Recent Eruptions of Arctic Volcanoes and their Impact

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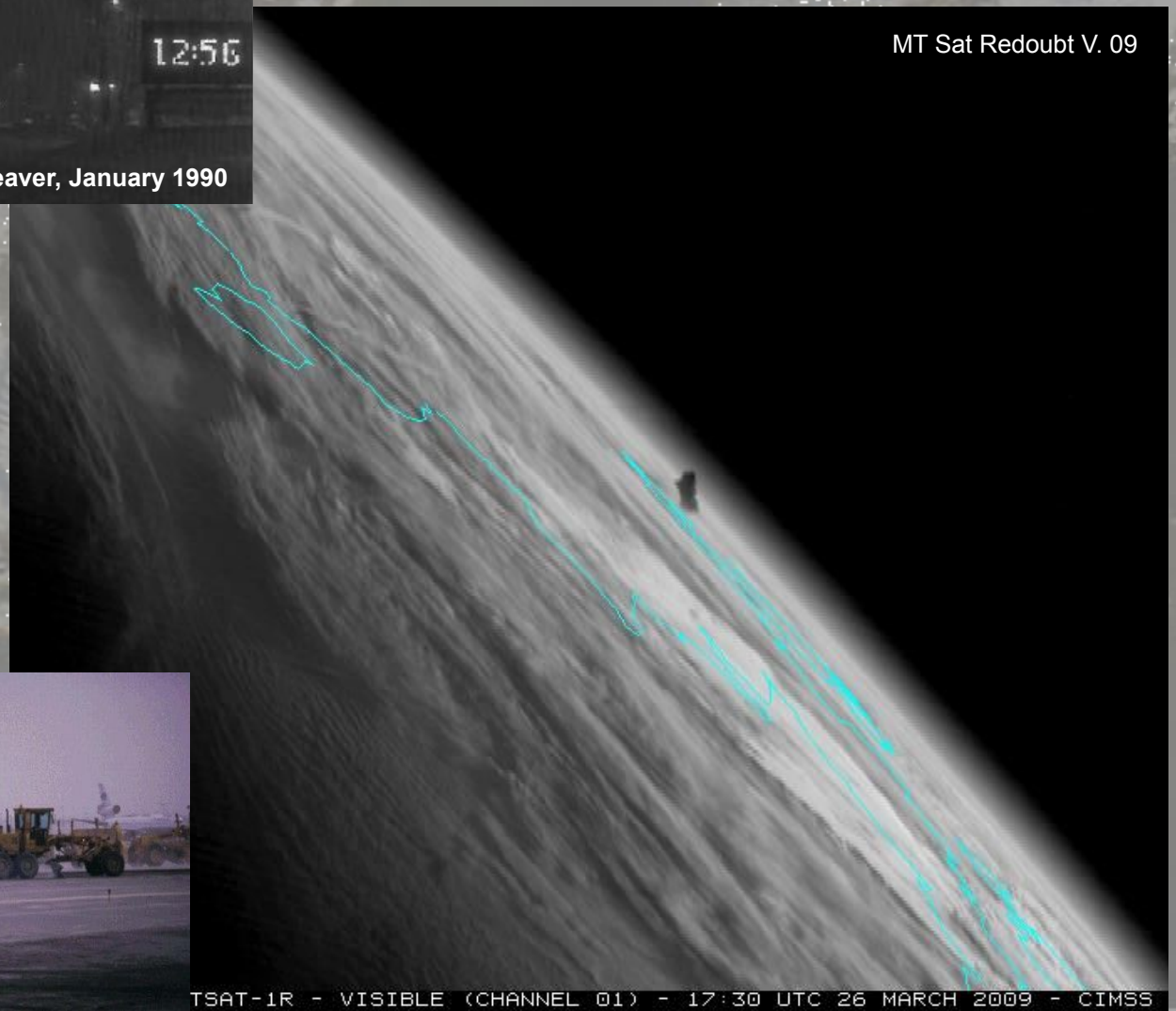
T. Weaver, January 1990



Outline of Presentation

1. Recent Arctic eruptions and impacts
2. 20 years of analysis
3. Problem airborne ash concentration
4. Solution: Airborne Ash Concentration Maps
   AACM
5. Technique
6. Prototype AACM
7. Other eruptions: Ash Composites

Iceland Eyjafjallajökull Volcano
March 27, 2010 (HALLDOR
KOLBEINS/AFP/Getty Images)

Recent Arctic Eruptions

1. Augustine, Ak. 2006 *
2. Okmok, Ak. 2008 *
3. Kasatochi, Ak. 2008 *
4. Redoubt, Ak. 2008 *
5. Sarychev, Ru. 2009 *
6. Iceland, 2010 *
7. Sheveluch, Ru. Ongoing
8. Kliuchevskoi, Ru. Ongoing
9. Karymsky, Ru. Ongoing
10. Bezymianny, Ru. Ongoing

* Primarily Explosive

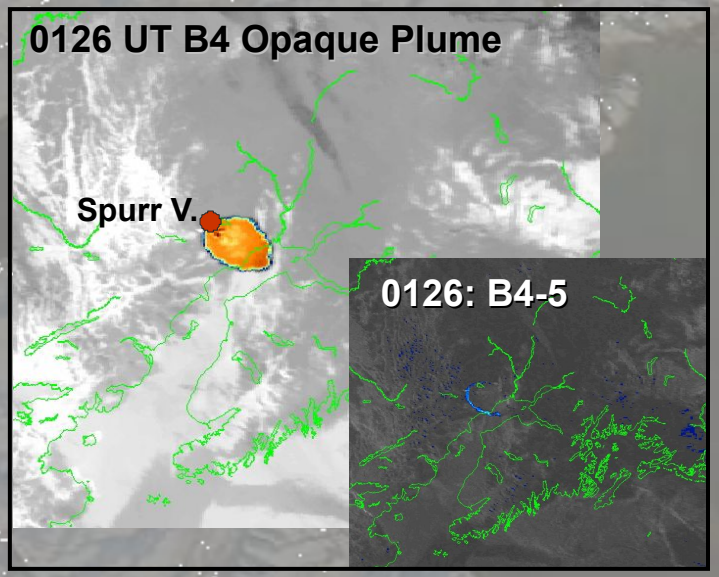
Arctic Eruption Impacts

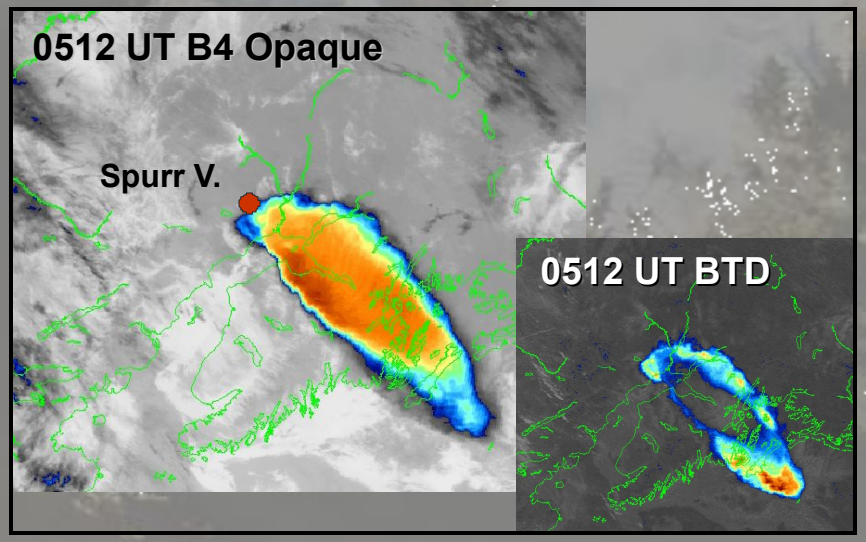
Airborne Ash Hazard

- Aircraft
- Machinery
- Infrastructure
- Transportation
- Human Health
- Large Areas Affected

Analysis: Detection/Evolution of Ash Clouds:

Eg. Spurr, 1992



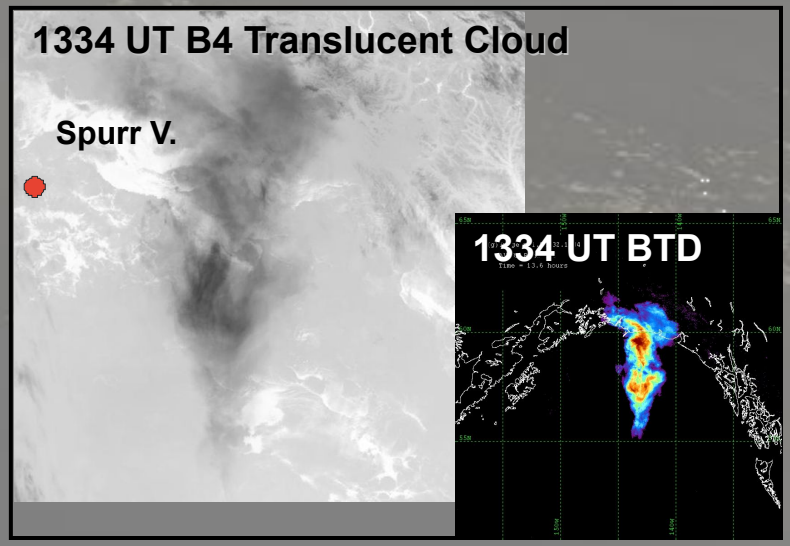


Opaque Plume To Translucent Clouds

Ash detection: BTD technique

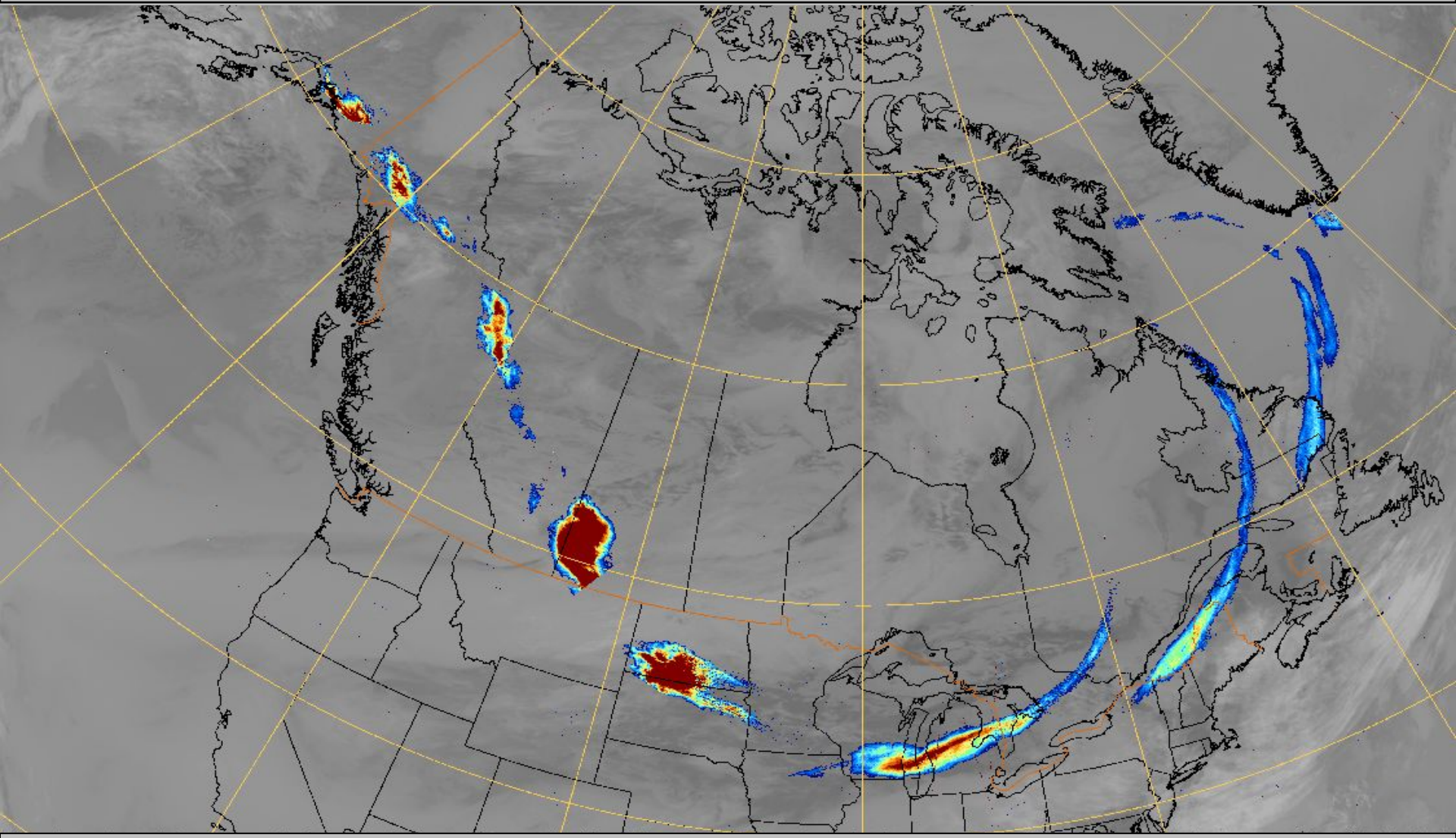
Absorption difference in long wave TIR data (Prata, 1989)

Brightness Temp. Diff. (BTD)
BTD = (10 – 11 µm) minus (11 – 12 µm)



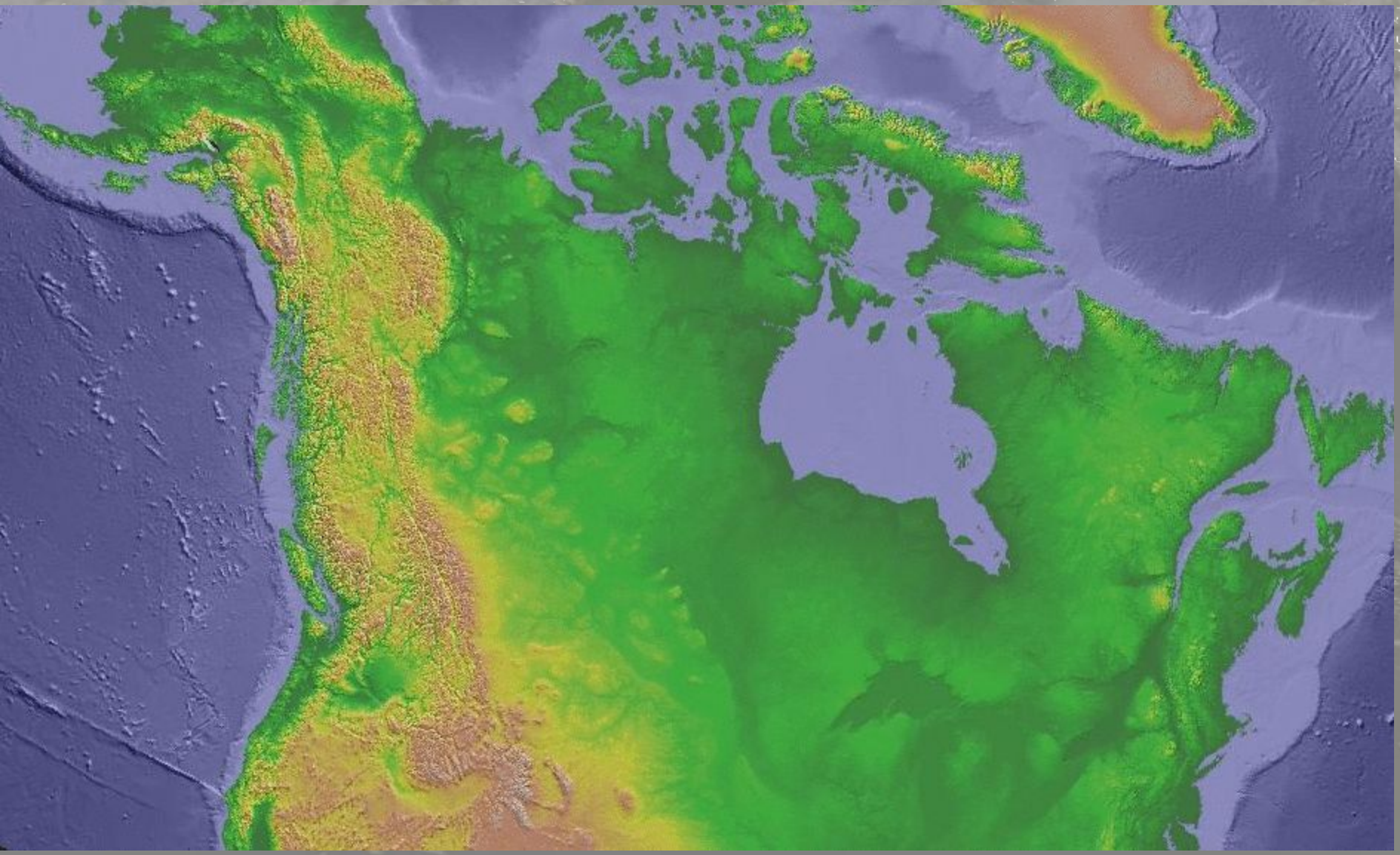
Analysis: Ash Cloud Tracking

Spurr, September 1992



Time Sequential Image: position/time, movement and rate

Analysis: Predicting Ash Cloud Movement
Spurr, 1992



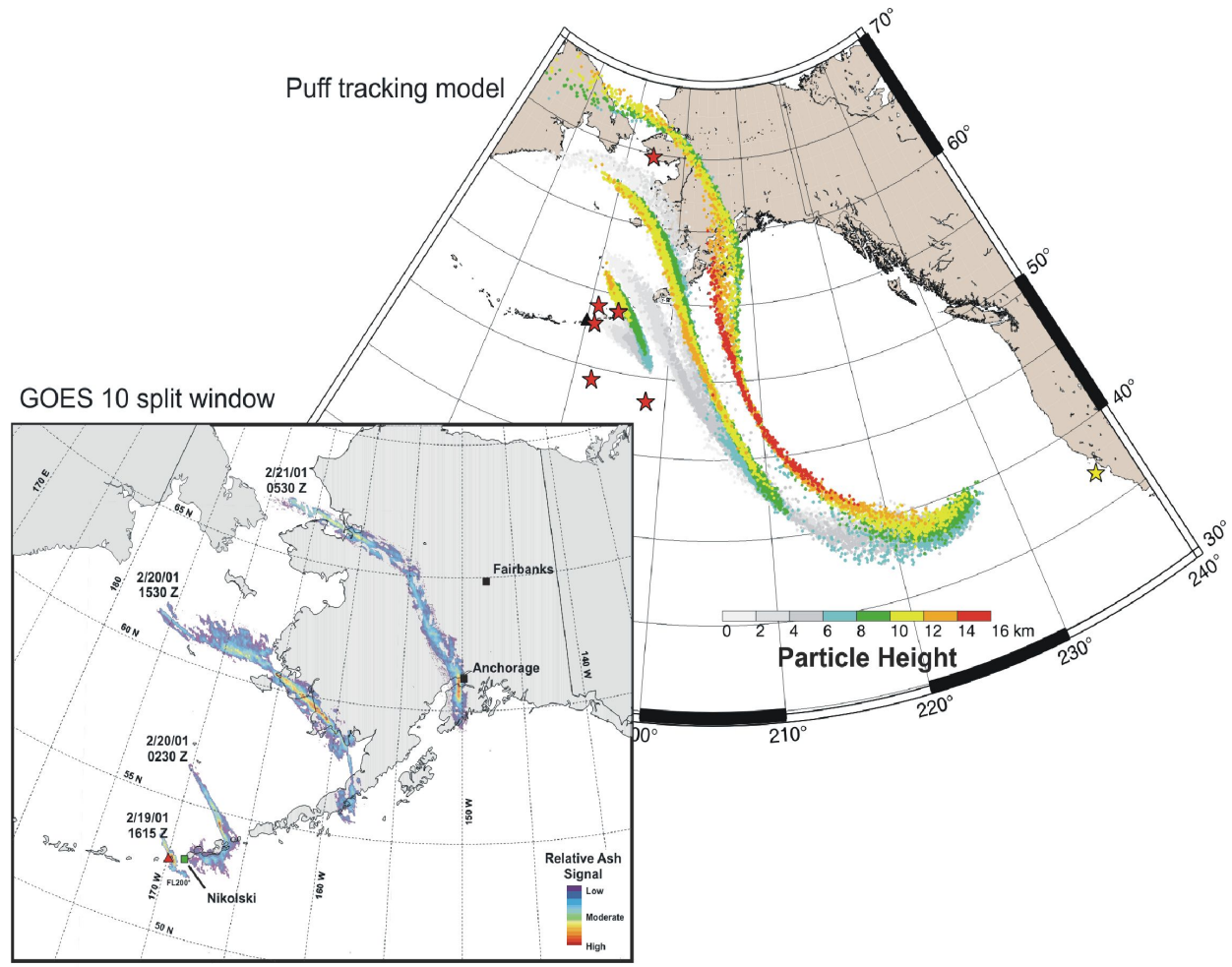
Analysis: Validating Predictions

Model: ash in areas not detected by satellite

Sat ash Signal affected by:

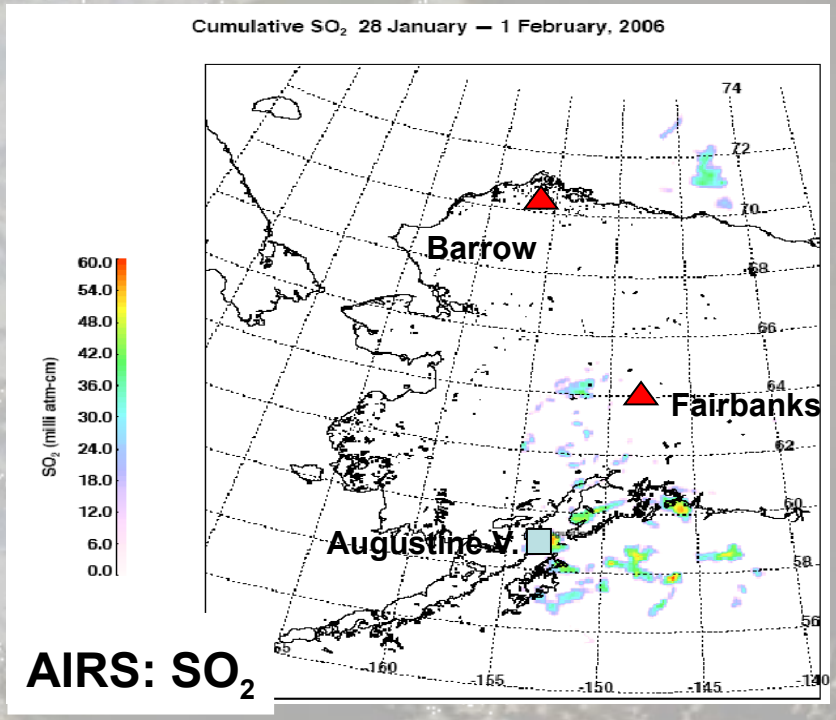
Temp. contrast
Ice,
Moisture,
Particle size,
Sensor detection limited
Other clouds,
Requires translucent cloud

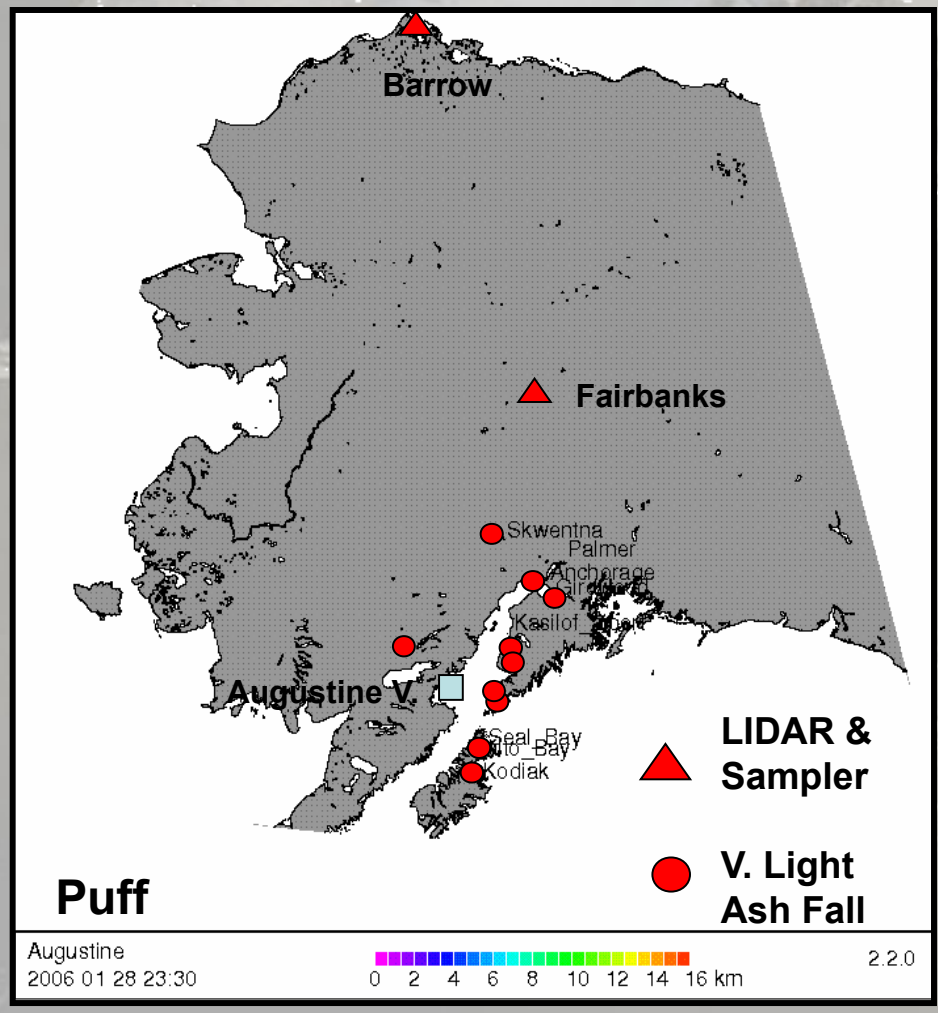
Cleveland V. 2001



Analysis: Validation Satellite Images and Dispersion Models

Augustine V.
28 Jan-2 Feb 2006





Analysis: Rapid Data Reception & Warning

Warning

Problem: Airborne Ash Concentration

- Little calibration to BTD ash signal
  Assume signal = highest concentration

- BTD environment affects signal strength

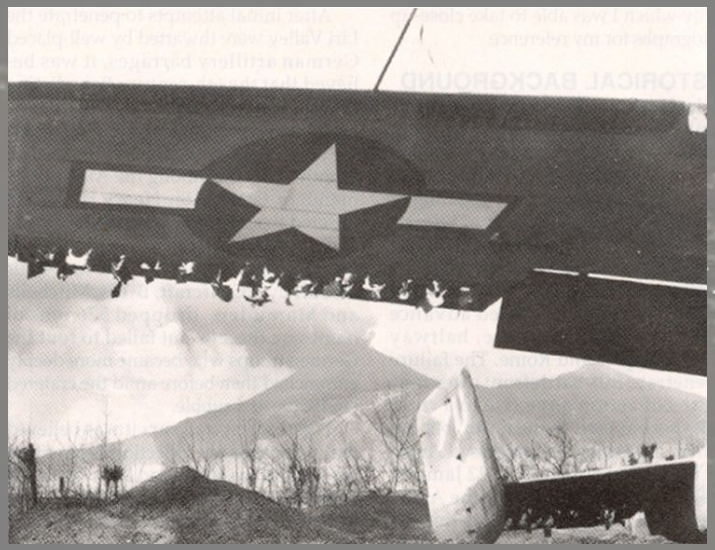
- Limited validation
  Ash fall and some LIDAR

- Limited [insitu] calibration to model data,
  Satellite data used as "ground truth"

- Difficult to calibrate and validate data
  Logistics & dynamics

* Iceland eruption calibration and validation
  Promising airborne sensors measurements

KLM, 1989

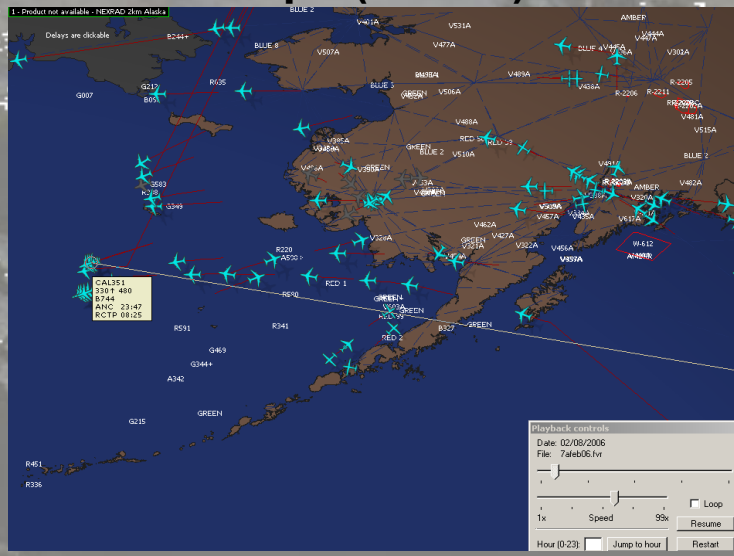


B25, 1944

A Solution: AACM

Goal: To develop near-real time Airborne Ash Concentration Maps (AACM)

- *Initially relative values*
- *Eventually "absolute" measurements*



Methodology

1. **Build on satellite and model capabilities**
   extent, position and mass

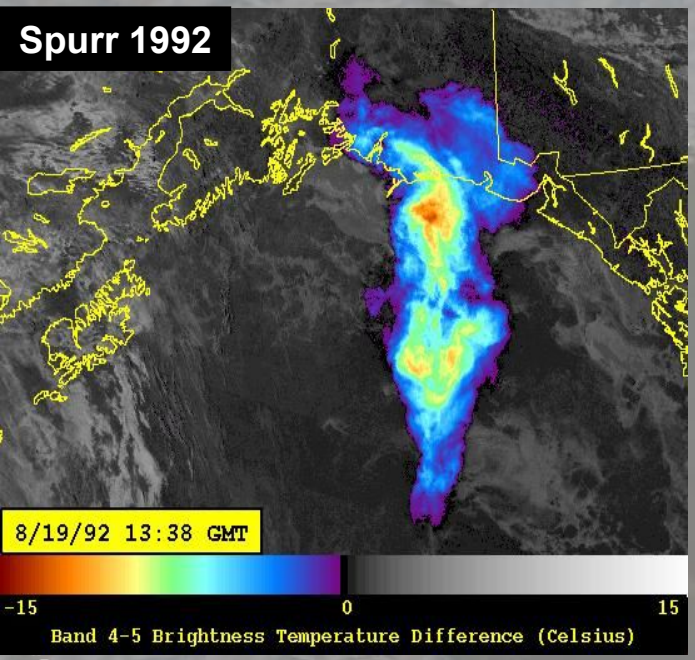
2. **Multi-temporal data merged with modeling**
   satellite and dispersion models validate relative concentrations

3. **Delineate zones with <u>relatively</u> high ash concentration**
   satellite and dispersion model values

1. ***Identify AACM* zones [satellite data & modeling]**
   High, intermediate and low
   Mass, particle size (Wen and Rose. 1994) and particle numbers

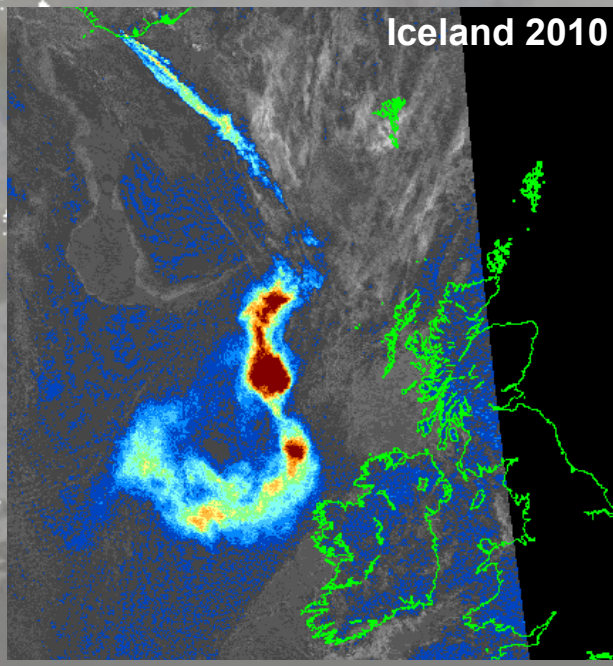
4. **Incorporate future measurements to calibrate and validate [absolute]**

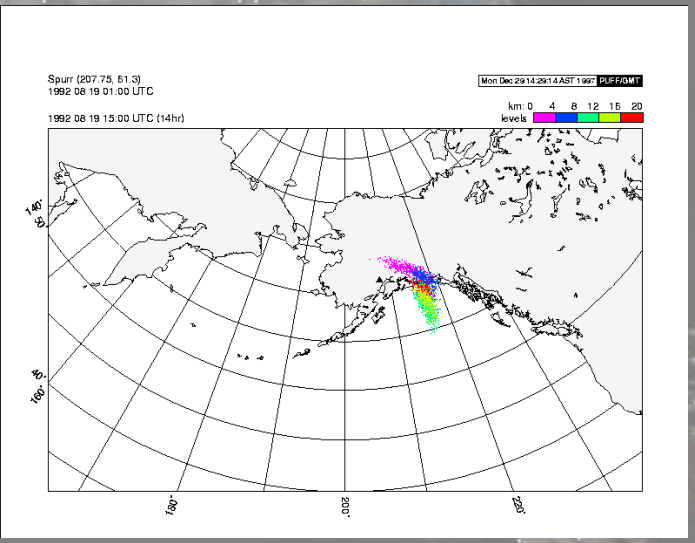
Technique: Delineating Impacted Areas



Satellite provides temporal snapshot:

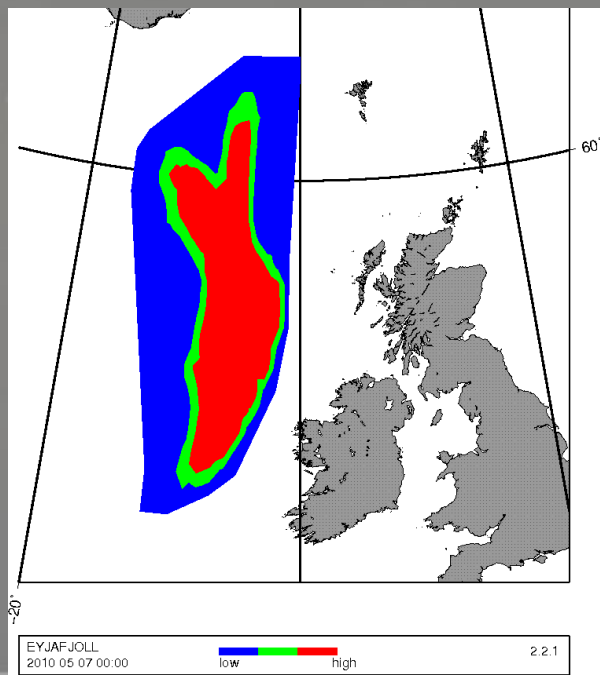
- cloud location
- areal extent
- relative strength (concentration)





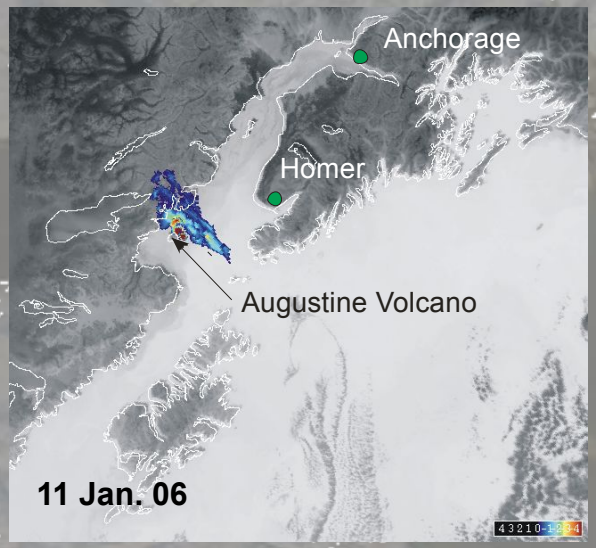
Dispersion model predicts:

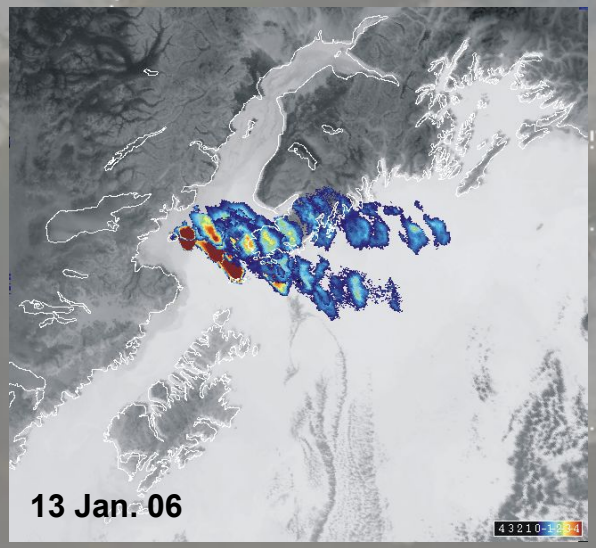
- areas that cloud passes over
- relative particle concentration
- extent of cloud
- areas below satellite detection

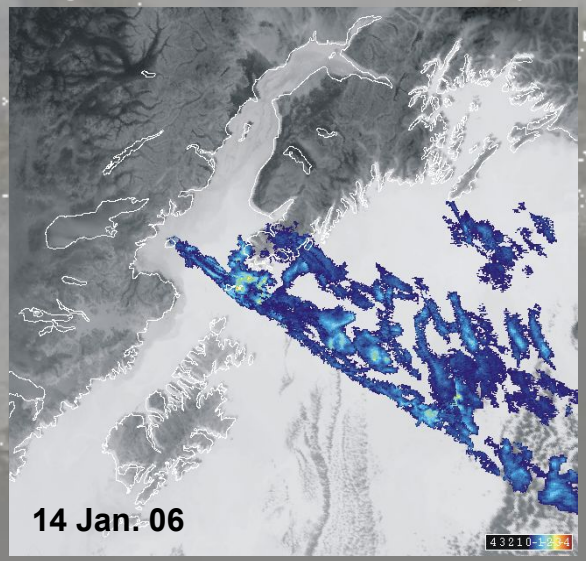


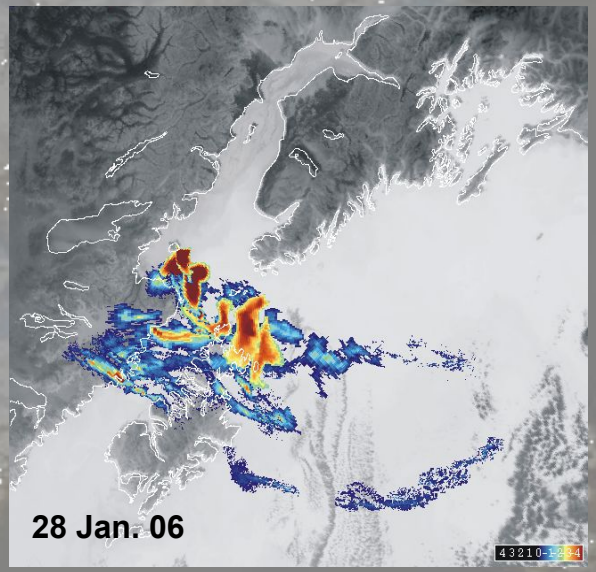
Technique: Merging Multi-temporal: Satellite Data

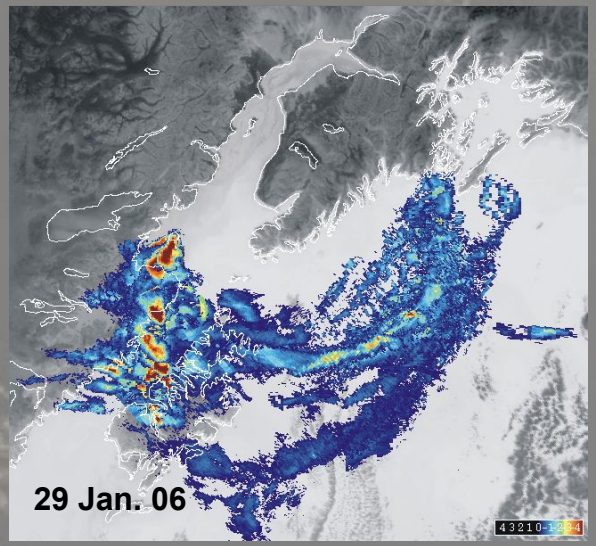
Near-real time daily composites, Augustine 2006

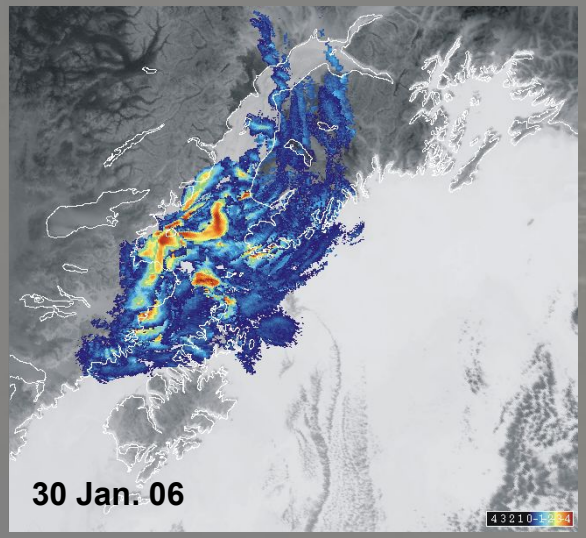












Technique: Map Signal and Area

Augustine, 2006

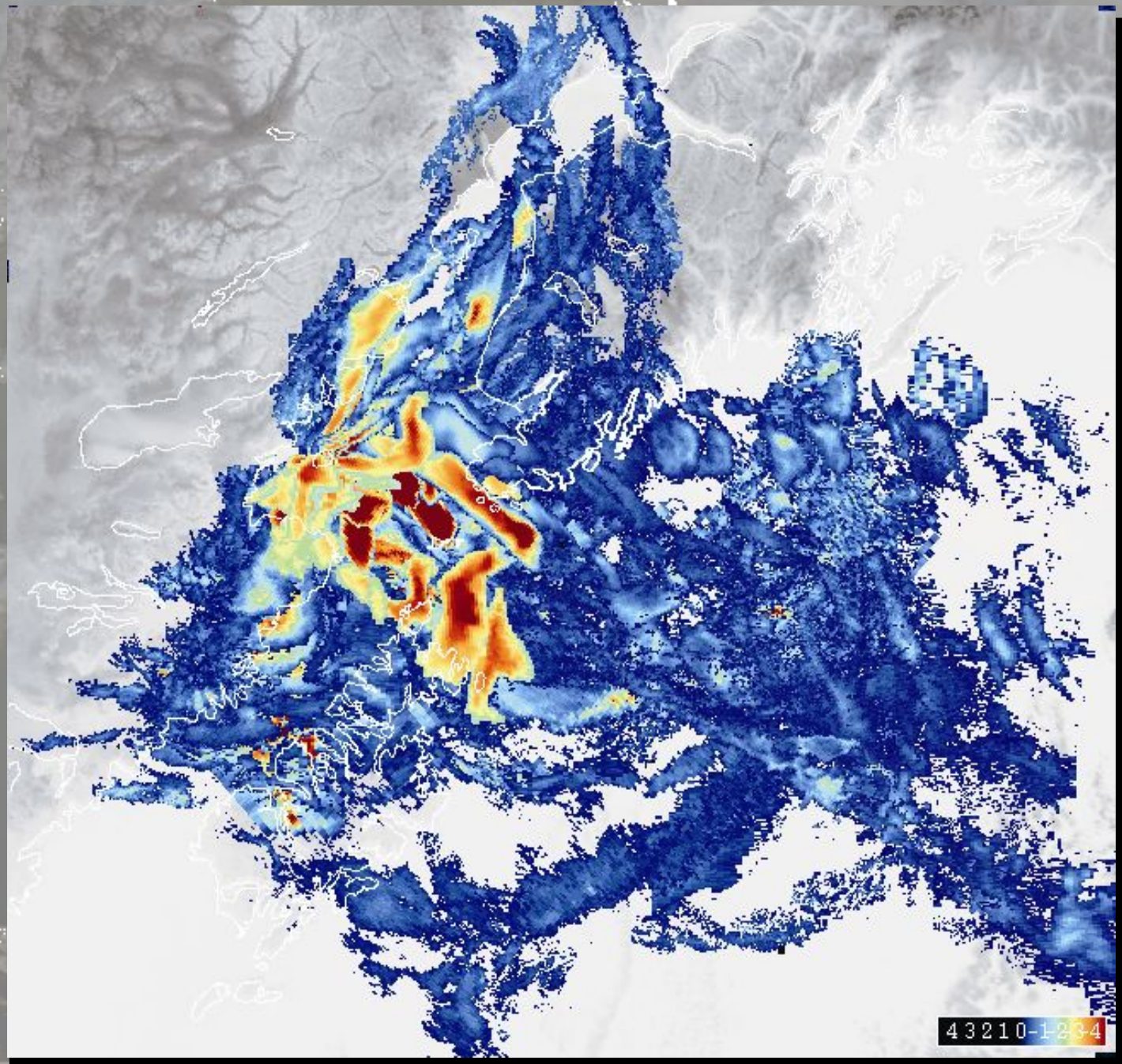
Full eruption view

Strongest Signal (most negative)

Classify ash (two levels) to ID zones

1. Hi Ash Signal (red to yellow)

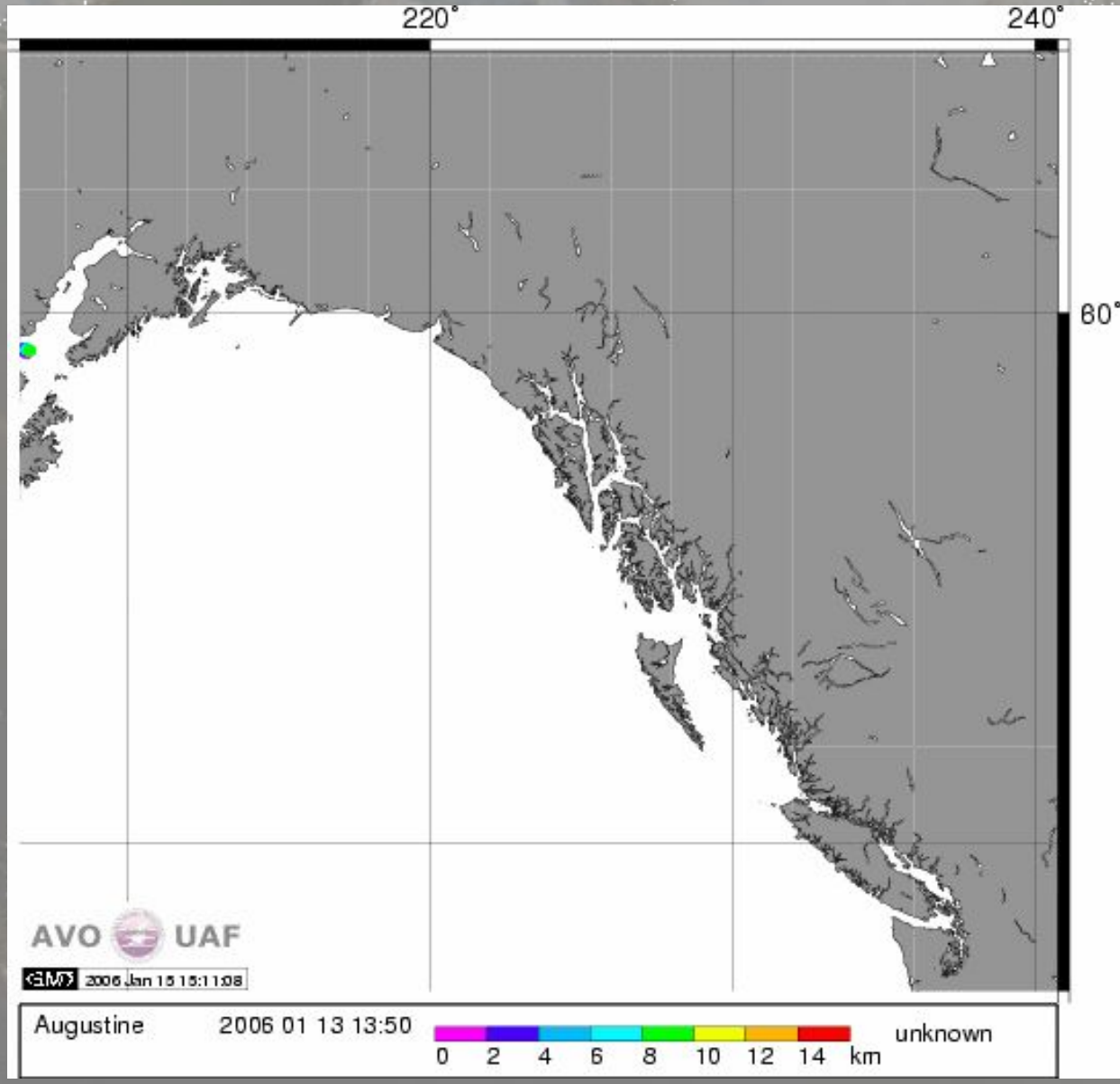
2. Intermediate signal (shades of blue)



Technique: Merging Dispersion Model Runs

Define Maximum Extent of Impact Area

Augustine, January 13-14, 2006



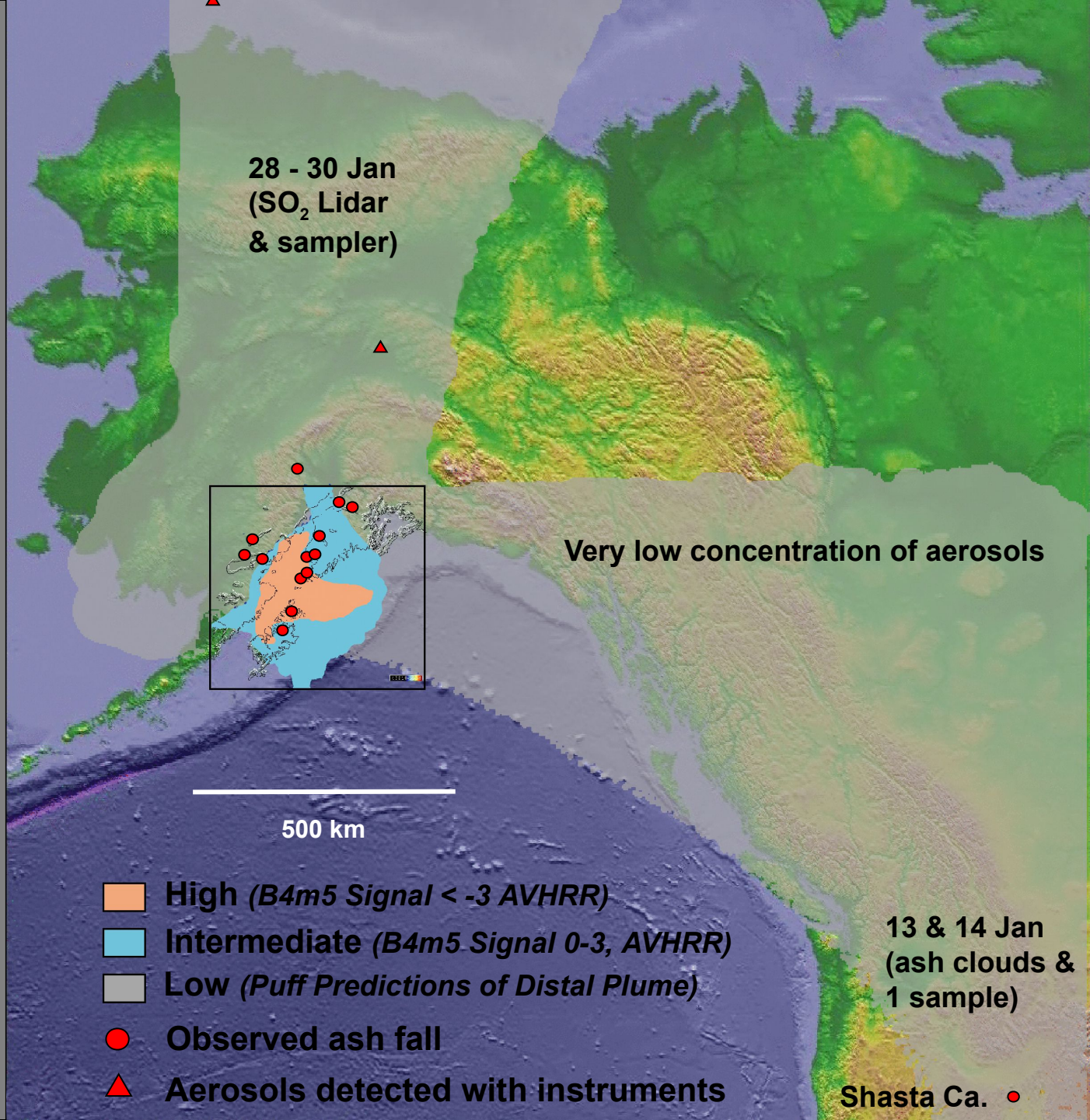
Prototype Relative AACM

Augustine V. 2006

Colored Zones
BTD Data

Gray zones
dispersion model

Generated in
near-real time



Hypothetical Absolute AACM

Augustine V. 2006

Aircraft

- 50mg/m^3 = Dangerous
- 500mg/m^3 = Stall
- 2000mg/m^3 = KLM

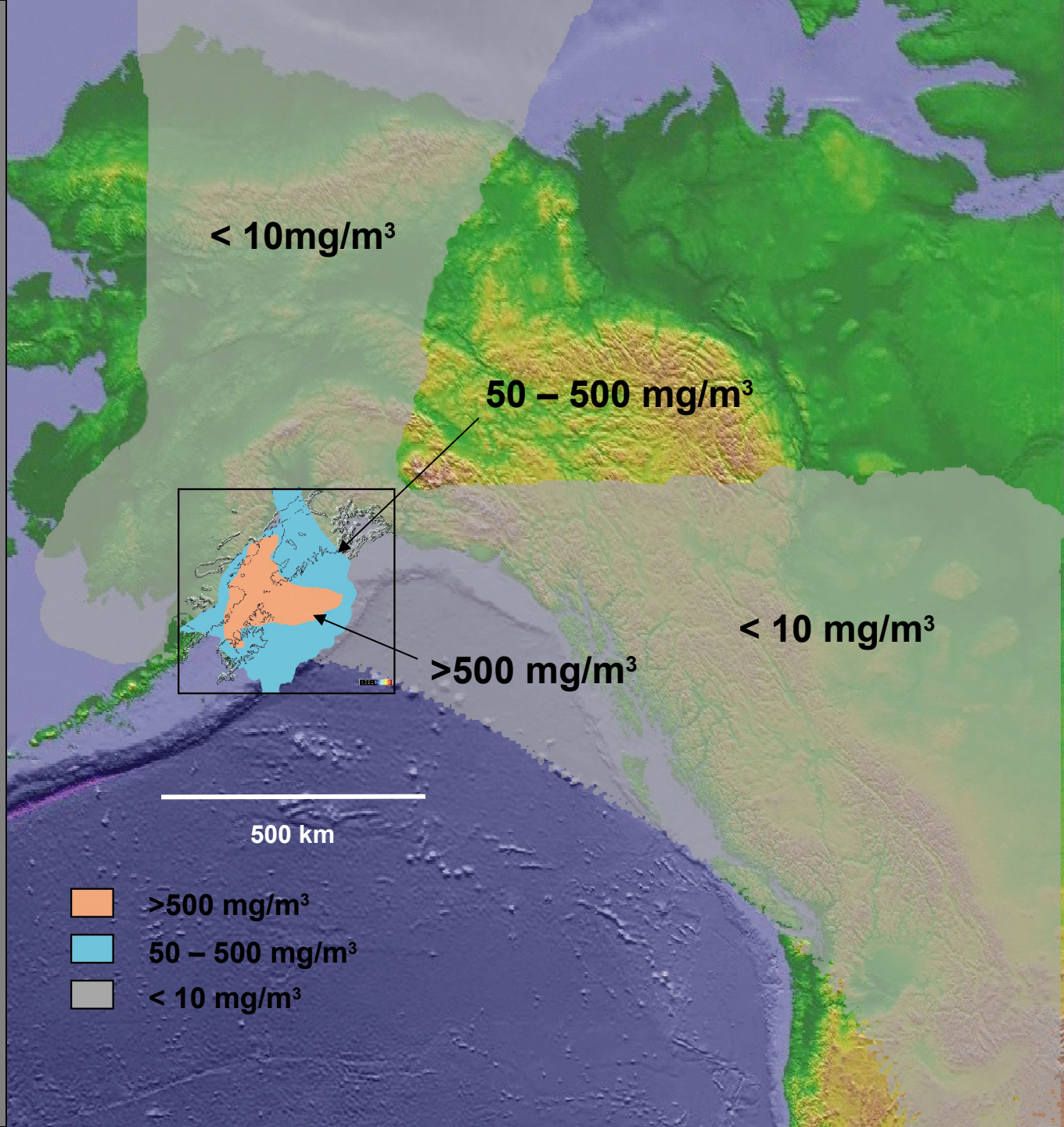
(Foreman, 1991)

Human Health (Cahill)

- 15 ug/m^3/yr for <2.5 microns size

- 35 ug/m3 / 24 hour average

(National Ambient Air Quality standards)

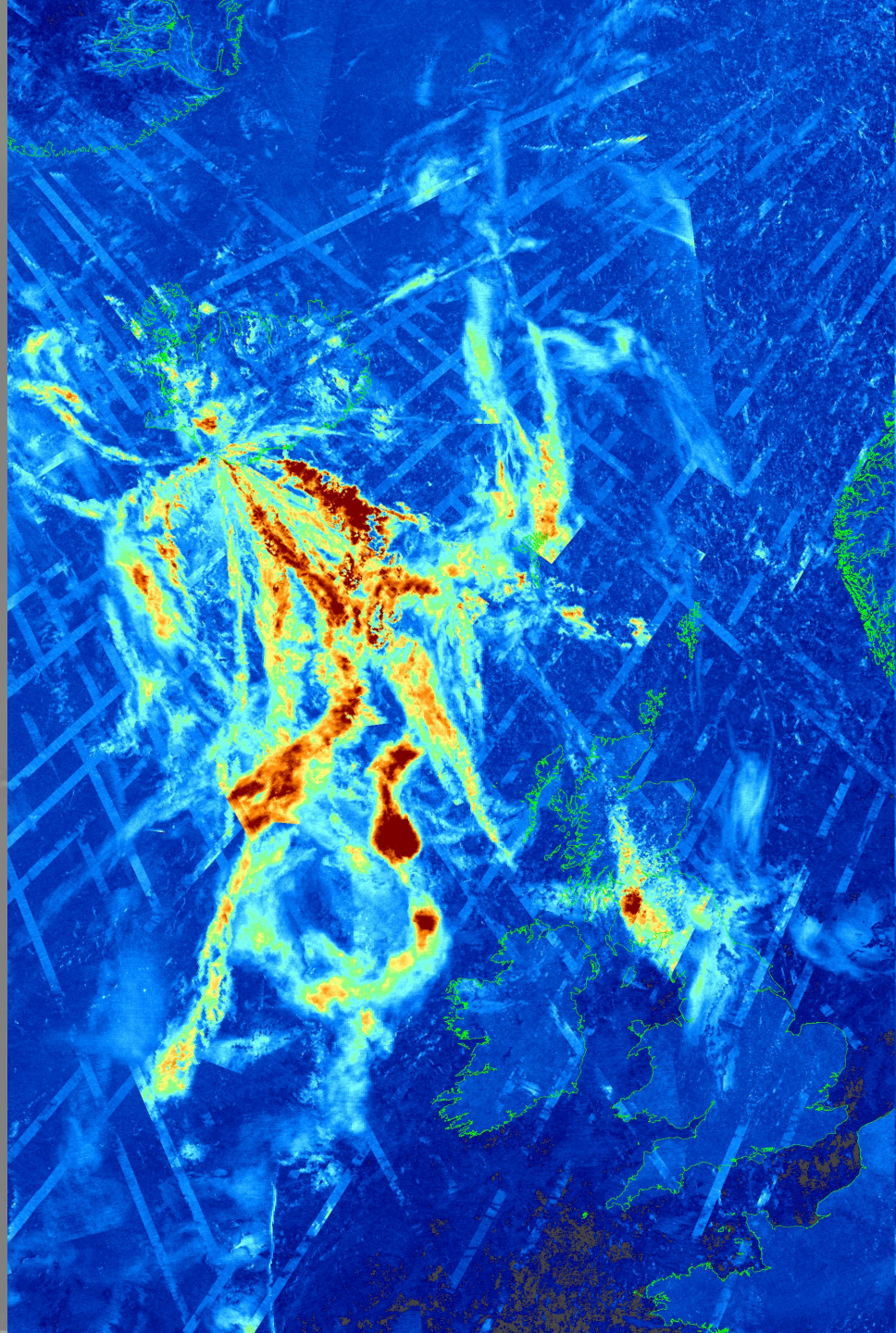


Other Eruptions: Ash Composite, Iceland, 2010

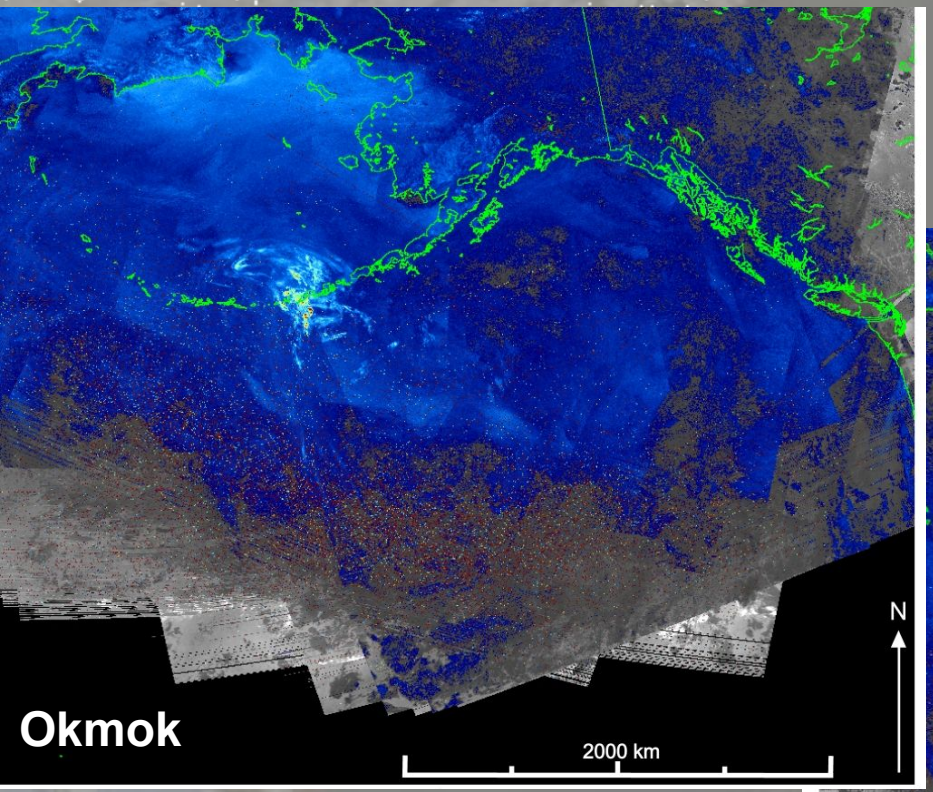
<u>Raw Composite</u>

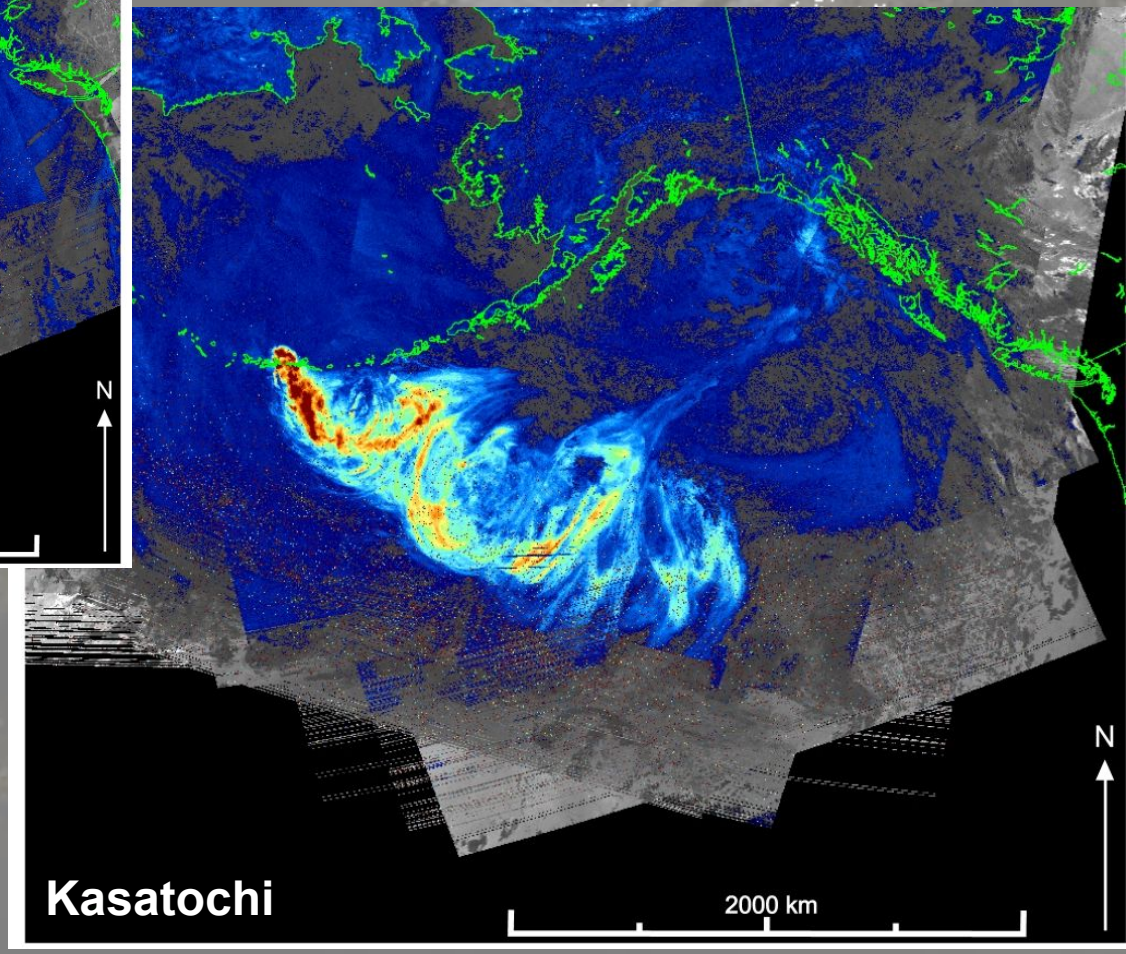
Research Product
Not Operational
Time: 10April – 23May 2010

Ideally: Operational products would be real-time and cover 6 to 24 hr. period._



Other Eruptions: Ash Composite Alaska, 2008





The End, Home for the Winter