Workshop Agenda

July 8	***Workshop – Day 1***	
8.30-9.30	**Registration of participants, Coffee**	
9.30-10.00	Welcome	***Adriaan van der Meer,*** ISTC Executive Director; ***Dr. Frank Schauff***, CEO, AEB; ***Marina Petrova,*** Meteoagency of Roshydromet, Director General; ***Academician Evgeny Gordeev***
	Section A. Volcano monitoring, Worldwide warning systems of volcanic activity	***Moderator: Konstantin Latynin, ISTC***
10.00-10.15	ISTC activity	***Prof. Waclaw Gudowski***, ISTC, Deputy Executive Director
10.15-10.30	Monitoring of volcanic activity and air traffic in the Russian Federation	***Kseniya Shavina.,*** Roshydromet, Duputy Head of Department
10.30-11.00	Monitoring of volcanic activity in Kamchatka	***Academician Evgeny Gordeev***, Director of the Institute of Volcanology and Seismology FEB RAS, Petropavlovsk-Kamchatsky, Russia
11.00-11.30	Condition and prospects of development of seismic supervision on active volcanoes of Kamchatka and Kuriles	***Dr. Alexey Malovichko***, Director of the Geophisical Servey, Obninsk, Russia
11.30-12.00	Monitoring and activity prediction of the Kamchatkan volcanoes using seismological data	***Dr. Victor Chebrov,*** Kamchatkan Branch of Geophysical Survey RAS, Petropavlovsk-Kamchatsky
12.00-13.15	Lunch	***"Marseilles" Restaurant***
	Section A.	***Moderator: Valentina Rudneva***
13.30-14.00	U.S. Volcanic Ash Monitoring and Prediction in Alaska	***Ms. Renee Tatusko***, NOAA/National Weather Service Headquarters Office of International Activities Silver Spring, Maryland, USA
14.00-14.25	Volcanic Activity in Canada	***Prof. Henry Mantsch,*** Department of Foreign Affairs, Ottawa, Canada, Senior Science Advisor, Canadian SAC Representative
14.25-14.50	Monitoring of the volcanic activity in the Kurile Islands	***Dr. Alexander Rybin***, Institute of Marine Geology & Geophysics FEB RAS, Chief of SVERT group, Russia
14.50-15.20	Geophisical observation research for volcano monitoring and magnitude early warning	***Prof. Hiroaki Takahashi***, Institute of Seismology and Volcanology, Hokkaido

		University, Sapporo, Japan
15.20-15.45	The new geophysical observatory in Northern Caucasus: modern system of geophysical instrumental observations in the Elbrus volcanic area	***Prof. Alexey Sobisevich,*** Institute of Earth physics, Head of Laboratory of Volcanology, Russia
15.45-16.00	Coffee	***ISTC Cafeteria***
	Section A.	***Moderator: Academician Evgeny Gordeev***
16.00-16.30	The IAVW (International Airways Volcano Watch) and the Eyjafjoll eruption	***Dr. Philippe Husson,*** VAAC Toulouse manager, Aviation Weather Forecasting Dept., Deputy Head, France
16.30-17.00	Application of experience in GTE FOD investigations to volcanic ash impact studies	***Dr. Igor Egorov,*** Deputy Head of Department, CIAM, Russia
17.00-17.30	Possibilities of volcanic plumes diagnostic and simulation	***Dr. Konstantin Moiseenko, Dr. Andrey Skorokhod,*** A.M.Obukhov Institute of Atmospheric Physics RAS, Moscow, Russia
17.30-18.00	Tephrostratigraphy of Kuril islands: evaluation of Holocene eruptive activity	***Prof. Mitsuhiro Nakagawa,*** Earth & Planetary System Science, Hokkaido Univ., Sapporo, Japan
18.00-18.30	Detection of volcanic ash caused by Icelandic Eyjafjallajokull volcano eruption on 14 April 2010 using dispersion models and lidar observations	***Dr. Vyacheslav Khattatov,*** Central aerologocal observatory, Moscow
18.30-19.00	Discussions	
19.00-20.00	Buffet Reception	***ISTC Cafeteria***
July 9	***Workshop - Day 2***	
08.30-09.00	Coffee	***ISTC Cafeteria***
	Section B. Standardized assessments of the risks related to volcanic eruptions, in particular for air traffic, Mitigation of the global/regional consequences of volcanic eruptions	***Moderator: Albert Gozal***
09.00-09.30	Using the Su-30(27) flying test bed for researching and impacting the volcano clouds.	***Dr. Anatoly Kvochur , FGUP "PRS"*** Gromov Flight Research Institute, Moscow, Russia – No presentation for publishing
09.30-10.00 Cancelled	A global framework for natural hazards and risks evaluation : a probabilistic approach for Volcanic Hazards	***Prof. Ahmed Mebarki,*** University Paris-Est, France - CANCELLED
10.00-10.30	Reduce the risk of aircraft encounters with volcanic ash clouds in the North Pacific region	***Dr. Olga Girina***, Institute of Volcanology and Seismology, Head of the KVERT, Kamchatka

10.30-11.00	Standardisation of volcano early warning and alert systems: lessons from the US Geological Survey and the 2010 Eyjafjallajokull ash crisis in the UK	***Ms. Carina Fearnley***, Aon Benfield UCL Hazard Research Centre, UK
11.00-11.30	Explosive volcanic eruption and other atmospheric aerosol catastrophes	***Prof. Alexander Ginzburg***, Deputy Director, A.M. Obukhov Institute of Atmospheric Physics, Russian Academy of Sciences
11.30-12.00	Ash fall impact: the consequences of eruptions, standardization of data gathering for risk assessment, and the need for holistic mitigation solution	***Ms. Victoria Sword-Daniels***, UCL Earthquake and People Interaction Centre (EPICENTRE), UK
12.00-13.15	Lunch	***"Marseilles" Restaurant***
	Section C. Ongoing and planned research project.	***Moderators: Academician Evgeny Gordeev, Prof. Hiroaki Takahashi, Dr. Philippe Husson, Prof. Waclaw Gudowski***
13.30-14.00	Forecast and dynamics of eruptions of the Nothern group of volcanoes (Kamchatka) for promotion of safety to population and reducing their impact on the environment	***Academician Evgeny Gordeev,*** Director of the Institute of Volcanology and Seismology FEB RAS, Petropavlovsk-Kamchatsky, Russia
14.00-14.30	Satellite and ground-based monitoring of volcanic activity	***Prof. Valery. Sorokin***, IZMIRAN, Troitsk, Moscow reg., Russia
14.30-15.00	Pleistocene - Holocene late collision volcanism of the territory of Armenia and volcanic hazard assessment.	***Dr. Khachatur Meliksetian,*** Senior Research Scientist, Laboratory of Volcanology, Institute of Geological Sciences, Armenian National Academy of Sciences
15.00-15.30	Flying research and test-control laboratory for a remote monitoring of the Earth surface and atmosphere.	***Dr. Artashes Arakelyan*** , ECOSERV Remote Observation Centre Co. Ltd., Yerevan, Armenia
15.30-15.40	Ecological and geodynamic monitoring of hazardous natural and anthropogenic objects based on comprehensive interpretation of satellite and surface data	***Prof. Valentin Mikhaylov,*** Institute of Physics of the Earth, Moscow, Russia
15.40-16.10	**Discussions and closing of the workshop**.	***Panel: M. Petrova, H. Takahashi, P. Husson, E. Gordeev, W. Gudowski***

RESOLUTION

OF THE INTERNATIONAL WORKSHOP

"Worldwide System of Early Warning against Volcanic Activity and Mitigation of Global/Regional Consequences of Volcanic Eruptions"

Moscow, Russia, 8-9 July 2010

European community was unprepared to deal with volcanic ashes phenomena on such scale and duration. There is little scientific evidence in this area, most of the data is missing, there is no available risk assessment to enable policy makers to react to scientific evidence. Actions must be taken now to ensure that other unforeseen disasters are better planned for. The scientific community needs to be more proactive and the response from scientists must be timely and tailored to the needs of policy makers. Multidisciplinary approach is essential for success of these activities.

To sum up presentations, made during the Workshop by the leading experts in volcanology from Russia, European Union, US, Japan, Canada and Armenia, and contributions by representatives of ROSGIDROMET, ROSAVIATION and other relevant organizations and ISTC management, and subsequent discussions, the Workshop participants wish to come up with the following recommendations:

1. Appreciating the ISTC for its activities and recognizing the relevance of the further strengthening of international science and technology cooperation to ensure global and regional security during volcanic eruptions, consider worthwhile to expand the ISTC involvement in this area through support of research and development and the related activities in Russia/CIS.

2. The Workshop notes a high scientific potential of experts in volcano research and availability of highly-skilled staff, which opens up prospects for increased involvement of the leading organizations in the joint international projects, also through the attraction of the ISTC's funds and its organizational resources.

Further research should be conducted on the basis of co-funding by governmental agencies and through attracting private investments, including private and public partnership as a format of cooperation.

3. Considering that even minor eruptions may cause incommensurable economic losses, recommend that the public authorities seek to promote a closer and properly regulated interaction between services in charge of volcano monitoring and those ensuring safety of air traffic, such as national meteorological services and aviation authorities. It must be recognized that volcanologists, meteorologists and the aviation authorities all provide a critical function.

In this context it is recommended that up-to-date technical systems of active volcano monitoring using surveillance equipment of ground and space deployment and methodic support of the monitoring process be implemented in a broader way, meanwhile improving the methods of volcanic eruption risk prediction and evaluation.

4. Recommend that the ISTC management put the research, complying with the subject and goals of projects and programs in the sphere of global and environmental security, implemented by the states, represented at the workshop, on the list of priorities.

In doing so a special attention should be paid to:

- Development of technologies and equipment;

- Assessment of the impact of volcanic ashes on aviation engines and environment.
- Development of new analytical methods and instrumentation to provide a high-quality base to be used for analyzing the condition of the environment and for conducting basic and applied research;
- Basic research of reasons, mechanisms and consequences of the environmental changes, provoked by volcanic eruptions;
- Development of equipment and technologies, ensuring monitoring of volcanic eruptions.
- Drafting recommendations on the risk mitigation for the population in areas of manifested volcanic activity;
- Development of methods and techniques for prediction of volcanic eruption product transfer and precipitation in the atmosphere, including chemically active changes. Investigate into possible precipitation of volcanic clouds by aircrafts;
- Construction of a pilot satellite system for monitoring precursors of volcanic eruptions and the related air transport risks;
- Promote training and procedures testing through exercises involving volcanologists, meteorologists, civil aviation traffic management in cooperation with the Volcanic Exercises Steering Group (VOLCEXISG) of the International Civil Aviation Organization (ICAO).

5. To implement the abovementioned recommendations and to ensure coordination of activities, related to the adopted Workshop follow-up program it is suggested that a Task Force be set up to be composed of representatives from the ISTC, public authorities from the states, represented at the Workshop and research organizations.

6. Request that the Workshop organizers prepare and publish the Workshop Proceedings, and put presentations to the ISTC website.

7. Recommend the ISTC to provide support in organization of a conference on volcanic ashes in the US (Alaska) in May 2011.

Workshop Co-Chairs:

Acad. Gordeyev E.I.
Director
Institute of Volcanology and Seismology

Prof. W. Gudowski
Deputy Executive Director
International Science and Technology Center

“Worldwide early warning system of volcanic activities and mitigation of the global/regional consequences of volcanic eruptions”, Moscow, Russia, July, 8-9

Prof. Waclaw Gudowski

Deputy Executive Director

ISTC

8-9 July 2010

Few words about ISTC

www.istc.ru

ISTC Core Programs and Services

Regular Project Program

Partner Project Program

Sustainability and Commercialisation Program

Patenting Program

Competence Building Program

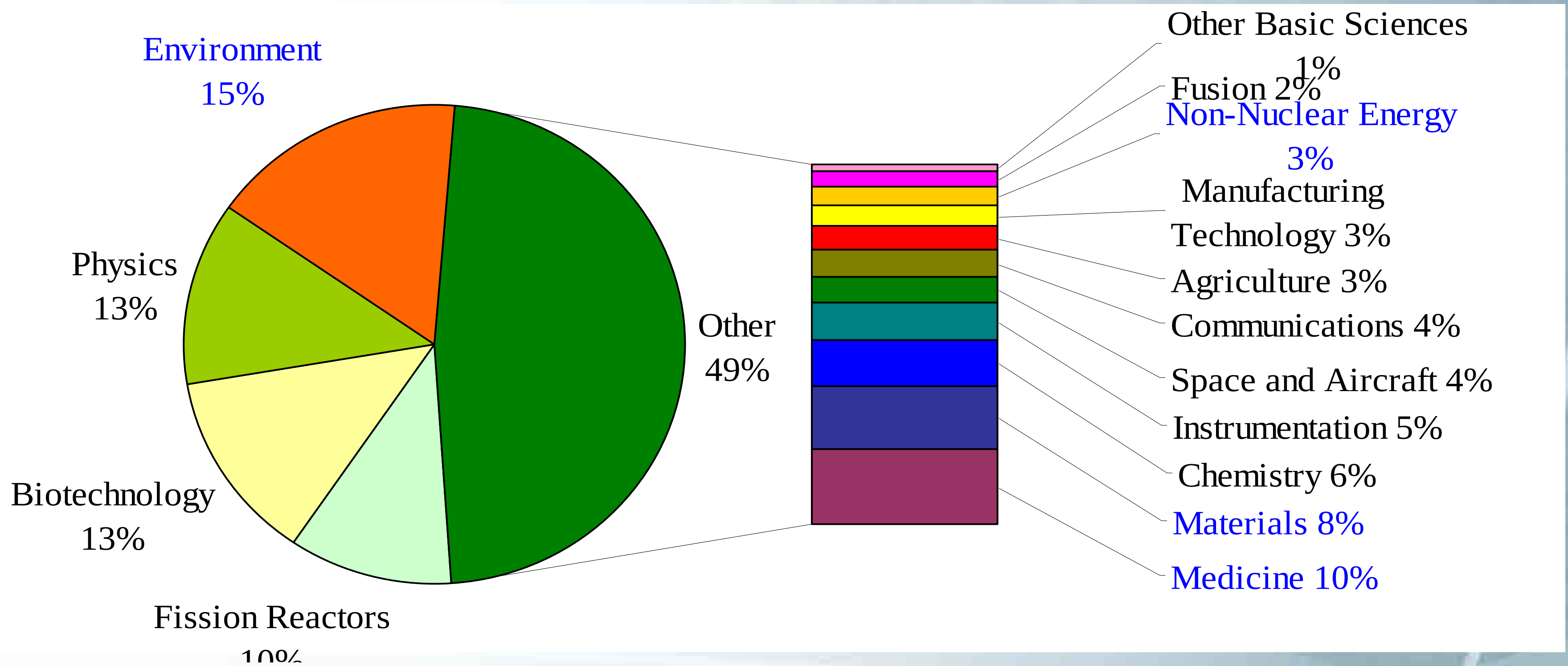
Workshops and Scientific Seminars

Travel Grants

Partner Promotion Program

ISTC Core activity: realizing the projects in Science and Technology

Over 2650 projects with ~850 M$ funding



Europe 'totally unprepared' for volcanic ash

- Roland Schenkel (head of the European Commission's Joint Research Centre) at the EuroScience Open Forum (ESOF) in Turin, warned that Europe was "completely unprepared" for the incident.

Schenkel's assessment

- Many previous instances [of aircraft flying through volcanic ash] were known," .
- "In some instances engines stopped and when the planes came out the engines started again. **But we did not ask questions about what happens if such an incident would block travel between Europe and the US.**

  "There was little scientific evidence. Most of the data was missing. There was no available risk assessment to enable policy makers to react to scientific evidence."

Schenkel's assessment

- A European Commission recently called for better modelling of outcomes and systems to measure ash concentration. And engine manufacturers are currently conducting experiments to build up evidence in the hope of avoiding a repeat of the economic damage caused by the eruption.

- **Action must be taken now to ensure that other unforeseen disasters are better planned for.**

- "The scientific community need to be more proactive,"
- **"The response from scientists must be timely and tailored to the needs of policy makers. Horizon scanning is essential,"**

An ambition of our workshop is to addresses most of the concerns expressed by scientific community.

ISTC is a very suitable platform for:
"**Interdisciplinary, international approach which is essential**"

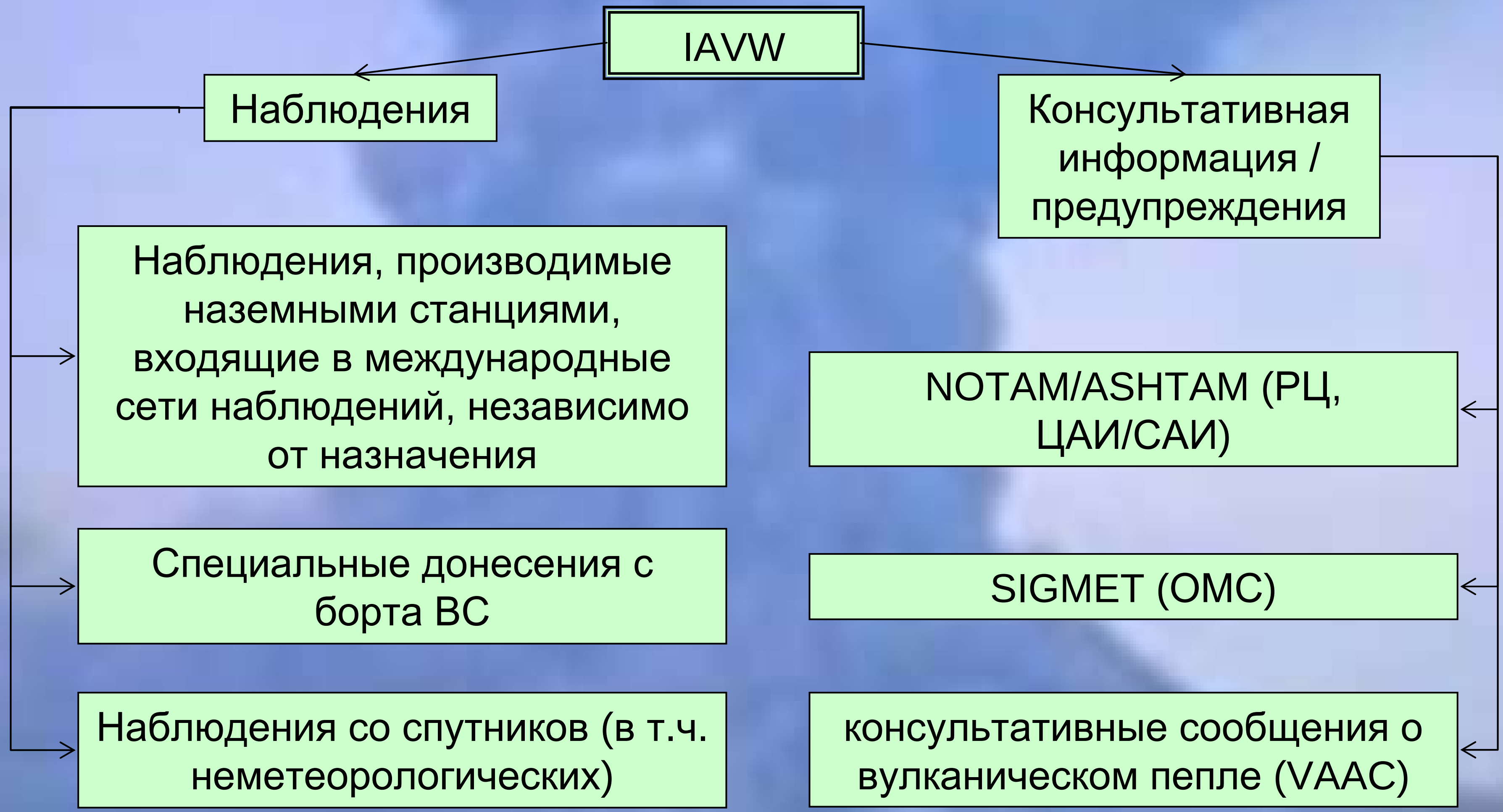
Мониторинг вулканической деятельности и организация предупреждений о ней в облаках вулканического пепла в РФ

Зам. начальника отдела
АНО «Метеоагентство Росгидромета»
К.К. Шавина

Координация действий ответственных сторон

Служба слежения за вулканическим пеплом (IAVW).

Задачей деятельности ее участников является обеспечение контроля за облаками вулканического пепла, предупреждение пилотов, и изменение маршрутов полета в обход облаков вулканического пепла.



Основные «участники» IAVW:

1. Вулканологические обсерватории

2. Авиационные метеорологические станции/центры

3. Экипажи воздушных судов

4. Органы метеорологического слежения

5. Органы единой системы организации воздушного движения

6. Консультативные центры по вулканическому пеплу

7. Всемирные центры зональных прогнозов

Основные положения, определяющие функциональные рамки созданной ICAO Службы слежения за вулканической деятельностью (IAVW) представлены в **Справочнике по службе слежения за вулканической деятельностью на международных авиатрассах (IAVW)** - ICAO Doc 9766 – AN/968.

Основным руководящим документом ICAO, содержащим описательный и инструктивный материал по вулканическому пеплу является **«Руководство по облакам вулканического пепла, радиоактивных материалов и токсических химических веществ» (** Doc 9691 ICAO, изд.2, 2007 г.) **.**

В Doc. 9691 ICAO отмечено, что «первой линией защиты являются вулканологические обсерватории, которые располагают сетью датчиков, размещенных вблизи вулканов и должны анализировать и интерпретировать весь объем данных поступающих на непрерывной основе от всех датчиков и передавать по заранее установленным каналам связи согласованному кругу абонентов».

Вулканологические обсерватории первыми наблюдают за вулканической деятельностью и оперативно передают информацию абонентам по заранее установленным схемам (***соответствующим ACC, MWO и VAAC)***.

Авиационные метеорологические станции/центры, находящиеся в пределах прямой видимости от вулканов, выпускают сводку о вулканической деятельности. В случае ухудшения видимости за счет распространения на аэродроме вулканического пепла, данное явление включается в местные сводки и сводки METAR/SPECI, а также, при необходимости, в прогноз по аэродрому (TAF).

С борта воздушных судов (ВС) проводятся специальные наблюдения, которые передаются органам ОВД, которые, в свою очередь, незамедлительно направляют их соответствующему органу метеорологического слежения или аэродромному метеорологическому органу. Кроме того, по прибытии ВС на аэродром экипаж ВС сообщает в метеорологический орган устную информацию о вулканической деятельности, наблюдавшихся во время полета.

Органы метеорологического слежения (ОМС/MWO) при получении информации о вулканической деятельности составляют и выпускают информацию SIGMET об облаке вулканического пепла. MWO собирают донесения, полученные с борта воздушных судов через органы ОВД и направляют другим метеорологическим органам в соответствии со схемой обмена метеорологической информацией, а также используют для последующего выпуска сообщений SIGMET.

Органы единой системы организации воздушного движения составляют и выпускают информацию NOTAM/ASHTAM и направляют заинтересованным пользователям в соответствии со схемой обмена информации

Районные диспетчерские центры передают информацию о вулканической деятельности находящимся в полете воздушным судам, которые могут быть затронуты облаком вулканического пепла, и информировать РДЦ в соответствующих соседних РПИ, MWO и VAAC.

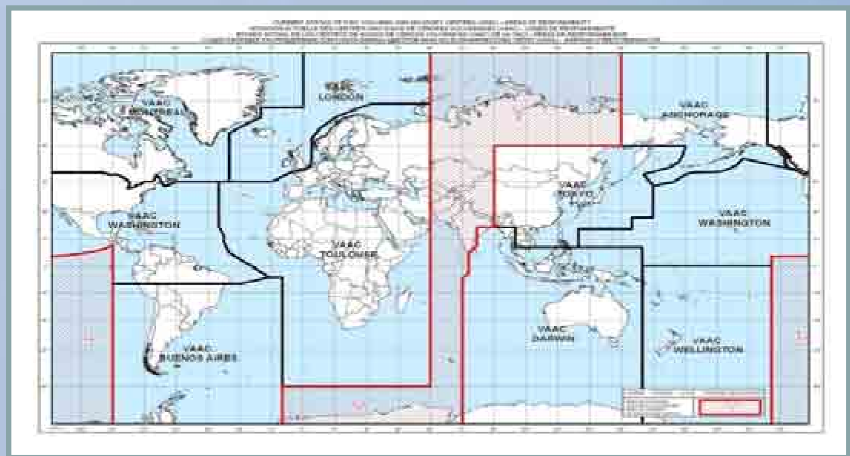
Консультативные центры по вулканическому пеплу (VAAC) по получении информации о вулканическом извержении и/или появлении облака вулканического пепла должны:

– задействовать модель траектории движения/рассеивания вулканического пепла;

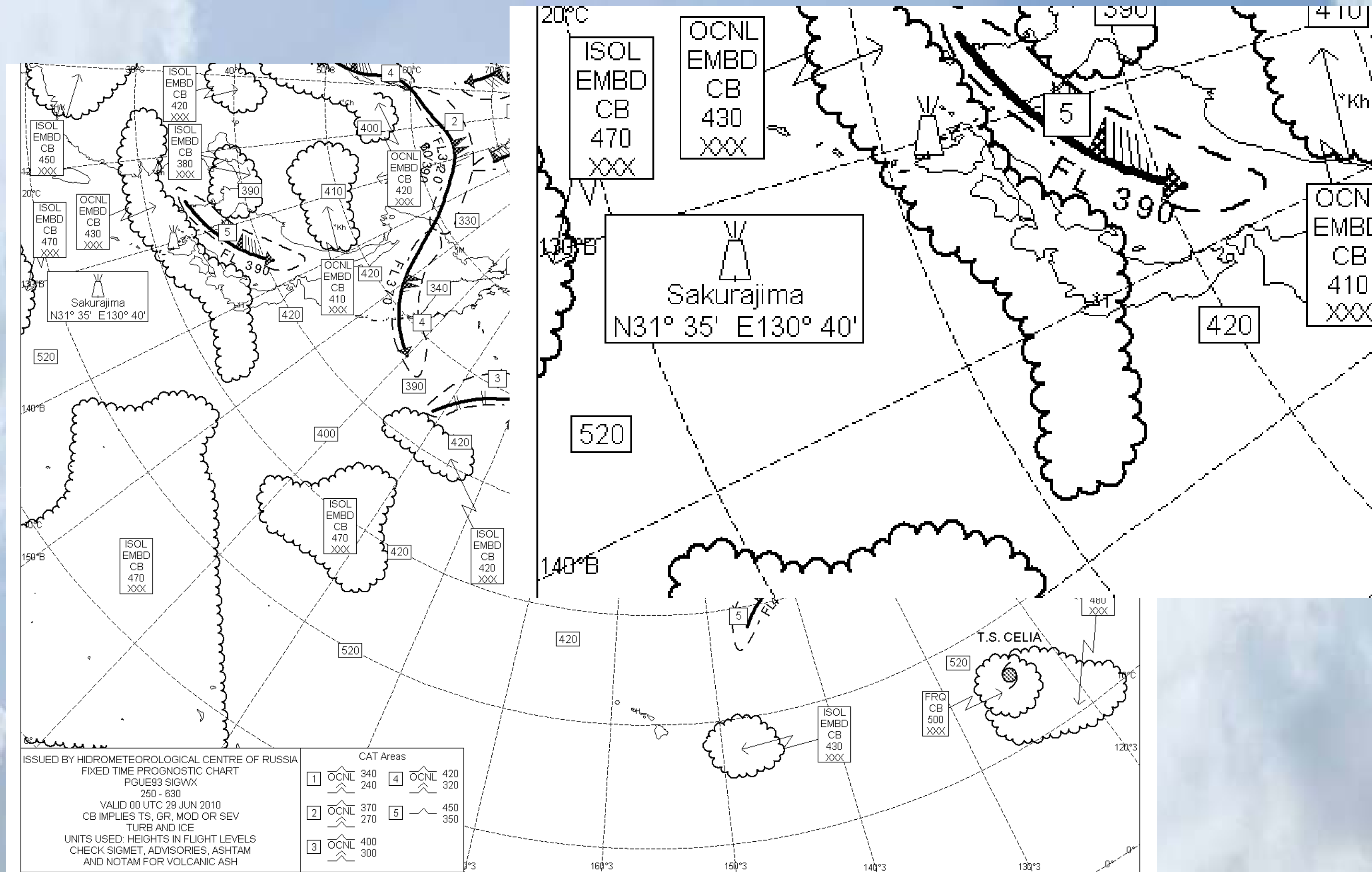
– изучить спутниковые и другие данные с целью оценки возможности определения облака вулканического пепла и масштабов его распространения;

– подготовить и выпустить консультативную информацию о масштабах распространения и прогнозируемой траектории движения облака вулканического пепла в виде сообщения и/или графического изображения для передачи соответствующим MWO, ACC и авиакомпаниям, функционирующим в районе ответственности VAAC,

– вести контроль за последующей информацией, поступающей со спутника, для оказания помощи в отслеживании движения облака вулканического пепла;



Всемирные и региональные центры зональных прогнозов при получении информации о вулканических извержениях включают стандартный символ «вулканическое извержение» в прогнозы особых явлений погоды (SIGWX), тем самым напоминая пилотам о необходимости проверять сообщения SIGMET, относящиеся к данному району.



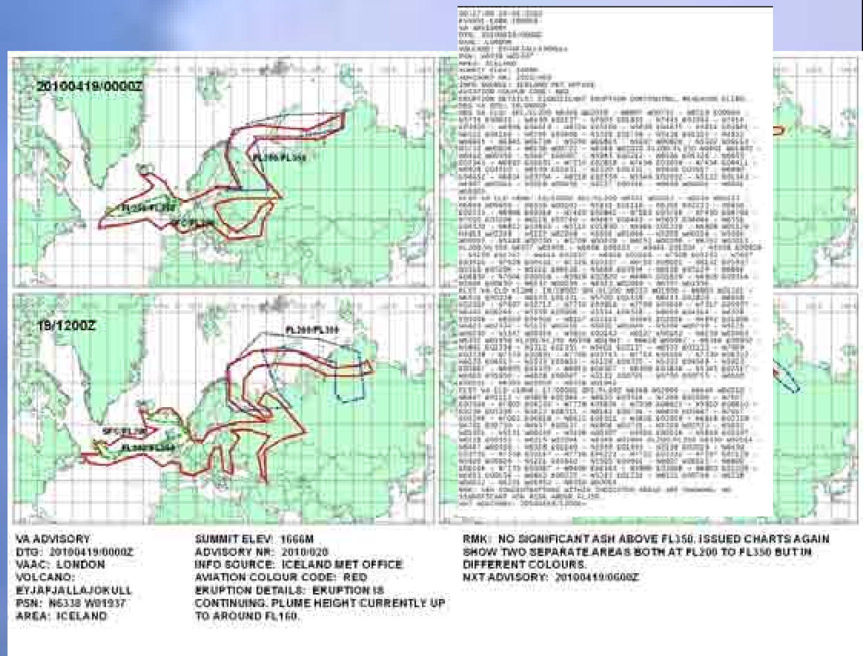
Краткий анализ реагирования ответственных организаций РФ в условиях вулканического извержения вулкана Эяфьятлайокуль

В Российской Федерации определены 49 органов метеорологического слежения (ОМС), 22 из них закреплены ИКАО для зоны ответственности VAAC Тулуза.

Первое консультативное сообщение об извержении вулкана Эяфьятлайокуль было получено от VAAC Лондон в 09:48:48 14.04.2010 г. Позже было получено сообщение от VAAC Тулуза, в котором рекомендовалось использовать информацию VAAC Лондон.

Первое SIGMET сообщение об облаке вулканического пепла выпустил ОМС Пулково.

Экипажи воздушных судов на высотах от 800 м до 11 600 м по Северо-Западному и Центральному регионам России отмечали серые и полупрозрачные полосы, которые были интерпретированы как вулканический пепел.



Наблюдатели Домодедово в 02:30 UTC 16.04.2010 г. Выпустили сводку по аэродрому (METAR) о наблюдаемом вулканическом пепле на аэродроме Домодедово.

Сообщения SIGMET и сводки METAR о вулканическом пепле передавались авиаметеоподразделениями Росгидромета в Банк авиационных метеорологических данных (БАМД) Росгидромета и в международный обмен ОРМЕТ данными. В первую очередь, указанная информация направлялась непосредственно авиационным пользователям РФ (руководству и диспетчерскому составу районных и зональных центров.

Информация SIGMET об облаке вулканического пепла выпускались для FIR Мурманск, Архангельск, Амдерма, Великие Луки, Котлас, Санкт-Петербург, Петрозаводск, Москва, Вологда, Воркута, Калининград, Киров, Нарьян-Мар, Пенза, Пермь, Ростов-на-Дону, Самара, Сыктывкар.

Росгидромет и его ОМС предприняли все необходимые меры по оповещению:

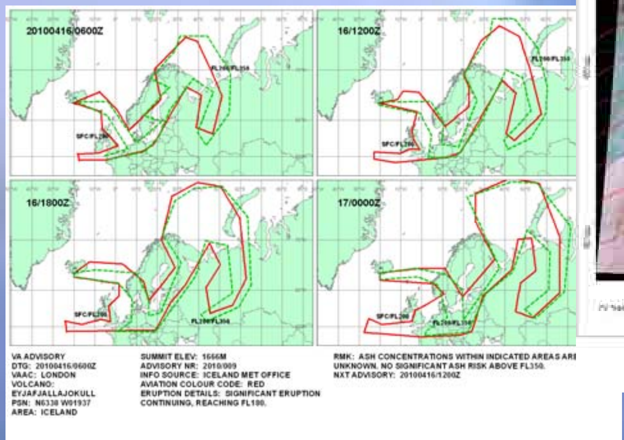
- органов Единой системы организации воздушного движения Российской Федерации;
- должностных лиц Росавиации, участвующих в принятии решений по производству полетов воздушных судов, в том числе литерных рейсов;
- гидрометслужбы Вооруженных сил Российской Федерации;
- Министерства Российской Федерации по делам гражданской обороны, чрезвычайным ситуациям и ликвидации последствий стихийных бедствий (Emergency Control Ministry of Russia).

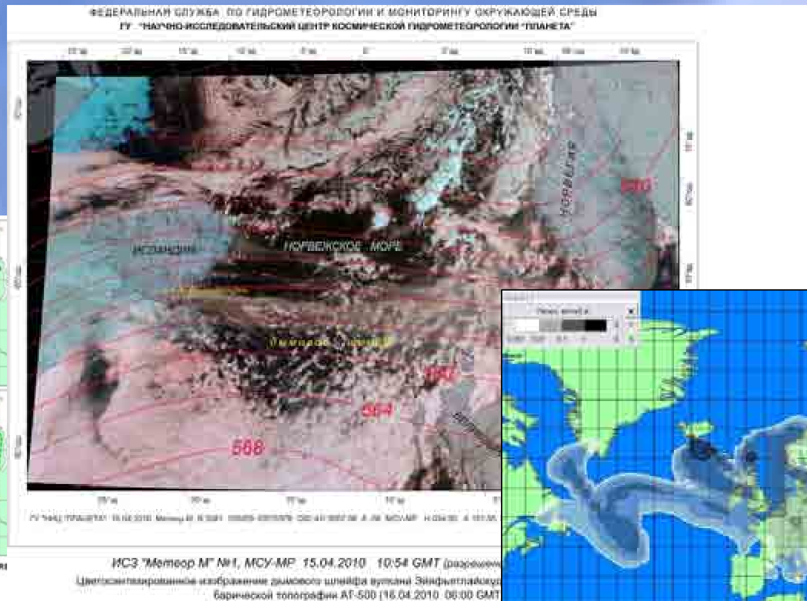
Органы управления воздушным движением Росавиации информировались в оперативном режиме для принятия ими решений по вводу ограничений полетов воздушных судов и закрытию воздушного пространства РФ.

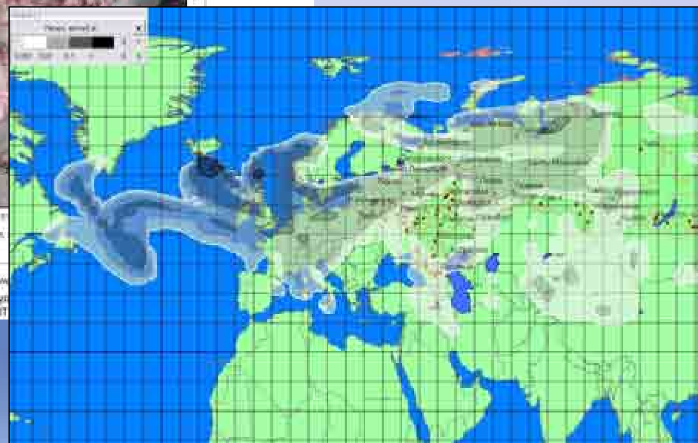
Работниками АМСГ регулярно проводились консультации руководящего, диспетчерского и летного составов. Обращалось особое внимание на наличие в полетной информации действующих по маршрутам полетов сообщений SIGMET о вулканическом пепле.

Таким образом, представляемая пользователям информация об извержении вулкана Эяфьятлайокуль и распространении связанного с этим извержением облака вулканического пепла, основывается на данных VAAC Лондон, бортовой погоды, получаемой от экипажей воздушных судов, а также ИСЗ от НИЦ «Планета» Росгидромета.

Кроме этого, организациями Росгидромета были приняты меры по возможному обнаружению облаков вулканического пепла с помощью методов дистанционного зондирования атмосферы.







Организационные мероприятия, предпринимаемые в РФ

Принимая во внимание шаги, предпринятые международными организациями по совершенствованию информации о вулканической деятельности, в Российской Федерации были проведены мероприятия, направленные на координацию работы ведомств:

Определена структура, назначенная для исполнения функций вулканологической обсерватории в соответствие с принципами ICAO и обеспечивающая мониторинг вулканов Дальнего Востока (Институт Вулканологии и Сейсмологии Дальне-Восточного отделения)

Готовится Соглашения между Полномочным Метеорологическим органом (Росгидромет), Вулканологическим органом (РАН) и Полномочным Аэронавигационным органом (Росавиация) - в соответствии с положениями Справочника по службе слежения за вулканической деятельностью на международных авиатрассах (IAVW) - ICAO Doc 9766..

Кроме того, предполагается организовать Консультативный центр по вулканическому пеплу в РФ на базе ГУ НПО «Тайфун»

В соответствии с Приложением 3 ICAO к Конвенции о международной гражданской авиации «Метеорологическое обеспечение международной аэронавигации» необходимо, чтобы Государство, которое берет на себя ответственность за создание VAAC обеспечивало, чтобы данный центр:

a) следил за соответствующими данными спутников;

b) задействовал численную модель определения траектории перемещения/рассеяния вулканического пепла.

c) выпускал консультативную информацию относительно мощности и прогнозируемого перемещения облака вулканического пепла для:

- ОМС,РДЦ и ЦПИ;
- других VAAC;
- всемирных центров зональных прогнозов,
- международных банков данных OPMET,
- органов международных NOTAM,
- центров эксплуатации спутниковых систем рассылки данных;
- авиакомпаний, запрашивающих консультативную информацию.

Кроме того, функцией метеорологических органов при вулканических извержениях является мониторинг концентрации вулканического пепла в атмосфере и предупреждение авиационных пользователей при переходе значений концентрации через установленные пороговые значения, которые будут делить воздушное пространство на зоны, запрещенные для полетов, зоны ограниченные для полетов во времени и зоны расширенных возможностей.

Для обеспечения мониторинга концентрации вулканического пепла в атмосфере необходимо:

– Провести исследование существующих инструментальных методов наблюдений загрязнения атмосферы продуктами вулканических извержений и разработать технологию наблюдений с использованием радиолокационных, спутниковых, лазерных и др. методов;

– Усовершенствовать модели переноса загрязнения в атмосфере применительно к извержениям вулканов;

– Разработать методы определения и прогноза абсолютной концентрации пепла с учетом пороговых значений допустимой концентрации пепла (с точки зрения авиационных пользователей и эксплуатантов);

Также необходимо провести комплекс мер по координации действий в части производства глобальных наблюдений за облаками вулканического пепла, обмена этой информацией в квази-оперативном режиме.

Спасибо за внимание

Системы наблюдений и слежение за активностью вулканов на Камчатке

Е.И. Гордеев, Институт вулканологии и сейсмологии ДВО РАН


ВУЛКАНЫ
КАМЧАТКИ

В Курило-Камчатском регионе насчитывается 69 действующих вулканов, что составляет до 15 % от общего количества вулканов “Тихоокеанского огненного кольца”.
Ежегодно в состоянии извержения находилось от 3 до 5 вулканов.

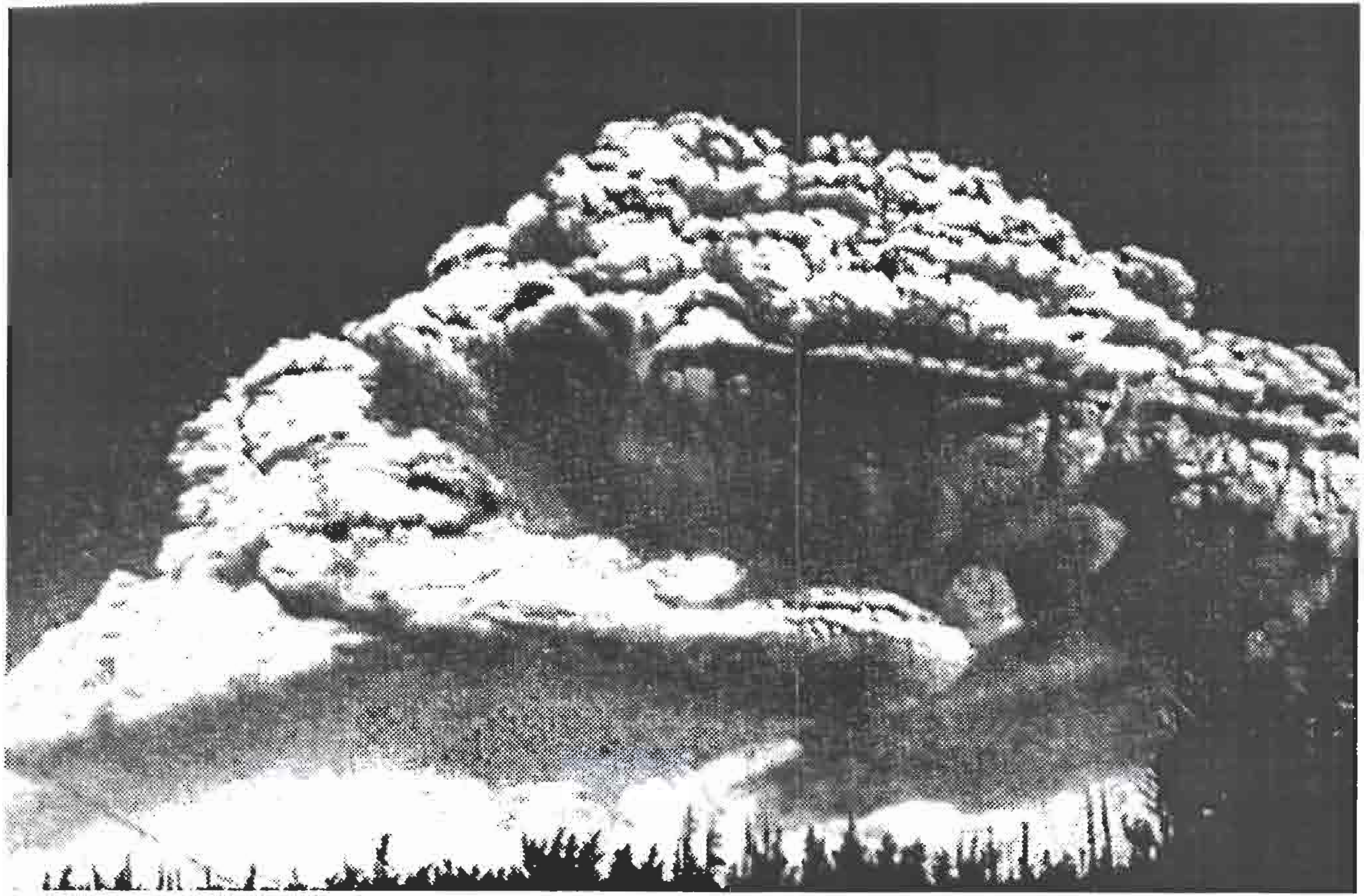
Суммарный объем изверженных продуктов за последние 5 лет составил около 0,5 км^3.
Подавляющий вклад внесли экструзивно-эксплозивные извержения вулкана Шивелуч (~ 0,3 км^3), Ключевского (~ 0,06 км^3), Безымянного (~ 0,05 км^3) и последнее эксплозивное извержение Пика Сарычева (не менее 0,1км^3).

Для вулканов Курило-Камчатской дуги общая продуктивность составляет порядка 20% от объема изверженного материала вулканами земного шара.

Shiveluch is the northern and more active volcano in Kamchatka



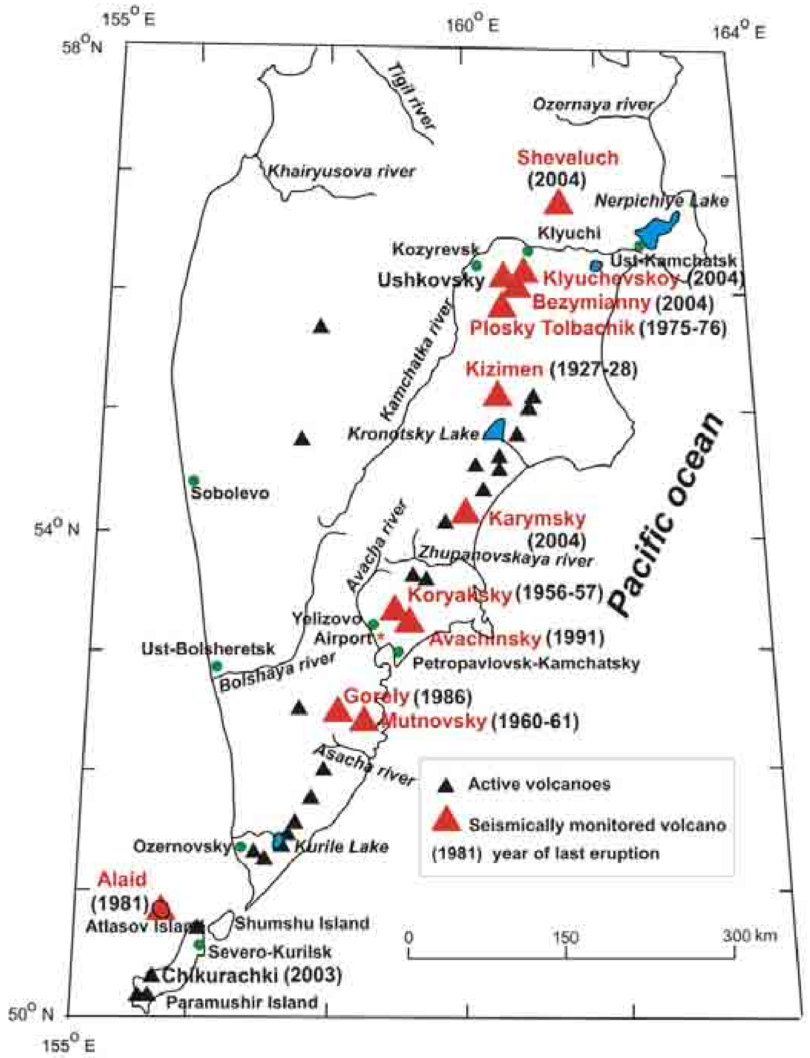

01 Oct 1994
Kliuchevskoi Volcano
from Space Shuttle




К

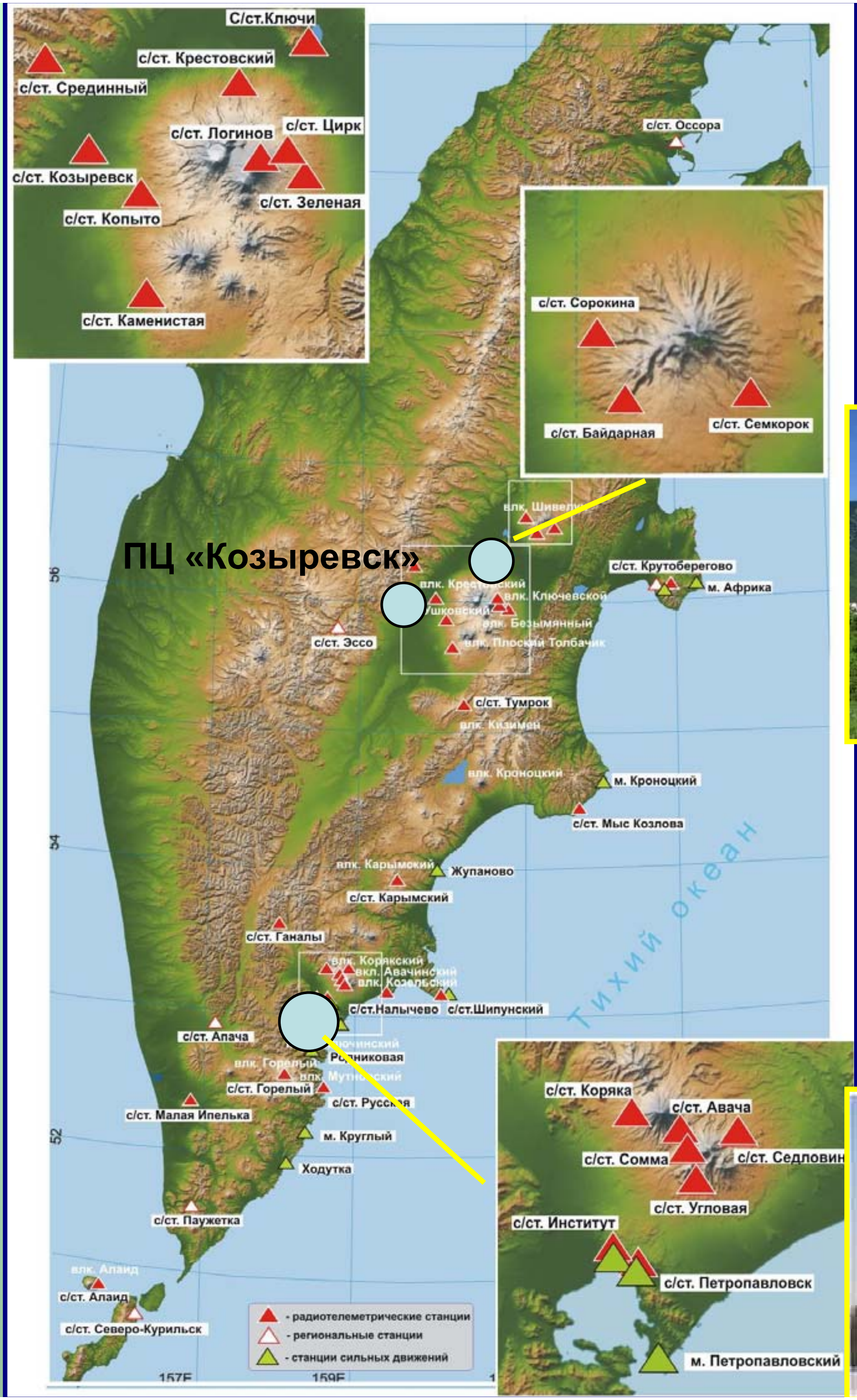

10.01.2009

Контроль состояния вулканов



Active volcanoes of Kamchatka and the Northern Kurile Islands

- На 13 вулканах сейсмические наблюдения
- Визуальные наблюдения, сообщения пилотов, 5 видеосистем с непрерывной передачей изображений вулканов
- Спутниковые наблюдения
- Ежедневные и еженедельные сообщения
- Оперативные сообщения об опасности извержений



Приемные центры радиотелеметрических данных

ПЦ «Ключи»

Центр сбора и обработки данных «Петропавловск»

Фактографическая база данных «Активность вулканов Камчатки»

Обобщает результаты обработки сейсмических, спутниковых, визуальных и видео наблюдений за наиболее активными вулканами Камчатки.

На основании зарегистрированных данных производится оценка состояния вулканов Камчатки и определяется степень их опасности.

База содержит информацию о состоянии вулканов с февраля *2000* г.

Обновление производится ежедневно.

Адрес в *Internet:*
http://emsd.iks.ru/~ssl/monitoring/main.htm.

Мониторинг вулканической [illegible]

Лаборатория Исследований Сейсмической и Вулканической Активности, КОМСП ГС РАН

(отладочная версия, автор проекта - Сенюков С.Л., e-mail: ssl@emsd.iks.ru)

Последняя информация

Архив
2009
Март
Февраль
Январь
2008
Декабрь
Ноябрь
Сентябрь
Август
Июль
Июнь
Май
Апрель
Март
Февраль
Январь

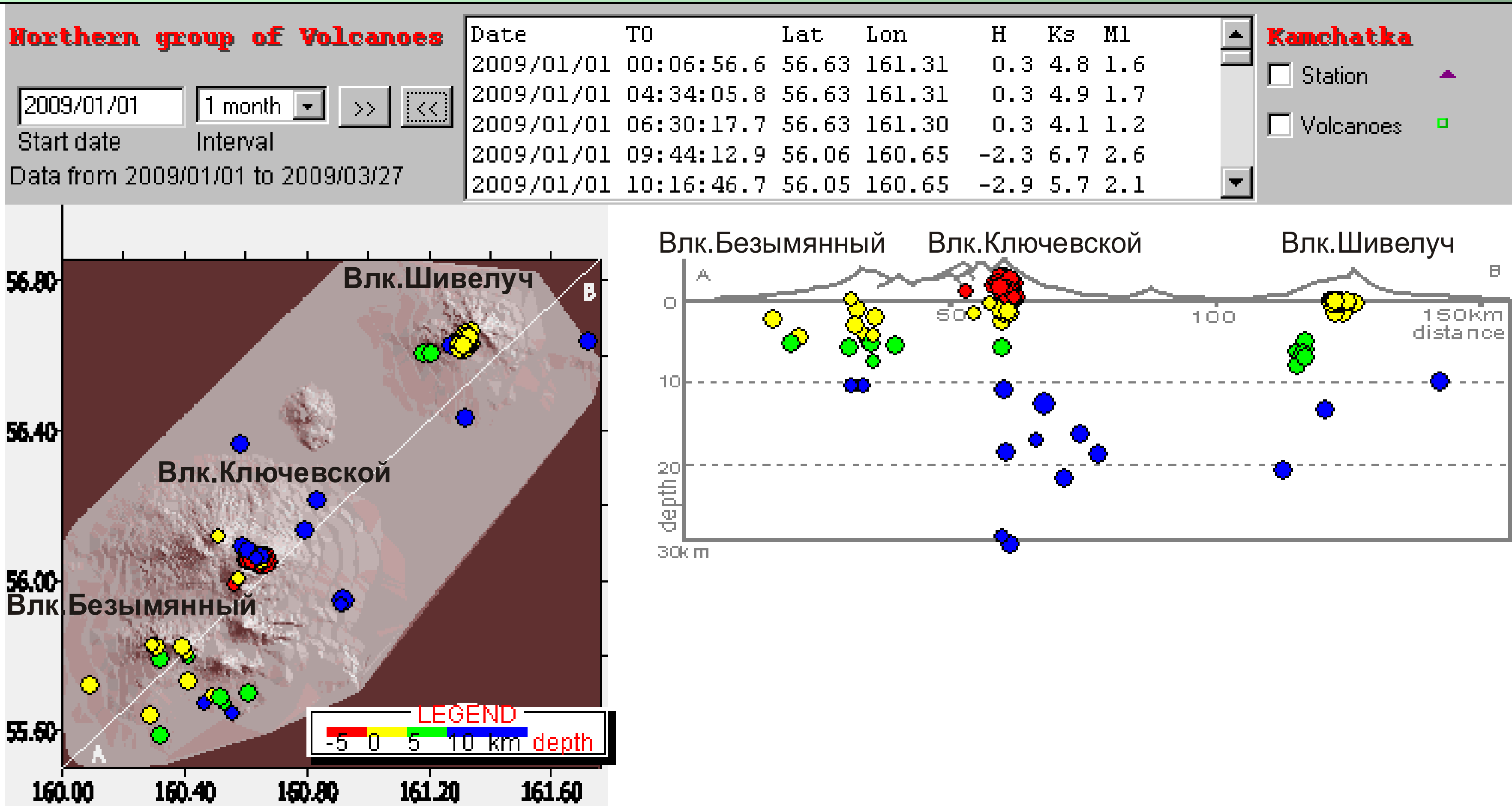
ОКТЯБРЬ 2008

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Шивелуч	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	ж	[illegible]
Ключевской	ж	ж	ж	ж	ж	ж	ж	ж	ж	ж	ж	ж	ж	ж	ж	ж	ж	ж	ж	ж	ж	ж	ж	ж	ж	ж	ж	ж	ж	ж	ж
Безымянный	з	з	з	з	з	з	з	з		з	з	з	ж	з	з	з	з	з	з	з											
Толбачик	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з
Кизимен	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з
Карымский	ж	з	ж	ж	[illegible]	ж	ж	[illegible]	[illegible]	ж	[illegible]	ж	ж	ж	[illegible]	з	ж	з	з	[illegible]		ж	ж	ж	ж	ж	ж	ж	ж	ж	ж
Корякский	з	з	ж	з	з	з	з		з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	ж	з	ж	з	з	з
Авачинский	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з	з
Мутновский	ж	ж	ж	ж	ж	ж	ж	ж	з	з	ж	ж	ж	ж	ж	ж	ж	ж	ж	ж	з	ж	ж	ж	ж	ж	ж	ж	ж	ж	ж
Горелый	ж	ж	ж	ж	ж	ж	ж	ж	з	з	ж	ж	ж	ж	ж	ж	ж	ж	ж	ж	з	ж	ж	ж	ж	ж	ж	ж	ж	ж	ж
Алаид	з	з	з	з	з	з	з	з	з		з				з	з	з	з	з	з			з	з		з	з	з	з	з	

Автор ЛИСВА КОМСП, ответственный - Сенюков С.Л.
Адрес: ssl@emsd.iks.ru

Сейсмичность Северной группы вулканов

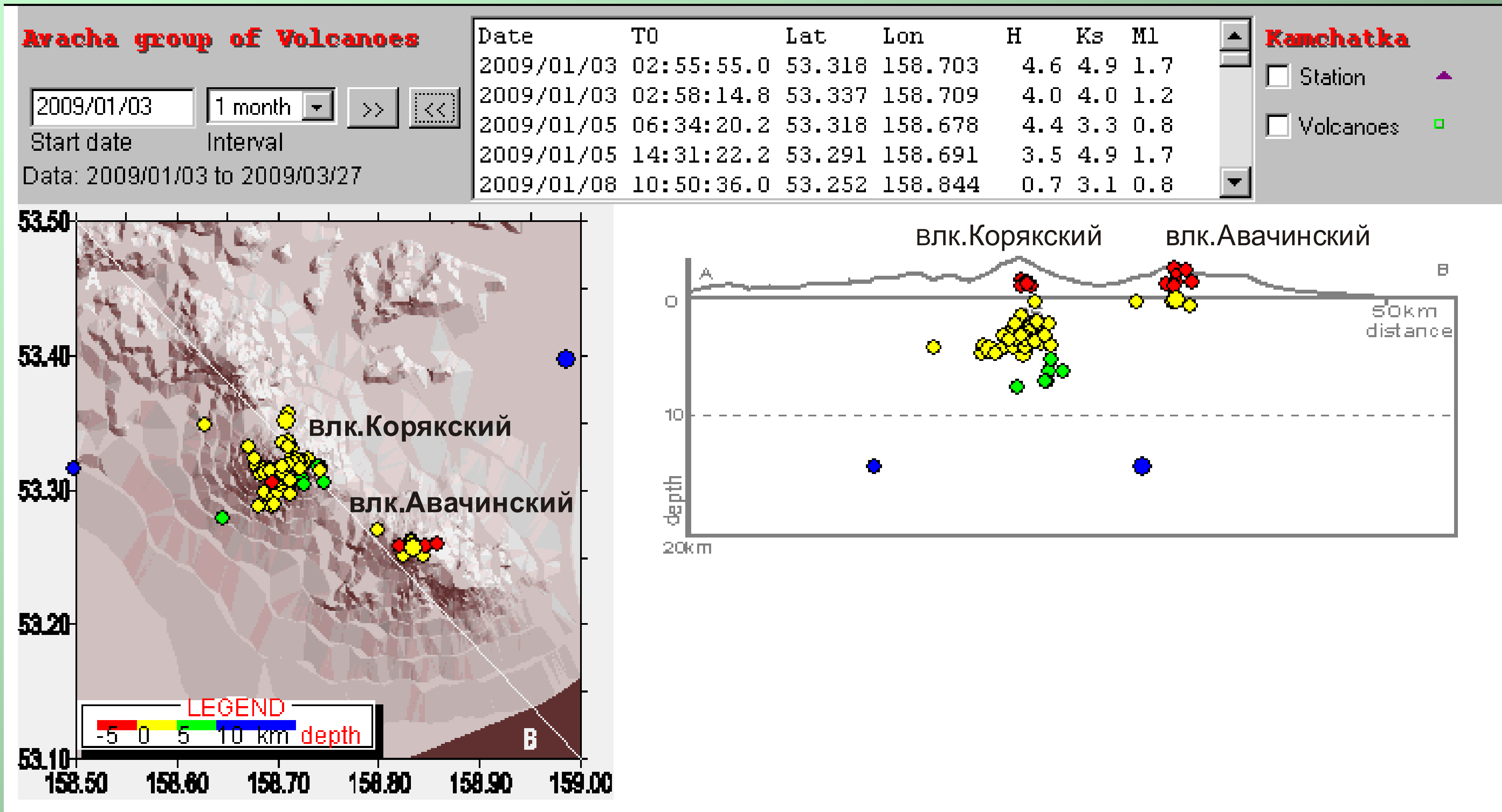
Http://data.emsd.iks.ru/klyquake



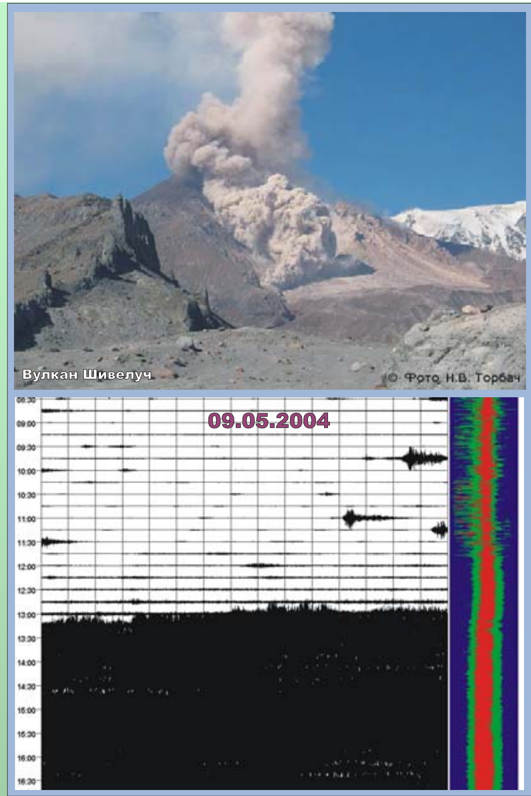
Date	T0	Lat	Lon	H	Ks	Ml
2009/01/01	00:06:56.6	56.63	161.31	0.3	4.8	1.6
2009/01/01	04:34:05.8	56.63	161.31	0.3	4.9	1.7
2009/01/01	06:30:17.7	56.63	161.30	0.3	4.1	1.2
2009/01/01	09:44:12.9	56.06	160.65	-2.3	6.7	2.6
2009/01/01	10:16:46.7	56.05	160.65	-2.9	5.7	2.1

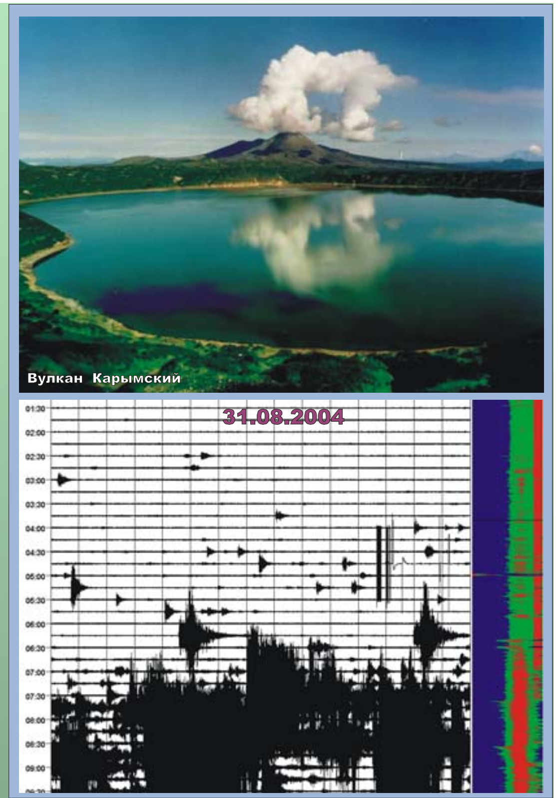
Сейсмичность Авачинской группы вулканов

Http://data.emsd.iks.ru/avhquake

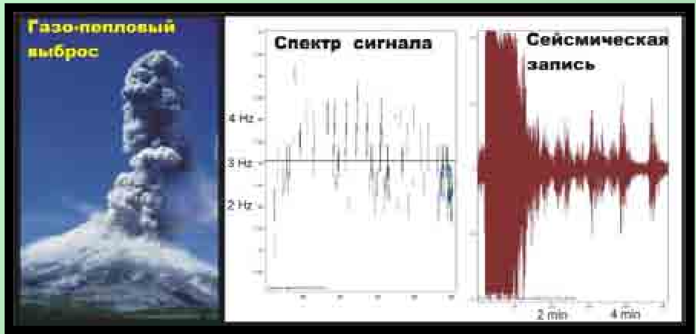


КОНТРОЛЬ ВУЛКАНИЧЕСКИХ ИЗВЕРЖЕНИЙ ПО СЕЙСМИЧЕСКИМ ДАННЫМ

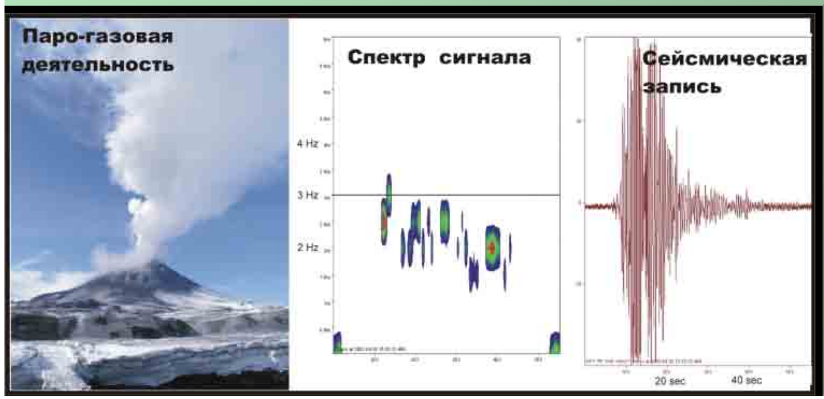


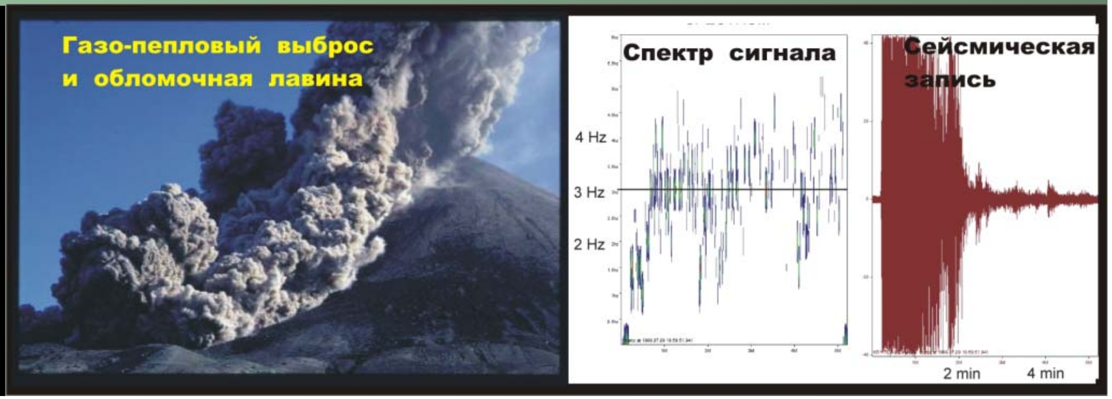


Распознавание происходящих на вулкане событий по сейсмическим данным



Создается база данных, включающая снимки зафиксированных на вулканах явлений и соответствующих им сейсмических записей.





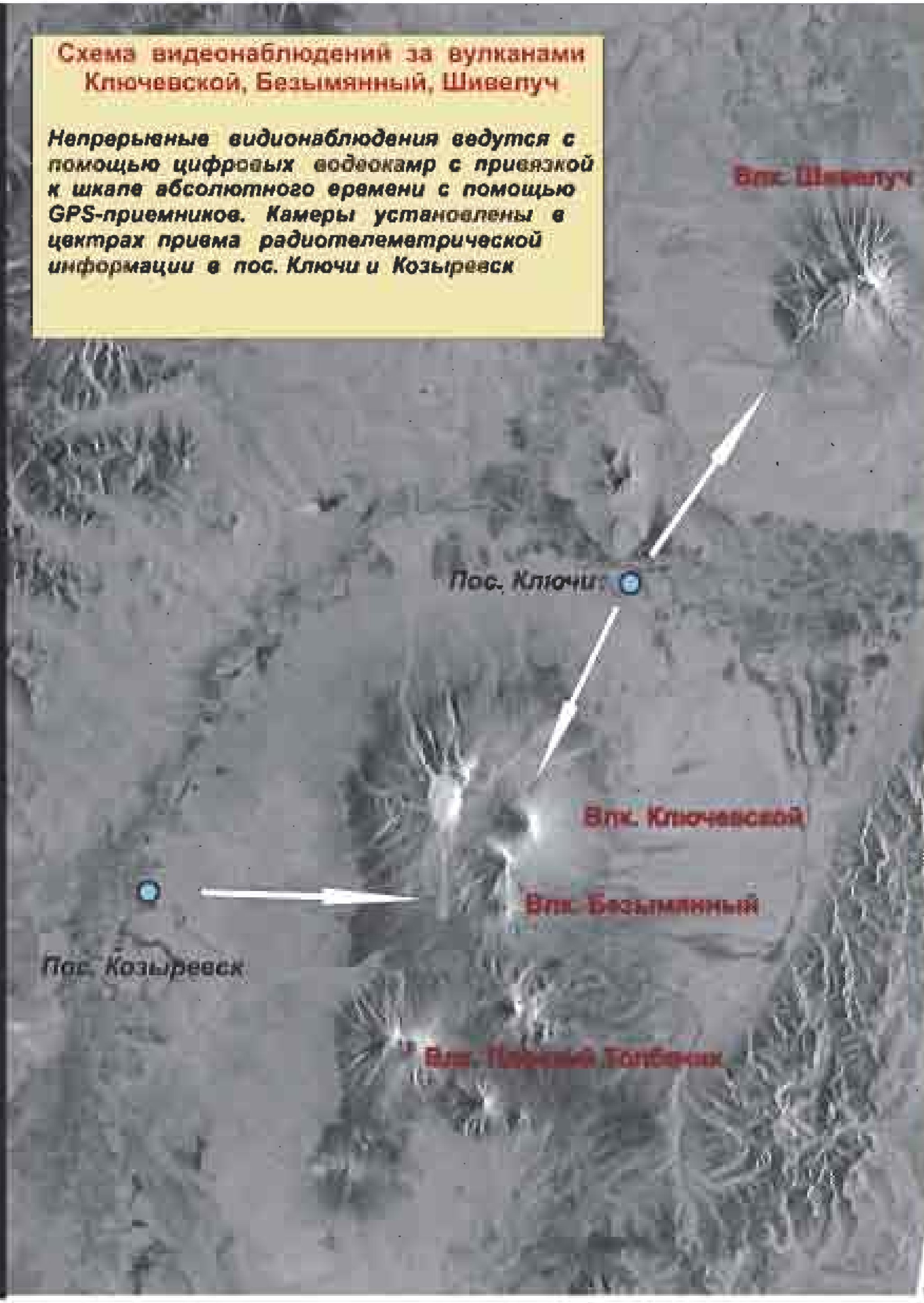
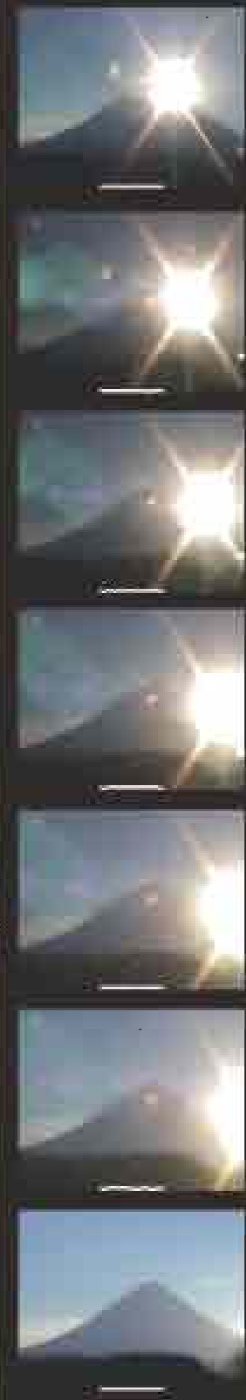
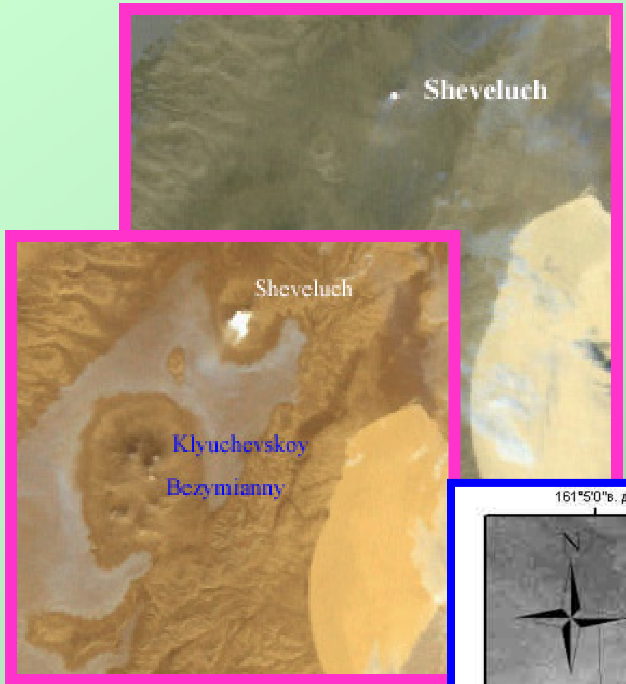


Схема видеонаблюдений за вулканами
Ключевской, Безымянный, Шивелуч
Непрерывные видионаблюдения ведутся с помощью цифровых водеокамр с привязкой к шкале абсолютного времени с помощью GPS-приемников. Камеры установлены в цектрах привма радиотелеметрической информации в пос. Ключи и Козыревск
Влк. Шивелуч
Пос. Ключи
Влк. Ключевской
Влк. Безымянный
Пос. Козыревск



Спутниковые данные о вулканической активности

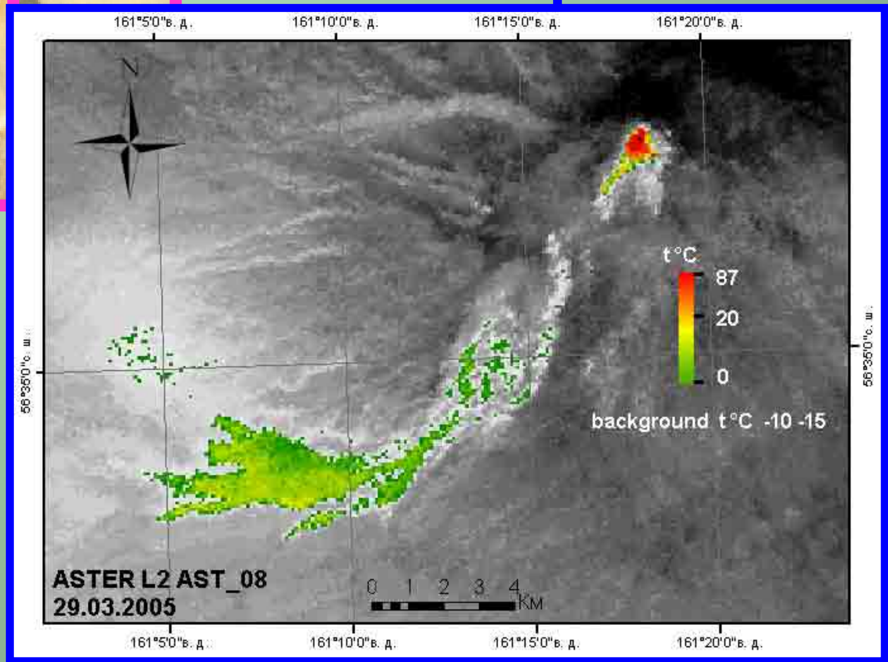
Разогретые участки



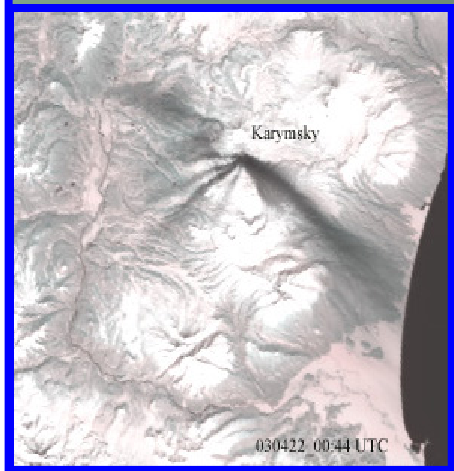
Data from Rosgeolfond, MPR RF

Пепловые выбросы

Ash deposits



Температура отложений пирокластического потока извержения в. Шивелуч 28 февраля 2005 г.
Данные обработал с.н.с. Д.В. Мельников

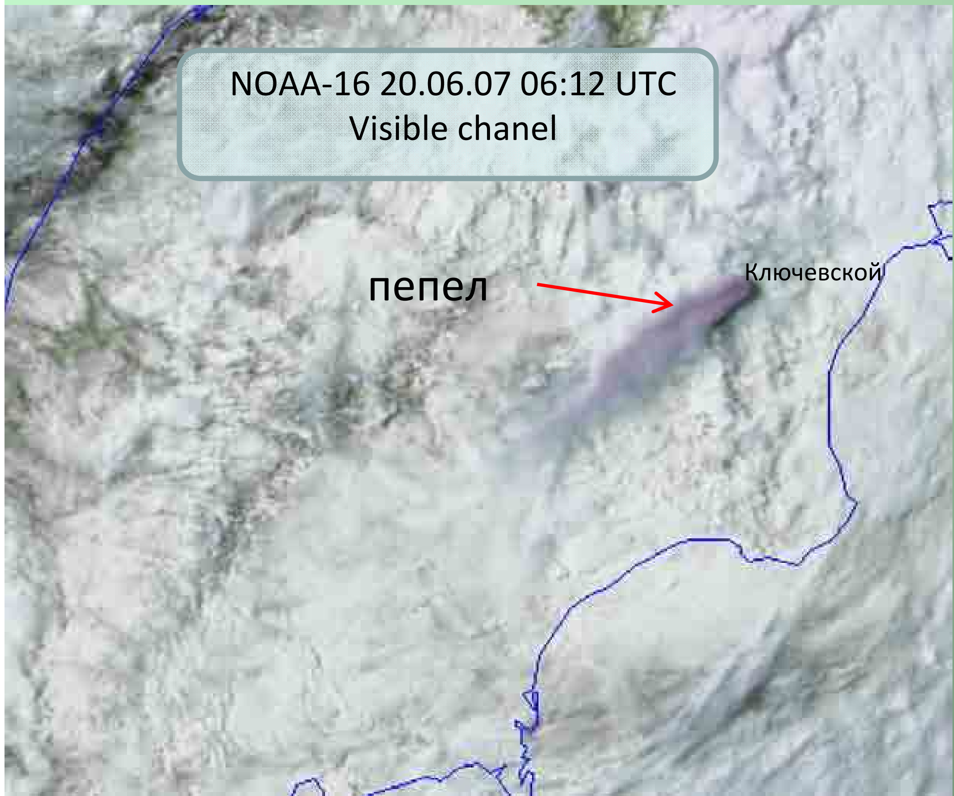


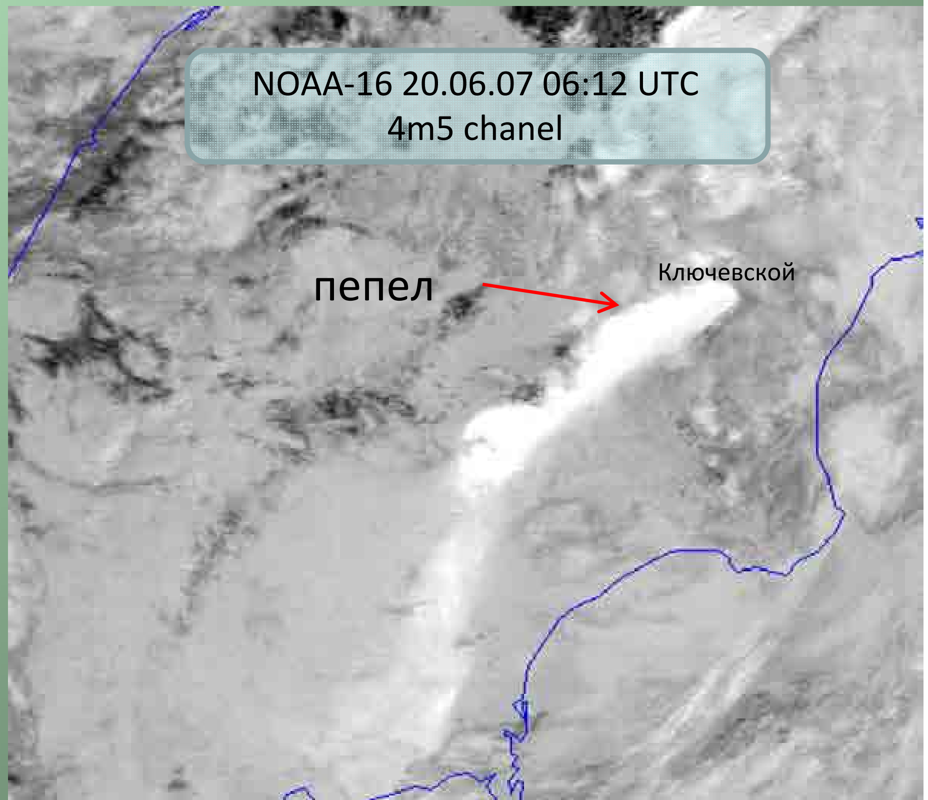
Data from Rosgeolfond MPR RF

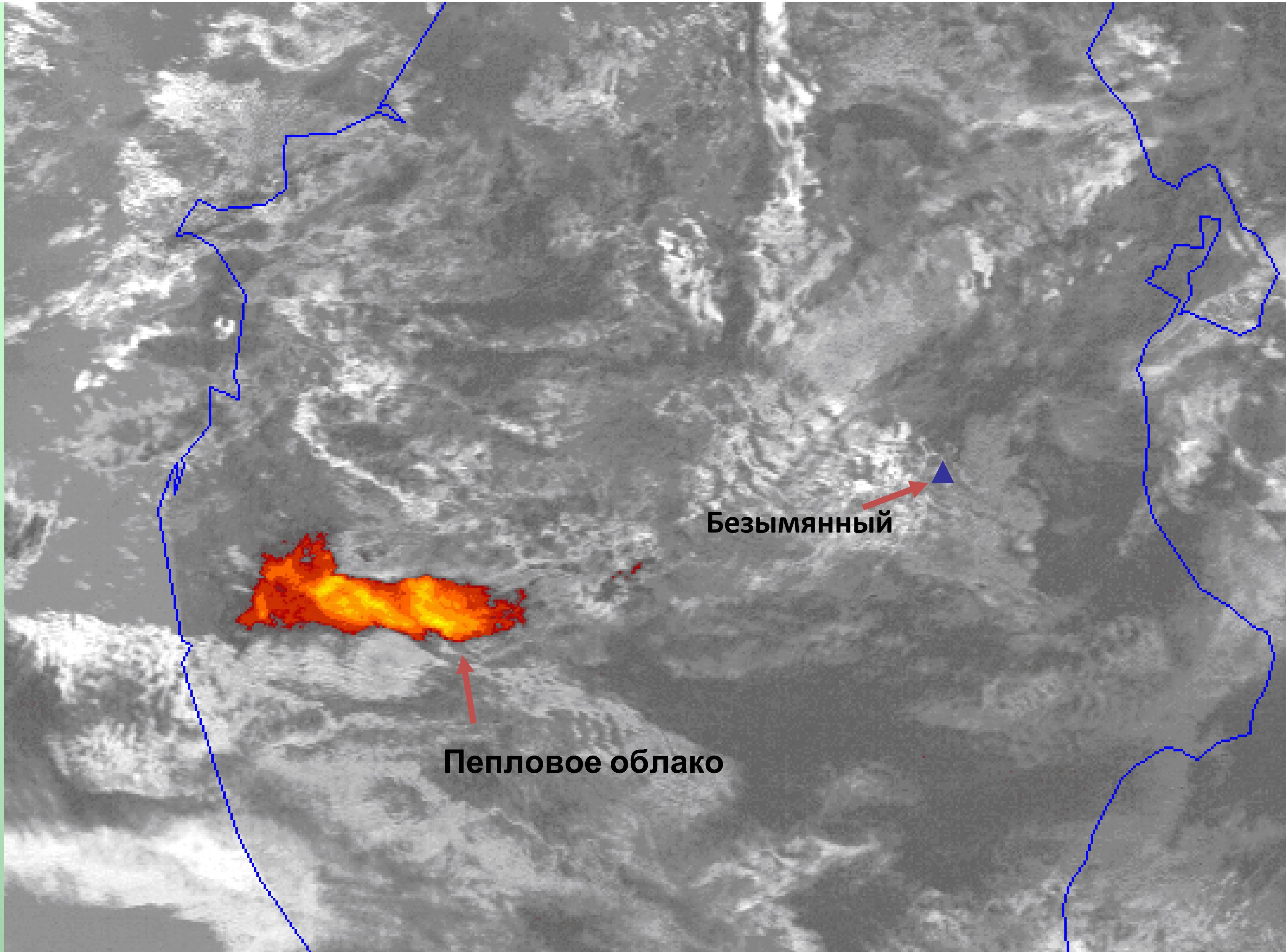
ОПЕРАТИВНЫЙ МОНИТОРИНГ

Спутники серии NOAA AVHRR (NOAA-16, NOAA-17, NOAA-18, NOAA-19)

Данные принимаются в оперативном режиме до 10-16 снимков в сутки, пространственное разрешение 1.1 км
Анализируются вулканогенные термальные аномалии и пепловые шлейфы



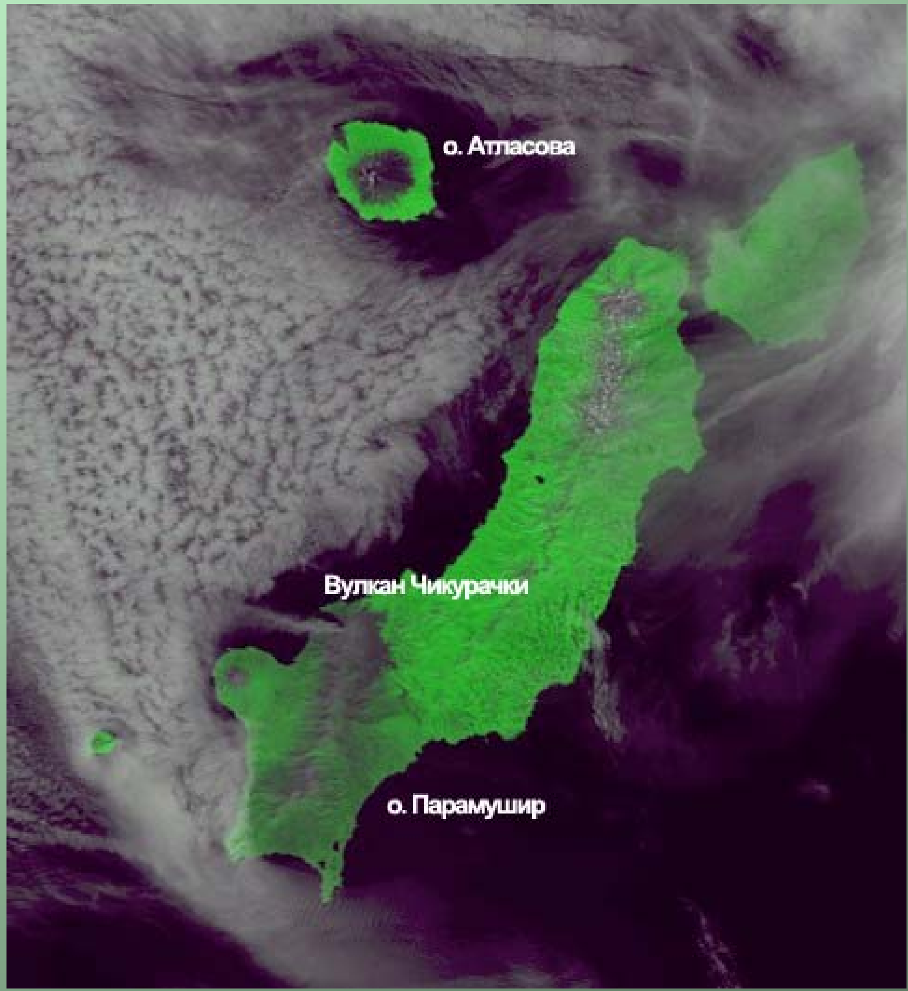




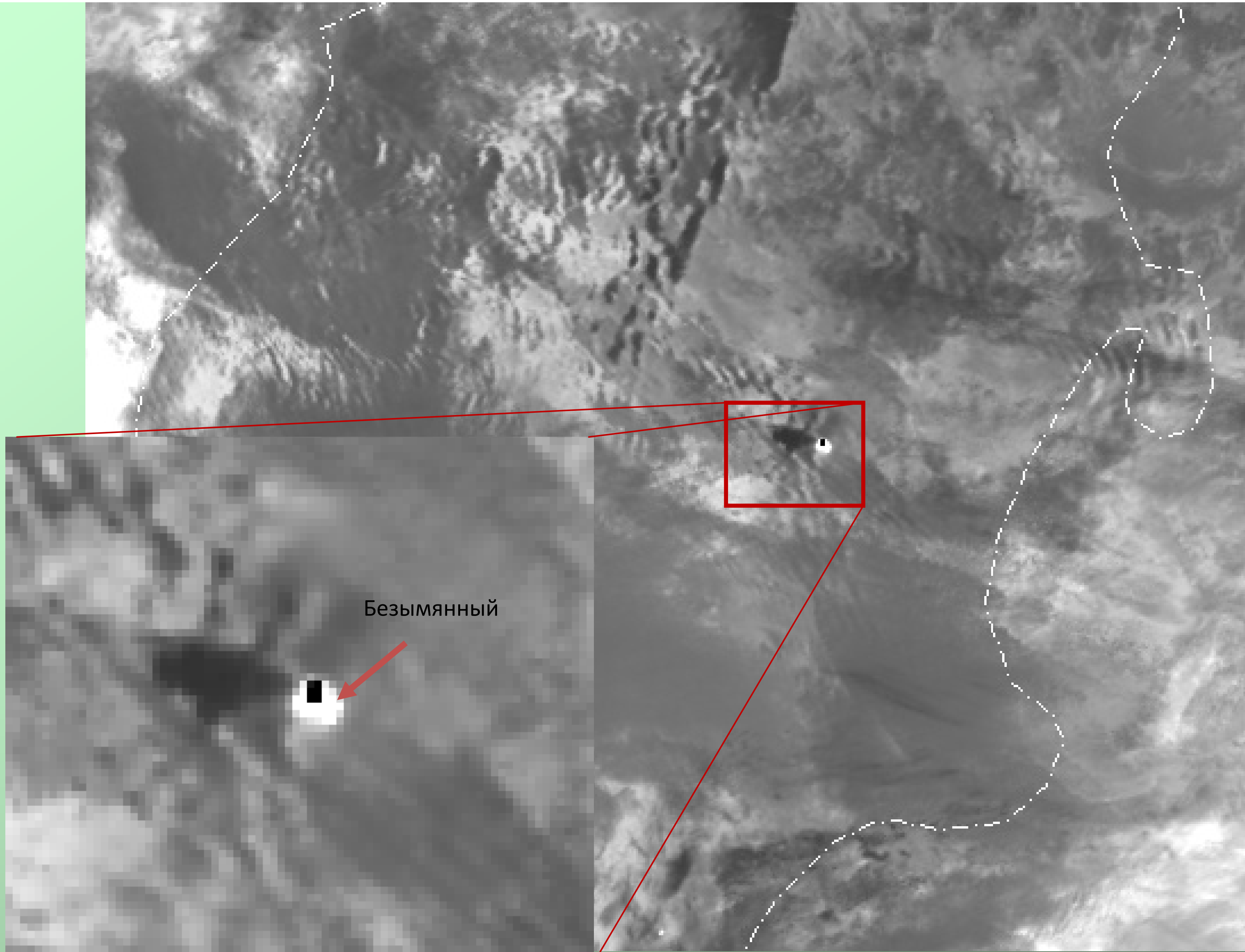
NOAA-18 разность каналов 4m5, 19.08.2008 16:09 UTC. Пепловое облако (размер 90x30 km) расположено на расстоянии 230 км от вулкана.

Спутники серии TERRA (MODIS и AQUA)

Несколько снимков в сутки. Пространственное разрешение от 250 м до 1 км
Анализируются вулканогенные термальные аномалии и пепловые шлейфы



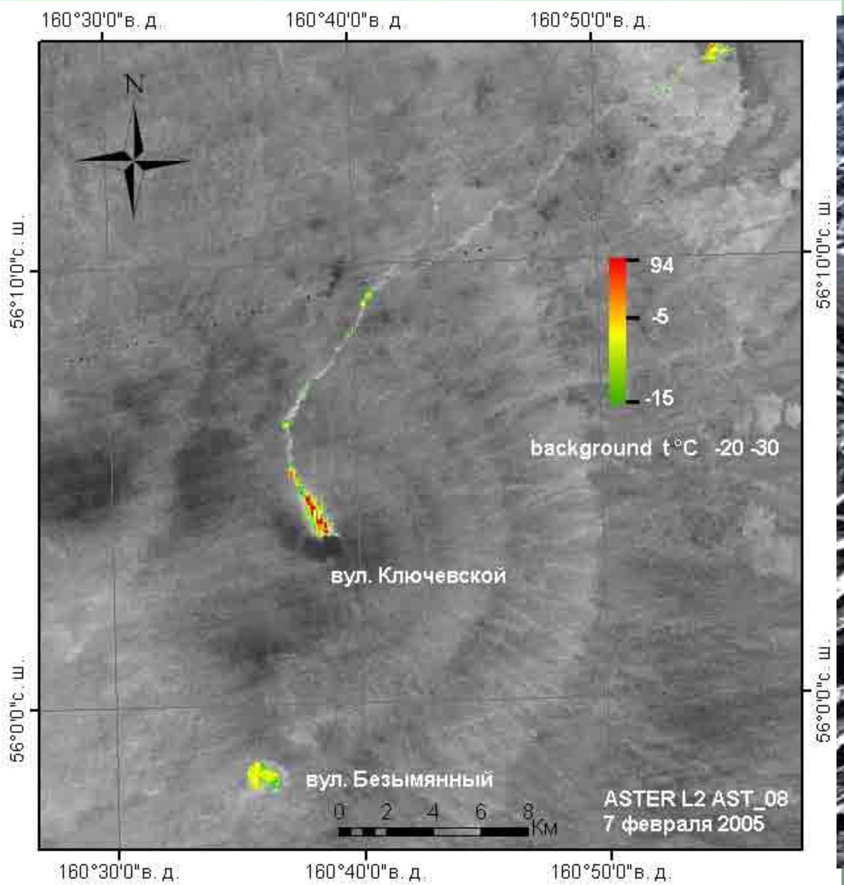
Пепловые шлейфы от вулкана Чикурачки на спутниковых снимках TERRA MODIS в 2008 г.: 31 июля (31m32) (а); 2 августа (б).

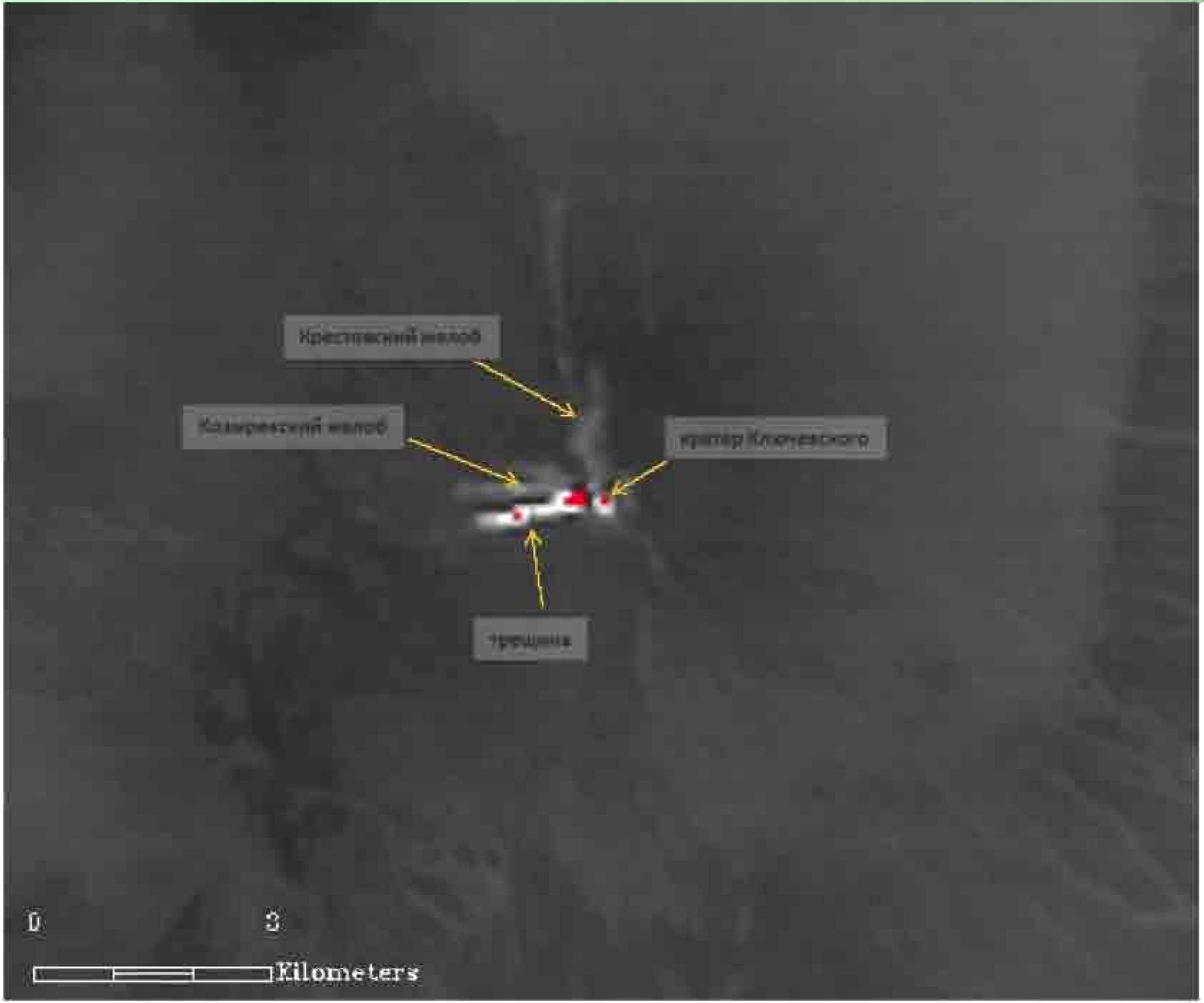


TERRA MODIS канал 20, 19.08.2008 10:54 UTC. Термальная аномалия. 31 пиксель, максимальная температура 51 С, фон -9 С

Спутник TERRA ASTER

Повторение орбиты раз в 14 суток. Пространственное разрешение от 15 м до 90 м в видимом и инфракрасном диапазоне.
Детальный анализ вулканических процессов – термальные аномалии, вулканогенные отложения и их морфология, пепловые шлейфы.



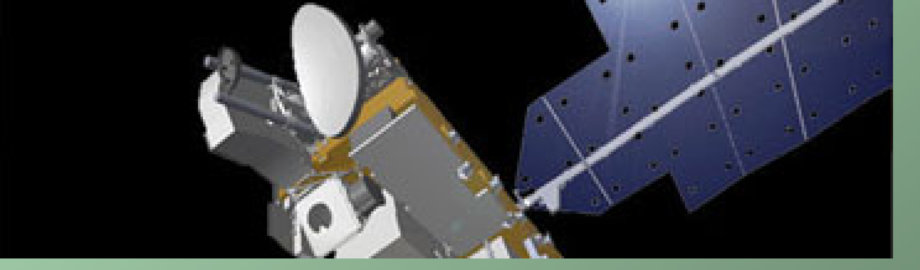


Крестовский желоб
Козыревский желоб
кратер Ключевского
трещина
0
3
Kilometers

Ozone Monitoring Instrument (OMI)

Ozone Monitoring Instrument (OMI) установлен на борту искусственного спутника Земли **AURA** (NASA EOS), выведен на орбиту 14 июля 2004

OMI - является совместной разработкой Голландского аэрокосмического агентства, Финского метеорологического института и NASA



Характеристики

Гиперспектральны радиометр:

- 270-500 nm диапазон длины волны
- спектральное разрешение 0.5 nm
- пространственное разрешение 13x24 км/пиксель
- ширина полосы обзора 2600 км
- частота съёмки 1 раз в сутки

Обнаружение содержащихся в атмосфере

O_3, NO_2, BrO, OClO, **SO2**, HCHO

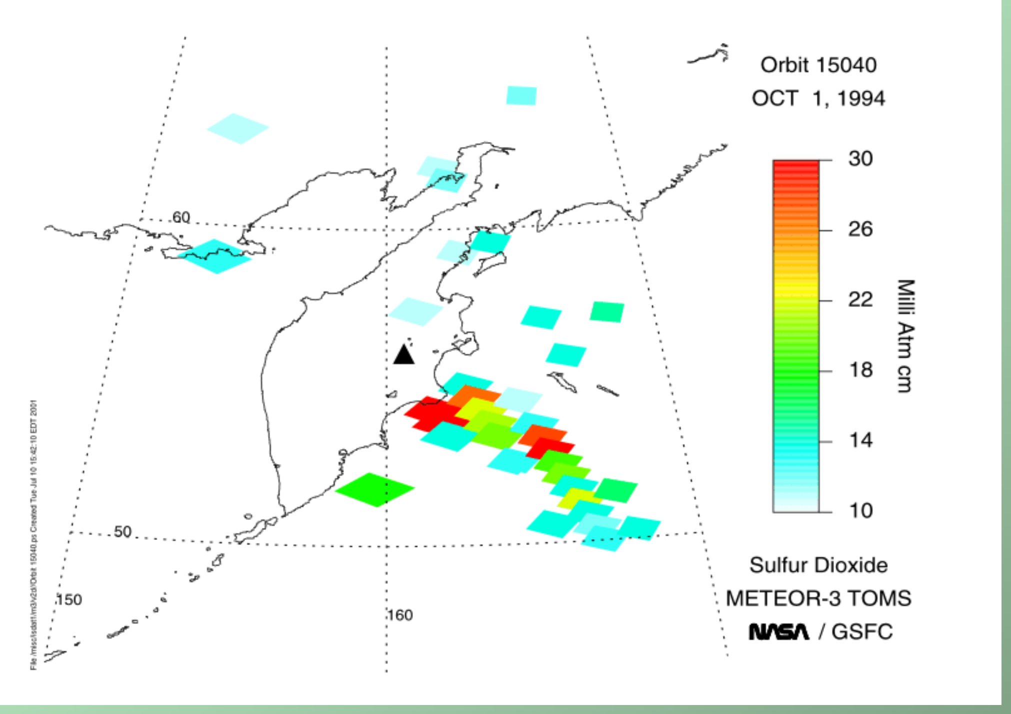
Аэрозоли (дым, пепел, пыль)

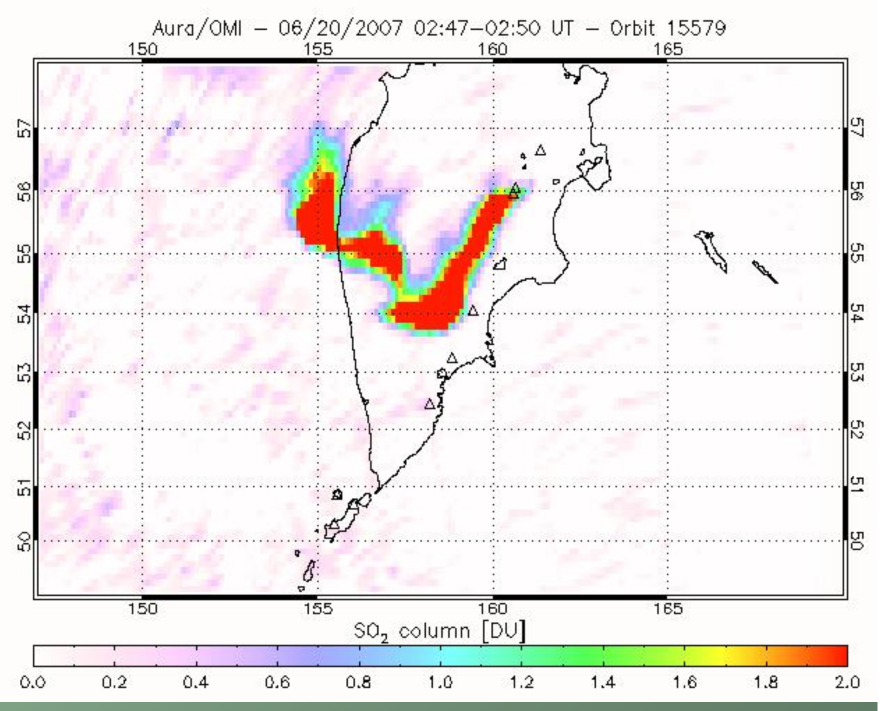
Облачный покров

Ozone Monitoring Instrument (OMI) пришёл на смену своему предшественнику **Total Ozone Mapping Spectrometer (TOMS)**, миссия которого продолжалась несколько десятилетий (Nimbus-7: 1978-1993, Meteor-3: 1992-1994, Earth Probe: 1996-2005)

TOMS

AURA

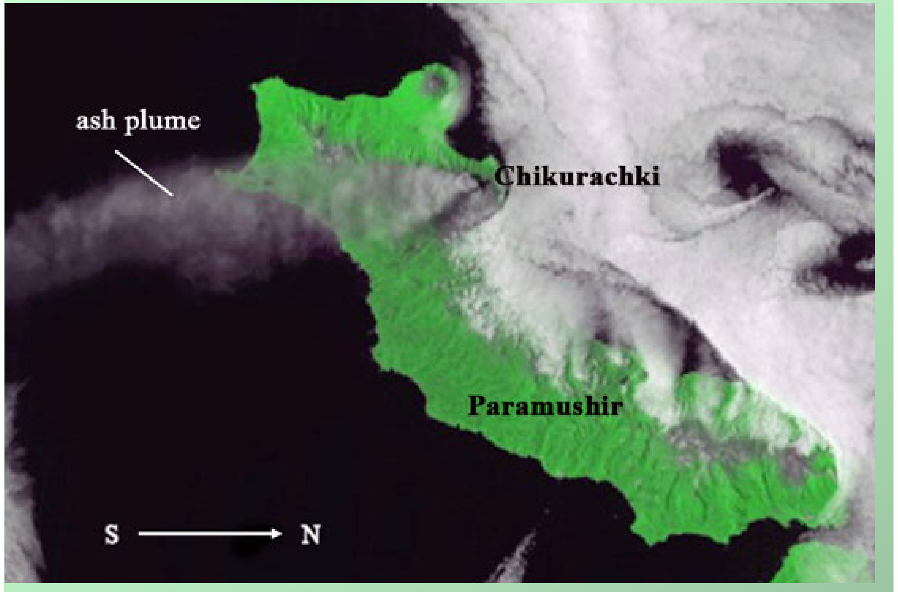


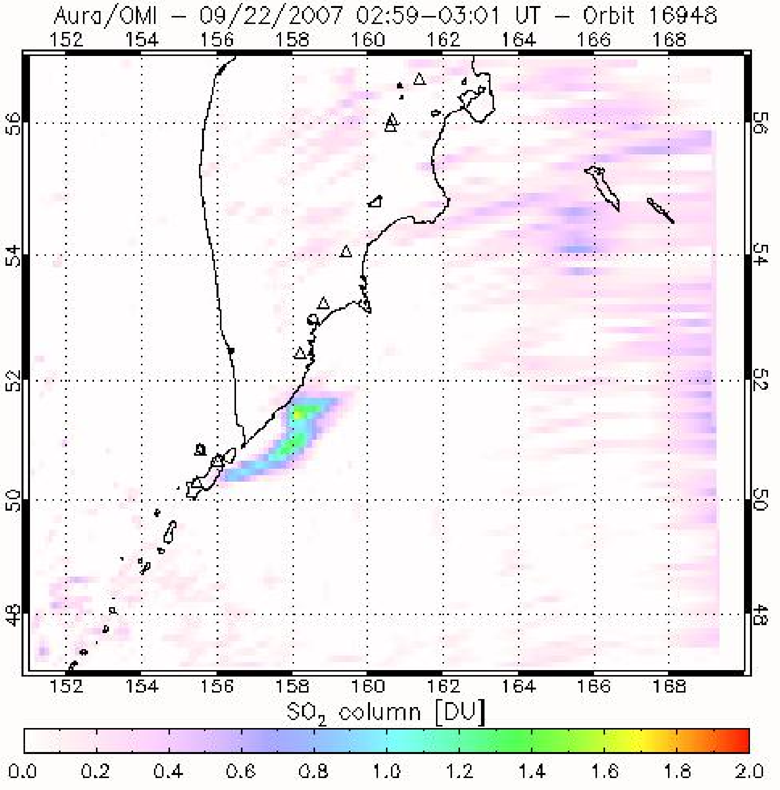


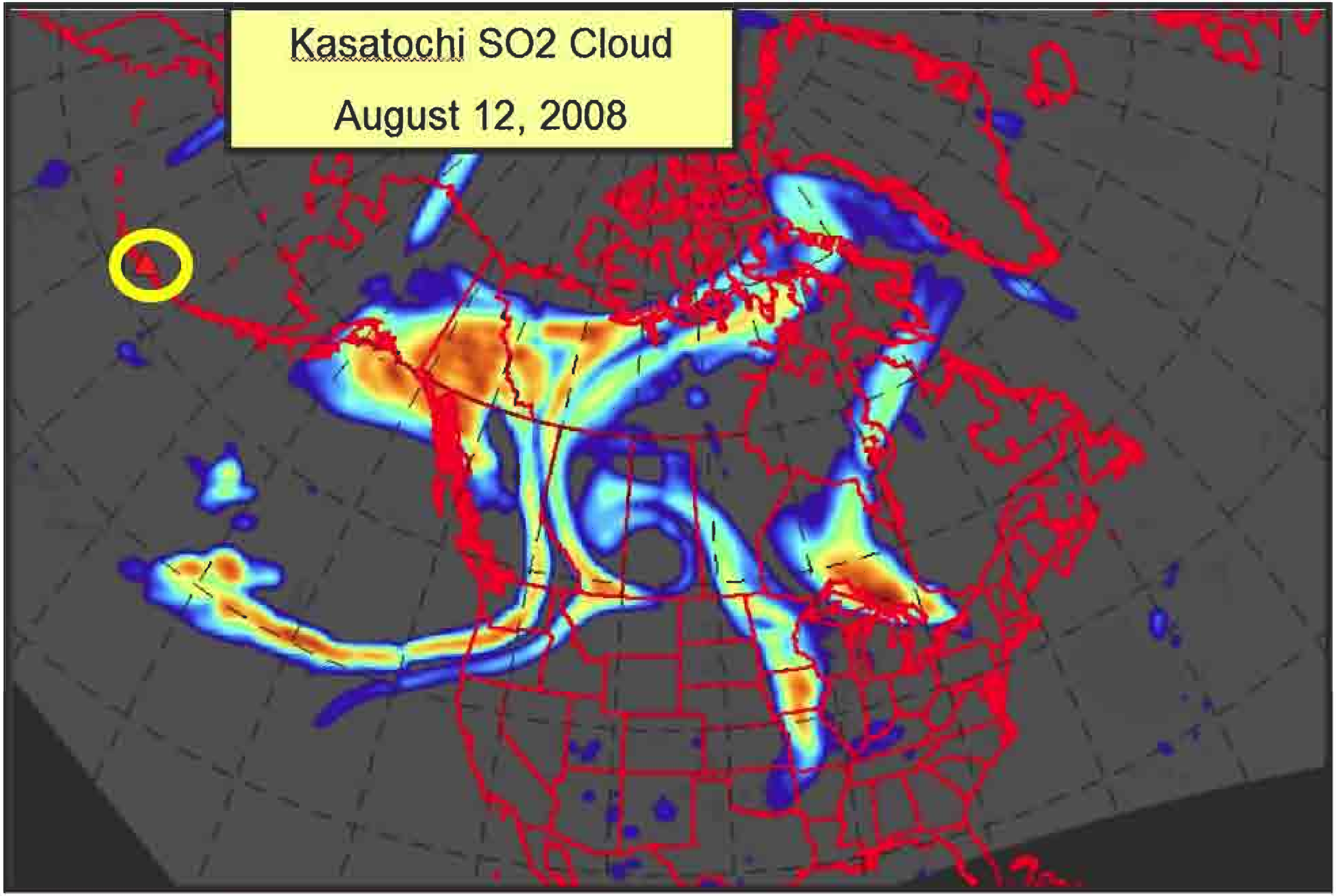
Извержение Ключевского вулкана
1 октября 1994

Извержение Ключевского вулкана
20 июня 2007

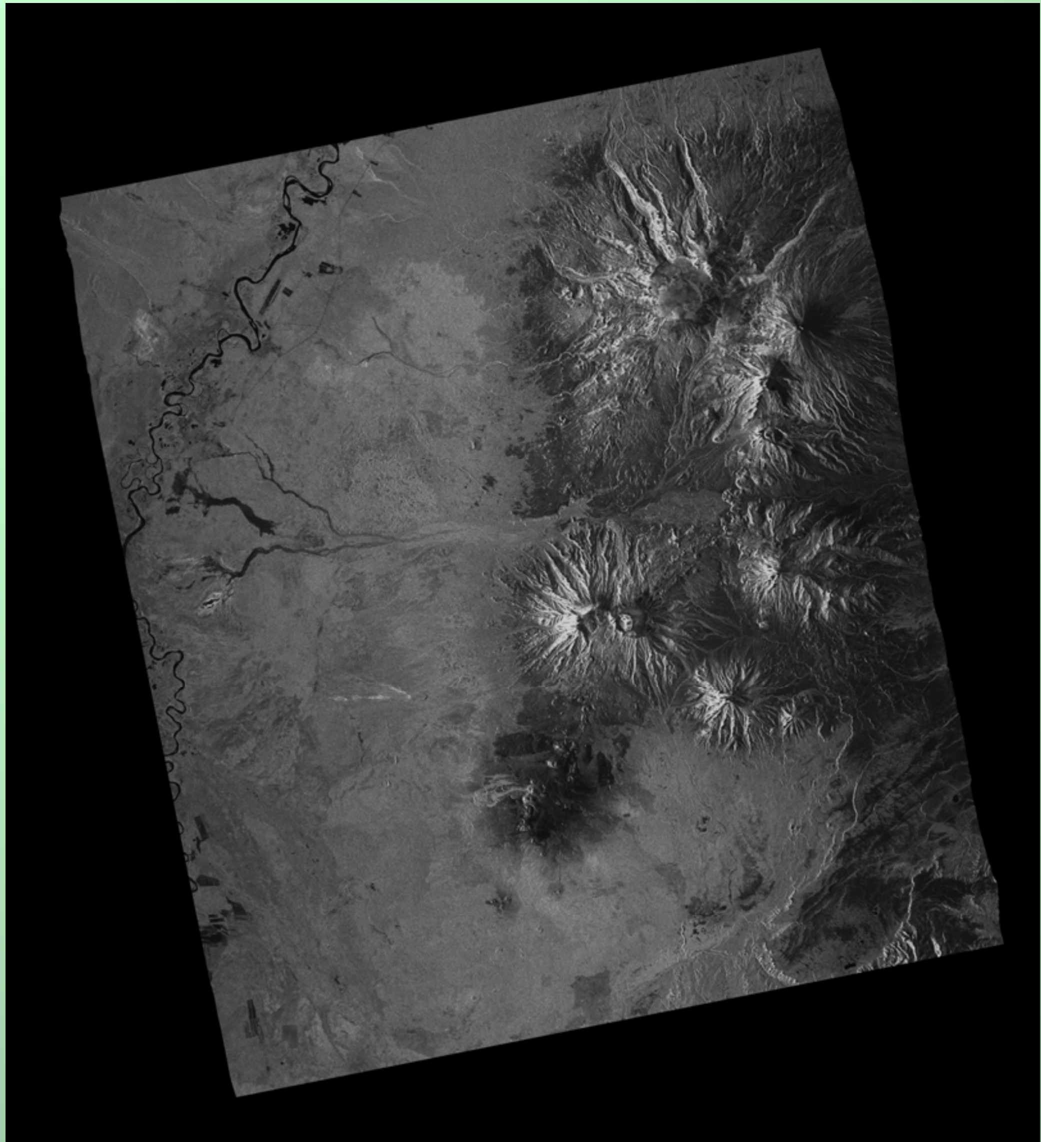
The Chikurachiki volcano eruption in 2007






Kasatochi SO2 Cloud
August 12, 2008

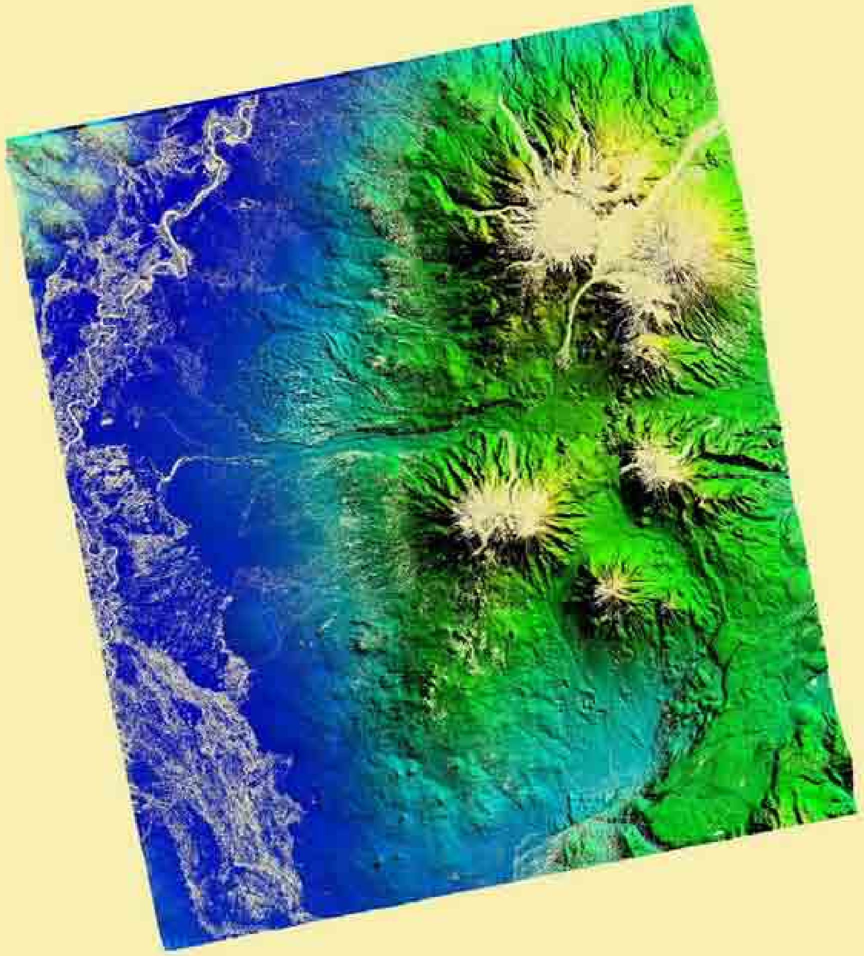
Радарные спутниковые данные
ALOS PALSAR

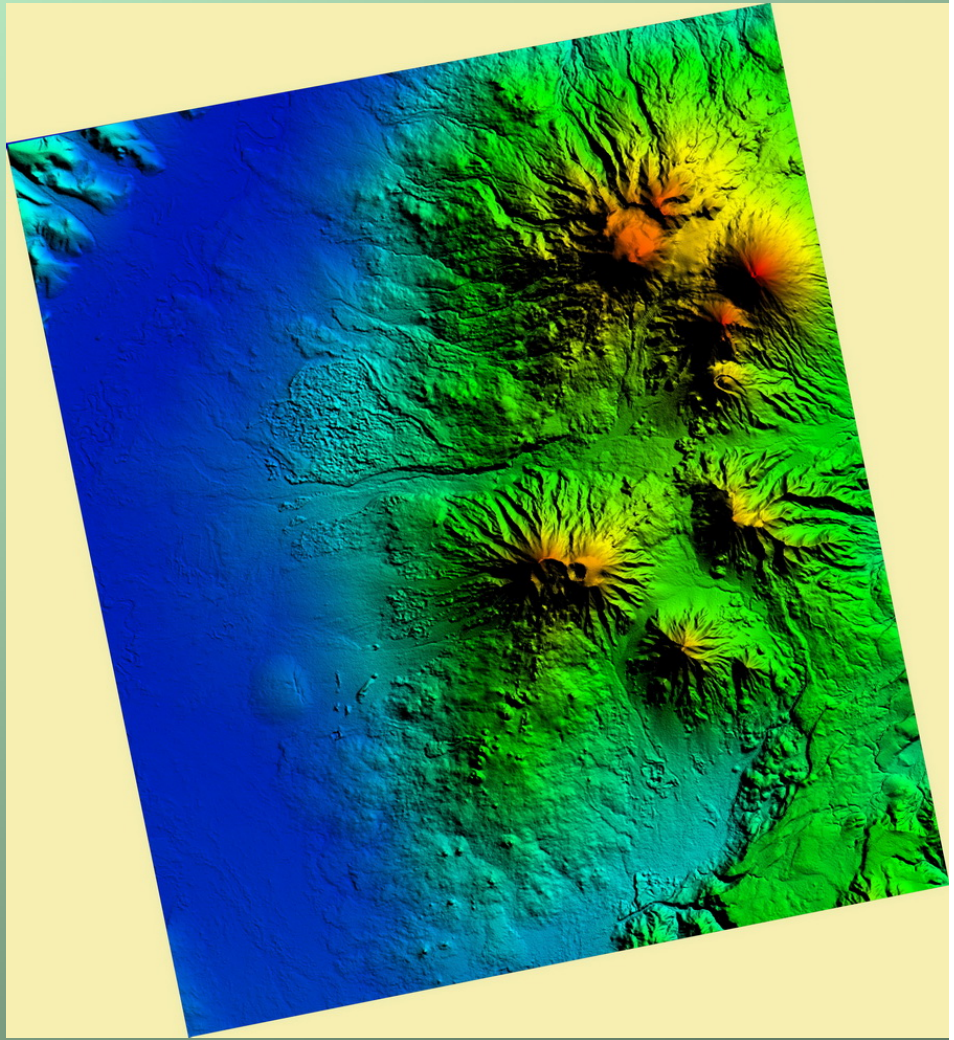


Радар L-диапазона (23,5 см) PALSAR установлен на спутнике ALOS.
Пространственное разрешение от 7 до 100 метров. Период повторения орбит – 46 суток

Построение цифровых моделей рельефа, интерферометрия, анализ деформаций

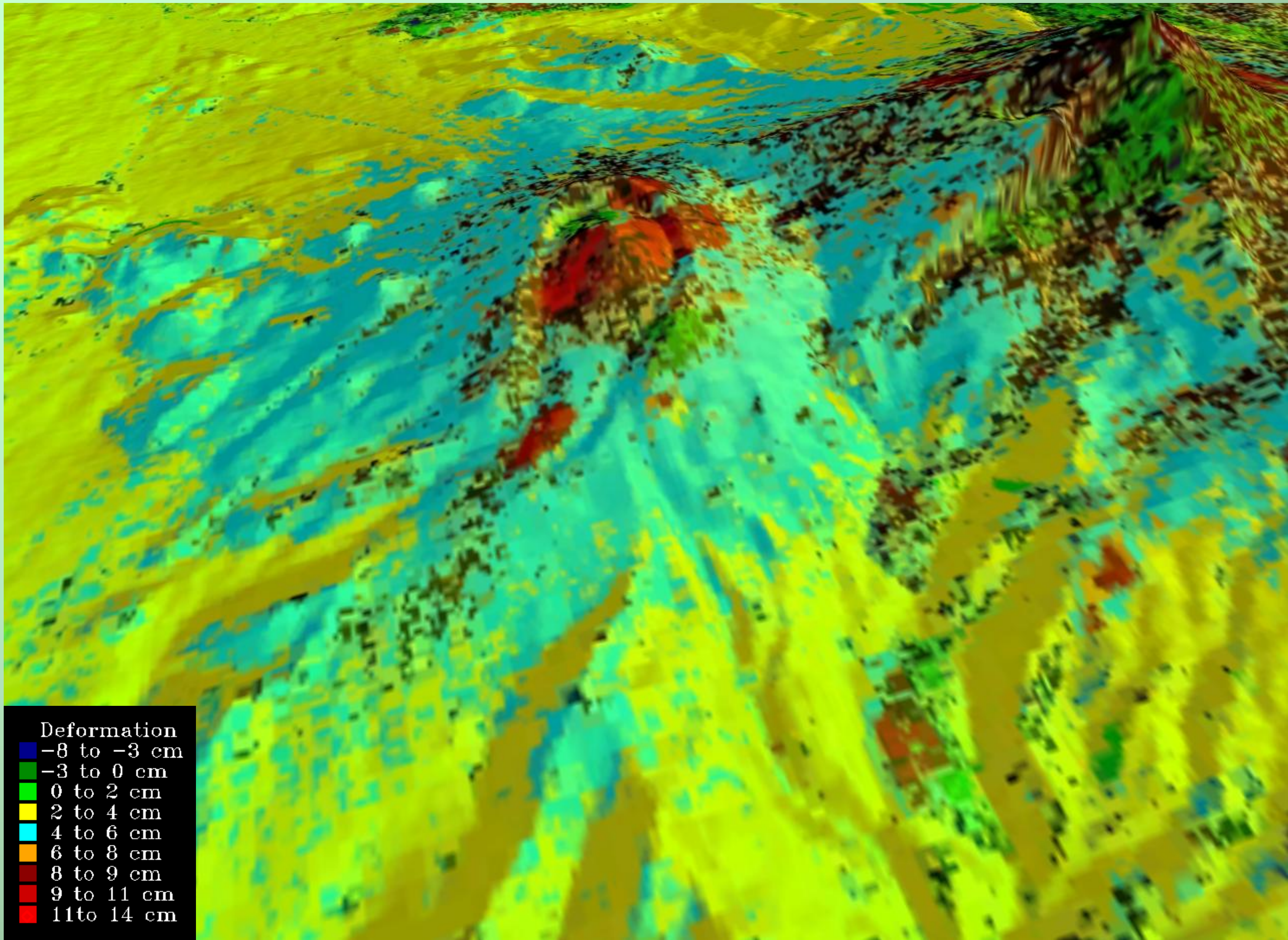
ALOS PALSAR DEM





DEM на основе пары PALSAR FBD 25.07.2007-09.09.2007

Анализ деформаций вулкана Безымянный

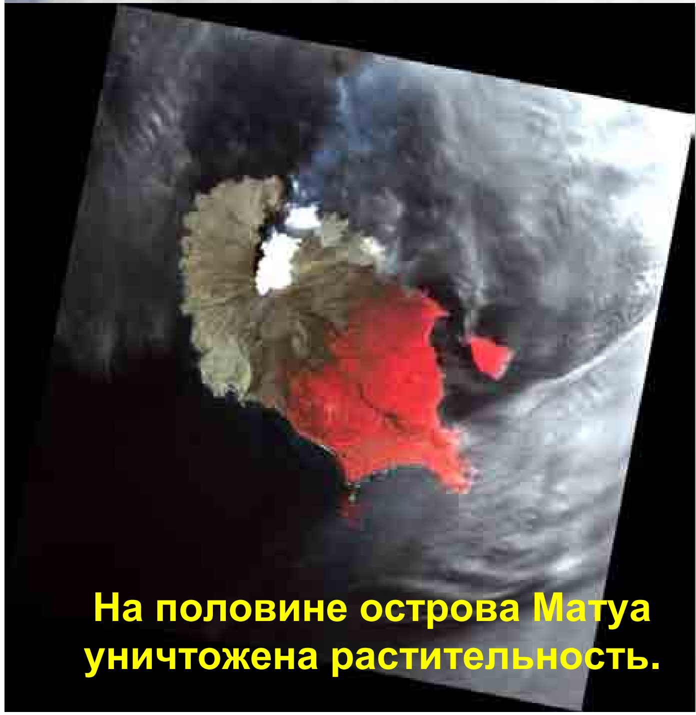


25.07.2007-9.09.2007

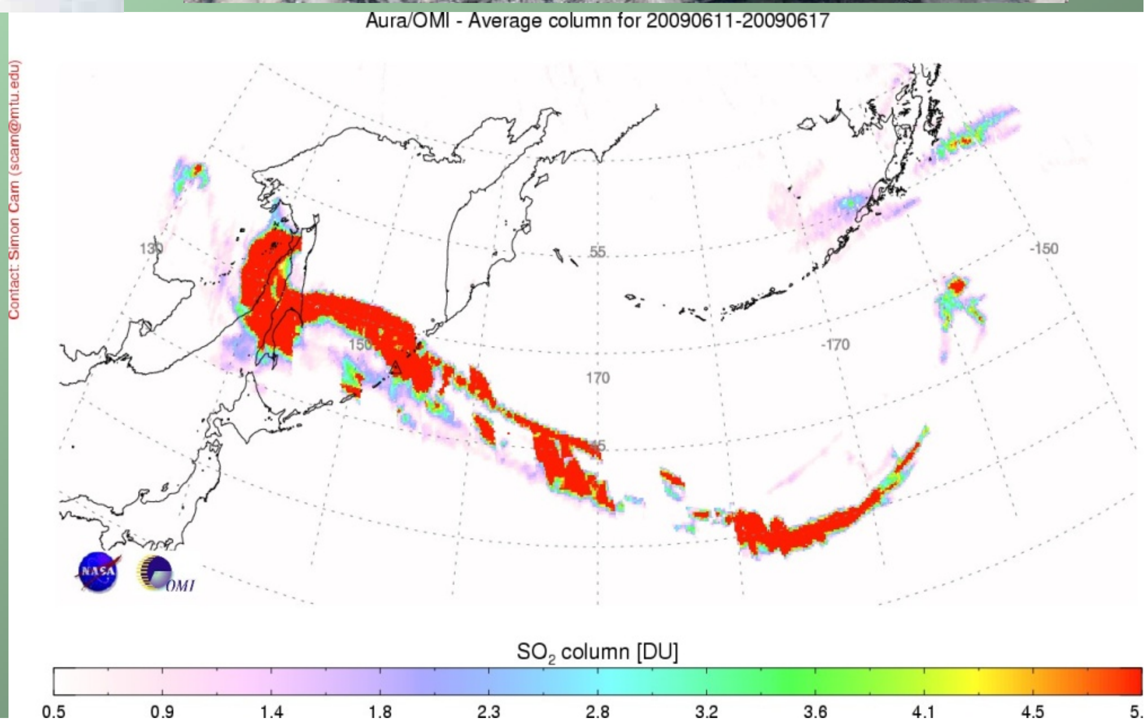
Извержение вулкана Пик Сарычева в июне 2009 г.

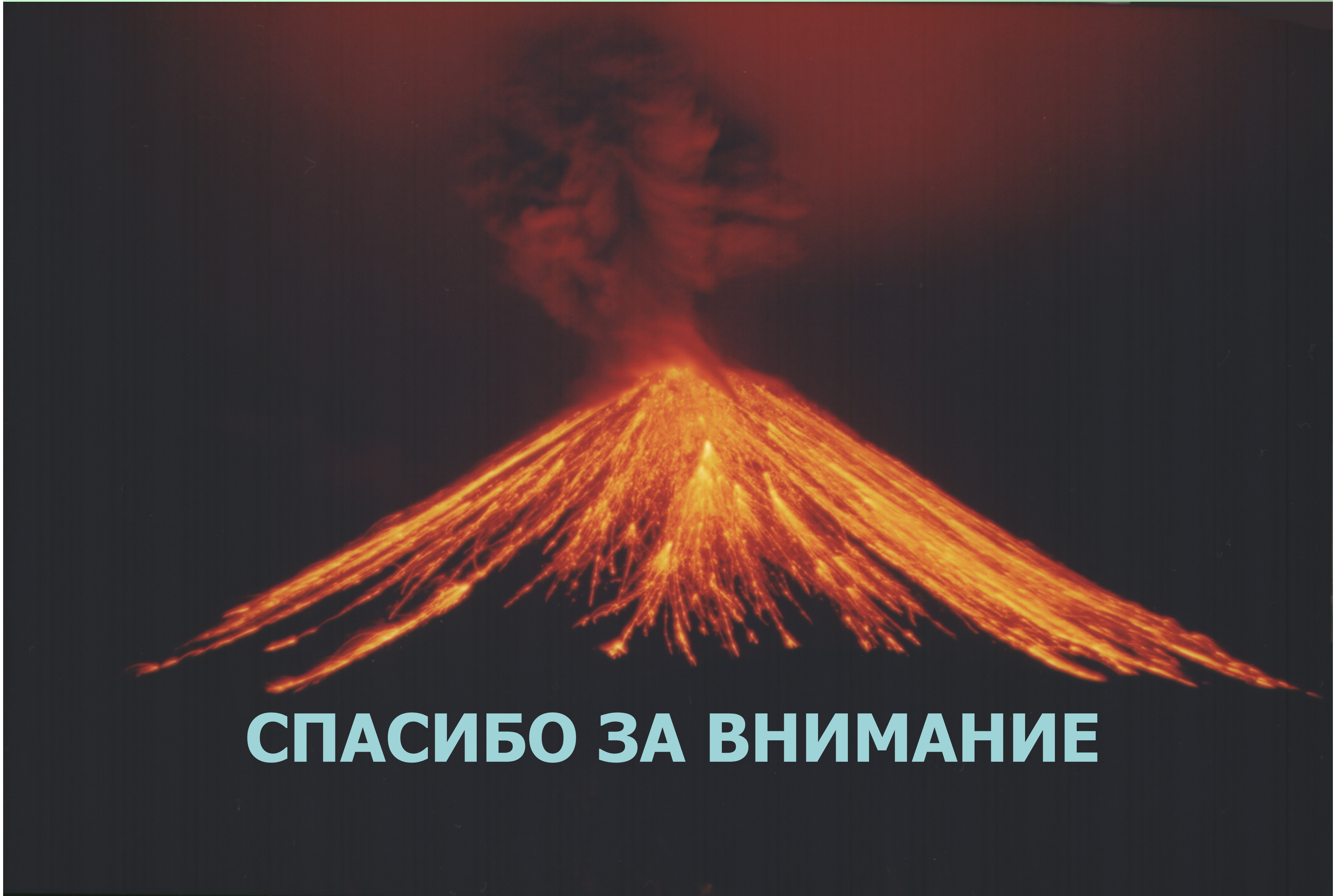
Пароксизмальная фаза извержения.

Эруптивное облако от Пика Сарычева над Охотским морем. Середина июня 2009 г.



На половине острова Матуа уничтожена растительность.




СПАСИБО ЗА ВНИМАНИЕ

ISTC International Workshop "Worldwide early warning system of volcanic activities and mitigation of the global/regional consequences of volcanic eruptions"

СОСТОЯНИЕ И ПЕРСПЕКТИВЫ РАЗВИТИЯ СЕЙСМИЧЕСКИХ НАБЛЮДЕНИЙ НА АКТИВНЫХ ВУЛКАНАХ КАМЧАТКИ И КУРИЛЬСКИХ ОСТРОВОВ

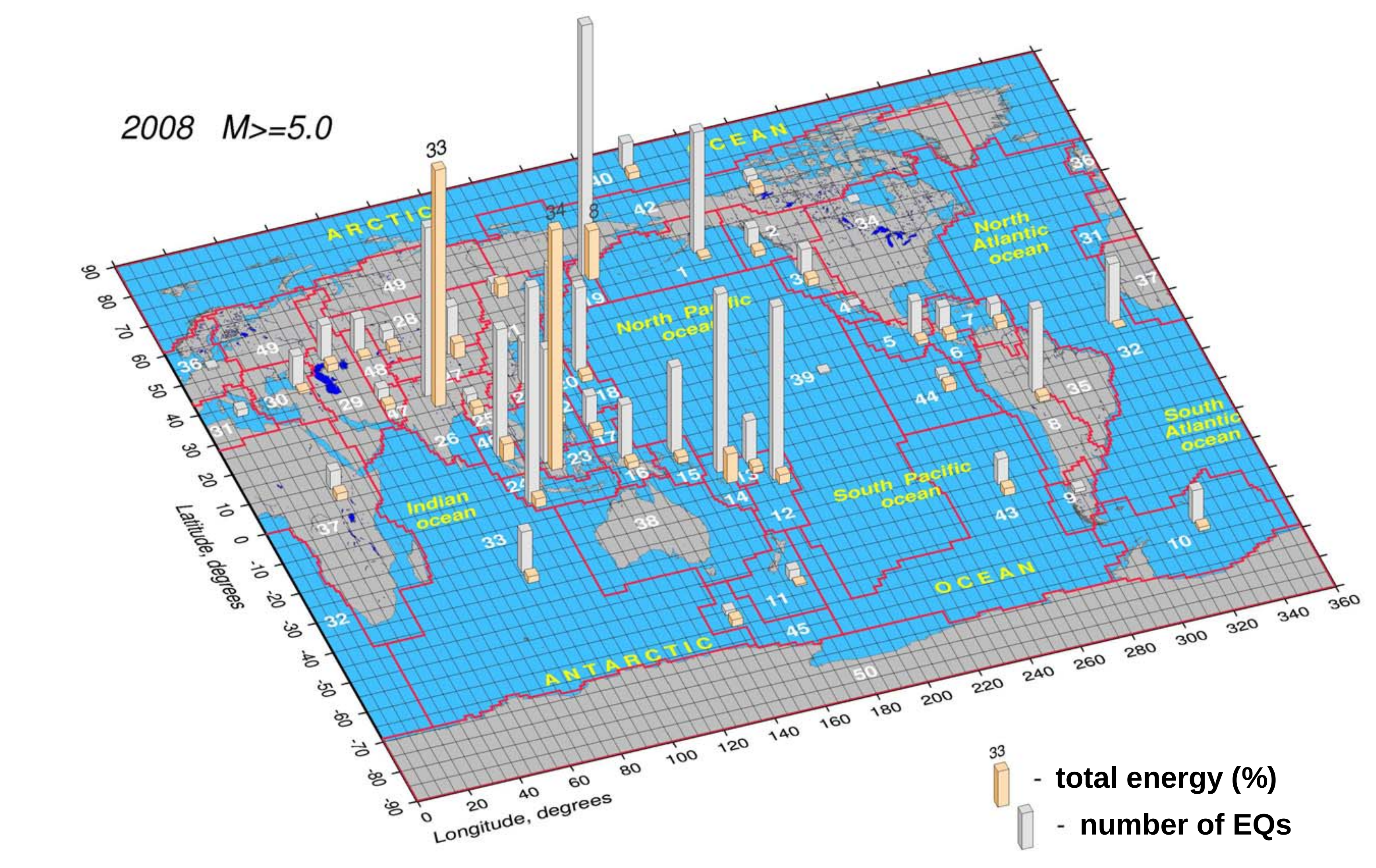
А.А. Маловичко[1], В.Н. Чебров[2], С.Л. Сенюков[2], А.В. Рыбин[3]

[1] *Геофизическая служба РАН, г. Обнинск*
[2] *Камчатский филиал Геофизической службы РАН, г. Петропавловск-Камчатский*
[3] *Институт морской геологии и геофизики ДВО РАН, г. Южно-Сахалинск*

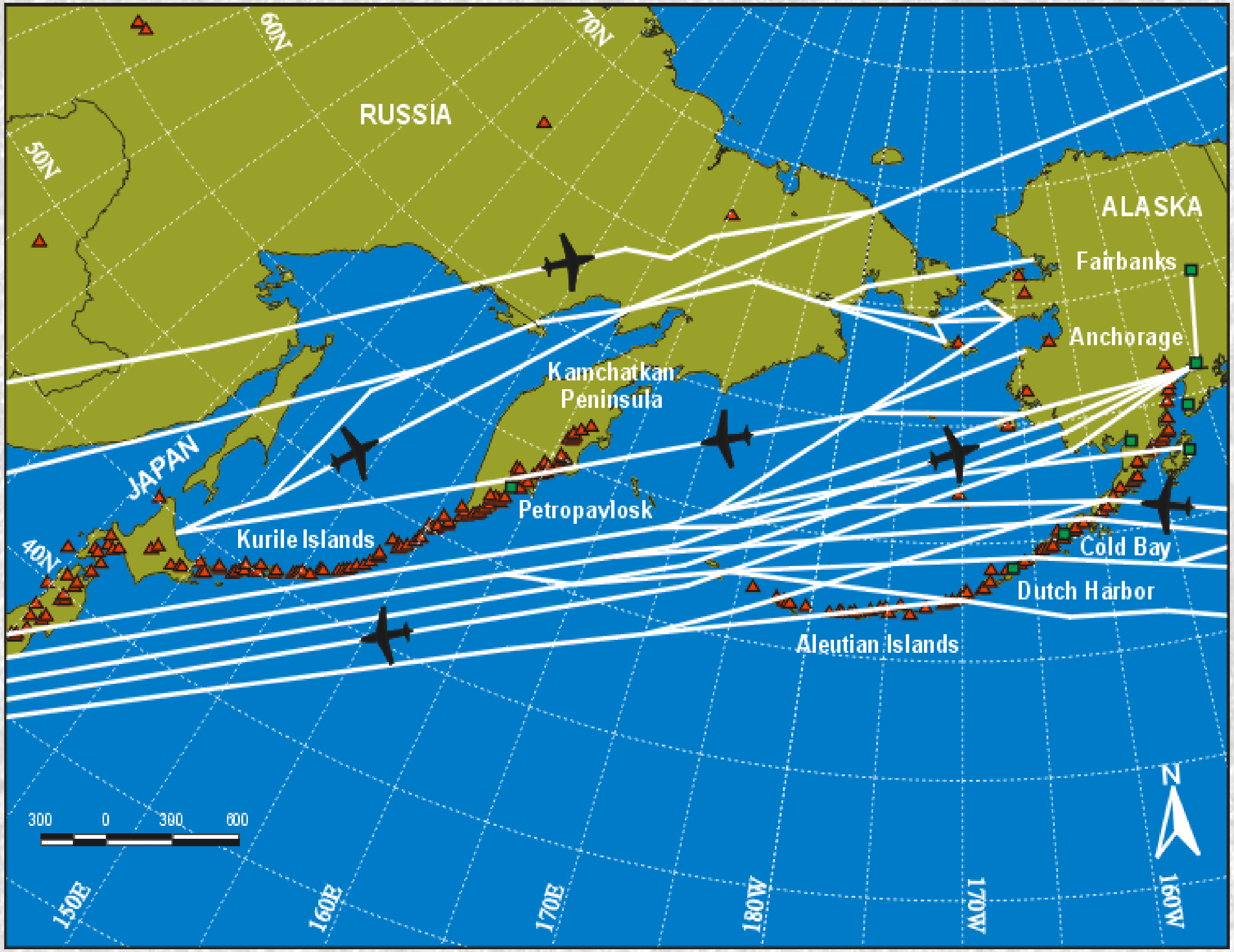
Moscow, Russia, July 8-9, 2010

Japan - Kuril islands - Kamchatka

19 region according Flinn-Engdahl seismic regionalization scheme



На Камчатке и Курильских островах около *100* вулканов, из них *65* действующих, среди которых вулкан Ключевской (*4750* м) – самый высокий действующий вулкан Евразии. Ежегодно на Камчатке и Курилах происходит несколько извержений вулканов.



Вулкан Ключевской

Н= *4750* м

Оценка состояния и развития активности действующих вулканов Камчатки и Северных Курил, а также оценка опасных явлений, связанных с их извержениями, является одной из главных задач для обеспечения безопасности населения и авиационных полетов.

Особенности таких извержений и степень вулканической опасности от них устанавливается на основе изучения истории активности вулкана и определения типа, силы и геологического эффекта его извержений.

Для оперативного прогноза вулканической опасности для населения необходимо проводить непрерывный комплексный мониторинг вулканов Камчатки и Северных Курил.

История развития сейсмологических наблюдений на Дальнем Востоке России

Первая сейсмическая станция на Дальнем Востоке в г. Петропавловске-Камчатском была открыта по инициативе академика Б. Б. Голицына в *1915* г. Станция с перерывами проработала до *1927* г. Сейсмическая станция «Владивосток» была открыта Сейсмологическим институтом АН СССР в октябре в октябре *1929* г. (закрыта в *1990*-х гг.);

АН СССР были открыты сейсмические станции:

- в *1946* г. на Камчатке в п. Ключи;
- в *1948* г. - в г. Южно-Сахалинск;
- в *1950* г. – в Углегорске;
- в *1951* г. – в Петропавловске-Камчатском;
- в *1952-1953* гг. - в Курильске (о. Итуруп) и в Магадане;
- в *1958* г. – в Охе (о. Сахалин) и в Северо-Курильске (о. Парамушир).

С *1957* г. на Курильских островах, с *1961* г. на Камчатке и далее в других регионах Дальнего Востока началось создание региональных сетей сейсмологических наблюдений.

Первые наблюдения сейсмичности на вулкане Ключевской

А К А Д Е М И Я   Н А У К   С С С Р
БЮЛЛЕТЕНЬ ВУЛКАНОЛОГИЧЕСКОЙ СТАНЦИИ НА КАМЧАТКЕ, № 16

Н. Е. СОКОЛОВ

НАЧАЛО РАБОТ НА СЕЙСМИЧЕСКОЙ СТАНЦИИ В с. КЛЮЧИ НА КАМЧАТКЕ

Сейсмическая станция расположена на юго-восточной окраине селения Ключи, в удалении 300—500 м от жилых домов и в 200 м от Вулканологической станции. Она представляет собой одноэтажное деревянное здание, срубленное из бревен камчатской лиственницы, толщиной 20—25 см. Здание имеет рабочую и жилую половины.

Аппаратура станции состоит из двух горизонтальных сейсмографов для оптической регистрации системы проф. П. М. Никифорова, двух коллиматоров и одного регистрир-аппарата. Она была изготовлена Сейсмологическим институтом Академии Наук СССР.

Сейсмографы расположены на фундаменте бутовой кладки, размером 1.25 × 1.25 × 4 м, возвышающимся над уровнем пола на 0.7 м, подпочва — песок.

Коллиматоры и регистрир-аппарат расположены на другом фундаменте, размером 1 × 1 × 2.5 м. Расстояние между фундаментами 1 м.

Постоянные сейсмографа П. М. Никифорова:

$\varphi_N = 56°19'25''5$; $\lambda_E\, 160°45'48''$; $h = 37$ м.

Составляющие прибора	$l_{мм}$	$T_{сек}$	μ^2	$A_{мм}$	η
$N-S$	10.3	2.5	0.63	1450	276
$E-W$	5.5	2.5	0.84	1250	455

где l — приведенная длина сейсмографа; T — период колебания прибора; μ^2 — постоянная затухания; A — оптический рычаг; η — увеличение прибора; h — высота над уровнем моря.

Составляющая $N—S$ прибора образует угол $N—S$ с направлением меридиана $\alpha = 29°20'$.

На лампочки коллиматоров подается ток от аккумуляторов 8 V.

Регулировка накала нити лампы производится ползунковыми реостатами.

Для отметки времени на сейсмограмме предназначены контактные электрические часы конструкции Ю. Д. Буланже. Часы дают поминутную марку. Для питания часов подается ток напряжением в 24 V от батареи аккумуляторов. Работа электрических часов сочетается с хронометром.

Первая сейсмограмма получена 29 декабря 1946 г. В ночь с 1 на 2 января 1947 г. сейсмограф отметил множество мелких колебаний, следовавших одно за другим через 10—20 секунд. Первый толчок зафиксирован 31 декабря 1946 г. в $23^{ч}55^{м}2^{с}$ по поясному времени. Толчки продолжа-

Первые сейсмические станции стационарного типа для исследований на вулканах на Камчатке были созданы лабораторией вулканологии АН СССР в районе Ключевской группы вулканов: станция «Ключи» в 1946 г.;

Сейсмическая станция «Ключи»

Фиг. 1. Здание сейсмической станции.

Первые наблюдения сейсмичности на вулкане Ключевской

лись до $6^h\ 39^m\ 12^s$ 1 января 1947 г. Всего за ночь отмечен 21 толчок.

31 декабря 1946 г.		
i_1	$23^h\ 56^m\ 2^s$	I балл
i_2	$23^h\ 56^m\ 14^s$	То же
i_3	$23^h\ 56^m\ 40^s$	»
i_4	$23^h\ 56^m\ 56^s$	»
i_5	$23^h\ 57^m\ 24^s$	»
1 января 1947 г.		
i_6	$0^h\ 09^m\ 30^s$	»
i_7	$0^h\ 09^m\ 55^s$	»
i_8	$0^h\ 10^m\ 23^s$	»
i_9	$0^h\ 10^m\ 33^s$	»

i_{10}	$0^h\ 14^m\ 49^s$	I балл
i_{11}	$0^h\ 40^m\ 59^s$	То же
i_{12}	$1^h\ 35^m\ 22^s$	»
i_{13}	$2^h\ 01^m\ 18^s$	»
i_{14}	$2^h\ 02^m\ 41^s$	»
i_{15}	$2^h\ 02^m\ 59^s$	»
i_{16}	$3^h\ 20^m\ 25^s$	»
i_{17}	$3^h\ 29^m\ 17^s$	II балла
i_{18}	$3^h\ 35^m\ 33^s$	То же
i_{19}	$4^h\ 22^m\ 23^s$	»
i_{20}	$5^h\ 07^m\ 42^s$	»
i_{21}	$6^h\ 39^m\ 12^s$	»

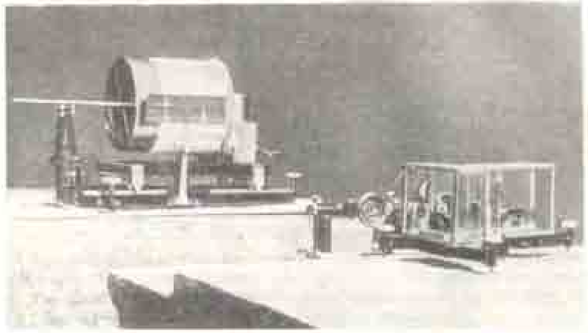
Отсутствие на сейсмограмме раздельных фаз и наличие одной фазы с резко выраженным вступлением волн, а также кратковременность колебания (2—3 сек.) указывают на близость эпицентра. Направление всех толчков было с юга на север. Надо полагать, что очаг их расположен около Ключевского вулкана.

24 января 1947 г. в $23^h\ 07^m\ 26^s$ ощущался толчок силою в III балла, направление толчка с юга на север. Очаг землетрясения расположен около Ключевского вулкана.

27 февраля 1947 г. была записана серия разнообразных толчков разного периода и амплитуд:

i_1	$19^h\ 11^m\ 53^s$	Tp_1 2 сек.	A — 4 мм	II балла
i_2	$21^h\ 48^m\ 6^s$	Tp_2 18 »	» 9 мм	То же
i_3	$21^h\ 50^m\ 56.5^s$	Tp_3 16 »	» 1 мм	»
i_4	$22^h\ 20^m\ 3.6^s$	Tp_4 3 »	» 19 мм	III балла
i_5	$22^h\ 30^m\ 14^s$	Tp_5 2 »	» 11 мм	То же

Это, повидимому, также вулканические землетрясения, эпицентр которых находится около Ключевского вулкана (30—40 км).



Фиг. 2. Сейсмографы системы проф. Никифорова.

механической регистрацией (фиг. 3). Описание сейсмической станции было дано в свое время Н. Е. Соколовым (1948). Необходимо только отметить, что некоторые постоянные приборов, приведенные им, оказались ошибоч-

Фиг. 3. Сейсмографы системы Боша — Омори.

История развития сейсмологических наблюдений на Дальнем Востоке России

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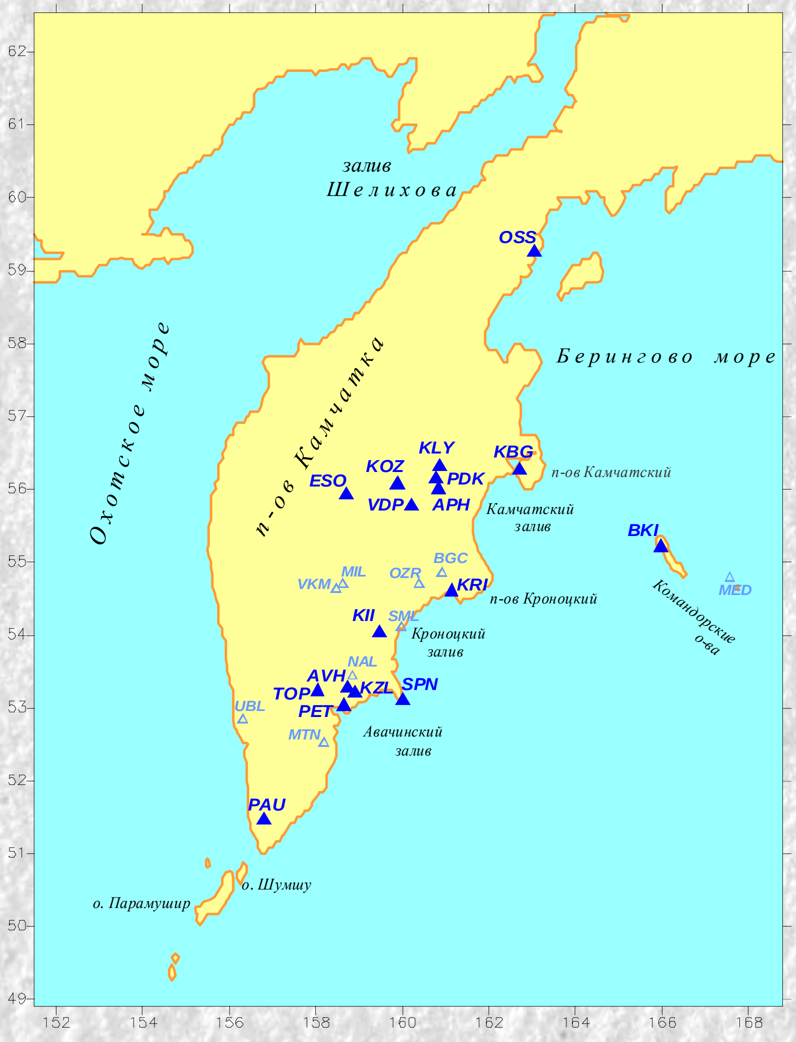
С 1957 г. на Курильских островах, с 1961 г. на Камчатке и далее в других регионах Дальнего Востока началось создание региональных сетей сейсмологических наблюдений.

СЕТЬ СЕЙСМИЧЕСКИХ СТАНЦИЙ КАМЧАТКИ

1974 - 1979 гг.

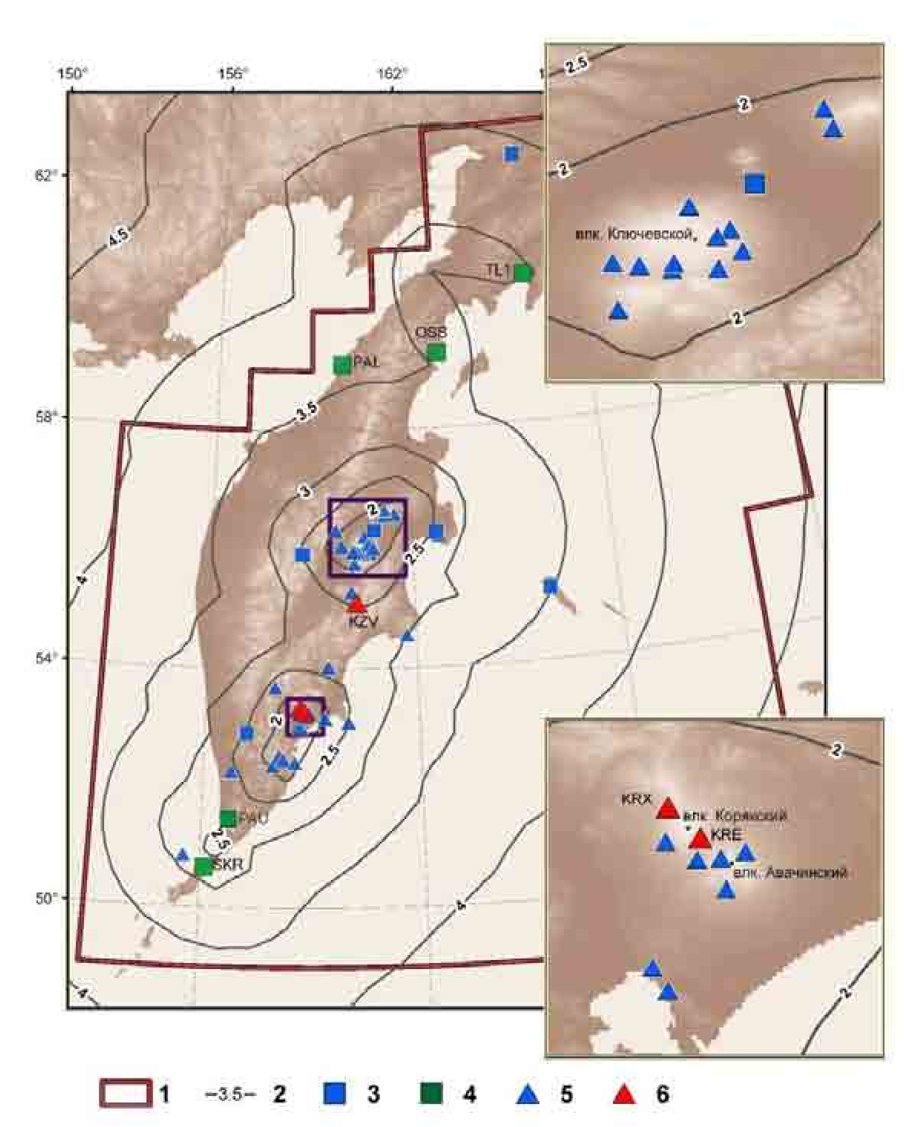


В Институте вулканологии ДВНЦ АН СССР с целью необходимости расширения системы контроля активности действующих вулканов в 1974 г. были начаты работы по созданию радиотелеметрических сейсмических станций (РТСС). В 1977 г. на Авачинской группе вулканов были открыты первые 4 станции РТСС.

В 1979 г. - 19 станций, из них 4 - радиотелеметрические.

СЕТЬ СЕЙСМИЧЕСКИХ СТАНЦИЙ КАМЧАТКИ

2000 - 2009 гг.



12 цифровых стационарных цифровых сейсмических станций

38 радиотелеметрических сейсмических станций (РТСС)

Данные всех станций доступны в режиме реального времени на региональном ИОЦ Камчатского филиала ГС РАН

1 – граница сейсмоактивного региона «Камчатка и Командорские острова»;

2 - расчетные контуры надежной регистрации землетрясений с указанной Ml;

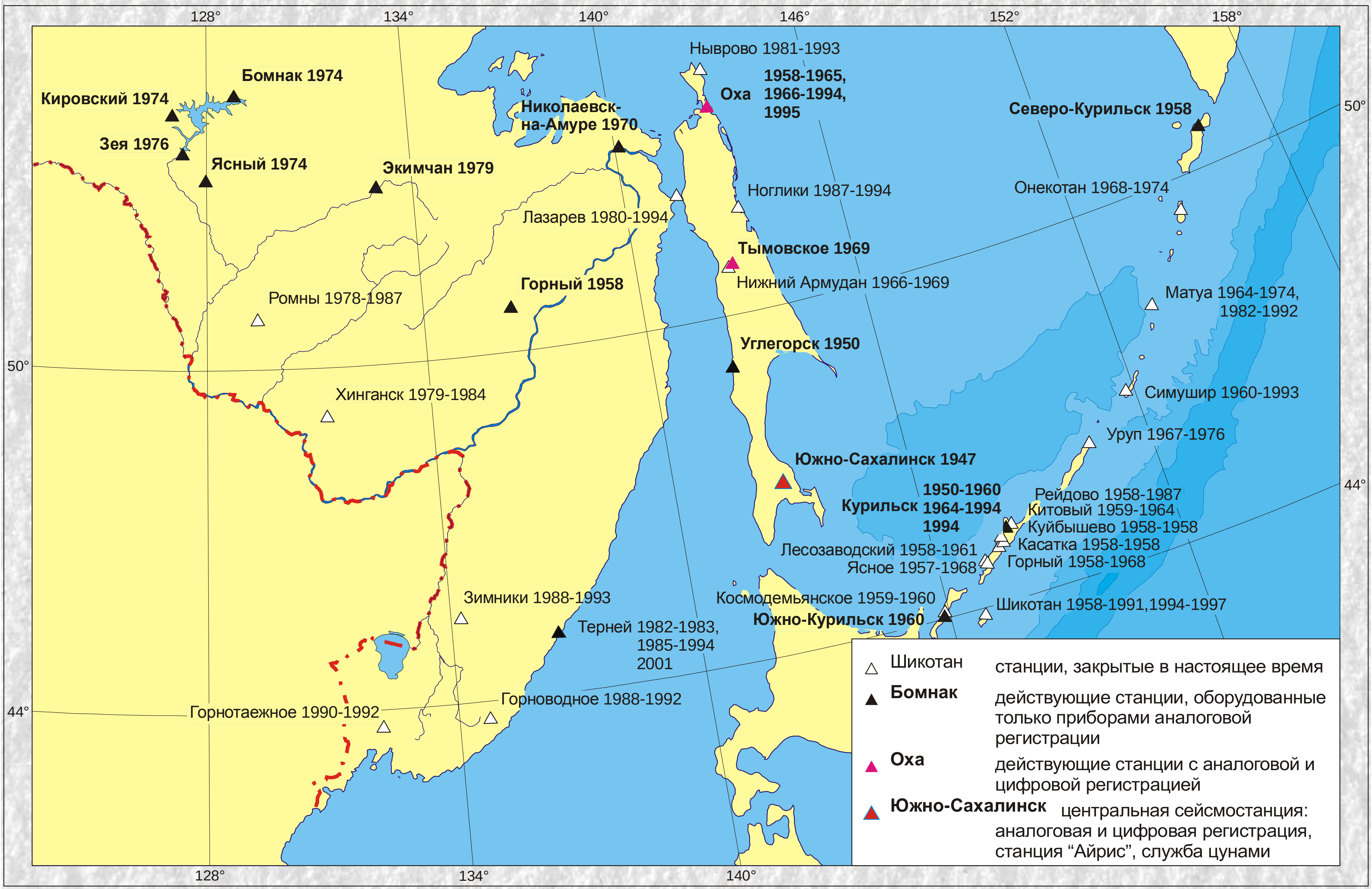
3 - стационарные цифровые станции;

4 – модернизированные в 2009 г. стационарные станции;

5 - станции РТСС по состоянию на 1.01.2009;

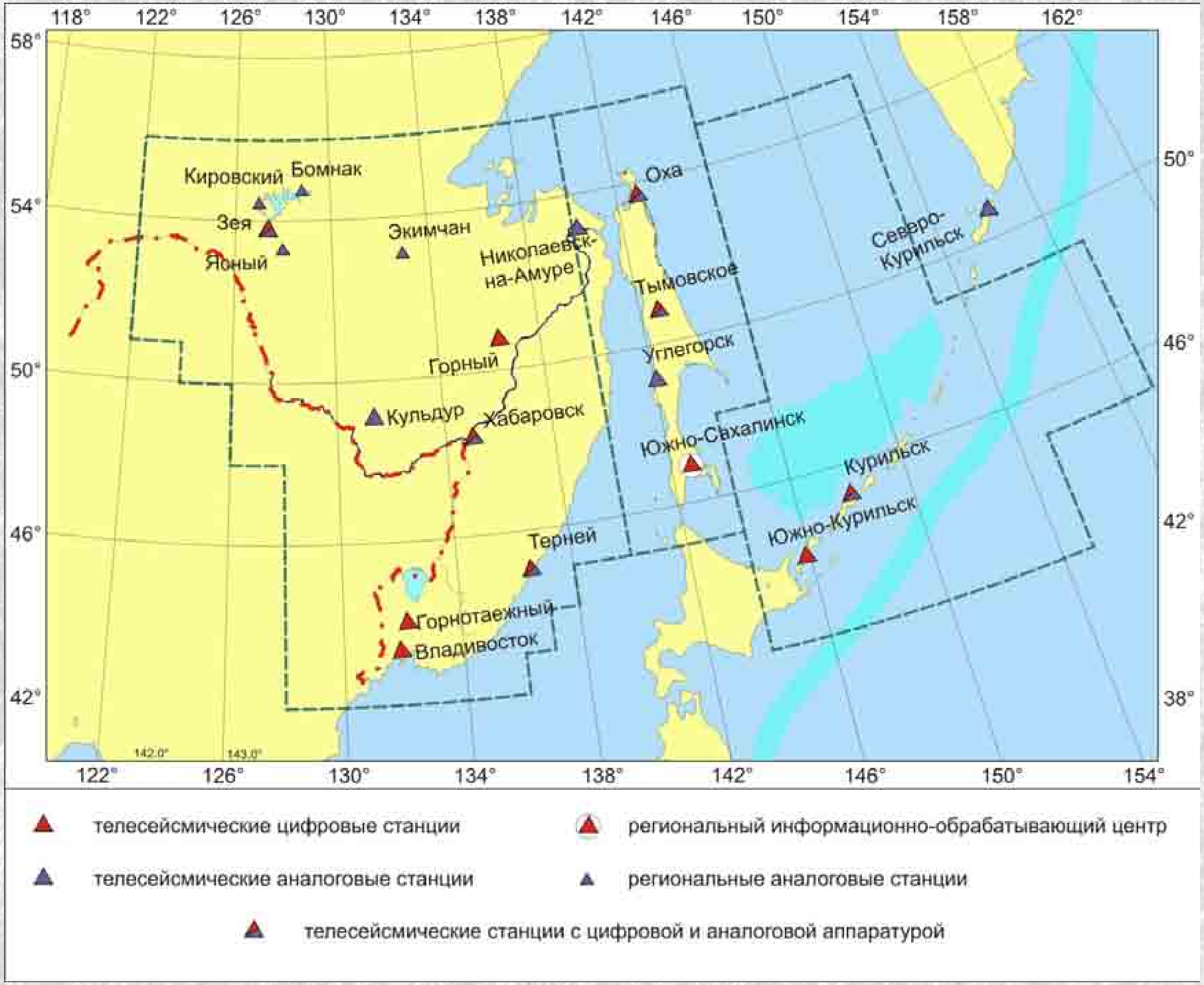
6 – станции РТСС, установленные в 2009 г.

Развитие сети сейсмических станций на Курильских островах 1947 - 2000 гг.



Сеть станций ГС РАН на Курильских островах, о. Сахалин, Приморском и Хабаровском краях , современное состояние

12 цифровых станций , из них *10* широкополосные, доступны в реальном времени данные *4* станций



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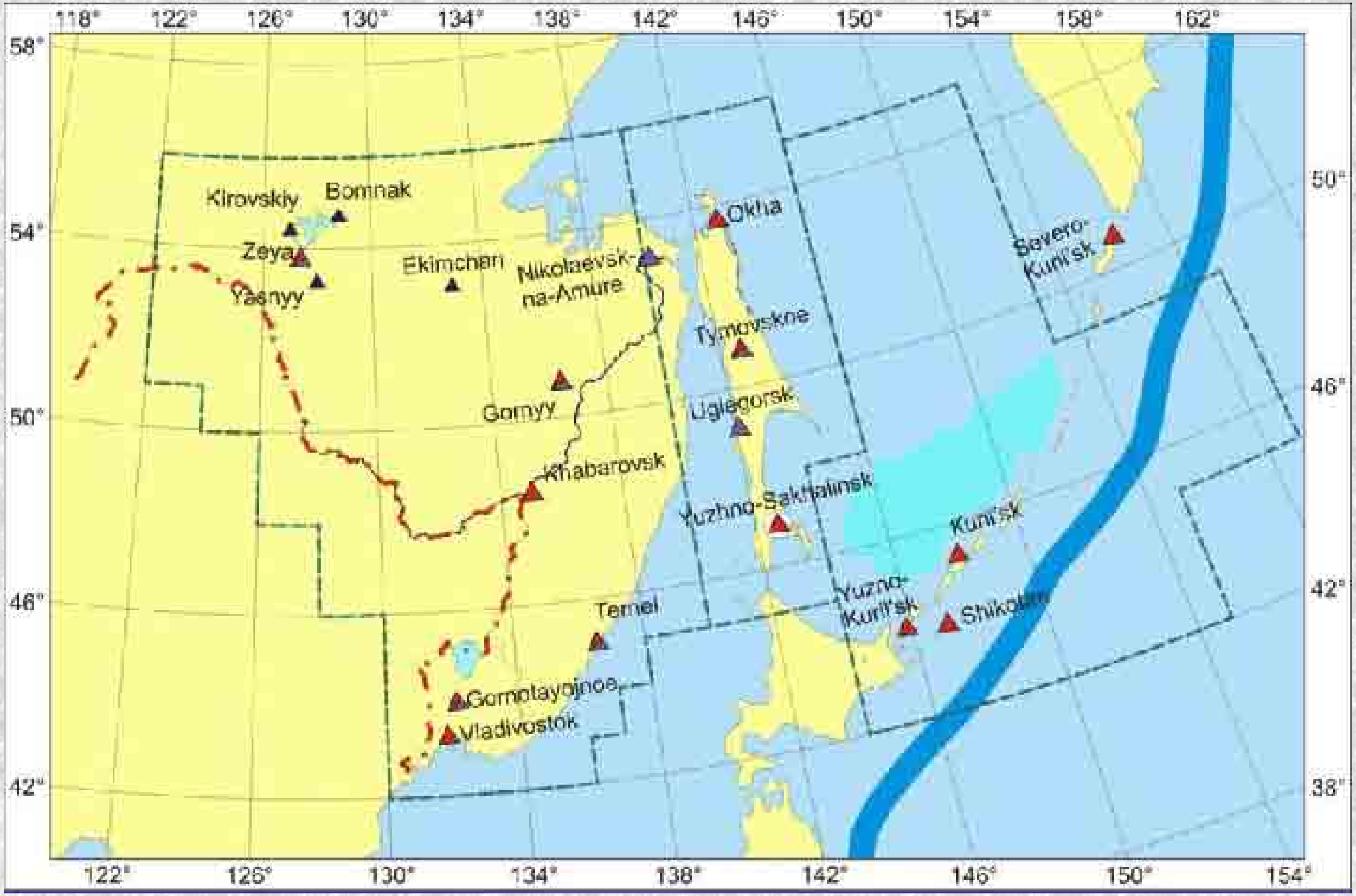
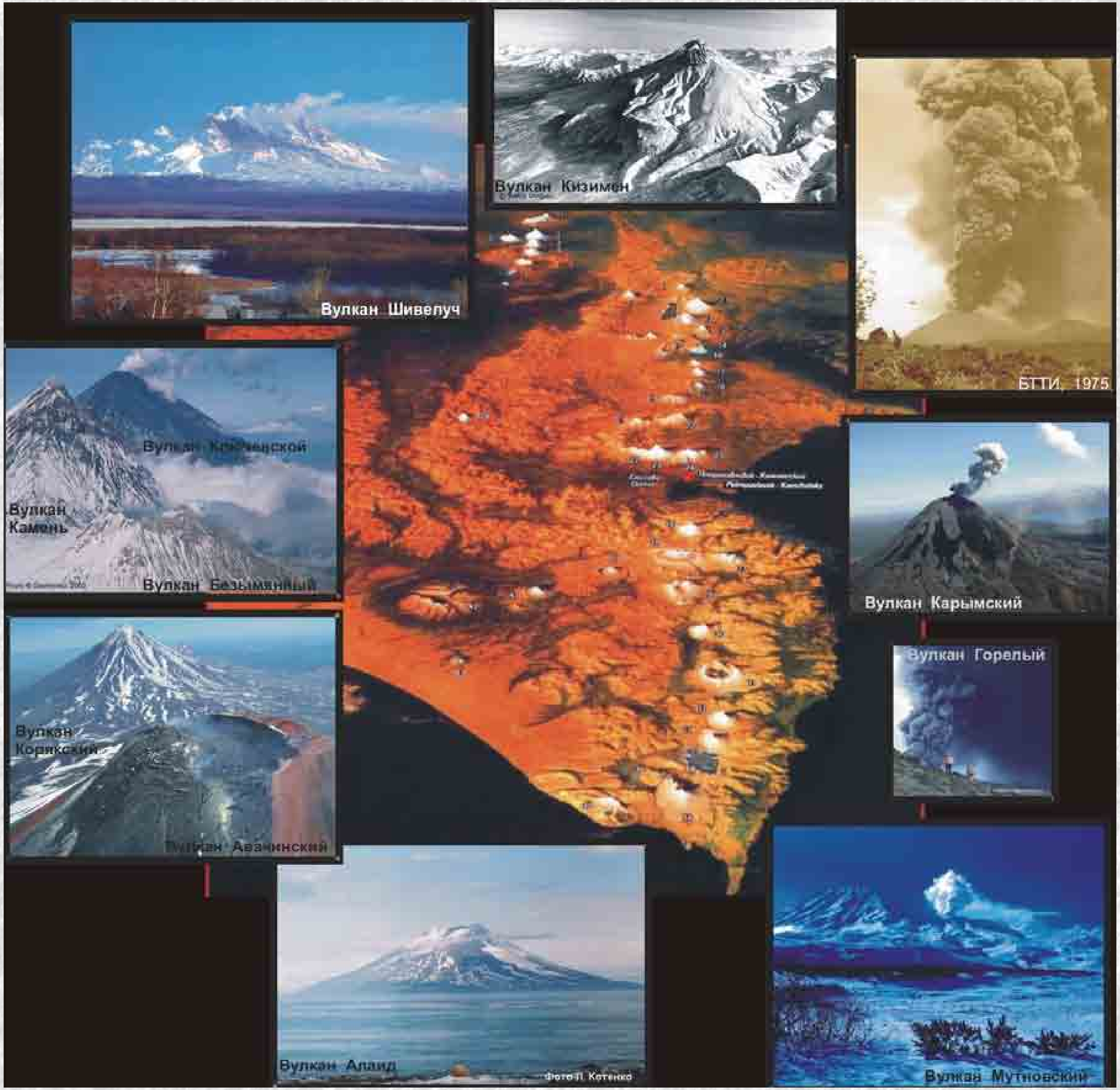




Сегодня с разной степенью детальности контролируется 12 наиболее активных камчатских вулканов и вулкан Алаид на о.Атласова.

Радиотелеметрические сейсмические станции на активных вулканах Камчатки

9

3

5

3

2

В настоящее время достаточная для адекватных оценок вулканической опасности детальность наблюдений обеспечена сетями радиотелеметрических сейсмических станций только на Ключевской и Авачинской группах вулканов.

На Курильских островах специальные сейсмические наблюдения на активных вулканах не ведутся.

Геофизической службой РАН, Институтом вулканологии и сейсмологии, Институтом морской геологии и геофизики ДВО РАН разработаны предложения, которые предусматривают развитие системы сейсмического мониторинга действующих вулканов на Камчатке и создание такой системы на Курильских островах.

Реализация этих предложений требует значительных финансовых затрат.

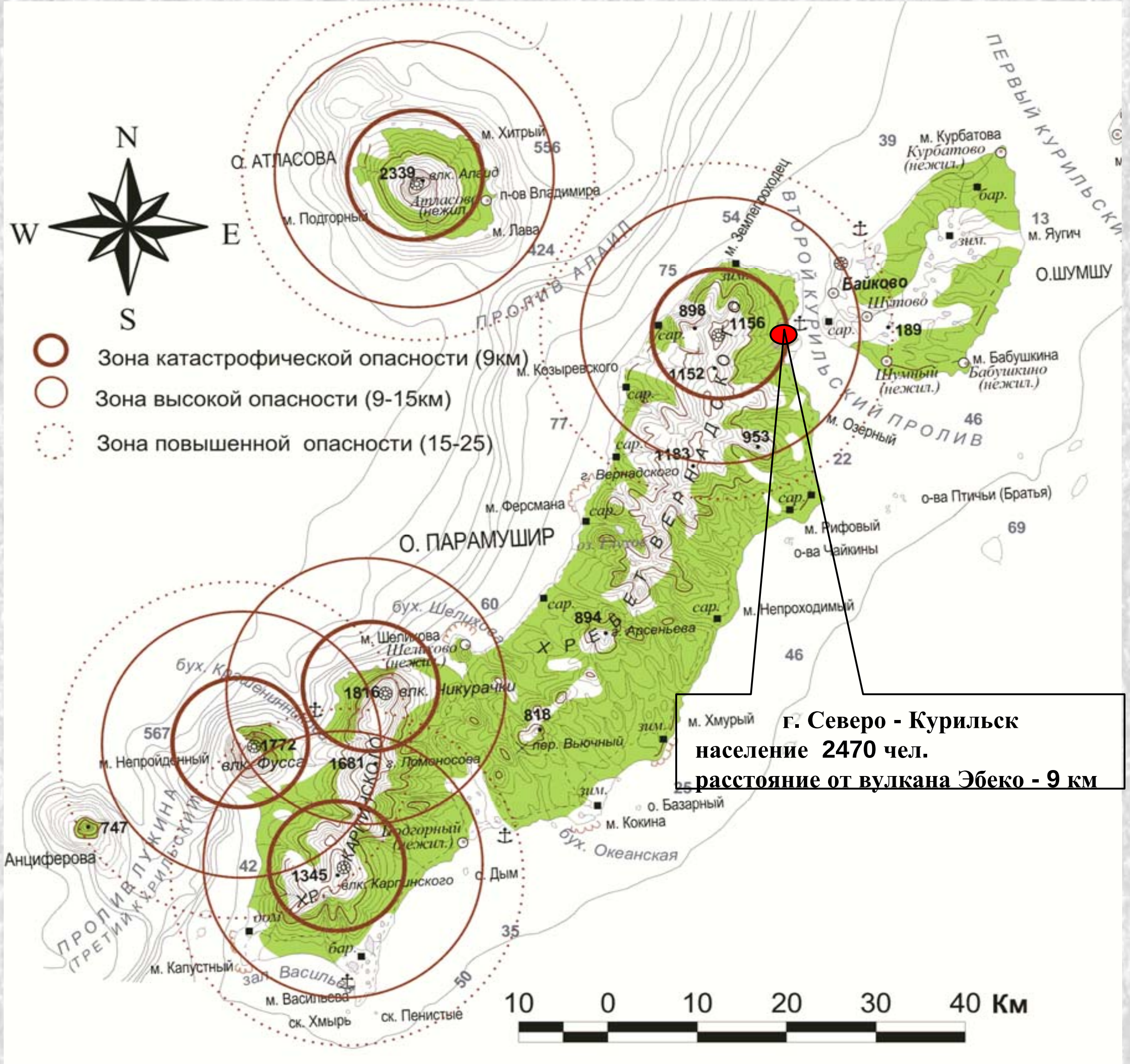
На локальном уровне полной (достаточной) системой мониторинга не обеспечены действующие вулканы южной части Камчатки (кроме Авачинского), Северных и Южных Курил.

Это вулканы Карымский, Корякский, Мутновский, Горелый, Асача, Эбеко, Алаид, Чикурачики, Фусса, Немо, Креницына, Менделеева, Тятя и др.

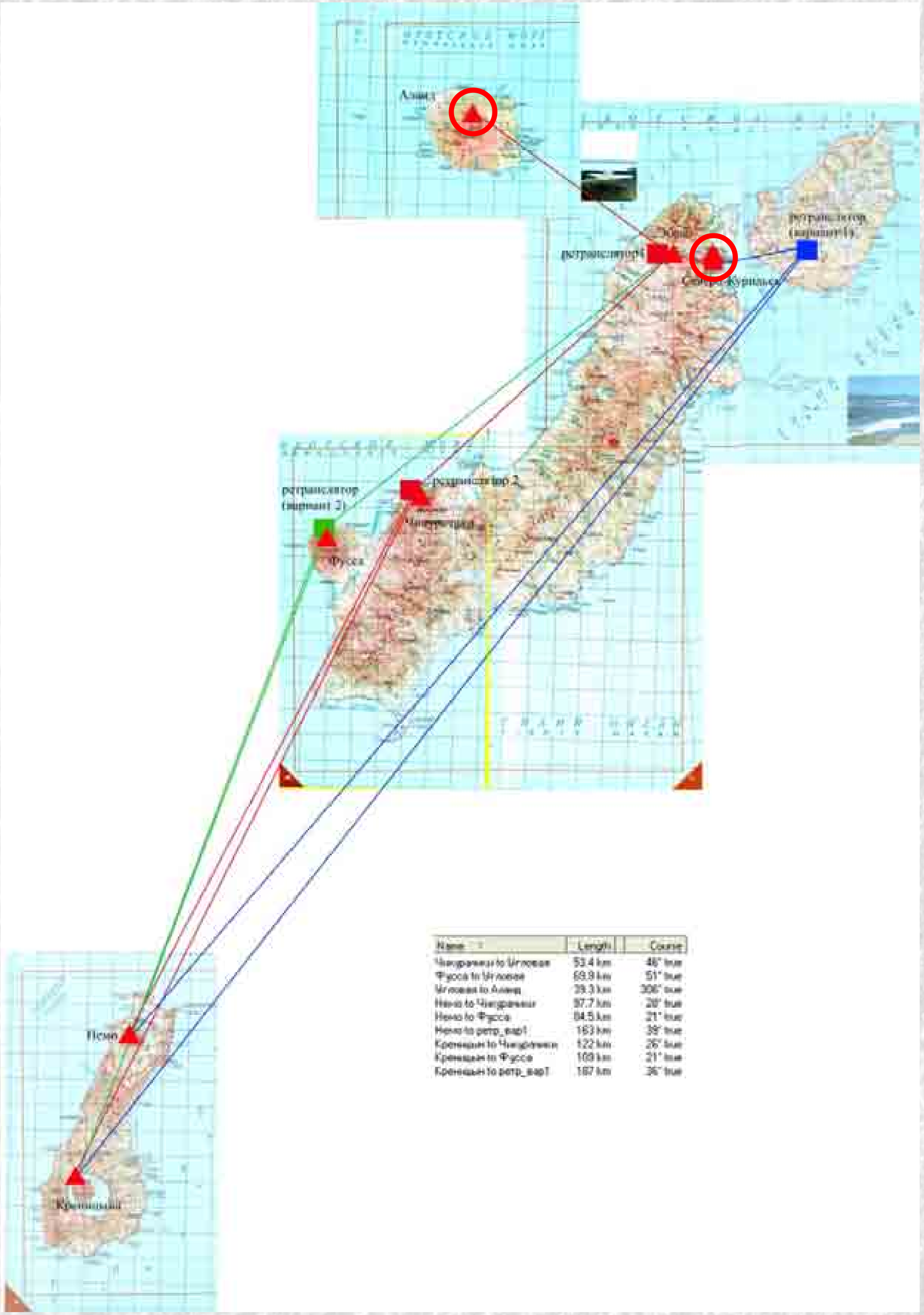
В настоящее время контроль активности вулканов выполняется ежедневно с 08:30 до 18:00 местного времени. Для обеспечения безопасности населения и полетов при извержениях вулканов Камчатки и Северных Курил необходим непрерывный, круглосуточный, режим слежения за вулканами.

Предложения ГС РАН, ИВиС и ИМГиГ ДВО РАН предусматривают создание локальных систем мониторинга вулканов Камчатки и Северных Курил , объединенных в единую систему контроля и предупреждения о вулканической опасности.

Прогноз опасности возникновения ЧС, связанных с извержением вулканов на острове Парамушир



Проект системы мониторинга вулканической активности Северных Курил



Name	Length	Course
Чикурачки to Угловая	53.4 km	46° true
Фусса to Угловая	69.9 km	51° true
Угловая to Алаид	39.3 km	306° true
Немо to Чикурачки	97.7 km	28° true
Немо to Фусса	84.5 km	21° true
Немо to ретр_вар1	163 km	39° true
Креницын to Чикурачки	122 km	26° true
Креницын to Фусса	109 km	21° true
Креницын to ретр_вар1	187 km	36° true

Проект системы мониторинга вулканов Эбеко и Алаид

Прогноз опасности возникновения ЧС, связанных с извержением вулканов на острове Кунашир

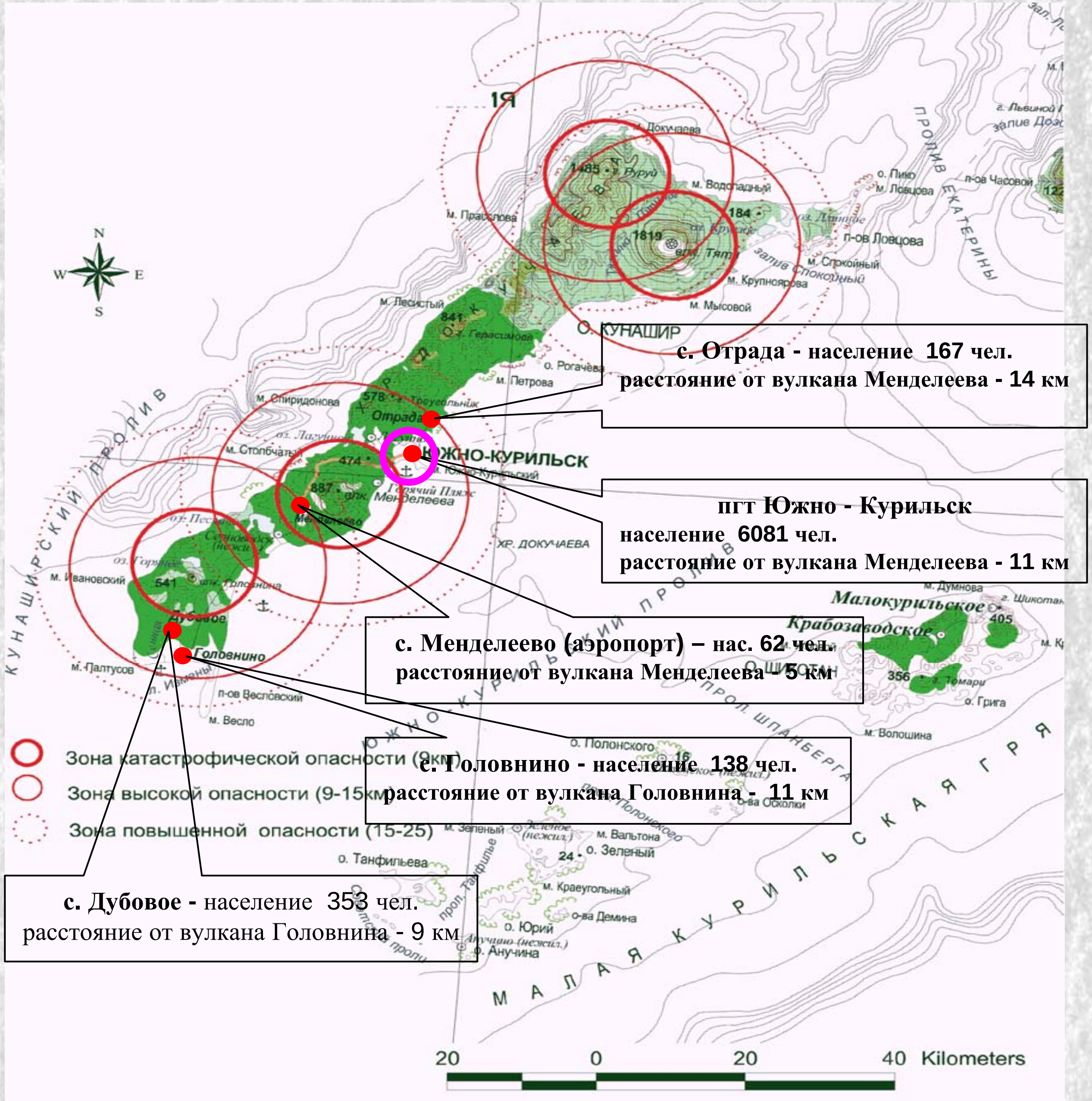
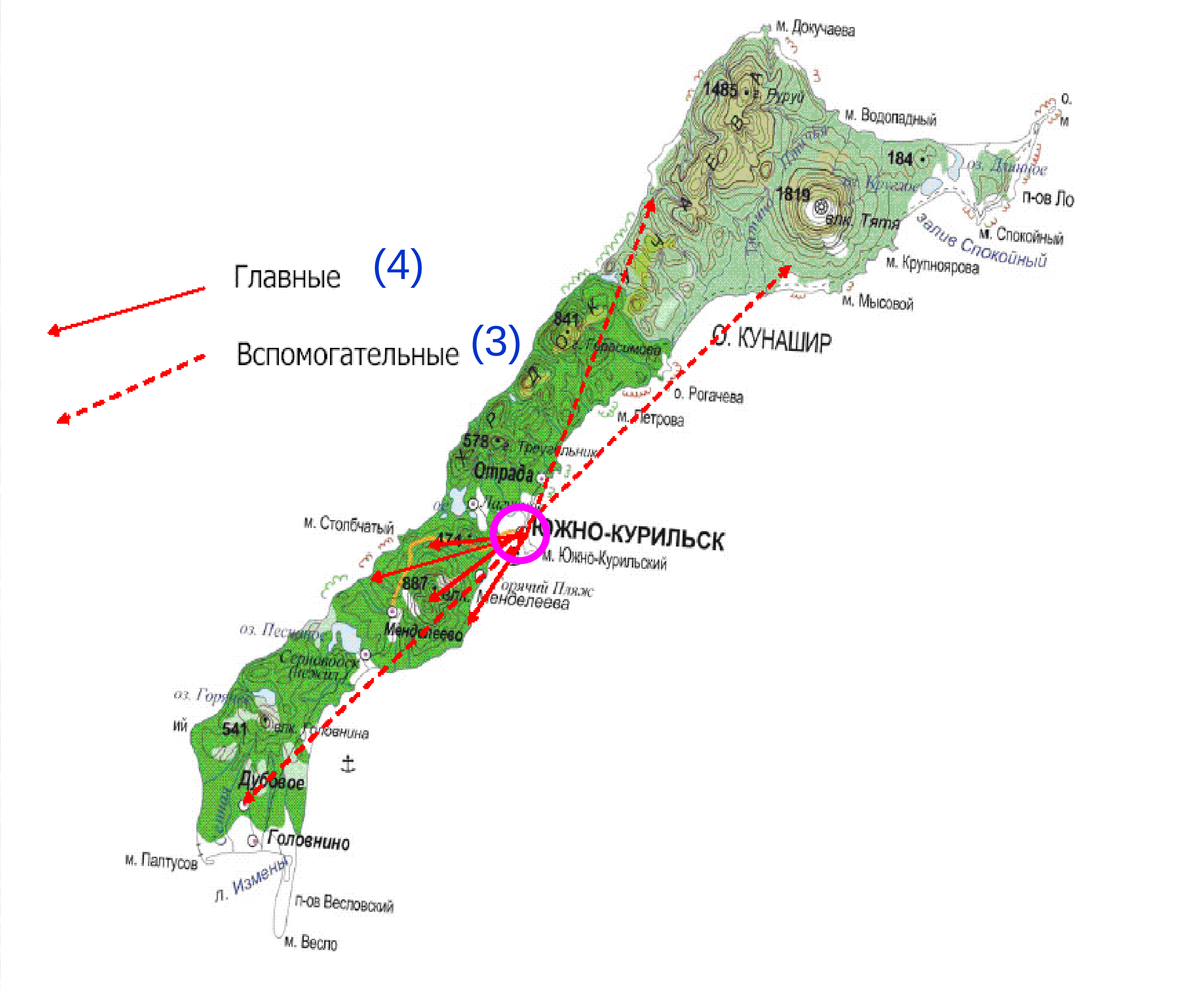


Схема размещения телеметрических станций на о. Кунашир

Окончания стрелок - места установки телеметрических станций

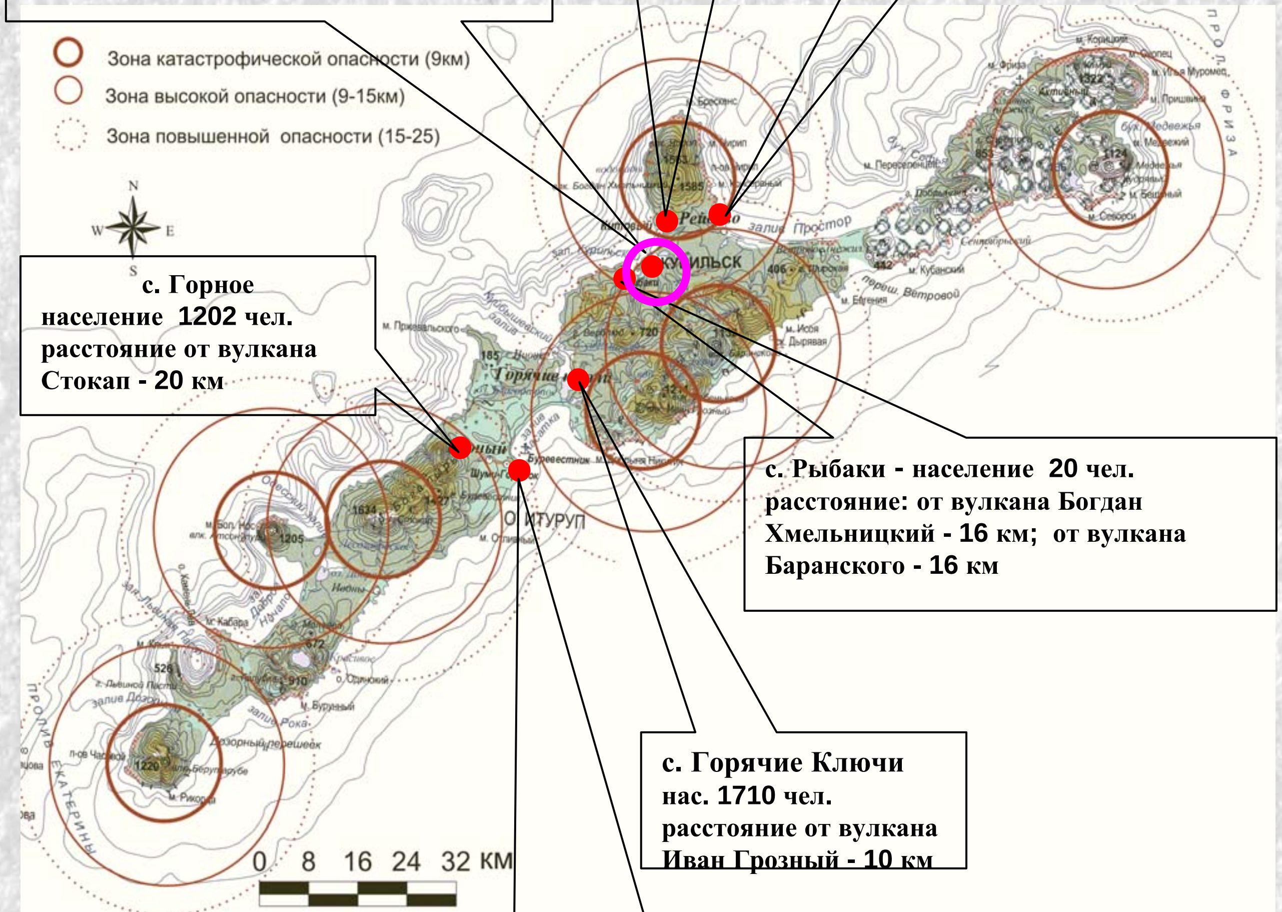


Прогноз опасности возникновения ЧС, связанных с извержением вулканов на острове Итуруп

с. Китовое - население 602 чел.
Расстояние от вулкана Богдан Хмельницкий - 9 км
от вулкана Баранского - 19 км

с. Рейдово - население 1007 чел.; расстояние от вулкана Богдан Хмельницкий - 12 км

г. Курильск - население 2005 чел.
расстояние: от вулкана Богдан Хмельницкий - 13 км
от вулкана Баранского - 16 км



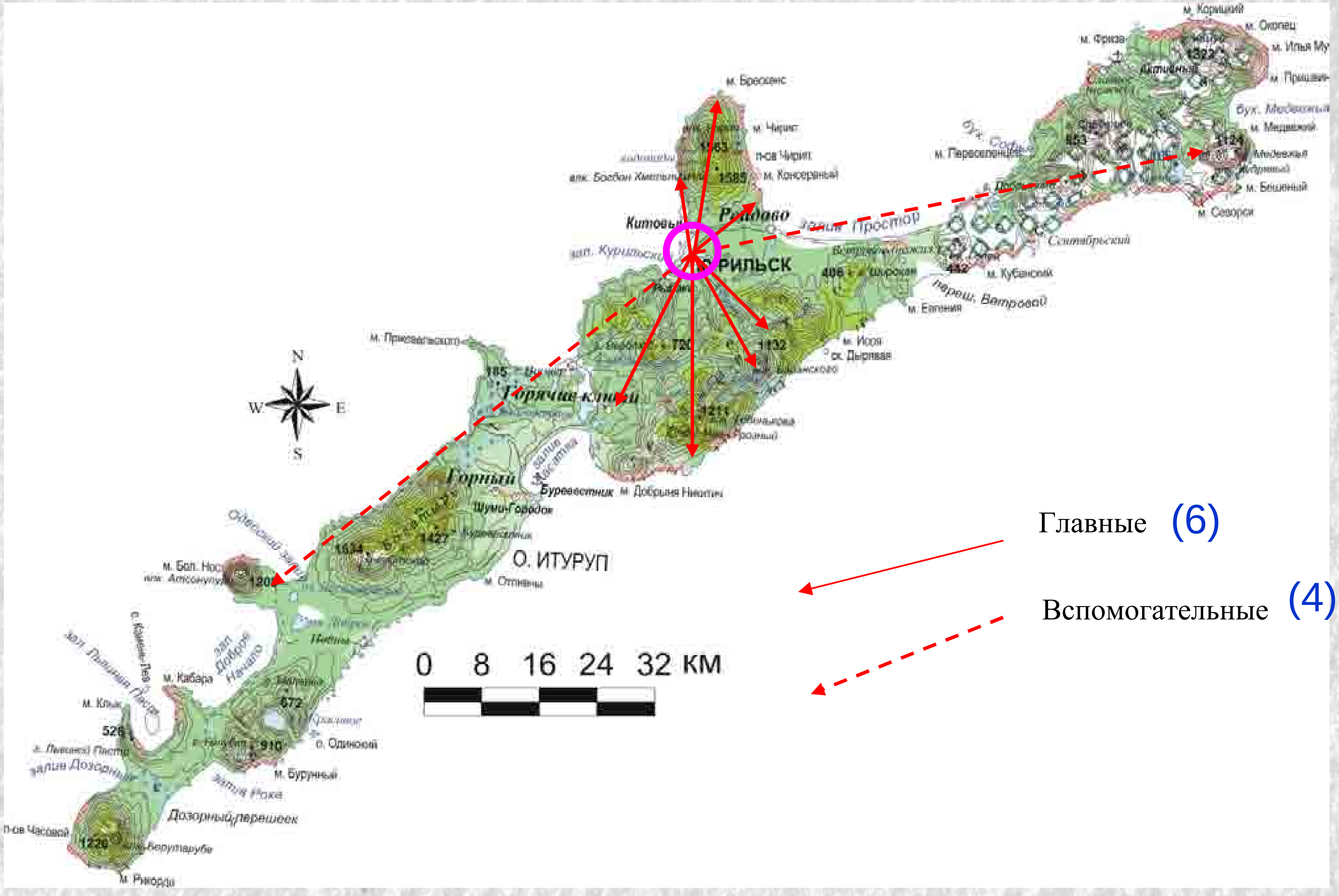
с. Горное
население 1202 чел.
расстояние от вулкана Стокап - 20 км

с. Рыбаки - население 20 чел.
расстояние: от вулкана Богдан Хмельницкий - 16 км; от вулкана Баранского - 16 км

с. Горячие Ключи
нас. 1710 чел.
расстояние от вулкана Иван Грозный - 10 км

с. Буревестник (аэропорт)
население 193 чел.; расстояние от вулкана Стокап - 23 км

Схема размещения телеметрических станций на о. Итуруп
Окончания стрелок - места установки телеметрических станций



Главные (6)

Вспомогательные (4)


Спасибо!

ISTC "Worldwide early warning system of volcanic activities and mitigation of the global/regional consequences of volcanic eruptions"

МОНИТОРИНГ СОСТОЯНИЯ И ПРОГНОЗ АКТИВНОСТИ ВУЛКАНОВ КАМЧАТКИ ПО СЕЙСМИЧЕСКИМ ДАННЫМ

В.Н. Чебров, С.Л. Сенюков

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г.Петропавловск-Камчатский,

Камчатский Филиал Геофизической Службы (КФ ГС) РАН

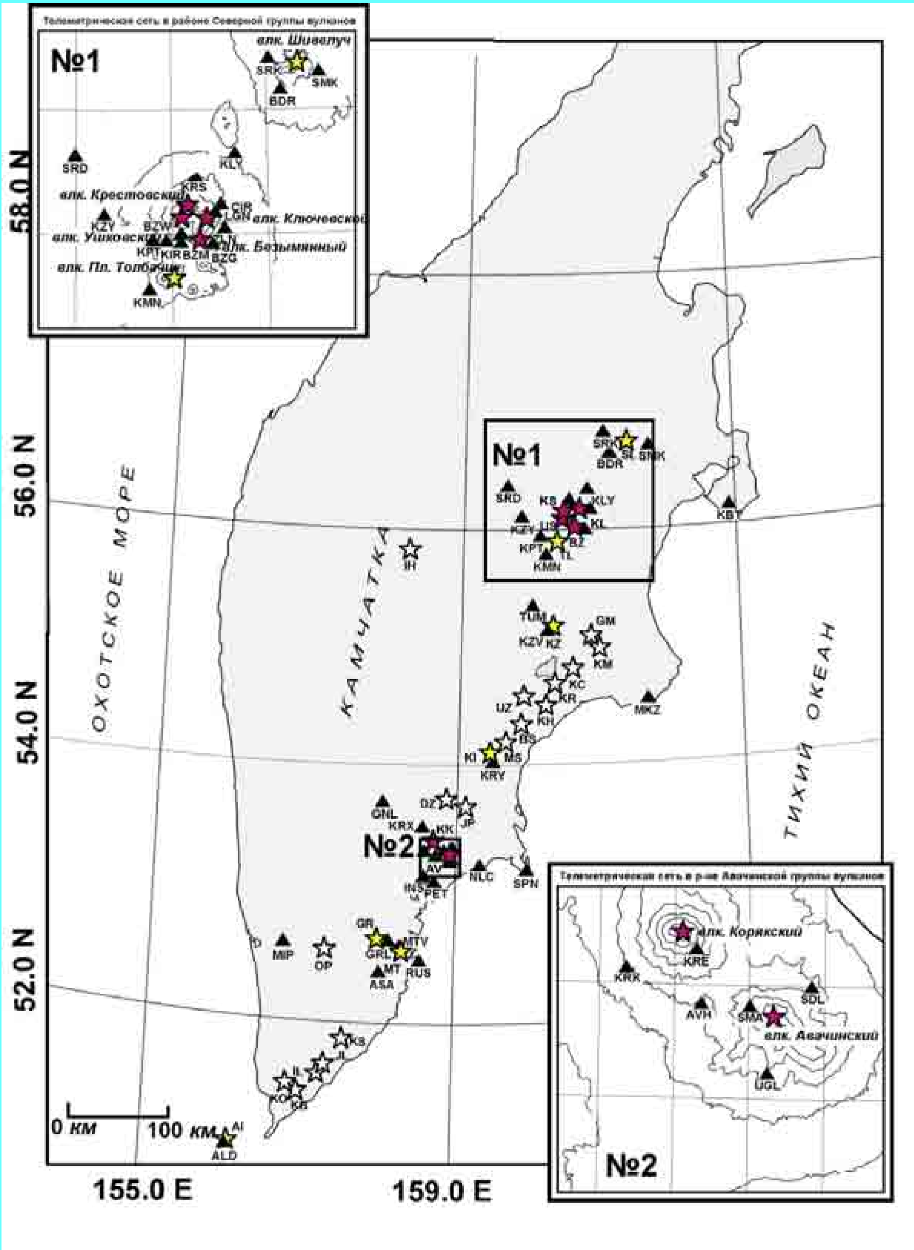
проводит мониторинг активности вулканов Камчатки в режиме близком к реальному времени с 2000г. **(http://www.emsd.ru/~ssl/monitoring/main.htm) по данным сейсмических, спутниковых, визуальных и видео наблюдений.**

Срочная информация о вулканической опасности передается по электронной почте или телефонам в ГУ МЧС Камчатского края, а также в рамках международного проекта KVERT в Аляскинскую Вулканологическую Обсерваторию (АВО) и в Институт вулканологии и сейсмологии ДВО РАН (ИВиС ДВО РАН) (в группу KVERT - Камчатская Группа Реагирования на Вулканические Извержения).

Из всех перечисленных выше направлений сейсмический мониторинг является ведущим методом, т.к. обеспечивает непрерывный круглосуточный контроль в режиме реального времени.

Первые исследования взаимосвязи активности вулканов с сейсмическими событиями были проведены известным камчатским вулканологом Г.С. Горшковым. Детальный анализ сейсмичности вулканов Ключевской группы был выполнен П.И. Токаревым и В. И. Горельчик.

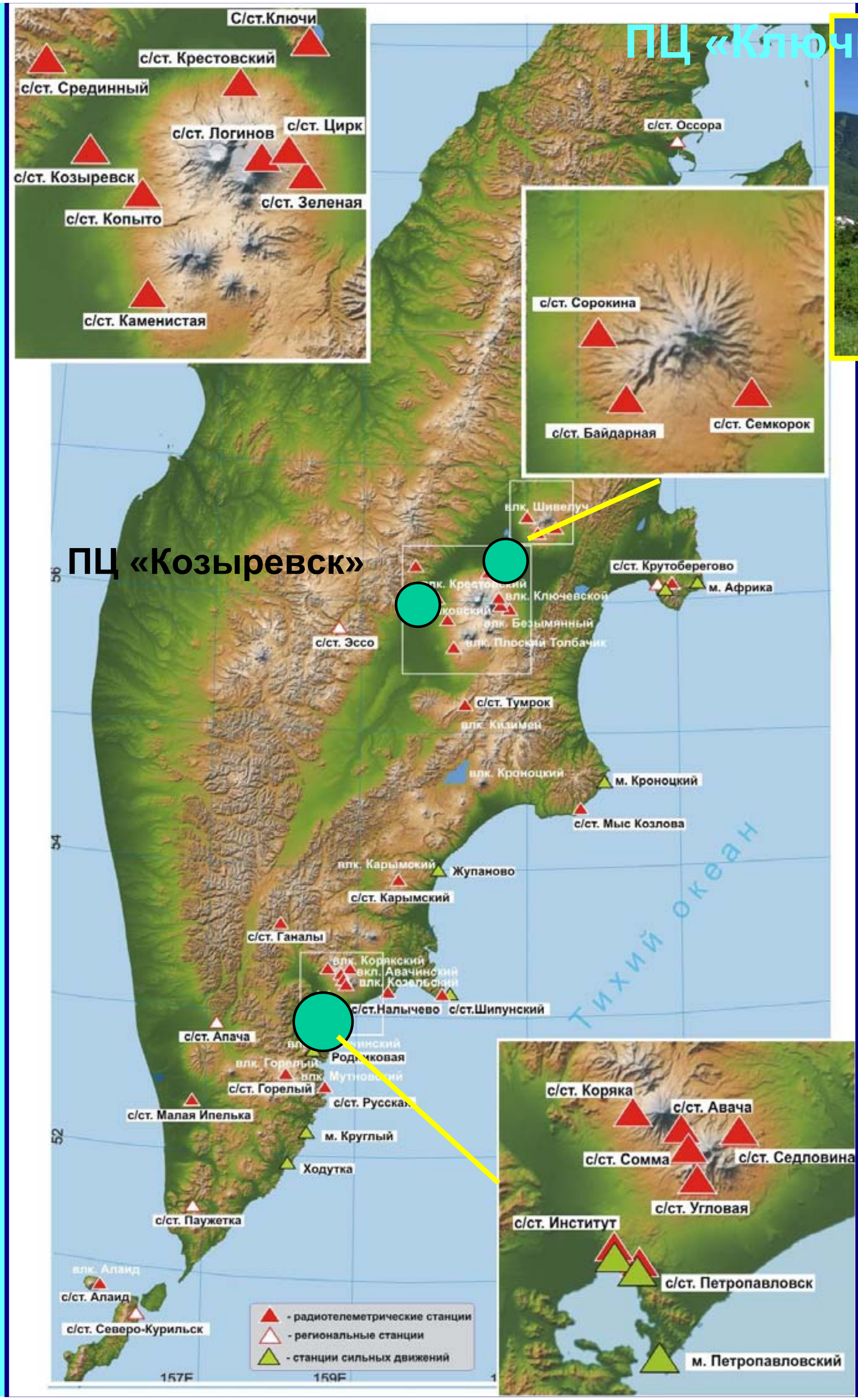
Результаты предыдущих исследований активных вулканов позволяют предположить, что интенсивность сейсмической подготовки пропорциональна силе готовящегося извержения.



- станции РТСС
- вулканы: белый цвет - нет контроля сейсмичности;
желтый цвет - ненадежный контроль сейсмичности
красный цвет - надежный контроль сейсмичности.

Эффективность мониторинга состояния и прогноза активности вулканов определяется детальностью системы наблюдений. В настоящее время необходимая детальность наблюдений обеспечена сетями радиотелеметрических сейсмических станций на Ключевской и Авачинской группах вулканов.

Всего на Камчатке *29* действующих вулканов *(*белый цвет*)*, на *6 (*красный цвет*)* из них установлено более *1* станции и на *7 (*желтый цвет*)* только по одной станции*.*



Сеть сейсмических станций Камчатки

Центр сбора и обработки данных «Петропавловск»

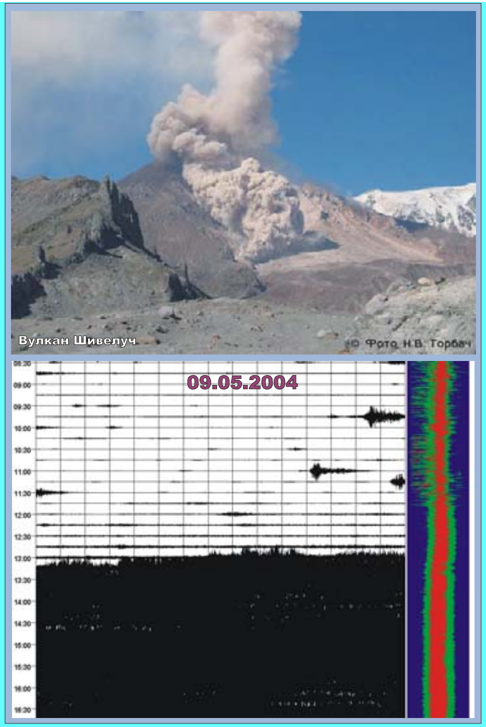
Основные принципы оценки состояния и прогноза вулканической активности по данным сейсмических наблюдений

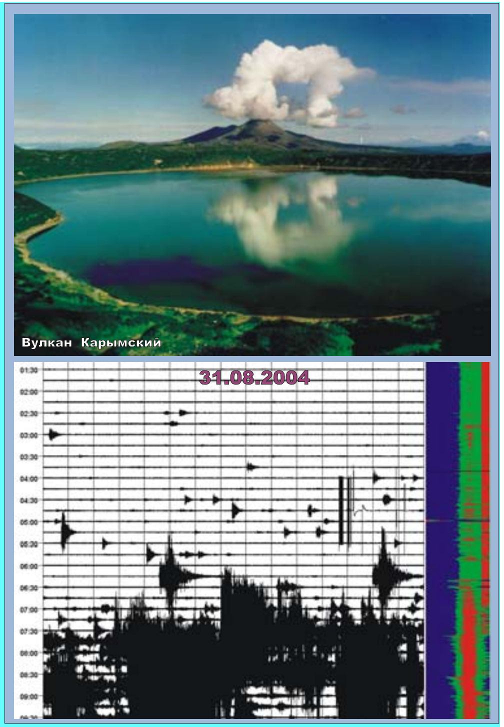
При регистрации сейсмических сигналов на действующих вулканах по числу землетрясений и их распределению в пространстве и времени, по выделившейся энергии, а также по спектральному составу сигналов и другим параметрам идентифицируются два уровня сейсмической активности: "фоновая" и "выше фона".

Понятие "фоновая", индивидуальное для каждого вулкана, оценивается по опыту регистрации. Уровень "фоновой" активности характеризуется отсутствием проявлений вулканической активности, представляющей реальную опасность (пепловые выбросы, лавовые потоки, лавины из раскаленного материала).

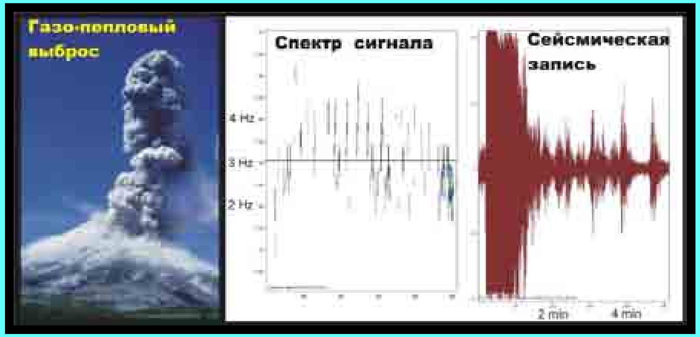
В режиме, близком к реальному времени, опираясь на понятие "выше фона" и на динамику уровня сейсмической активности, а также на накопленный опыт по регистрации извержений вулкана дается формализованное предупреждение об активизации вулкана с указанием типа извержения, его интенсивности, времени начала и продолжительности события, степени опасности для населения.

Контроль вулканических извержений по сейсмическим данным

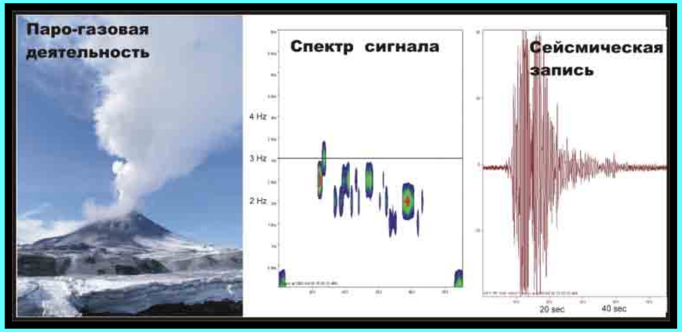


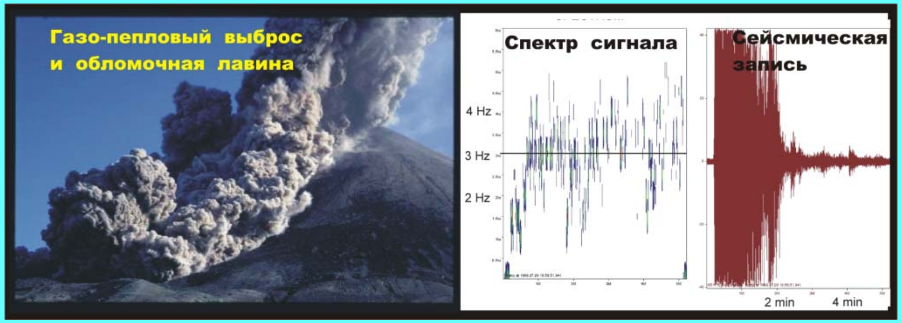


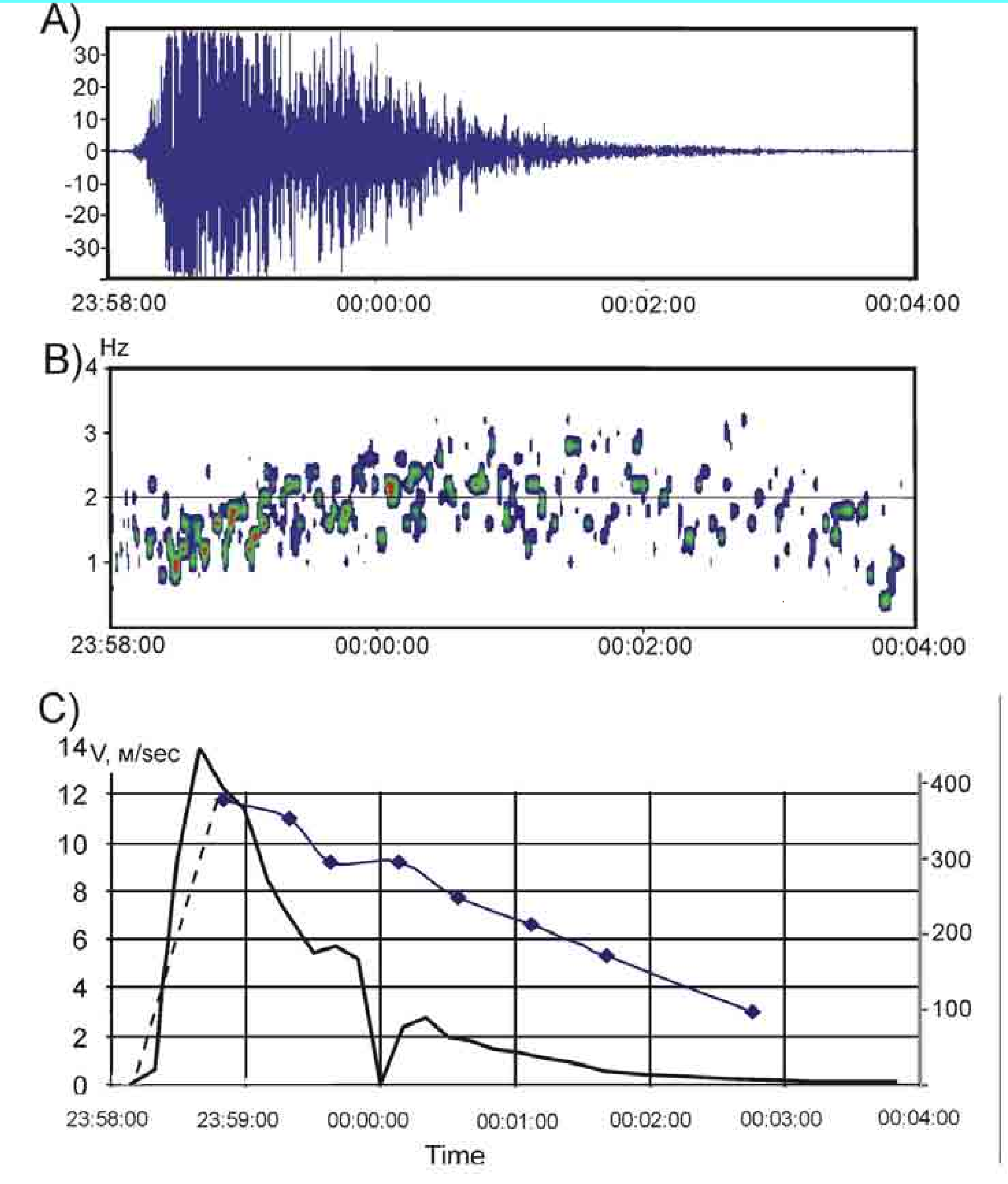
Распознавание происходящих на вулкане событий по сейсмическим данным



Создается база данных, включающая снимки зафиксированных на вулканах явлений и соответствующих им сейсмических записей.





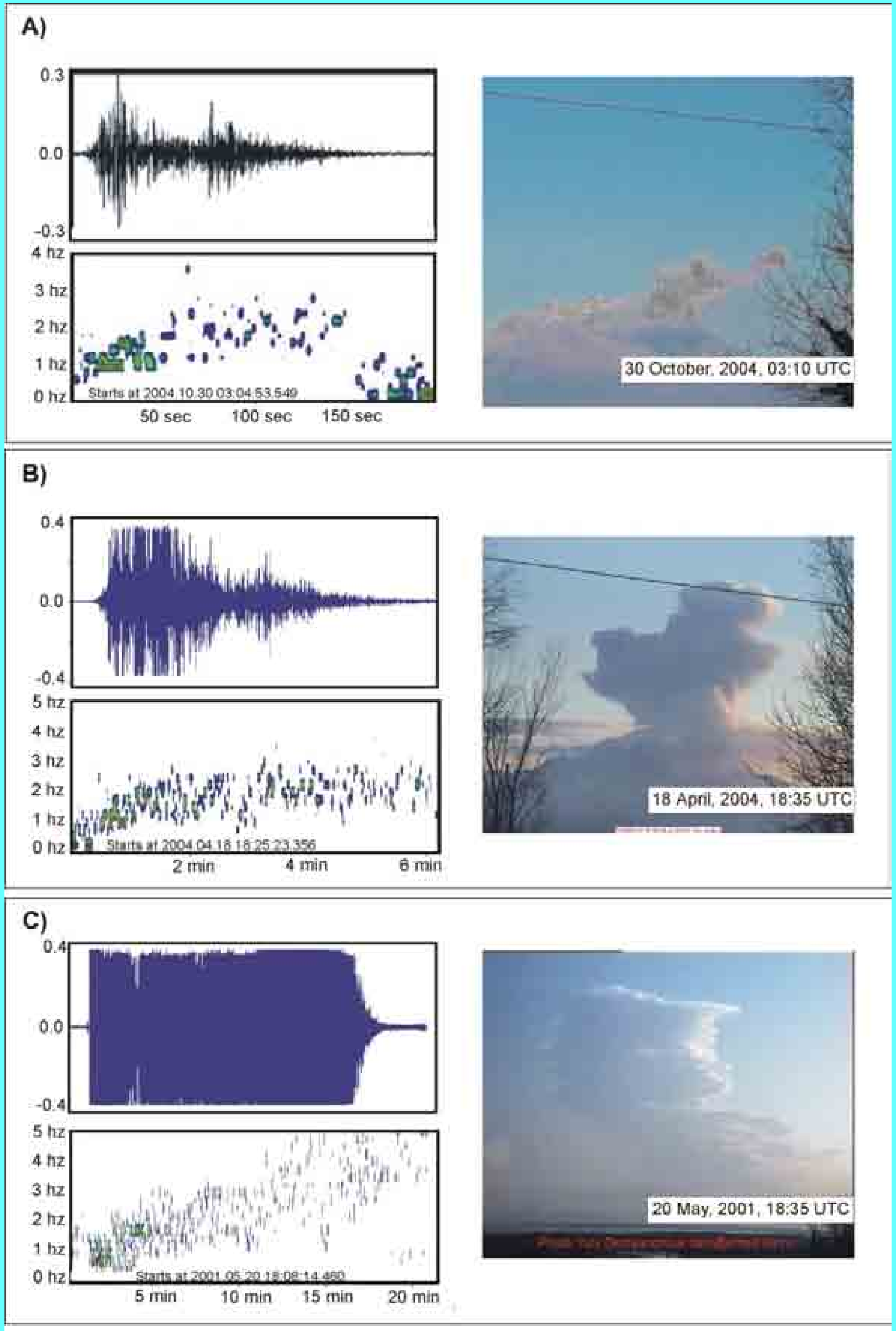


Эксплозивный взрыв на вулкане Шивелуч, *16* сентября *2002* г в *23* ч *58* мин*:*

А) сейсмический сигнал*;*

В) спектрограмма*;*

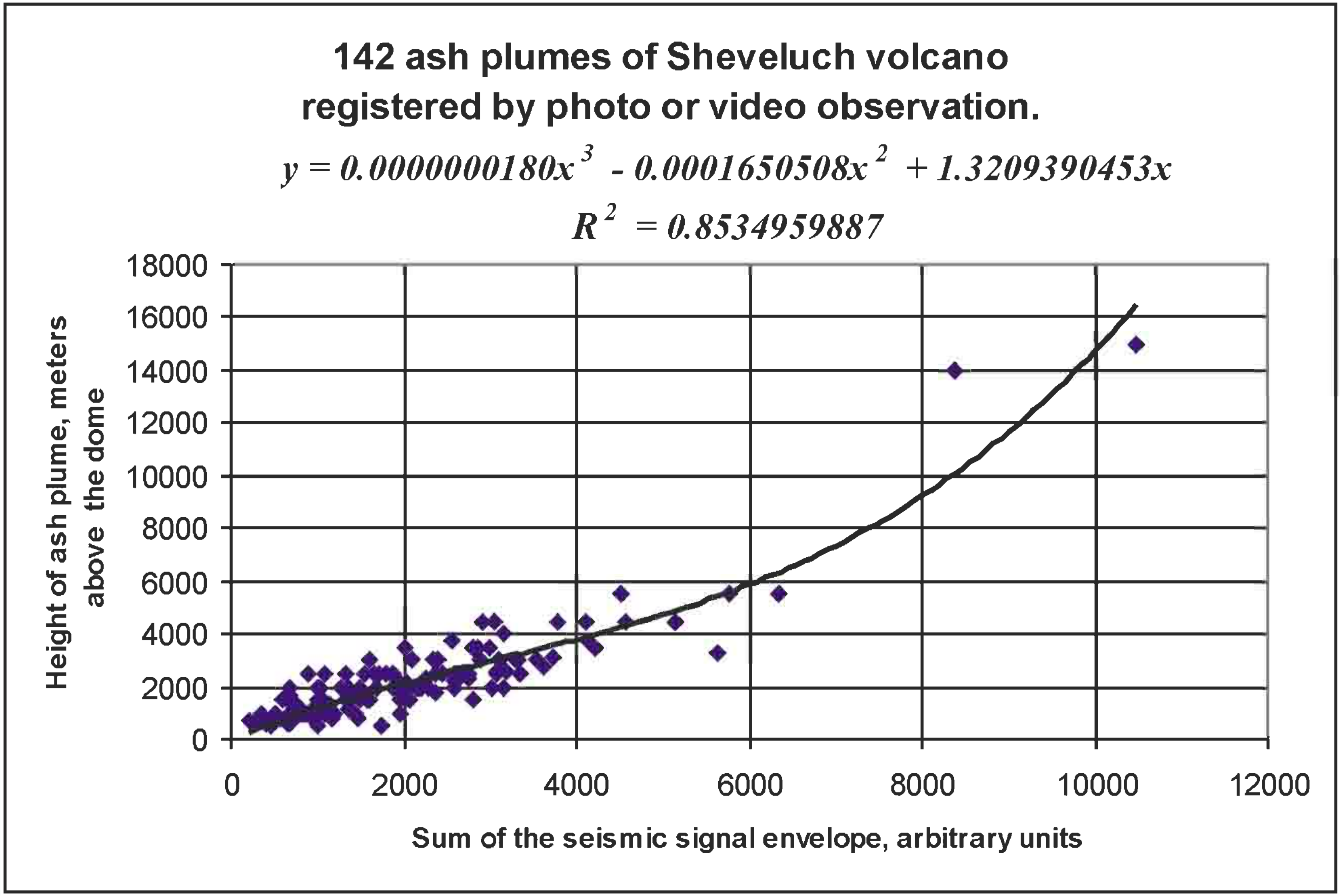
С) график огибающей сейсмического сигнала *(*черный цвет*)* и график скорости подъема пеплового облака *(*синий цвет*).*



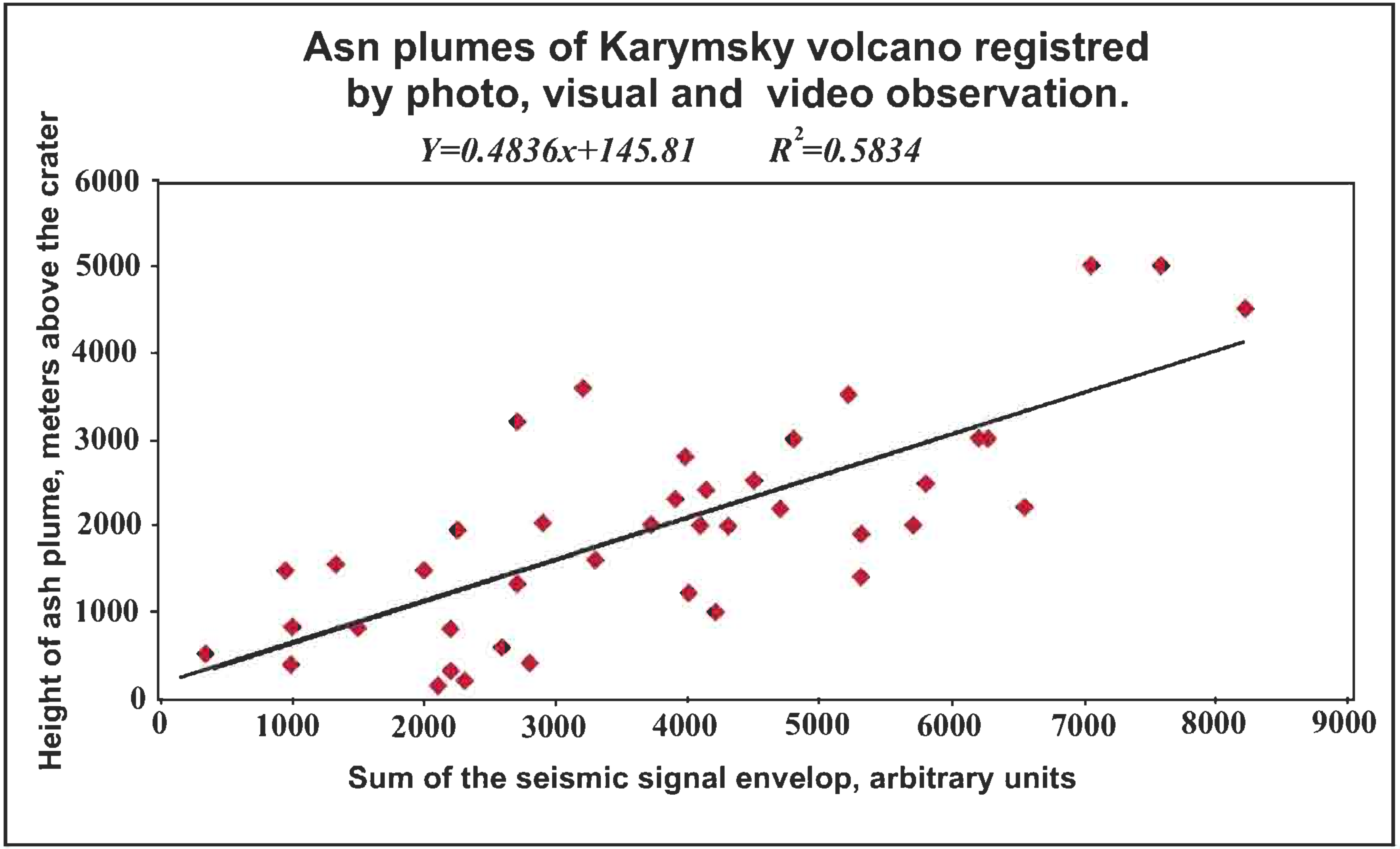
А) слабый пепловый выброс *30* октября *2004* г, запись сейсмического сигнала, сопровождающего этот выброс и СВАН-диаграмма сейсмического сигнала;

В) пепловый выброс *18* апреля *2004* г с высотой до *4* км над куполом, запись сейсмического сигнала, сопровождающего этот выброс и СВАН-диаграмма сейсмического сигнала;

С) пепловый выброс *20* мая *2001* г с высотой *9.5* км над куполом и последующим пирокластическим потоком, запись сейсмического сигнала, сопровождающего этот выброс и СВАН-диаграмма сейсмического сигнала.

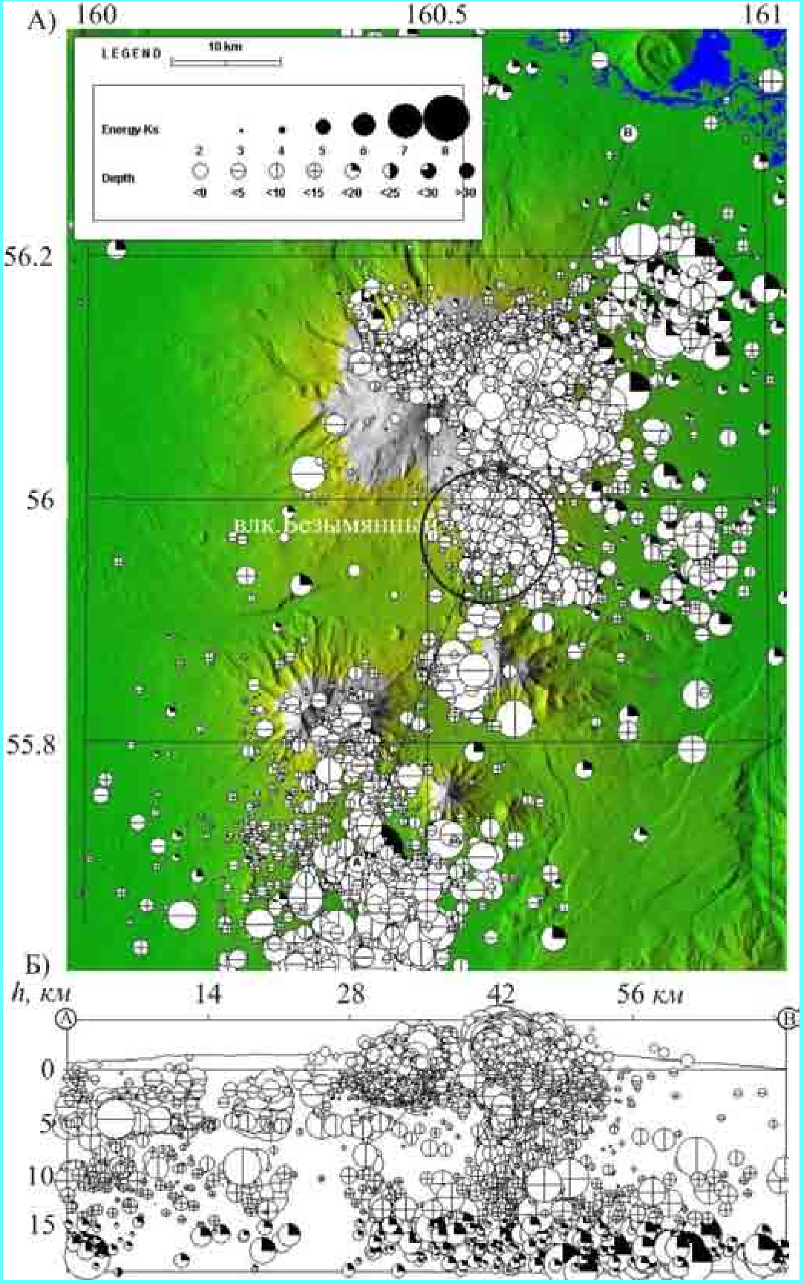


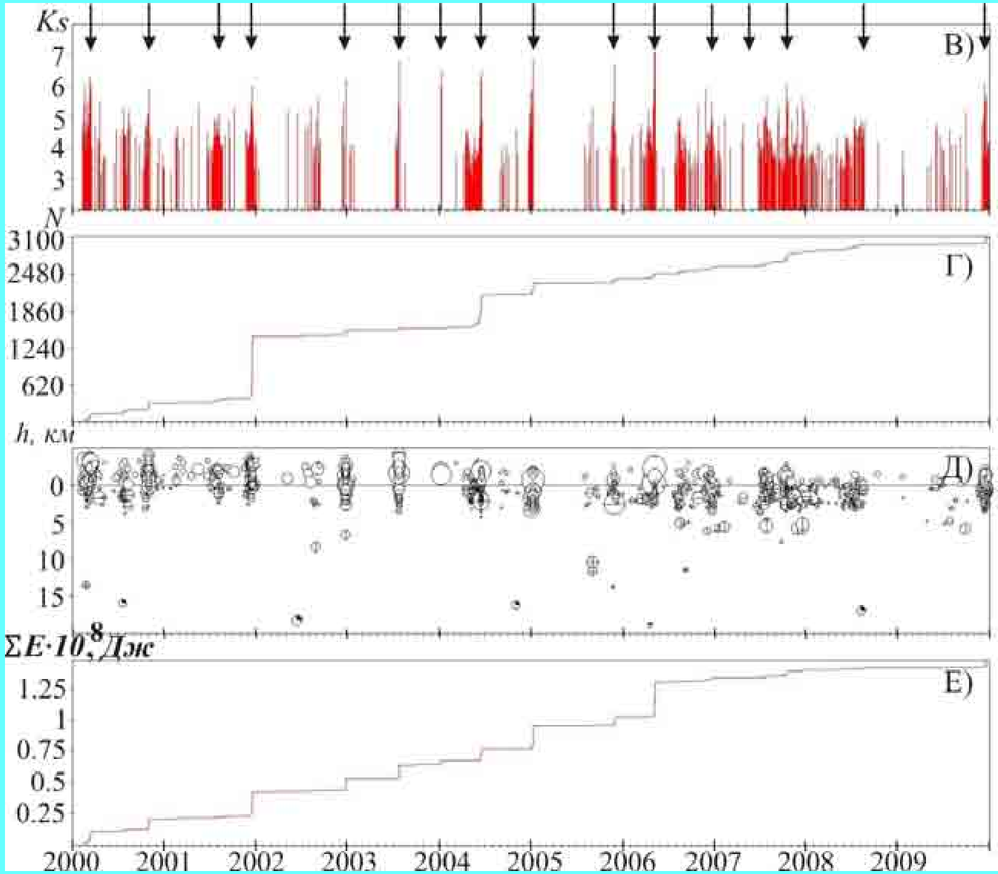
142 ash plumes of Sheveluch volcano
registered by photo or video observation.
y = 0.0000000180x^3 - 0.0001650508x^2 + 1.3209390453x
R^2 = 0.8534959887
Height of ash plume, meters above the dome
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
0
2000
4000
6000
8000
10000
12000
Sum of the seismic signal envelope, arbitrary units


Asn plumes of Karymsky volcano registred
by photo, visual and video observation.
Y=0.4836x+145.81
R2=0.5834
Height of ash plume, meters above the crater
0
1000
2000
3000
4000
5000
6000
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
Sum of the seismic signal envelop, arbitrary units

Большой накопленный материал по регистрации сейсмичности для различных состояний вулканов позволил создать базу данных для изучения разных режимов активности.

В результате исследований были выделены предвестники извержений вулканов Безымянный и Ключевской. Регистрация выделенных предвестников в режиме реального времени позволила официально сделать 6 успешных краткосрочных прогнозов из 7 последних эксплозивных извержений вулкана Безымянный и 3 успешных среднесрочных прогноза развития активности вулкана Ключевской.





Сейсмичность вулкана Безымянный в 2000-2009 гг.: А) карта эпицентров землетрясений; Б) проекция гипоцентров на вертикальный разрез вдоль линии А-В. Графики распределения во времени различных параметров землетрясений, выделенных окружностью: В) энергетический класс по S-волне; Г) кумулятивное количество землетрясений; Д) глубина гипоцентров, км; Е) кумулятивная энергия, Дж. Стрелками указаны эксплозивные извержения.

Цветовые коды состояния вулкана Безымянный по сейсмичности.

Минимальный класс землетрясений по одной станции “BZG”– 2.9, представительный класс по трем станциям – 3.8.

Белый **– корректный сейсмический мониторинг невозможен, если средняя амплитуда дрожания на вулкане Ключевском по с/ст «CIR» >1.0 мкм.сек;**

Зеленый **(фоновая сейсмичность)– землетрясения с глубиной от –5 км до +5 км, их количество N(3.0<Ks<4.0)< 10, слабая термальная аномалия, не интенсивнее, чем БТТИ 1975-76;**

Желтый **(сейсмичность выше фона)– землетрясения с глубиной от –5 км до +5 км, их количество N(Ks≥4.0) ≥1 или N(Ks≥3.0) ≥10;**

или наличие термальной аномалии, которая интенсивнее БТТИ 1975-76;

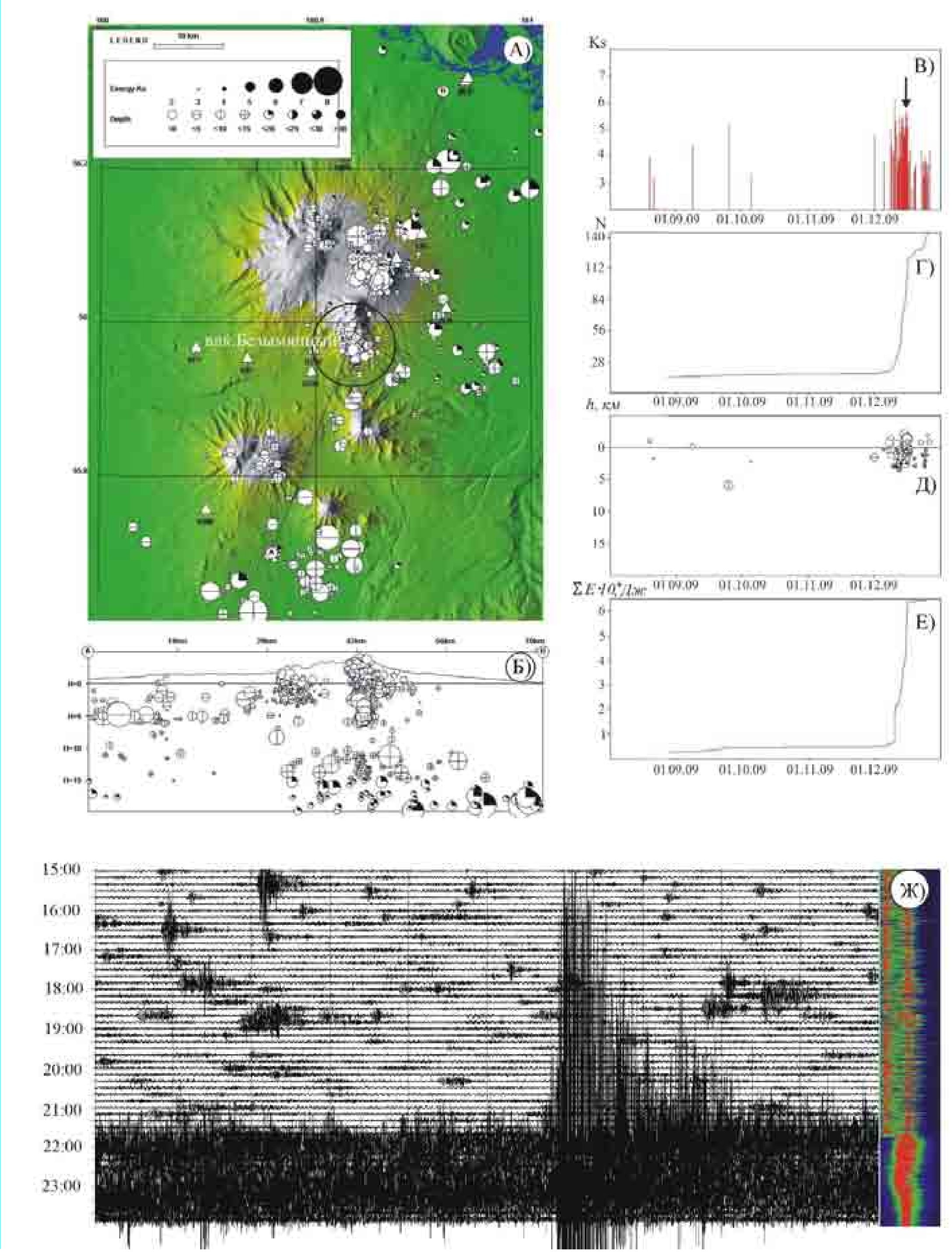
или вулканическое дрожание с A/T < 0.5 мкм/сек. на с/ст. “ ZLN ”;

или слабые пепловые выбросы до 2500м над кратером;

больше 5 лавин.

Оранжевый **(сейсмичность выше фона)– вулканическое дрожание с A/T ≥ 0.5 мкм/сек на с/ст. “ ZLN ”; или пепловые выбросы на высоту от 2500 м до 5000м над кратером.**

Красный **(сейсмичность выше фона)– вулканическое дрожание A/T ≥4.0 мкм/сек на с/ст. “ ZLN ” (или пепловые выбросы на высоту 5000м над кратером и более).**



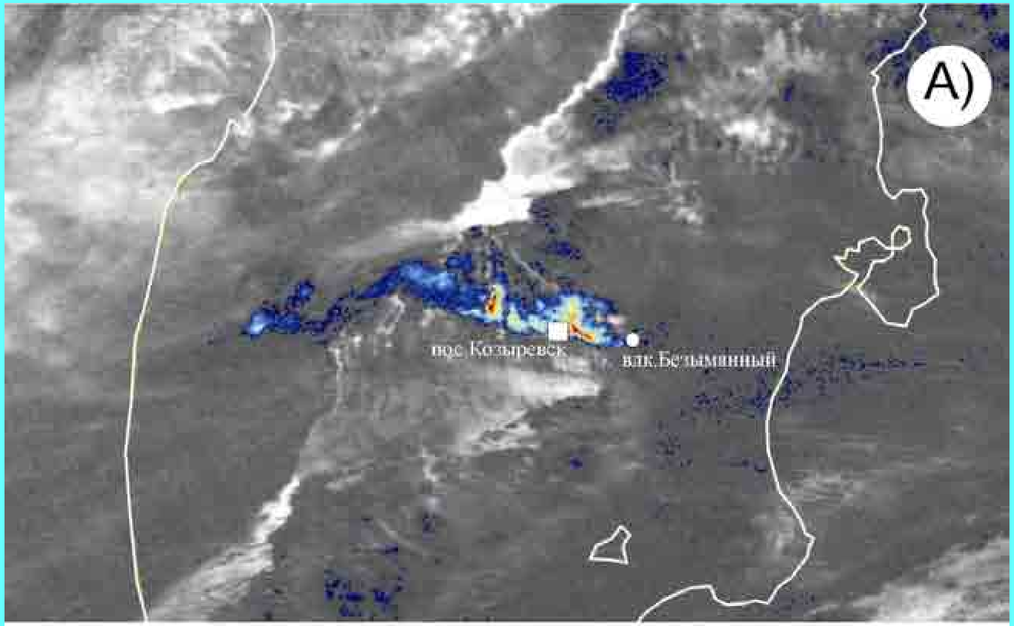
Успешный прогноз был сделан для извержения вулкана Безымянный 16 декабря 2009 г.

Сейсмический режим в районе вулкана резко изменился 8 декабря - начался рой поверхностных землетрясений, количество и энергия которых постепенно увеличивалась. Первый прогноз по сейсмическим данным был сделан 11 декабря 2009 г. в 12 ч 00 мин.

Уточнение даты начала эксплозивного извержения было сделано 14 декабря 2009 г. в 15 ч 00 мин. по признаку увеличения количества, амплитуды и продолжительности сейсмических сигналов.

По спутниковым данным, температура термальной аномалии в районе купола Безымянного резко выросла до предельной (64 град С) в 20:17 UTC 16 декабря (по данным AVO).

Эксплозивное извержение вулкана Безымянный началось через 1 ч 28 мин (в 21:45 UTC) и продолжалось несколько часов.



По сейсмическим данным это был самый сильный взрыв из 17 эксплозивных извержений вулкана за последние 10 лет. По спутниковым данным высота пеплового шлейфа достигала 8 км над уровнем моря А). Основное выпадение пепла произошло в северо-западном направлении от вулкана. По предварительной оценке Ю.В. Демянчука (ИВиС) на расстоянии приблизительно 40 км от вулкана по оси пеплопада выпало около 700 г пепла на 1 м^2. В пос. Козыревск мощность слоя выпавшего пепла составила 2 мм Б).

Эксплозивные (взрывные) извержения вулкана Безымянный за *1999-2009* гг.

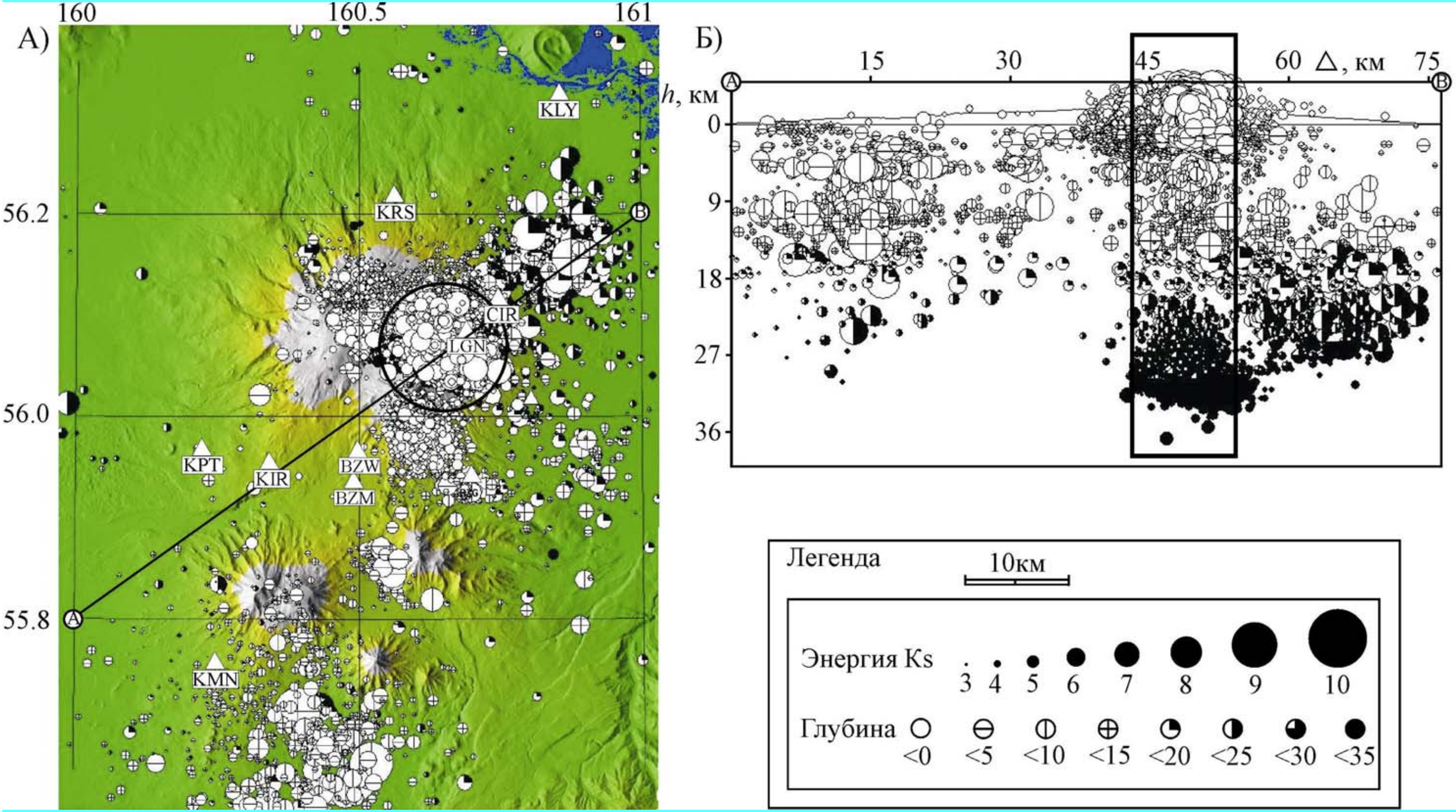
№	Дата извержения	Код	Комментарий
1	1999, 24 февраля	XXX	
2	2000, 13 марта	XXXX	дано предупреждение
3	2000, 30 октября	XXXX	дано предупреждение
4	2001, 6 августа	XXX	не дано предупреждение
5	2001, 15 декабря	XXXX	дано предупреждение
6	2002, 25 декабря	XX	дано предупреждение
7	2003, 26 июля	XX	дано предупреждение
8	2004, 13 января	X	не дано предупреждение

№	Дата извержения	Код	Комментарий
9	2004, 18 июня	XXXX	сделан прогноз по сейсмическим данным
10	2005, 11 января	XXXX	сделан официальный прогноз по сейсмическим данным
11	2005, 30 ноября	XXX	сделан официальный прогноз по сейсмическим и спутниковым данным
12	2006, 9 мая	XXXX	сделан официальный прогноз по сейсмическим данным
13	2006, 24 декабря	XXX	сделан официальный прогноз по сейсмическим и спутниковым данным
14	2007, 11 мая	X	сделан официальный прогноз по спутниковым данным
15	2007, 14 октября	XX	прогноз не был сделан, дано предупреждение
16	2008, 19 августа	XX	сделан официальный прогноз по спутниковым данным

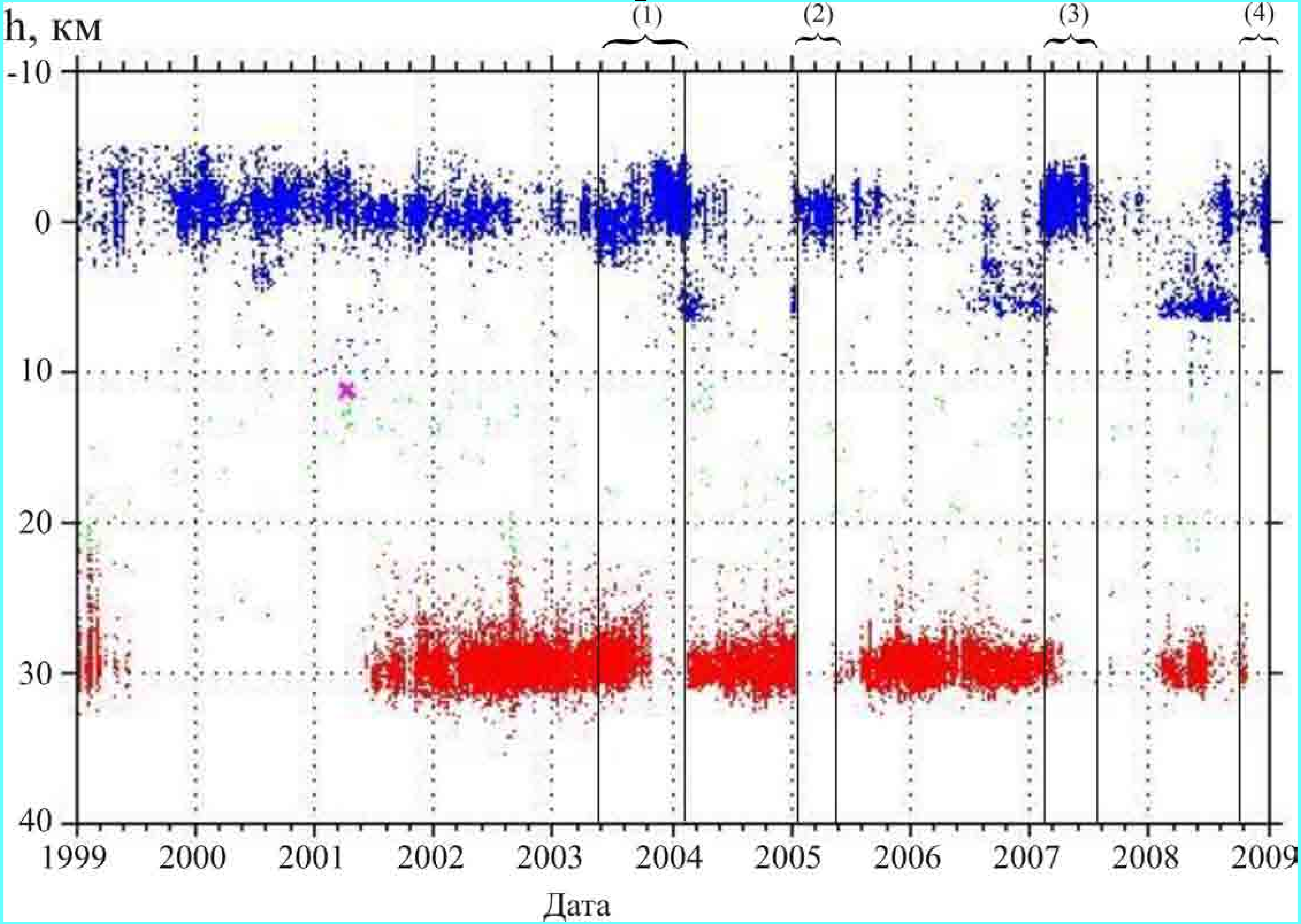
_17_ эксплозивное извержение вулкана Безымянный произошло _16_ декабря _2009_ г –

для него был сделан успешный краткосрочный прогноз по сейсмическим данным

Сейсмичность вулкана Ключевской с 1999 до 2009 г. Карта с эпицентрами и проекция гипоцентров на вертикальный разрез А-В.

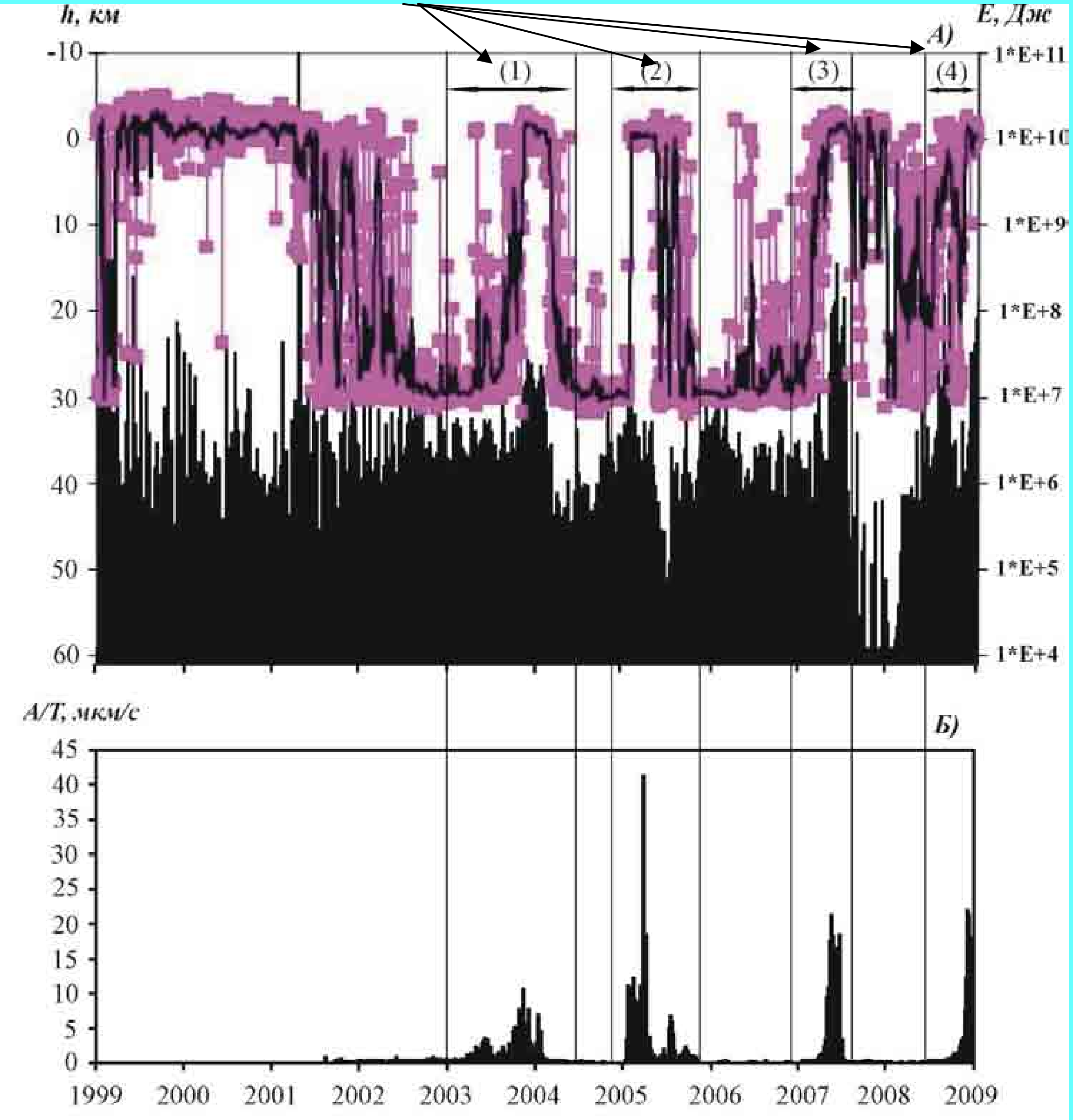


Изменение глубины очагов землетрясений вулкана Ключевской во времени.



В 1999-2009 гг. произошло 4 активизации вулкана Ключевской, для 3 последних из них были даны успешные, среднесрочные прогнозы.

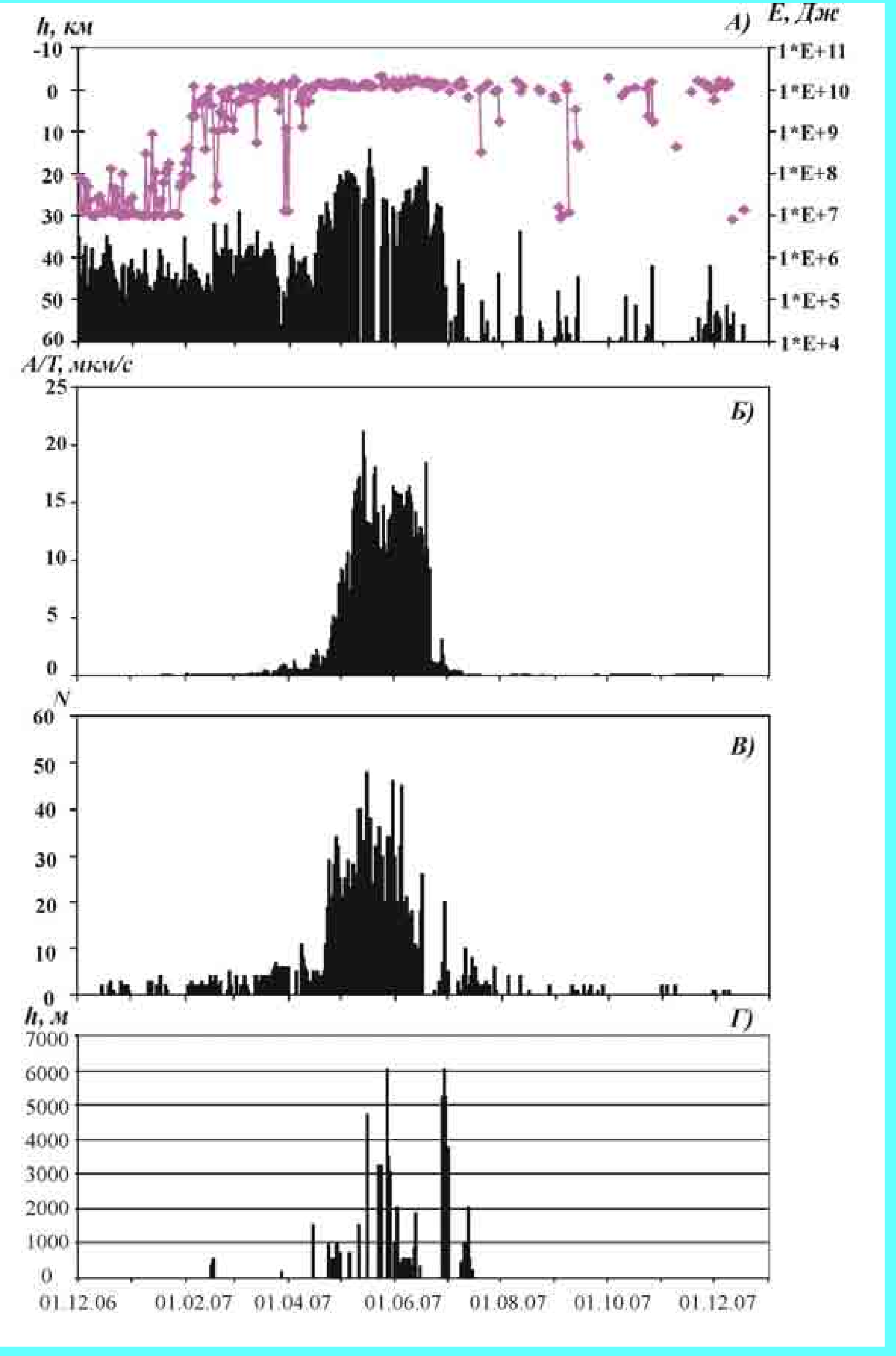
Активизации выделены на рисунке номерами в скобках.



А) Изменение глубины и силы центра выделенной сейсмической энергии во времени.

Центр выделенной сейсмической энергии (ЦВСЭ) за выделенные сутки определялся как одно эквивалентное землетрясение с координатами очага, вычисленными как среднеарифметическое из координат землетрясений зарегистрированных за выбранные сутки с учетом веса, пропорционального энергии события. Энергия этого эквивалентного землетрясения равна сумме энергий выбранных событий.

Б) Изменение амплитуды вулканического дрожания во времени.



Центр выделенной сейсмической энергии.

Амплитуда вулканического дрожания.

Количество пикселей в термальной аномалии.

Высота пепловых выбросов над кратером.

Излияние лавы на вулкане Ключевской, фотография – Демянчук Ю.В.

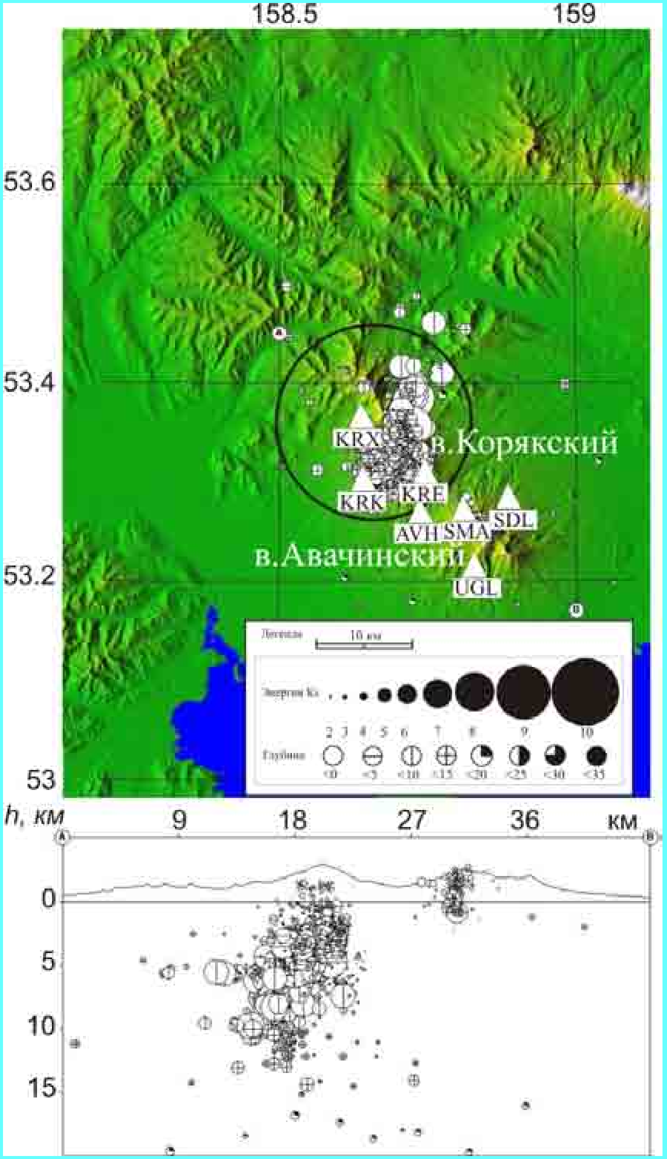
Активизация вулкана Корякский в 2008 году

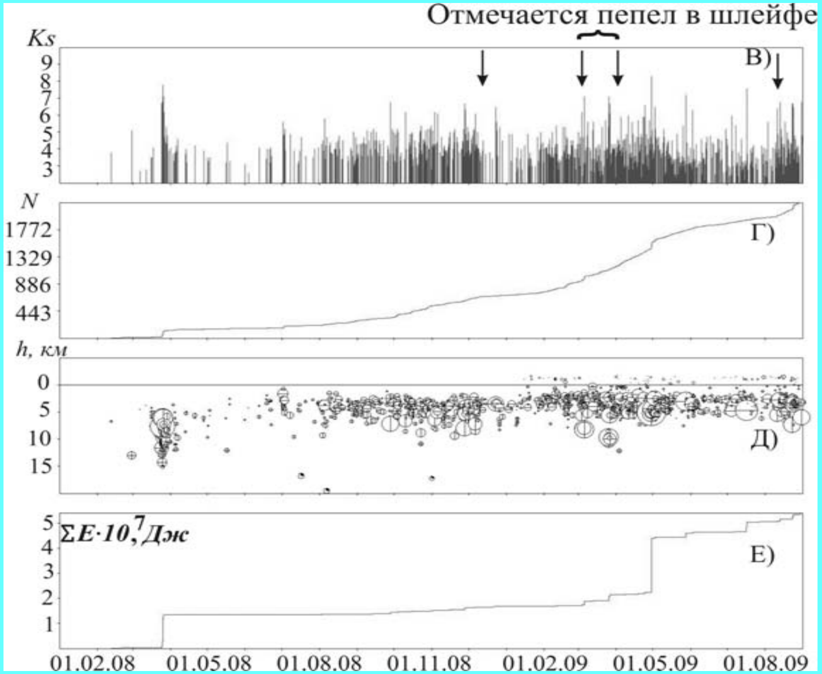
Фумарола на вулкане Корякский, 28 ноября 2008 г.
Фото – Сокоренко А.В.

Три фумаролы на вулкане Корякский,

10 января 2009 г.
Фото – Сокоренко А.В.

Вид на вулканы Корякский (слева) и Авачинский (справа), 25 декабря 2008 г.
Паро-газовый шлейф от вулкана Корякский. На переднем плане г.Петропавловск-Камчатский. Фото – Сокоренко А.В.





Сейсмичность вулкана Корякский в 2008-2009 гг.: А) карта эпицентров землетрясений; Б) проекция гипоцентров на вертикальный разрез вдоль линии А-В. Графики распределения во времени различных параметров землетрясений, выделенных окружностью: В) энергетический класс по S-волне; Г) кумулятивное количество землетрясений; Д) глубина гипоцентров, км; Е) кумулятивная энергия, Дж.

Результаты обработки и интерпретации данных наблюдений, оценки состояния активности вулканов доступны на странице КФ ГС РАН через Интернет.

Информационные ресурсы КФ ГС РАН включают в себя следующие основные компоненты:

Фактографическая база данных «Активность вулканов Камчатки», ресурс включен в Государственный регистр баз и банков данных, № 0220711891. Адрес в Internet: http://www.emsd.ru/~ssl/monitoring/main.htm.

Ежедневно информация о вулканических землетрясениях и о состоянии вулканов передается по установленному регламенту в заинтересованные организации и размещается на сервере КФ ГС РАН в Интернете:

http://www.emsd.ru/ts - база данных землетрясений Камчатки

http://www.emsd.ru/ts/datareload.php?id=1 - землетрясения Северной группы вулканов;

http://www.emsd.ru/ts/datareload.php?id=0 - землетрясения Авачинско-Корякской группы вулканов;

http://www.emsd.ru - видеонаблюдения в реальном времени за состоянием камчатских вулканов Шивелуч, Ключевской и Безымянный.

Фактографическая база данных «Активность вулканов Камчатки»

Обобщает результаты обработки сейсмических, спутниковых, визуальных и видео наблюдений за наиболее активными вулканами Камчатки.

База содержит информацию о состоянии вулканов с февраля *2000* г.

Обновление производится ежедневно.

Выводы

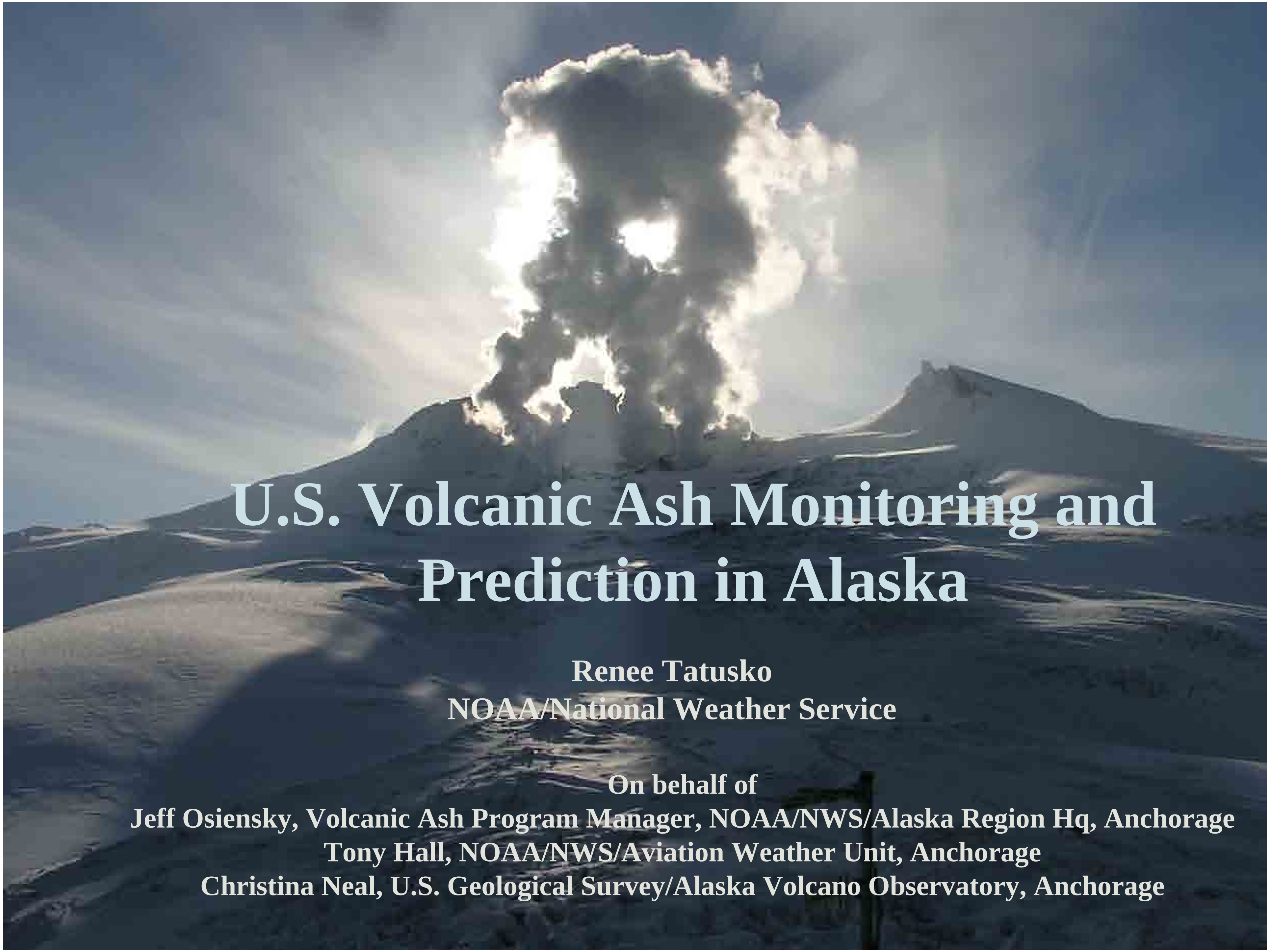
Основные направления развития системы и методов мониторинга на действующих вулканах:

•внедрение цифровых широкополосных сейсмометрических каналов и расширение зоны контроля активных вулканов;

•создание баз данных комплексных наблюдений по извержениям вулканов с привлечением и расширением использования спутниковой и видео информации;

•создание экспертных информационно-аналитических систем для оценки состояния и прогноза развития вулканической активности.


СПАСИБО ЗА ВНИМАНИЕ!



U.S. Volcanic Ash Monitoring and Prediction in Alaska

Renee Tatusko
NOAA/National Weather Service

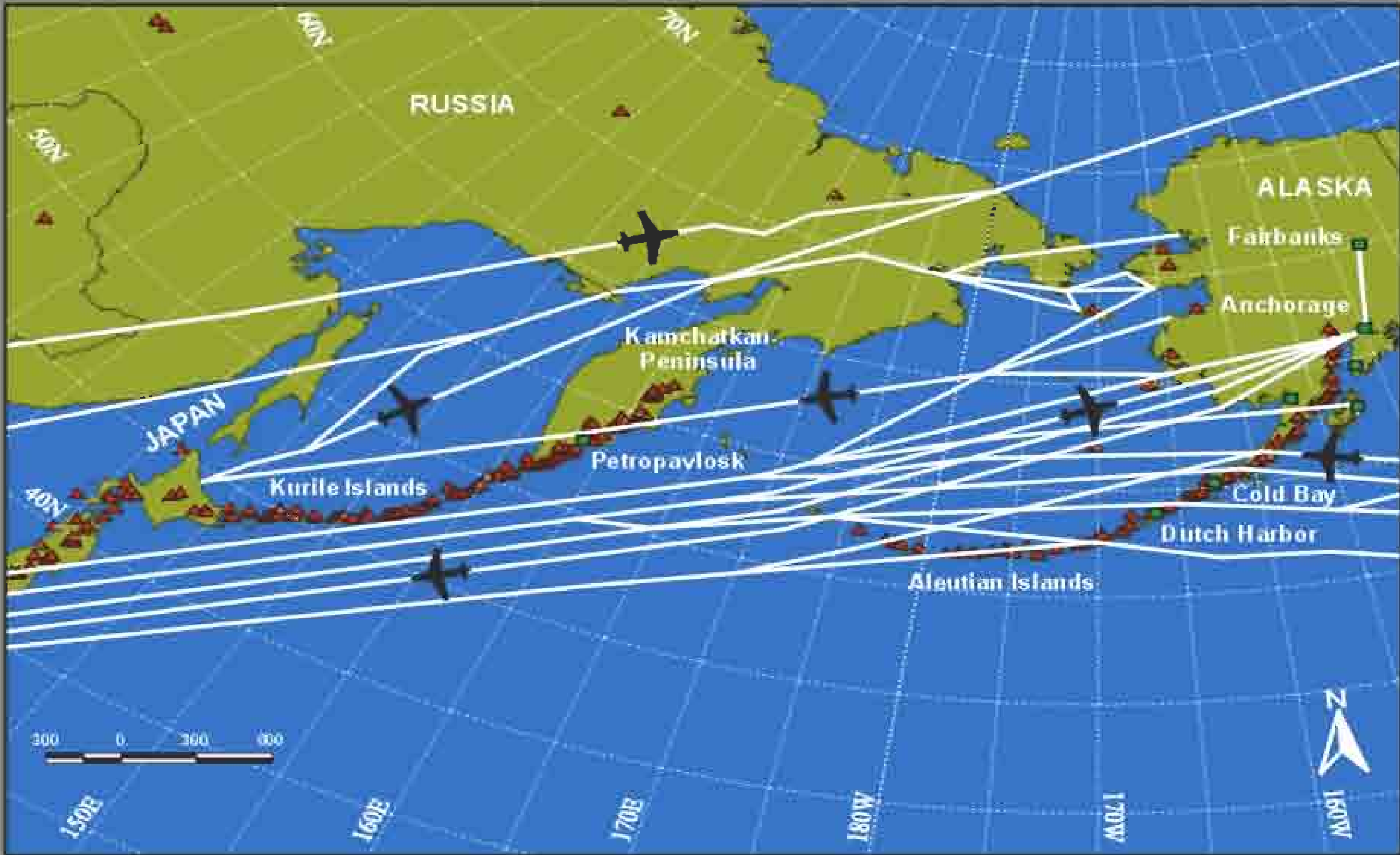
On behalf of
Jeff Osiensky, Volcanic Ash Program Manager, NOAA/NWS/Alaska Region Hq, Anchorage
Tony Hall, NOAA/NWS/Aviation Weather Unit, Anchorage
Christina Neal, U.S. Geological Survey/Alaska Volcano Observatory, Anchorage

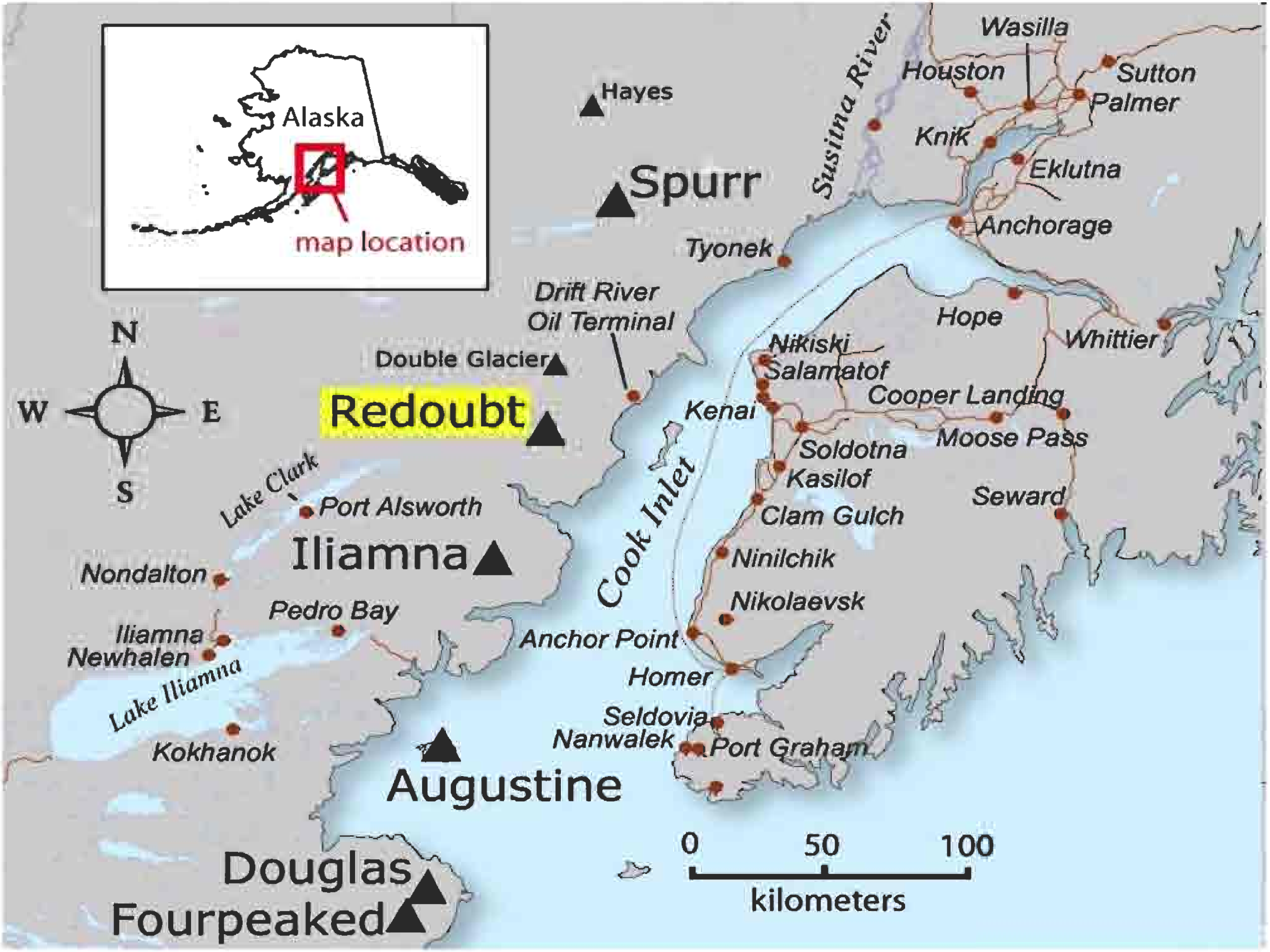
Talk Outline

- Volcano hazards in Alaska
- Alaska Volcano Observatory
- NOAA/National Weather Service
- Alaska Aviation Weather Unit
- Anchorage Volcanic Ash Advisory Center
- NOAA Volcanic Ash Working Group
- Volcanic Ash Modeling
- Conclusions


Historically Active Volcanoes of Alaska
Real-time seismic network as of Dec. 31, 2008
No seismic network
Instrumented fall 2005; poor telemetry prohibits official "monitored" status
Names in red indicate volcanoes discussed in this report
Wrangell
Spurr
Anchorage
Redoubt
Iliamna
Cook Inlet
Augustine
Homer
Kukak
Douglas
Novarupta
Griggs
Fourpeaked
Mageik
Snowy
Ukinrek Maars
Katmai
Chiginagak
Trident
Veniaminof
Martin
Amak
Bering Sea
Kiska
Little Sitkin
Great Sitkin
Semisopochnoi
Kliuchef/
Atka
Tanaga
Bogoslof
Akutan
Pavlof
Aniakchak
Ugashik-
Peulik
Fisher
Kagamil
Perryville
Kupreanof
Korovin
Okmok
Adak
Cold
Bay
Emmons
Dutton
Segula
Carlisle
Nikolski
Gareloi
Westdahl
Atka
Fort
Glenn
Gilbert
Shishaldin
Pacific Ocean
Kanaga
Seguam
Cleveland
Unalaska/
Dutch Harbor
Kasatochi
Amukta
Makushin
Vsevidof
Yunaska
Recheshnoi
100 50 0 100 miles
200 100 0 200 kilometers

"Ring of Fire" Air Routes

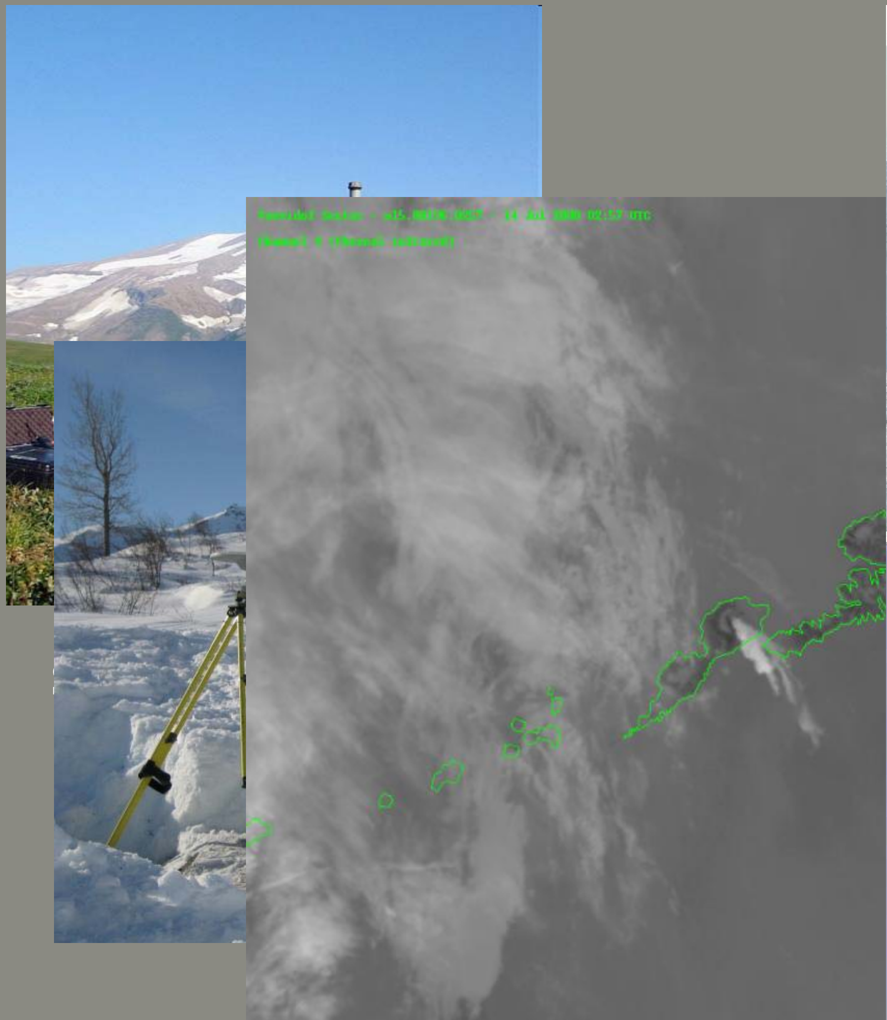



Alaska
map location
N
W
E
S
Hayes
Spurr
Susitna River
Wasilla
Houston
Sutton
Palmer
Knik
Eklutna
Anchorage
Tyonek
Drift River
Oil Terminal
Double Glacier
Redoubt
Hope
Whittier
Nikiski
Salamatof
Cooper Landing
Kenai
Moose Pass
Soldotna
Kasilof
Lake Clark
Port Alsworth
Seward
Clam Gulch
Cook Inlet
Iliamna
Nondalton
Ninilchik
Nikolaevsk
Pedro Bay
Iliamna
Newhalen
Anchor Point
Lake Iliamna
Homer
Seldovia
Nanwalek
Port Graham
Kokhanok
Augustine
0
50
100
kilometers
Douglas
Fourpeaked

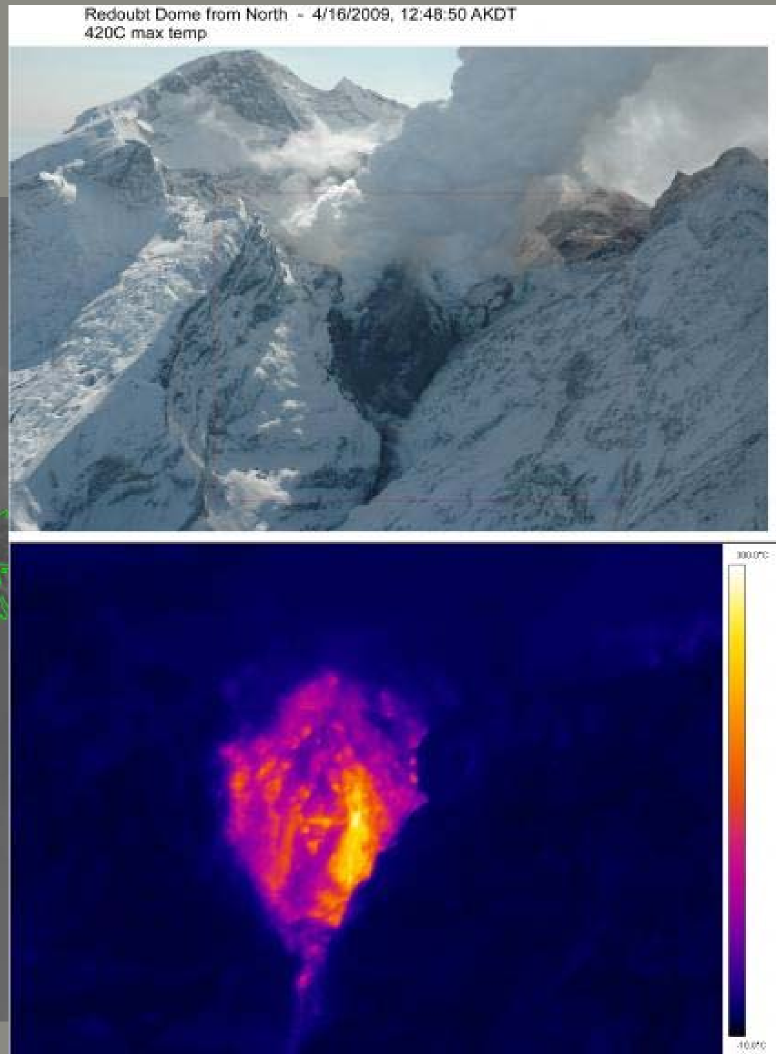
The Alaska Volcano Observatory (AVO)

- AVO formed in 1988
- Consists of ~30 scientists, staff, and students from:
  - US Geological Survey (Department of Interior)
  - University of Alaska Geophysical Institute (Fairbanks)
  - State of Alaska Division of Geological and Geophysical Surveys
- Offices in Anchorage and Fairbanks

AVO Monitoring



Remote Sensing



Other Techniques

AVO Issues Warnings

- AVO duty scientist carries a cell phone 24/7
- If an eruption or new unrest occurs, the AVO immediately telephones key government agencies (FAA, NWS, etc)
- These agencies have their own warning messages that are generated
- AVO sends a message via the Internet and fax to many users. All messages are posted on the AVO web site.
- AVO uses a color code for aviation threat and an alert level for ground-based threat.

Volcano Alert Levels Used by USGS Volcano Observatories

Alert Levels are intended to inform people on the ground about a volcano's status and are issued in conjunction with the Aviation Color Code. Notifications are issued for both increasing and decreasing volcanic activity and are accompanied by text with details (as known) about the nature of the unrest or eruption and about potential or current hazards and likely outcomes.

Term	Description
NORMAL	Volcano is in typical background, noneruptive state or, after a change from a higher level, volcanic activity has ceased and volcano has returned to noneruptive background state.
ADVISORY	Volcano is exhibiting signs of elevated unrest above known background level or, after a change from a higher level, volcanic activity has decreased significantly but continues to be closely monitored for possible renewed increase.
WATCH	Volcano is exhibiting heightened or escalating unrest with increased potential of eruption, timeframe uncertain, OR eruption is underway but poses limited hazards.
WARNING	Hazardous eruption is imminent, underway, or suspected.

Aviation Color Code Used by USGS Volcano Observatories

Color codes, which are in accordance with recommended International Civil Aviation Organization (ICAO) procedures, are intended to inform the aviation sector about a volcano'sstatus and are issued in conjunction with an Alert Level. Notifications are issued for both increasing and decreasing volcanic activity and are accompanied by text with details (as known) about thenature of the unrest or eruption, especially in regard to ash-plume information and likely outcomes.

Color	Description
GREEN	Volcano is in typical background, noneruptive state or, after a change from a higher level, volcanic activity has ceased and volcano has returned to noneruptive background state.
YELLOW	Volcano is exhibiting signs of elevated unrest above known background level or, after a change from a higher level, volcanic activity has decreased significantly but continues to be closely monitored for possible renewed increase.
ORANGE	Volcano is exhibiting heightened or escalating unrest with increased potential of eruption, timeframe uncertain, OR eruption is underway with no or minor volcanic-ash emissions [ash-plume height specified, if possible]
RED	Eruption is imminent with significant emission of volcanic ash into the atmosphere likely OR eruption is underway or suspected with significant emission of volcanic ash into the atmosphere [ash-plume height specified, if possible].

NOAA/National Weather Service
Anchorage Volcanic Ash Advisory Center
and
Alaska Aviation Weather Unit (AAWU)

National Weather Service
Anchorage, Alaska

- Mission of the NWS

- Home to the Alaska Aviation Weather Unit and Alaska River Forecast Center

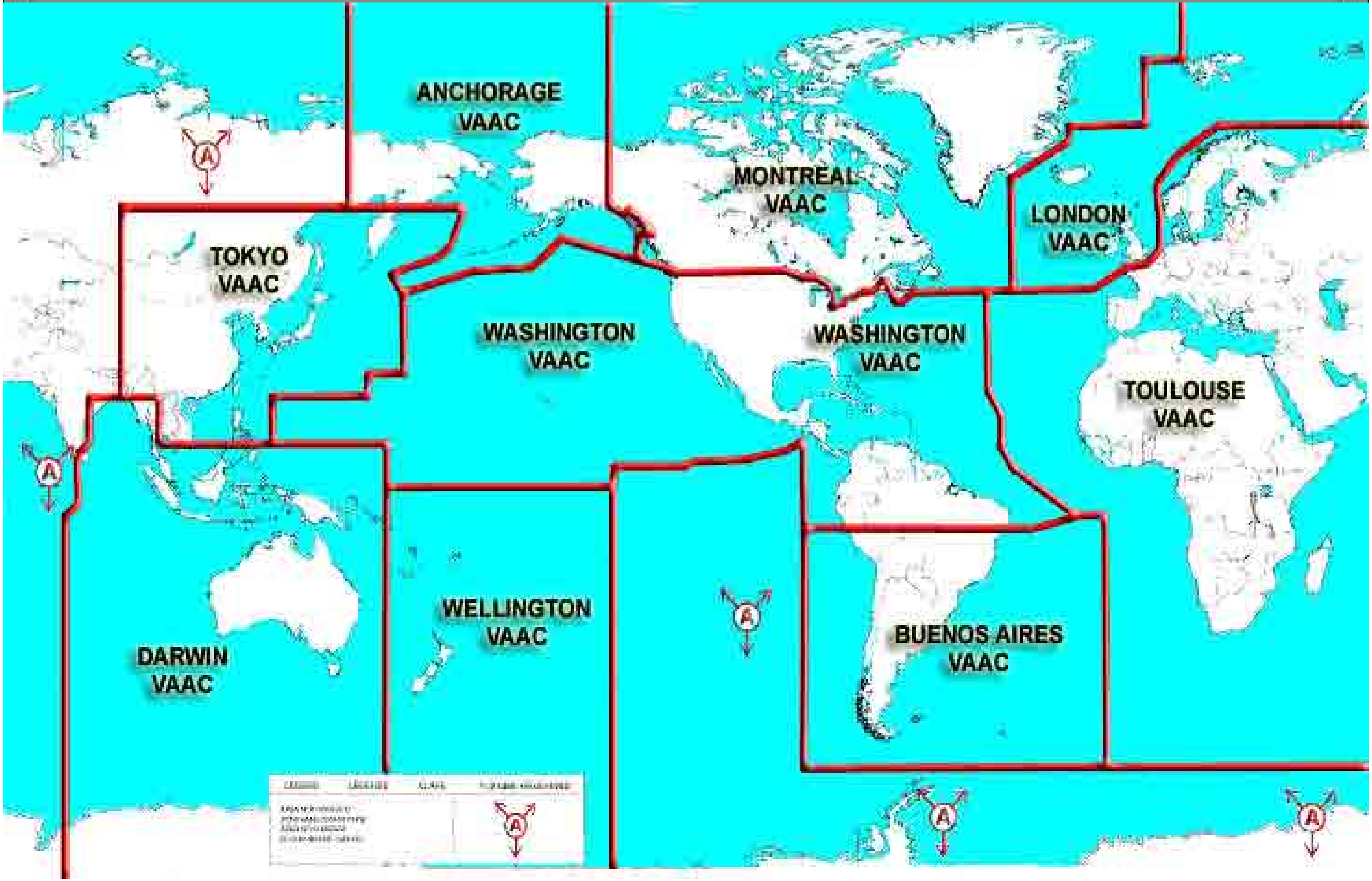
- Forecast Areas
  - Anchorage
  - Fairbanks
  - Juneau


Alaska WFO Areas of Responsibility
WFO Fairbanks
WFO Anchorage
WFO Juneau
0 200 400 800 Miles

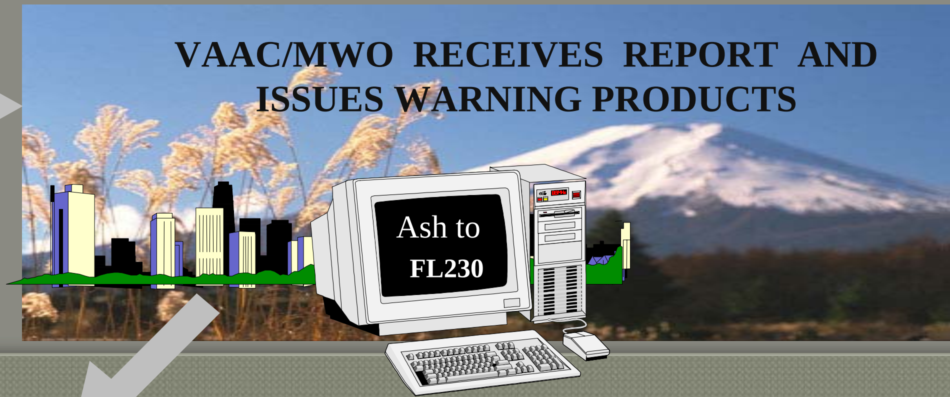
Alaska Aviation Weather Unit (AAWU)

- Two roles
  - Meteorological Watch Office (MWO)
  - Volcanic Ash Advisory Center (VAAC)
- Area of responsibility
  - Extends from Russian airspace to Canada
  - From the North Pole to the North Pacific Ocean
- Coverage: Two desks staffed at all times (north and south) – 24/7

Volcanic Ash Advisory Centers (VAACs)



Function of VAAC



Provides advisory service to Regional Area Forecast Center, MWOs, local emergency managers, and other VAACs

NOAA Volcanic Ash Working Group

- U.S. procedures for ash avoidance much different than in Europe in terms of how airspace is managed during a volcanic ash event
- The “Eya” eruption illuminated numerous science and service gaps
- Office of the Federal Coordinator for Meteorology (OFCM) established a Working Group for Volcanic Ash (WG/VA)
- OAR, NESDIS, and NWS represented on the OFCM WG/VA

Key Challenges in Volcanic Ash Modeling

- Dispersion modeling capability is dependent on the accuracy of the driving/underlying meteorology

- Atmospheric dispersion models frequently produce “conservative” ash clouds (both wider and extend farther downwind that observed)

Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT) Model

- Run by NOAA/NWS for smoke, dust, volcanic ash, radiological events, or other hazardous releases, and many other organizations
- Proposed HYSPLIT upgrades
  - time varying emission rate and height,
  - maintain ash from previous simulations,
  - ash plume initialization from observations, and
  - more realistic ash removal mechanisms
- NWS and OAR developing an implementation plan (fall 2010)
- Longer term plan to work with NESDIS to initialize HYSPLIT from satellite analyses
- NWS partnering with NASA to develop aerosol data assimilation system

Conclusions

- In the long term, a fully automated global ash monitoring system where EVERY volcano will be automatically monitored
- Much improved spectral and temporal measurements from future GOES missions
- Is this an area for collaboration between NOAA, Roshydromet, and the Russian Academy of Science under our bilateral agreement to develop improved modeling and observation capabilities?
- May 2011 North Pacific Volcanic Ash Workshop, Anchorage, AK


Thank you!
Mt. Augustine eruption. Credit: Cyrus Read, USGS

Canada

ISTC Workshop, Moscow, RF, July 2010

Volcanic Activity in Canada

Prof. Henry Mantsch

Department of Foreign Affairs, Ottawa, Canada

Senior Science Advisor, Canadian SAC Representative

The Canadian Federal (National) Ministry of

Natural Resources Canada   Ressources naturelles Canada

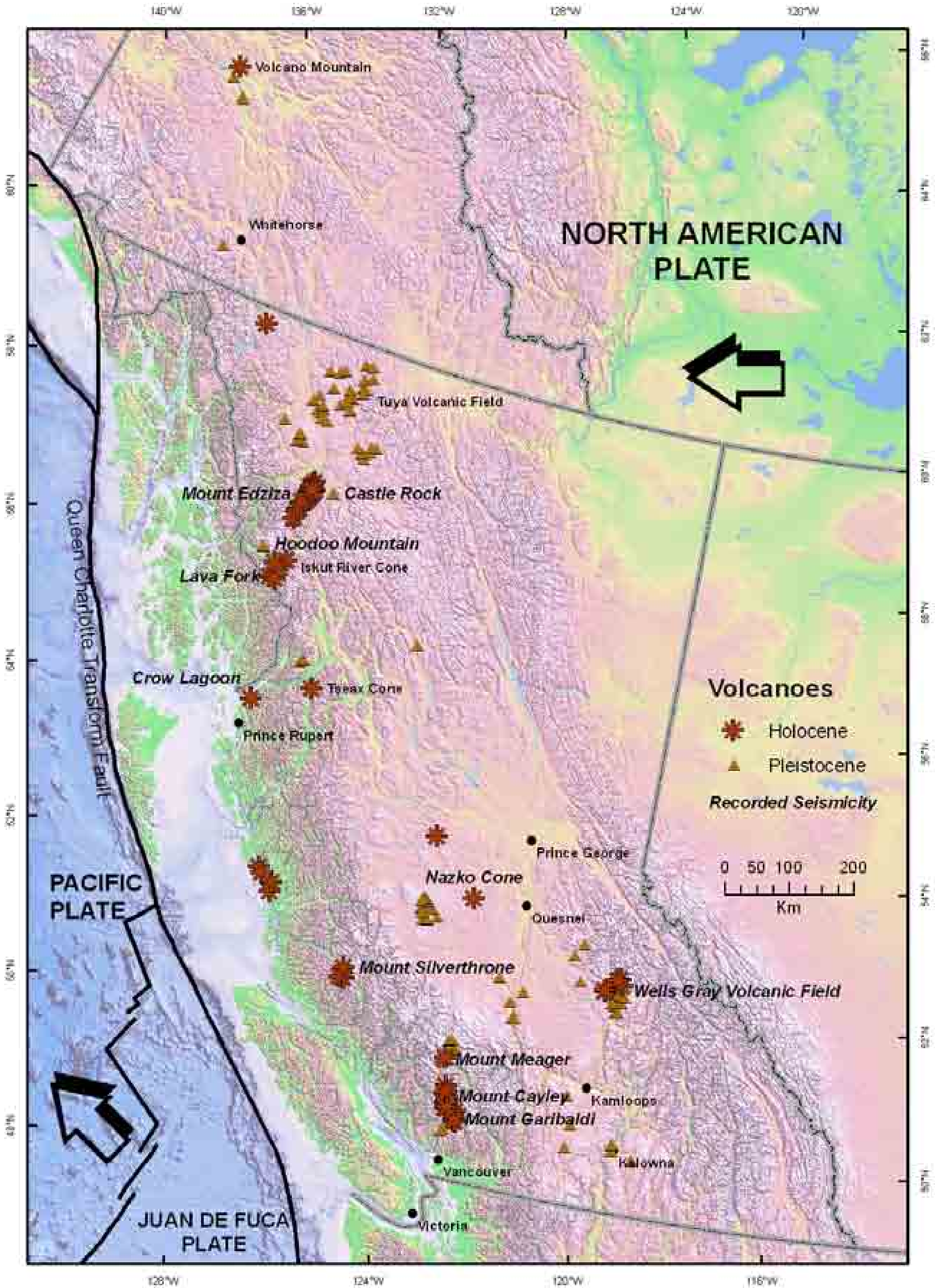
EARTH SCIENCES SECTOR

Geological Survey of Canada

Volcanoes

Natural Resources Canada
Ressources naturelles Canada

Canada has examples of almost every type of volcano found in the world, including strato-volcanoes, shield volcanoes, calderas, cinder cones, and maars. While none have erupted recently, at least 3 did in the last few hundred years and numerous others have the potential to erupt in the near future. Canada has one historically active volcano, Tseax cone; its 1775 eruption killed an estimated 2000 Nisga’a First Nations people.



The Canadian volcanoes are all located in western Canada (British Columbia and Yukon) where the North American Plate collides with the Pacific Plate and with the Juan de Fuca Plate. The individual volvanoes can be grouped into seven volcanic belts.

Natural Resources Canada

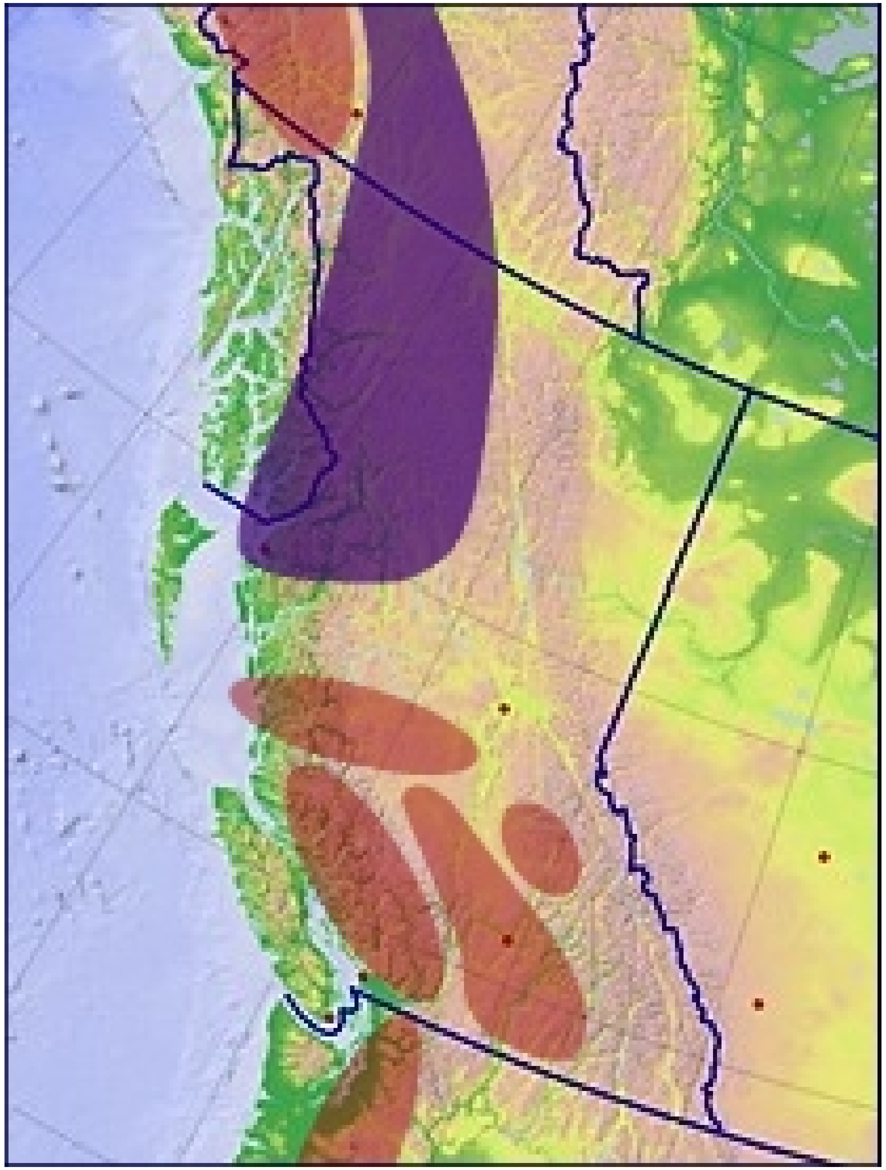
Ressources naturelles Canada

The seven volcanic belts are

Anahim
Chilcotin
Garibaldi
Stikine
Wells Gray-Clearwater
Wrangell
Cascades

Stikine Volcanic Belt

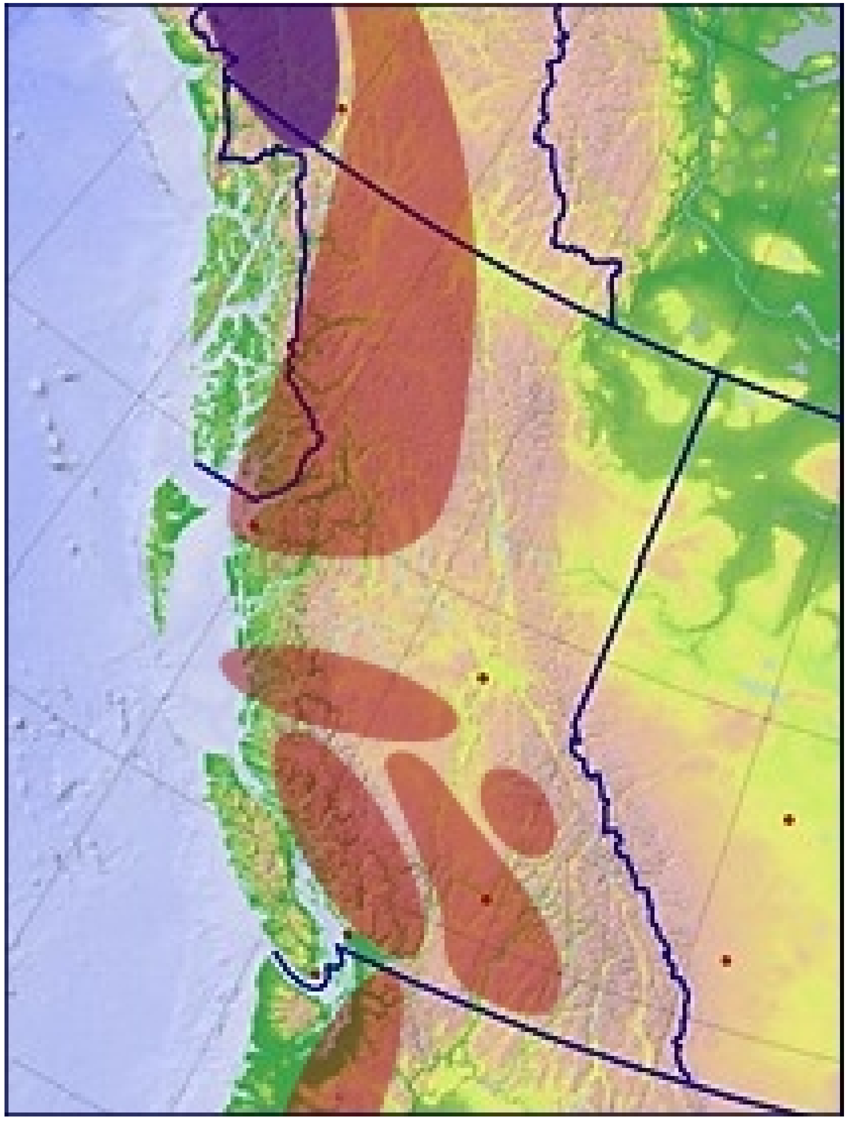
(also called the Northern Cordilleran Volcanic Province)



This large area of volcanism stretches from just north of Prince Rupert, into the Yukon Territory and the Alaska border. It is the most active volcanic region in Canada, containing more than 100 volcanoes, 3 of which erupted in the last few hundred years (2 witnessed by people). These volcanoes formed due to extensional cracking of the crust in response to the Pacific Ocean plate dragging northward along the edge of the North American plate, on its way to the Aleution subduction zone. This belt includes the volcanoes Volcano Mtn., Mt. Edziza, Level Mtn., and the extremely youthful Tseax Cone (240 years), Lava Fork (360 years) and Ruby Mtn. (103 years).

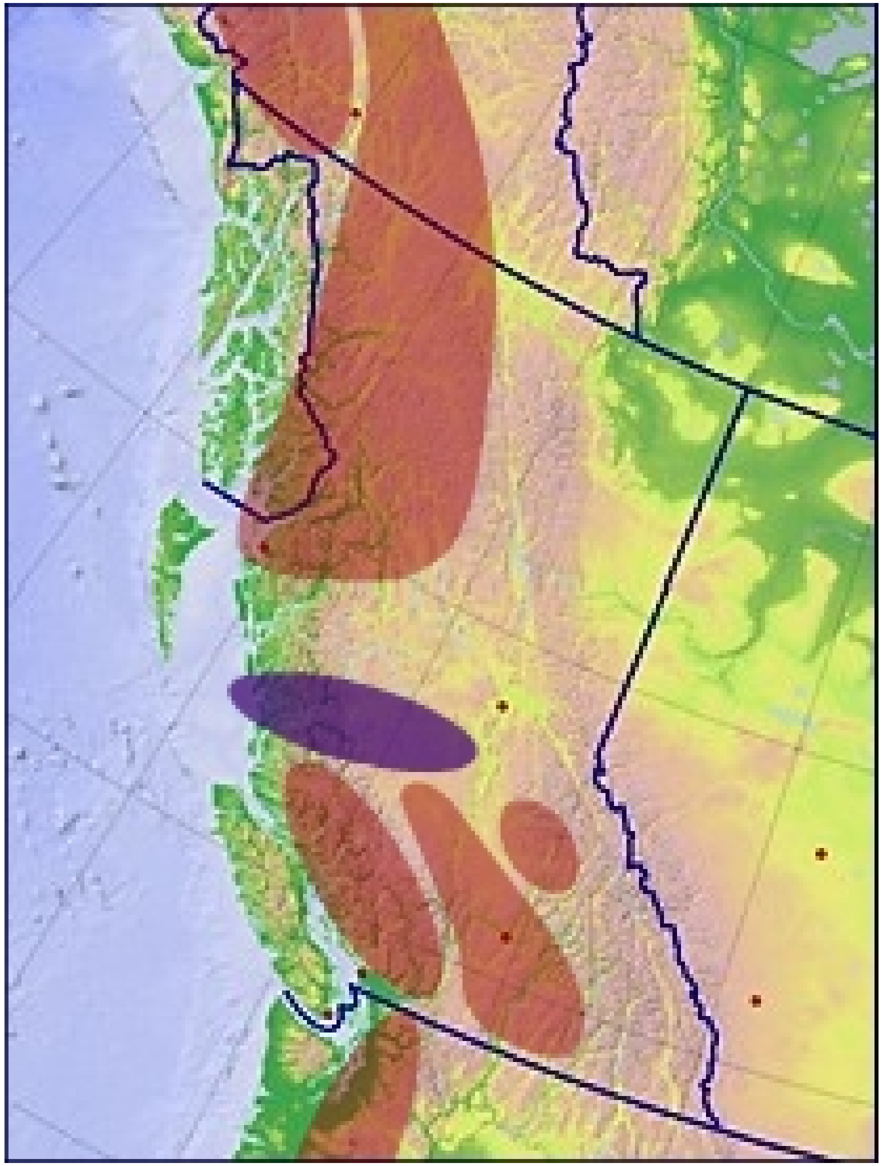
[Wrangell Volcanic Belt](#)

This belt of volcanoes lies largely in Alaska but extends across the border into southwestern Yukon Territory. It formed as a result of melting of the crust due to subduction of the Pacific Ocean plate beneath the North American plate at the Aleution arc. It includes the volcanoes Mt. Wrangell, which has been active historically, and Mt. Churchill, which has had 2 large-magnitude explosive eruptions in the last 2000 years that blanketed most of the Yukon with ash.



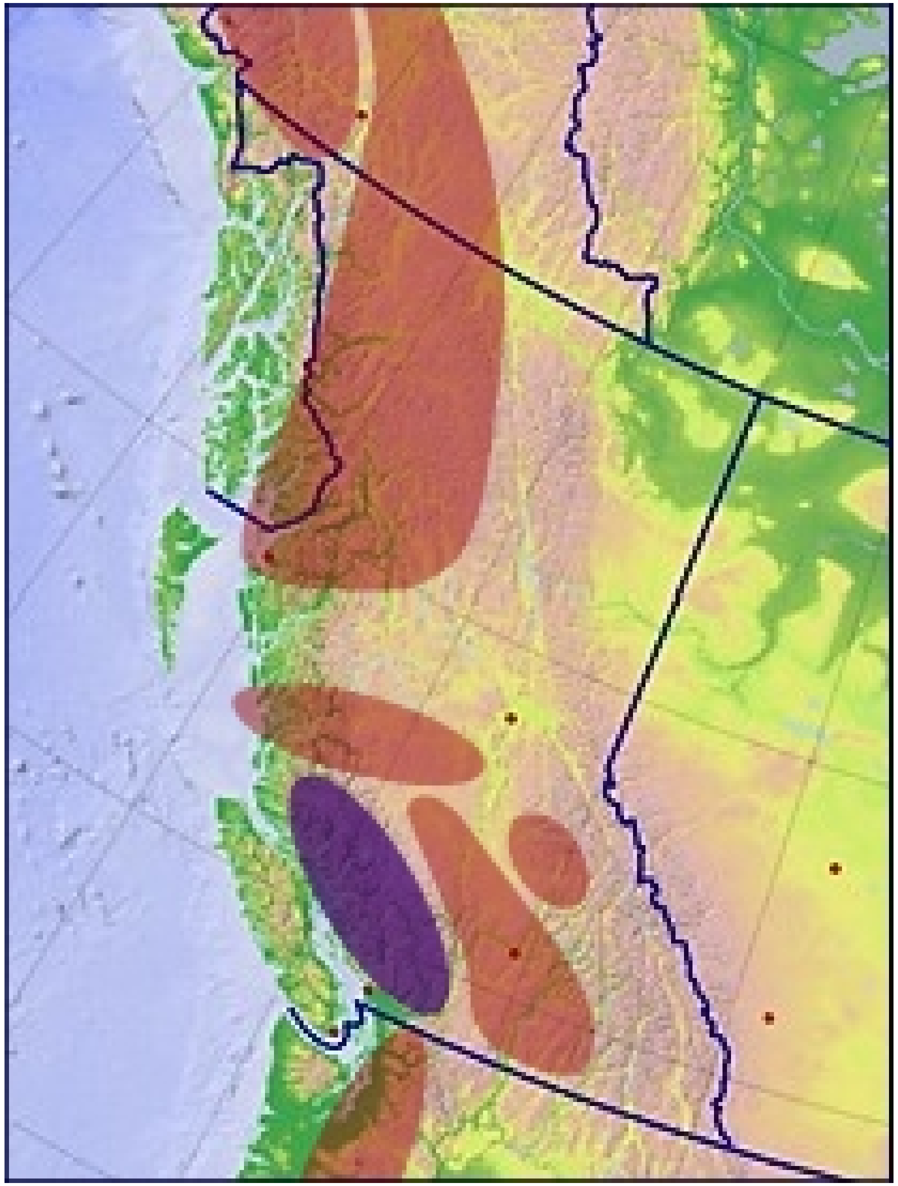
[Anahim Volcanic Belt]

This nearly east-west line of volcanoes stretches from the west coast of B.C., just north of Vancouver island, and reaches into the Interior Plateau near Quesnel. The volcanoes generally get younger as you go from the coast to the interior. These volcanoes probably formed as a result of the North American continent sliding westward over a small "hotspot", like the one feeding the Hawaiian islands. Volcanoes in this belt include the Rainbow, Ilgachuz, and Itcha ranges, and the Nazko cone which is only 7200 years old.



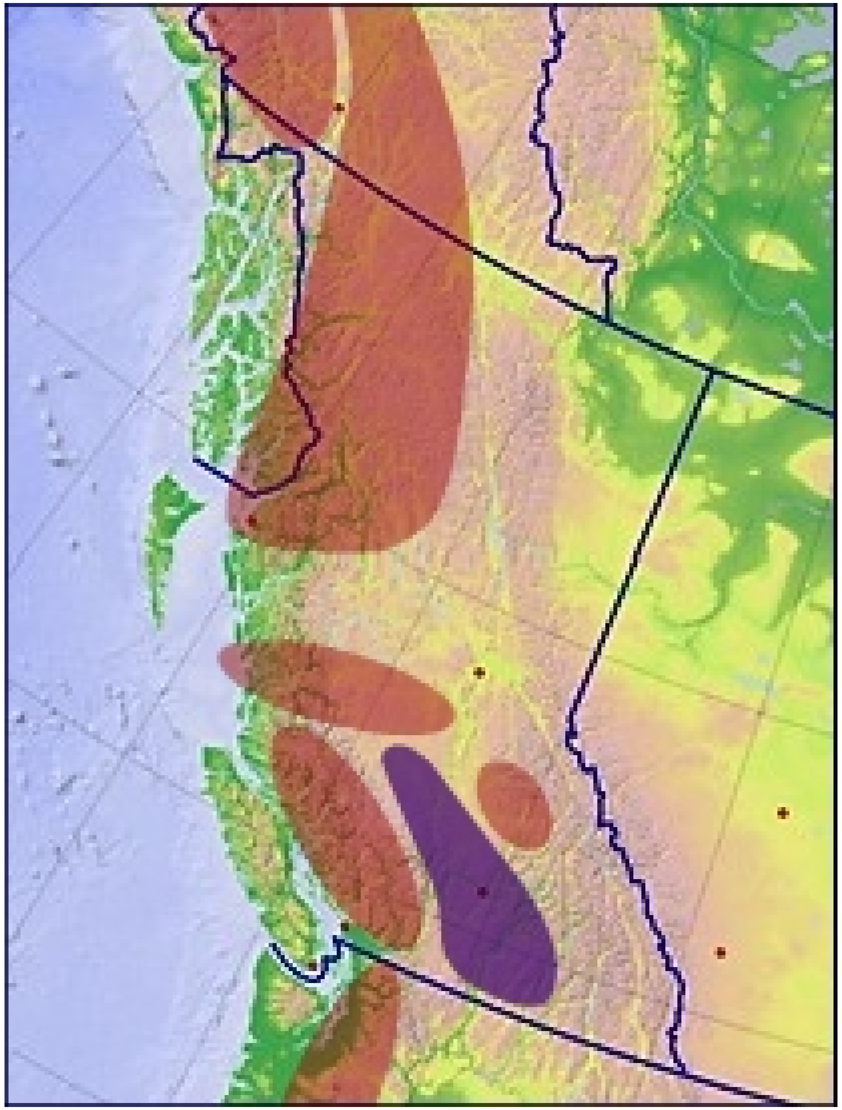
Garibaldi Volcanic Belt

The Garibaldi Volcanic Belt is the northern extension of the Cascades Volcanic Belt in the northwestern United States and contains the most explosive young volcanoes in Canada. Its volcanoes are also the closest to British Columbia's densely populated southwest corner. These volcanoes are the result of subduction of the Juan de Fuca tectonic plate beneath the North American tectonic plate; the plates meet just seaward of the west coast of Vancouver island. The volcanoes of the Garibaldi Volcanic Belt generally are strato-volcanoes typical of subduction zones, and include Mt. Garibaldi, Mt. Cayley and Mt. Meager. Mt. Meager's eruption of 2350 years ago was the most explosive eruption in Canada. It was similar to that of Mt. St. Helens in 1980 and that of Montserrat in the Caribbean.



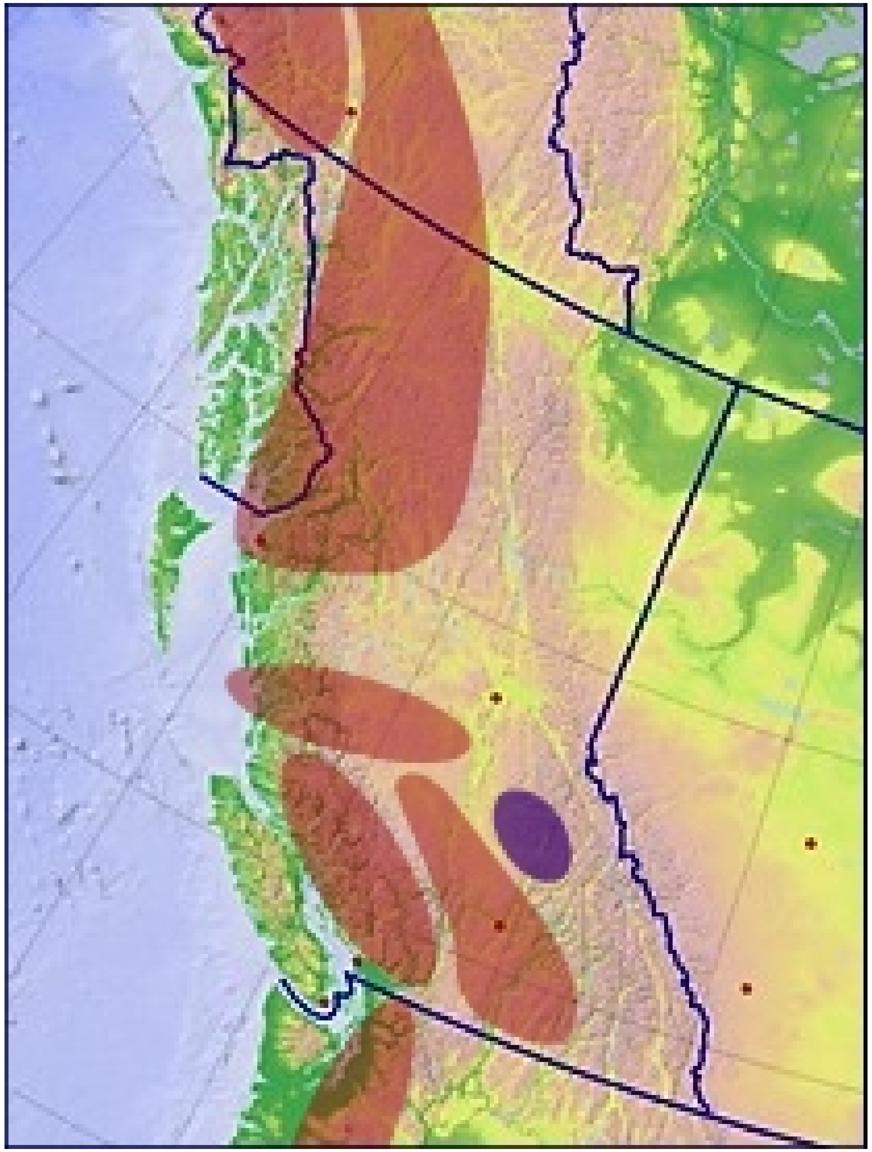
[Chilcotin Plateau Basalts]

A zone of small-volume basaltic lava flow eruptions about 150 km inland from and running parallel to the Garibaldi volcanic belt. Activity in this area is thought to be a result of extension of the crust behind the coastal subduction zone, a common phenomenon worldwide termed "back-arc extension volcanism". Chilcotin eruptions happened mainly 6-10 million years ago and 2-3 million years ago in the early stages of Garibaldi belt activity. In addition there have been a few eruptions in the Pleistocene (0.01 to 1.6 million years ago). The map show only the Chilcotin eruptions that are Pliocene and younger (younger than 5.3 million years).



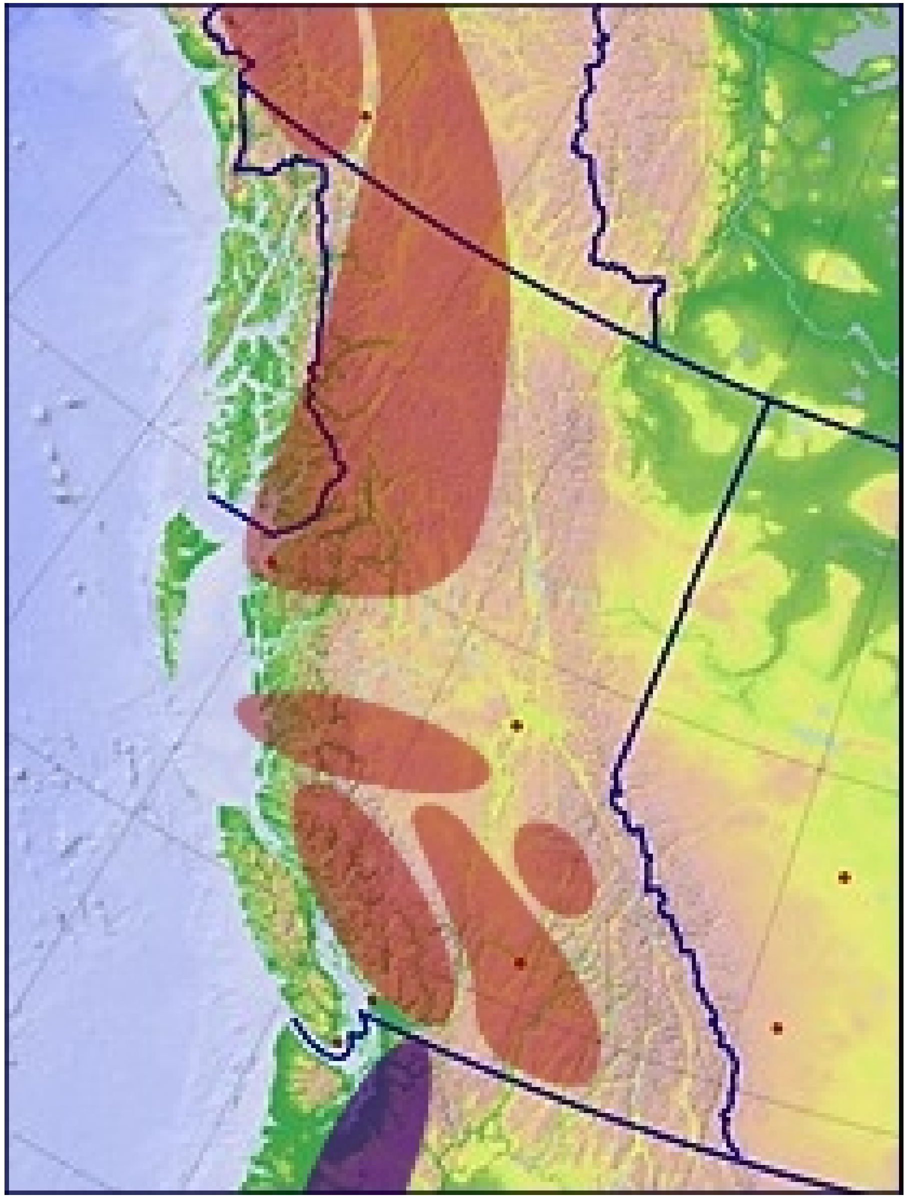
Wells Gray-Clearwater Volcanic Field

The Wells Gray-Clearwater Volcanic Field is a tight cluster of basaltic volcanoes, and includes the Quesnel Cone Group. The origin of this volcanism is not yet clear, but appears to be a result of local crustal thinning. Many of these eruptions occurred during periods of glaciation, so the eruptions interacted with the ice sheets in complex ways, forming distinctive volcanic forms. A number of these eruptions have occurred in the last 10 thousand years. The volcanoes included in this field are Pyramid Mtn. and Kostal Cone



[Cascades Volcanic Belt]

This belt of volcanoes stretches from northern California to the Canada-U.S. border, where the belt does not stop but changes name, to the Garibaldi volcanic belt. The volcanoes in this belt formed as a result of melting of the crust related to the subduction of the Juan de Fuca oceanic plate beneath the west coast of North America. Volcanoes in this belt are frequently active, and include Mt. St. Helens, Mt. Baker, Glacier Peak, Mt. Rainier, Mt. Hood, Crater Lake and Long Valley, plus others. Mt. St. Helens' most recent eruptive activity was in 1986. Many of these volcanoes exhibit frequent volcanic earthquakes.



Volcano Monitoring in Canada

In Canada, even though some volcanoes could pose a significant threat to local communities in western Canada, volcano monitoring is limited. Because no large eruptions have occurred in Canada in the last few hundred years volcano monitoring is a lower priority than dealing with the hazards of earthquakes, landslides and tsunamis.

Nevertheless, over the last 50 years, scientists at the Geological Survey of Canada and at Canadian universities have documented the behaviour of a number of Canadian volcanoes. Unfortunately we don't yet know enough about the frequency of eruptions to predict which volcanoes are most likely to erupt next, and what the nature of the eruption will be.

Natural Resources Canada | Ressources naturelles Canada

The Geological Survey of Canada website contains the

Interagency Volcanic Event Notification Plan (IVENP)

This Plan outlines the procedure that would be involved in response to an eruption event at a Canadian volcano or an event that is near enough to Canada's borders or large enough that the eruption will have an impact on Canadians.

The document includes a flow chart, the report forms, details of the agency contacts for use in reporting volcanic events, and an outline of the relevant responsibilities of each participating agency. This information is provided for the awareness of both national and international agencies.

Foreign Affairs and International Trade Canada

Affaires étrangères et Commerce international Canada

The Ministry of Foreign Affairs and International Trade Canada

is responsible for coordinating the Government of Canada's operational response to major natural disasters abroad through **START.**

The **Stabilization and Reconstruction Task Force (START)**

.......was designed to help answer the growing international demand for Canadian support and involvement in complex crises – conflict or natural disasters

For more detailed information please consult the web pages

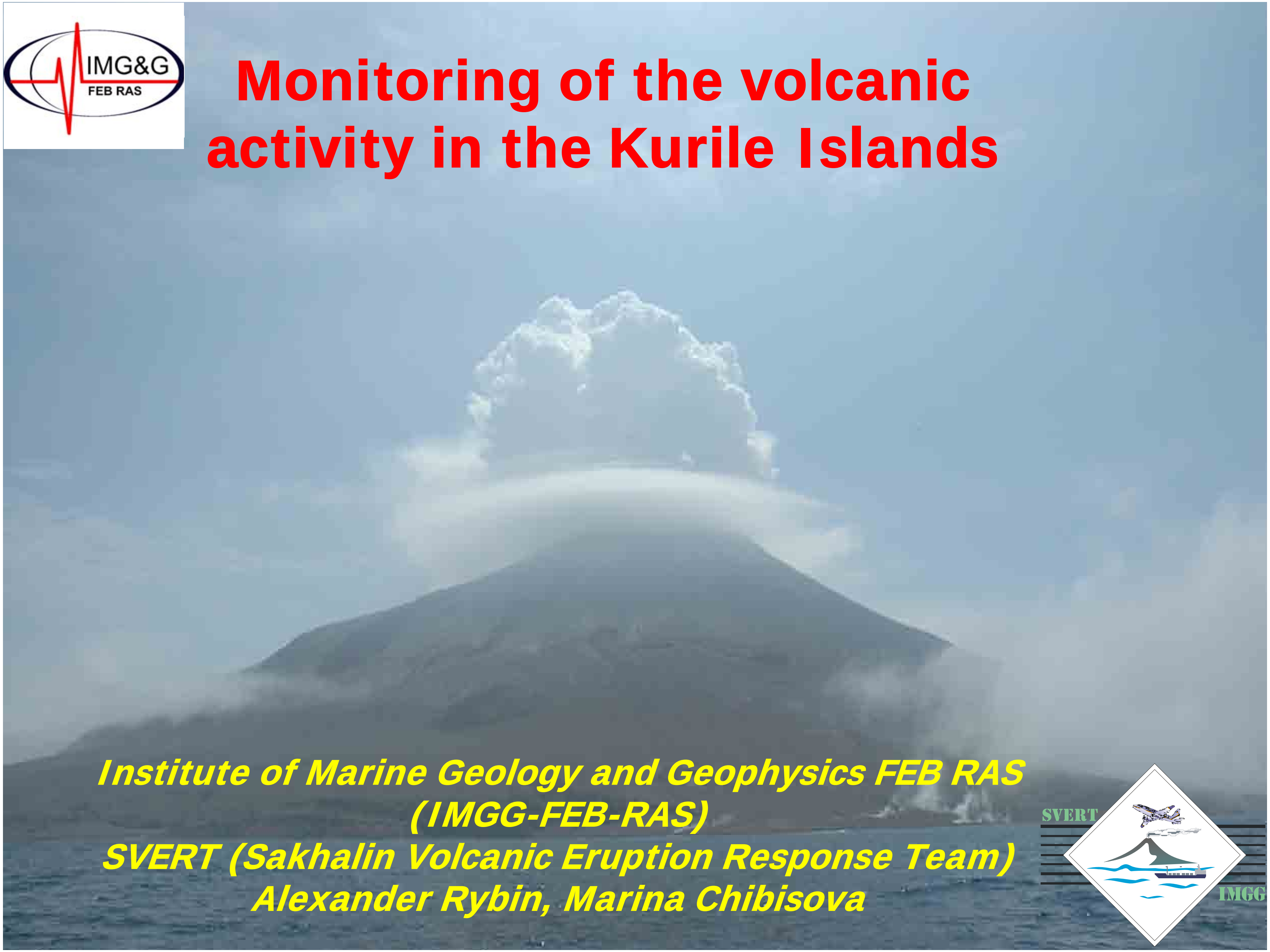
Natural Resources Canada / Ressources naturelles Canada

www.nrcan.gc.ca

Foreign Affairs and International Trade Canada / Affaires étrangères et Commerce international Canada

www.international.gc.ca

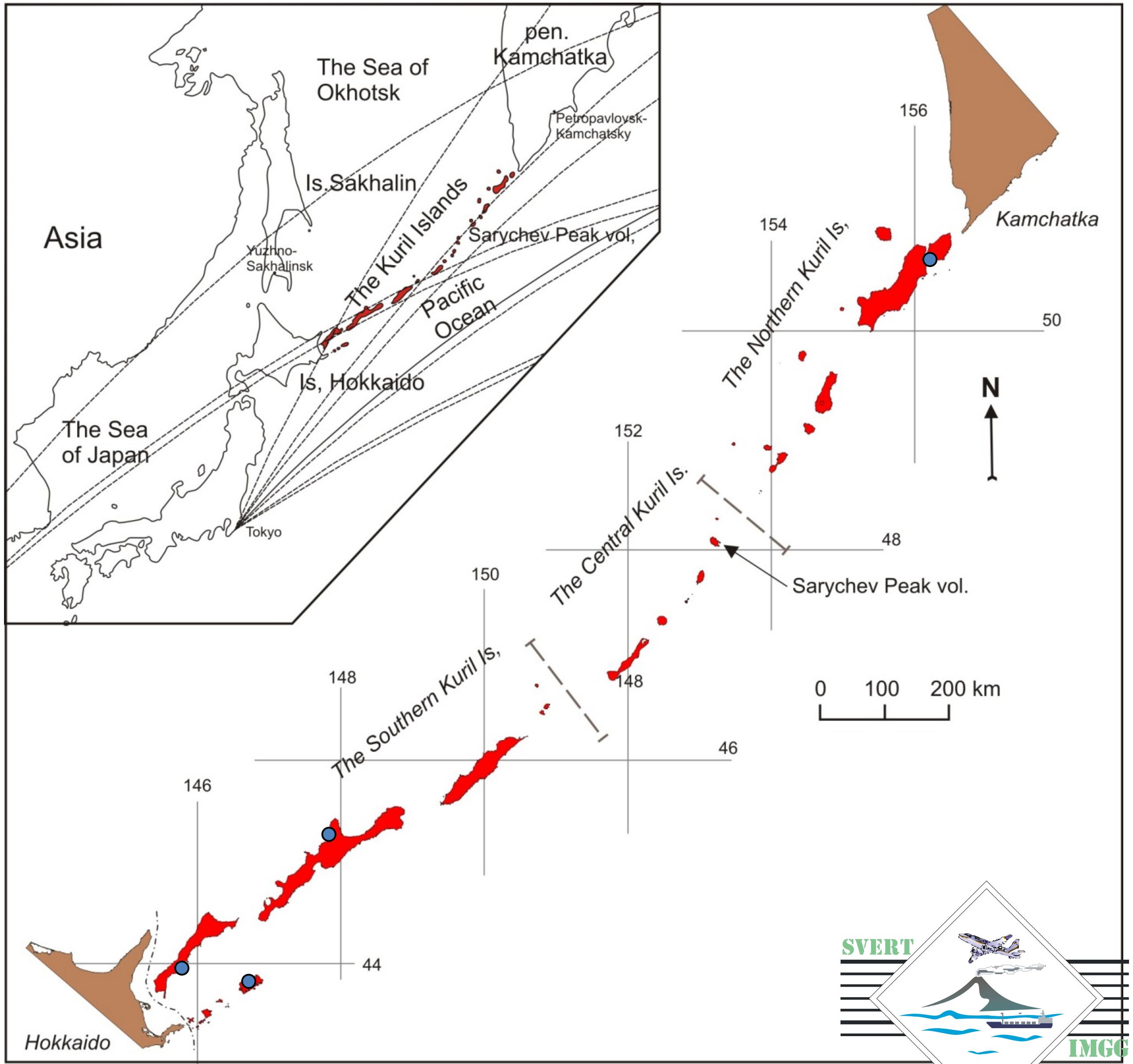
Monitoring of the volcanic activity in the Kurile Islands

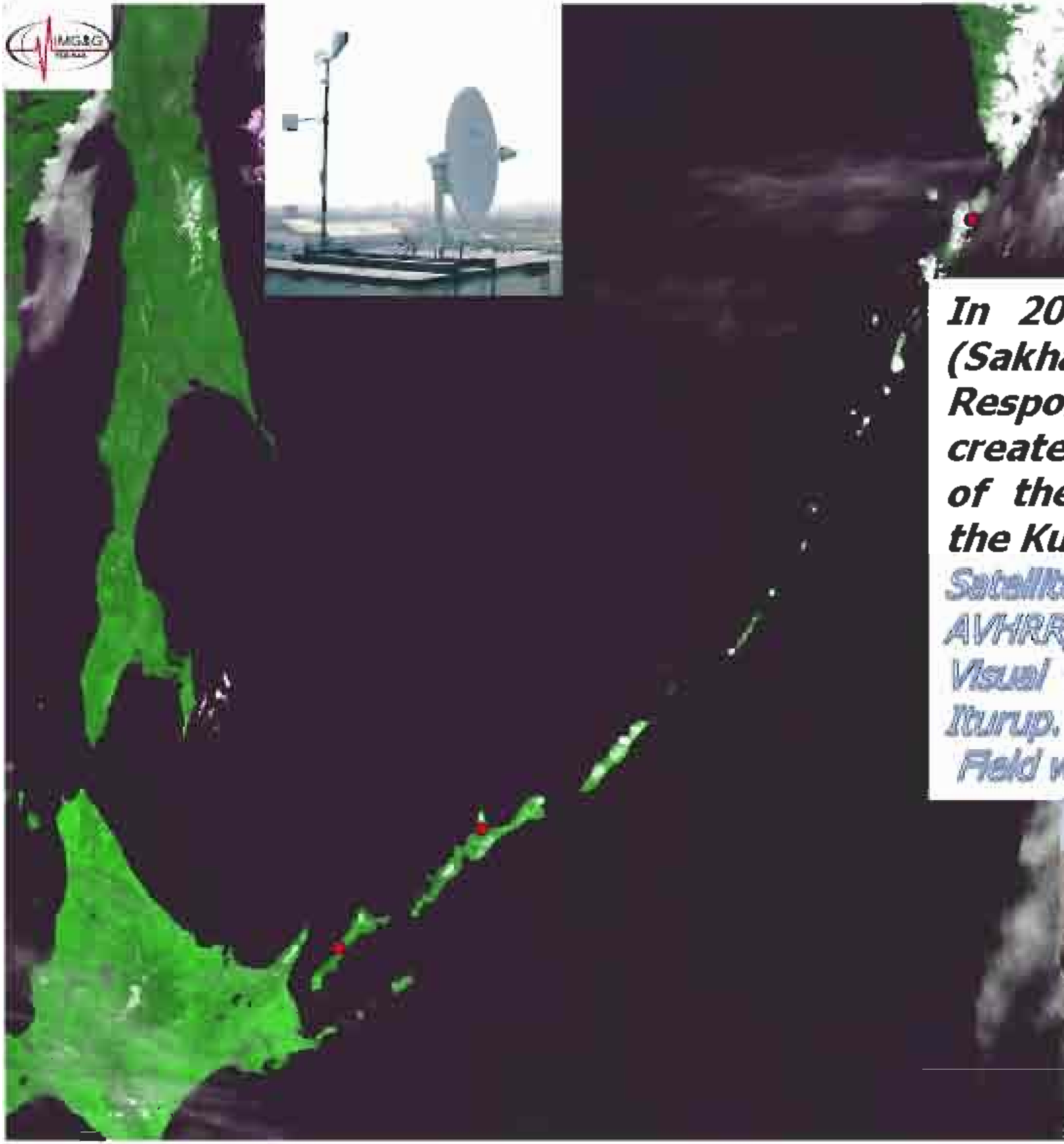


Institute of Marine Geology and Geophysics FEB RAS
(IMGG-FEB-RAS)
SVERT (Sakhalin Volcanic Eruption Response Team)
Alexander Rybin, Marina Chibisova

There are 68 terrestrial volcanoes in the bounds of the Kuril island arc, among them 36 are active and potentially dangerous.

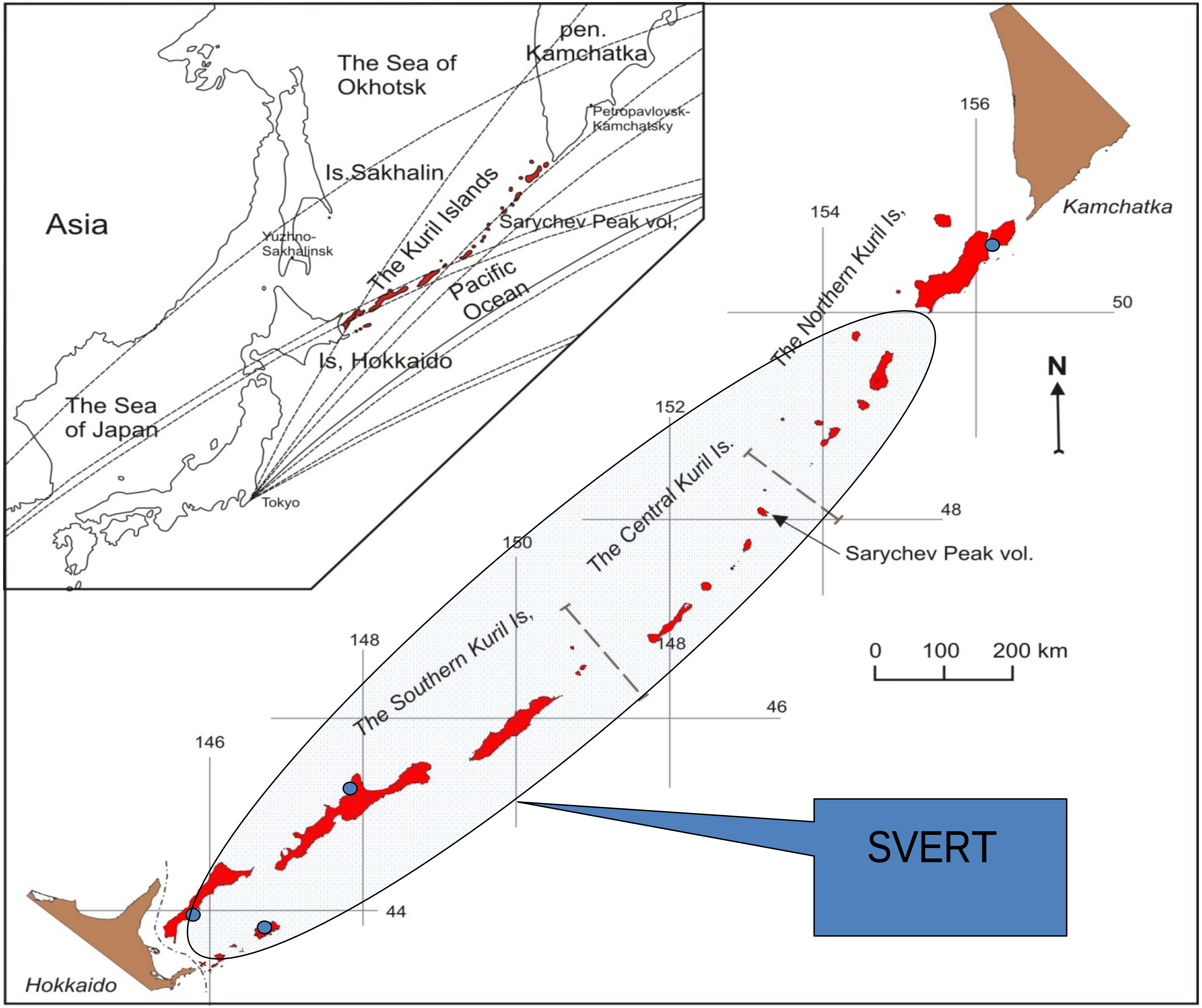
They are erupted in historical time or show the signs of the activity in present time. In Kuril Islands small eruptions occur once 1-2 years, moderate eruptions are fixed every 11 years, medium are once 22 years, great are once 33 years, catastrophic eruptions are observed once a century .



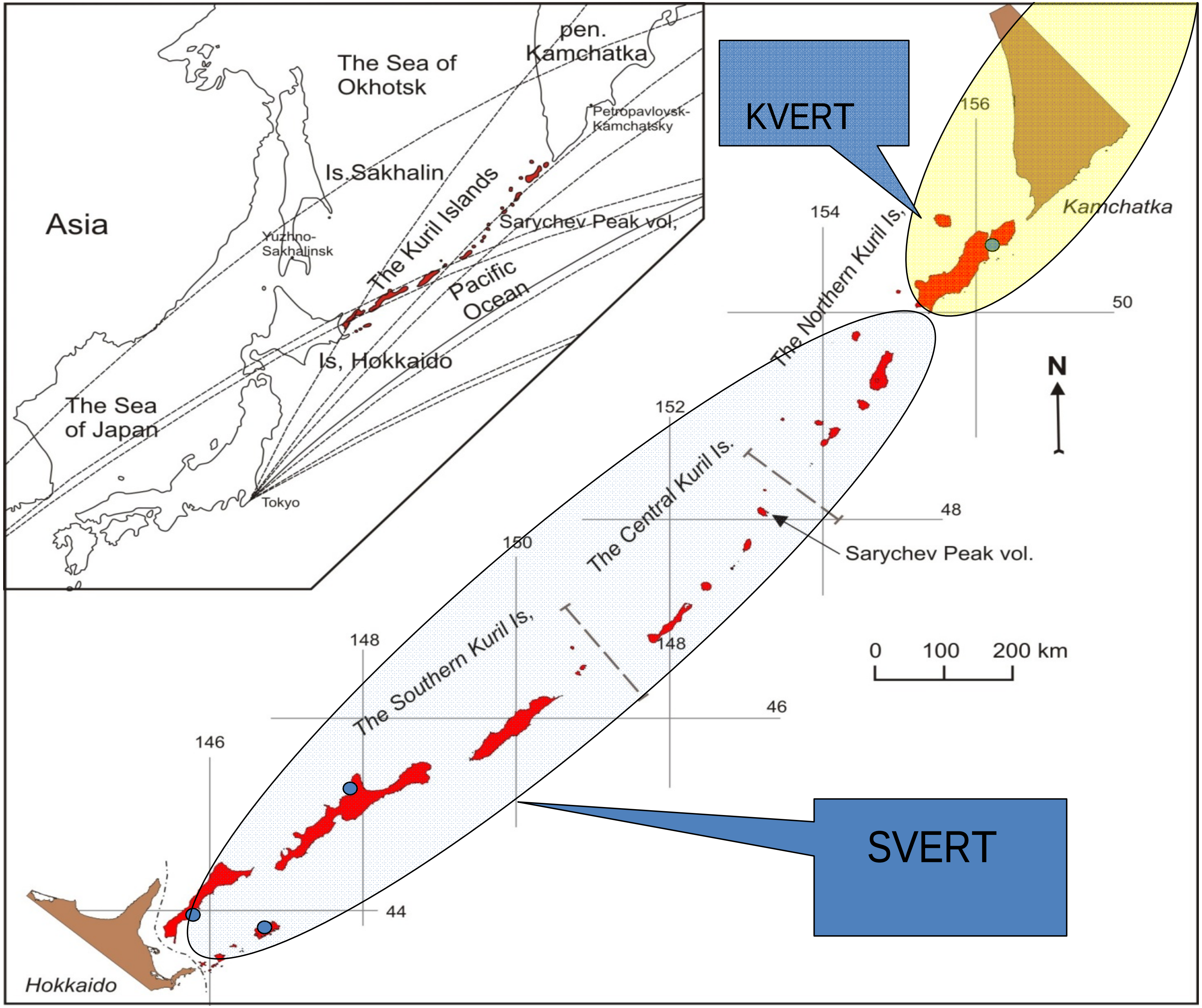


In 2003 the group SVERT (Sakhalin Volcanic Eruptions Response Team) was created for the monitoring of the active volcanoes of the Kurile Islands.

Satellite monitoring - MODIS, AVHRR, MTSAT.
Visual observations – Kunashir, Iturup.
Field works

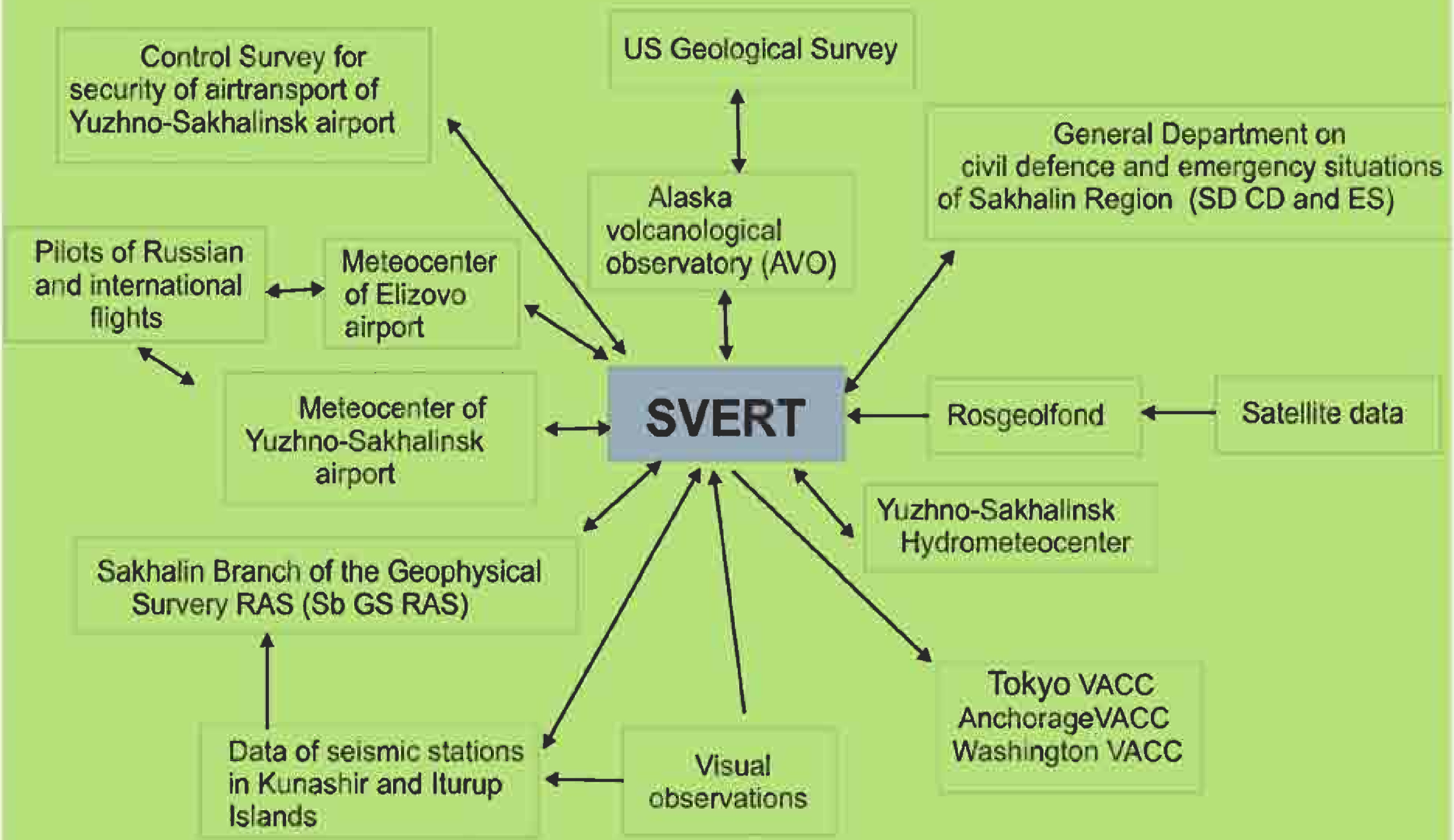


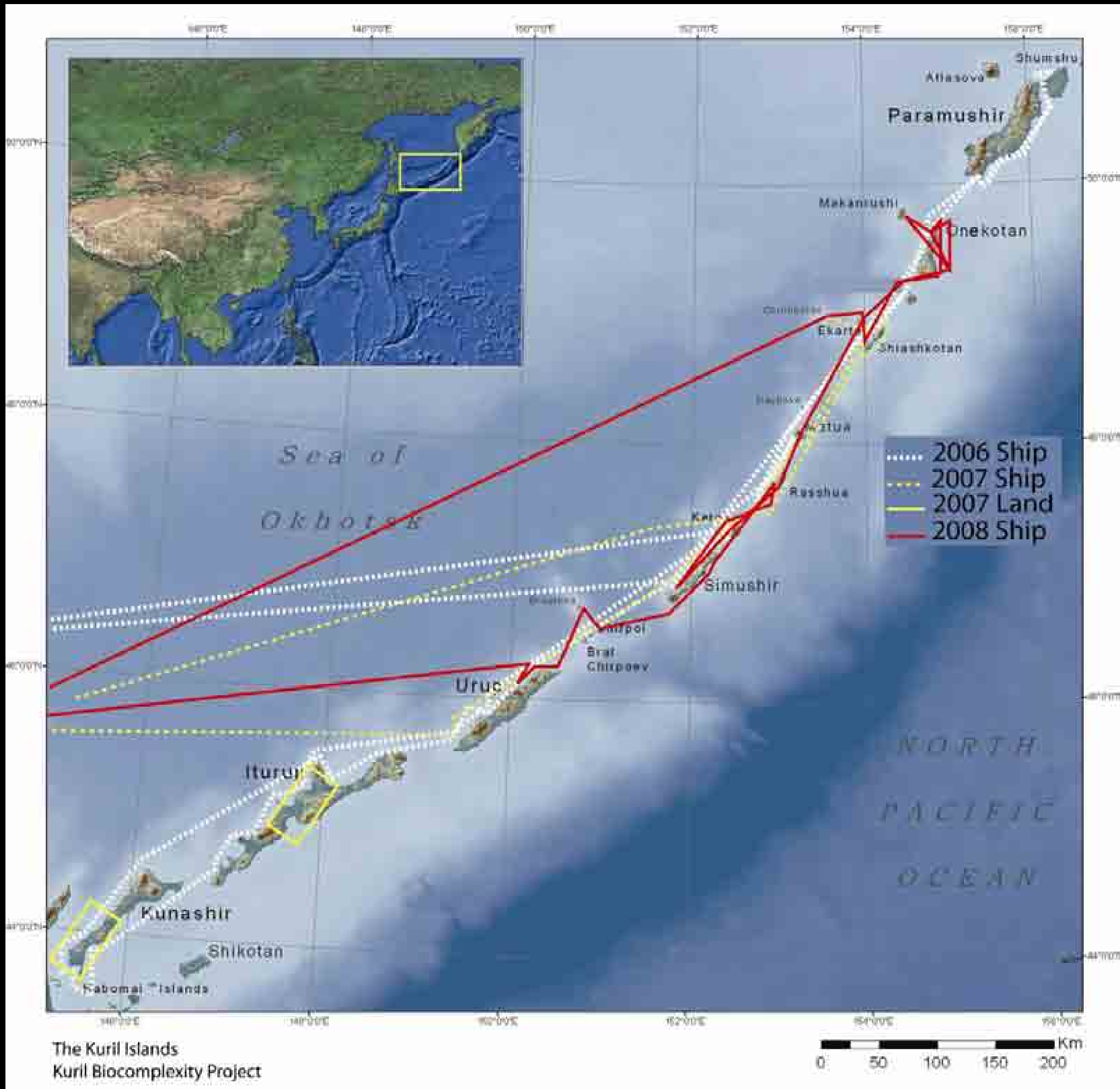
pen.
Kamchatka
The Sea of
Okhotsk
Petropavlovsk-
Kamchatsky
Is.Sakhalin
The Kuril Islands
Sarychev Peak vol,
Asia
Yuzhno-
Sakhalinsk
Pacific
Ocean
Is, Hokkaido
The Sea
of Japan
Tokyo
156
Kamchatka
154
The Northern Kuril Is,
50
N
152
The Central Kuril Is.
48
Sarychev Peak vol.
150
The Southern Kuril Is,
148
148
0
100
200 km
46
146
SVERT
44
Hokkaido



pen. Kamchatka
The Sea of Okhotsk
Petropavlovsk-Kamchatsky
Is.Sakhalin
The Kuril Islands
Sarychev Peak vol,
Asia
Yuzhno-Sakhalinsk
Pacific Ocean
Is, Hokkaido
The Sea of Japan
Tokyo
KVERT
156
Kamchatka
154
The Northern Kuril Is,
50
N
152
The Central Kuril Is.
48
Sarychev Peak vol.
150
The Southern Kuril Is,
148
0 100 200 km
46
146
SVERT
44
Hokkaido

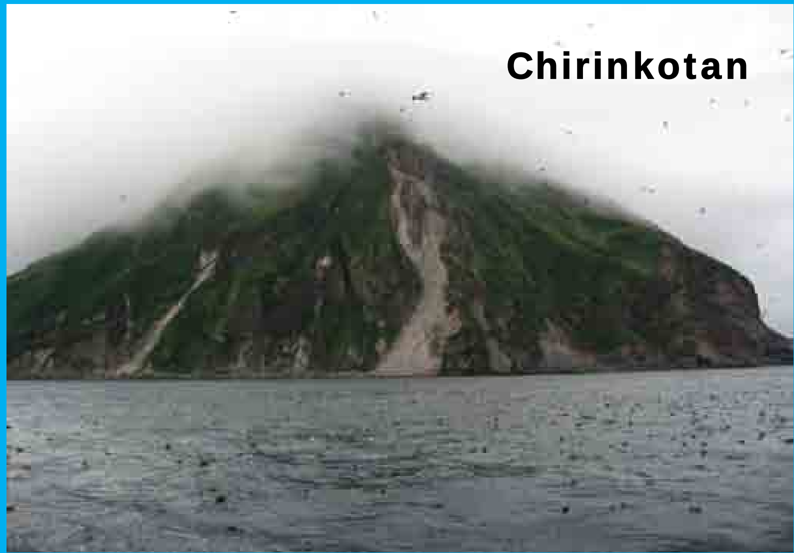
Scheme of Interactions of SVERT group



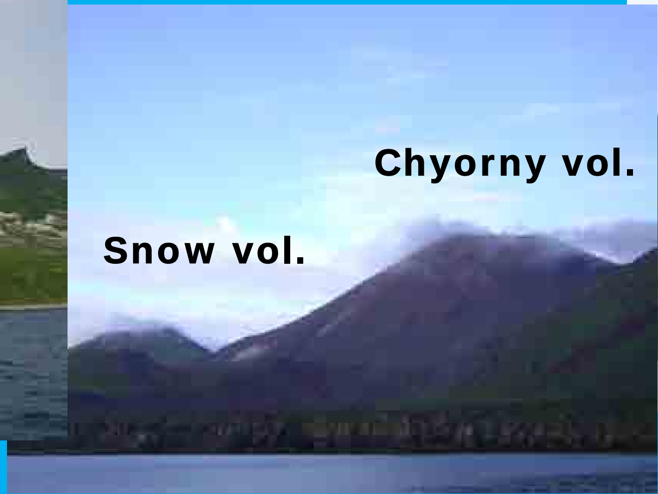


KBP – 2006, 2007, 2008 Expeditions

Volcanological researches of KPB 2006-2008



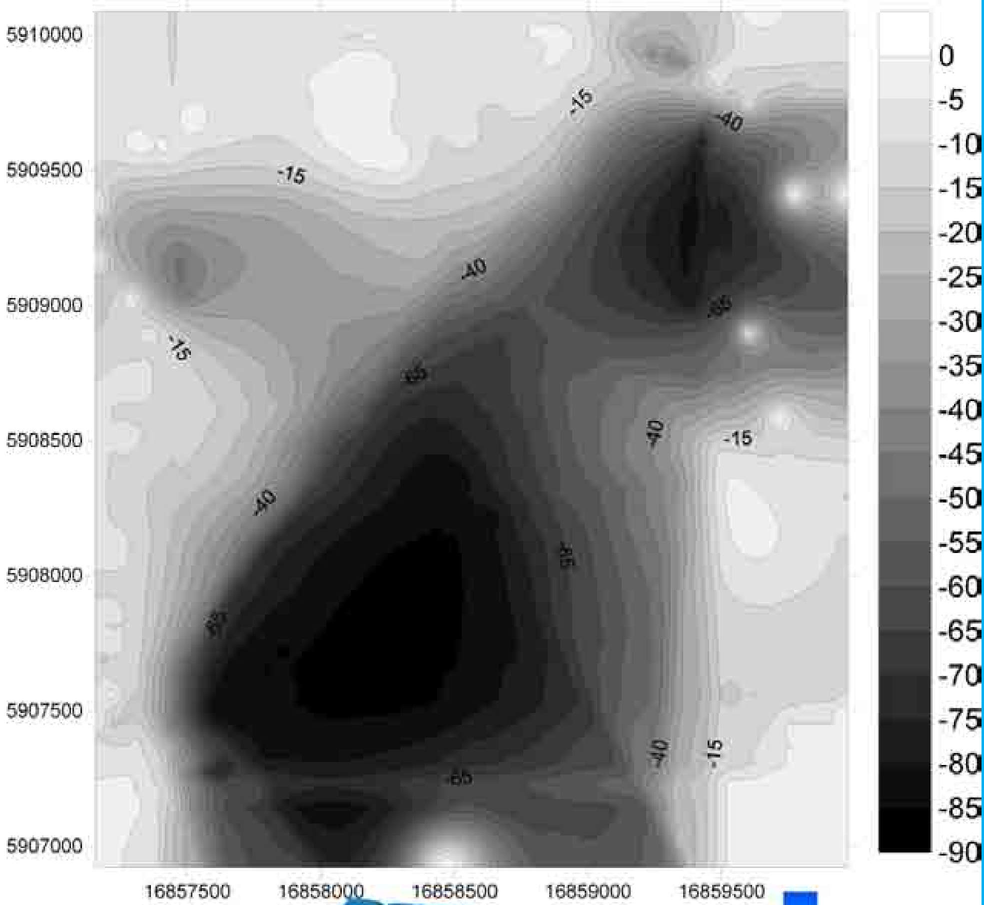

Severgin vol.

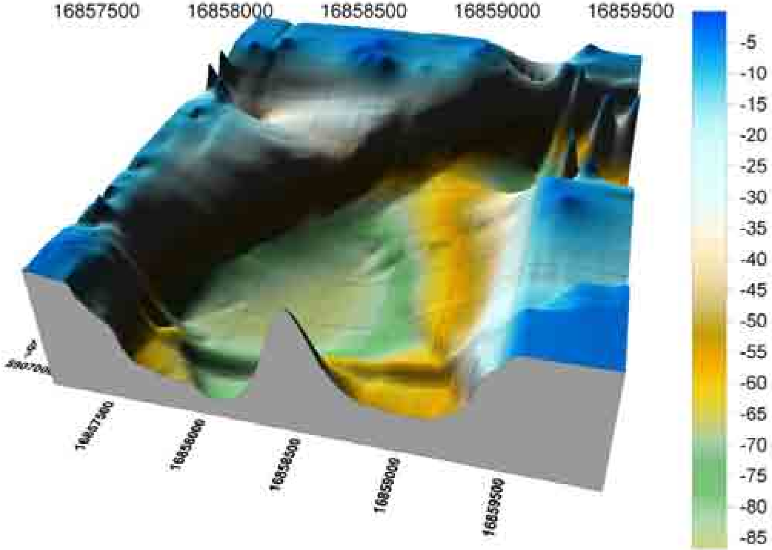

Chyorny vol.
Snow vol.


Sinarka

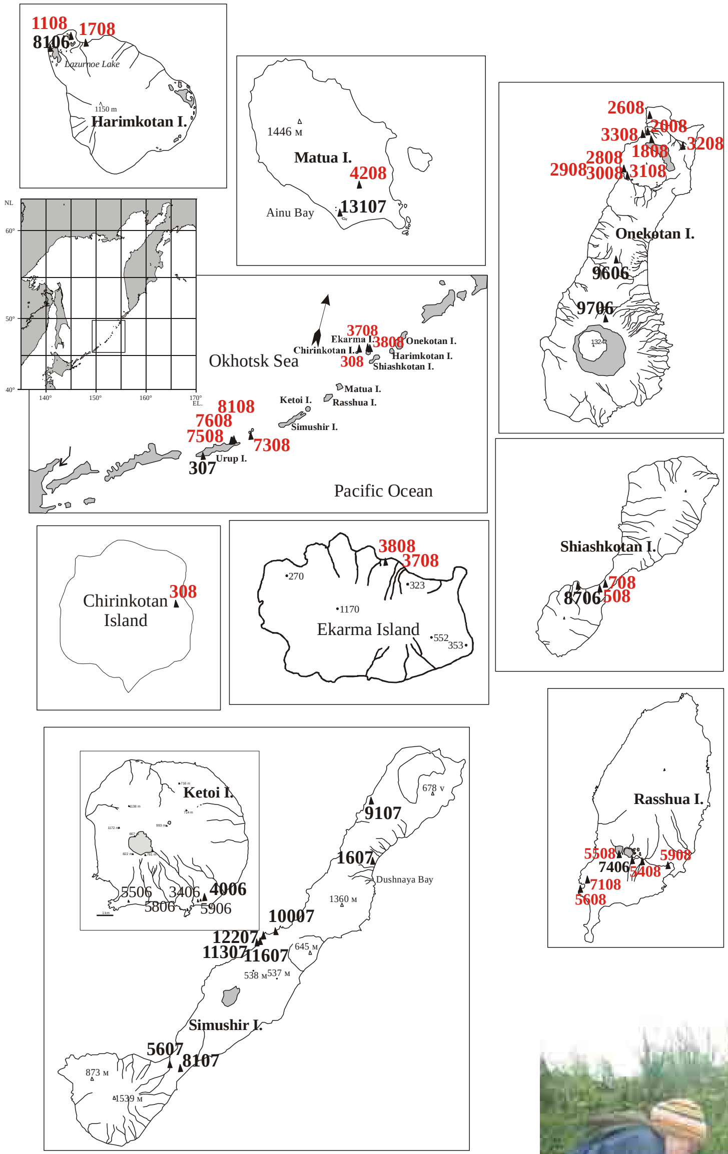

Zavaritsky caldera

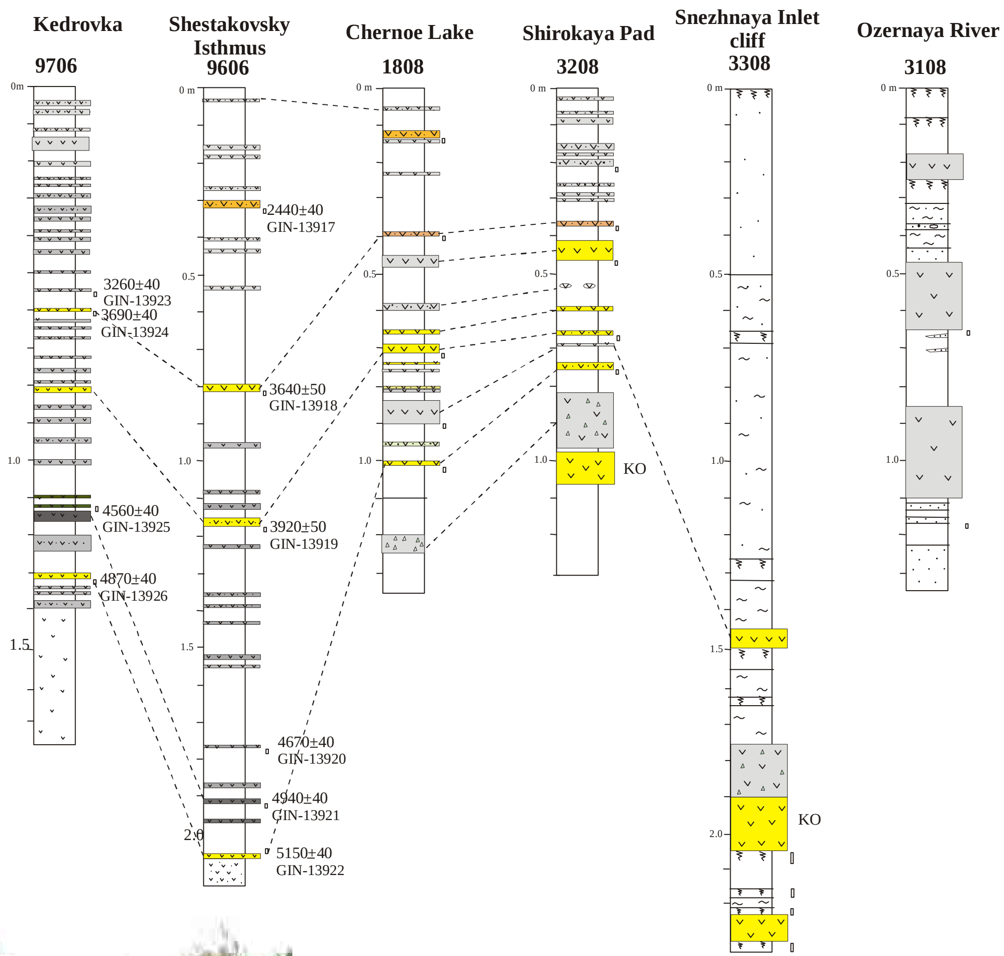
Sinarka volcano





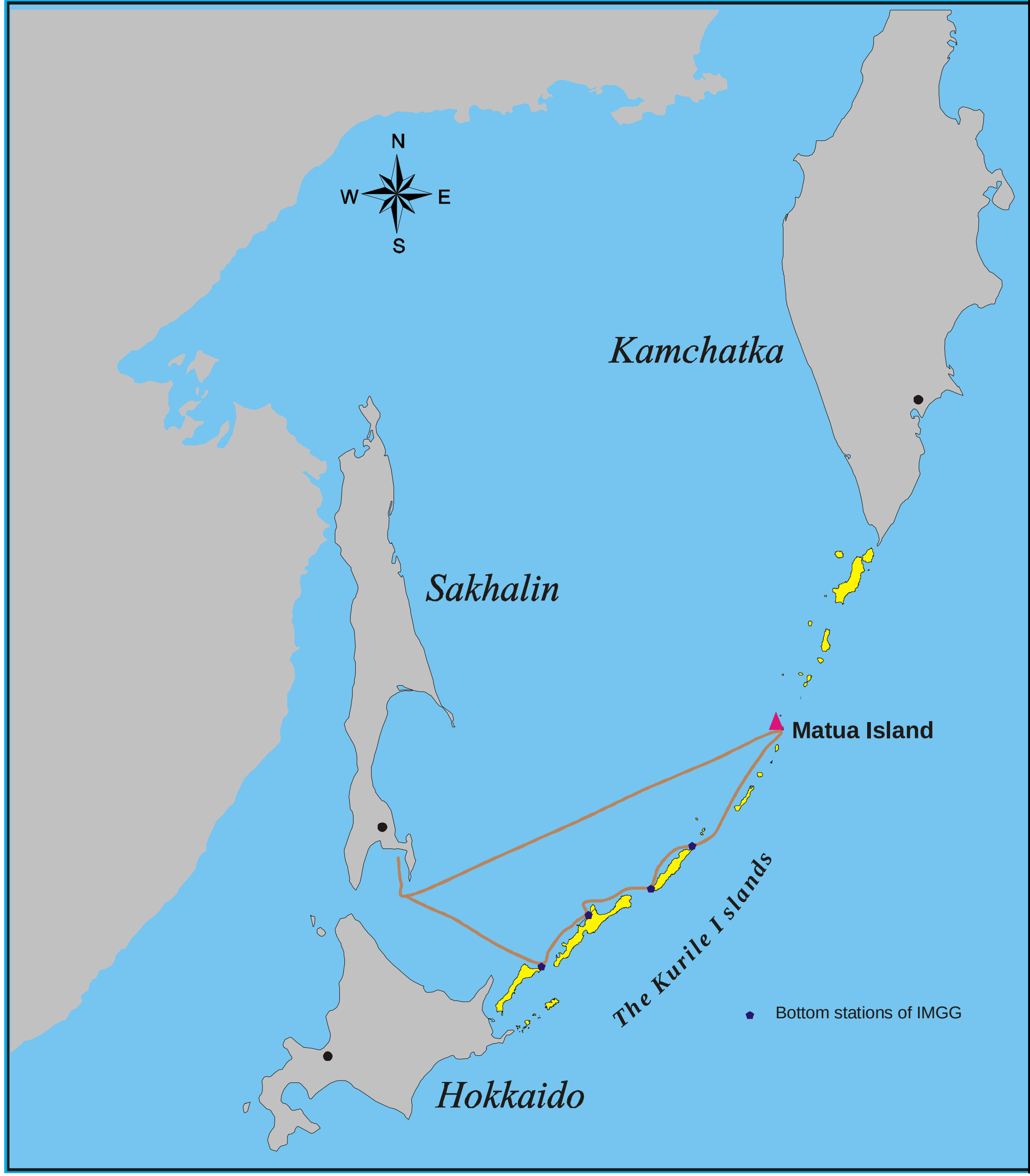
Golovnin caldera (Kunashir Is.)
Zavaritsky caldera (Simushir Is.)
Nemo caldera (Onekotan Is.)





The volcanoes in the islands Ketoi, Rasshua, Shiashkotan were lesser active in the Middle and Late Holocene.

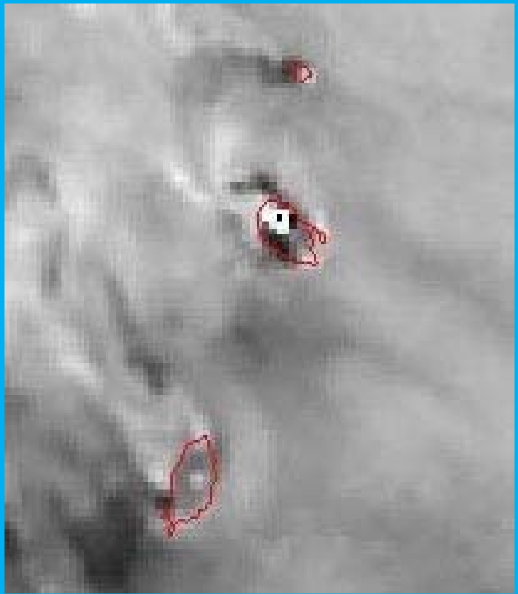
The eruption of Peak Sarychev Volcano in June 2009



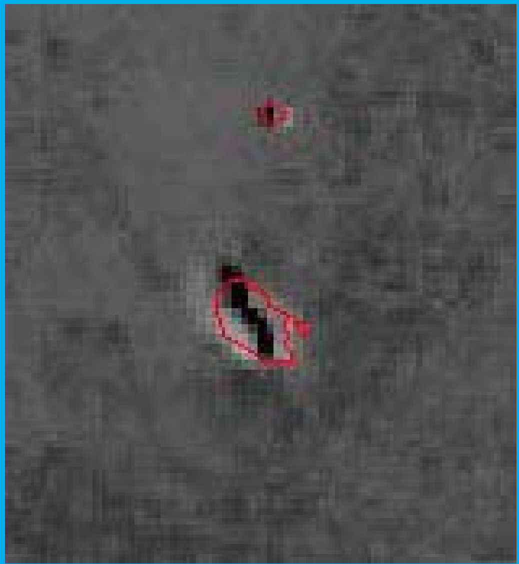
1760	Great explosive eruption.
1878-1879	Quiet effusion of lava on the northeast flank reaching the sea.
1923	Explosions with ash and scoria.
1928	Explosive eruption.
1930	Great explosive eruption lasting 13 hours.
1946	Very strong explosive-effusive eruption with ash clouds to 7 km.
1954	Weak ash emissions.
1960	Explosive eruption, a single event from the upper crater, ash to 4.5 km.
1976	Series of explosions destroyed lava dome. Ash and gas cloud extended 300 km north-northeast at 2.5 km altitude. Simultaneous lava flows from the summit advanced down the southwest, west, and northwestern slopes. Post-eruption the crater floor was relatively flat and 200 m in diameter.
1982-89	Intense fumarolic activity in the summit crater. Occasional phreatic explosions and related lahars.

Thermal anomalies

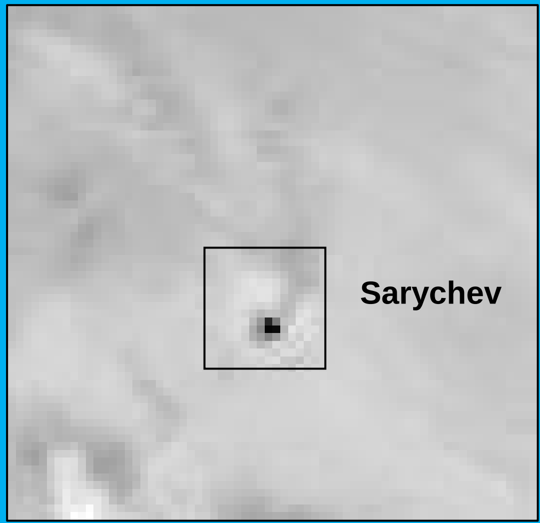
11.06.2009



Mod.021km.A0906110031r20

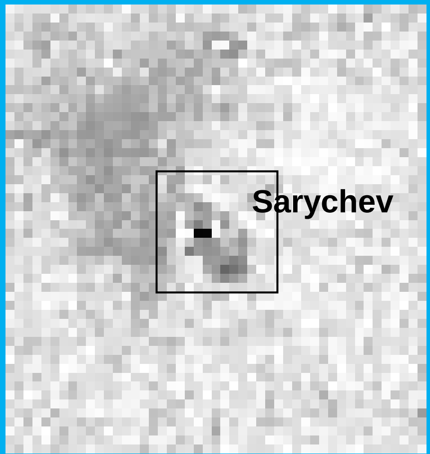


Mod.021km.A0906110031r(32m31)

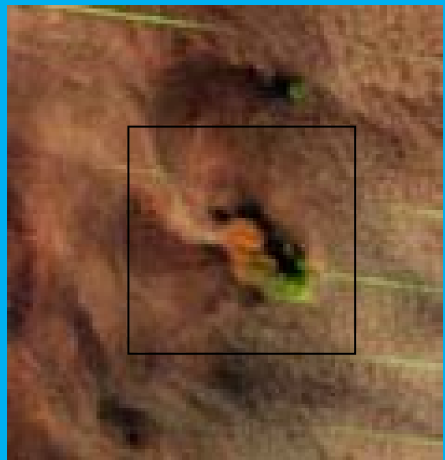


NOAA 0906110532r3

NOAA 0906110532r4

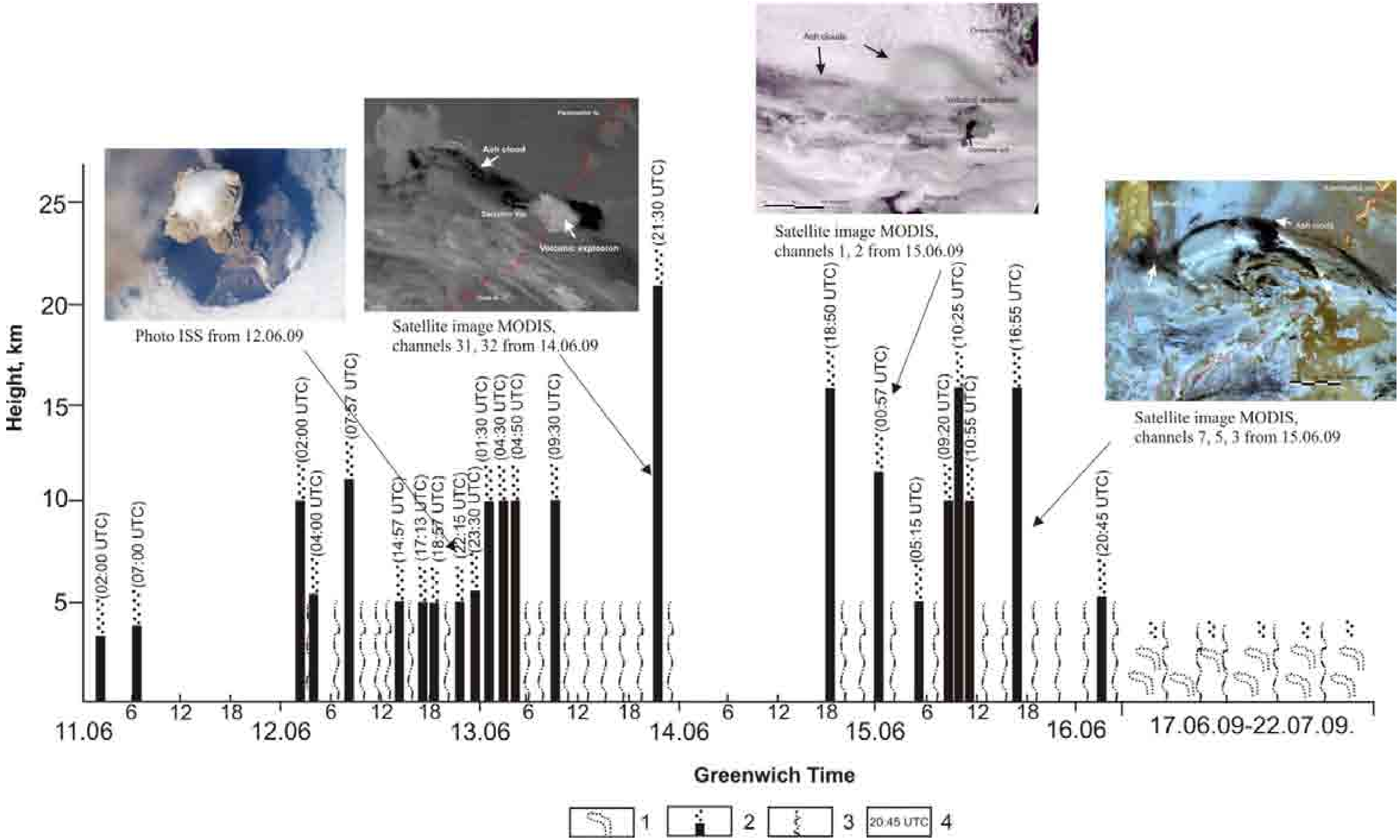


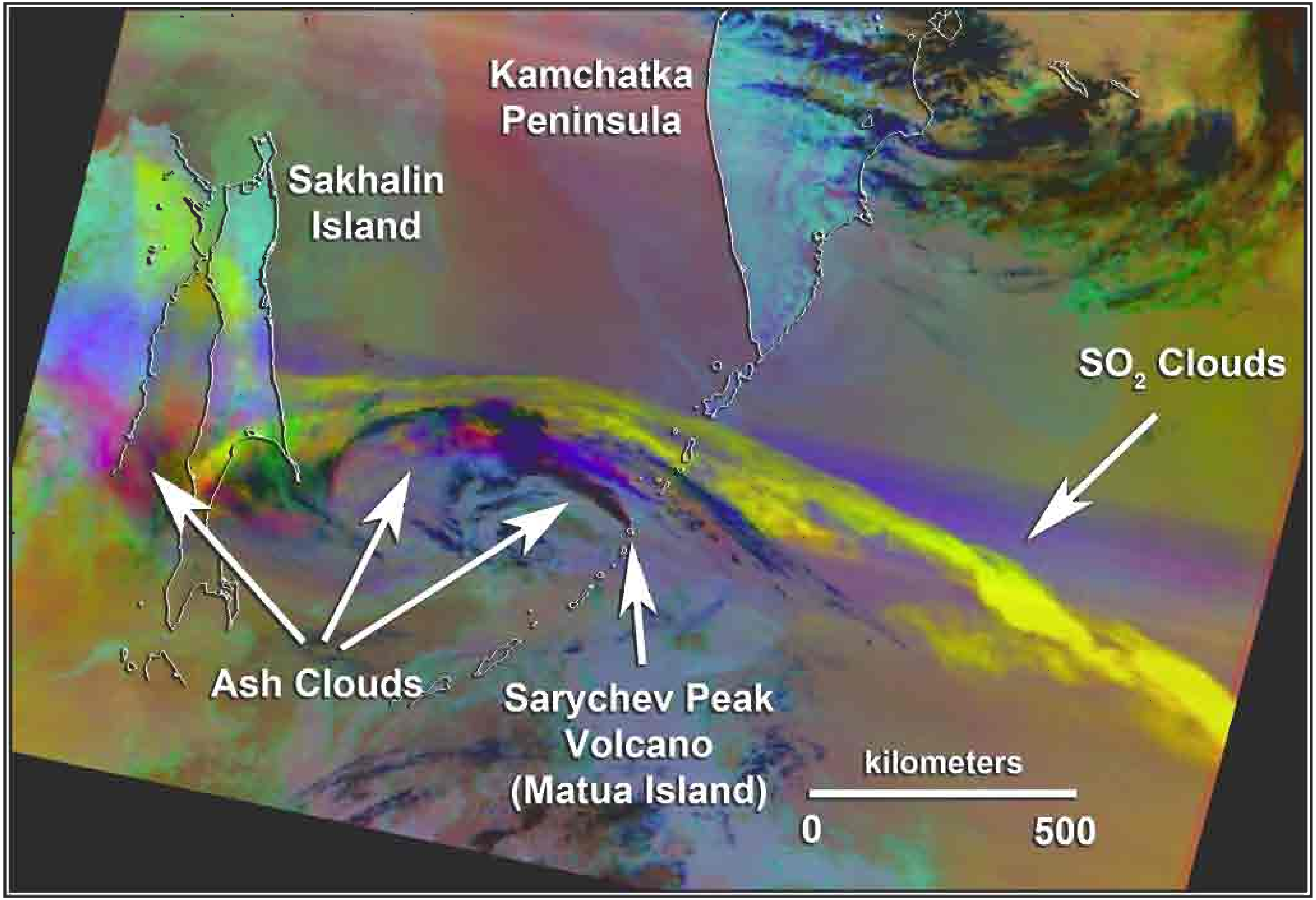
NOAA 0906110532r(4m5)



Mod.021km.A0906110031r

The chronology of Peak Sarychev volcano eruption according to the satellite data





Kamchatka
Peninsula
Sakhalin
Island
SO_2 Clouds
Ash Clouds
Sarychev Peak
Volcano
(Matua Island)
kilometers
0
500

Остров Матуа до и после извержения (снимки ASTER)

27 мая 2007 года   30 июня 2009 года







Поверхность пирокластических потоков в западной части острова

Between 12 JUN 09 and 17 JUN 09 the eruption and the ash cloud resulted in

- **65 re-routes**
- **6 diversion**
- **2 turn backs to originating departure cities**
- **12 fuel stops.**

(Salinas L.J., 2010)
(http://www.agiweb.org)

Фото МКС 12.06.09

Thank you for the attention

Geophysical Observation Research for Volcano Monitoring and Eruption Magnitude Early Warning - A Strategy Proposition-

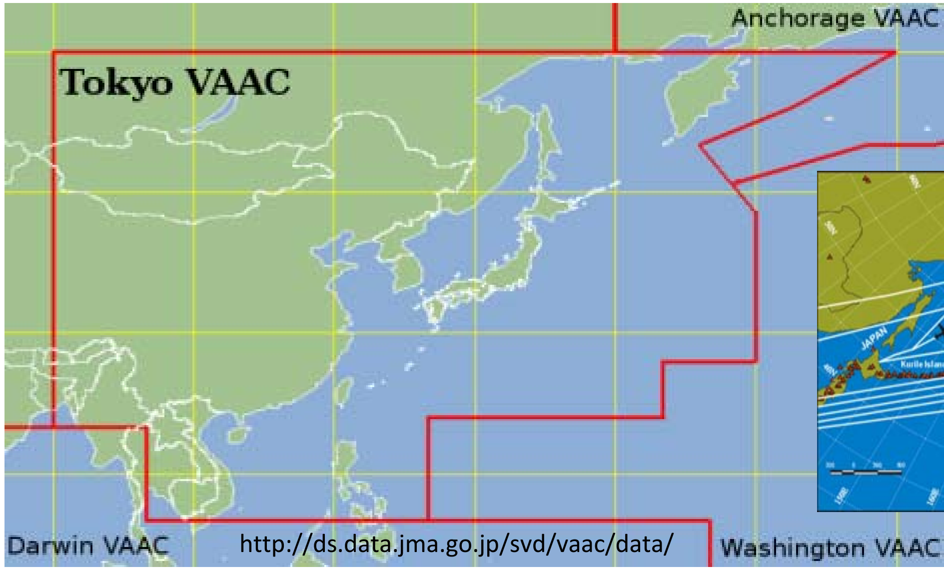
Hiroaki Takahashi

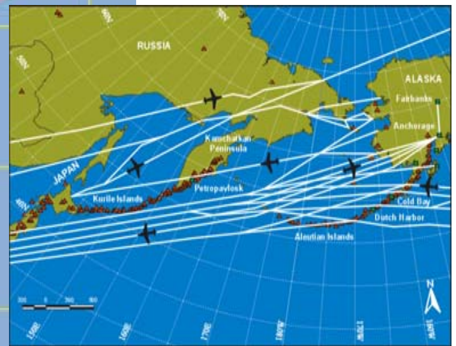
Hokkaido University, Sapporo, Japan


Japan has many volcanoes
in populated areas
Citizen, Hot-spring hotel, …So many human activities are doing near active vent (<2km)
“Precise” information for disaster mitigation operation are required.
Because, evacuation will cause large economic loss.
Photo by JMA: http://www.jma.go.jp

Meanwhile, Japan has responsibility to monitor activities in adjacent regions

Tokyo VAAC must watch from Philippine to Kamchatka



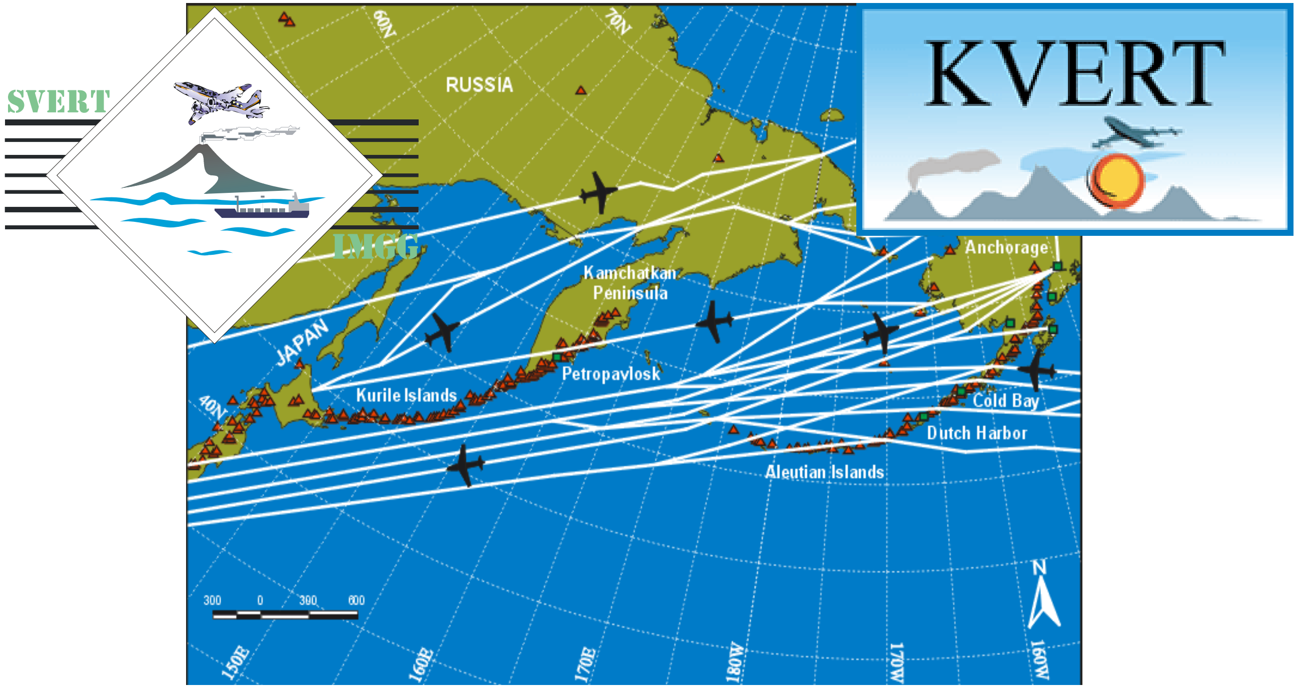


*Tokyo VAAC belong to Volcanological section, not meteorological, of JMA

Japanese volcano monitoring has two aspect:

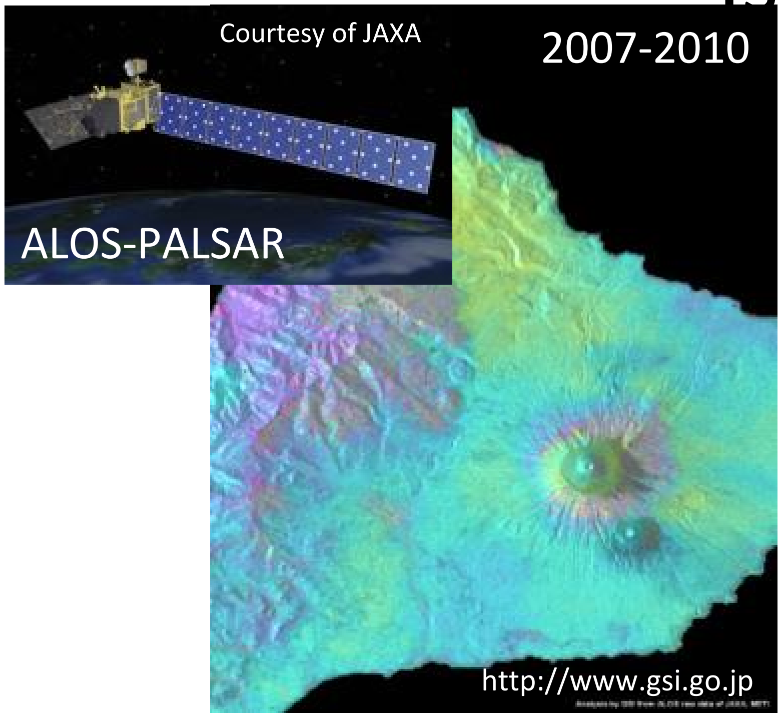
- For populated-area (Japanese Islands)
- For remote area (e.g. Kuril Islands)

KVERT and SVERT in Kuril

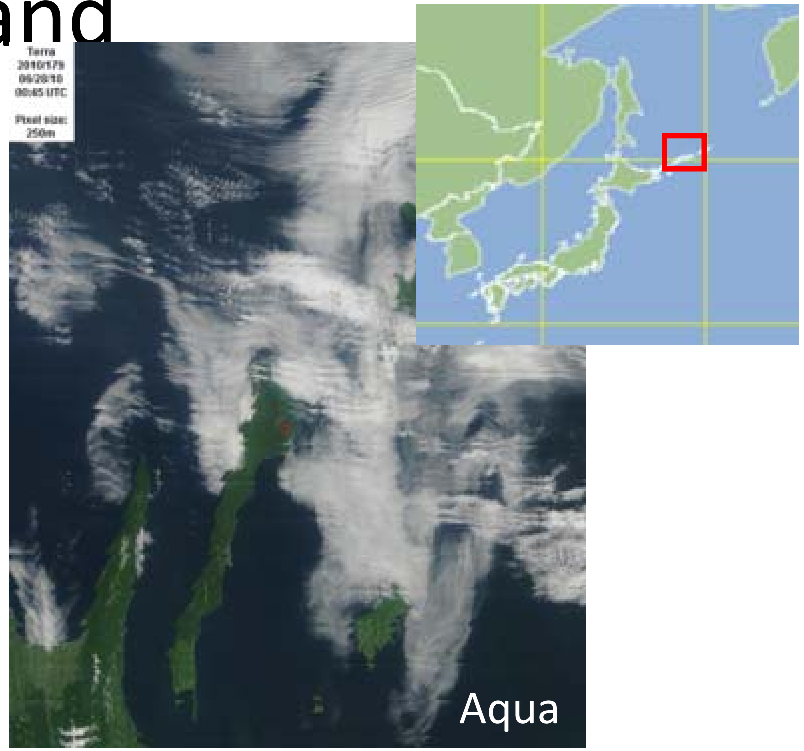


SVERT and KVERT activity is very important for Kuril monitoring.

Recent Tyatya unrest signals, Kunasir Island



Analysis by GSI from ALOS raw data of JAXA, METI



Thermal anomaly has been observed but no signal of crustal deformation by Japanese satellite-based INSAR analysis.

Japan-Russia government agreed for disaster mitigation cooperation at adjacent region.
I hope this unrest will be monitored under above intergovernmental agreement.

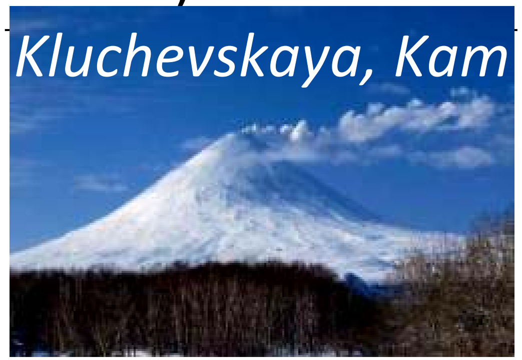
Japanese government supports our new project

New scientific project at Kluchevskaya volcano in Kamchatka will work from 2010 to 2014 by

- Hokkaido University
- Institute of Volcanology and Seismology, FEB-RAS
- Kamchatka Branch of Geophysical Survey, RAS

funded by Ministry of Education, Culture, Sports, Science and Technology of Japan (MEXT-KAKENHI).

This project will product valuable output for volcano monitoring, especially for basaltic volcanoes (e.g. Fuji volcano).

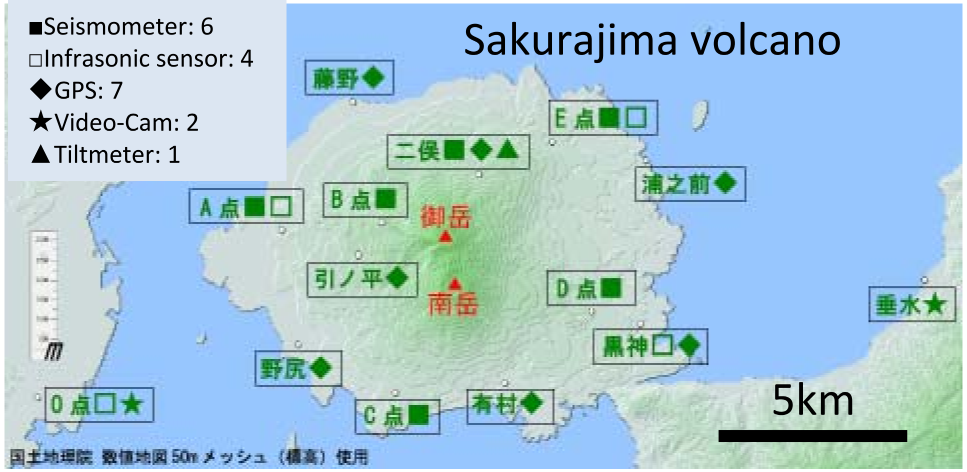


Monitoring Research in "populated" Japanese Islands

Left:
The 2000 Usu-Eruption

Phreatomagmatic eruptions attack hot-spring resort area.

Fulfilling 24hrs Monitoring in Japan



Data in Real-time Telemetering

Volcanic Observation and Information Centers are in operation at four district JMA observatories

Eruption Prediction Information must be issued with high reliability.

That is, It will be dangerous or not for resident activity?

Prediction need to say followings,

- When it will start?
- From Where?
- How large?
- What style? Explosive? Lava flow?
- How long continue?
- When it will stop?

Because evacuation will stop all living and economic activities of residents.

Can we reply in Real-time or advance?

- ✓ Data is data, they do not teach us answers….
- ✓ Many unrest signals without eruption are usually observed. Dense and high-precision observation network complicit in increasing of such experiences.
- ✓ Past experiences is workable, but volcano sometimes try to find fully new approach.

Questions	Current Status	Data
When start?	Green+Yellow	Hypocenter migration? Geodetic data?
From where?	Green+Yellow	Hypocenter migration & Geodetic data
How large?	Orange	**Geodetic data => Target of this report**
What style?	Red	Geodetic data?
How long continue?	Red	Only status monitoring is available
When stop?	Red	Only status monitoring is available

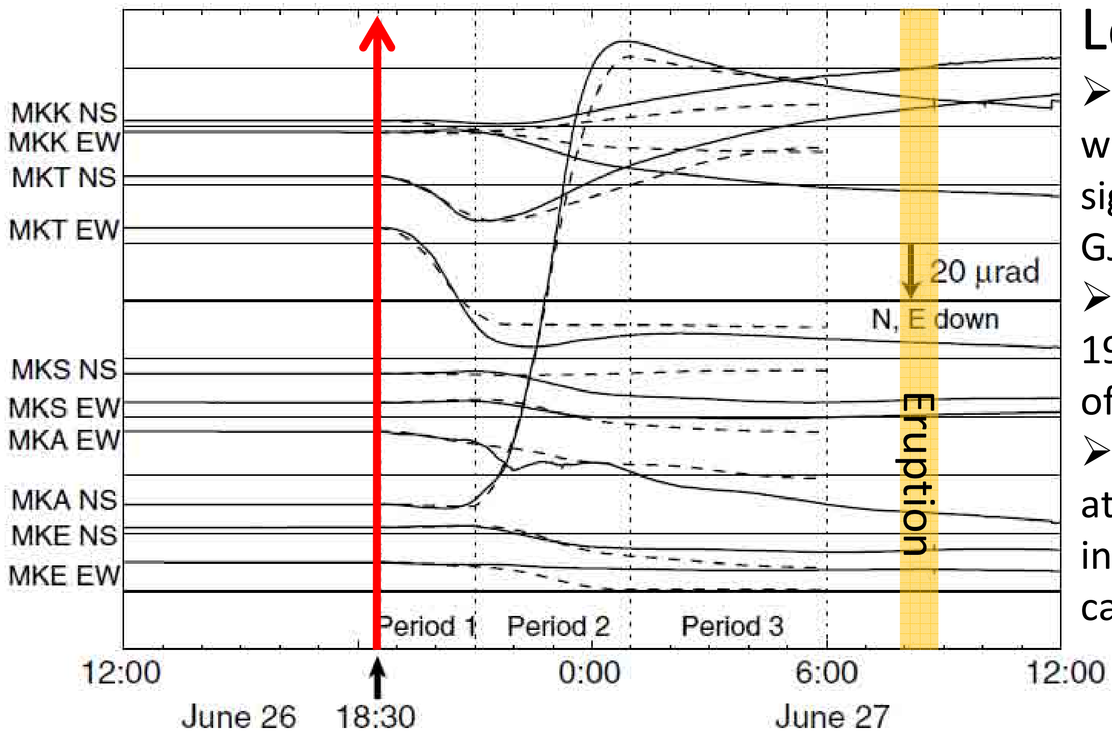
Objective of Presentation

How to estimate eruption magnitude in advance.

Eruption magnitude prediction is very important for everything, e.g. evacuation, aviation etc.

Sometimes it happen sudden

Less than half-day precursor for eruption is usual.
2000 Miyake: 8hrs, 1983 was only 1h15min



Left: 2000 Miyake

- Dense tiltmeter network well captured precursor signals (Ueda et al., 2005, GJI).
- JMA issued an alert on 19:33 (1hour after beginning of unrest activity).
- Submarine eruption occur at 9:00am but this is only a introduction for catastrophic caldera formation.

Real-time data processing and judgment for prediction parameter are required for information release.

How to pursue rapid and extensive phenomena?

- ✓ *Required system:*
  - Real-time data transfer
  - Simple data pre-processing and visualization

    =>achieved in Japan, etc…

    =>not in Kuril

- ✓ *Data processing*
  - Simple and robust modeling for extracting essential information from observation data

Eruption have long time constant: Why seismometer?

- Seismometer can record phenomena less than 120 second (STS-2).
- Time constant of eruption is more and yet more longer.

Seismometers give only exclusive information

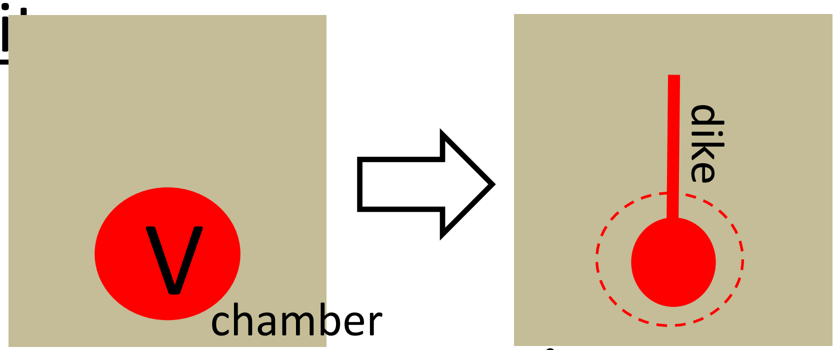
To monitor volcanoes, **geodetic equipment** is necessary.

Meakan-dake, Hokkaido, Japan

Magma volume is most important!

Here I believe simple assumptions, that is,

<u>Magma volume strongly control eruption activi</u>



Discharge rate with viscosity

$$\frac{d}{dt}\Delta V = \frac{d}{dt}\int (dike)dz$$

may predict eruption type.

$\int(\mathrm{dike})dz+\Delta V=V$

$\Delta V \geqq \int(\mathrm{dike})dz$

•Capturing magma intrusion rate/total from (a) chamber(s) give a clue to predict eruption size and type

•Successive magma volume detection may provide valuable information.

How to detect magma volume?

Far-field classical geodetic instrument is preferable
=>Borehole tiltmeter/strainmeter

<u>Why Far-Field?</u>

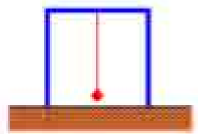
=>To avoid near-field effect of deformation field

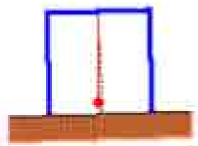
<u>Why Borehole Tiltmeter?</u>

=>No need pre-processing (GPS need data processing!)
output voltage=physical value=tilt(micro-radian)

=>High precision (than GPS!)

=>Replaceable (Strain-meter is not replaceable)





Far-Field data is useful!
For real-time monitoring

<u>Near-field geodetic data</u> contain following problem for real-time data processing

<u>1. Near-Field term:</u>

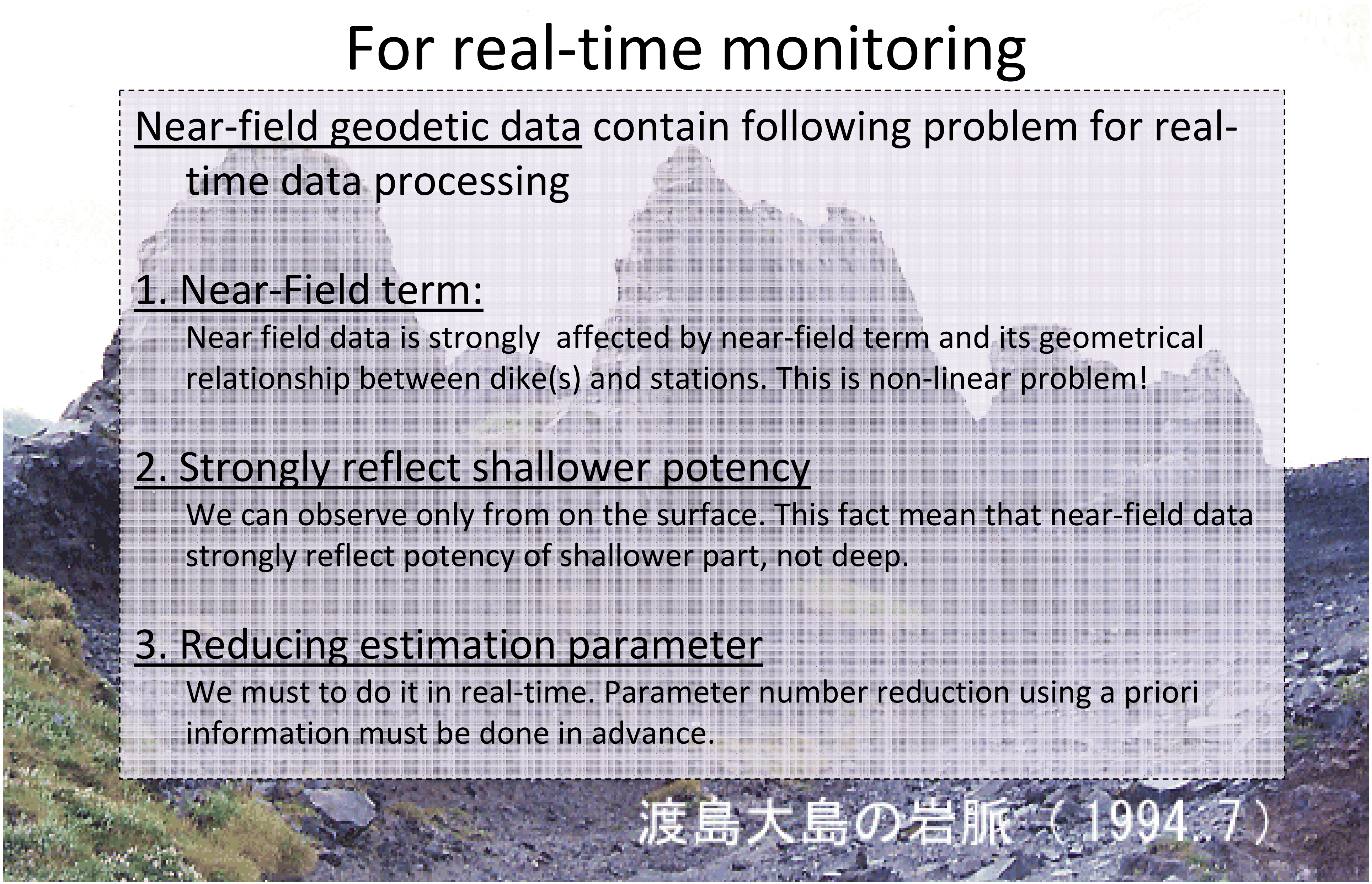
Near field data is strongly affected by near-field term and its geometrical relationship between dike(s) and stations. This is non-linear problem!

<u>2. Strongly reflect shallower potency</u>

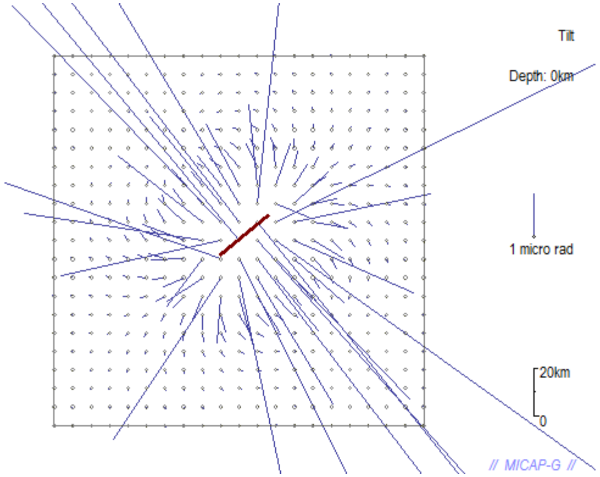
We can observe only from on the surface. This fact mean that near-field data strongly reflect potency of shallower part, not deep.

<u>3. Reducing estimation parameter</u>

We must to do it in real-time. Parameter number reduction using a priori information must be done in advance.

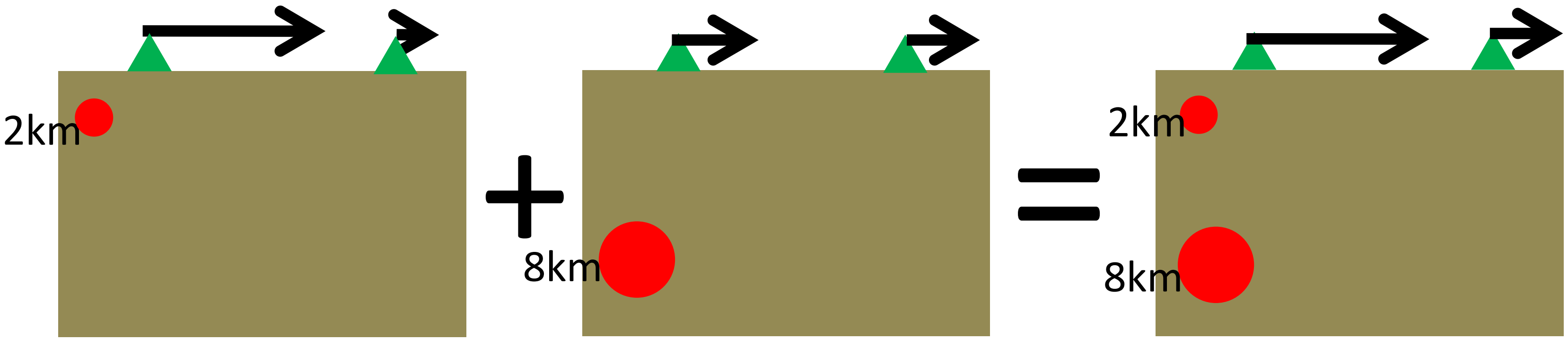


Near-field problems



Deformation is strongly affected by geometrical relationship between dike and stations.

This information is good for detailed source modeling but it need dense network.



Near-field station strongly reflect potency of shallower source

Deeper source activity is more essential for prediction!

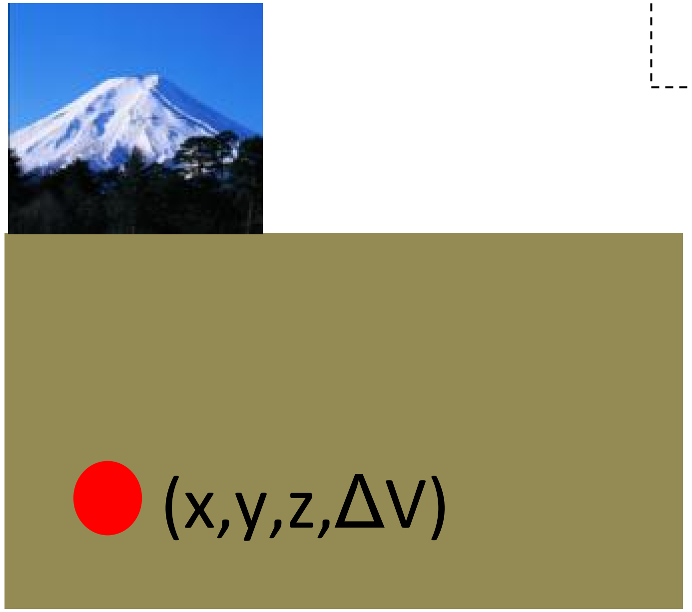
Far-field advantage

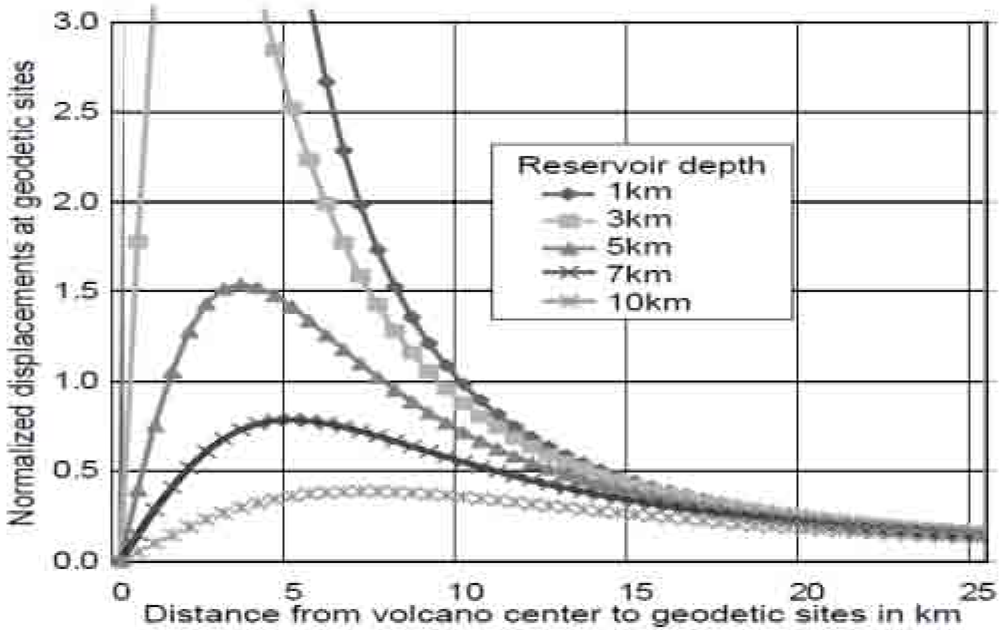
To acquire magma activity, we need to estimate

✓LOCATION(x,y,z)

✓POTENCY, that is, ΔV

- (x,y)=under volcano; a priori fixing
- ΔV from far-field data is not effected by depth variation!

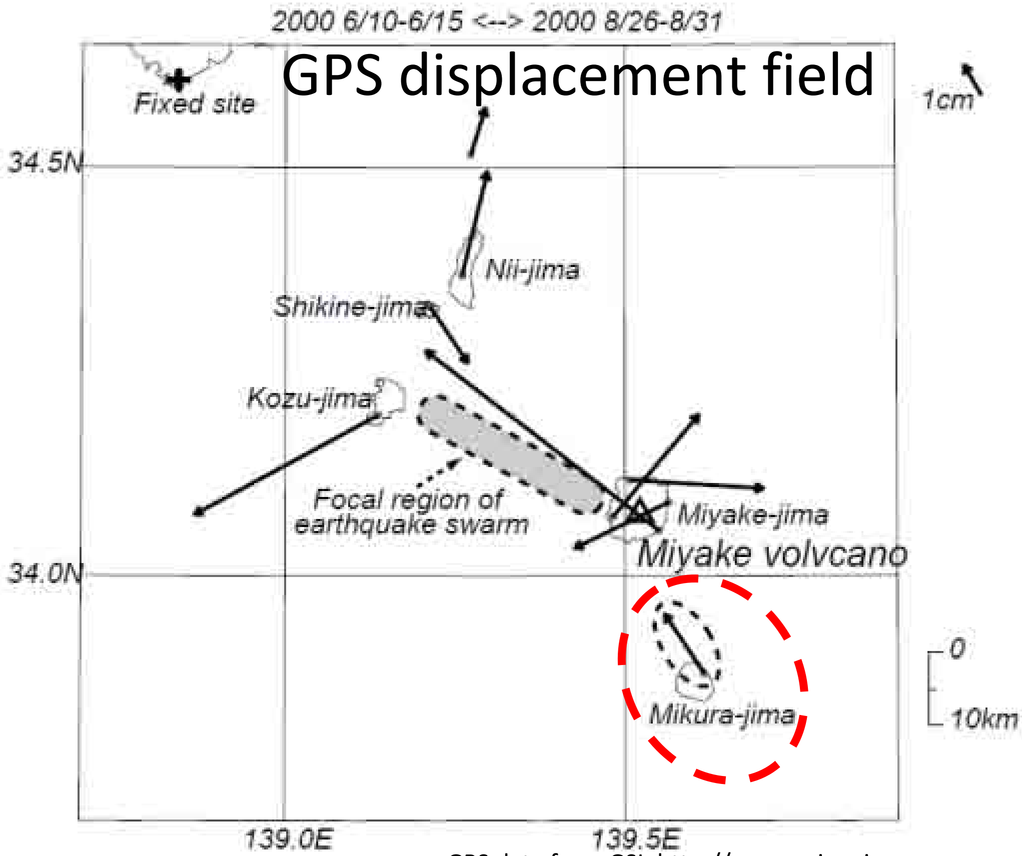




=>unknown parameter is only ΔV

A far-field data can estimate volume change in the deeper magma source

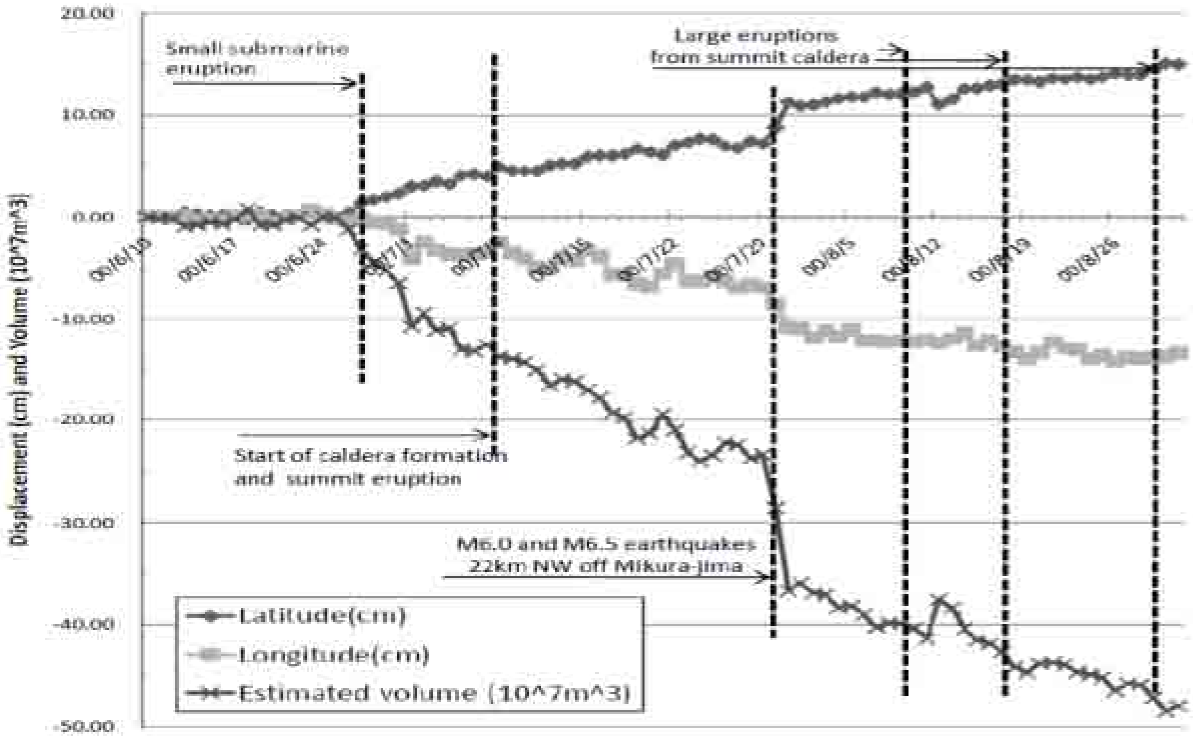
Nakata et al., J. Geogra., 110, PL3-5, 2001



GPS data from GSI: http://www.gsi.go.jp

Near-field stations illustrated shallow dike movements
Far-field data reflect volume change of deeper main source

Far-field data steadily record huge deflation of deep source



- More than $10^8 m^3$ deflation is recorded.
- If we used this data in real-time, we might predict anomalous caldera formation before its occurrence.

I propose *Mvp* index:
Predictive Volcanic Eruption Magnitude

If we assume that ΔV is in proportion to eruption size,

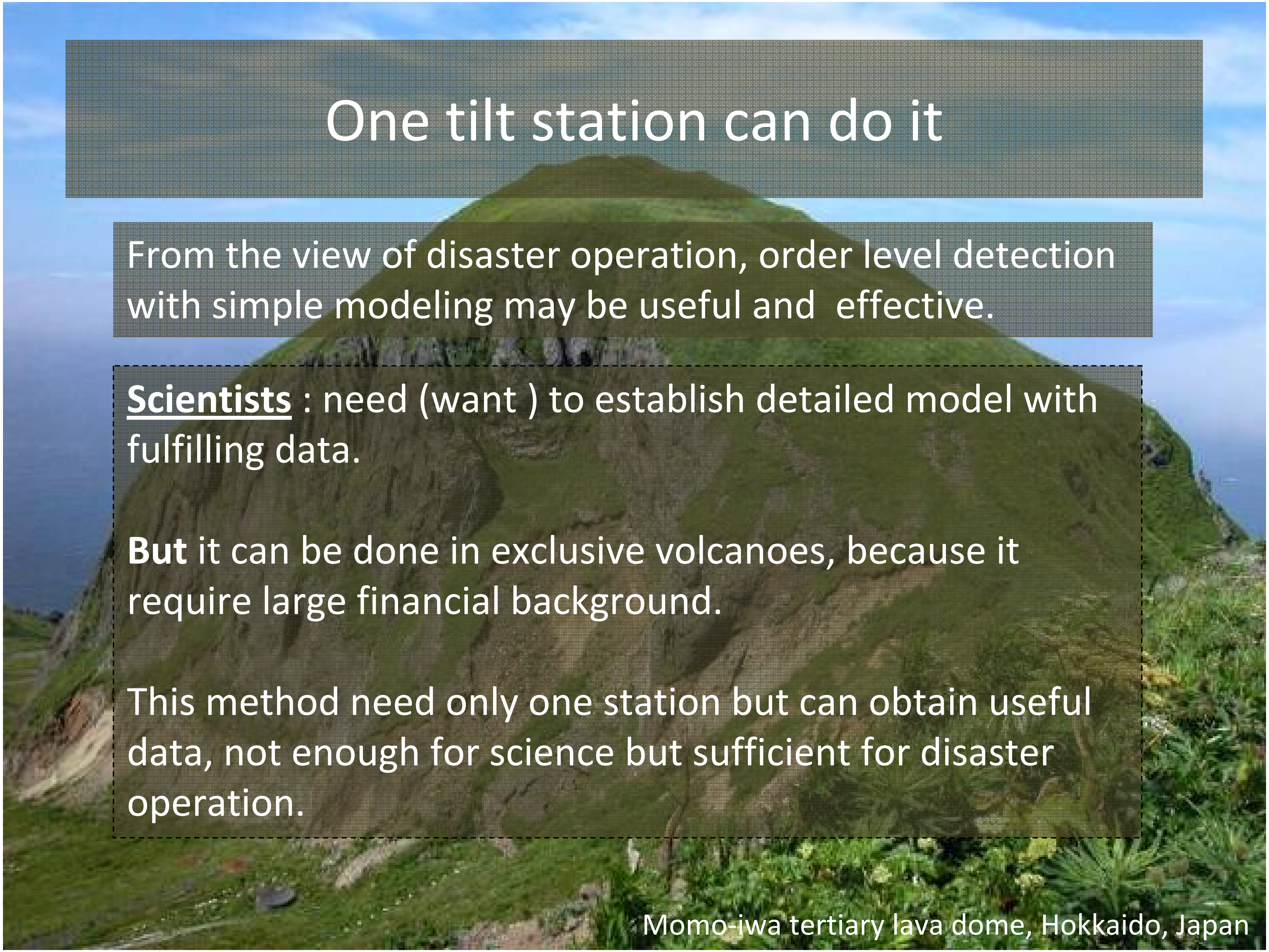
- ΔV is estimated by a far-field geodetic data in real-time.
- Define ***Mvp=logΔV-6***

because ΔV in m^3 is hard to grasp for residents.

VEI is a posteriori.

We can reply to the general question,

"How large is coming eruption?"



Momo-iwa tertiary lava dome, Hokkaido, Japan

Only tiltmeter is feasible, GPS is NO!

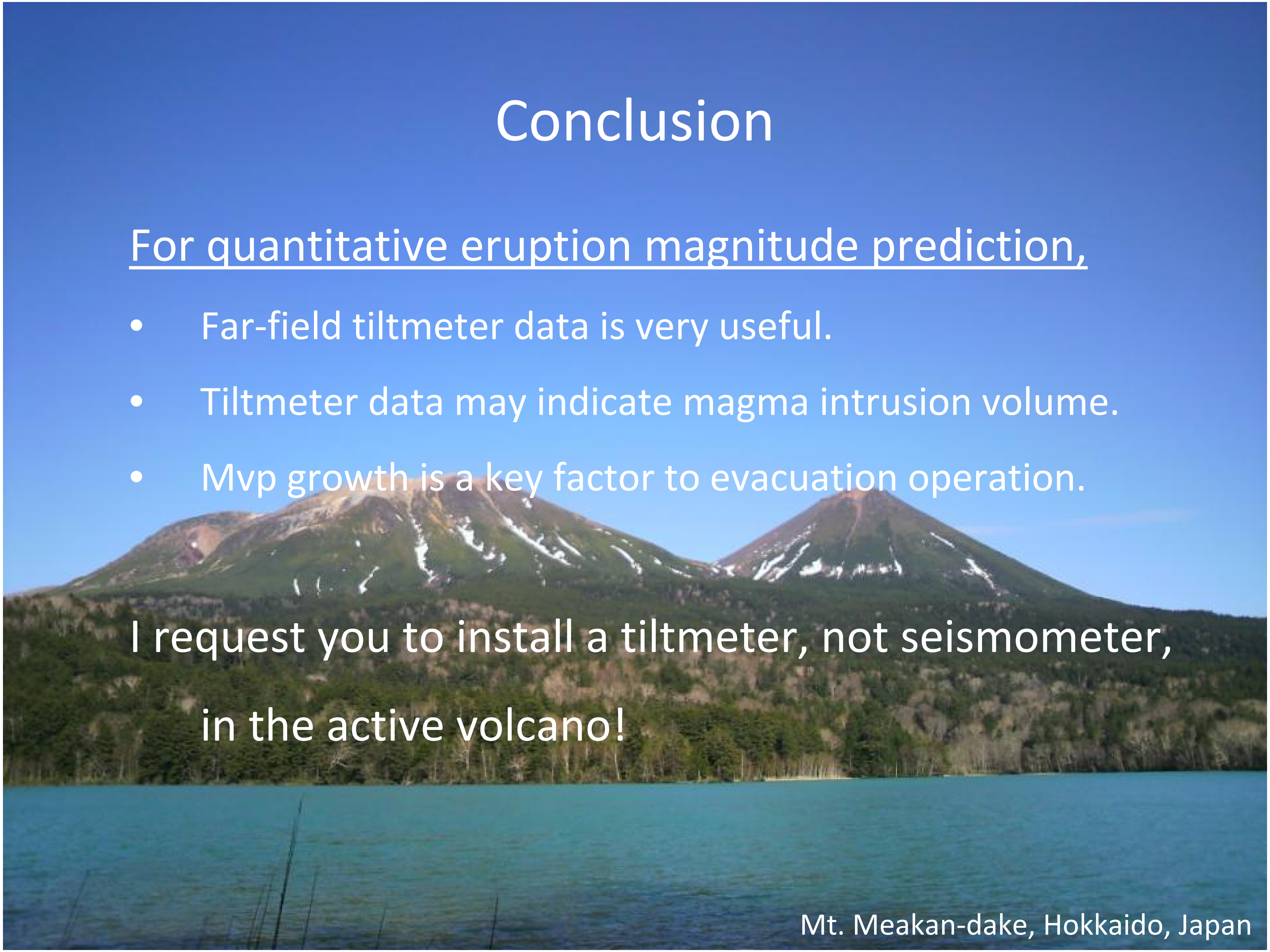
Far-field require high sensitivity

Equipment	Accuracy	Pre-processing	Price in Japan
Tiltmeter	10^{-9} radian	No need	30,000 dollars
GPS	2-5mm	Necessary	30,000 dollars

Tiltmeter is more and more sensitive than GPS for less than a few weeks period.

Far-field GPS can not detect initial small signals
<=not good for prompt disaster information release

GPS can do its best effort for >1cm or more longer period data.
GPS is not perfect tool.


Conclusion
For quantitative eruption magnitude prediction,
• Far-field tiltmeter data is very useful.
• Tiltmeter data may indicate magma intrusion volume.
• Mvp growth is a key factor to evacuation operation.
I request you to install a tiltmeter, not seismometer,
in the active volcano!
Mt. Meakan-dake, Hokkaido, Japan


Thank you for your attention!
Большое спасибо!
ご清聴ありがとうございました.
Chirip volcano, Itrup Island, Kuril Islands

The new geophysical observatory in Northern Caucasus: modern system for geophysical instrumental observations in the Elbrus volcanic area

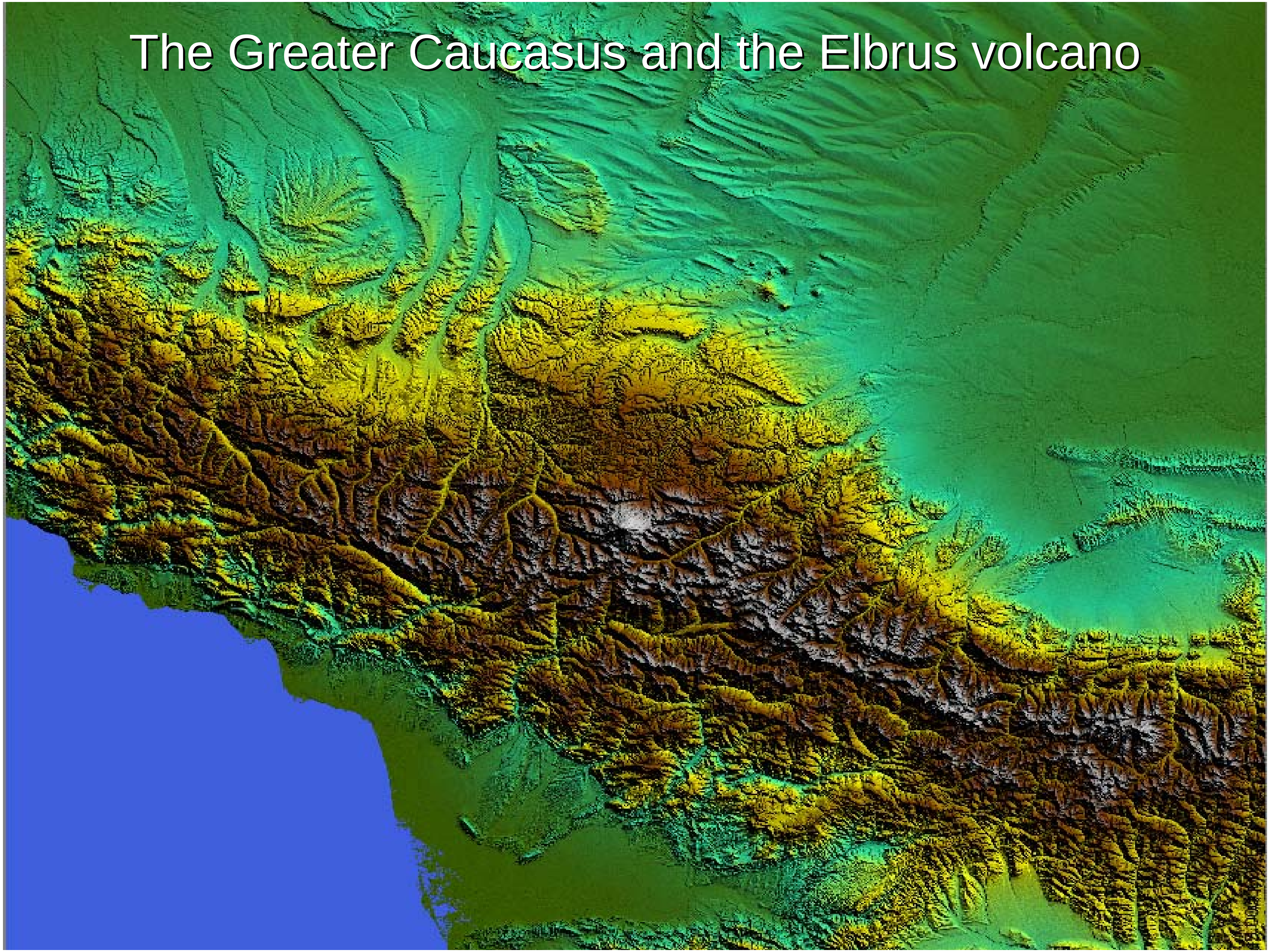
Alexey L. Sobisevich

Schmidt Institute of Physics of the Earth, Russian Academy of Sciences
Laboratory of Applied Geophysics and Volcanology

www.ifz.ru

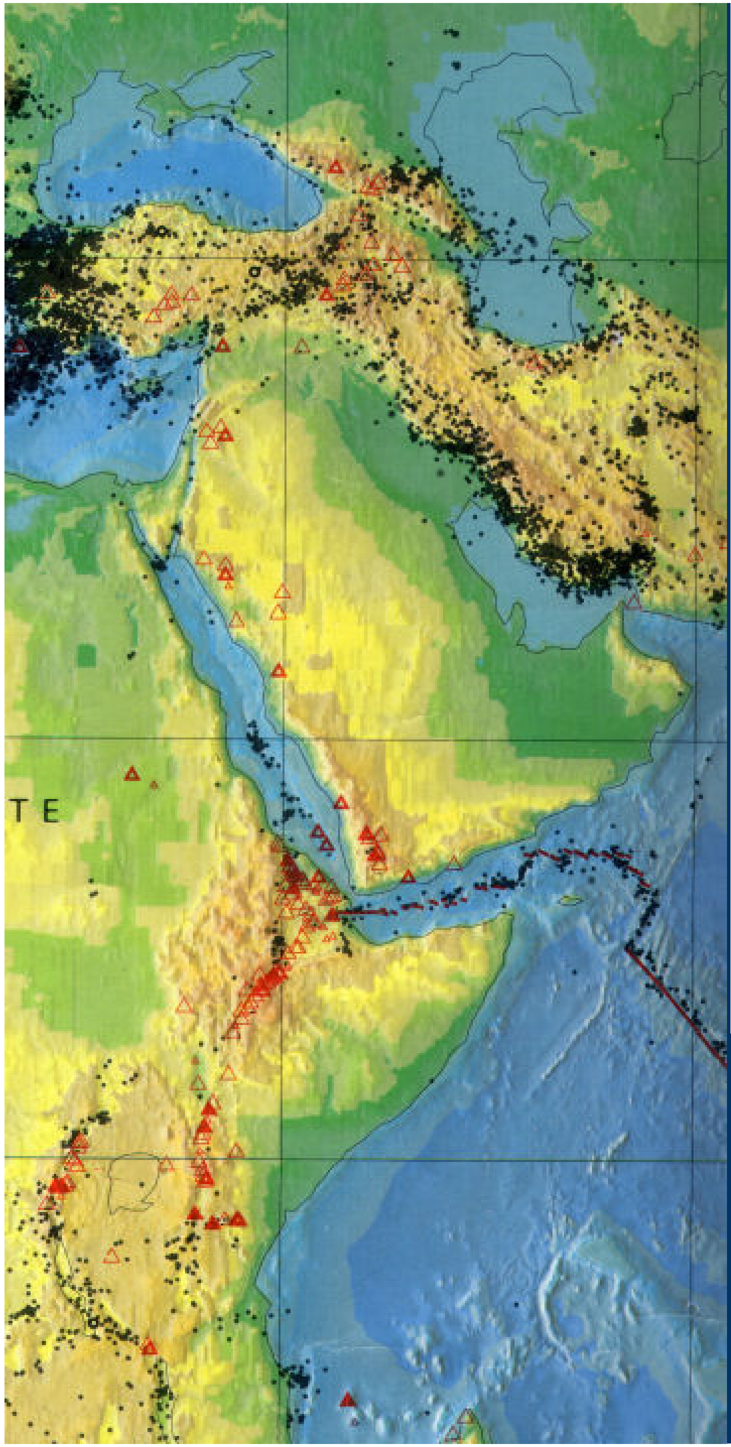
2010

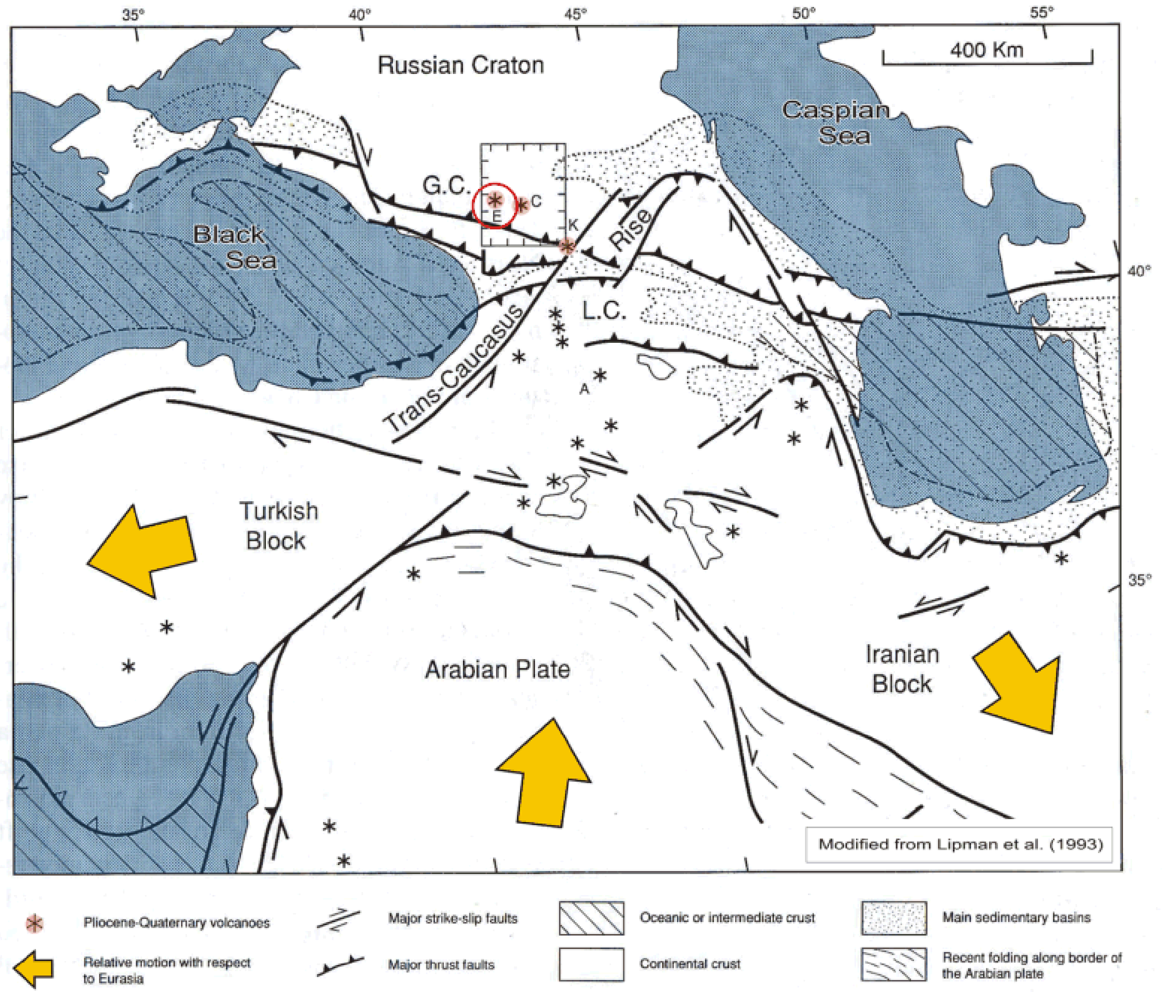
The Greater Caucasus and the Elbrus volcano



The Elbrus volcano, Northern Caucasus

- The Elbrus volcano, top of Caucasus. Mt. Elbrus is the highest (5,643 m) active volcano in Europe.
- It represents an example of volcanism related to the axis of a continental collision zone.
- Elbrus has erupted more than 10 dacitic lava flows during the Holocene.
- The twin-summit stratovolcano volcano has the glacial ice cap (~140 sq.km).
- East summit (right, 5621 m) and West summit (left, 5642 m).
- Radiocarbon dating of samples from down-valley lahars and debris avalanches are: 8150±100, 6200±120, 5100±100, 4060±40, 2520±60, and 1750±30 years bp.
- Solfataric activity reported near the saddle and on the West summit, hot mineralized springs on its slopes and in adjacent areas.
- Recreational area famous for great outdoor activities.

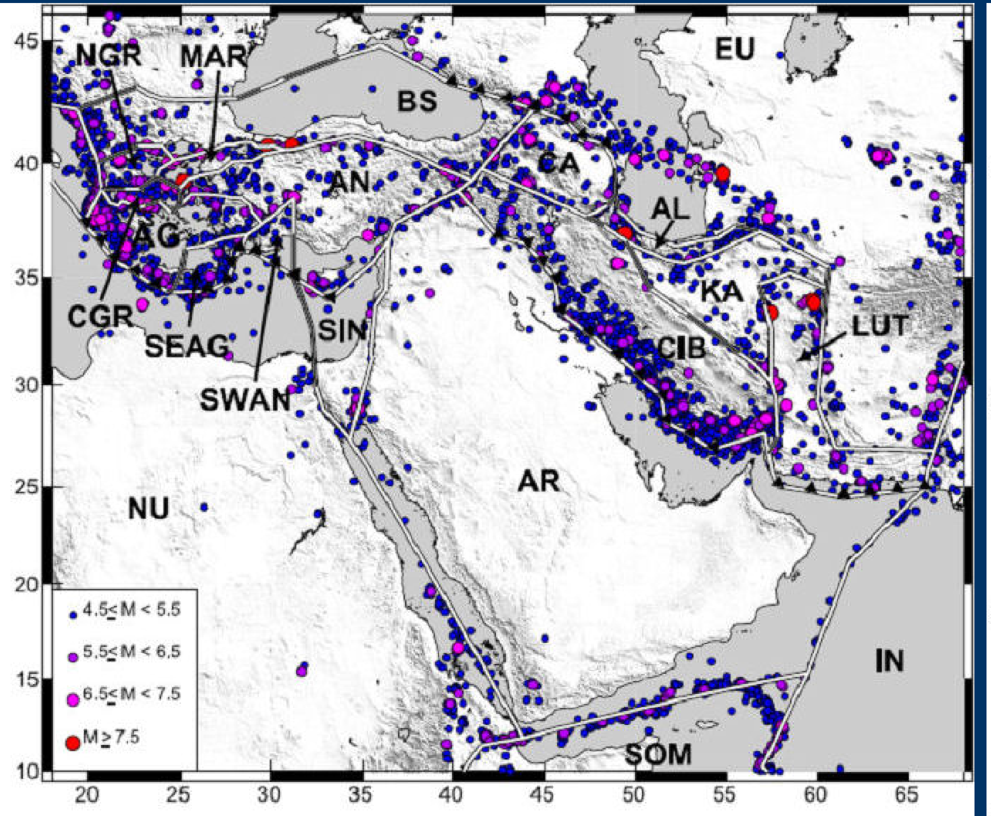




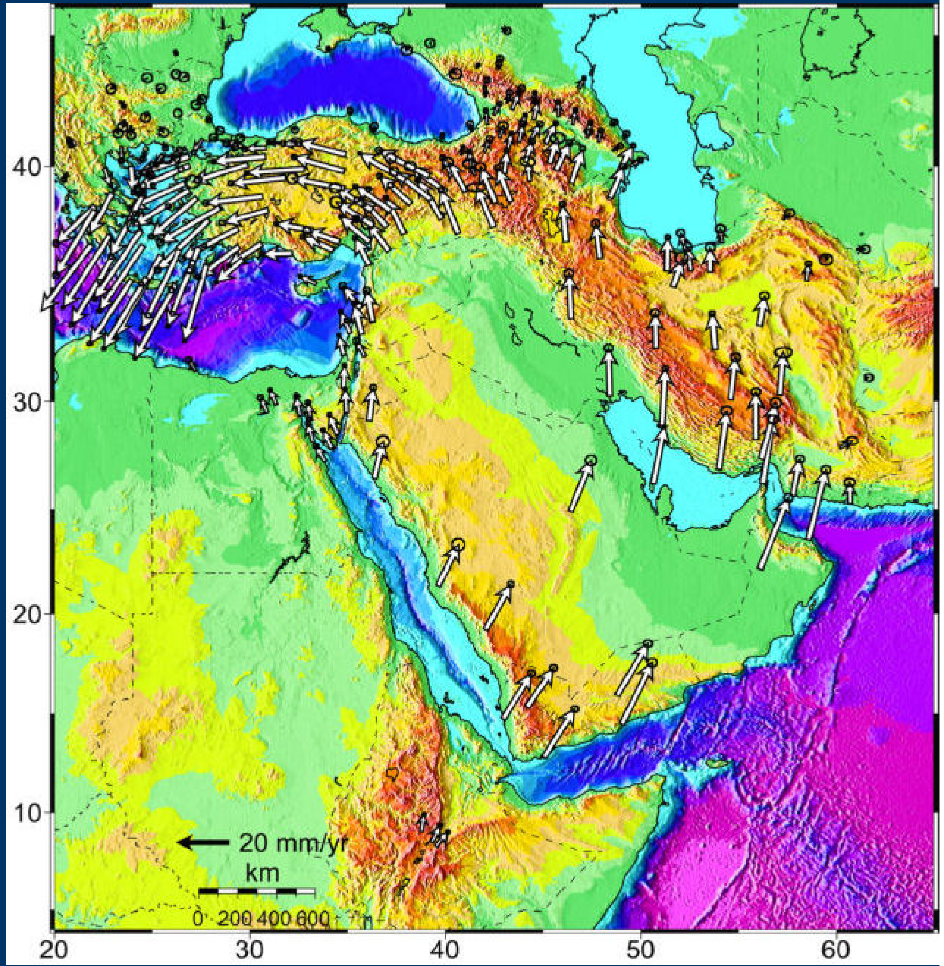
Geodynamic model of the central segment of Alpine-Himalaya mobile folded system and the Greater Caucasus, after [Lipman et al., 1993].

Fragment of the “World map of volcanoes, earthquakes and plate tectonic” composed by T. Simkin, R. I. Tilling, J. N. Taggart, W. J. Jones and H. Spal, published by Smithsonian Institution & U.S. Geological Survey in 1989.

Africa-Arabia-Eurasia continental collision zone



Block model consisting of 19 plates/blocks and M > 4.5 earthquakes (h > 35 km) (NEIC catalog; 1973 to Jan 2005), Nubian (NU), Somalian (SOM), Arabian (AR), Eurasian (EU), Anatolian (AN), Aegean (AG), Lut(LUT), central Iran block (CIB), Kavir (KA), Alborz (AL), Caucasus (CA), Black Sea (BS), Sinai (SIN), SW Anatolian (SWAN), SE Aegean (SEAG), central Greece (CGR), northern Greece (NGR), Marmara (MAR), India (IN) [*Reilinger et al.*, 2006].



GPS velocity field 1988-2005 for the Eastern Mediterranean with respect to Eurasia showing CCW rotation of a broad region in the Africa-Arabia-Eurasia collision zone [*Reilinger et al.*, 2006],

Robert Reilinger (MIT) et al., "GPS constraints on continental deformation in the Africa-Arabia-Eurasia continental collision zone and implications for the dynamics of plate interactions", JGR, 2006.

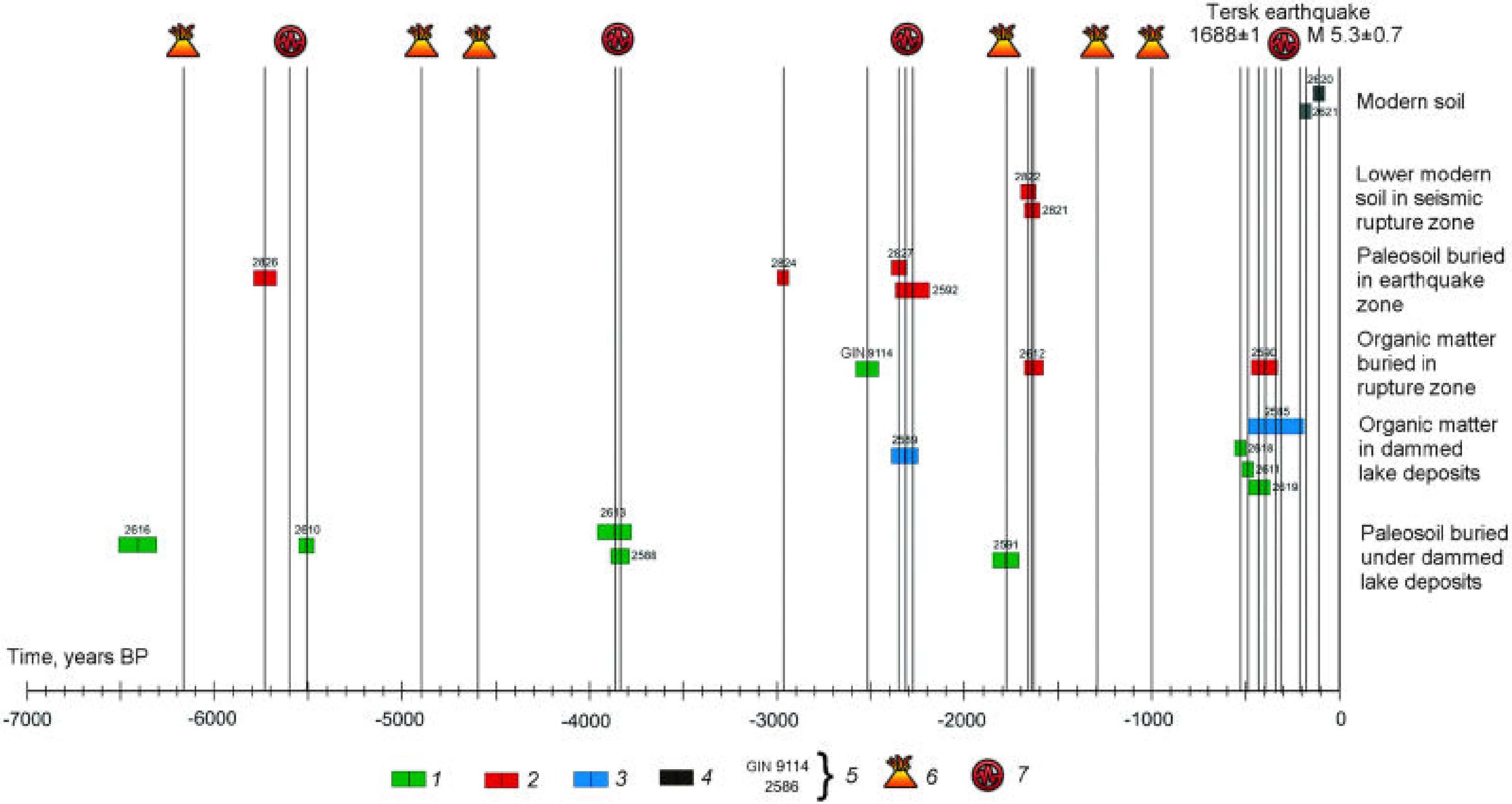
Evidences of past seismic and volcanic events

Paleoseismic fault.

Columnar-joined ice-contact structures.

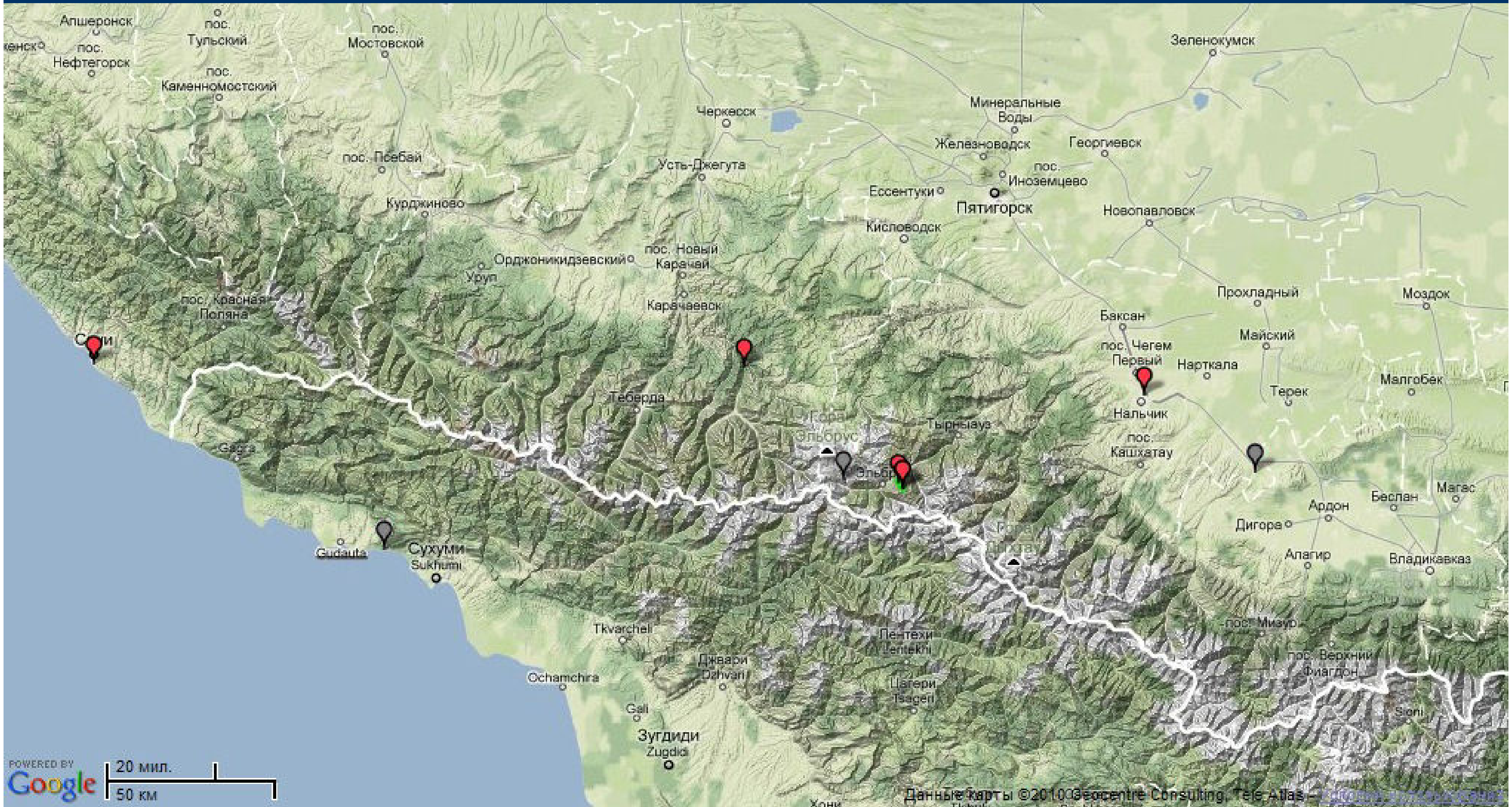
Ancient (about 2000 years ago) rock avalanche in the valley of the Baksan river, Elbrus volcanic area.

Paleoseismic events and eruptive history of Mt. Elbrus



Timeline of various types of paleoseismodislocations and results of radiocarbon dating of Holocene seismic and volcanic events in the Elbrus volcanic area: 1-2 results of radiocarbon dating (GI RAS): 1 – lower age boundary of seismic event; 2 – age of dislocation coincident with seismic event; 3 – upper age limit of the event; 4 – modern soil samples taken for verification purposes (size of rectangles equals to measurement error); 5 – sample tag; 6 – volcanic eruption [References]; 7 – seismic event.

Map of operational and planned Laboratories of NCGO

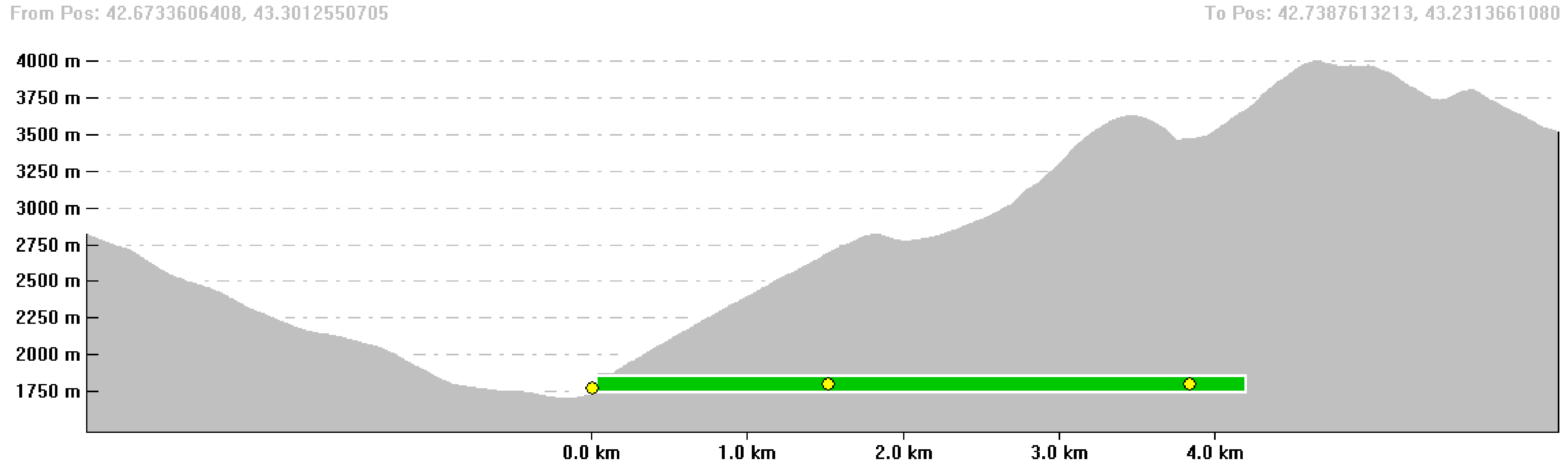


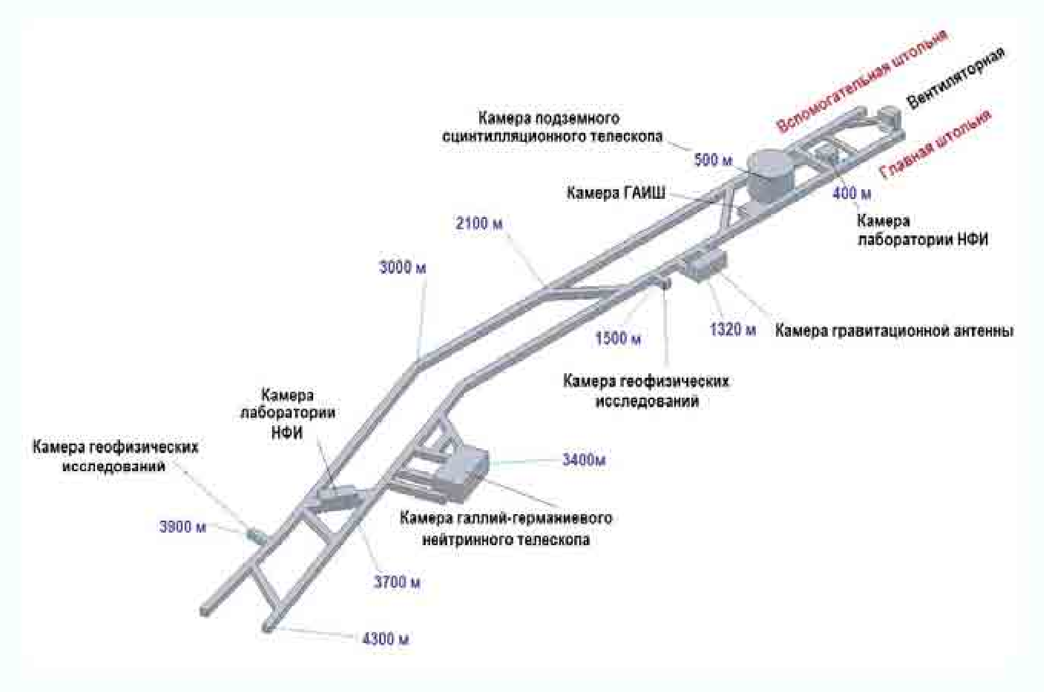
Locations of existing/operational (red waypoint markers) and planned (grey waypoint markers) Laboratories of the Northern Caucasus Geophysical Observatory. At the moment there are five operational Laboratories: #1 and #2 (underground tunnel in the Baksan valley), #3 (city of Nal'chik, KDSU), #4 (Elbrusskiy place, Kuban river valley), #5 (near the city of Sochi).

Geophysical Laboratories # 1 and # 2

Digital elevation model (SRTM3/GM) for the territory of the valley of Baksan river close to the site of the horizontal system of tunnels drilled under the mount Andyrchi (~20 km from the Elbrus volcano). The main and the secondary tunnels are shown as the green line and the positions of Laboratories # 1 and # 2 are shown as the two red waypoint marks in their exact geographical positions. Underground structure of tunnels extends up to 4300 m under the mountain.

The underground research facility: “Neutrino” tunnel





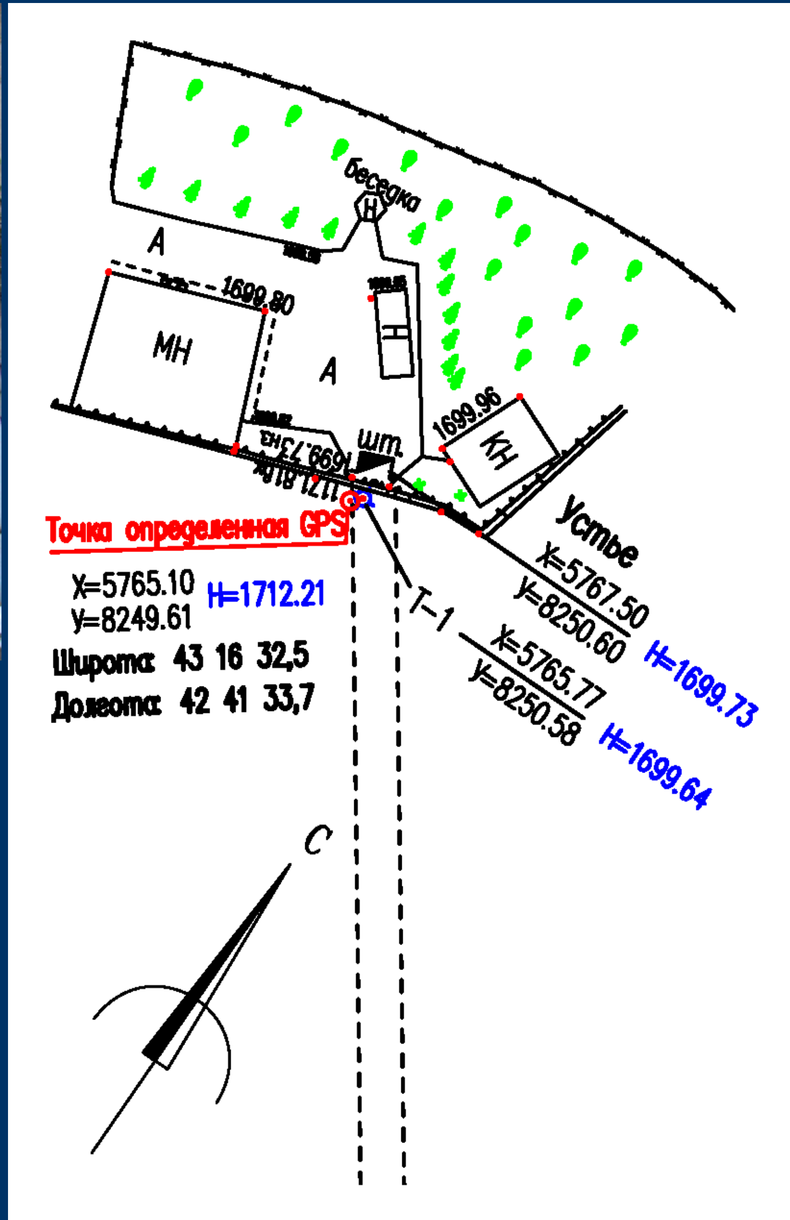
The system of tunnels under Mt. Andyrchi is nearly horizontal, the two parallel tunnels going slightly upwards to ensure successful drainage of mineral waters from underground springs.

There also are several intersection galleries for ventilation purposes.

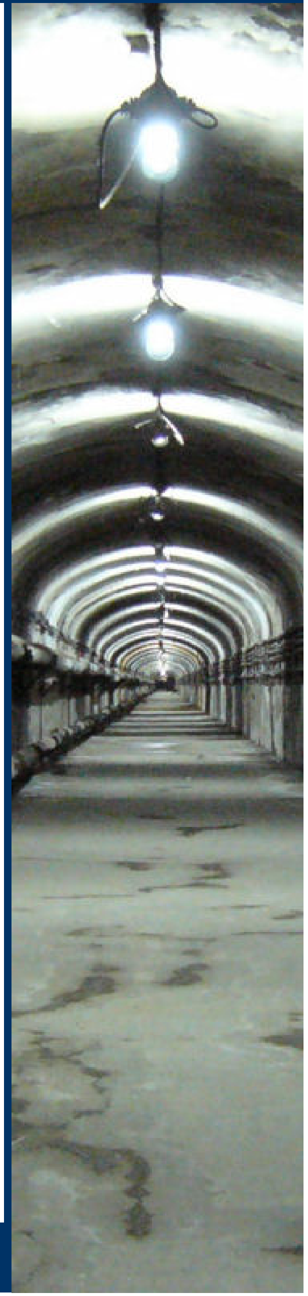
The main and the secondary tunnels have a system of underground railway transportation, system of ventilation and the surveillance/access control system.

The underground research facility: “Neutrino” tunnel

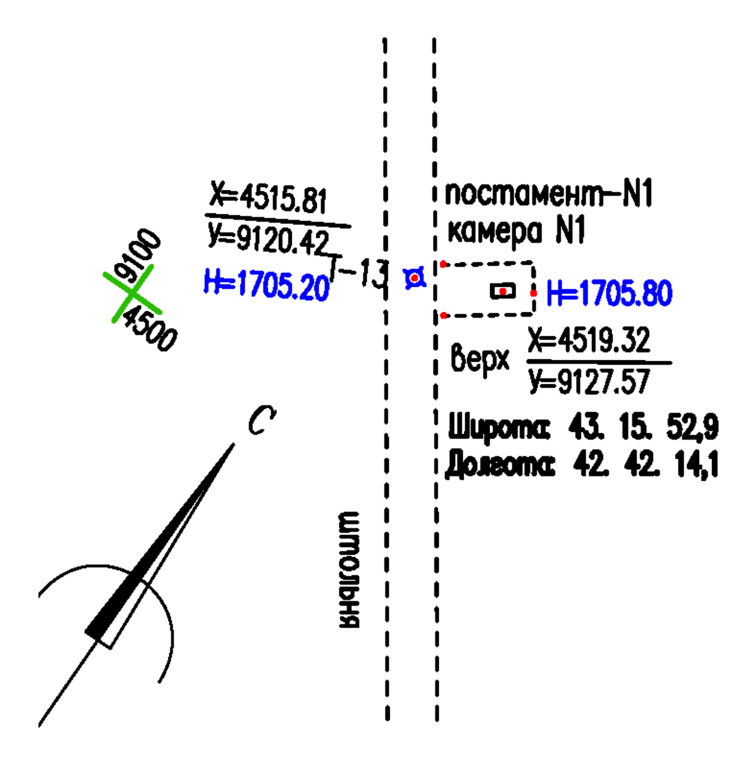
The “Neutrino” tunnel is the unique underground research facility built specifically for fundamental studies of Solar neutrino, cosmic rays, physics of elementary particles and other subjects of the Institute of Nuclear Research of RAS. The construction work carried out by the “Metrostroy” company from mid 197x till the end of 199x.



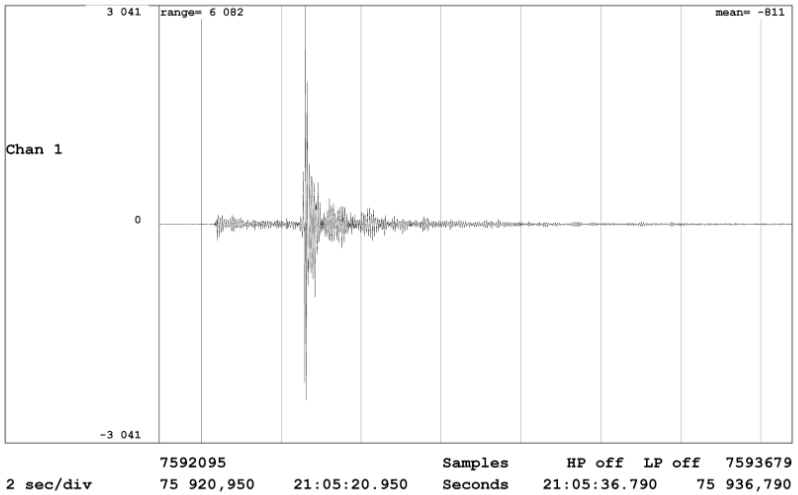
Structural drawing of the tunnel, view from the top.



Laboratory # 1, 1500 m down the tunnel

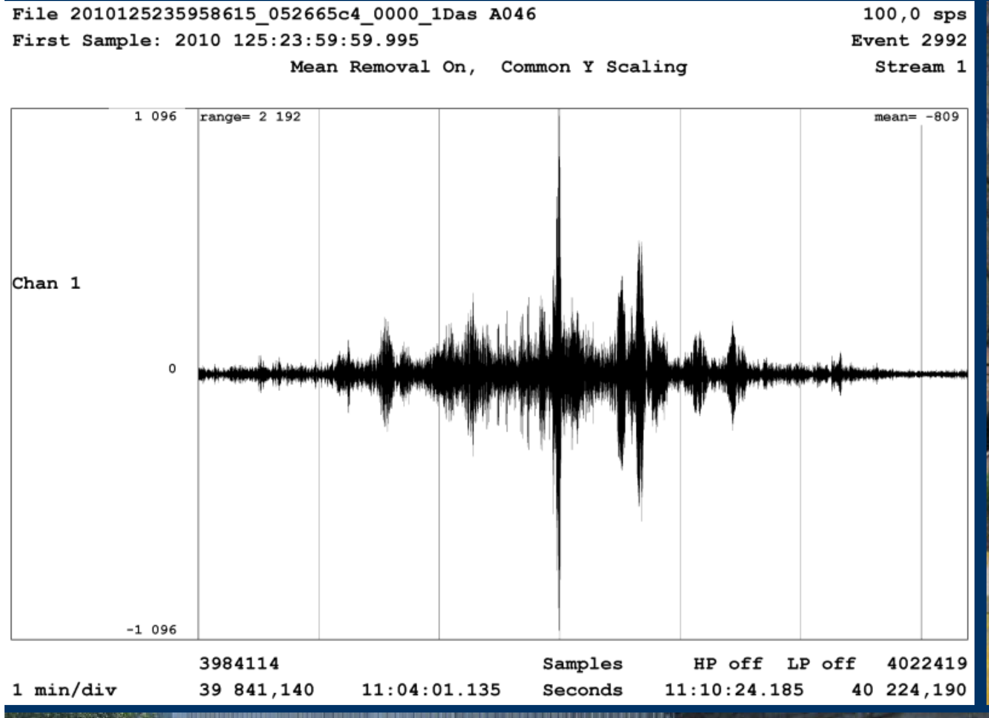


Instrumental foundation in the Lab. #1 built on solid rock in 2004. The following equipment is installed: N-S and E-W quartz tilt-meters, ferromagnetic probe, and thermometer connected via L-card E-24 ADC to PC-based registration system; Triaxial seismometer (Geospace GS-13C Seismonitor) connected to a REF TEK 130b datalogger.



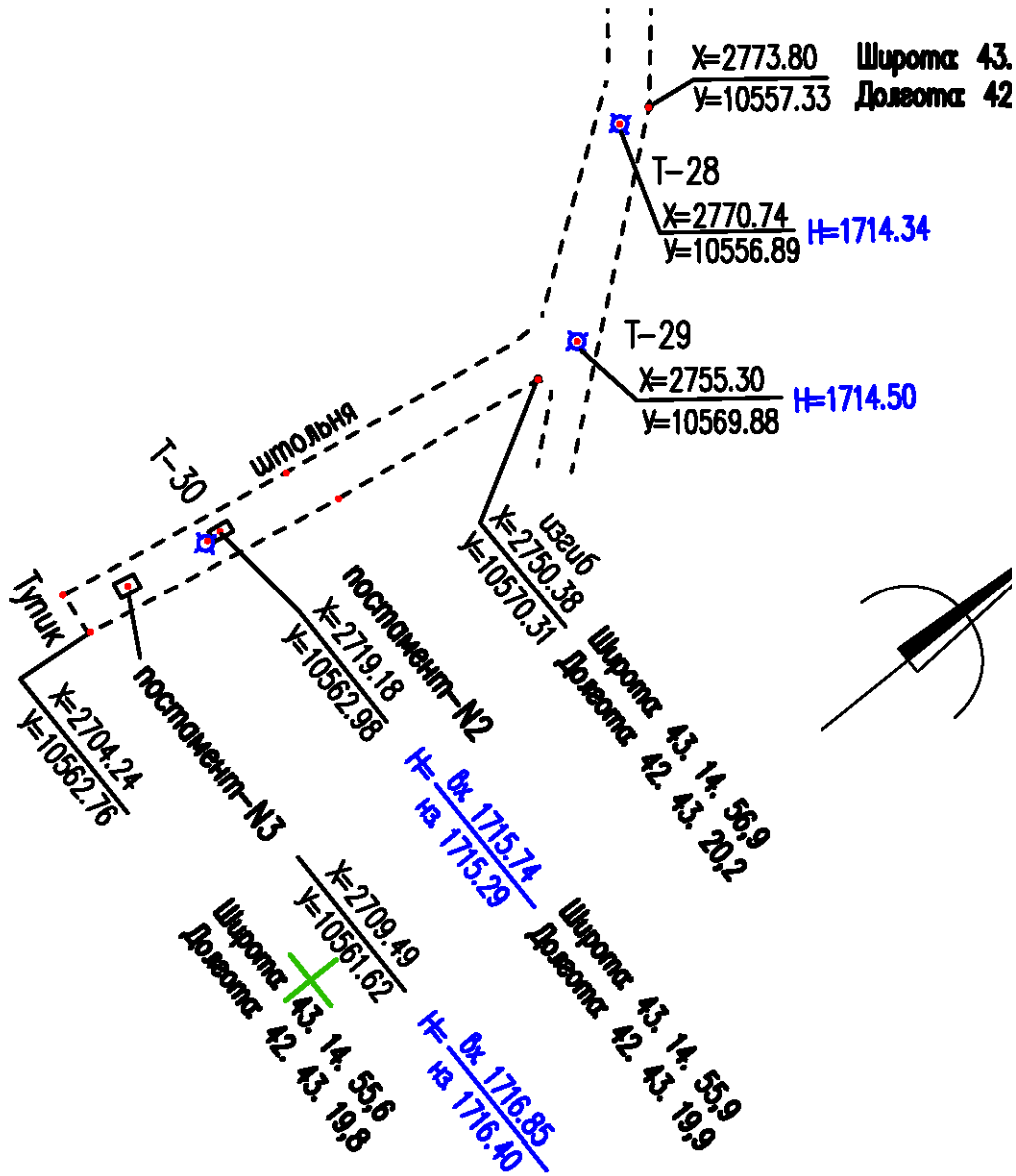
Z-component of a seismic record featuring a rock burst.

Laboratory # 1, 1500 m down the tunnel



Example of a seismic record of a train passage along the main tunnel. Local railway system normally operates twice a day only. There are no trains scheduled for weekends and public holidays. Other commonly registered signals are: rock bursts, distant and local earthquakes, snow avalanches.

Laboratory # 2, 3900 m down the tunnel, year 2004



Structural drawing of the Laboratory # 2 close to the end of the tunnel. Initial conditions in the unfinished gallery with dead end.

Laboratory # 2, one year later

The next year the Laboratory # 2 has been upgraded with the main utility power plus several extra cables (TP cat. 5 Ethernet, telephone, RS-485/RS-232 and other remote interfaces) + the first instrumental foundation.

Temperature observations

- Nearly constant ambient temperature:

  +38 deg. C near the floor of the gallery;

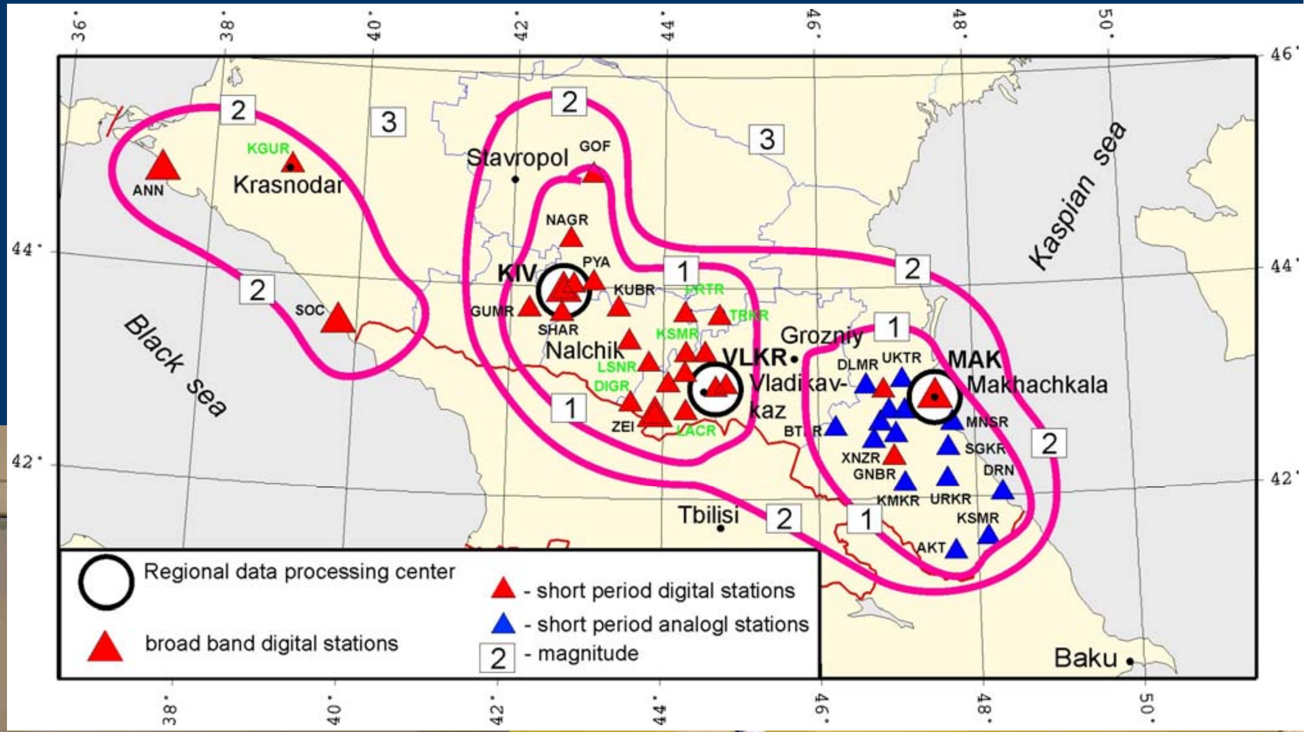
  +39 deg. C near the ceiling of the gallery.

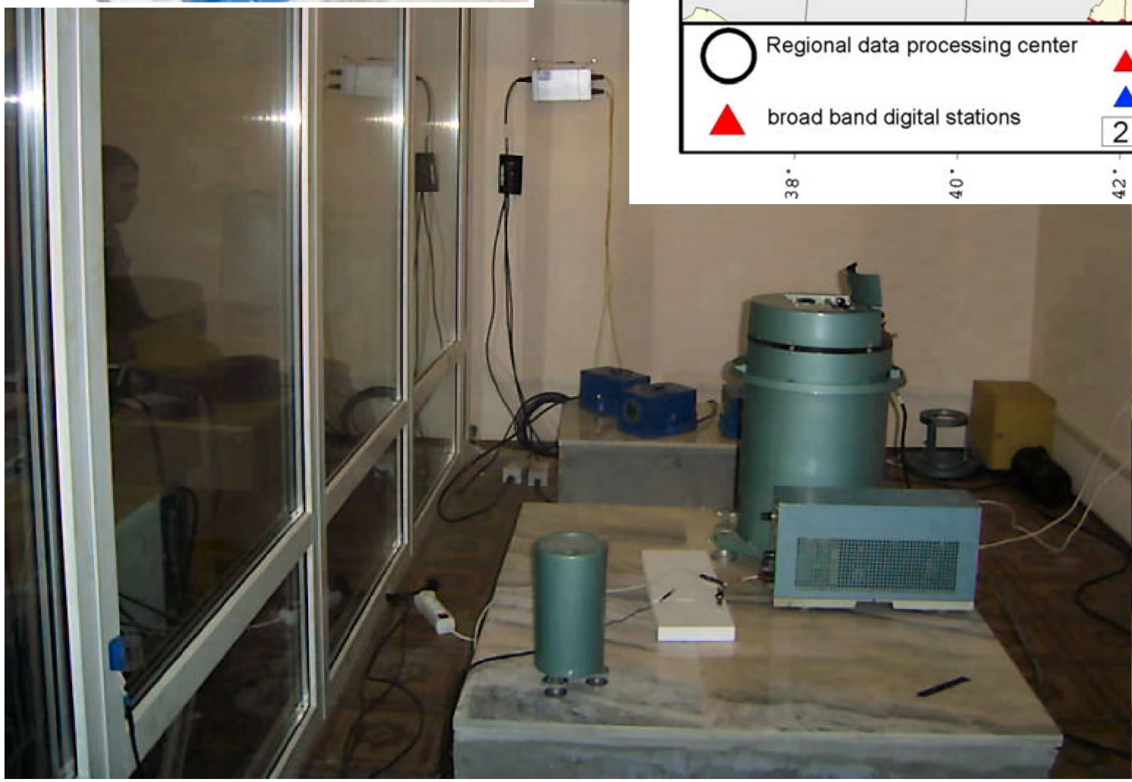
Progress on instrumental foundations 2005 – 2007

Laboratory #3 in the City of Nal'chik, KBSU

- 2005 in the redesigned basement of the Kabardino-Balkar State University, the City of Nal'chik, the Laboratory # 3 has been established. There are 3 instrumental foundations in a thermally stable environment with fiber optic connection to the Internet via the university network.

The GS RAS seismostation in the Lab. # 3 since 2006

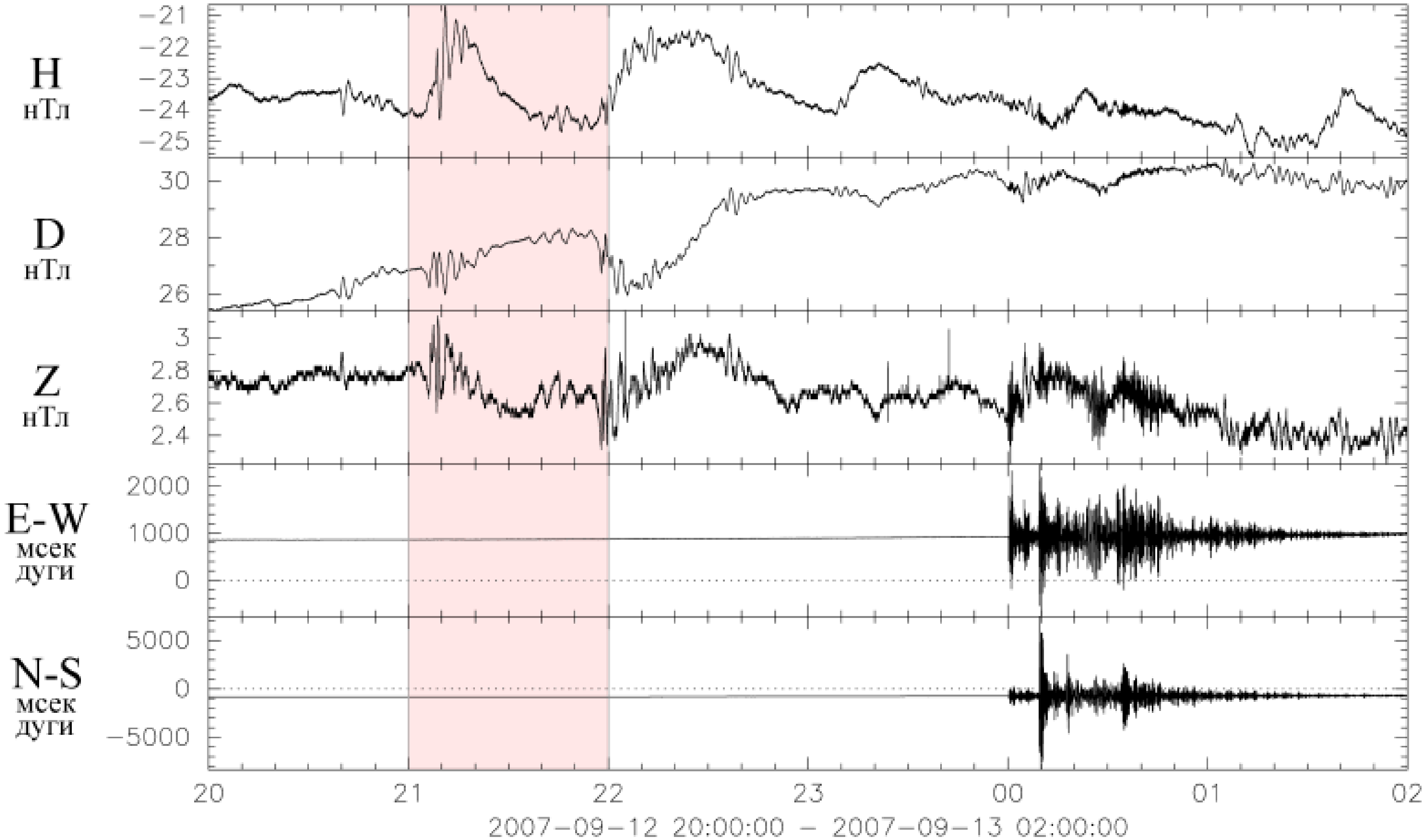




Laboratory # 4, the “Verkhnekubanskiy” test site

In 2008 the Laboratory # 5 located near the village Elbrusskiy, has been set up for continuous operation in collaboration with Pushkov Institute of Terrestrial Magnetism, Ionosphere and Radiowave Propagation of RAS. The instrumental foundation designed specifically for measurements of magnetic variations has been built from scratch along with the remote operator lab unit and secondary foundation.

Magnetic variations preceding strong earthquakes



Seismic event near the coast of southern Sumatra, September 12, 2007, 23:49:01, M = 7.3, H = 33 km, magnetic variations T = 150 s, amplitude of magnetic variations = 3.5 nT. Laboratory # 3 (Nalchik).

Magnetic variations preceding strong earthquakes

Seismic event near the coast of southern Sumatra, September 12, 2007, 23:49:01, M = 7.3, H = 33 km, ULF magnetic variations T = 150 s, amplitude of magnetic variations = 3.5 nT. Laboratory # 3 (Nalchik).

Laboratory # 5 in the City of Sochi

In 2009 the Laboratory # 5 located in the City of Sochi has been set up for continuous operation. It is designed specifically for measurements of magnetic variations (and auxiliary meteorological data). The Pushkov Institute of Terrestrial Magnetism, Ionosphere and Radiowave Propagation of RAS is responsible for maintenance of the HDZ magnetic variometer while near real time data streams are incorporated into NCGO on-line database.

Future plans on development of the NCGO

The TRSK station (GPS/GLONASS) of the Regional Northern Caucasus network [*Milyukov*, 2010], Terskol Peak, 3150 m, 3 km from the Elbrus volcano.

- In collaboration with the Geophysical Survey of RAS and Shternberg State Astronomical Institute (MSU): installation of a broadband digital seismic station at the Terskol Peak, only 3 km from the Elbrus volcano for monitoring of possible signs of volcanic activity and seismicity related to glaciers evolution.
- In collaboration with the Institute of Computational Mathematics and Mathematical Geophysics SB RAS: installation of a linear seismic array in the underground tunnel for scheduled geophysical experiments.
- In collaboration with Pushkov Institute of Terrestrial Magnetism, Ionosphere and Radiowave Propagation of RAS: development and implementation of an open database of magnetic observations, integration with data streams from Armenian magnetic observatories.

List of publications (filtered)

- *Sobissevitch A.L., Gridnev D.G., Sobissevitch L.E., and Kanonidi K.Kh.,*
  Instrumental Equipment of Geophysical Observatory at North Caucasus // Seismic Instruments. Vol. 44, 2008, pp. 12 – 25.
  DOI: 10.3103/S0747923908010027

- *Sobisevich L.E., Kanonidi K.Kh., and Sobisevich A.L.*,
  Ultra Low-Frequency Electromagnetic Disturbances Appearing before Strong Seismic Events // Doklady Earth Sciences, 2009, Vol. 429A, No. 9, pp. 1549 – 1552.
  DOI: 10.1134/S1028334X09090281

- *Masurenkov Yu.P., Sobisevich A.L., Likhodeev D.V., and Shevchenko A.V.,*
  Thermal Anomalies of the Northern Caucasus // Doklady Earth Sciences, 2009, Vol. 429, No. 8, pp. 1318–1321.
  DOI: 10.1134/S1028334X09080170

- *Masurenkov Yu.P., Sobisevich A.L., and Laverova N.I.*,
  Relation between Structural and Material Circular Motions in a Volcanic Center // Doklady Earth Sciences, 2009, Vol. 429, No. 8, pp. 1359 – 1363.
  DOI: 10.1134/S1028334X09080261

- *Sobisevich A. L., Kanonidi K.Kh., Sobisevich L.E., and Gridnev D.G.*,
  On a Class of Electromagnetic Disturbances Preceding Strong Earthquakes // Seismic Instruments, 2010, Vol. 46, No. 3, pp. 214 – 219.
  DOI: 10.3103/S0747923910030047

PDF copies are available upon request via e-mail: alex@ifz.ru

Geophysical Observatory in Northern Caucasus

- Main objective: development of the first geophysical observatory in Northern Caucasus.
- Primary purpose of the observatory: fundamental scientific studies for geophysics.
- Ways of implementation: sequential development of spatially scattered laboratories responsible for geophysical instrumental observations and integrated in a network.
- Ongoing activities: multidisciplinary monitoring over geodynamic processes in the Central part of the Greater Caucasus and in the Elbrus volcanic area.
- Specific problems: study of a deep underground structure in the Elbrus volcanic area, determination of sizes, shapes and locations of regional magmatic structures by means of geophysical methods (seismology, micro-gravimetric surveys, magnetotelluric sounding, and studies of magnetic variations) accompanied by remote sensing technologies.
- Generation and dissemination of knowledge in frames of the Federal Programme for Integration between Russian Academy of Sciences and local Universities.
- Practical outcome includes but is not limited to: prospecting of regional alternative energy resources (geothermal), better management of possible consequences of natural hazards, and relevant risk assessment.

Thank you!

- Research activities associated with development of the Northern Caucasus Geophysical Observatory are simultaneously supported by the Programme 4 of the Presidium of RAS, the Russian Foundation for Basic Research, and the Russian Science Support Foundation.

The IAVW and the Eyjafjallajokull eruption

Philippe Husson, Toulouse VAAC

Moscow, ISTC 8 –9 July 2010

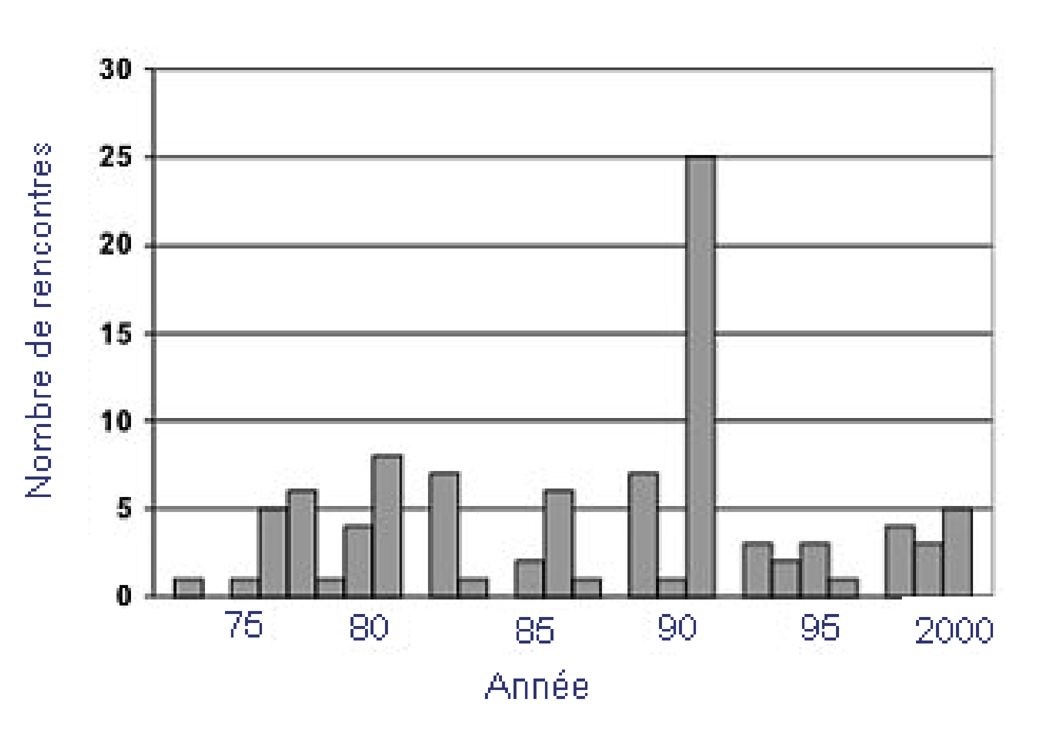
METEO FRANCE
Toujours un temps d'avance

VOLCANIC ASH AND AVIATION

METEO FRANCE
Toujours un temps d'avance

A THREAT FOR AVIATION

- A hundred of encounter with volcanic ash have been reported since the beginning of 70's, on which three implied the jet total loss of power during several minutes.



- The cost of encounters since the 80's has been evaluated to more than € 250 millions

Photo REUTERS/Lucas Jackson

FIRST

- Mechanical abrasion mécanique

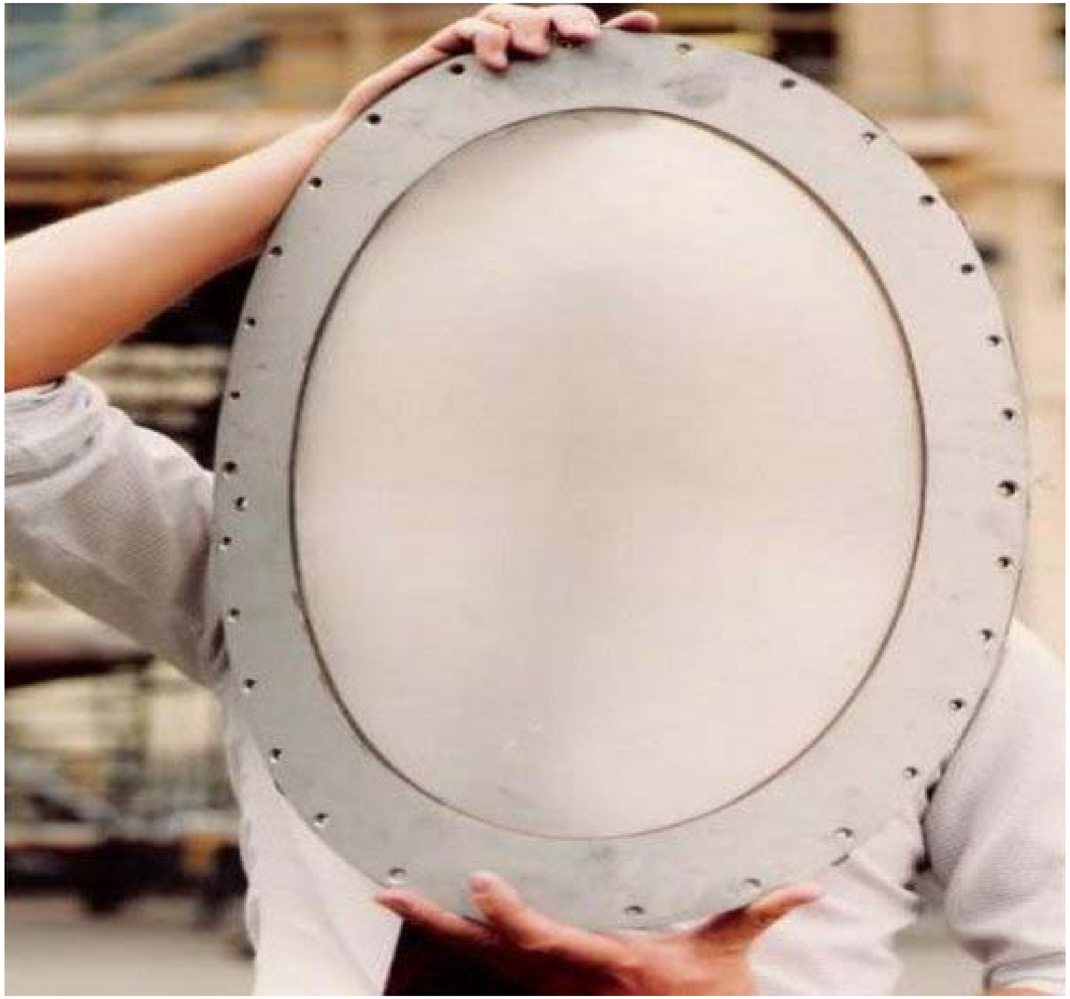
Pitot tube, antennas)

- Opacification of transparent

surfaces

(windshield, landing light,

windows)

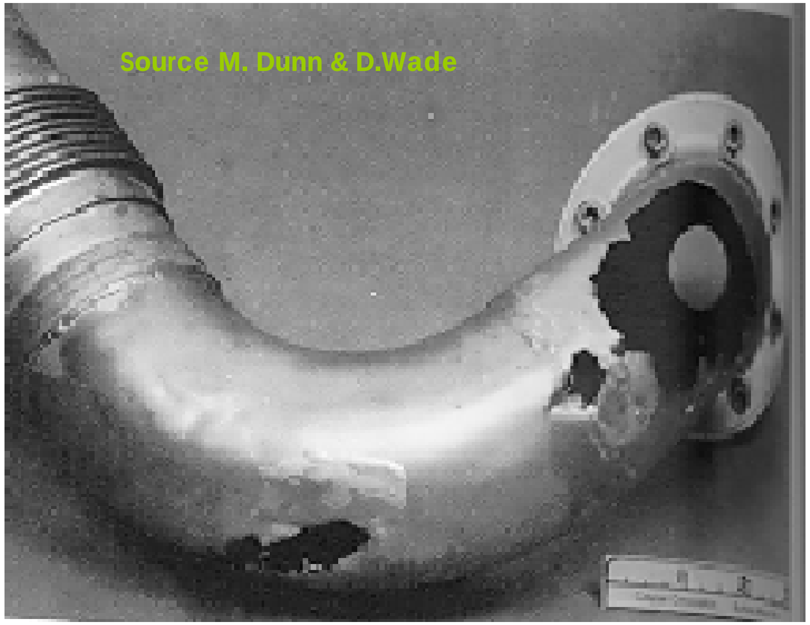


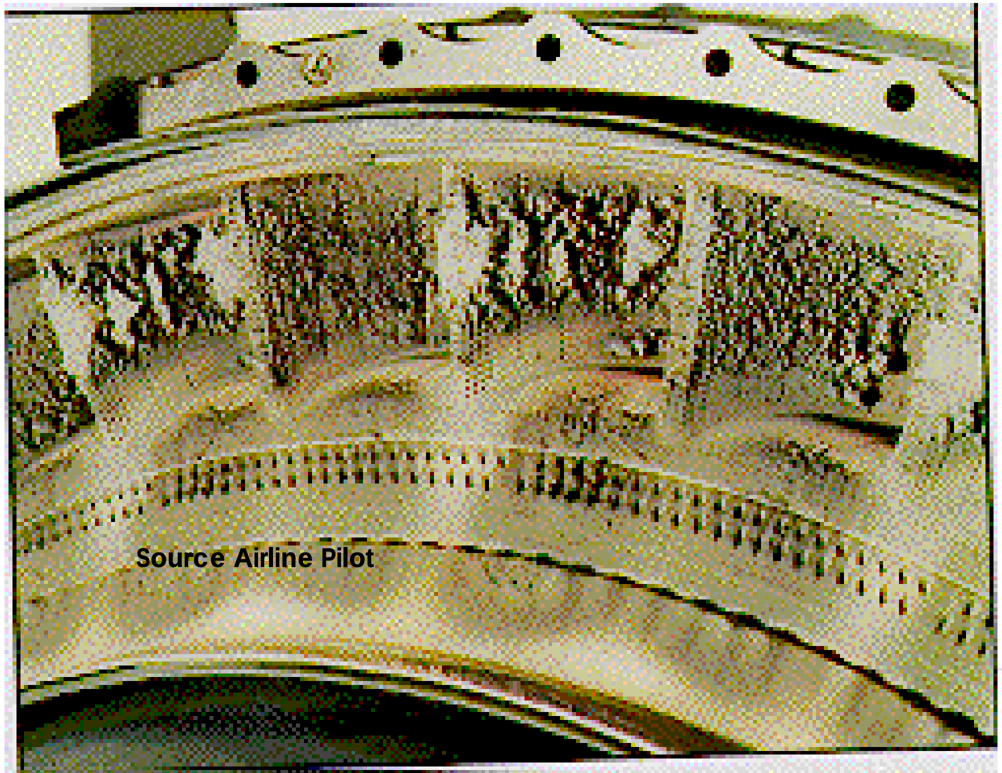
Source Airline Pilot

METEO FRANCE
Toujours un temps d'avance

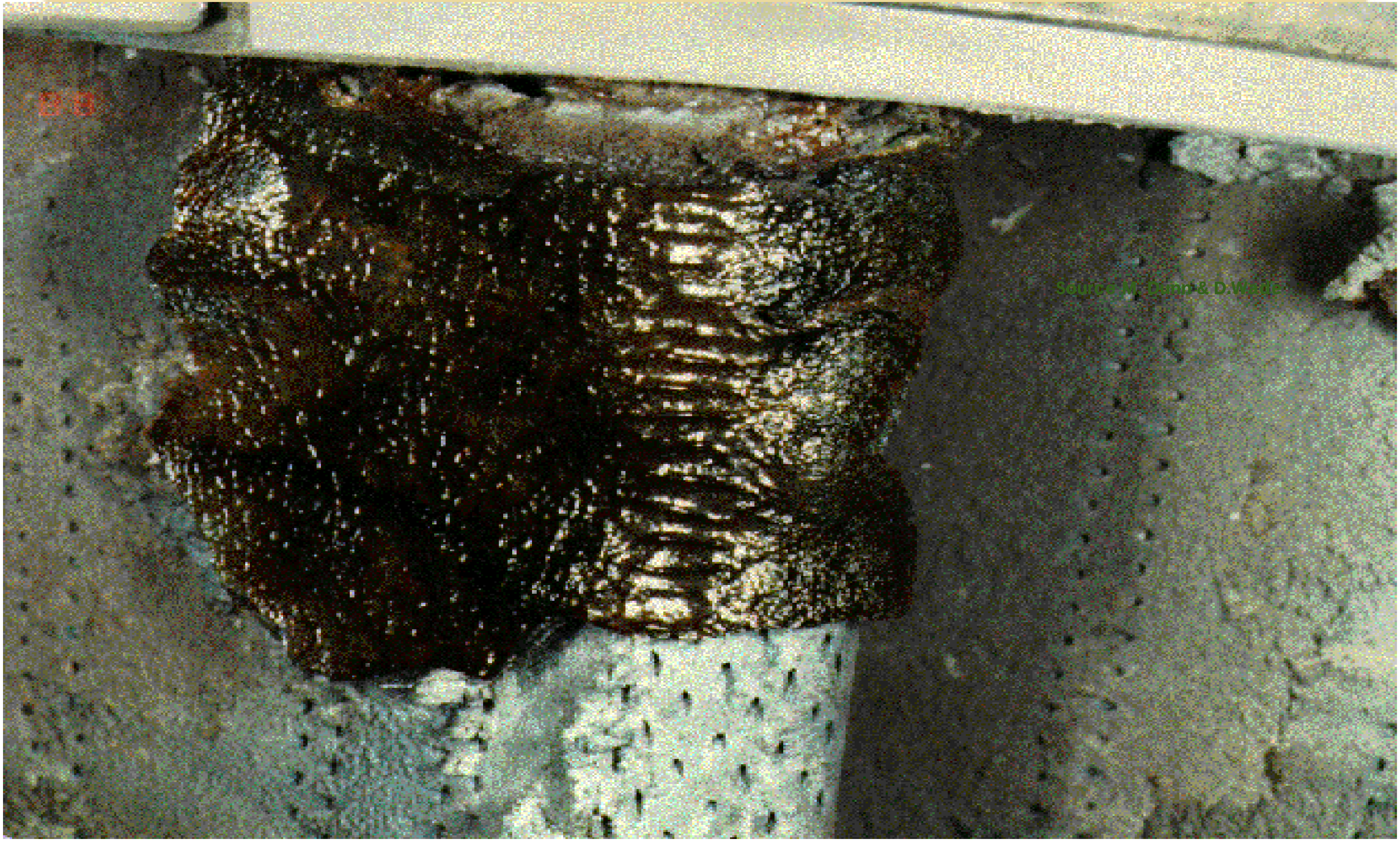
CONCRETELY ….. ON THE ENGINE SIDE ….

- Deposition on engine pieces (hot section)
- Erosion of the rotor blades and composants





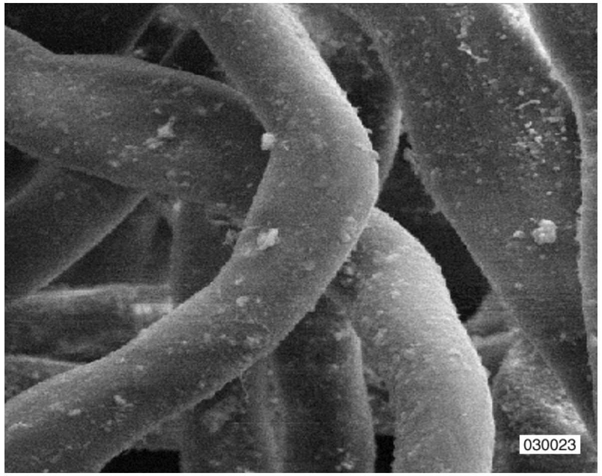
… BUT OVERALL …



… AND THEN …

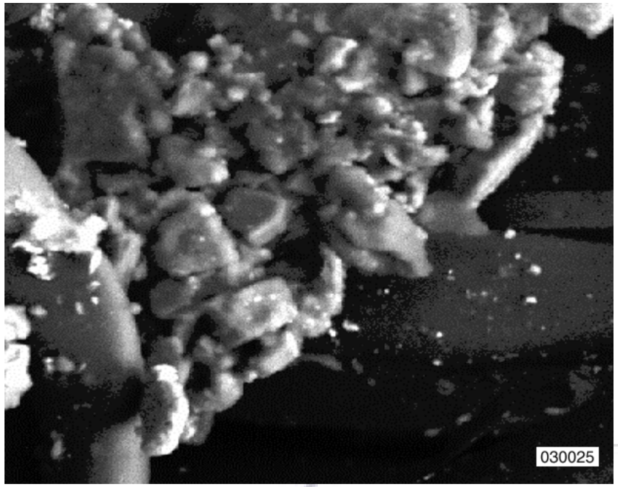
- Electronic and avionic contamination

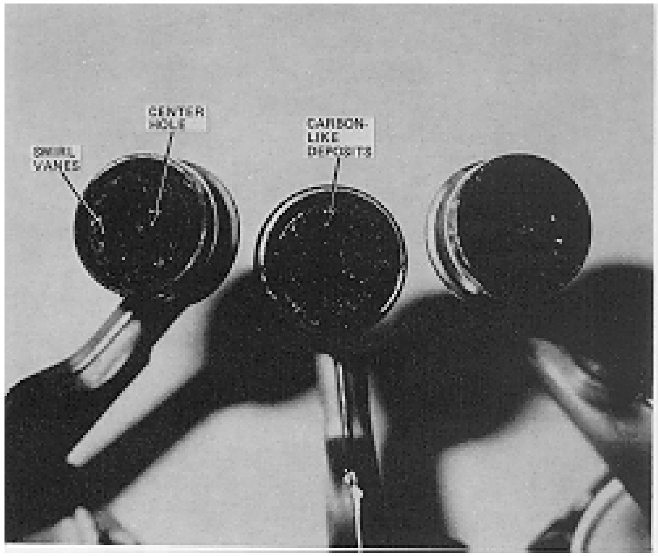
- Clogging of fuel, air entry



Used filter before/after ash ingestion

10 µm 1500X.





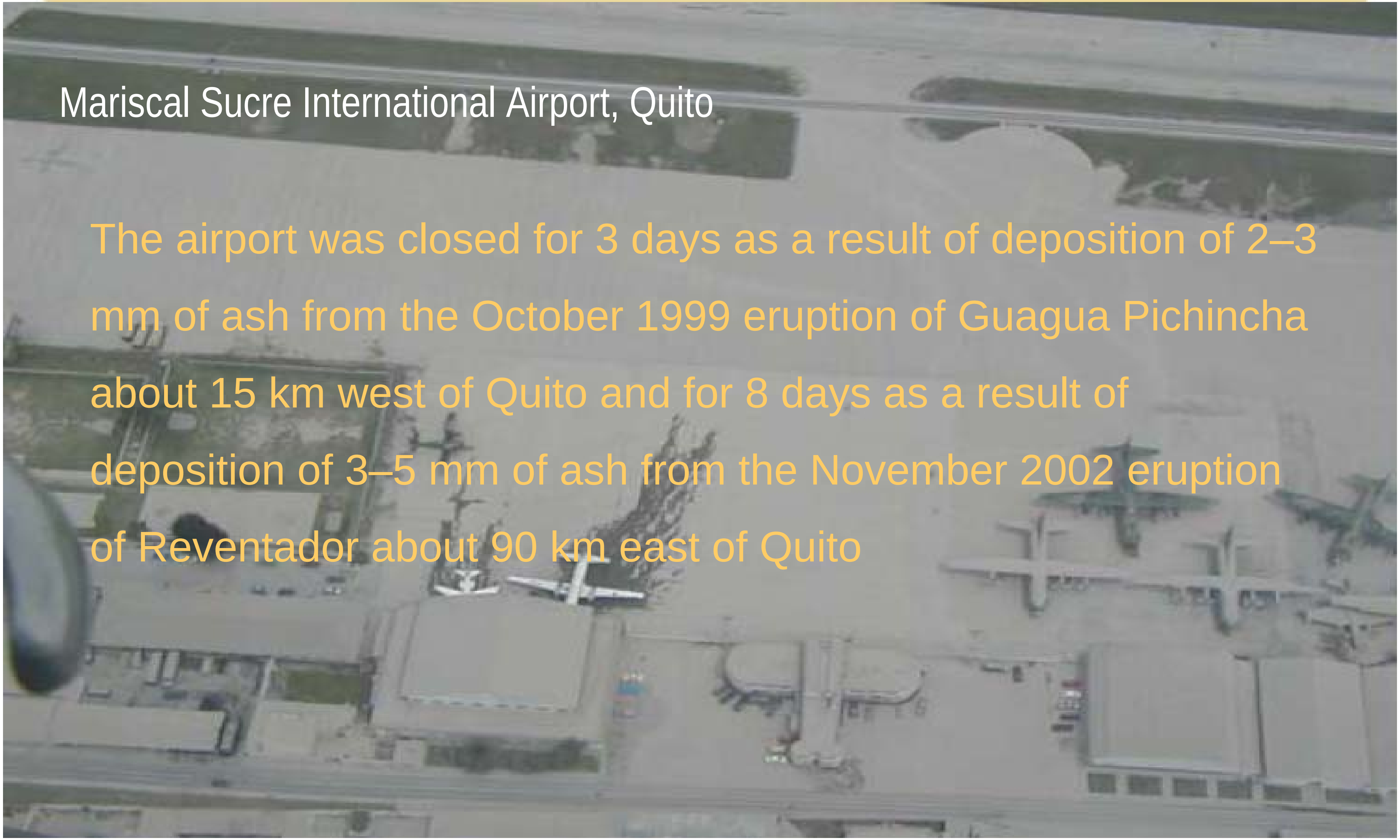
… BUT NOT ONLY …

- Radio electric effects (radio communications black out)

Chaiten, Chili

2 Mai 2008 (source La Tercera)

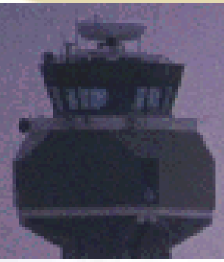
CLOSE TO THE VOLCANO



Mariscal Sucre International Airport, Quito

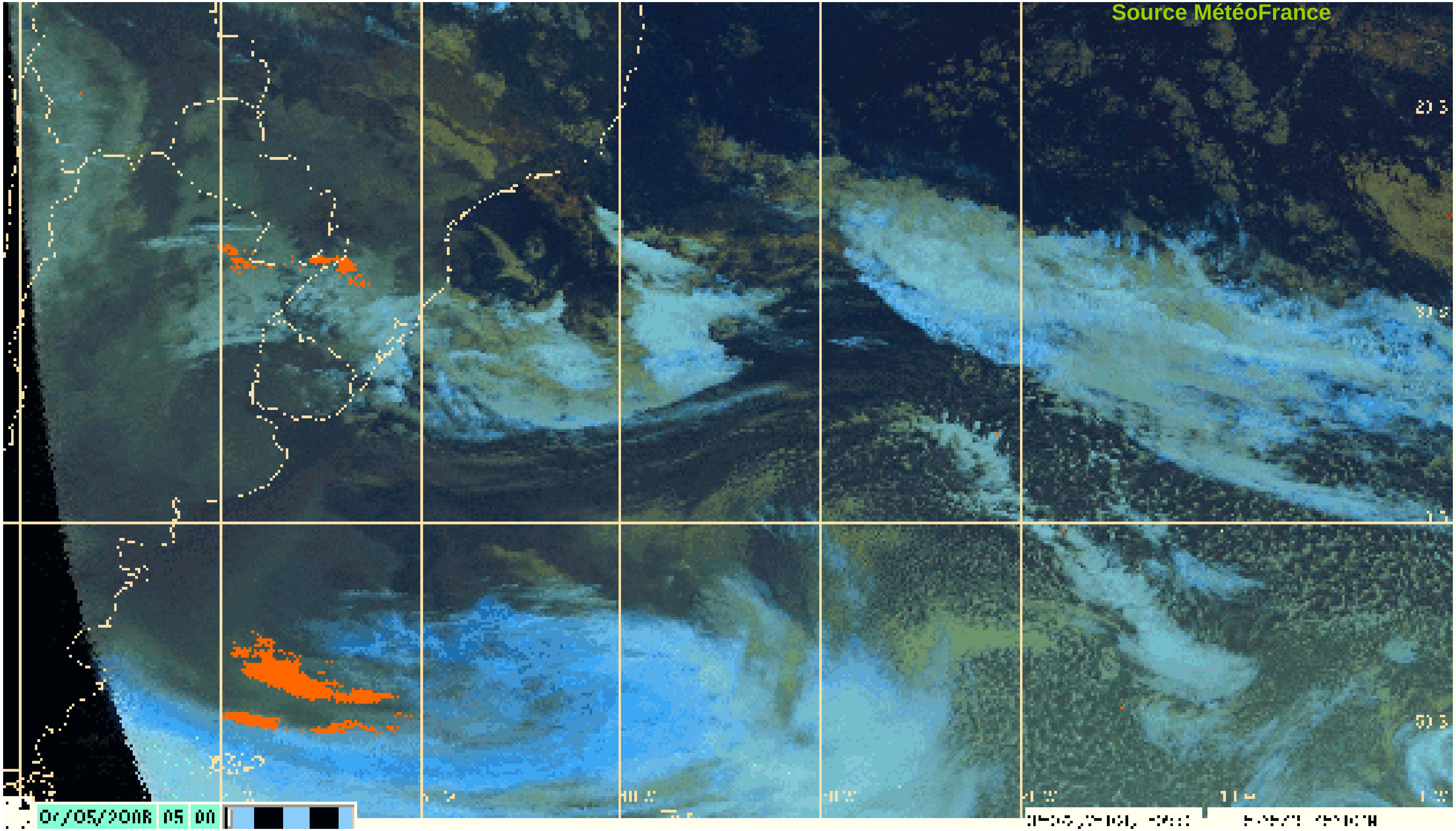
The airport was closed for 3 days as a result of deposition of 2–3 mm of ash from the October 1999 eruption of Guagua Pichincha about 15 km west of Quito and for 8 days as a result of deposition of 3–5 mm of ash from the November 2002 eruption of Reventador about 90 km east of Quito

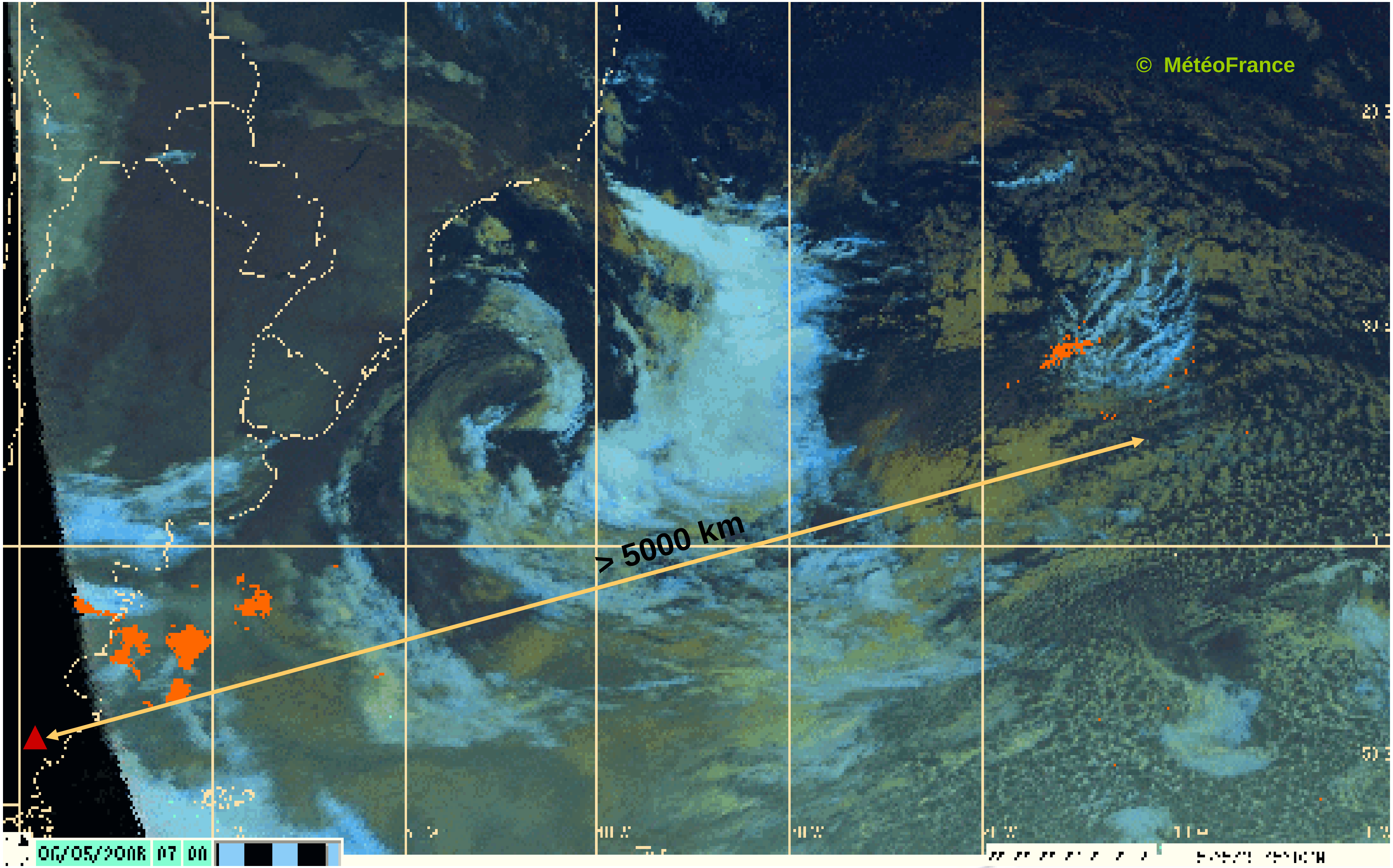
VOLCANOES NEIGHBORING AIRPORTS



$35 millions - Economic impact estmated for Anchorage Airport following the 1989-1990 eruption of Mt Redoubt

OR EVEN FAR AWAY FROM THE VOLCANO





MSG detection of airborne ash, coming from Chile

METEO FRANCE
Toujours un temps d'avance

LONG DISTANCE DAMAGE

- **Pinatubo, 1991 (VEI 6 – 34km): 930 km from volcano-** Encounter occurred at FL370 engine #1 surged and was shut down; engine #4 lost power. (Casadevall et al. 1996)
- **Pinatubo, 1991: 1150 km du volcan** Encounter at FL290

St. Elmo's fire on the windshield . (whitish) fog in the cabin. Once in Tokyo, engine inspection revealed that all four engines were damaged . First-stage nozzle guide vane cooling air holes were 70-80% blocked Other damage occurred to the cockpit windows, cabin windows, Pitot static probes, landing light covers, navigation lights, and all leading edge areas. (Casadevall et al. 1996)

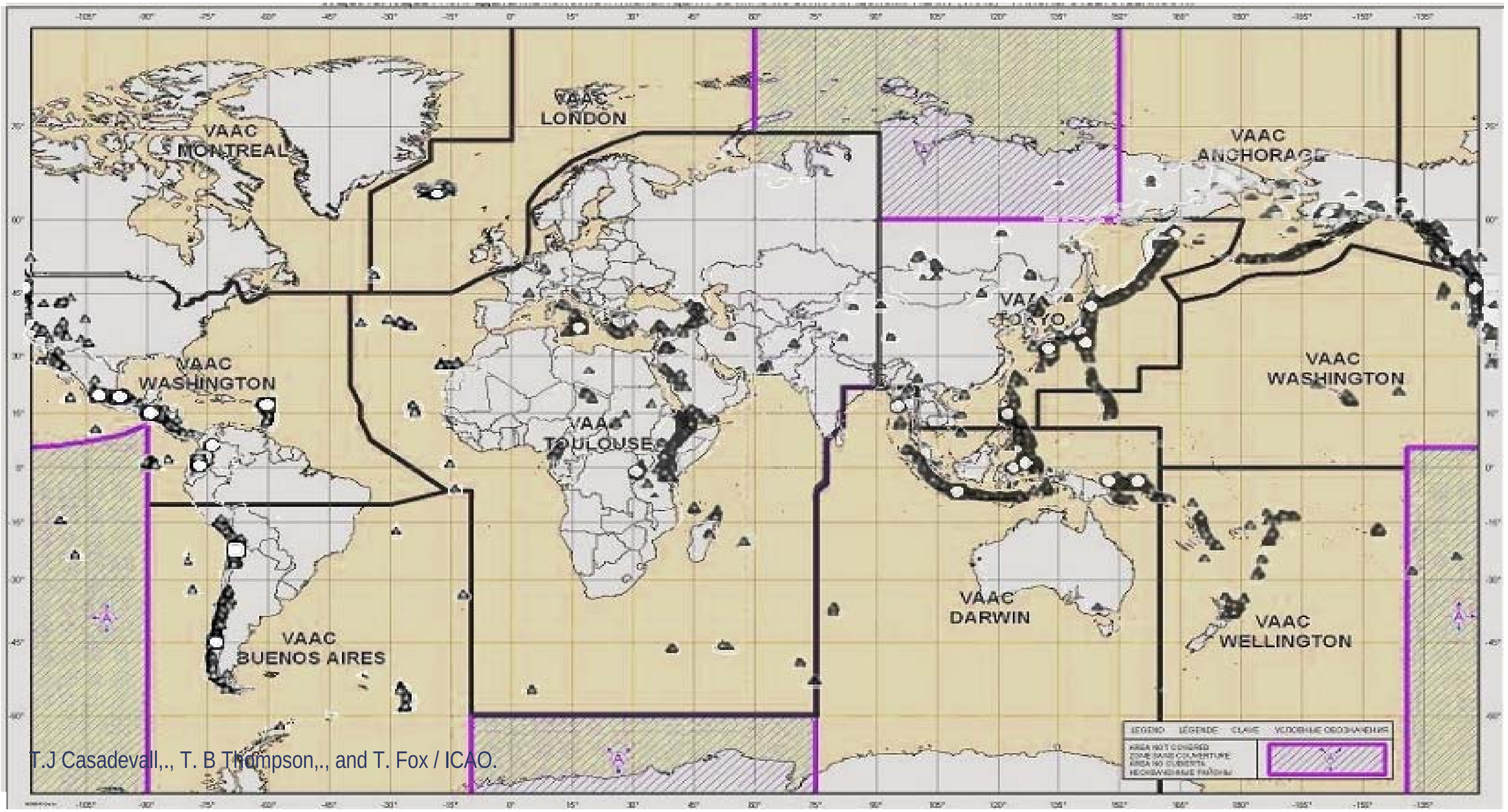
- **Hekla, Fevrier 2000 (VEI 3 - 11km): 1480 km du volcan, (35h)**

The NASA DC-8 flew for seven minutes in cloud that had up to 0.8 ppm SO2, and nearly 30,000 particles cm-3 aerosols. In-flight performance checks and post flight visual inspections revealed no damage to the airplane or engine first-stage fan blades; subsequent detailed examination of the engines revealed clogged turbine cooling air passages.
(Grindle and Burcham 2002-2003).

- **Redoubt, 1989 (VEI 3 - 12km) : 5400 km du volcan (35 / 55h)**

2 encounters over Texasengine failure / leading edges abrasion (Casadevall 1994).

IAVW : 9 V A A C



9 VAACs designed by ICAO to monitor satellite data and run dispersion models as to issue advisories in text and graphic format.

ICAO ANNEX3 STANDARDS §3.5.1

A VAAC … shall .. respond to a notification that a volcano has erupted, or is expected to erupt or volcanic ash is reported in its area of responsibility, by :

a) monitor relevant geostationary and polar-orbiting satellite data to detect the existence and extent of volcanic ash in the atmosphere in the area concerned;

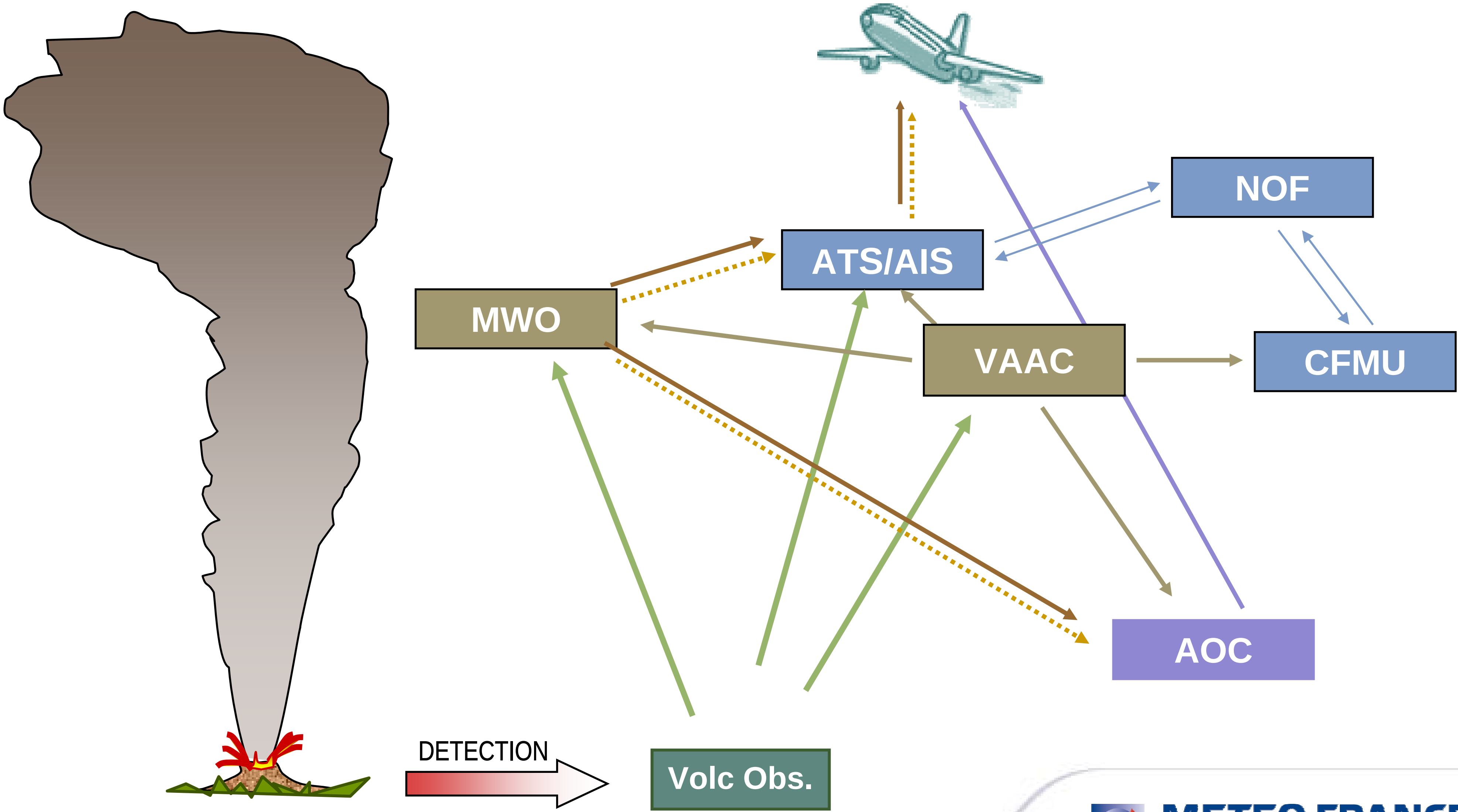
b) activate the volcanic ash numerical trajectory/dispersion model in order to forecast the movement of any ash “cloud” which has been detected or reported;

c) issue advisory information regarding the extent and forecast movement of the volcanic ash “cloud”

METEO FRANCE
Toujours un temps d’avance

RESPONSE TO A NOTIFICATION

ICAO WARNING PROCEDURES



METEO FRANCE
Toujours un temps d'avance

LOCAL DETECTION

- By designed volcano observatory notifying to VAACs, Met Watch Offices MWO and Area Control Centres ACC volcanic activity and pre-activity
- By Pilots Reports (PIREP) reporting by voice communication to ACC

VONA

(1) VOLCANO OBSERVATORY NOTICE FOR AVIATION (VONA)

(2) Issued	20081106/0855Z
(3) Volcano:	Água de Pau 1802-09
(4) Current Aviation Color Code:	RED
(5) Previous Aviation Color Code:	RED
(6) Source:	CVARG (Centre of Volcanology and Geological Risks Assessment)
(7) Notice Number:	2008/003
(8) Volcano Location:	3746N02528W
(9) Area:	Azores and Madeira
(10) Summit Elevation:	0947 m (3107 ft)
(11) Volcanic Activity Summary:.	A new explosive eruption at Água de Pau volcano has started approximately at 0845Z and keeps ongoing. This follows the increase in eruptive activity started yesterday, November 5th. Seismic activity remains at high levels.
(12) Volcanic Cloud Height:	The height of the ash cloud is estimated up to 15000 m (50000 feet) above sea level, based on ground observations.
(13) Other Volcanic Cloud Information:	Preliminary height up to15000 m (50000 feet) above sea level.
(14) Remarks:	NIL
(15) Contacts:	Volcano observatory Coordinator Tel: +351 296 654 471 / +351 296 650 147; Fax +351 296 650 142
(16) Next Notice	A new VONA will be issued when conditions at the volcano warrant changing the aviation color code or when a significant volcanic event occurs within the current color code.

METEO FRANCE
Toujours un temps d'avance

Volcanic report

Veðurstofa Íslands

Volcanic ash status report

Date and time of report: 05.05.2010, 21:00 UTC
Reported by: Helga Ívarsdóttir

Current height and the height of the eruption for the last 3 hou (extremes and estimated averages)
Increased activity in Eyjafjallajökull Radar: Upp to 10 km, but mostly between 5.5-6.2km for the last hou Pirep: (Aircraft in FL200) At 20:00Z. Plume 25-30.000 feet. Ashgr plume, very dark and massive. Not seen on webcams

Nature of reports: e.g. by radar, by aircraft or by eye
Radar signal and pirep.

Any obstructions to the observations (clouds, etc.)
Low clouds and fog around and over the volcano.

Veðurstofa Íslands

EBE-010-1

Volcanic ash status report

Date and time of report: 22.05.2010, 06:00 UTC

Reported by: Þorsteinn V. Jónsson

Please contact the Icelandic Met Office to discuss any of the content on +354 522 6313 (direct number) / +354 522 6300

Current height and the height of the eruption for the last 3 hours (extremes and estimated averages)
Plume height according to radar: N/A **Satellite images:** Trace of plume seen over top of volcano. **Webcam:** Plume obscured in clouds. **IMO-scientists estimated height of plume:** 3-4 km.

Nature of reports; e.g. by radar, by aircraft or by eye
PIREP: N/A Satellite imagery Webcam

Any obstructions to the observations (clouds, etc.)
Overcast at volcano. Moderate/poor visibility.

PIREP

Goodday sirs,

This morning pirep received from KLM571D from Dar es Salaam to Amsterdam.

Volcano Ol Doinyo Lengai reported explosion at 0945z with ash cloud upto fl330.

Kind regards,

KLM Dispatch

MONITORING

REMOTE SENSING

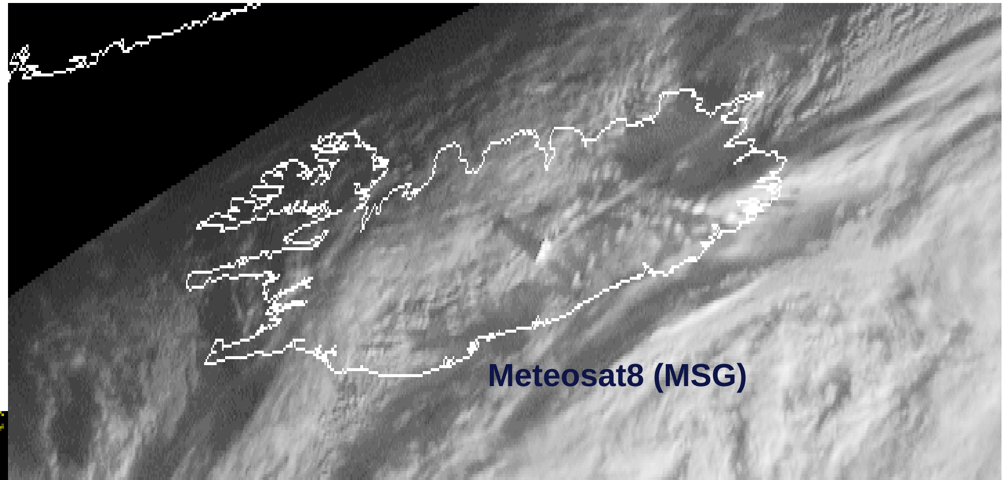
- Most volcanoes are not monitored on a regular basis.
- SAT information is of paramount importance
- The main limitation of SAT data comes from :
  - the presence of atmospheric clouds (mask effect, confusion between the cloud types).
  - the lack of quantitative data
- Neat preference to geostationaries providing loops beeing more informative (history of the cloud)

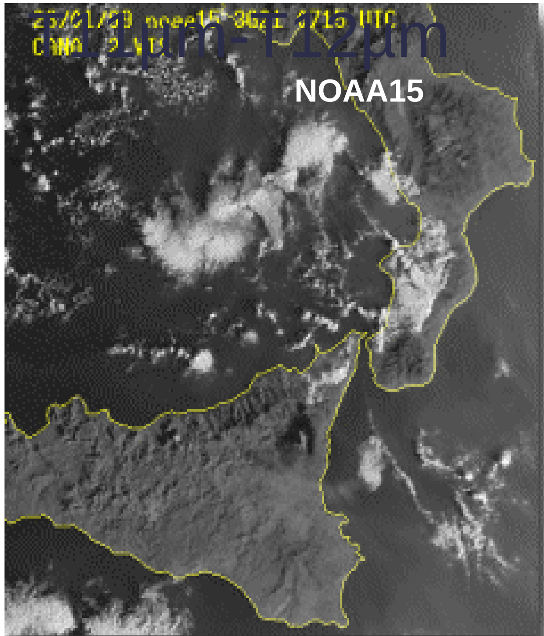
METEO FRANCE
Toujours un temps d'avance

DISCRIMINATION ASH vs WATER

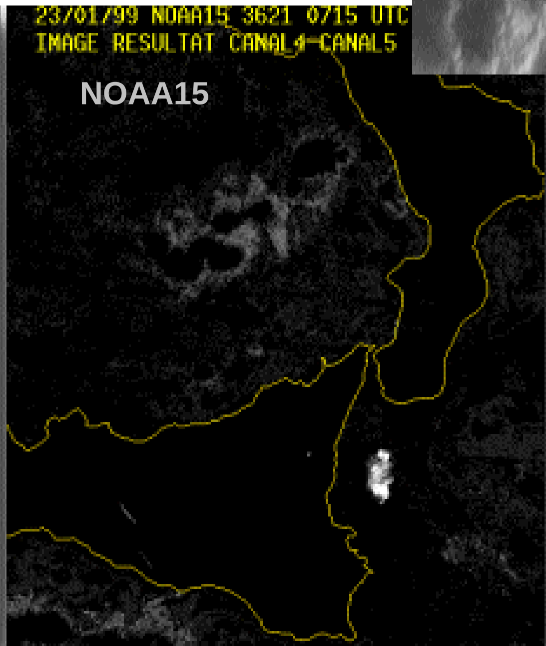
- ' split-window ' :

based on bright temperature difference from channels IR 11µm-12µm

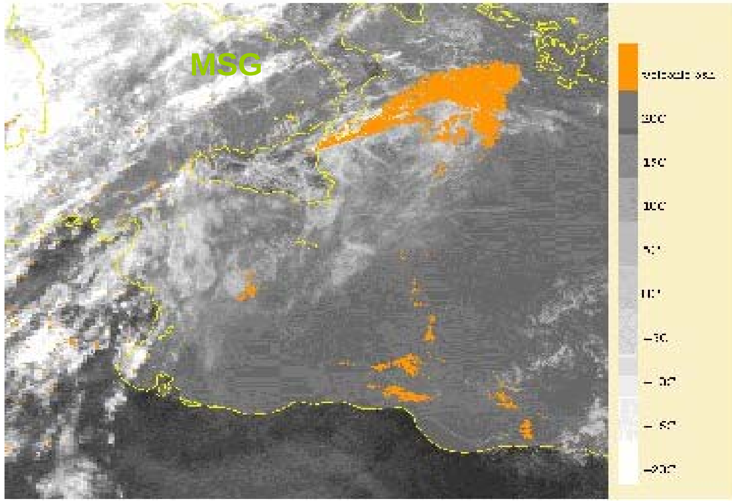




VIS

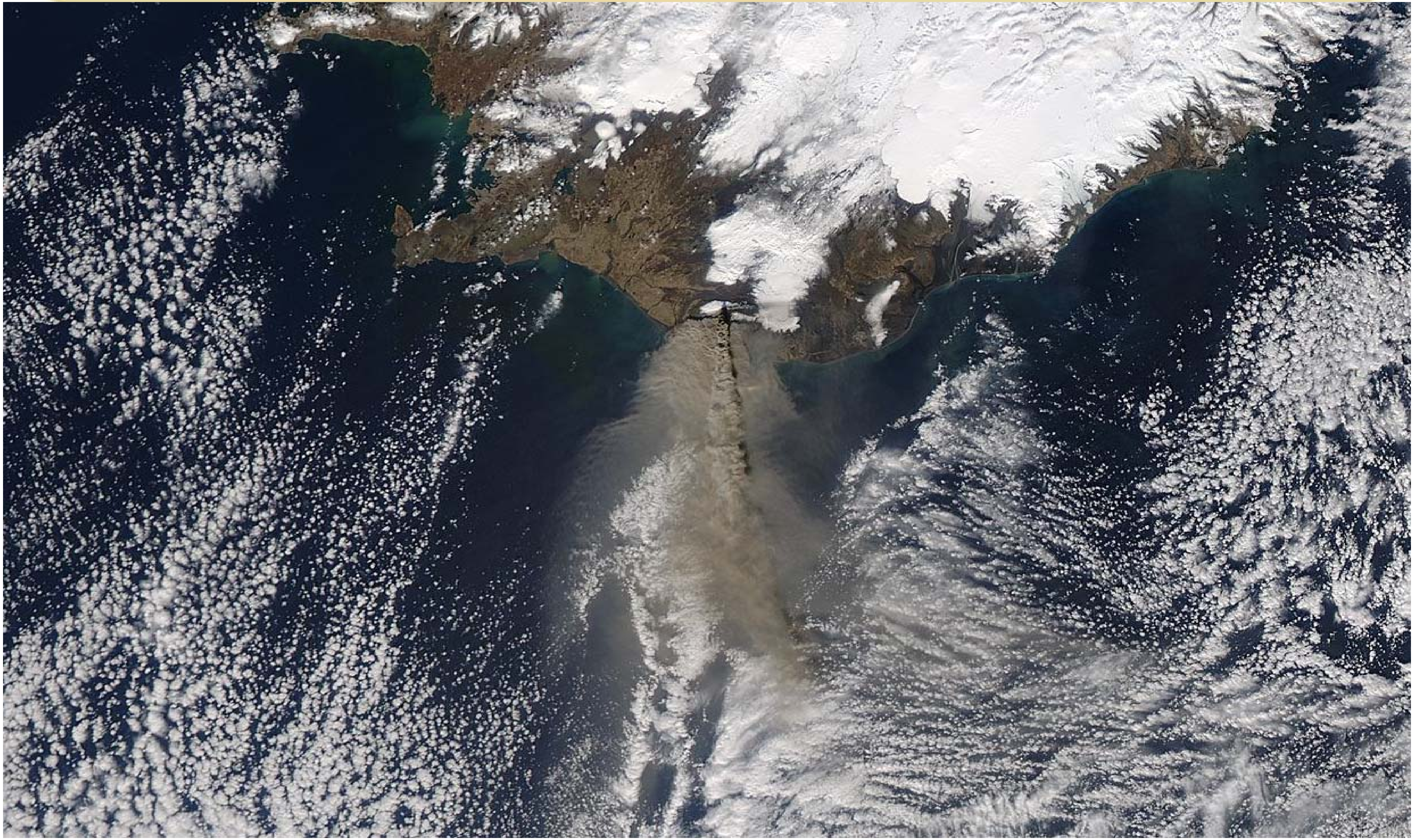


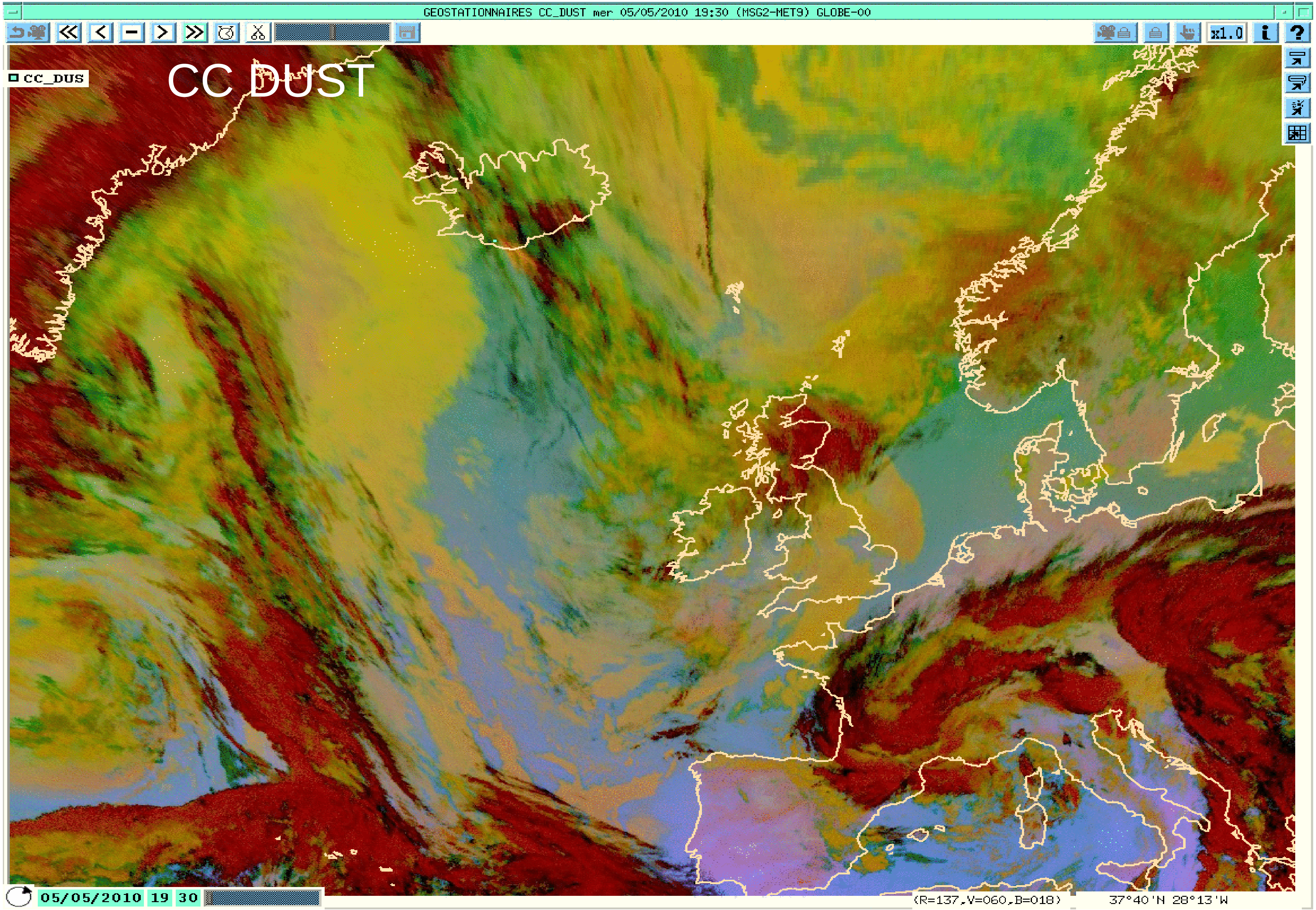
Split window



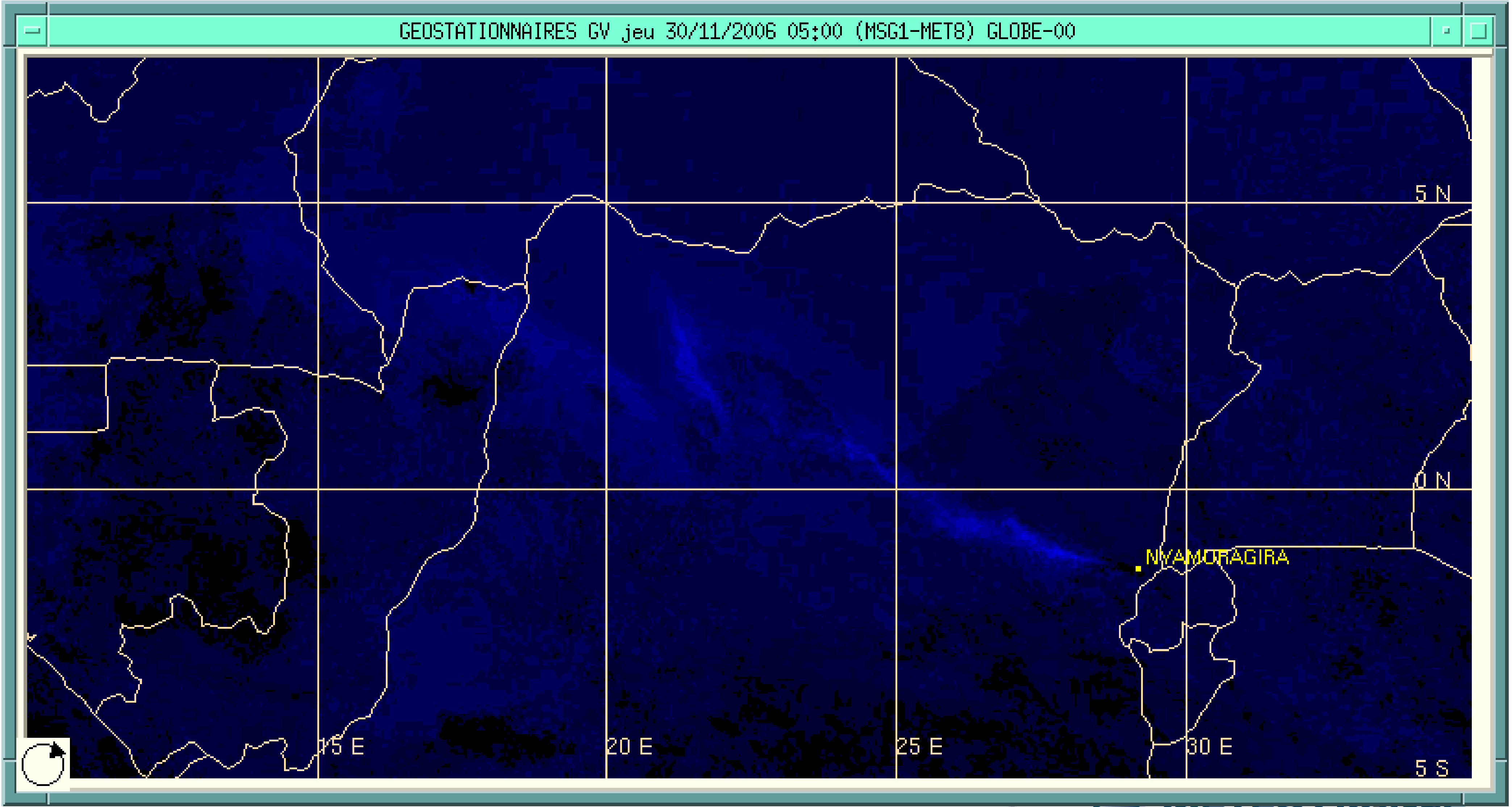
METEO FRANCE
Toujours un temps d'avance

POLAR ORBITING SATELLITES



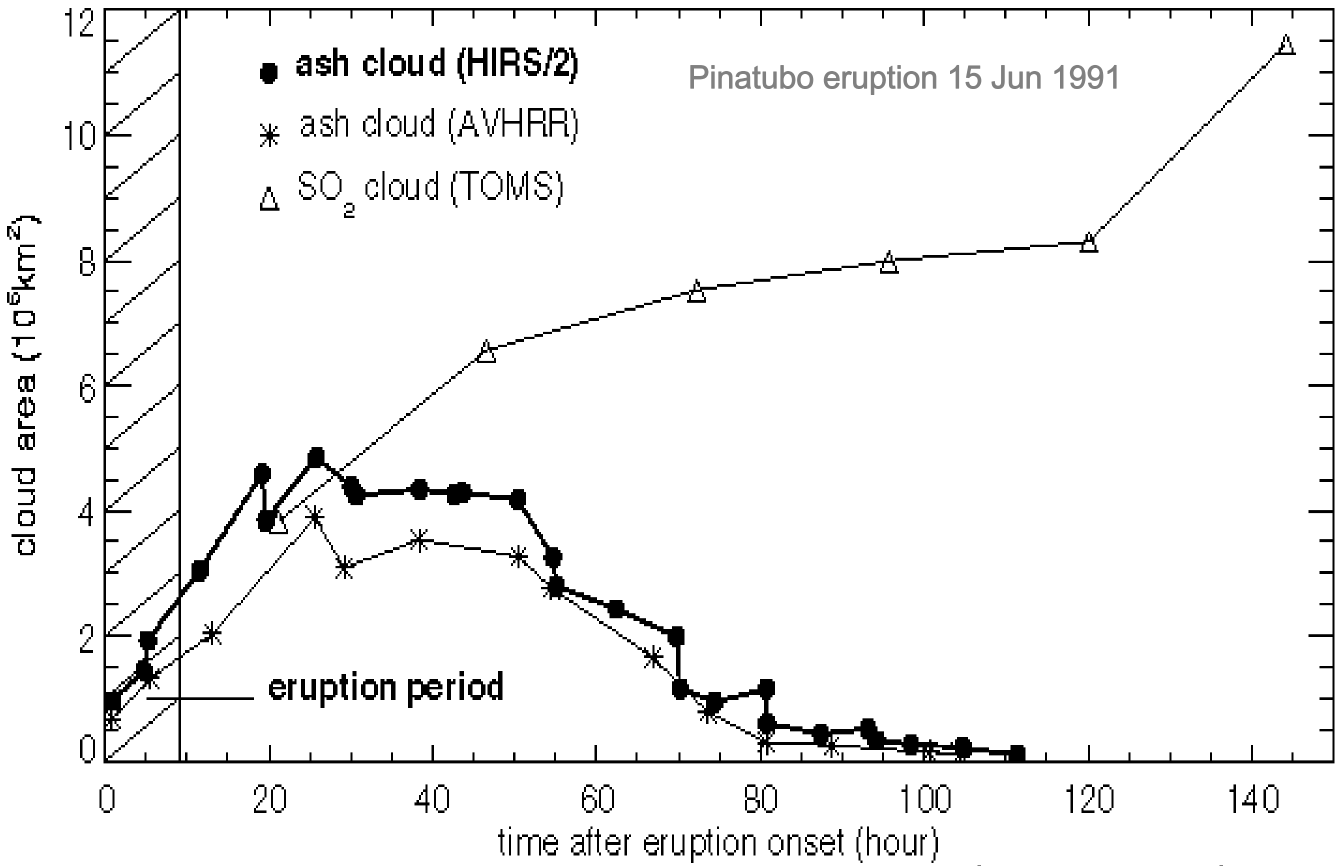

GEOSTATIONNAIRES CC_DUST mer 05/05/2010 19:30 (MSG2-MET9) GLOBE-00
CC_DUS
CC DUST
x1.0
05/05/2010 19 30
(R=137,V=060,B=018)
37°40'N 28°13'W

SO2 DETECTION



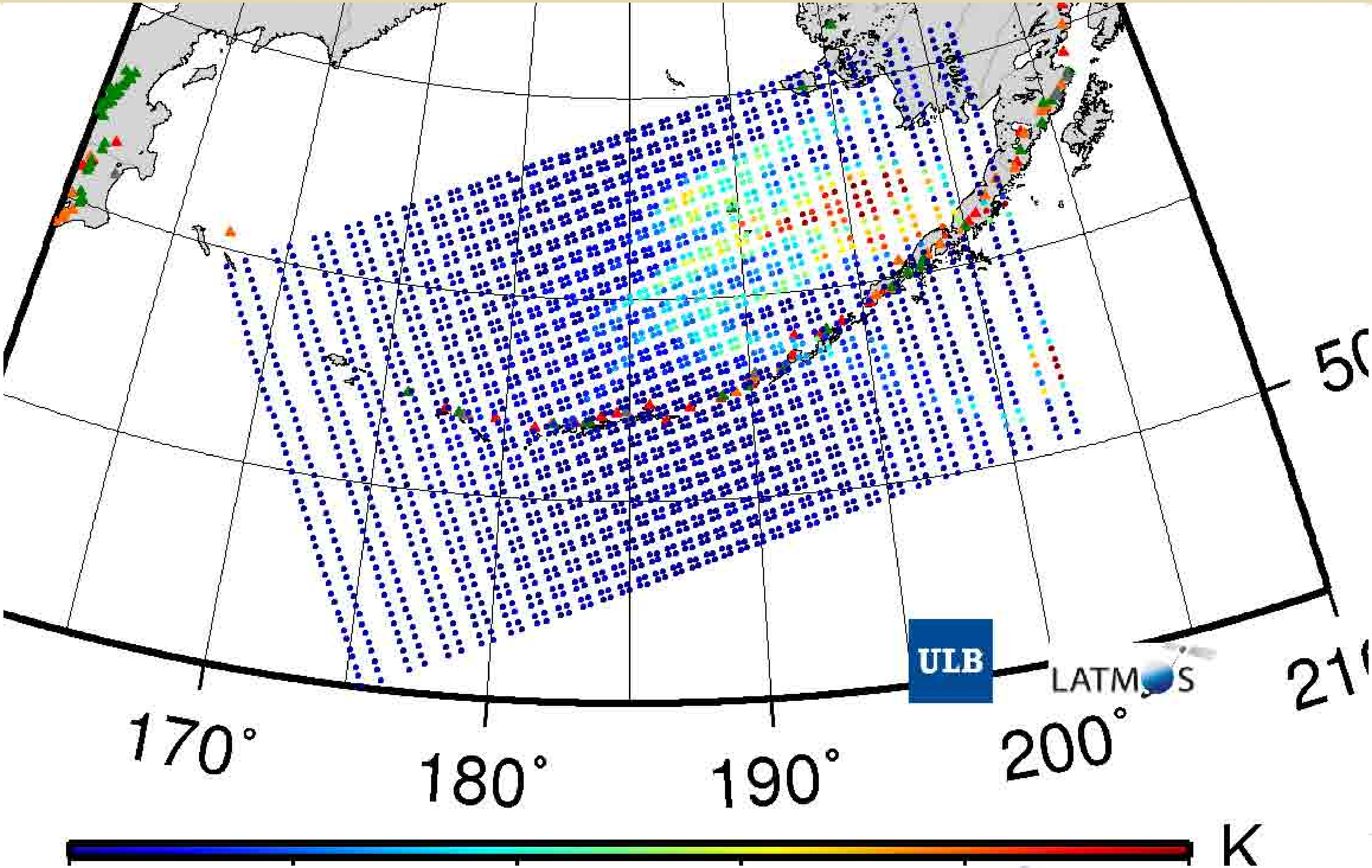
SO2 DETECTION

The SO2 cloud splits apart from ash cloud – often higher, ahead and very larger after 24/36h.



Guo et al, 2004, G3, vol 5, no 5

SO2 RETRIEVAL FROM IASI



METEO FRANCE
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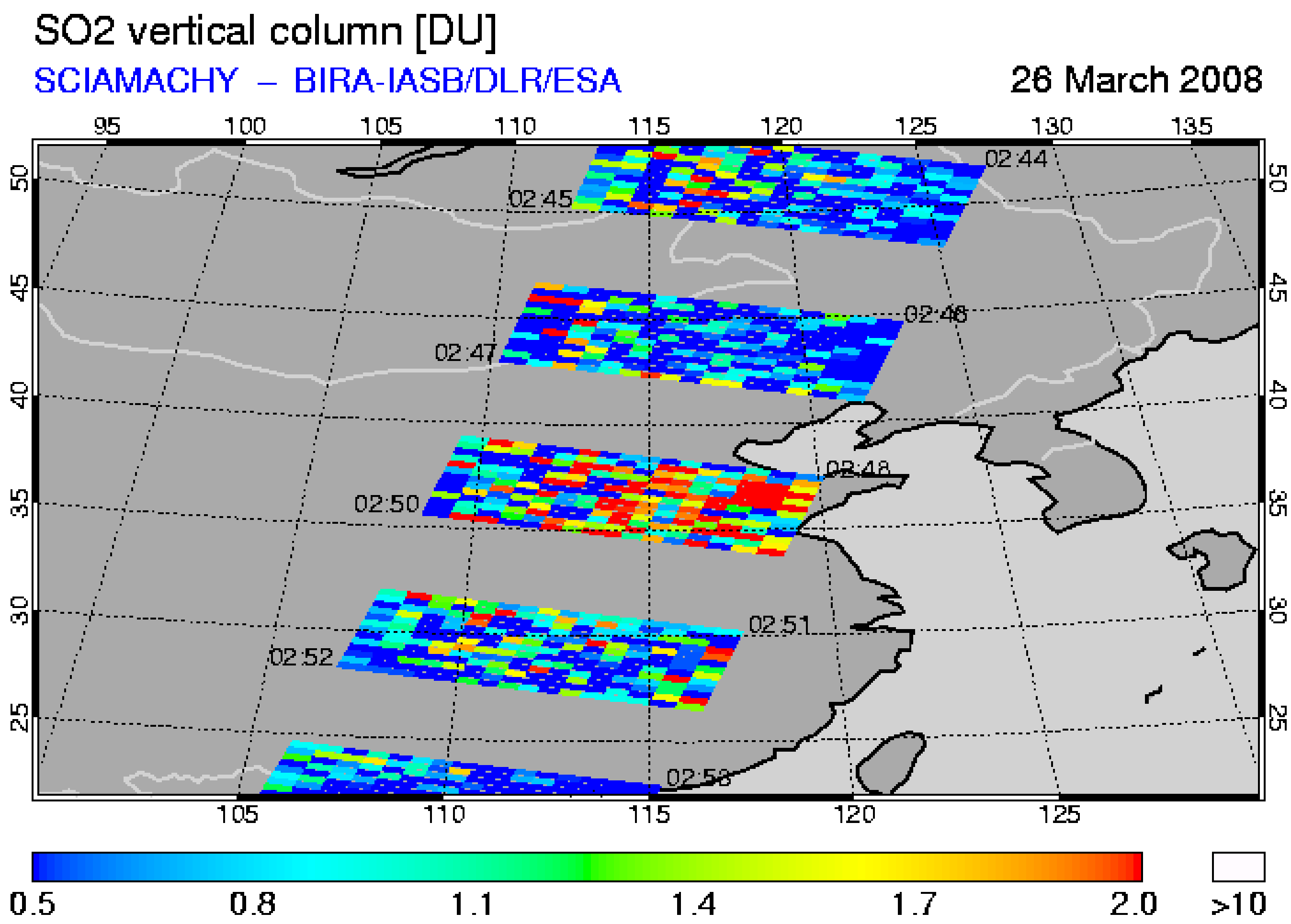
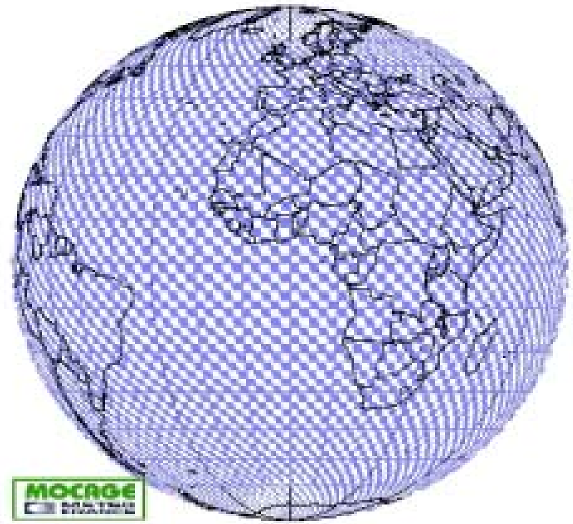
SO2 RETRIEVAL FROM SCIAMACHY



MODELLING

METEO FRANCE
Toujours un temps d'avance

MOCAGE ACCIDENT FOR VOLCANIC ASH



- Specific configuration :
  - Global at 0.5 °
  - 47 vertical levels, from the ground up to 5 hPa
  - No chemistry
  - Complete physical processes + sedimentation of particles
- Specific constraints : the response time must be as shorter as possible (max 5 minutes for a 12h run)
- Specific emission module : depending on the height of the source and the wind (working for gaseous emissions too)

MOCAGE

- Large –Scale Transport (wind) : Semi-Lagrangian scheme

(Williamson & Rasch, 1989)

- Parameterized transport : Convection and eddy diffusion

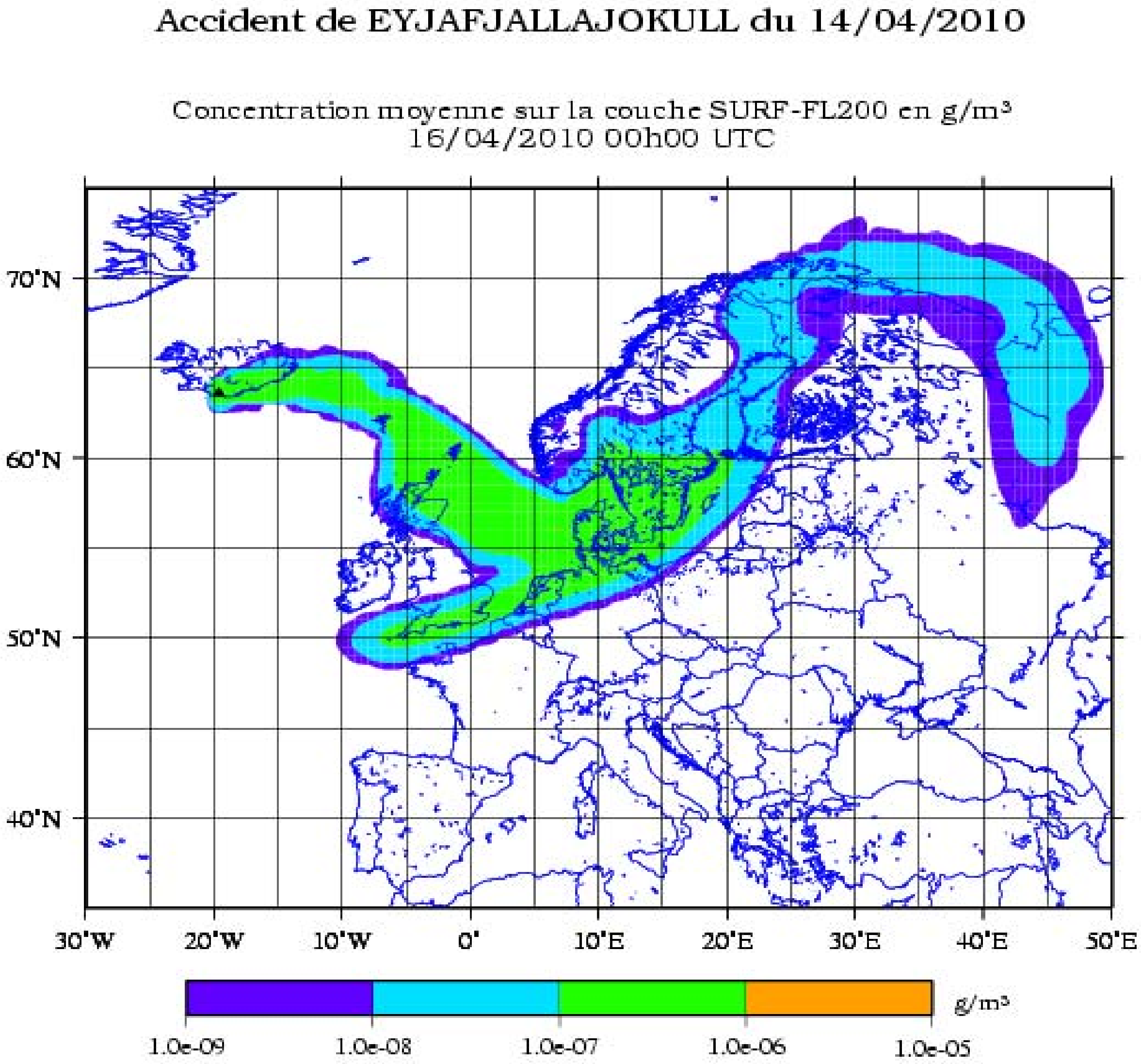
(*Bechtold et al, 2000) (Louis,1979)*

- Dry and wet depositions

(Wesely et al, 1989) (Mari et al, 2000 ; Liu et al, 2001)

- Chemistry : different schemes

DISPERSION FORECAST



modèle de dispersion : MOCAGE-accident
modèle météo : ARPEGE

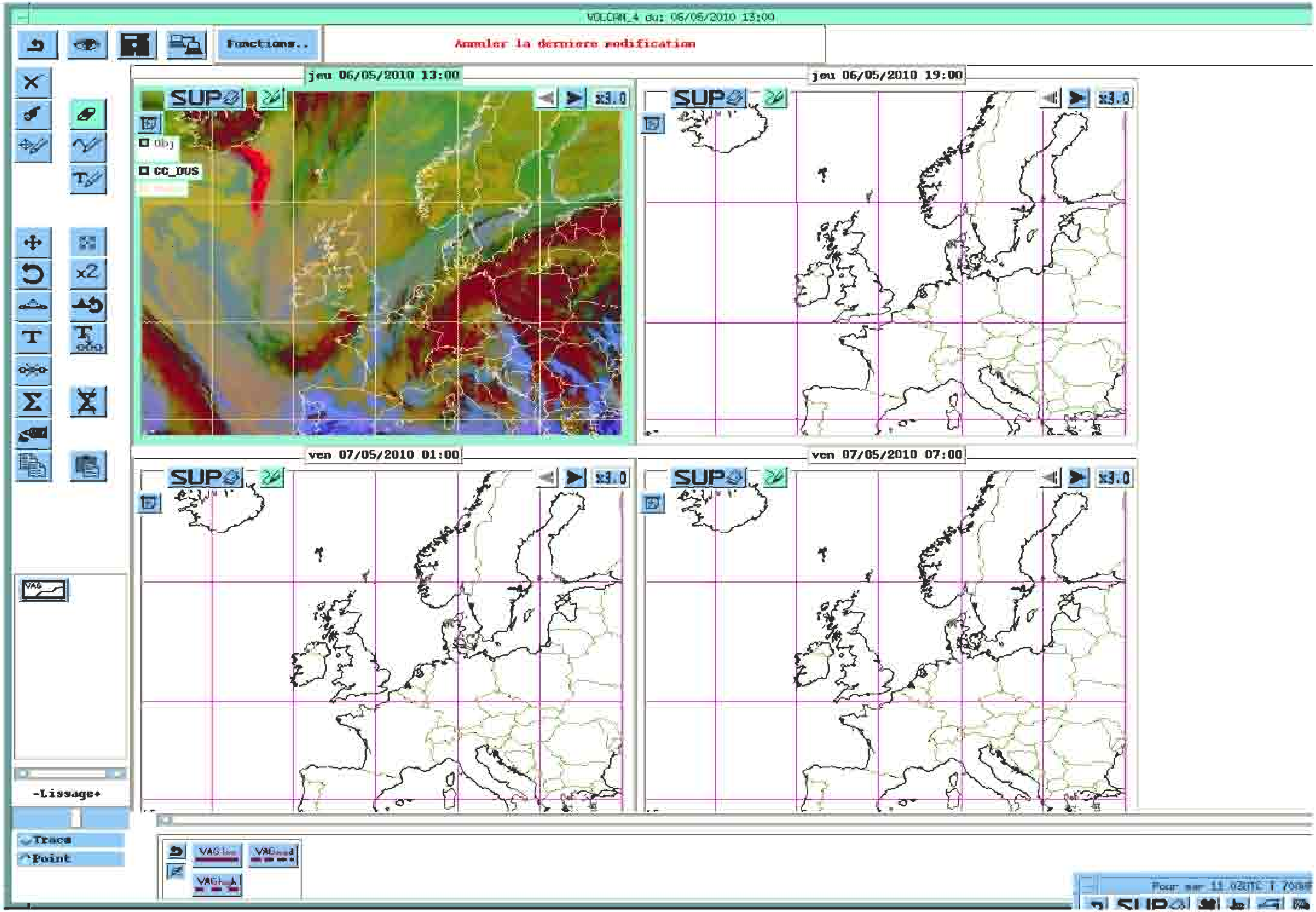
INFOS REJET
Site : EYJAFJALLAJOKULL
Début émission : 14/04/2010 06h00 UTC
Duré rejet : 216h00
Lat. rejet : 63.633 63°37'58"
Lon. rejet : -19.617 -19°-37'-1"
Débit d'émission : 1.4e+08 g/h
Base : 1300m
Sommet : 7500m
Polluant émis : CENDRE

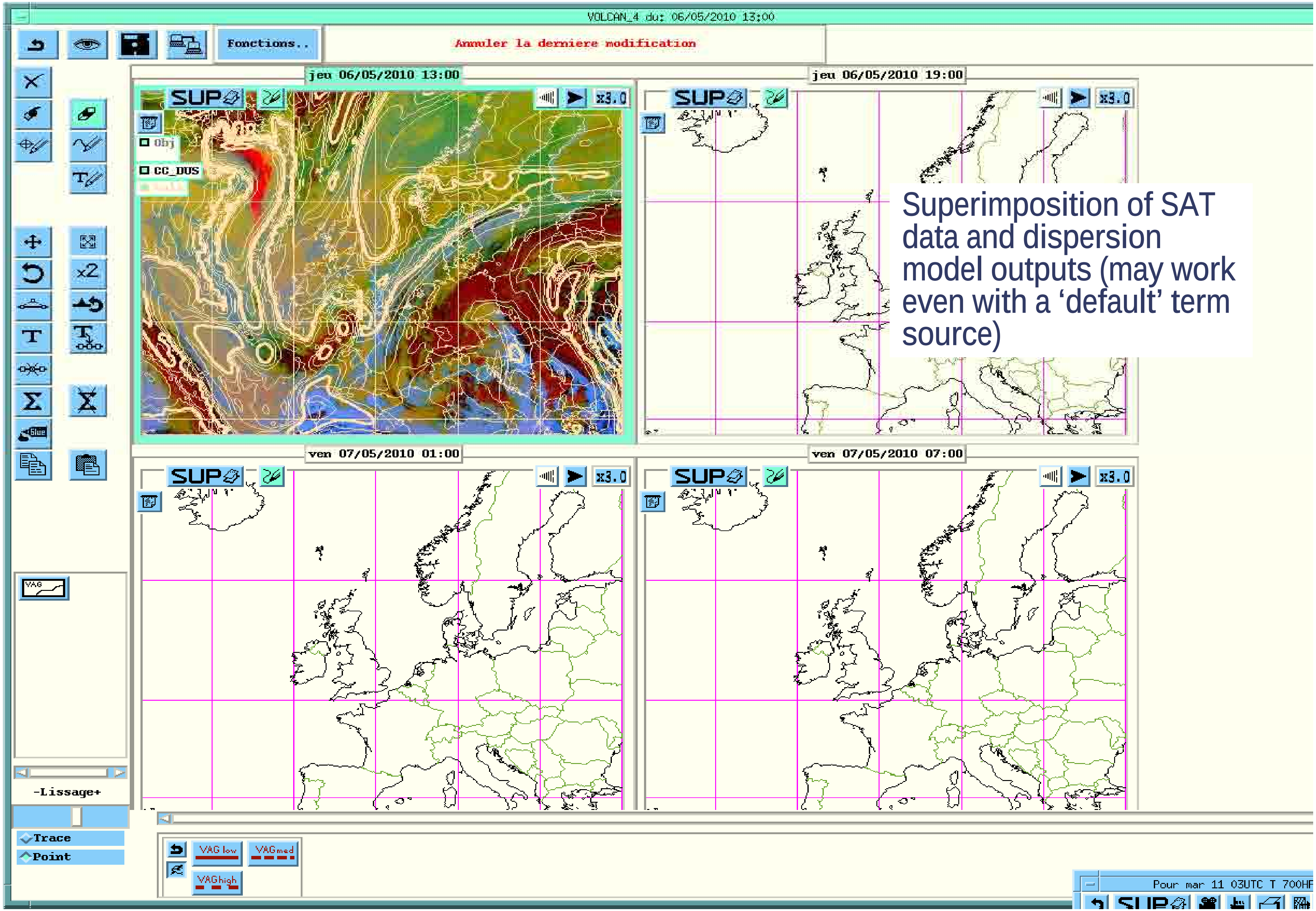
INFOS MODELE
grille resolution : 0.5°
Base modèle ARPEGE
Réseau : 16/04/2010 12UTC

Valeur max échéance courante :
1.0e-06 g/m³

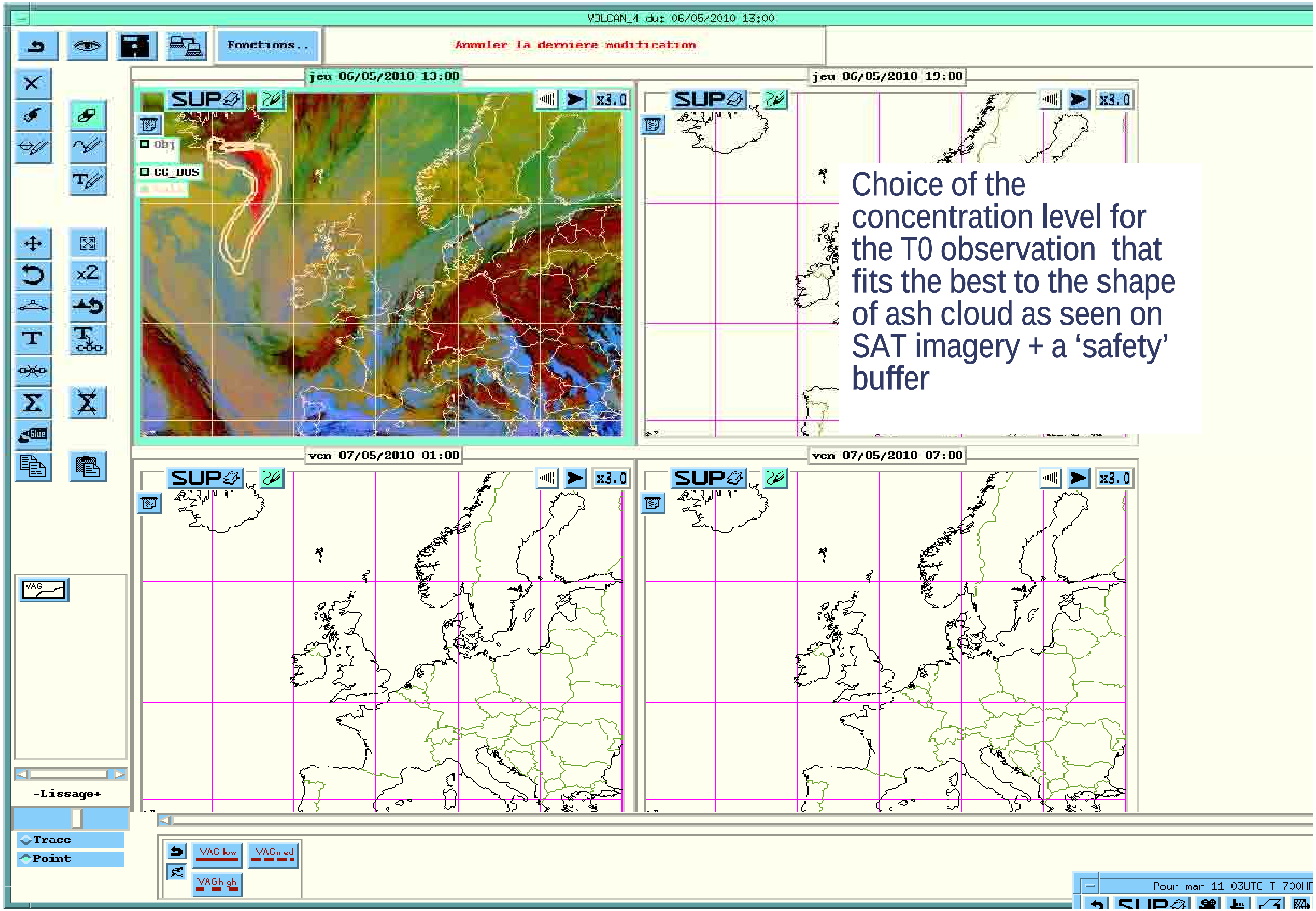
METEO FRANCE
VAAC TOULOUSE

VAAC METHODOLOGY

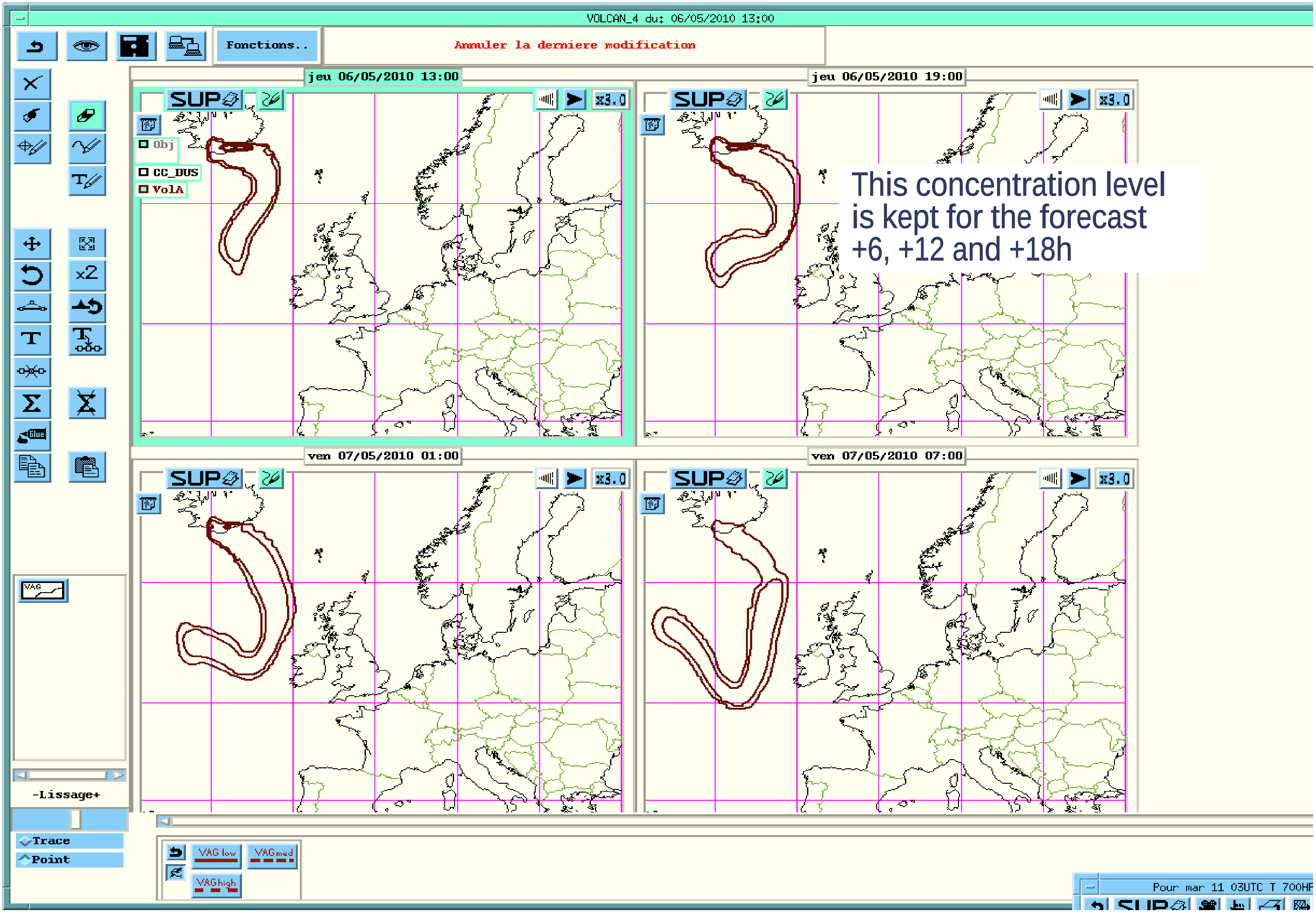

VOLCAN_4 du: 06/05/2010 13:00
Fonctions..
Annuler la derniere modification
jeu 06/05/2010 13:00
jeu 06/05/2010 19:00
ven 07/05/2010 01:00
ven 07/05/2010 07:00
SUP
x3.0
Obj
CC_DUS
-Lissage+
Trace
Point
VAG

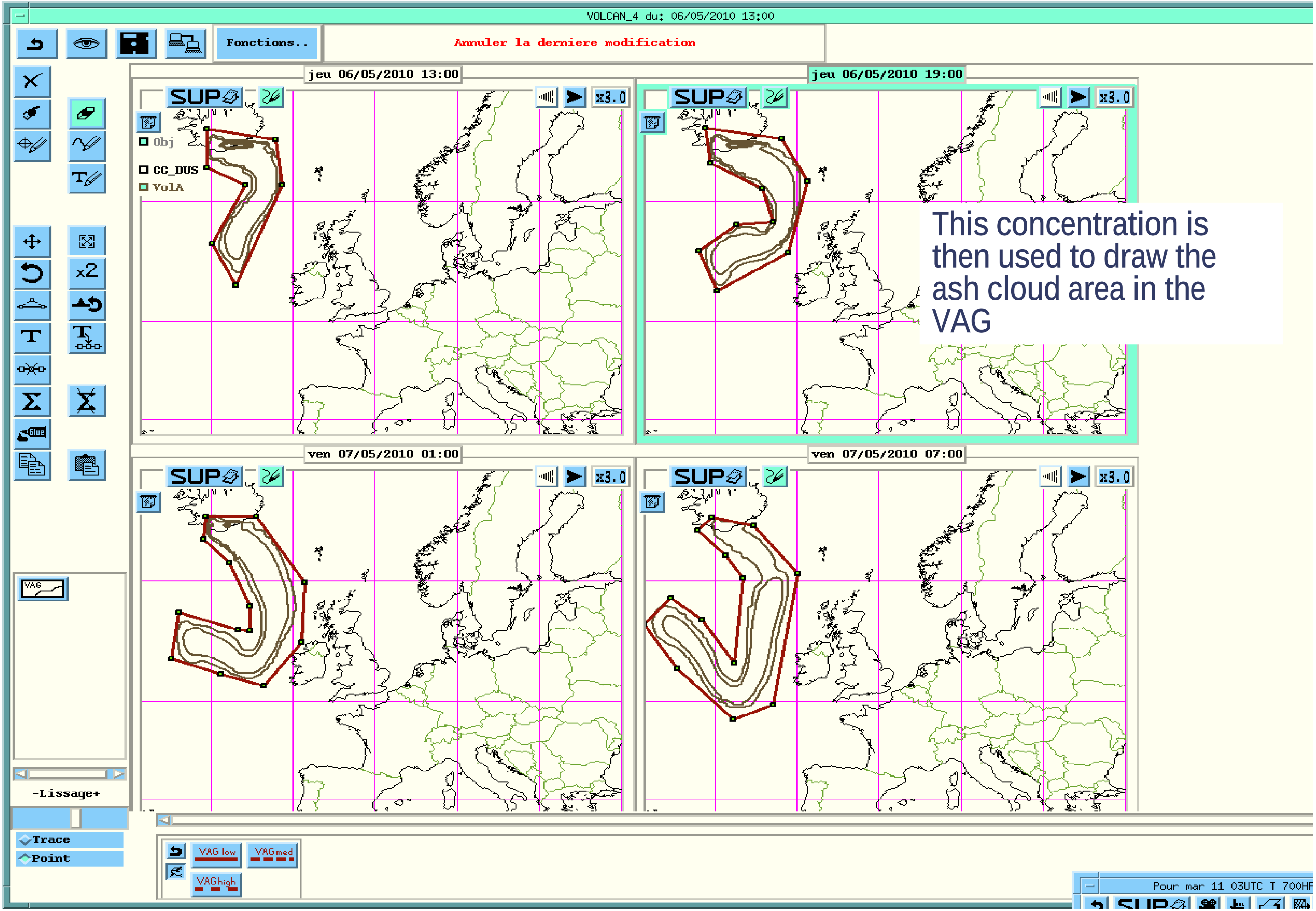


Superimposition of SAT data and dispersion model outputs (may work even with a 'default' term source)



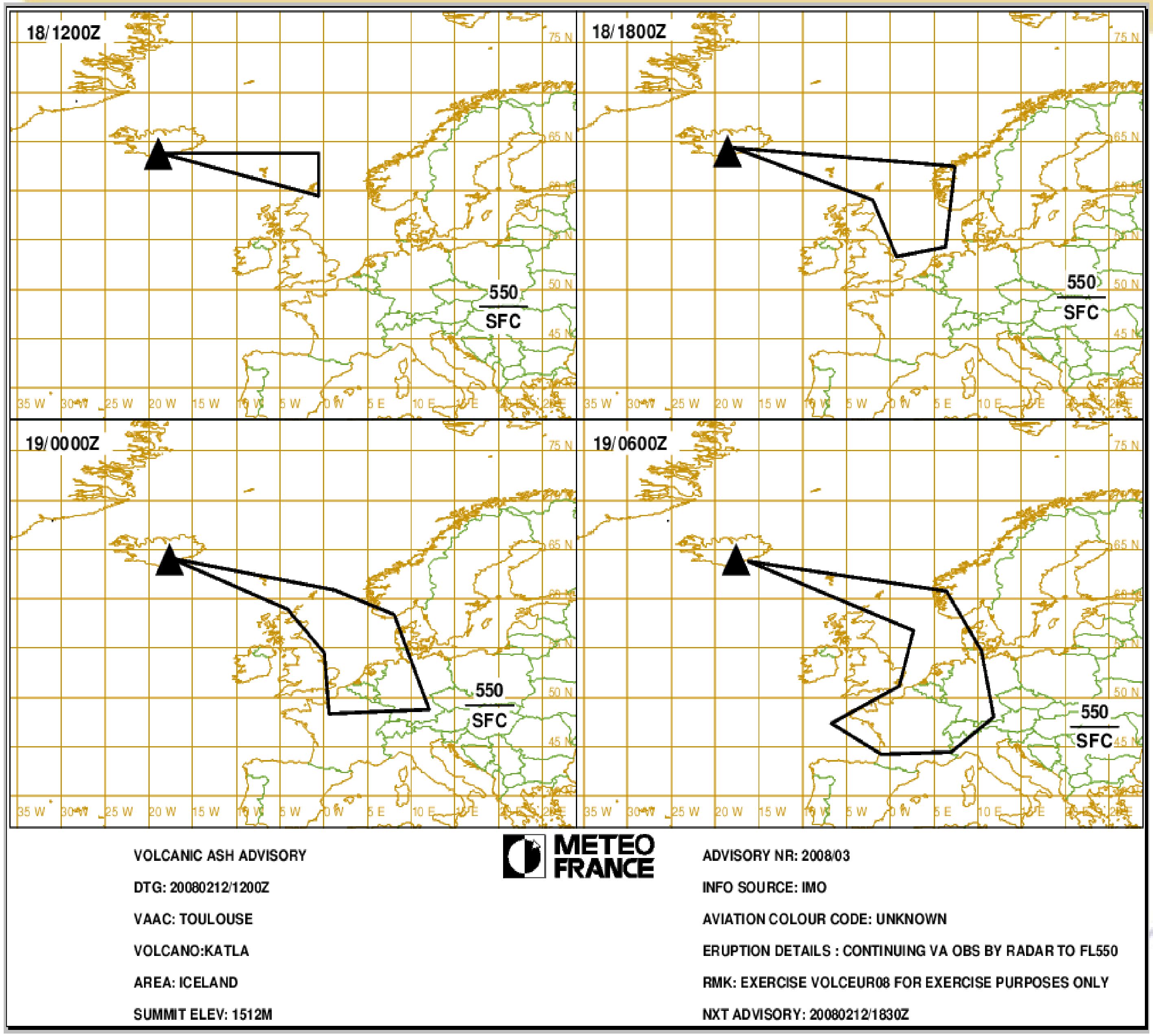
Choice of the concentration level for the T0 observation that fits the best to the shape of ash cloud as seen on SAT imagery + a 'safety' buffer


VOLCAN_4 du: 06/05/2010 13:00
Fonctions..
Annuler la derniere modification
jeu 06/05/2010 13:00
jeu 06/05/2010 19:00
ven 07/05/2010 01:00
ven 07/05/2010 07:00
SUP
x3.0
Obj
CC_DUS
VolA
This concentration level is kept for the forecast +6, +12 and +18h
x2
Glue
VAG
-Lissage+
Trace
Point
VAG low
VAG med
VAG high
Pour mar 11 03UTC T 700HP



This concentration is then used to draw the ash cloud area in the VAG

VAG/VAA



The area depicted is a VAAC expertise about the area observed and forecast where airspace is contaminated by *presence* of volcanic ash.

ICAO guidance :

Avoid, avoid, avoid

What is out of the polygons is safe.

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Toujours un temps d'avance

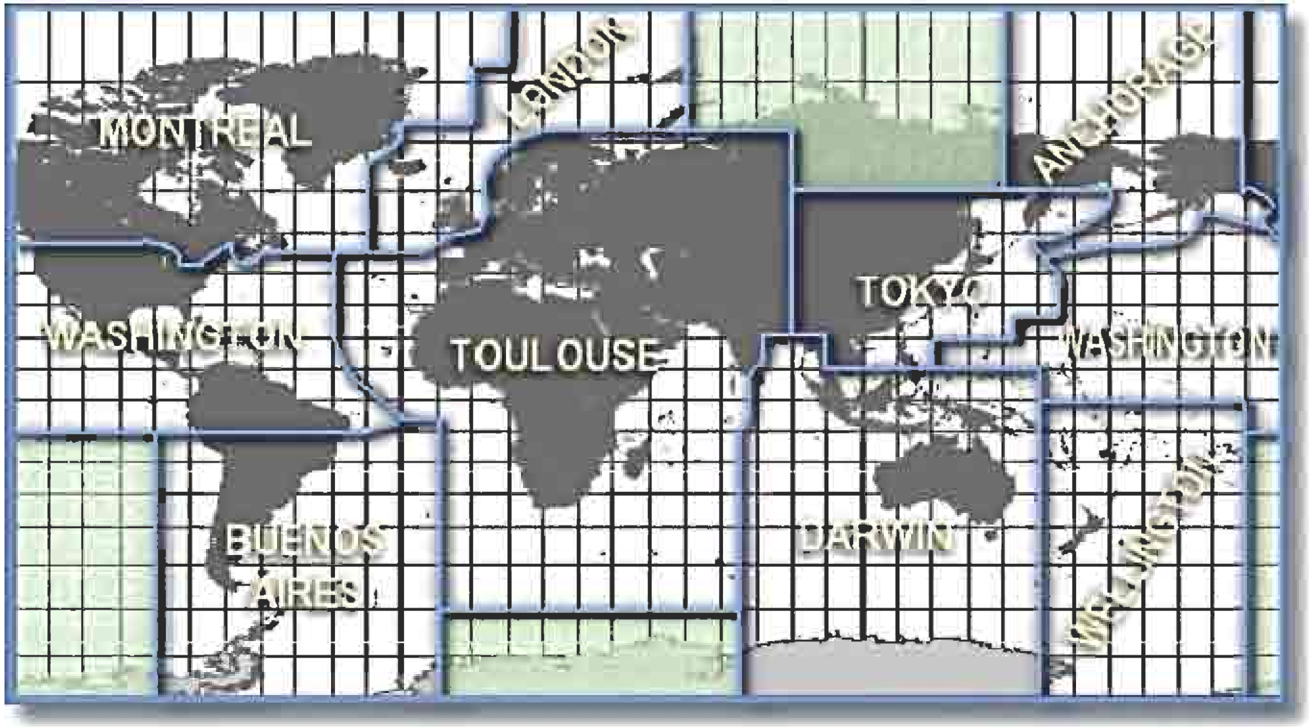
METEO FRANCE
Toujours un temps d'avance

Home

TOULOUSE VAAC

Les VAAC (Volcanic Ash Advisory Center : Centre Conseil en Cendre Volcanique), au nombre de neuf, fournissent leur expertise à l'aviation civile internationale en cas d'éruption volcanique significative.
Ils sont une pièce fondamentale de la Veille Volcanique des Routes Aériennes Internationales.
(ou IAVW : International Airways Volcano Watch).

- VAA et VAG
- La cendre et l'aviation
- Exemple fictif : ETNA
- Contacts



Carte cliquable des zones de responsabilité des VAACs

METEO FRANCE
Toujours un temps d'avance

TOULOUSE VAAC WEB SITE – ONLINE VAA / VAG

METEO FRANCE
Toujours un temps d'avance

TOULOUSE VAAC

Home Accueil

Toulouse VAAC - Volcanic Ash Advisories

Last updated: Wednesday, 07 March 2007 11:00:01 UTC

Most recent five messages, regardless of volcano:
01-03-2007 - 14:30 UTC - 2007-01 -- STROMBOLI
08-02-2007 - 12:30 UTC - 2007-02 -- KATLA -- has graphic attached (Graphic only)
08-02-2007 - 09:30 UTC - 2007-01 -- KATLA -- has graphic attached (Graphic only)
13-12-2006 - 17:15 UTC - 2006-12 -- ETNA
07-12-2006 - 15:00 UTC - 2006-14 -- NYAMURAGIRA

ETNA :
13-12-2006 - 17:15 UTC - 2006-12
05-12-2006 - 14:40 UTC - 2006-11
05-12-2006 - 14:40 UTC - 2006-11
05-12-2006 - 14:40 UTC - 2006-11
05-12-2006 - 08:41 UTC - 2006-10 -- has graphic attached (Graphic only)

KATLA :
08-02-2007 - 12:30 UTC - 2007-02 -- has graphic attached (Graphic only)
08-02-2007 - 09:30 UTC - 2007-01 -- has graphic attached (Graphic only)

NYAMURAGIRA :
07-12-2006 - 15:00 UTC - 2006-14
07-12-2006 - 09:00 UTC - 2006-13
02-12-2006 - 11:20 UTC - 2006-12
02-12-2006 - 11:20 UTC - 2006-12
02-12-2006 - 04:43 UTC - 2006-12

STROMBOLI :
01-03-2007 - 14:30 UTC - 2007-01

TOULOUSE VAAC WEB SITE – ONLINE VAA / VAG

METEO FRANCE
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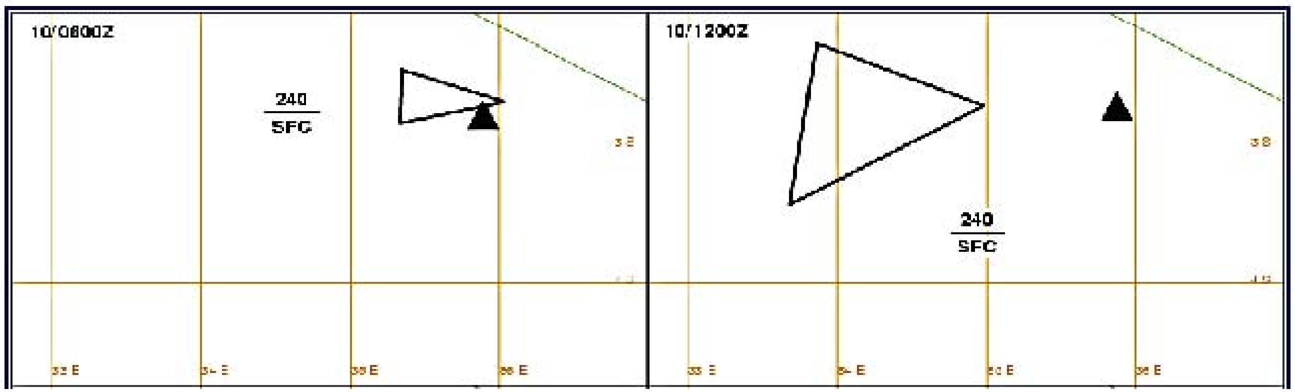
TOULOUSE VAAC

Home Accueil

FVXX02 LFPW 100722
VA ADVISORY
DTG: 20080310/0711Z
VAAC: TOULOUSE
VOLCANO: OL DOINYO LENGAI 0202-12
PSN: S0246 E03555
AREA: AFRICA-E
SUMMIT ELEV: 2962M
ADVISORY NR: 2008/20
INFO SOURCE: METEOSAT
AVIATION COLOUR CODE: NIL
ERUPTION DETAILS: UNKNOWN
OBS VA DTG: 10/0600Z
OBS VA CLD: SFC/FL240 S0240 E03600 - S0225 E03520 - S0250 E03520 -
S0240 E03600 MOV W 15 KT
FCST VA CLD +6H: 10/1200Z SFC/FL240 S0240 E03500 - S0215 E03350 -
S0325 E03340 - S0240 E03500
FCST VA CLD +12H: 10/1800Z NO VA EXP
FCST VA CLD +18H: 11/0000Z NO VA EXP
RMK: PLEASE CHECK SIGMET FOR CURRENT WARNINGS.
NXT ADVISORY: LAST ADVISORY=

Les VAA et VAG sont disponibles en temps réel sur le site.



FROM APRIL 19TH

CONCENTRATION CHARTS

METEO FRANCE
Toujours un temps d'avance

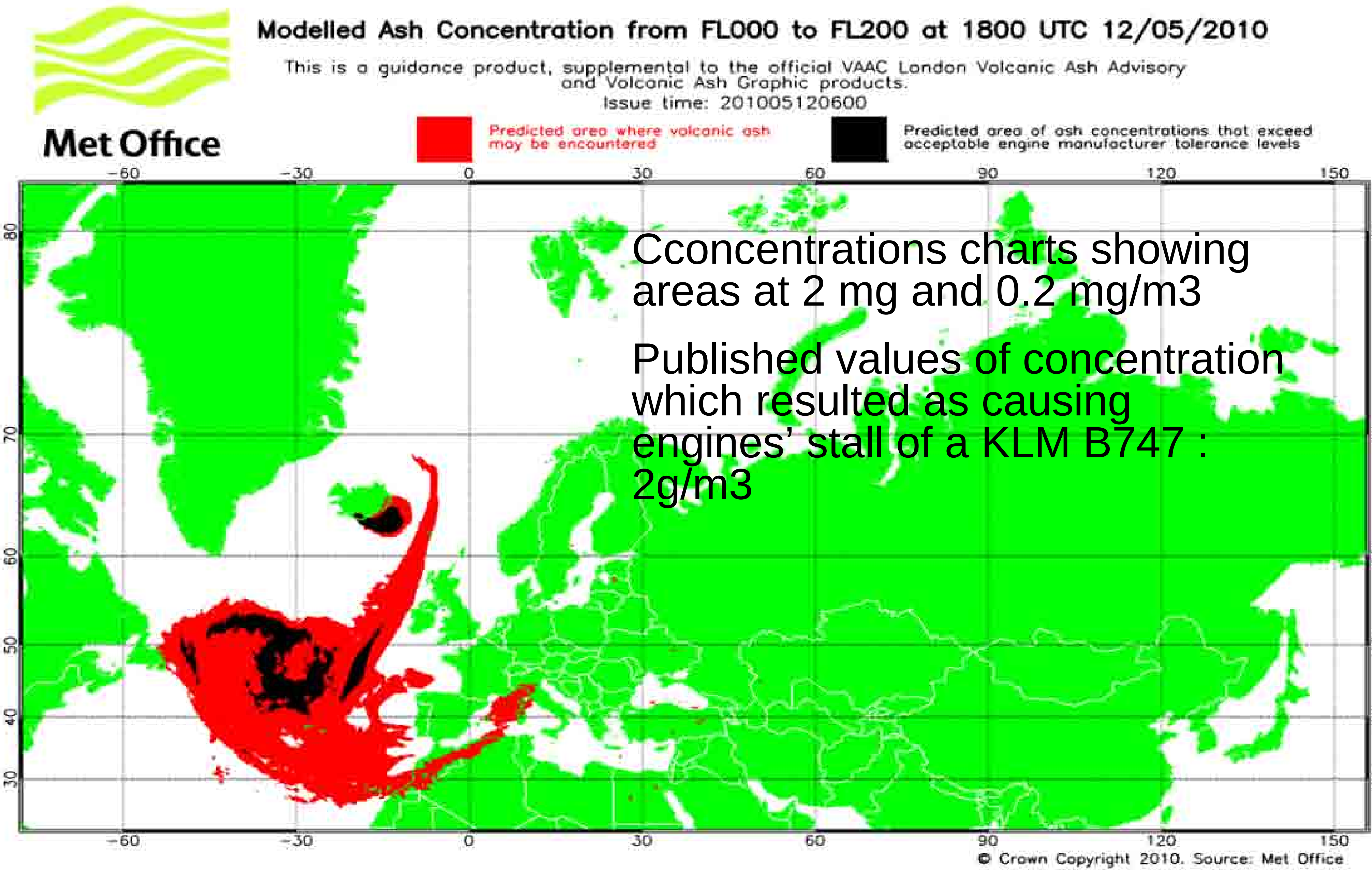
What has changed since April 20

A threshold of concentration of volcanic ash possibly damageable for jet engines has been provided by engine industry. Testls should be probably conducted in wind tunnels with volcanic ash on engines to confirm this number.

Dispersion models for volcanic ash therefore can be used no longer in **relative but in absolute terms without necessary reference to the observation satellite**

The **uncertainty** on the values provided by volcanologists to initialize dispersion models (an order of magnitude, according to them), however, lead to uncertainty of the same value in the depiction of concentration maps provided by these models.

Volcanic Ash concentrations FL000 to FL200



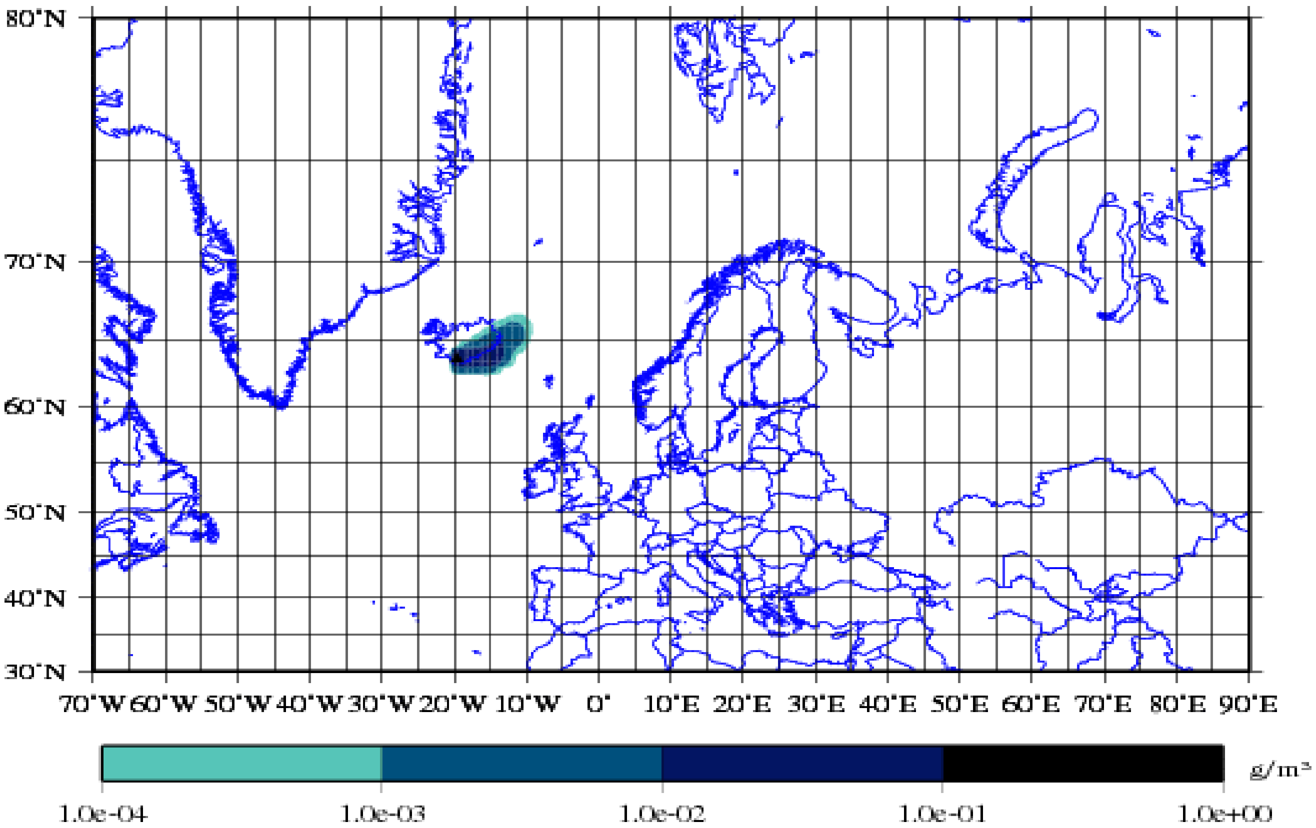
Cconcentrations charts showing areas at 2 mg and 0.2 mg/m3

Published values of concentration which resulted as causing engines' stall of a KLM B747 : 2g/m3

MODELLED ASH CONCENTRATION

Accident de EYJAFJALLAJOKULL du 14/04/2010

Concentration moyenne sur la couche SURF-FL200 en g/m³
14/04/2010 12h00 UTC



modèle de dispersion :
MOCAGE-accident
modèle météo : ARPEGE

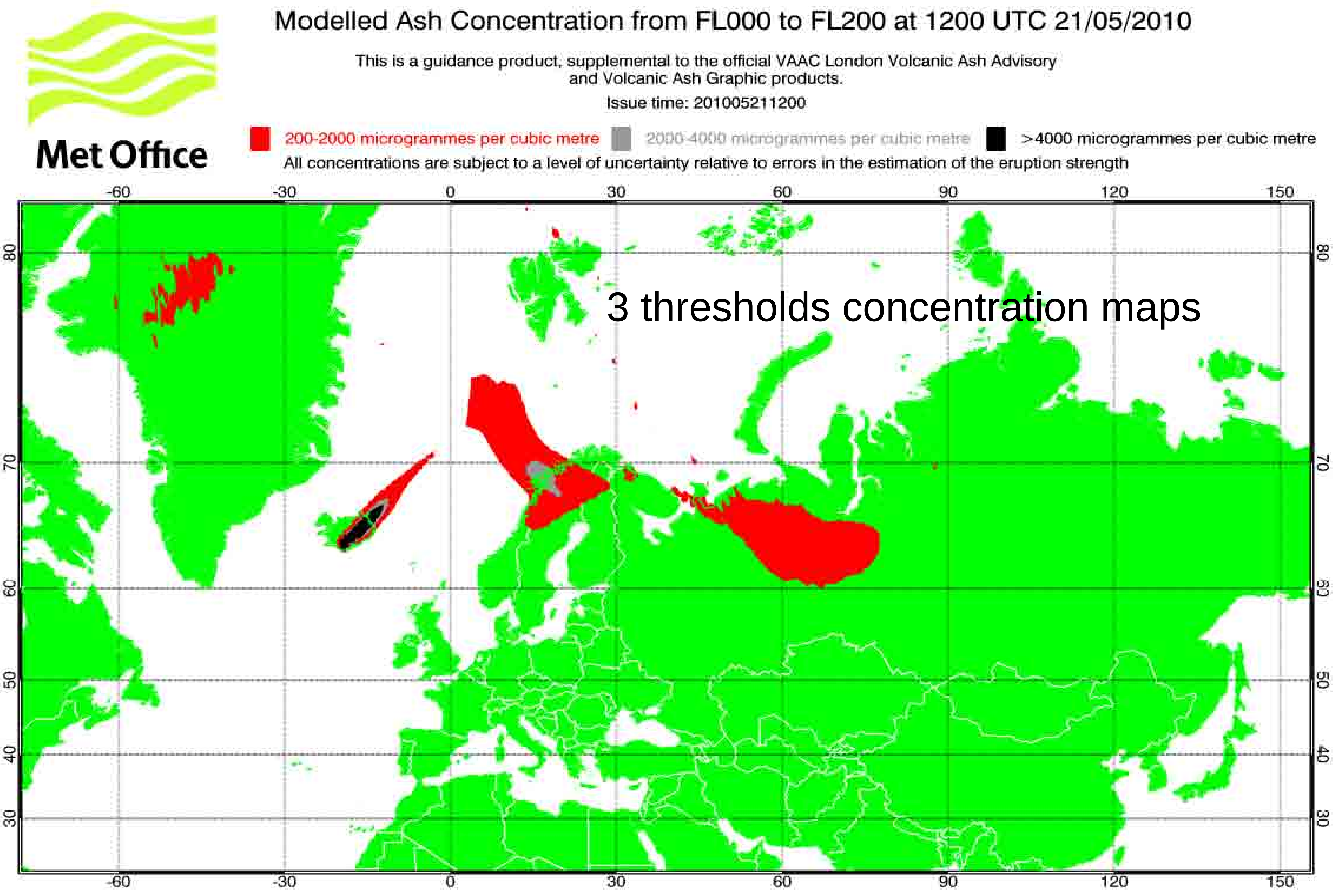
INFOS REJET
Site : EYJAFJALLAJOKULL
Début émission : 14/04/2010 06h00 UTC
Durée rejet : continue
Lat. rejet : 63.633 63°37'58"
Lon. rejet : -19.617 -19°-37'-1"
Débit d'émission : 1.4e+11 g/h
Base : 1300m
Sommet : 4000m
Polluant émis : CENDRE

INFOS MODELE
grille resolution : 0.5°
Base modèle ARPEGE
Réseau : // UTC

Valeur max échéance courante :
4.4e-02 g/m³

Ces produits issus des modèles de Météo-France
n'ont pas de valeur réglementaire ou officielle,
et sont fournis à titre de compléments des produits
du VAAC Londres.
Ils ne doivent pas être communiqués au public.

METEO FRANCE
VAAC TOULOUSE

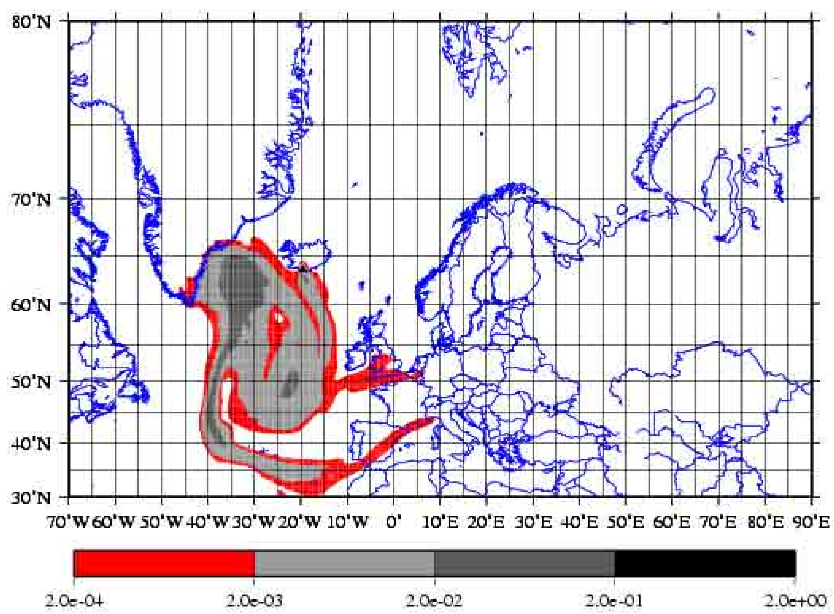


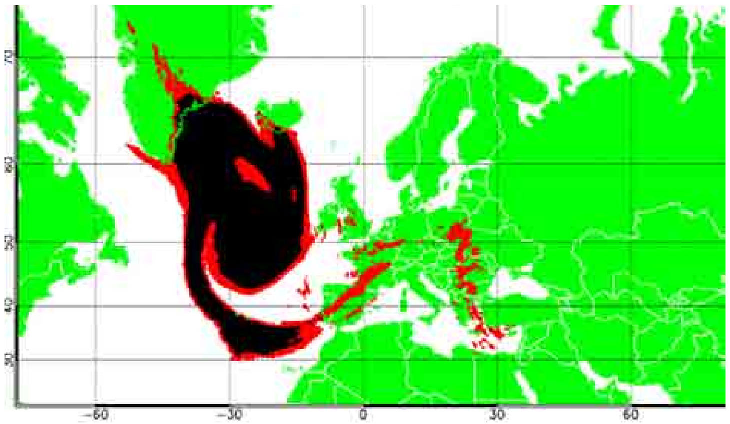
3 thresholds concentration maps

MODELS INTERCOMPARAISON

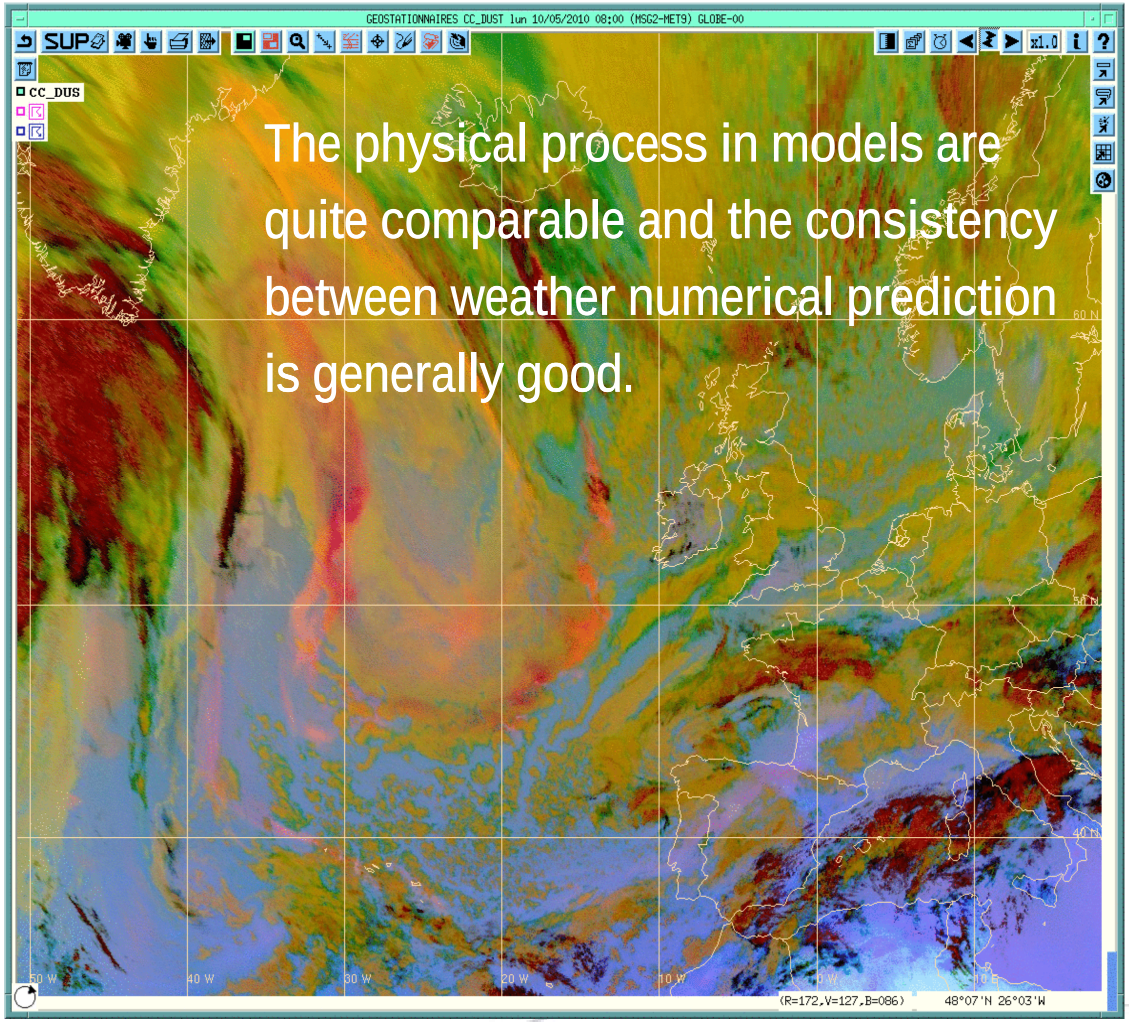
Accident de EYJAFJALLAJOKULL du 14/04/2010

Concentration moyenne sur la couche SURF-FL200
10/05/2010 12h00 UTC



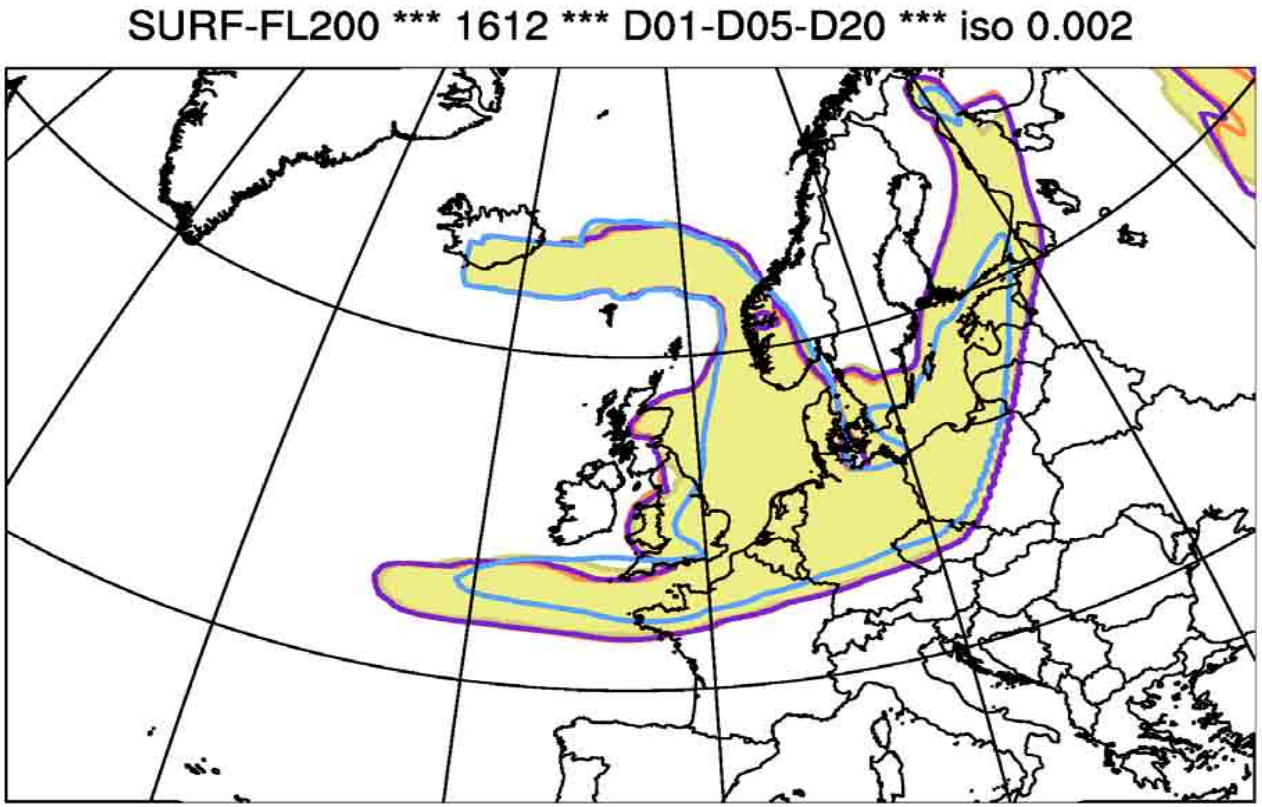


Based on the same source term :



The physical process in models are quite comparable and the consistency between weather numerical prediction is generally good.

Sensitivity tests



D = 1 µm *D = 5 µm* *D = 10 µm* *D = 20 µm*

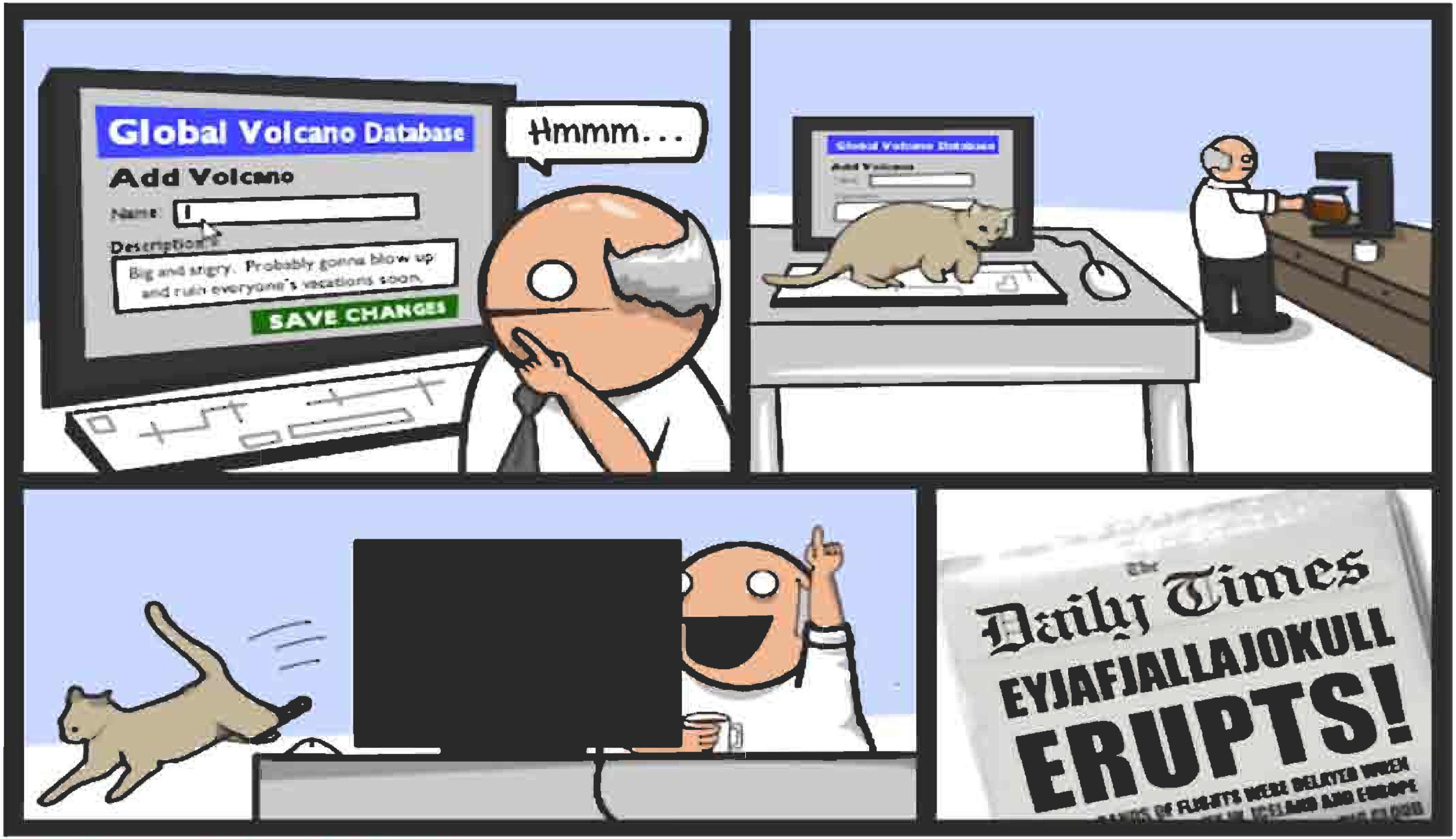
PERSPECTIVE – QUESTIONS STILL TO ANSWER

- What about non monitored volcanoes for which no data for masse rate and plume height will be available in real time?

- Sensitivity test has proved that the error on the mass rate induces a similar error on the computed concentration (linear correlation). How to estimate the uncertainty in the source term of models (mass rate) ? Once known, how to reduce it?

- Impact on airlines operations are very level dependant. How to improve the vertical information about presence and concentration – fixed layers can be misleading ?

HOW TO NAME A VOLCANO



HTTP://THEOATMEAL.COM

BY THE OATMEAL

METEO FRANCE
Toujours un temps d'avance

CENTRAL INSTITUTE OF AVIATION MOTORS

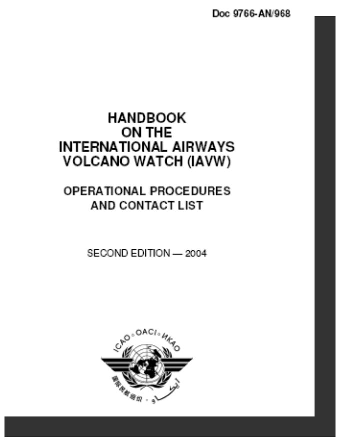
Experience Studies Damage GTE from Foreign Object in Relation to the Effects of Volcanic Ash

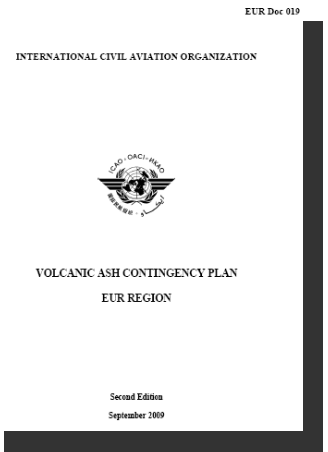
Dr. I. Egorov

Moscow 2010

STATE OF THE PROBLEM

According to the existing ICAO norms, civil aviation flights inside areas with volcanic dust (VD) clouds are not permitted. In case of unintended entry of an aircraft into a VD cloud, the norms provide for emergency escape out of the zone and lowering engine thrust to decrease its damageability.





ICAO Doc 9766 - Handbook On The International Airways Volcano Watch (IAVW) Operational Procedures And Contact List (2nd Edition); ICAO PANS ATM (Doc 4444) Appendix I – ICAO Special Air-report of Volcanic Activity Form (model VAR)

First & Second International Symposium on Volcanic Ash and Aviation Safety,

Nevertheless, situation with recent volcano eruptions in Iceland showed that there is no regulatory basis for flights in areas with *comparatively low* VD content.

FREQUENCY OF INCIDENTS, LINKED TO EXPOSURE TO AIRCRAFT IN AREA ASH

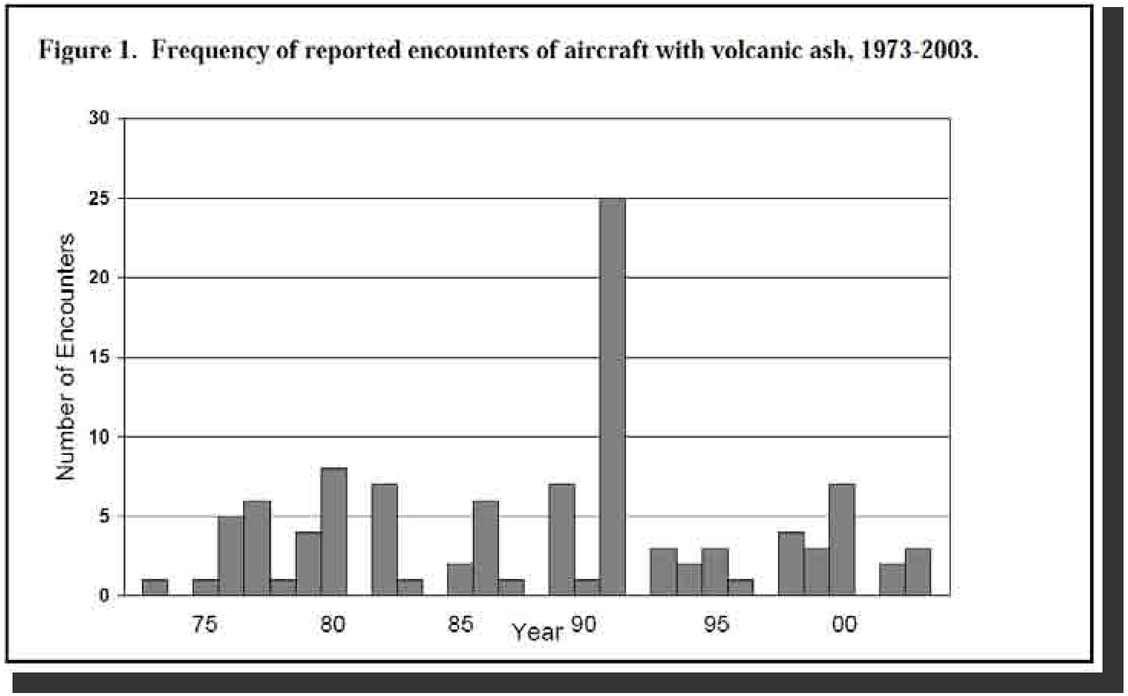


Figure 1. Frequency of reported encounters of aircraft with volcanic ash, 1973-2003.

In June 1982, a passenger plane Boeing-747 British airlines flying at an altitude of 12,21 thousand meters from the city of Kuala Lumpur (Malaysia) Perth (Australia), suddenly there was a failure of four engines. The plane began to fall and only at a height of 4,62 thousand meters again managed to run one engine, a bit later - the other two, and the plane made an emergency landing in Jakarta (Indonesia). The cause of this incident became ashes thrown into the atmosphere during explosive volcanic eruptions Galuggung, which erupted in April 1982.

Problems:

- Over 20 years (until 2003) was noted more than 100 cases of civil aircraft collisions with clouds of volcanic ash
- In 8 cases, these clashes have resulted in significant damage to the CCD, impacting on safety
- Engine damage depends on the concentration of ash, the duration of the flight in the volcanic cloud and the actions of the crew during the passage of clouds

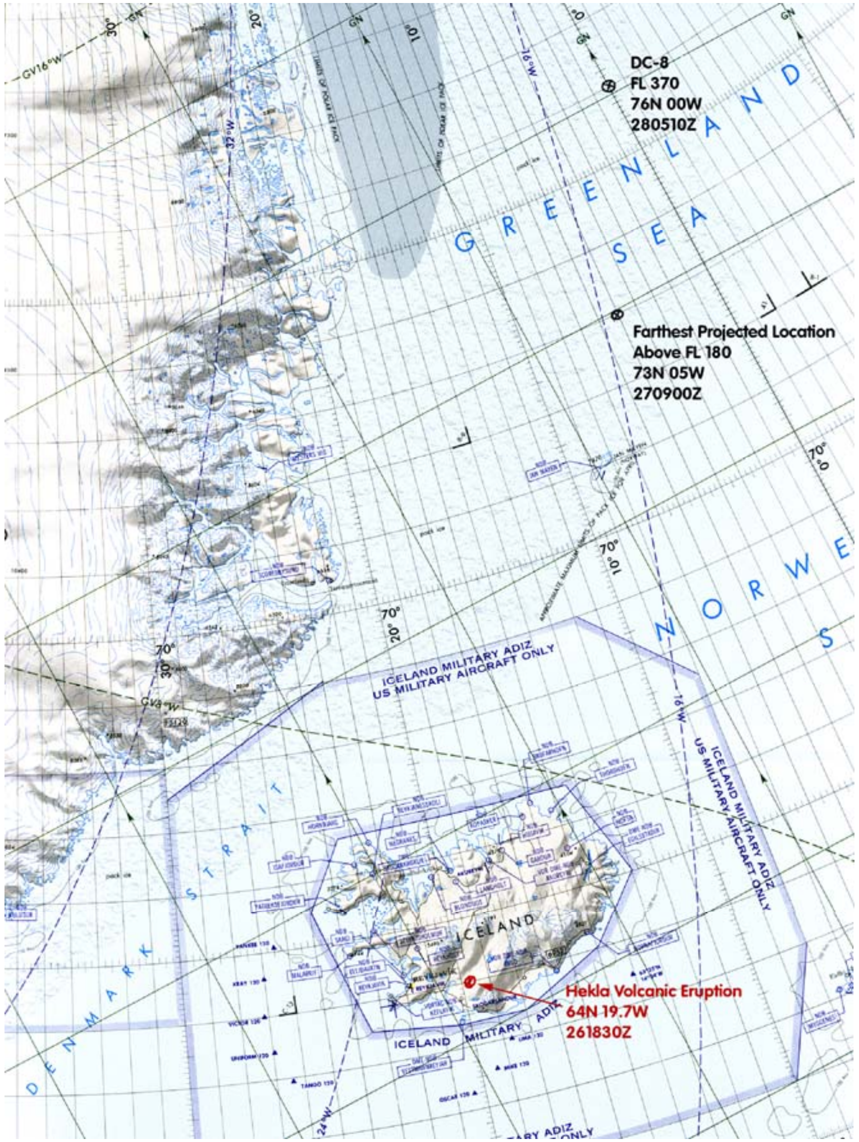
Study CFM-56 engine DC-8 aircraft after the flight in a zone of volcanic ash

Authors: **Том Grindle,** ***NASA Dryden Flight Research Center***

Bill Burcham, ***Analytical Services and Materials, Inc.***

- **Flights were instrumental to study the composition of the atmosphere in the zone of an active volcano Hecla, in February 2000**
- **In the execution of all the flight, the crew did not reveal any abnormalities in the testimony that control the engines**
- **Postflight control flow engine parts by means of endoscopy revealed substantial damage to the compressor blades and turbine**

Location



- The eruption occurred on Feb. 26, 2000
- The crew of a DC-8 had a flight plan, which excluded the possibility of falling into the epicenter of volcanic ash clouds
- Field of flight is approximately 200 miles north of the active volcano

Comparison of Flight Data

CASE #1

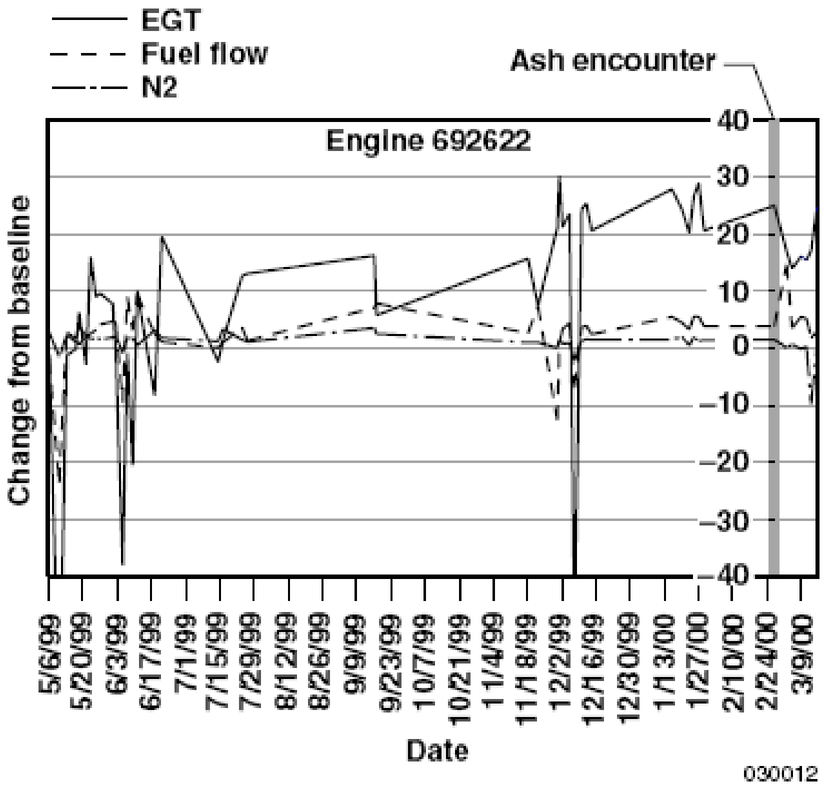
Date	TAT	ALT	MACH	Engine #	N1	Oil Press	Fuel Flow	N2	EGT
1/27/00	-32	34910	0.779	1	89.3	50	3160	92	699
				2	89.3	51	3020	92	661
				3	89.3	46	3100	92	689
				4	89.0	53	3050	92	687
Ash Fly Through on February 28 2000									
3/3/00	-33	35000	0.788	1	88.0	50	3330	90	670
				2	88.0	52	3190	90	637
				3	88.0	47	3290	90	661
				4	88.0	55	3275	90	665

CASE #2

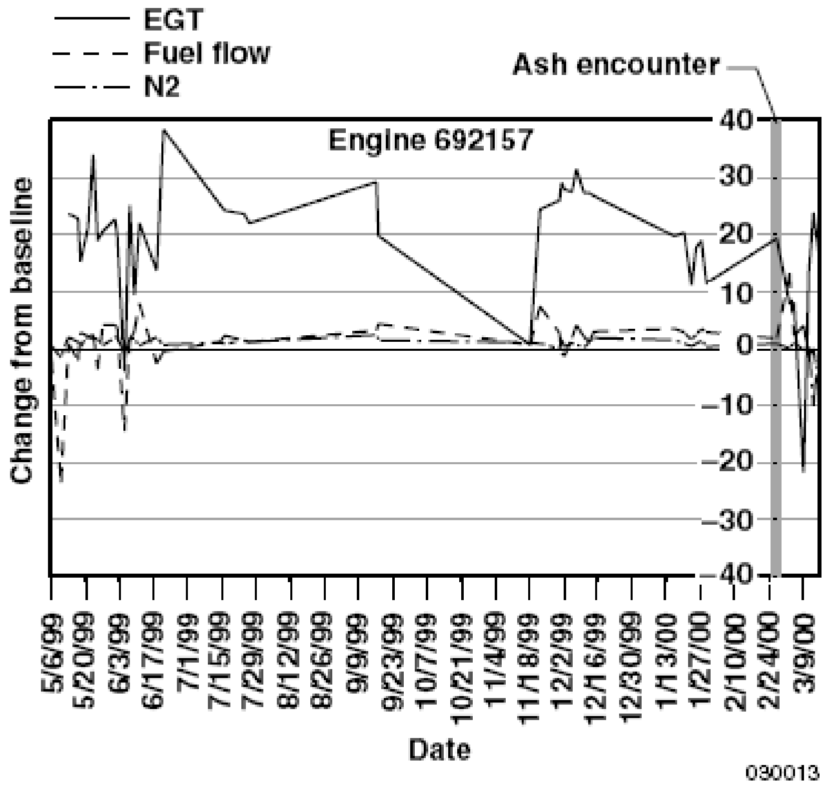
Date	TAT	ALT	MACH	Engine #	N1	Oil Press	Fuel Flow	N2	EGT
1/25/00	-37	35013	0.792	1	89.0	50	3208	92	688
				2	89.0	52	3016	91	646
				3	89.0	46	3110	91	679
				4	89.0	54	3112	91	680
Ash Fly Through on February 28 2000									
3/11/00	-37	34992	0.795	1	90.0	50	3300	91	689
				2	90.0	52	3000	91	650
				3	90.0	47	3090	91	687
				4	90.0	54	3200	91	679

(Shaded cells indicate a lower values)

Analysis of Trends Flight Parameters

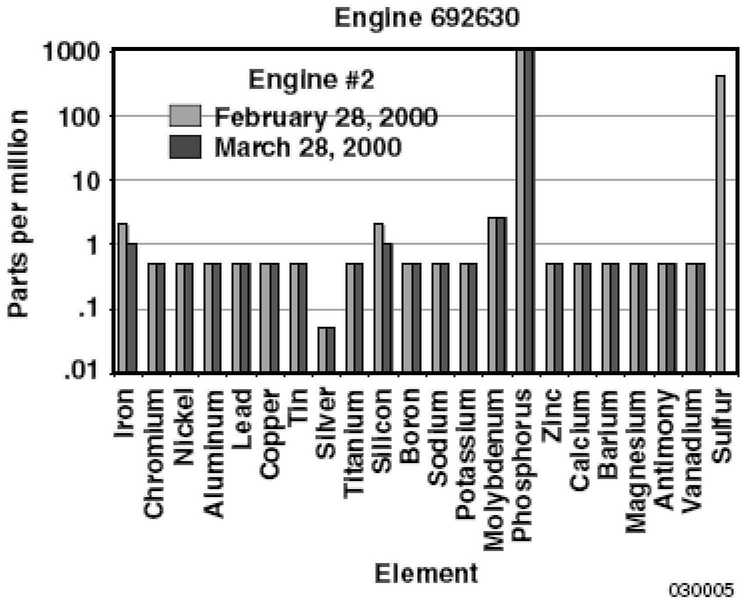


(a) Engine 692622.

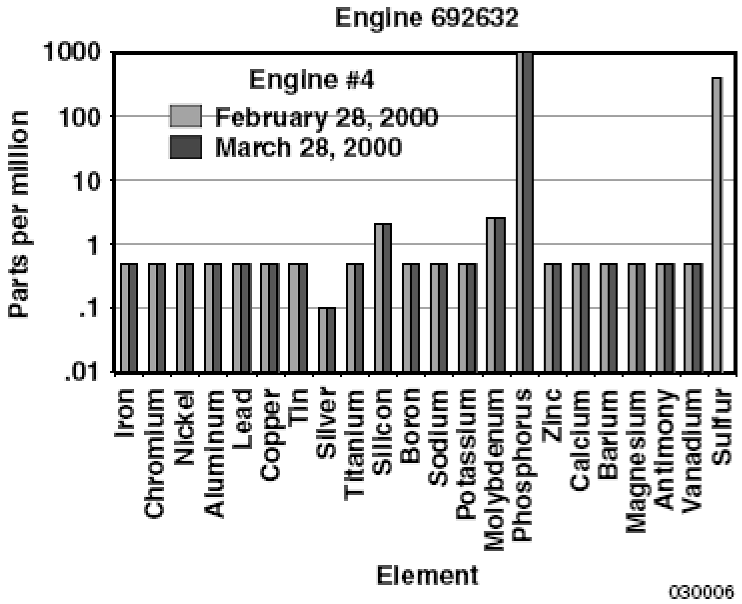


(b) Engine 692157.

Spectral Analysis of the Oil

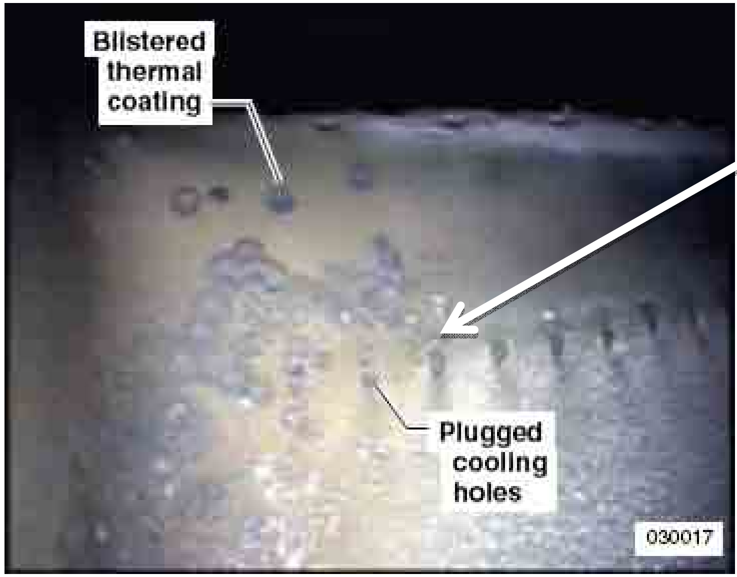


(c) Engine 692630.



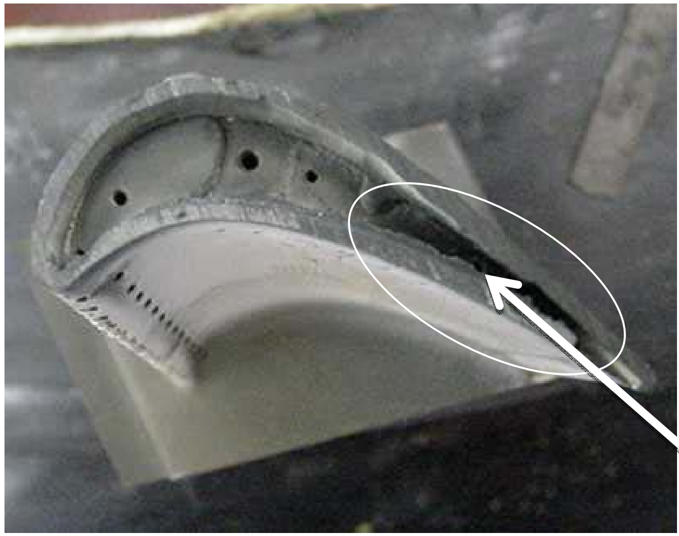
(d) Engine 692632.

Damage to Rotor Blades of the Turbine



Damage as form bubble on perforation

Erosion input edge of вlades



Deposition of ash in the area of issue cooling air

The Cost of Restoring Engines

- Engines with the numbers 1, 2, and 3:

  0.7 million USD for each

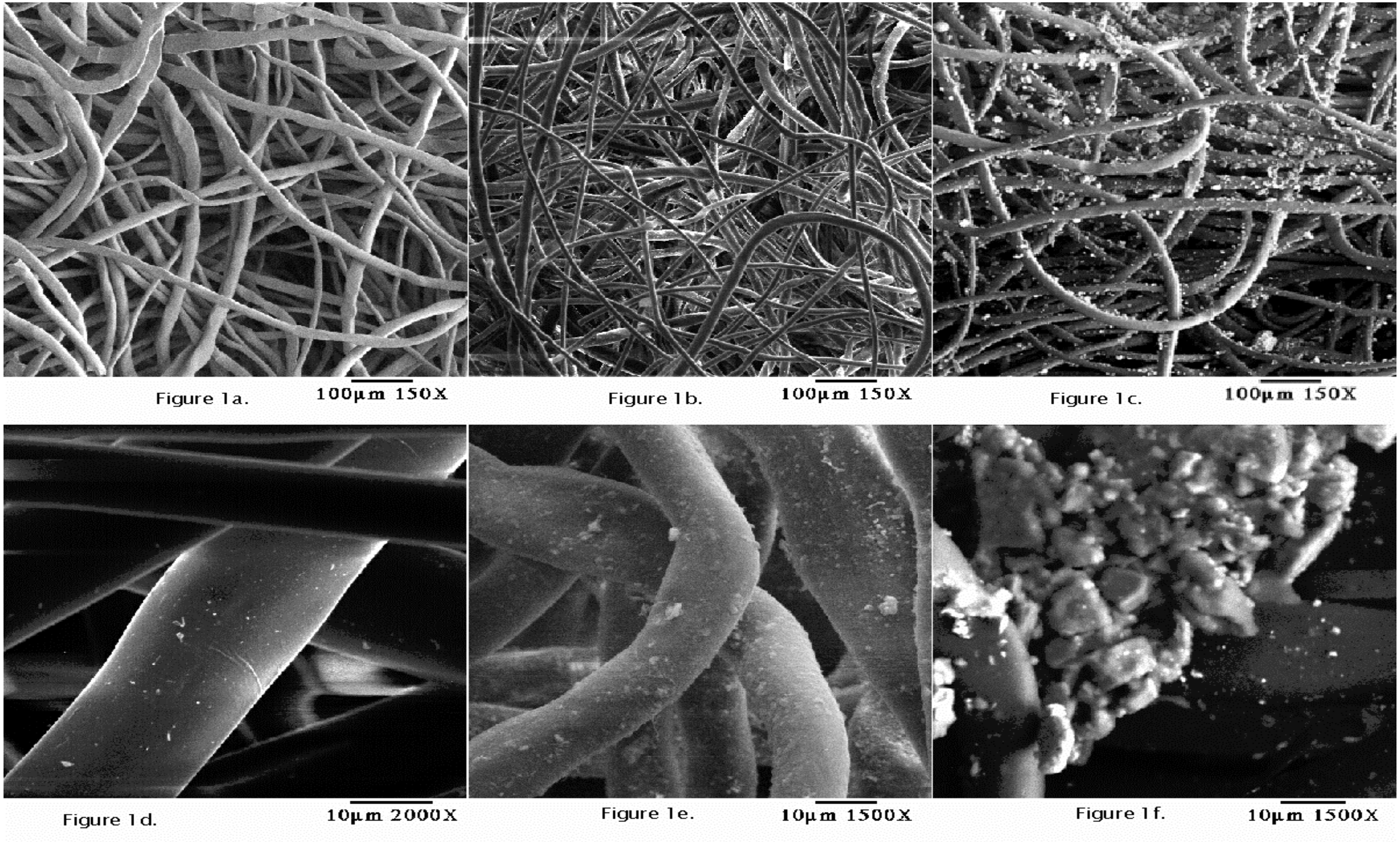
  Engine number 4:

  1.1 million USD

- The total cost of repair

  3.2 million USD

Photo Filters of Heat Exchanger DC-8 Aircraft



a. New b. Used, a typical mud c. The filter after the passage of aircraft through the cloud of ash

TURBINE DAMAGE

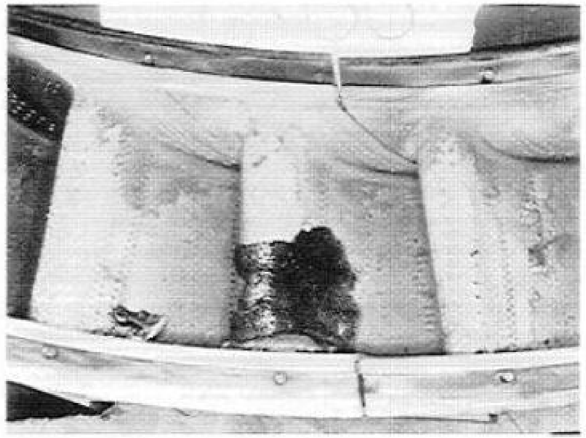


Figure 3. Dark, glassy deposits of remelted volcanic ash on leading edge of stage-1 high-pressure-turbine (HPT) nozzle guide vane (NGV).

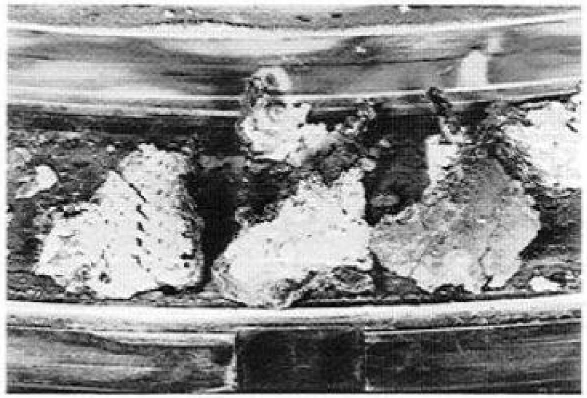


Figure 4. Leading-edge deposits dislodged during disassembly of stage-1 high-pressure-turbine (HPT) nozzle guide vanes (NGV's).

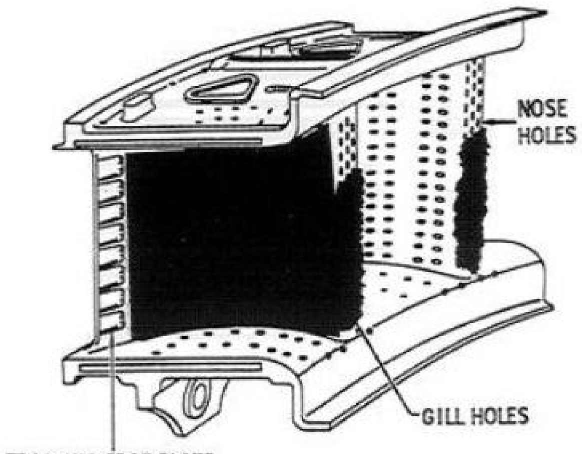


Figure 5. Sketch of deposits on stage-1 HPT nozzle guide vanes, based on borescope inspection of engine 1.

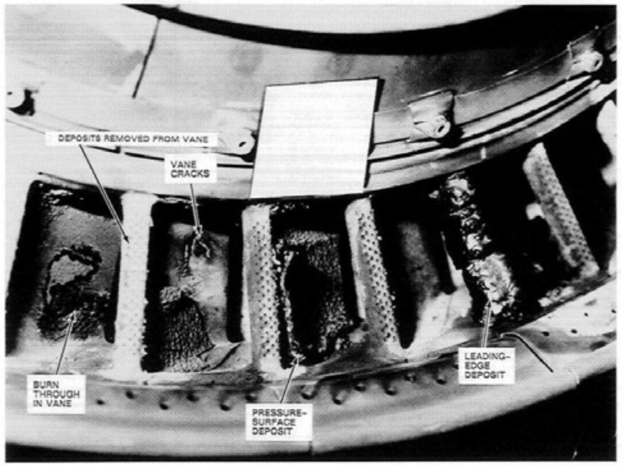
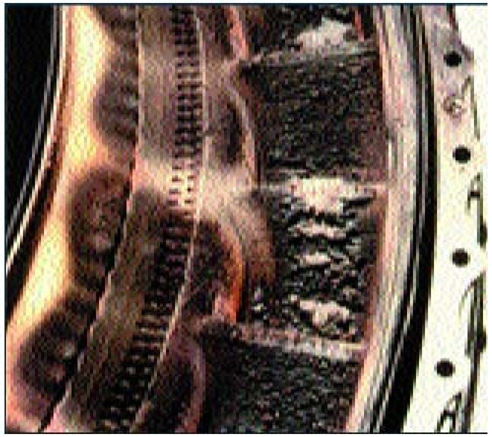


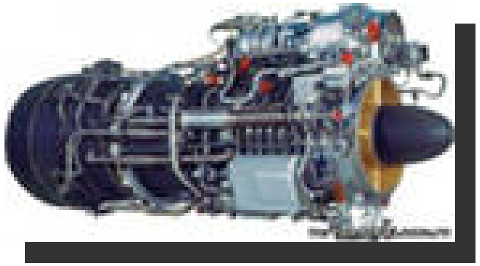
Figure 9. Photograph of nozzle guide vane for first-stage high-pressure turbine. Figure shows a portion of the nozzle guide vane row taken from an engine that was subjected to a dust mixture containing black scoria. This figure illustrates the heavy deposits on the leading edge and on the pressure surface.



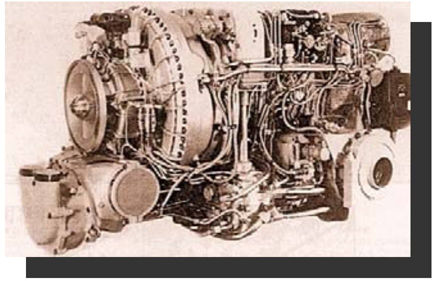
CIAM EXPERIENCE

CIAM has large experience in numerical and experimental studies of helicopter and tank GTE's damageability during their operation on airfields and testing grounds with sand an dust.

Methods for protection of GTE's against loess dust dust were implemented:



- ❖ **Dust-protection devices**
- ❖ **Special blade profiling**
- ❖ **Cleaning and repair technology**



Test conditions

- ➢ Dust content range between 0,05 g/m3 and 0,20 g/m3
- ➢ Size of dust particles between 1 and 2 mkm

- ➢ Dust content up to 2,5 g/m^3
- ➢ Size of dust particles between 6 and 8 mkm

Certification tests for 50 to 300 hours of operating time

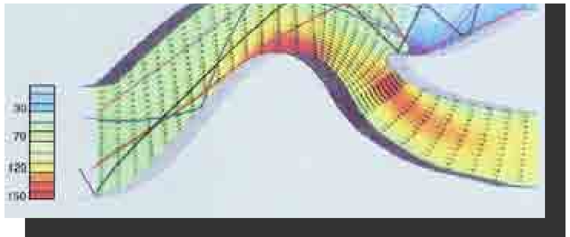
90% separation coefficient

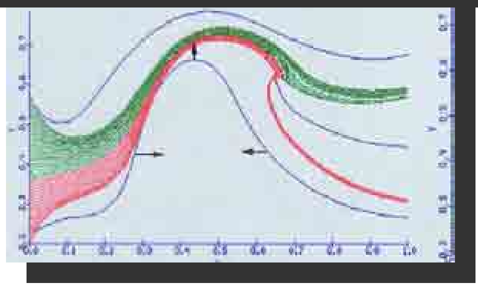
Numerical and experimental investigations of GTE damageability in dusty environment

CIAM is a leader in studies of GTE damageability in dusty environment.

Methods for simulation of complicated thermal gas-dynamic processes in GTE's having air / gas flow rich with dust of various origin

- 3-D models
- Calculation of flight path for particles with size up to 12 mkm
- Air intake channel optimization





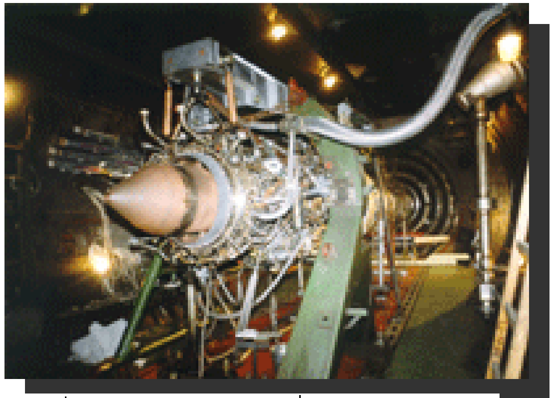
Design solutions, inventions and know-how reducing damages during engine operation in dusty environment

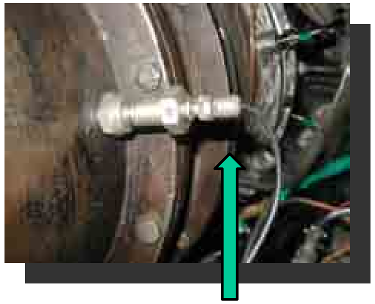
- Experimental verification through model and full-scale tests of dust-protection devices

Test benches and devices for ingestion and detection of various particles

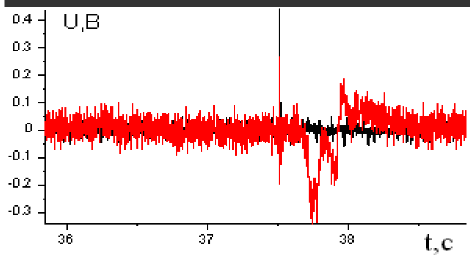
Novel electro-static methods and means for measuring air flow particles concentration and composition

Bench studies of detection of particles ingested into engine air intake





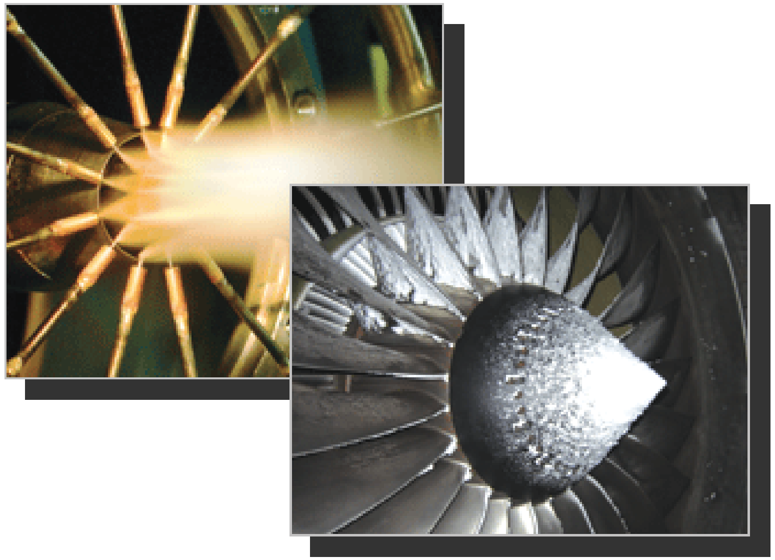
Electro-static sensor



Identification signal

Means and devices for ingestion of water, ice and other fractions into engine inlet

- **Simulation of atmospheric conditions leading to icing, through water ingestion into air flow**
- **Droplet speed, size and phase state control**



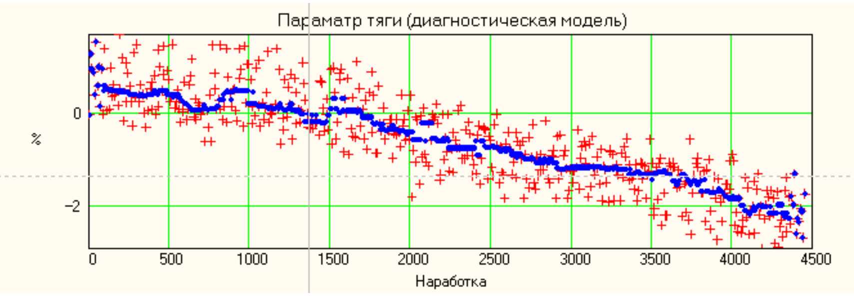
Diagnostics methods and means

Software for engine flow path health prediction based on parameters registered in flight

Tribological diagnostic means for evaluation of foreign particles content in engine oil system

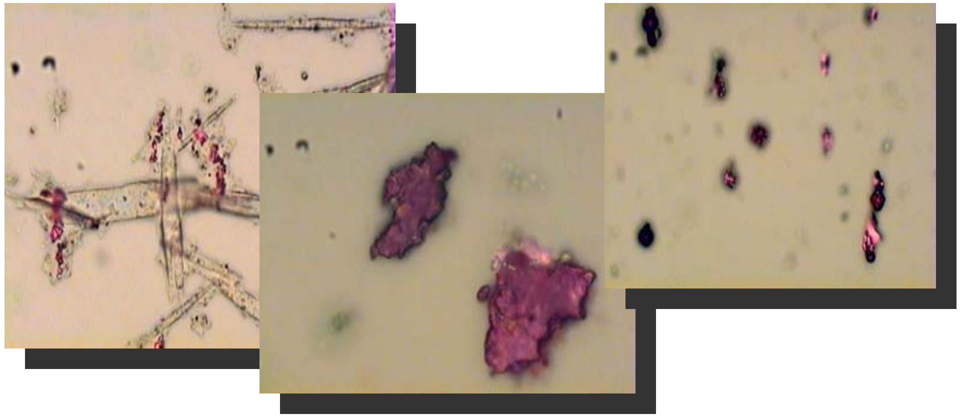
Flight data processing lab

Evaluation of engine performance degradation caused by flow path wear



Tribological diagnostics lab

Atlas of foreign particles in engine oil system

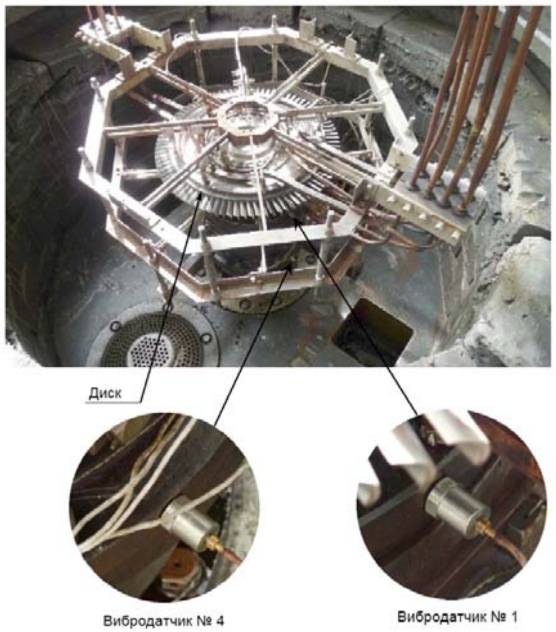


CENTRAL INSTITUTE OF AVIATION MOTORS

Diagnostics methods and means

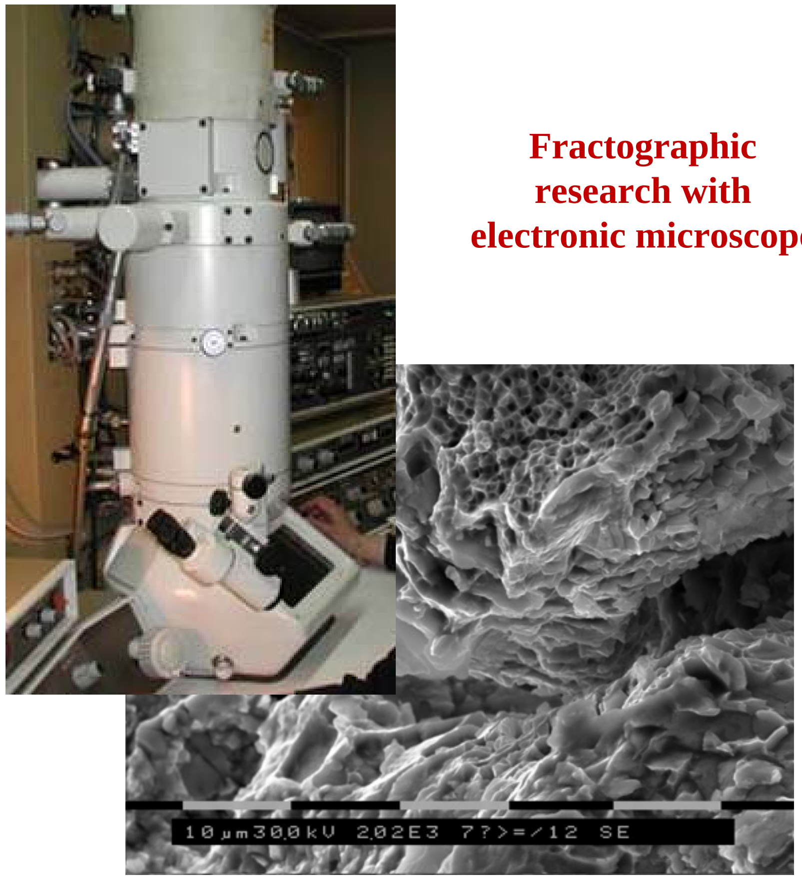
Strength tests of parts damaged by external environment

Acceleration chamber for evaluation of strength characteristics of damaged rotor parts



Methodology and devices for investigation of surface of damaged compressor and turbine parts

Fractographic research with electronic microscope



PROPOSALS FOR INVESTIGATION OF INFLUENCE OF VOLCANIC ASHES ON ENGINE OPERATION PERFORMANCE AND SAFETY

Work goals:

Development of recommendations for maintenance of gas turbine engines operated in atmospheric conditions with increased concentration of volcanic particles (VP).

Objectives:

- Experimental bench investigation of damageability of engines and their parts due to influence of VD with various concentration.
- Development of hardware methods for controlling and diagnosing engine damages resulting from VD influence.
- Development of hardware and software methods for assessment of residual life of parts damaged by VD.
- Definition of standards for tolerable damages of parts and assemblies caused by VD.
- Development of technology for operational repair of VD-damaged engine parts (at operating companies)
- Development of documents regulating operation of engines in atmosphere with various VD concentration.
- Applicability study for onboard electro-static diagnostic means that would send signals to the crew about intolerable concentration of volcanic dust in engine flow path.

Possibilities of volcanic plumes diagnostic and simulation

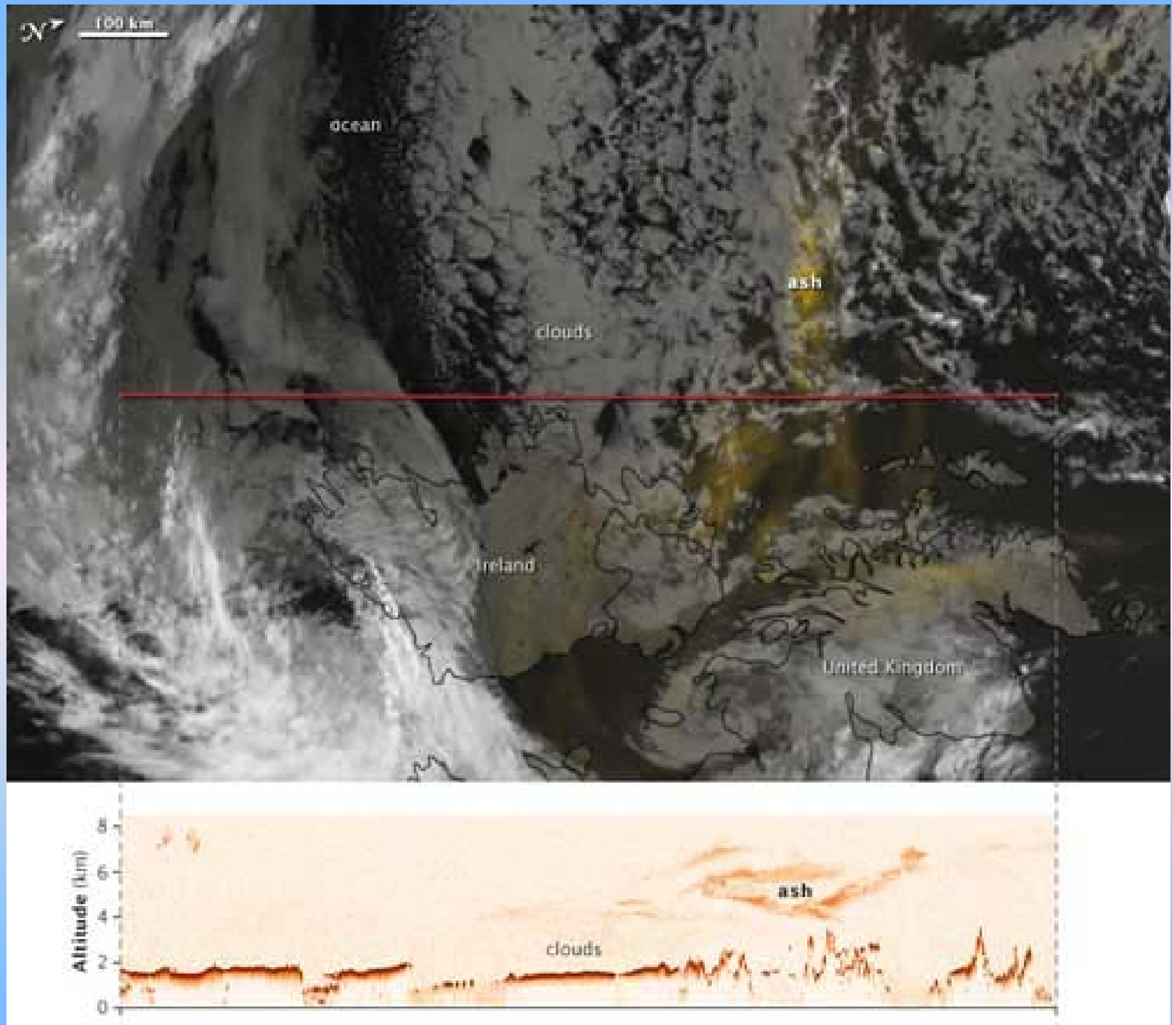
K. Moiseenko, A.Skorokhod

A.M. Obukhov Institute of Atmospheric Physics RAS

skorokhod@ifaran.ru

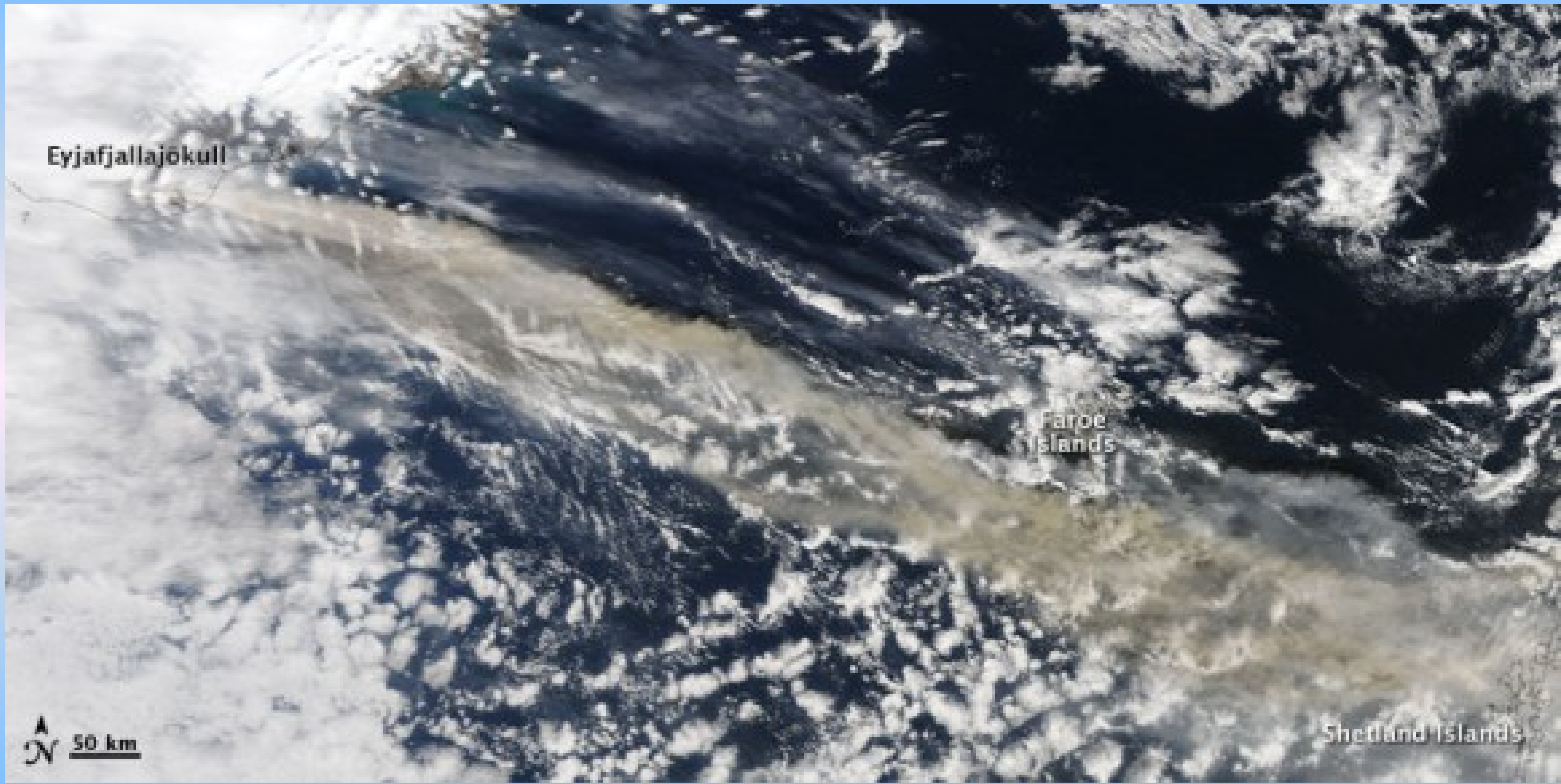
Moscow, ISTC, 8-9 July, 2010

Eyjafjallajökull plume from space



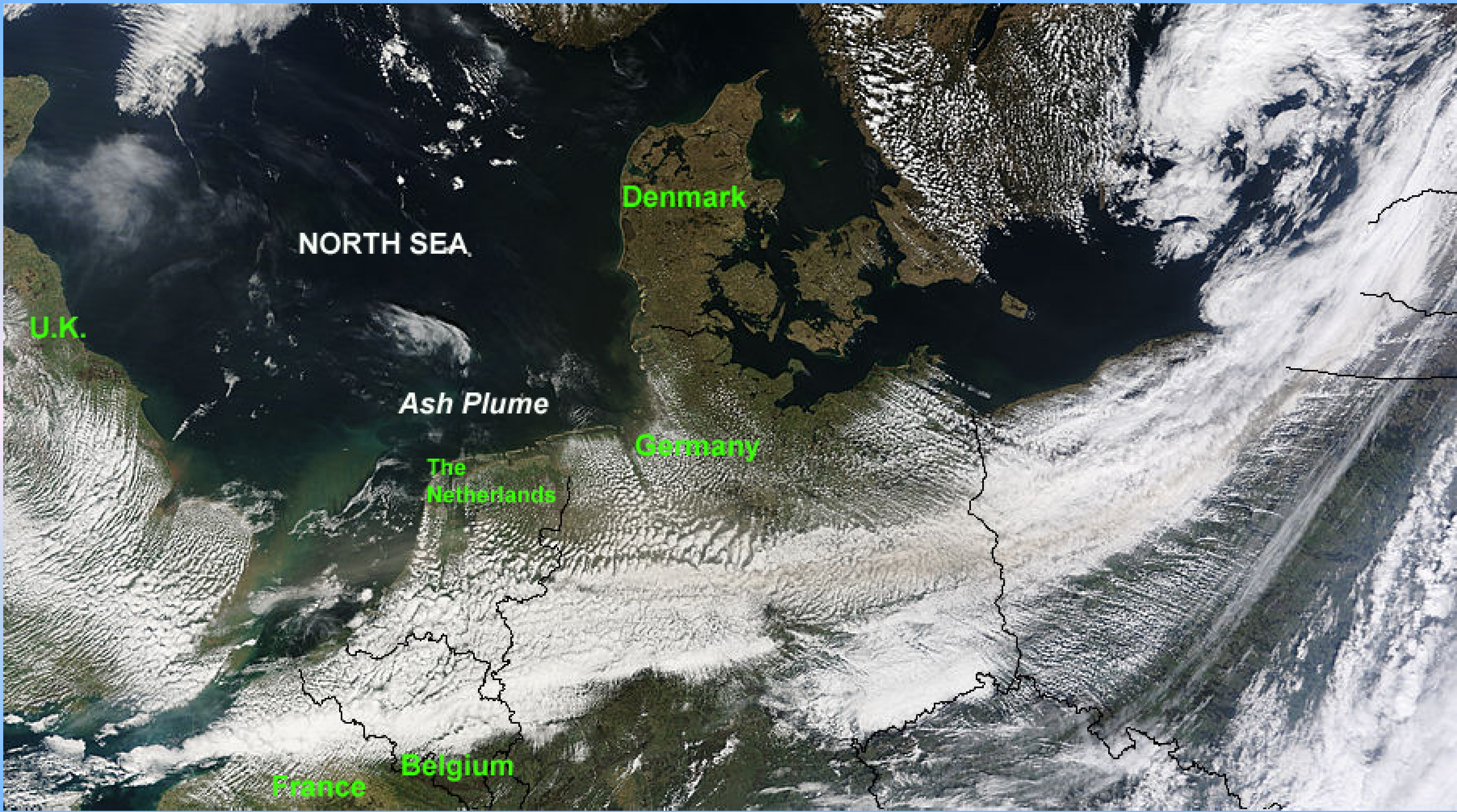
Source: www.nasa.gov

Eyjafjallajökull plume from space



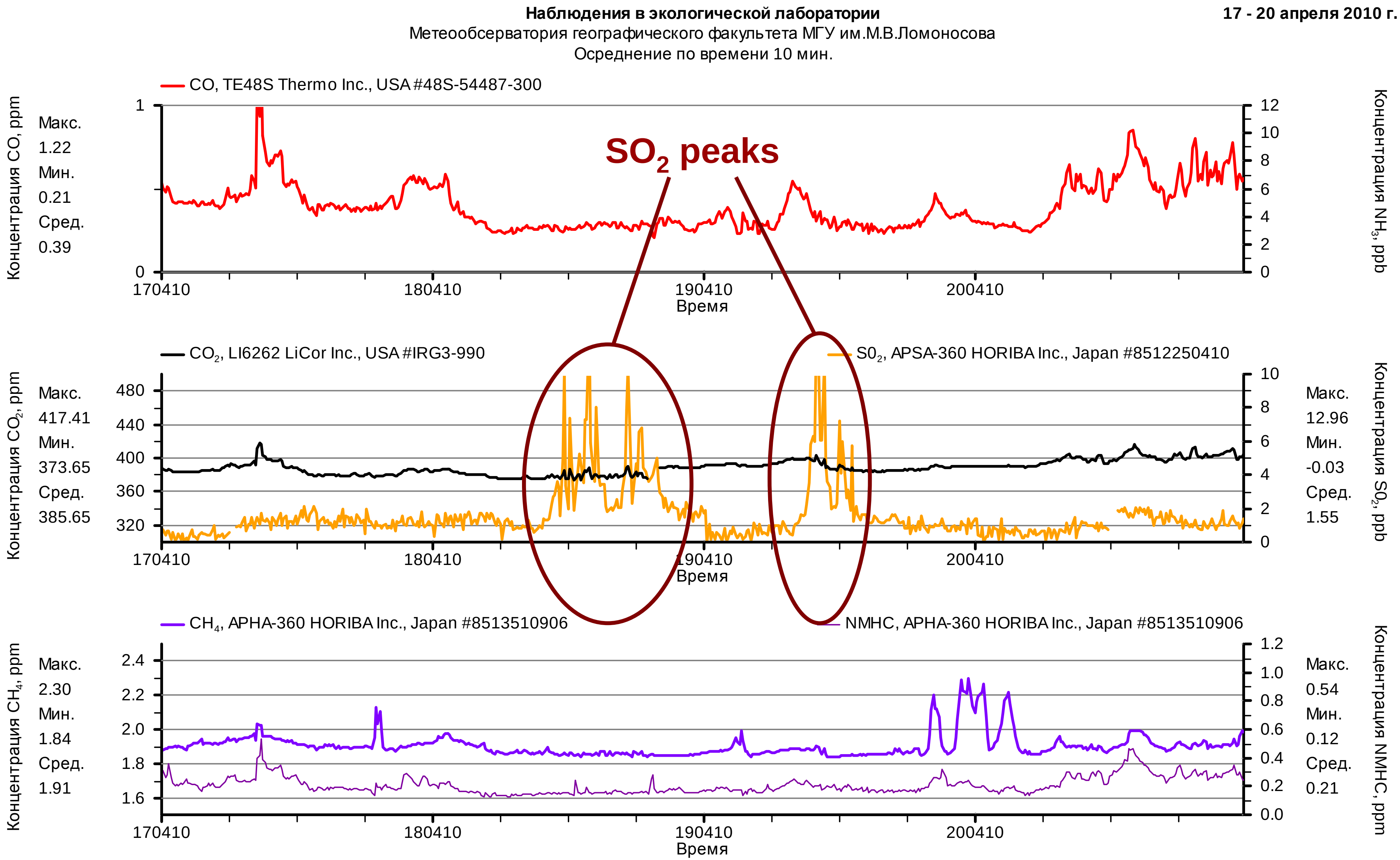
Source: www.nasa.gov

Eyjafjallajökull plume from space

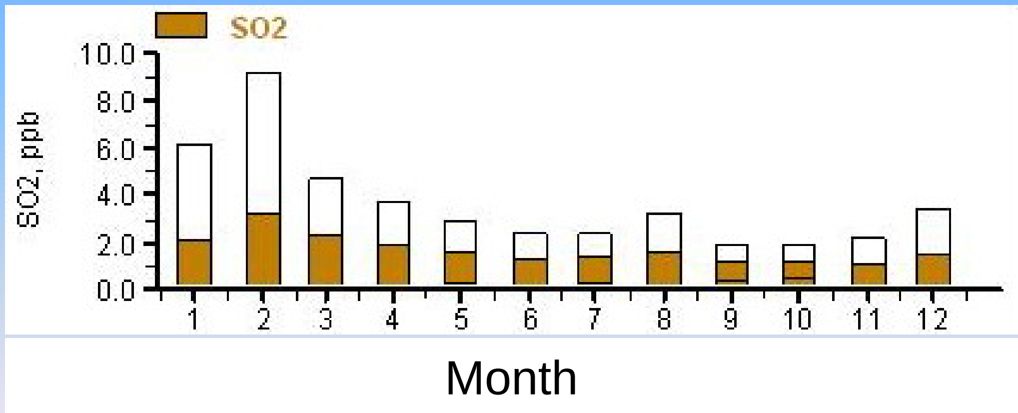


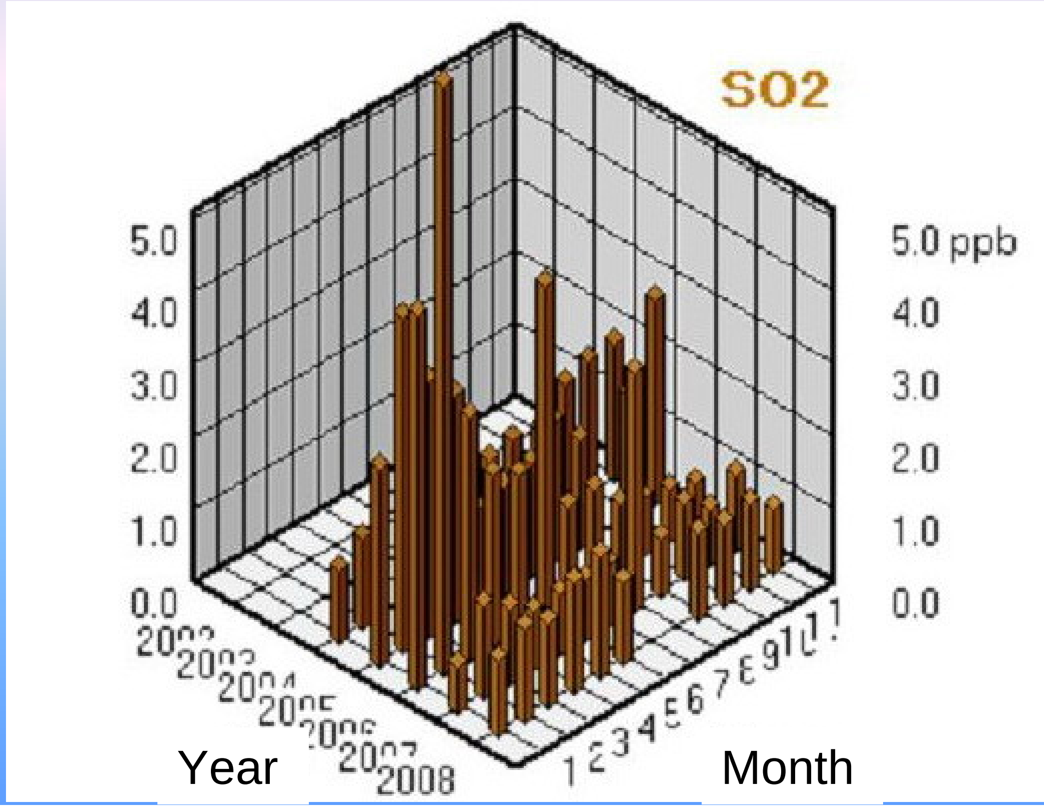
Source: www.nasa.gov

Surface concentrations of trace gases at OIAP-MSU Ecological Station (Moscow) during Eyjafjallajökull plume passage (17-20 April, 2010)

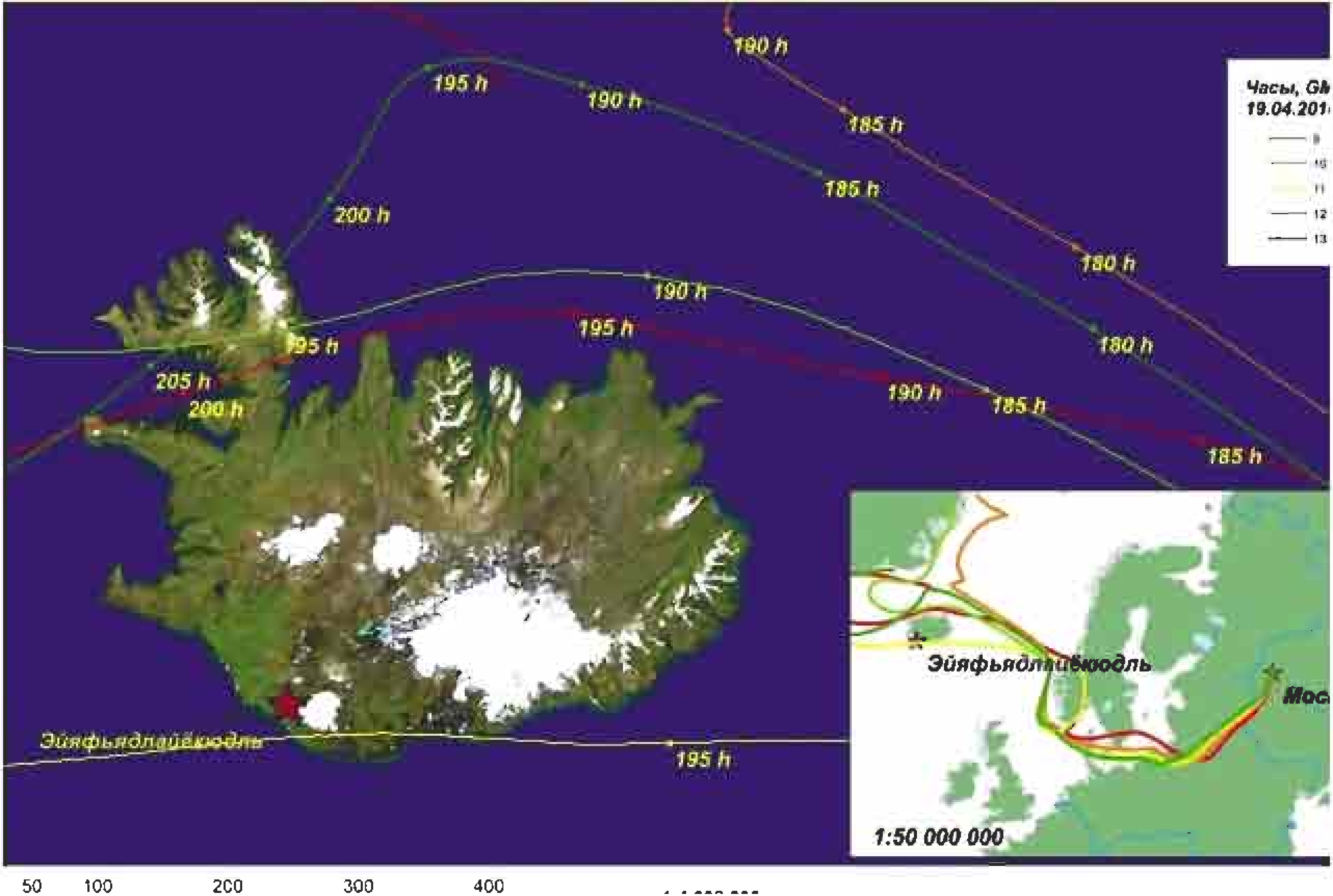


SO_2 concentrations at OIAP-MSU Ecological Station on base of observations since 2004

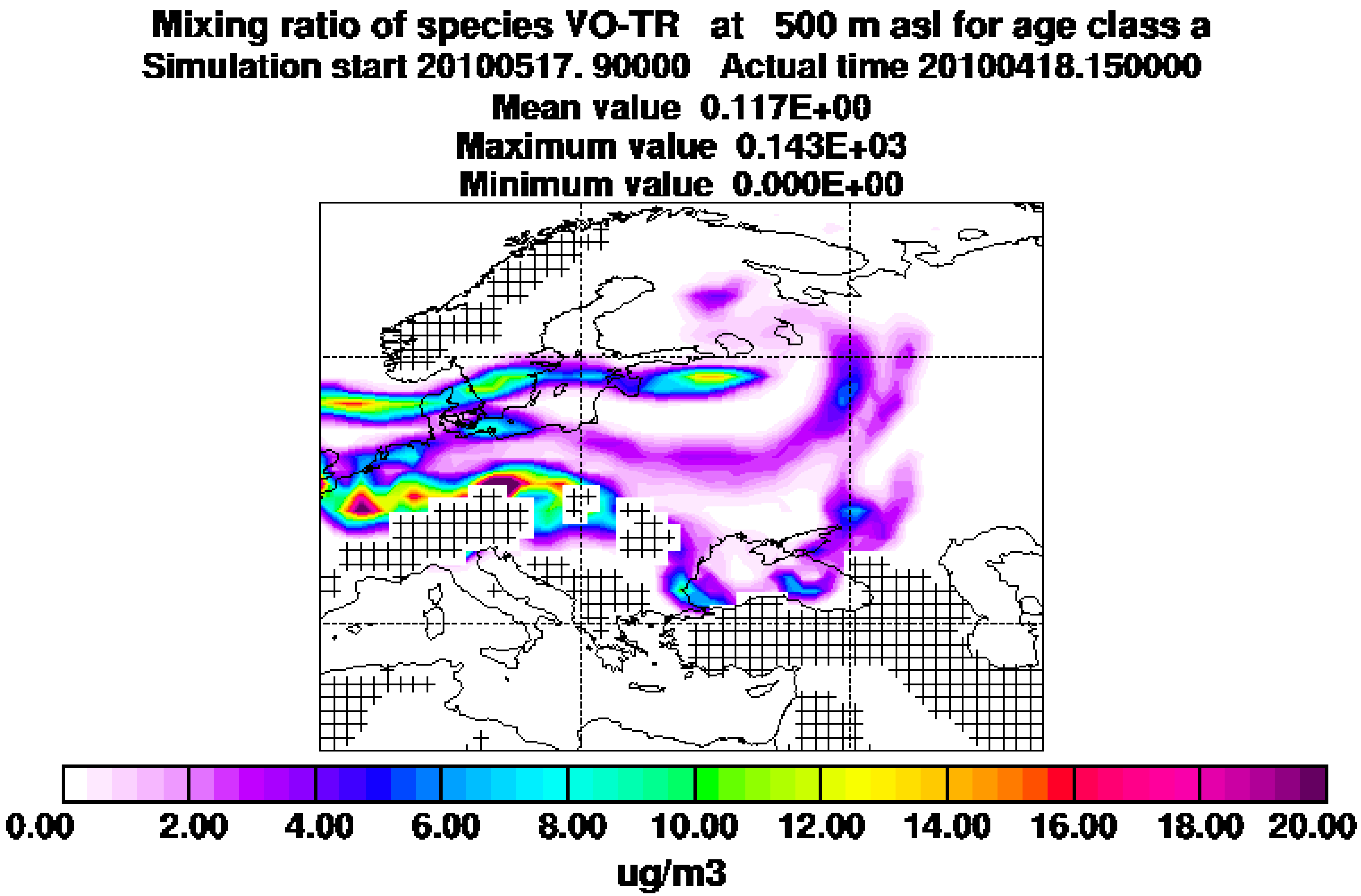




Обратные траектории движения воздушных масс, рассчитанные по модели NOAA hysplit, казывают на возможность выноса вулканического пепла на г. Москву 19.04.2010 09:00 - 13:00 GMT, 100 метров a.g.l. Слабая активность вулкана 11.04.2010 (196 часов обратного отсчета).



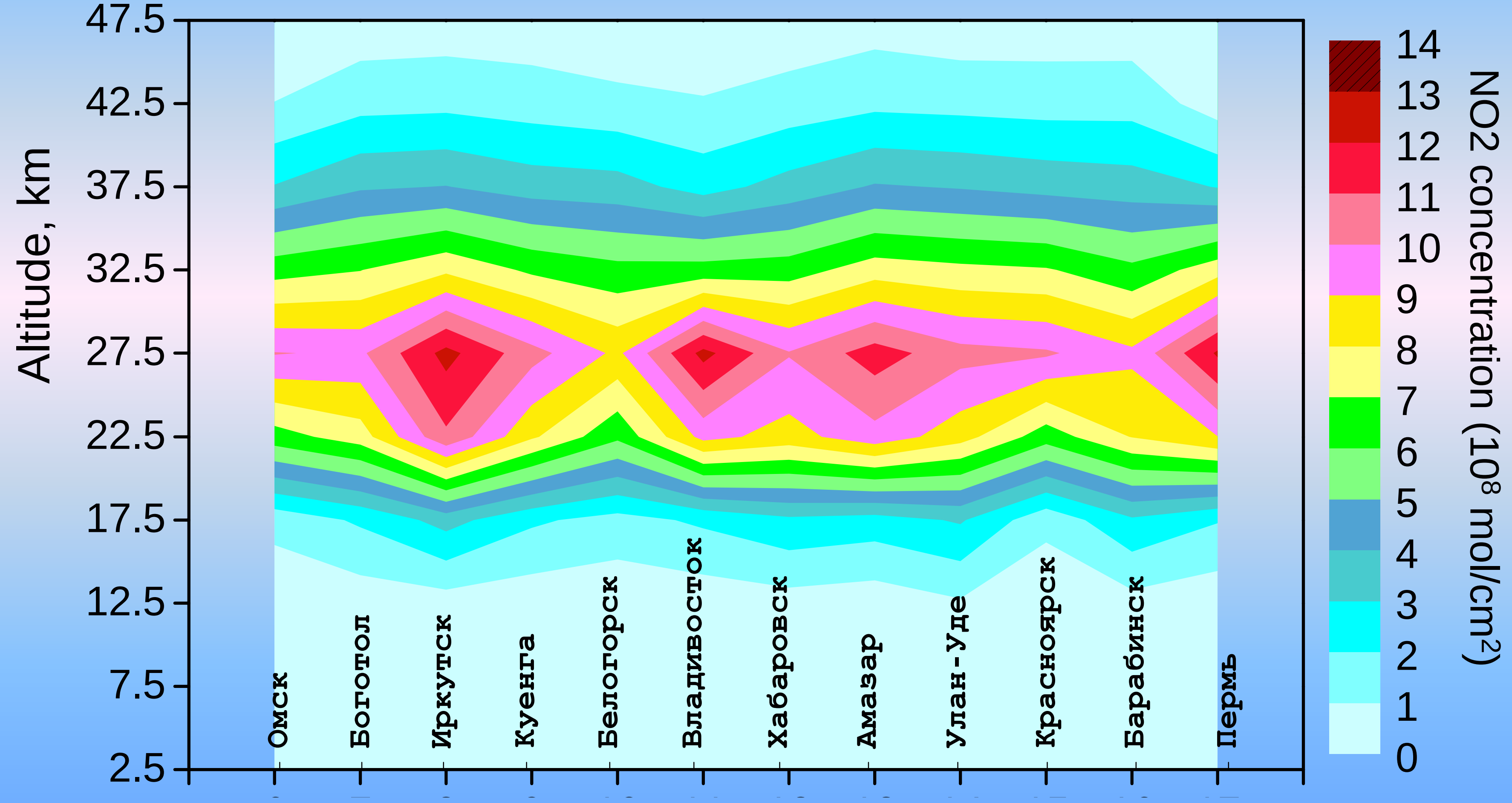
Распространение шлейфа от вулкана Эйяфьятлайокудль по Европейской части России 18-19 апреля 2010 г. согласно расчетам по модели FLEXPART



TROICA

Main locations of OIAP atmospheric measurements

Vertical distribution of NO_2 concentration from the morning measurements on section Omsk-Perm' (TROICA-9 campaign, October 2005)



Predicting tephra dispersion with use of numerical hydrodynamic models of atmospheric transport and chemistry

K.B. Moiseenko[1], N.A.Malik[2], A.I. Skorokhod[1]

(1) A.M. Obukhov Institute of Atmospheric Physics RAS, Atmospheric Composition Dinision.
(2) Institute of Volcanology and Seismology FEB RAS, Laboratory of active volcanism and eruption dynamics.

ISTC 8-9 Jul 2010

Atmospheric Composition Division: Principle modeling tasks

• Investigations of physical and chemical mechanisms affecting atmospheric balance of minor gaseous and aerosol compounds in the northern Eurasia with application to the problems of air quality and climate variability.

• Studies of the influence of natural and anthropogenic emissions on atmospheric composition at various spatial and temporal scales – from local up to inter-continental.

Applications

• Quantitative assessments of ecological burdens by climatically significant sources of atmospheric emissions for various regions of Russian Federation including remote areas of Siberia and Arctic.

• Diagnostics and forecast of a severe air pollution episodes.

Formulation of the general problem of atmospheric transport of chemically active species in limited area domain (Cauchy problem):

Prognostic equation:

$\partial n / \partial t$ = Advection + Turbulent diffusion + Dry and wet deposition + Chemical processes + Microphysics + Volume emission sources

n – mass mixing ratio,

Initial conditions:

3D concentration fields for all species *n*.

Boundary conditions:

Fluxes of species on lower, upper, and lateral boundaries.

External (known) parameters:

Meteorological fields, surface layer parameters, emission sources distributions.

Numerical models:

• Regional Atmospheric Modeling System (RAMS) – Numerical limited-area model of weather forecast

• Hybryd Particle and Concentration Transport model (HYPACT) – RAMS oriented hybrid (Eulerian- Lagrangian) transport model of passive trasser with prescribed life-time.

• Comprehensive Air quality Model with extensions (CAMx) – RAMS oriented transport model with bulk of atmospheric gas and aerosol chemistry.

RAMS, the Regional Atmospheric Modeling System, is a highly versatile numerical code developed by several groups over the years, including the scientists at Colorado State University, the *ASTER division of Mission Research Corporation, and ATMET. ***RAMS*** is used for simulating and forecasting meteorological phenomena, and for depicting the results.

The atmospheric model is constructed around the full set of nonhydrostatic, compressible equations that atmospheric dynamics and thermodynamics, supplemented with a large selection of parameterizations for turbulent diffusion, solar and terrestrial radiation, moist processes including the formation and interaction of clouds and precipitating liquid and ice hydrometeors, kinematic effects of terrain, cumulus convection, and sensible and latent heat exchange between the atmosphere and the surface, which consists of multiple soil layers, vegetation, snow cover, canopy air, and surface water.

Other features: Two-way interactive grid nesting, MPI parallelization.

The RAMS HYbrid Particle And Concentration Transport model HYPACT is a code developed to simulate the motion of atmospheric tracers with prescribed life time under the influence of atmospheric flow including turbulence. The hybrid Lagrangian and Eulerian approach used in HYPACT represents a tracer by Lagrangian particles near the source region where concentration gradients are large and converts particles to Eulerian concentrations where appropriate at large distances downwind thus utilizing the advantages of both schemes.

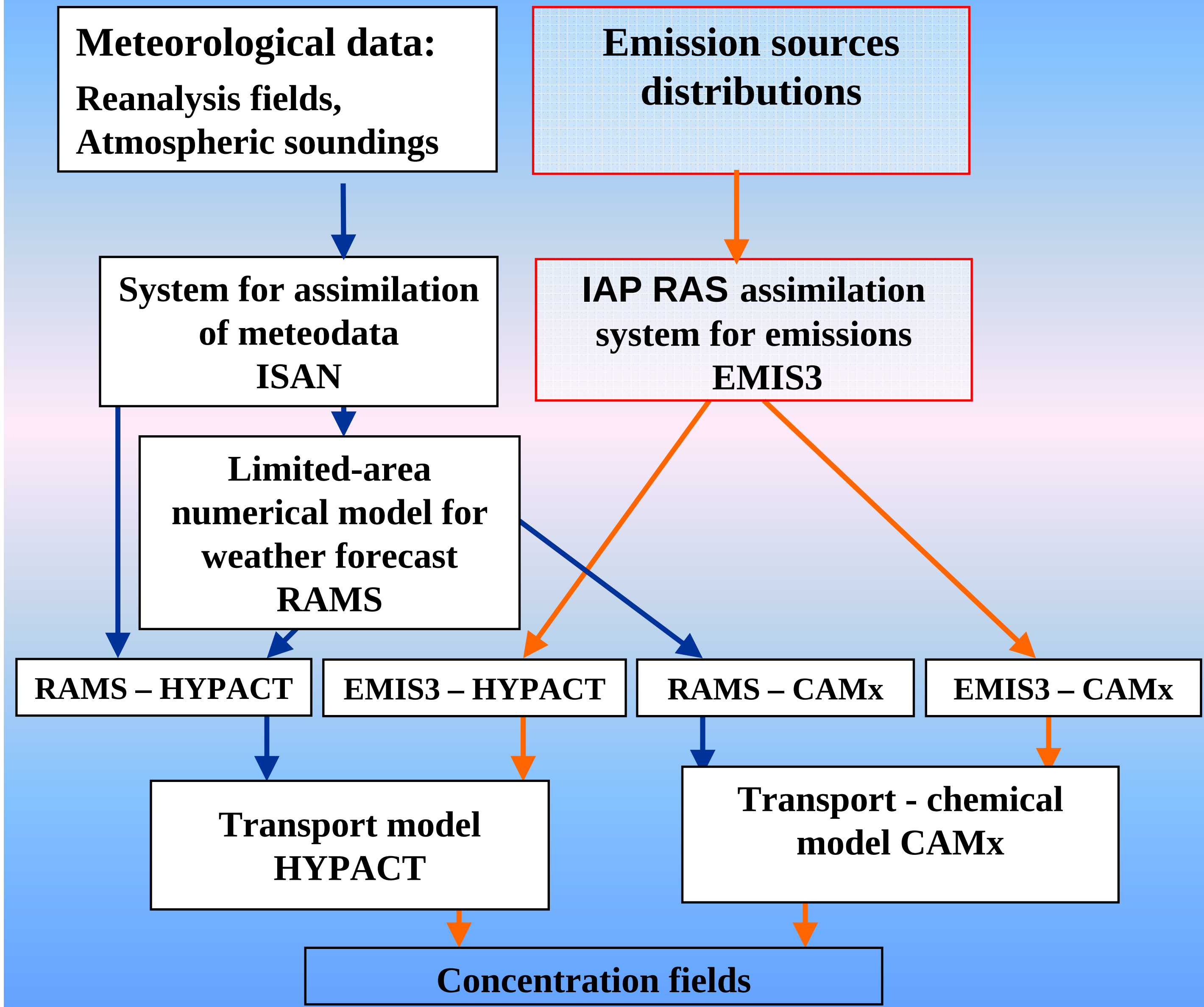
HYPACT is often driven by wind and potential temperature fields simulated in the RAMS atmospheric model, and is currently run as a postprocessing step using a time series of datasets previously output from the atmospheric model.

Other features: Particle Fall Model following to Wilson (2006) was included to simulate tephra deposition.

The **C**omprehensive **A**ir quality **M**odel with e**x**tensions (CAMx) is an Eulerian photochemical dispersion model that allows for an integrated “one-atmosphere” assessment of gaseous and particulate air pollution (ozone, PM2.5, PM10, air toxics, mercury) over many scales ranging
from sub-urban to continental. It is designed to unify all of the technical features required of “state-of-the-science” air quality models into a single system that is computationally efficient, easy to use, and publicly available.

CAMx simulates the emission, dispersion, chemical reaction, and removal of pollutants in the troposphere by solving the pollutant continuity equation for each chemical species (*l*) on a system of nested three-dimensional grids.

Modeling system RAMS / HYPACT / CAMx



Initial data from various databases

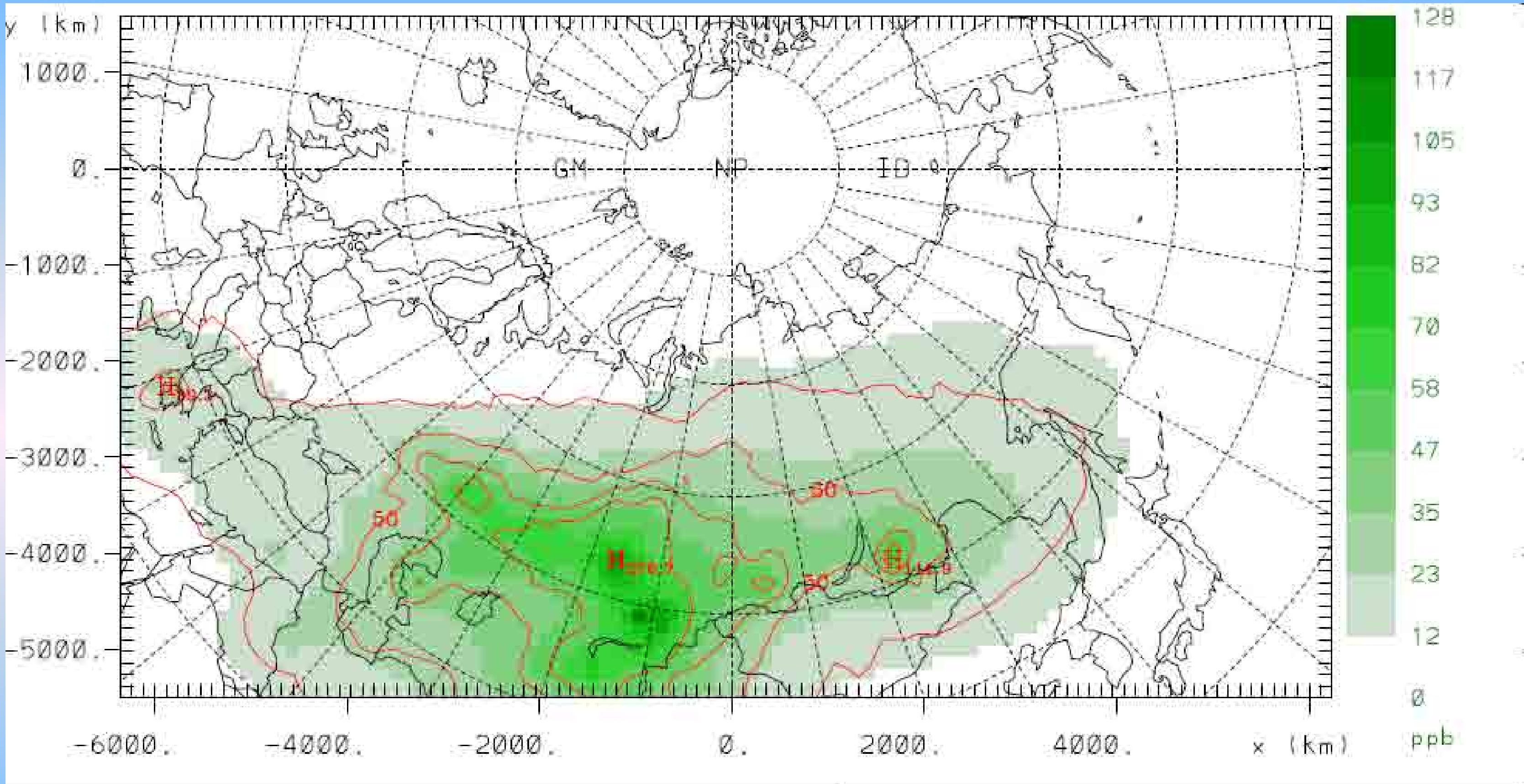
Diagnostic fields

Prognostic meteorological fields RAMS (WRF-ARW)

Interfaces to transport – chemical models

Prognostic concentration fields for various gases and aerosols

Monthly-mean surface CO distribution from forest fires in the Northern Eurasia for September 2007 calculated with use of RAMS/CAMx and fire emission model developed in IAP RAS.



Northen Eurasia – Test Run		grid 1			
z = 38.0 m	2007–09–01–0000.00 UTC	min	max	inc	lab*
tiles	Avg Eul– CO (ppb)	0.1645	116.9	11.67	1e–4
contours	Avg Eul– none (ppb)	0.2333	276.7	25.00	1e 0

Example of calculations

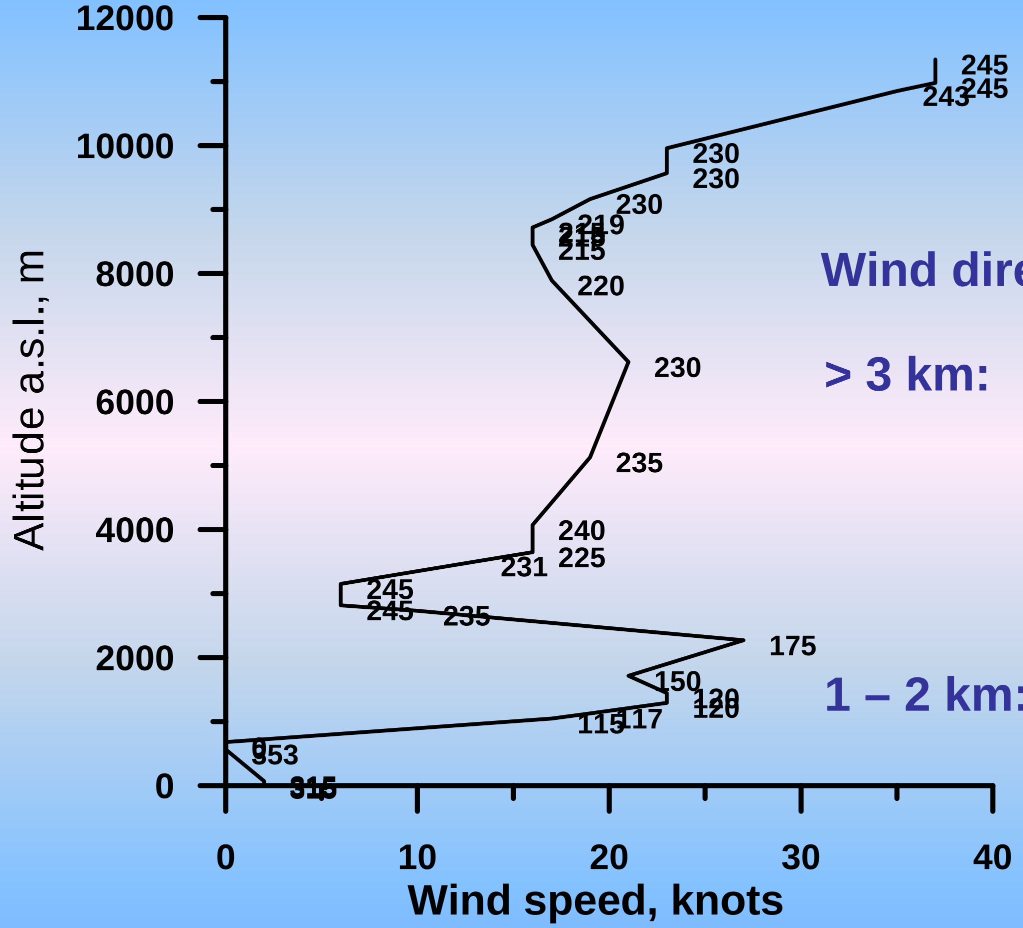
Volcano Bezimyannii   55°58' n.lat., 160°36' e.lon.
Elevation: 2900 m a.s.l.

Eruption event 24 Dec 2006 21:20-22:10 local time.

Tephra plume up to 13 km (visual observations), 9 – 10 km (satellite data), advected to North-East.

Ash is composed by andesites, the density of solid phase of pyroclastic deposites varies from 2,46 – 2,76 g/sm^3.

Atmospheric vertical structure from the rawin sonde observations at Kljuchi on 24 Dec 2006 12:00 GMT.

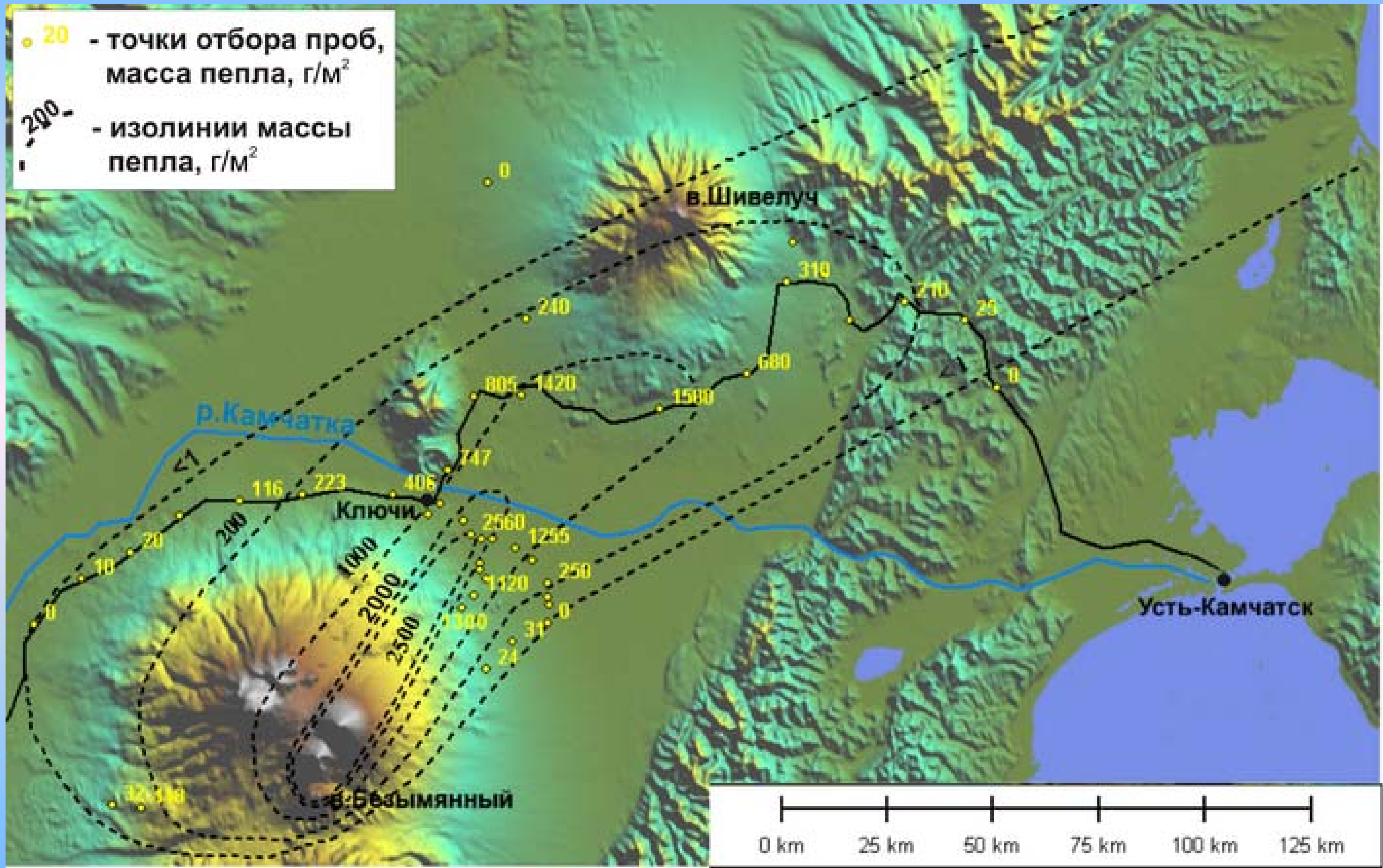


Wind direction:

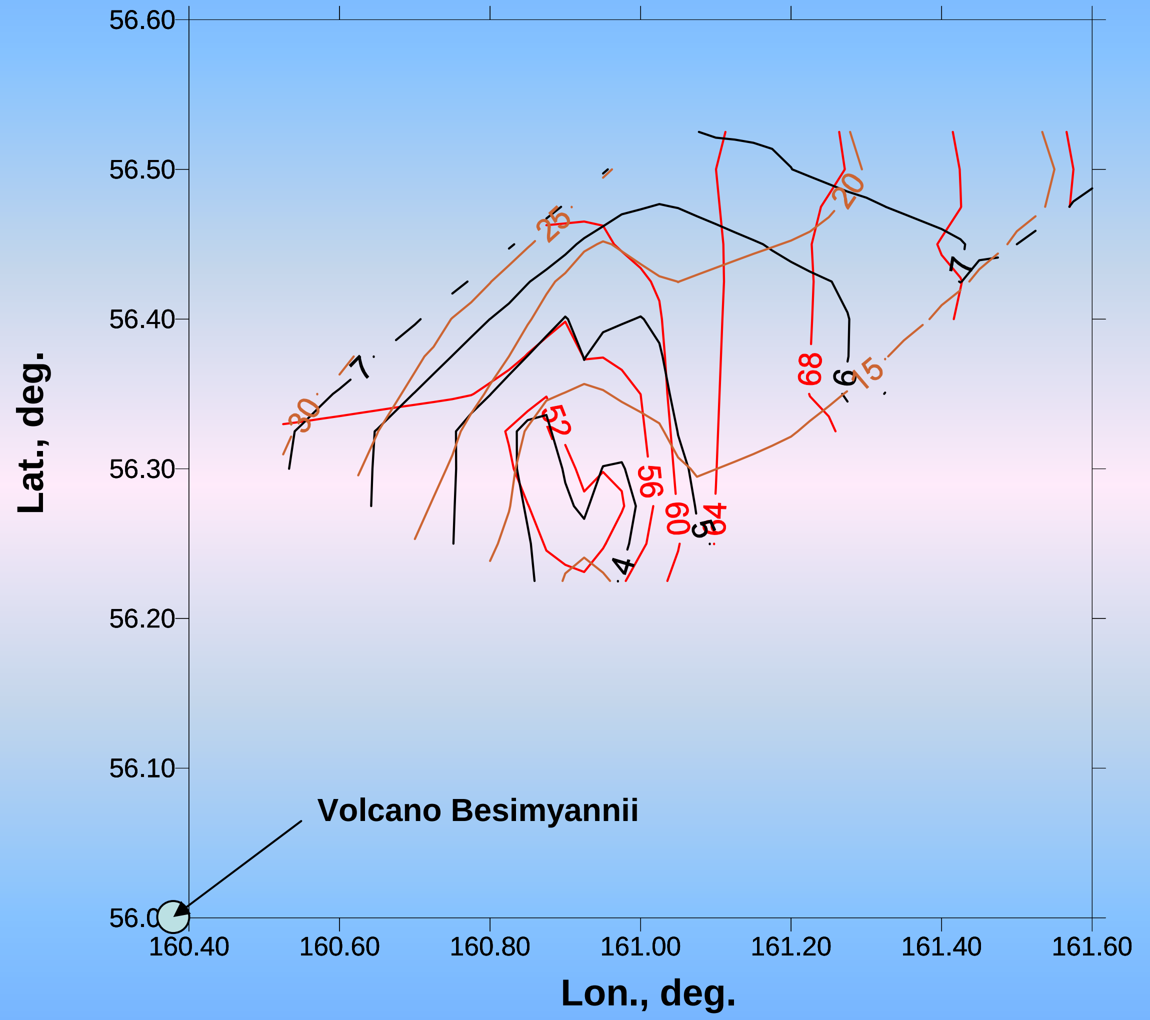
> 3 km: Ю-З

1 – 2 km: В, Ю-В, Ю

Distribution of tephra-fall deposits for December 2006 Besimyannii eruption based on field measurements. Isolines of deposited mass, g/m^2.



Distribution of tephra-fall deposits for December 2006 Besimyannii eruption based on field measurements. Isolines of deposited mass, g/m².



Isolines of deposited mass, g/m2, for particle diameters 125 – 71 µm (brown), 56 – 71 µm (black), <56 µm (red).

Observation data:

• Tephra-fall deposites mass concentration for the particles < 56 µm increases along the direction of the wind above 3 km (from SW to NE);

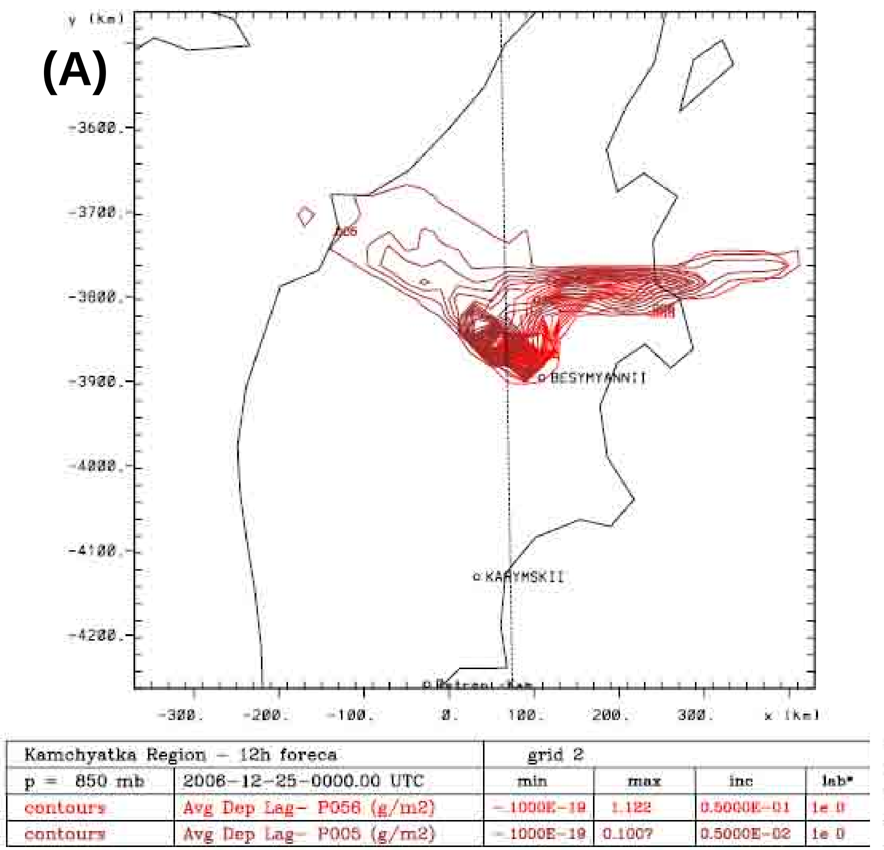
• The deposited mass for the particles from 70 – 125 µm increases along wind direction approximately below 1.5 – 2 km (from E, SE to W, NW).

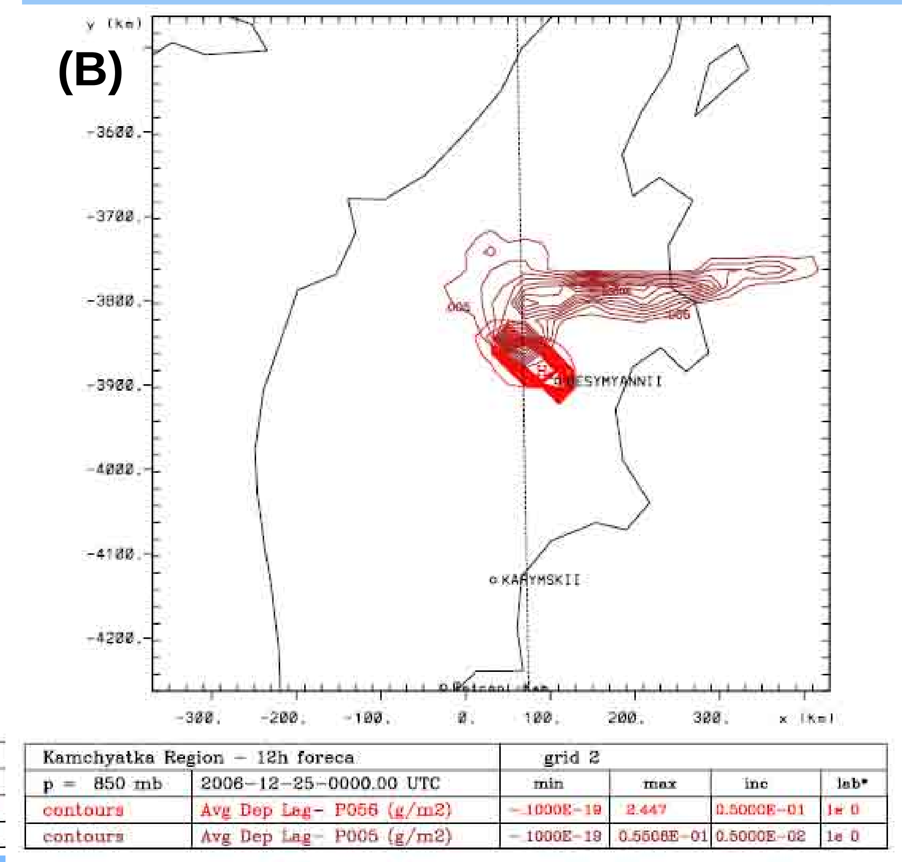
• The maximal deposited mass for particles 56 – 70 µm is to the N and N-E.

The spatial distribution of deposited mass strongly depends on wind speed and direction variation in the layers of effective atmospheric transport.

Particle size distribution in eruption column is essentially inhomogeneous. The particles with small size (< 50 µm) can be transported by convective fluxes at significantly higher altitudes compared to heavy particles (> 100 µm).

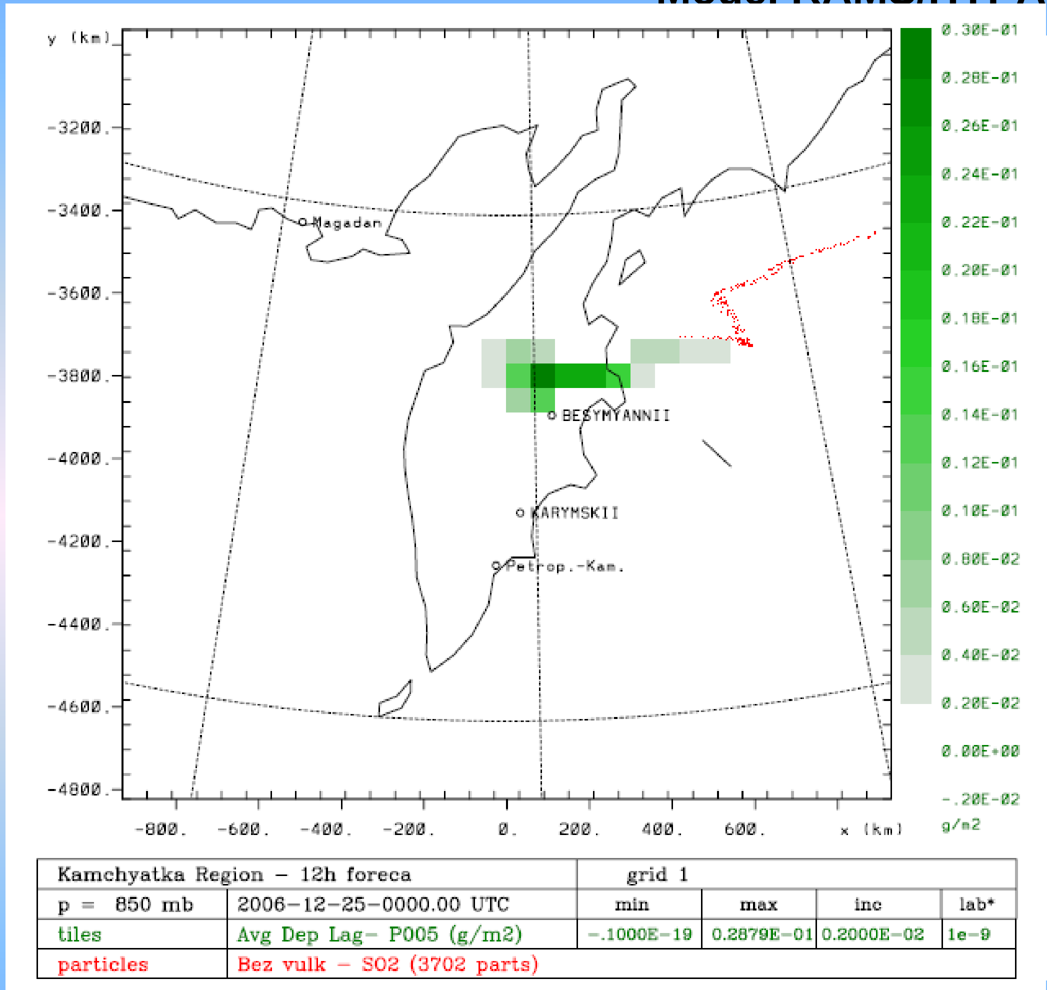
Volcano Bezimyannii. Calculations of tephra dispersion and fallout with use of HYPACT transport model and particle fall model by Wilson & Huang (1979), and Pfeiffer et al. (2005). Isolines of deposited mass density for particle ranges (I) 0.005 – 0.056 µm (brown), and (II) 0.056 – 0.071 µm (red).

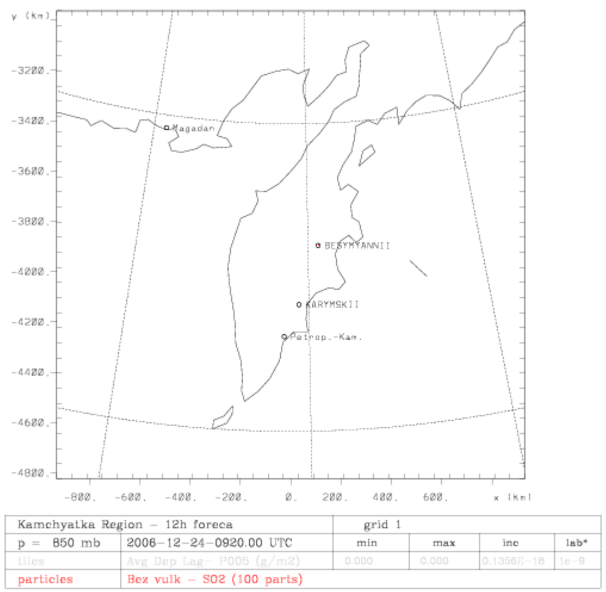




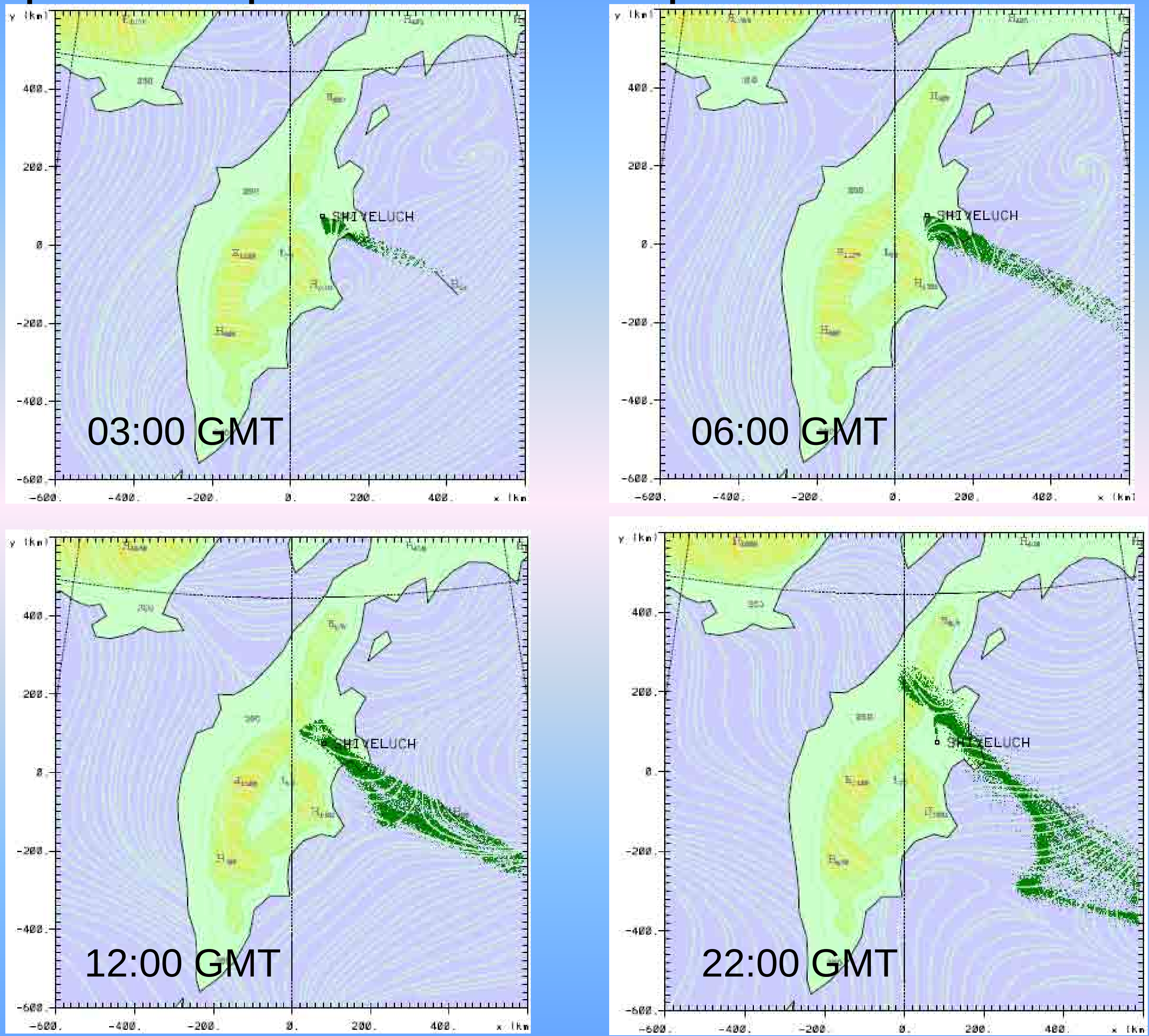
(A): Particles (I) and (II) have uniform distributions from 0 – 12 km above the ground level.
(B): Particles (I) and (II) have uniform distributions from 0 – 3 km and 3 – 12 km a.g.l., correspondingly.

Volcano Bezimyannii: Numerical simulation of gas plume (red particles) and particle fall out (green izopatches, g/m2) for the particle range 0.005 – 0.056 µm, Model RAMS/HYPACT





RAMS/HYPACT simulation: SO2 plume from volcano Shiveluch on 2 Sep 2008. Example of deformation of the plume in wind field.



Conclusions:

The developed in IAP RAS emission model for various biogenic and anthropogenic sources, along with RAMS/HYPACT/CAMx modeling system can be used to predict tephra dispersion and fallout in a wide range of atmospheric scales – local (1 – 20 km), regional (20 – 2000 km), and transcontinental.

The modeling system can be operated in forecast mode to provide prognostic fields of atmospheric and deposited concentrations of tephra for a period of 1 – 3 days, basing on forecast for large-scale meteorological fields.

Validity of the modeling system should be further tested with use of observational data on tephra dispersion and fallout.

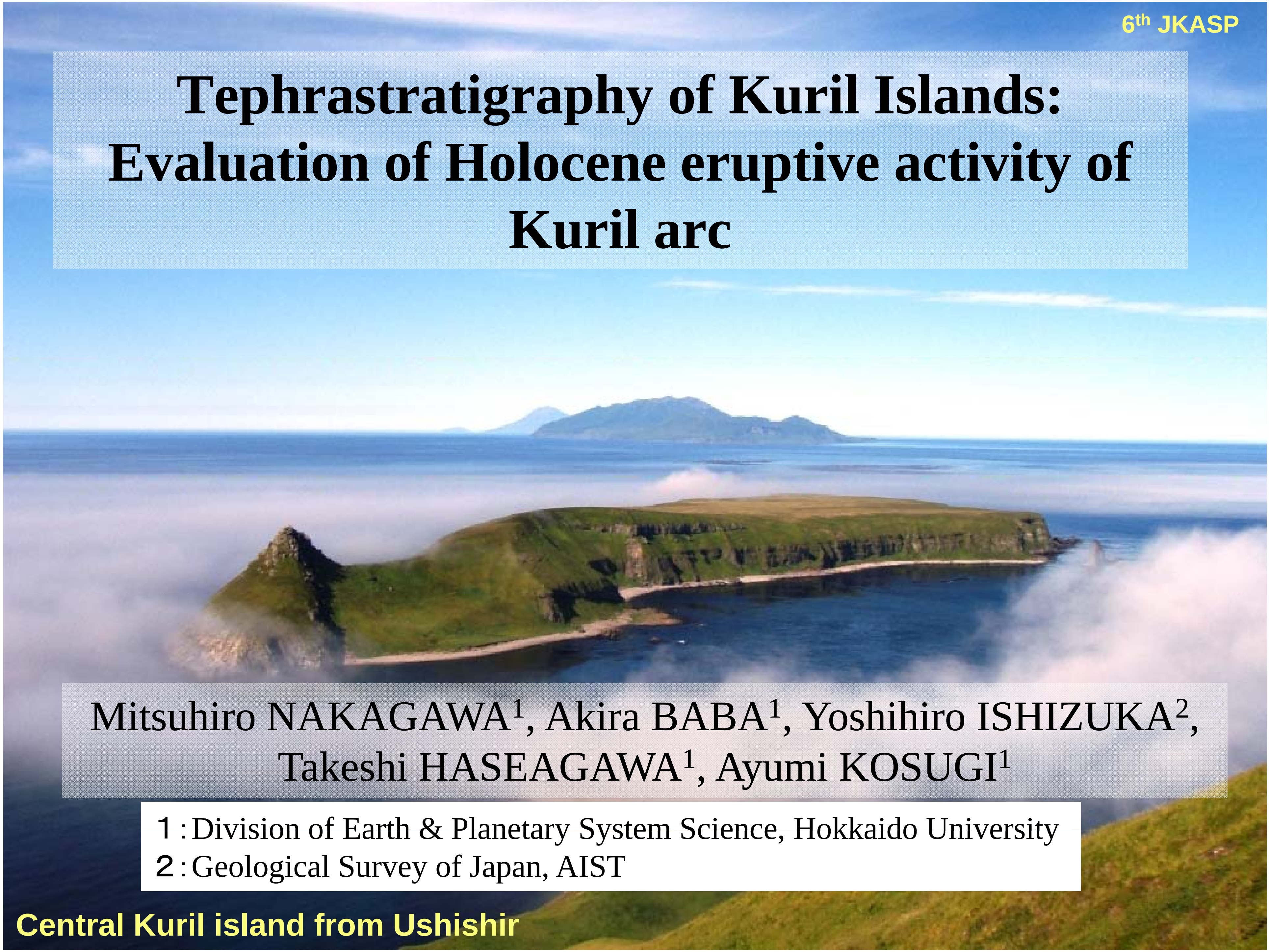
Comparison of the results of numerical simulations with field measurements can provide useful complementary information on some parameters of eruptions (amounts of tephra emitted, eruptive column elevation, tephra particles size distribution, and so on).

6th JKASP

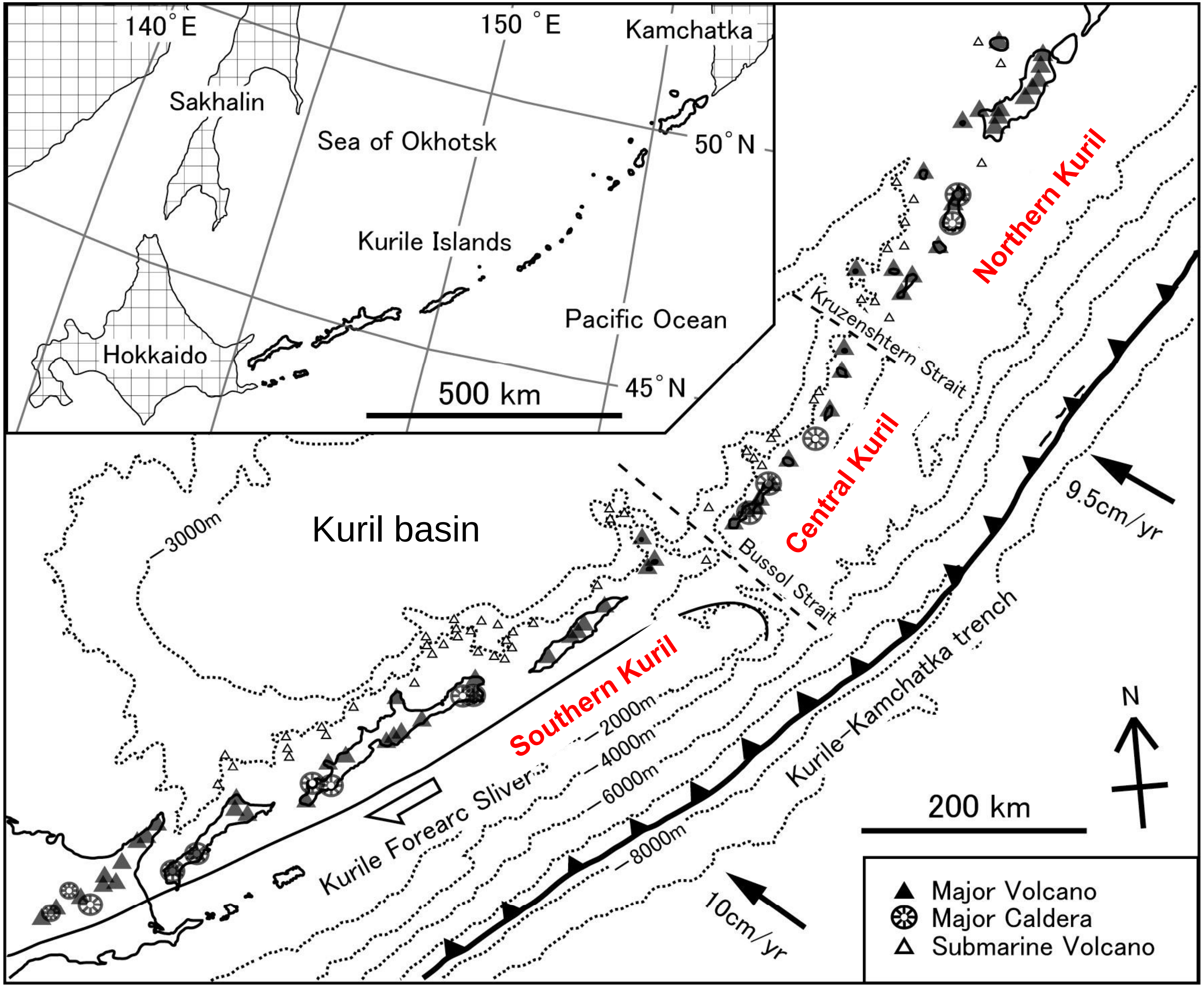
Tephrastratigraphy of Kuril Islands: Evaluation of Holocene eruptive activity of Kuril arc

Mitsuhiro NAKAGAWA[1], Akira BABA[1], Yoshihiro ISHIZUKA[2], Takeshi HASEAGAWA[1], Ayumi KOSUGI[1]

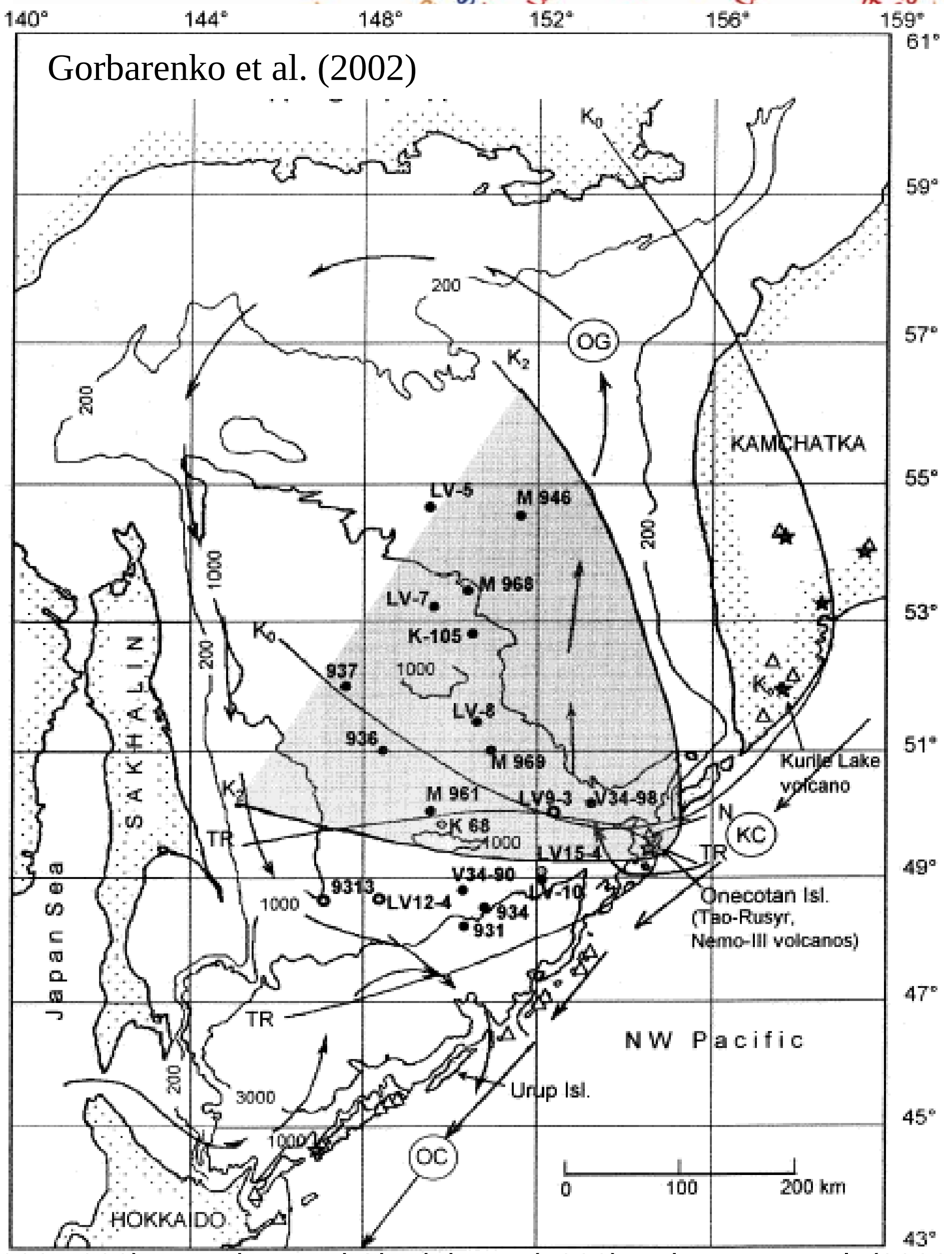
１: Division of Earth & Planetary System Science, Hokkaido University
２: Geological Survey of Japan, AIST

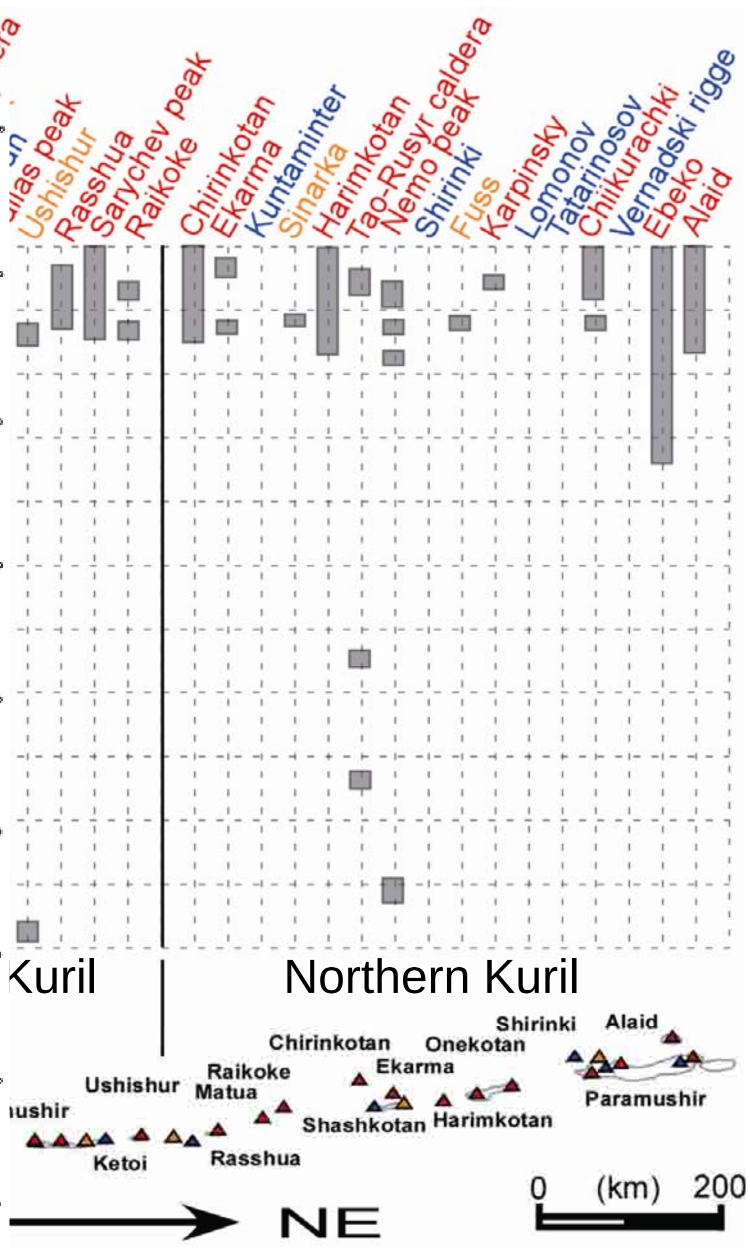


Central Kuril island from Ushishir

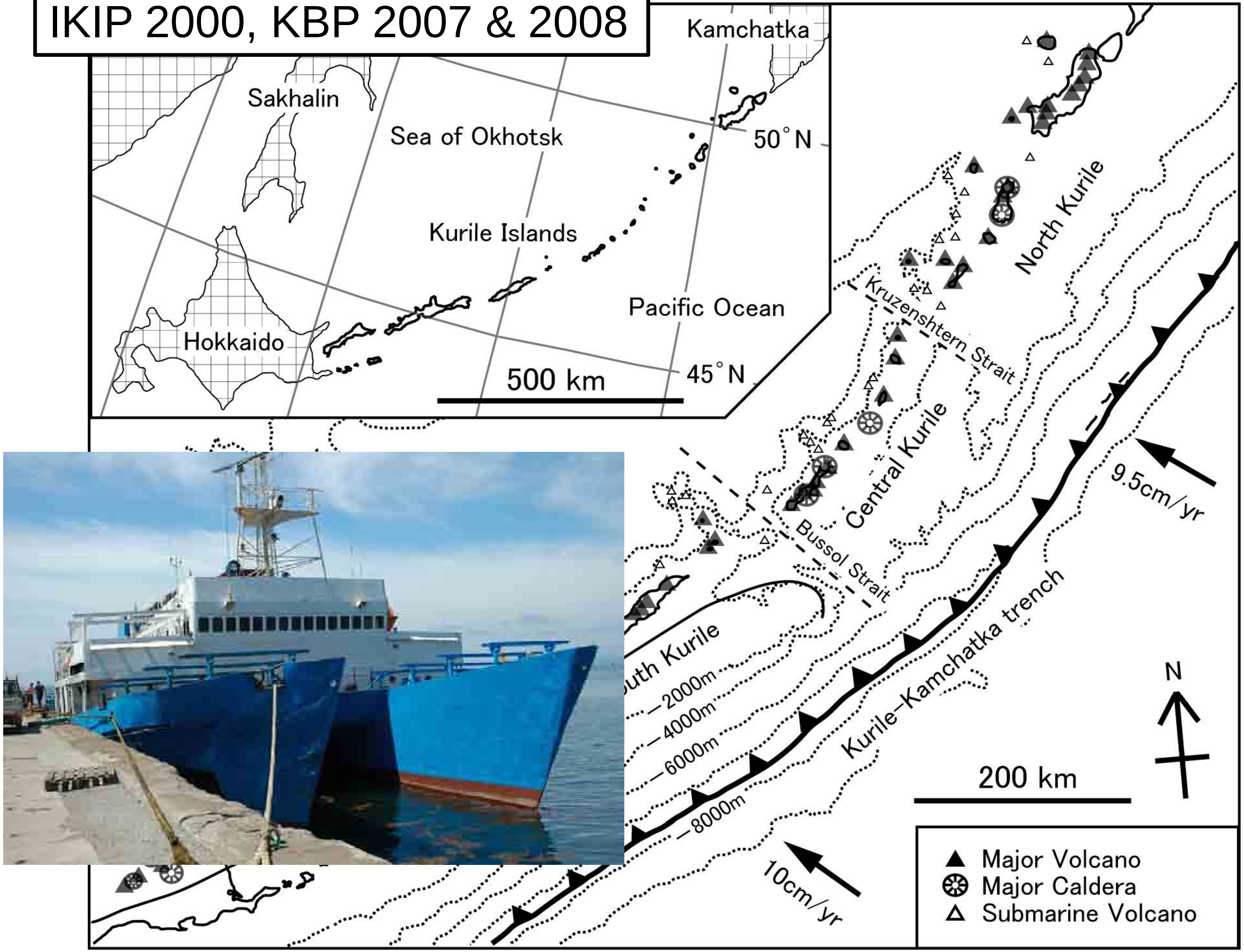

140°E
150 °E
Kamchatka
Sakhalin
Sea of Okhotsk
50°N
Kurile Islands
Pacific Ocean
Hokkaido
500 km
45°N
Northern Kuril
Kruzenshtern Strait
Central Kuril
Kuril basin
3000m
Bussol Strait
9.5cm/yr
Southern Kuril
2000m
4000m
6000m
8000m
Kurile-Kamchatka trench
Kurile Forearc Sliver
N
200 km
10cm/yr
Major Volcano
Major Caldera
Submarine Volcano

Eruptive history of Kuril islands



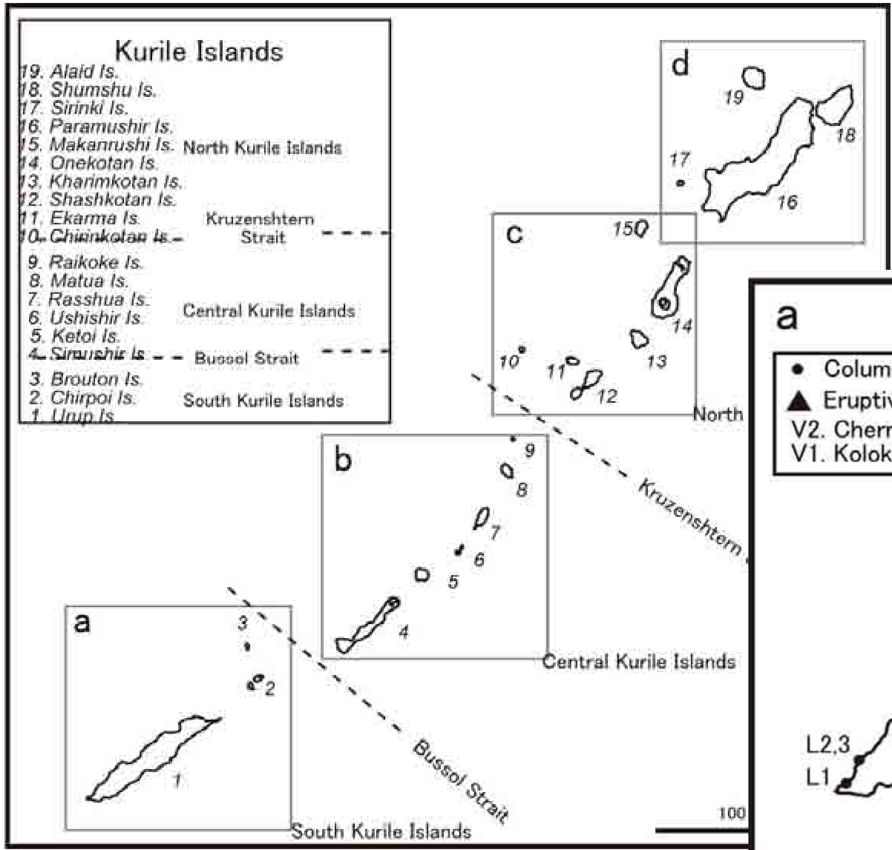


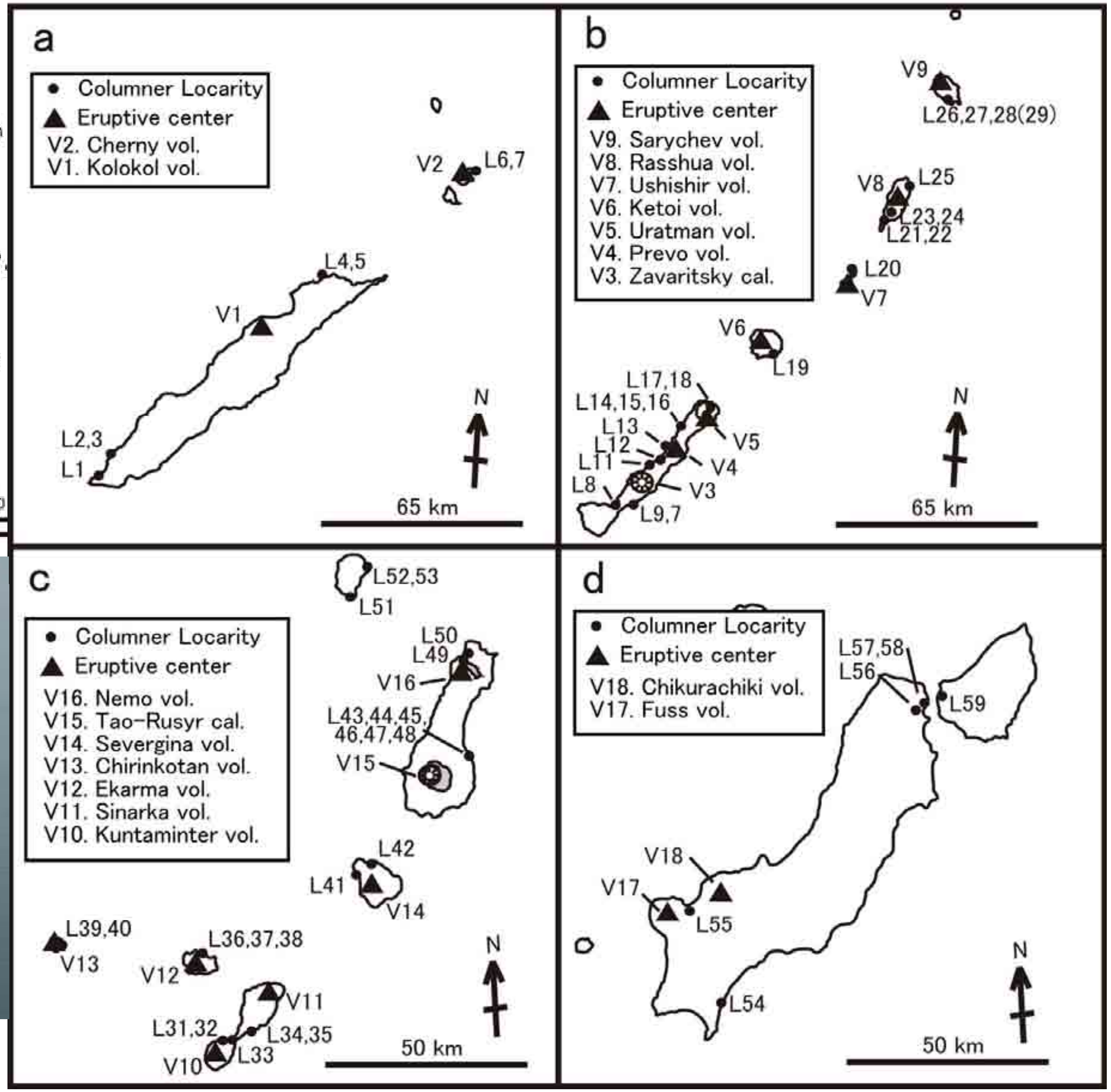
Refe… …kov and Muraviev.,(1993) ,Menyailov et al.,(1… …t al.,(1997), Melekestsev et al.,(1997) , Razzhigaeva et al.,(1998,1999). Ermakov and Shteinberg, (1999) Nakagawa et al.,(2002),Gorbarenko et al.(2002), Gurenko et al.,(2005) IKIP 2000, KBP 2007 & 2008



Sites for tephrastratigraphy : 59

(IKIP 2000, KBP 2007 & 2008)



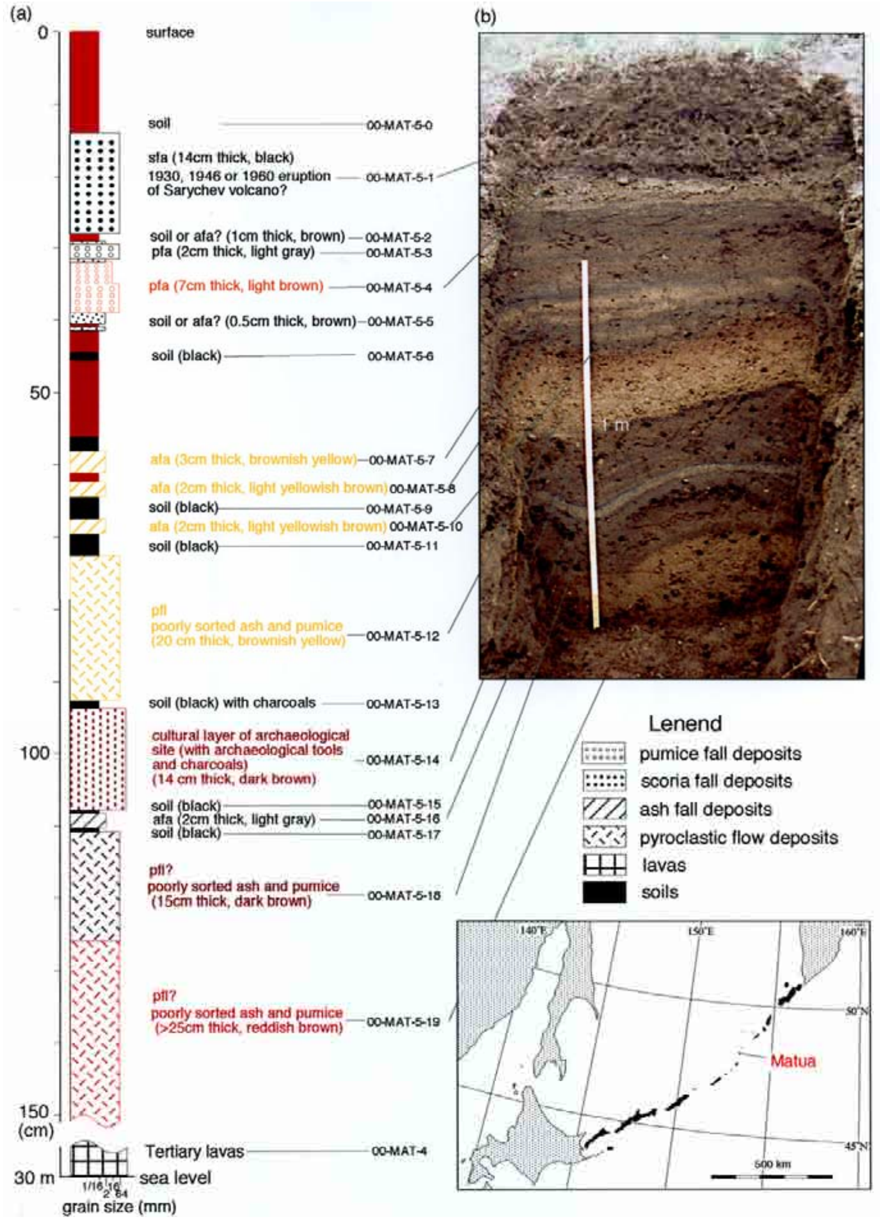


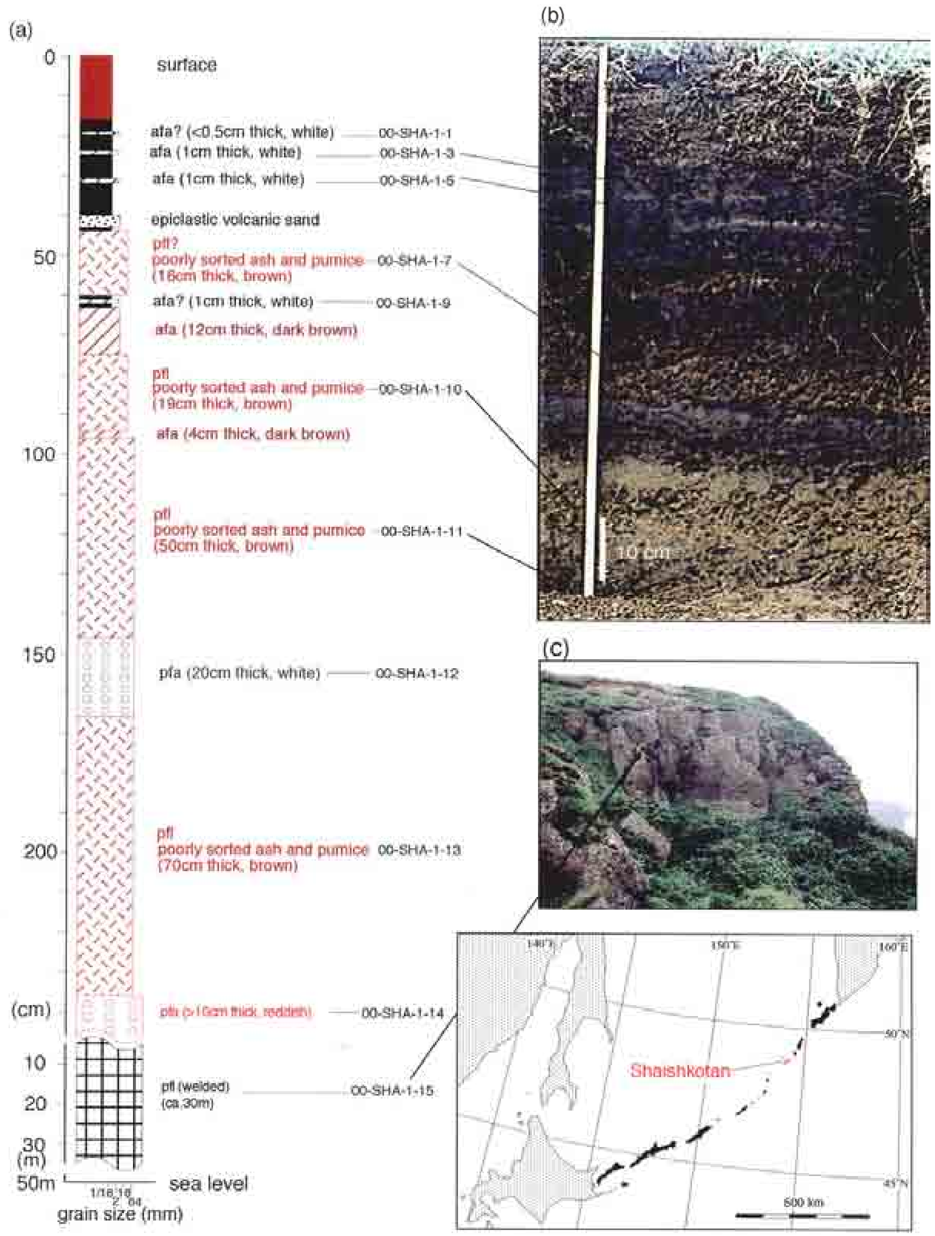
Costal terrace

- Distal~medial tephra

In order to cover tephra layers during Holocene

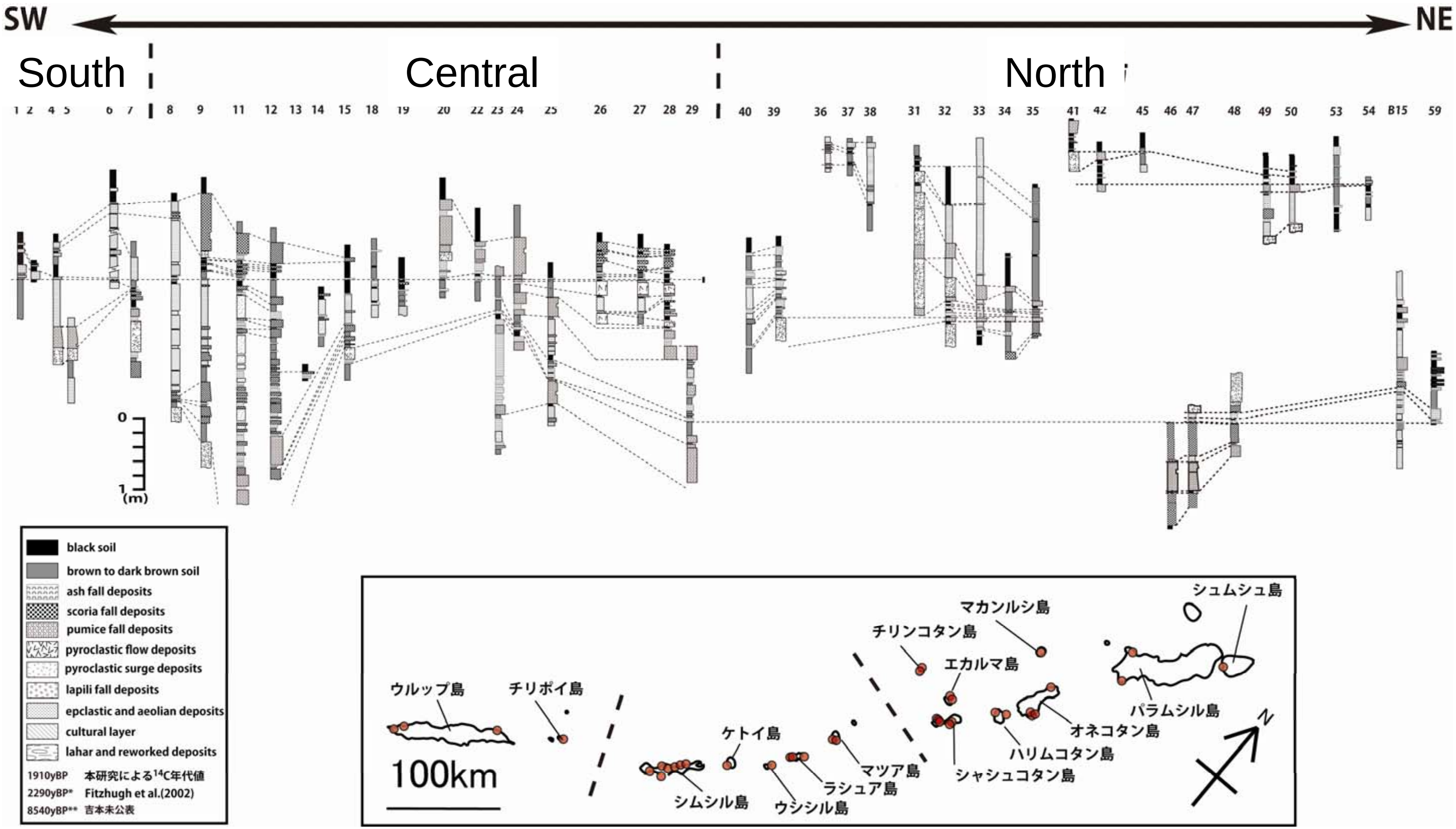
Columnar sections & Sampling





Columnar sections

503 tephra layers from 49 sites



Correlation of tephra layers：
stratigraphy + petrography and petrology

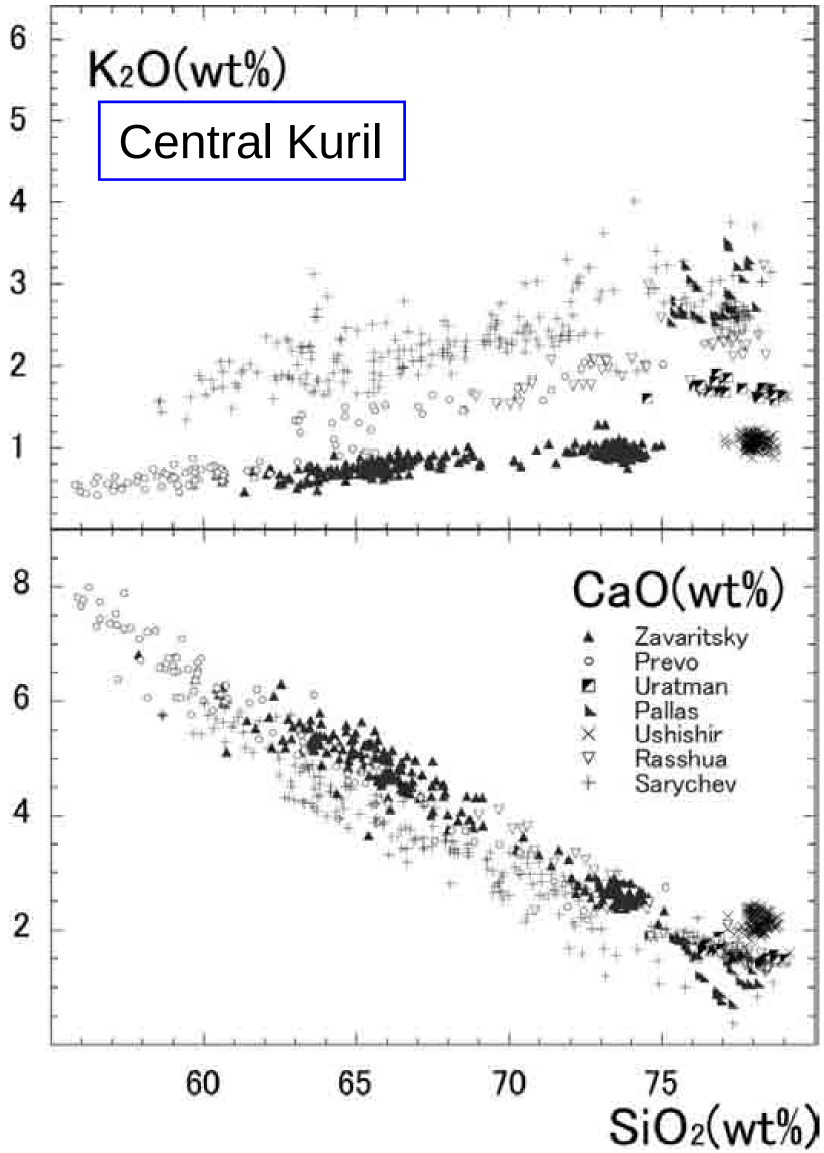


Fig.4-2 Glass compositions of volcanoes from Central Kurile Islands

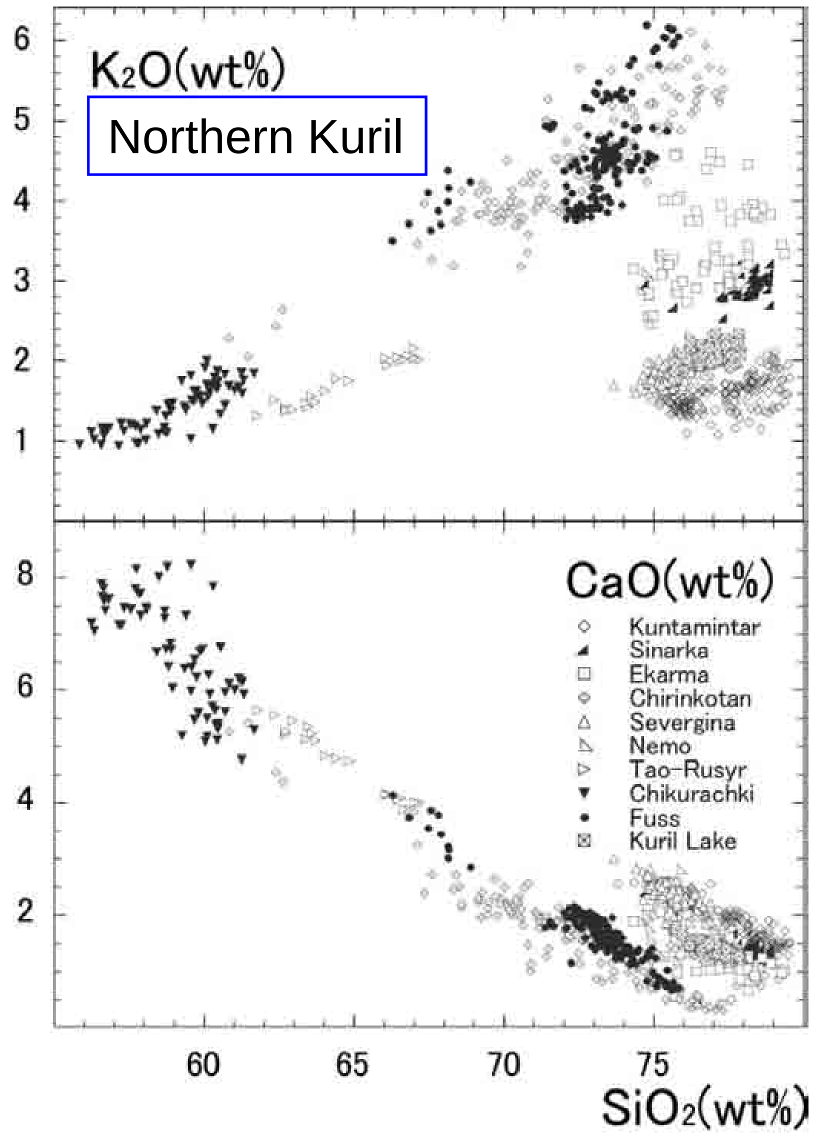
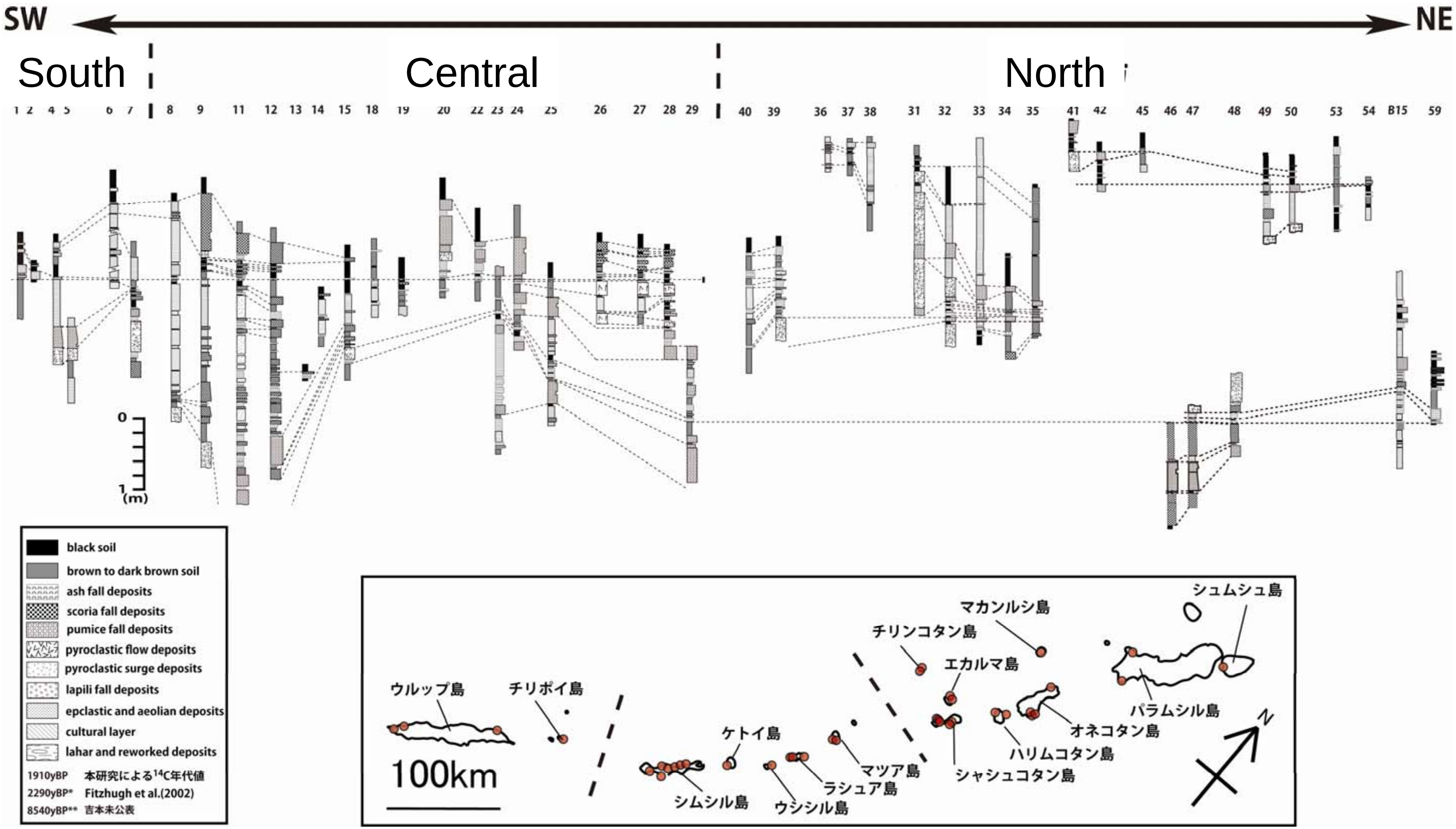


Fig.4-3 Glass compositions of volcanoes from North Kurile Islands

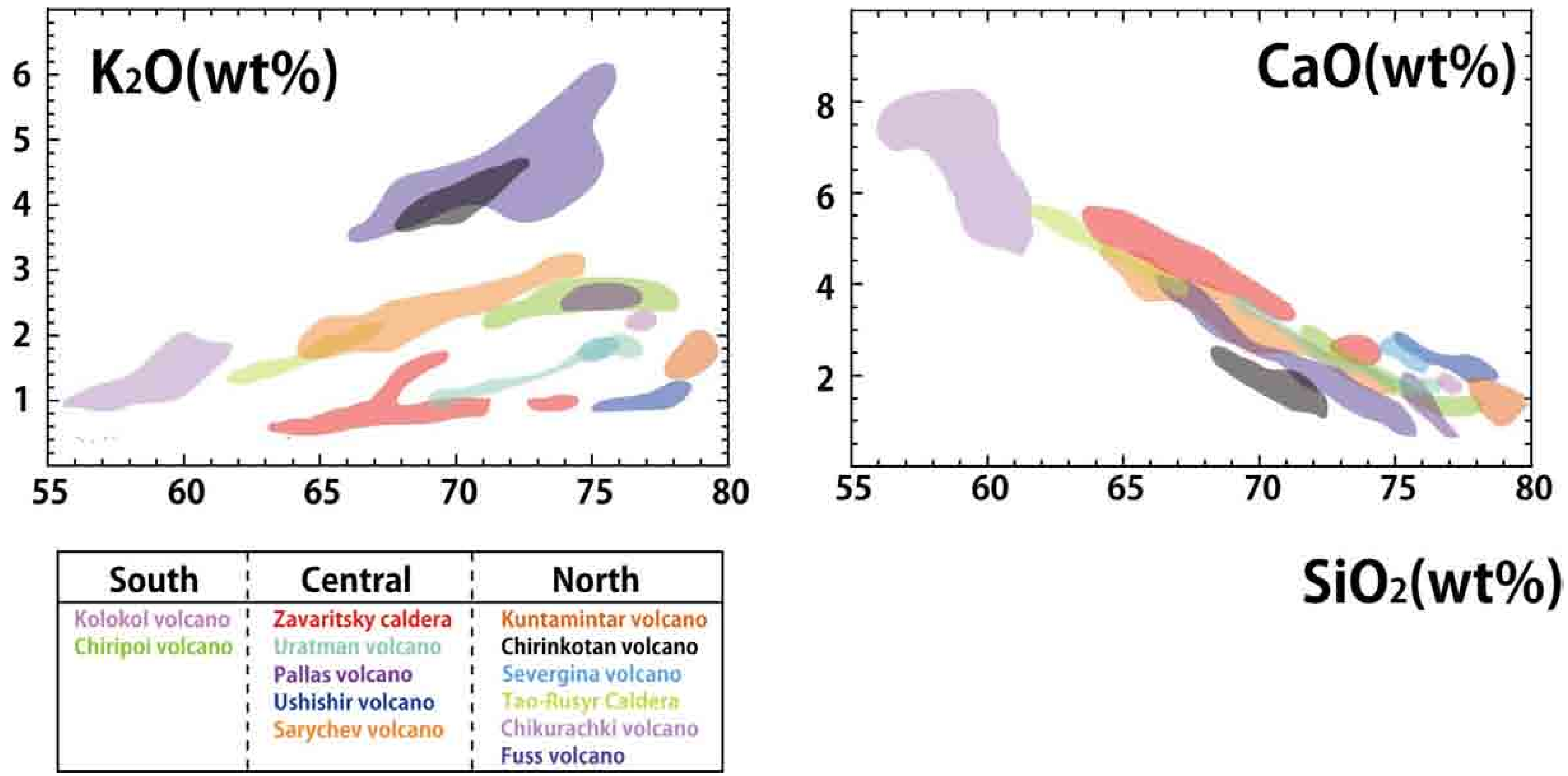
Columnar section

503 tephra layers from 49 sites

155 eruptive units

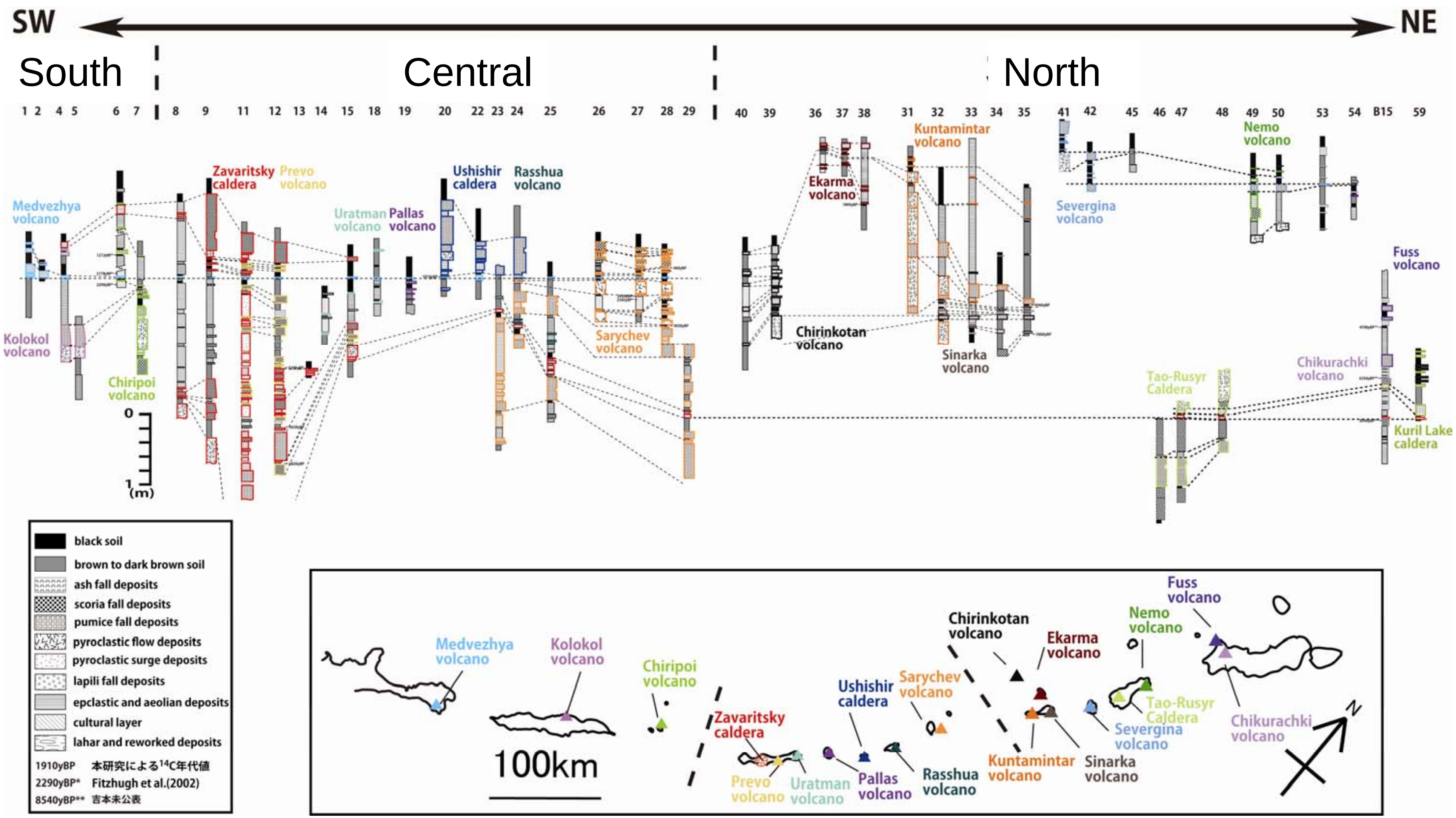


Identification of source volcano of each tephra unit

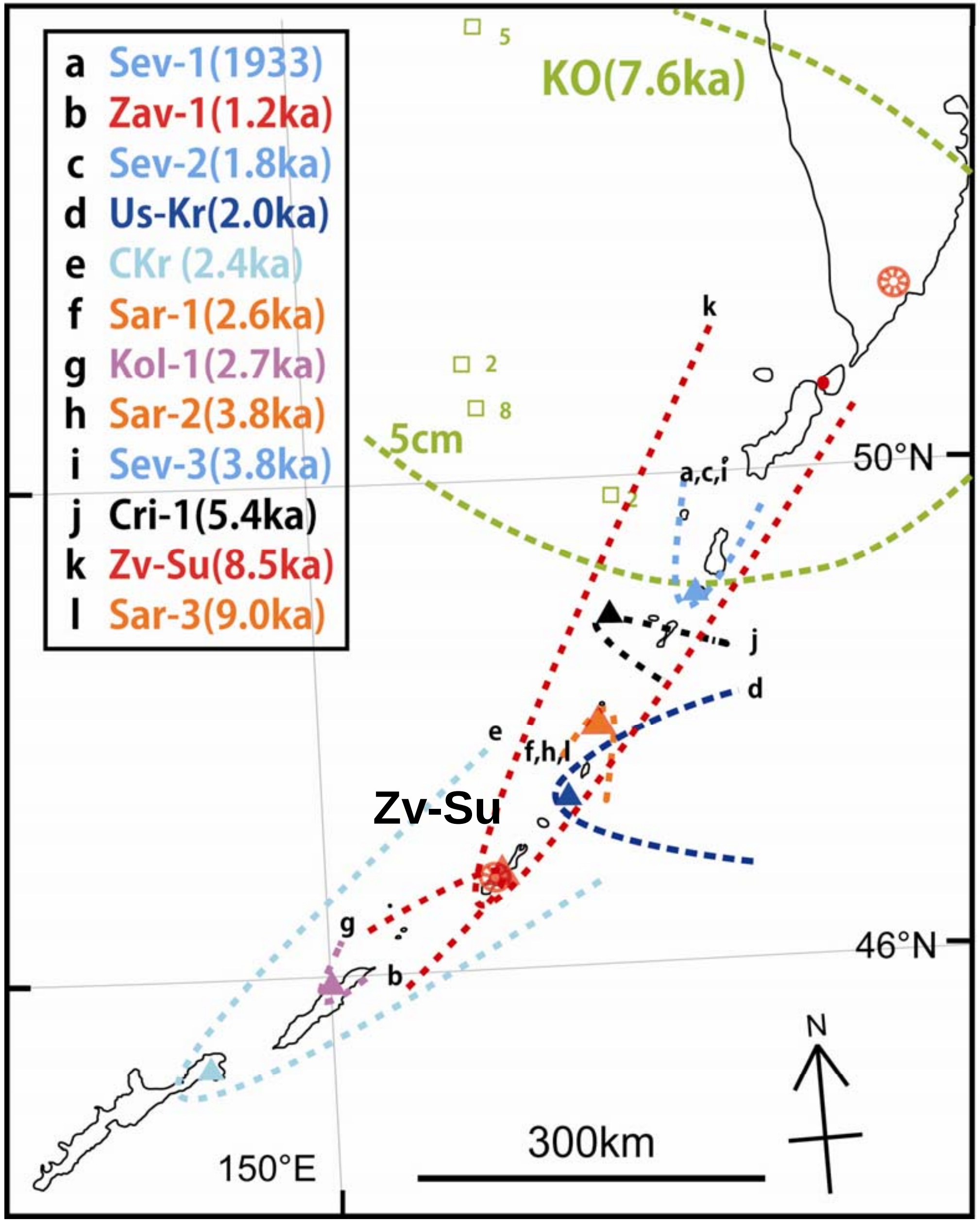


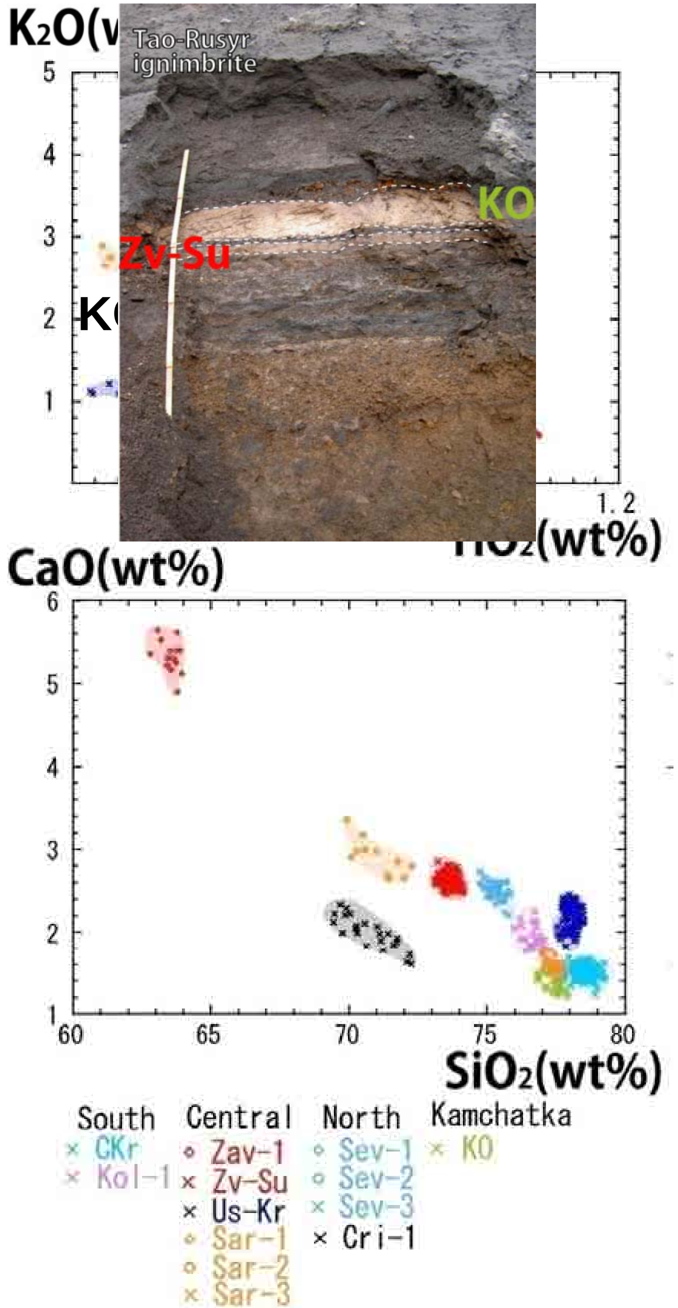
Identification of source volcano

19 volcanoes



Marker tephra layers during Holocene



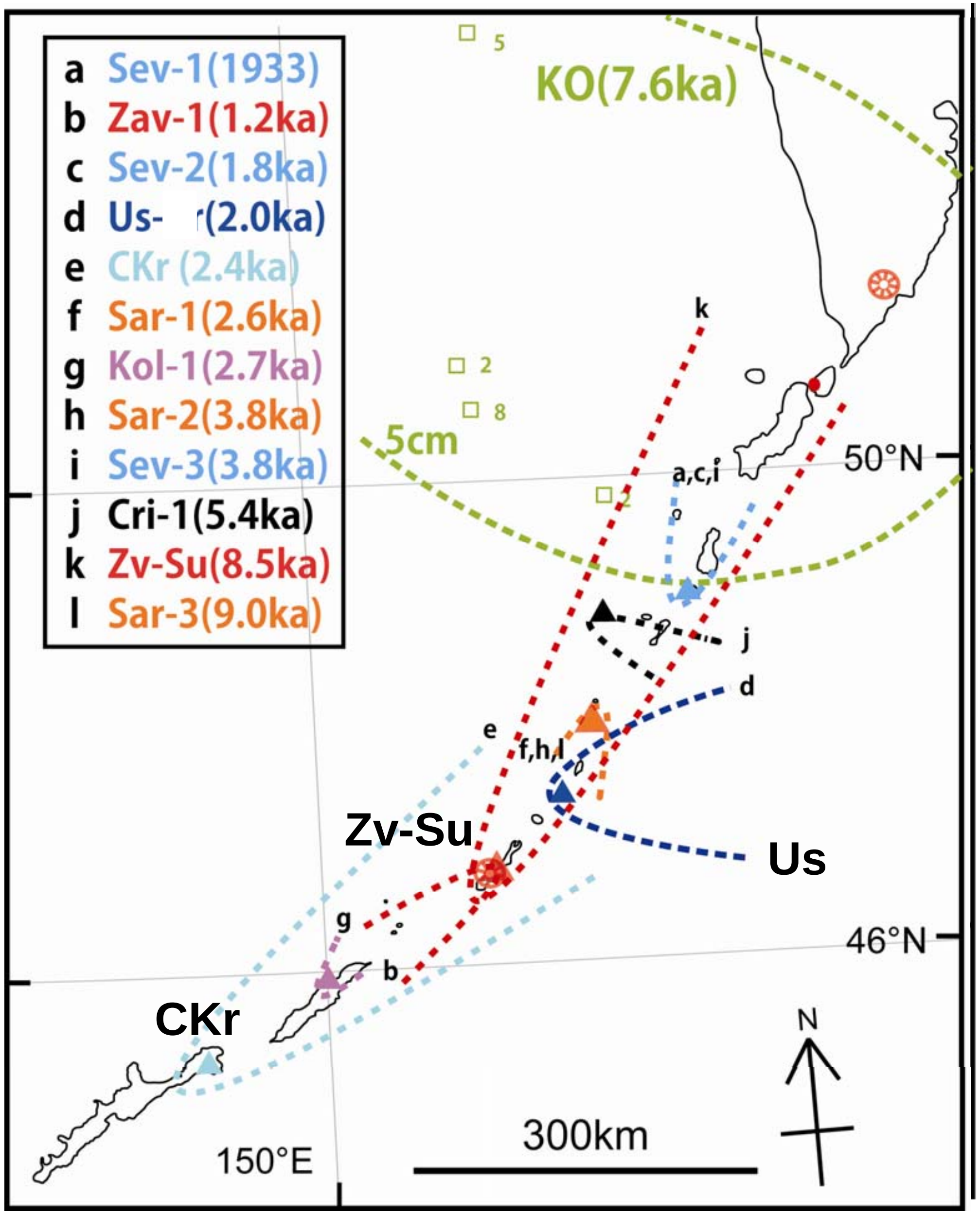


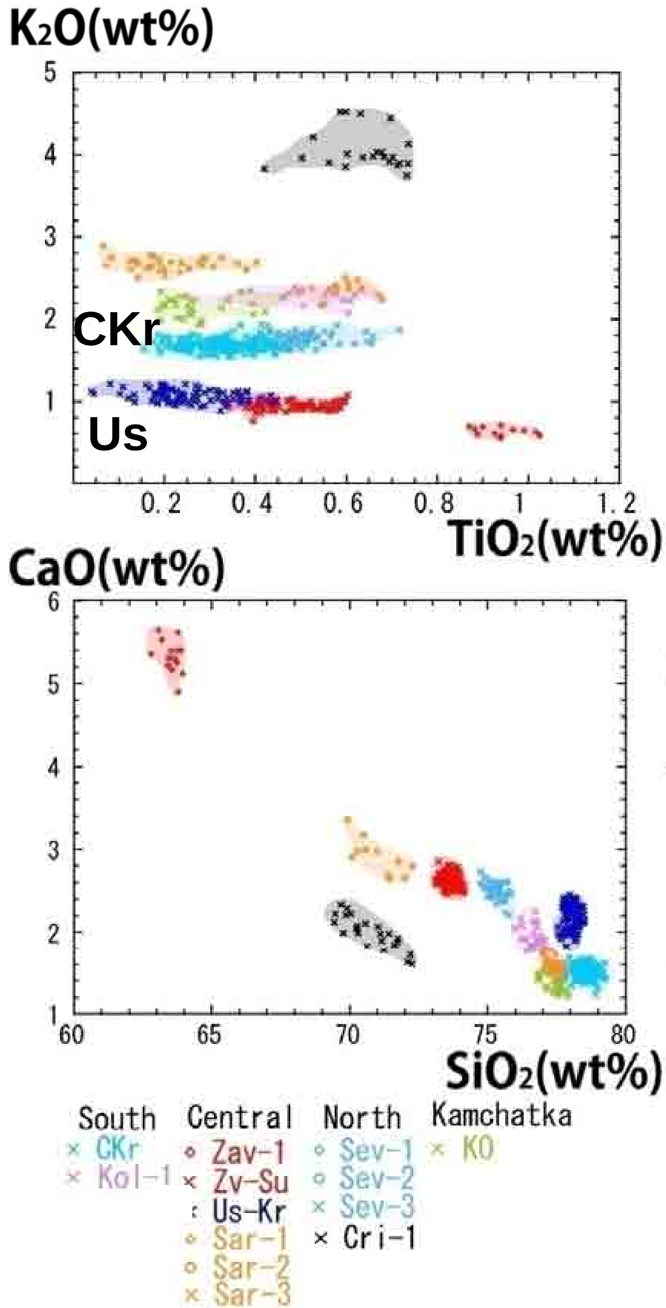
Zv-Su tephrs

（Zavaritsky – Shumushu:8.5 ka）

Simushir island

Marker tephra layers during Holocene





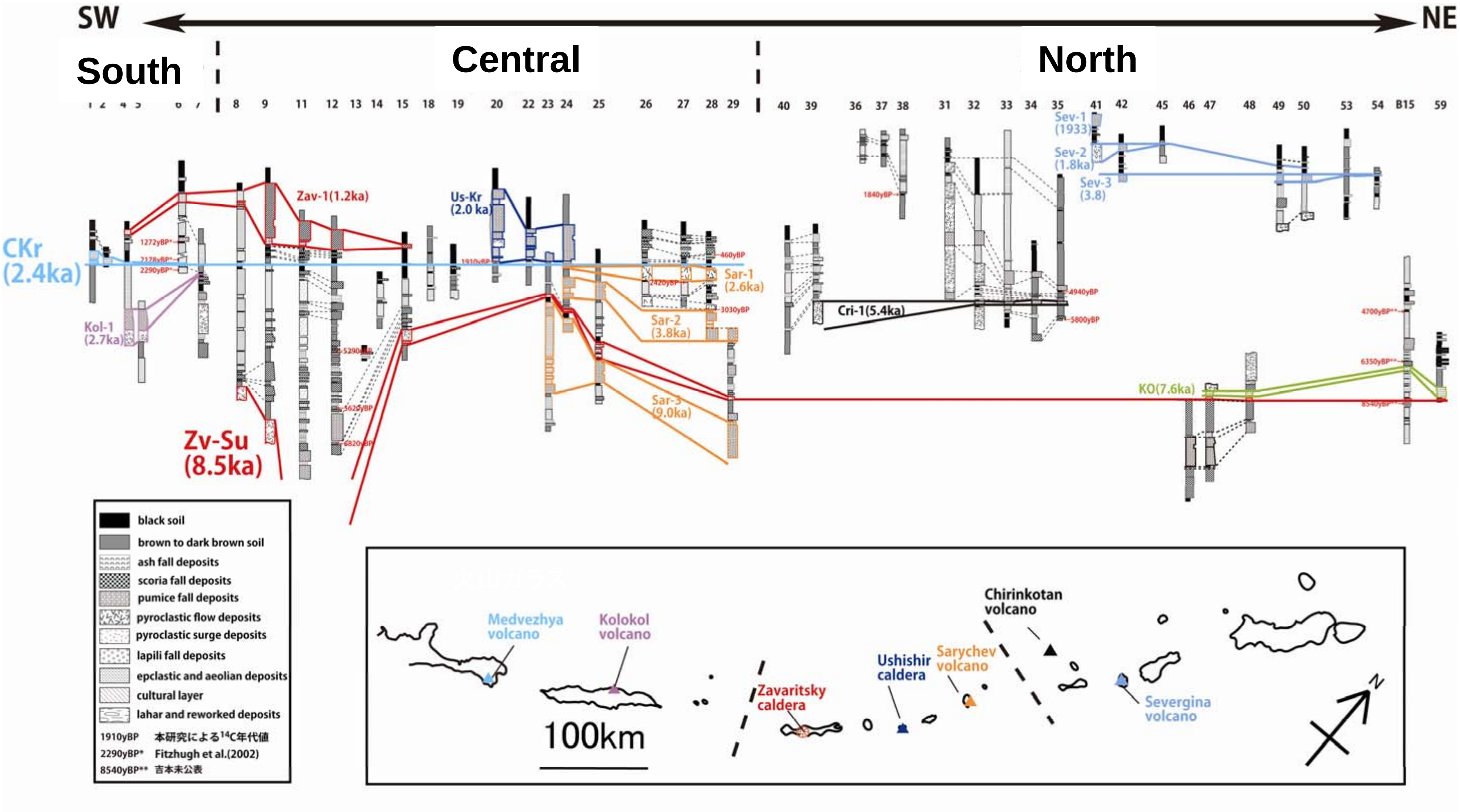
Us tephra（Ushishir: 2.0 ka）

Ushishir, central Kuril

Marker tephras in Holocene

Identified in more than two islands

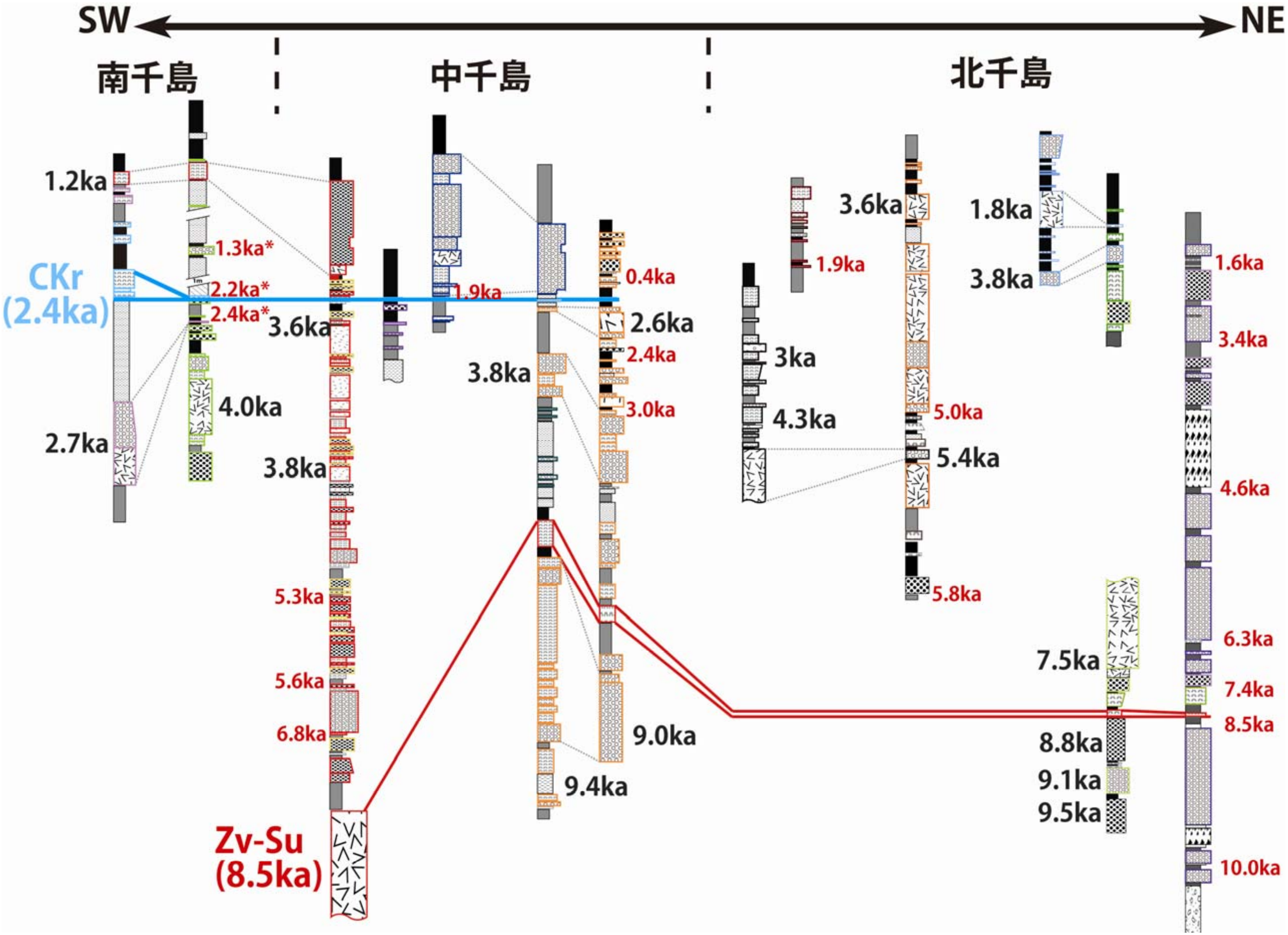
13 layers



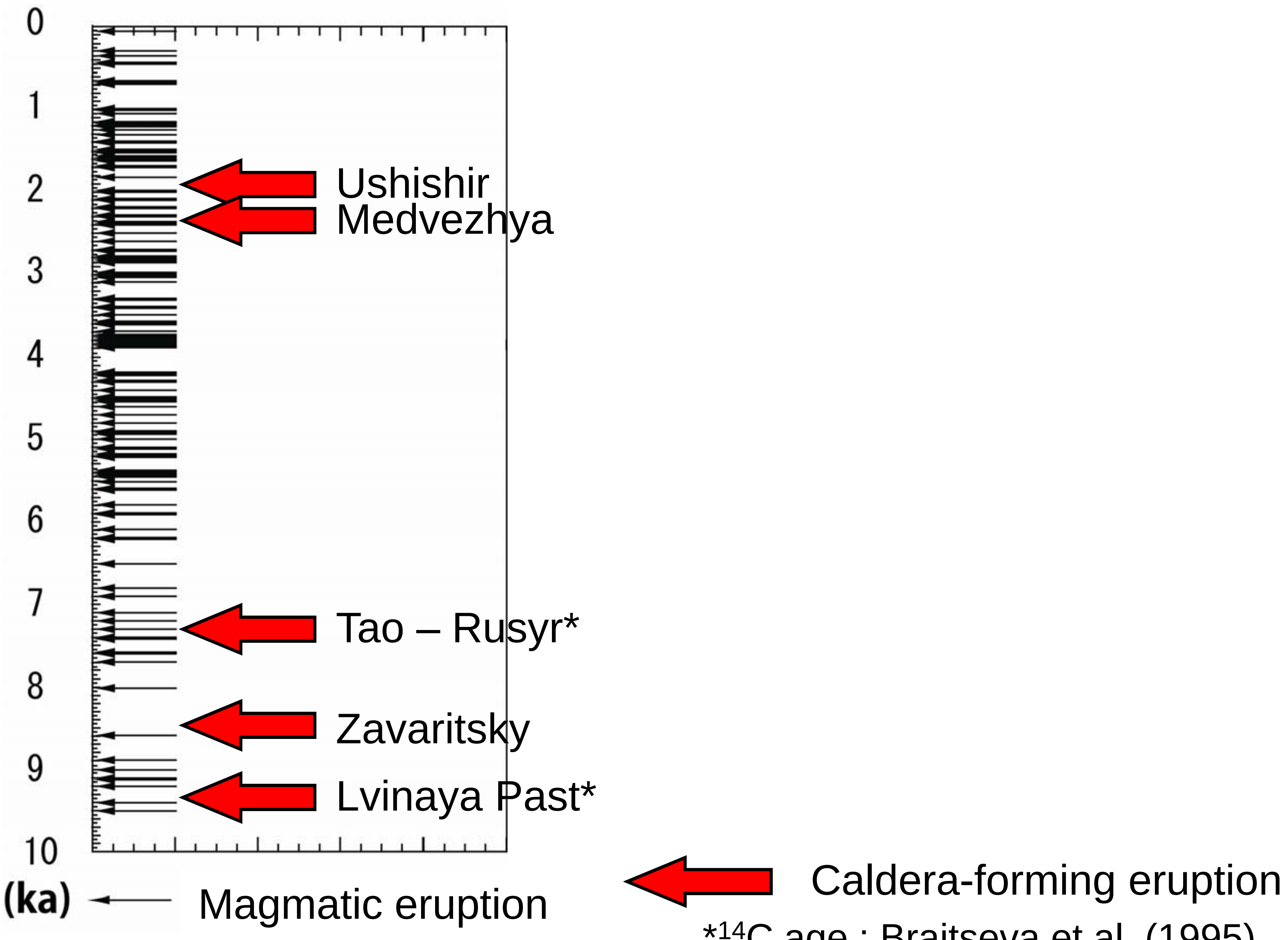
Chronology

^{14}C age & Marker tephra

Interpolation age using soil thickness



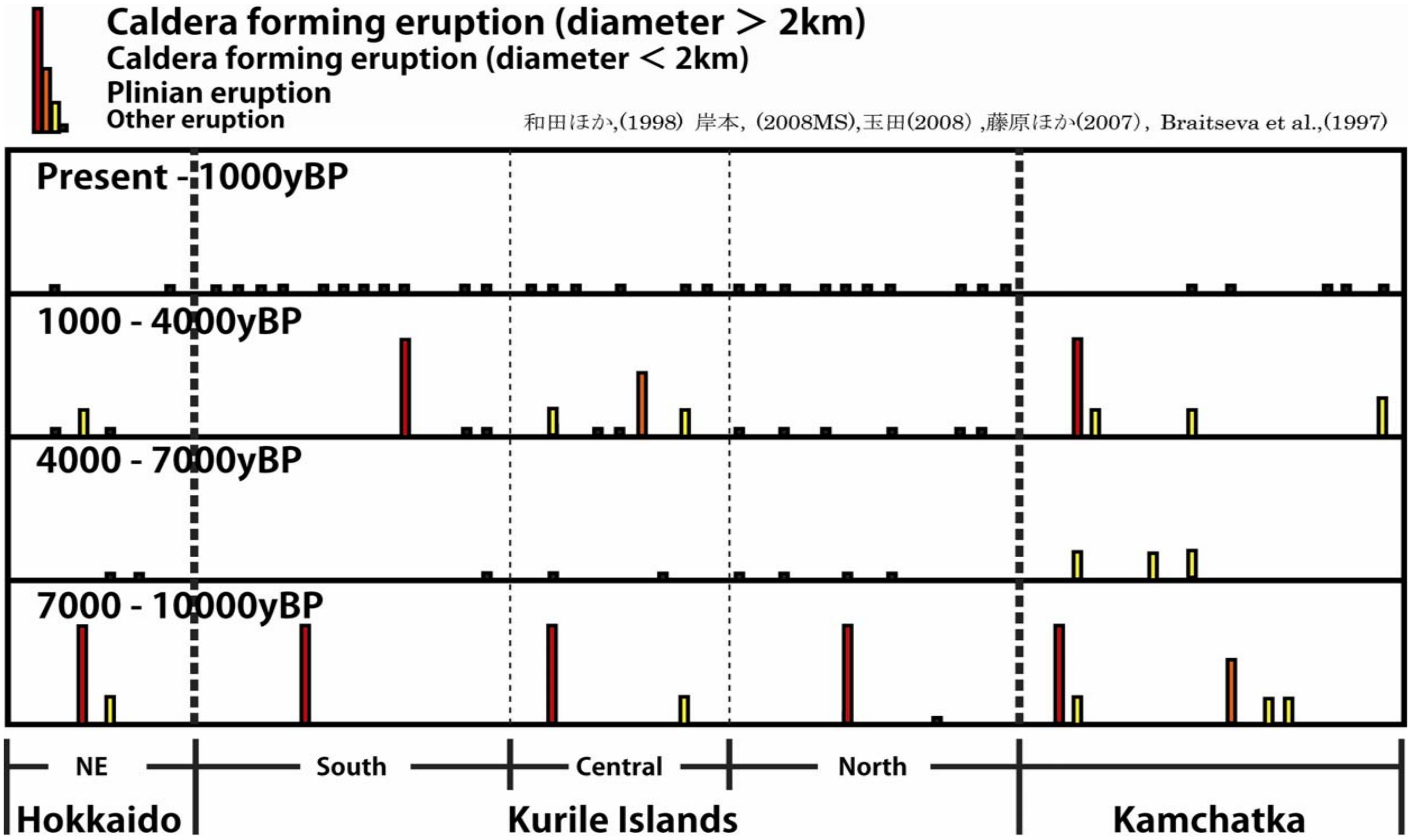
Eruptive activity of Kuril islands during Holocene



*[14]C age : Braitseva et al. (1995)

Eruptive activity from Hokkaido to Kamchatka during Holocene

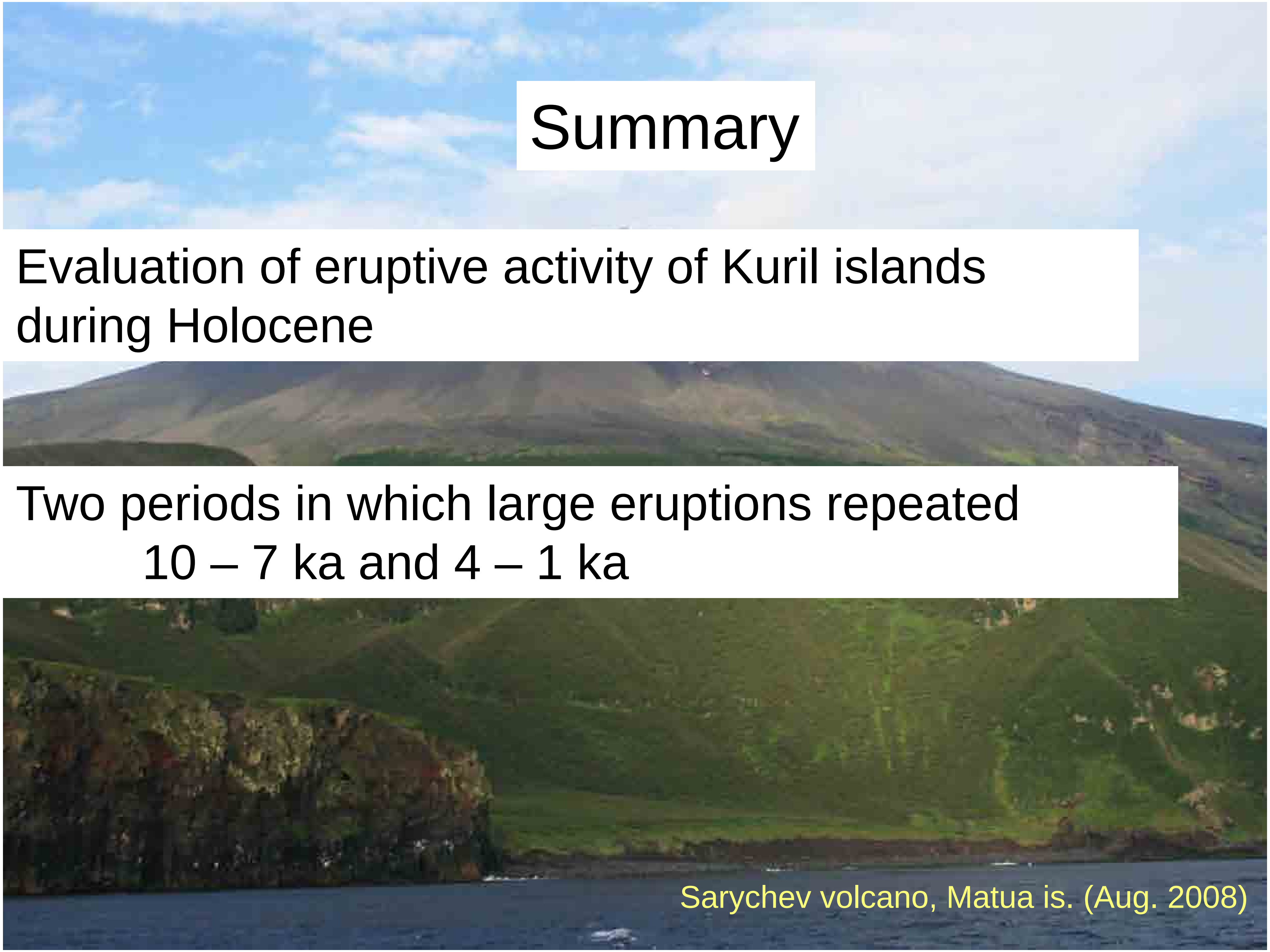
10.0～7.0ka : Frequent caldera-forming eruptions
4.0～1.0ka : Frequent large plinian eruptions



Summary

Evaluation of eruptive activity of Kuril islands during Holocene

Two periods in which large eruptions repeated
10 – 7 ka and 4 – 1 ka



Sarychev volcano, Matua is. (Aug. 2008)

Detection of volcanic ash caused by Icelandic Eyjafjallajokull volcano eruption on 14 April 2010 using dispersion model and lidar observations

V, Khattatov [1], A. Lukyanov [1], A. Ganshin [1], V. Yushkov [1], I. Veselovskii [2]

[1] Central Aerological Observatory (CAO), Dolgoprudny, Russia
[2] Physics Instrumentation Center of General Physics Institute, Troitsk, Moscow region, Russia

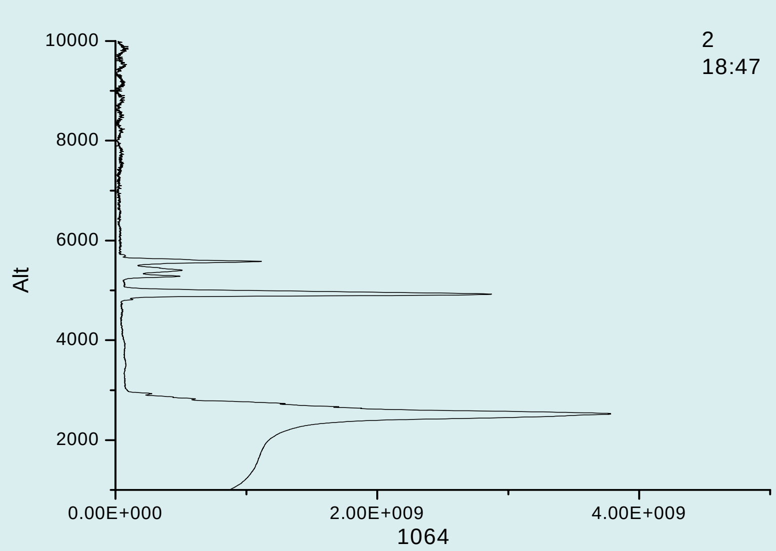
8-9 July, ISTC, Moscow

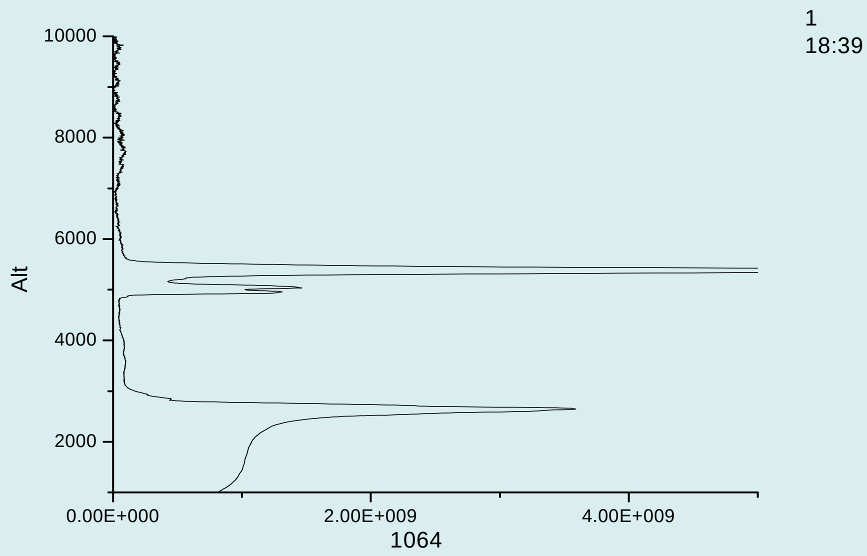
Lidar applications

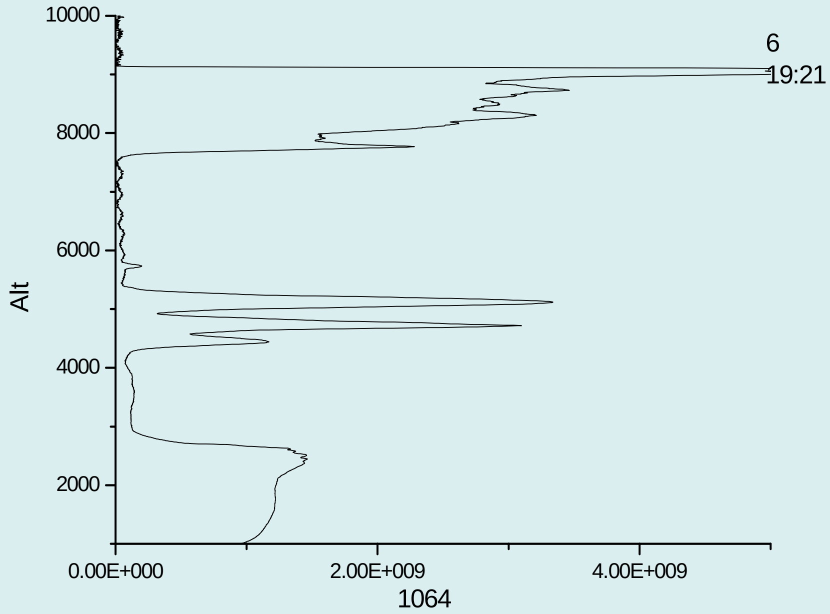
- Multi-wavelenght aerosol lidar is designed to observe parameters of stratospheric and tropospheric aerosol.

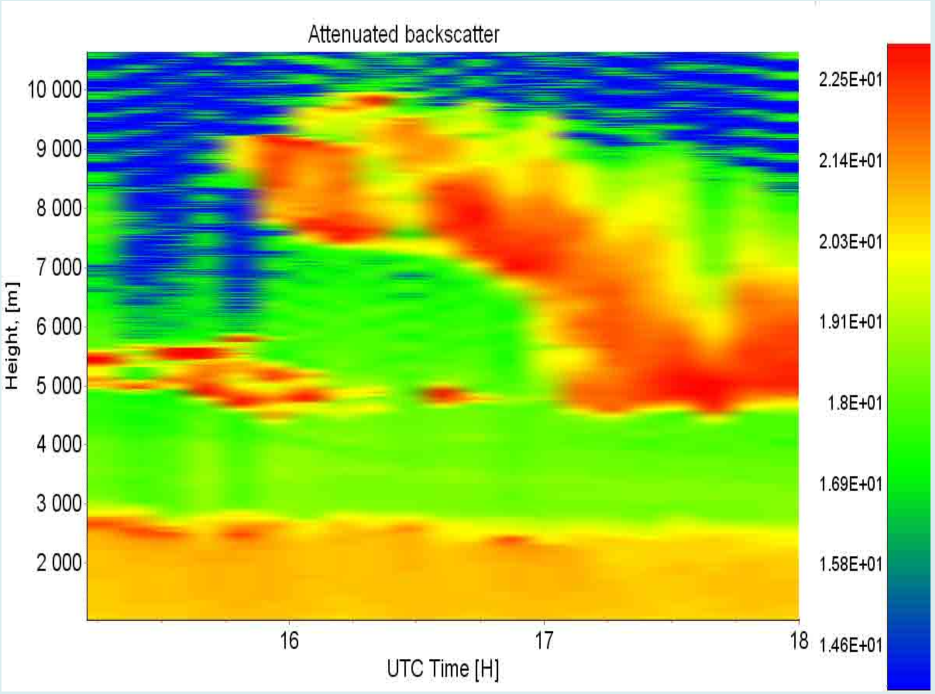
- Lidar provides the vertical distribution of following aerosol parameters:
  - backscatter coefficient at wavelenght 355, 532, 1064 nm;
  - depolarization coefficient;
  - mean and effective radius;
  - number, surface and volume densities.

Lidar sounding of atmosphere April 19, 2010

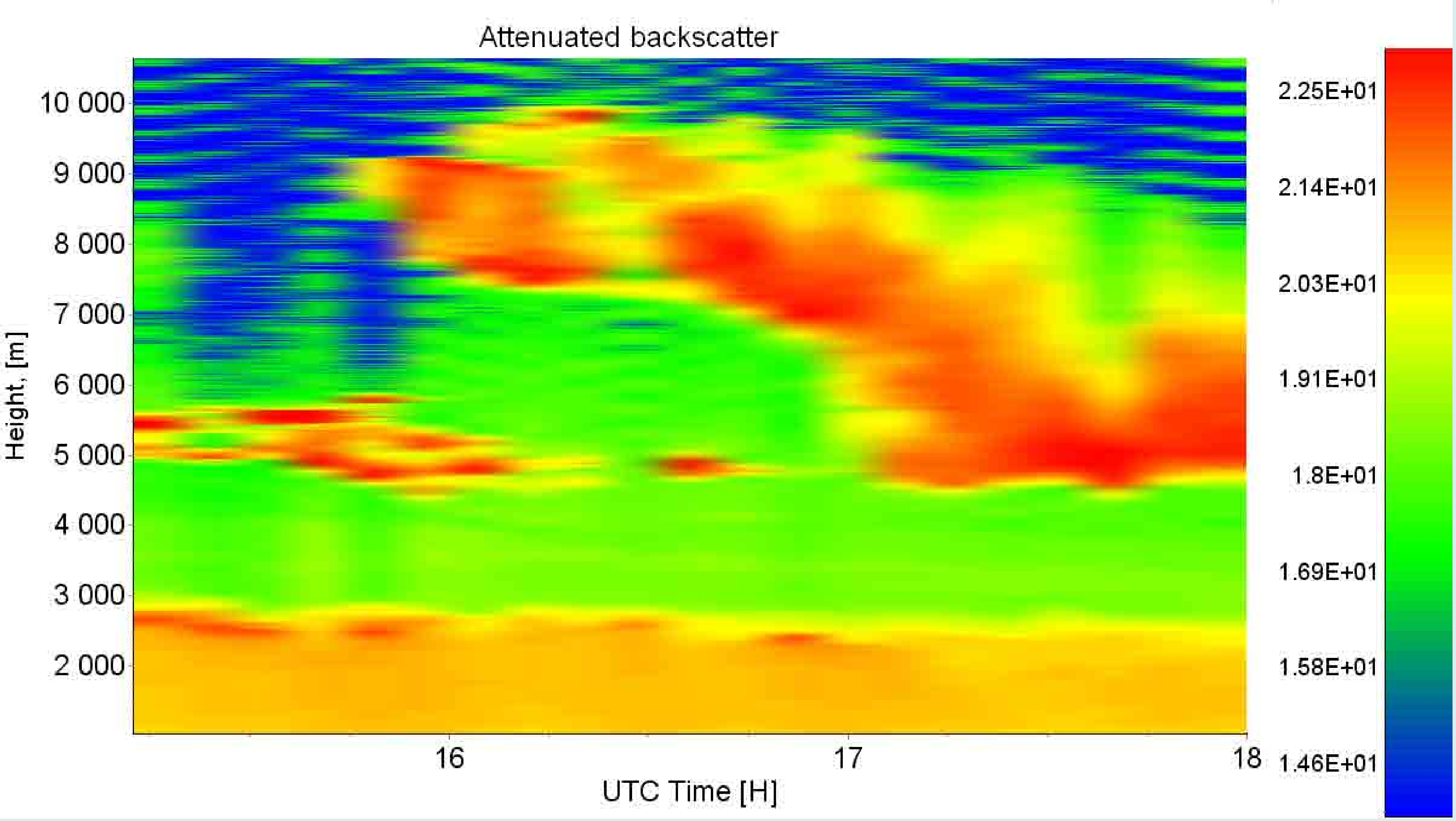




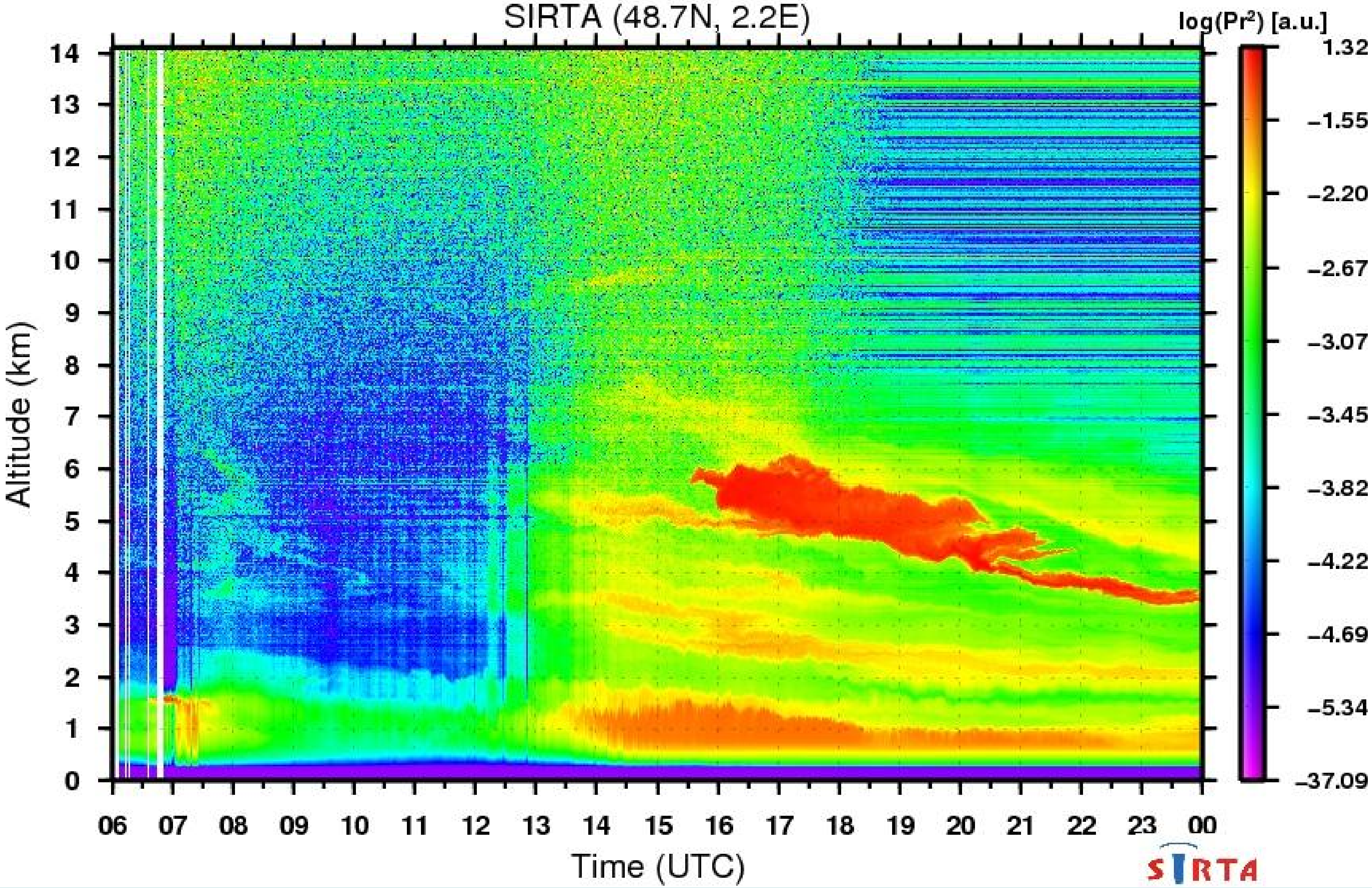




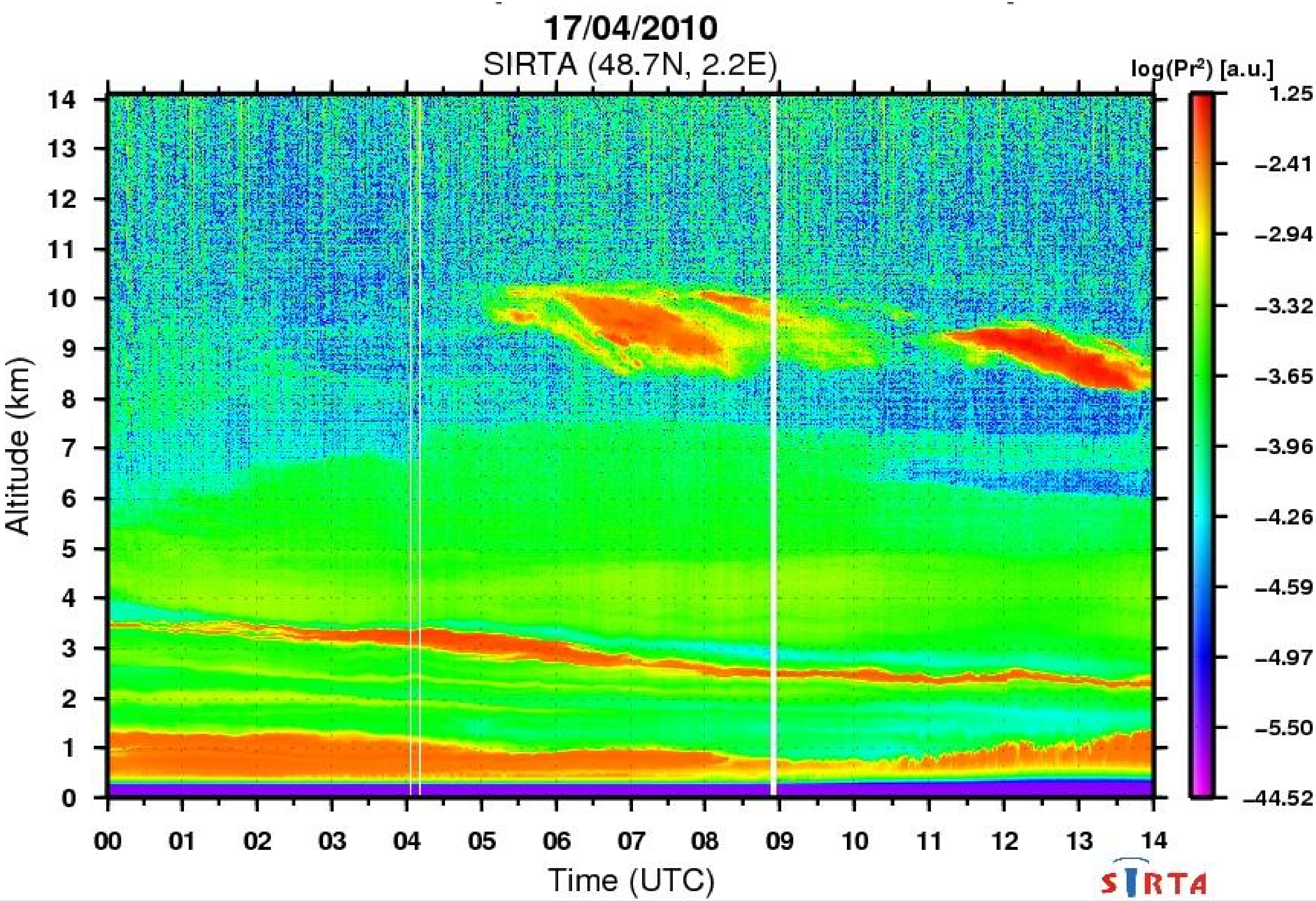
Evolution of volcanic ash cloud based on lidar sounding, April 19, 2010



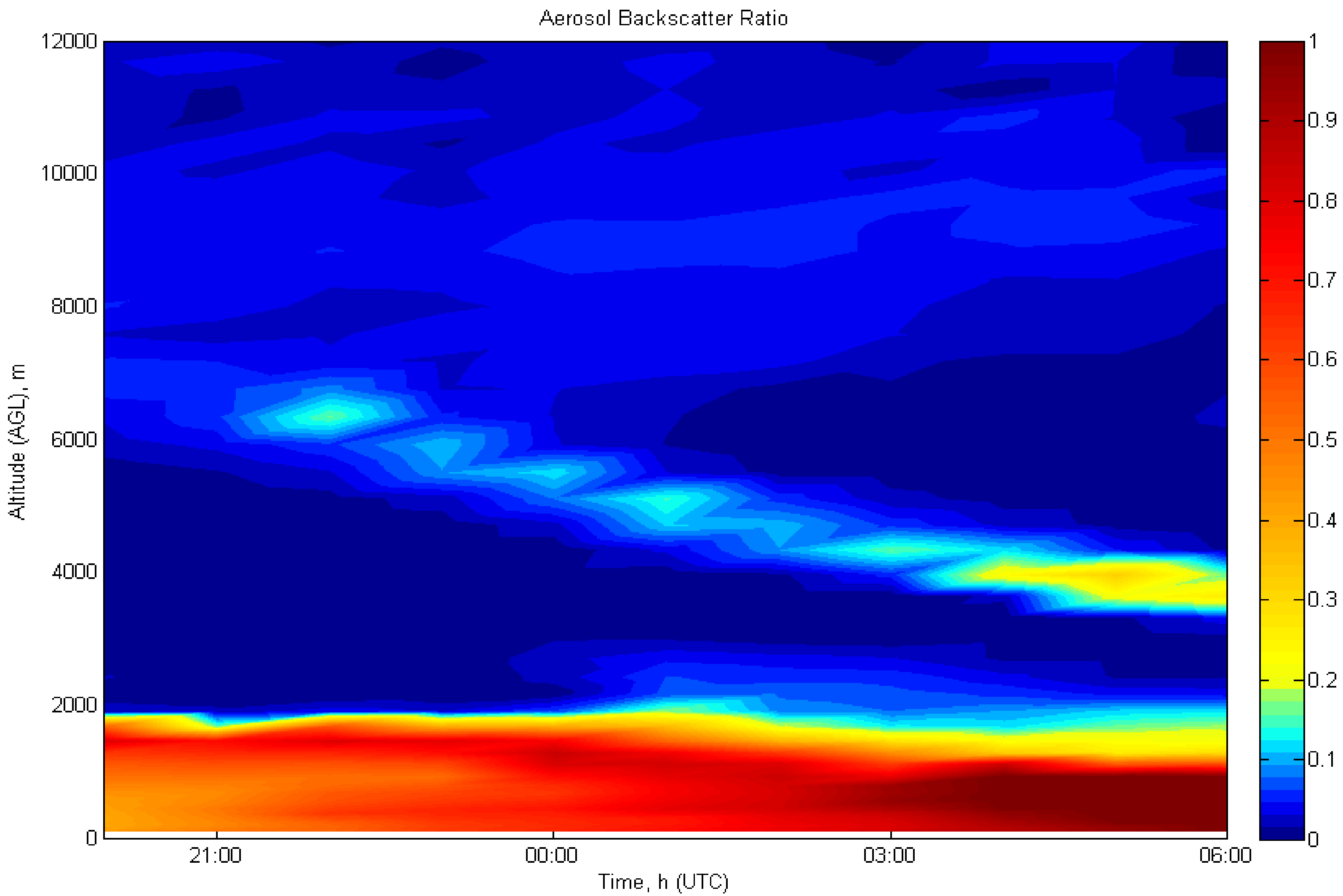
Lidar sounding in France April, 16, 2010 at wavelenght 0,53 mkm

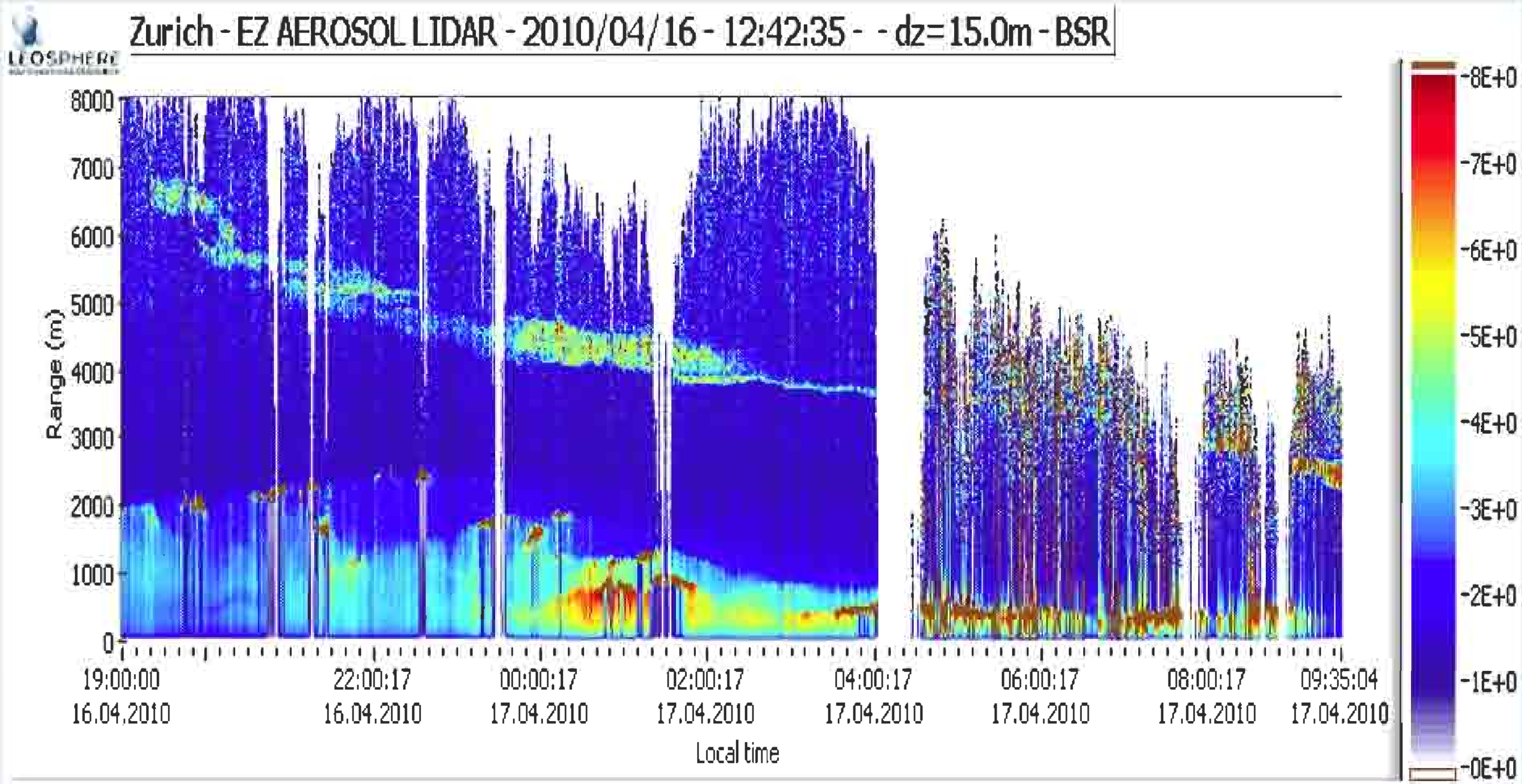


Lidar sounding in France April, 17, 2010 at wavelenght 1,06 mkm



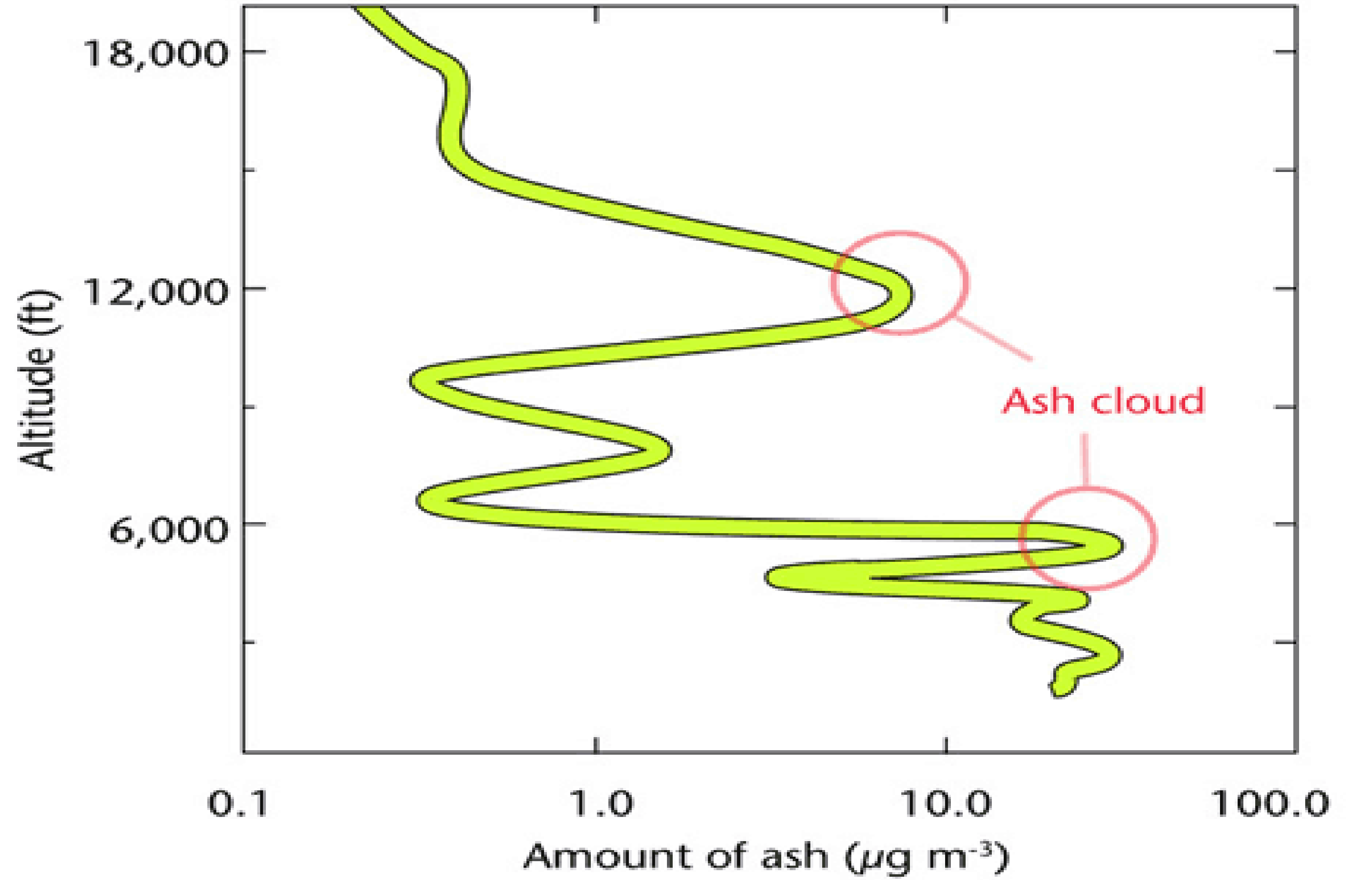
Lidar sounding in Swizerland April, 17, 2010



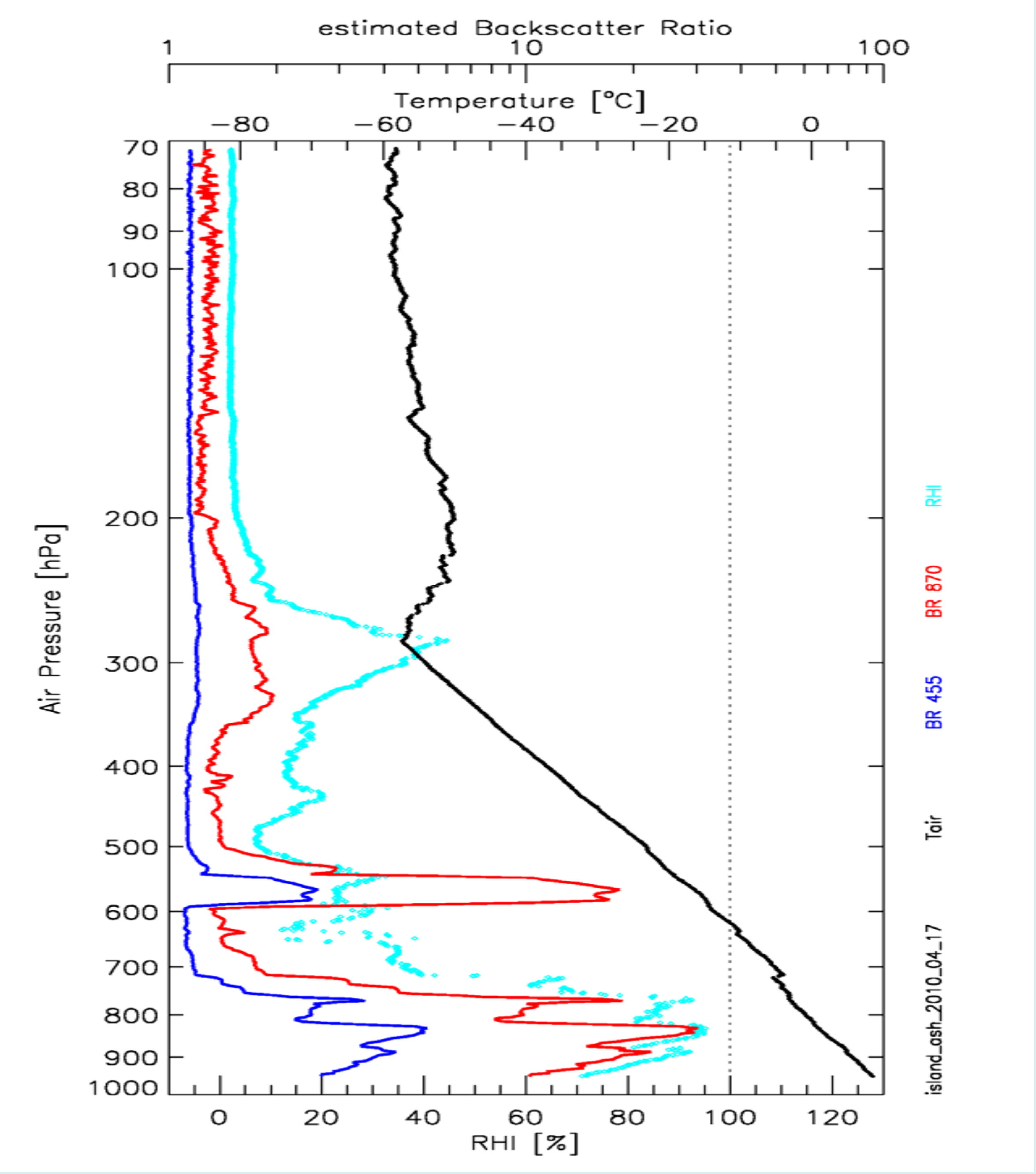


Zurich - EZ AEROSOL LIDAR - 2010/04/16 - 12:42:35 - - dz=15.0m - BSR
LEOSPHERE
Range (m)
8000
7000
6000
5000
4000
3000
2000
1000
0
19:00:00
16.04.2010
22:00:17
16.04.2010
00:00:17
17.04.2010
02:00:17
17.04.2010
04:00:17
17.04.2010
06:00:17
17.04.2010
08:00:17
17.04.2010
09:35:04
17.04.2010
Local time
8E+0
7E+0
6E+0
5E+0
4E+0
3E+0
2E+0
1E+0
0E+0

Aircraft observations in UK 19-21 of April



Balloon backscatter sonde observations



FLEXPART

Lagrangian particle dispersion model

(http://zardoz.nilu.no/~andreas/flextra+flexpart.html)

Input data:

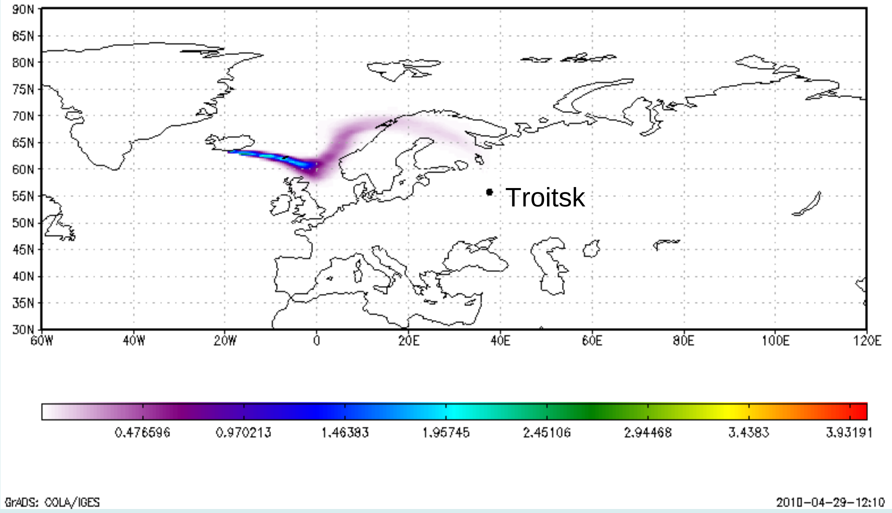
- Emission coordinates: 63.63°N, 19.62°W
- Emission height: 1 – 8.5 км
- Emission start: 14 April 2010, 06 UTC
- Model run duration: 6 days
- Ash flux: 2000 kg/s
- Composition density 2.33 г/см^3
- Mean diameter 1 mkm
- Reanalysis data NCEP
-
-

Output data:

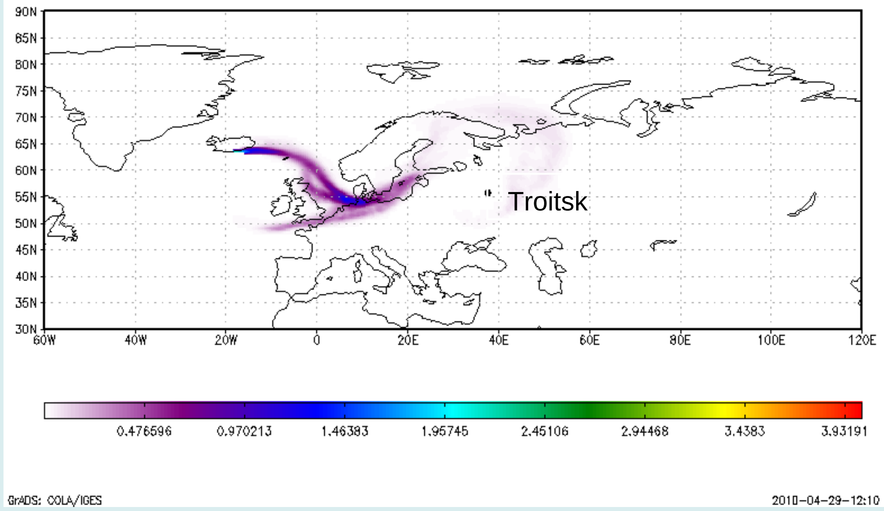
- Mean mass concentration (mg/m^3) in column from 0 to 10км

Volcanic ash cloud evolution obtained by using FLEXPART dispersion model

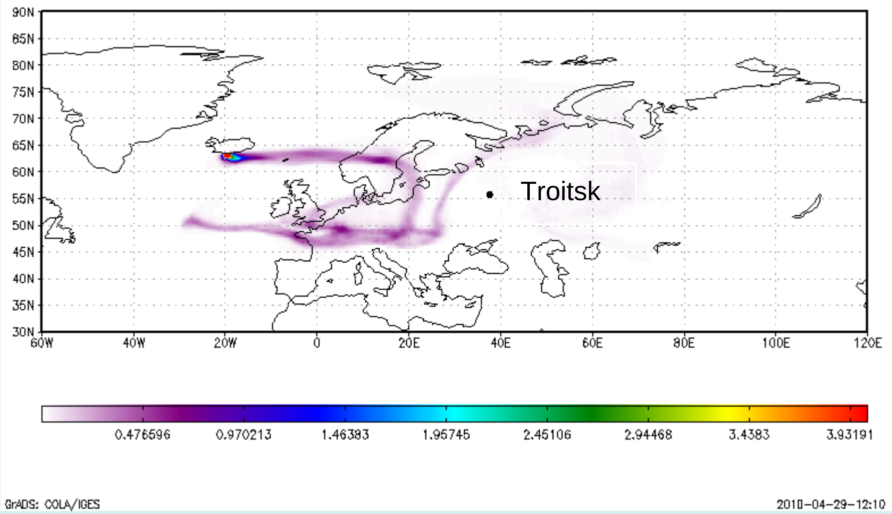
15.04.06



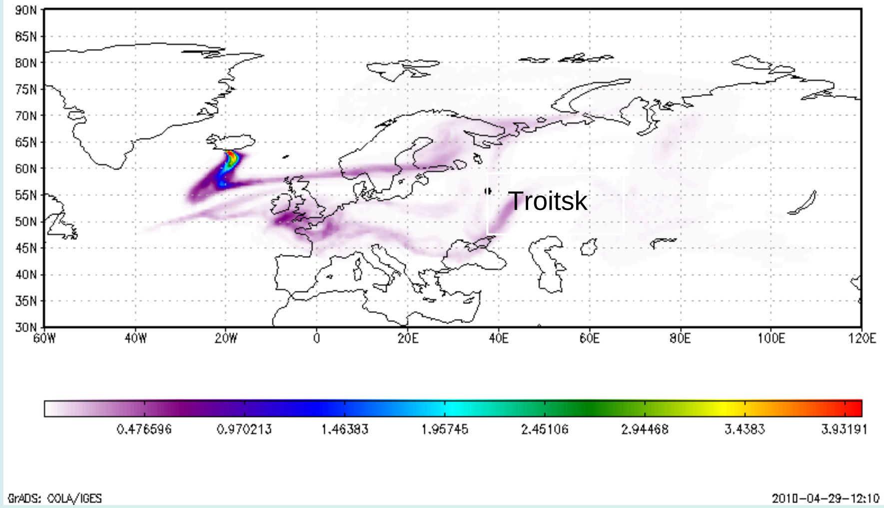
16.04.06



17.04.06

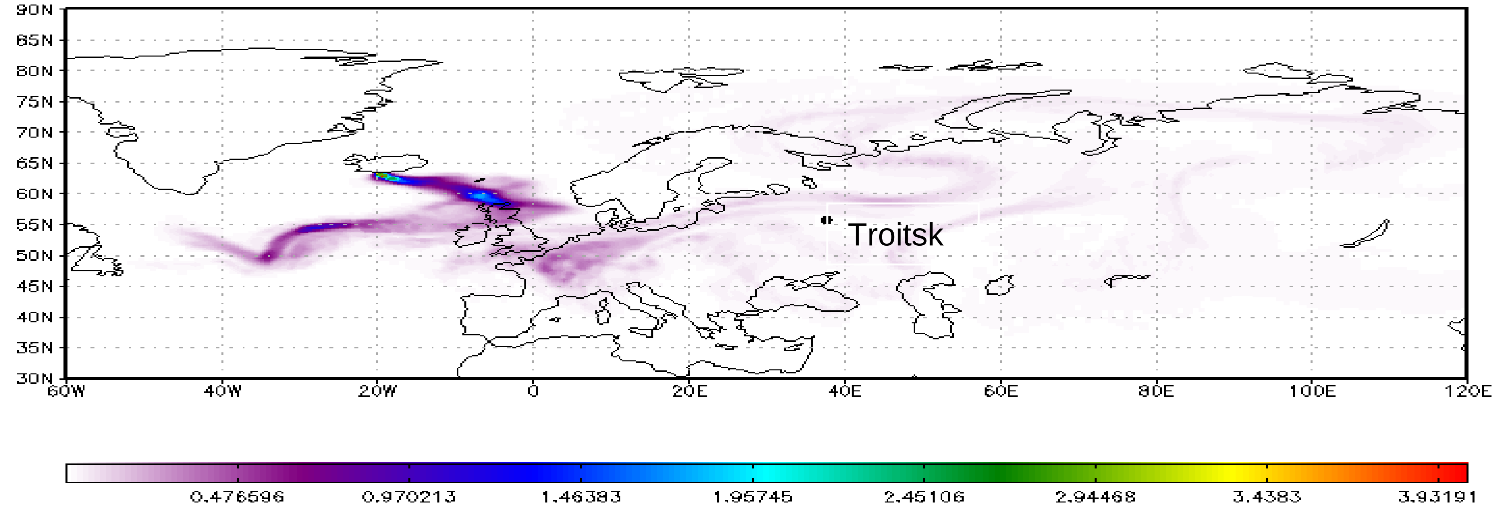


18.04.06



Volcanic ash cloud evolution obtained by using FLEXPART dispersion model

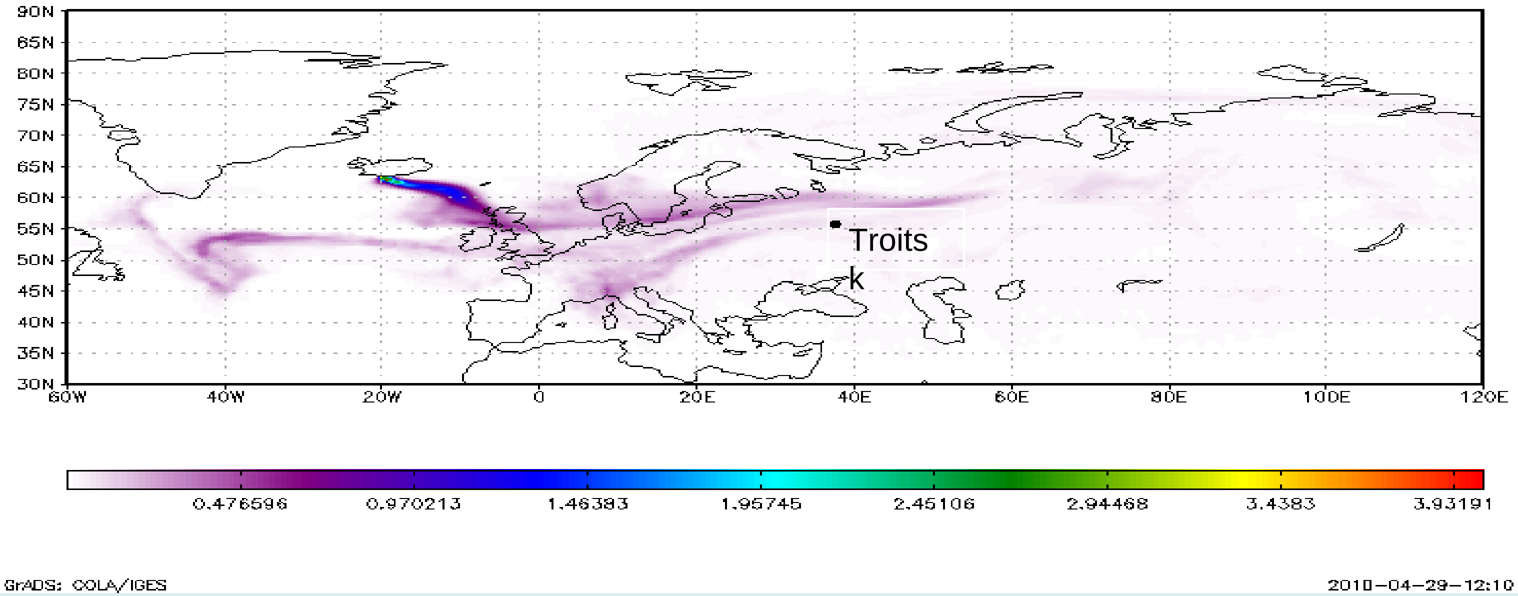
19.04.06



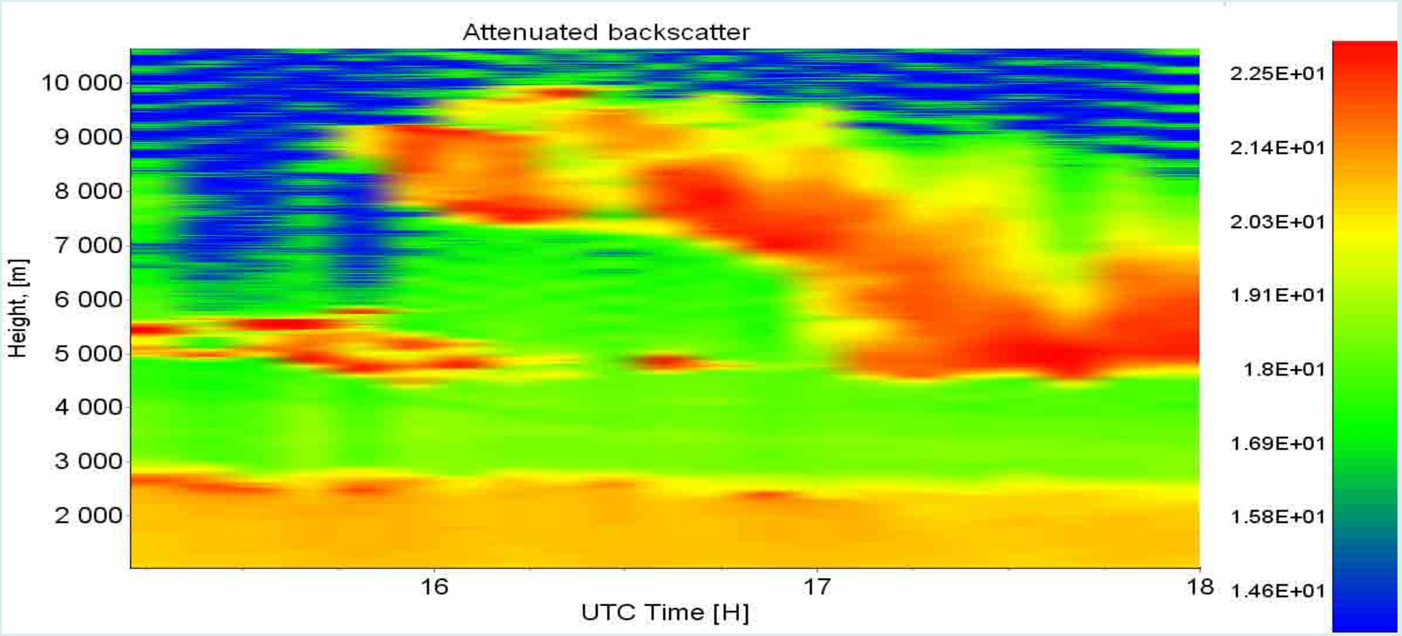
GrADS: COLA/IGES

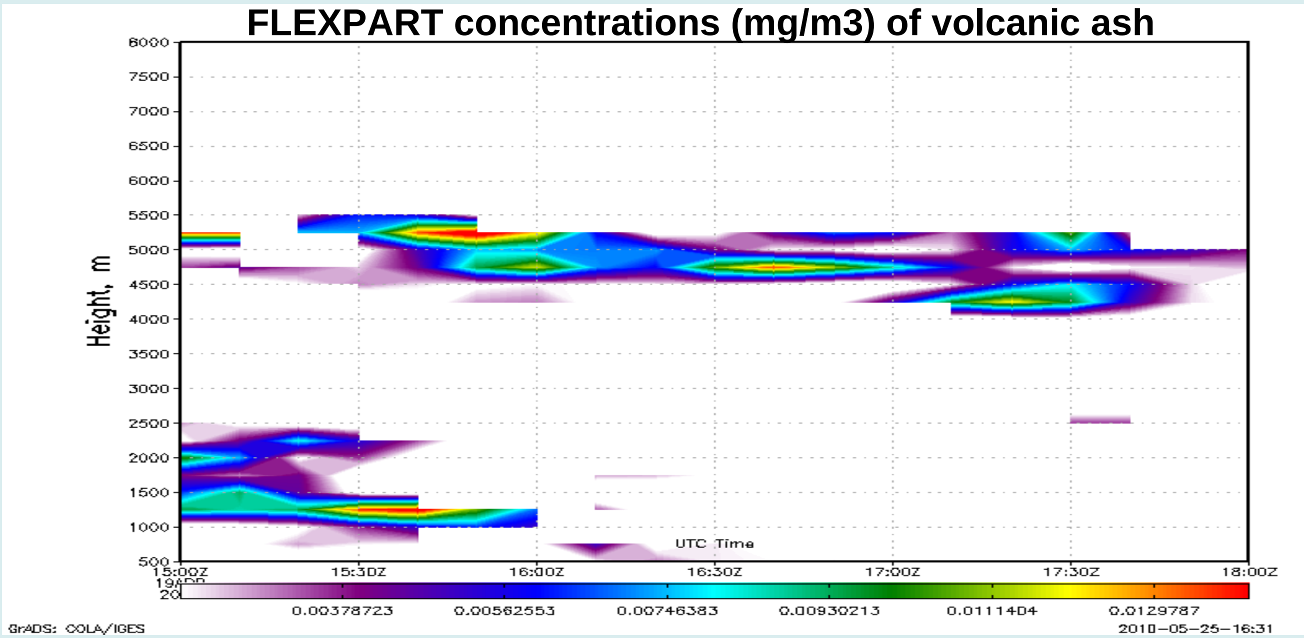
20.04.06

2010-04-29-12:10



Observations (top) and modeling (bottom) of ash cloud evolution over Troitsk on 19 April





Summary

- Model results and observations confirmed the presence of the volcanic ash near Moscow at the heights 5-7 km similar to other European regions.

- FLEXPART model has been successfully validated realistically reconstructing the lidar observations over Troitsk, Moscow region.

- Dispersion models based on forecast data can be used for planning of lidar and *in situ* observations.

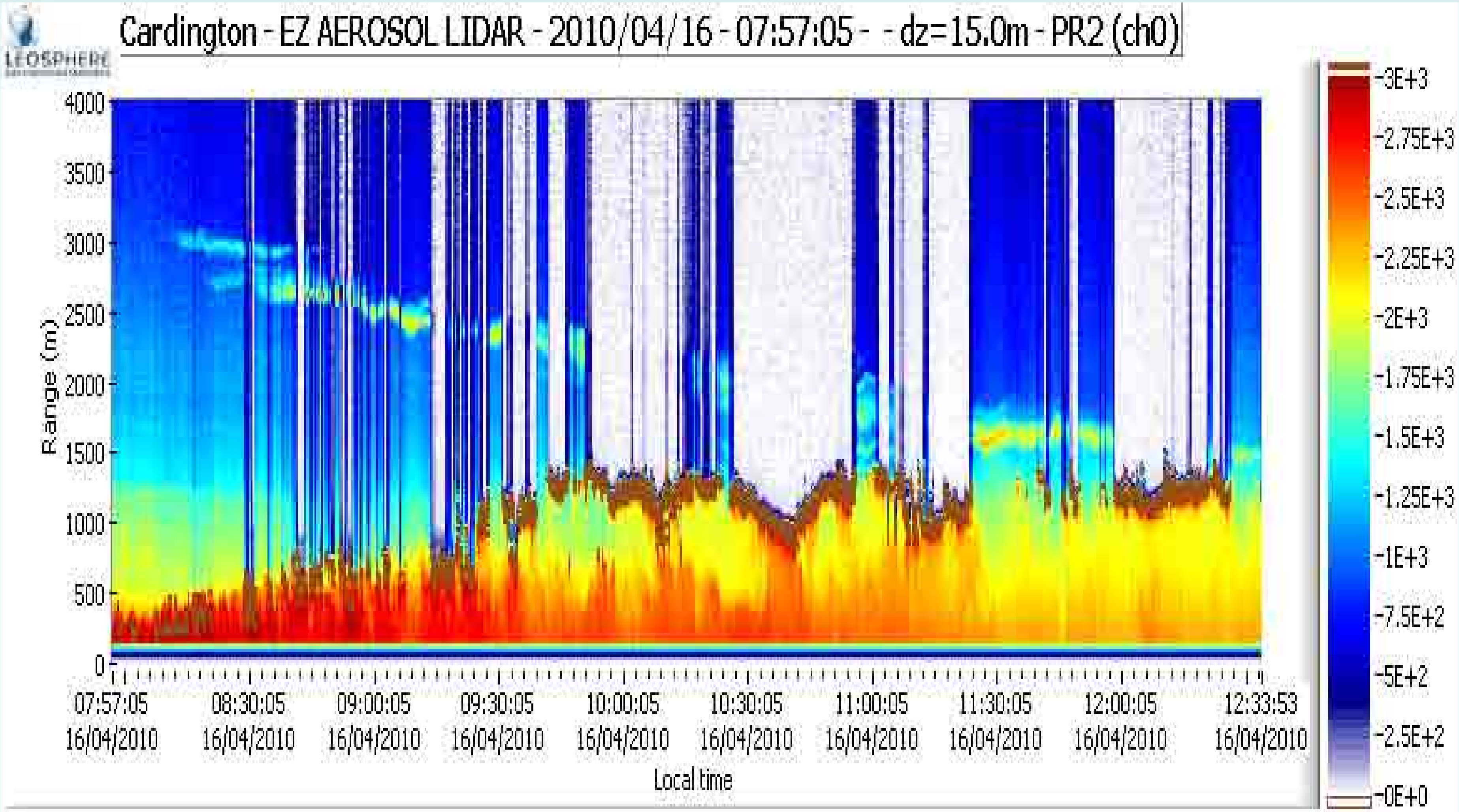
- Such a coupling of models and observations can provide the useful information for air traffic regulations.

Lidar observations near Troitsk, Moscow region

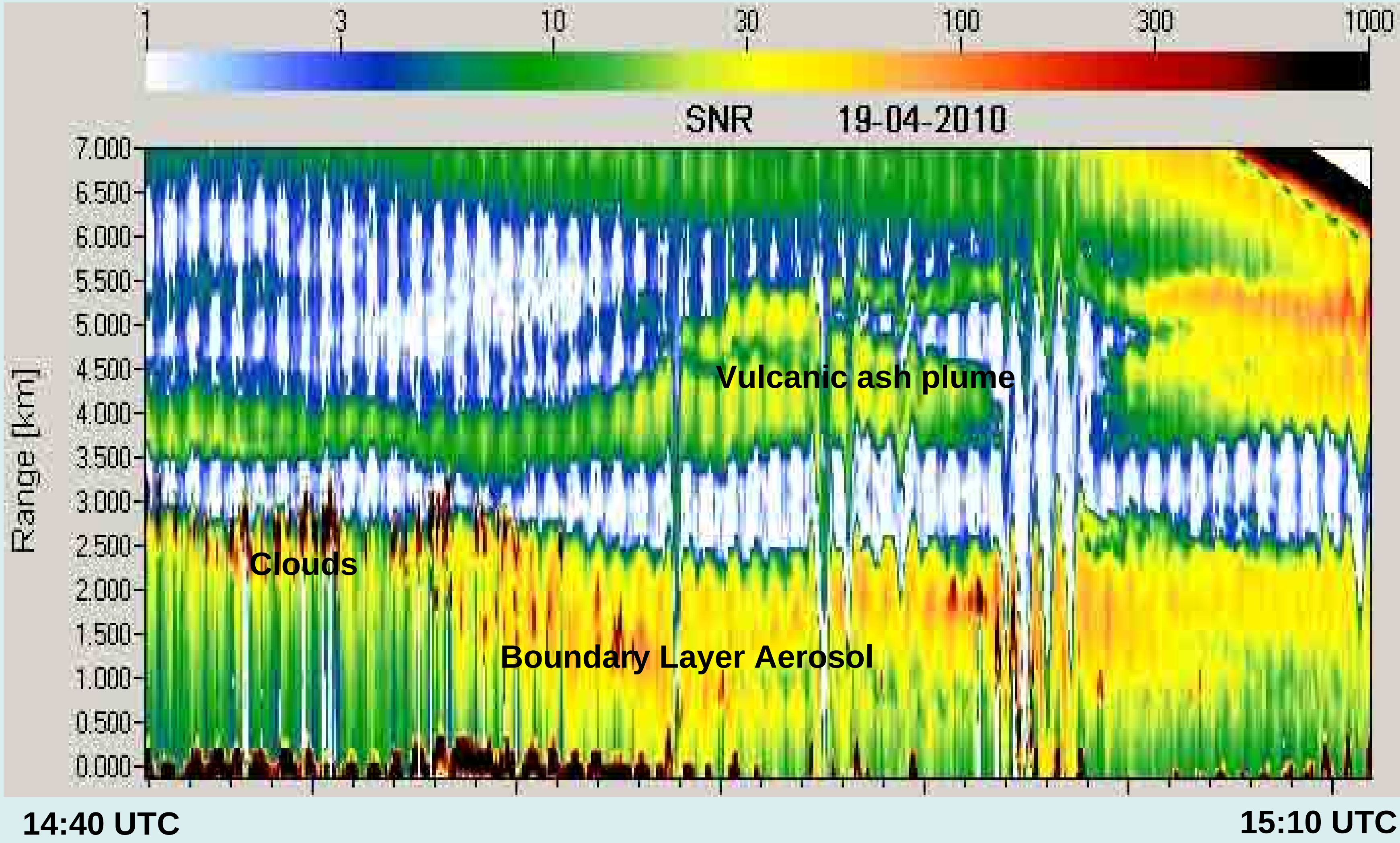
Lidar characteristics

- Height range
  1 км – 12 км
- Height resolution
- 7.5 m
- Observation time
  1 min
- Telescope aperture
  300 mm
- Telescope field of view
  0.25-0.5 mrad
- Width of the transition spectrum
  0.3 – 0.5 nm

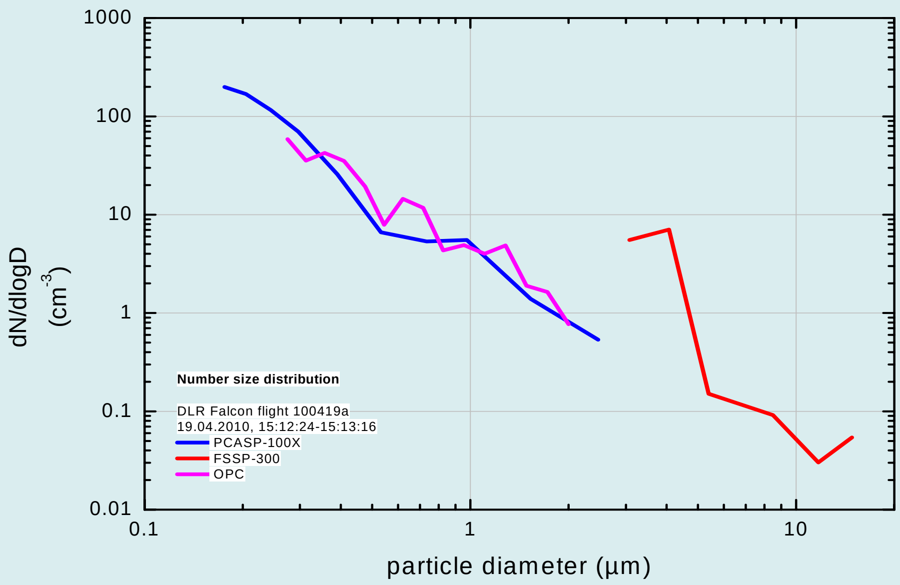
Lidar sounding in UK April, 16, 2010

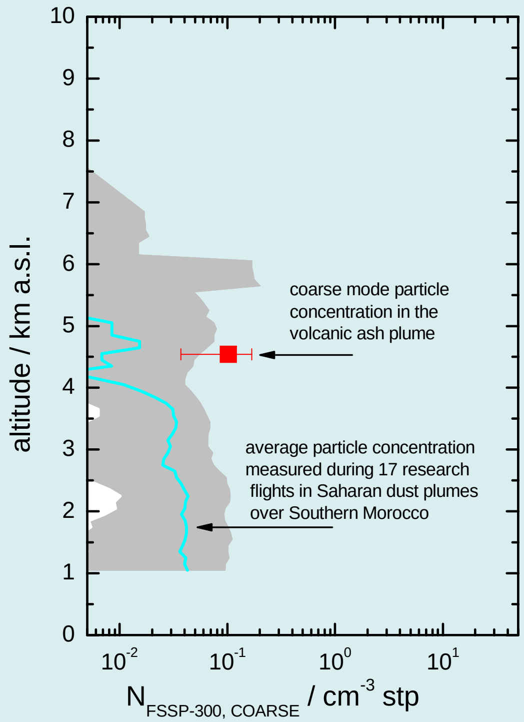


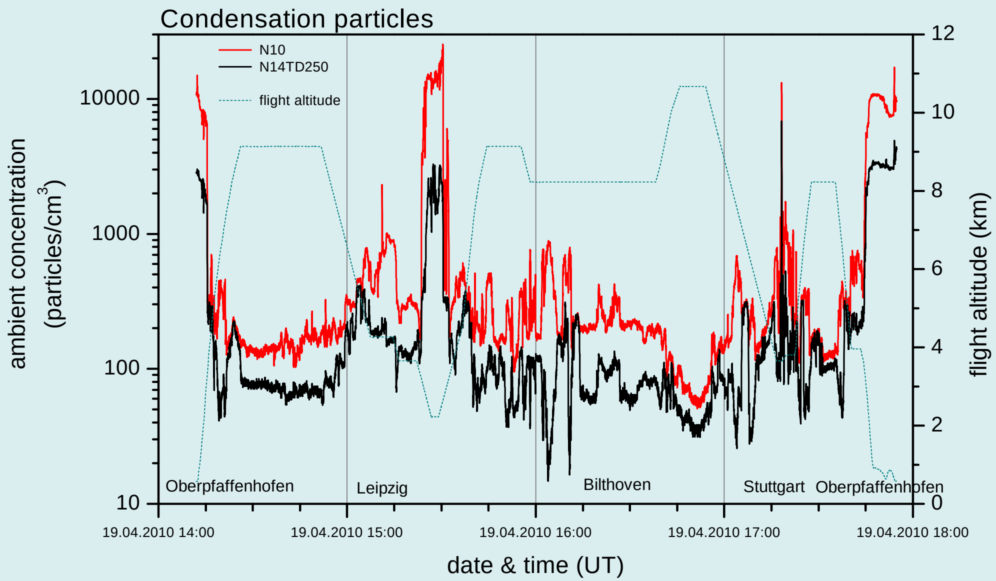
Aircraft lidar sounding in Germany April, 19, 2010

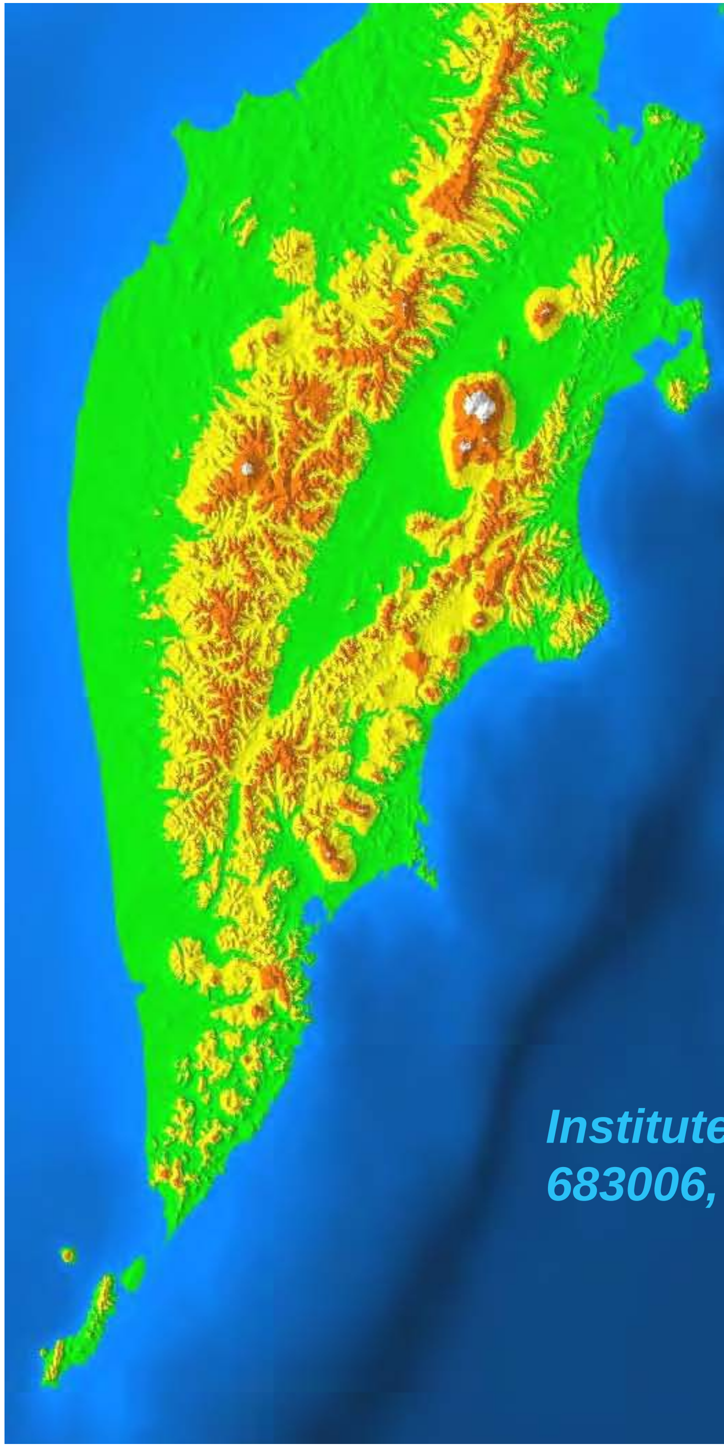


Aircraft observations of aerosol microstructure over Germany









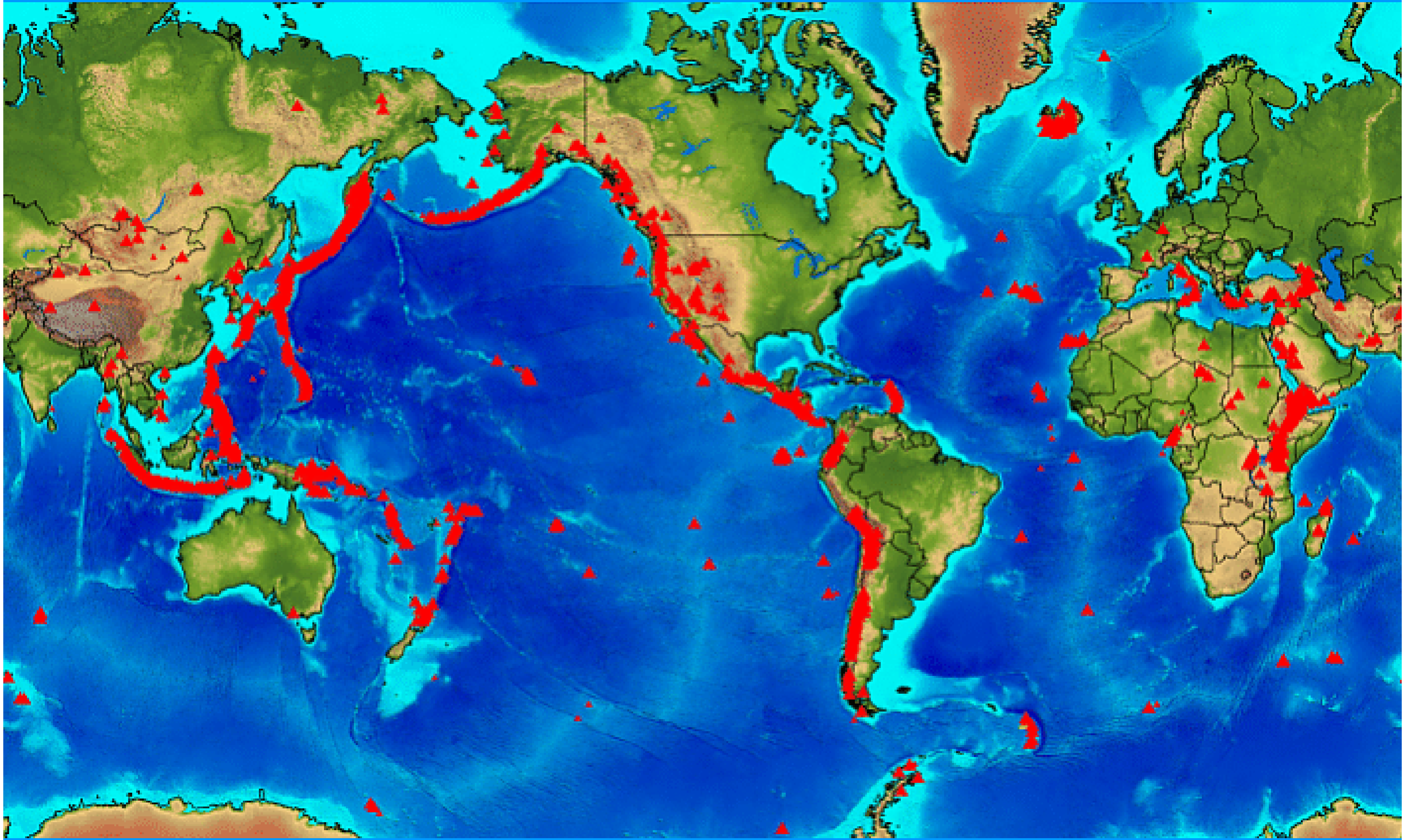
Reduce the risk of aircraft encounters with volcanic ash clouds in the North Pacific region

Olga A. Girina

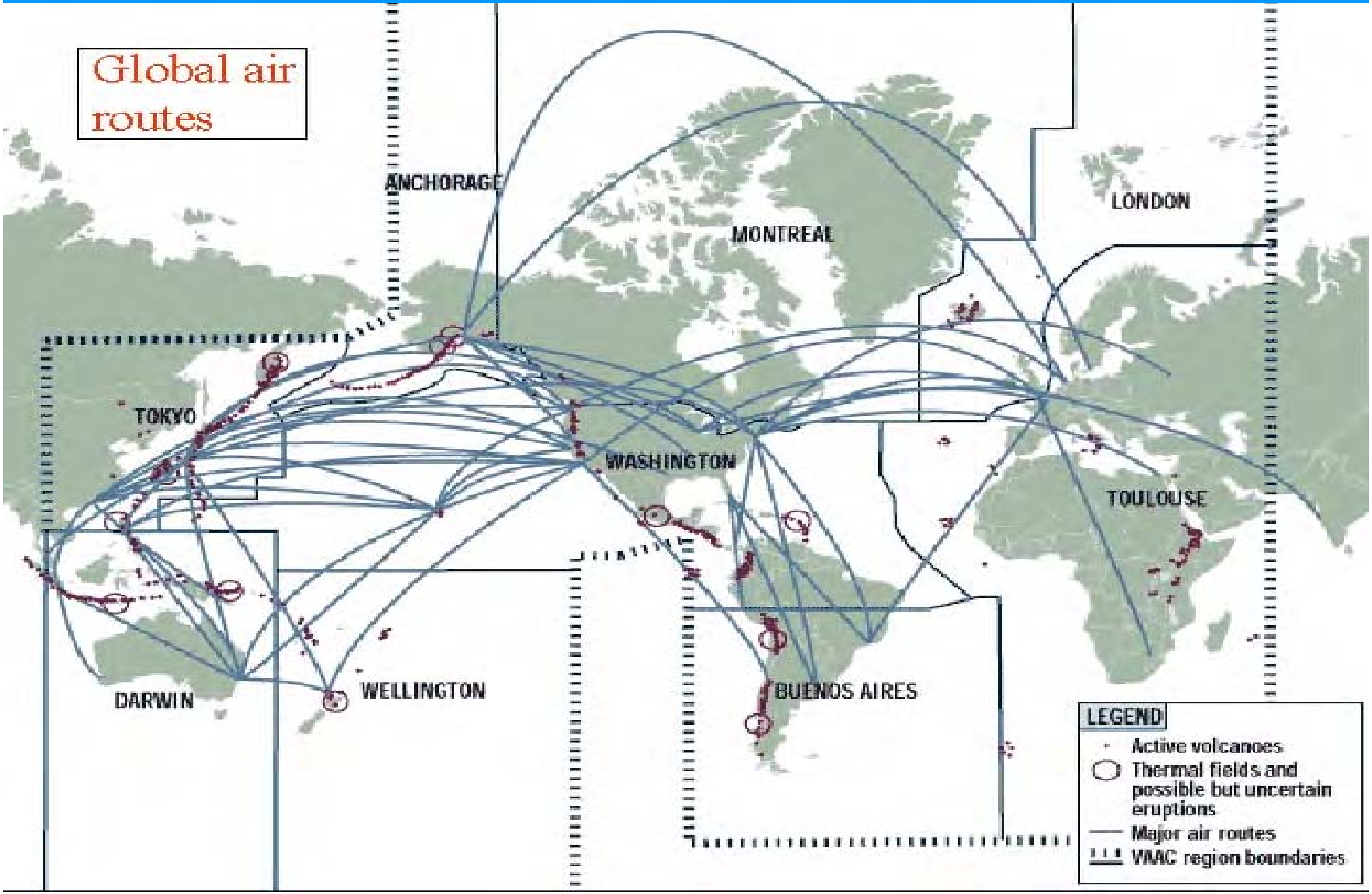
Institute of Volcanology and Seismology FED RAS,
683006, Petropavlovsk-Kamchatsky, Russia

Группа KVERT
(Kamchatkan Volcanic Eruption Response Team)

Active volcanoes of the world



Air Routes

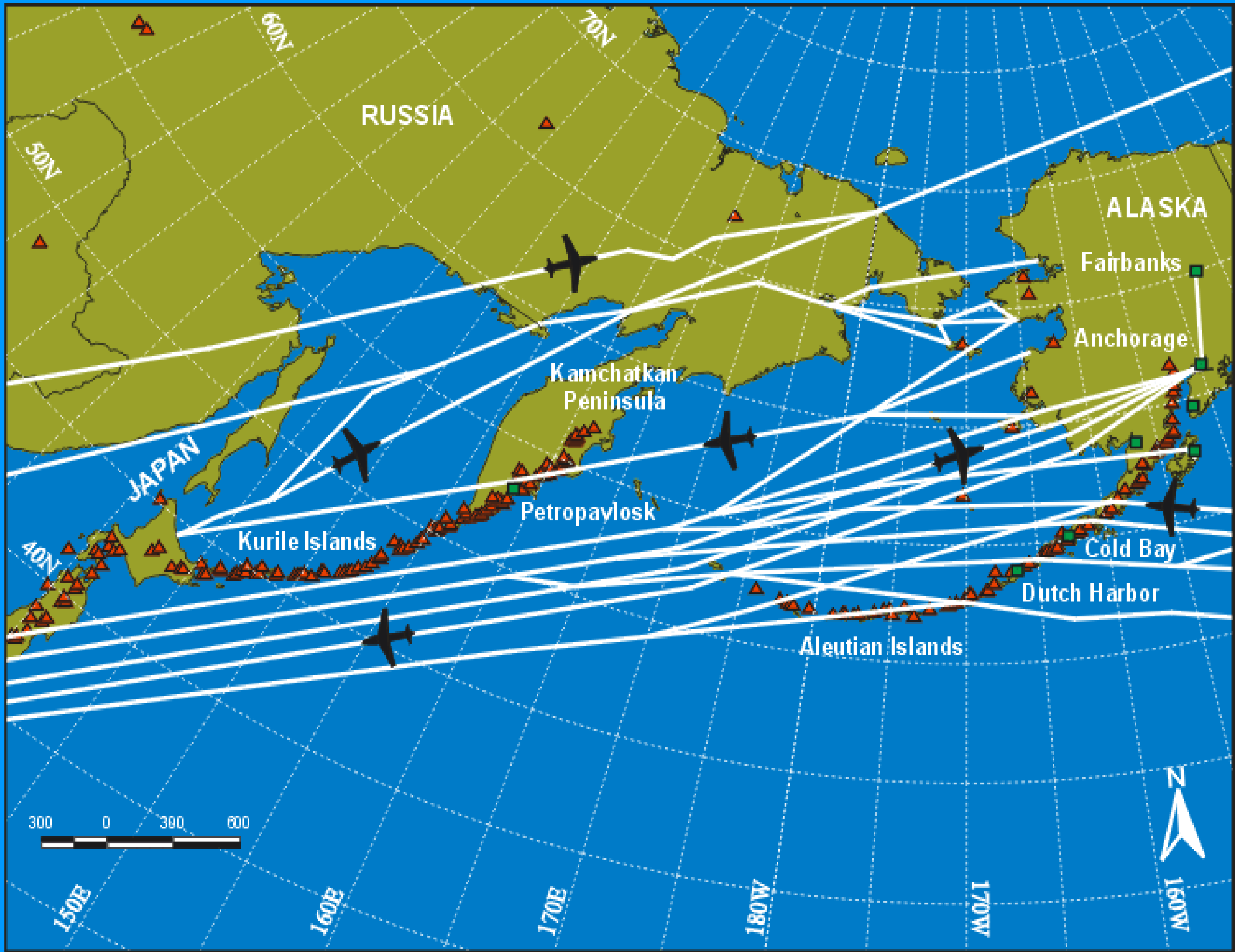

Global air routes
ANCHORAGE
MONTREAL
LONDON
TOKYO
WASHINGTON
TOULOUSE
DARWIN
WELLINGTON
BUENOS AIRES
LEGEND
Active volcanoes
Thermal fields and possible but uncertain eruptions
Major air routes
VAAC region boundaries

Air Routes and Volcanoes of the North Pacific

*>100 volcanoes from Alaska to the Kuriles

*5-6 explosive eruptions/yr

*30,000 passengers and more than 200 flights per day



USGS

Plinian volcanic eruptions

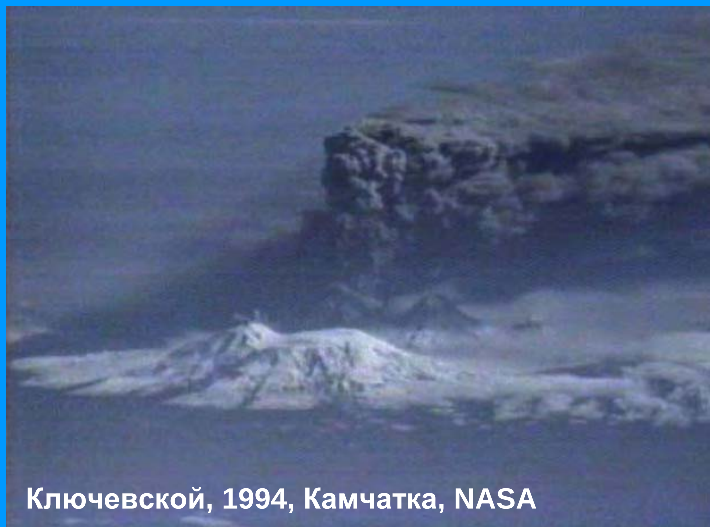
Height of ash plumes up to 30-40 km ASL


Ласкар, Чили, 1993. Фото А.Нюмен

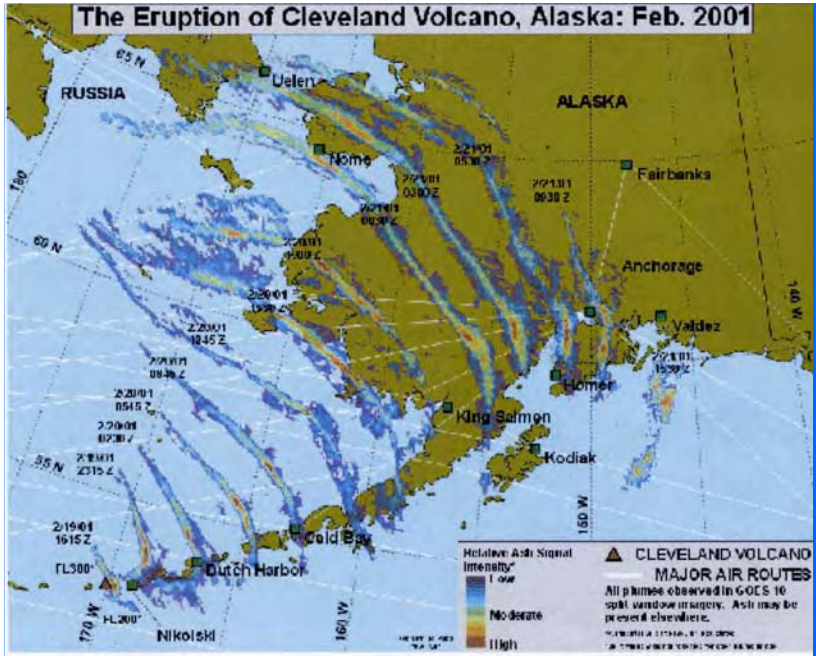

Редутский, 1989, Аласка, USGS, USA


Безымянный, 1956, Фото В.Шамшина

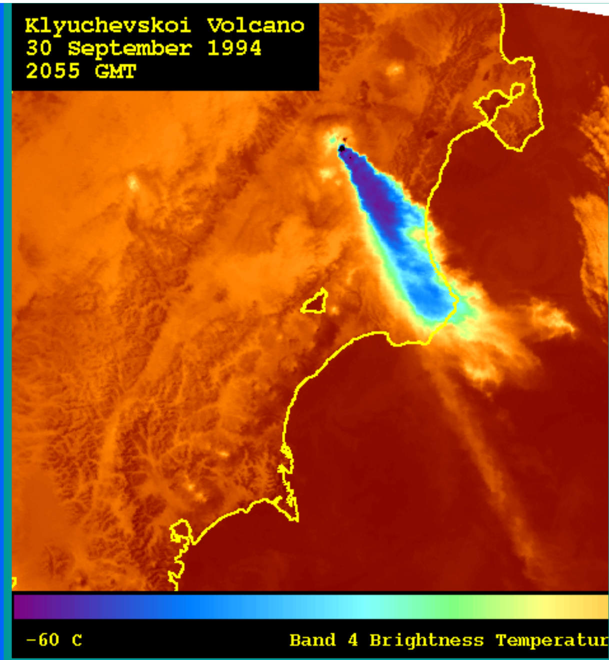

Ревентадор, Эквадор

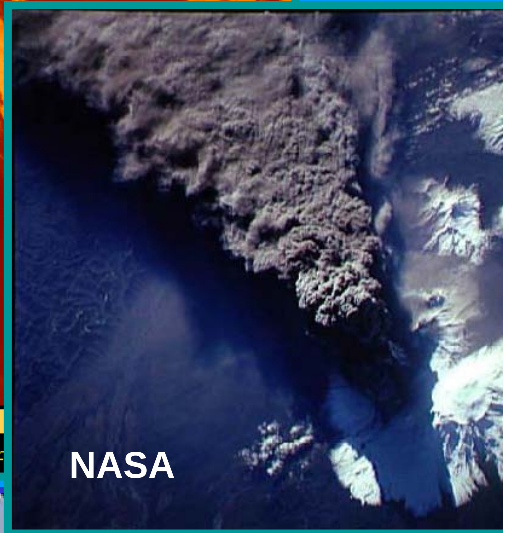

Ключевской, 1994, Камчатка, NASA

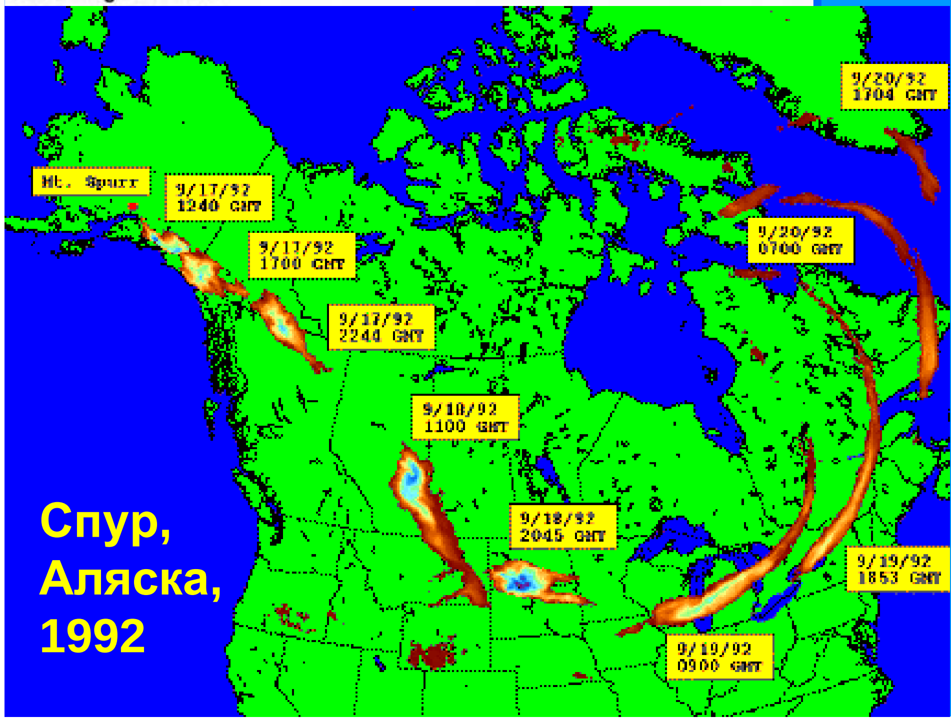
Шивелуч, 2001, Фото Ю. Демянчука



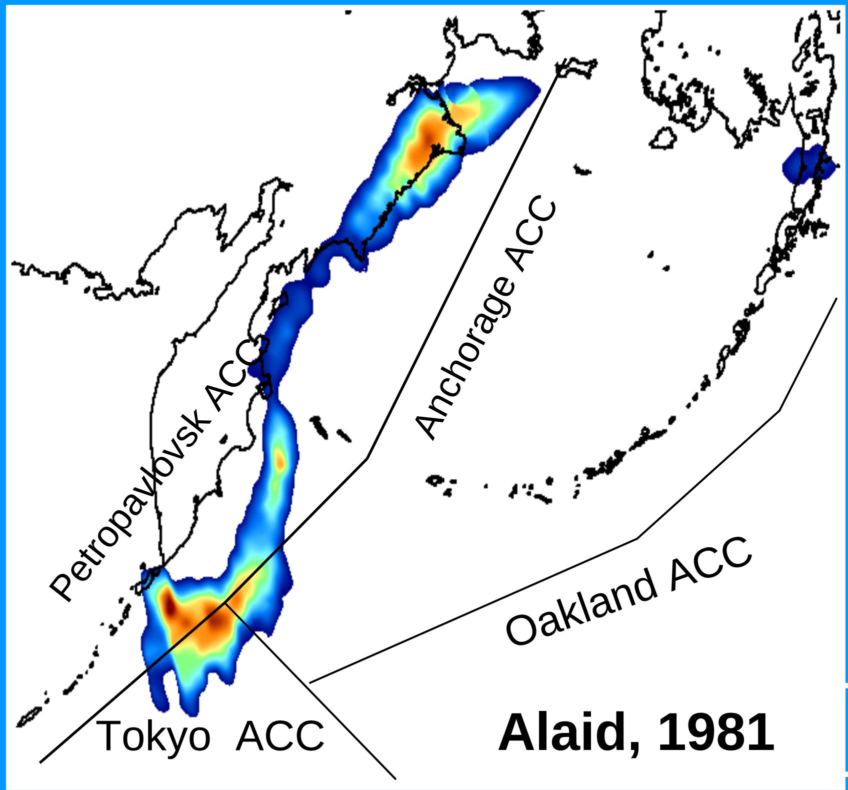
Cleveland Volcano
February 19, 2001
GOES image animation



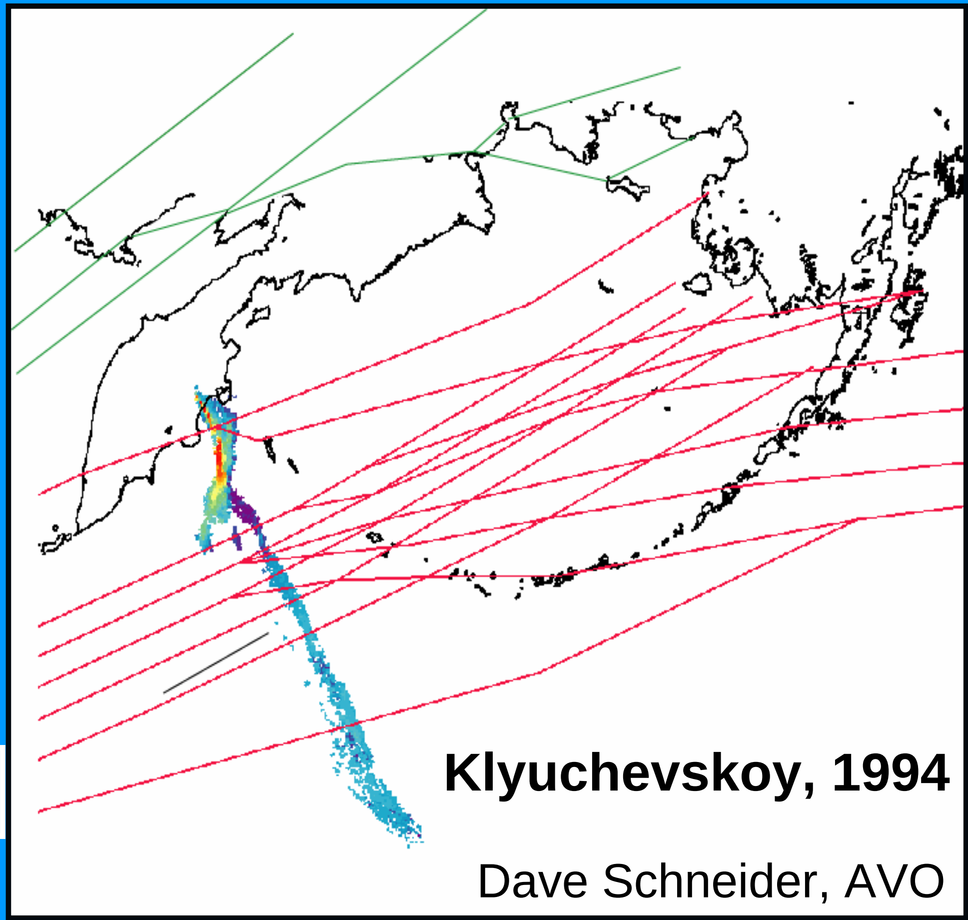




Because ash clouds can cross FIRs…

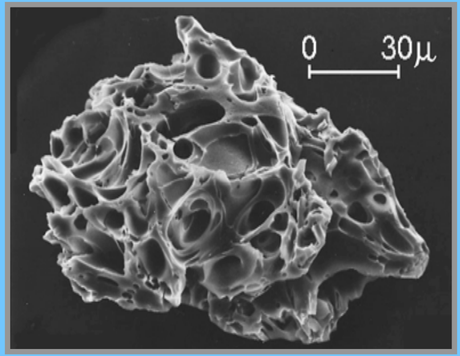


Dave Schneider, AVO



…eruptions in the North Pacific require an international response

USGS

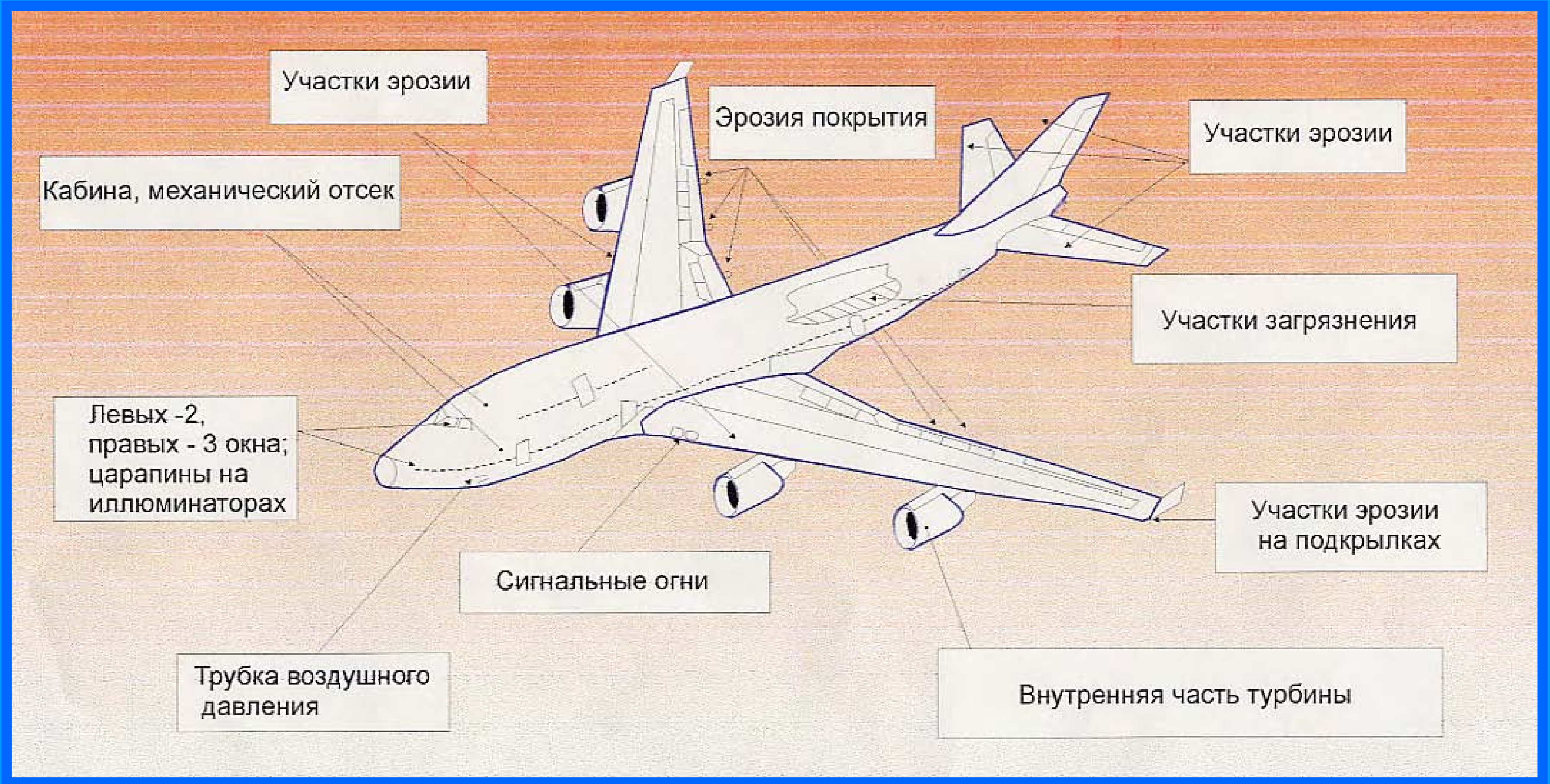


Volcanic Ash

- Small rock & mineral fragments – not soft powdery ash as from a wood fire.
- Ash particles are very hard, sharp, angular, <u>abrasive</u>.
- Melting temperature of glass is lower than the operating temperatures of modern engines.

Ash plumes and ashfalls for Aviation

Самолет DC-10 на авиабазе ВМС Кьюби-Поинт, Филиппины.

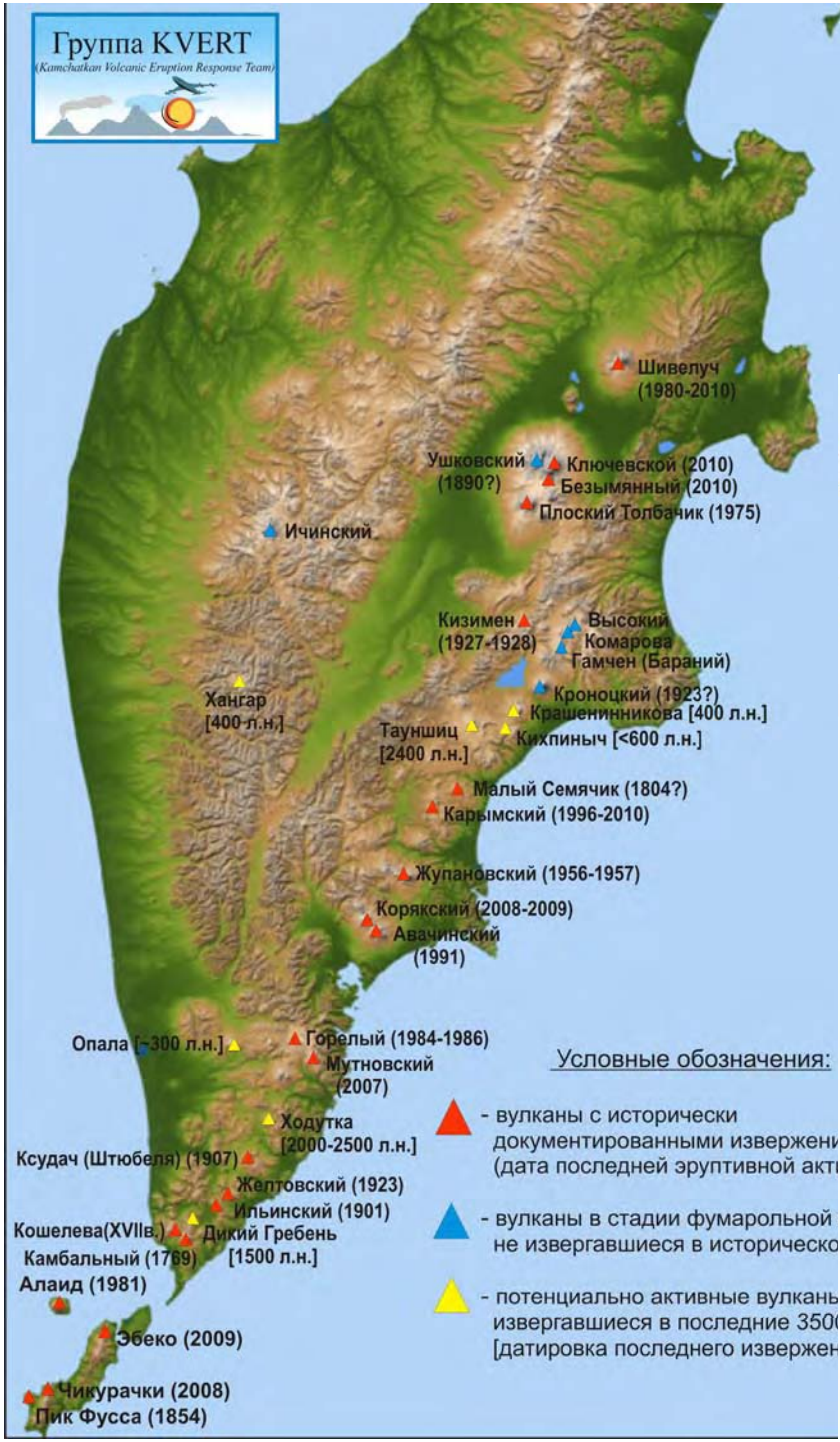


Acute Aircraft Damage

- **Abrasion of forward-facing surfaces.**
- **Ash infiltration into ventilation, pitot-static, and other flight instrument systems.**
- **Erosion of moving parts (compressor, turbine blades).**
- **Melting of ingested ash & accumulation of re-solidified material..** ***Principle cause of engine failure!!***
- **Blockage of fuel nozzles & cooling passages.**
- **Contamination & overheating of electronics.**
- **Contamination of hydraulic system.**

Active volcanoes of Kamchatka and Northern Kuriles

http://www.kscnet.ru/ivs/kvert/volcanoes/index_eng.html



KVERT: ACTIVE VOLCANOES OF KAMCHATKA AND NORTHERN KURILES

Back | Main | IVS FEB RAS | KSC FEB RAS   Russian

№	Name	IAVCEI CATALOG #	Location	Last Eruption	Elevation
					Google Earth
			KAMCHATKA		
	SECTION North:				
1	Sheveluch	1000-27	56°39'N, 161°21'E	2010	3,283 m
2	Klyuchevskoy	1000-26	56°03'N, 160°39'E	2009-2010	4,750 m
3	Ushkovsky	1000-261	56°04'N, 160°29'E	1890	3,943 m
4	Bezymianny	1000-25	55°58'N, 160°36'E	2010	2,882 m
5	Plosky Tolbachik	1000-24	55°49'N, 160°24'E	1975	3,085 m
6	Ichinsky	1000-28	55°40'N, 157°43'E	~ 300-400 BP	3,621 m
	SECTION Center:				
7	Kizimen	1000-23	55°08'N, 160°19'E	1927-1928	2,485 m
8	Vysoky		55°03'N, 160°45'E	2000 BP	2,153 m
9	Gamchen	1000-21	55°08'N, 160°42'E	Unknown	2,576 m
10	Komarov	1000-22	55°04'N, 160°00'E	Unknown	2,070 m
11	Kronotsky	1000-20	54°45'N, 160°30'E	1922-1923	3,528 m
12	Krasheninnikov	1000-19	54°35'N, 160°16'E	400 BP	1,856 m
13	Kikhpinych	1000-18	54°29'N, 160°14'E	~ 600 BP	1,552 m
14	Taunshits	1000-16	54°32'N, 159°48'E	2400 BP	2,353 m
15	Maly Semyachik	1000-14	54°08'N, 159°40'E	1804	1,560 m
16	Karymsky	1000-13	54°03'N, 159°27'E	2010	1,486 m
17	Zhupanovsky	1000-12	53°35'N, 159°08'E	1956-1957	2,958 m
18	Koryaksky	1000-09	53°19'N, 158°43'E	2008-2009	3,456 m
19	Avachinsky	1000-10	53°15'N, 158°51'E	1991	2,751 m
	SECTION South:				
20	Opala	1000-08	52°32'N, 157°20'E	~ 300 BP	2,475 m

Strong Volcanic Activity in Russia

Klyuchevskoy

Koryaksky

Avachinsky

Mutnovsky

Chikurachki

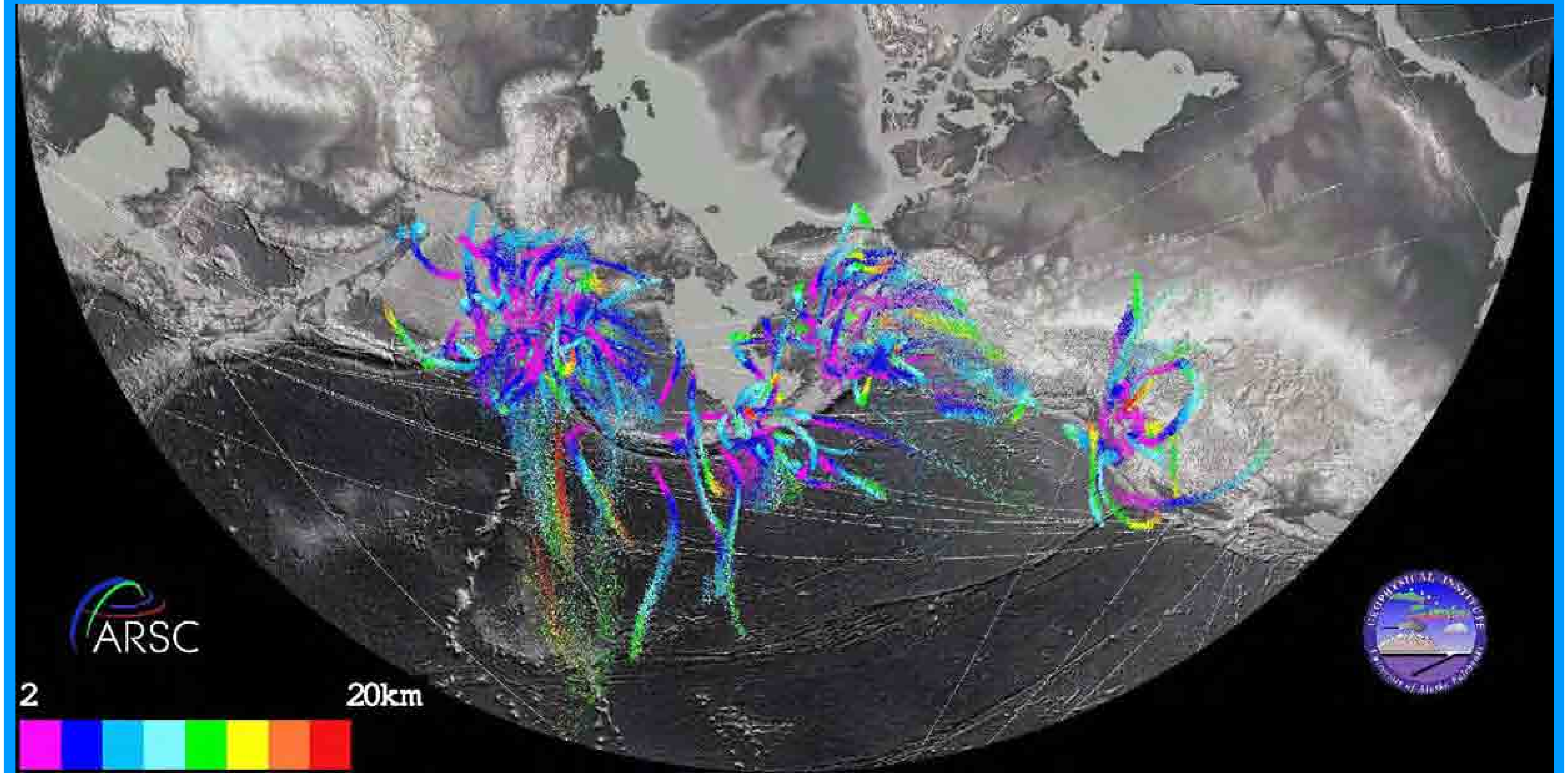
Bezymianny

Sheveluch

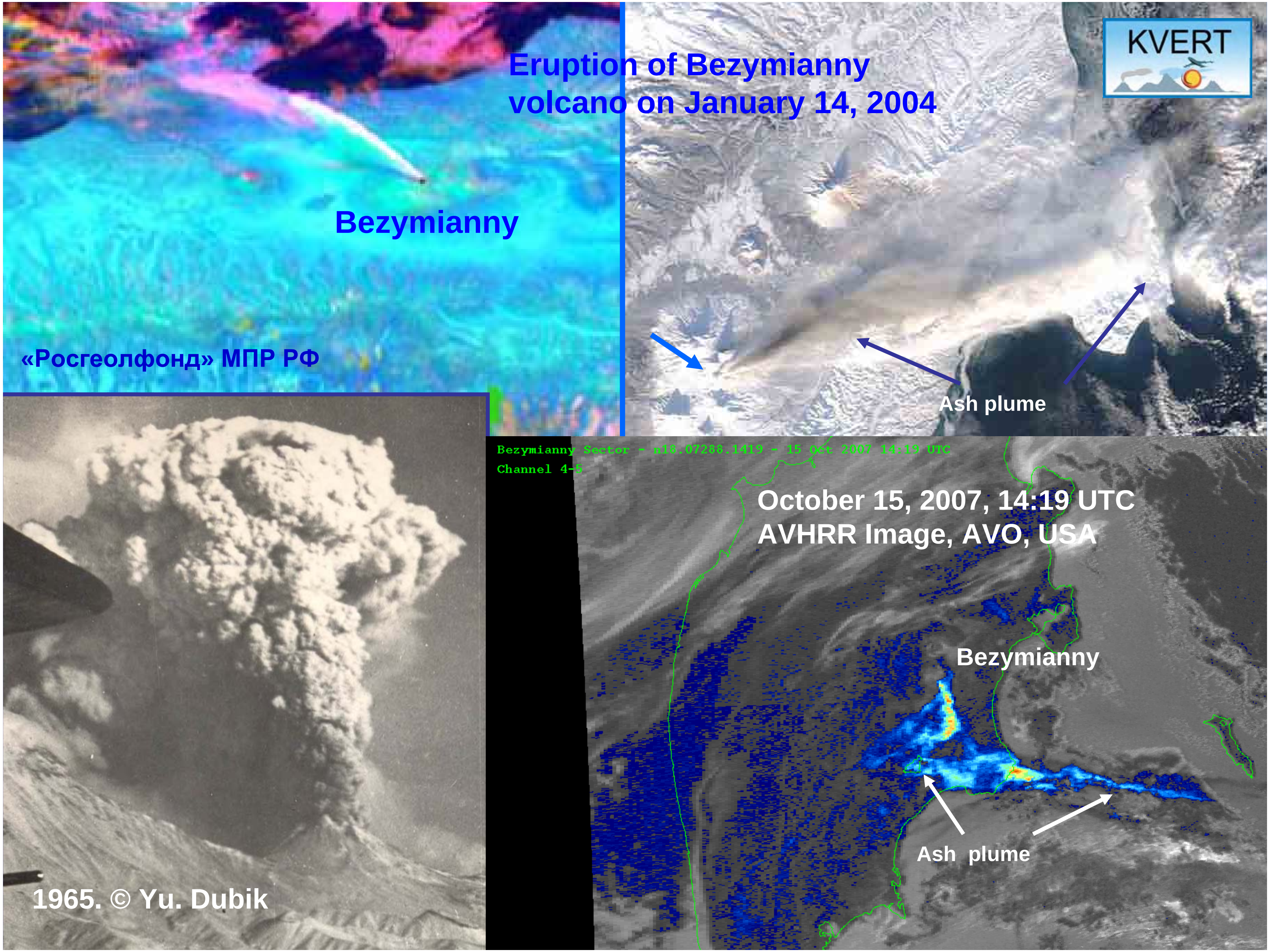
Gorely

Karymsky

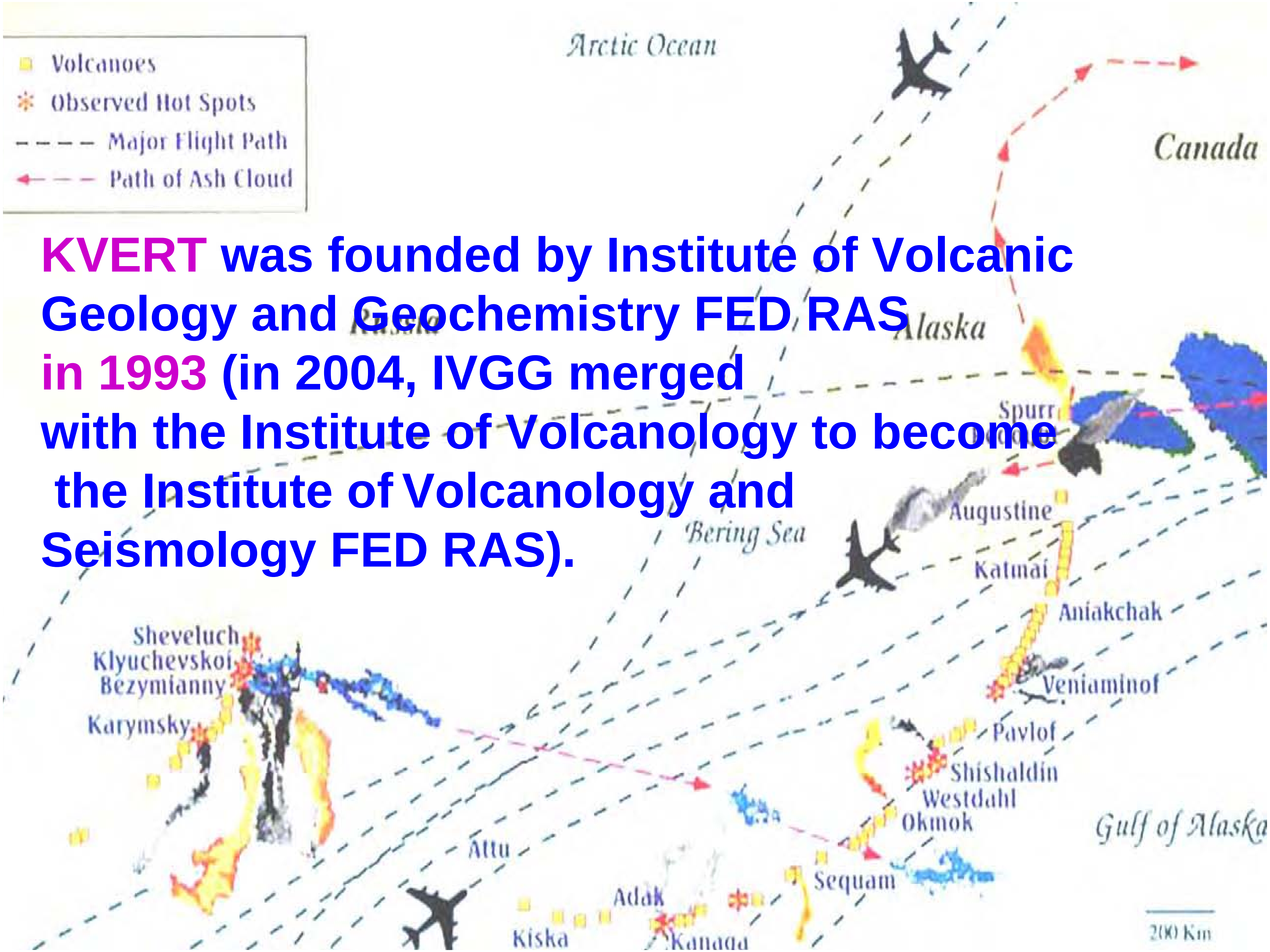
Puff 1975 – 2006 Ash Cloud predictions
Airborne Ash color-coded by altitude



212 discrete events from July 1975 – August 2006, by P. W. Webley
Composite image shows location of volcanic ash clouds +12 hrs after the start of each event


Eruption of Bezymianny volcano on January 14, 2004
KVERT
Bezymianny
«Росгеолфонд» МПР РФ
Ash plume
Bezymianny Sector - n18.07288.1419 - 15 Oct 2007 14:19 UTC
Channel 4-5
October 15, 2007, 14:19 UTC
AVHRR Image, AVO, USA
Bezymianny
Ash plume
1965. © Yu. Dubik

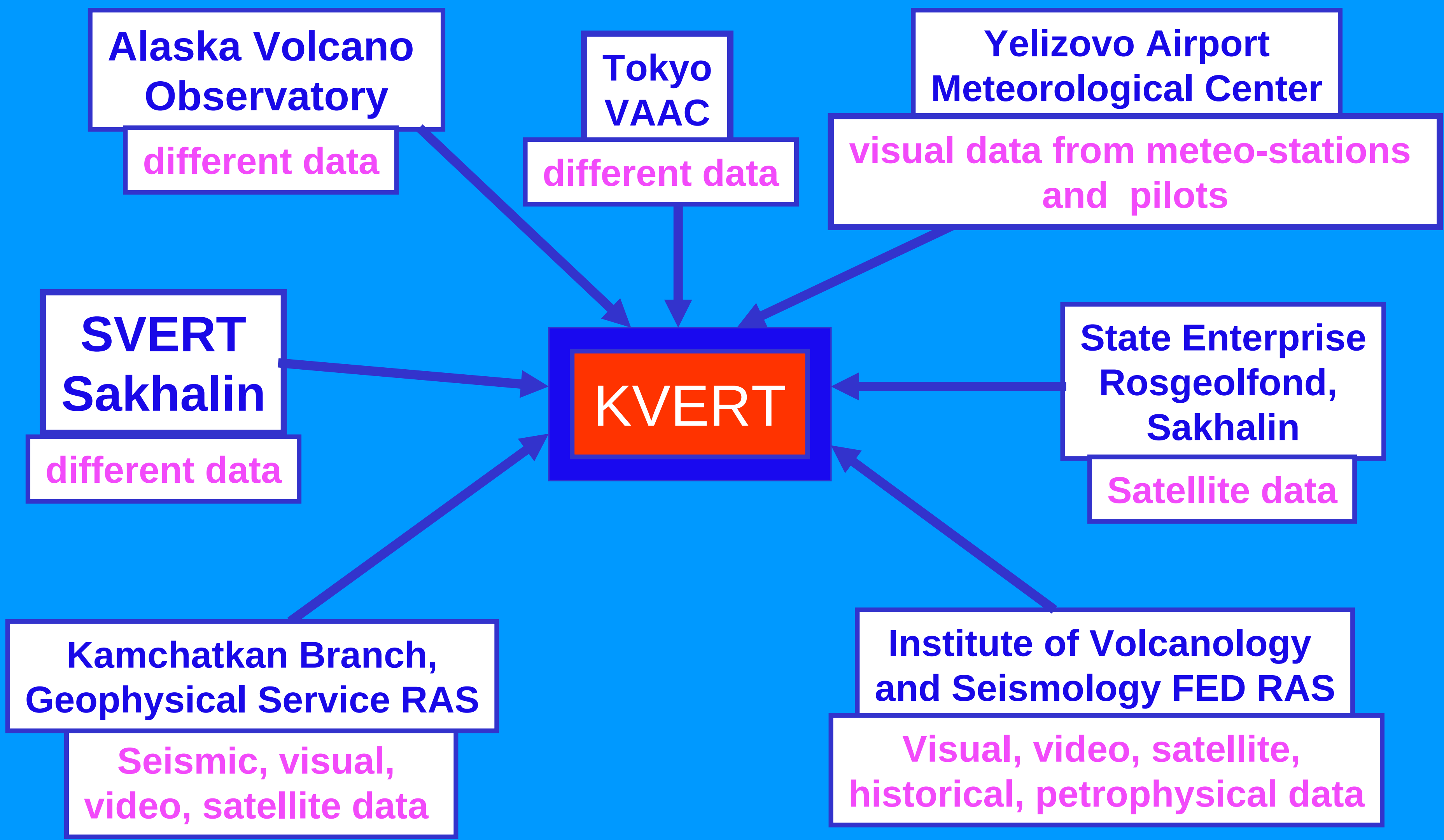
KVERT was founded by Institute of Volcanic Geology and Geochemistry FED RAS in 1993 (in 2004, IVGG merged with the Institute of Volcanology to become the Institute of Volcanology and Seismology FED RAS).

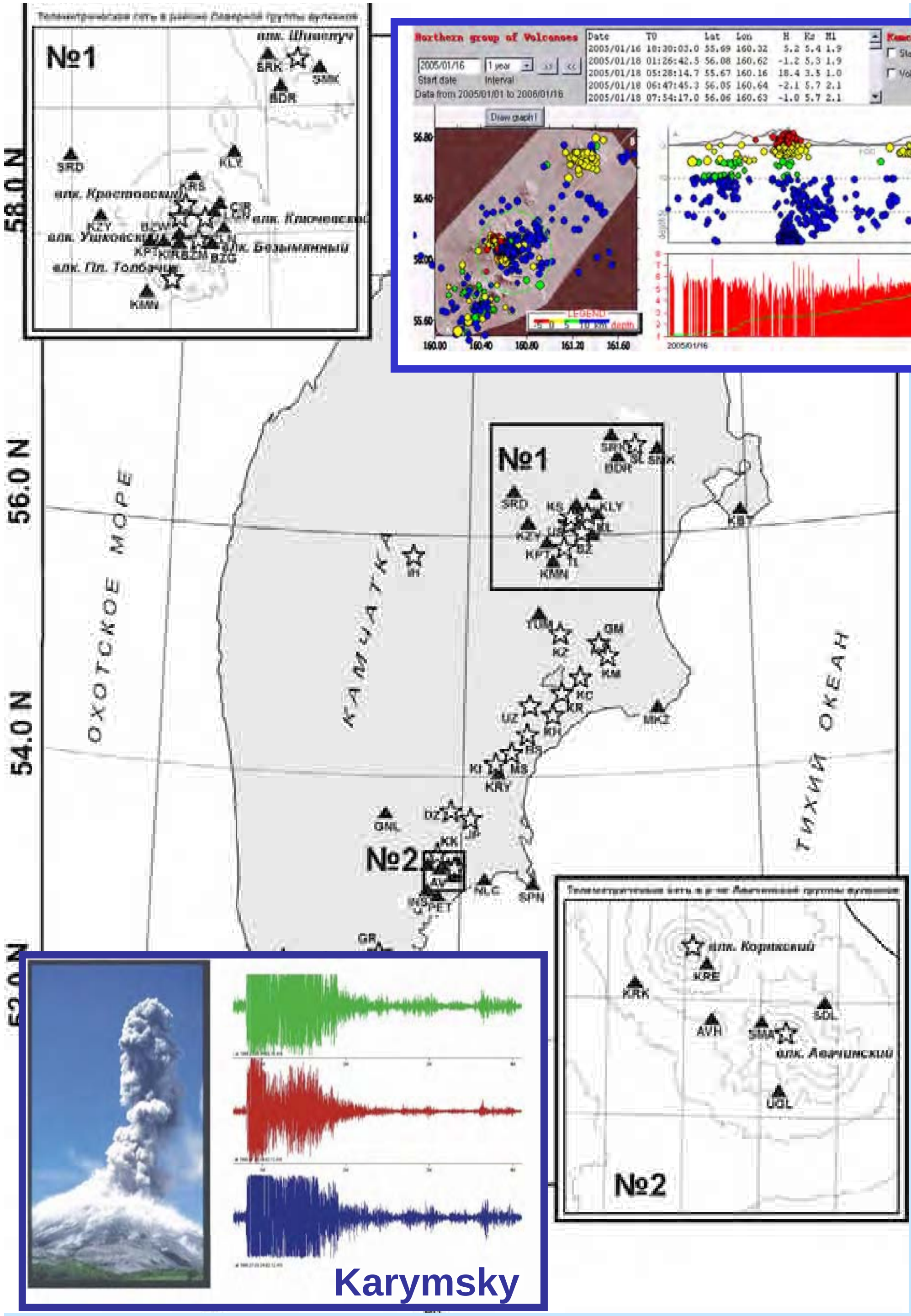


The Kamchatkan Volcanic Eruption Response Team (KVERT) is a collaborative project of scientists from the Institute of Volcanology and Seismology, the Kamchatka Branch of Geophysical Surveys, and the Alaska Volcano Observatory **(IVS, KB GS and AVO).**

The purpose of KVERT is to reduce the risk of costly, damaging, and possibly deadly encounters of aircraft with volcanic ash clouds. To reduce this risk KVERT collects all possible volcanic information and issues eruption alerts to aviation and other emergency officials.

Collecting data



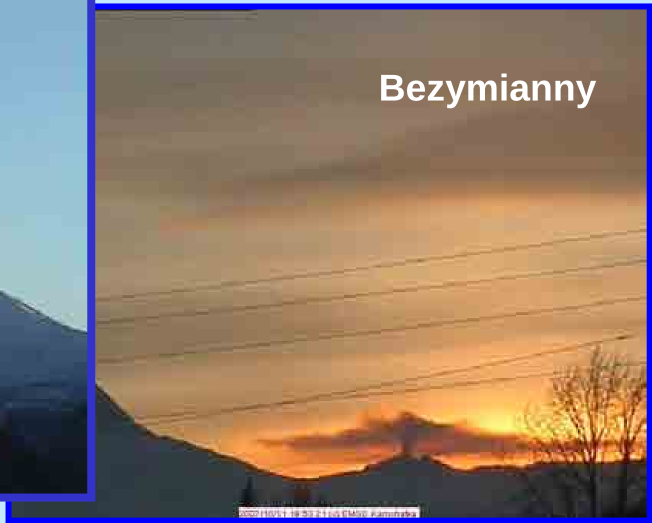


KVERT receives seismic monitoring data from KB GS (the Laboratory for Seismic and Volcanic Activity).

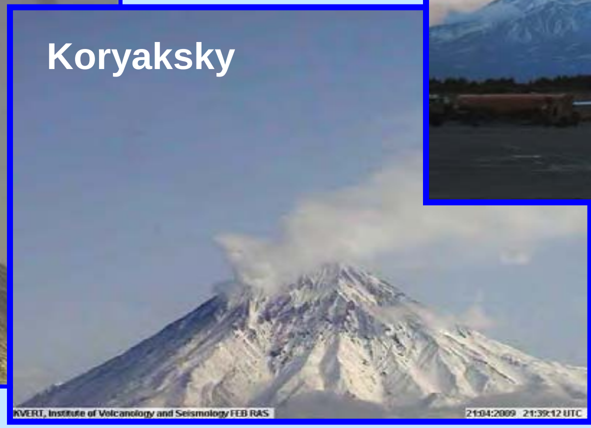
KB GS maintains telemetered seismic stations to investigate 10 of the most active volcanoes in Kamchatka.

Data are received around the clock and analysts evaluate data each day for every volcano to determine the number and type of seismic events at these monitored volcanoes.

KVERT obtains visual volcanic information from web-cameras that monitor Klyuchevskoy (established in 2000, 2009), Sheveluch (2002, 2008), Bezymianny (2003), Koryaksky (2009) and Avachinsky (2009) volcanoes



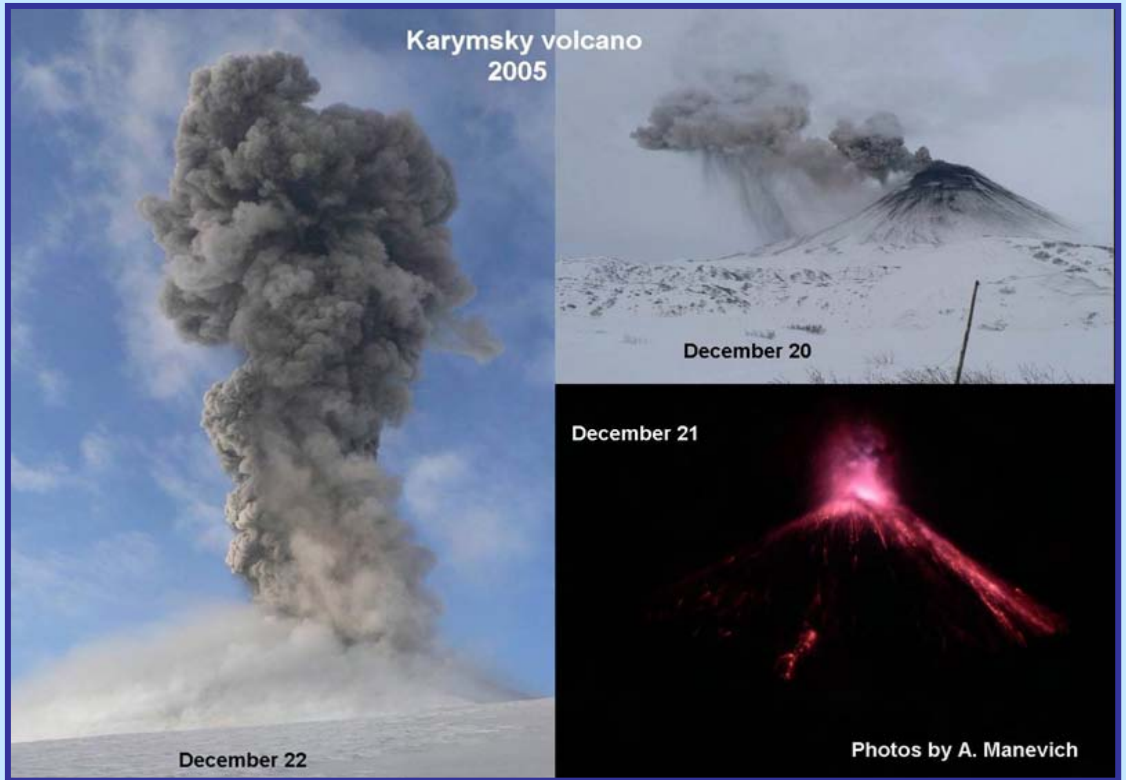
From KB GS RAS



From IVS FED RAS

KVERT

Volcanic activity: Visual observation



Sheveluch volcano, 2001

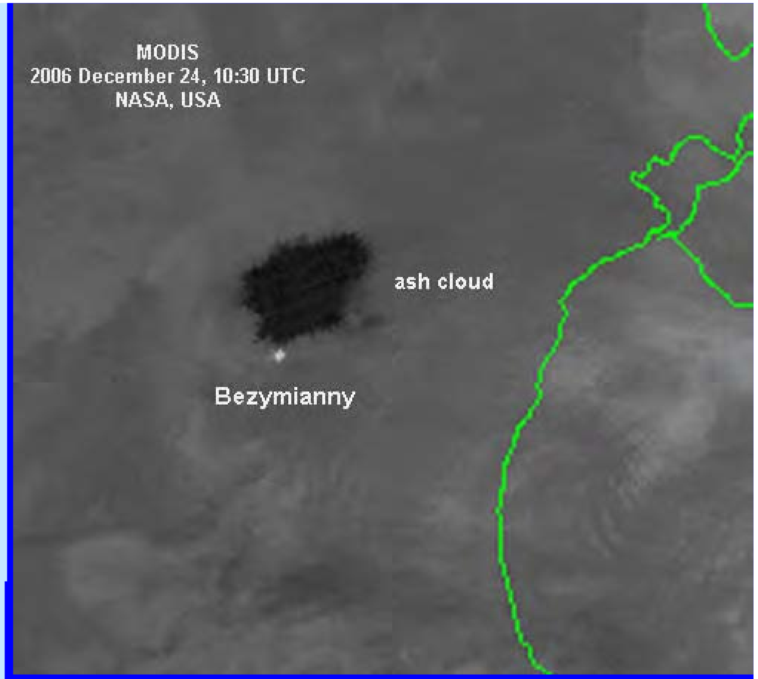
Bezymianny volcano

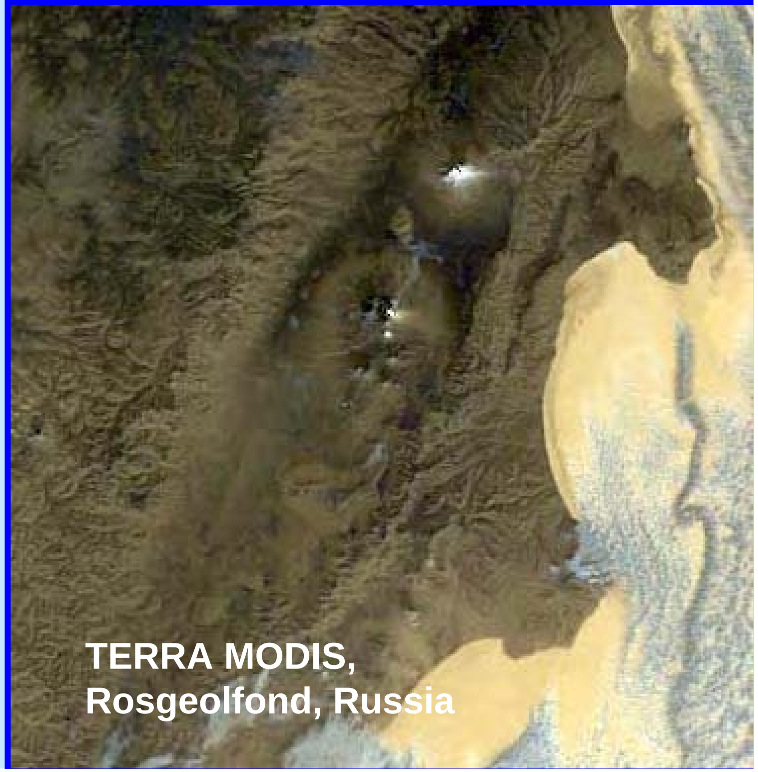
KVERT obtains visual volcanic information from volcanologist’s field trips IVS and pilots.

Karymsky

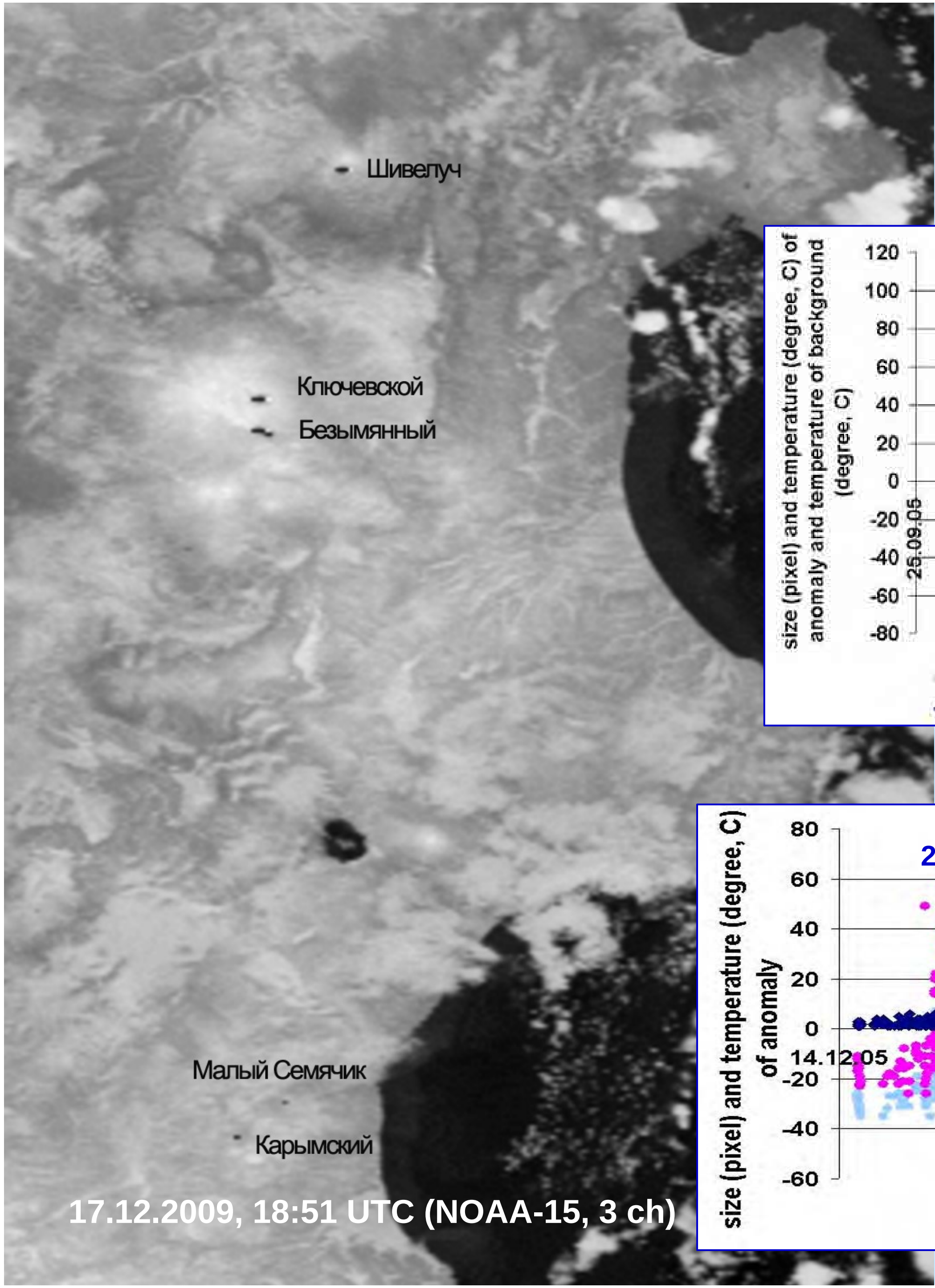
Bezymianny

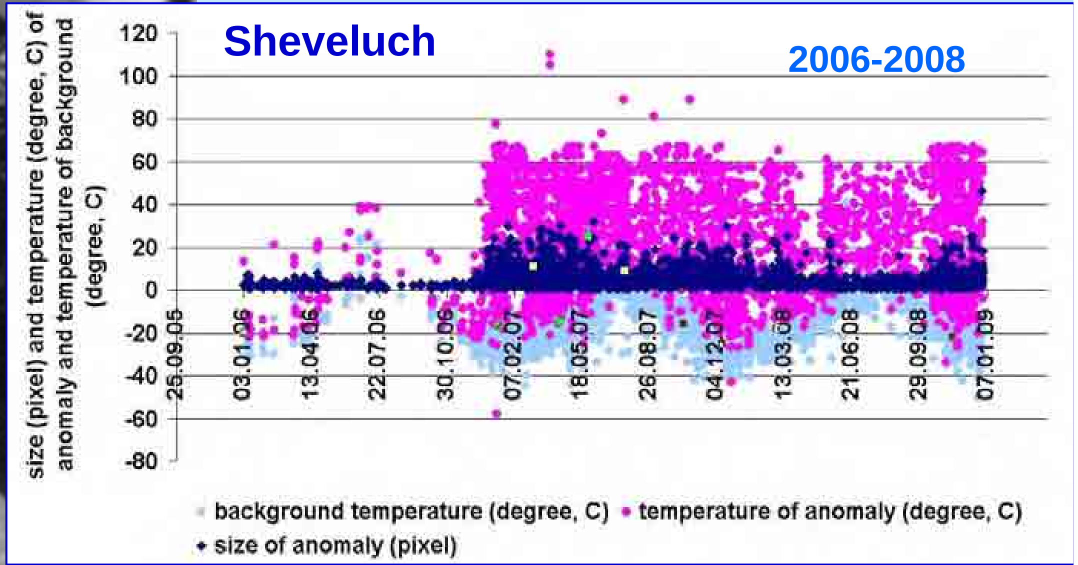
Satellite data are provided from several sources to KVERT. AVO conducts satellite analysis of the Kuriles, Kamchatka, and Alaska as part of it daily monitoring and send the interpretation to KVERT staff. KVERT conducts satellite analysis of the Kamchatka and Northern Kuriles as part of it daily monitoring and send the interpretation to the KVERT database. KVERT interprets MODIS and MTSAT images and processes AVHRR data to look for evidence of volcanic ash and thermal anomalies.

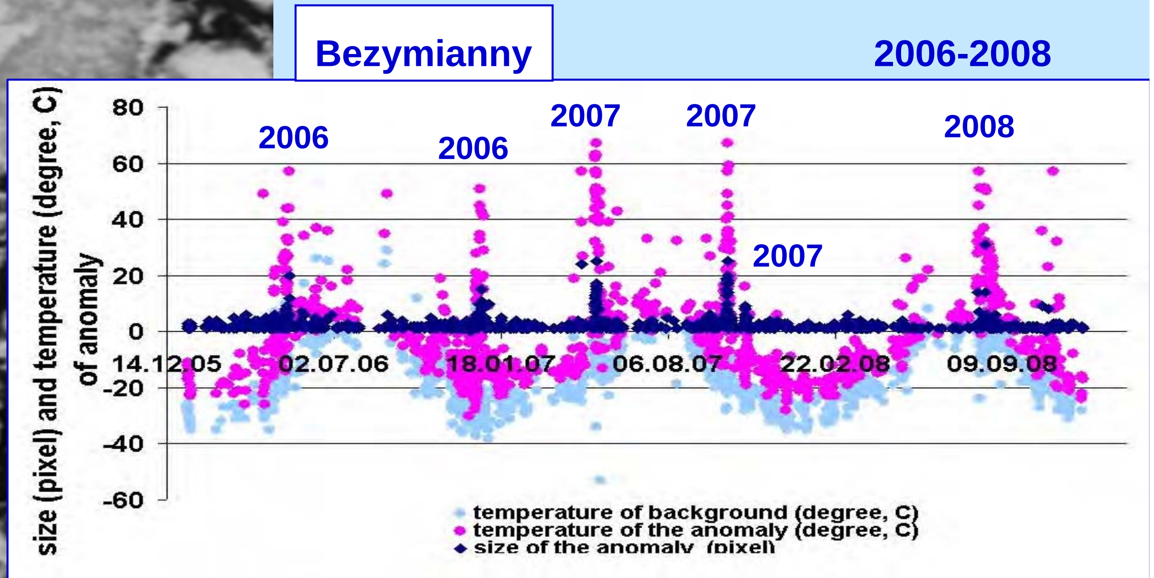




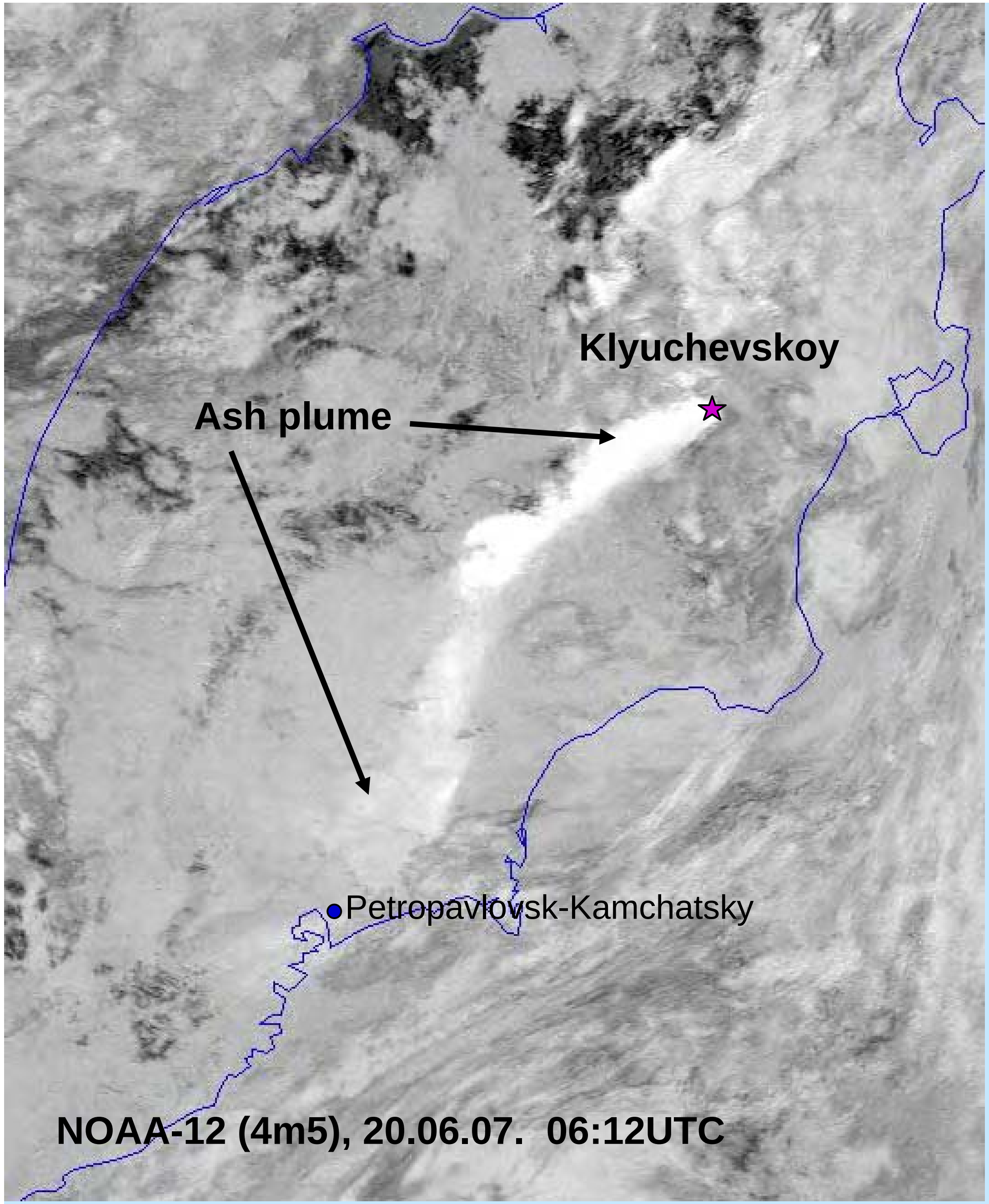
Thermal anomalies at Kamchatkan volcanoes

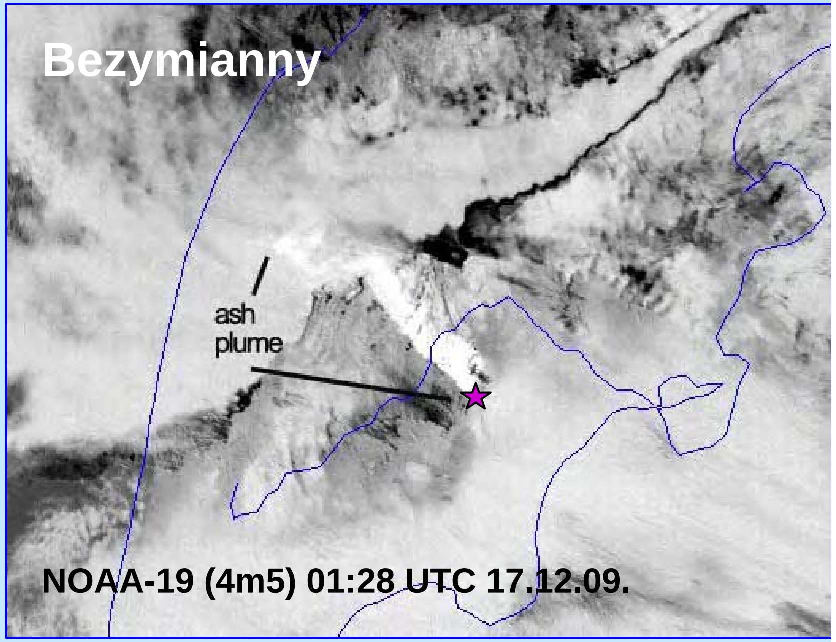


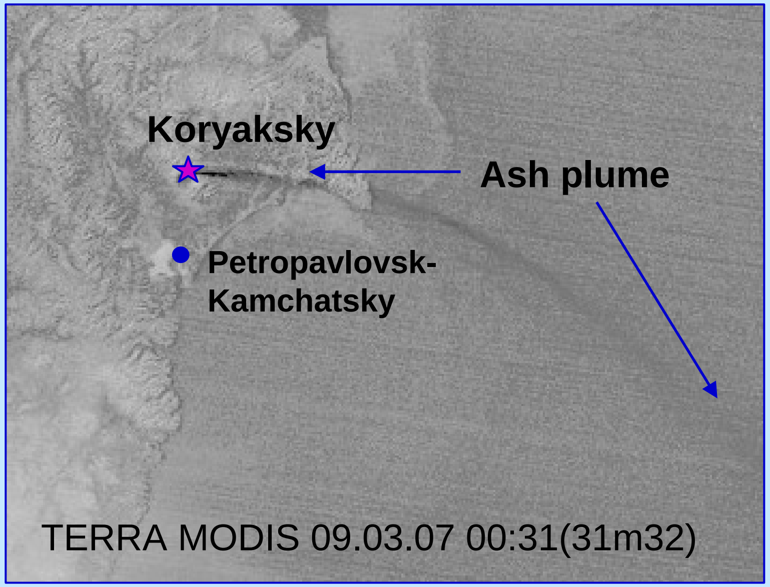


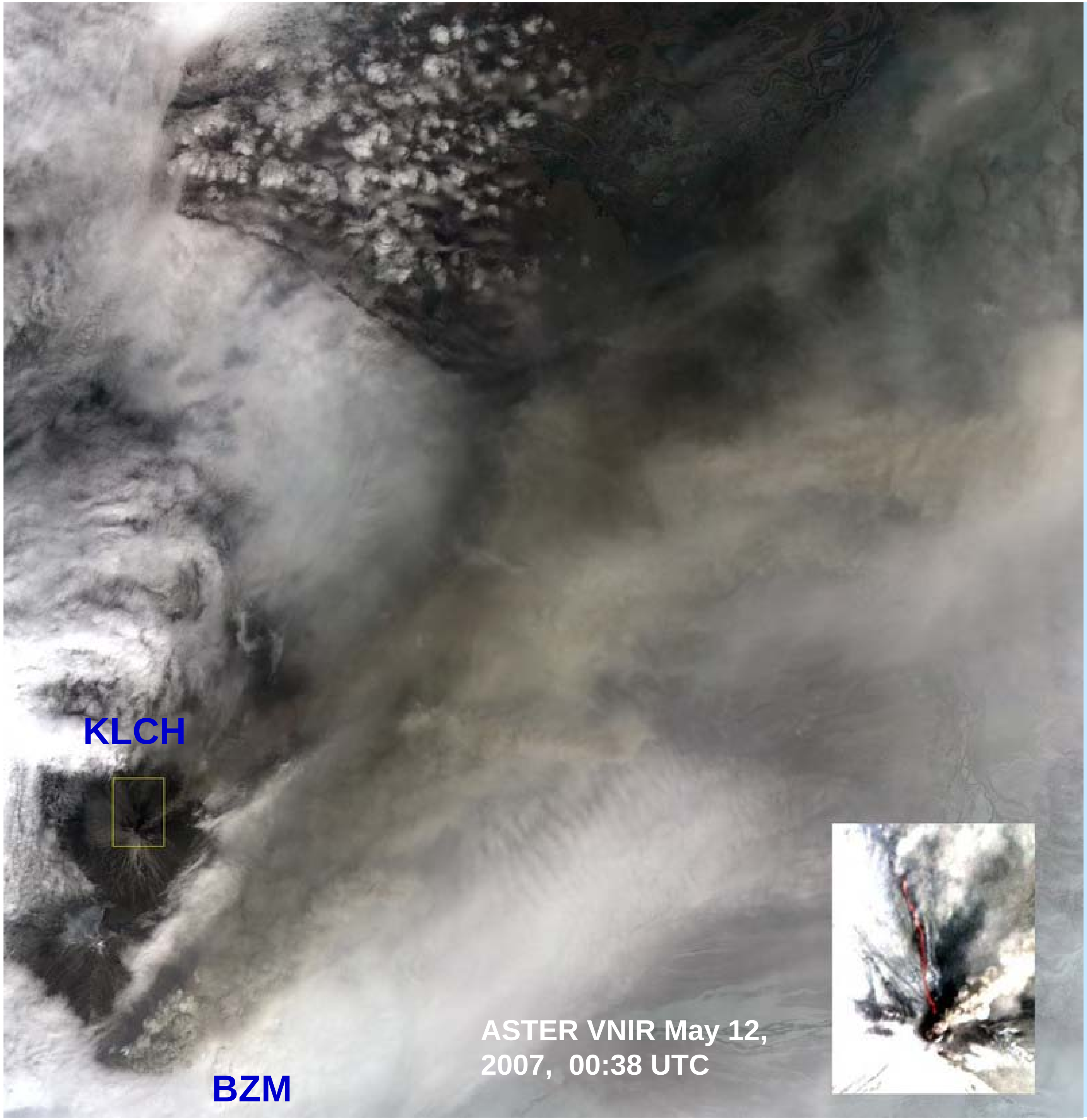


Ash plumes


Klyuchevskoy
Ash plume
Petropavlovsk-Kamchatsky
NOAA-12 (4m5), 20.06.07. 06:12UTC


Bezymianny
ash plume
NOAA-19 (4m5) 01:28 UTC 17.12.09.


Koryaksky
Ash plume
Petropavlovsk-Kamchatsky
TERRA MODIS 09.03.07 00:31(31m32)



Ash plumes

from Bezymianny and Klyuchevskoy volcanoes

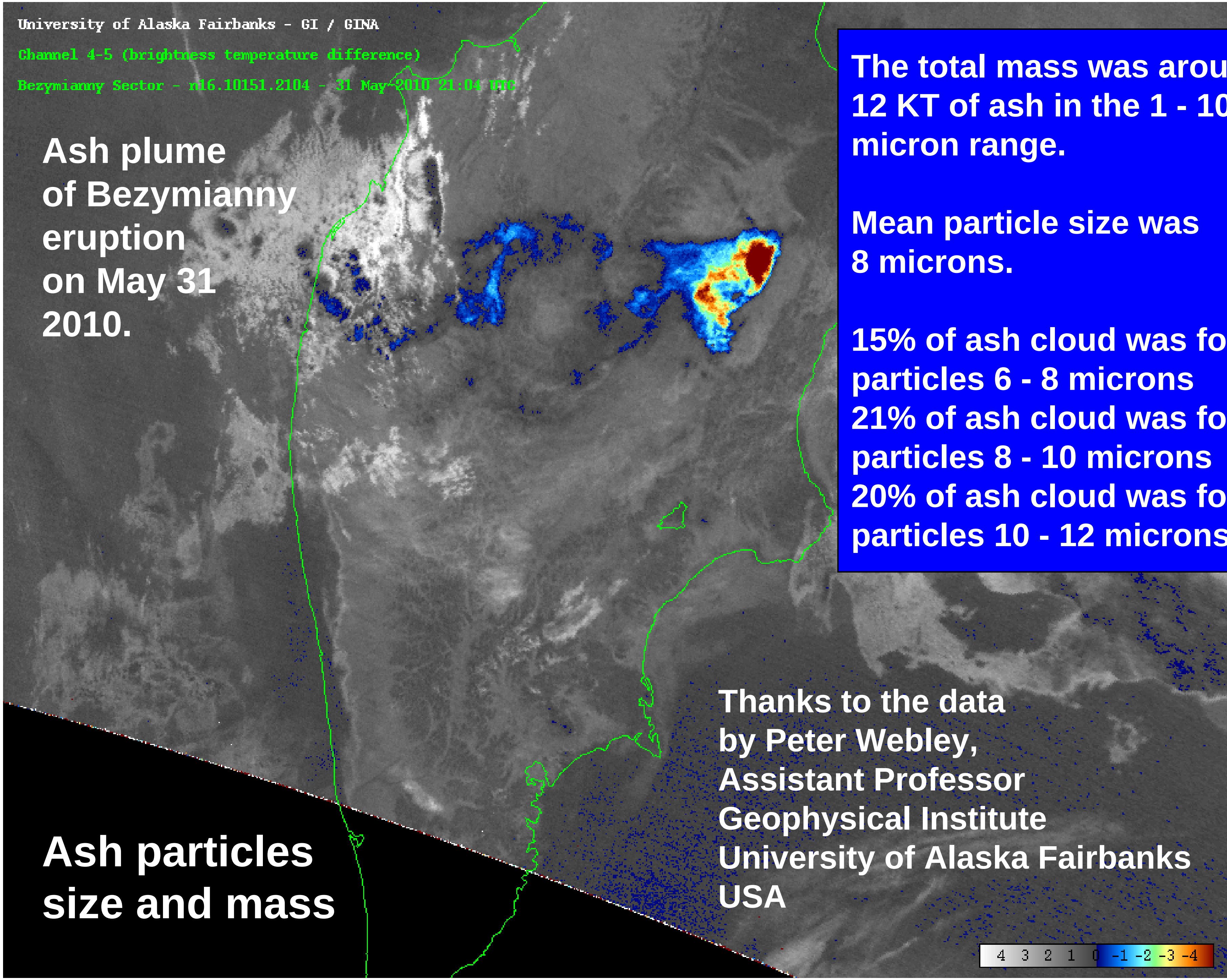
Thanks to M. Ramsey

Ash plume of Bezymianny eruption on May 31 2010.

The total mass was around 12 KT of ash in the 1 - 10 micron range.

Mean particle size was 8 microns.

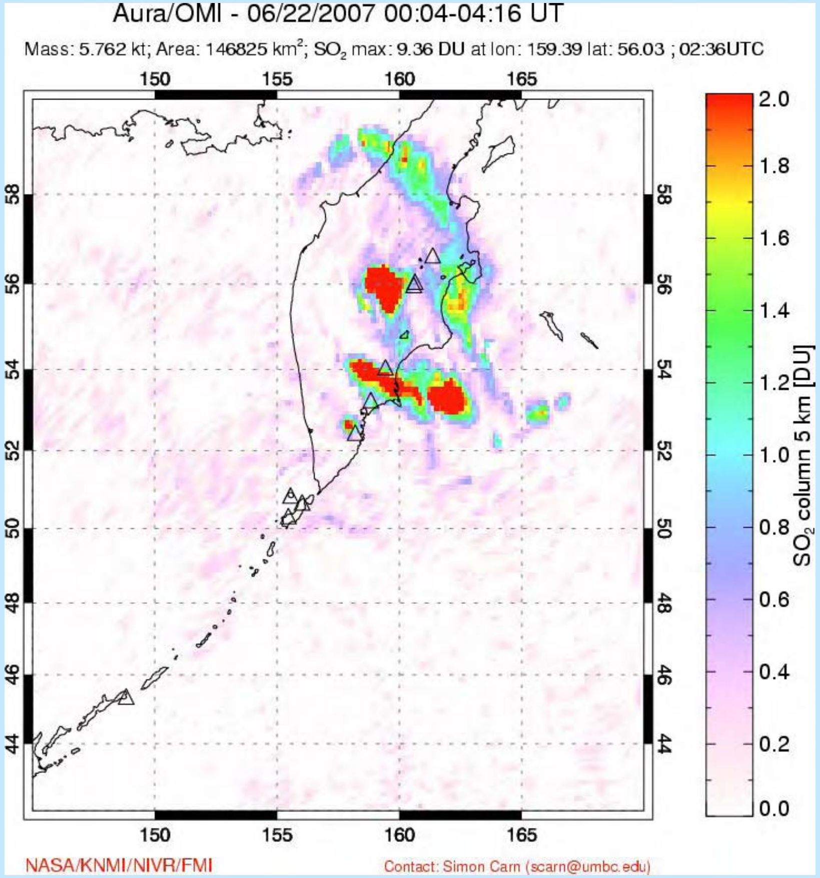
15% of ash cloud was for particles 6 - 8 microns
21% of ash cloud was for particles 8 - 10 microns
20% of ash cloud was for particles 10 - 12 microns

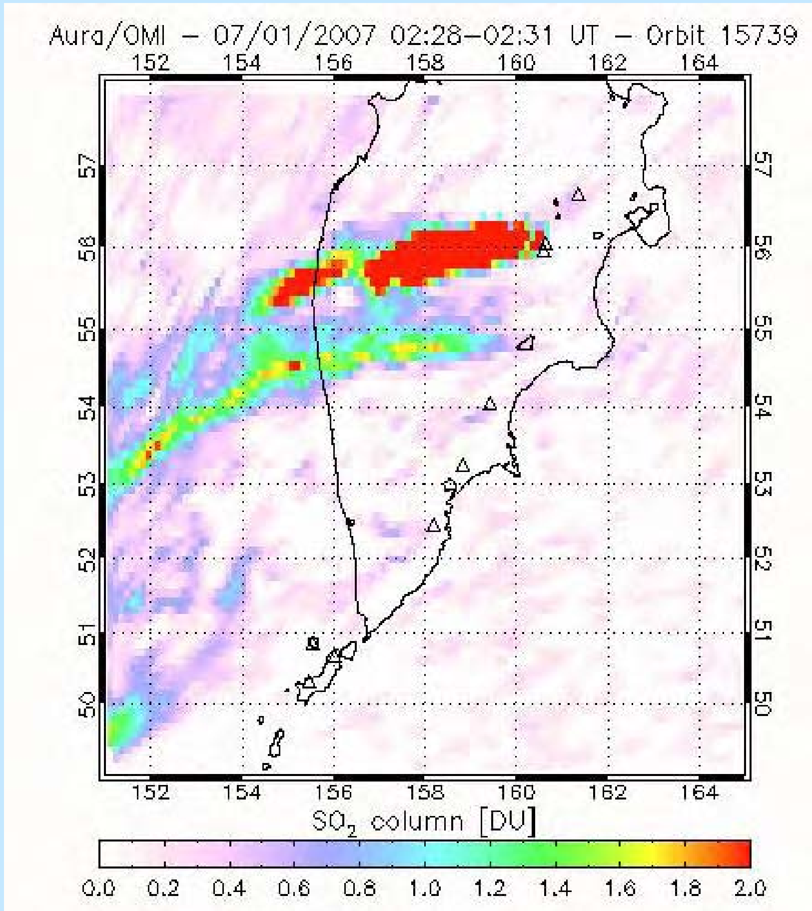


Thanks to the data by Peter Webley, Assistant Professor Geophysical Institute University of Alaska Fairbanks USA

Ash particles size and mass

SO_2 in aerosol plumes of Klyuchevskoy eruption (OMI data)





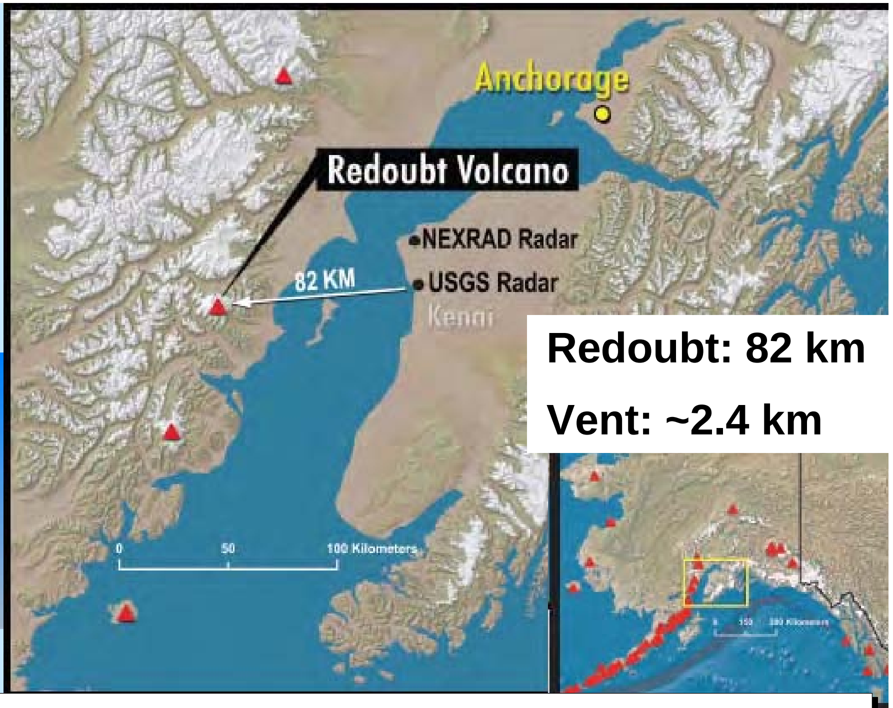
OMI images on June 22 and July 01, 2007.

There was about 100 kt SO_2 for the eruption of Klyuchevskoy in 2007. (15.05.- 24.06.2007.)

Height of ash plume

USGS Volcano Science Center Radar

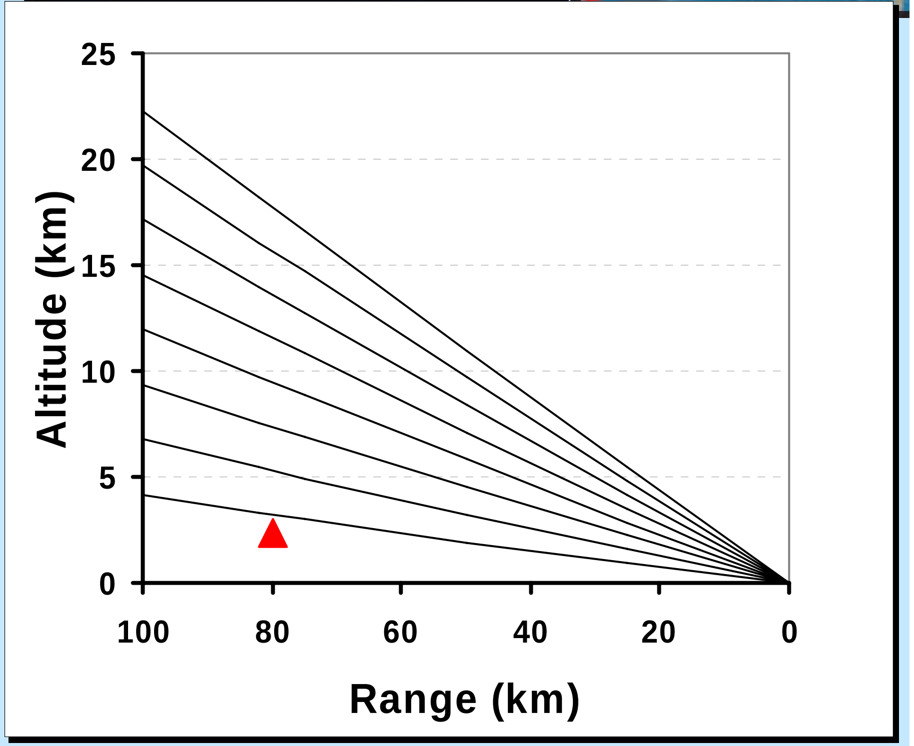
- C-Band Doppler
- 5.36 cm wavelength
- 300 watts peak power
- Horizontal polarization
- 2.4 m dish
- 1.6 degree beam width
- Maximum range 240 km
- Rapid RHI and PPI sector scans



Redoubt: 82 km

Vent: ~2.4 km

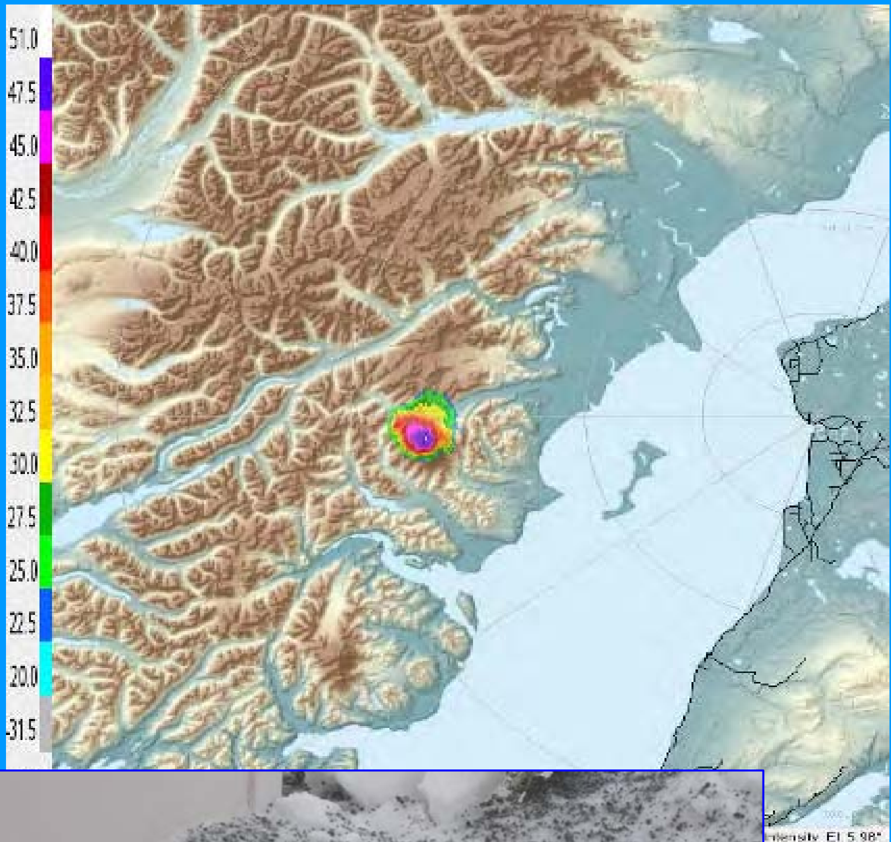
Transmit Power: 300 W
Range: 100 km
Range Gate: 250 m
Pulse Length: 1.6 μs
PRF: 1000 Hz

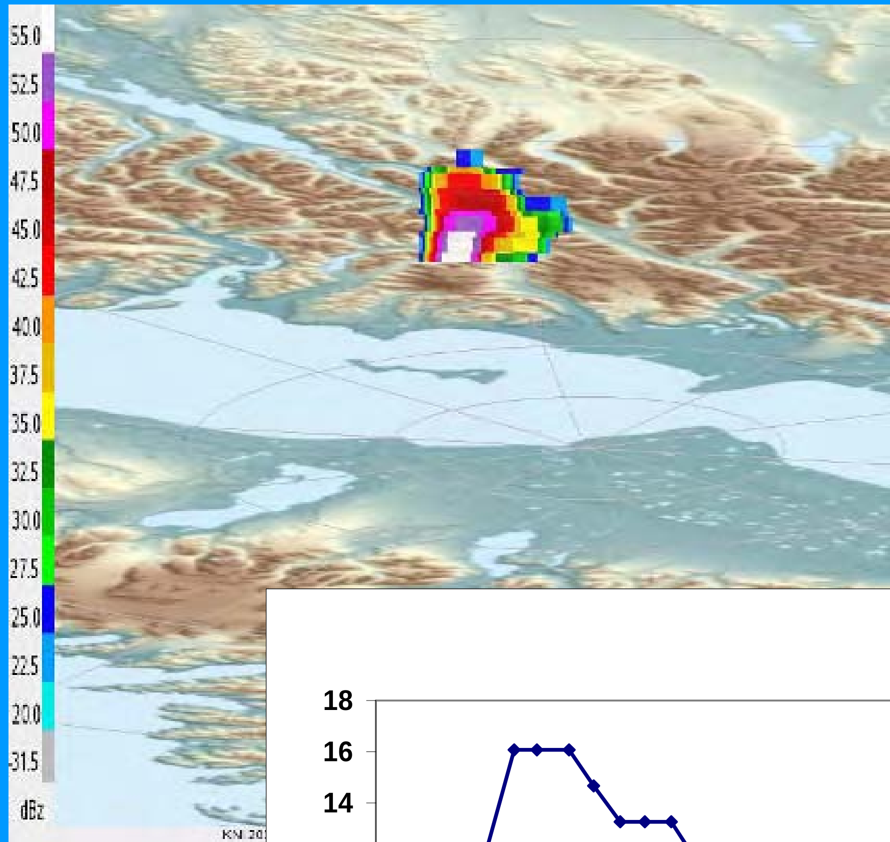


Thanks to the data by David Schneider, U.S. Geological Survey, Alaska Volcano Observatory, USA

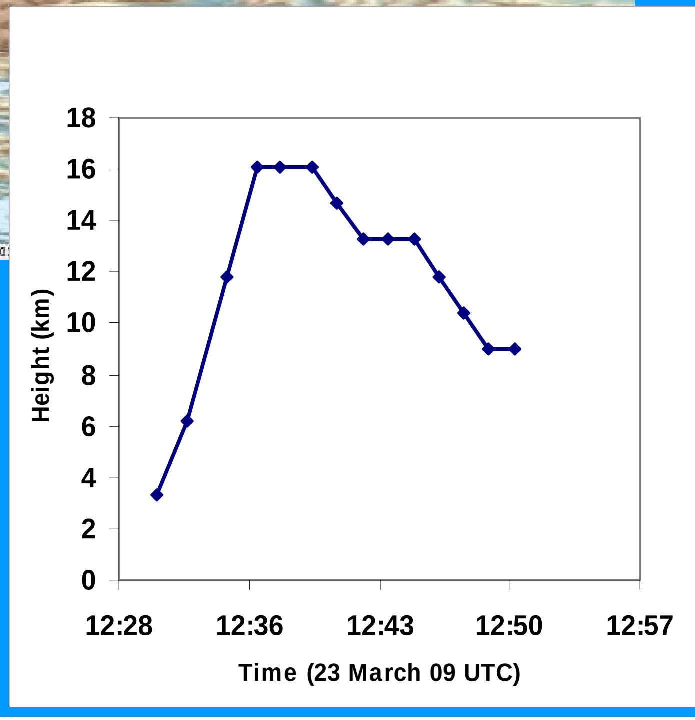
23 March 2009: 1238 UTC

Eruption of Redoubt volcano 23.03.2009.

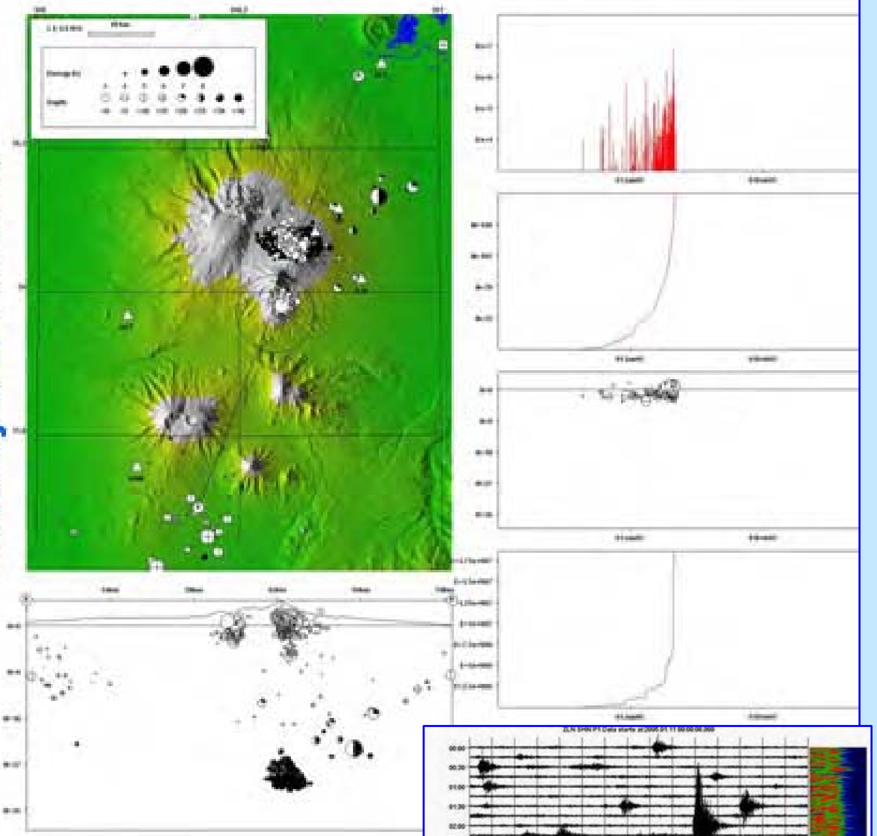




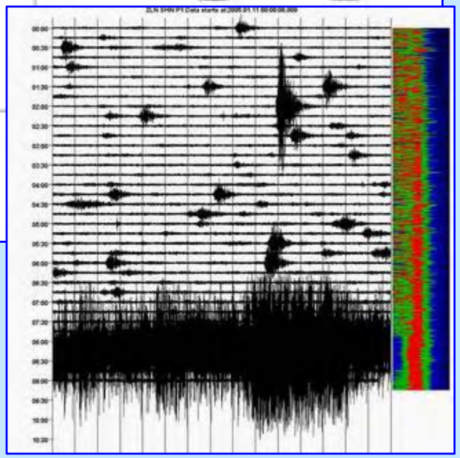
Rapid decrease in radar cloud height due to accretionary lapilli formation



**Bezymianny volcano,
eruption on January 11, 2005.**



Data by KB GS RAS



Seismologists of KB GS RAS determine height of volcanic ash plumes using a function of seismic signal envelope with time. An error of this method is about 25% for ash plumes up to 8 km ASL.

**Sheveluch volcano
May 10, 2004**

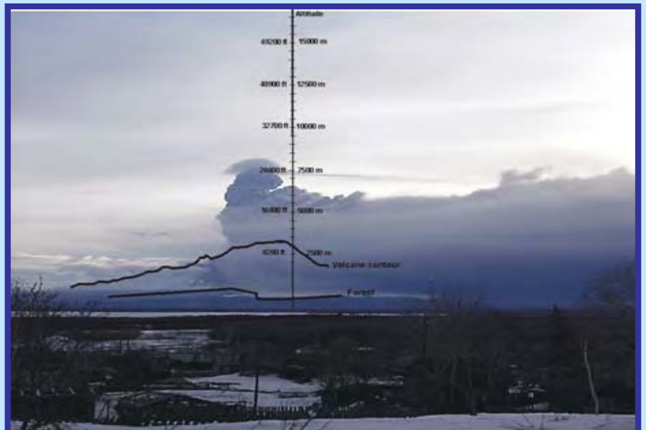
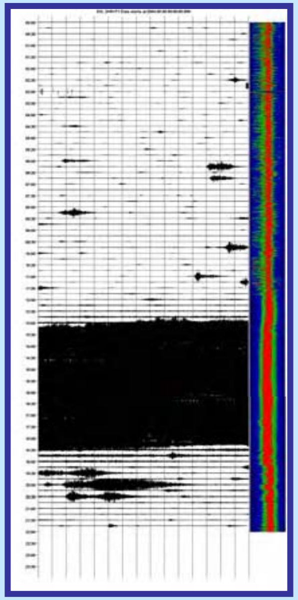
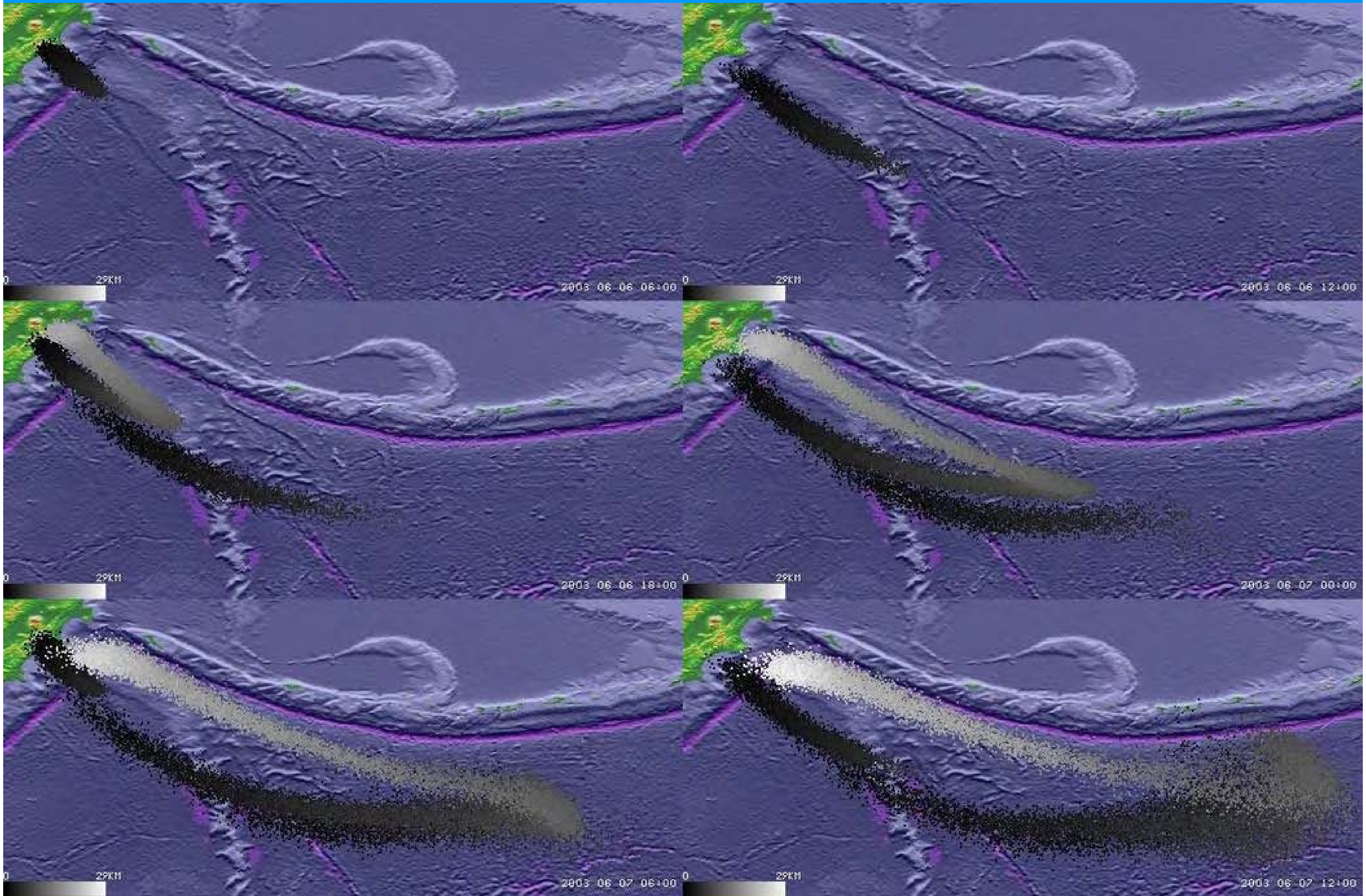


Photo by Yu.Demyanchuk



Height of ash plume

PUFF animation, AVO: Hypothetical eruption of Bezymianny 06.06. 2003

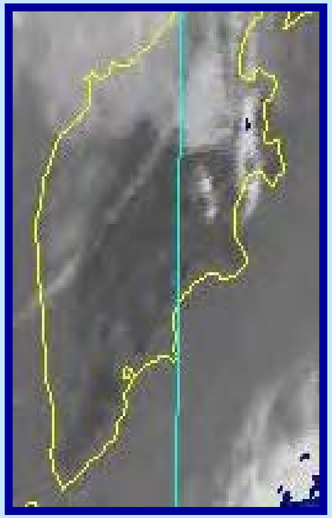


Prognosis

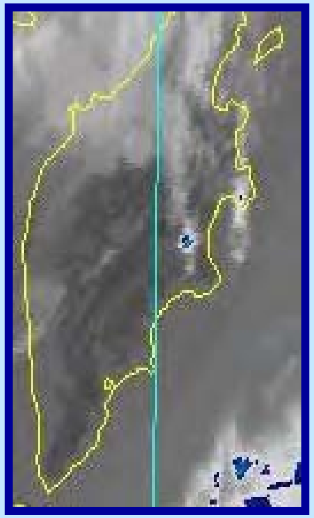
***Airborne ash displayed only**

Prognosis

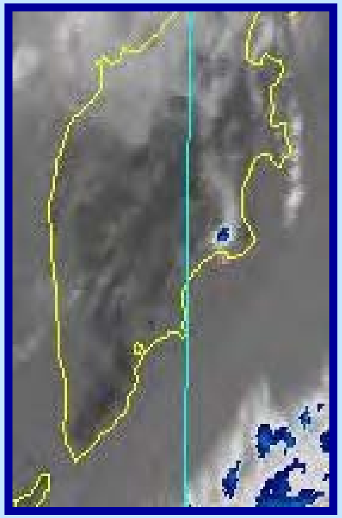
Bezymianny, 2001



23:33 UTC



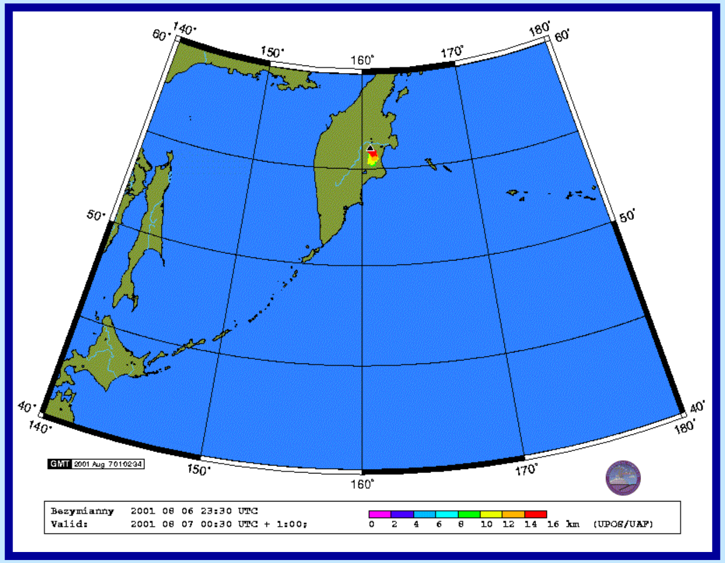
00:32 UTC



01:32 UTC

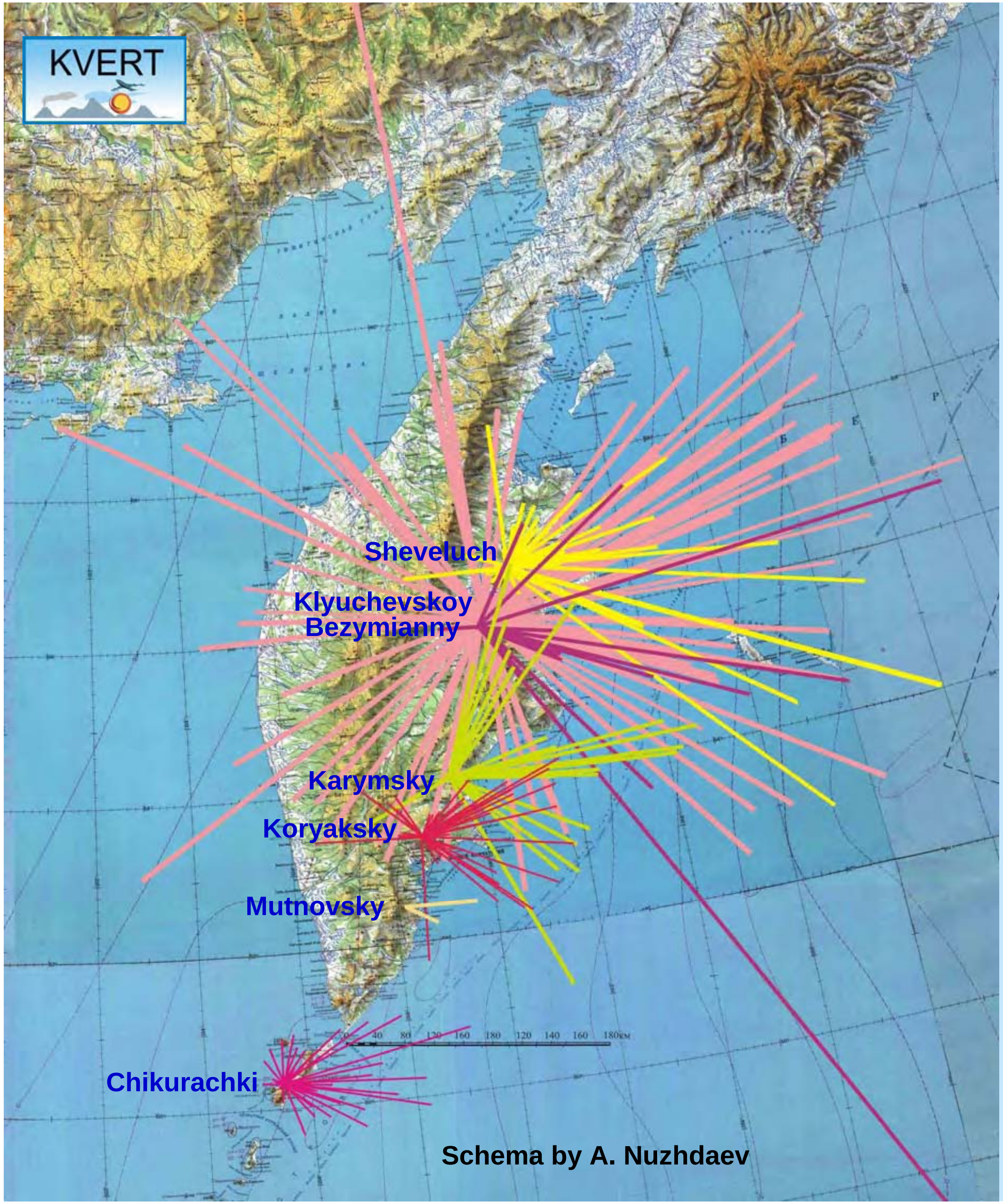
The movement of ash clouds of Bezymianny on August 6 -7, 2001 (from AVO-satellite data)

Prognosis



PUFF animation, AVO

At 15:02 UTC on August 06 an ash plume from Bezymianny was observed in a satellite image from AVO US. The plume was centered off the eastern coast of Kamchatka about 200 km south of Kronotsky.



> 1500 ash plumes from Kamchatkan and Northern Kuriles volcanoes were noted by scientists of KVERT Project in 2005-2008.

Klyuchevskoy: for example, 2007: ash plumes rose up to 10-12 km ASL and extended > 5500 km to the different directions from the vol.
Sheveluch: for example, ash column rose up to 15 km ASL on 29.03.07; ash plumes ~ 800 km.
Bezymianny: for example, May, 9 and December, 24, 2006: eruptive columns rose up to 13-15 km ASL, ash plumes > 1,300 km.
Karymsky: for example, May 13-14, 2006: ash columns rose up to 8 km ASL, ash plumes ~ 300 km.
Koryaksky: ash plumes rose ~ 5.5 km ASL and extended > 650 km.
Mutnovsky: on April 16-17, 2007, ash plumes ~ 50 km.
Chikurachki: ash plumes rose up to 6 km ASL and extended > 260 km.

KVERT

KVERT analyzes volcano monitoring data (seismic, satellite, visual and video, and pilot reports), assigns a Aviation Color Code for aviation and issues reports on eruptive activity and unrest at Kamchatkan (since 1993) and Northern Kurile (since 2003) Volcanoes.

Klyuchevskoy 12.02.2010. © Yu. Demyanchuk

Aviation Color Codes

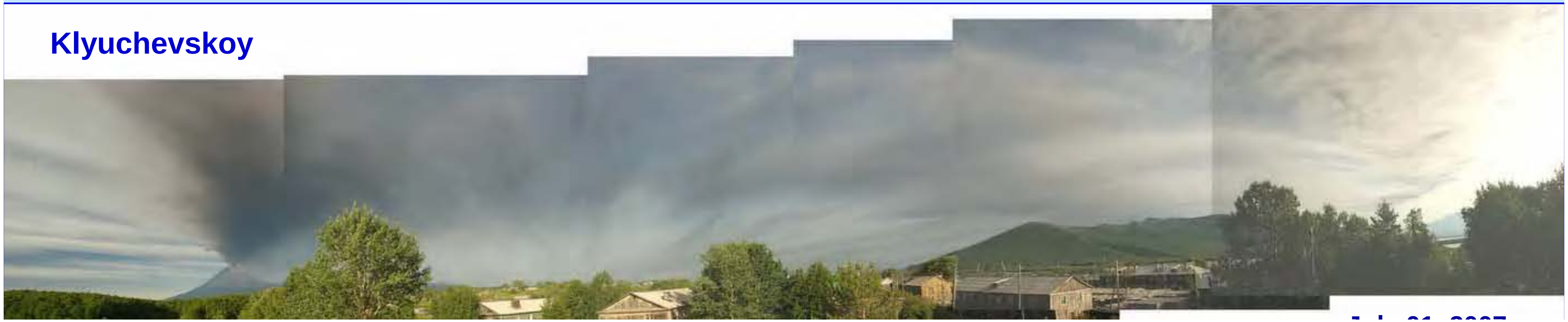
COLOR	The state of the Volcano
GREEN	Volcano is in typical background, noneruptive state or, after a change from a higher level, volcanic activity has ceased and volcano has returned to noneruptive background state.
YELLOW	Volcano is exhibiting signs of elevated unrest above known background level or, after a change from a higher level, volcanic activity has decreased significantly but continues to be closely monitored for possible renewed increase.
ORANGE	Volcano is exhibiting heightened or escalating unrest with increased potential of eruption, timeframe uncertain, OR eruption is underway with no or minor volcanic-ash emissions [ash-plume height specified, if possible].
RED	Eruption is imminent with significant emission of volcanic ash into the atmosphere likely OR eruption is underway or suspected with significant emission of volcanic ash into the atmosphere [ash-plume height specified, if possible].

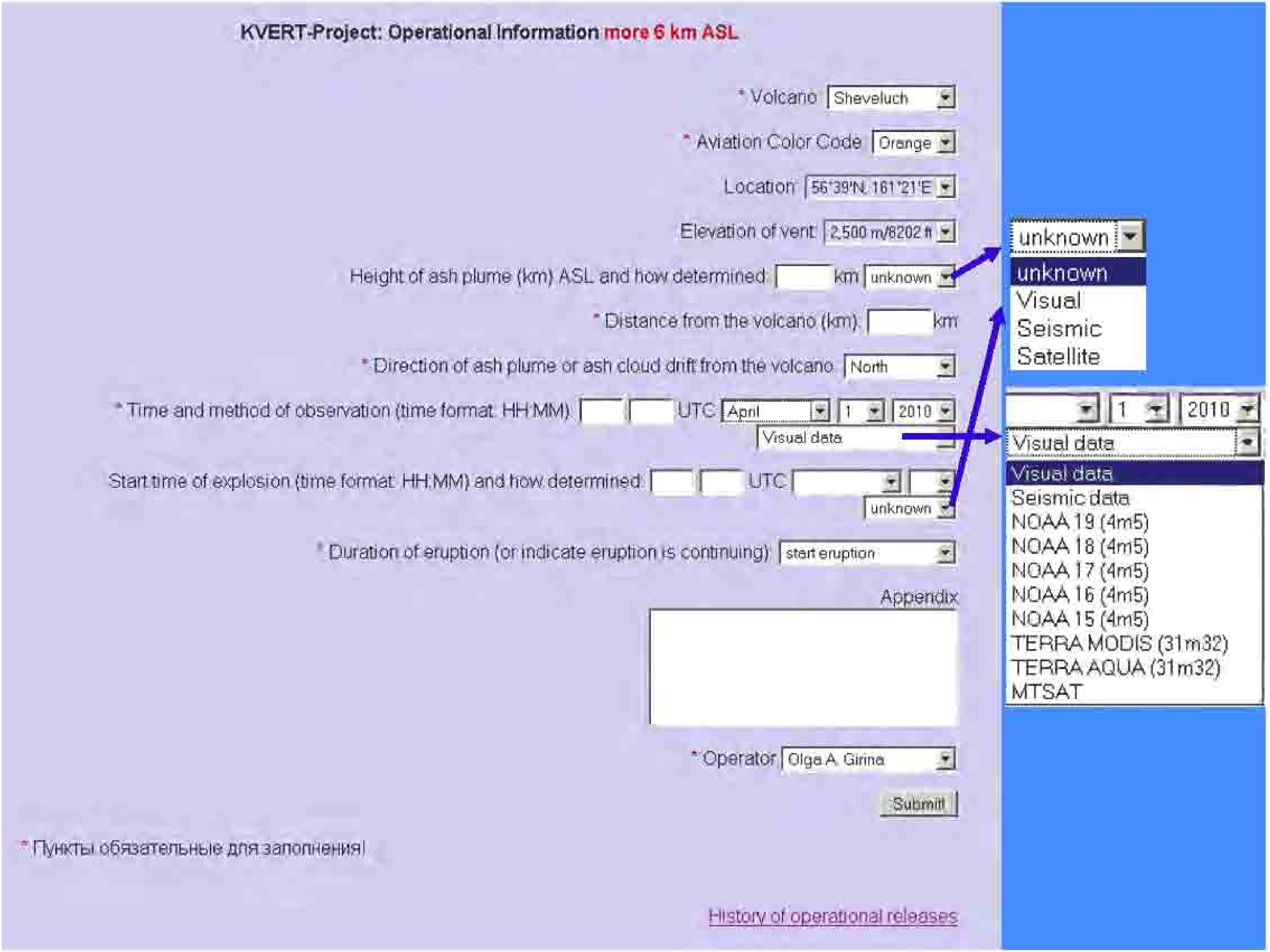
Information about volcanic unrest based on seismic data from KB GS; satellite information from AVO and KVERT; or visual data from a variety of sources is shared by email among IVS, AVO and KB GS to facilitate evaluation of possible activity.

Koryaksky, 18.03.09. © V. Ivanov

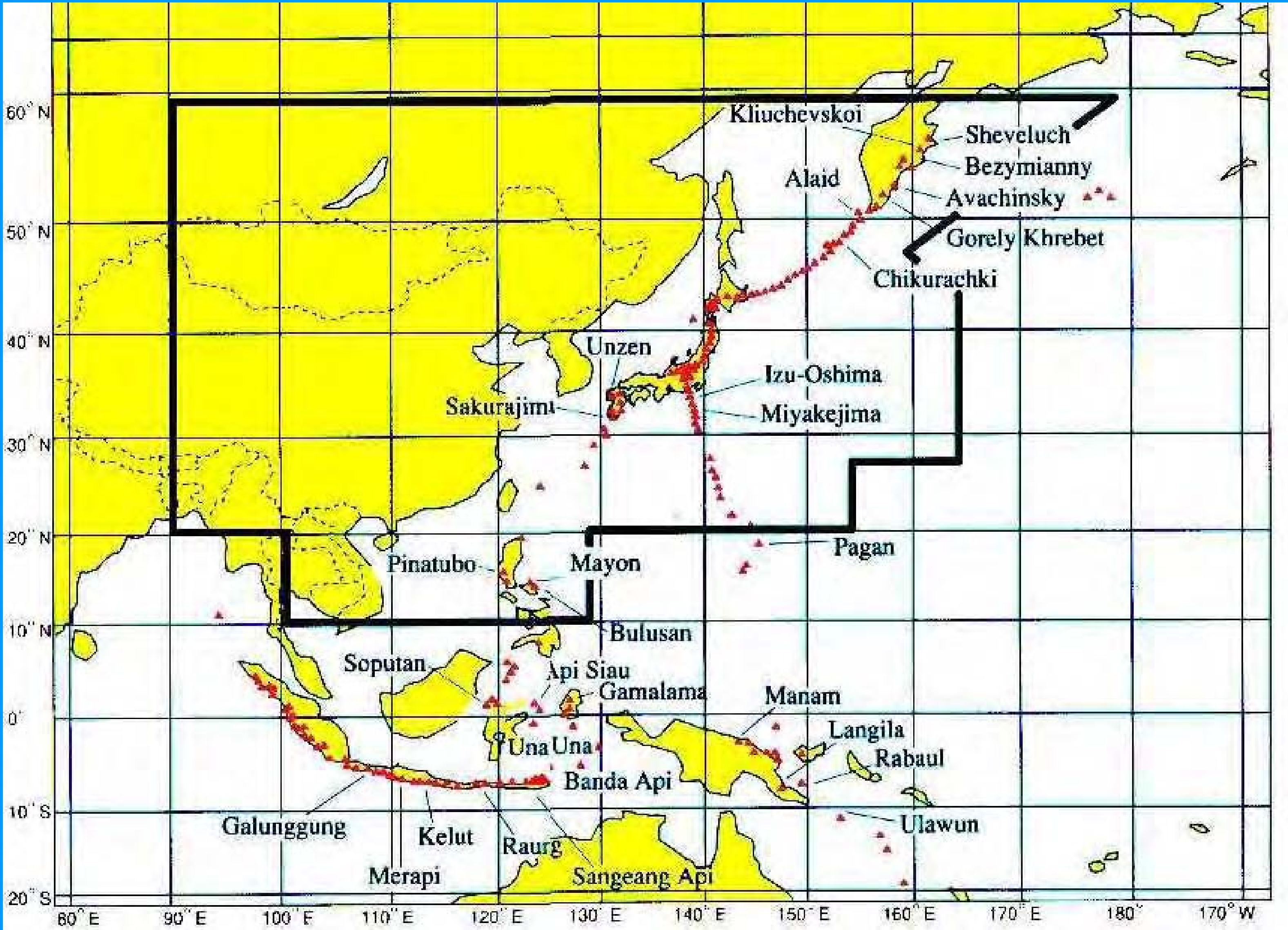
After confirmation, urgent information is sent by email to government agencies, aviation services, and scientists (>300 users) located throughout the North Pacific region.

Klyuchevskoy




KVERT-Project: Operational Information more 6 km ASL
* Volcano Sheveluch
* Aviation Color Code Orange
Location 56°39'N 161°21'E
Elevation of vent 2,500 m/8202 ft
Height of ash plume (km) ASL and how determined: km unknown
* Distance from the volcano (km): km
* Direction of ash plume or ash cloud drift from the volcano North
* Time and method of observation (time format: HH:MM) UTC April 1 2010
Visual data
Start time of explosion (time format: HH:MM) and how determined: UTC
unknown
* Duration of eruption (or indicate eruption is continuing): start eruption
Appendix
* Operator Olga A. Girina
Submit
* Пункты обязательные для заполнения!
History of operational releases
unknown
unknown
Visual
Seismic
Satellite
1 2010
Visual data
Visual data
Seismic data
NOAA 19 (4m5)
NOAA 18 (4m5)
NOAA 17 (4m5)
NOAA 16 (4m5)
NOAA 15 (4m5)
TERRA MODIS (31m32)
TERRA AQUA (31m32)
MTSAT

Tokyo Volcanic Ash Advisory Center Responsible Area



KVERT staff work closely with staff of AVO, AMC (Airport Meteorological Center) at Yelizovo Airport and the Tokyo Volcanic Ash Advisory Center (VAAC), the Anchorage VAAC, and the Washington VAAC to release timely eruption warnings.

От: vaac@eqvol.kishou.go.jp
Кому:
Тема: Tokyo VAAC (KLIUCHEVSKOI 2010/16)

```
FVFE01 RJTD 080403
(STX)
VA ADVISORY

DTG: 20100408/0403Z
VAAC: TOKYO
VOLCANO: KLIUCHEVSKOI 1000-26
PSN: N5603E16038
AREA: RUSSIA
SUMMIT ELEV: 4835M
ADVISORY NR: 2010/16
INFO SOURCE: MTSAT-1R KVERT
AVIATION COLOUR CODE: NIL
ERUPTION DETAILS: VA AT 20100408/0116Z FL190 EXTD NW WAS REPORTED.
OBS VA DTG: 08/0259Z
OBS VA CLD: VA NOT IDENTIFIABLE FROM SATELLITE DATA. WINDS ABV THE VO
LCANO AT 08/0110Z FL100 160/12KT FL190 210/28KT FROM JMA NWP MODEL.
FCST VA CLD +6HR: NIL
FCST VA CLD +12HR: NIL
FCST VA CLD +18HR: NIL
RMK: NIL
NXT ADVISORY: NO FURTHER ADVISORIES=
```

Daily updates from KVERT Project

Volcanoes	Seismicity	Visual data	Satell data
Sheveluch	Above background levels. ~47 seismic events into the edifice of the volcano. 00:58 and 00:56 - shallow events indicating possible ash-gas explosions ~ 4100m; 4400m and 4800m ASL accordingly (or) avalanches, then height of ash cloud was less than 4100m; 4400m and 4800m. Possible weak ash-gas explosions and avalanches. 02:48 – 05:33 no data.	03:00 obscured . 23:00 obscured .	No data.
Klyuchevskoy	Above background levels. ~368 seismic events into the edifice of the volcano. Intermittent spasmodic volcanic tremor up to 7.22*10-6mps. 02:48 – 05:33 no data.	03:00 weak gas-steam plume. 23:00 obscured .	No data.
Bezymianny	Strong volcanic seismicity at Klyuchevskoy volcano obscures seismic data for Bezymianny .	06:00 obscured . 22:00 obscured.	No data.
Plosky Tolbachik	No detectable seismicity.	06:00 obscured . 22:00 obscured.	No data.
Kizimen *)	Above background levels. 8 EQs – 1.6<M<2.75	No data.	No data.
Karymsky	Above background levels. Possible weak ash-gas explosions.	No data.	No data.
Koryaksky	At background levels.	06:00 obscured. 21:00 obscured.	No data.
Avachinsky	No detectable seismicity.	06:00 obscured. 21:00 obscured.	No data.
Gorely	No data.	06:00 obscured. 21:00 q uiet.	No data.
Mutnovsky	No detectable seismicity.	06:00 obscured. 21:00 q uiet.	No data.

OPERATIONAL REPORT ON THE KAMCHATKAN VOLCANOES ACTIVITY ON TELEMETRIC DATA KB GS RAS April 14, 2010, GMT.

Archives of daily updates and satellite images: http://emsd.iks.ru/~ssl/Volcanoes

Video of 5 volcanoes on line: http://www.emsd.ru /

Группа KVERT

(Kamchatkan Volcanic Eruption Response Team)

ИВ…

Группа реагирования на вулканические изверж…

http://www.kscnet.ru/ivs/kvert/index.php

Текущие извержения | Прогноз для авиации опасности вулканов | Еженедельные KVERT-сообщения | Каталог вулканов Камчатки | Цветовая шкала опасности вулканов | KVERT: история | Сот…

Текущая активность вулканов

Активные вулканы в Google Earth

Видеонаблюдения за вулканами в реальном вр…

Вулкан Ключевской | Вулкан Безымянный
Вулкан Шивелуч | Вулкан Корякский

KVERT

IVS FEB RAS | KCS FEB RAS

Kamchatka Volcanic Eruption Response Team

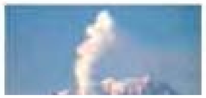
Current activity of the volcanoes | Volcanic danger prognosis for aviation | KVERT information releases | Catalogue of active volcanoes | Level of concern color codes | KVERT: history | Staff

Web-camera: Koryaksky volcano

Due to the large increase in air-traffic during the last ten years, airplanes are now at a getter risk of encountering a volcanic ash cloud. For example, in 1982 a British airline Boeing-747 was flying at a height of 12,200m.
The aircraft had departed Kuala-Lumpur, Malaysia and was en-route to Perth, Australia when unexpectedly it began to lose altitude due to sudden engine failure. The pilots were able to re-establish power to one of engines but were only able to maintain an altitude of 4620 m. In addition, two other planes were forced to land in Jakarta, Indonesia. These incidents were due to the effect of ash erupted from Galunggung volcano near the path of international air-routes, which connect Asia and Australia.
Three weeks later, a Singaporean airline Boeing-747 entered a volcanic ash cloud practically in the same place as the earlier British aircraft. The plane was forced to land because of failure of two of its four engines.

On December 15, 1989 a Boeing-747 flying from Amsterdam with 231 passengers and 13 crewmen on board started to descend from the cruising altitude in order to land in Anchorage, Alaska, USA. The plane was at a height of 7500 m, and was flying a distance of 240 km from Redoubt volcano, when suddenly it entered an ash cloud from a volcanic eruption. As a result, all four engines died. After eight minutes, and with only 2000 m to land, the pilots finally were able to restart the engines. After the aircraft landed, over 60 kg of volcanic ash was removed from each turbine-engine. All four engines, as well as the navigation system, and electric system had to be completely replaced. The loss to the airline due to this incident was over 80 million dollars.
Over two-thirds of all active volcanoes are in the Northern hemisphere with most of the volcanic eruptions occurring in the Pacific region. Therefore, the volcanoes of the Pacific region pose a serious threat to the high volume of air-traffic flying overhead. In Alaska alone, with in the past 40 years, there have been four serious incidents where planes have encountered ash clouds. Three of which have occurred during the last 15 years. There are several tens of such incidents that have occurred worldwide.

The problem of maintaining flight safety during a volcanic eruption with ash falls has received much attention all over the world. This problem is studied by specialists in the Colombia, France, Great Britain, Indonesia, Italy, Japan, Mexico, Philippines, USA, as well as other countries, including Russia. In Russia, the Kamchatka peninsula has [illegible] active volcanoes, nine of which have erupted during the last 10 years. There is a very high volume of both domestic and international air-traffic over the volcanically active Kamchatka peninsula.



…к перевозок, все более
…о пепла.
…анской авиакомпании,
…я) внезапно произошел
…ать, и лишь на высоте
… и самолет совершил
…пепел, выброшенный в
…ллунгунг, расположенного рядом с

…те с "Боингом-747" Сингапурской авиа…
… посадку в результате выхода из ст…

…ма с 231 пассажиром и 13 членами э…
…нкоридж (США). На высоте 7500 м, в
…чу извержения этого вулкана, в резул…
…инут пилотам все же удалось их запу…
…аждой турбины самолета было извлеч…
…авигационные и электрические системы…
…и составили около 80 млн. долларов.
…еанском регионе, причем наибольшая
…асположено 2/3 действующих вулкано…
…ледние 40 лет произошло 4 серьезны…
…шли за последние 15 лет. Всего таких

http://www.kscnet.ru/ivs/kvert/index_eng.php

KVERT

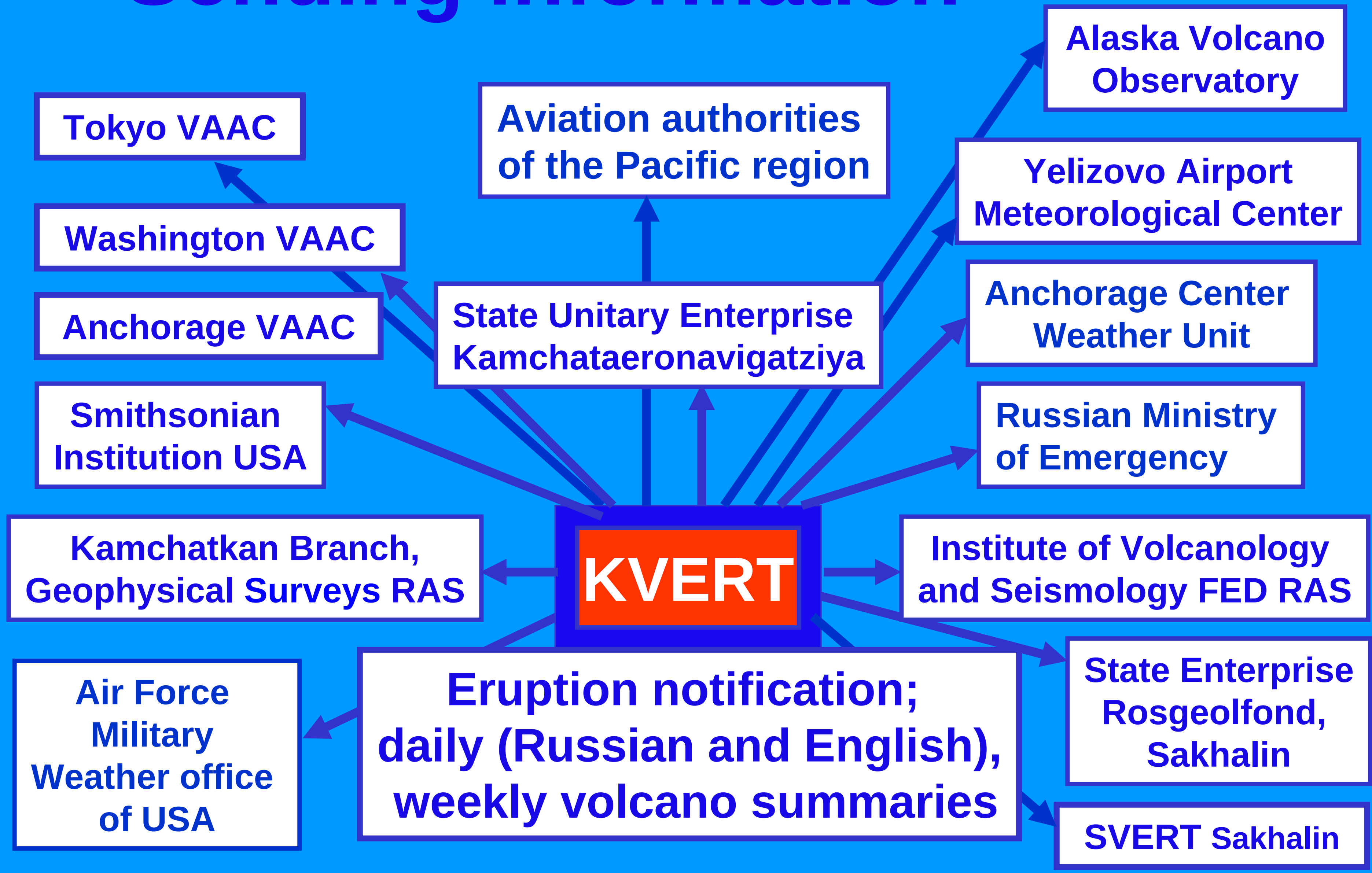
KVERT staff also notify AMC and other emergency agencies in Kamchatka by telephone.

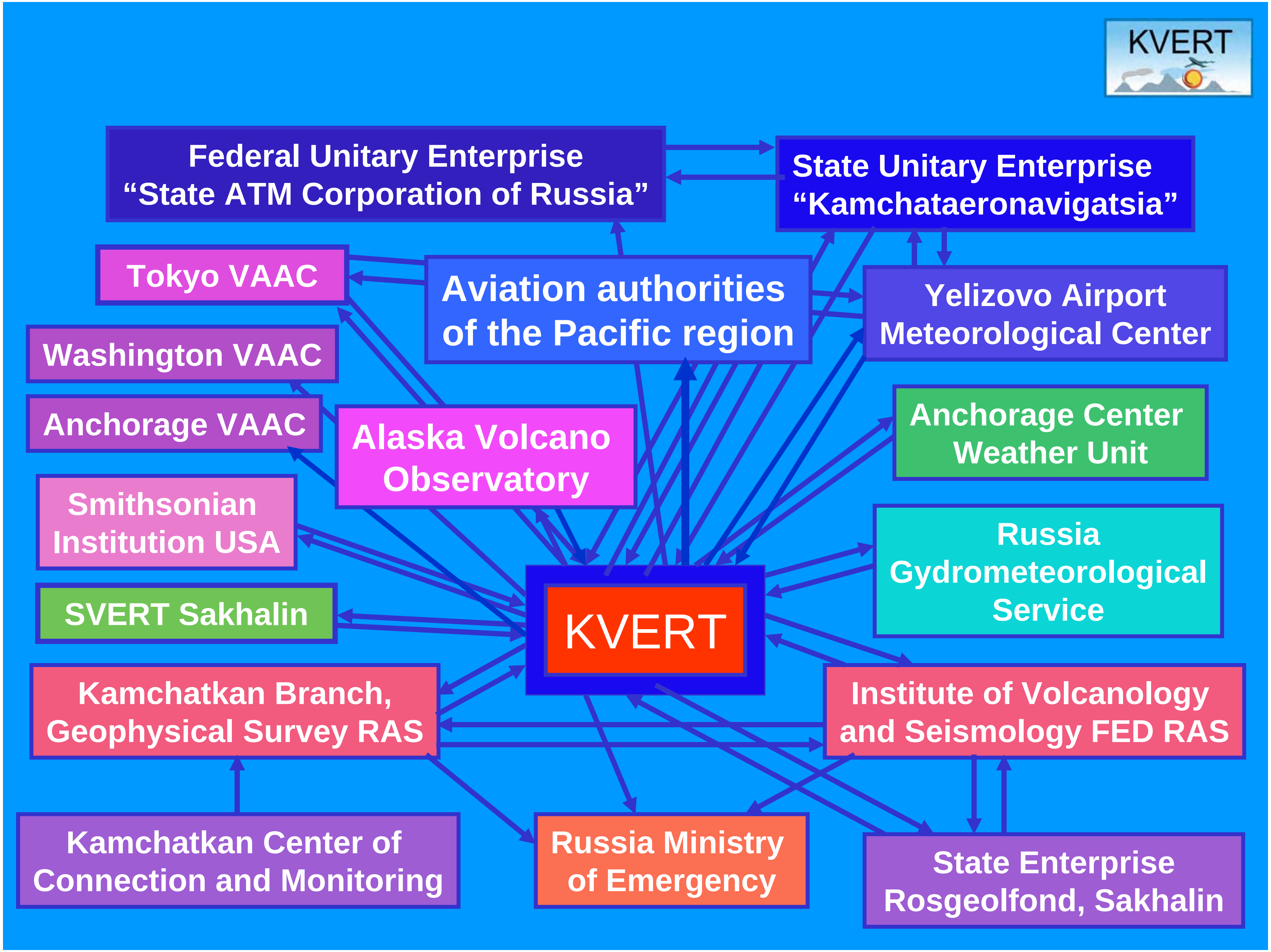
KVERT Information Releases are formal written notifications that are sent by email to these same users to announce Aviation Color Code changes and significant changes in activity. These statements are posted on the KVERT and the AVO web site.

Every year KVERT issued from 44 till 76 KVERT Information Releases.

http://www.kscnet.ru/ivs/kvert/updates.shtml

Sending information




KVERT
Federal Unitary Enterprise
“State ATM Corporation of Russia”
State Unitary Enterprise
“Kamchataeronavigatsia”
Tokyo VAAC
Aviation authorities
of the Pacific region
Yelizovo Airport
Meteorological Center
Washington VAAC
Anchorage VAAC
Alaska Volcano
Observatory
Anchorage Center
Weather Unit
Smithsonian
Institution USA
Russia
Gydrometeorological
Service
SVERT Sakhalin
KVERT
Kamchatkan Branch,
Geophysical Survey RAS
Institute of Volcanology
and Seismology FED RAS
Kamchatkan Center of
Connection and Monitoring
Russia Ministry
of Emergency
State Enterprise
Rosgeolfond, Sakhalin

в. Безымянный

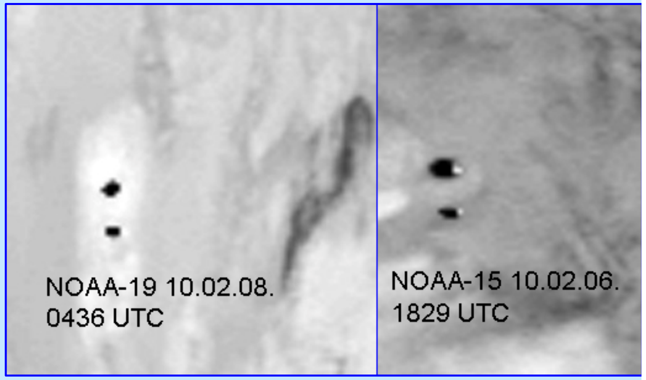
рост купола
после извержения 30 марта 1956 г.

KVERT-Predict. According to satellite data by AVO and KVERT staff, a temperature of the thermal anomaly over the lava dome of Bezymianny volcano began increasing from **May 19, 2010** (from -1 (9:49 UTC) to +18 (15:52 UTC) degrees of C).

And this stand for a preparation of new strong explosive eruption of Bezymianny volcano.

Possibly this explosive eruption of Bezymianny volcano can occurs during **May 21 - May 30 or May 21 - June 10.**

The eruption start: at 12:30 UTC on May 31, 2010.




The eruption of Bezymianny volcano on May 09, 2006. © Yu. Demyanchuk.

An example of integrated use of seismic data, video, visual and satellite observations, as well as the results of their interpretation is a prognosis and control of Bezymianny eruption in May 09, 2006.

The eruption had been predicted by scientists KB GS RAS on the seismic data over two days before the event, and Aviation Color Code (ACC) has been changed from Yellow to Orange on May 07.

Experience of studying of Bezymianny volcano allowed volcanologists IVS FED predict the culmination of this eruption, two hours before the start: ACC has been changed from Orange to Red at 06:35 UTC on May 09, and the volcanic eruption began at 08:21 UTC on May 09. Ash cloud rose up to 15 km ASL and ash plume extended > 400 km to the east from the volcano.

Early Warning is Essential to Reducing the Risk

- Rapid notification that an eruption has occurred is possible <u>if</u> volcano monitoring networks are in place.
- Monitoring requires people, instrumentation, communication, stable funding.
- Geologic studies, professionalism, and coordination with interagency partners are keys to minimizing risk.


Спасибо!
© ИВиС фото А СОКОРЕНКО

Standardisation of Volcano Early Warning and Alert Systems:

Lessons from the U.S Geological Survey and the 2010 Eyjafjallajökull ash crisis in the UK

Photo: Marco Fulle, 16 April 2010

Carina Fearnley[1]

Bill McGuire[1], Gail Davies[2], John Twigg[3]

[1]Aon Benfield UCL Hazard Research Centre, UCL London, UK

[2]Dept. of Geography, UCL, London, UK

[3] Dept. of Civil, Environmental and Geomatic Engineering, UCL

Contents

1. The role of Volcano Early Warning Systems (VEWS)

2. The 2010 Eyjafjallajökull ash crisis in the UK

3. Standardisation of VEWS: Lessons from the U.S Geological Survey

4. Implications of research findings for the standardisation of VEWS

Photo by Carina Fearnley

Photo by Carina Fearnley

1. THE ROLE OF VOLCANO EARLY WARNING SYSTEMS (VEWS)

AON BENFIELD UCL Hazard Research Centre

What is an Early Warning System (EWS)?

The role of an EWS is to:

1. **detect** impeding disaster
2. provide that **warning** to people at risk
3. enable those in danger to make **decisions** and take action

There is no clear definition but the UN define it as:

'the provision of timely and effective information, through identifying institutions, that allow individuals exposed to a hazard to take action to avoid or reduce their risk and prepare for effective response' (UN ISDR 2003)

This requires:

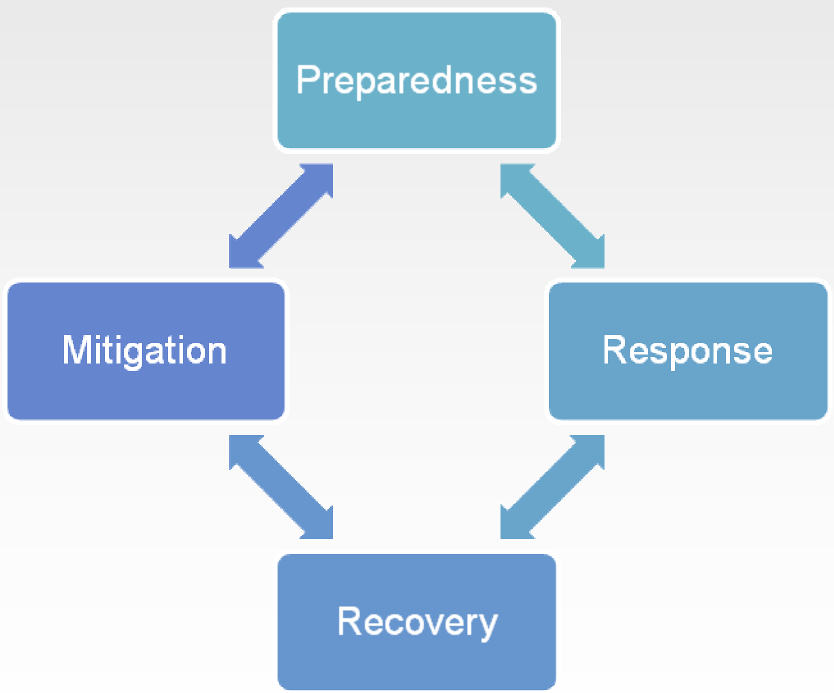
- Selection of indicators
- **Monitoring** of indicators
- **Forecasting**
- Issuing and **communicating a warning**
- Receiving the warning
- Acting on the warning

In practice this is highly complex due to variations:

- Spatially
- In Time
- In Function
- In Hazard

Where do EWS fit within disaster management?

Disasters take place in a cyclical process that has four key stages:



Early Warning Systems Place in Disaster Management:

- **Preparedness**: Building capabilities before a disaster to facilitate an effective response
- **Response:** Actions taken immediately prior, during and after a disaster to save lives

The UN Hyogo Agreement est. in 2005 has five key priorities for actions, one of which is to:

- **Identify , assess and monitor disaster risks and enhance early warning**
- **It is a key component of the UN's strategy of Disaster Risk Reduction (DRR) to achieve sustainable development and livelihoods**

Conflicting viewpoints

EWS operate in different:

- **contexts:** economic, political and social
- use different **communicative tools**
- **link** different specialities and organisations

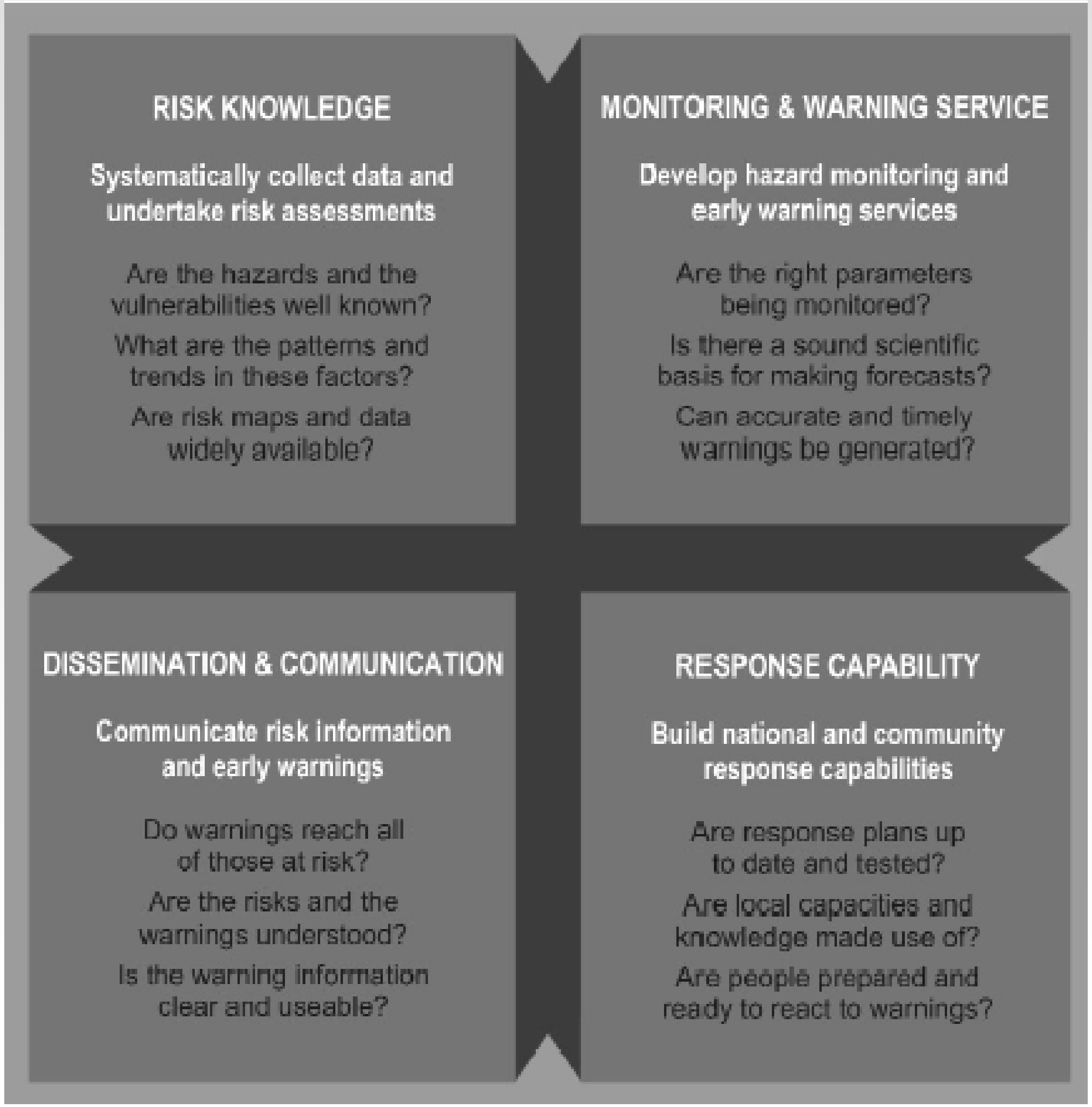
This leads to:

- Different perspectives of what an EWS is and should do
- Changing societal demands and expectations of EWS over time
- Hazard characteristics can also change over time
- ➢ What indicators can be used to suggest that a warning is warranted / effective?

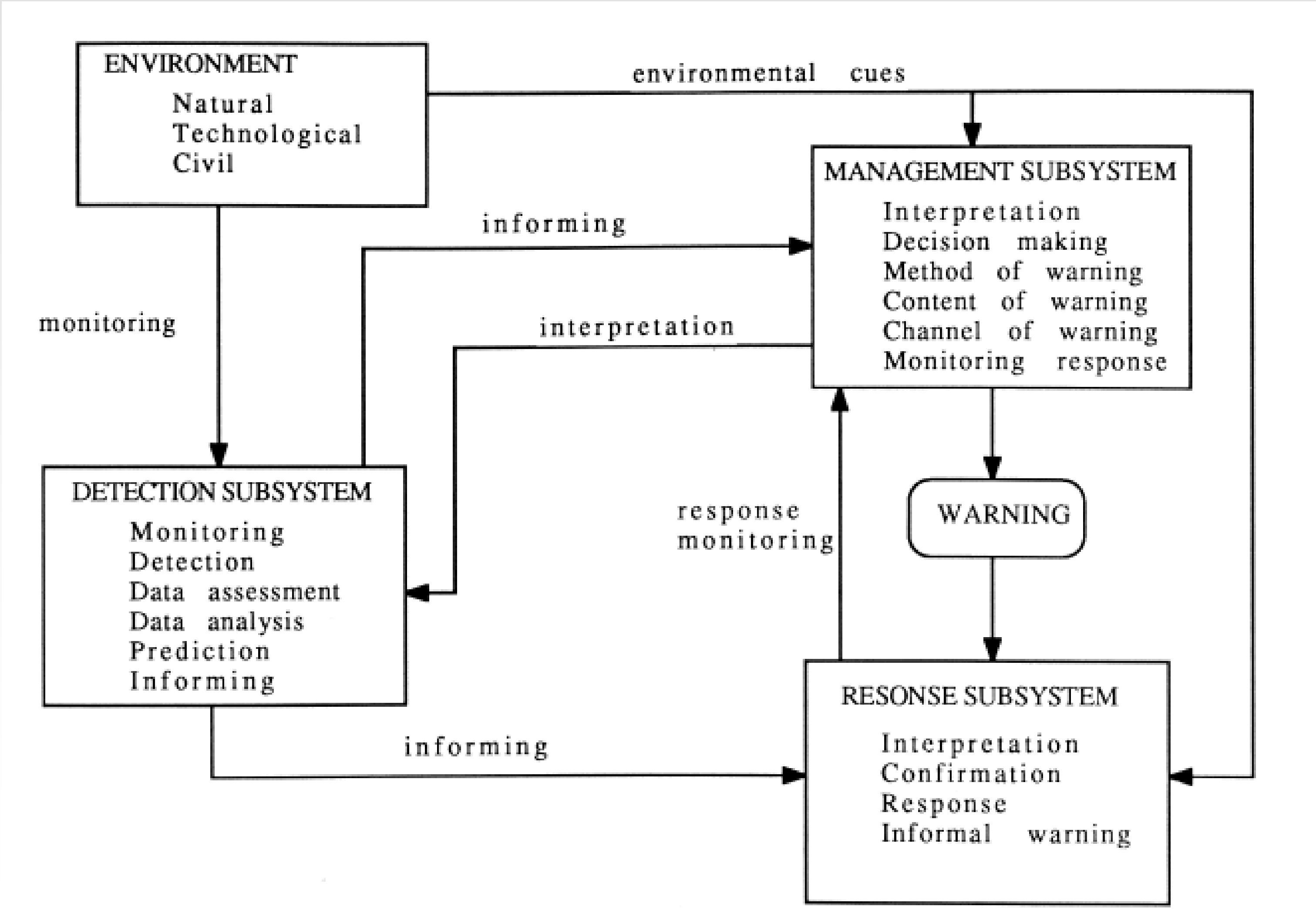
As a result EWS involves compromises:

- **Cost:** What is the cost-benefit of an EWS?
- **Timeliness:** What constitutes a warning? Are they a forecast, projection or trend? How early is early? Are there different levels of warning?
- **Reliability:** Should there be accountability for EWS? If so who? What happens with false warnings?

1. The UN’s people centred model (2006)



2. Mileti and Sorenson's model (1990)



Volcano Early Warning Systems (VEWS) and Volcano Alert Level Systems (VALS)

- VEWS are used in volcanically active countries to manage the many and complex hazards of volcanoes including fall and flow processes
- VALS are a key component of a VEWS, used to communicate warning information from scientists to civil agencies to manage volcanic hazards.
- Typically within a VALS scientists assess the state of the volcano, anticipate future behaviour and decide the alert level. The USGS defines a VALS as:

A series of levels that correspond generally to increasing levels of volcanic activity.

As a volcano becomes increasingly active or as our monitoring data suggest that a given level of unrest is likely to lead to a significant eruption, we declare a corresponding higher alert level.

This alert level ranking thus offers the public and civil authorities a framework they can use to gauge and coordinate their response to a developing volcano emergency (USGS 2008).

- VALS for ground hazards tend to nationally standardised (e.g. New Zealand, USA, Japan)
- In 2005 the ICAO adopted the colour code VALS for ash hazards as an international standard.

Image by NASA captured on April 15, 2010

2. THE 2010 EYJAFJALLAJÖKULL ASH CRISIS IN THE UK

AON BENFIELD UCL Hazard Research Centre

Implementing standard protocols for the Eyjafjallajökull eruption

Ash from the 15-20 April 2010 explosive eruption of Eyjafjallajökull volcano, resulted in:

- Unprecedented closure of the UK, European, and North Atlantic air space for six days
- Chaos generated by stranded passengers and business travellers globally
- Cost of the flight ban of 15-20 April for the European aviation and travel industry, estimated at between **£1.3 and £2.2 billion** in Europe (IATA)

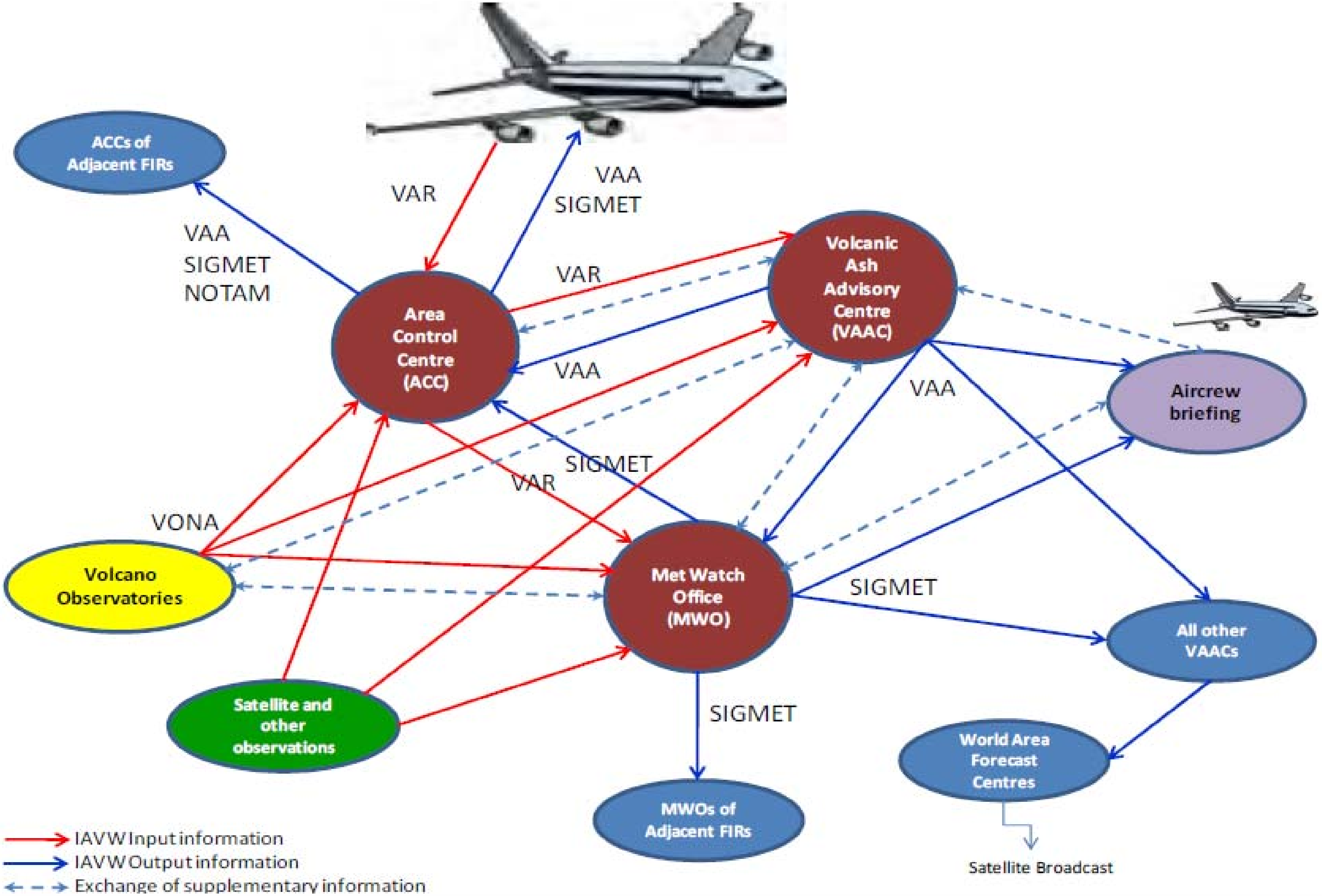
The decision to close commercial airspace followed international guidelines for responding to the presence of volcanic ash clouds along established flight paths

- Developed following two significant aircraft encounters with ash in the 1980s
- A policy of 'if ash, no fly' was adopted globally

ICAO, along with the World Metrological Organisation (WMO), established the International Airways Volcano Watch (IAVW):

- Responsible for dealing with volcano ash warnings from scientists

International Airways Volcano Watch:



Guidance for State Volcano Observatories: The International Airways Volcano Watch, 1st Edition – December 2009, p14

Aviation Colour Code (Alert Level): Adopted by ICAO

Aviation Color Code Used by USGS Volcano Observatories

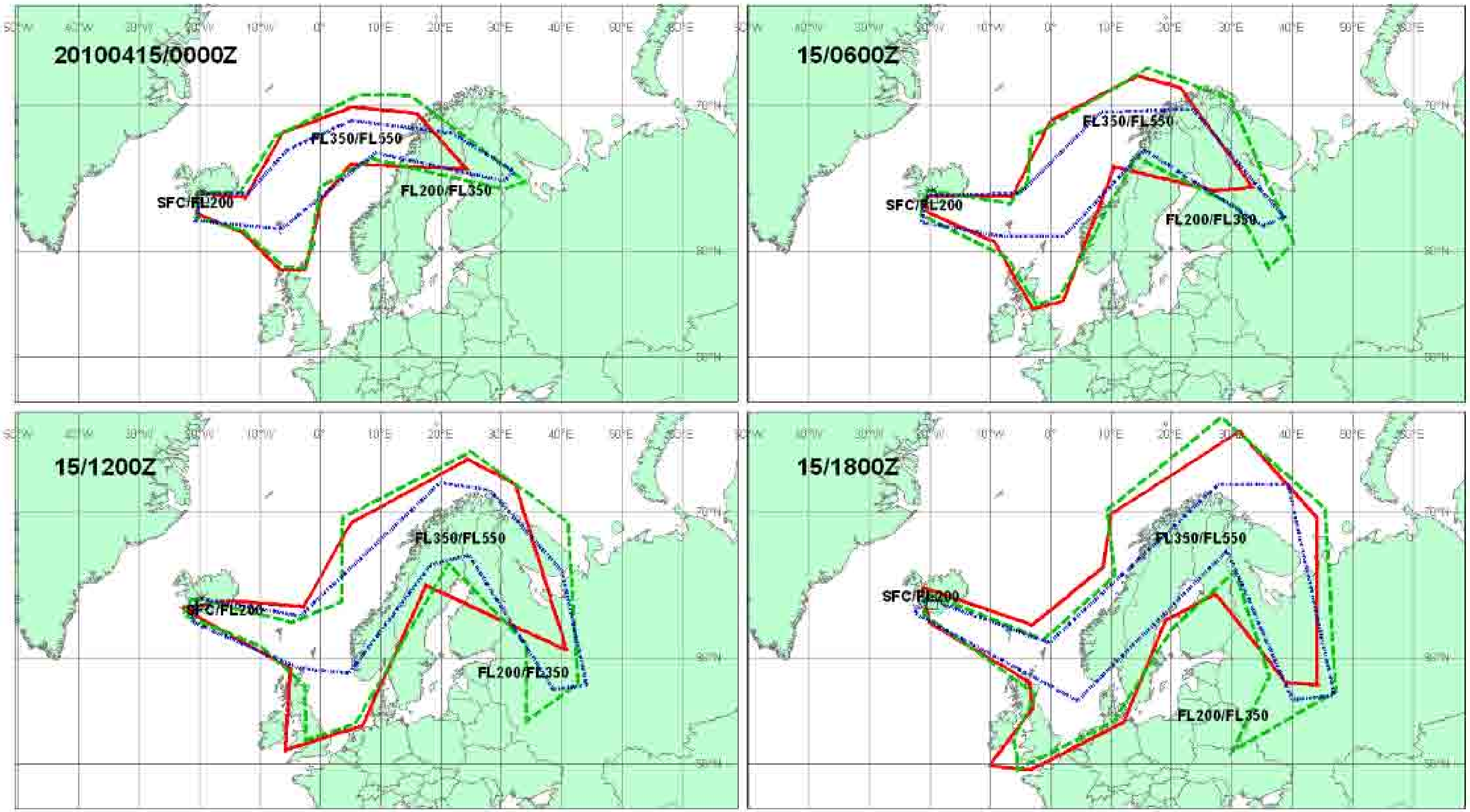
Color codes, which are in accordance with recommended International Civil Aviation Organization (ICAO) procedures, are intended to inform the aviation sector about a volcano's status and are issued in conjunction with an Alert Level. Notifications are issued for both increasing and decreasing volcanic activity and are accompanied by text with details (as known) about the nature of the unrest or eruption, especially in regard to ash-plume information and likely outcomes.

Color	Description
GREEN	Volcano is in typical background, noneruptive state or, *after a change from a higher level*, volcanic activity has ceased and volcano has returned to noneruptive background state.
YELLOW	Volcano is exhibiting signs of elevated unrest above known background level or, *after a change from a higher level*, volcanic activity has decreased significantly but continues to be closely monitored for possible renewed increase.
ORANGE	Volcano is exhibiting heightened or escalating unrest with increased potential of eruption, timeframe uncertain, OR eruption is underway with no or minor volcanic-ash emissions [ash-plume height specified, if possible].
RED	Eruption is imminent with significant emission of volcanic ash into the atmosphere likely OR eruption is underway or suspected with significant emission of volcanic ash into the atmosphere [ash-plume height specified, if possible].

http://pubs.usgs.gov/fs/2006/3139/

- Issued for the aviation sector to ascertain the status of volcanoes and determine if they need to act, reroute or do any other measures.
- Based only on the activity of the volcano i.e. ash plumes, NOT relevant for distal ash clouds.
- Although internationally standardised in 2005, only actively used in the USA – although adopted during the Eyjafjallajökull ash crisis.

Volcanic Ash Advisory (VAA):



VA ADVISORY
DTG: 20100415/0000Z
VAAC: LONDON
VOLCANO:
EYJAFJALLAJOKULL
PSN: N6338 W01937
AREA: ICELAND

SUMMIT ELEV: 1666M
ADVISORY NR: 2010/004
INFO SOURCE: ICELAND MET SERVICE
AVIATION COLOUR CODE: UNKNOWN
ERUPTION DETAILS: PLUME FROM VOLCANO
REPORTED TO BE UP TO 11KM HEIGHT

RMK: LIGHTNING REPORTED IN PLUME OVER ICELAND
NXT ADVISORY: 20100415/0600Z

http://www.metoffice.gov.uk/aviation/vaac/vaacuk_vag.html

- Note initially no aviation colour code was assigned until 15/04/10 12pm Report

The importance of context: new UK policy

- European disruption in Europe does not reflect a failure in the warning system, but inadequate evaluation of the potential impact in a large densely-populated region

- International protocols assumed that aircraft can divert or re-route to access the destination country; European context is different:
  - Crowded flight paths
  - Small countries that can be 'locked in' by ash clouds
  - Countries that do not host active volcanoes can be affected by volcanic activity

- It also reflects:
  - Inadequate abilities to monitor atmospheric ash concentrations
  - The absence of agreed safe ash concentration thresholds

- After five days of UK airspace closure, the CAA introduced new measures of regulations
  - April 20: Safe ash limit of $2^{-3}g/m^3$ of ash
  - 10 May: Removed flying buffer zone of 60 nautical miles
  - 17 May: Introduced a 'time limited zone' whereby aircraft can fly through $4^{-3}g/m^3$ of ash for limited time

➢ These disregarded international policy, raising fundamental questions about the application of standardised protocols in volcanic ash hazard management:

Issues the Eyjafjallajökull ash crisis raises:

- There is scepticism and concern that within three weeks the CAA established a 'safe' concentration of ash and removed the buffer zone based on 'evidence gathering', when this had not been achieved in thirty years.
- These rapid changes appear to be driven by:
  - Social and economic circumstances outweighing and possibly manipulating the scientific evidence, or lack thereof
  - Lobbying conducted under financial pressure
- The distinct lack of scientific information to enable a quantitative 'risk assessment' is probably why, historically, a precautionary approach had been adopted by the aviation sector.

➢ This crisis raises some fundamental questions about the standardisation and globalisation of early warning systems:

1) What is the role of social and economic risk factors in managing natural hazards?
2) How do you make decisions in complex, uncertain and risky situations, particularly when there are issues of accountability?
3) What is the efficiency of standard protocols if they do not consider local contexts?

Photo: Carina Fearnley

3. STANDARIDSATION OF VALS: LESSONS FROM THE U.S. GEOLOGICAL SURVEY

AON BENFIELD UCL Hazard Research Centre

Research aim

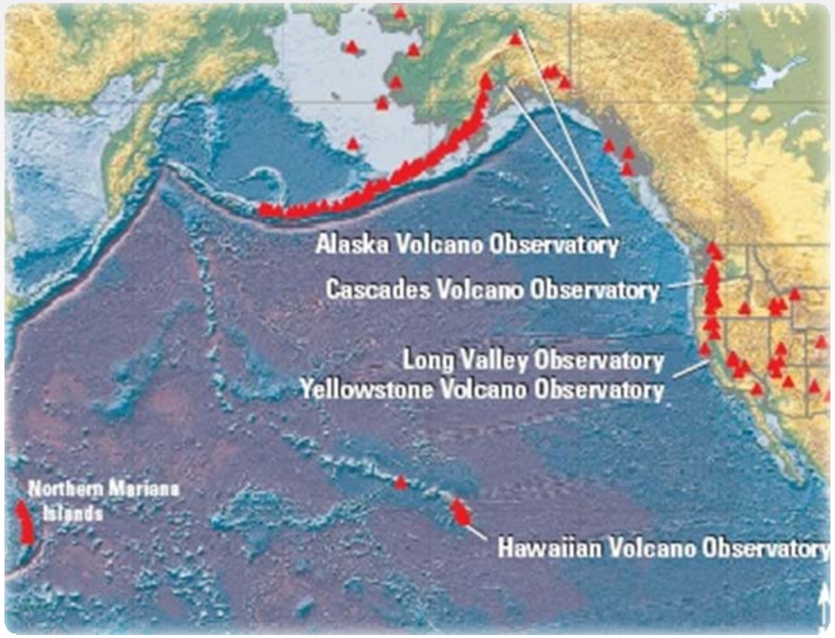
How effective is the standardisation of VALS for communicating volcanic hazards between different users?

Selected Case Study: U.S Geological Survey

- All five observatories adopted the standardised VALS in 2006
- Four different locally developed systems prior to standardisation to provide a comparison
- Excellent resources for monitoring volcanoes and communicating warnings
- Wide range of volcanic styles and hazards, many active
- Collaborates with KVERT and SVERT
- Involved in international crises with the Volcano Disaster Assistance Program (VDAP)

Research interviews were conducted with:

- USGS observatory staff / collaborators to understand how VALS work in practice
- Interviewed users to see if they are getting the info that they need from the VALS:



http://volcano.wr.usgs.gov/

Example of a locally developed VALS prior to the standardised VALS

CONDITION	USGS RESPONSE[1]	ACTIVITY LEVEL	RECURRENCE INTERVALS[2]
GREEN – No immediate risk	Normal operations plus information calls to local and other authorities for weak through strong unrest as appropriate	Background or quiescence	Most of the time
		Weak Unrest	Days to weeks
		Minor Unrest	Weeks to months
		Moderate-to-Strong Unrest	Months to years
YELLOW (WATCH)	Full call-down and EVENT RESPONSE	Intense Unrest	Years to decades
ORANGE (WARNING)	Full call-down and EVENT RESPONSE (if not already in place under YELLOW)	Accelerating intense unrest: Eruption likely within hours to days	Decades to centuries
RED (EUPTION IN PROGRESS)	Full call-down and EVENT RESPONSE (if not already in place under YELLOW or ORANGE) Daily or more frequent updates on eruption levels	LEVEL 1: Minor eruption	Centuries
		LEVEL 2: Moderate explosive eruption	Centuries
		LEVEL 3: Strong explosive eruption	Centuries
		LEVEL 4: Massive explosive eruption	Centuries to millennia

Rationale of the standardisation of VALS

Pressures to standardise came from:

Level	Rationale
International	Aviation users via ICAO wanted national and internationally accepted standards for ash warnings
National	Following 9/11 attack in the U.S. increasing standardisation of warning procedures and protocols, which the USGS VALS had to comply with
State	Federal agencies were confused by using different VALS at each observatory
Local	Emergency managers in the Cascades wanted to use terms they were familiar with for the alert levels to prevent confusion
Internally	For the USGS, standardised levels would provide more consistency

- The process and design of the standardised VALS at the USGS was a socially constructed process, determined by the demands of users and governmental policy

The USGS standardised linear VALS (2006)

Volcano Alert Levels Used by USGS Volcano Observatories

Alert Levels are intended to inform people on the ground about a volcano's status and are issued in conjunction with the Aviation Color Code. Notifications are issued for both increasing and decreasing volcanic activity and are accompanied by text with details (as known) about the nature of the unrest or eruption and about potential or current hazards and likely outcomes.

Term	Description
NORMAL	Volcano is in typical background, noneruptive state or, *after a change from a higher level,* volcanic activity has ceased and volcano has returned to noneruptive background state.
ADVISORY	Volcano is exhibiting signs of elevated unrest above known background level or, *after a change from a higher level,* volcanic activity has decreased significantly but continues to be closely monitored for possible renewed increase.
WATCH	Volcano is exhibiting heightened or escalating unrest with increased potential of eruption, timeframe uncertain, **OR** eruption is underway but poses limited hazards.
WARNING	Hazardous eruption is imminent, underway, or suspected.

Aviation Color Code Used by USGS Volcano Observatories

Color codes, which are in accordance with recommended International Civil Aviation Organization (ICAO) procedures, are intended to inform the aviation sector about a volcano's status and are issued in conjunction with an Alert Level. Notifications are issued for both increasing and decreasing volcanic activity and are accompanied by text with details (as known) about the nature of the unrest or eruption, especially in regard to ash-plume information and likely outcomes.

Color	Description
GREEN	Volcano is in typical background, noneruptive state or, *after a change from a higher level,* volcanic activity has ceased and volcano has returned to noneruptive background state.
YELLOW	Volcano is exhibiting signs of elevated unrest above known background level or, *after a change from a higher level,* volcanic activity has decreased significantly but continues to be closely monitored for possible renewed increase.
ORANGE	Volcano is exhibiting heightened or escalating unrest with increased potential of eruption, timeframe uncertain, **OR** eruption is underway with no or minor volcanic-ash emissions [ash-plume height specified, if possible].
RED	Eruption is imminent with significant emission of volcanic ash into the atmosphere likely **OR** eruption is underway or suspected with significant emission of volcanic ash into the atmosphere [ash-plume height specified, if possible].

Managing complexity and uncertainty

- There are many complex systems involved in VALS
- Complex systems are non-linear, are unpredictable and self-organise
- ➢ Complexities lead to uncertainty, particularly scientific uncertainty

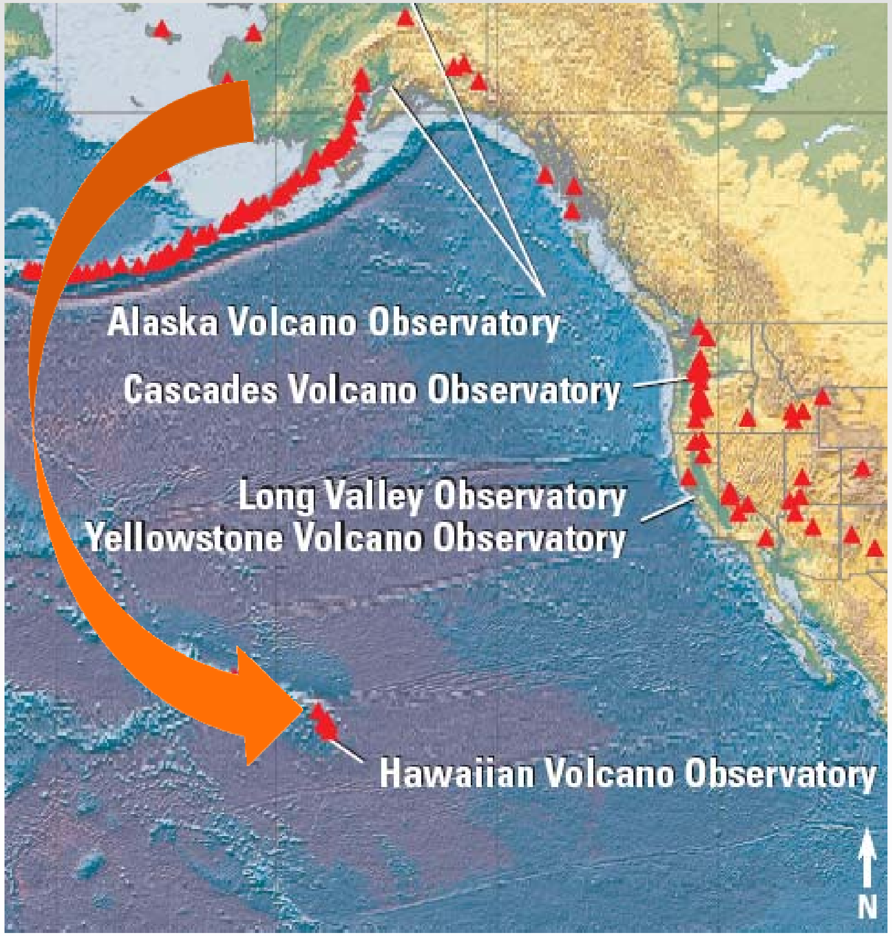
- Because of uncertainty decision-making is difficult and subjective.

- Scientists do not only assign alert levels based on the science or volcanic activity, but also consider **risks** which are dependent on the local social contexts.

- To make effective decisions that generate an effective warning requires all the actors involved to integrate closely to reduce the gaps between expertise and knowledge

- ➢ This requires **communication**

Standardised VALS in practice: The Troublesome USA Trips!

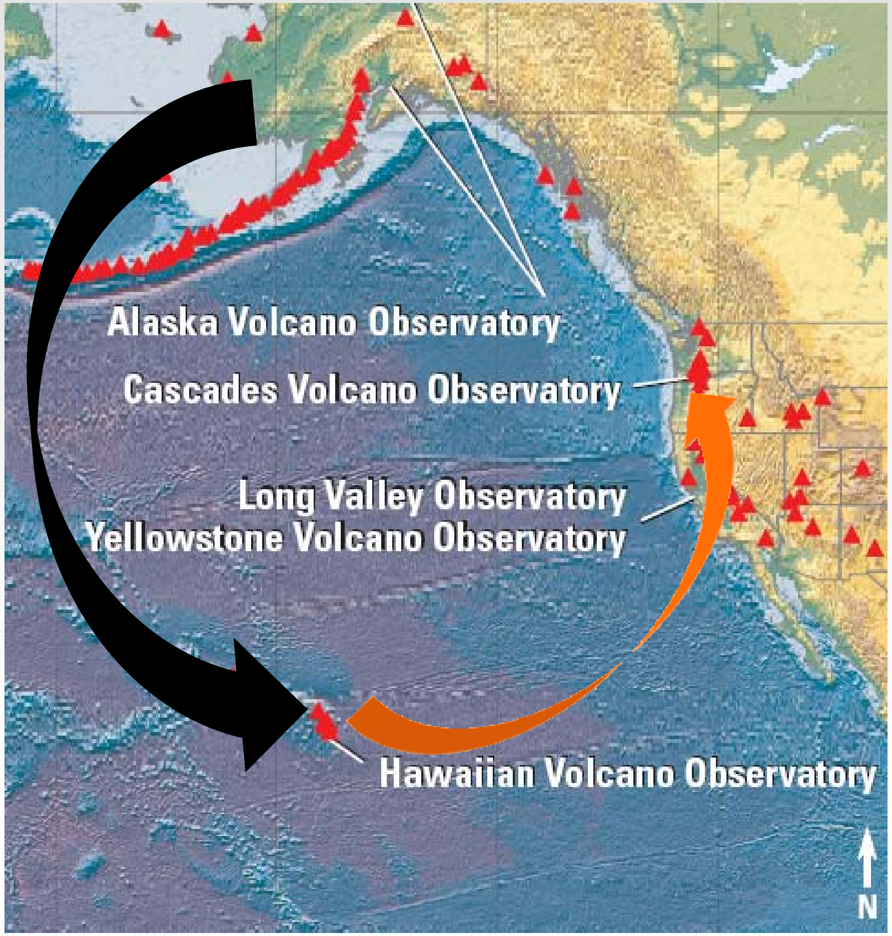


Pilots Trip (Orange)

- Alaska: Significant diversion
- Hawaii: No nearby low level flying

BENFIELD UCL Hazard Research Centre

Standardised VALS in practice: The Troublesome USA Trips!



Pilots Trip (Orange)

- Alaska: Diversion
- Hawaii: No nearby low level flying

Lucky Tourists Trip (Watch)

- Hawaii: Eruption underway
- Long Valley: Eruption imminent (hours to days)

➢ The implication is that alert level terms are standardised throughout the USA, they mean different things:

- to different users
- at different locations

Issues raised from the local vs. the national:

Issues	Local (individual USGS Observatories)	National (new standardised system)
Management	Local stakeholders develop close relationships	Streamlines communication within federal agencies reducing confusion
Decision Making	Gear decision on local needs, circumstances and knowledge	Descriptions provide guidelines / criteria, but implications may vary
Communication Methods	Local interpretation likely to be more effective	Common terminology and understanding, but must be known
Users needs	Provides flexibility to local community but global users may be confused	Limits flexibility possible, but two systems specific for their users

- These results challenge the ability for a VALS or VEWS to respond to local knowledge and context.

Research conclusions

- Therefore a VALS can be reconceptualised as:
  - A communication tool (to provide information needed by users)
  - An instrument to trigger communication and to coordination plans (requires education)
  - Provide a general awareness about the state of the volcano rather than a specific hazard

- Therefore 'one glove does not fill all' – it has to be adapted!

- A VALS is like a coat stand:
  - It provides a frame from which to hang various protocols
  - If these protocols are in place (i.e. communication, co-ordination plans, education and outreach) the coat stand balances and completes its function and is no longer visible
  - If all the protocols are not in place then the VALS will still be needed to provide a framework otherwise the coat stand will fall over as it is not balanced

➢ VALS could be reconceptalised as a framework, than as a linear system

Photo by Carina Fearnley

4. IMPLICATIONS OF RESEARCH FINDINGS ON VEWS

BENFIELD UCL Hazard Research Centre

Addressing the questions raised by the Eyjafjallajökull ash crisis

1) What is the role of social and economic risk factors in managing natural hazards?
   - Social and economic contexts are highly significant in the design, use and effectiveness of VALS and VEWS
   - Research has shown that although science is a critical component to EWS, there needs to be more consideration of social and economic contexts
2) How do you make decisions in complex, uncertain and risky situations, particularly when there are issues of accountability?
   - Communication is vital to understand users needs, capabilities and to share understanding of uncertainties and risk
3) What is the efficiency of standard protocols if they do not consider local contexts?
   - The research indicates that standardised VALS/VEWS are not hugely useful or meaningful if they do not consider local contexts

- The Eyjafjallajökull crisis demonstrated that there is a need for local and adaptive VEWS within broader international policy for the aviation sector

- It is recommended that, rather than trying to define a linear standardised product, future VALS iterations should be based on ***processes and best practice designed to facilitate communication and interaction between scientists and users in context.***

University College of London

- UCL Institute for Risk and Disaster Reduction launched early 2010
- Focus: Interdisciplinary research on hazards and risk reduction with over 70 academics across 12 departments and seven faculties
- Published Volcanic Hazard from Iceland: Analysis and Implications of the Eyjafjallajökull Eruption available on: www.ucl.ac.uk/rdr
- Actively collaborating with international researchers

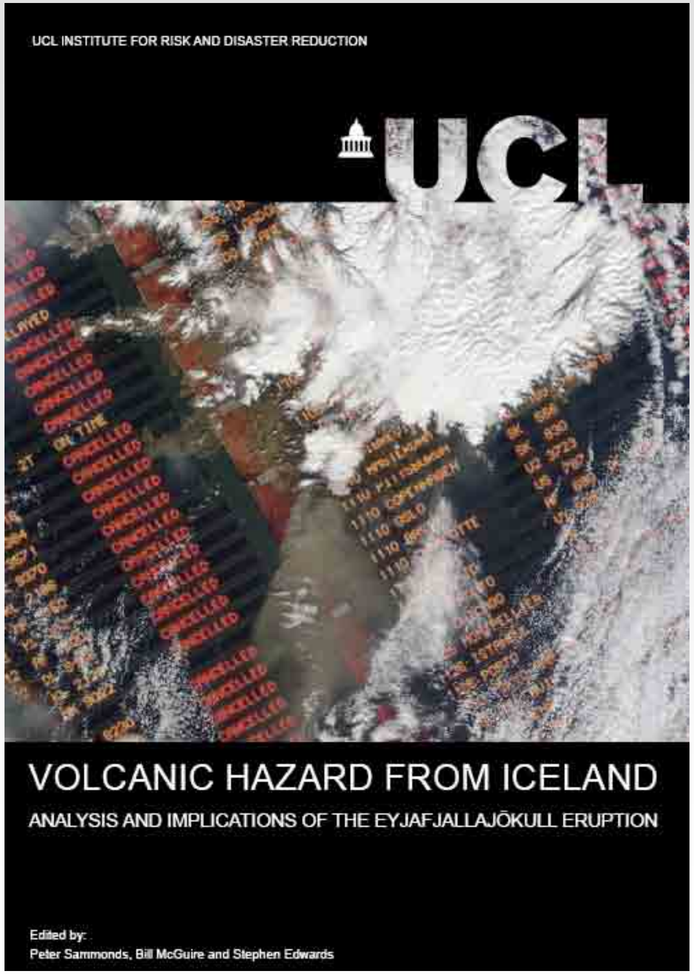


Photo by NASA

Thank You!

AON BENFIELD UCL Hazard Research Centre

ISTC International Workshop
"Worldwide early warning system of volcanic activities and mitigation of the global/regional consequences of volcanic eruptions",
Moscow, Russia, July, 8-9, 2010

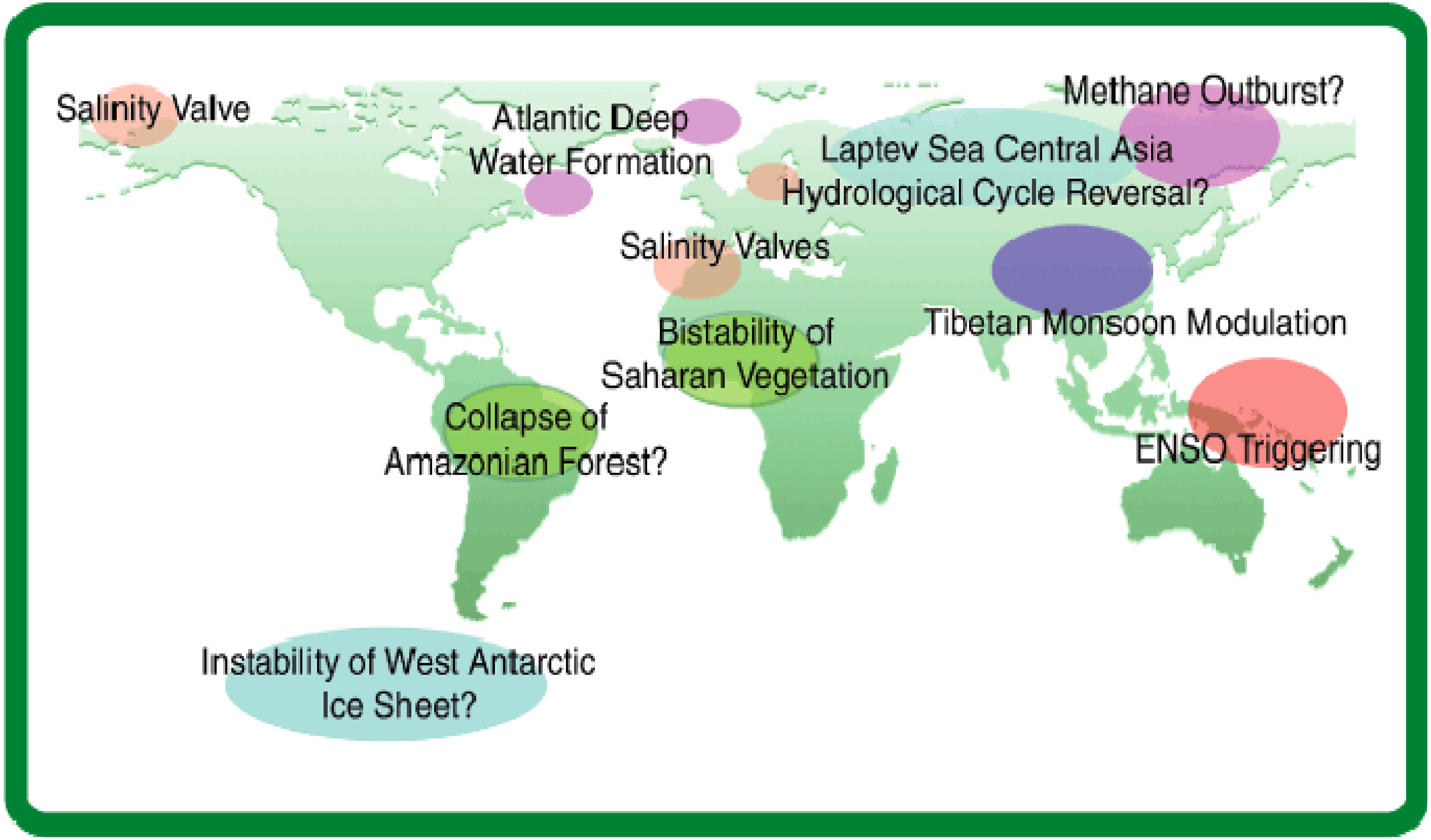
Explosive volcanic eruption and other atmospheric aerosol catastrophes

Alexander Ginzburg

Deputy Director

A.M. Obukhov Institute of Atmospheric Physics
Russian Academy of Sciences

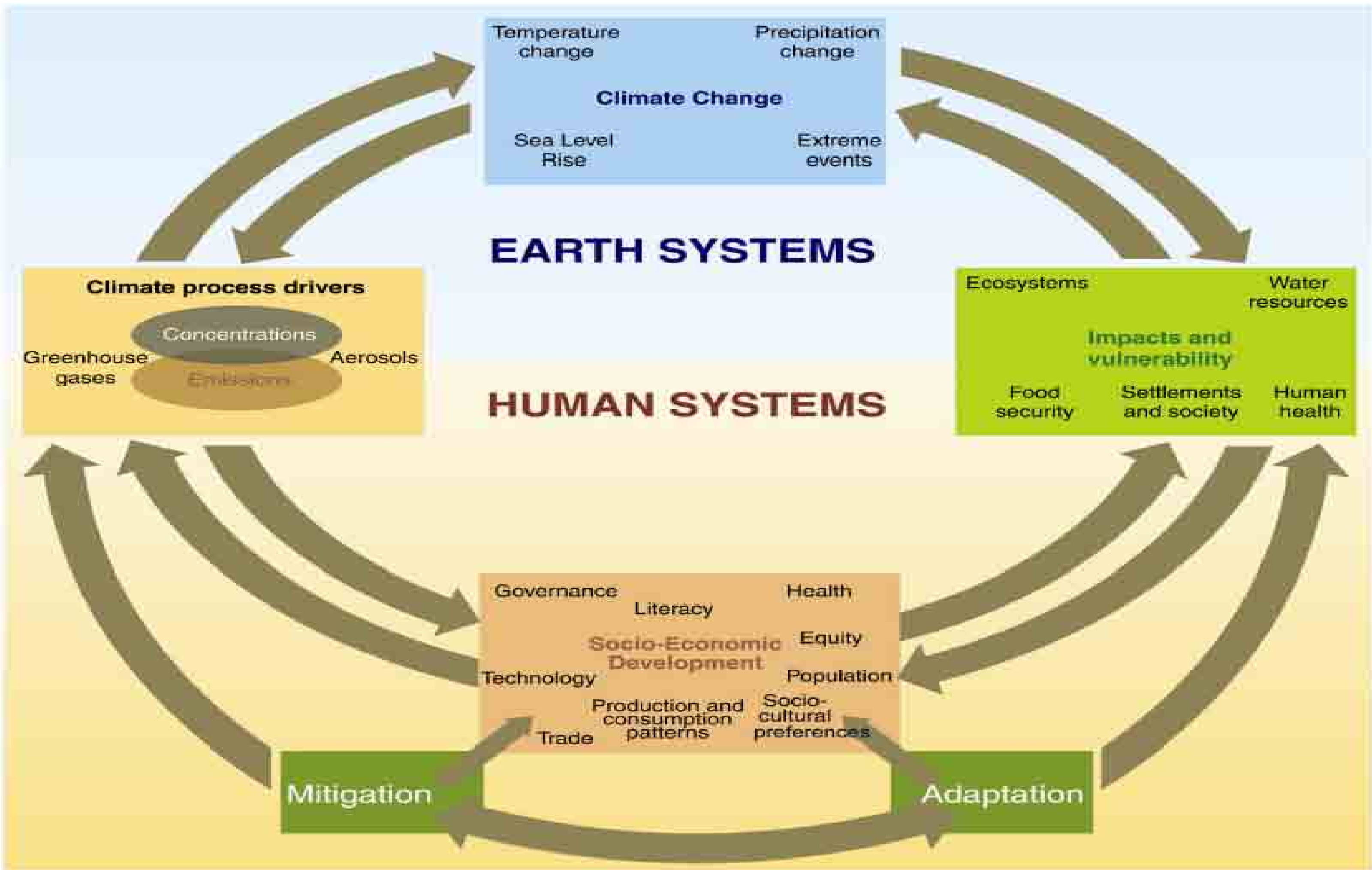
Earth System Questions

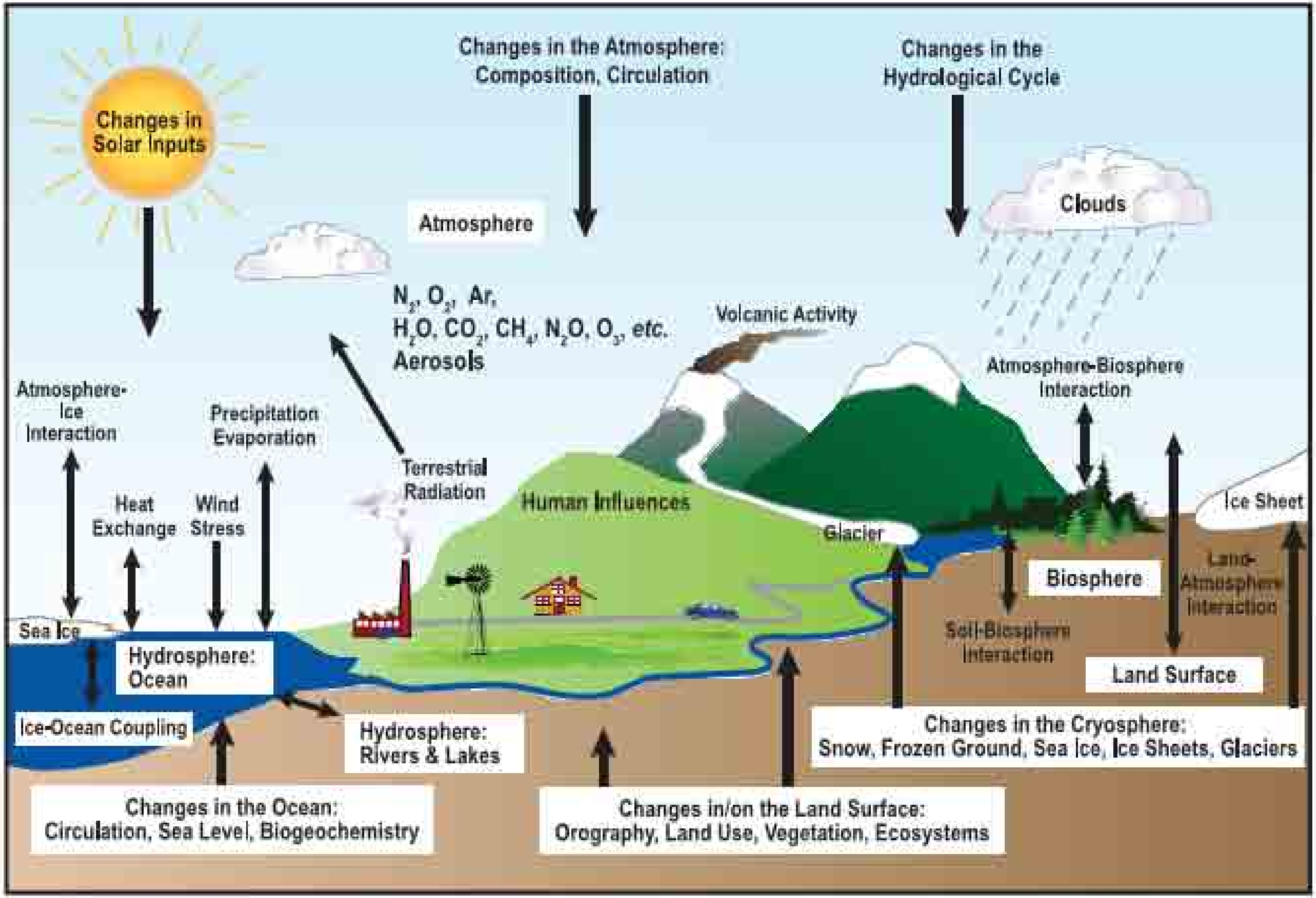


GLOBAL IGBP CHANGE

Intergovernmental Panel on Climate Change
Fourth Assessment Report
Climate Change 2007: Synthesis Report

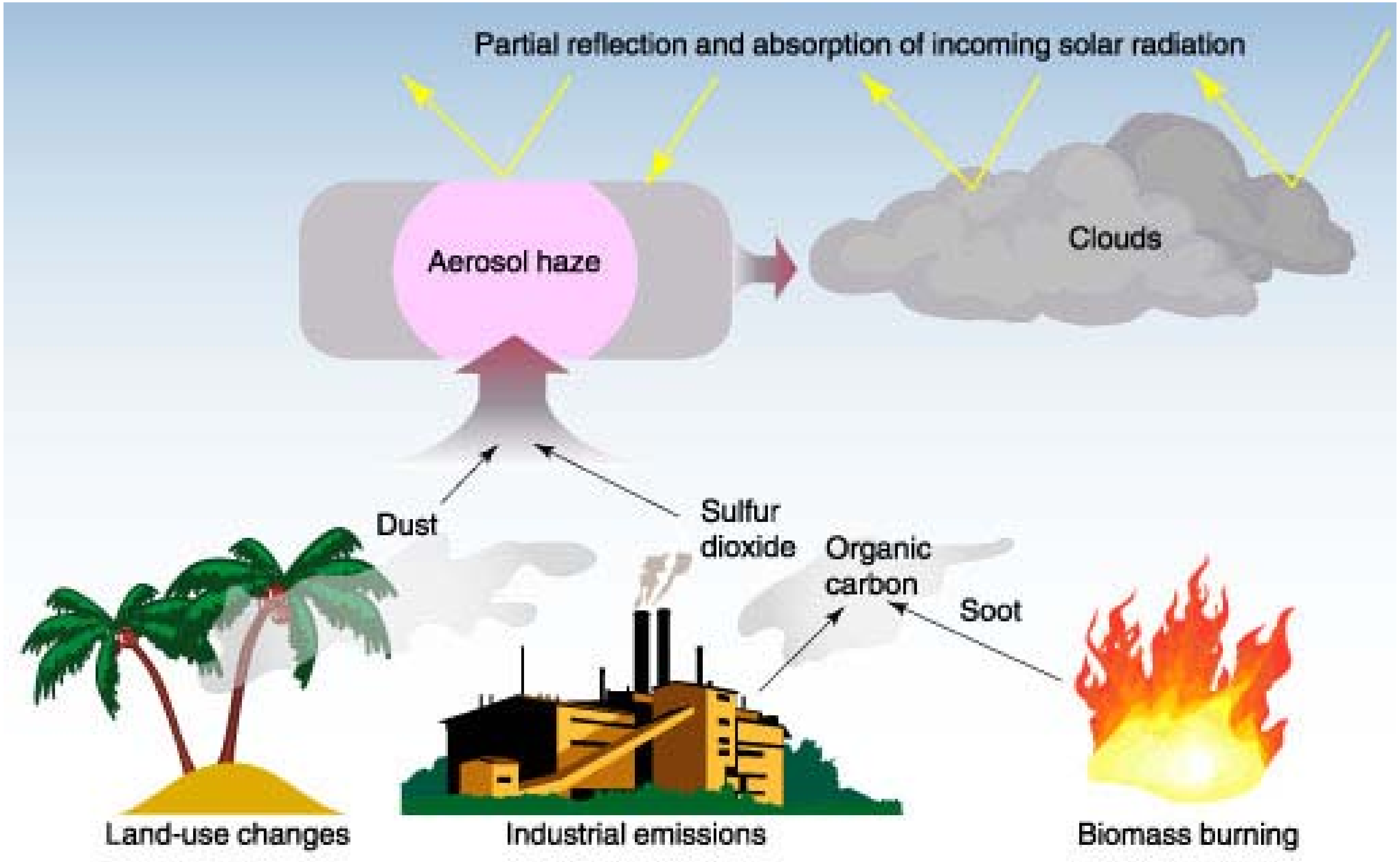
Schematic framework of anthropogenic climate change drivers, impacts and responses

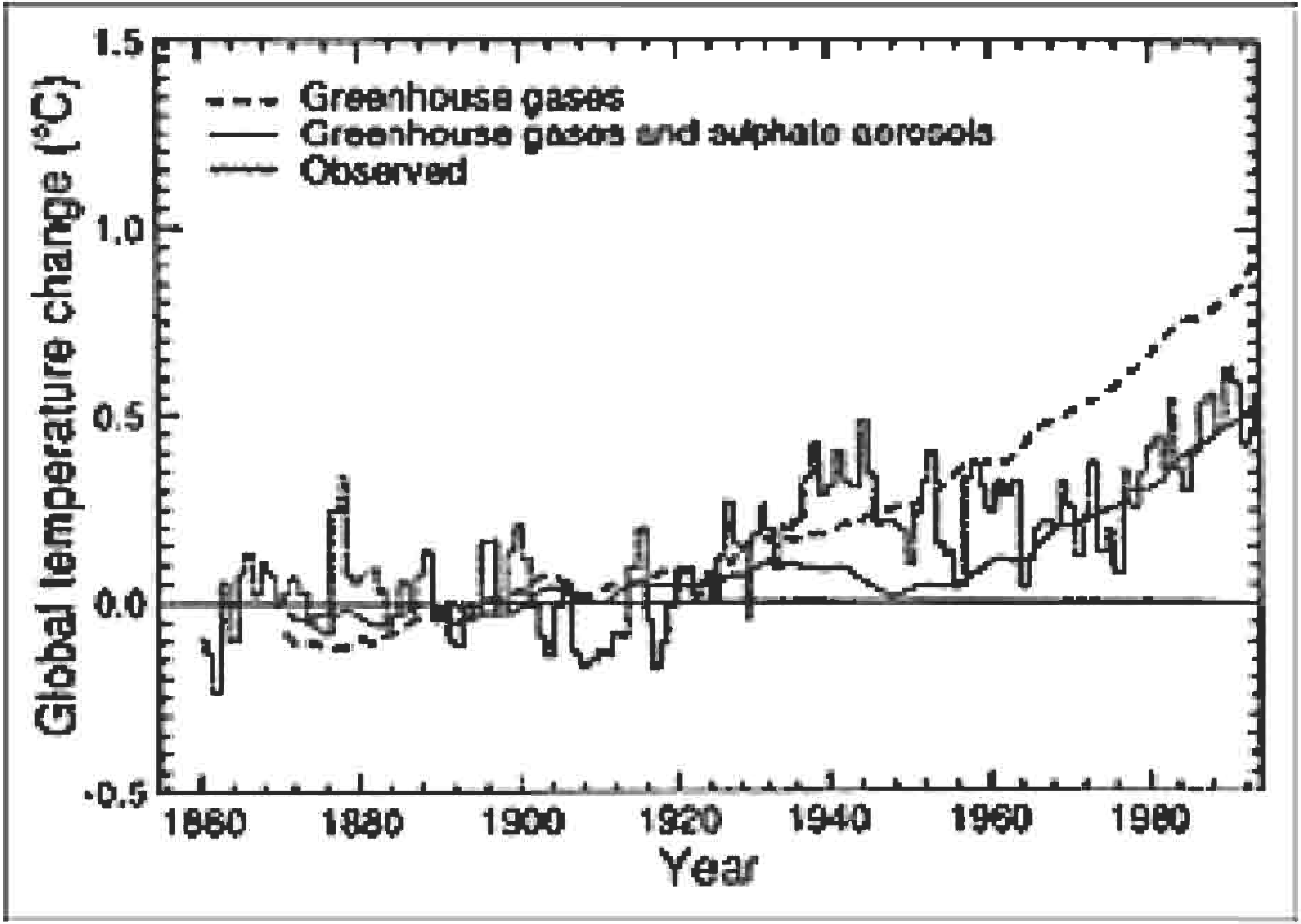




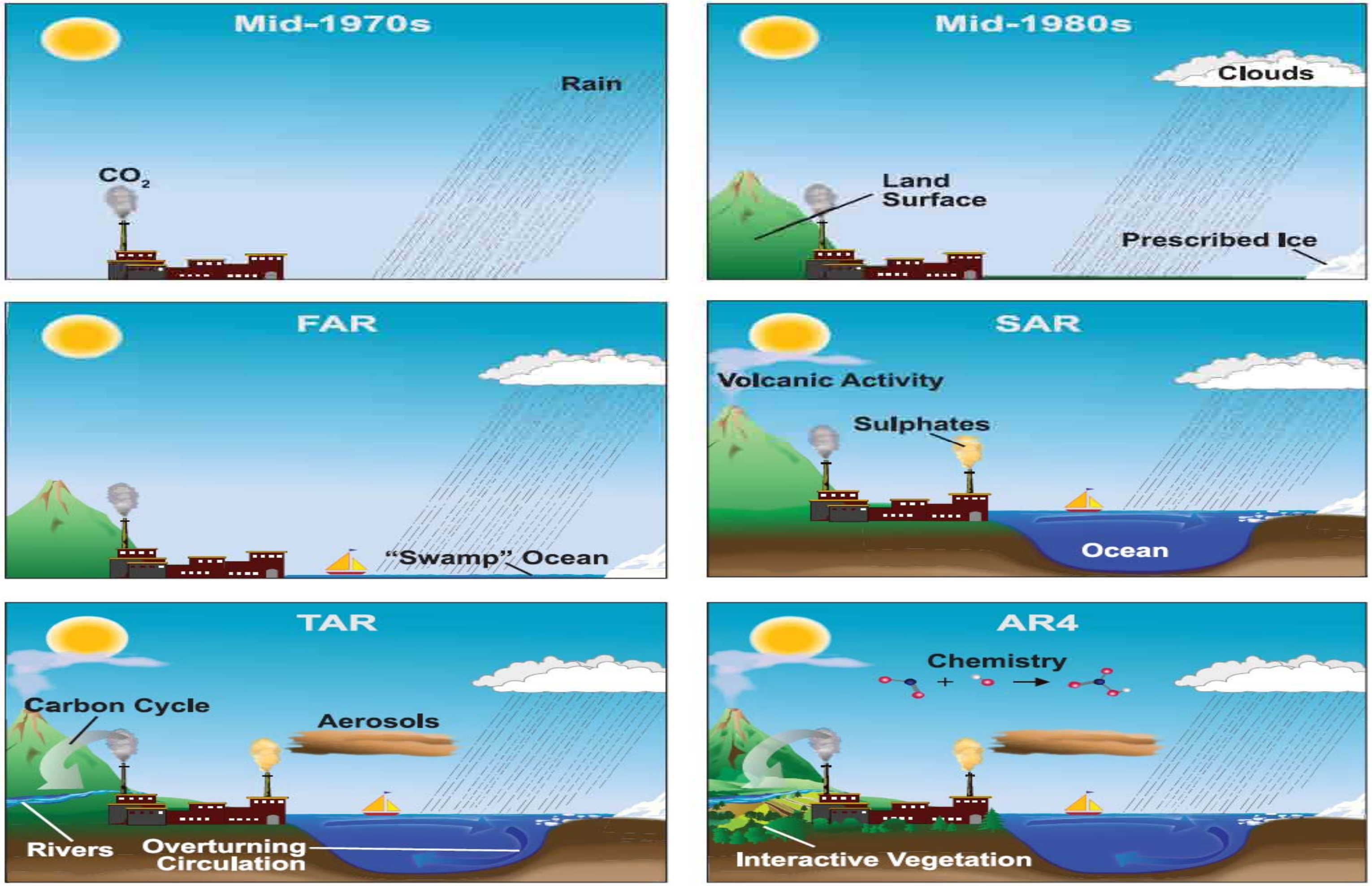
The Earth Climate System

Some Anthropogenic Impacts on Climate System



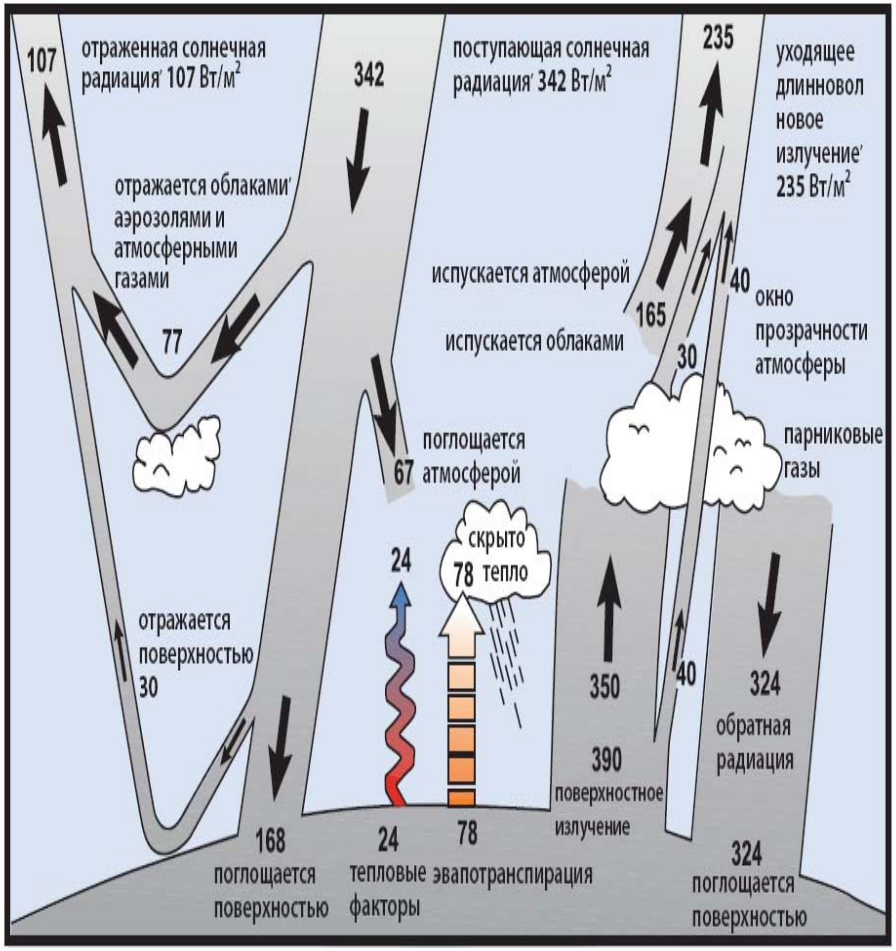


Greenhouse gases
Greenhouse gases and sulphate aerosols
Observed
Global temperature change (°C)
1.5
1.0
0.5
0.0
-0.5
1860
1880
1900
1920
1940
1960
1980
Year

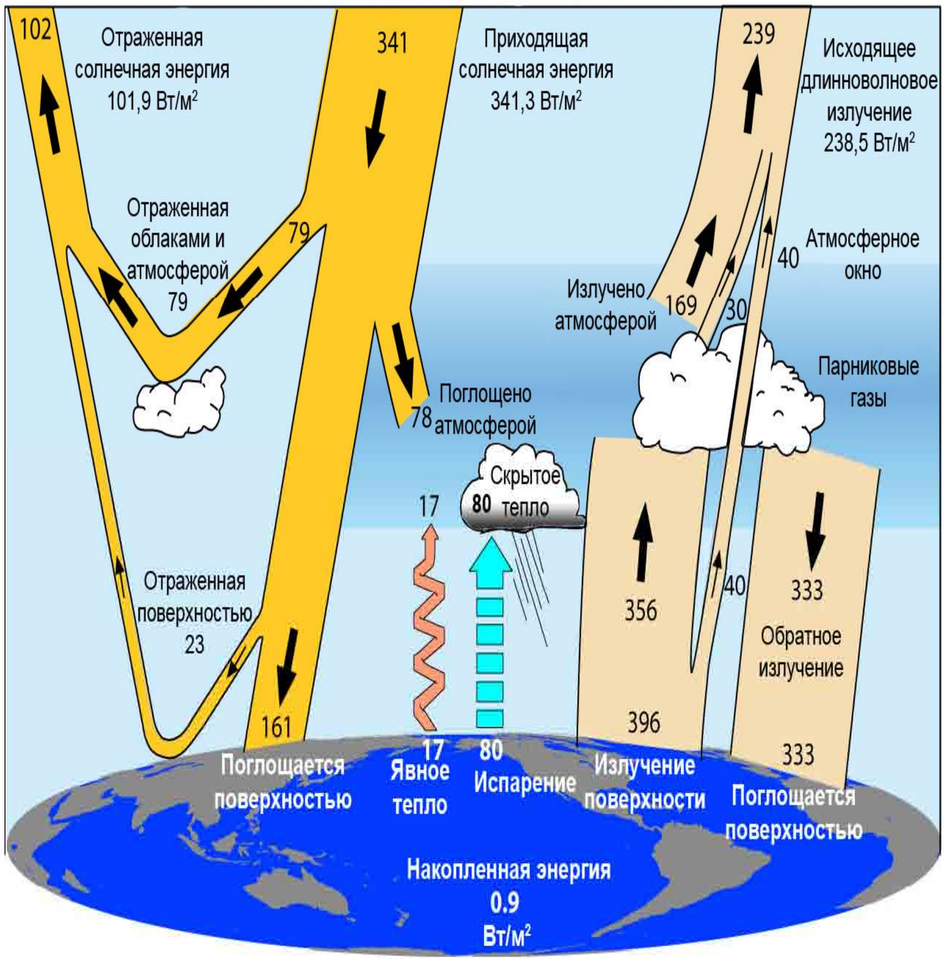


The complexity of climate models increasing and additional physics incorporation

Global Energy Balance of Earth Climate System



Kiehl and Trenberth
1997



Trenberth, Fasullo and Kiehl
2008

Climate effects of aerosols

Aerosol particles can influence climate in several ways:

Scatter and absorb (in the case of black carbon) solar radiation (direct effects).

Act as cloud condensation nuclei (CCN) around which cloud droplets can form, and thereby influence cloud reflectivity and cloud lifetime (indirect effects).

More CCN causes liquid clouds to consist of more, but smaller, droplets. The resulting cloud is more reflective (first indirect effect).

Due to the smaller size of cloud droplets, the formation of precipitation may be suppressed, resulting in a longer cloud lifetime and larger cloud cover (second indirect effect).

Black carbon can have another indirect effect by changing the albedo of snow and ice, but that's not the topic of this post.

The aerosol indirect effects are the greatest source of uncertainty in assessing the human impact on climate change.

Three types of global aerosol atmospheric and climate catastrophes:

1. Impact (asteroid) winter

2. Volcanic winter

3. Nuclear winter

ELSEVIER

Global and Planetary Change 20 (1999) 281–288

GLOBAL AND PLANETARY CHANGE

www.elsevier.com/locate/globlacha

Climate catastrophes

Mikhail Budyko

Climate catastrophes occur with large-scale environmental changes which cause mass deaths of living organisms. Long-term, strong reductions in temperature cause a considerable decrease in the number of many animal species, even full extinction.

The results of the falling of large meteorites should be a considerable increase in aerosol layer optical density in the atmosphere.

Benjamin Franklin was the first to pay attention to the possible climatic effects of volcanic gases and dust. He proposed that a large eruption of the Laki volcano in Iceland in 1783 resulted in 'dry fog', i.e., haze that caused a cold summer and poor harvests in Europe.

Toba Catastrophe

According to the Toba Catastrophe Theory, a mega-colossal eruption at Toba Caldera, Sumatra, about 74,000 years ago, was 3500 times greater than the Tambora eruption.

According to model simulations, an eruption this large can pump so much sulfur dioxide gas into the stratosphere that the atmosphere does not have the capacity to oxidize all the SO_2 to sulfuric acid aerosol.

САНТОРИН

В результате извержения на греческом острове Санторин около 1500 г. до н.э. остров практически перестал существовать: образовалась кальдера объемом 80 км^3.

Освобожденная энергия вызвала приливную волну высотой до 30 м, опустошившую остров Крит, спустя несколько часов затопившую дельту Нила и разрушившую порт, удаленный на 1000 км от места извержения.

Некоторые исследователи связывают с этим извержением легендарную гибель Атлантиды и библейскую "тьму египетскую".

Middle Age warming & Little Ice age

During the last millennium there were periods with high and low volcanic activity.

There were relatively few volcanic eruptions took place between the 11th and 13th centuries during the Middle Age warming period

After that there were at least 100 volcanic eruptions between 1500 and 1800 during the Little Ice age.

Weather Underground
wunderground.com

535 - 536 A.D. event – probably the most massive volcanic eruption of New Era took place at the time of King Arthur in Britain

"The sun was dark and its darkness lasted for eighteen months; each day it shone for about four hours; and still this light was only a feeble shadow; the fruits did not ripen and the wine tasted like sour grapes."

Many documents from 535 - 536 A.D. speak of the terrible "dry fog" or cloud of dust that obscured the sun, causing widespread crop failures in Europe, and summer frosts, drought, and famine in China.

This eruption threw so much sulfur dioxide (SO_2) gas into the stratosphere that a "Volcanic Winter" resulted. Sulfur dioxide reacts with water to form sulfuric acid droplets (aerosol particles), which are highly reflective and reduce the amount of incoming sunlight.

Volcanic winter

The eruptions capable of causing "Volcanic Winter" effects severe enough to depress global temperatures by 2°F (1°C) and trigger widespread crop failures for 1 - 2 years afterwards could occur about once every 200 - 300 years.

The Huaynaputina eruption with a magnitude 6 is blamed for the Russian famine of 1601-1603, which killed over half a million people and led to the overthrow of Tsar Boris Godunov.

In the past 200 years, Mt. Pinatubo in the Philippines (June 1991), El Chichon (Mexico, 1982), Mt. Agung (Indonesia, 1963), Santa Maria (Guatemala, 1902) Krakatoa (Indonesia, 1883), and Tambora (1815) all created noticeable cooling.

Last two centuries

Year	Volcano, region	Height of injec-tion, km	Quantity of material	Global temperature de-crease and other conse-quences
1783–1784	Laki, Iceland	> 20	> 122 Mt of SO_2, of which about 95 Mt erupted into the lower stratosphere	Almost complete absence of direct solar radiation for 5 months
1815	Tambora, Indonesia	> 50	70–150 Mt of gaseous substances	3–4°C; year without direct solar radiation
1883	Krakatau	> 50	25–55 Mt of gaseous substances	0.5°C
1912	Katmai, Alaska	~20	20 Mt of sulfide aerosols	0.3–0.5°C
1963	Agung, Indonesia	~20	> 16 Mt of sulfide aerosols	0.2–0.3°C
1982	El Chichon, Mexico	~20	~12 Mt of sulfide aerosols	0.3°C
1991	Pinatubo, the Phillippines	20–25	~30 Mt of sulfide aerosols, 20 Mt SO_2	0.3–0.5°C

The most intense volcanic eruptions in the 18th–20th centuries

(from Izrael et al, 2007)

ТАМБОРА

По-видимому, крупнейшим в истории человечества было извержение вулкана Тамбора в Индонезии в *1815* г. При взрыве было поднято в воздух *150* $км^3$ вещества.

"Годом без лета" был назван последующий за извержением *1816* г. в Северной Америке и Западной Европе.

В Новой Англии летом *1816* г. снег выпадал в июне, были заморозки в июле и августе.

В Швейцарии и Франции в *1816* г. зарегистрировано самое позднее созревание урожая винограда за период с *1782* г.

В Англии, Швейцарии и на севере США лето *1816* г. было самым холодным с начала метеорологических наблюдений.

Lord Byron "DREAM"

I had a dream, which was not all a dream.
The bright Sun was extinguished, and the stars
Did wander darkling in the eternal space,
Rayless, and pathless, and the icy earth
Swung blind and blackening in the moonless air;
Morn came and went--and came, and brought no day...

The habitations of all things which dwell,
Were burnt for beacons; cities were consumed,
And men were gathered round their blazing homes
To look once more into each other's face;
Happy were those who dwelt within the eye
Of the volcanoes, and their mountain-torch...

The winds were withered in the stagnant air,
And the clouds perish'd; Darkness had no need
Of aid from them--She was the Universe.

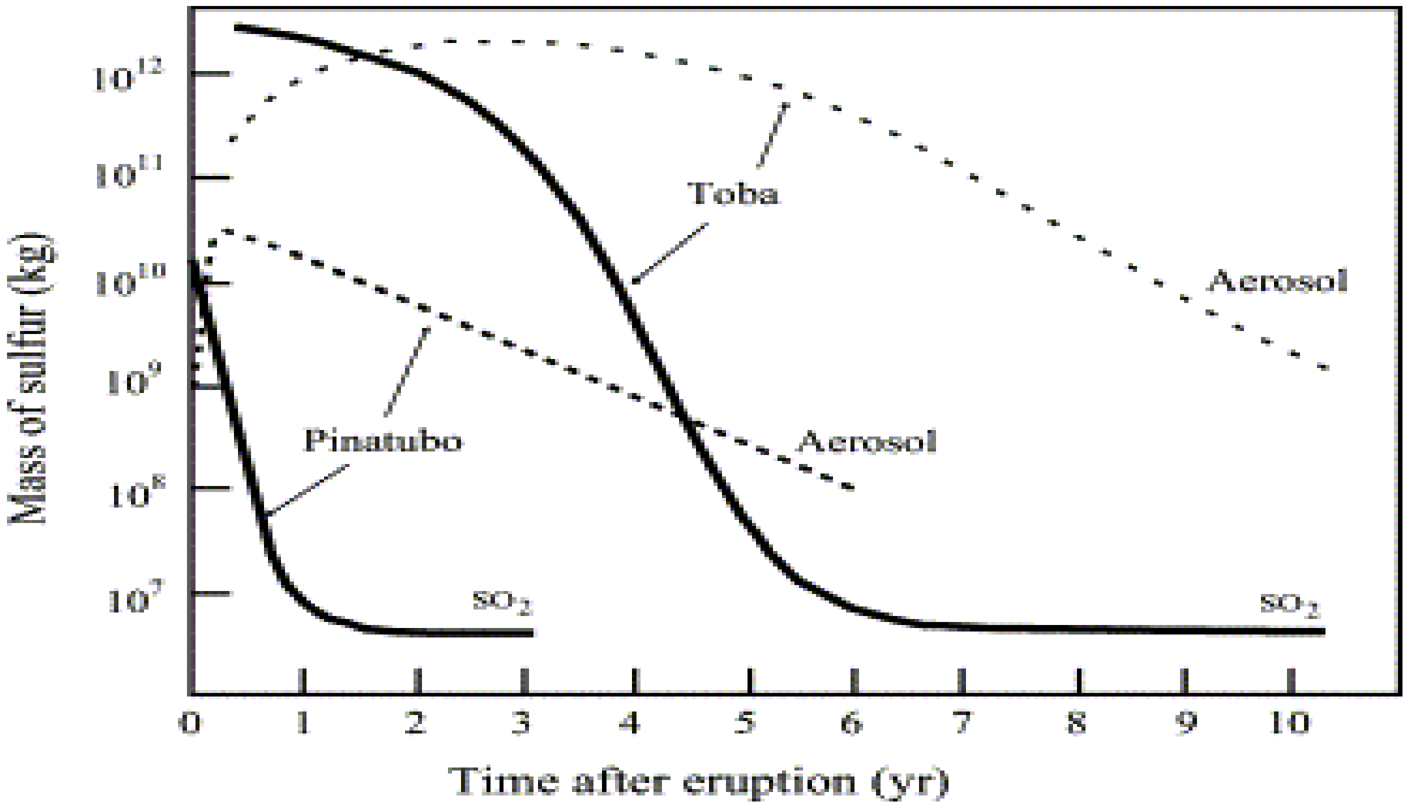
Джордж (Лорд) Байрон - «Тьма»

Я видел сон... Не все в нем было сном.
Погасло солнце светлое, и звезды
Скиталися без цели, без лучей
В пространстве вечном; льдистая земля
Носилась слепо в воздухе безлунном.
Час утра наставал и проходил,
Но дня не приводил он за собою...

...Жилища всех имеющих жилища -
В костры слагались... города горели...
И люди собиралися толпами
Вокруг домов пылающих - затем,
Чтобы хоть раз взглянуть в глаза друг другу.
Счастливы были жители тех стран,
Где факелы вулканов пламенели...

...Завяли ветры в воздухе немом...
Исчезли тучи... Тьме не нужно было
Их помощи... она была повсюду...

An 18 km-high volcanic plume from one of a series of explosive eruptions of Mount Pinatubo beginning on 12 June 1991, viewed from Clark Air Base (about 20 km east of the volcano). Three days later, the most powerful eruption produced a plume that rose nearly 40 km, penetrating well into the stratosphere. Pinatubo's sulfur emissions cooled the Earth by about 1°F (0.5°C) for 1 - 2 years. (Photograph by David H. Harlow, USGS.)



Total mass of sulfur dioxide and sulfate aerosol in the stratosphere (heavy solid and dotted lines, respectively) modeled for a 6 petagram stratospheric injection of SO_2 for Toba eruption.

Observed SO_2 and aerosol amount for the 1991 Pinatubo eruption are shown for comparison.

*Data from Read et al. (1993) and Bekki et al. (1996). Fig. from Oppenheimer, C., 2002, Quaternary Science Reviews, **21,** No 14-15, P. 1593-1609.*

Эйяфьятлайокудль днем, апрель *2010*

Эйяфьятлайокудль ночью, апрель *2010*

М.Ю. Лермонтов

ПРОРОК

…Посыпал пеплом я главу,
Из городов бежал я нищий,
И вот в пустыне я живу,
Как птицы, даром божьей пищи…

Similarities and differences

Pinatubo (1991) – 20 Mt of SO_2

Big E (2010) – 15 Mt of ash

Local nuclear war (????) – 5 Mt of soot

Volcanoes also warm the climate

While volcanoes cool the climate on time scales of 1 - 2 years, they act to warm the climate over longer time scales, since they are an important source of natural CO_2 to the atmosphere.

Volcanoes add 0.1 - 0.3 gigatons (Gt) of carbon to the atmosphere each year, which is about 1 - 3% of what human carbon emissions to the atmosphere were in 2007, according to the Global Carbon Project.

In fact, volcanoes are largely responsible for the natural CO_2 in the atmosphere, and helped make life possible on Earth.

A M B I O

A JOURNAL OF THE HUMAN ENVIRONMENT

Volume XI Number 2-3, 1982. Special issue

NUCLEAR WAR: THE AFTERMATH

Volume XVIII Number 7, 1989

Nuclear War and the Environment

the night after…

Climatic and biological consequences of a nuclear war

Moscow
Mir Publishers, 1985

Georgi Golitsyn
Corresponding Member of the USSR Academy of Sciences
Aleksandr Ginsburg
Candidate of Physical and Mathematical Sciences

Natural analogs of a nuclear catastrophe

Georgi Golitsyn. Born 1935. Graduated from Moscow State University in 1957. Doctor of Physics and Mathematics. Corresponding Member of the USSR Academy of Sciences, Head of the Department of Climate Theory, Institute of Physics of the Atmosphere, USSR Academy of Sciences. Specializes in oceanology and physics of the atmosphere. Member of the Soviet Scientists' Committee for the Defence of Peace Against Nuclear Threat

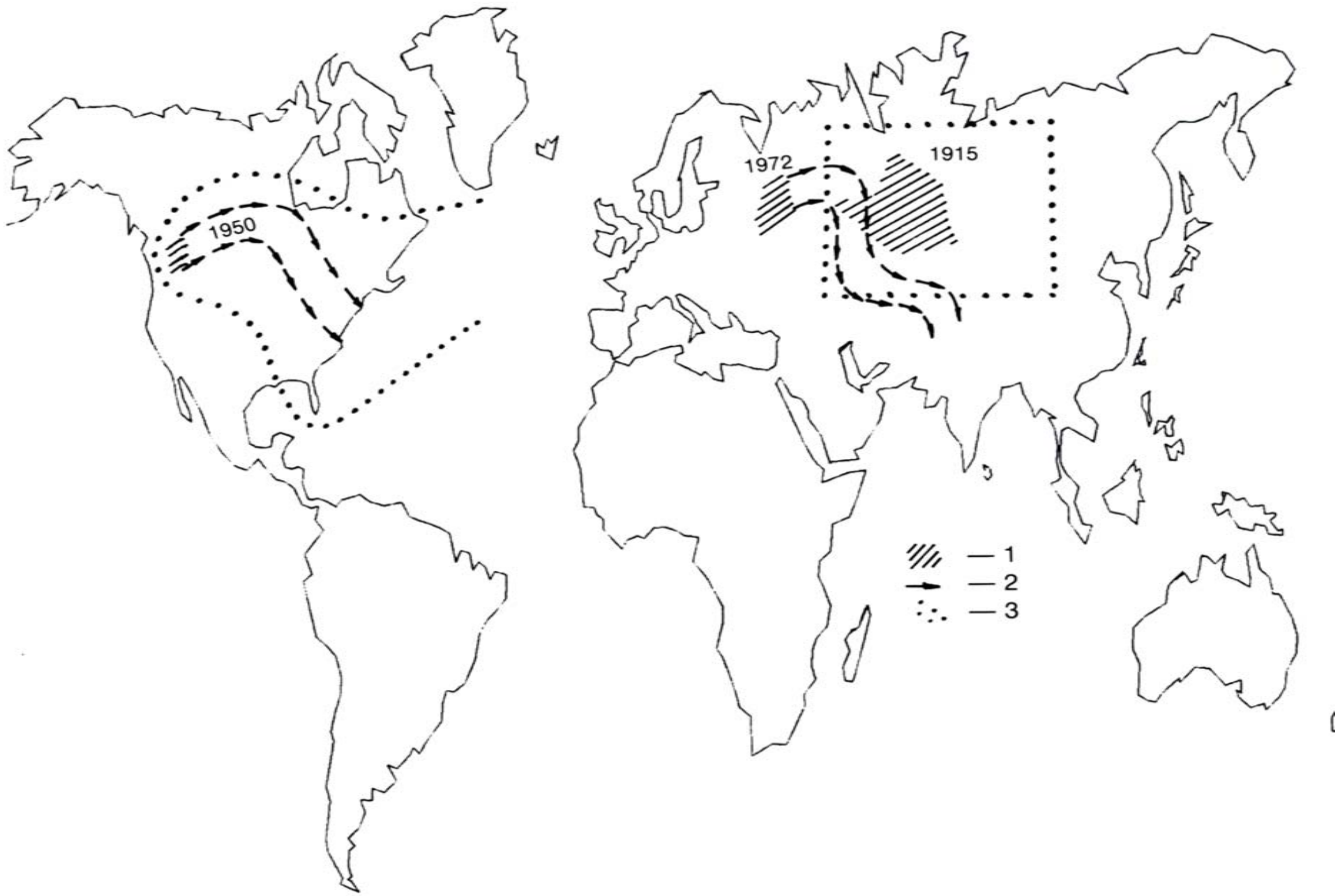
Aleksandr Ginsburg. Born 1944. Graduated from Moscow State University in 1966. Candidate of Physics and Mathematics. Deputy Head of the Laboratory of Climate Theory of the Institute of Physics of the Atmosphere, USSR Academy of Sciences. Specialist in physics of the atmosphere. Consultant to the Soviet Scientists' Committee for the Defence of Peace Against Nuclear Threat

Today mankind has reached such a level of development that it can modify natural situation on the Earth more than all catastrophes, known or conceivable, except perhaps for collision with a large celestial body. Beyond the direct material destruction and the immediate loss of human life by the hundreds of millions, a nuclear war causes radioactive contamination over vast land spaces, depletion of the protective stratospheric ozone layer, multiple urban and forest fires, and firestorms.

There are more or less relevant physical analogs in nature for some of the effects that might be expected as a result of a nuclear war. On the Earth, such catastrophic natural phenomena include earthquakes, floods, droughts, falls of large meteorites, volcanic eruptions, and massive wildfires. On Mars, there are global dust storms. Investigation of these phenomena provides a better understanding and more accurate conception of the possible consequences of a nuclear war.

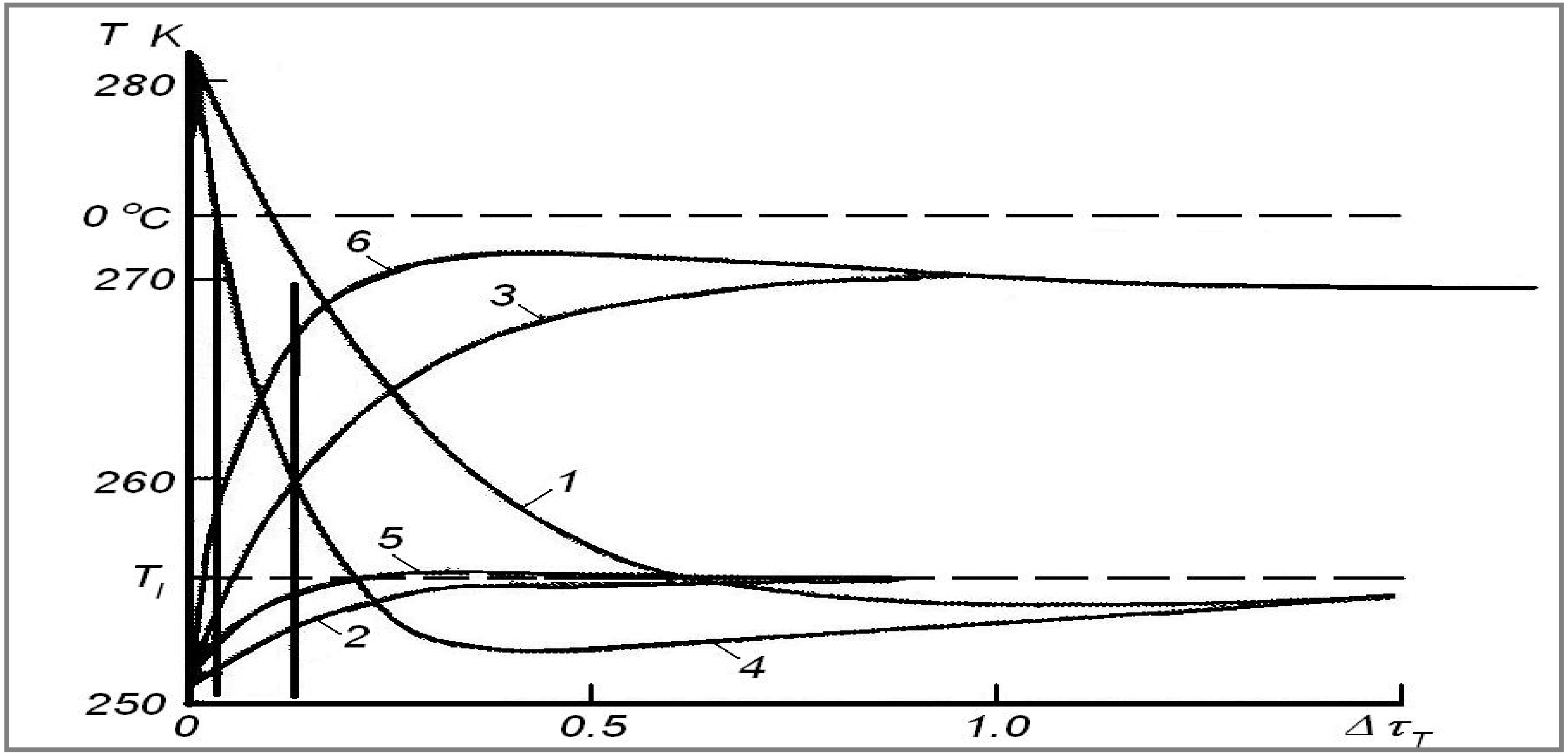
The nuclear war would be unlike any war or natural disaster known to us from past history due to the massive and unpredictable secondary long-term effects. They are consequences which, in the case of a nuclear war, would be critical for the immediate survivors of nuclear blasts. Far from all of the likely global consequences—human and ecological—of a nuclear war are clearly understood today. But it is quite obvious that certain aftermaths leave no room for illusions about a favourable 'post-war' future, even for a few remote regions of the Earth. A nuclear war would spell catastrophe for everyone without exception.

Some greatest forest and peat fires in XX century



1 – fire areas, 2 - smoke paths, 3 – smoke clouds boundaries

The Simplest Nuclear Winter Model

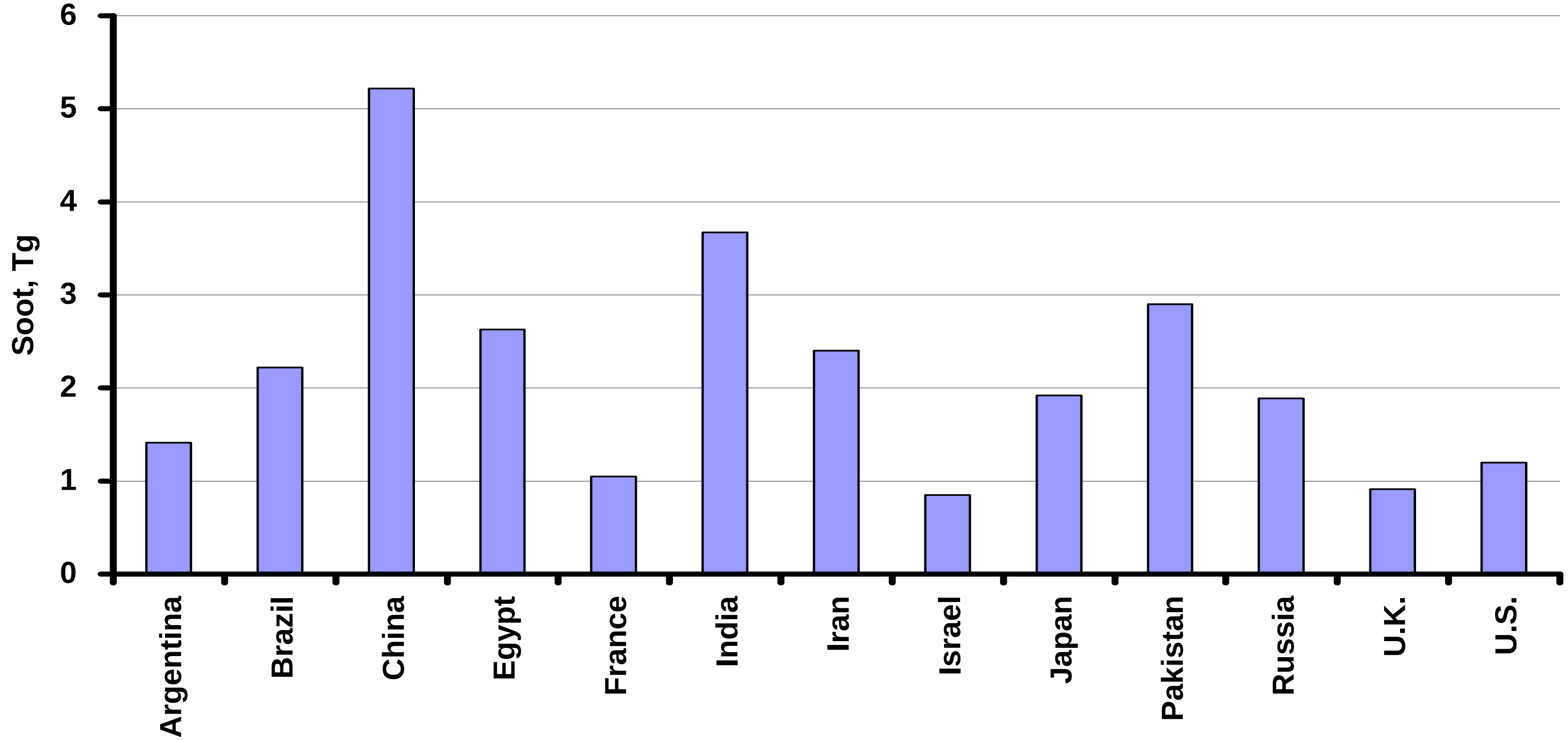


Atmosphere, Land and Ocean surface Temperature Changes Depend on Smoke Layer Optical Depth and Height

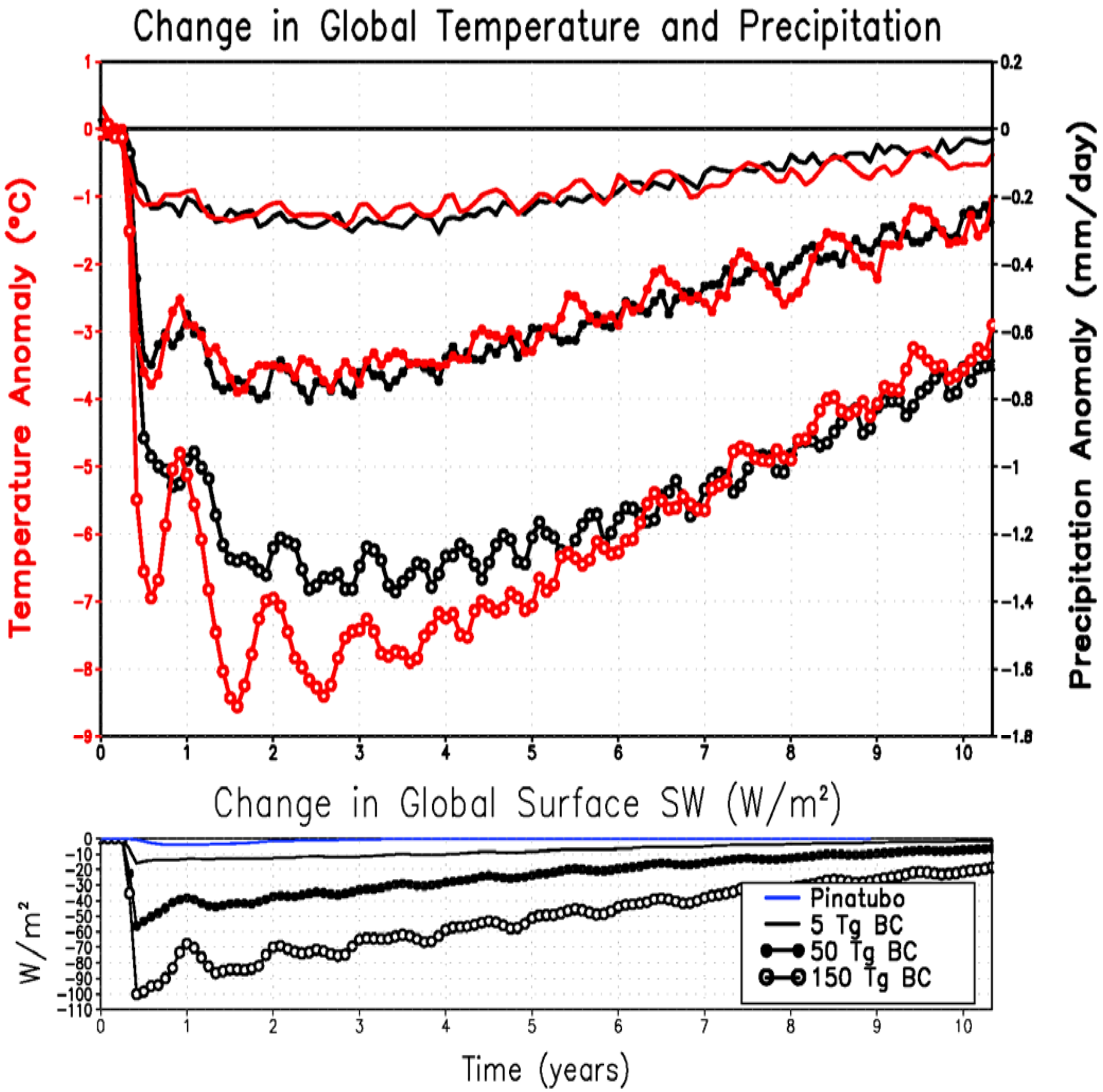
Environmental Consequences of Nuclear War

Owen B. Toon, Alan Robock, and Richard P. Turco

December 2008, Physics Today



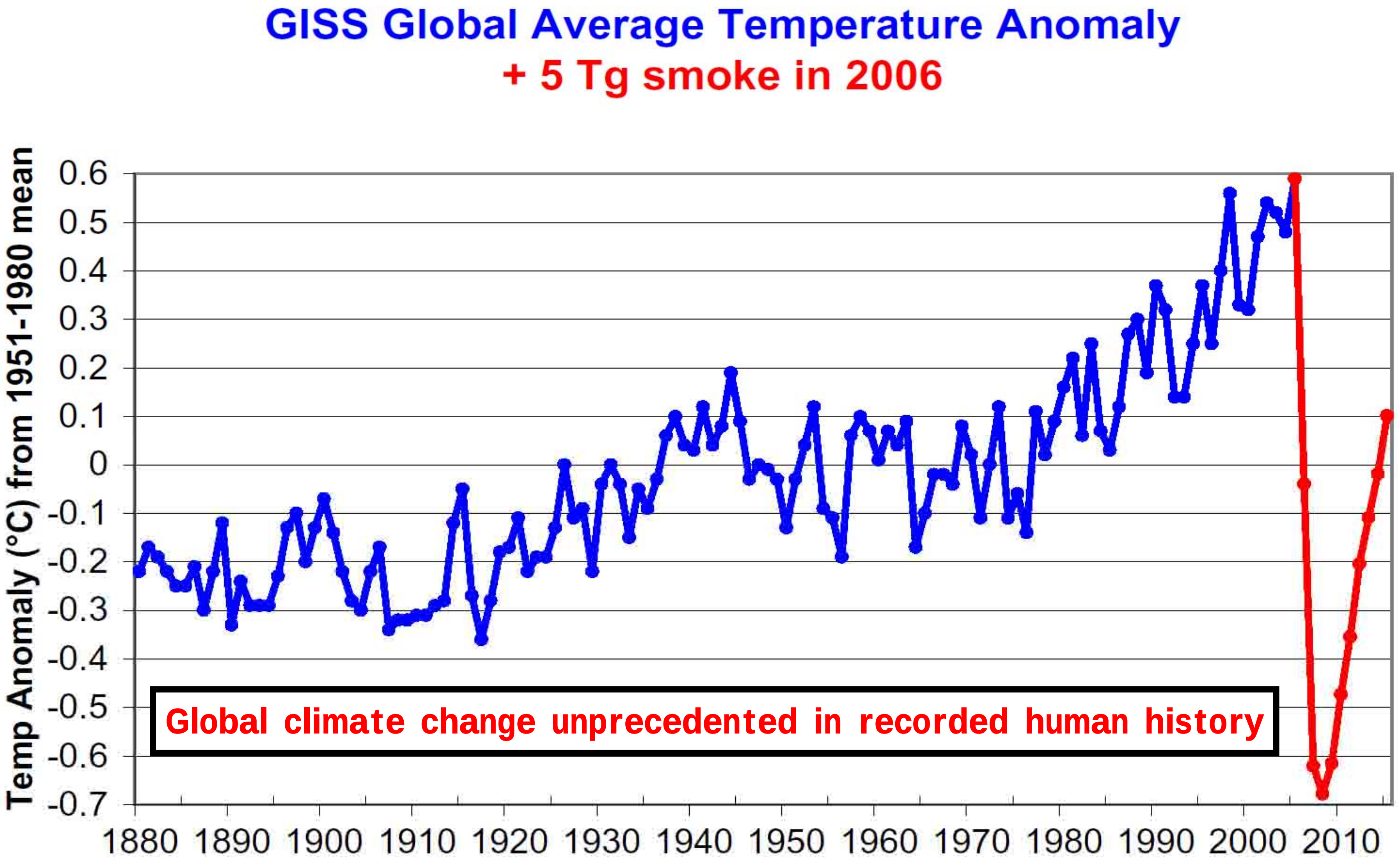
Soot Generation from 50 Weapons (15 kt each)



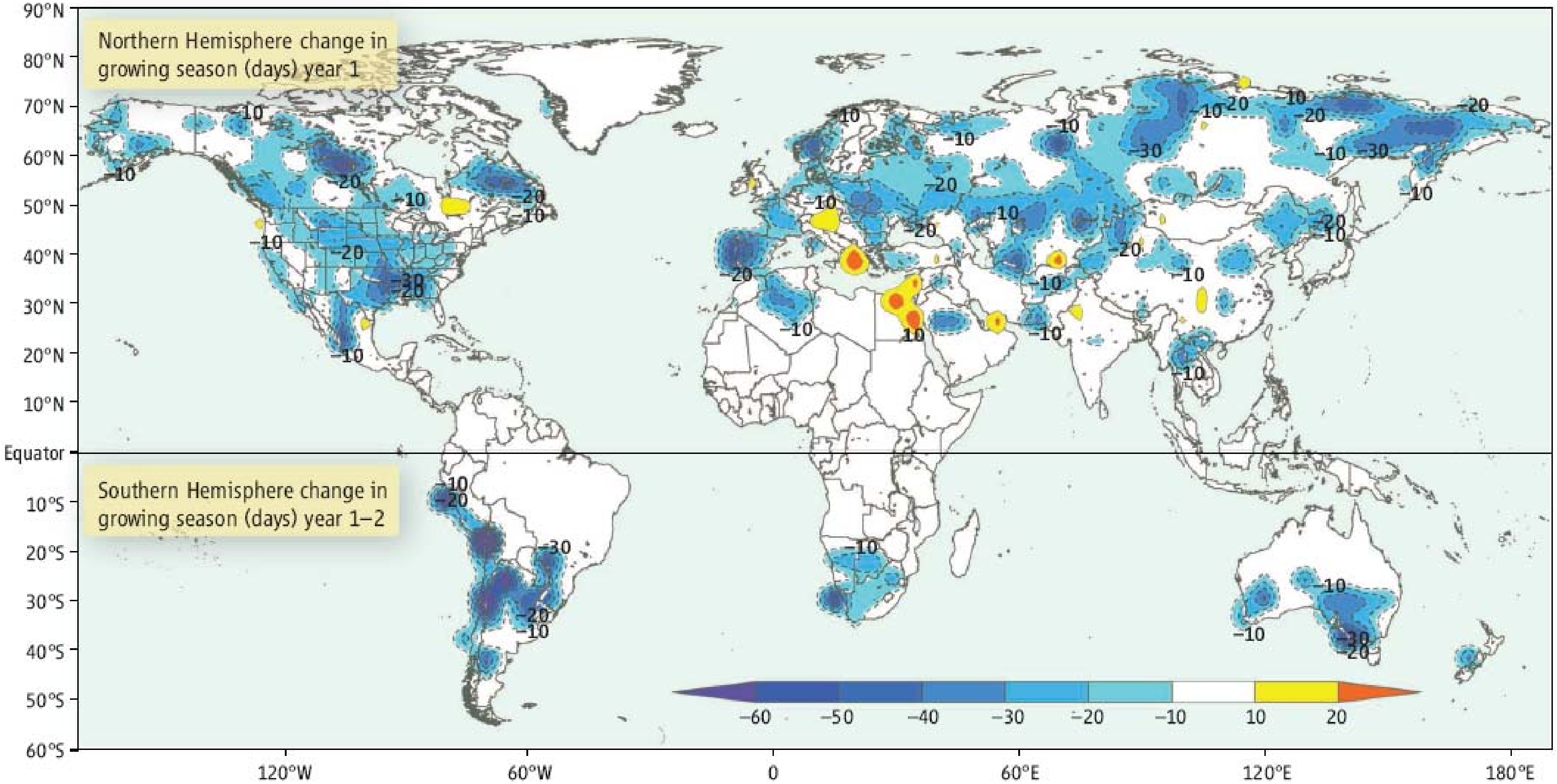
Time variation of global average surface air temperature, and precipitation changes for the 5, 50 and 150 Tg of black soot loaded into the atmosphere

Time variation of net surface shortwave radiation (5, 50 and 150 Tg cases) in comparison with the 1991 Mt. Pinatubo eruption

Robock, Oman, Stenchikov, Toon, Bardeen, and Turco, 2007: Climatic consequences of regional nuclear conflicts. *Atm. Chem. Phys.*, 7, 2003-2012.



http://envsci.rutgers.edu/~robock



Change in growing season (period with freeze-free days) in the first year after smoke release from 100 15-kt nuclear explosions

UNITED NATIONS FOUNDATION

SIGMA XI
THE SCIENTIFIC RESEARCH SOCIETY

CONFRONTING CLIMATE CHANGE:

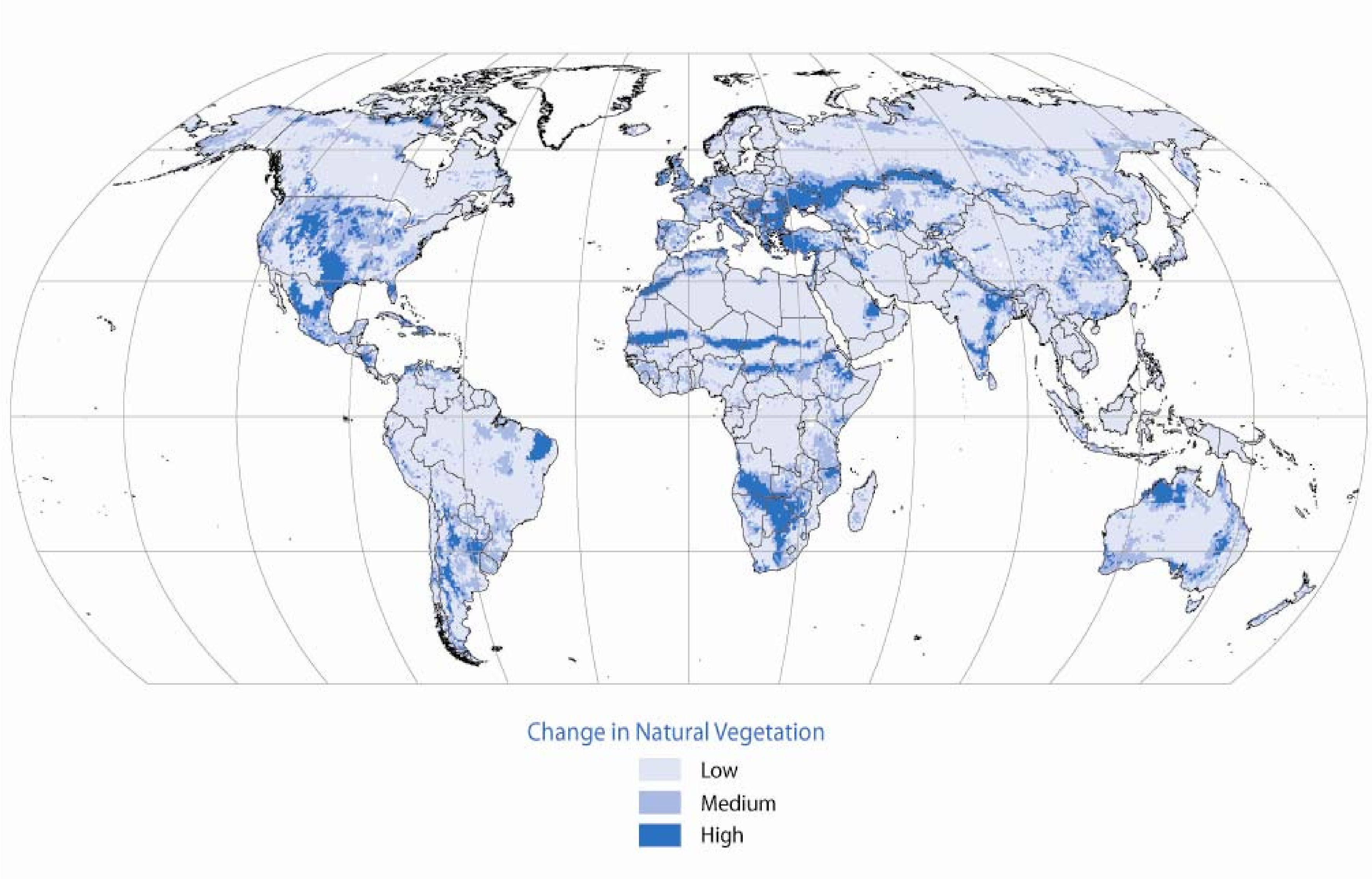
AVOIDING THE UNMANAGEABLE AND MANAGING THE UNAVOIDABLE

Scientific Expert Group Report on Climate Change and Sustainable Development

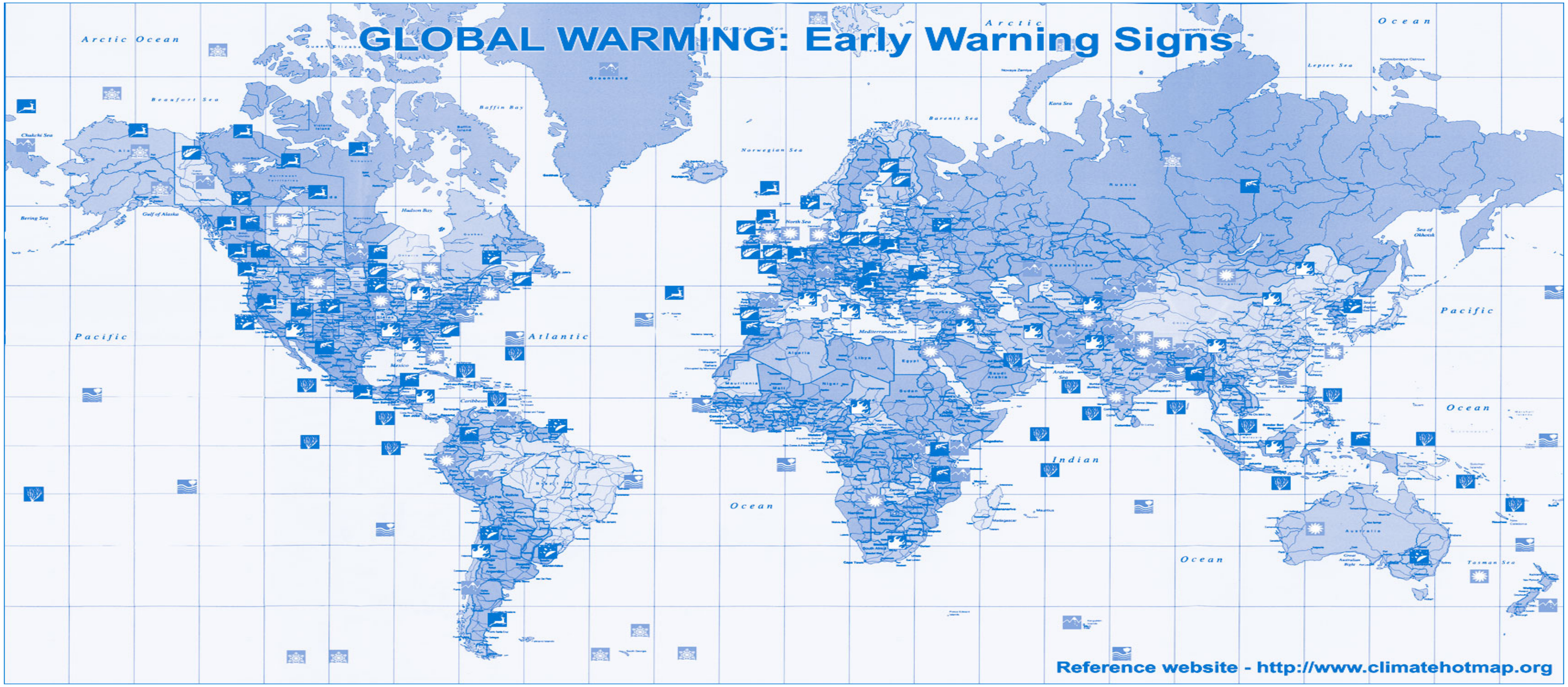
Prepared for the 15th Session of the Commission on Sustainable Development.

Einstein & SEG, Washington DC, 2006, August 18

Climate change vulnerability



Early Warning Signals of Global Warming



Thank you very much

for your attention

Ash fall impacts: the consequences of eruptions, standardisation of data gathering for risk assessment, and the need for holistic mitigation solutions

Victoria Sword-Daniels
Tiziana Rossetto, David Johnston, Tom Wilson,
Sue Loughlin, Susanne Sargeant, John Twigg

Structure of this talk

1. Introduction to volcanic ash: the problem & properties
2. Research methods
3. Systems thinking and systems engineering as a conceptual framework
4. Eyjafjallajokull case study – systems thinking in practice
5. Consequences of eruptions - overview of known ash fall impacts
6. Gap analysis - what don't we know about ash impacts?

7. Addressing the knowledge gaps
   – Standardisation of data gathering: field and laboratory data for risk assessment
   – Challenges to Mitigation

8. Continuing this research
9. Ongoing and future research

Ash fall on the ground: what's the problem?

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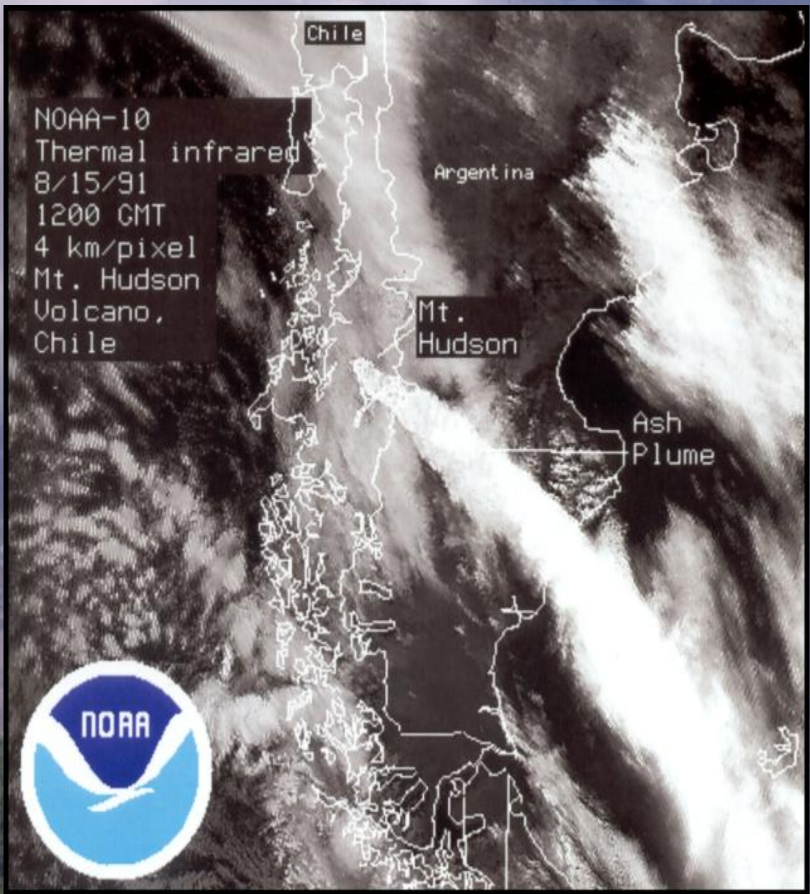
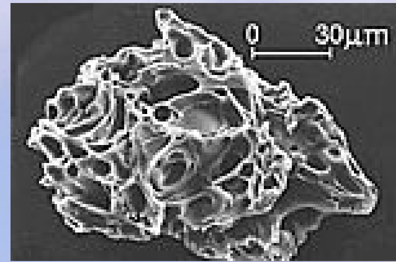
- *Ash fall on the ground causes:*
  - Power cuts from electrical flashover
  - Contamination of water supplies – potability + toxicity
  - Blockage of water networks + turbulence
  - Roof collapse
  - Exacerbates respiratory health problems
  - Decreases monitoring capability (power + solar panels)

- *What does this mean?*
  - Power cuts = no electricity
  - No power to critical infrastructure facilities
  - Hospitals, schools, power plants, observatories

➡ **Affects essential facilities at a critical time**

Volcanic ash: its properties





- Dense
- Abrasive
- Chemically corrosive
- Conductive
- Variable grain size (<2µm)

- Eruption size, wind direction & speed affects distribution
- Most impacts are *disruptive* rather than destructive
- Impacts are *variable* & *widespread*

- Volcanic hazard that most frequently *affects* the most people

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Research Methods

Holistic assessment of vulnerability, resilience and adaptations:-

- Systems engineering framework
- Literature search and conceptual models
- Case studies at three sites –
  - Observation, anecdote, semi-structured interviews
- Laboratory testing of critical components

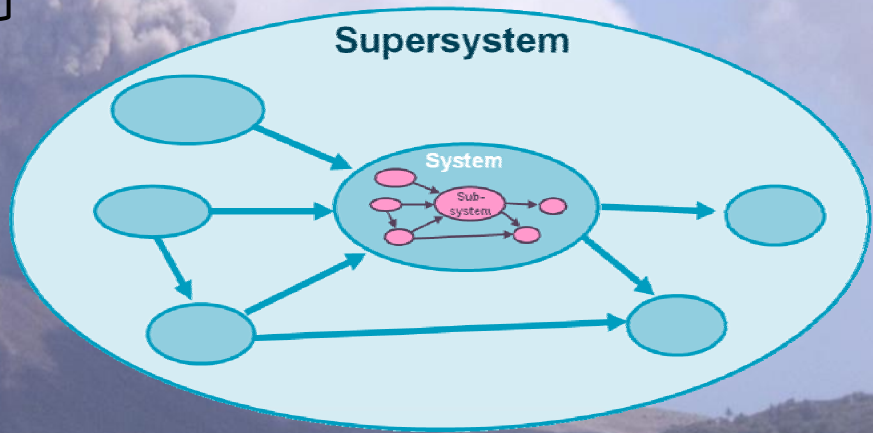
A way of assessing complex and interdependent Infrastructure systems

Systems thinking &
a systems engineering framework

<u>Whole-system view to manage a complex problem</u>:

- Systems Thinking focuses on interactions between subsystems & environment
- Boundaries & partitioning of subsystems

Managing complexity

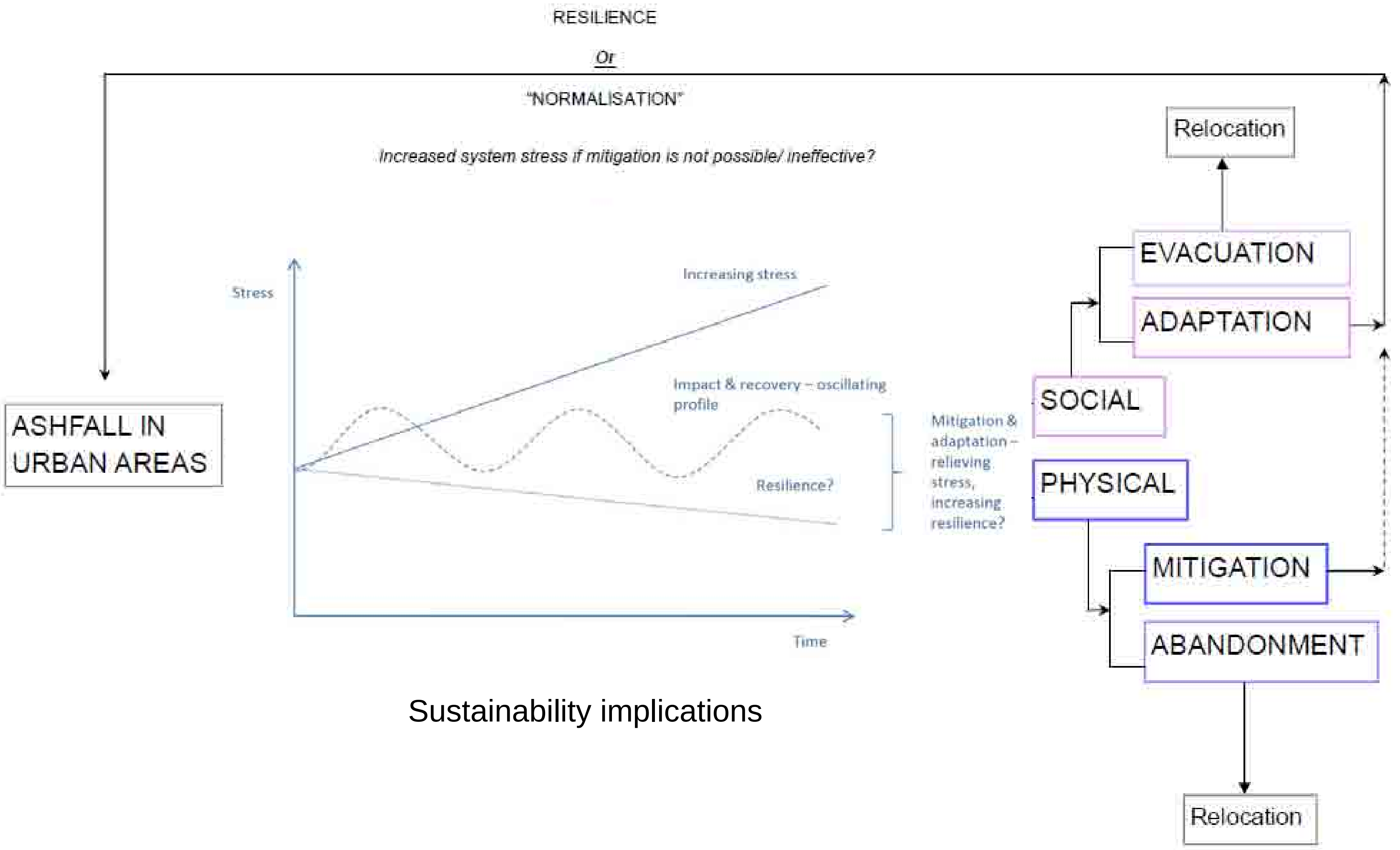


- Problems treated in context
- The dynamic interactions between subsystems need to be understood - physical & social impacts

- Holism - cause and effect thinking
- Aim: improving overall performance

A complete solution

Long terms implications of ash fall impacts on infrastructure systems: a conceptual model



Sustainability implications

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www.swisseduc.ch; VAAC; www.metoffice.co.uk; NASA

Interdependency of subsystems: An Eyjafjallajokull case study

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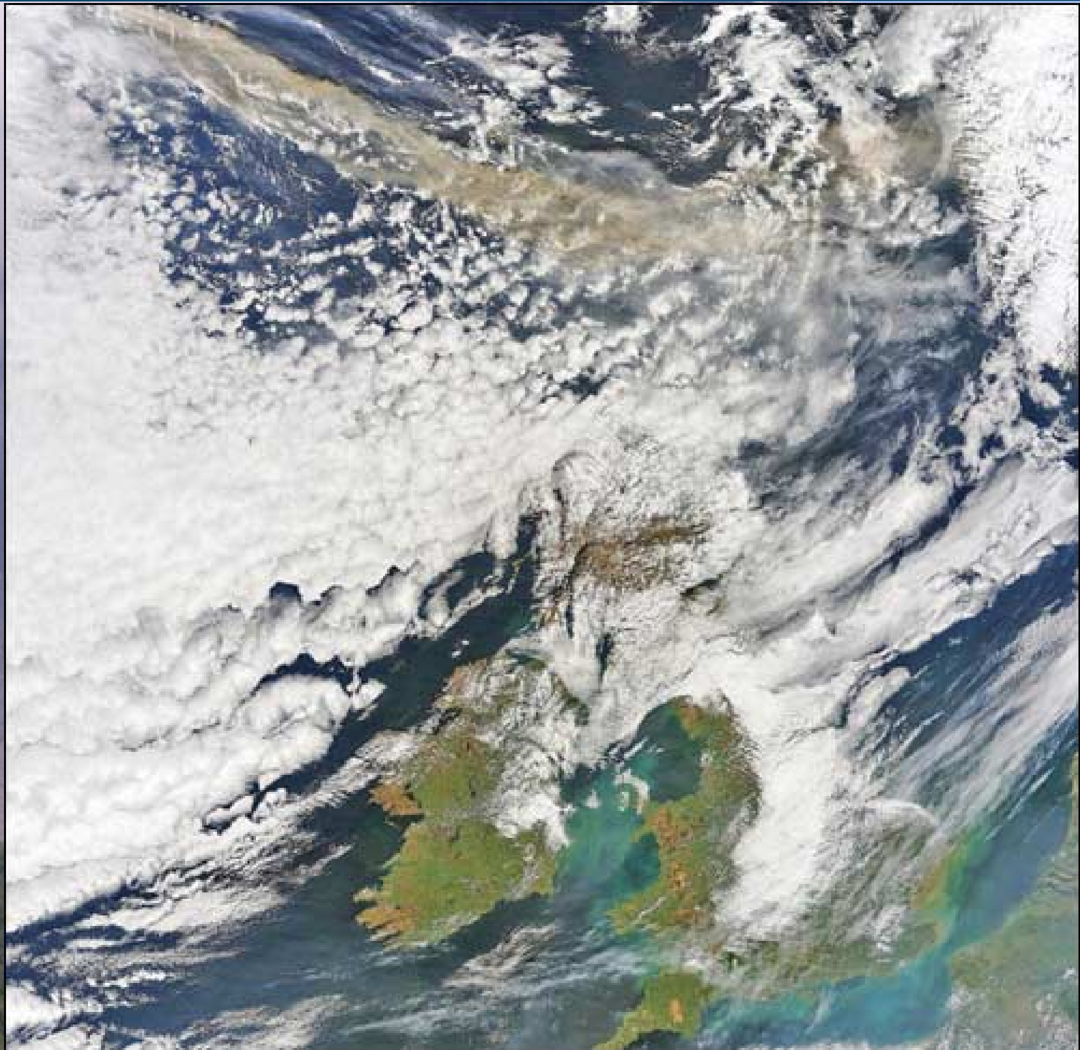

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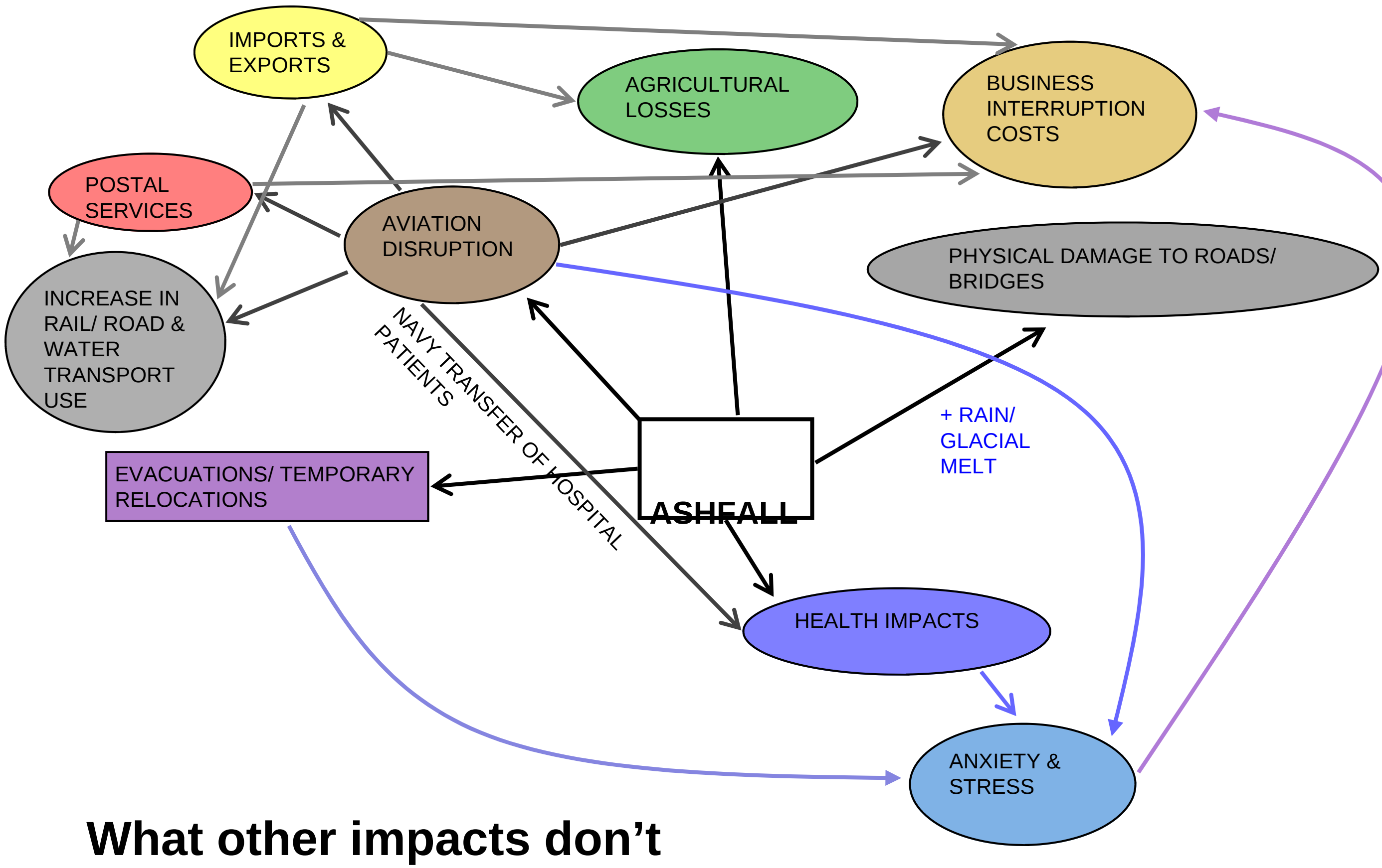
What are the known impacts of Eyjafjallajokull?



What other impacts don't we know about yet?

The Main Ash Problems

- Ash falling on urban areas:
  - Disruptions to power, infrastructure services
  - Disruptions to livelihoods
  - Social disruption
- Economic losses from business interruption
- Economic losses from infrastructure failure & replacement
- Sustainable development implications (physical, social & economic)

The known Impacts of ashfall

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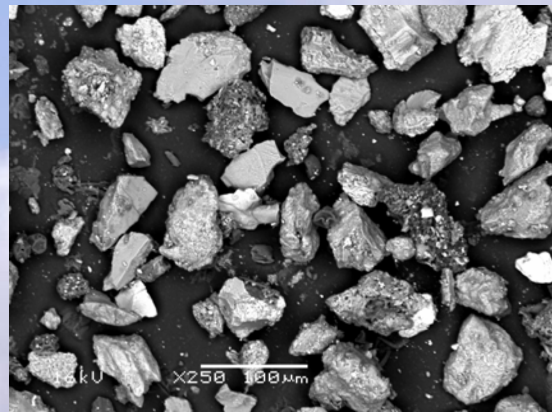
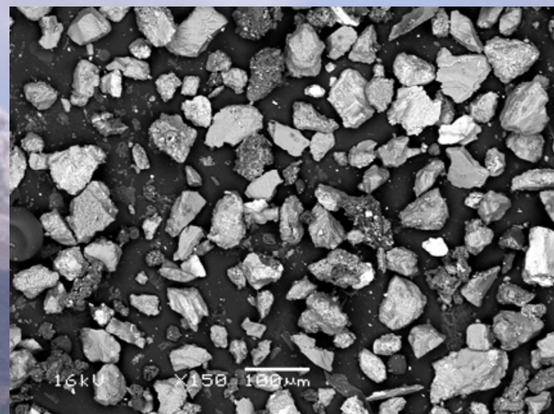
This is a young field, we have much to learn and discover





Desk-based research reveals knowledge in:

- Health
- Structures
- Agriculture & Environment
- Water & Contamination
- Electrical Distribution Networks and Computers
- Aircraft
- Land Transport Infrastructure
- Emergency Management
- Economic Loss Assessment

Treated by discipline- and we know that impacts are interdependent

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Continued impacts of ash, after the event

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What don't we know about ashfall impacts?

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Some of the gaps that have been found in the current published research include:

- Transportation Infrastructure and access
- Effect of abrasion from ash
- Corrosion of materials
- Critical Infrastructure (utilities/ lifelines/ facilities)
- Communications networks
- Early Warning Networks & Monitoring
- Social Networks
- Long Term Impact Studies

What else don't we know that we don't know?

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Long term Impacts

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Addressing the knowledge gaps

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To address the knowledge gaps we need to use:-

- Holistic thinking & understand the dynamic interactions
- Choose a conceptual framework for managing complexity
- Standardisation of data gathering protocols
  - Field data
  - Laboratory data

  For holistic vulnerability assessment
- Application to risk assessment
- Planning ahead for mitigation solutions

It is important to move forward and to provide some solutions

Addressing the knowledge gaps: Field data

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- Ash impacts is a young field & we need more data
- Data collection must be made across all impacted sectors, regardless of the focus of the study team
- Shared data repository available for specific studies
- No blind spots in knowledge from specific eruptions

Suggested best practice:-

- Standardised collection for reliable and comparable data
  - Standardised methods for data collection: ash thickness, density, particle size distributions
- Useful methods: interviews & observation (*interdisciplinary*)

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Addressing the knowledge gaps: Field data

Additional considerations:-

- Timing of field trips – different impacts manifest in different timeframes:
  - Rapid assessment of health hazards
  - Early physical impacts assessment
  - Manifestation of social impacts may be delayed

- Longitudinal studies – the need to return to impact sites to gather knowledge across all sectors, physical & social impacts

Addressing the knowledge gaps: Laboratory data

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Understanding physical vulnerability:-

- Mechanisms of component failure
- Tolerance levels of components & critical stress points
- Ash properties that induce failures (grain size, chemistry, density)

- Vulnerability function development for risk assessment

Addressing the knowledge gaps: Laboratory data

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Consortium of research organisations investigating the impact of volcanic ashfall to infrastructure

Active collaboration with:

- University College London
- University of Cambridge
- Bonneville Power Administration
- USGS

UC UNIVERSITY OF CANTERBURY — Massey University — UNIVERSITY OF CAMBRIDGE

EQC EARTHQUAKE COMMISSION — GNS SCIENCE — UNIVERSIDAD NACIONAL DEL COMAHUE

EPICentre — UC UNIVERSITY OF CANTERBURY — Massey University — GNS SCIENCE — BGS

Risk Assessment

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RISK = HAZARD x VULNERABILITY

- Data on all impacted sectors – holistic & standardised data
- Mapping connections and interdependencies of impacts & identifying critical paths
- Identifying vulnerabilities
- Quantifying vulnerability where possible
- Developing vulnerability functions e.g. Roofs (Spence, 2005) & Agriculture (Wilson, 2010)

+ Hazard data (probabilistic ashfall hazard – plume models)

= Holistic risk assessment

Addressing vulnerability in practice: Challenges to mitigation

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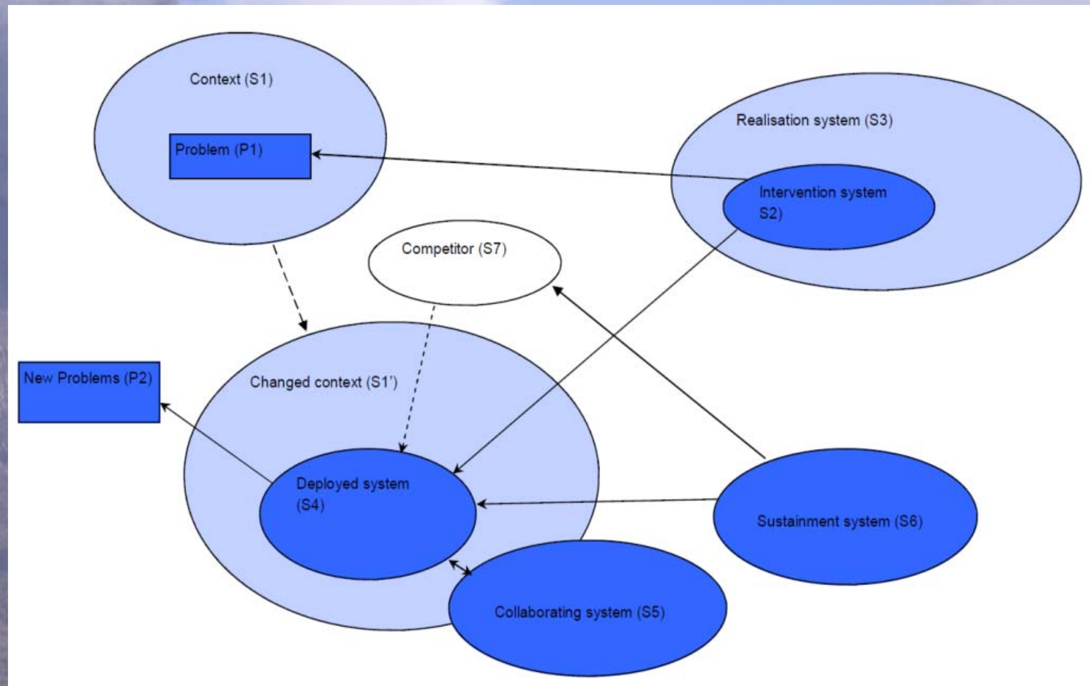
Planning ahead for mitigation solutions – a systems engineering approach:

- Anticipating new problems
- Identifying local collaborators
- Identifying & planning local maintenance options
- 2-way knowledge transfer
- Whole-life costing
- Solution flexibility as the context changes



➢ Sustainable solutions, for sustainable living

Continuing this research…

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- Impacts are an accumulation of small effects; social & physical
- This research focuses on the vulnerability and resilience of critical infrastructure systems
- A whole systems view to research, using systems engineering principles (interdependency & complexity)
- Identifying key stress points & the social importance of impacts

- Comparison of three case studies, with Montserrat as a focus, to understand long term vulnerability & resilience
- Laboratory testing of critical components (from identified critical stress points)

- Planning for mitigations…

The future of ash impacts research?

- Address the gaps in our understanding
- To use a holistic approach to understand the "*big picture*" & manage complexity
- Looking at interdependency and consequences – an interdisciplinary approach
- Development of data gathering protocols & data repositories
- Collaborations (with other institutes & locally)
- Planning mitigations for resilience & sustainable living

Ongoing & planned research

Volcanic Ash Impacts Working Group

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Who are we?

USA

- United States Geological Survey (USGS) - includes all the volcano observatories

New Zealand

- Institute of Geological and Nuclear Sciences (GNS)
- University of Canterbury (UC)
- Massey University
- University College London (UCL)
- University of Hawaii (Bruce Houghton)

UK

- British Geological Survey (BGS)
- Cambridge University
- University College London (UCL)
- Durham University

Volcanic Ash Impacts Working Group

UCL

Purpose: Understanding and mitigating the impacts of volcanic ash fall

Working group objectives proposed at the GSA meeting & at University of Cambridge meeting & Cities on Volcanoes Conference 6:-

1. Improved ash fall impact data and image repositories; improved communication

2. More effective ash fall warning messages

3. Ash impact loss-damage functions for risk calculation

4. Protocols for data collection and analysis

5. Checklist of topics and indicators to collect impact data on following eruptions

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Ongoing volcanic ash research projects:-
Joint Centre for Disaster Research

Current projects:

Vulnerability of *high voltage electricity* transmission networks to volcanic ashfall (Johnny Wardman)

Clean String

Contaminated with 3mm 0.018M NaCl pseudo basalt <1mm

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Ongoing volcanic ash research projects:-
Joint Centre for Disaster Research

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Current projects:

Vulnerability of *modern computers* and volcanic surveillance equipment to volcanic ash fall and gas hazards

A quantitative analysis of Volcanic Ash Damage to New Zealand *Roof Materials* (Jim Cole, Dean Podolsky, Tom Wilson, Sam Broom, Carol Stewart, Zengwei Li)

Development of *pseudo volcanic ash* for quantitative testing of infrastructure components (Sam Broom; John Wardman; Grant Wilson; Tom Wilson)

Performance of common *flocculants and coagulants* in removing volcanic ash from water supplies and waste water

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Future volcanic ash research projects:-
Joint Centre for Disaster Research

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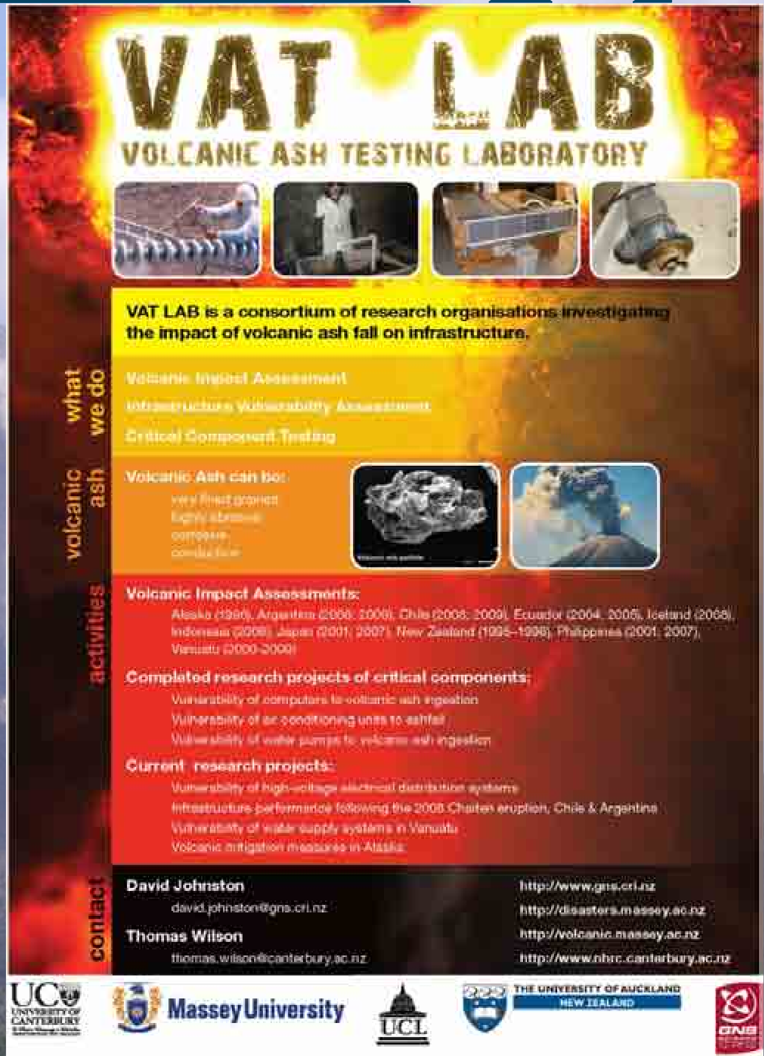
Future projects:

- Vulnerability of ground transportation to volcanic ash fall hazards
- Vulnerability of low voltage electricity distribution networks to volcanic ashfall
- Vulnerability of waste water systems and treatment plants to volcanic ashfall (next 12 months)



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Ongoing & future volcanic research projects:- UCL (EPICentre & ABHRC)

- Assessing the impacts of volcanic ash fall on critical infrastructure systems (BGS)
- The design of warning systems (USGS)
- Caldera Dynamics (Campi Flegrei & Rabaul)
- Campi Flegrei deep drilling project (4km into caldera)
- Seismic precursors to eruptions (Etna, Hawaii & Rabaul)
- The dynamics of lava domes (Mt St Helens, Montserrat, Colima)
- Evolution of lava flow fields (Etna & Tenerife)
- Multi-hazard risk assessment; development of tools for use by NGOs (CAFOD)
- Perception of volcanic hazards and emergency plans (Vesuvius)
- Edifice collapse and the run out of giant landslides (Canary Islands)

Acknowledgements

ISTC – International Science & Technology Centre

EPSRC – through University College London

The Joint Centre of Disaster Research

Massey University, New Zealand

Institute of Geological and Nuclear Sciences, New Zealand

University of Canterbury, New Zealand

BUFI fund through the British Geological Survey

Montserrat Volcano Observatory

Arup Global Research Fund

Thank you

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Questions?

victoria.sword-daniels.09@ucl.ac.uk

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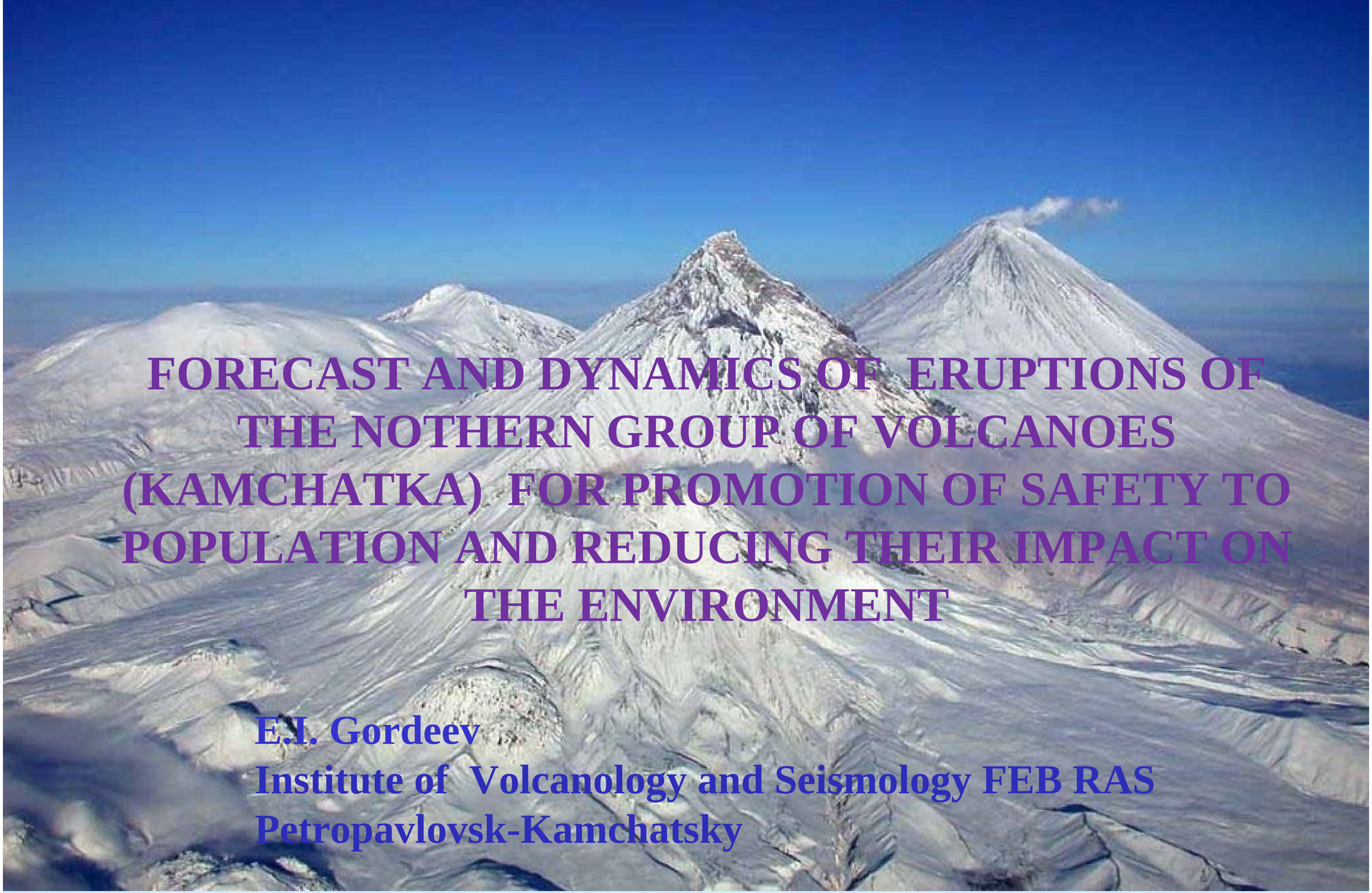
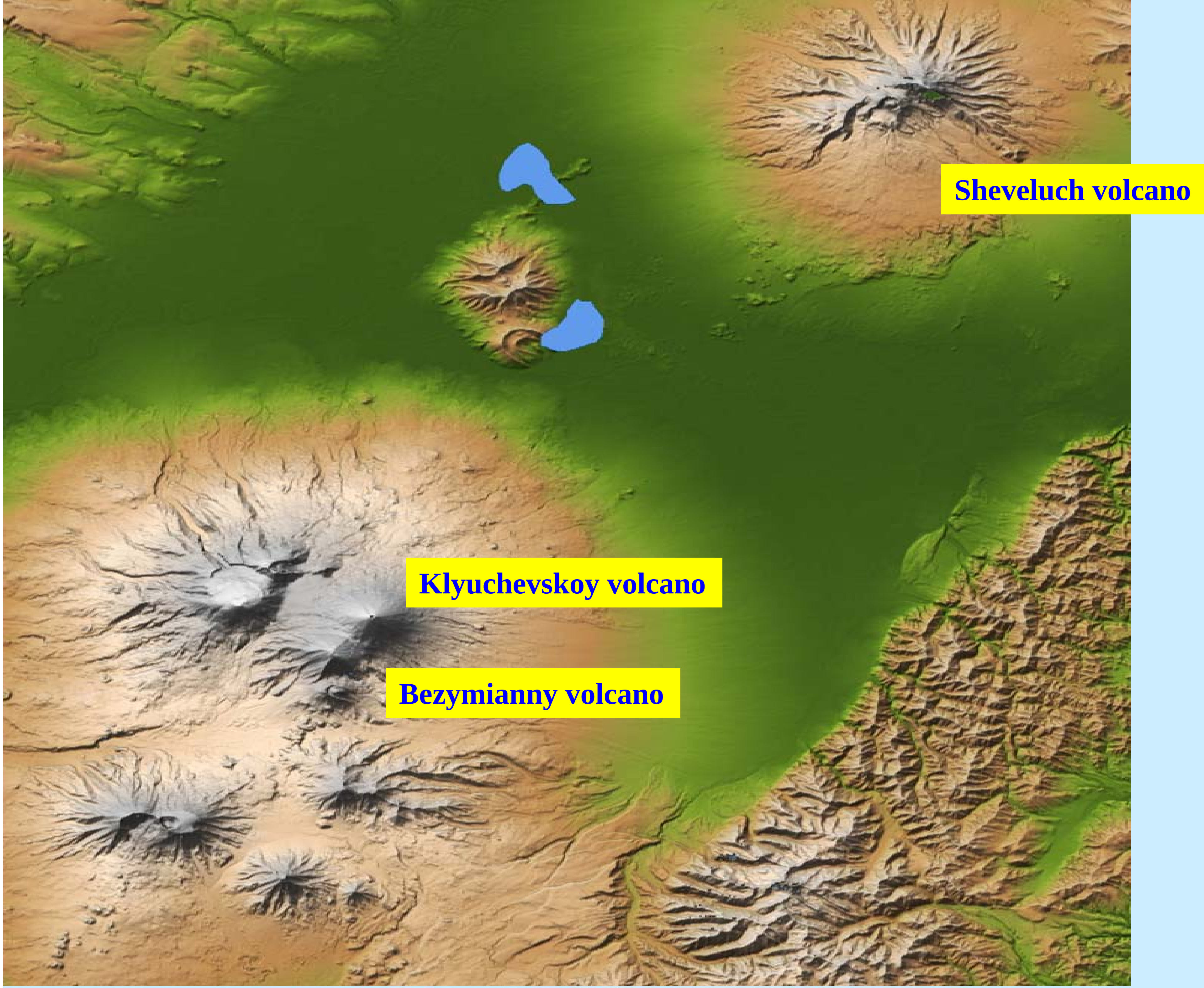


FORECAST AND DYNAMICS OF ERUPTIONS OF THE NOTHERN GROUP OF VOLCANOES (KAMCHATKA) FOR PROMOTION OF SAFETY TO POPULATION AND REDUCING THEIR IMPACT ON THE ENVIRONMENT

E.I. Gordeev
Institute of Volcanology and Seismology FEB RAS
Petropavlovsk-Kamchatsky


Sheveluch
Ushkovsky
Klyuchevskoy
Bezymianny
Tolbachik
Ichinsky
Kizimen
Kronotsky
Krasheninnikov
Semiachik
Karymsky
Zhupanovsky
Koryaksky
Avachinsky
Opala
Gorely
Mutnovsky
Ksudach
Alaid
Ebeko
Fuss Peak
Andesite
Basalt


Sheveluch volcano
Klyuchevskoy volcano
Bezymianny volcano

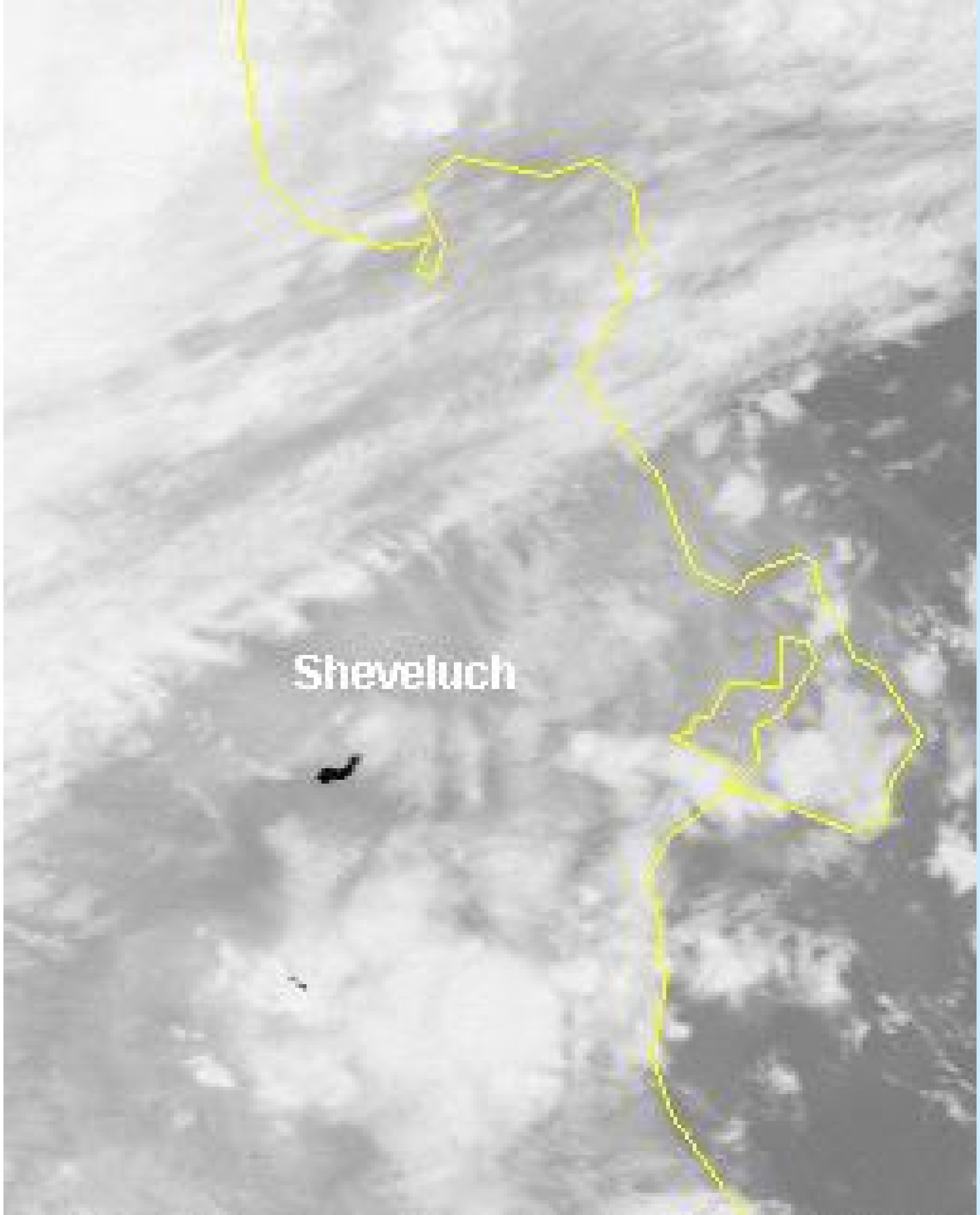
Shiveluch volcano, 3283 m

Age- 60-70 thousands years

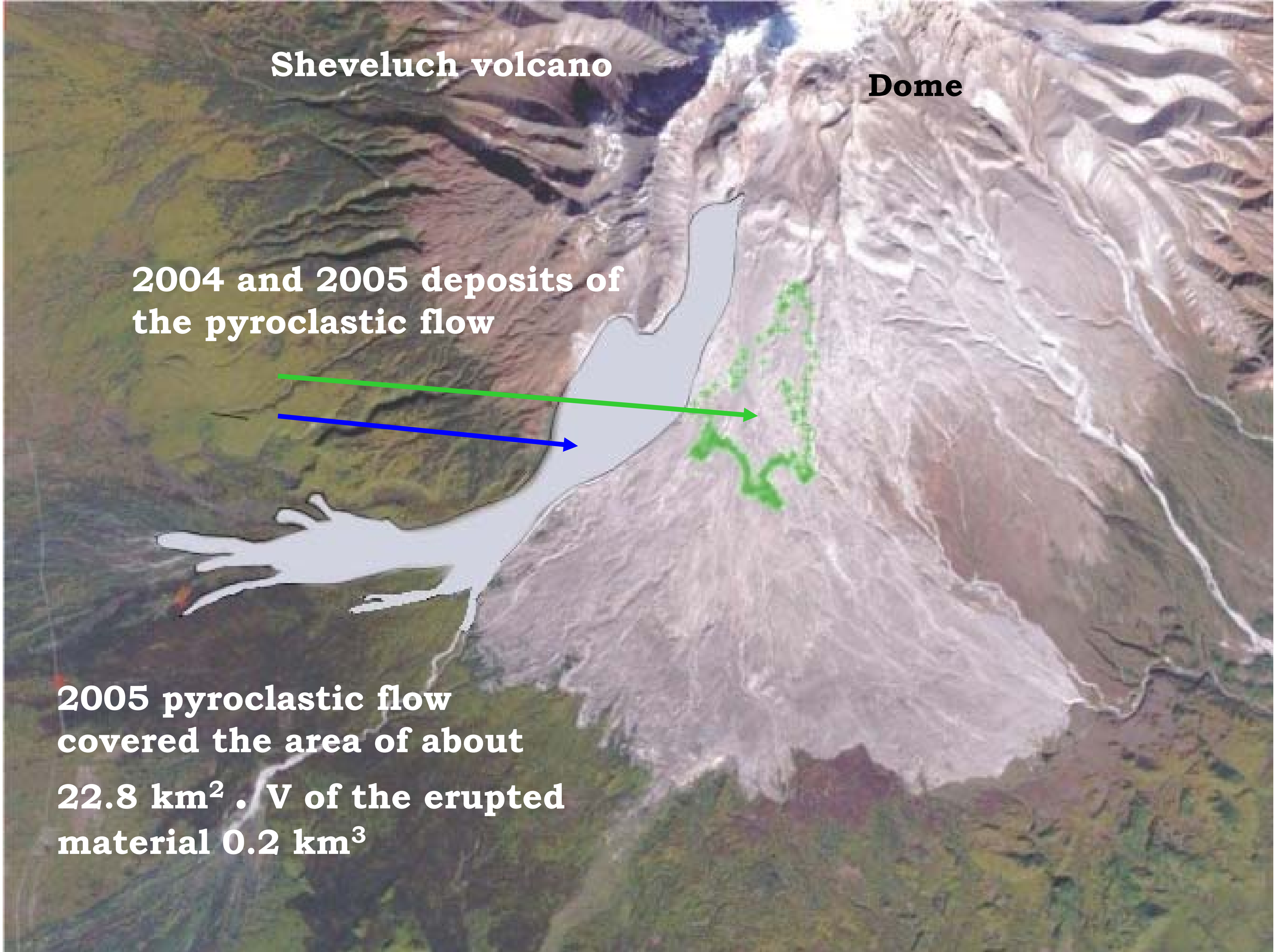
Last big eruption -1964, the total erupted volume around 2 km^3.

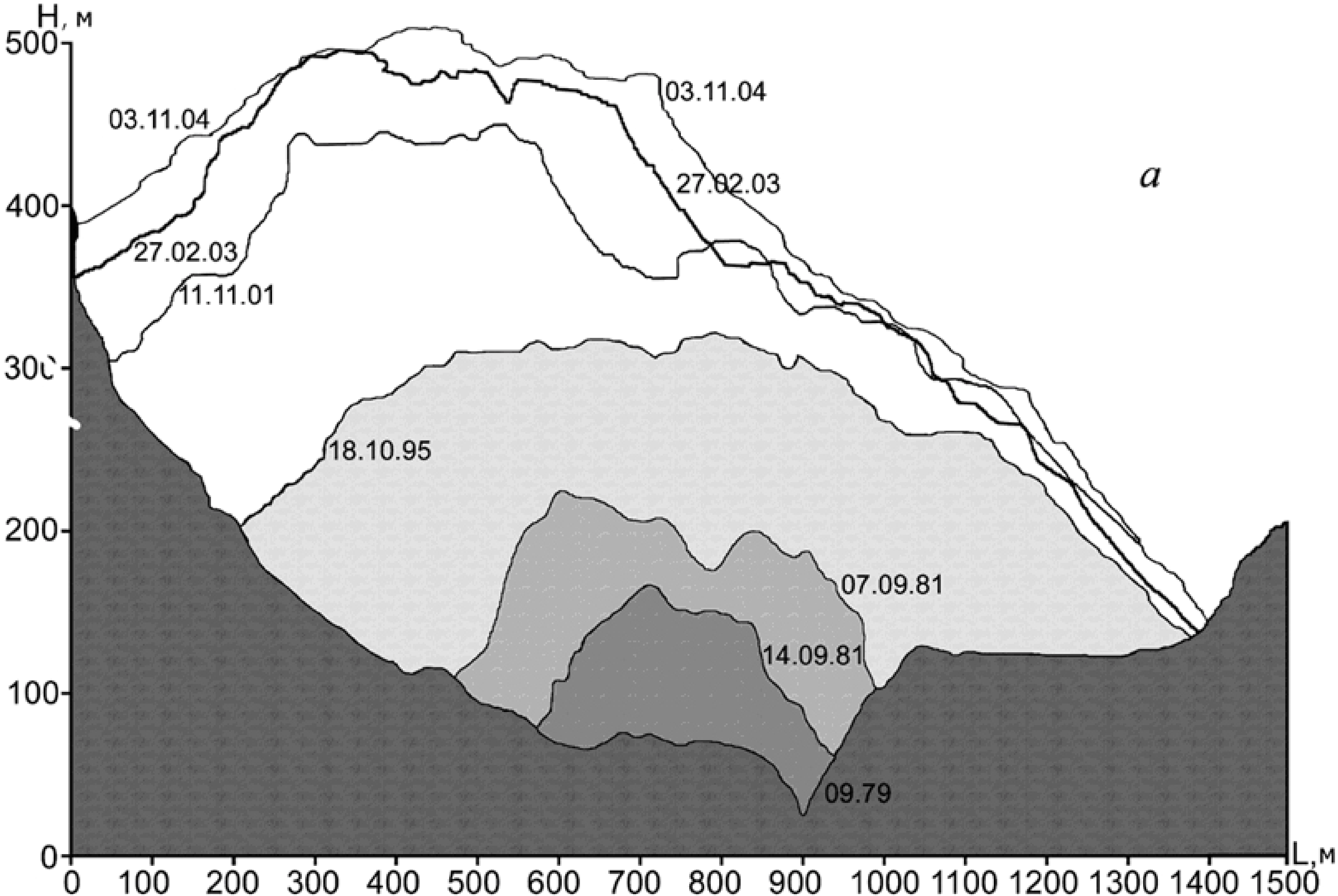
The dome start in 1980


2001



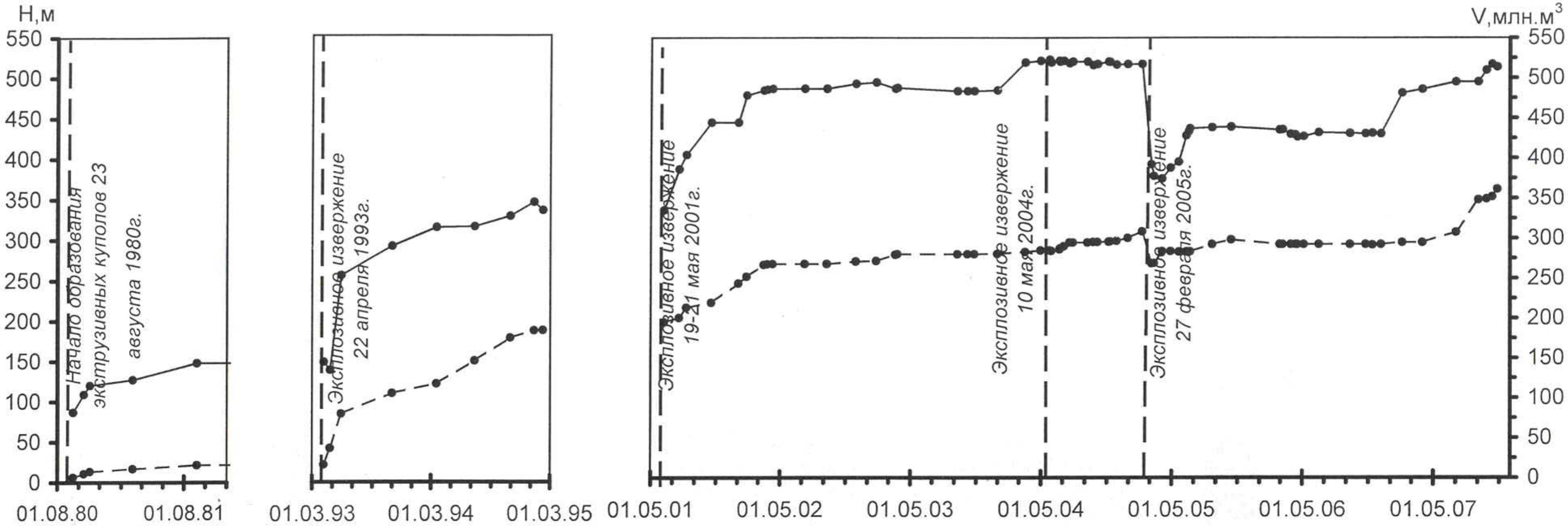
- 45 – pixel- thermal anomaly at Sheveluch volcano associated with the 2005 pyroclastic flow in AVHRR image
-
-

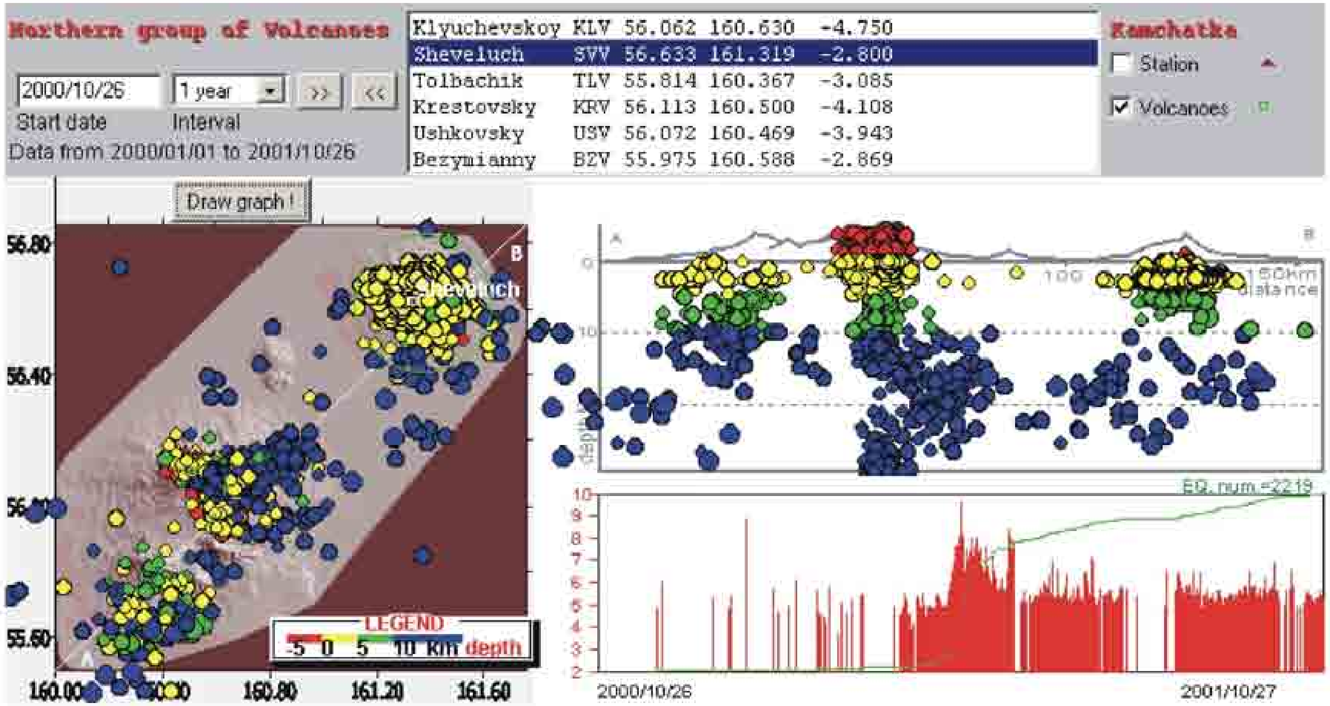

Sheveluch volcano
Dome
2004 and 2005 deposits of the pyroclastic flow
2005 pyroclastic flow covered the area of about 22.8 km^2 . V of the erupted material 0.2 km^3



H, м
500
400
300
200
100
0
03.11.04
27.02.03
11.11.01
03.11.04
27.02.03
a
18.10.95
07.09.81
14.09.81
09.79
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500
L, м

The height and volume rate since 1980 till 2008 for new dome of Shiveluch volcano





Explanation.

Date - year/month/day.
TO - origin time (UTC), hour : minute : second.
Lat - geographic latitude in decimal degrees(north).
Lon - geographic longitude in decimal degrees(east).
H - depth in kilometers.
Ks - class from the amplitude of S-wave, defined by Fedotov S.A.
Ml - magnitude using the formula Ml=Ks*0.5-0.75 .
Size of the earthquake circle corresponds to Ks (number of pixels is equal integer(Ks)).
Bottoms ">>"and "<<" change automatically selected earthquakes according to interval of time.
Line "A-B" on a map (left figure) is a line of the vertical section (right figure).
To draw a volcano location on a map set flag "Volcanoes" and click on the requested volcano in List.

Kljuchevskoi volcano, 4750 m

Age is around 7000 years

Two type eruptions: explosive from the summit crater and mostly effusive flank eruptions.

The biggest summit eruption in 1944-1945. Total volume 0.6 km^3.

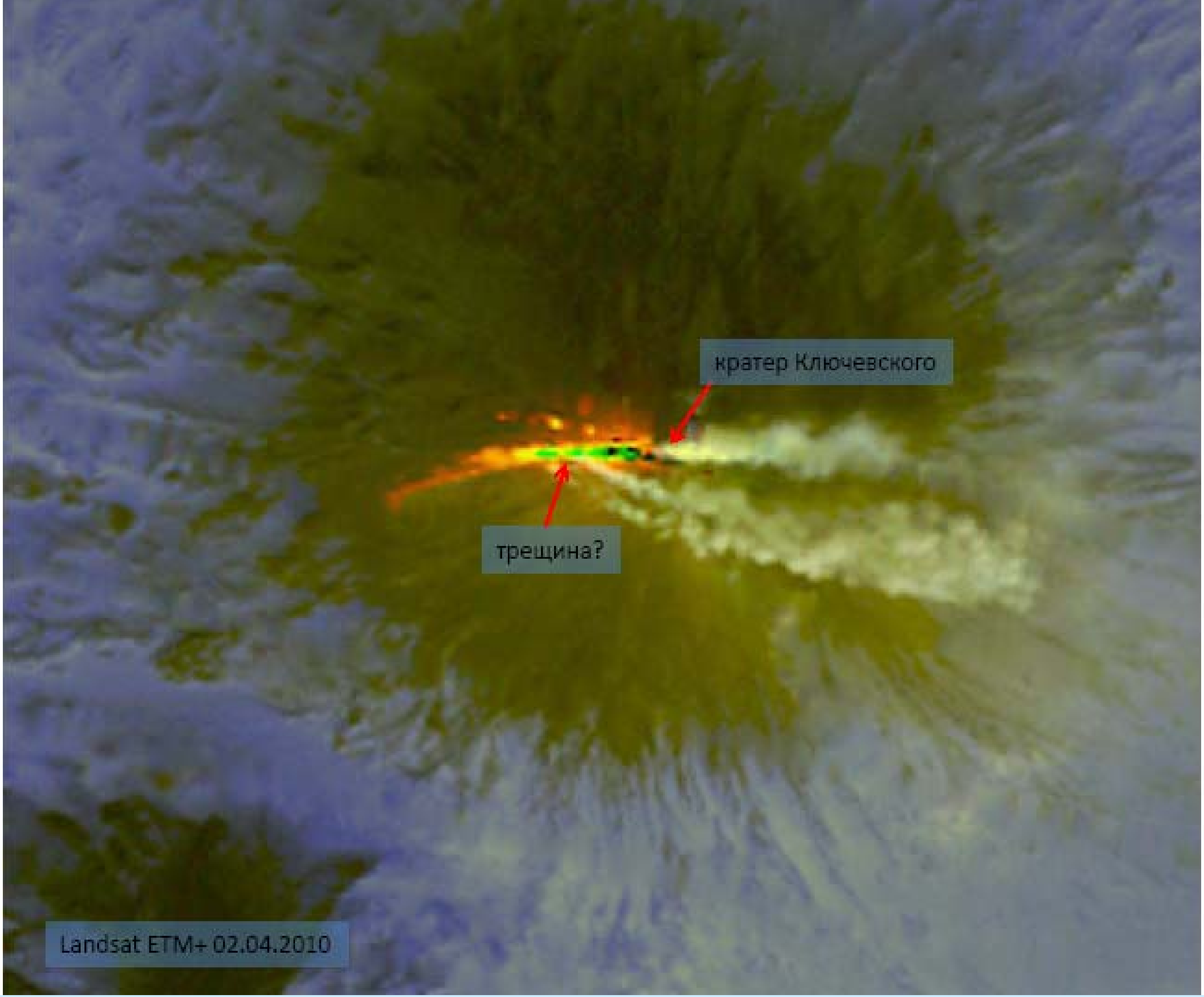
Usually the volume of flank eruption 0.05-0.1 km^3.


01 Oct 1994
Kliuchevskoi Volcano
from Space Shuttle

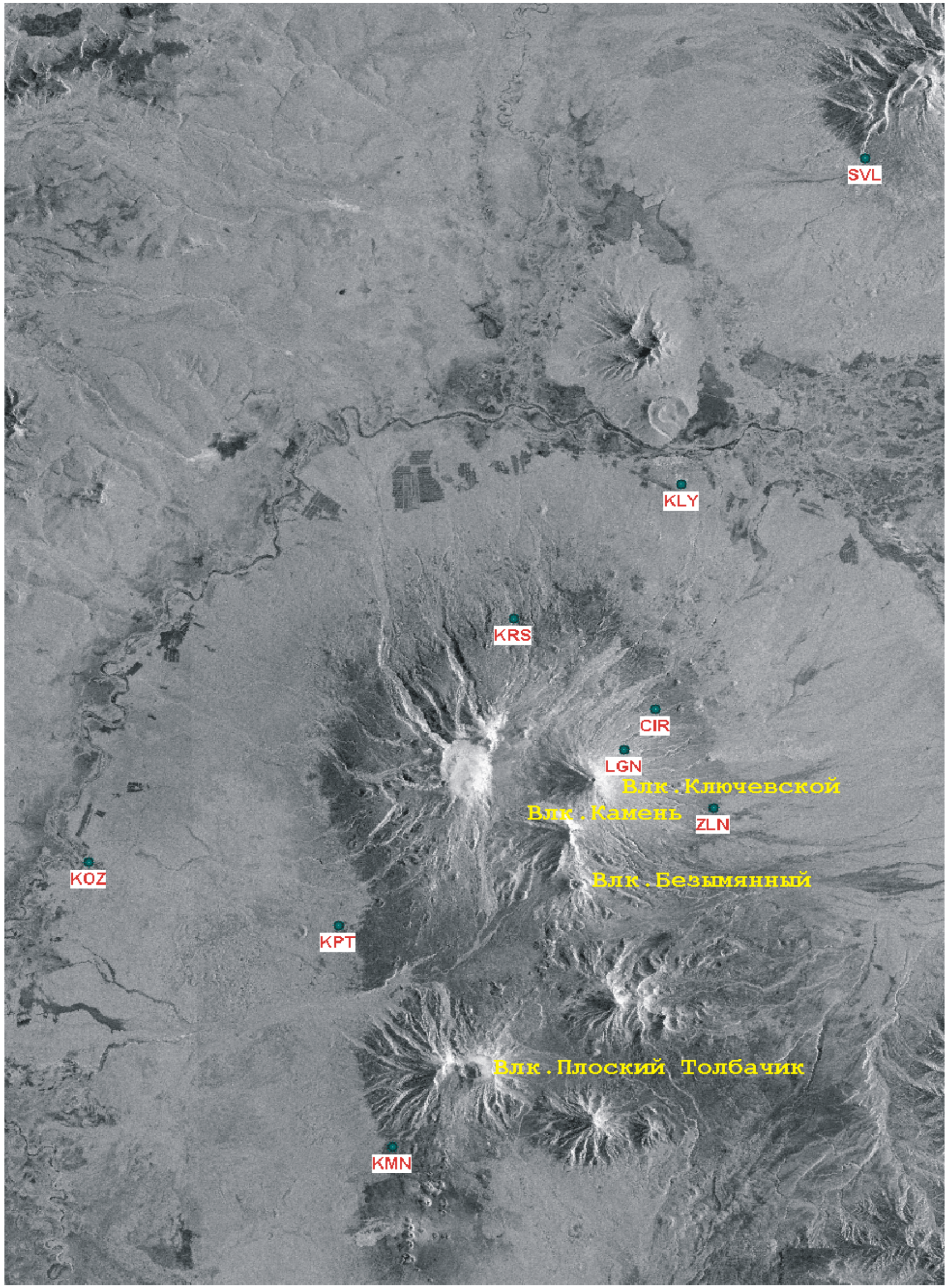

March, 24-28

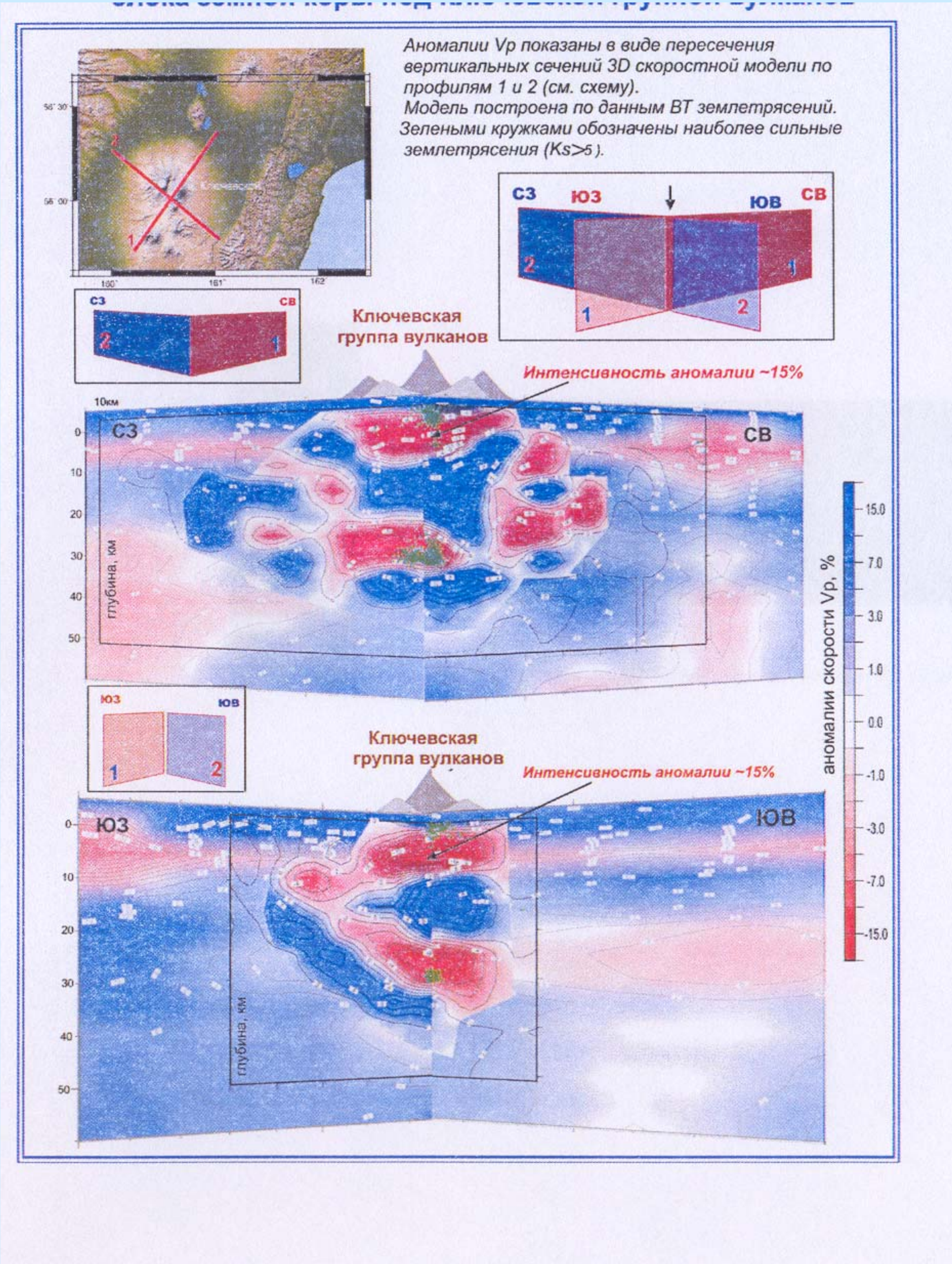

March 8, 2005

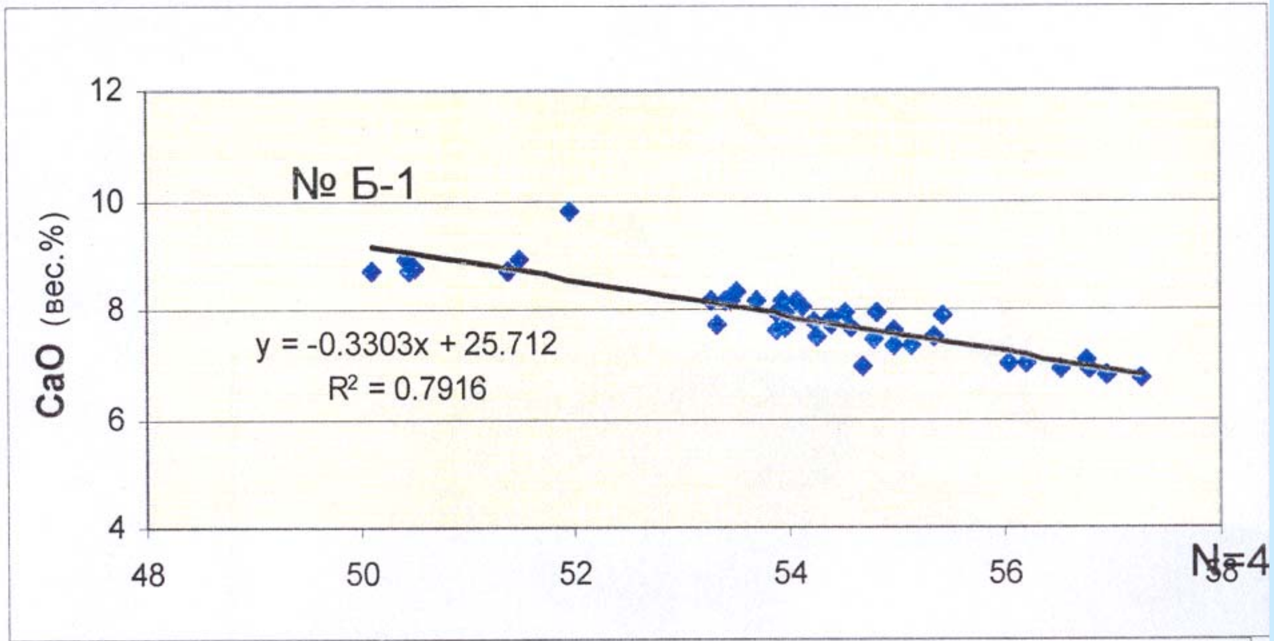

Terminal eruption
March 17, 2005


кратер Ключевского
трещина?
Landsat ETM+ 02.04.2010

Seismic network around Klyuchevskaya volcanic group




Аномалии Vp показаны в виде пересечения вертикальных сечений 3D скоростной модели по профилям 1 и 2 (см. схему).
Модель построена по данным ВТ землетрясений.
Зелеными кружками обозначены наиболее сильные землетрясения (Ks>5).
СЗ
ЮЗ
ЮВ
СВ
Ключевская группа вулканов
Интенсивность аномалии ~15%
10км
глубина, км
аномалии скорости Vp, %
15.0
7.0
3.0
1.0
0.0
-1.0
-3.0
-7.0
-15.0
ЮЗ
ЮВ
Ключевская группа вулканов
Интенсивность аномалии ~15%
глубина, км


№ Б-1
y = -0.3303x + 25.712
R² = 0.7916
CaO (вес.%)
12
10
8
6
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48
50
52
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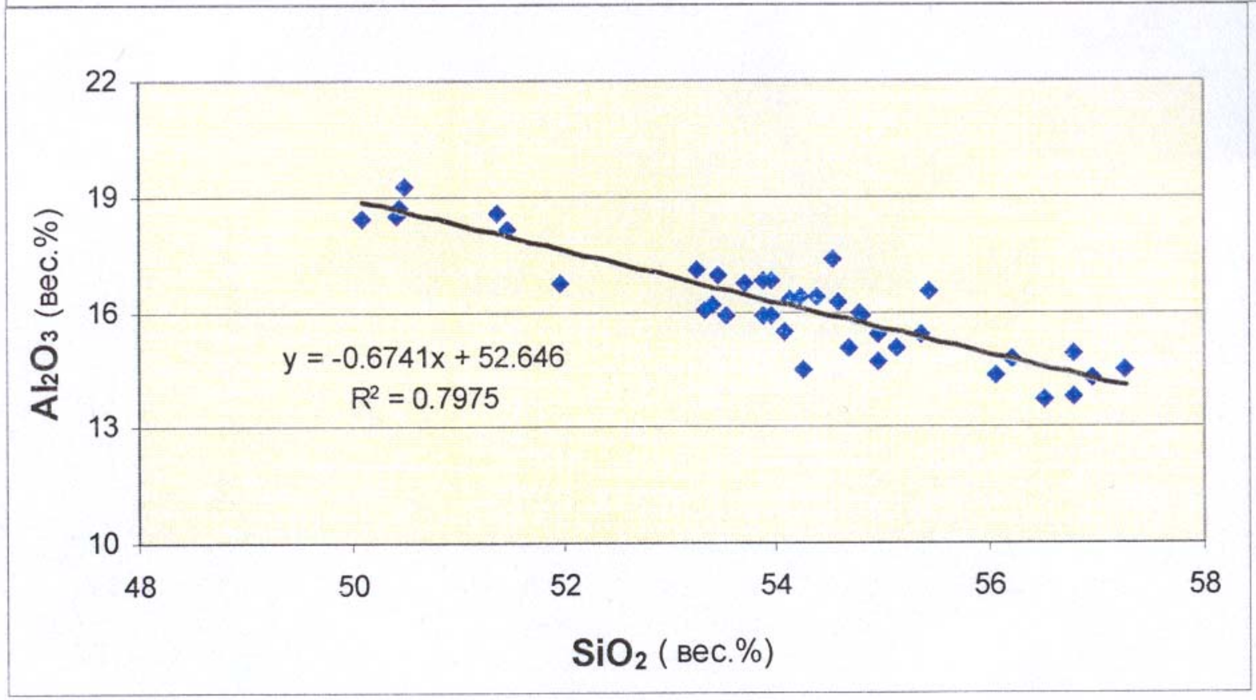
56
58
N=4


y = -0.6741x + 52.646
R² = 0.7975
Al2O3 (вес.%)
22
19
16
13
10
48
50
52
54
56
58
SiO2 (вес.%)

Bezymyanny volcano, 2882 m

Age – 10-11 thousands years

The biggest eruption in 1956 after 1000 years of silence.
Total volume around 1.0 km^3.

After eruption of 1956 continuous new dome growing.


Фото © Демянчук 2006 п.Козыревск

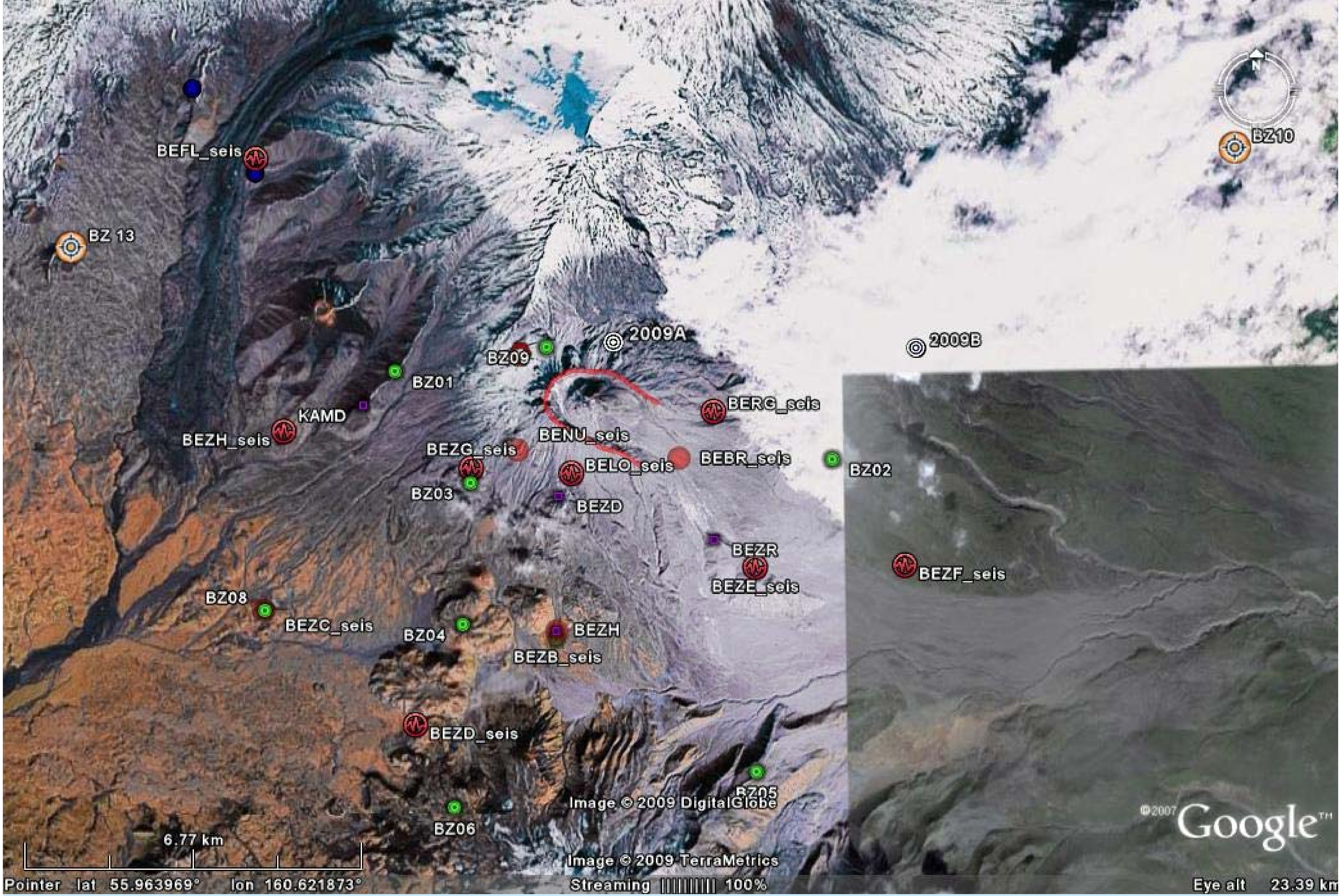
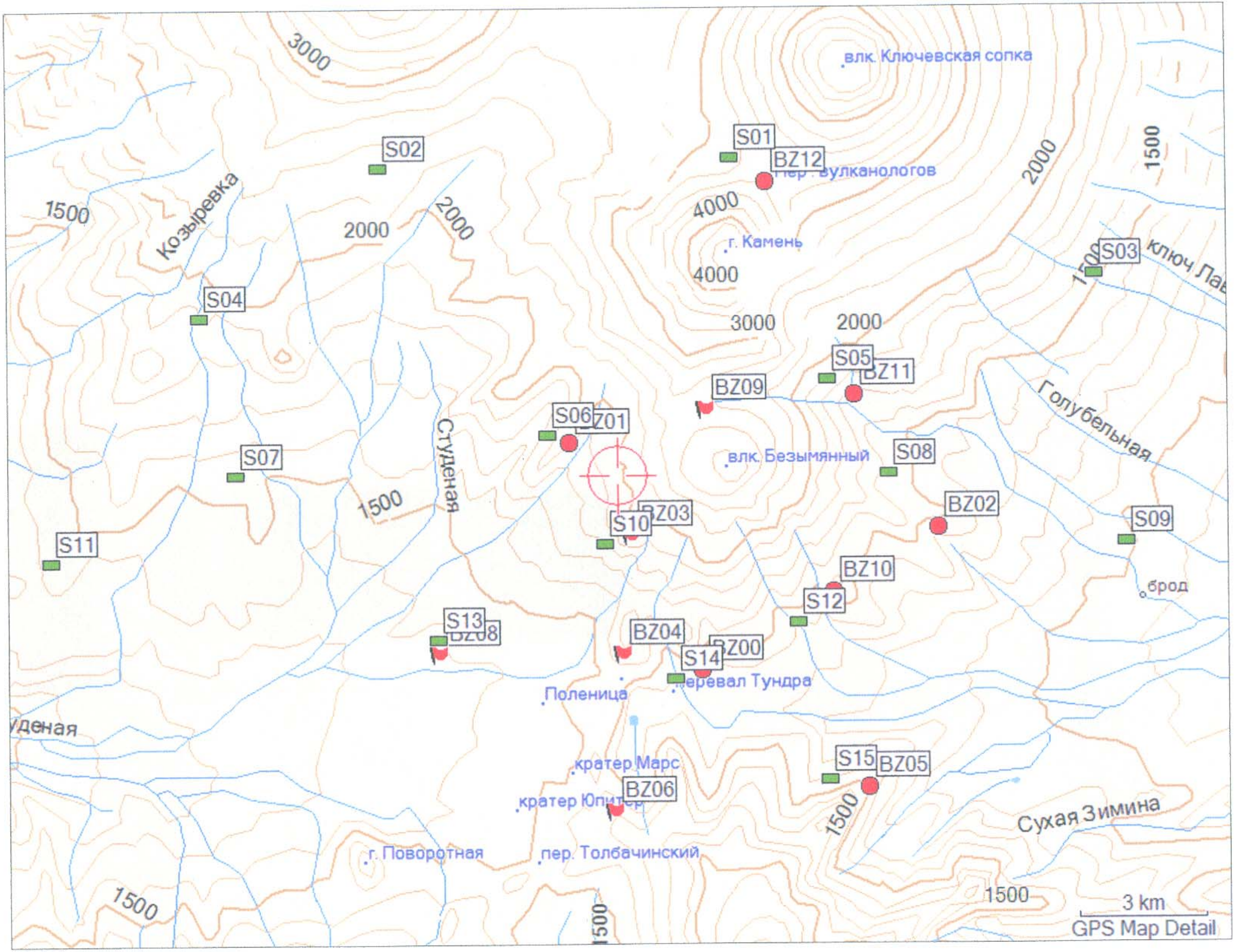

BEFL_seis
BZ 13
BZ10
2009A
2009B
BZ09
BZ01
KAMD
BEZH_seis
BENU_seis
BERG_seis
BEZG_seis
BELO_seis
BEBR_seis
BZ02
BZ03
BEZD
BEZR
BEZE_seis
BEZF_seis
BZ08
BEZC_seis
BZ04
BEZH
BEZB_seis
BEZD_seis
BZ05
BZ06
6.77 km
Image © 2009 DigitalGlobe
Image © 2009 TerraMetrics
©2007 Google™
Pointer lat 55.963969° lon 160.621873°
Streaming |||||||||| 100%
Eye alt 23.39 km

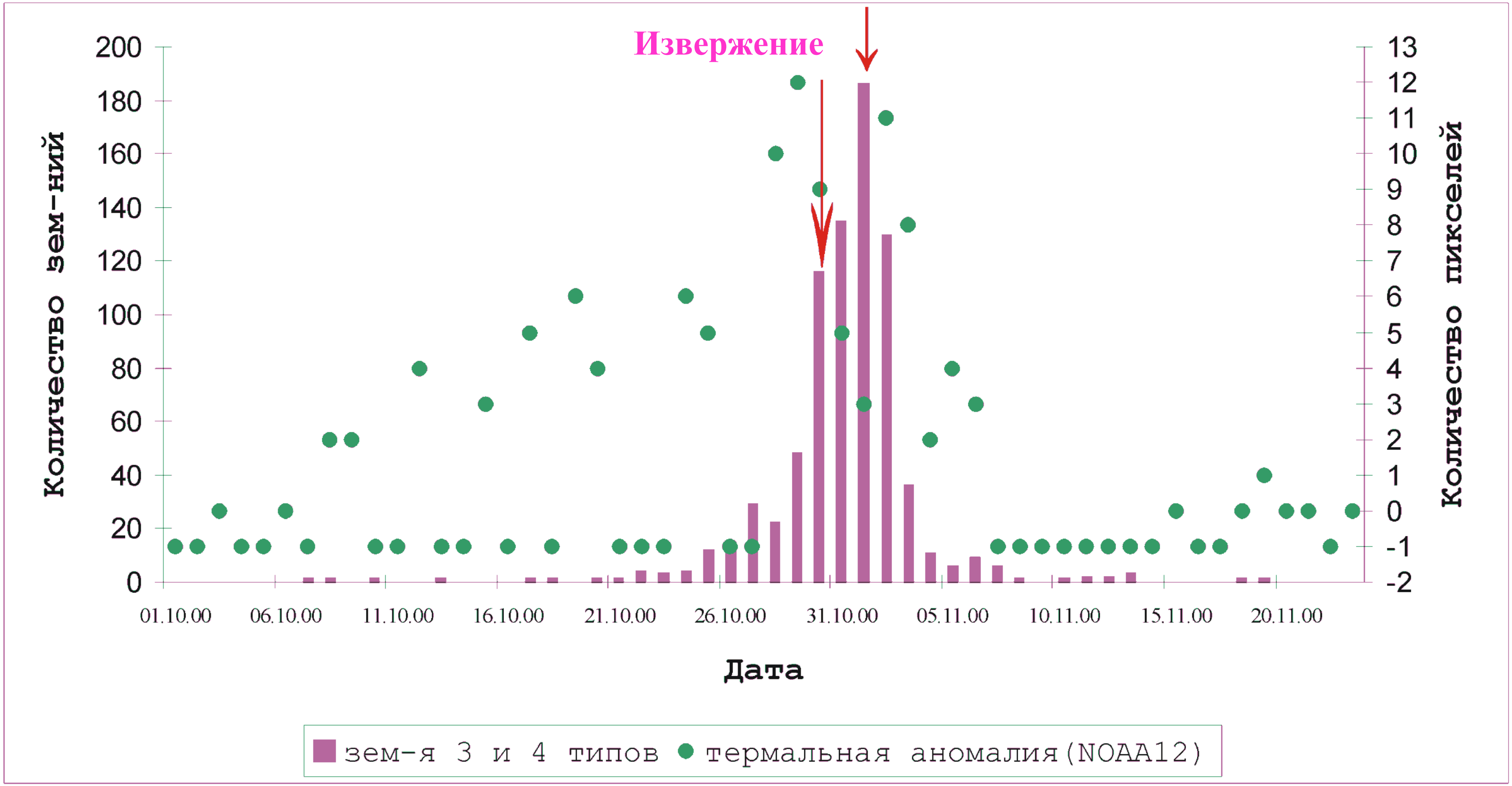

Фото © Озеров, 2006



влк. Ключевская сопка
3000
S01
BZ12
вулканологов
S02
2000
1500
Козыревка
2000
2000
4000
г. Камень
4000
1500
S03
S04
3000
2000
S05
BZ11
BZ09
Голубельная
S06
Студеная
S07
влк. Безымянный
S08
1500
BZ02
BZ03
S10
S09
S11
BZ10
брод
S12
S13
BZ04
BZ00
S14
Тундра
Поленица
кратер Марс
S15
BZ05
BZ06
Сухая Зимина
1500
г. Поворотная
пер. Толбачинский
1500
1500
1500
3 km
GPS Map Detail

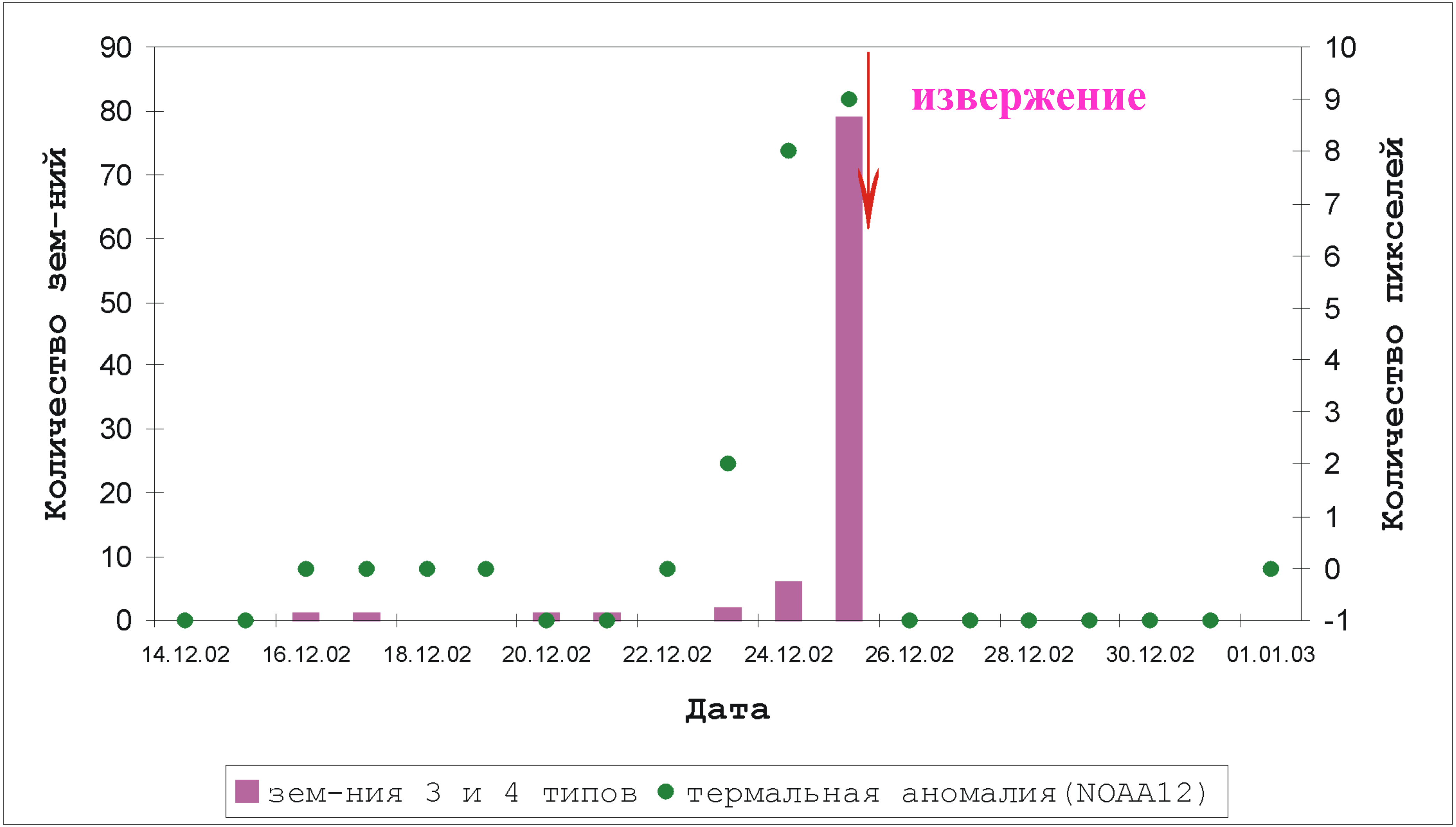
Seismicity and thermal anomaly of Bezymianny volcano, Oct. 2000

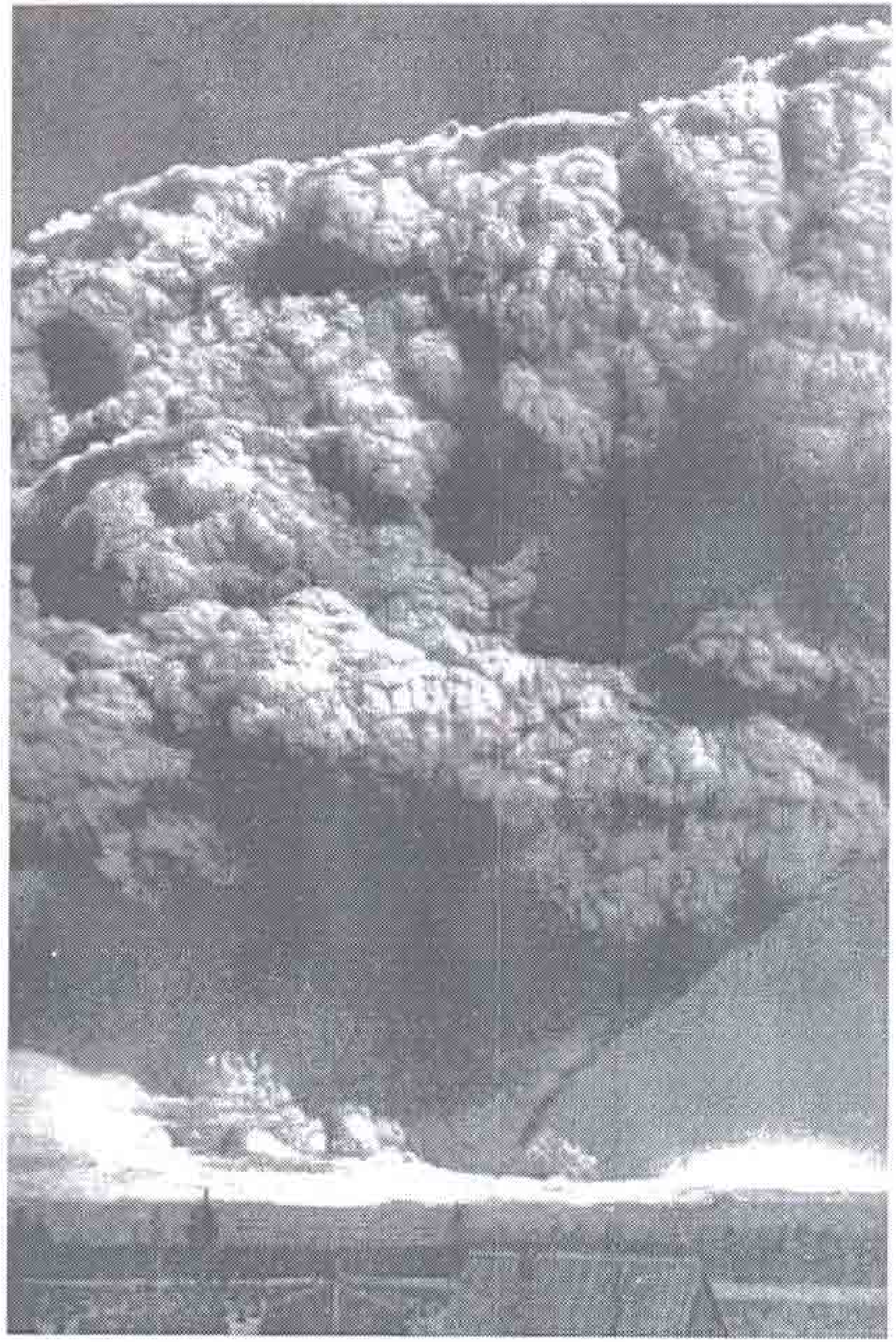
Сейсмичность и термальная аномалия на вулкане Безымянный в октябре 2000 года.



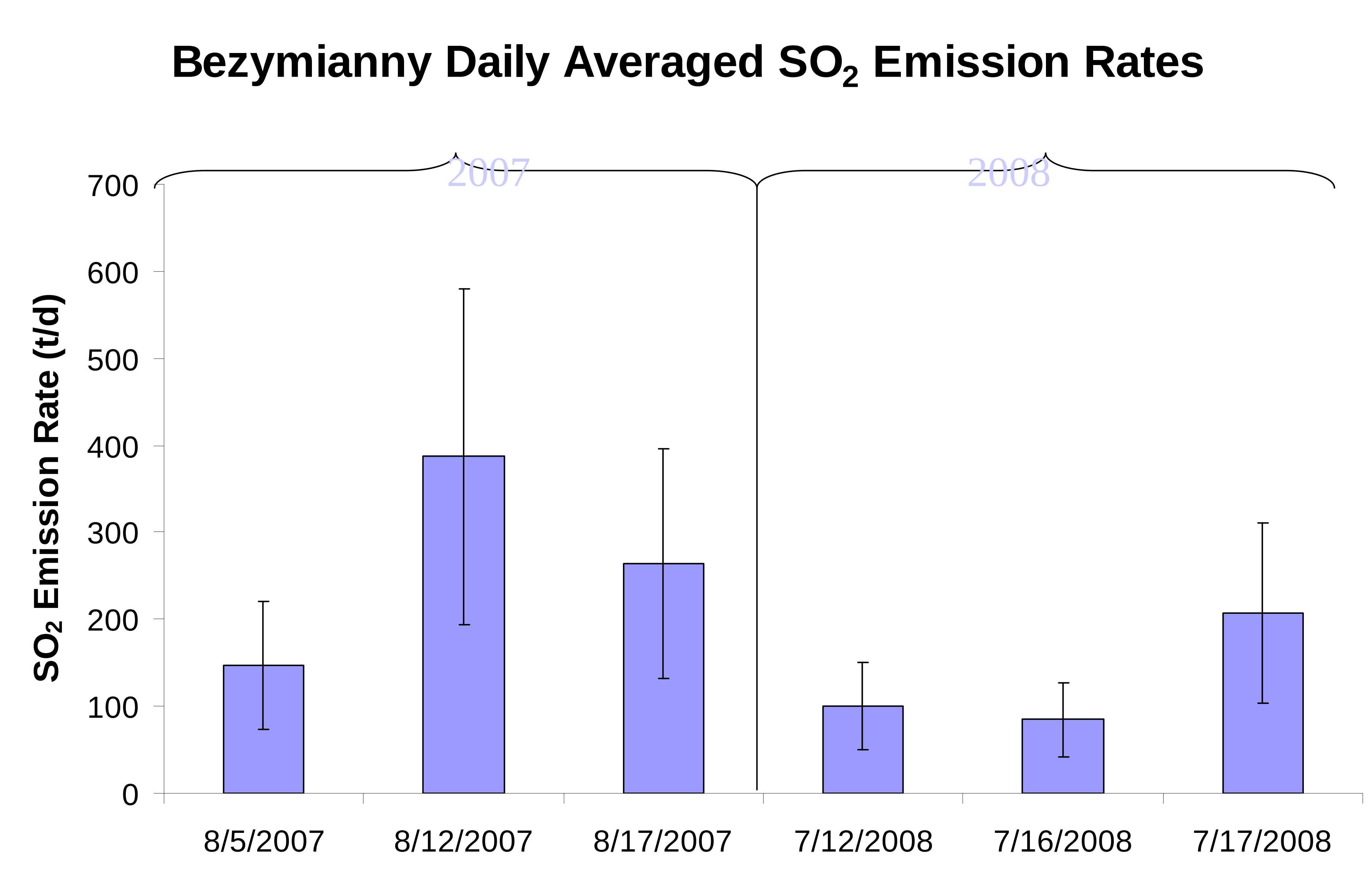
Seismicity and thermal anomaly of Bezymianny volcano, Dec. 2002

Сейсмичность и термальная аномалия на вулкане Безымянный в декабре 2002 года.



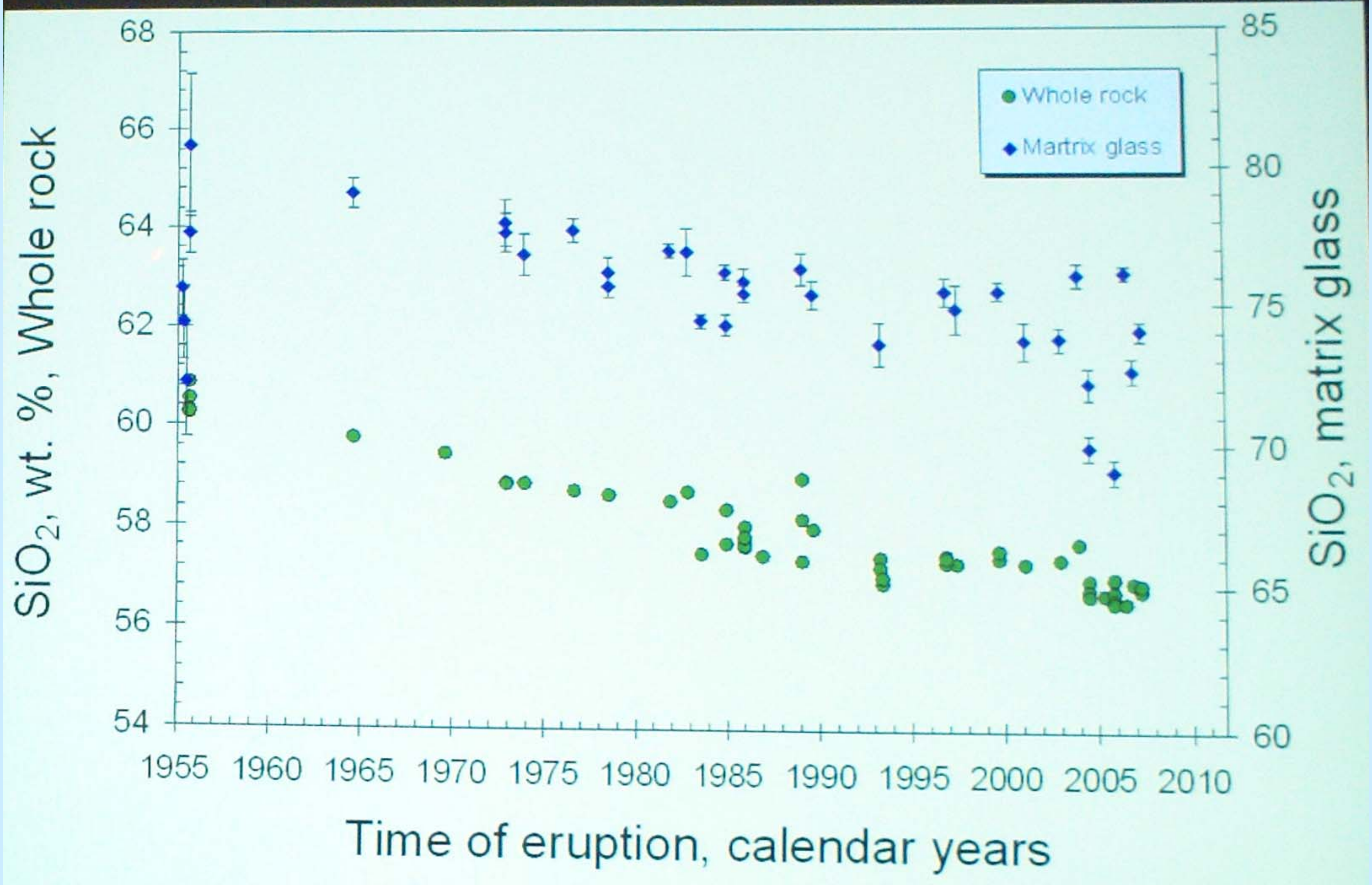


Expolosion of Bezymyanny volcano in 1956



Bezymianny Daily Averaged SO_2 Emission Rates
2007
2008
SO_2 Emission Rate (t/d)
0
100
200
300
400
500
600
700
8/5/2007
8/12/2007
8/17/2007
7/12/2008
7/16/2008
7/17/2008

Whole rock and matrix glass compositions



Комплексные геологические и геофизические исследования вулканов Северной группы на Камчатке, прогноз и динамика извержений с целью обеспечения безопасности населения и минимизации их воздействия на окружающую среду

ЦЕЛЬ ПРОЕКТА: Комплексные геологические и геофизические исследования вулканов Северной группы Камчатки, их непрерывный сейсмический и геофизический мониторинг с целью изучения развития активности вулканов, динамики извержений. Восстановление движений и деформационных процессов, оценка объемов изверженных продуктов экструзивных куполов вулканов Безымянный и Шивелуч.

Изучение пространственно-временных характеристик изменений напряженно-деформированного состояния блока земной коры района с целью изучения взаимодействия крупных региональных геологических структур.

Оценка возможности прогноза извержений вулканов для обеспечения безопасности населения и минимизации их воздействия на окружающую среду.


СПАСИБО ЗА ВНИМАНИЕ

ISTC International Workshop
"Worldwide early warning system of volcanic activities and mitigation of the global/regional consequences of volcanic eruptions",
Moscow, Russia, July, 8-9 2010

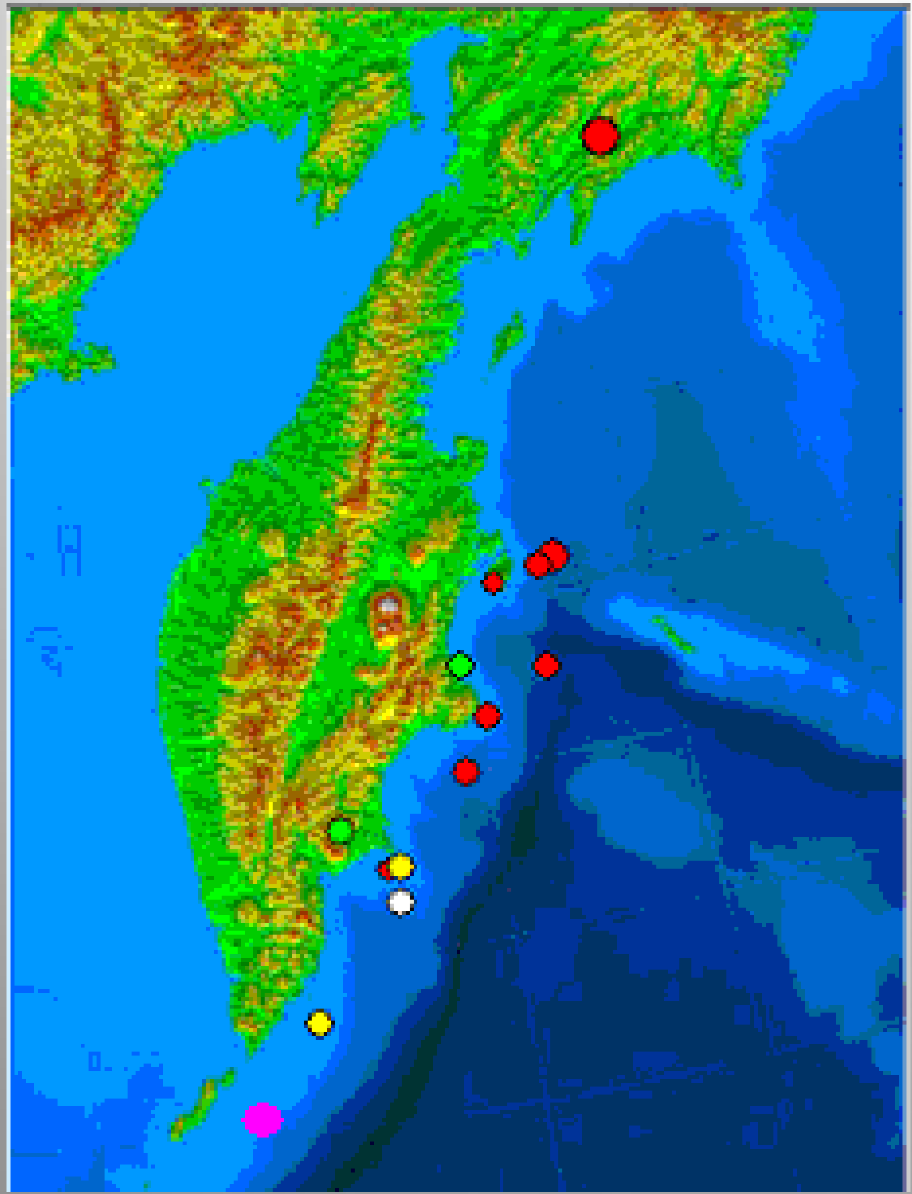
Satellite and ground-based monitoring of volcanic activity

V.M. Sorokin and V.M. Chmyrev

Pushkov Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Russian Academy of Sciences (IZMIRAN), 142190 Troitsk, Moscow region, Russian Federation

Schmidt Institute of Physics of the Earth (IPE), Russian Academy of Sciences, 10B, Gruzinskaya Str., 123995 Moscow, Russian Federation

This report presents the methods for monitoring of volcanic activity and warning of powerful eruptions. The methods are based on the latest achievements in study of the seismo-ionospheric coupling and the formation mechanisms of the disturbances in near Earth space at the preparatory phases of earthquakes and volcanoes.



Kamchatka peninsula is seismic region

29 active volcanoes annually produce 3 to 4 eruptions of explosive type

Klyuchevskoy Volcano eruption in northern Kamchatka.

This is the photograph taken by NASA from a space shuttle, which shows the ash cloud.

Volcanic ash reach the altitudes above 15 km and spread the distance up to several thousand km from their source filling the air space over the ocean.

Basic experimental results.

- Enhancement of seismic activity and typhoons produce DC electric field disturbances in the ionosphere of the order of 10 mV/m.

- These ionospheric disturbances occupy the region of the order of several hundred km in diameter over epicenter.

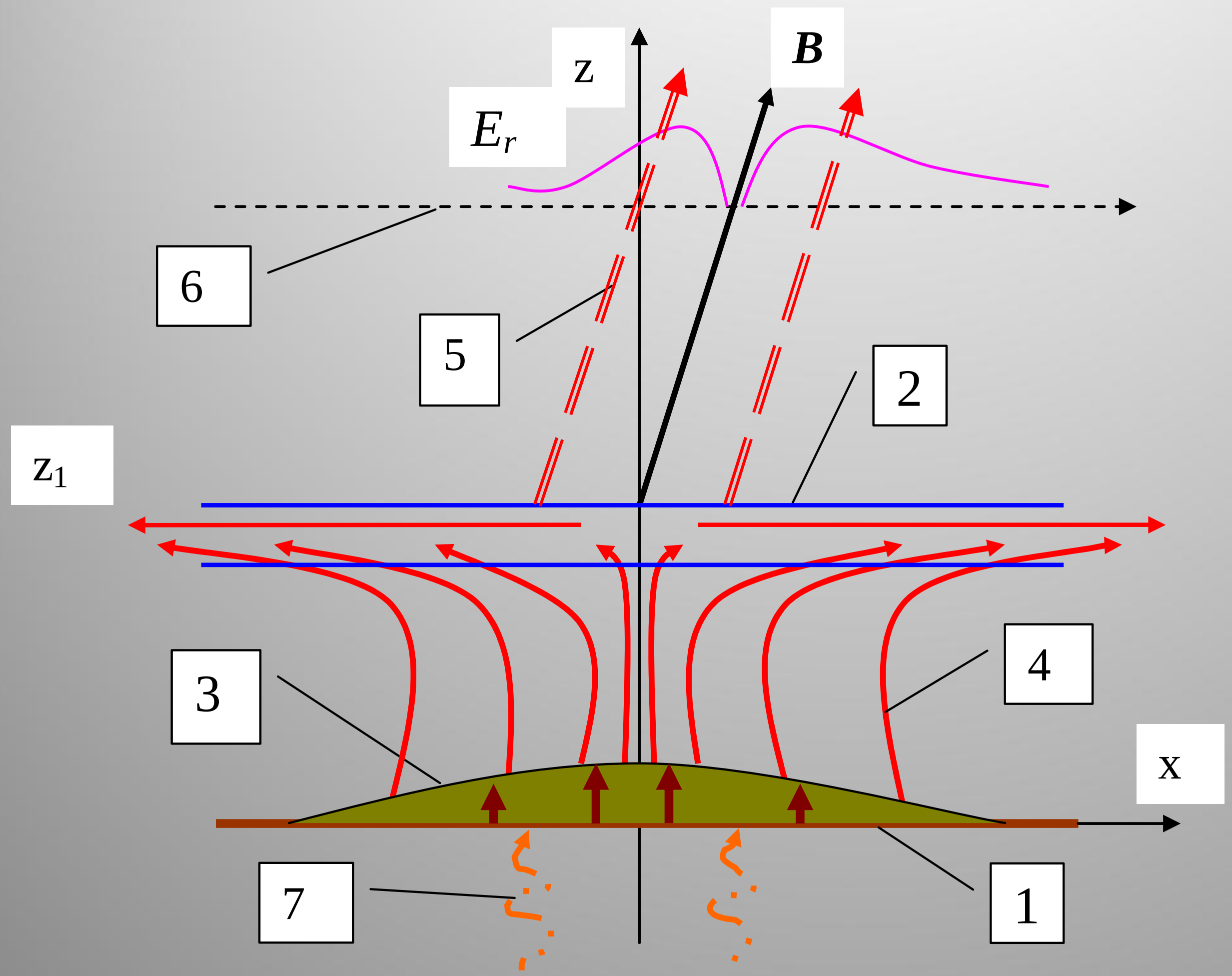
- DC electric field enhancements arise in the ionosphere from hours to 10 days before earthquakes.

- Within the seismically disturbed geomagnetic field tube the small scale (~10 km) irregularities of plasma density with relative amplitude ~10 % are observed together with the magnetic field disturbances ~10 nT and the electromagnetic emissions in ELF range with amplitude ~10 pT.

- DC electric field on the Earth surface in epicenter area does not exceed the background value ~100 V/m.

The key role in the seismo-ionospheric interaction belongs to external currents in the lower atmosphere. The external current is excited in a process of vertical atmospheric convection and gravitational sedimentation of charged aerosols. Aerosols are injected into the atmosphere due to intensifying soil gas elevation in the lithosphere during the enhancement of seismic activity. Its inclusion into the atmosphere – ionosphere electric circuit leads to DC electric field growth up to 10 mV/m in the lower ionosphere.

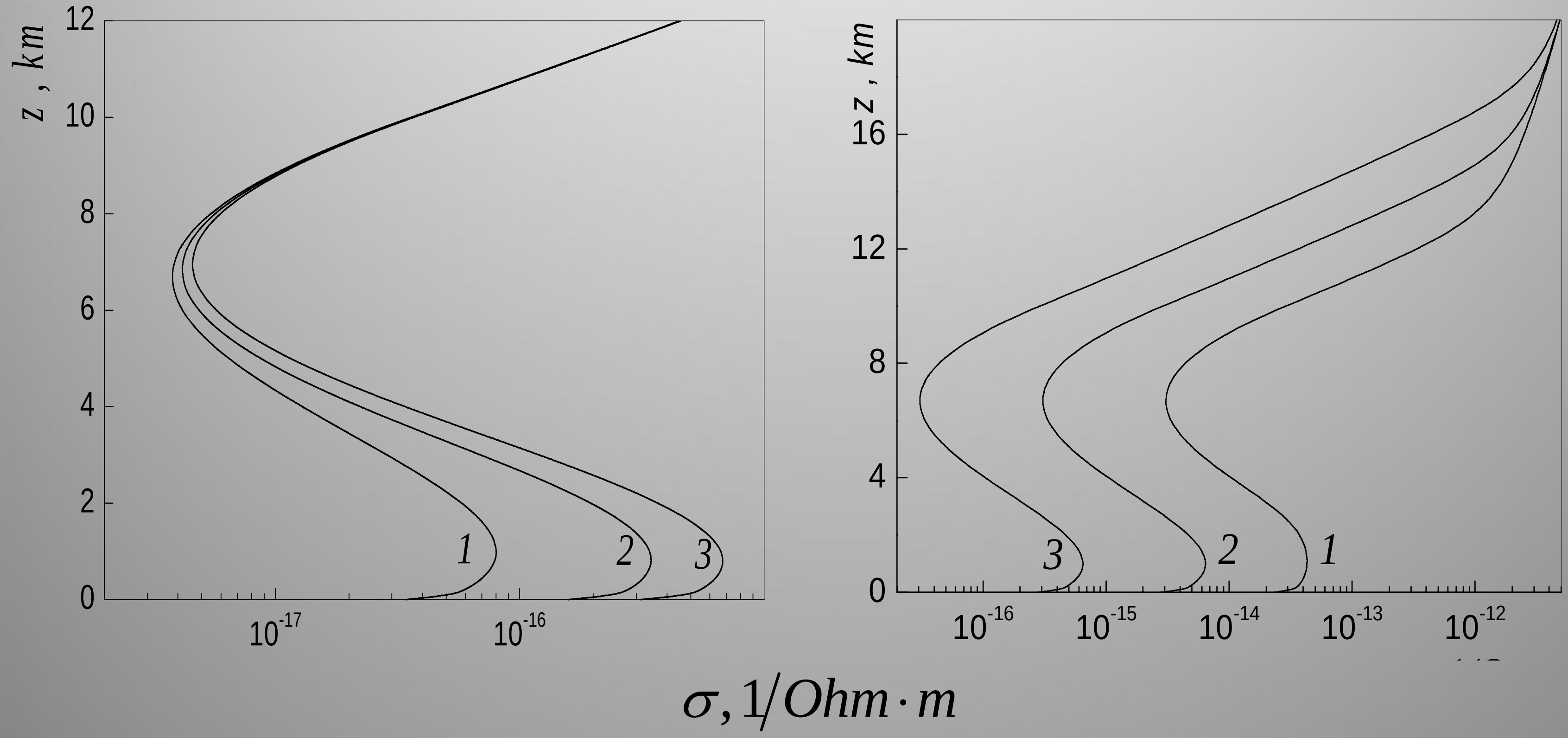
The proposed methods for monitoring of seismic activity are based on the electrodynamic model of the atmosphere – ionosphere coupling



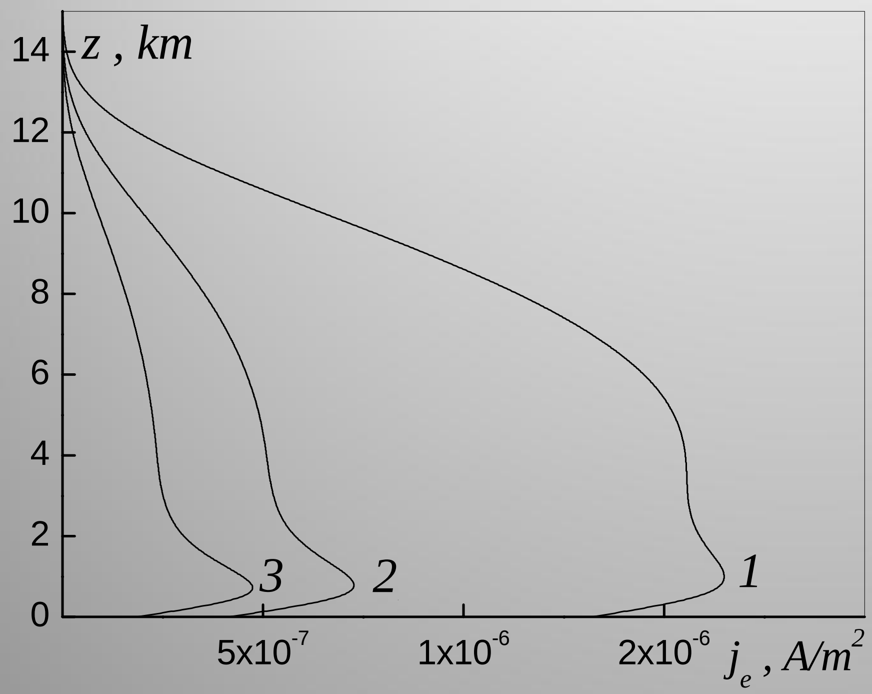
1. Earth surface
2. Conductive layer of the ionosphere
3. External electric current in the lower atmosphere
4. Conductivity electric current in the atmosphere – ionosphere circuit
5. Geomagnetic field - aligned electric current in the ionosphere
6. Satellite trajectory
7. Charged aerosols injected into the atmosphere by soil gases

Calculation results of the altitude dependences of atmosphere conductivity at the epicenter of disturbed region.

Left panel shows the atmosphere conductivity at different levels of atmospheric radioactivity.
Right panel presents the atmosphere conductivity at different number density of charged aerosols over the Earth's surface.



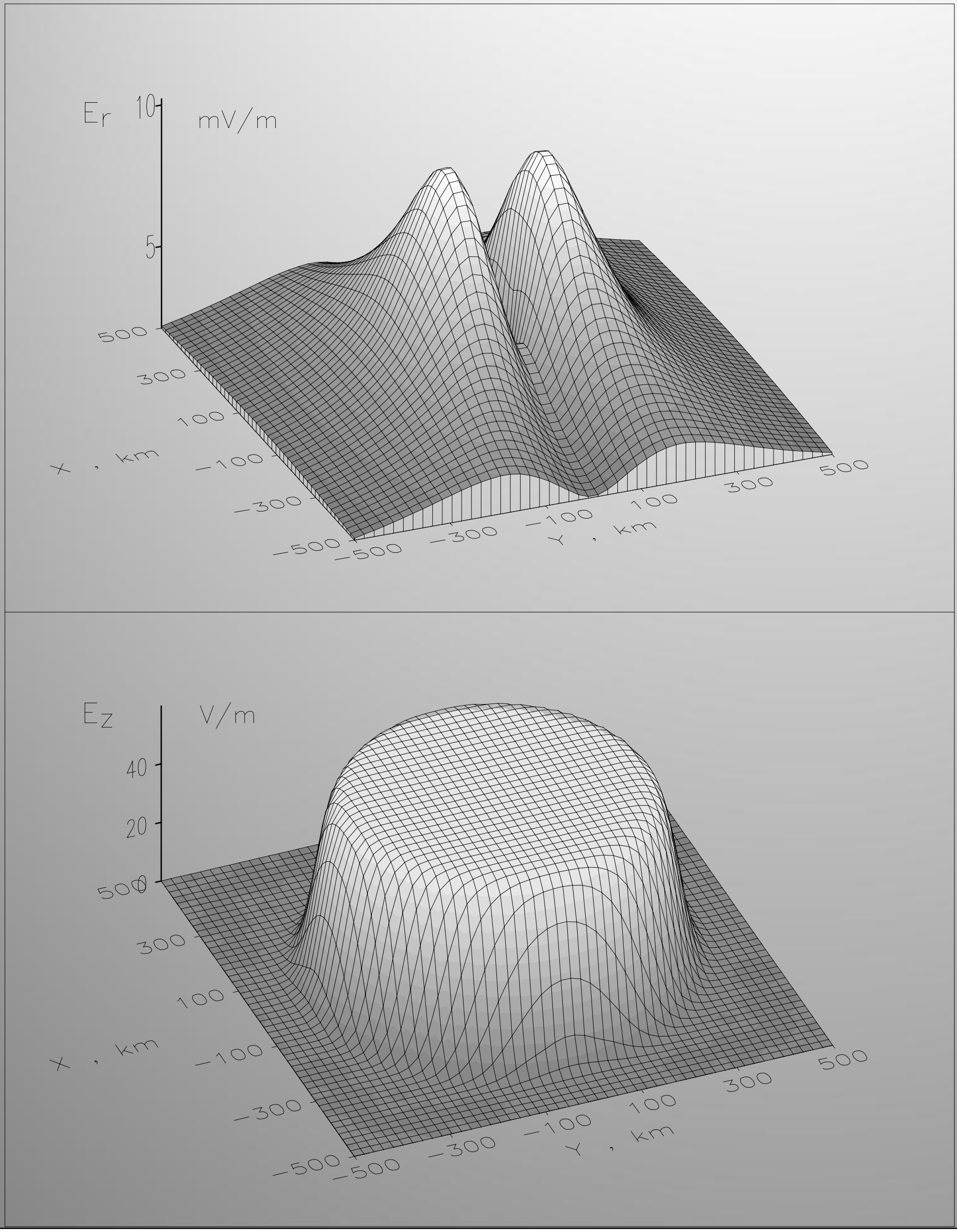
The altitude dependences of external electric current at the epicenter of disturbed region.



External current is formed as a result of:

- convective transfer of charged aerosols,
- ionization of lower atmosphere by radioactive sources,
- adhesion of electrons to molecules,
- interaction of charged ions with charged aerosols

Spatial distributions of DC electric field calculated for axially symmetric distribution of the external electric current



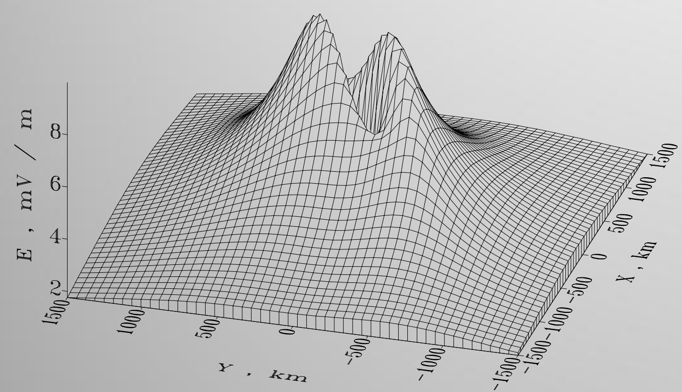
Upper panel:

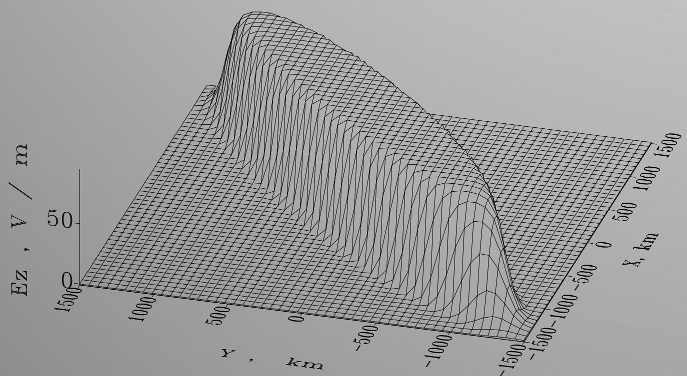
Horizontal component of DC electric field in the ionosphere. Angle of the magnetic field inclination is $\alpha = 20^{\circ}$

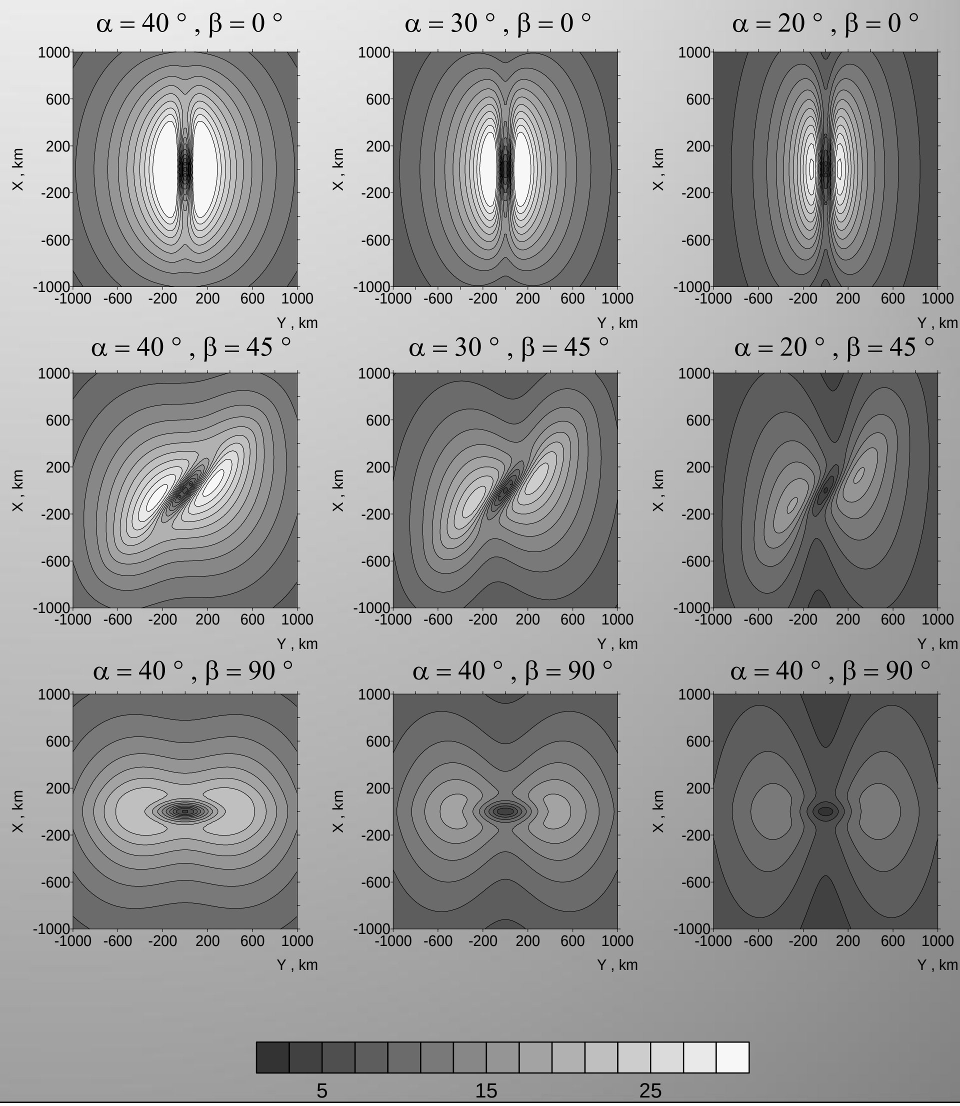
Lower panel:

Vertical component of DC electric field on the ground.

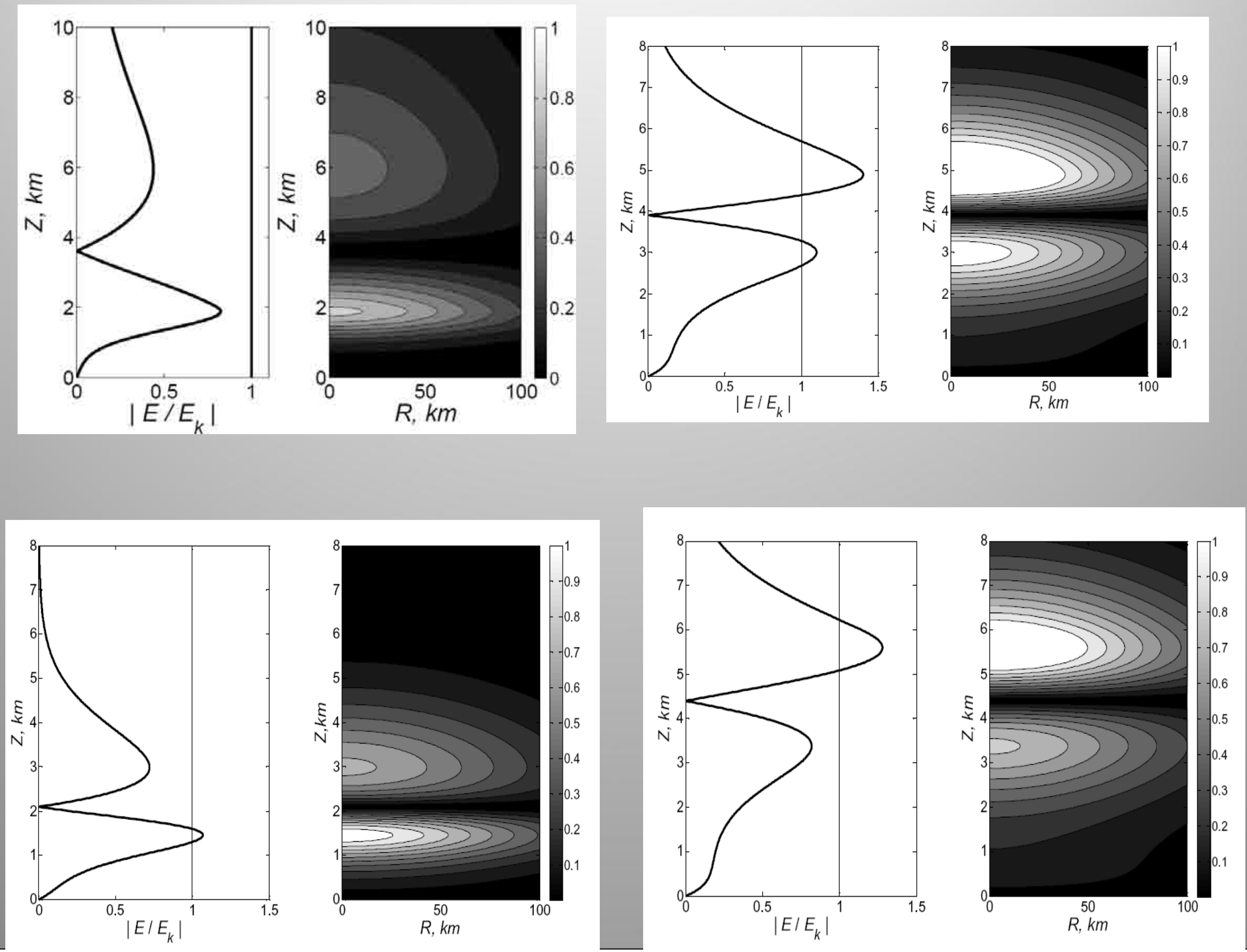
Spatial distribution of horizontal component of the electric field in the ionosphere and of vertical component of the electric field on the Earth surface over the fault in a form of ellipse.



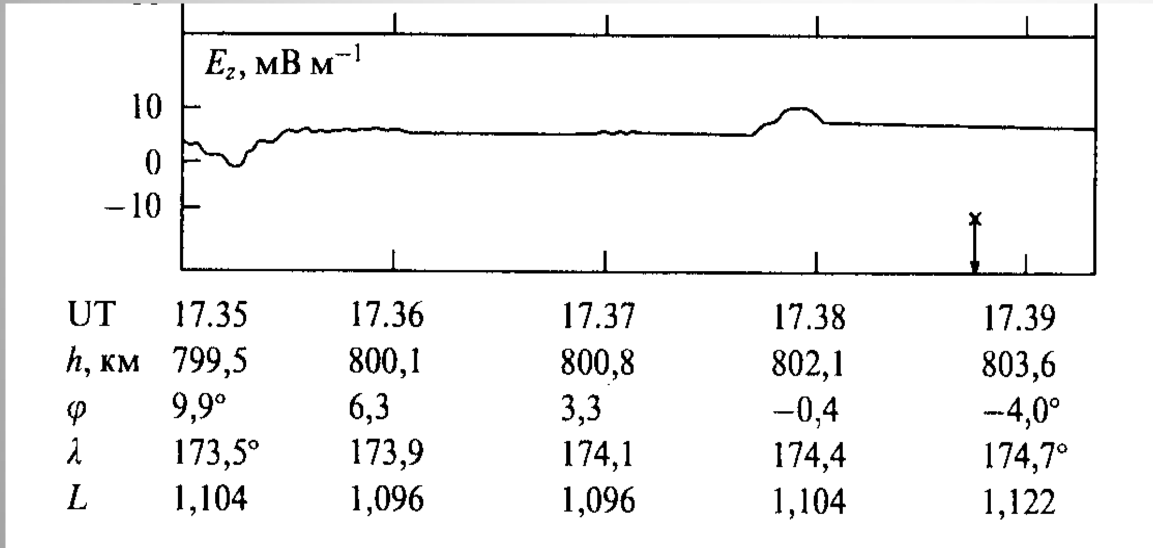




- Model examples of the altitude electric field distribution in the Earth – ionosphere layer (in relative units).

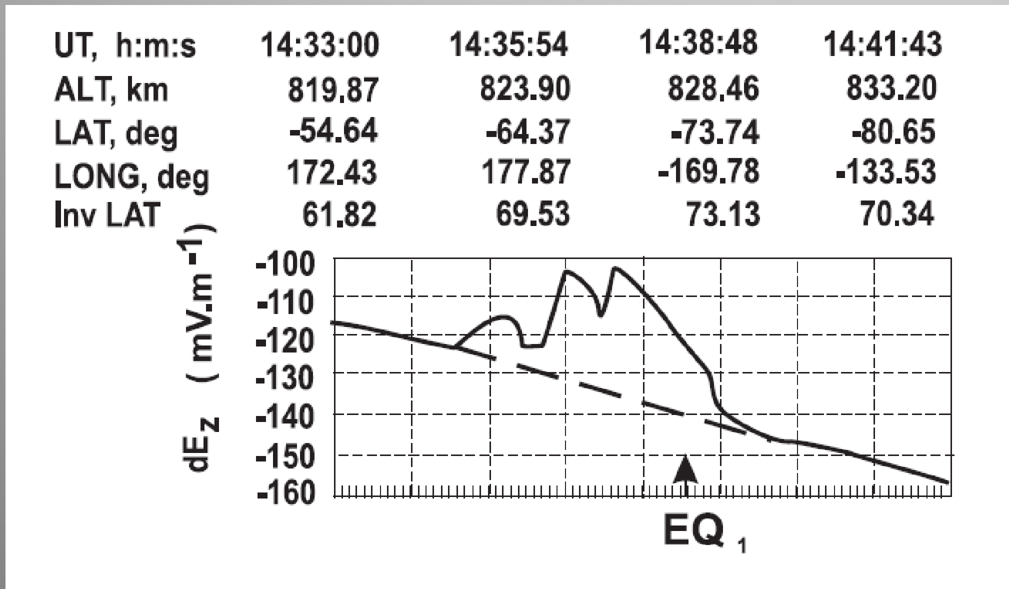


Examples of satellite observations of DC electric field



- DC electric field observed by the *"ICB -1300"* satellite within 15-min interval before the earthquake occurred on January 12, 1982 at 17.50.26 UT .

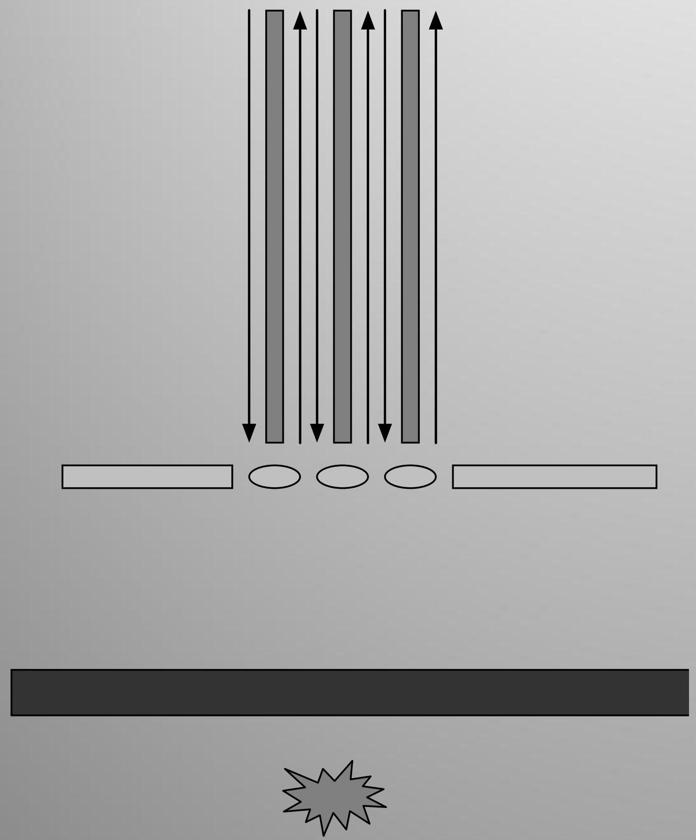
Chmyrev et al., Phys. Earth Planet. Inter. 1989.



- DC electric field observed by the *"ICB -1300"* satellite within 33-h interval before the earthquake occurred on August 23, 1981 at 23:45:28 UT.

Gousheva et al., Nat.Haz.Earth Syst.Sci., 2008.

Formation of field-aligned currents and plasma irregularities in the upper ionosphere as a result of Acoustic Gravity Wave (AGW) instability in the lower ionosphere.



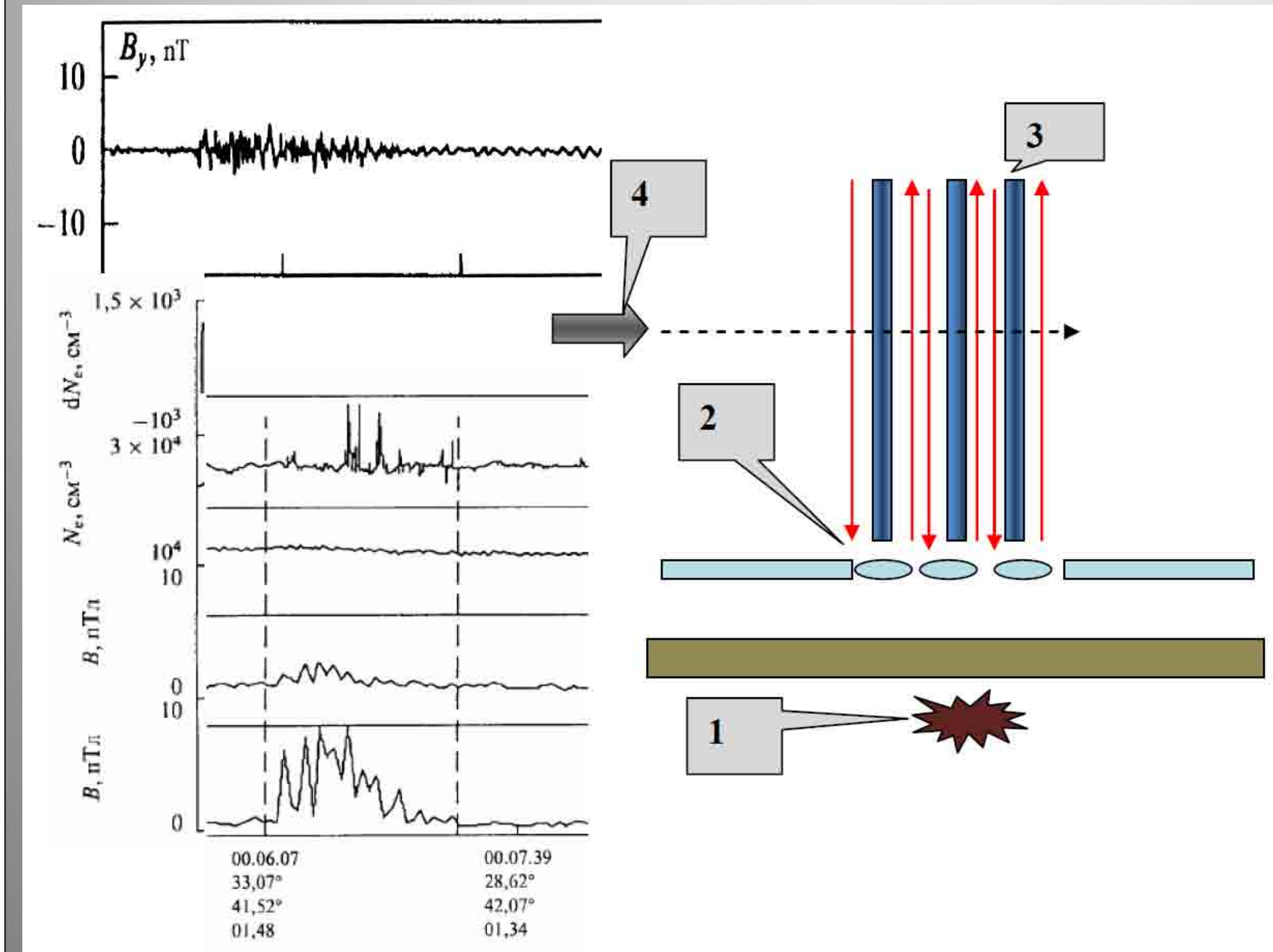
The excitation of horizontal spatial structure of conductivity in the lower ionosphere results in the formation of magnetic field-aligned currents and plasma layers stretched along the geomagnetic field.

$$\Delta N / N_0 \approx \nu_i cnE / \omega_i aB \approx (1.6 - 16)\%$$

$$b \approx \pi E \Sigma_{P0} / c \approx 5nT$$

$$\Delta t \approx \pi a / v_g \omega_g n(\omega_g) \approx (0.3 - 3)s$$

Examples of satellite observations of ULF magnetic field oscillations, electron number density fluctuations and ELF electromagnetic emissions caused by the formation of the ionosphere conductivity irregularities.

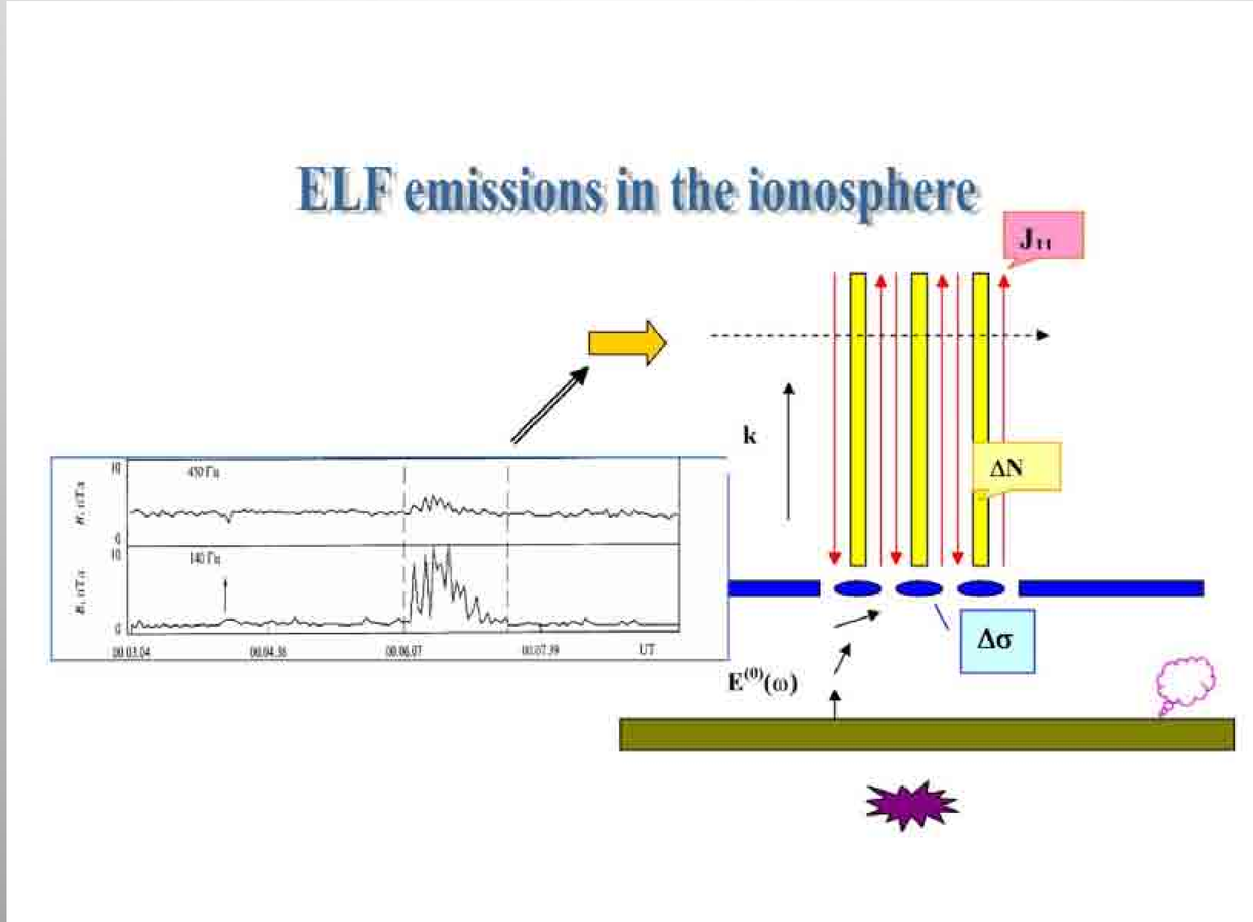


1. Earthquake.
2. Irregularities of ionosphere conductivity.
3. Field-aligned currents and irregularities of electron number density.
4. Satellite trajectory crossing the disturbed region.

ULF magnetic field.

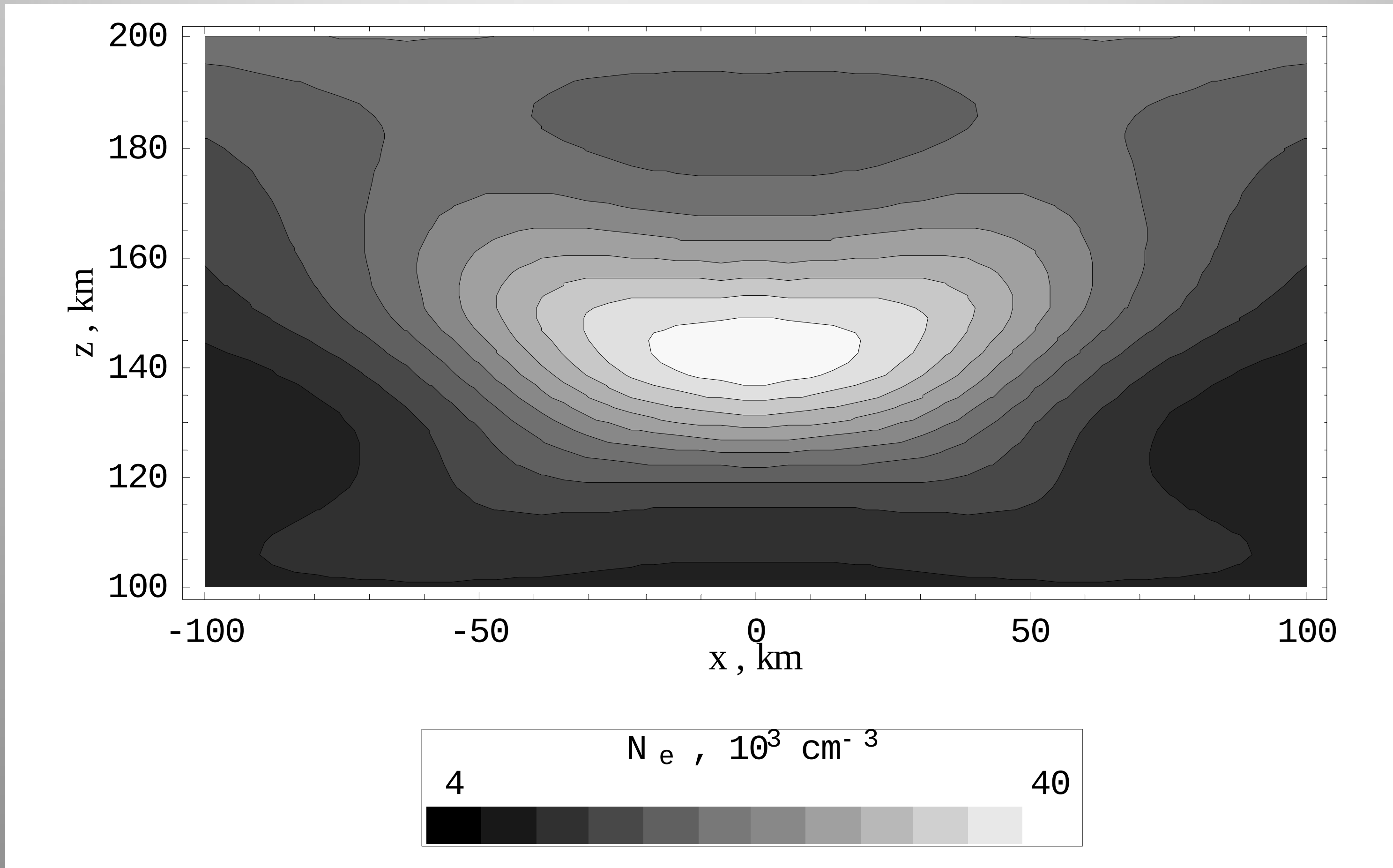
Electron number density fluctuations.

ELF electromagnetic emissions

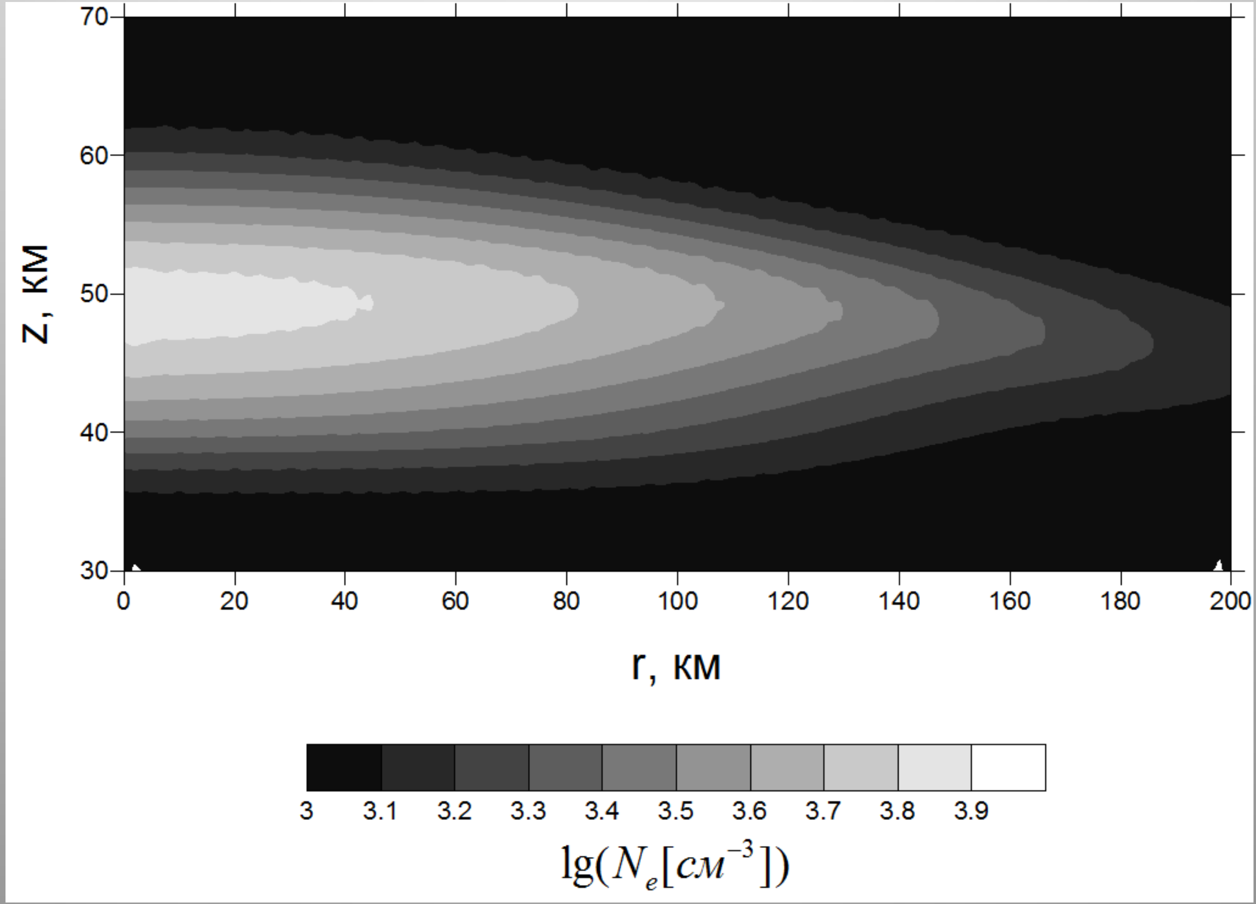


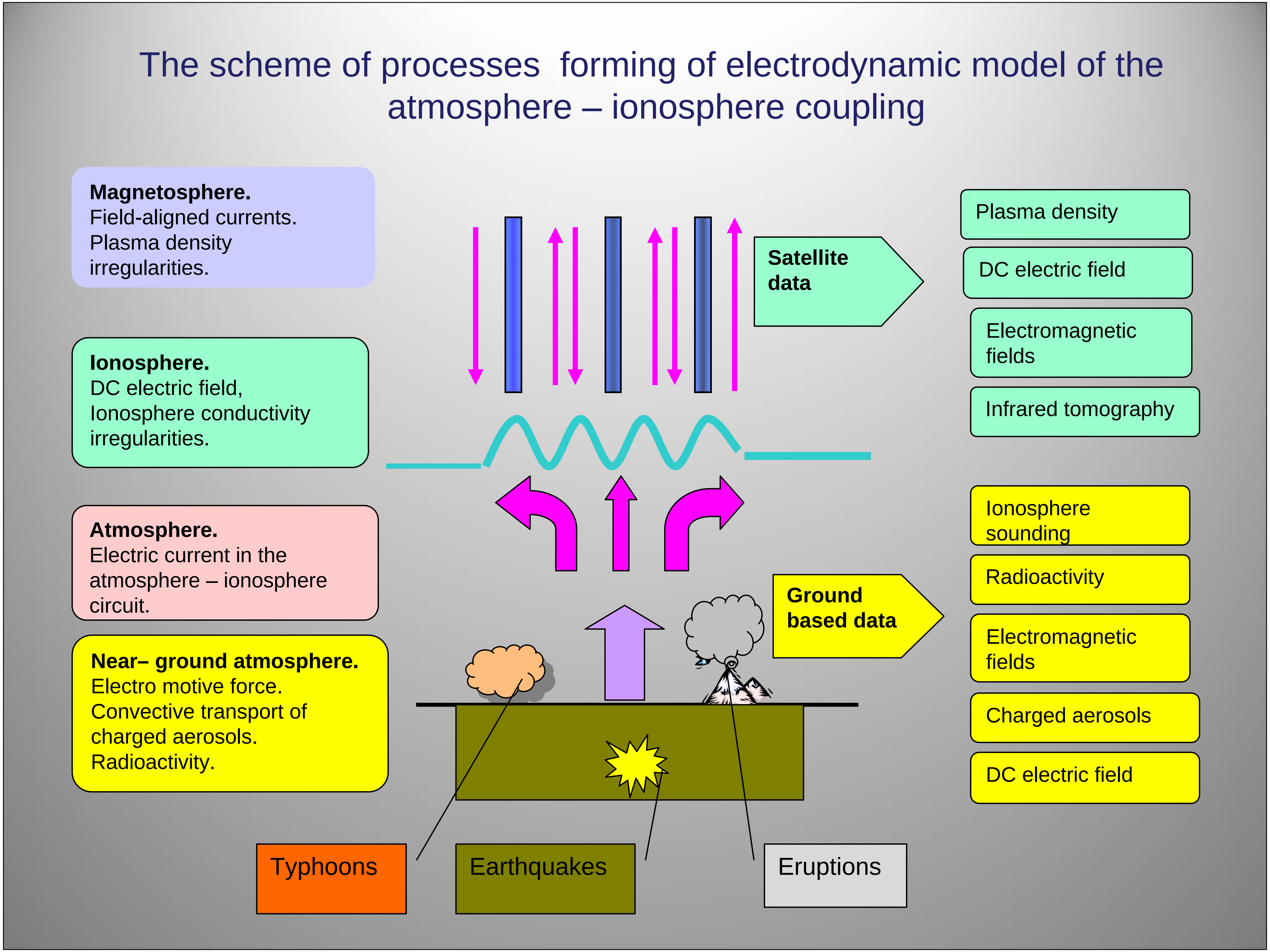
ELF electromagnetic waves are generated in a process of interaction of thunderstorm related *EM* radiation with small-scale plasma irregularities excited in the lower ionosphere before earthquakes.

Spatial distribution of electron number density in the ionosphic E - region caused by the electric current flowing into the ionosphere from the atmosphere.



Spatial distribution of electron number density in the D layer of the ionosphere caused by the electric current flowing from the atmosphere to the ionosphere




The scheme of processes forming of electrodynamic model of the atmosphere – ionosphere coupling
Magnetosphere.
Field-aligned currents.
Plasma density irregularities.
Ionosphere.
DC electric field,
Ionosphere conductivity irregularities.
Atmosphere.
Electric current in the atmosphere – ionosphere circuit.
Near– ground atmosphere.
Electro motive force.
Convective transport of charged aerosols.
Radioactivity.
Satellite data
Plasma density
DC electric field
Electromagnetic fields
Infrared tomography
Ground based data
Ionosphere sounding
Radioactivity
Electromagnetic fields
Charged aerosols
DC electric field
Typhoons
Earthquakes
Eruptions

Satellite and ground based monitoring of volcano activity

The above consideration gives experimental and theoretical base for development and practical implementation of new satellite methods for monitoring of volcanic activity and short-term forecasting of high-power volcano eruptions.

Within project it is supposed to develop the specialized set of equipment for direct measurements of definite types of ionosphere perturbations above volcanoes and the remote sensing of thermal field parameters and the humidity in an active zone.

The hardware should be placed onboard the special micro-satellite to be launched on solar synchronous orbit at the altitudes ~700 km. This activity should be supported by ground based geophysical and radio physical observations in a zone of active volcanoes in Kamchatka.

Composition of the
Combined Space and Ground-Based
Short – Term Volcanoes Forecasting System

Space segment

Small satellite grouping

Microsatellite grouping

Ground segment

Network of geophysical stations

Ground Control Complex
&

Data Processing and Analysis Center

The satellite segment of the monitoring system should provide the measurements of the following field and plasma parameters:

- Three components of DC electric field;
- Electromagnetic field waveforms;
- Spectral density for wave components;
- Thermal plasma parameters - components of ion drift velocity, ion number density, ion temperature, ion density oscillations;
- Intensity of IR radiation for mapping thermal anomalies;
- Limb measurements of the spectral distribution of hydroxyl emission;
- Thunderstorm activity.

GROUND GEOPHYSICAL SEGMENT

EACH STATION IS EQUIPPED WITH INSTRUMENTS FOR CONTINUOS MEASUREMENTS OF

- SEISMIC AND MAGNETIC FIELD OSCILLATIONS,
- NATURAL ULF/ELF/VLF ELECTROMAGNETIC EMISSIONS AND VLF/LF TRANSMITTER SIGNALS,
- ATMOSHERIC *DC* ELECTRIC FIELDS AND TELLURIC CURRENTS,
- CHEMICAL COMPOSITION OF SOIL, WATERS, AND ATMOSPHERIC GAS,
- AEROSOL CHARACTERISTICS,
- RADON AND OTHER RADIOACTIVE GAS EMISSIONS,
- DISTURBANCES OF *D, E,* AND *F* LAYERS OF THE IONOSPHERE.

ALL GEOPHYSICAL STATIONS ARE CONNECTED WITH GROUND CONTROL COMPLEX AND DATA PROCESSING CENTER.

Conclusion

The results of experimental research and the theoretical modeling gives grounds for initiation of project aimed at the development and practical implementation of new methods for monitoring of volcanic activity and warning of powerful eruptions. The suggested project includes two main parts.

First is the development of ground network of observational sites in the vicinity of Kamchatka volcanoes and equipping them with new instruments for hydro-chemical, geophysical and radio physical measurements.

The second part includes manufacturing and piggyback launching of the micro-satellite with the purposeful instrumentation set for the direct measurements of definite types of ionospheric disturbances over volcanoes and the remote sensing of the parameters of thermal fields and humidity in active zones.

It is assumed that synchronized ground-based and satellite observations of the expended set of the parameters sensible to enhancement of volcano activity will give an opportunity to develop the practical methods for short-term forecasting and timely warning (from hours to days before) of strong volcanic eruptions with subsequent communication to the authorities and aviation community in Russia, Canada, USA, Japan, China, Korea and other interested countries.

Planned research project.

I S T C

М Н Т Ц

PROJECT PROPOSAL # **3512**

Full title:

- Development of new satellite methods for monitoring of volcanic activity to avoid the hazardous effects of volcanic ash on jet aircraft flights over the North Pacific

Short title:

- Reducing threat of volcanic eruptions for aviation

Leading Institution:

- Pushkov Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation (IZMIRAN), Russian Academy of Sciences

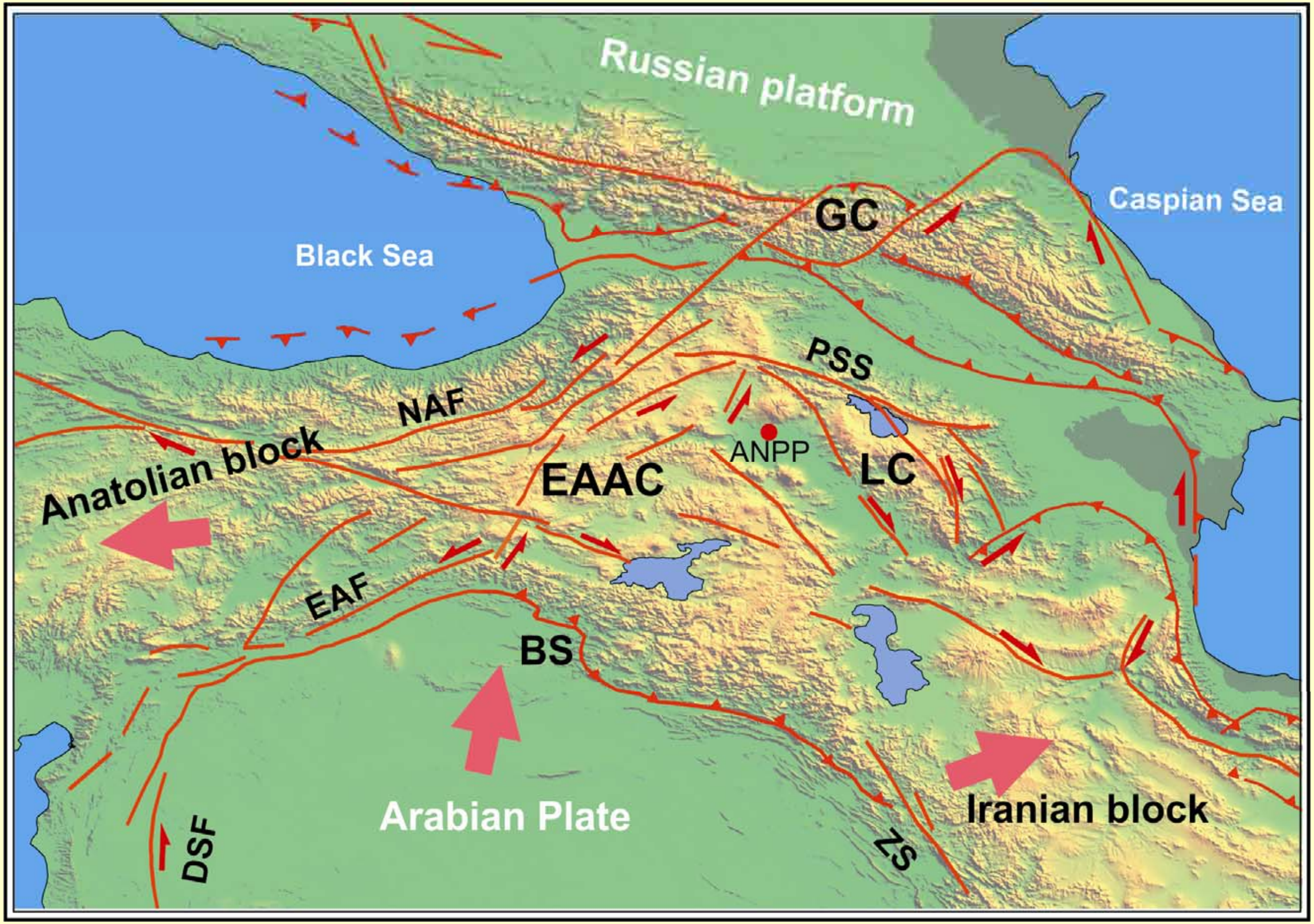
Pleistocene - Holocene late collision volcanism of the territory of Armenia and volcanic hazard assessment.

Kh. Meliksetian, G. Navasardyan, C. Connor, I. Savov

Institute of Geological Science NAS, Armenia
University of South Florida, US
University of Leeds, UK

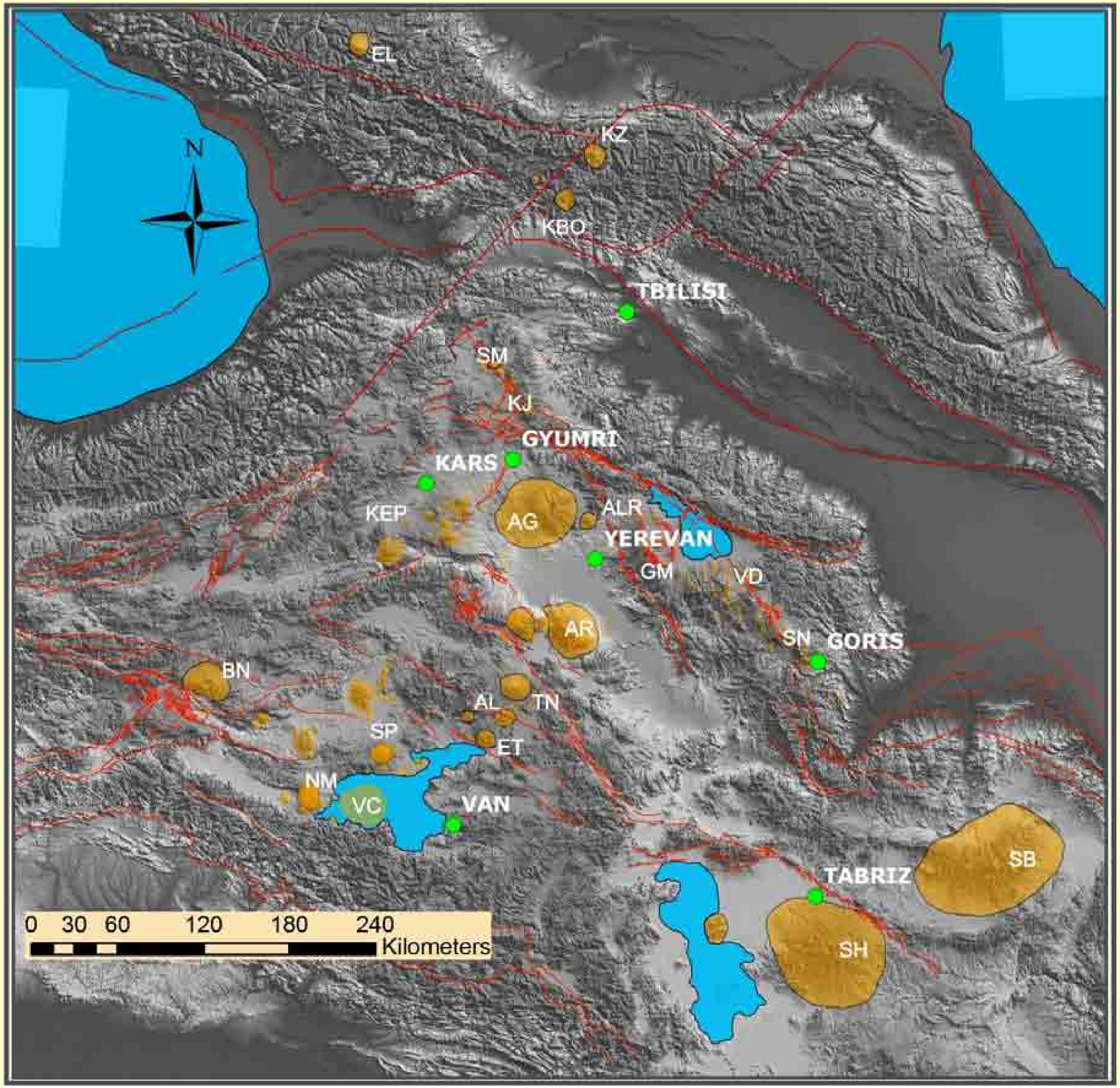
Nazeli Holocene volcano, Syunik volcanic highland, south Armenia

Tectonic settings of the regional collision zone

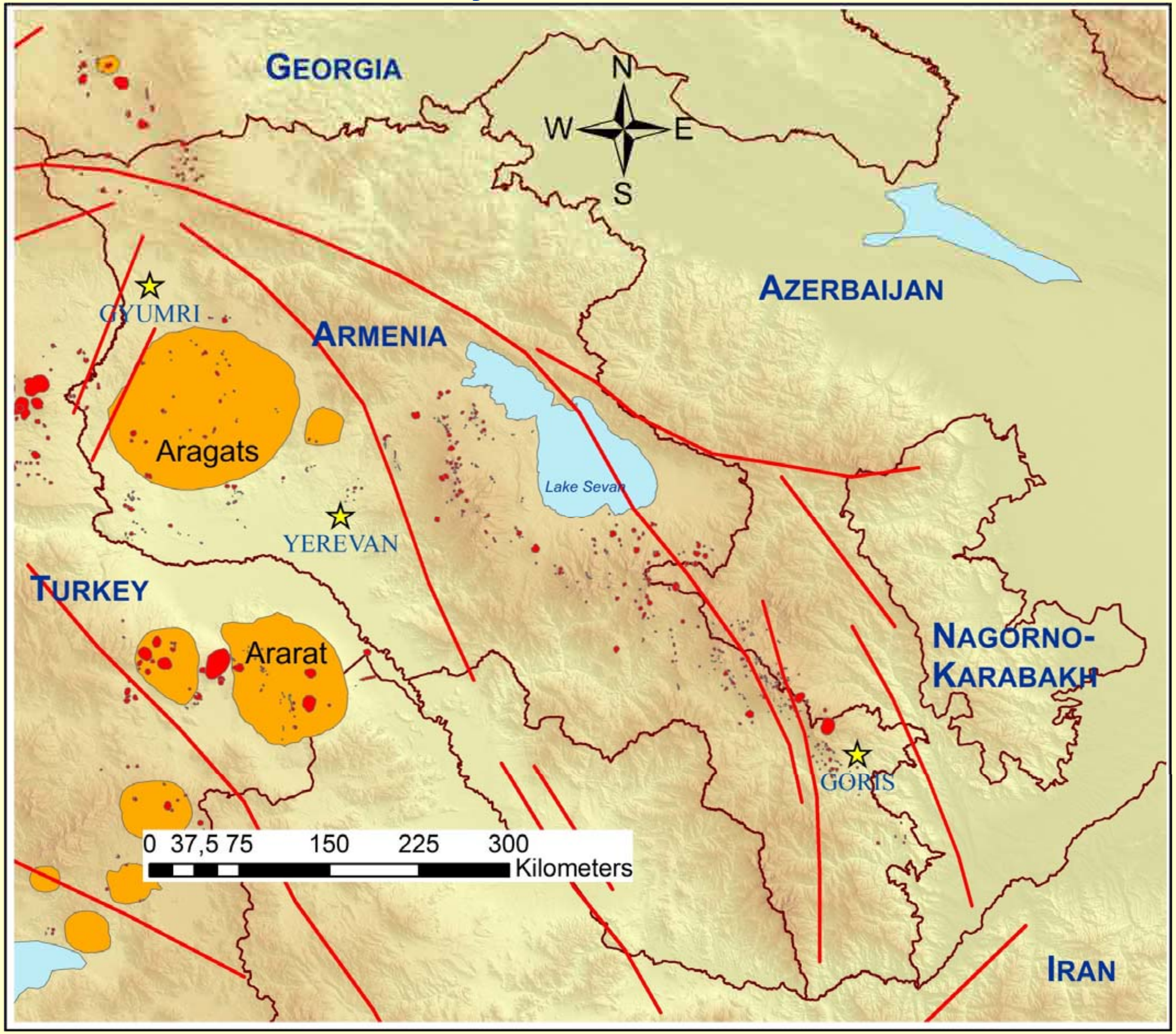


After Phillip et al., 1989; Karakhanian et al., 2003. Map key: North Anatolian fault (NAF), East Anatolian fault (EAF), Dead Sea fault (DSF), Bitlis suture (BS), Zagros suture (ZS), Pambak Sevan Syunik fault (PSS), Great Caucasus (GC), East Anatolian accretionary complex (EAAC), Lesser Caucasus (LC), Armenian nuclear power plant (ANPP).

Distribution and tectonic setting of Pliocene–Quaternary volcanoes in the region



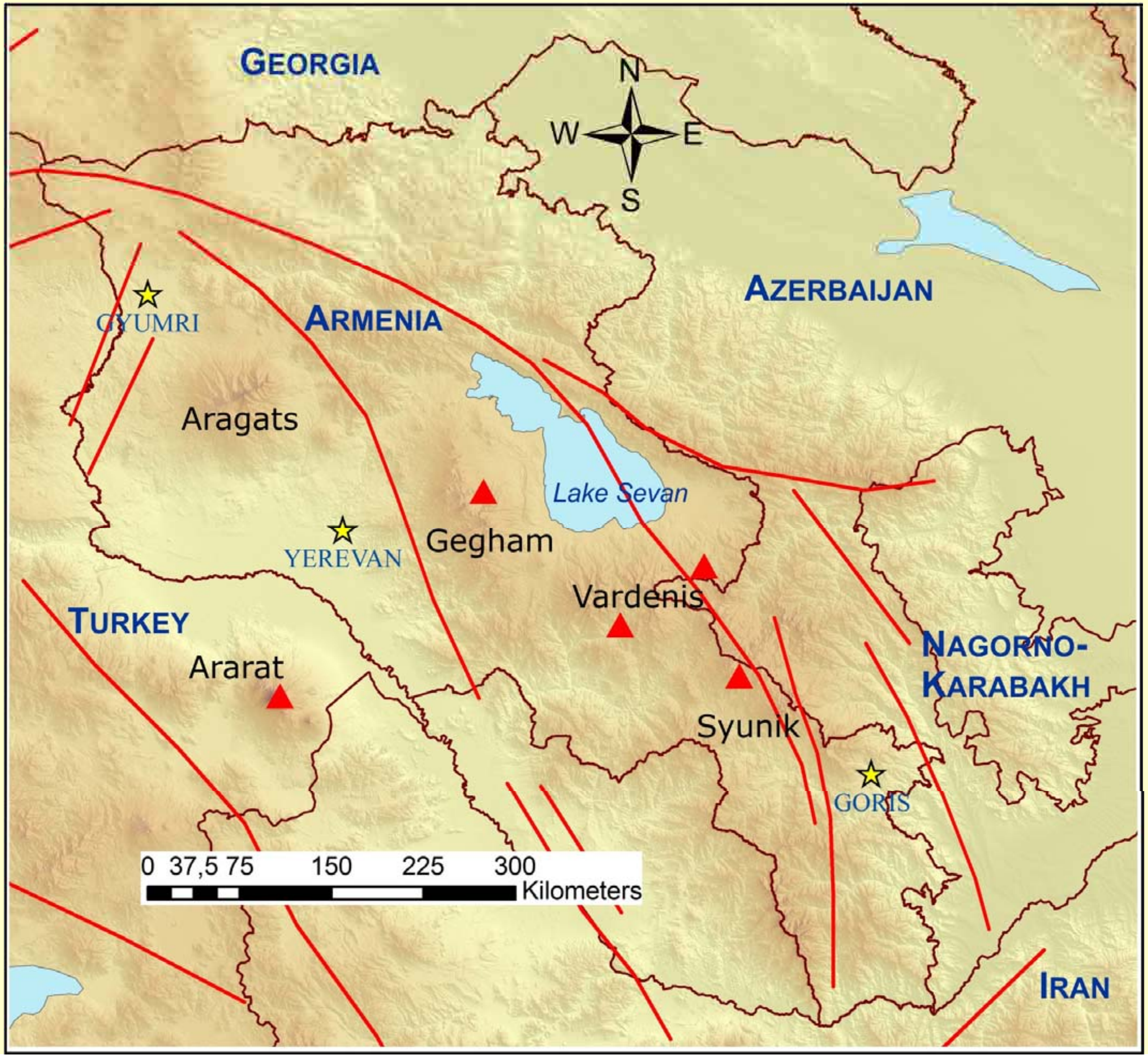
There are more than 500 volcanic centers in the territory of Armenia, most of them are monogenetic cinder cones, but also 4 big stratovolcanoes, as well as rhyolite domes.



Some noteworthy features of Aragats volcano

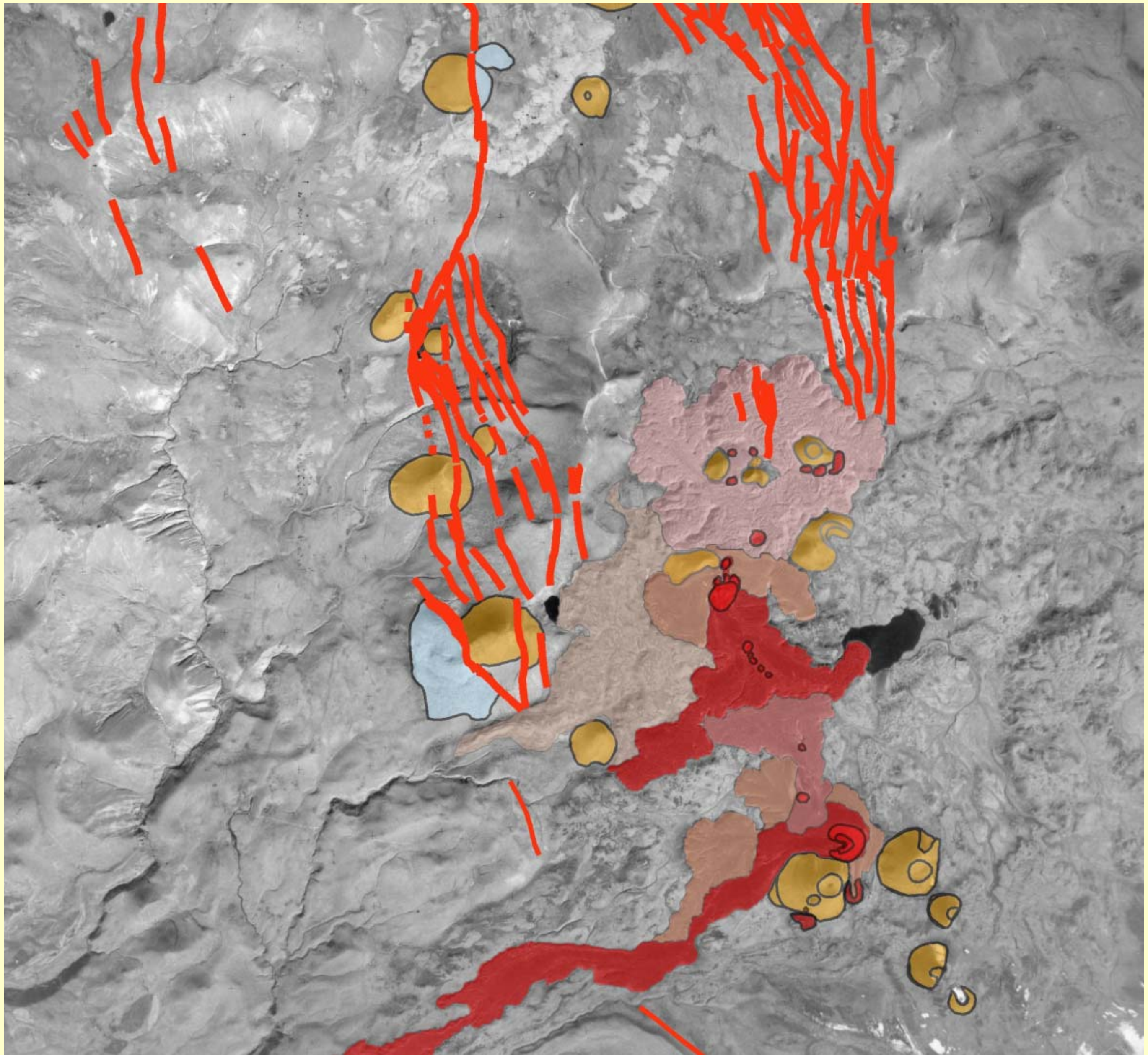
- Altitude 4090m, area of Aragats volcanic province ~5000 km^2
- Long period of activity, more than 2 Ma, last activity is dated to 450 Ka.
- Huge volume of central-vent eruptions, including ~6km^3 low aspect ratio ignimbrites.
- Intense flank activity from more than 100 monogenetic vents on the periphery.
- Super hot magma: an example is Tsakhkasar flank dacite volcano - one of the episodes produced 25 km (!) length huge dacite lava flow with total volume of 28 km^3 and thickness reaching 200 m. Such a length lava flows are typical mostly for basalts and basaltic andesites but not for dacites due to high viscosity related to SiO_2 content.

Some monogenetic cinder cones in Armenia were active in Holocene (<11700 years) and erupted during last 3-7 thousand years.
Tendurek, Nemrut and Ararat in eastern Turkey were active in historical time.

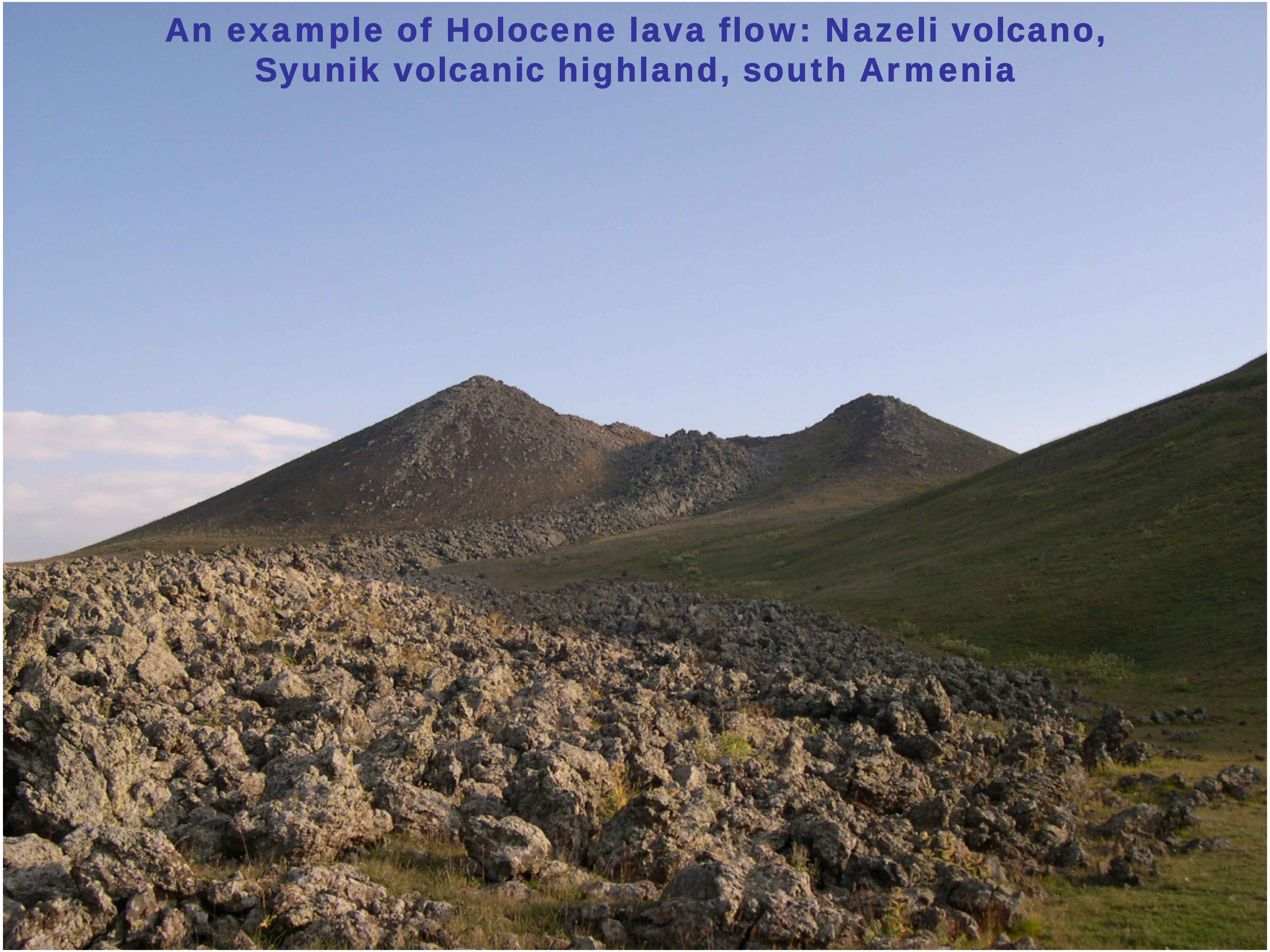


Red triangles show locations of Holocene volcanoes in Armenia, as well as Ararat with flank activity in Holocene and phreatic eruption in 1840.

Holocene lava flows of Karkar group of cinder cones, Syunik volcanic highland, south Armenia



An example of Holocene lava flow: Nazeli volcano, Syunik volcanic highland, south Armenia

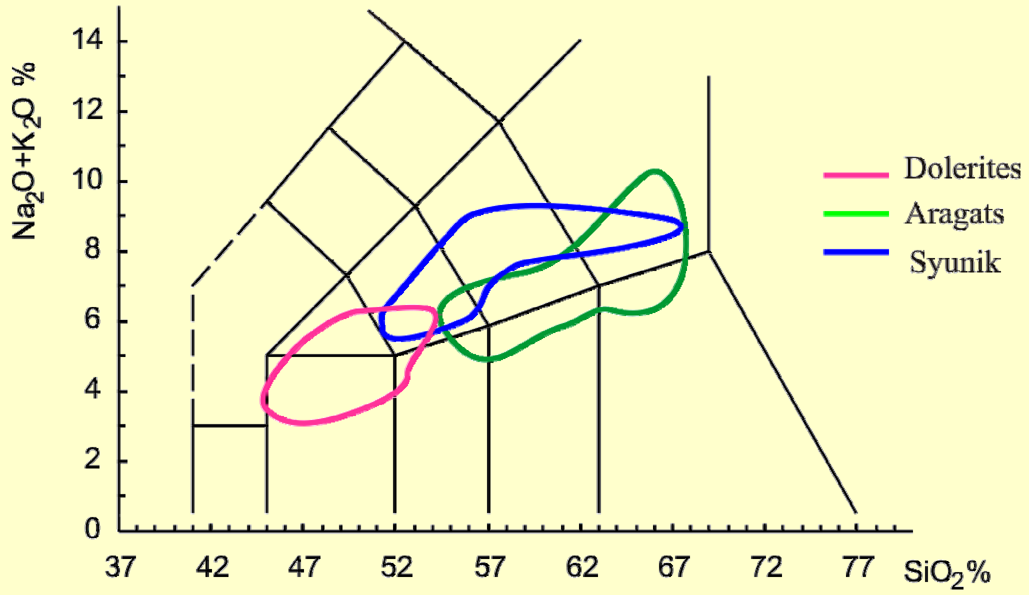


A petroglyph depicting volcanic eruption dated to the 6^{th}-7^{th} millennia B.C.

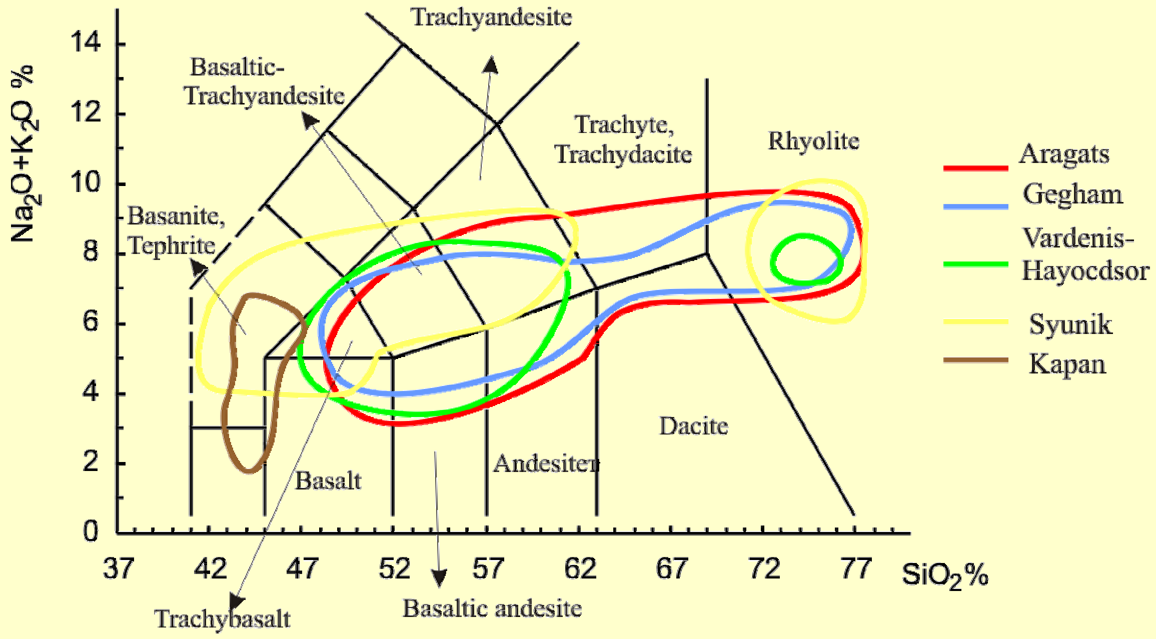
(after A. Karakhanyan and A. Avagyan)

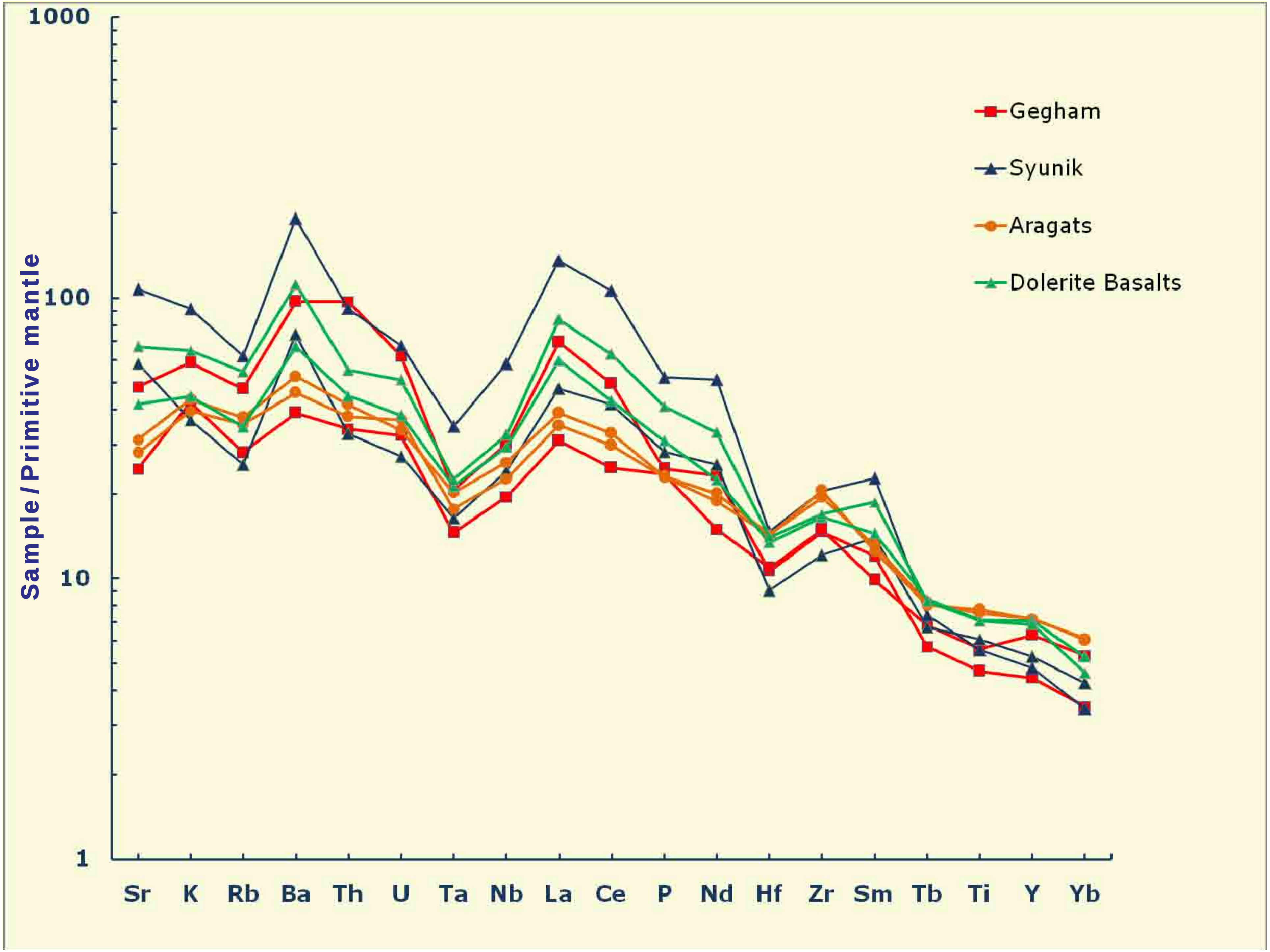
Alkali-Silica systematic of Armenian volcanic series

Fissure eruptions dolerite basalts; Stratovolcanoes



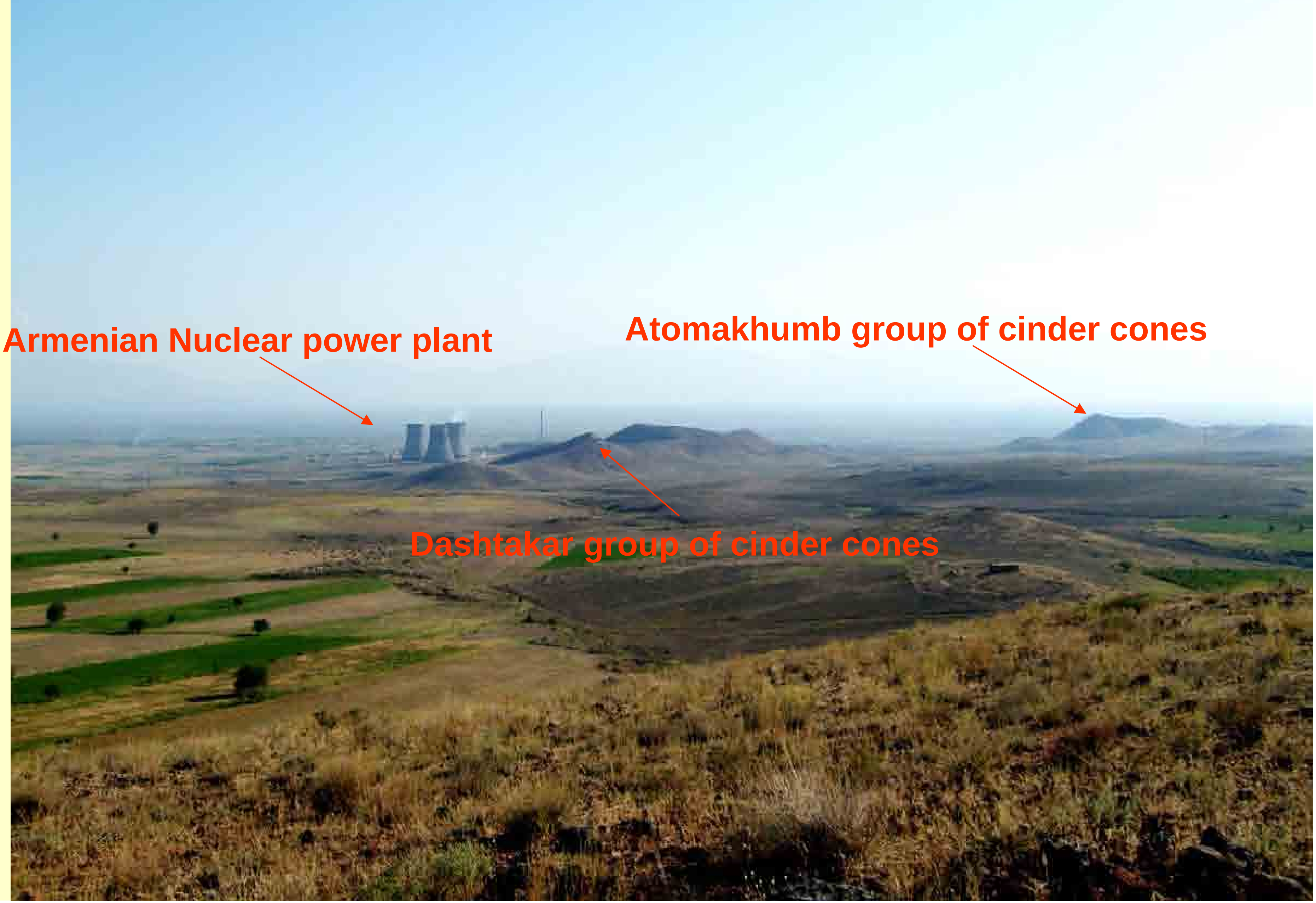
Monogenic volcanic cones



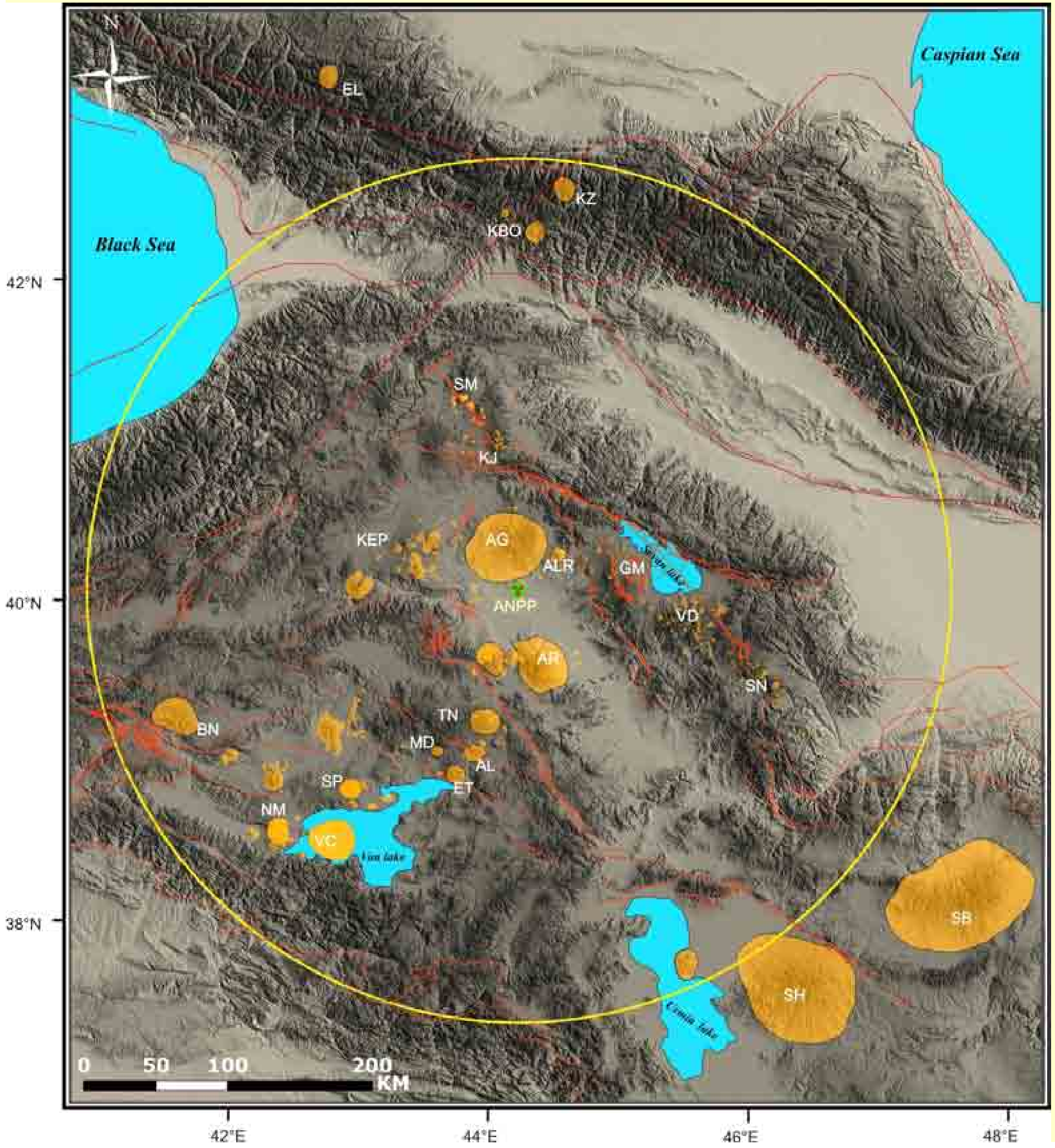


1000
100
10
1
Sample / Primitive mantle
Gegham
Syunik
Aragats
Dolerite Basalts
Sr
K
Rb
Ba
Th
U
Ta
Nb
La
Ce
P
Nd
Hf
Zr
Sm
Tb
Ti
Y
Yb

Volcanic Hazard Assessment of the Armenian Nuclear Power Plant Site (ANPP)



Distribution of volcanoes in 300 km zone around ANPP



The Armenian Nuclear Power Plant (ANPP) is located in a region of Quaternary (<1.8 Ma) and Holocene-Historical (<11.7 Ka) volcanism.

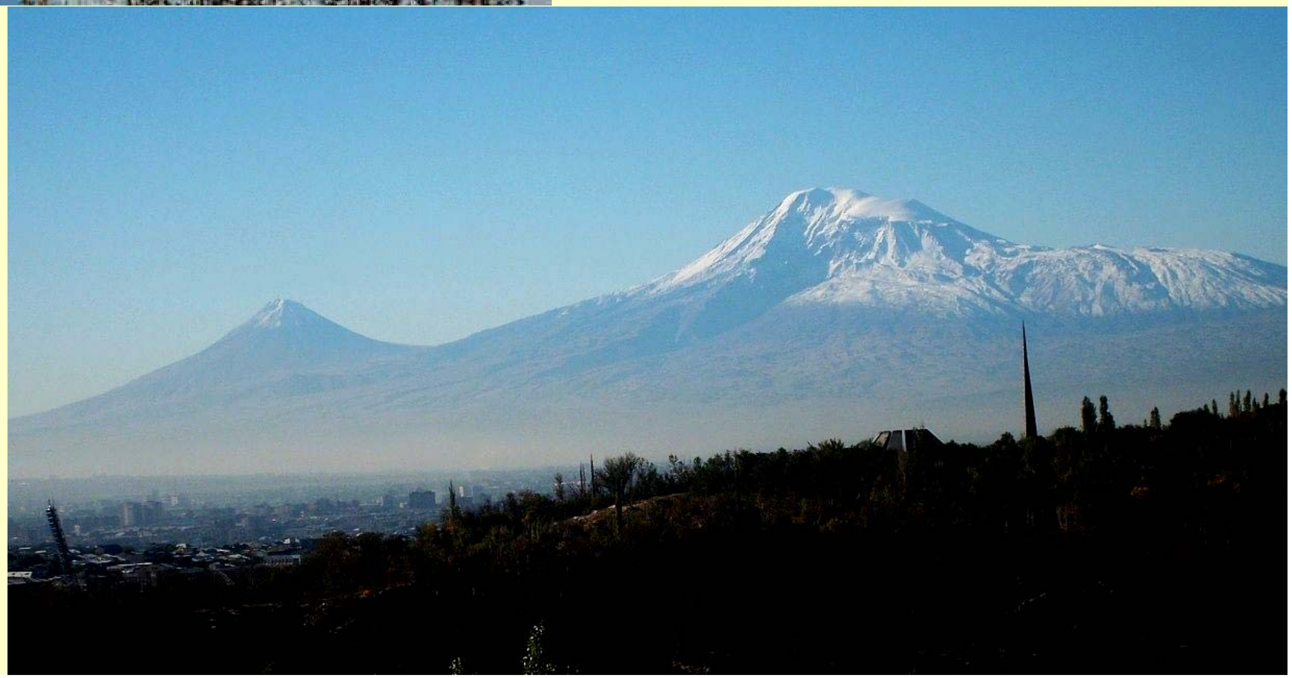
Because of this fact, volcanic hazards potentially exist for facilities at the ANPP site, and these hazards must be evaluated in a quantitative way.

Detailed analyses of potential volcanic hazards at the ANPP site follow International Atomic Energy Agency (IAEA) guidelines provided for volcanic hazard assessment and rely on:

- Development of a volcano database of the site region, which includes geologic data on the extent, timing and nature of past volcanic activity in the region;
- Development of a conceptual model of volcanism in the site region, based on state-of the-art geochemical and petrologic studies, as well as information about the tectonic setting and geologic history of volcanism,
- Detailed analyses of the recurrence rate using Ar-Ar dating and potential magnitude of each volcanic phenomena that may impact the ANPP site
- Numerical simulations of specific phenomena, such as tephra fallout and lava flows, used to estimate the probability that such phenomena have an effect the site.

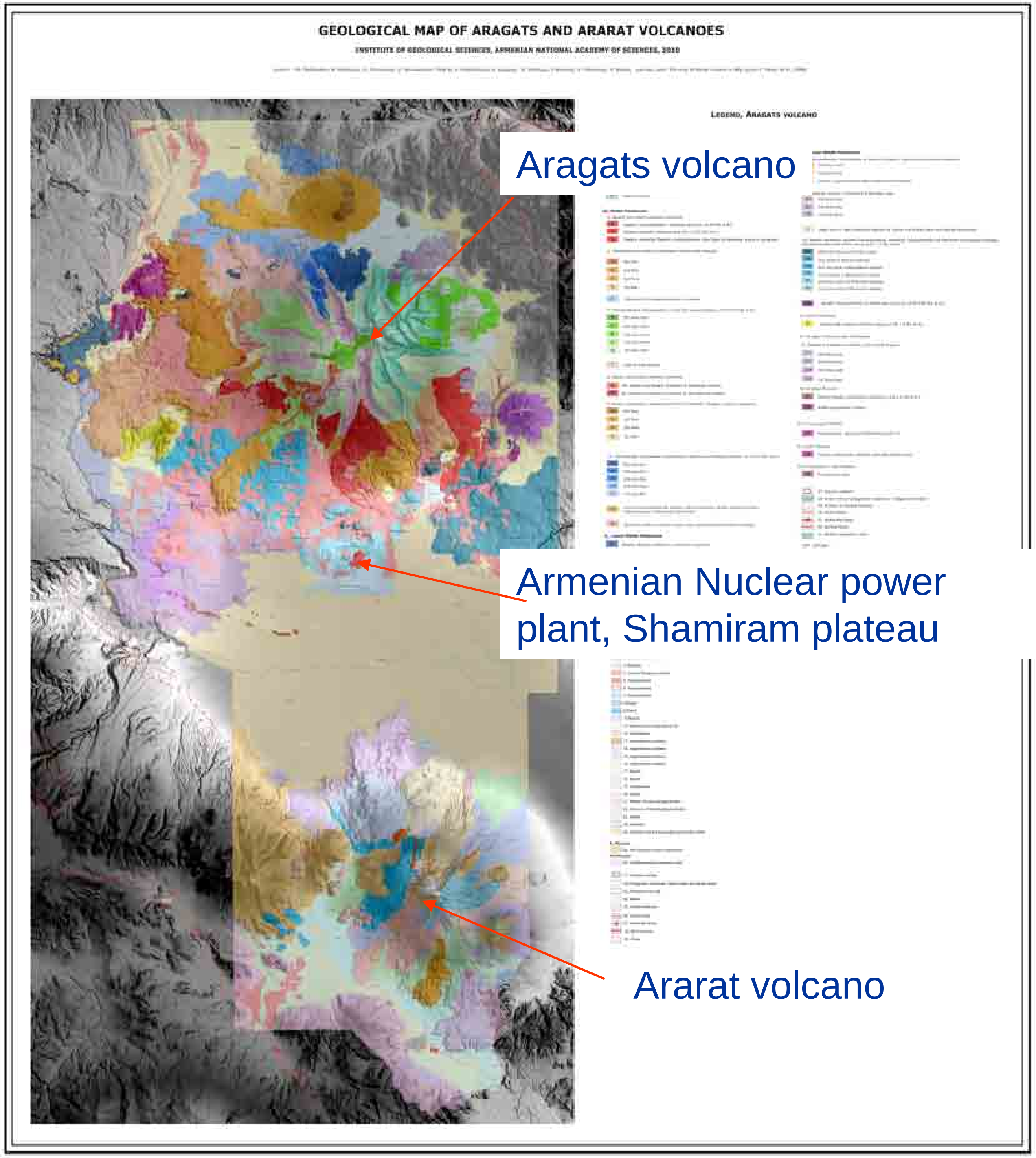
According to IAEA guidelines, a capable volcano or volcano group is one for which: Future volcanic eruption or other volcanic event is credible, and such an event has the potential to produce volcanic phenomena that may affect the site. These capable volcanoes include: Ararat volcano, Aragats volcano, and the monogenetic volcanoes of the Shamiram plateau, adjacent to the ANPP site.

Aragats volcano, 35 km from ANPP
Last flank activity ~450Ka



Ararat volcano, 54 km from ANPP,
Last flank Activity – Holocene,
Phreatic eruption, 1840

New site vicinity scale geologic map of the ANPP site vicinity, (Shamiram volcanic plateau) prepared to help develop a detailed understanding of the specific volcanic processes that have operated on the Shamiram plateau and adjacent areas in the ANPP vicinity.

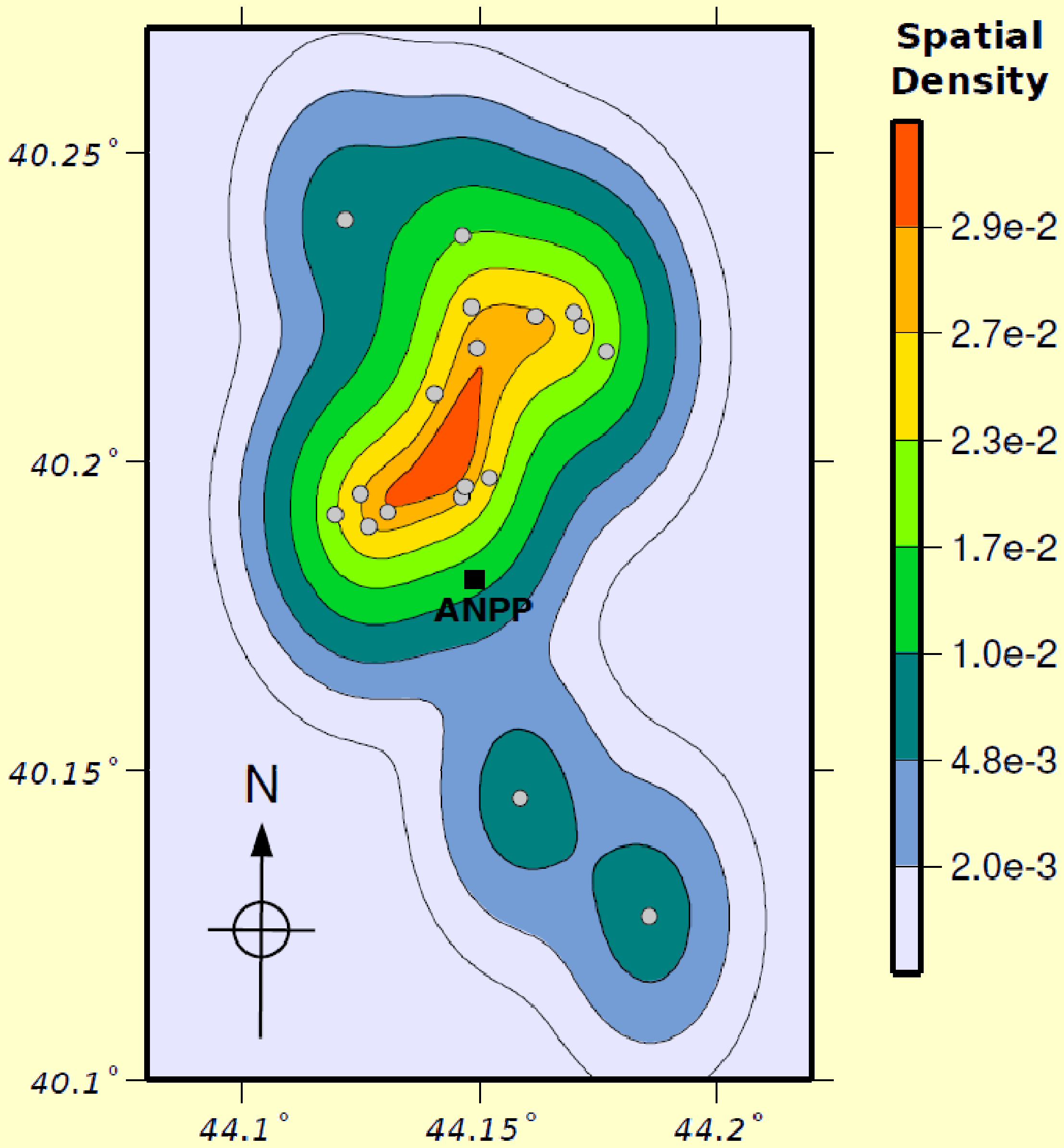


Near regional geological map of Aragats and Ararat volcanoes

Volcanic hazard assessment for ANPP site includes numerical simulations of the following potentially hazardous volcanic phenomena:

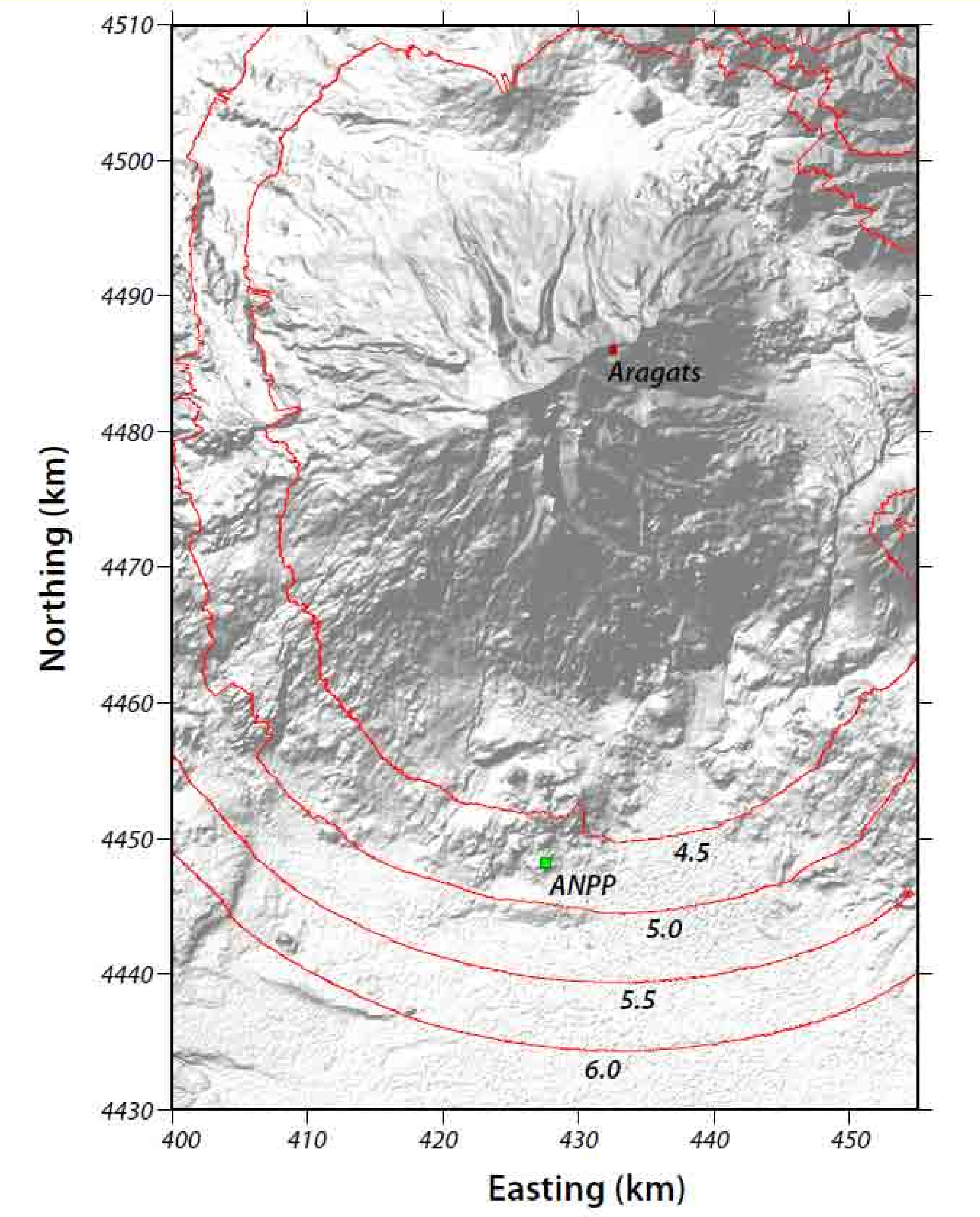
- **Opening of monogenetic vents**
- **Pyroclastic flows**
- **Tephra fallout**
- **Volcanic ballistic projectiles**
- **Lava flows**

Opening of monogenetic vents



Monogenetic volcanoes such as Dashtakar and Atomakhumb are located hundreds of meters from the ANPP site. Several alternative statistical models are developed for the location of future volcanic vents on the Shamiram plateau, leading to a probability of new monogenetic vent formation less than 2 km from the ANPP site center in the range of **2.6×10^{-9} – 1.6×10^{-6} per year.**

This uncertainty may be reduced through interpretation of new radiometric Ar-Ar ages, when these data become available.



Pyroclastic flows

Two sources of pyroclastic density currents (including pyroclastic flows and surges) are identified. Explosive eruptions from the summit region of Aragats volcano are capable of producing pyroclastic density currents that can reach the site. Based on the geologic record of past events, it appears the annual probability of such activity **is 2×10^{-6}.**

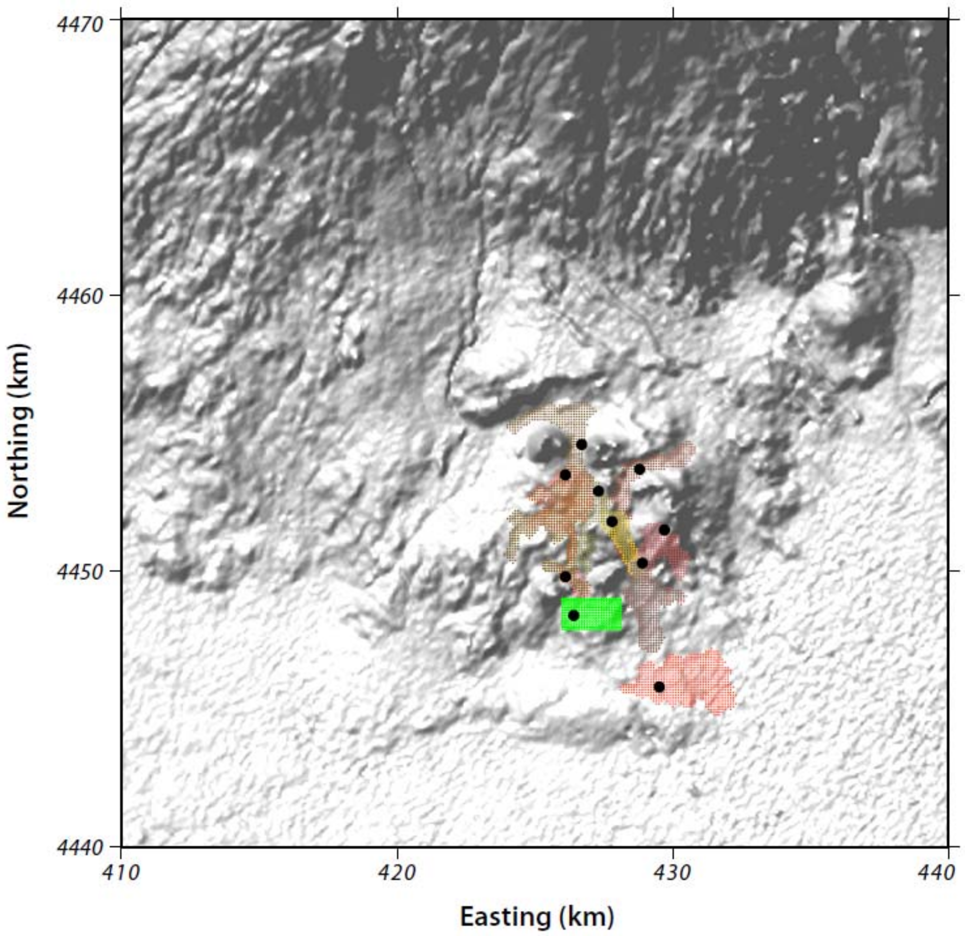
Tephra fallout

There is potential for tephra fallout to occur at the ANPP site due to eruptions at a number of volcanic sources in the region. Numerical simulation of tephra fallout using a wide range of eruption conditions indicates that Ararat volcano is the most substantial potential source of tephra fallout hazard in the site region. This is because Ararat is a Holocene composite volcano capable of VEI 4–6 eruptions during the lifetime of the ANPP. The probability of tephra accumulation at the ANPP site exceeding 100 kgm^{-2} due to an eruption of Ararat is estimated to be on order of **10^{-5} – 10^{-6} per year**.

Volcanic ballistic projectiles

Volcanic ballistic projectiles are rock fragments (up to 1m in diameter) that are expelled from volcanic vents during explosive eruptions. The probability of such projectiles impacting the site is tied to the probability of opening of new monogenetic vents the annual probability of the opening of a new vent within 6 km of the site center is approximately $\mathbf{3 \times 10^{-6}}$**.**

Lava flows



The probability of lava flow inundation of the site is approximately **1.5×10^{-6}** per year, based on this Monte Carlo analysis. The primary uncertainty associated with lava flow hazards at the ANPP site is uncertainty in the probability of future monogenetic volcanism on the Shamiram plateau. The probability of such events is 4.5×10^{-6} yr−1 and is based on the occurrence of nine independent events in the last 2 Ma. Acquisition of new radiometric age determinations should reduce uncertainty in this estimate.

Conclusions

- In spite of low probability, possible volcanic events must be considered when developing design bases for systems at the ANPP site.

- Should the decision be made that the site is acceptable for construction of a new nuclear power station, it is recommended that plans be developed to respond to potential volcanic activity at Ararat, Aragats, and the Shamiram plateau.

- IAEA guidelines further recommend the monitoring of capable volcanoes.

- Plans conforming to IAEA guidelines should be developed to monitor these volcanoes and study them in more details.

ECOSERV Remote Observation Centre Co.Ltd.
Yerevan, Armenia

A Scientific-Research and Control-Measuring Flying Laboratory for the Earth Surface and atmospheric remote sensing and monitoring

Prof., Dr. Artashes ARAKELYAN

Moscow

July 2010

Control and Monitoring Methods

- **In-Situ Methods**

Advantages: **A very high accuracy and unambiguity in measurements of a certain parameter of the survey surface or the environment.**

Shortages: I**mpossibility to get information simultaneously from a wide region and from the earth regions difficult of access**.

Overcoming: **Building and simultaneous exploitation of many measuring points and stations, extending of a staff of professionals, increasing finances for work, exploitation, transportation and living expenses, etc.**

- **Remote Sensing Methods**

Advantages: **A possibility to get multi-parametric information simultaneously, in real time scale from a wide region and from the earth regions difficult of access**.

Shortages: **Relatively low accuracy and ambiguity in measurements of a certain parameter of the survey surface or the environment.**

Overcoming: **Application of various kinds of remote sensors, increasing number of independent measurements, combining data of various independent measurements.**

Remote Sensing Methods

- **Optical Methods and Devices:** Cameras, Lidars, etc.
  Provide very high spatial resolution and sensitivity.
  Depend on daily time and illumination of surrounding, an availability of mist (fog), cloudiness and precipitation.

- **Infrared Methods and Devices:** IR radiometers, IR Lidars, etc**.**
  Provide high spatial resolution and sensitivity.
  Depend on an availability of mist (fog), cloudiness and precipitation.

- **Acoustic Methods and Devices :** Ultrasonoscopes, echo-sounders, etc.
  Poor spatial resolution and sensitivity, high external noises.

- **Radiophysical Methods and Devices:** Radar, radiometers, Doppler radar, scatterometers, etc.
  Independent of daily time and illumination of surrounding, an availability of mist (fog) and cloudiness.
  Appropriate spatial resolution and sensitivity.

New Approaches in Radiophysical Methods

- Microwave active sensing has a resonance character and is very sensitive to surface roughness. It depend as well from dielectric and cinematic parameters of the surface. Microwave active devices may provide high spatial and range resolutions and high threshold sensitivity.

- Microwave passive sensing has integral character and is very sensitive to surface temperature, surface roughness parameters, dielectric parameters.

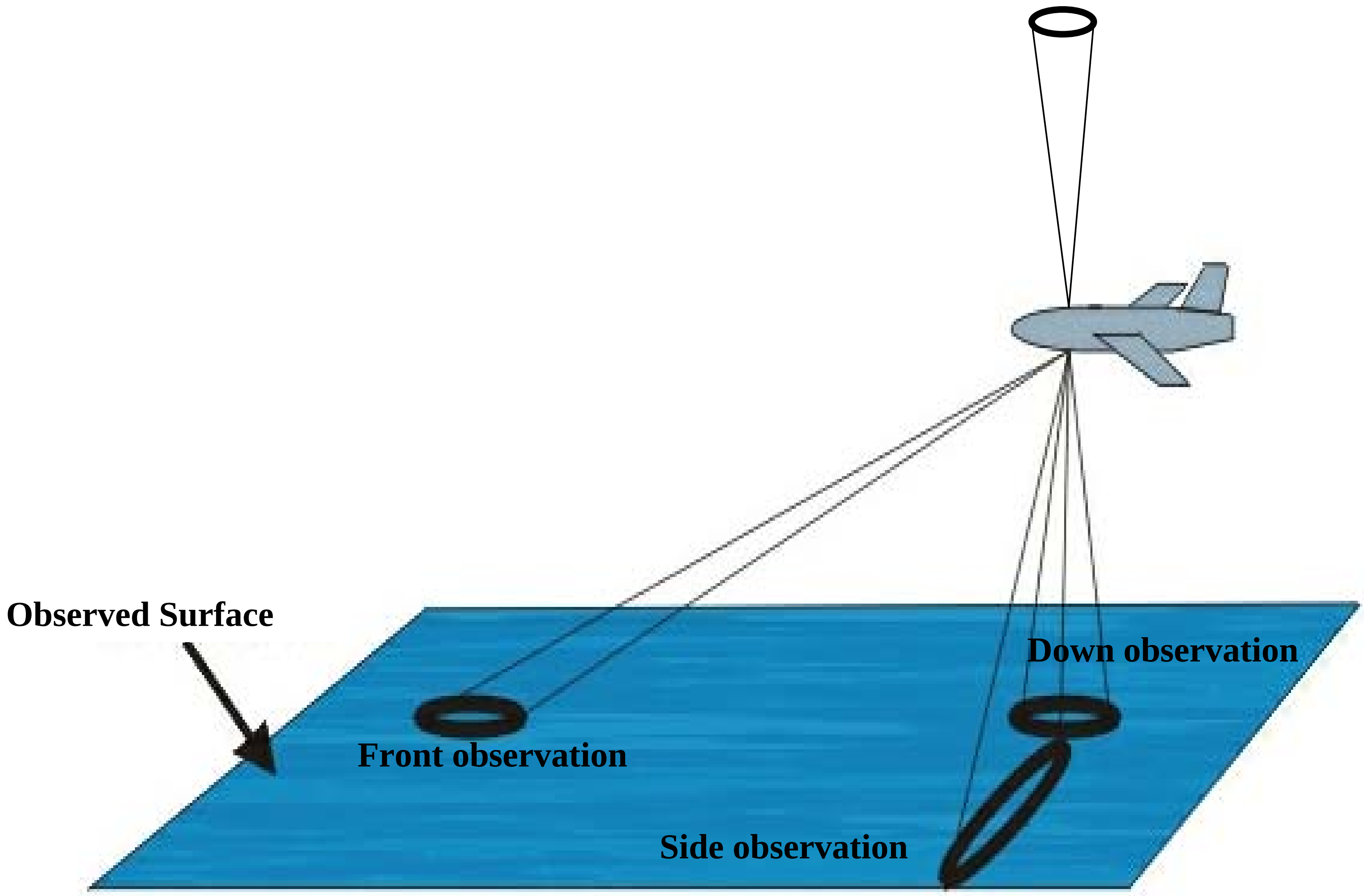
- **Combined Microwave Active-Passive Devices.**

  Single frequency or multi frequency, multi-polarization, combined radar-radiometer systems, which may provide spatio-temporally collocated measurements of the observed surface microwave reflective and emissive characteristics at various frequencies and polarizations.

Solution proposed

- To establish an international joint research center for the Earth surface and atmospheric remote sensing for solutions of ecological, nature-conservation and national economic problems of the Black Sea, the Near East, the Middle East, the Far East and the Pacific regions' Countries.

- To create an international flying laboratory equipped by modern means of remote sensing of optical, infrared and radio bands for sustainable and regular monitoring, controlling, assessment and management of economical, technical and environmental stages of vitally important establishments of the above mentioned regions.



ECOSERV ROC Company may fully equip the flying laboratory.

ECOSERV ROC Company’s R&D activities are in the field of the Earth surface and atmospheric microwave remote sensing.

ECOSERV ROC develops radio physical methods and corresponding microwave active-passive devices applicable for sustainable monitoring, security and protection of the Environment.

Under the framework of ISTC Project A-872 we have developed engineering prototypes of single frequency, multi-polarization, multi-channel, high-sensitive and thermo-stable, short pulse Doppler-Scatterometer-Radiometer Systems, Detectors-Identifiers at C (5.6GHz), Ku (15GHz) and Ka (37GHz) band of frequencies, for short, middle and long distance remote sensing applications, from low altitude platforms (3.5m of altitude), vehicles, vessels and aircrafts.

Engineering Prototypes of Single-Frequency, Combined Doppler-Radar-Radiometer Systems

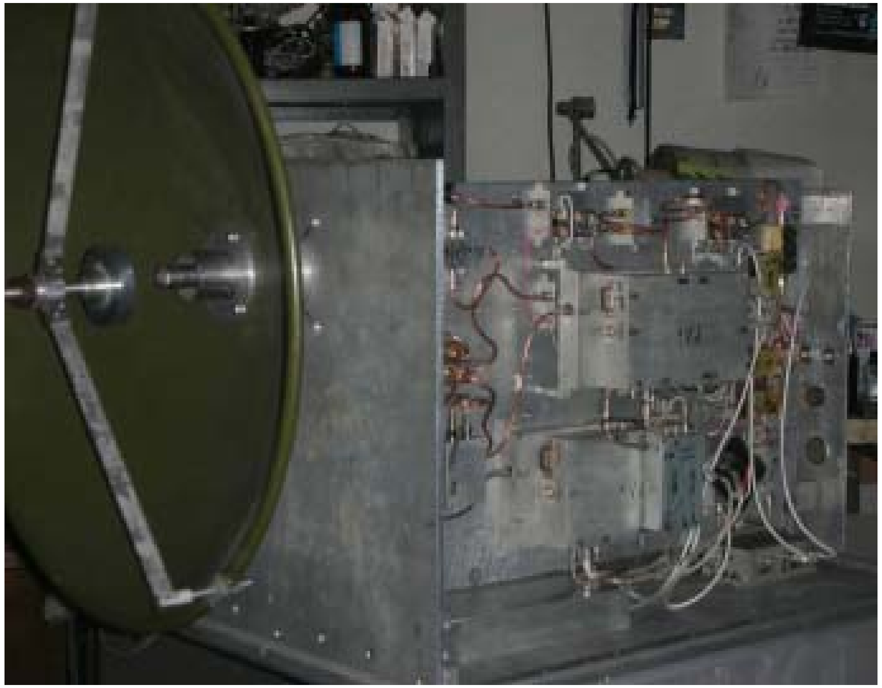
5.6GHz

15GHz

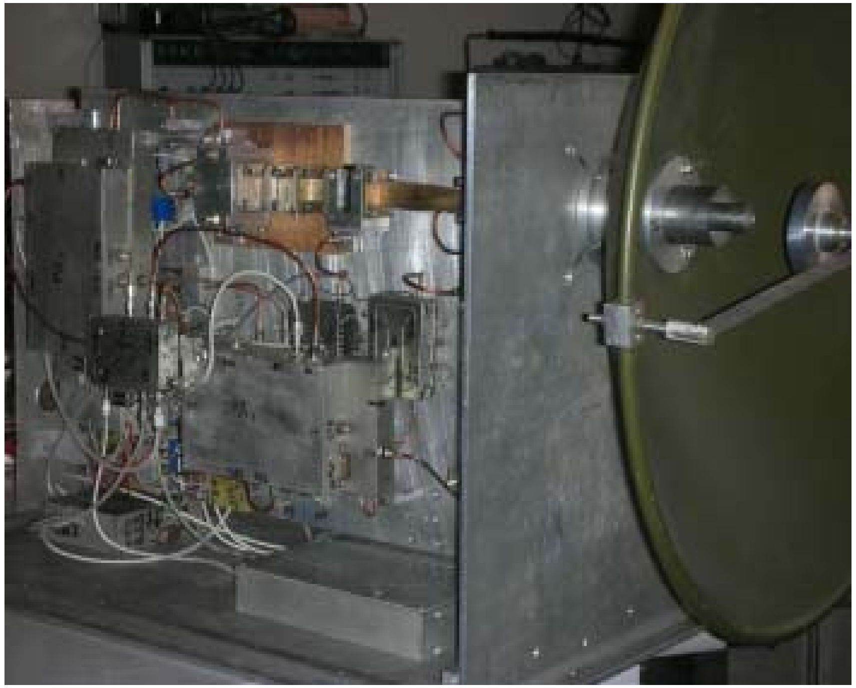
37GHz

Under the framework of ISTC Project A-1524 we have developed engineering prototype of dual-frequency, multi-polarization, multi-channel, high-sensitive and thermo-stable, short pulse Doppler-Scatterometer-Radiometer System, Detectors-Identifier at C (5.6GHz) & Ku (13.6GHz) band of frequencies, for short, middle and long distance remote sensing applications, from low altitude platforms (3.5m of altitude), vehicles, vessels and aircrafts.

Engineering Prototype of a Dual-frequency, Combined Doppler-Radar-Radiometer System



C-band (5.6GHz) Module



Ku-band (13.6GHz) Module

Such systems have direct and important application for remote detection and identification of land and sea surface signatures and subsurface targets, various atmospheric formations and phenomena, as well as for assessment their parameters.

Suggested Detector-Identifiers can be successfully used for sea surface wave field mapping and wake's detection, for sea surface and subsurface targets detection and classification, for unmanned remote control and management of riverine traffic, for ground moving targets detection and classification, for detection, control and assessment Tornados, for antipersonnel and antitank landmines, improvised explosive devices and unexploded ordinance detection and neutralization, and so forth.

The Problem We Address

Our technology has several civilian oriented applications and may provide new approaches:

• ***in remote retrieval of:***

- **soil and snow moistures and temperatures;**
- **water and soil salinities;**
- **near sea surface wind speed and sea wave force;**
- **near sea surface air and sea water temperatures;**
- **rainfall and snowfall parameters,**
- **lava temperature and velocity, etc.**

• ***in detection and classification of surface and subsurface targets:***

- **mines and minelike targets, oil spills, hazardous waste sites, etc.**

Our technology provides straight benefit for Weather Forecasting Industry, Hydrology, Agriculture and Forestry, Ecology and Environment Protection, Seismology and Volcanology, Defense and Security, Aviation and Space Industry, and others.

The Opportunity

Our technology allow:

Oceanographers - **simultaneously and unambiguously retrieve near sea surface wind speed, sea wave force, near surface air and water temperatures.**

Meteorologists - **improve prediction of storm features, retrieve precipitation and air turbulence parameters.**

Ecologists **- operative and precise monitor sea and land surface pollution.**

Farmers - **optimize the quality and quantity of the wheat harvest.**

Hydrologists - **predict snow water content and snow melting time for evaluating transport equation.**

Combat Engineers - **save lives, detect and identify mines and minelike targets, etc.**

Air Force and Navy **- protect Boundaries, detect and identify air, surface and subsurface (water, land) anomalies (signatures) and targets with high precision and unambiguity, etc.**

ECOSERV ROC uses the developed Systems to research multi-frequency and multi-polarization relationships between microwave reflective-emissive and geo-physical and bio-chemical parameters of soil, snow, ice, water surface and atmospheric formations, which are very important for development new, precise and unambiguous methods for retrieval of observed surfaces and mediums principal parameters.

IP Status

ECOSERV ROC and Dr. Artashes Arakelyan possess all Intellectual Property Rights, Author Certificates, National and International Patents on all developed devices and hold the critical know-how pertaining to these inventions and technologies application.

National Patents: #2257A; #2282A: #2313A
PCT Application: PCT/IB2009/000165, 02.02.09

Conclusion

Thus, we suggest to establish an international joint research center for the Earth surface and atmospheric remote sensing for solutions of ecological, nature-conservation and national economic problems and to create an international flying laboratory equipped by modern means of remote sensing of optical, infrared and radio band of frequencies.

The output of the flying laboratory will have a form of database and maps of IR, radar and radiothermal contrasts or corresponding physical-chemical and biological parameters, pictures and photos. As such parameters a surface temperature, a density, a conductivity, moisture, water content, a mass, a concentration, a velocity, and others, may be mentioned.

The information obtained by the flying laboratory will be of interest for Ministries, Committees and Departments of Agriculture and Forestry, Hydrology and Water Resource Management, Ecology and Environment Protection, Meteorology and Weather Forecasting Industry, Seismology and Volcanology, Fish Industry, Oil and Gas Industries, Defense and Security, Aviation and Space Industries, etc.

ACKNOWLEDGEMENT

I would like to express my gratitude to ISTC for this opportunity to represent our achievements and R&D potential.

Thank you

Prof., Dr. Artashes K. Arakelyan

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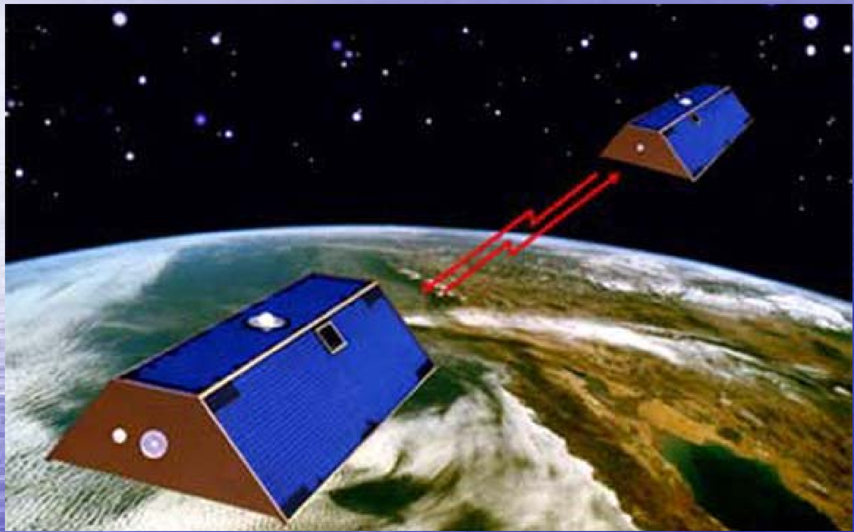
www.ecoservroc.com

ЭКОЛОГИЧЕСКИЙ И ГЕОДИНАМИЧЕСКИЙ МОНИТОРИНГ ОПАСНЫХ ПРИРОДНЫХ И ТЕХНОГЕННЫХ ОБЪЕКТОВ НА ОСНОВЕ СОВМЕСТНОЙ ИНТЕРПРЕТАЦИИ СПУТНИКОВЫХ И НАЗЕМНЫХ ДАННЫХ.



Ecological and geodynamic monitoring of hazardous natural and anthropogenic objects based on comprehensive interpretation of satellite and surface data.

Valentin Mikhailov[1], Nail' Sultanov[2], Michel Diament[3], Jasuqes Hinderer[4]

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2 Aerospace Institute, 13 prospect Pobedi, Orenburg, Russia,
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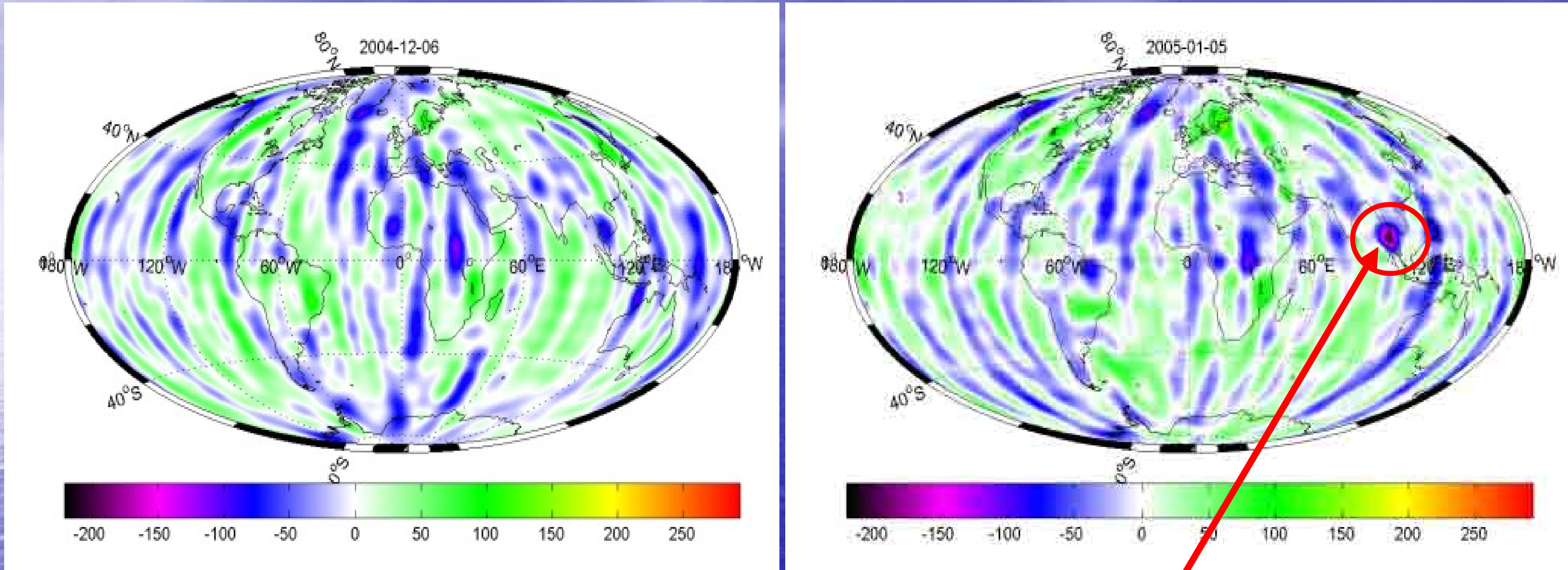
4 Institut de physique du Globe de Strasburg, 5 Rene Descartes*, France*

Comparison of 2 geoid models covering one month period before (left) and after (right) the Andaman-Sumatra earthquake.



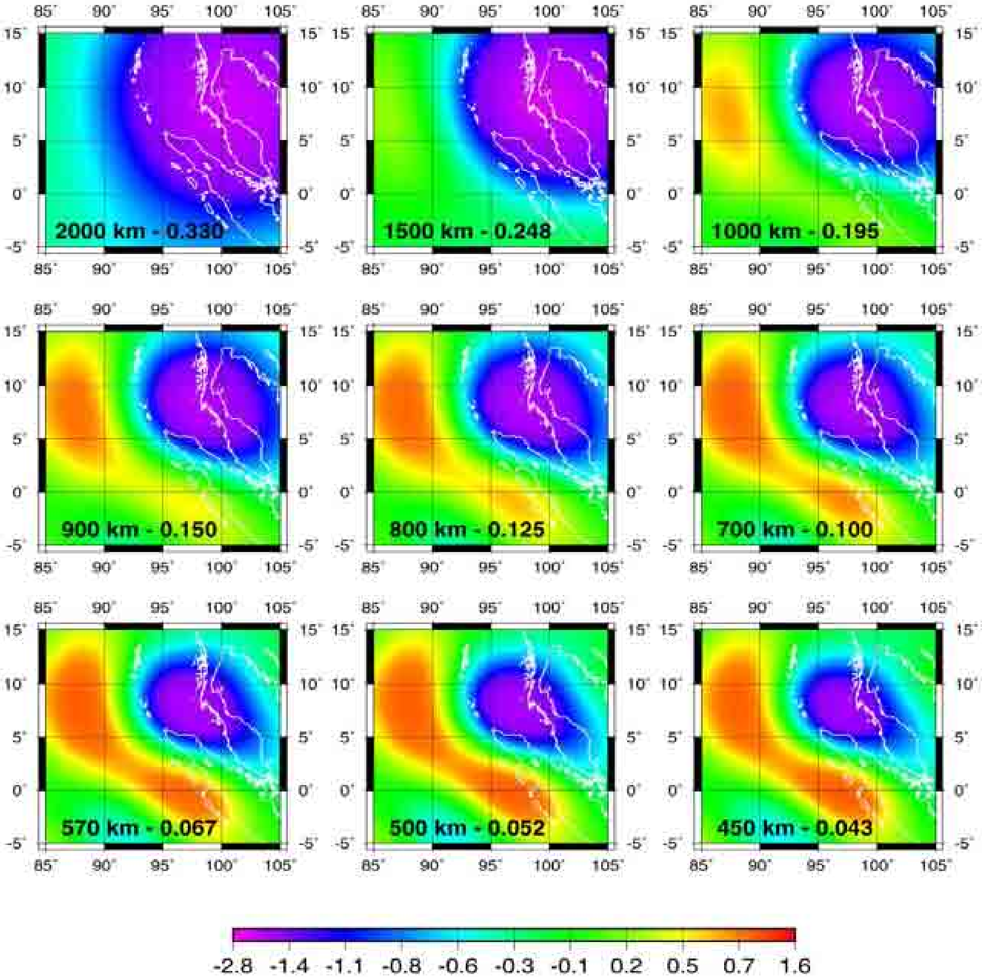
December 2004

January 2005

Stripes are due to aliasing and definitely are errors.

There are hydrology effects (for example in Amazonia)

A strong negative signal appeared after the earthquake over the Andaman Sea.

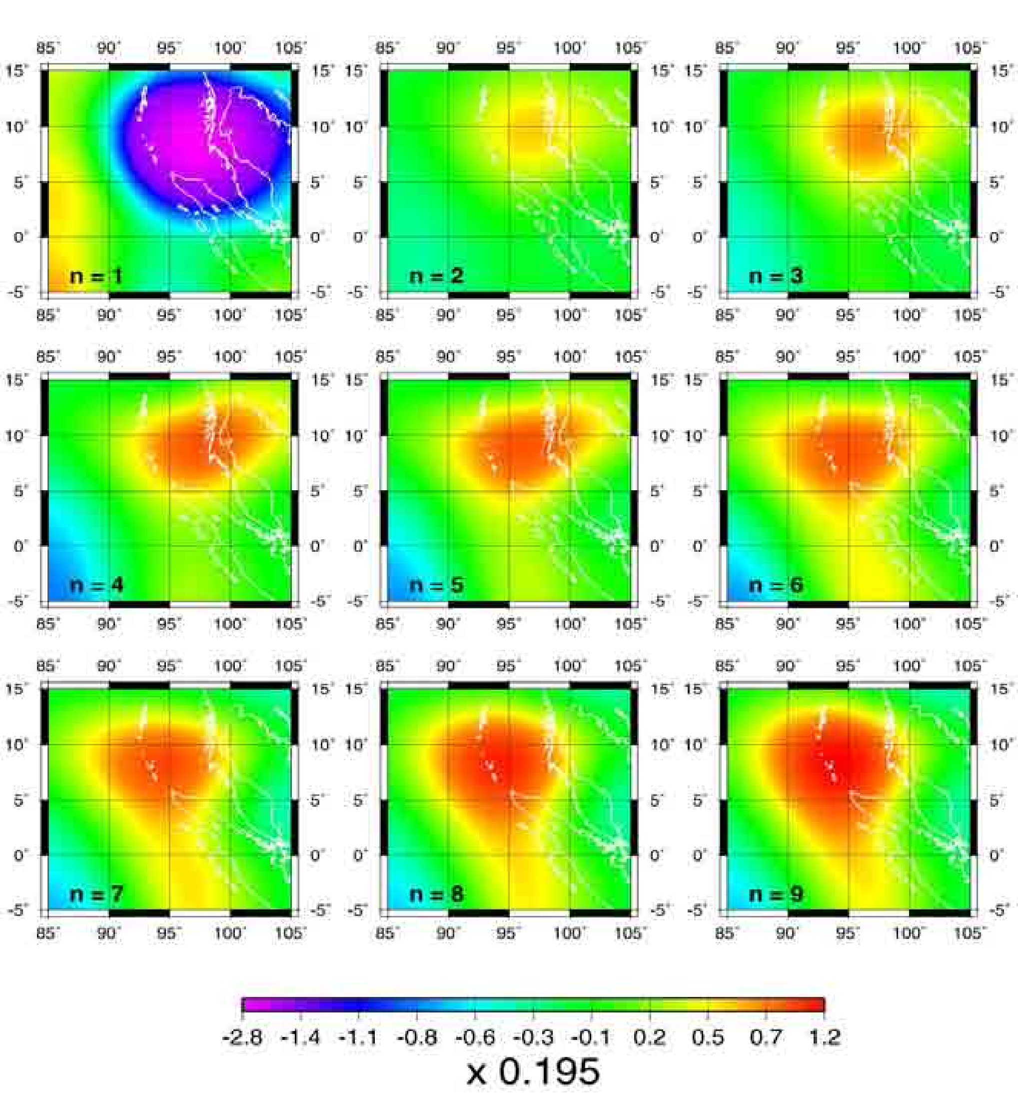


Continuous wavelet analysis coefficients of the geoid difference (mm) between 2005 and 2004, stacked over 9 months. The scale of the analysis is indicated on the subplot, with a scale factor. The colorbar should be multiplied by this scale factor for each subplot.

We observe very clear anomalies consistent over a wide range of scales. At larger scales, a strong negative anomaly dominates in the Andaman Sea and its surroundings.

At smaller scales, this anomaly appears to be precisely located in the Andaman Sea, around the Mergui Basin. A positive anomaly is apparently composed of two parts, the first one centered around latitude 7.5°N and longitude 88°W, and the second one around latitude 0°N and longitude 97°W.

Time-variation of the gravity signal, which consists of a slow reduction of the strong negative anomaly

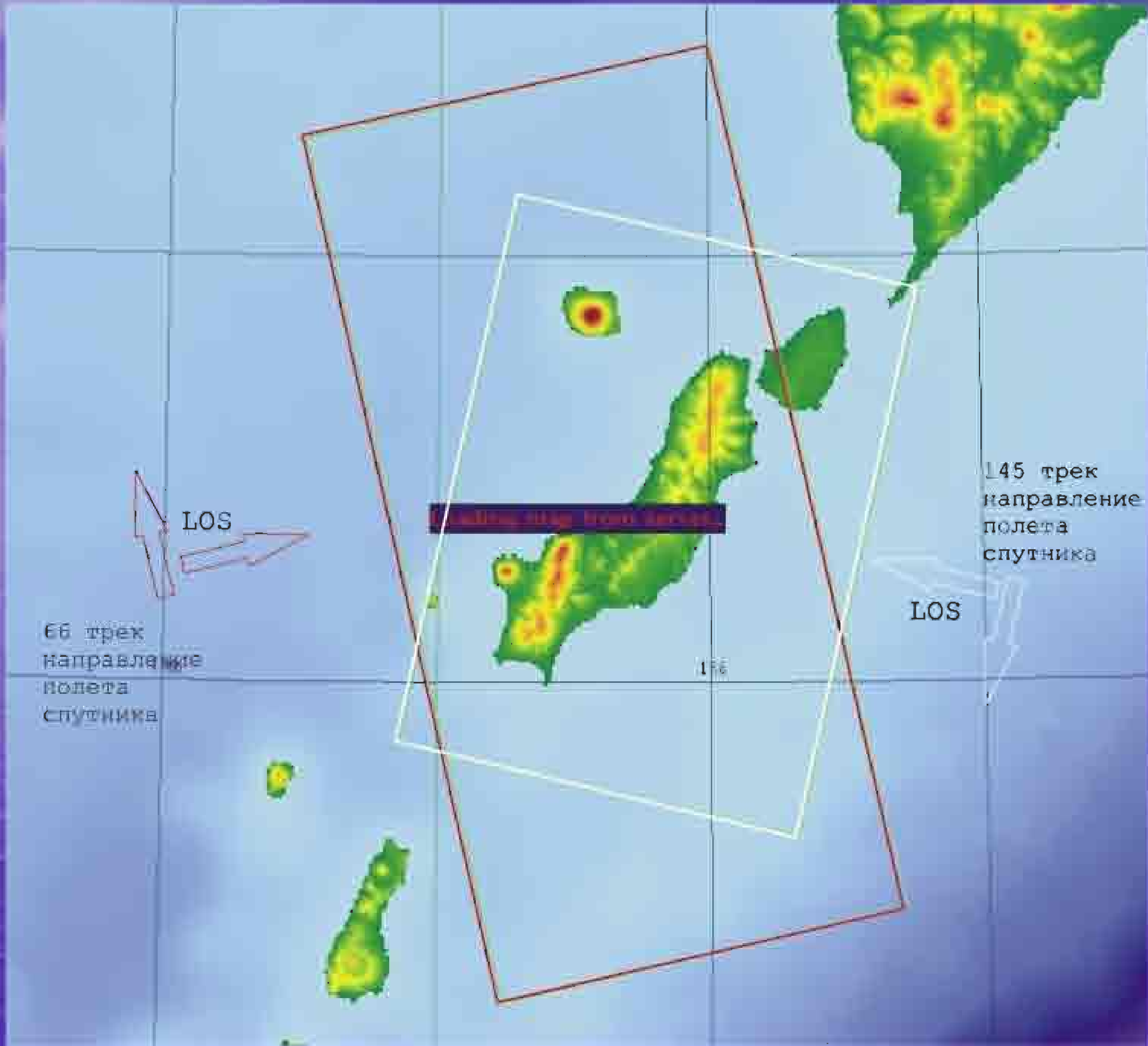


Continuous wavelet analysis coefficients at 1000 km scale of the geoid 2005/2004 differences stacked over *n* months, with *n* between 1 and 9. On the upper left subplot, the co-seismic signal (*n* = 1: January 2005 – January 2004) is represented. It has been subtracted from the other subplots (*n* = 2 to 9). The value of *n* is indicated on each subplot. Note stable growth of the signal with stacking interval (i.e. with time).

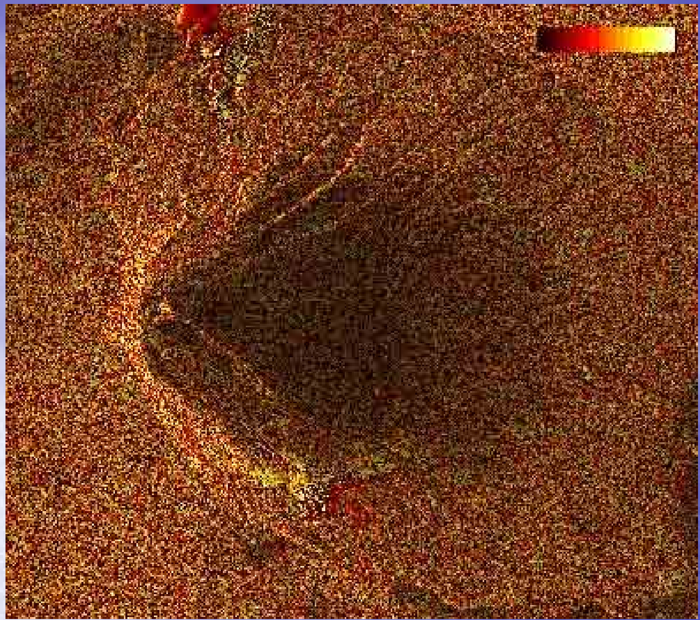
Основные задачи нового проекта

- Задача 1. Разработка новых методов комплексной интерпретации наземных и спутниковых данных при изучении деформаций техногенных и природных объектов.
- Задача 2. Демонстрация эффективности новых методов интерпретации спутниковых и наземных данных при исследовании и мониторинге реальных техногенных и природных объектов.
- Задача 3. Обработка и интерпретация новых высокоточных данных о глобальном гравитационном поле Земли с использованием спутниковых (GRACE и GOCE) и наземных данных.

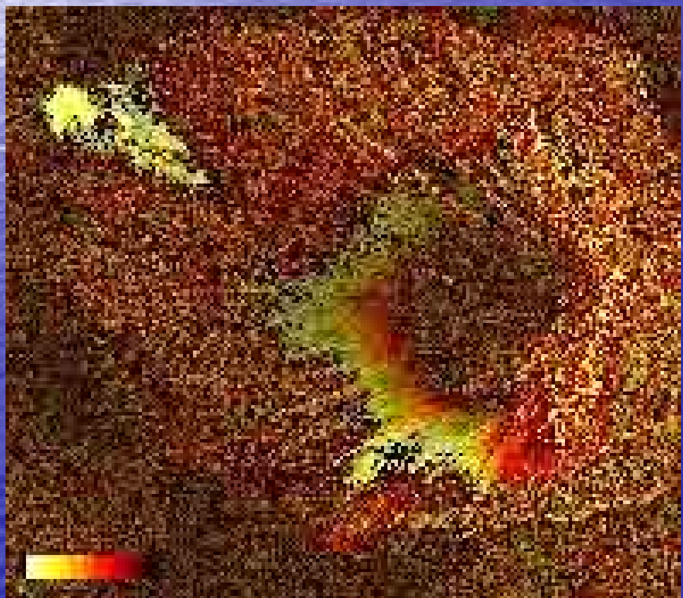
- Мы планируем использовать данные спутников ERS-2, ENVISAT, TerraSAR-X, RADARSAT-1,2, ALOS, GRACE и GOCE.


LOS
66 трек
направление
полета
спутника
145 трек
направление
полета
спутника
LOS

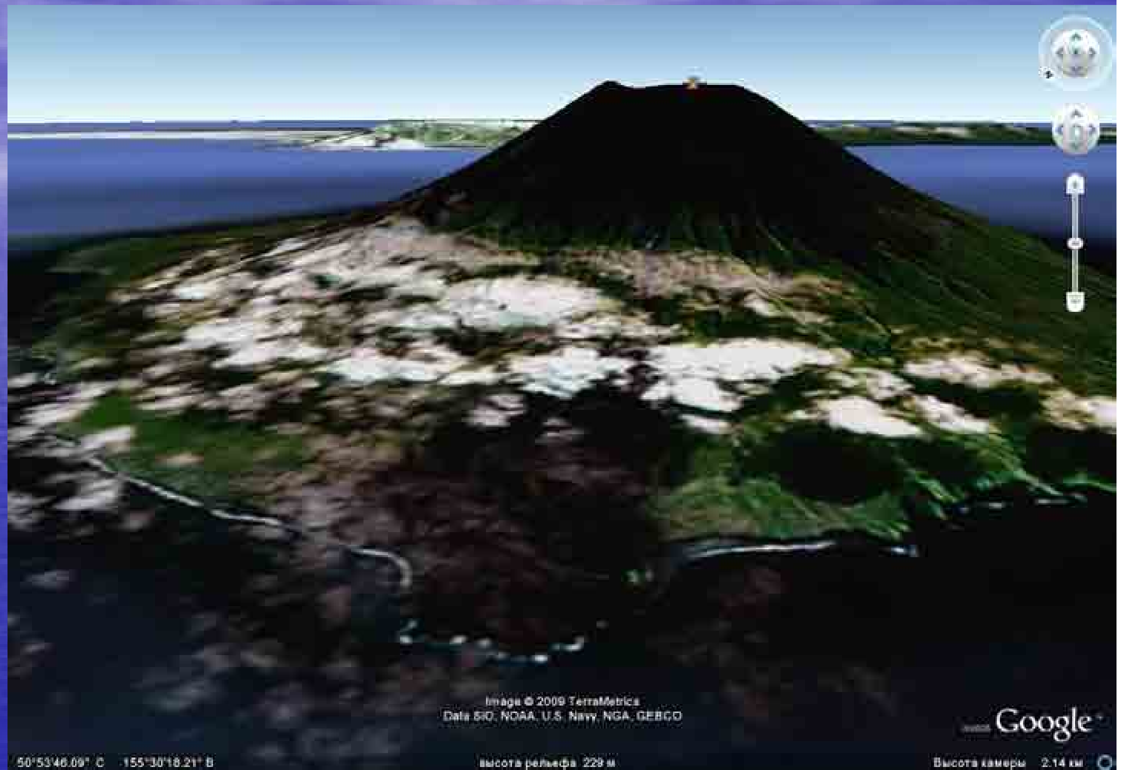
Alaid volcano

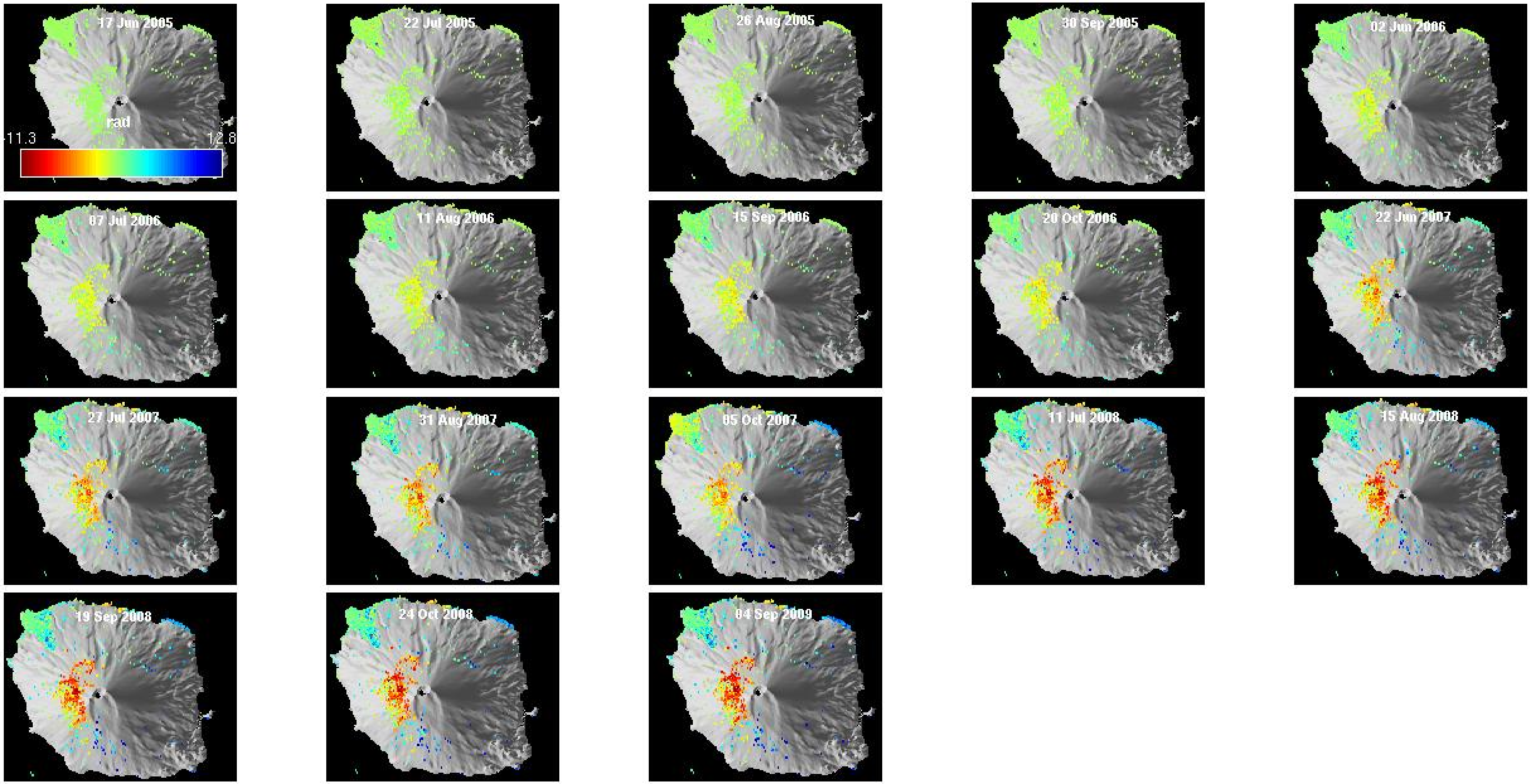


Track 66

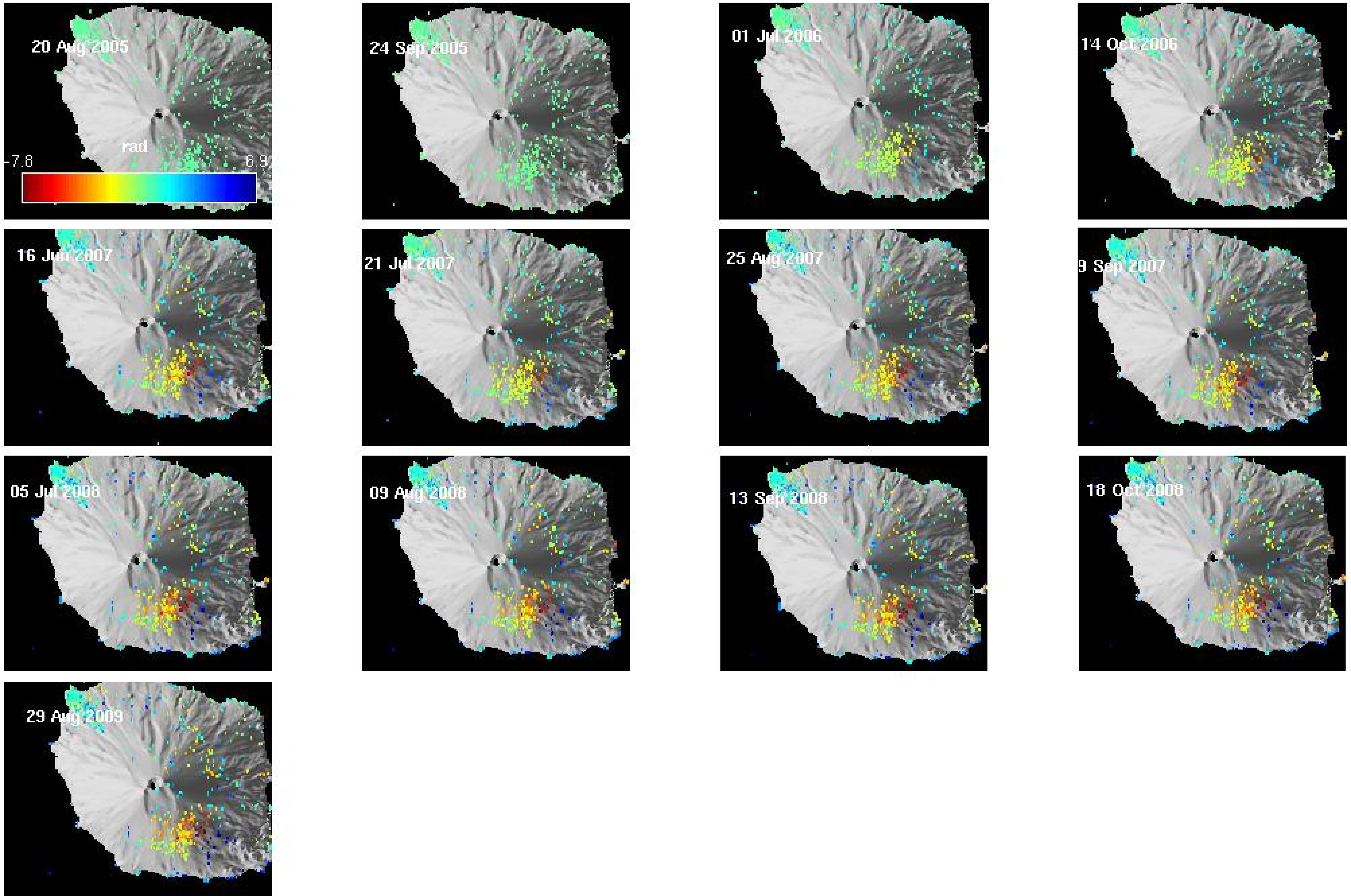


Track 145





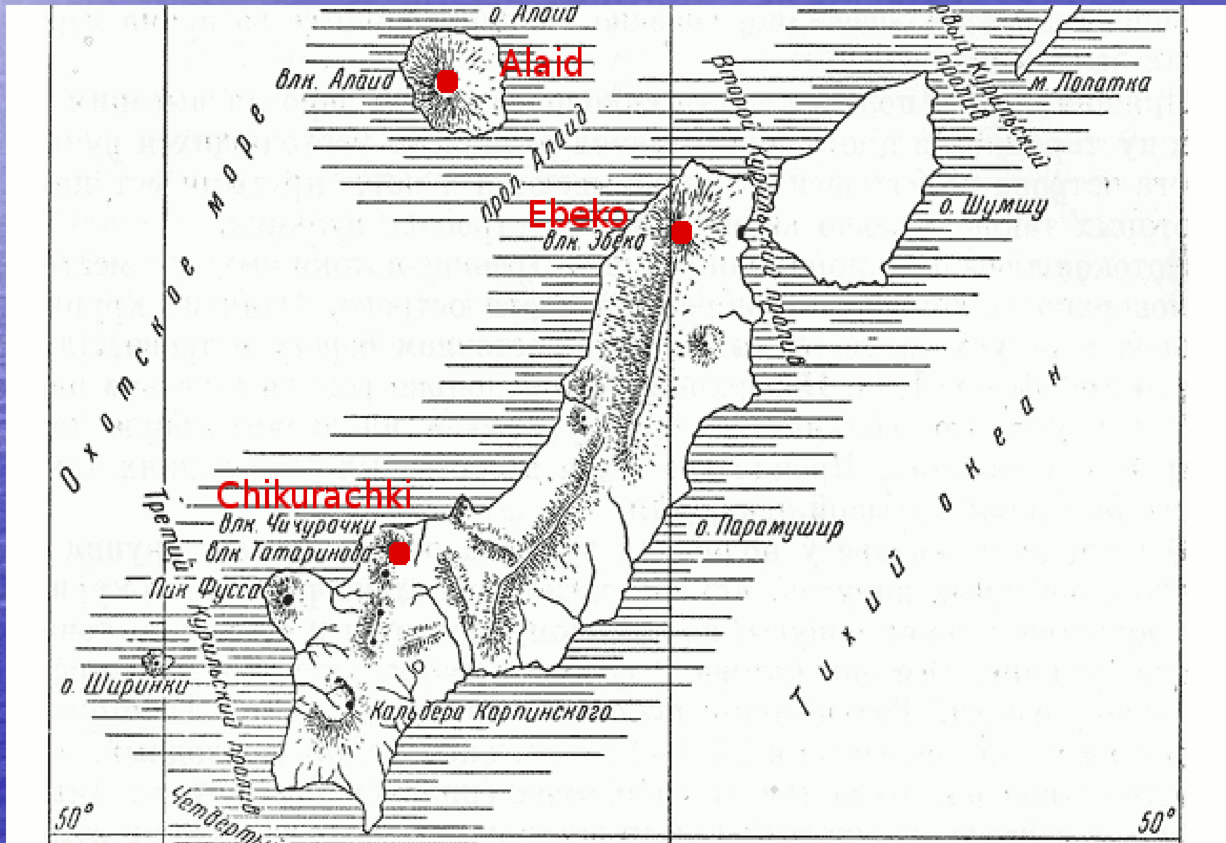
Small baselines, track 145, Alaid volcano

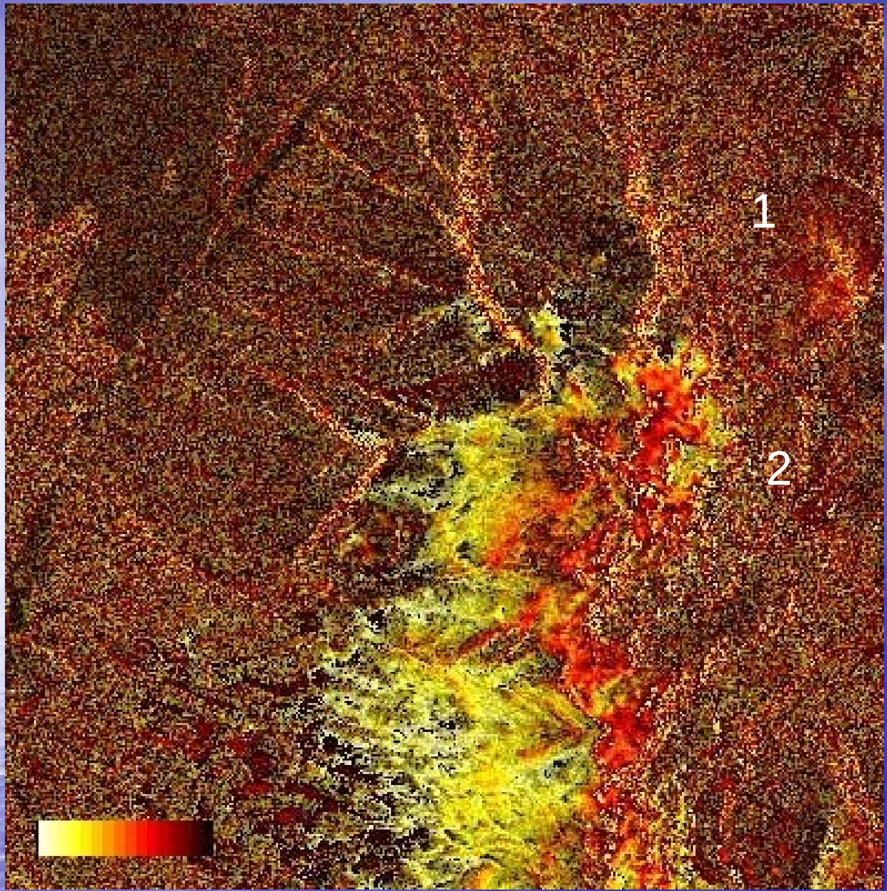


Small baselines, track 66, Alaid volcano

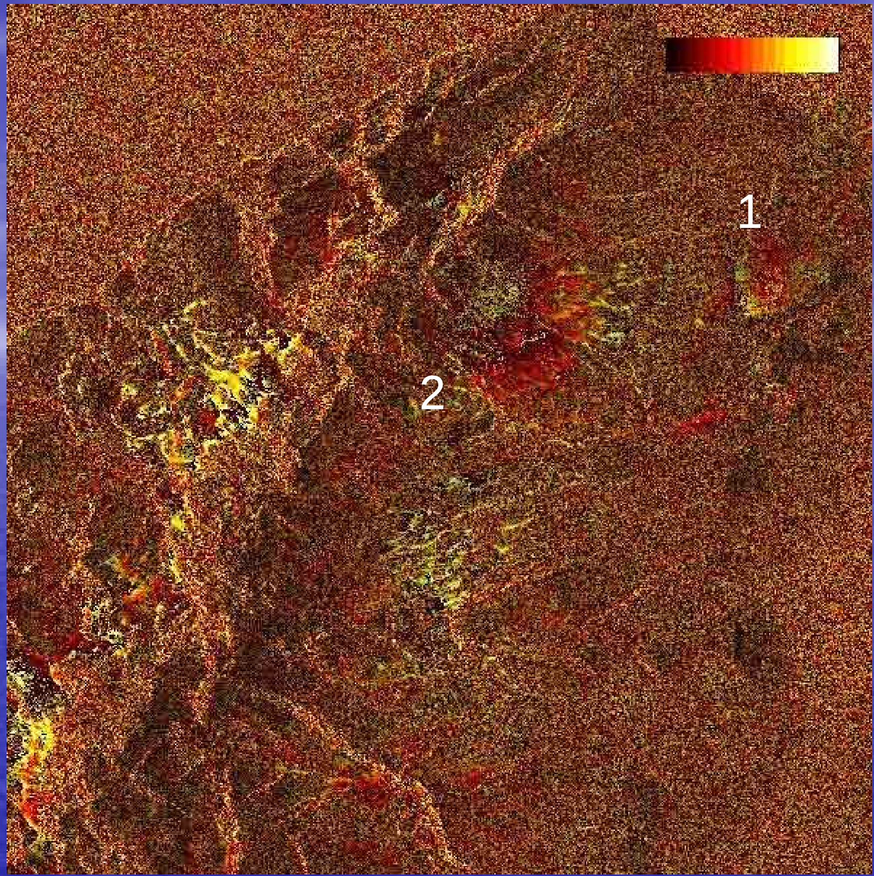
Paramushir volcanoes from INSAR

- Paramushir active volcanoes





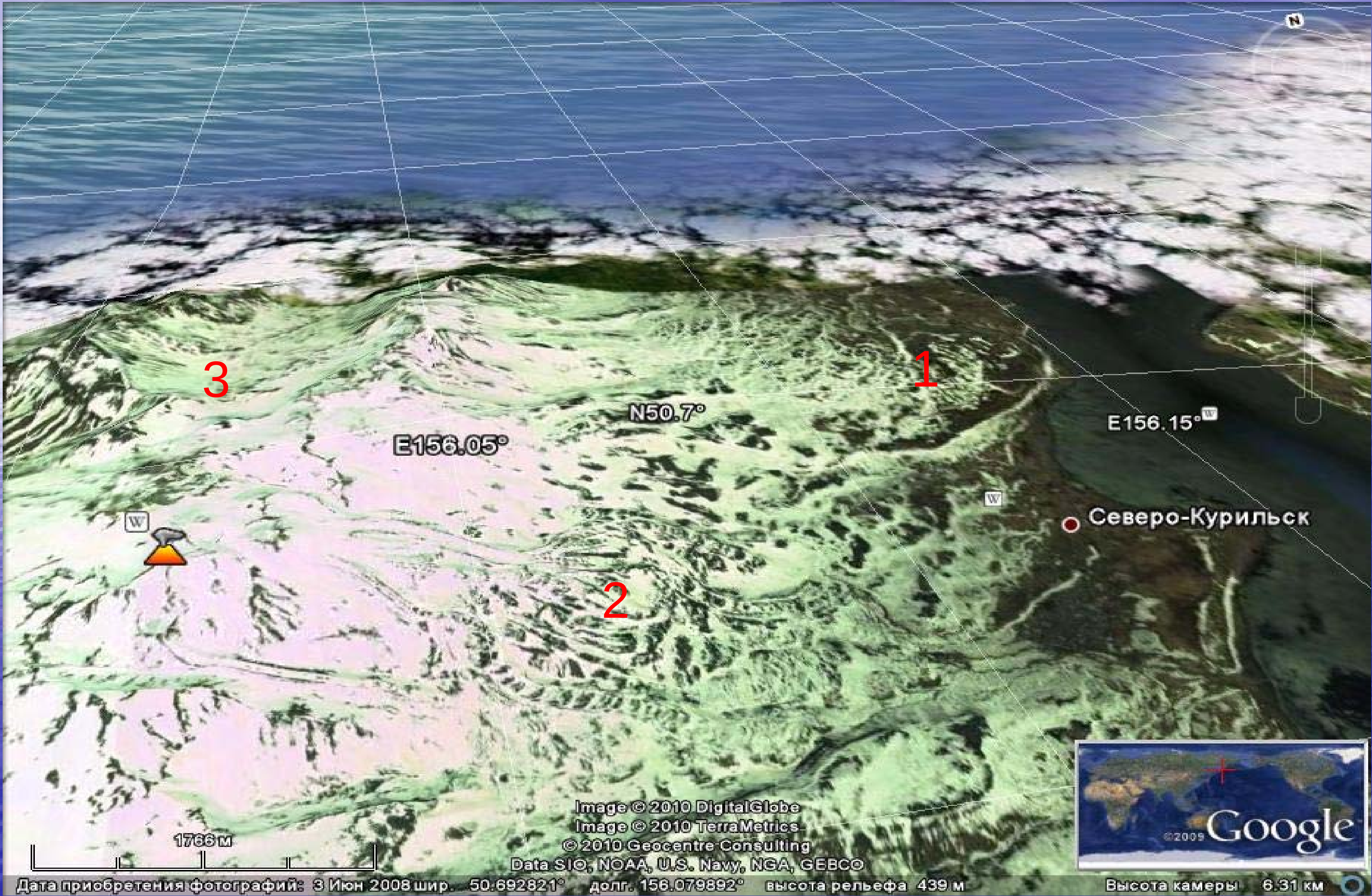
Ebeko_051007_190908_145



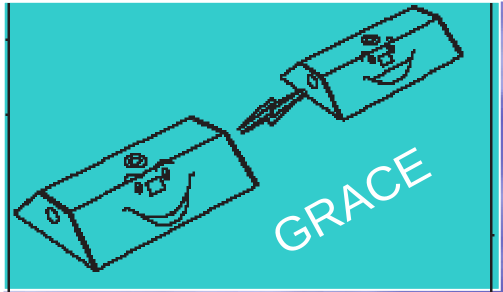
Ebeko_141006_291007_66

Differential interferrogrammes for Ebeko volcano

Ebeko



3
1
N50.7°
E156.05°
E156.15°
Северо-Курильск
2
Image © 2010 DigitalGlobe
Image © 2010 TerraMetrics
© 2010 Geocentre Consulting
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
1766 м
©2009 Google
Дата приобретения фотографий: 3 Июн 2008 шир. 50.692821° долг. 156.079892° высота рельефа 439 м
Высота камеры 6.31 км



Conclusions:

We believe that our first InSAR result are promising and could be useful for monitoring of deformations on volcanoes of Kuril-Kamchatka volcanic arc.

This study is a part of research work planned within the frameworks of our new ISTC project.