

ERTH 456 / GEOL 556
Volcanology

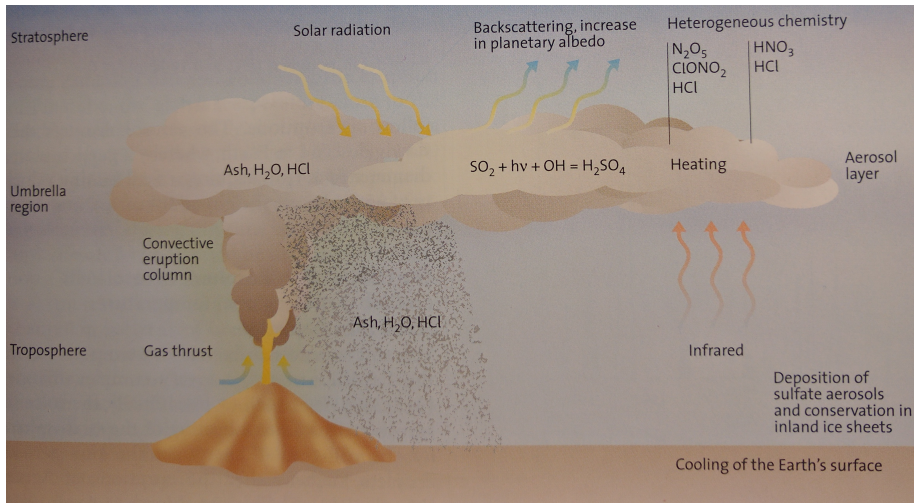
– Lecture 28: Volcanoes & Climate –

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hours: TR 3-4PM or appt.

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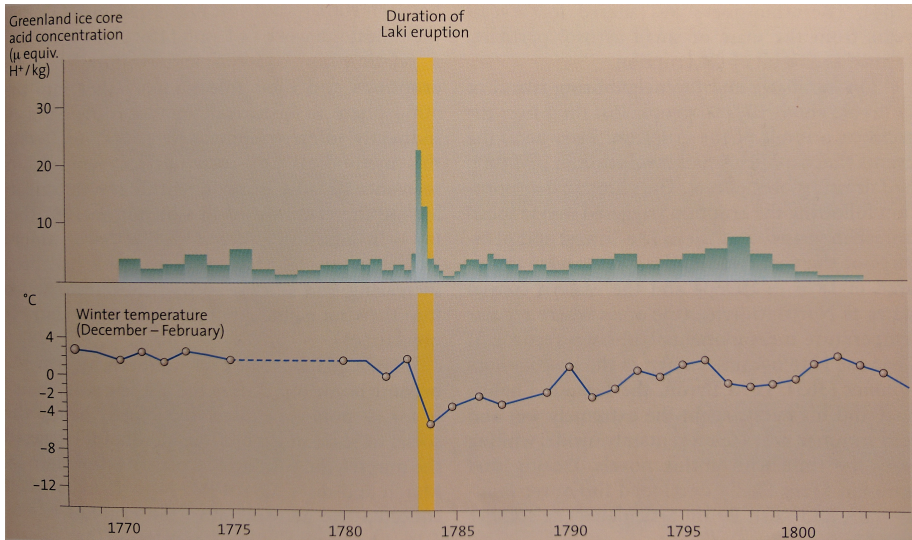
What do you remember from the Iceland / Laki case study?

How do Volcanoes Impact Climate?



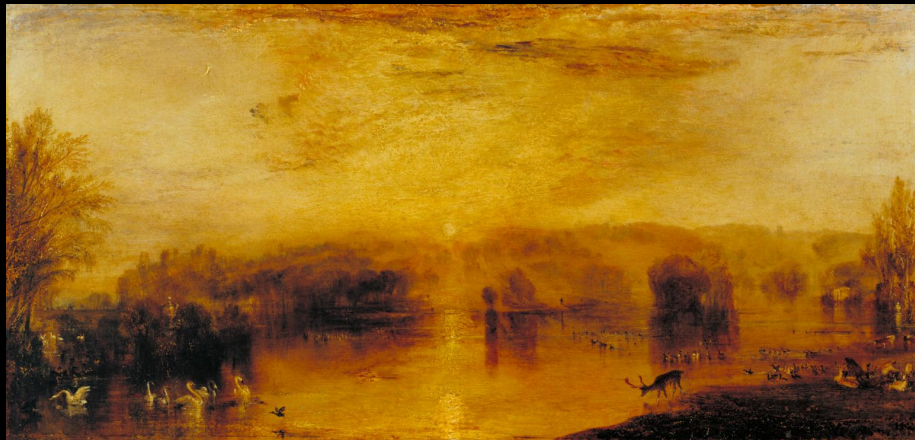
Schmicke, 2004

1783 Laki Example



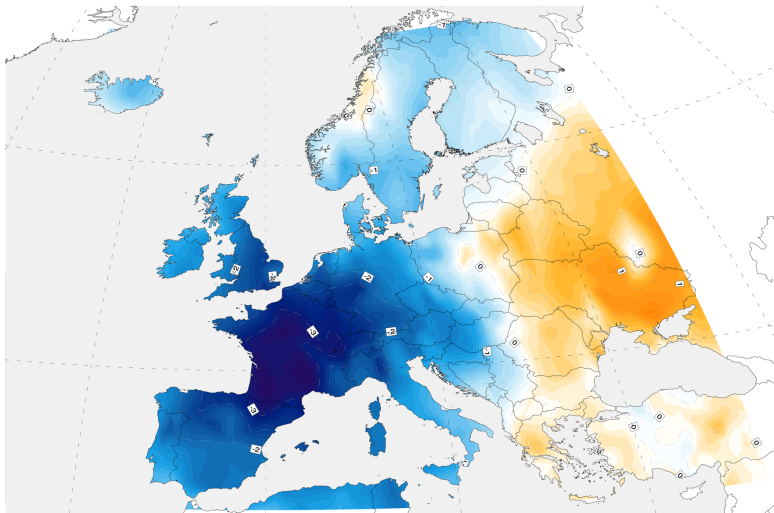
Schmicke, 2004

1815 Tambora - William Turner, "The Lake, Petworth"



1816 Temperature Anomalies

1816 Summer Temperature Anomaly



1816 temperature compared to 1971-2000, wikipedia.org

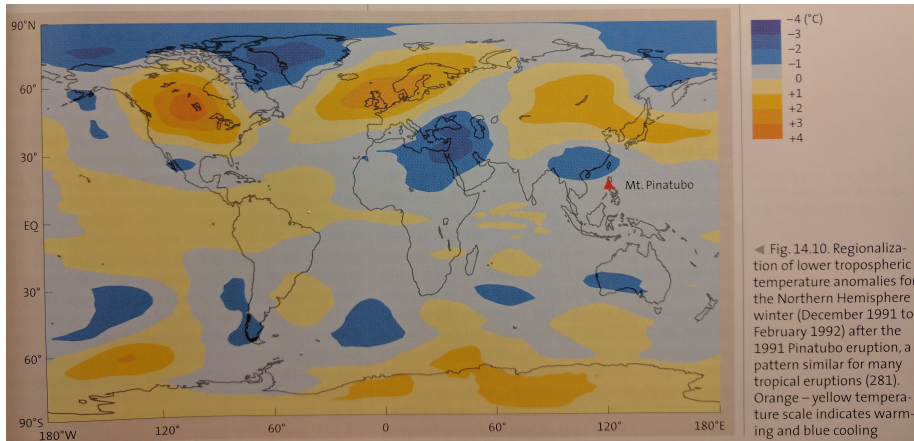
Making Connections

- Laki 1783, 12.5 km³ - famine, fluriosis, temperature drop
- Tambora 1815, 50 km³ - Year without a Summer, avg. global temp < 0.4-0.7°C
- Krakatau 1883 - brilliant sunsets explained by dust / ash due to eruption
- El Chichón 1982 - aircraft collected aerosols; mainly H_2SO_4
- 1980: TOMS (total Ozone Mapping Spectrometer) online, measured SO_2 during eruption
- Realization that volcanic gases responsible for short term climate changes

Making Connections

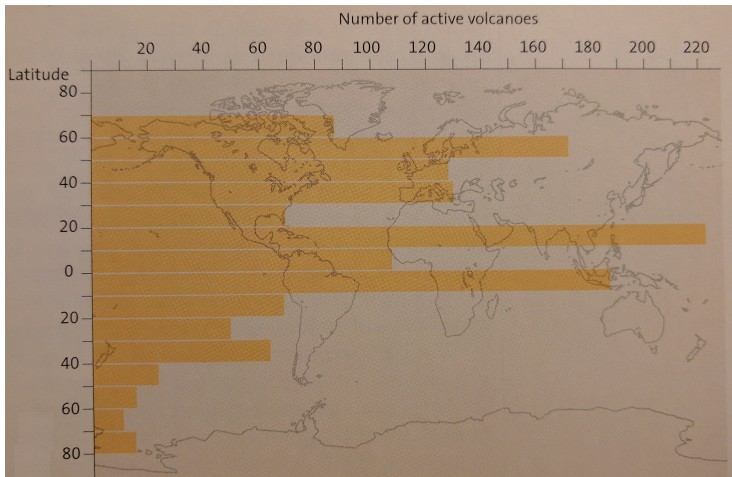
- Photochemical reaction between SO_2 , H_2S with H_2O , OH forms sulfuric acid droplets (≈ 1 μm diameter)
- Injection into stratosphere, heights of 20-30 km; results in km thick continuous aerosol veil
- Can remain in stratosphere for years (doesn't rain out as in troposphere)
- Heating of stratosphere from above and below changes atmospheric circulation, tropospheric temperatures

1991 Pinatubo - Regionalization of Impacts



Schmicke, 2004

Number of Active Volcanoes by Latitude

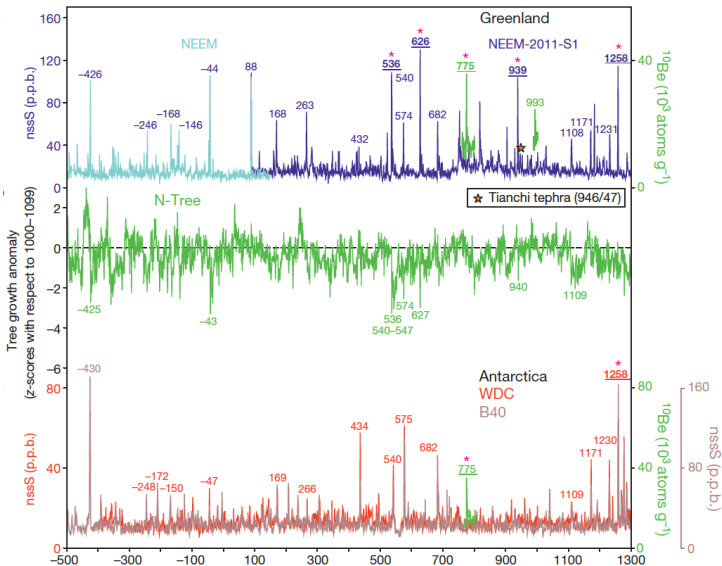


Schmiche, 2004

- Large eruption impact climate, few of those in historic record
- Analyze ice cores for atmospheric aerosol loading; Greenland & Antarctica.
- Where on the ice would you sample?
- (tree ring analysis another method to establish time lines)

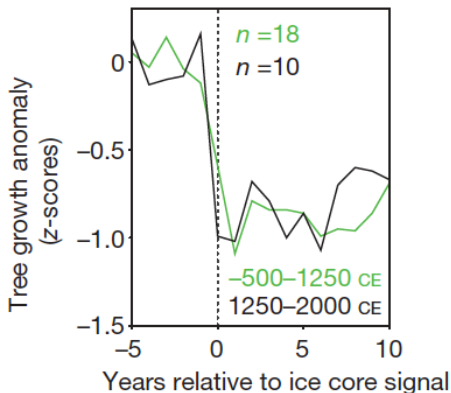
- *Sigl et al., 2015* analyzed past 2,500 year records
- Cooling proportional to magnitude of volcanic eruption
- Cooling persisted for up to 10 years after some of largest eruptions
- Volcanic eruptions implicated in 6th century pandemics, famines in Eurasia, Central America

Ice Core Records



Re-dated ice-core, non-sea-salt sulfur (nssS) records from Greenland and Antarctica in relation to growth anomalies
Sigl et al., 2015, Nature

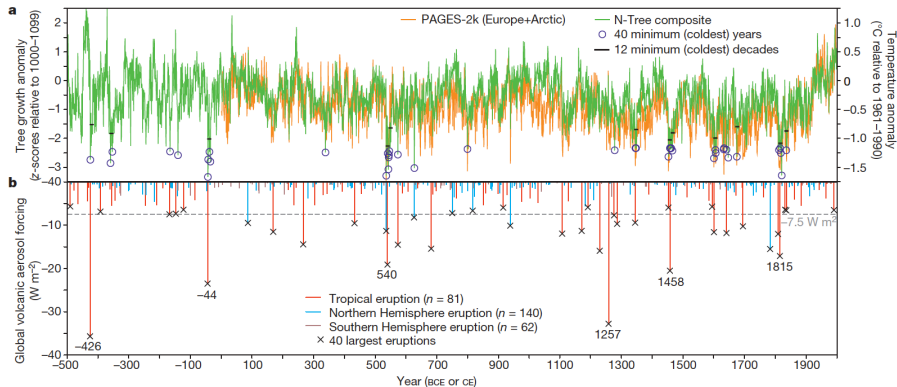
N-Tree Composite Anomalies



Superposed epoch analysis for 28 large volcanic signals during the past 2,500 years
Sigl et al., 2015, Nature

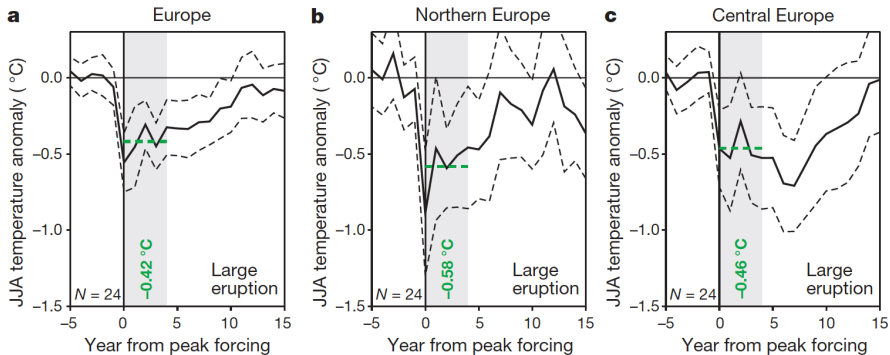
Global Volcanic Aerosol Forcing

Aerosol Forcing: incoming solar energy radiated back to space, energy lost for Earth



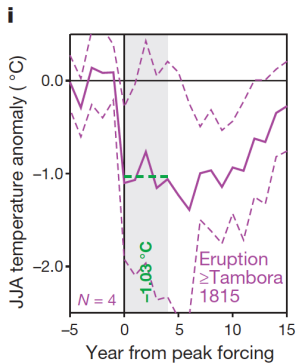
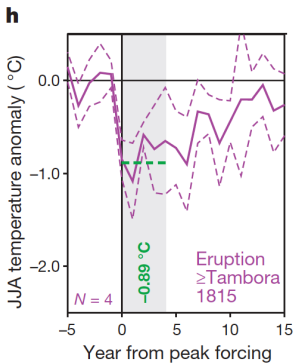
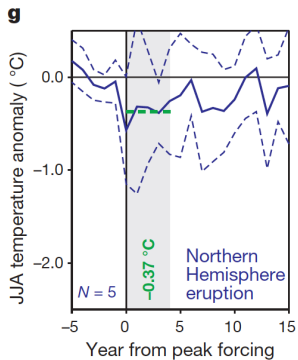
Global volcanic aerosol forcing and Northern Hemisphere temperature variations for the past 2,500 years;
Sigi et al., 2015, Nature

Post-Volcanic Cooling 1/2



Superimposed June-July-August (JJA) Temperature Anomalies;
Sigl et al., 2015, Nature

Post-Volcanic Cooling 2/2



Superimposed June-July-August (JJA) Temperature Anomalies
Sigl et al., 2015, Nature