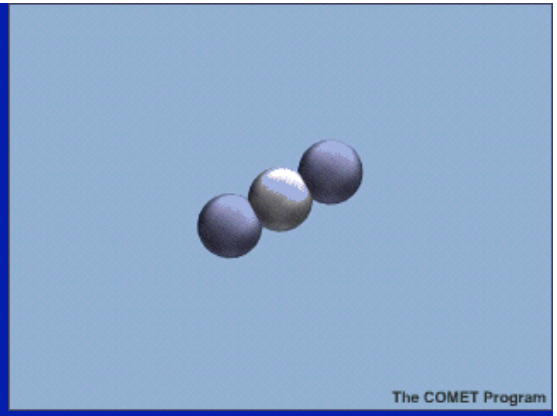

Our Climate: A Global Challenge

Academy for Lifelong Learning
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Aerosols

http://earthobservatory.nasa.gov/Features/Aerosols/

Airborne Aerosols

Understanding anthropomorphic effects on climate change means understanding aerosols.

Aerosols are micron scale particles consisting at least in part of solid material.

Density of an aerosol particle: 1.0 g/cm^3 (for soot) to 2.6 g/cm^3 (for minerals).

Natural aerosols:

salt (from seawater), natural terrestrial biomass burning, volcanic eruptions, windblown dust

Man-made aerosols:

pollution from industrial production, engine exhaust, burning trash, etc.

Density of aerosol particles varies a lot:

continent 2,300/cm^3 (windless desert), 3,000/cm^3 (clean air), 50,000/cm^3 (polluted), 160,000/cm^3 (urban)

sea 1,000/cm^3 (clean), 300-600/cm^3 (cleanest)

Arctic 6,600/cm^3 (mostly soot); Antarctic desert 43/cm^3 (sulfate)

Airborne Aerosols

Where are they found?

In the air over oceans, deserts, mountains, forests, ice, and every ecosystem in between

A billion tons of dust from the Sahara each year.

Small light particles stay in the atmosphere up to two weeks.

Volcanic ashes (small aerosols) rise in the atmosphere and can stay for 2 years.

Some aerosols block sunlight & cause cooling (by decreasing surface sunlight)

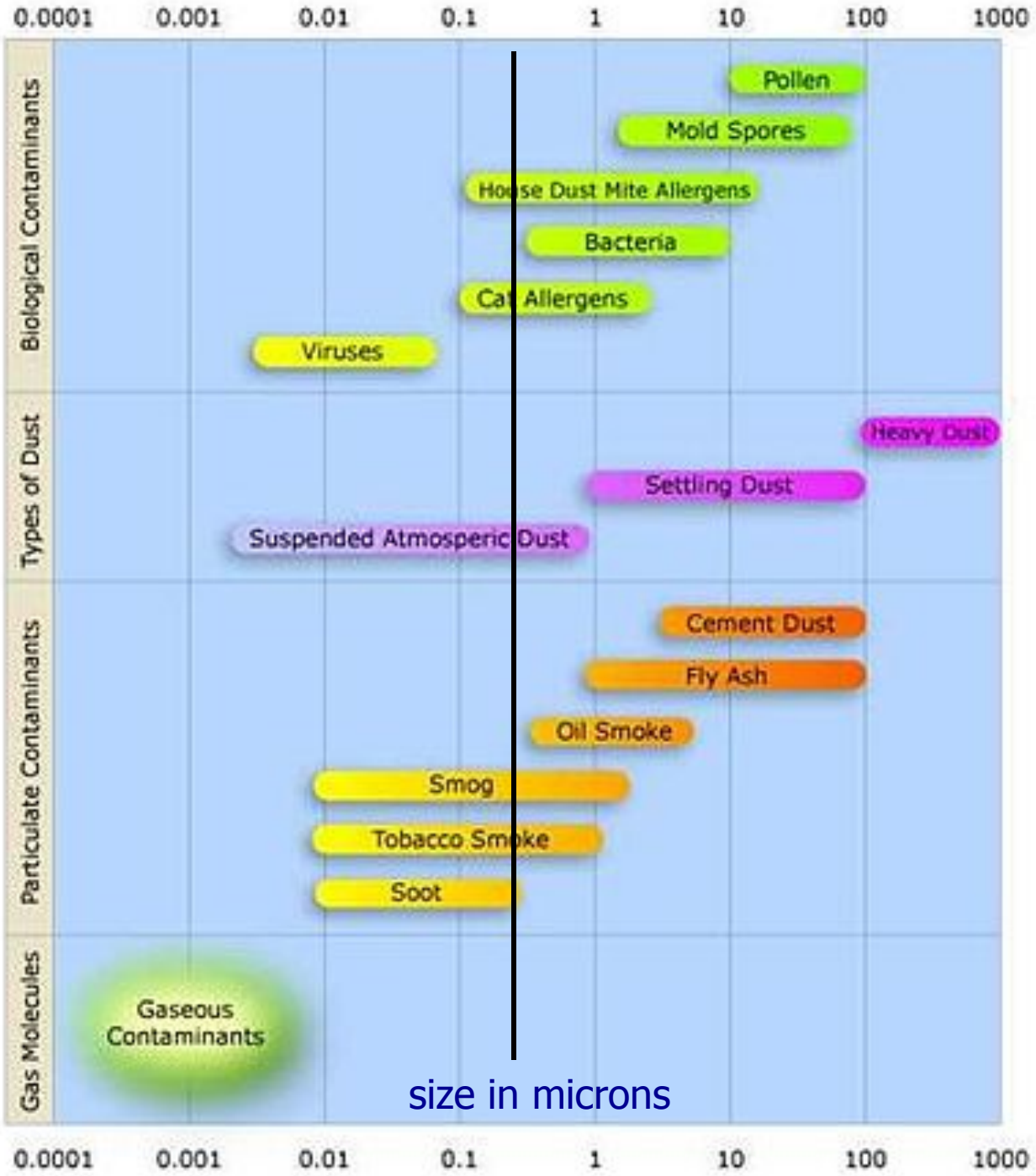
Volcanic emissions

Black soot absorbs solar radiation causing warming

Anthropogenic sources now overwhelm natural sources over much of the globe

Some aerosols are important in nucleating raindrops

Other aerosols nucleate water droplets causing “shallow” / thin clouds or haze.



Aerosol sizes

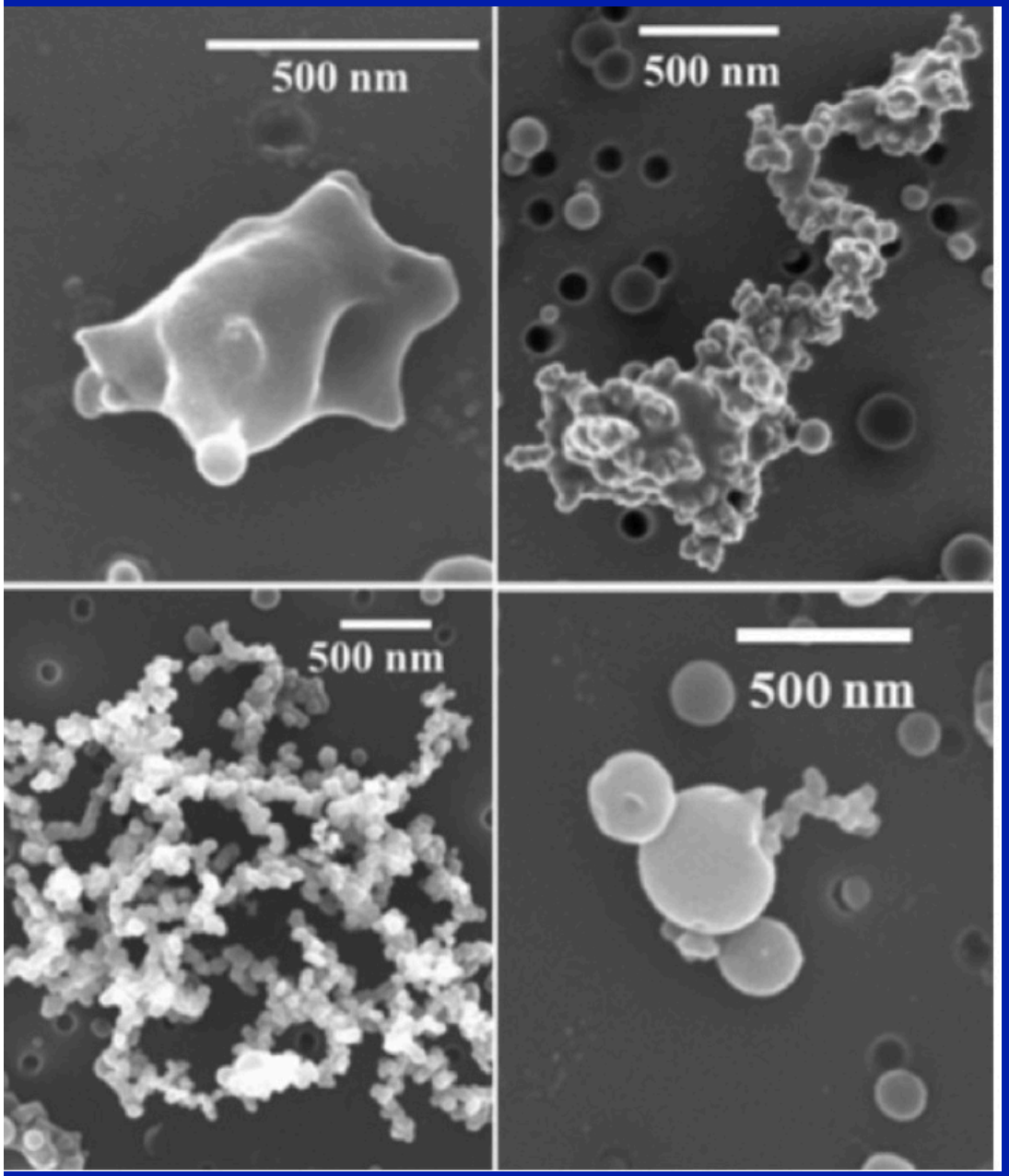
Cloud condensation nuclei <0.2 microns

sea salt, dust, soot and, yes, viruses

-> rain, which washes out some of the larger aerosols

Watch for the term bioprecipitation in the news, and don't go out and play in the rain.

Carcinogenic to humans



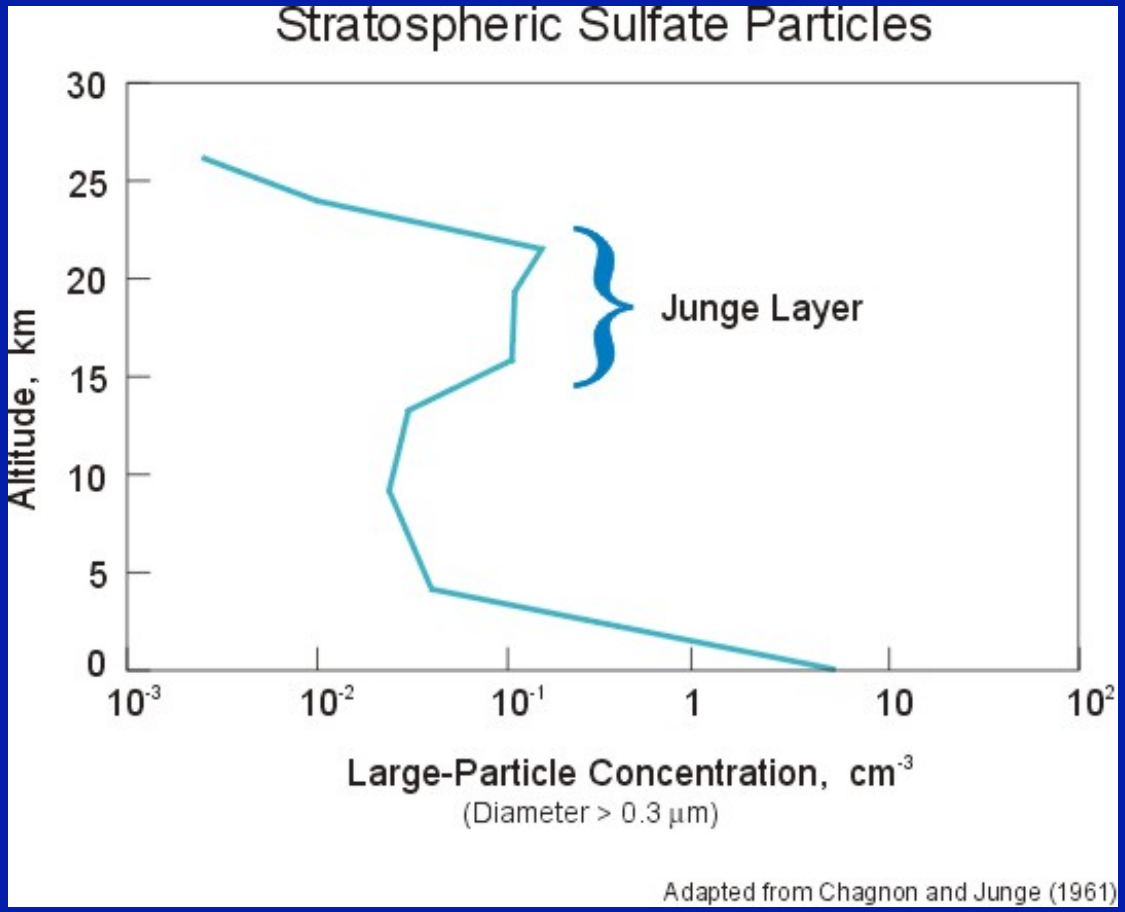
The enormous variety of aerosol shapes and chemical compositions is maddening to modelers

- These are soot particles, tarballs, etc. from a 2011 New Mexico fire

Credit Warren Wiscombe: NASA, GSFC 2014

Junge Layer

Volcanic sulfur dioxide (SO_2) and natural sulfur compounds end up here as sulfuric acid droplets, H_2SO_4 that hydrolize to SO_4. SO_4, sulfates, have a strong cooling effect (aka global dimming) until they precipitate out over a few years.



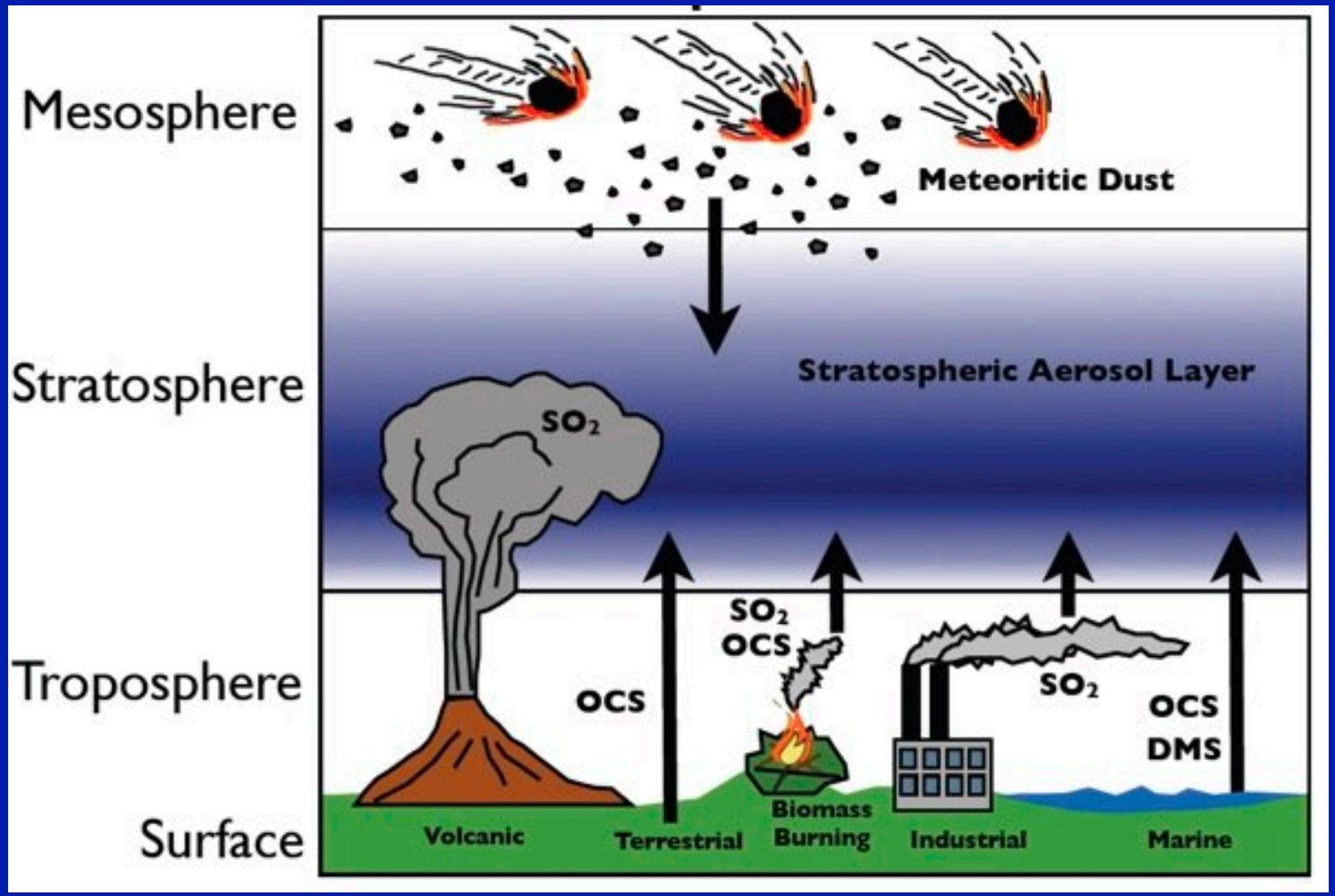
More under climate engineering.

See also sulfur cycle

Credit Warren Wiscombe: NASA, GSFC 2014

Stratospheric aerosol layer: sources

OCS: carbonyl sulfide; emitted from oceans, volcanoes and deep sea vents
DMS: dimethal sulfide $(CH_3)_2S$; marine phytoplankton, common in foods

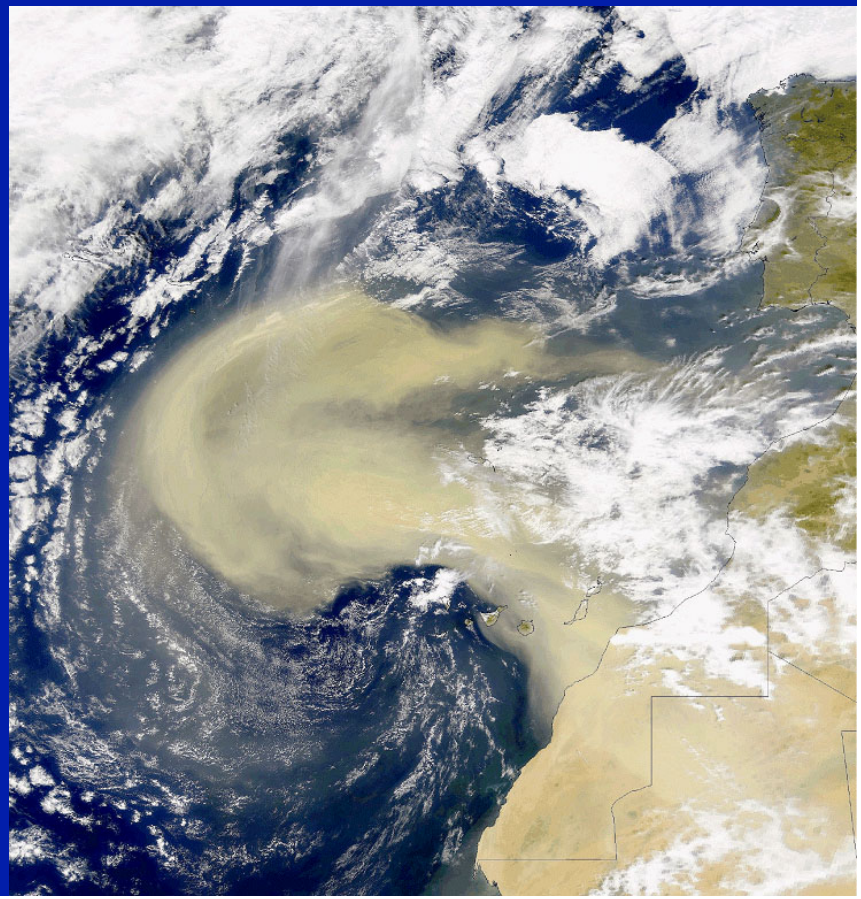


Credit Warren Wiscombe: NASA, GSFC 2014

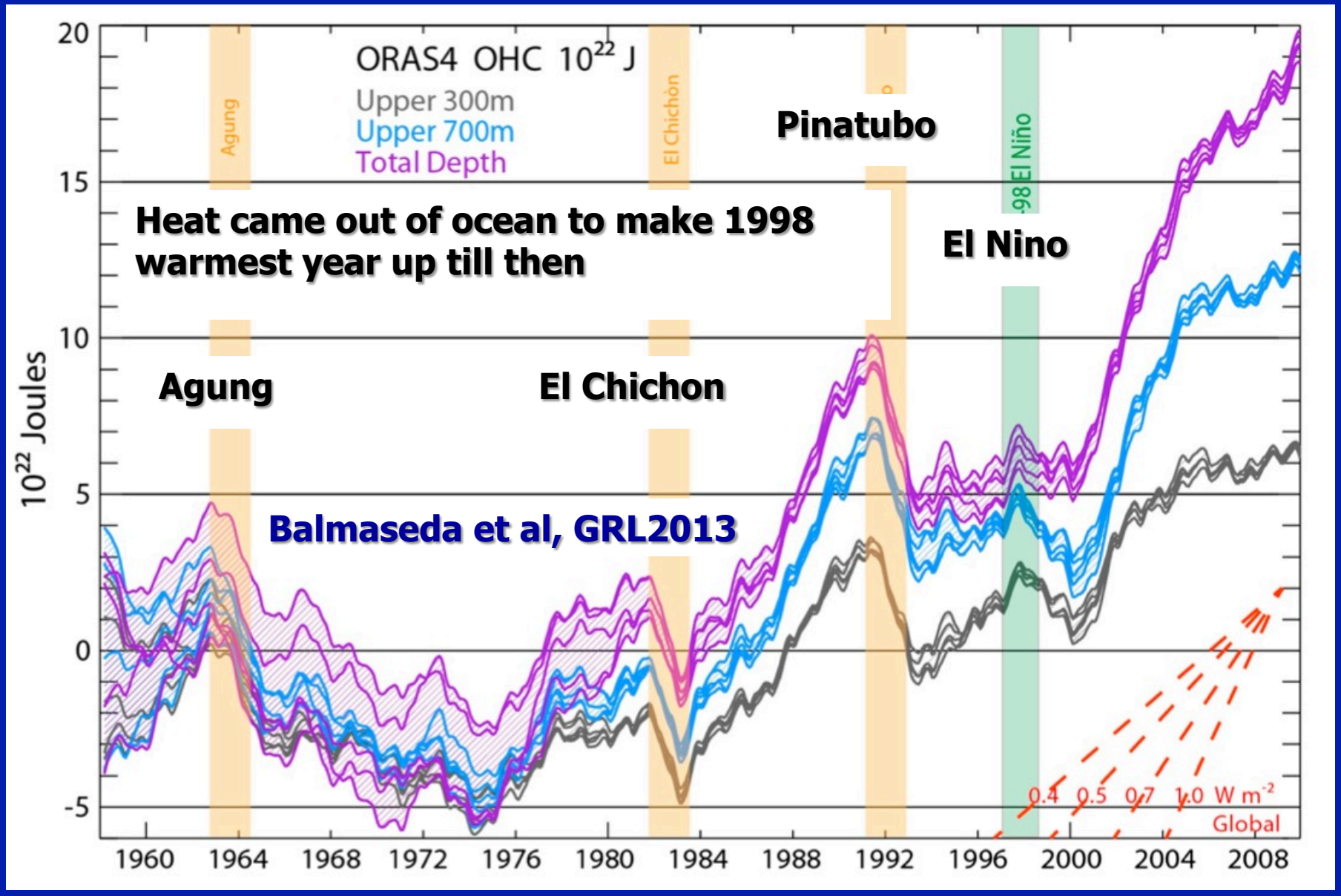
Saharan dust feeds the Amazon rain forest

http://www.worldclimatereport.com/index.php/2007/03/09/saharan-dust-savior-of-the-amazon-rainforests/

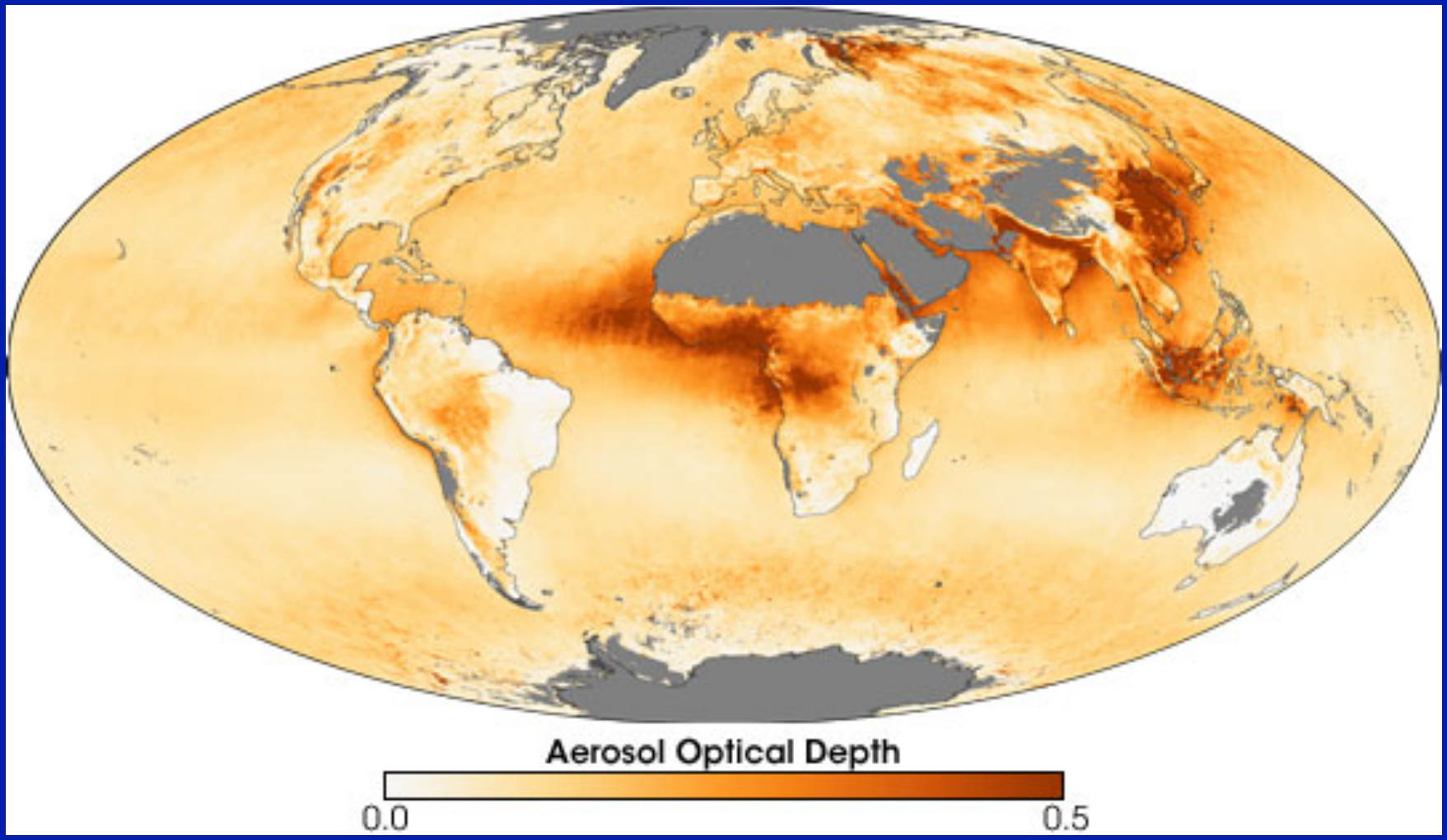
A single, very dusty, location in the Sahara Desert literally supplies half of the amount of the critical mineral dust needed by the Amazon rainforest to survive.



Volcanic aerosols affect Ocean Heat Content



Annual mean aerosol optical depth, 2006



τ = 1 => 63% transmittance; τ = 0.5 => 40% transmittance

Conclusion

Aerosols provide a net cooling of the planet. They are important in precipitation, and their effects are poorly understood.