



Resuspended Volcanic Ash from the Katmai Region to Kodiak Island

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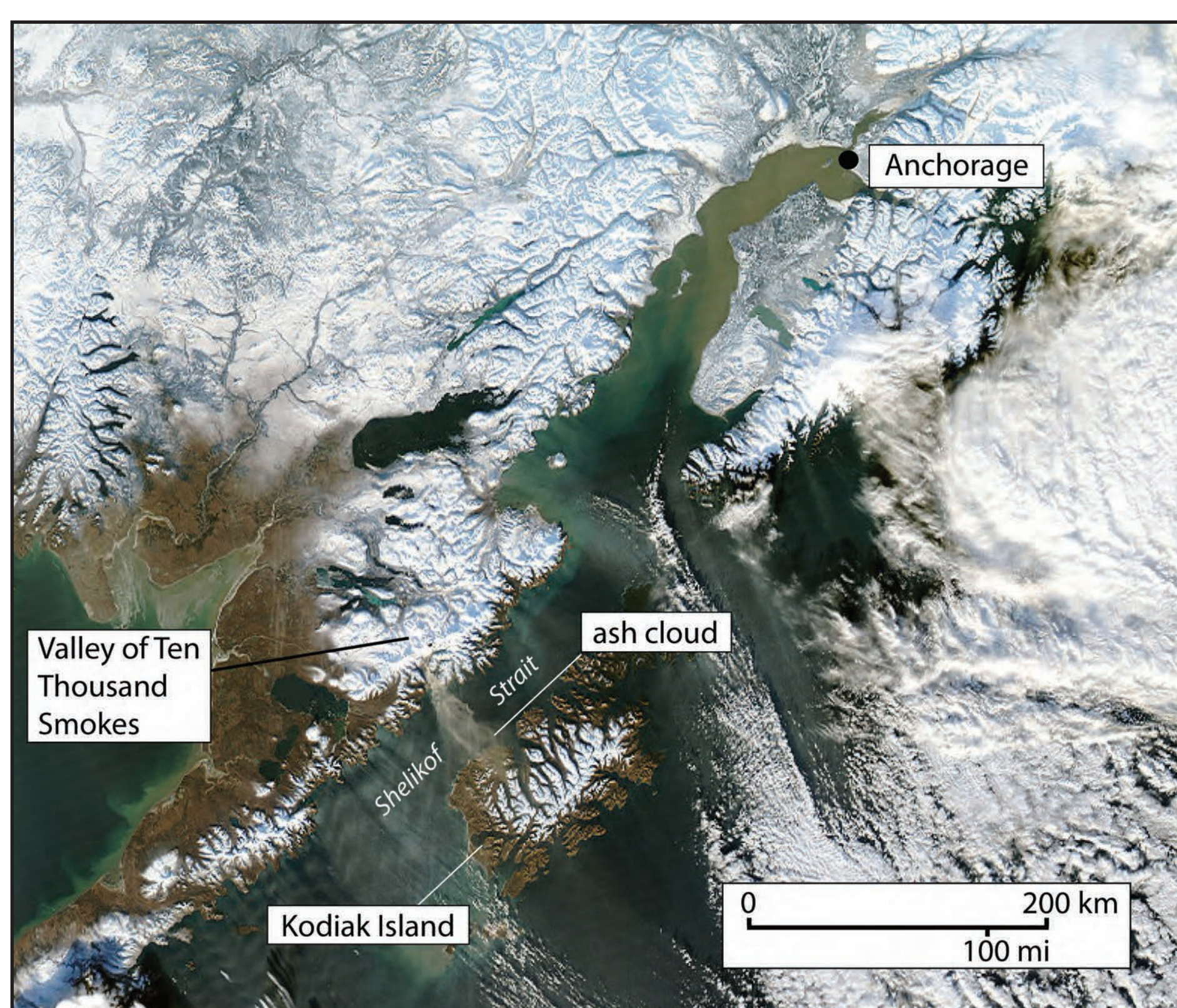
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Introduction

Resuspension and transport of fine-grained volcanic ash from the Katmai National Park and Preserve region of Alaska has been observed and documented over the past several decades and has likely been occurring ever since the 1912 Novarupta-Katmai eruption. This eruption produced approximately 4 mi³ (17 km³) of ash deposits and 2.6 mi³ (11 km³) of pyroclastic material that filled nearby valleys, creating what is today known as the Valley of Ten Thousand Smokes (VTTs). Ash in this valley is up to 660 ft (200 m) thick and the valley remains almost entirely free of vegetation.

During the spring and fall, or whenever strong northwesterly winds blow over the snow-free landscape, the ash can be reworked into dust clouds. The ash is especially susceptible to reworking when the ground is very dry. These dust clouds have been observed visually by individuals downwind and also in satellite imagery. These dust clouds are concentrated between 4,000 and 11,000 ft (1-3.4 km) above sea level and can extend up to 155 miles (250 kilometers) over Shelikof Strait, parts of Kodiak Island, and over the Gulf of Alaska. Trace amounts of ash fallout (typically less than 1/32 inch or 1 mm) have been reported on communities on Kodiak Island. Samples show this fallout is primarily composed of fine-grained volcanic ash that closely resembles "fresh" ash produced during volcanic eruptions.

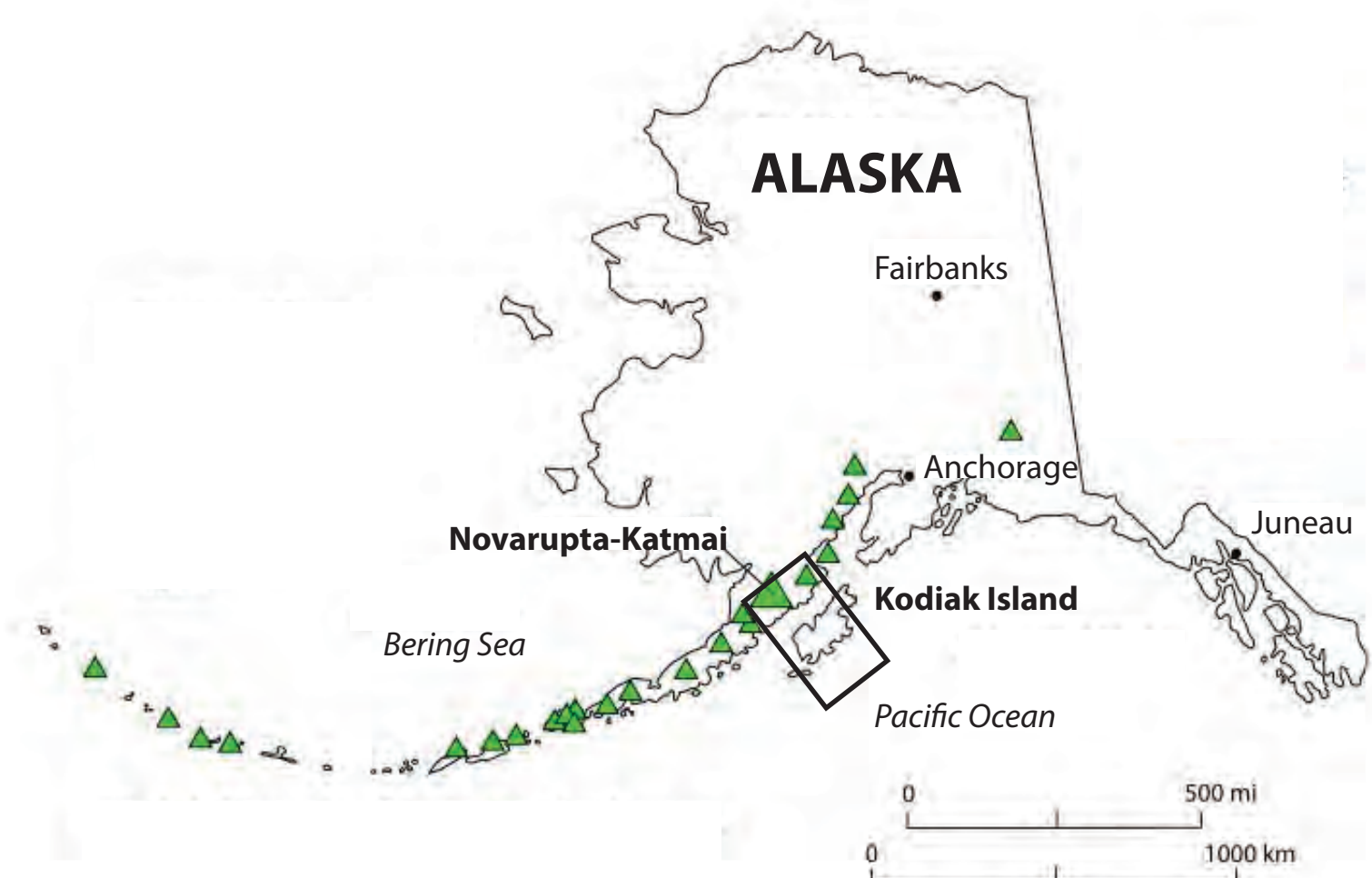


MODIS Aqua 1 km true color satellite image showing resuspended volcanic ash cloud (arrow) generated from high winds scouring exposed ash on the Pacific side of the Katmai volcanic range. The cloud stretches across the Shelikof Strait and western Kodiak Island. Image ID 2010333 taken November 29, 2010. Courtesy NASA.

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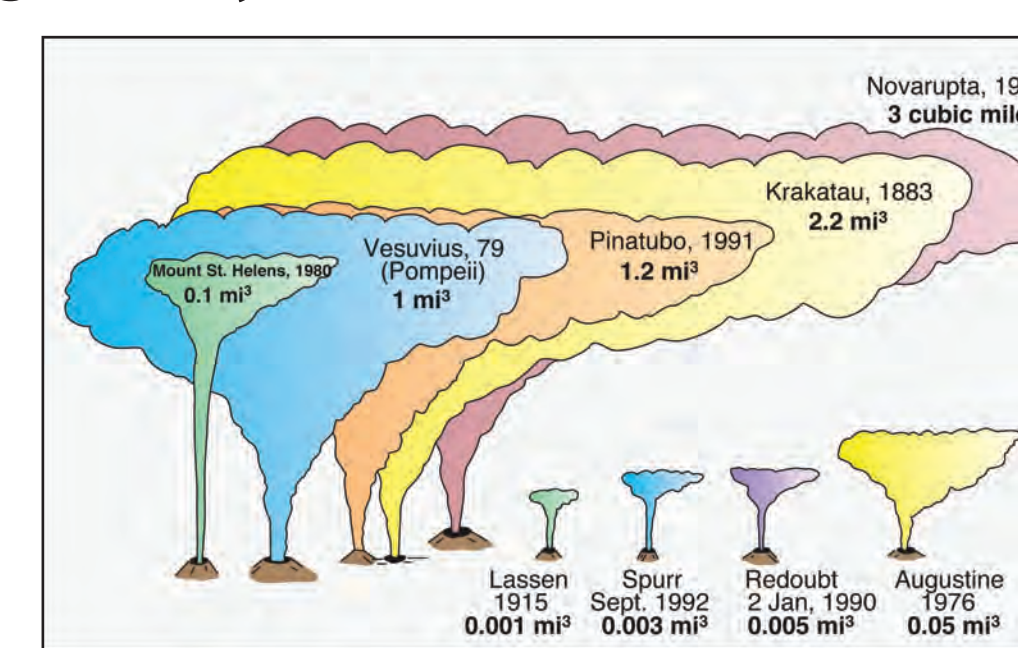


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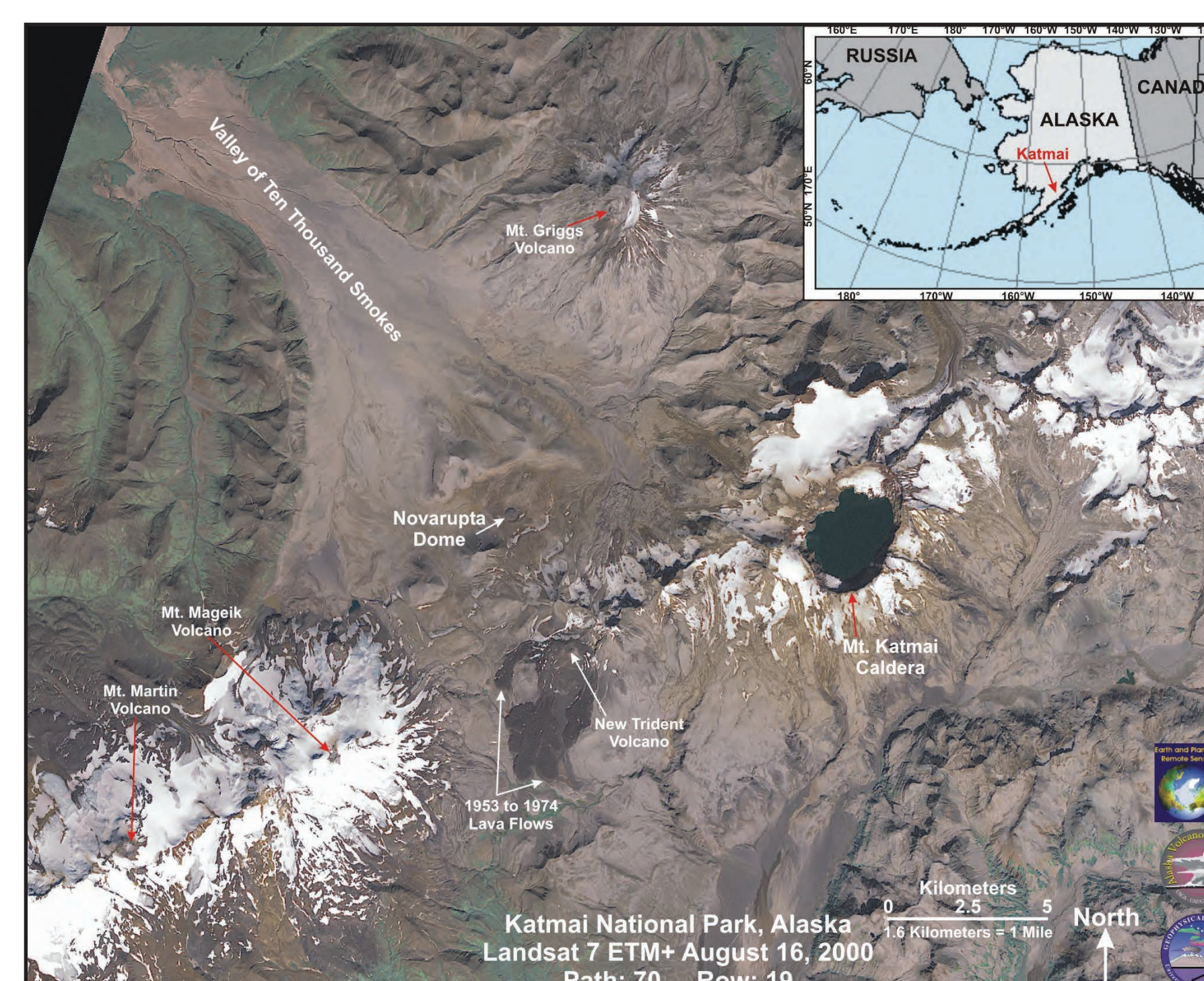
1912 Novarupta-Katmai Eruption

- 20th centuries largest eruption - globally
- 5th largest in historical times
- 3-day explosive eruption - 60 hr
- 100,000 ft (30 km) plume
- Created Katmai caldera - 2 mi (3.2 km) across
- 6.5 mi³ (28 km³) of ash (fallout & flowage)
- 600 ft (183 m) thick - ash deposits creating the "Valley of Ten Thousand Smokes" (VTTs)
- Covered Kodiak in up to 2 ft (0.6 m) of ash



City of Kodiak, 100 mi (162 km) east of the Novarupta vent on the day after the eruption. Kodiak was blanketed in 2 feet (0.6 m) of ashfall (photo right).

Kodiak

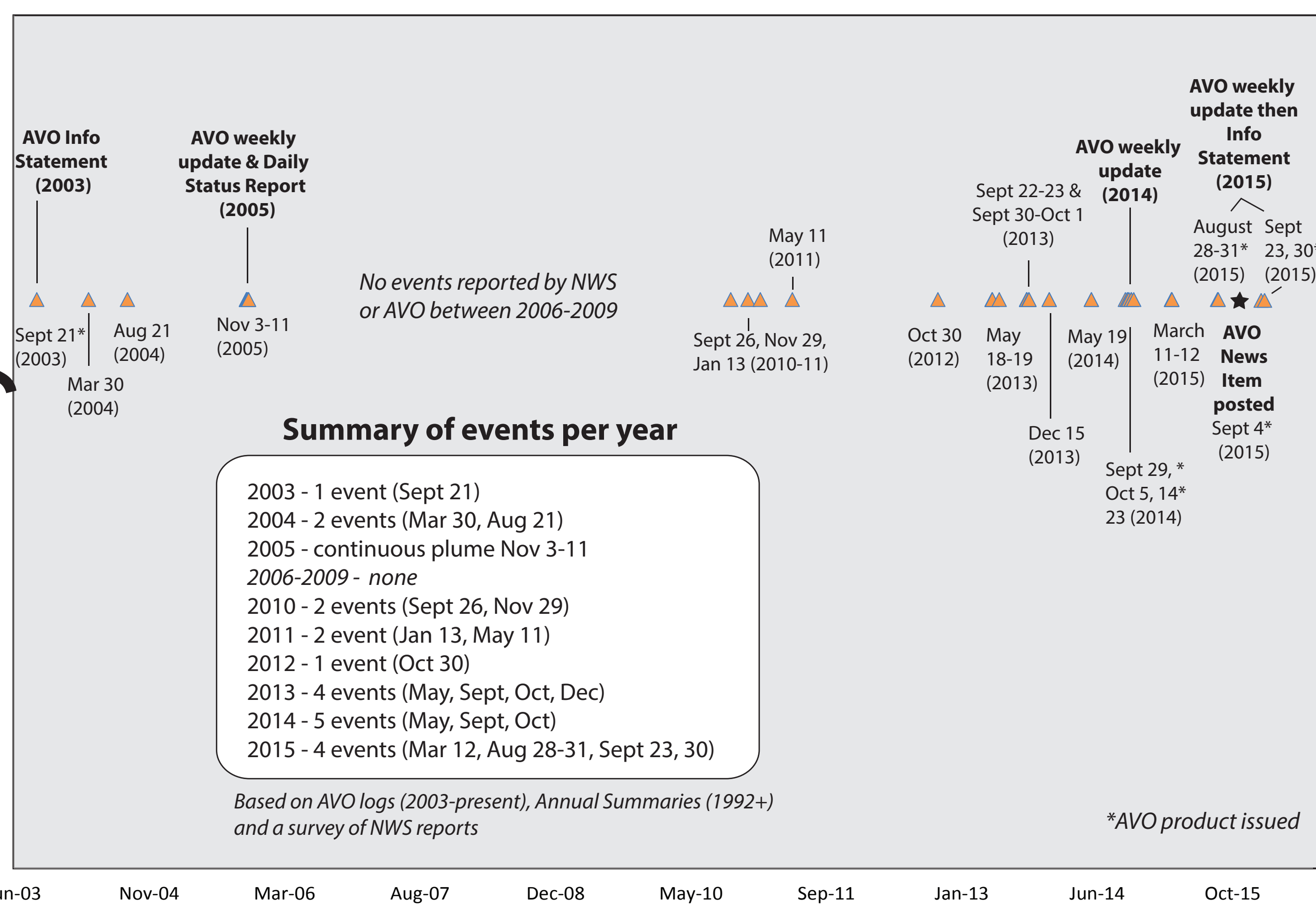


True color composite satellite image of Katmai National Park region of Alaska. The Valley of Ten Thousand Smokes received its name because the hot deposits were still steaming for many years after the eruption.



Pyroclastic deposits that fill the valley remain nearly vegetation-free more than 100 years after the eruption. Resuspended ash from VTTs seen in Katmai Pass area from KABU webcam.

Summary of Events

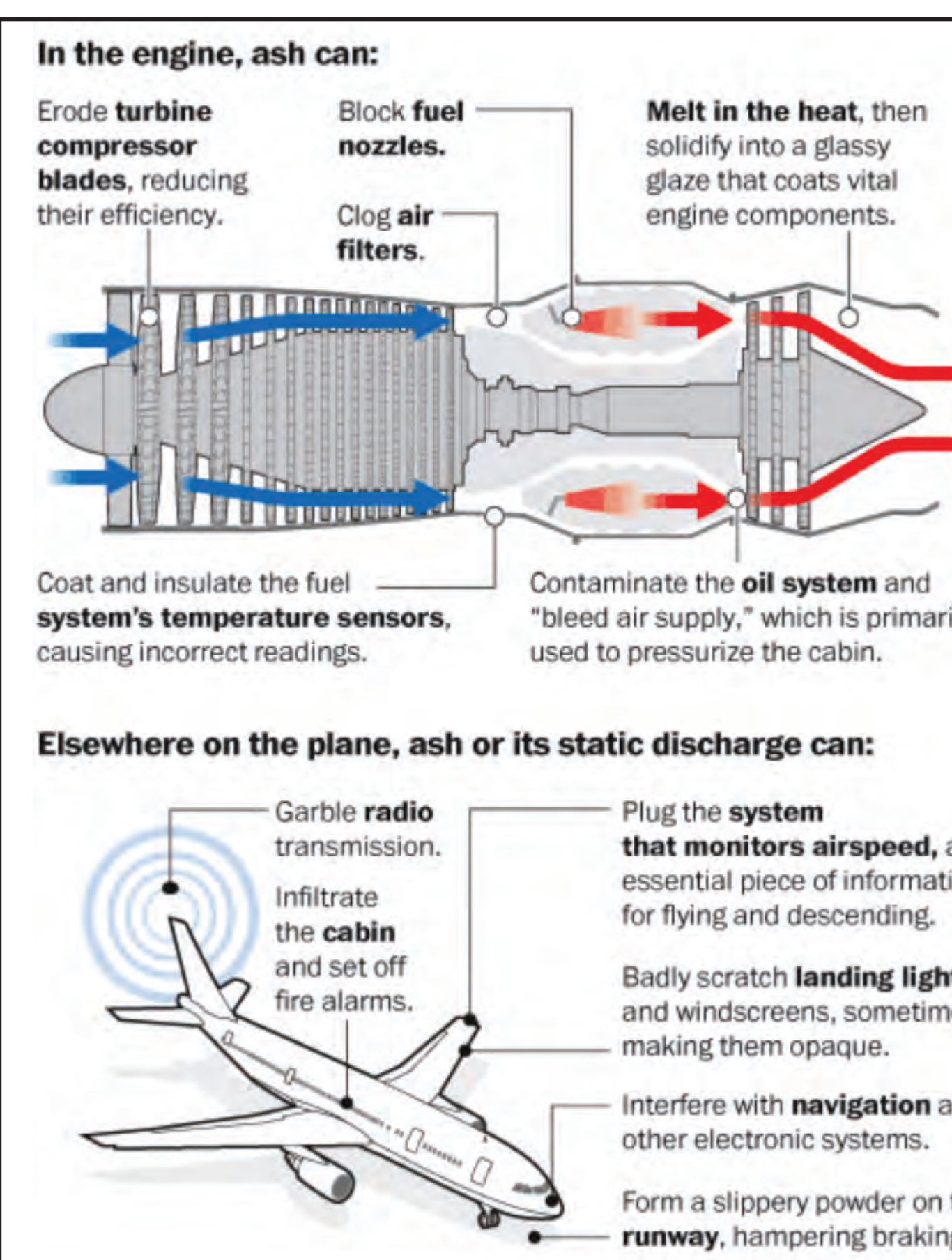


Event Characteristics

- Occur in late Spring and Fall - Snow-free & dry
- 1 to 5 events per year
- Winds speeds >20 kt (10.3 m/s)
- Clouds aloft 4,000 - 11,000 feet (1 - 3.5 km) above sea level
- Duration hours to days
- Enhanced by local terrain effects
- Extend up to about 250 km into Gulf of Alaska
- 2013+ trigger NOAA-NESDIS ash alert system
- Trace amounts of ashfall reported (<1 mm or 1/32nd inch)
- Samples look pristine - as if from erupting volcano

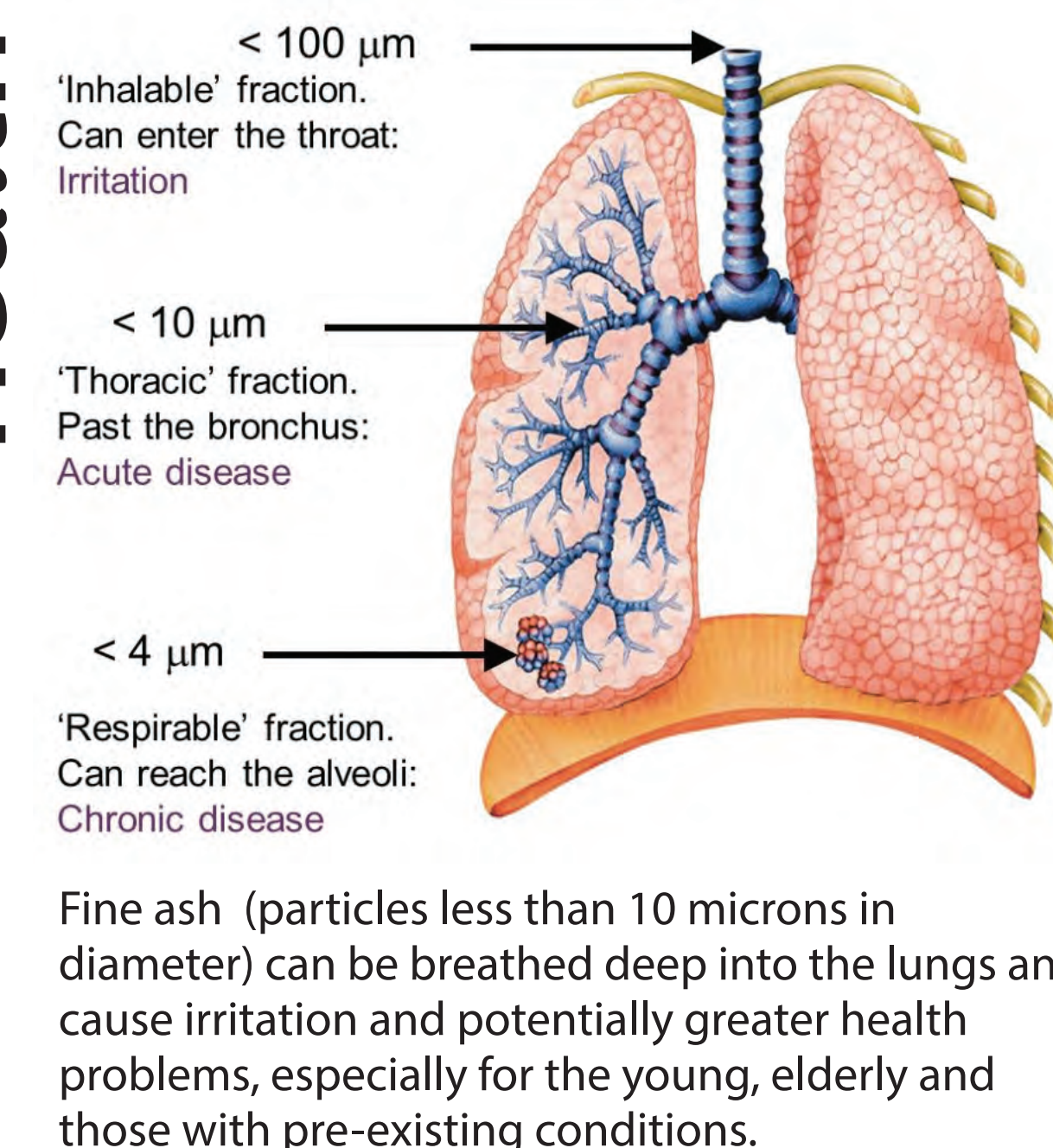
Hazards & Impacts of Resuspended Ash

Aviation



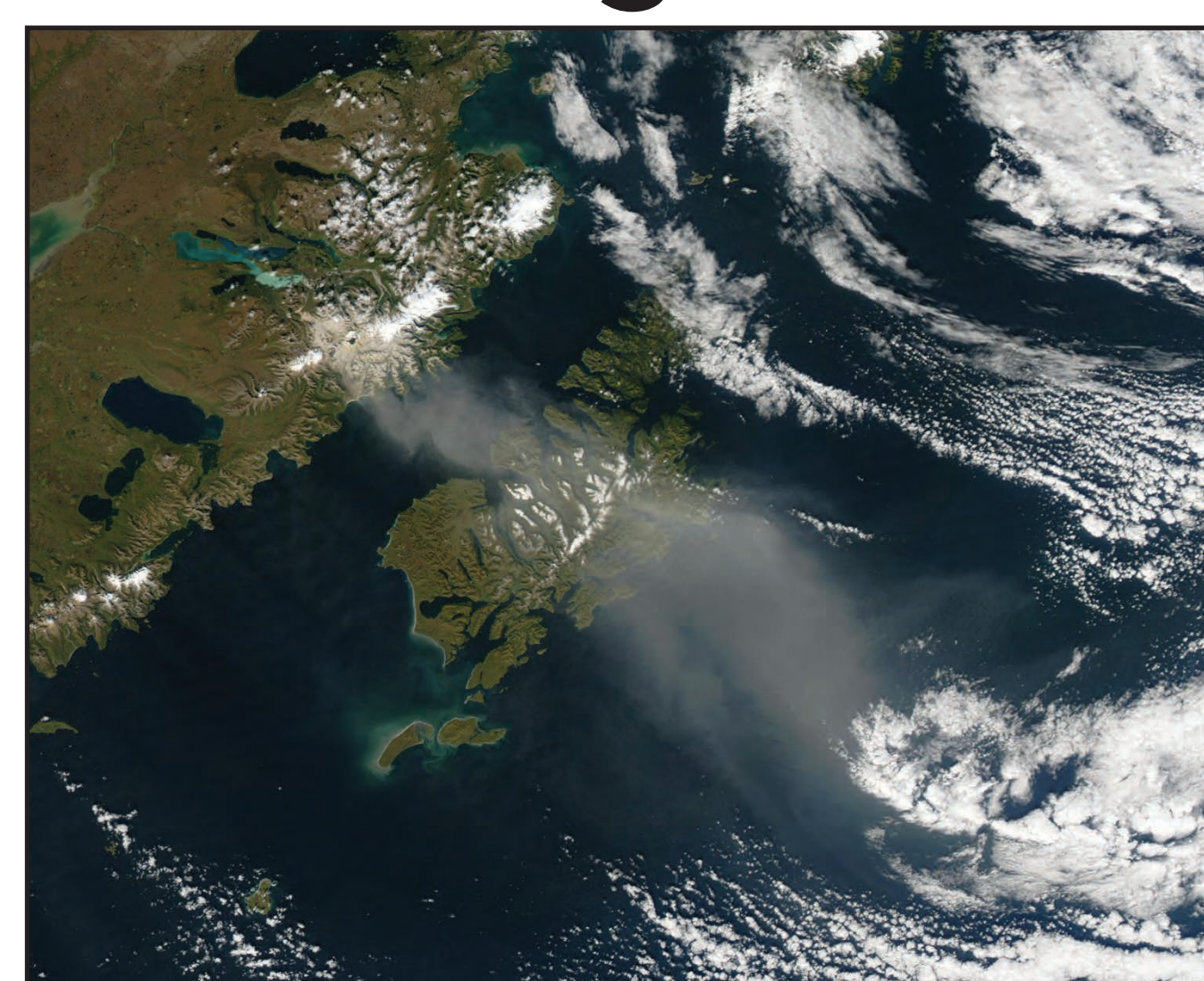
Ash deposits inside the jet engine that encountered the ash cloud from Redoubt Volcano 1989. Right: Dark glassy deposits of melted volcanic ash on leading edge of high-pressure turbine nozzle guide vanes. Left: Accumulation of unmelted volcanic ash in the high-pressure turbine rotor.

Health



Volcanic ash is known to be hazardous to aviation and flight cancellations to/from Kodiak (including both commuter and jet aircraft) are common during resuspension events from the Katmai region. Cloud heights are low (up to 11,000 ft (3.5 km) asl) so overlying aircraft are not impacted by these events. Little is known about the amount or sizes of ash particles in these resuspended clouds and thus studying their fallout (see below) may help to characterize the hazard to aviation. For example, quantifying the volume percentage of volcanic glass versus other material in these clouds may be useful.

Detecting/Tracking Resuspended Ash



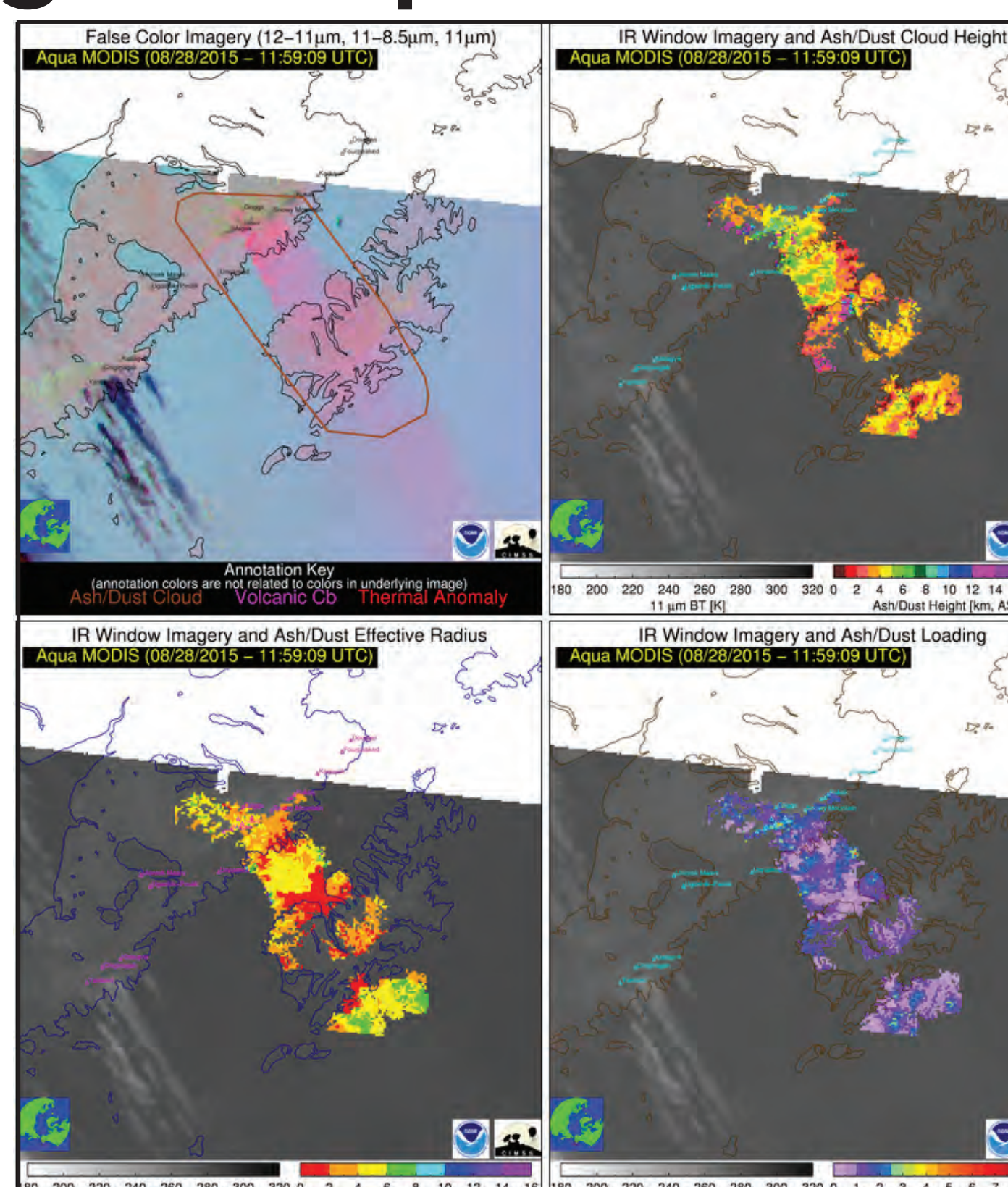
MODIS image from September 21, 2003 event. Cloud 5,500-6,000 ft (1.7-1.8 km) asl - 230 km aerial extent - 40 kt (20.5 m/s) winds.

Events are small and often hard to detect in satellite imagery. Forecasts of strong NW winds tip us to look closely at satellite imagery.

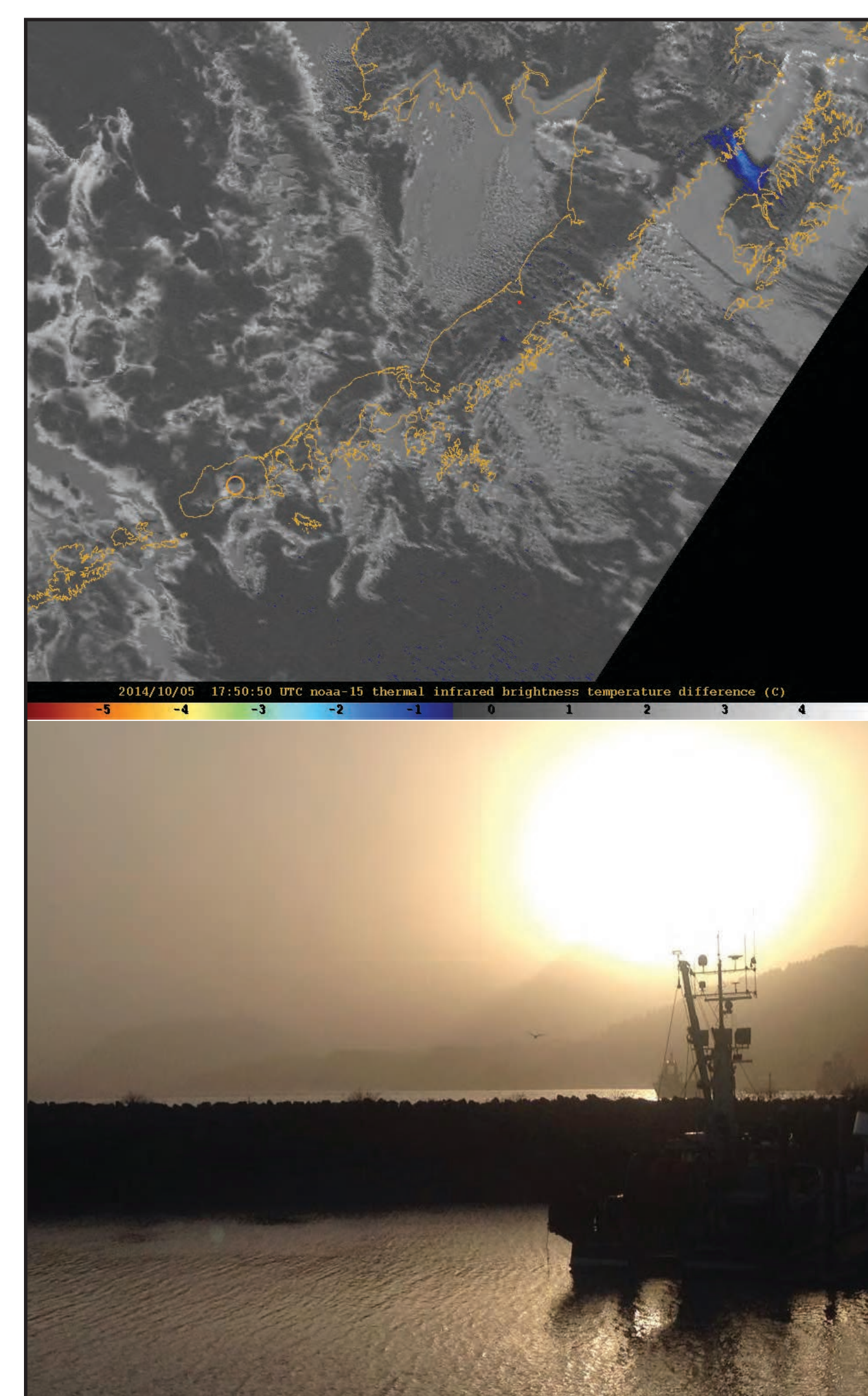
NOAA-NESDIS ash alert system is doing a good job alerting us of these events.

Coordination with the NWS is critical as they have the responsibility of issuing warnings.

PIREPS, observers from boats/land, webcams help to identify events.

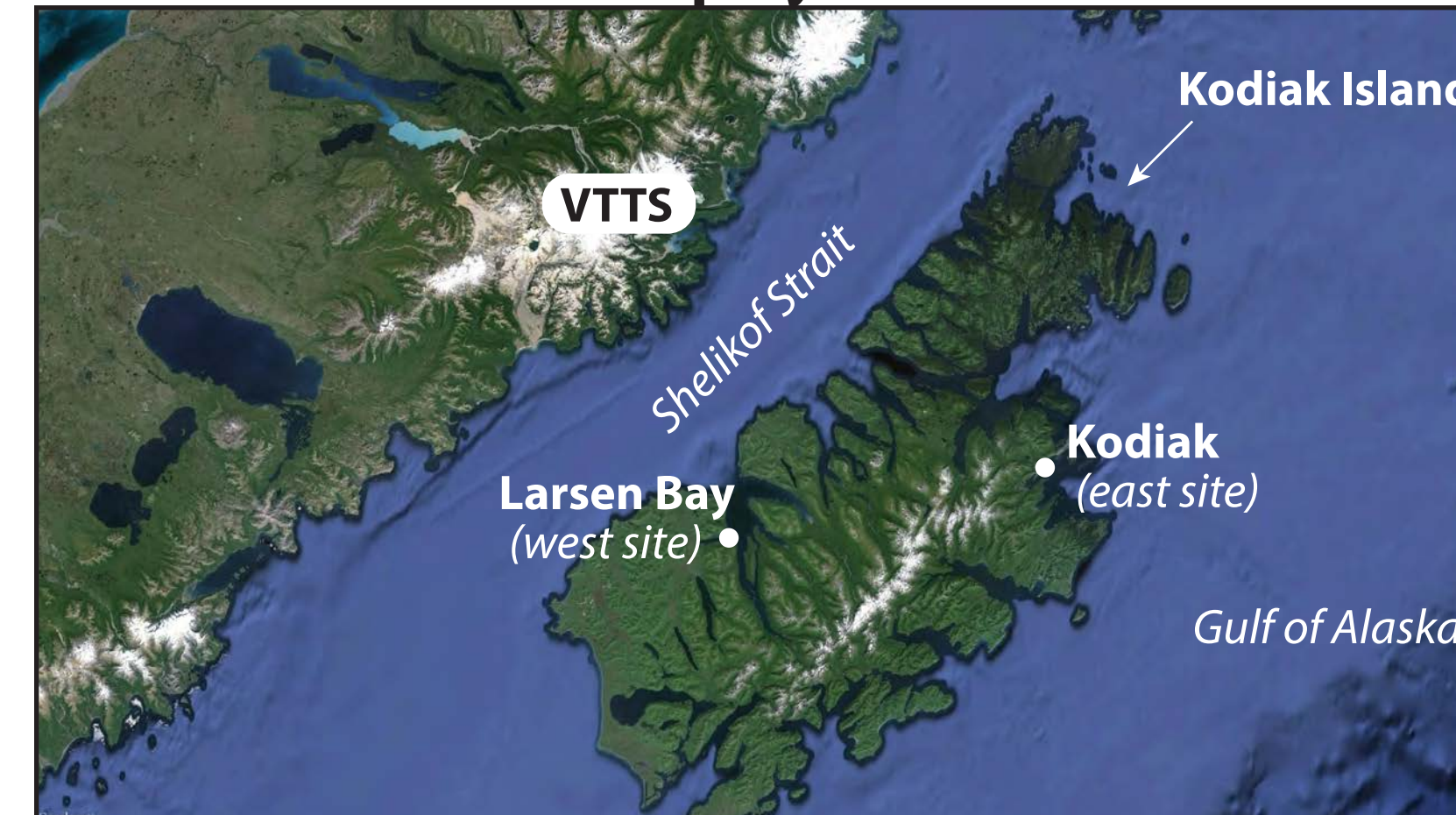


Aqua MODIS satellite imagery showing various aspects of a resuspended ash cloud on August 8, 2015. Provided by NOAA/CIMSS Volcanic Cloud Alert system (M. Pavlonis)



Very small event seen using AVO's Volcview satellite image viewer. Bottom - ash over Kodiak on Oct 5, 2014.

Particulate monitor deployment to Kodiak Island

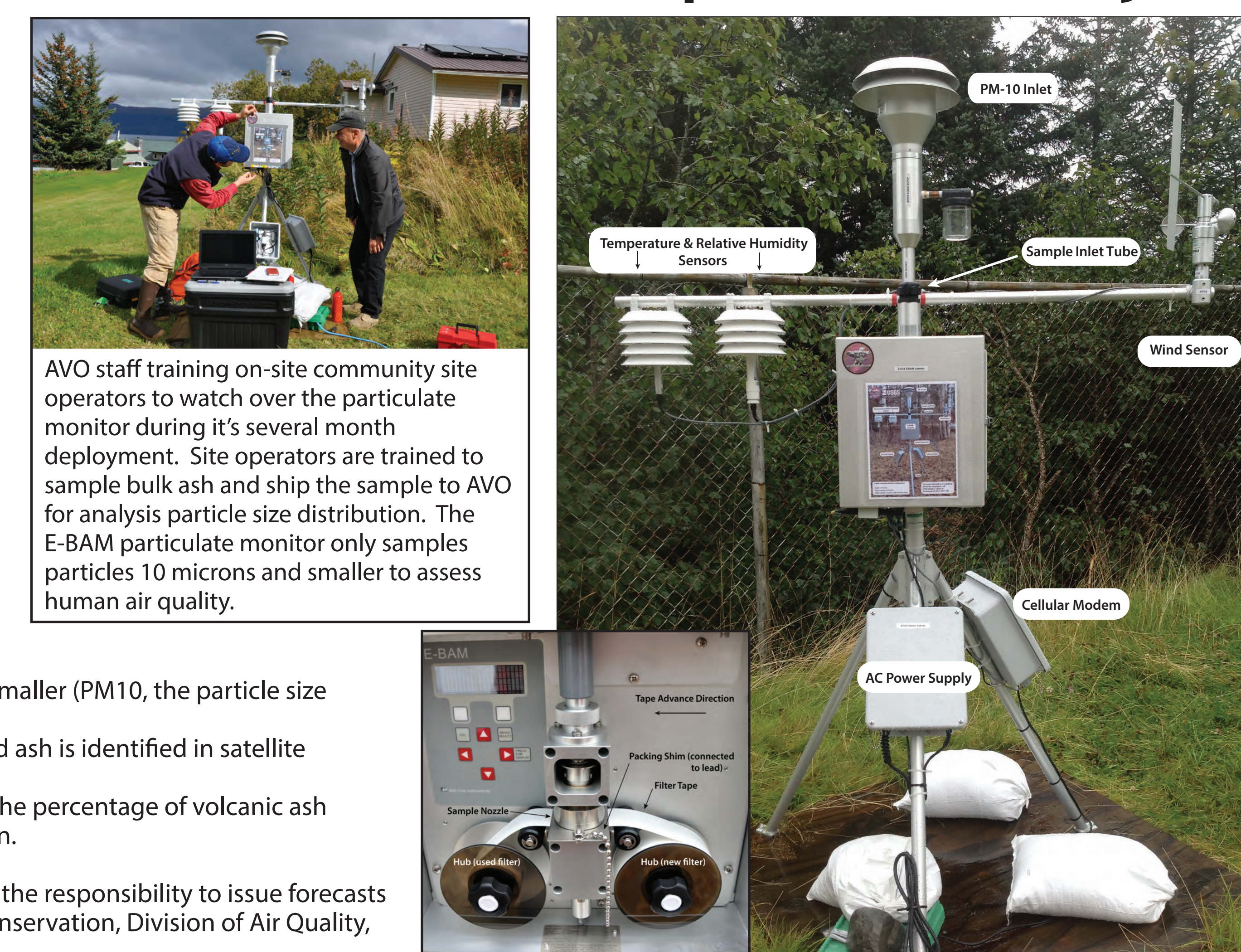


Clouds of resuspended volcanic ash have not been well studied and little is currently known about the amount or sizes of ash particles in the clouds. Unlike many other wind-related erosion events in Alaska composed of non-volcanic sand and silt, these clouds are composed of volcanic ash (primarily volcanic glass) and are similar to ash clouds from a volcanic eruption. Thus, dilute clouds may pose hazards to human health and aircraft operation. AVO has deployed particulate monitors to Kodiak Island during the fall of 2015 to:

- 1) Measuring the concentration of particulate matter 10 microns and smaller (PM10, the particle size known to be respirable).
- 2) Verify if and how much ash is falling during times when resuspended ash is identified in satellite imagery, by pilot reports or other observers, and
- 3) Characterizing physical samples of particulate fallout to determine the percentage of volcanic ash compared to other material as well as the shape and size distribution.

AVO is coordinating with the National Weather Service (NWS) who has the responsibility to issue forecasts and statements of resuspended volcanic ash and Alaska Division of Conservation, Division of Air Quality, who has the responsible for issuing air quality hazards and guidance.

2015 Ash Resuspension Study



AVO staff training on-site community site operators to watch over the particulate monitor during its several month deployment. Site operators are trained to sample bulk ash and ship the sample to AVO for analysis particle size distribution. The E-BAM particulate monitor only samples particles 10 microns and smaller to assess human air quality.

Measures concentration of particulate matter in real time. Takes a physical sample on a tape that can be analyzed on a scanning electron microscope.