USGS
science for a changing world

Earthquakes ★ Floods ★ Hurricanes ★ Landslides ★ Tsunamis ★ Volcanoes ★ Wildfires

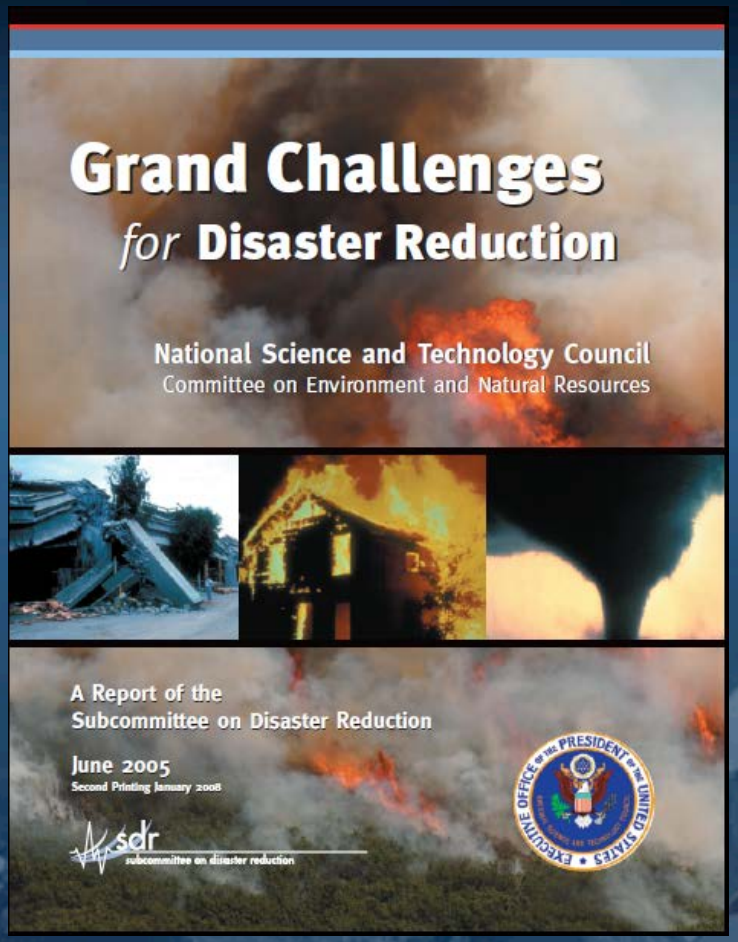
Mitigating Volcanic Risk in the United States and Adjacent Pacific Region

John C. Eichelberger

Volcano Hazards Program Coordinator

U.S. Geological Survey

Grand Challenges: Natural Disasters



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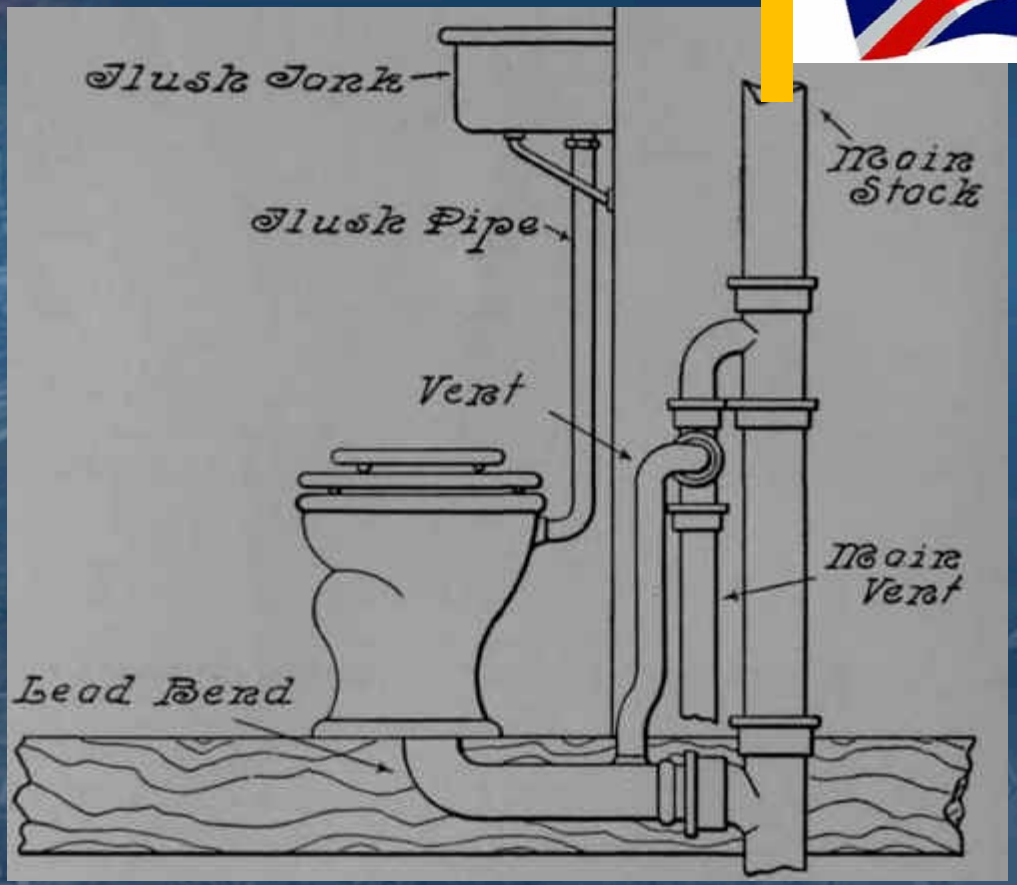
Grand Challenges: Sanitation



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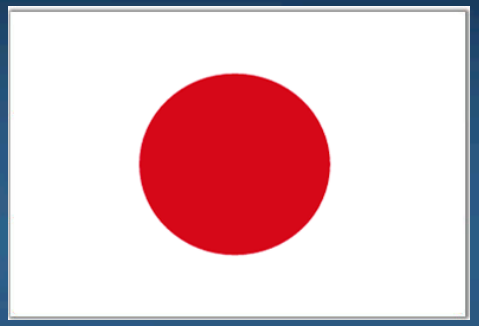
Grand Challenges: Sanitation



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Grand Challenges: Human Space Flight

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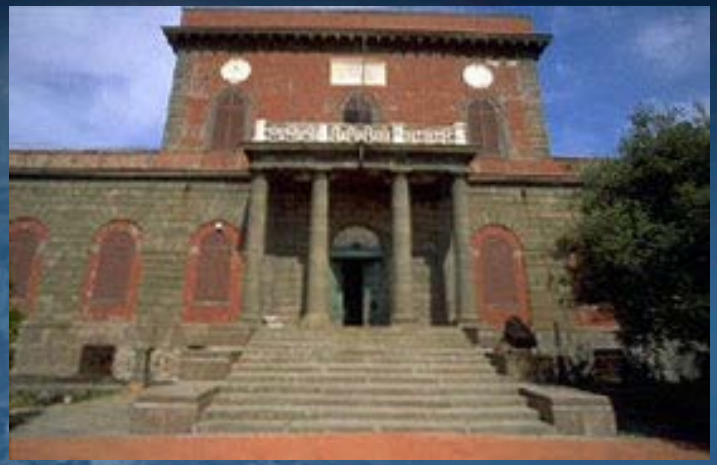
Grand Challenges: Volcano Monitoring



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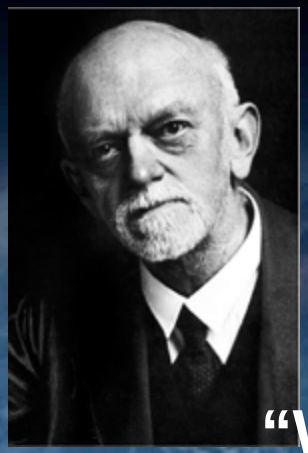
Origin of the Grand Challenges concept?



- German mathematician David Hilbert

"Who of us would not be glad to lift the veil behind which the future lies hidden; to cast a glance at the next advances of our science and at the secrets of its development during future centuries?…. A … problem should be difficult in order to entice us, yet not completely inaccessible, lest it mock at our efforts. It should be to us a guide post on the mazy paths to hidden truths, and ultimately a reminder of our pleasure in the successful solution." …1900

USGS

Grand Challenges

United Nations
International Strategy for Disaster Reduction

Hyogo Framework for Action 2005-2015:
Building the Resilience of Nations and Communities to Disasters

communication, outreach, advocacy

- **Priority Action 1: Ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation.**
- **Priority Action 2: Identify, assess and monitor disaster risks and enhance early warning.**
- **Priority Action 3: Use knowledge, innovation and education to build a culture of safety and resilience at all levels.**
- **Priority Action 4: Reduce the underlying risk factors.**
- **Priority Action 5: Strengthen disaster preparedness for effective response at all levels.**

Primary role of USGS Volcano Hazards Program

Work with communities, businesses, and other government agencies to develop response plans, test with disaster exercises.

USGS

Grand Challenges

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- **Priority Action 1: Ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation.**
- **Priority Action 2: Identify, assess and monitor disaster risks and enhance early warning*. + RESEARCH**
- **Priority Action 3: Use knowledge, innovation and education to build a culture of safety and resilience at all levels.**
- **Priority Action 4: Reduce the underlying risk factors.**
- **Priority Action 5: Strengthen disaster preparedness for effective response at all levels.**

Primary role of USGS Volcano Hazards Program

Work with communities, businesses, and other government agencies to develop response plans, test with disaster exercises.

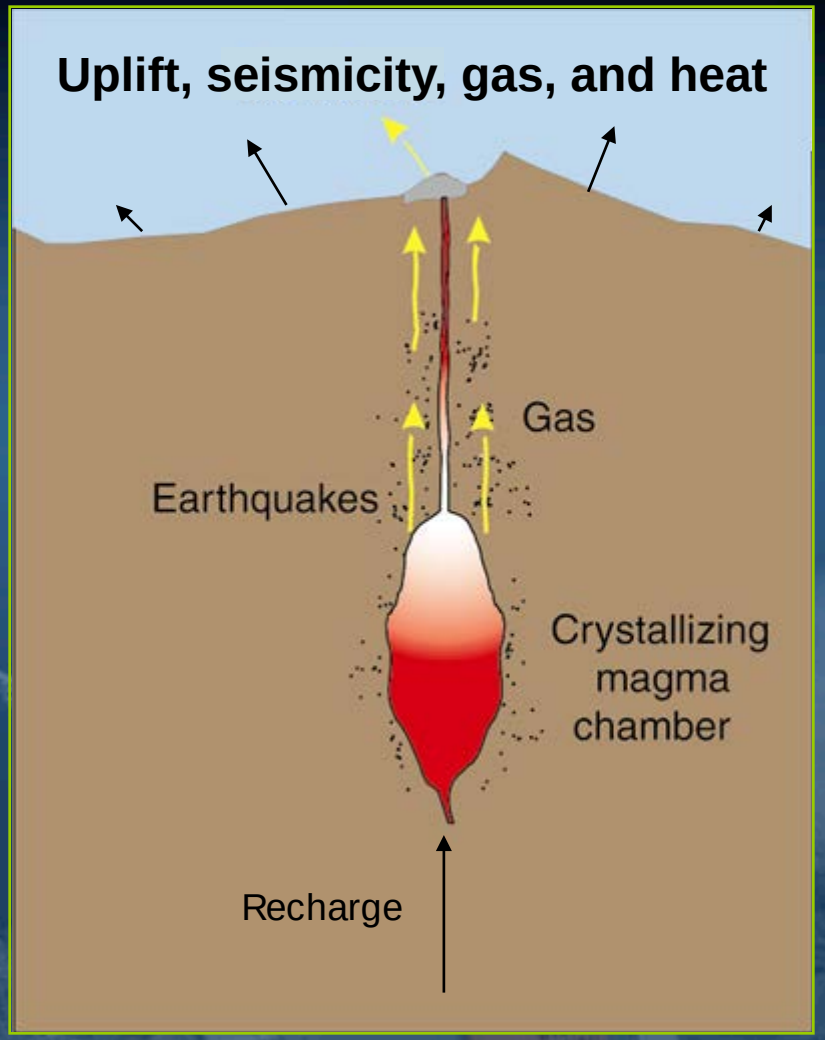
USGS

*** REQUIRES RESPONSE PLANNING**

Emphasis: Volcano Monitoring

- Two General Purposes of Monitoring:
  - Forecasting and Prediction
  - Eruption Detection and Alerting

- Mount Hood and Portland, Oregon



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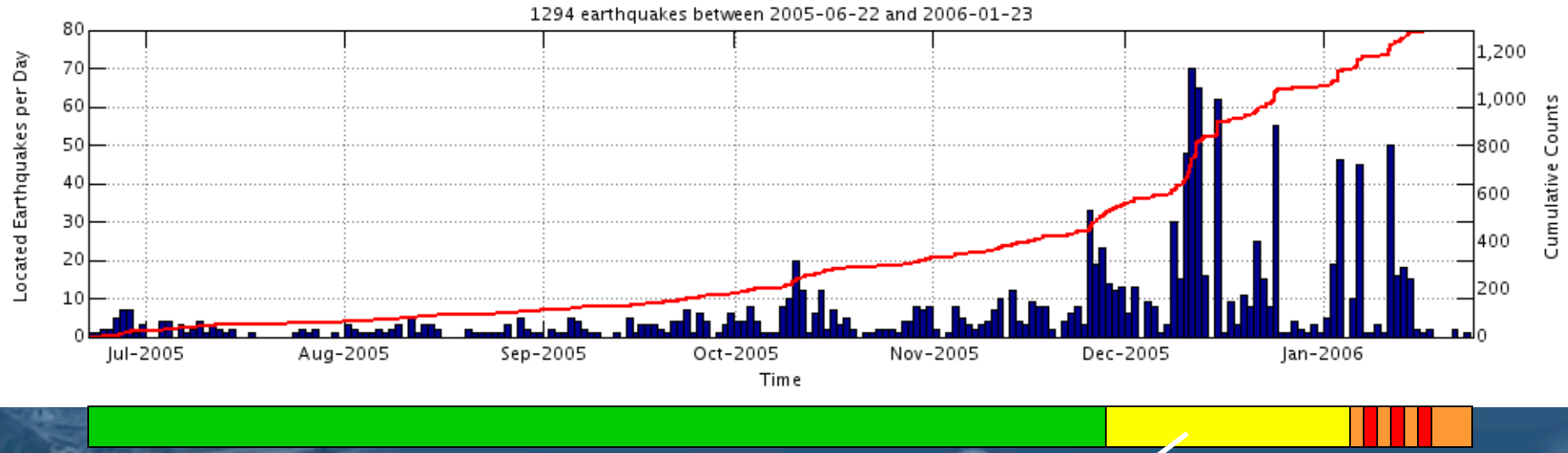
Basis for emphasis on ground-based volcano monitoring in the Space Age

- Volcanoes usually send warning signals, weeks to months in advance, of impending eruption.
- If this “unrest” is detected early and communicated effectively, communities will have time to prepare.

Augustine, 2006



- Level of Concern Color Code
- Steam explosions
- Jan 11 explosions
- Jan 13/14 explosions
- Jan 17 explosion

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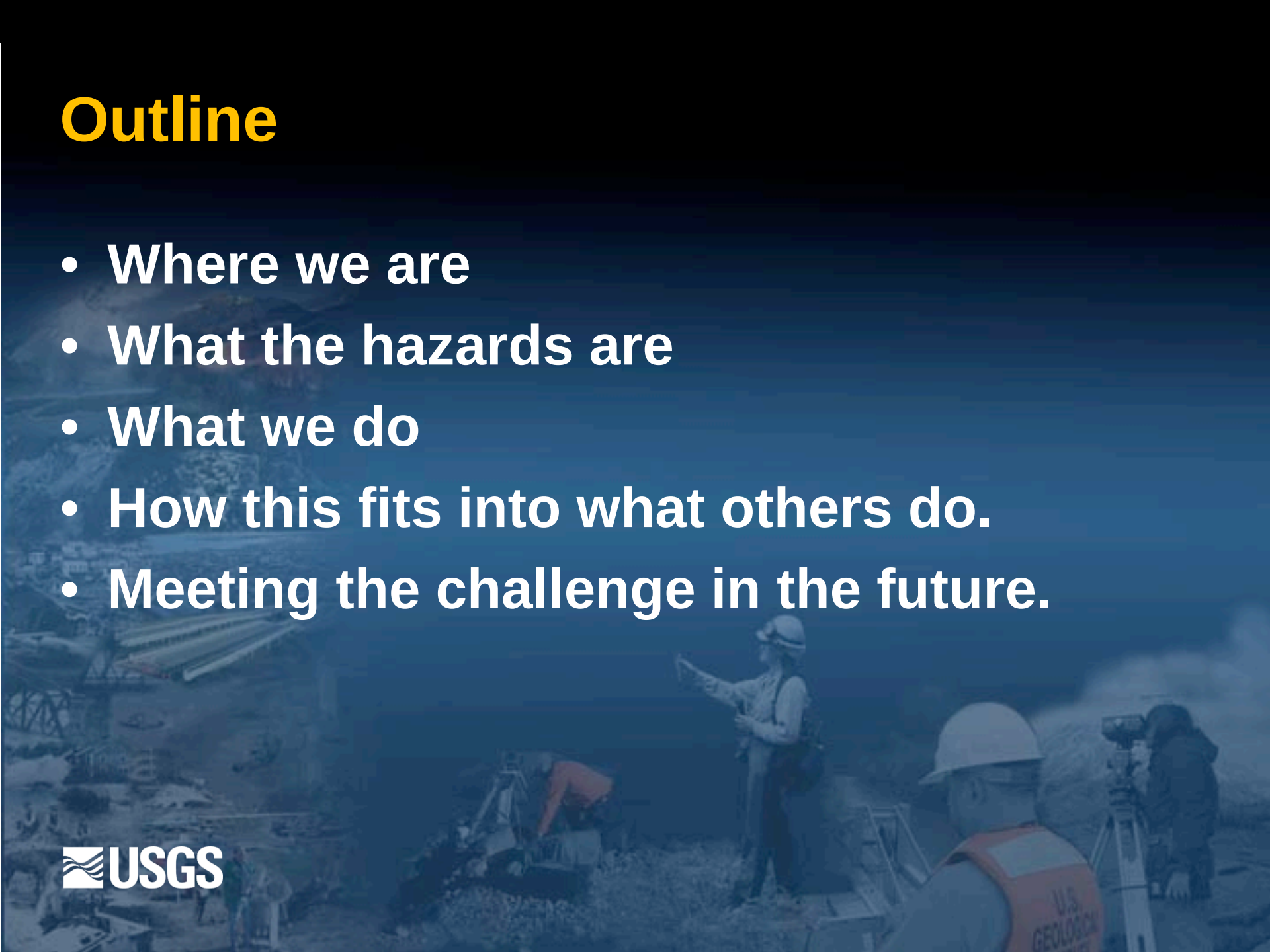
- Figure by Mike Poland

Outline

- Where we are
- What the hazards are
- What we do
- How this fits into what others do.
- Meeting the challenge in the future.



Some facts about volcano risk in USA

- The most frequently active volcanoes are in remote areas and impact aviation only.
- Only one major eruption on US mainland during western US's short written history.
- The US population is quite mobile, so many people living near volcanoes are newcomers.
- Therefore, general awareness of volcanic risk is low and continual education efforts are required.
- There has never been a mandatory evacuation in the US because of volcanic activity.

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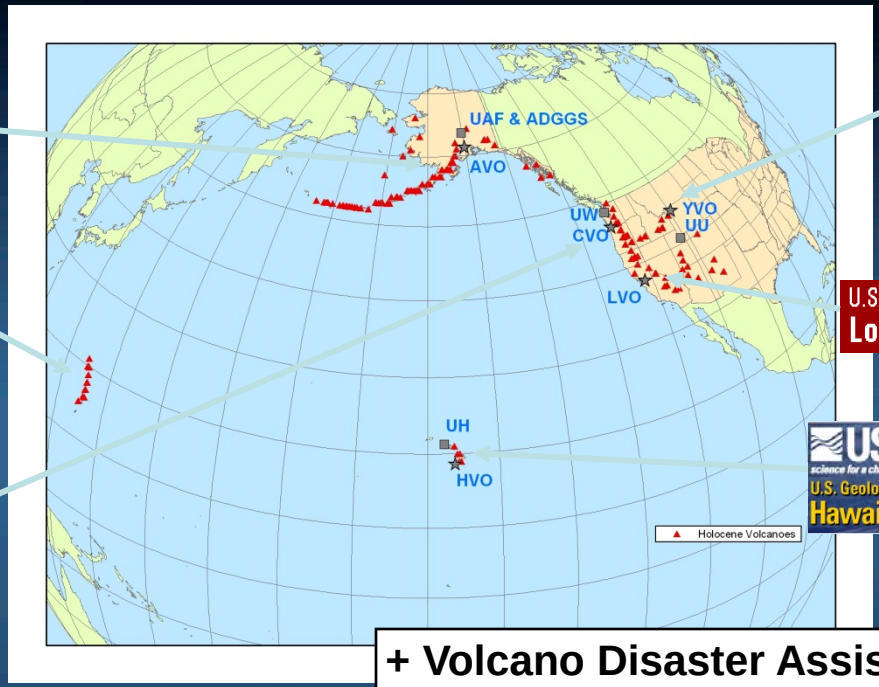
Monitoring is conducted by five volcano observatories



- Mariana
- Cascades Volcano Observatory

+ Volcano Disaster Assistance Program

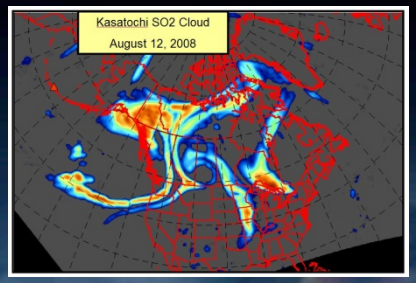
USGS Volcano observatories:

- HVO Hawaii Volcano Observatory
- AVO Alaska Volcano Observatory
- CVO Cascade Volcano Observatory
- YVO Yellowstone Volcano Observatory
- LVO Long Valley Observatory

Observatory Partners:

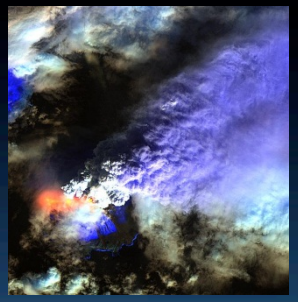
- UH University of Hawaii
- UAF Univ. Alaska
- ADGGS Alaska Div. Geol. & Geophys. Surveys
- UW University of Washington
- UU University of Utah
- SI Smithsonian Institution/Global Volcanism Program

VHP observatories combine an array of real time data streams to interpret the behavior of volcanoes, turning observations quickly into information that society needs:

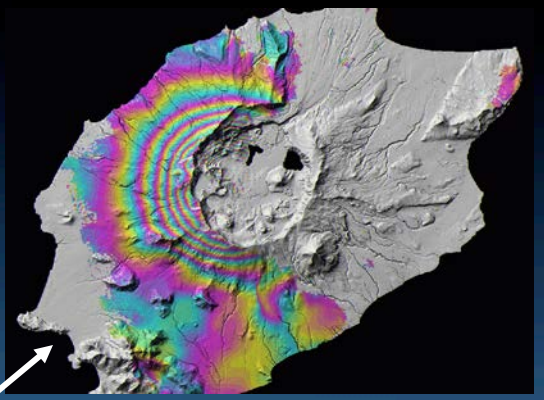


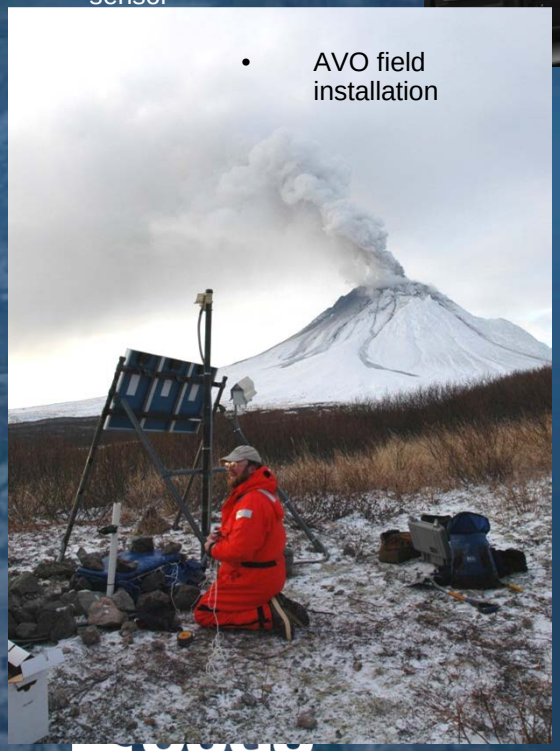
- Gas cloud from satellite UV sensor

- **AVO operations room**

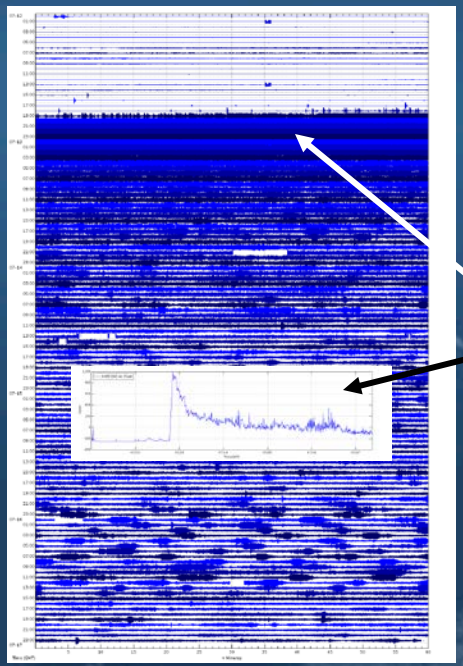


Satellite surveillance for hotspots and ash



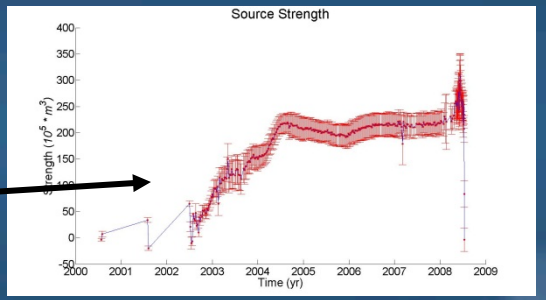


- AVO field installation



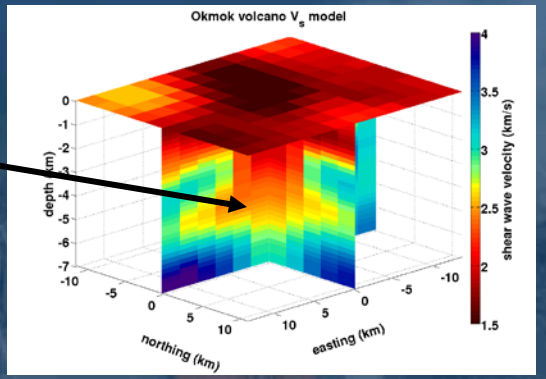
Volcano deformation from radar satellites

Volcano deformation from GPS



Eruption onset from seismic network

Magma chamber location from seismic tomography



Role of other U.S. agencies

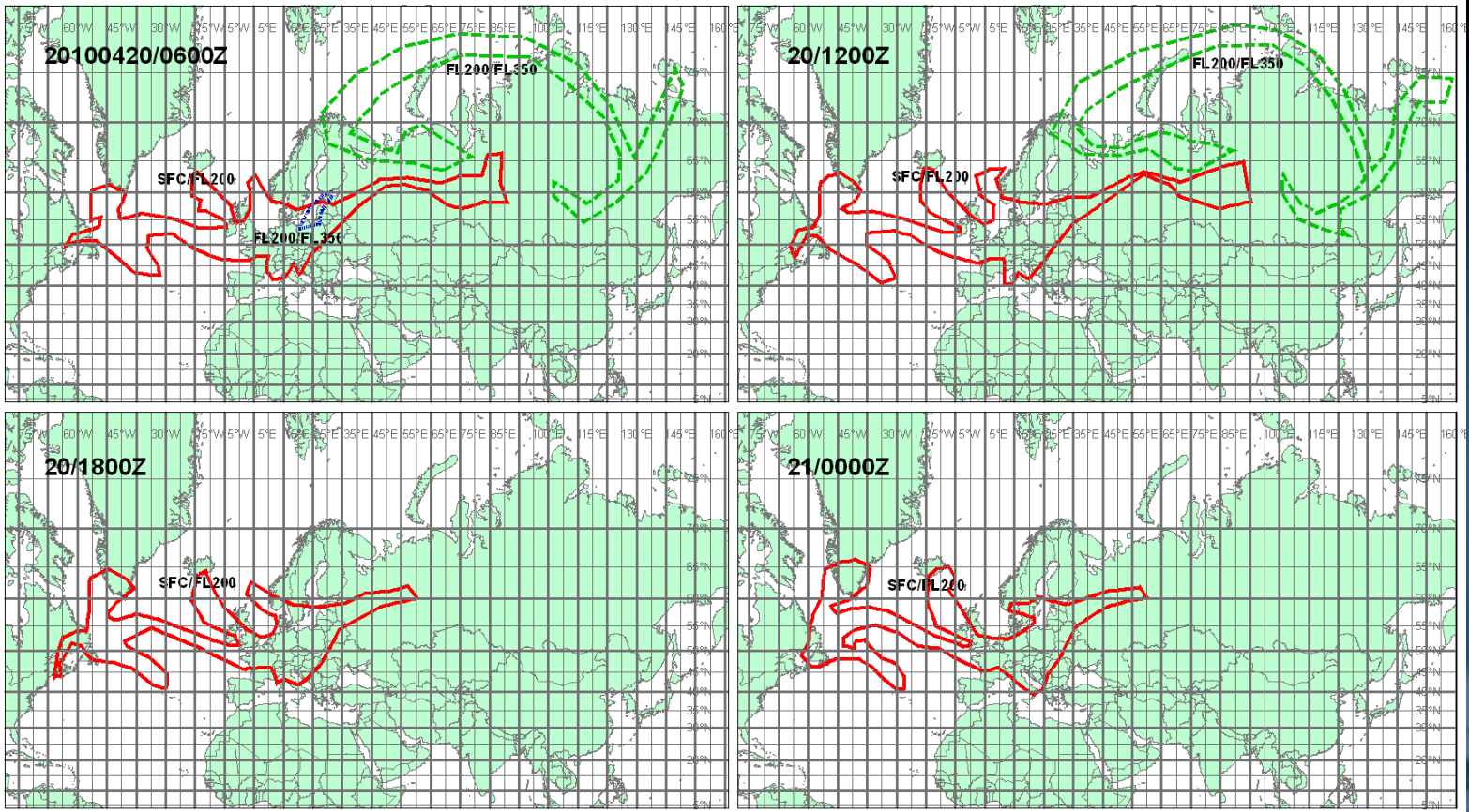
- **National Oceanic and Atmospheric Administration (NOAA)**
  - operates Washington and Anchorage VAACs
  - tracks ash clouds, issues warnings to pilots
- **Federal Aviation Administration (FAA)**
  - manages air traffic, warns pilots
- **Federal Emergency Management Agency (FEMA)**
  - responds to domestic disasters
- **Office of Foreign Disaster Assistance (USAID)**
  - funds response to disasters in other countries if requested by the country
- **National Science Foundation (NSF) and National Aeronautics and Space Administration (NASA)**
  - Fund basic research and technological development; do not do monitoring and warning

Other agencies: military, National Park Service, etc., may be involved in incident command structure, depending upon location of the crisis.

Some History

- **Founding of Hawaiian Volcanoes Observatory (HVO), 1912**
  - Observing, research
- **USGS Section of Volcanology established, 1926**
  - Director of HVO was head
- **Eruption of Mount St Helens, 1980**
  - Volcano hazards and public safety became primary rationale for USGS volcanology program
- **Eruption of Nevada del Ruiz, 1985**
  - USGS establishes international response capability
- **Near-fatal encounter of B-747 with ash cloud, 1989**
  - USGS began to instrument remote volcanoes for aviation safety
- **Eruption of Eyjafjallajokull, 2010**
  - Volcano monitoring becomes more internati**onal**

Economic cost: $5 billion Euros



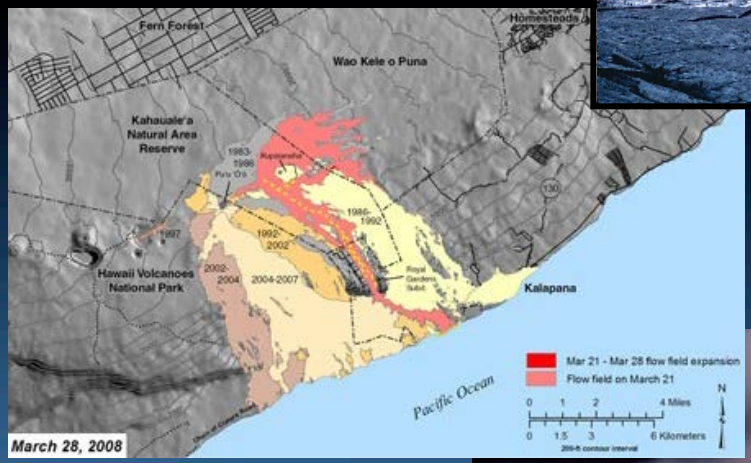
VA ADVISORY
DTG: 20100420/0600Z
VAAC: LONDON
VOLCANO:
EYJAFJALLAJOKULL 1702-02
PSN: N6338 W01937
AREA: ICELAND

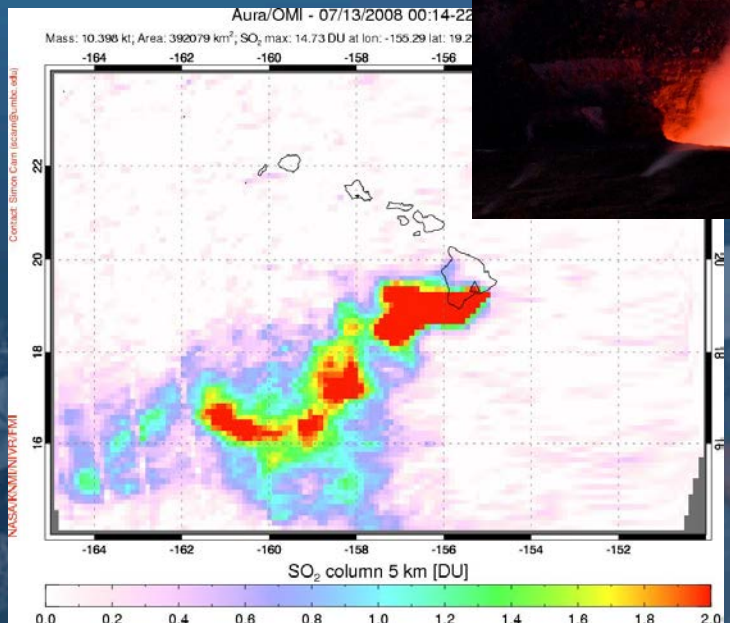
SUMMIT ELEV: 1666M
ADVISORY NR: 2010/025
INFO SOURCE: ICELAND MET OFFICE
AVIATION COLOUR CODE: RED
ERUPTION DETAILS: ERUPTION CONTINUING TO AROUND 4000M WITH LAVA VISIBLE IN THE CRATER.

RMK: NO SIG ASH ABOVE FL350, AND FROM 20/1800Z NO SIG ASH ABOVE FL200
NXT ADVISORY: 20100420/1200Z

Kilauea, 1983 - present

- 4 km^3 basaltic magma erupted from East Rift
- Lava inundation of residential areas
- New summit vent opened in 2008
- Heavy SO2 out-gassing requires land closures and damages agriculture and tourism

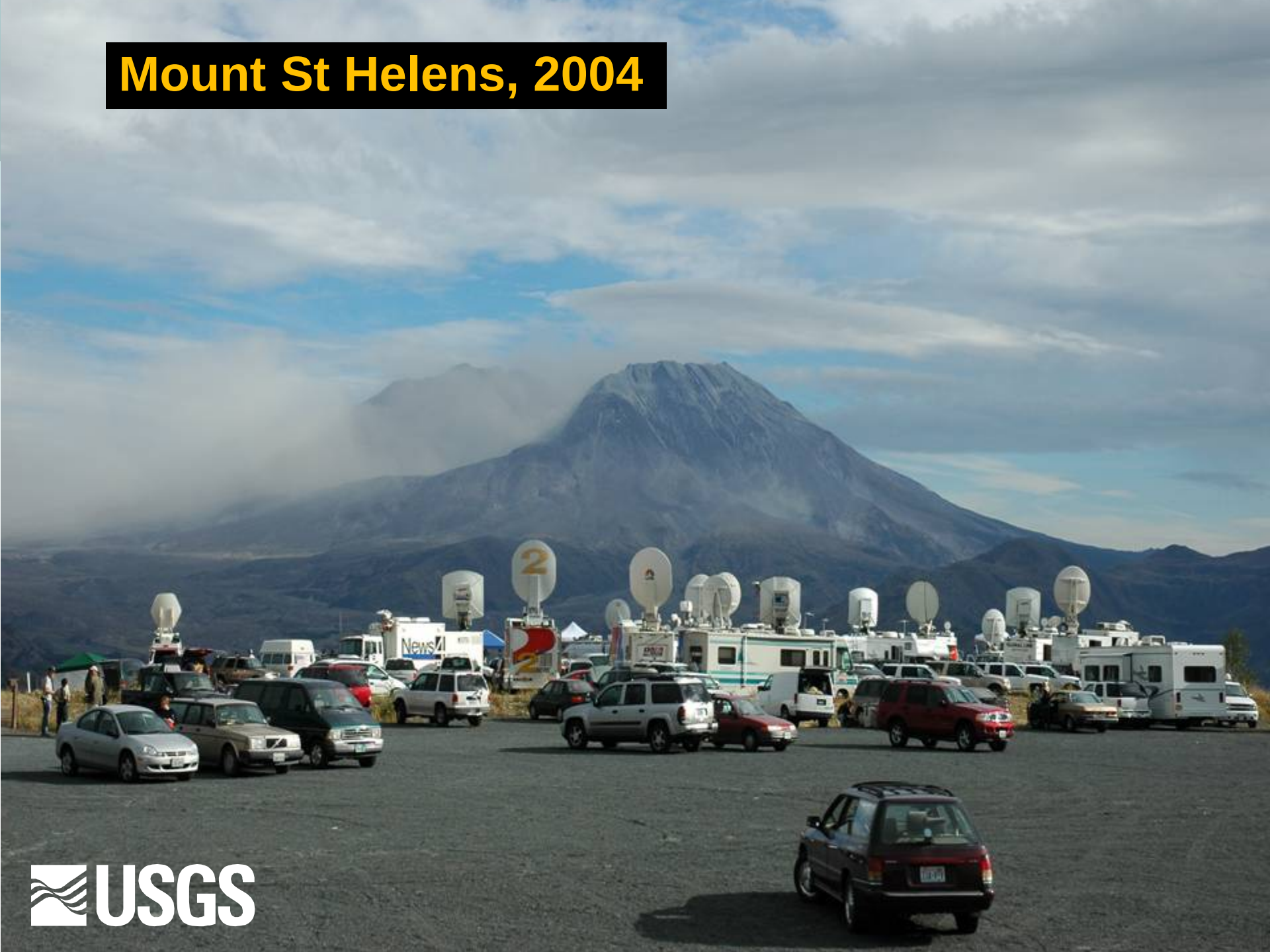




Mount St Helens, 2004 - 2008

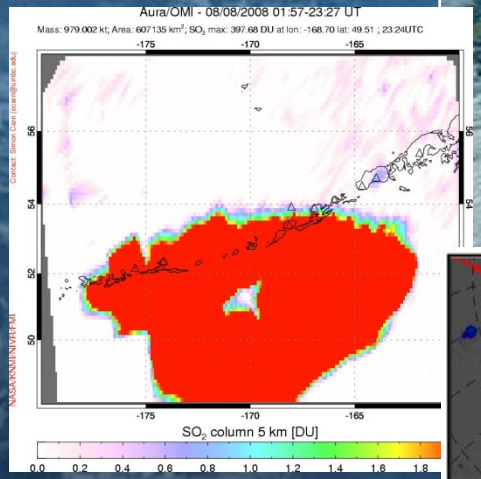
- New dome

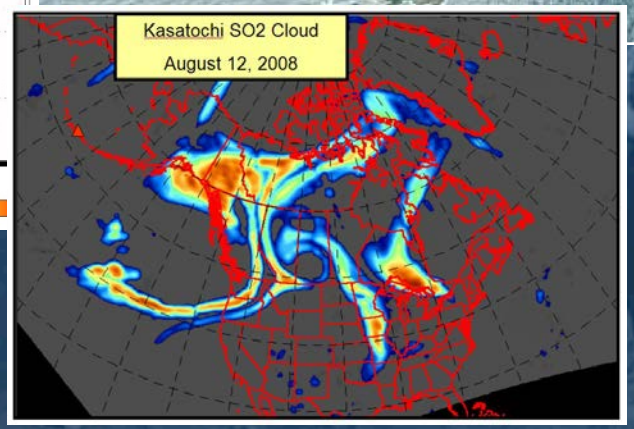
USGS


Mount St Helens, 2004
USGS

Kasatochi, 2008

- Large ash eruption, with pyroclastic flows; covered whole island and extended shoreline 400 m
- Two government biologists evacuated just in time
- All vegetation and wildlife killed
- Disruption of air traffic between eastern Asia and North America
- 1 Megaton SO2

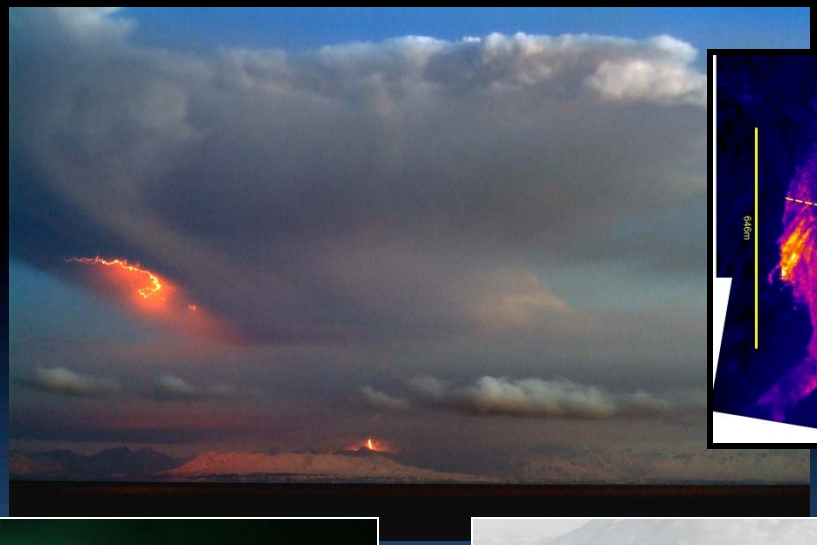


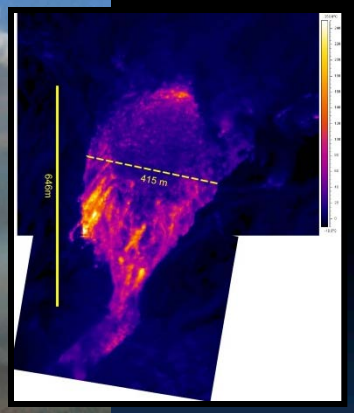


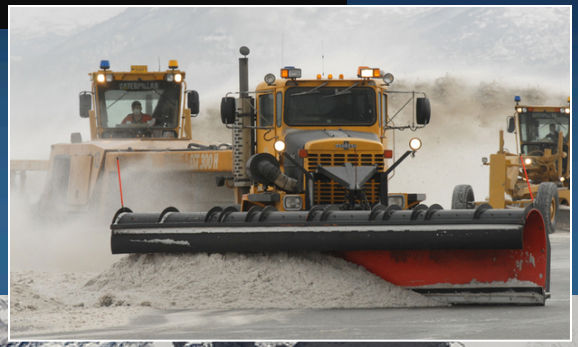
USGS

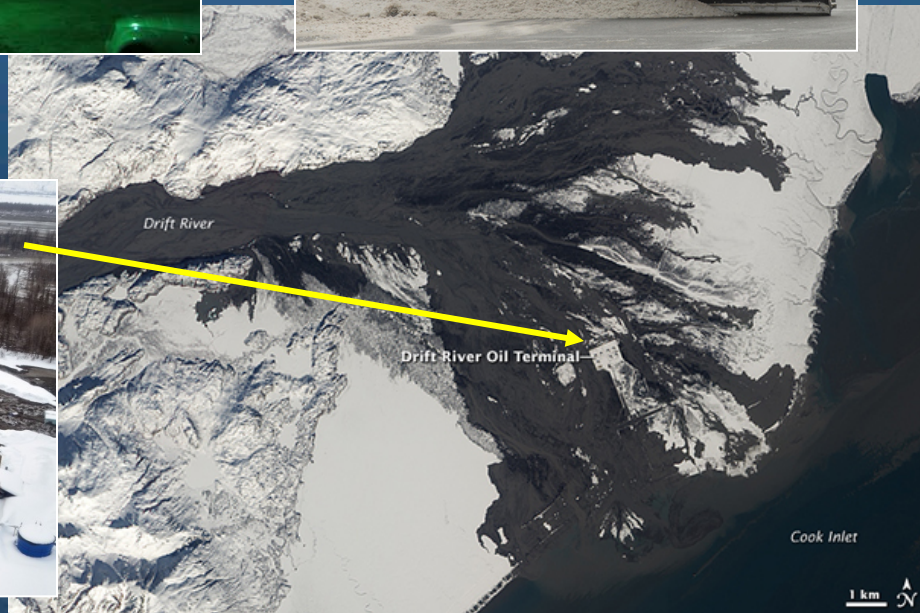
Redoubt, 2009

- 19 ash-cloud producing explosions; extrusion of large dome
- Disruption of air traffic between Alaska and mainland US
- Ash fall on Cook Inlet communities
- Closure of Anchorage airport
- Oil terminal inundated by lahars; oil production halted









USGS

Two Campi Flegrei – like places

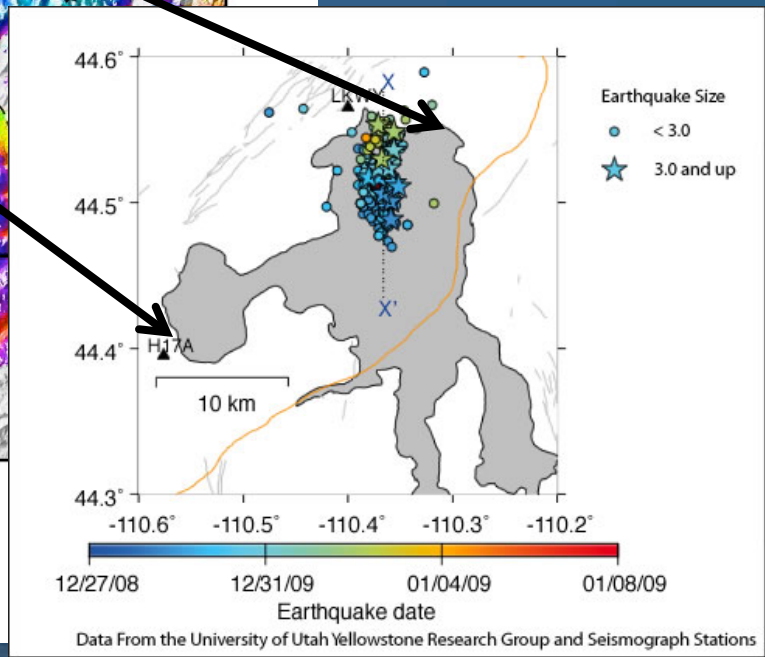
- **Yellowstone Caldera, Wyoming**
- **Long Valley Caldera, California**

- **Characteristics: Highly explosive events but long repose periods; episodes of unrest that would lead to eruption in "normal" volcano; gas and hydrothermal explosion hazard; much public interest as "super volcanoes".**

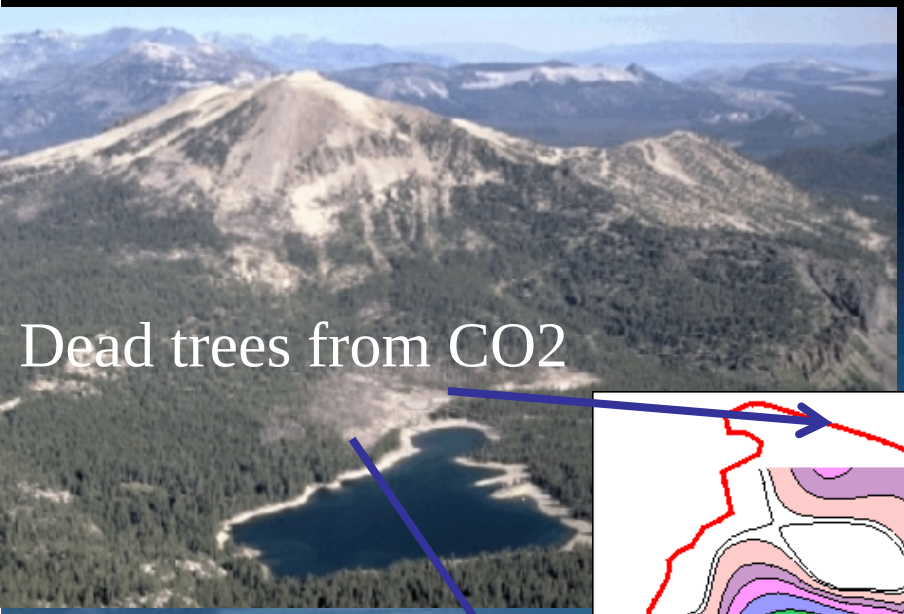
USGS

Yellowstone:

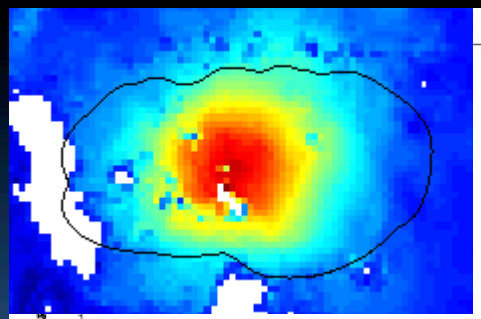
Seismic swarms, steam explosions and CO_2 hazards in a popular national park

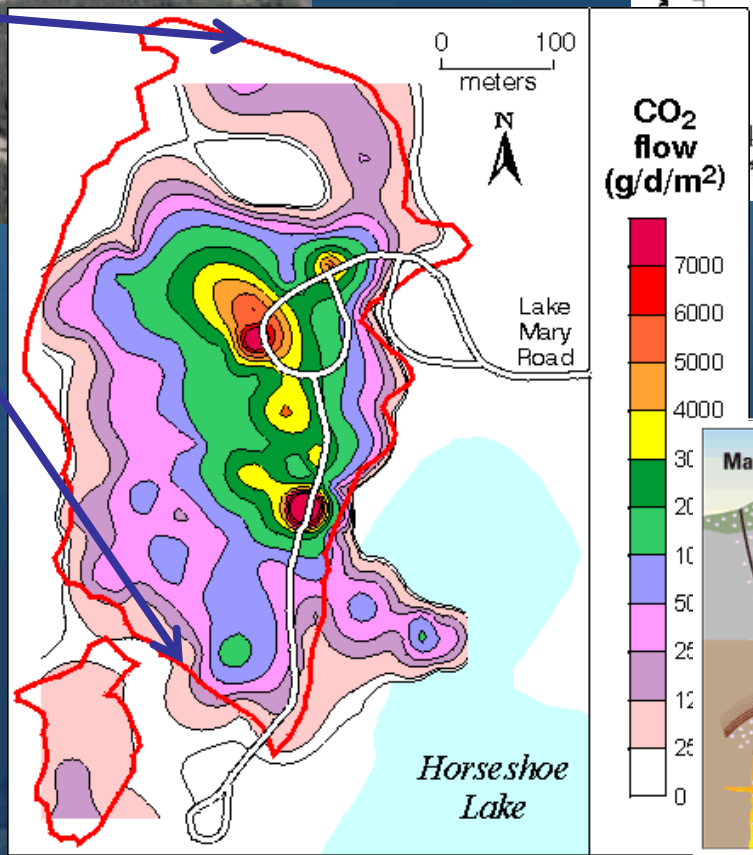


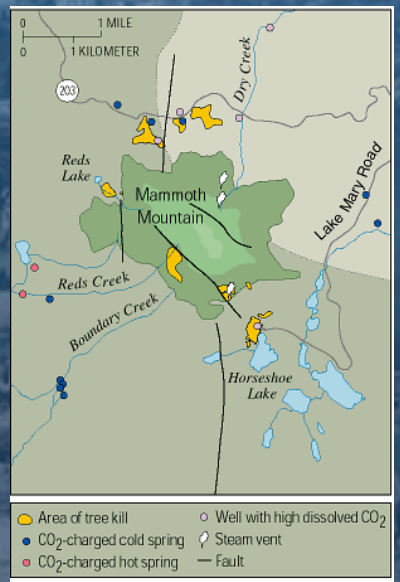
Long Valley Caldera, California

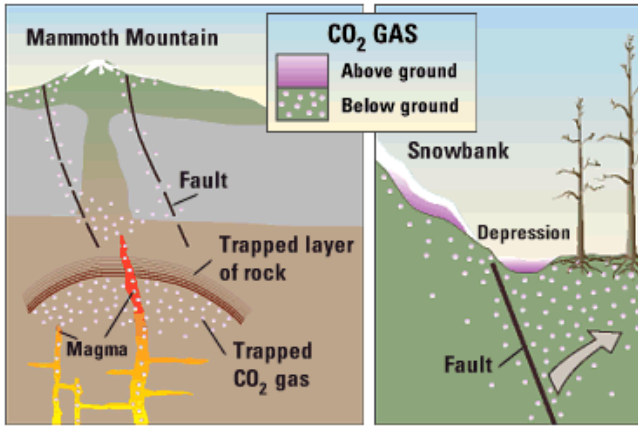


Dead trees from CO2









“Likely” major crisis scenarios in U.S.

1. **Major and/or prolonged explosive eruption in Alaska:** Interference with air access and resupply; revenue and job loss due to impacts to transportation hubs, oil and gas production, fisheries, and tourism. Disruption of Asia/North America air travel and air travel within North America.
2. **Eruption of Rainier, Hood, Baker, or Shasta:** Possible prolonged evacuations or relocations; cutting of transportation arteries; disruption of air travel; impacts to power generation, water supplies, waterways, agriculture.
3. **Return of unrest to Long Valley Caldera:** Possible prolonged evacuations or relocations; cutting of transportation arteries; impacts to tourism and real estate business; problematic because unrest at large calderas is not well understood.
4. **Eruption of Mauna Loa:** Cutting of transportation arteries; lava inundation of resorts and residential areas.

USGS

Sarychev, 2009

Cooperation with Russia

- **Ash clouds:** More than 20,000 passengers/day transit the northern Pacific where ash frequently reach flight levels.

- **RFE volcano observatories:** USGS scientists assisted their Russian counterparts in establishing the Sakhalin Volcanic Eruption Response Team (SVERT) and Kamchatka Volcanic Eruption Response Team (KVERT).

- **Warnings to airlines:** AVO, KVERT, and SVERT work closely together to detect volcanic activity and provide air carriers with timely ash warnings.

КфГс РАН

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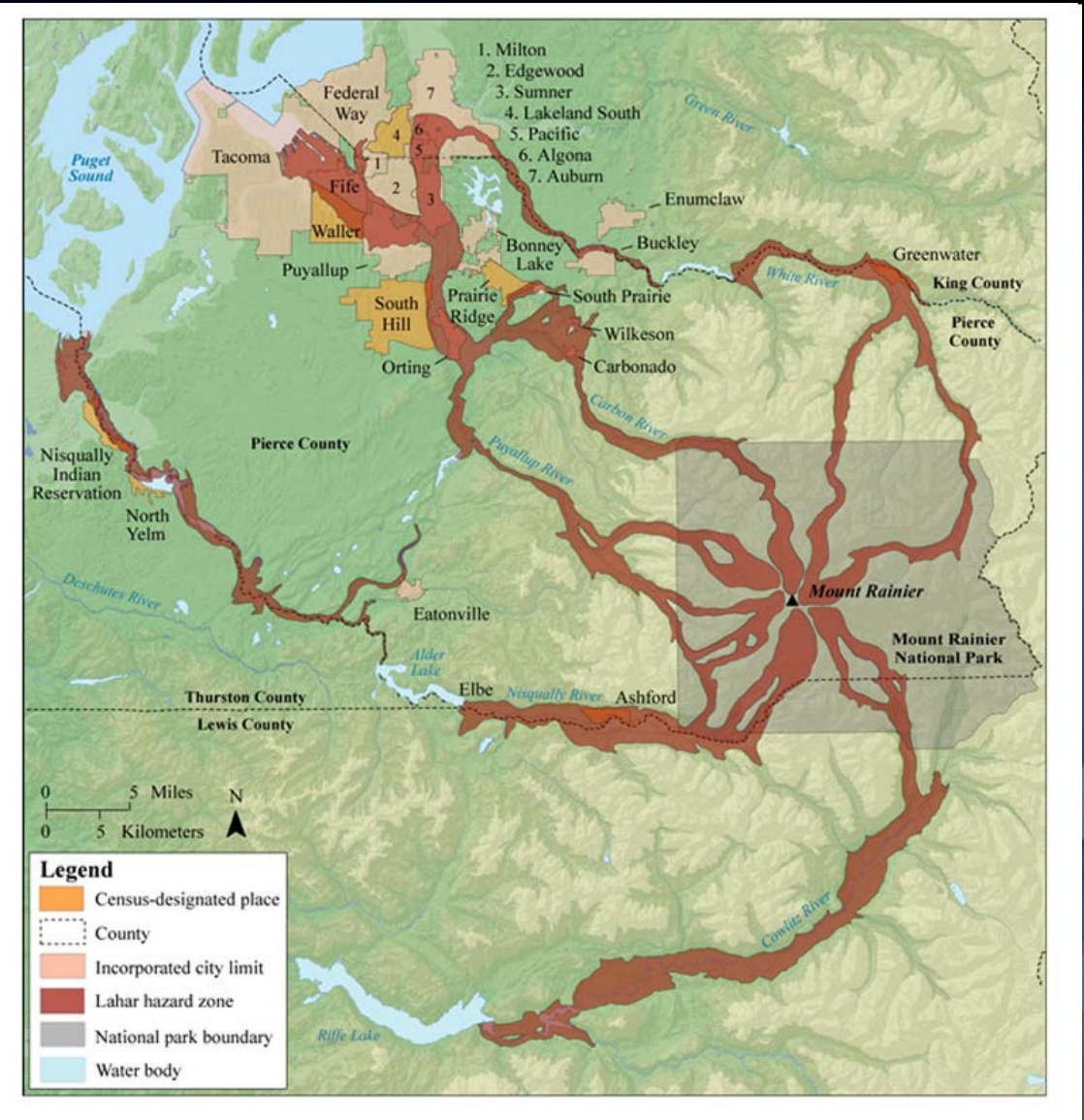
USGS

- **Holocene lahars from Mt Rainier**



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3 Die in Mammoth Mountain Ski Patrol Accident

THE STATE

Two men fall into a volcanic vent while fencing it off. A rescuer also is killed and seven are hurt. Resort's death toll this year

April 07, 2006|**Amanda Covarrubias and Doug Smith | LA Times Staff Writers**
Three ski patrol members were killed Thursday at Mammoth Mountain ski area when they fell into a geothermal vent that they were working to fence off. Seven other ski patrollers were injured in the incident.

Yellowstone earthquake swarm continues into third day, intensifies

By Howard Pankratz
The Denver Post

Posted: 01/19/2010 07:59:07 AM MST

Updated: 01/19/2010 04:25:04 PM MST

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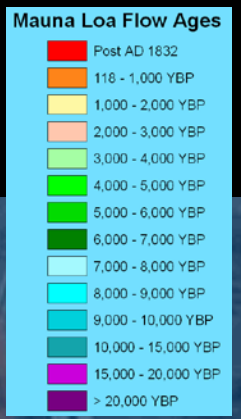
Hilo, Hawaii, 1984

Photo By D. Little

Mauna Loa Northwest Flank

- 2 hours to 1 day
- 8 days
- Eruptions typically start at ~300 m^3/s then gradually diminish.
- 40 % of Mauna Loa surface is covered /1,000 yr



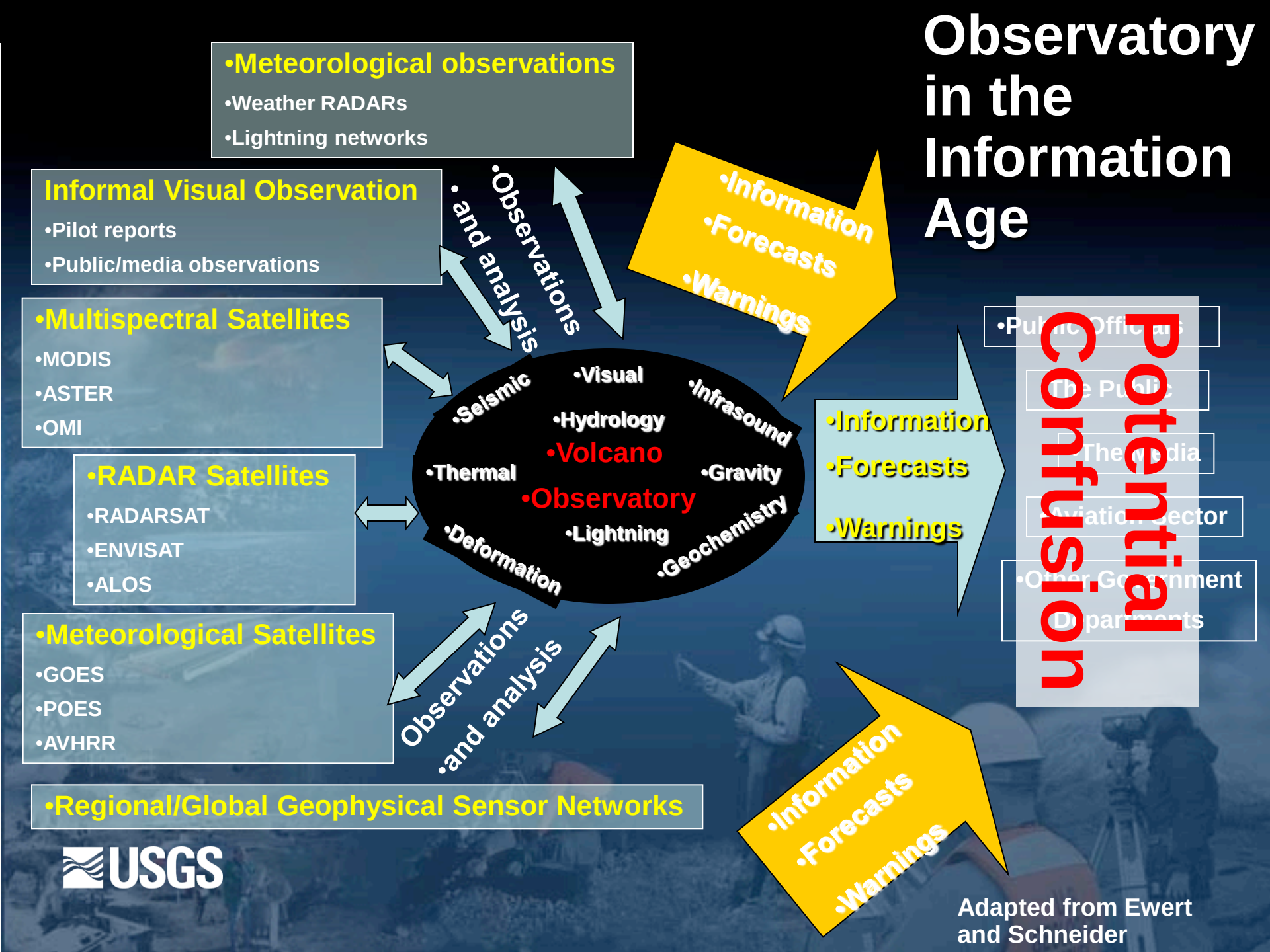
Observatory “Classic” model

- Local ground-based sensors and observations.
- One building, one volcano.
- Local hazard mitigation responsibilities.

•Frank Peret, Mt. Pelee, Martinique, ca. 1930

USGS

Observatory in the Information Age



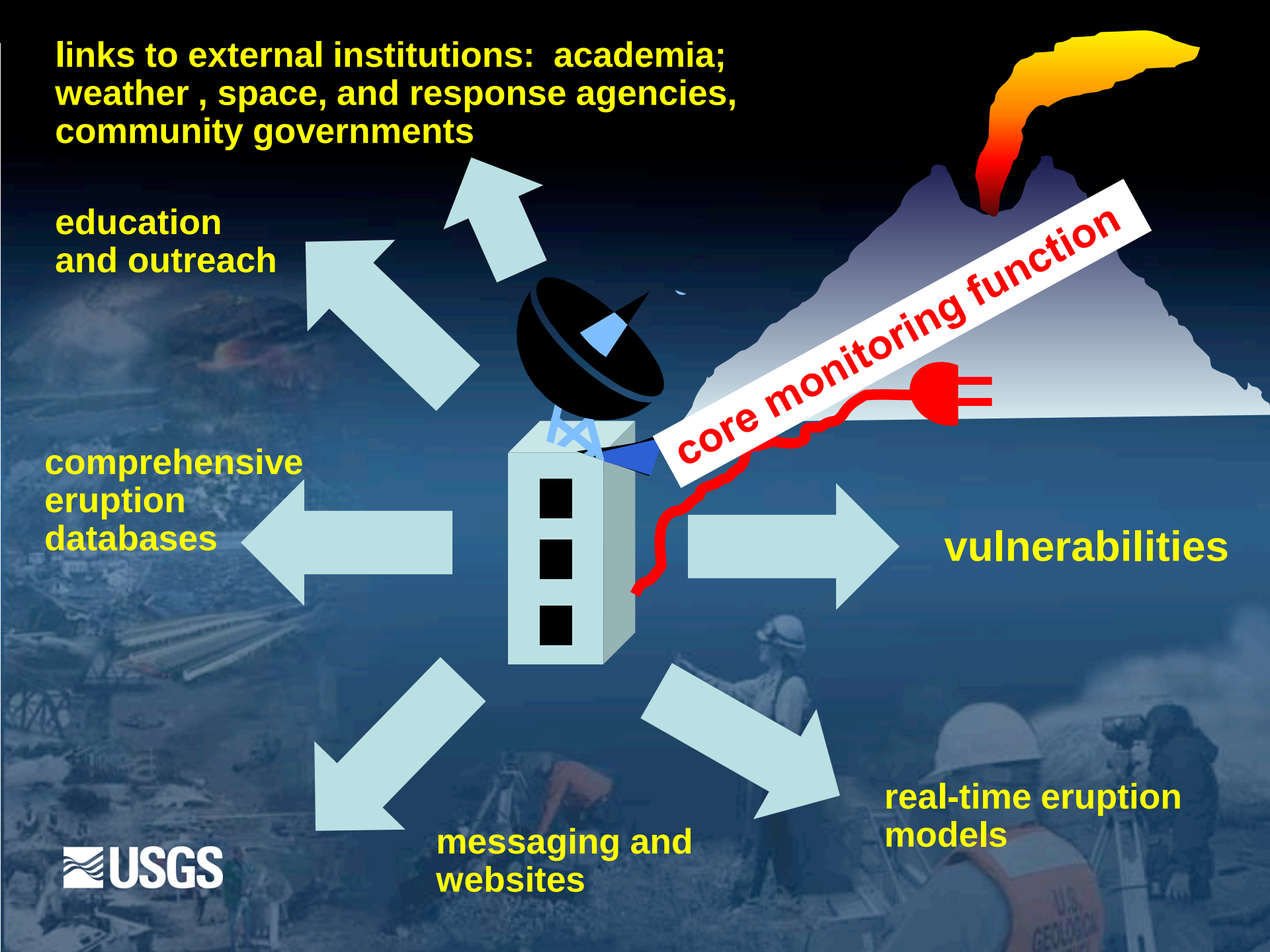
USGS

Adapted from Ewert and Schneider

Communication tools

1. **Calldown:** Emergency response agencies are notified of unrest by telephone and electronically to mitigate hazards to communities at risk.
2. **Email reports and notifications:** Emergency notifications and daily to weekly status reports and activity updates are provided to information users in the public and private sectors.
3. **Web sites:** Observatory web sites provide all warnings and updates together with real-time monitoring data, webcam views, and background information.
4. **Other communication techniques:** Eruption response plans, eruption scenario exercises, workshops, hazard maps, fact sheets.
5. **Scientific output:** VHP scientists publish about 75 peer-reviewed articles per year in internationally available journals. After major eruptions, VHP scientists produce a special volume of peer-reviewed papers documenting lessons learned.

USGS


links to external institutions: academia; weather , space, and response agencies, community governments
education and outreach
core monitoring function
comprehensive eruption databases
vulnerabilities
real-time eruption models
messaging and websites
USGS

Perhaps the grandest challenge of the day:

But we don’t have to separately do it all. We need a re-invigorated international volcano observatory community.

USGS

Long-term international interactions

- **ICAO, IATA, IUGG**

Contributions to ash protocols, procedures, training, research

- **Japan Kamchatka Alaska Subduction Processes (JKASP)**

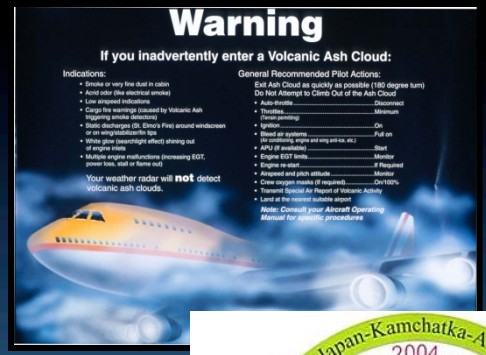
Formed tri-national consortium to promote natural hazards science

- **Global Volcanism Program**

With Smithsonian, global reporting and database

- **Volcano Observatory Best Practices**

Co-convening with Italy (INGV) to bring world observatories together



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 state.
YELLOW	Volcano is exhibiting signs of elevated unrest above known background level. *Or, after a change from 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].
	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].

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