GLOBE-AERONET
August 15th, 2013

AEROSOL Particles

What's all the fuss?

What are they?

Why are they important?

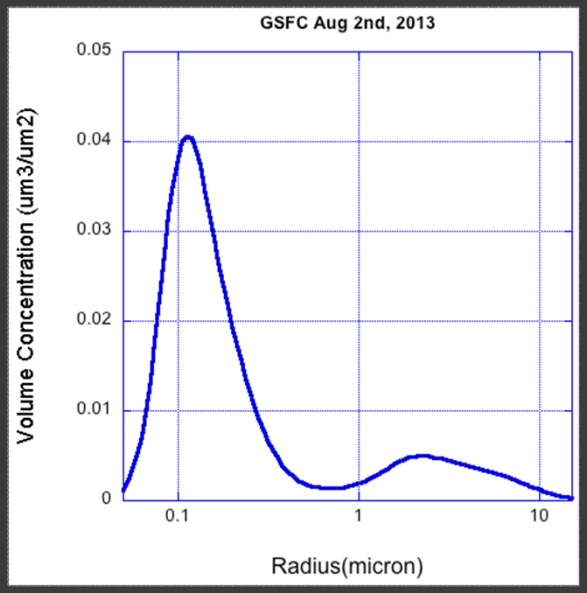
Where do they come from?

~~How are they measured?~~

~~What is AERONET all about?~~

What is an AEROSOL?

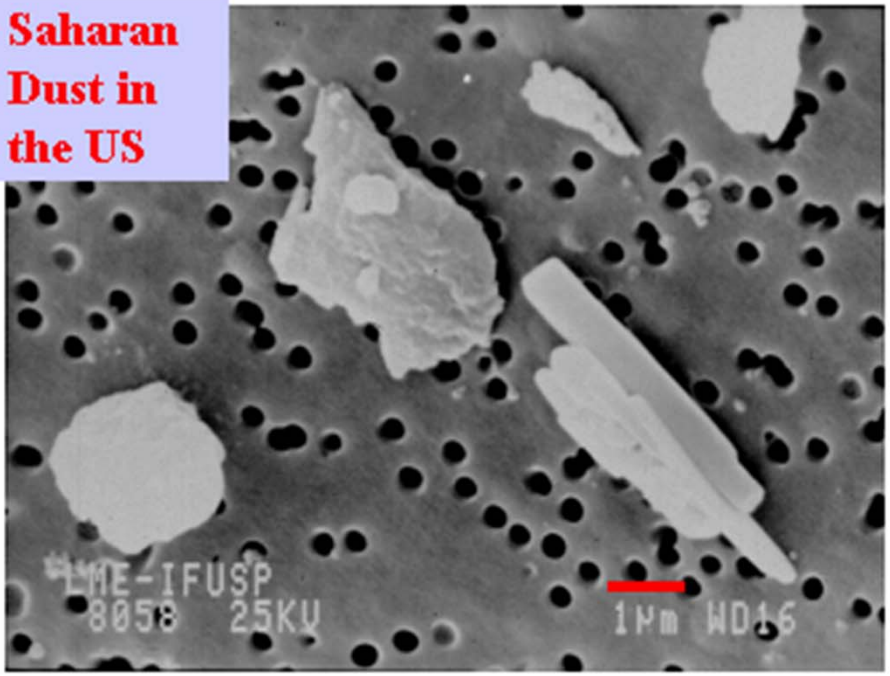
- Liquid or solid particle suspended in the atmosphere
- Size: Typically 0.01 to 20 μm in diameter
- Composition:
  - Liquid: Water, sulfate, sea salt
  - Solid: BC,WSOC, mineral (dust)
- Shape: Spherical to angular
- Types: Anthropogenic, Natural



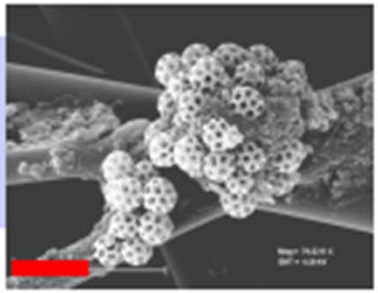
Types of Particles

University of Sao Paulo – Institute of Physics

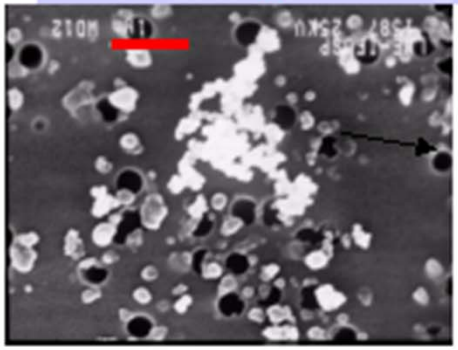
Saharan Dust in the US

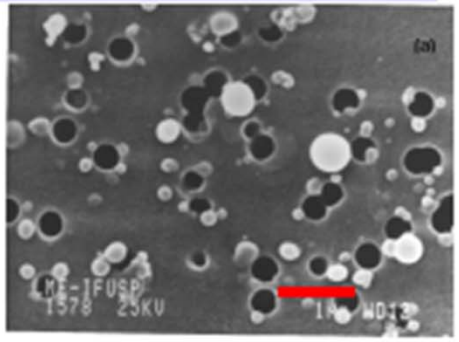


Amazon: Biogenic Cluster

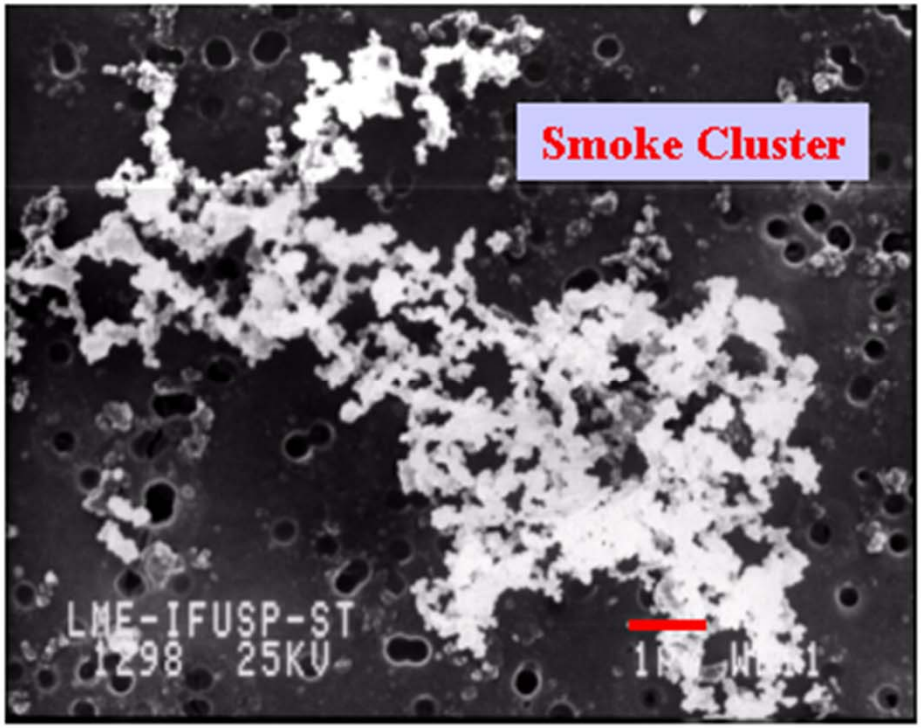


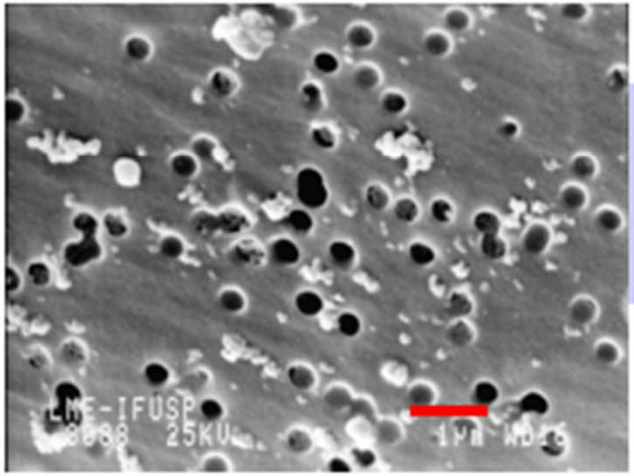
Flaming Smoke Smoldering





Smoke Cluster

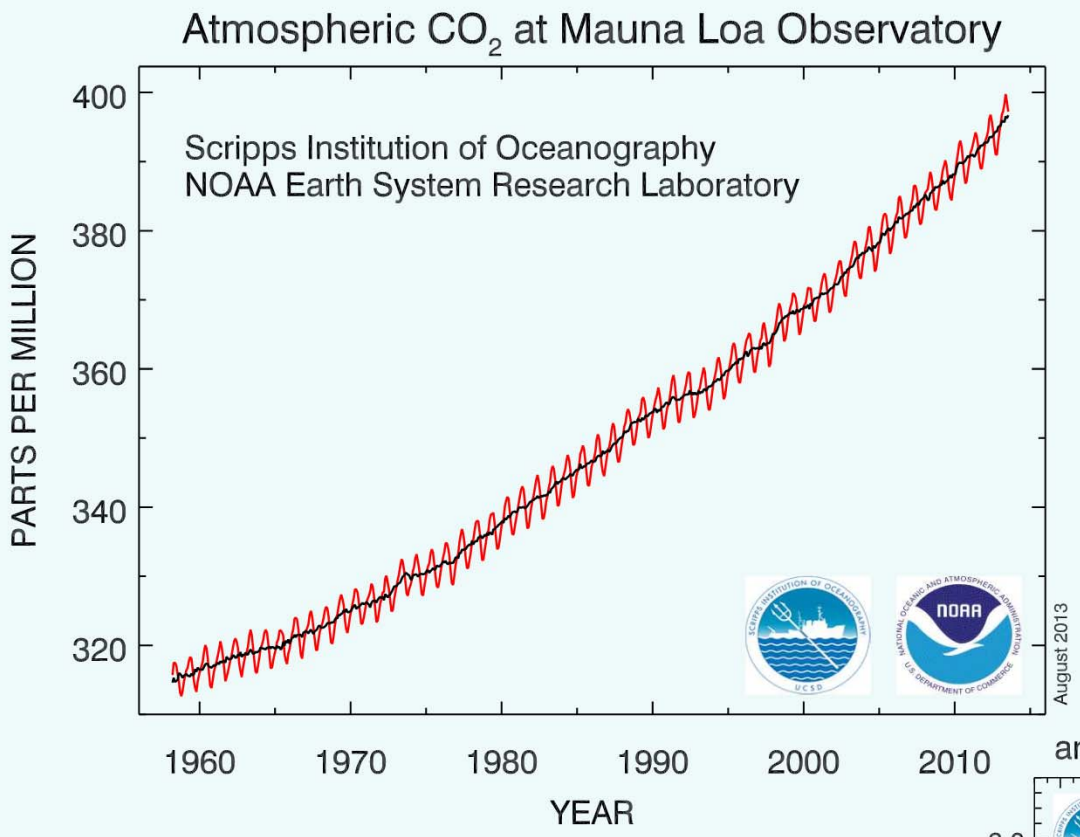




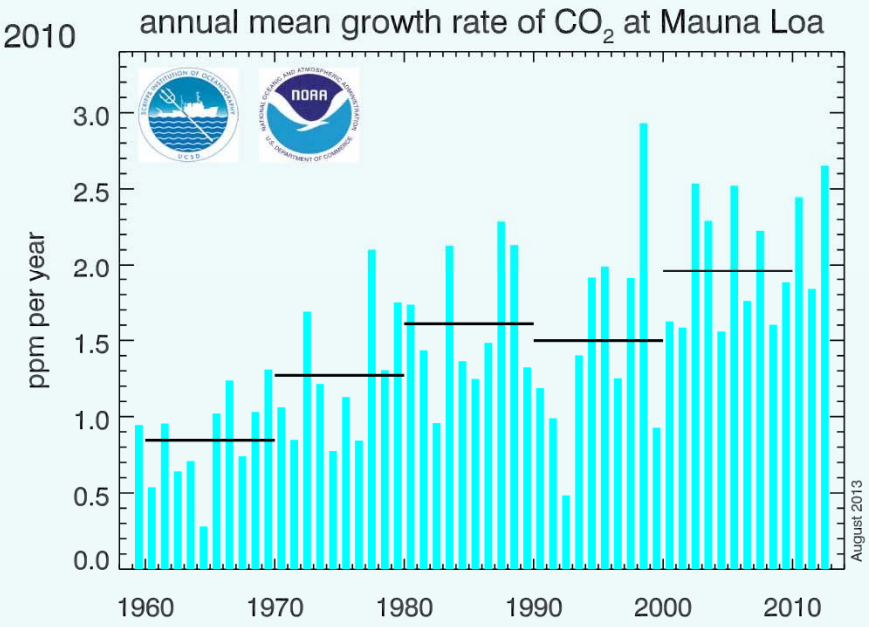
US Urban Pollution

Effects of Atmospheric Aerosols

- Climate and Weather
  - Short-term: modification of regional precipitation + solar radiation at the surface
  - Long-term: planetary albedo/energy balance
- Human health
  - Increased discomfort, illness + mortality (PNAS study)
- Agricultural impacts
  - Alteration of crop photosynthesis + productivity, changes of monsoon patterns



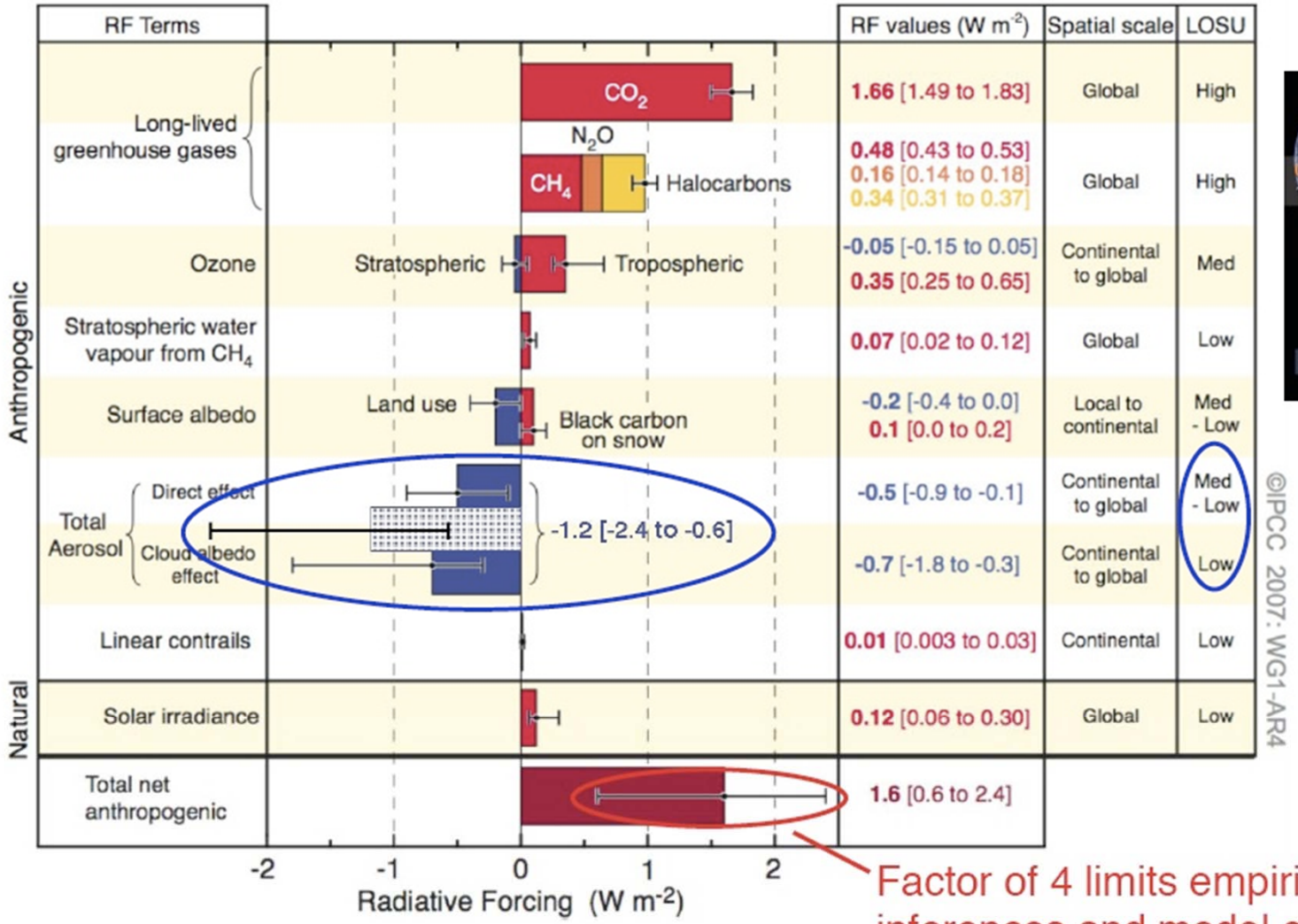
CO2 (and water vapor) are main drivers of climate modification

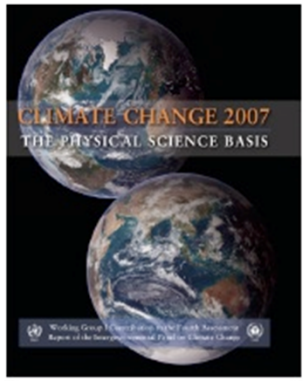


However, CO2 is well-mixed, well-understood and it's effects are relatively easy to model

GLOBAL-MEAN RADIATIVE FORCINGS (RF)

Pre-industrial to present (Intergovernmental Panel on Climate Change, 2007)





Factor of 4 limits empirical inferences and model evaluation.

LOSU denotes level of scientific understanding.

The most basic forcing is simply that of the modification of net fluxes by scattering and absorption processes, referred to as the direct effect. Such forcing may be defined for the top of the atmosphere or at the surface and is calculated as the difference between net fluxes assessed with and without aerosol loading in the atmosphere.

Aerosol Direct, Indirect and ‘Semi-direct’ Effects

Indirect effects of aerosols have much greater and include derivative consequences such as changes in cloud optical depth, albedo, and precipitation efficiency (and thus cloud lifetime.

Semidirect effects result from increases in atmospheric stability due to heating of the troposphere by absorbing aerosols and reduction of solar flux at the surface, thereby causing clouds to evaporate or suppressing cloud formation.

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Words

How about a diagram?

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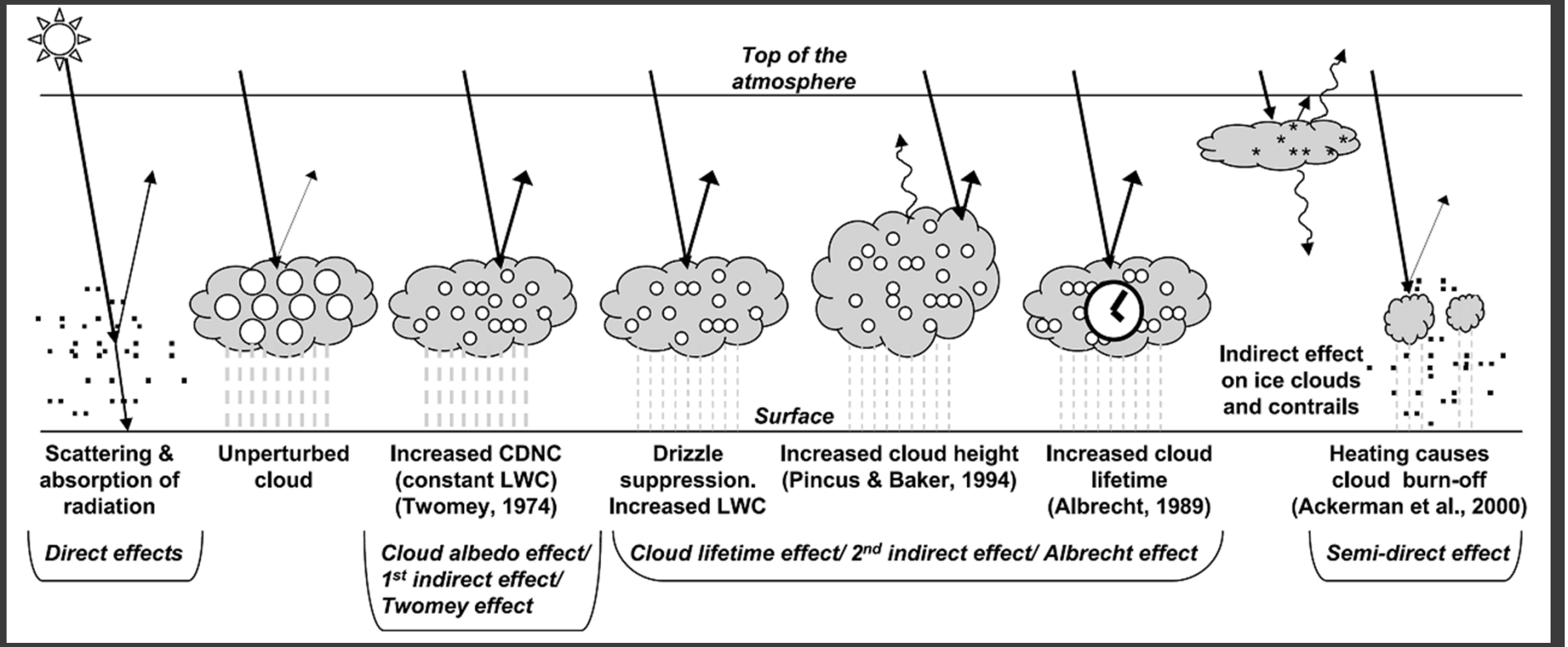

CCTV Headquarters; Architectural Rendering

The Dream

January 2013: Beijing

PM 2.5 = 900 ug/m3

WHO guidelines: Safe level= 25 ug/m3 (Beijing was 36x higher than this)

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The dire effects on health should be self-evident

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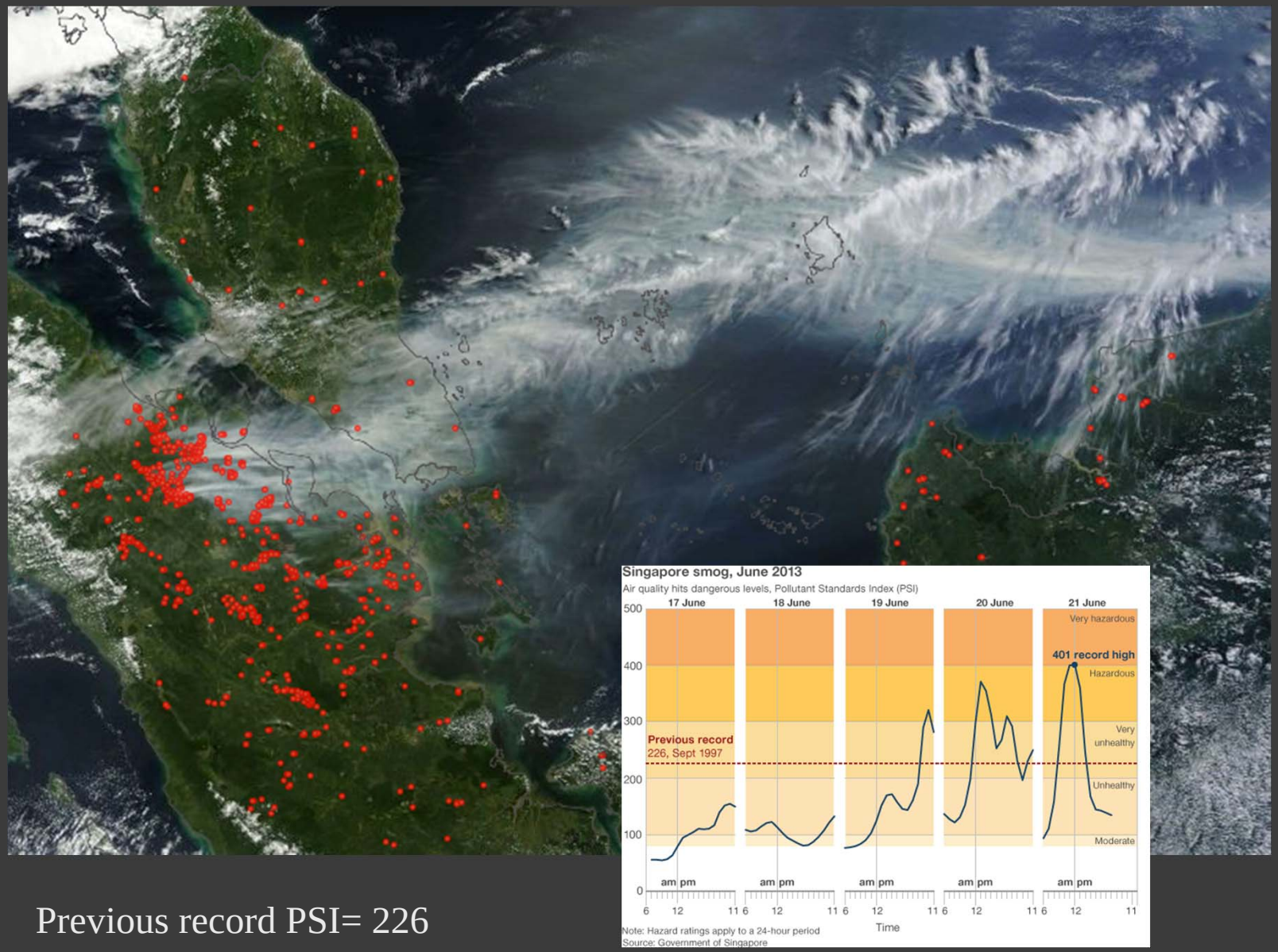
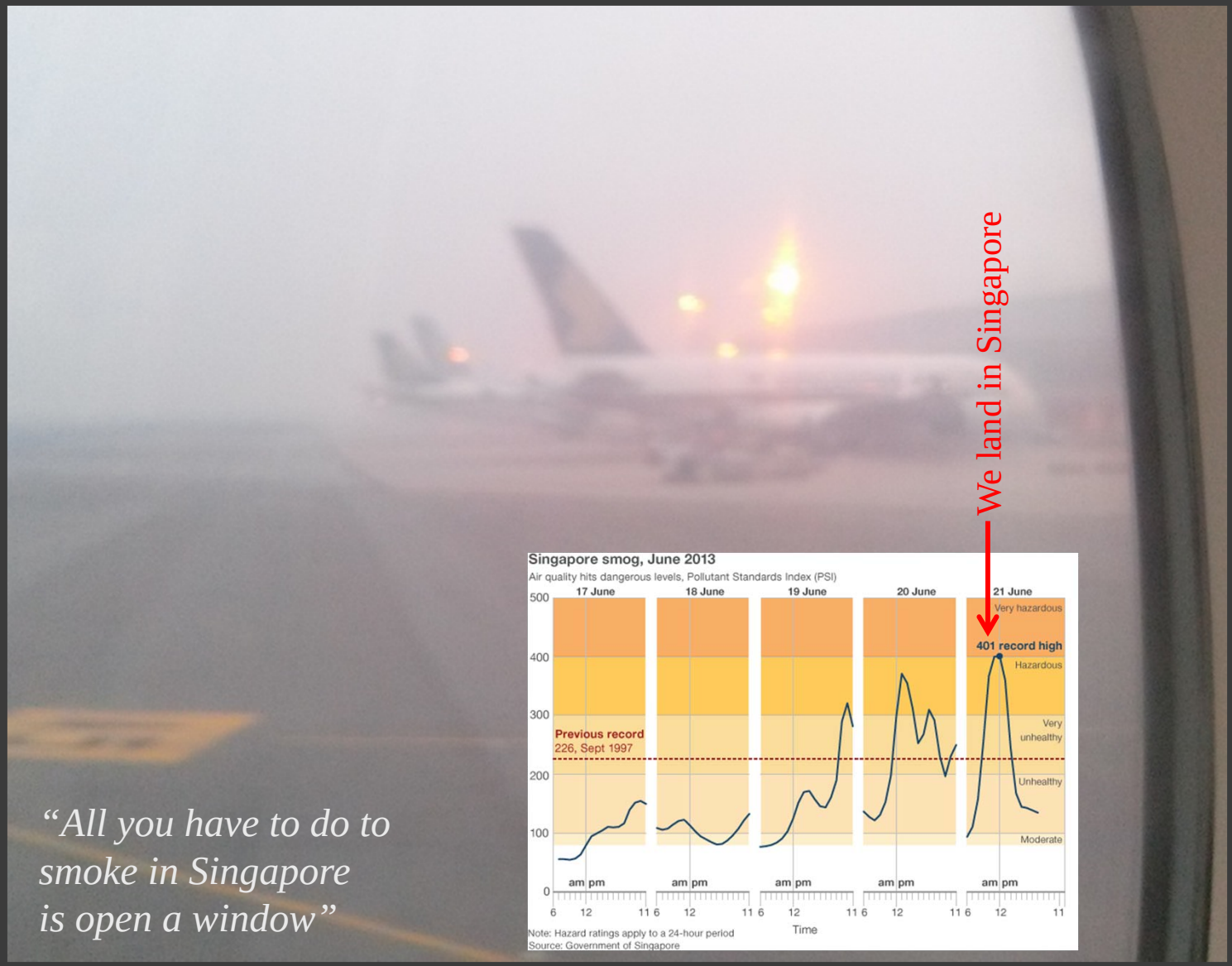
The Sunny Optimists

Singapore, June 21st, 2013 Air Quality Index (PSI) hits record= 401



Previous record PSI= 226

Also, my family lands at Changi Airport



"All you have to do to smoke in Singapore is open a window"

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What are the sources of aerosol particles?

- Natural (~90%)
  - Volcanoes
  - Dust storms
  - Wildfires
  - Vegetation
  - Sea spray
- Anthropogenic (~10% but mostly in N. hemisphere)
  - Industrial emissions
  - Fossil Fuel combustion
  - Land use/land cover changes

Natural Aerosols

Marine aerosols, wind/wave generated, large particles (>1μm), lowest 100 m, Non absorbing, restricted to oceans, conc. low

Aerosols from Biomass Burning

Flaming Phase⇒oxygen starved, black carbon, absorbing

Smoldering Phase ⇒oxygen rich combustion, less absorbing

Dust-Natural and Anthropogenic sources

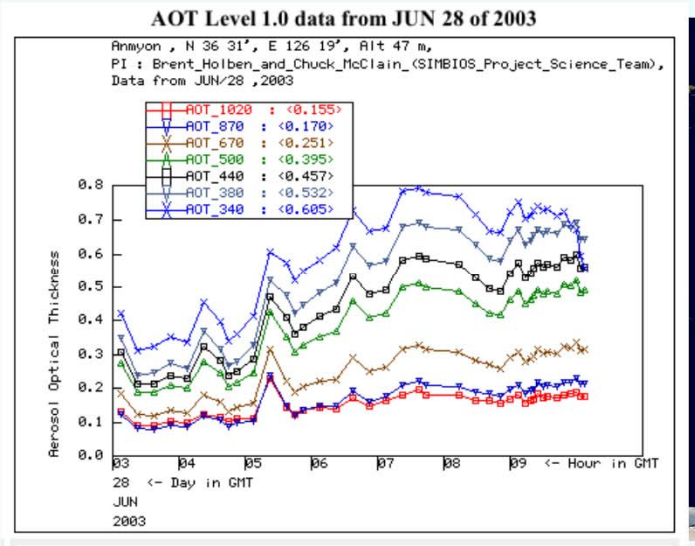
Anthropogenic: Urban Aerosols

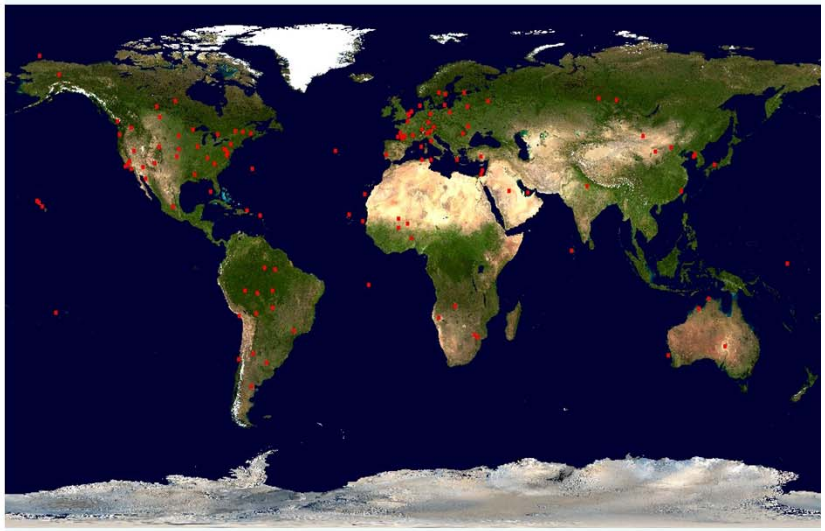
Black Carbon (highly absorbing): diesel engines, coal

SO_4(small, non absorbing): factories, power plants, gas engines

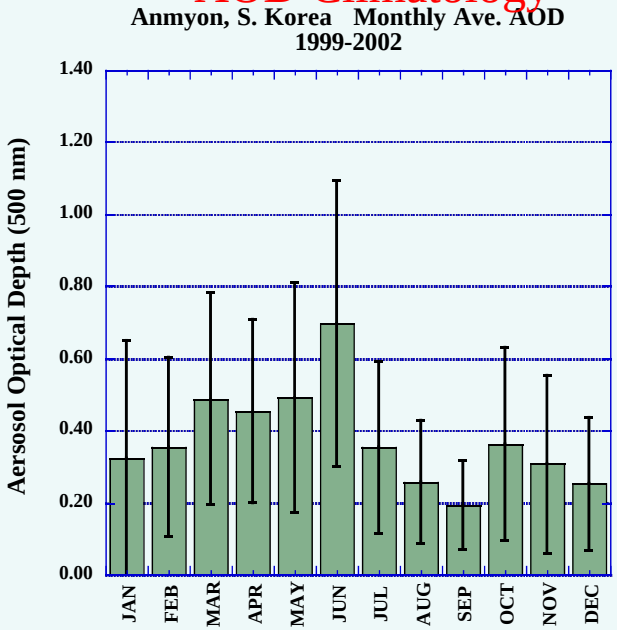
What Does AERONET Provide?

AOD 15 minute observations

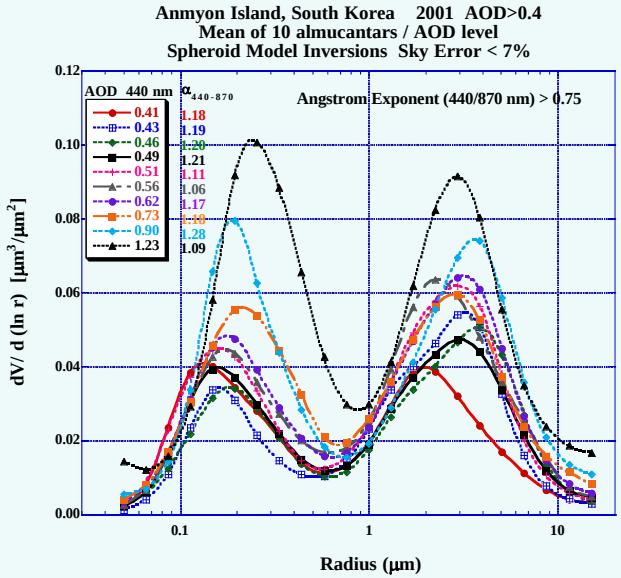




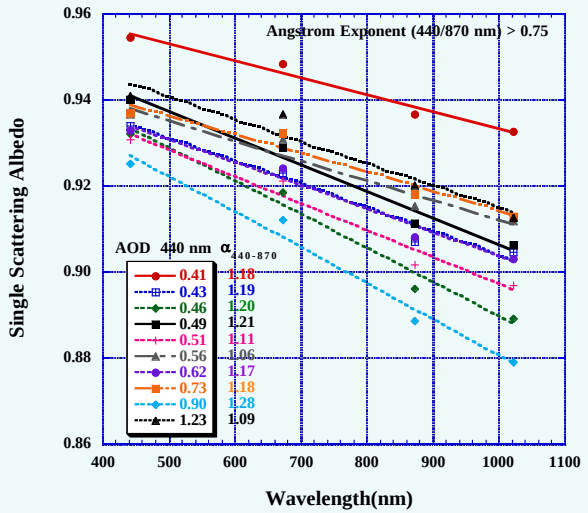
AOD Climatology



Size Distributions



Single Scattering Albedo



Aerosols-general characteristics

- Ubiquitous:
  - 5 to 1000 mg/m^3
- Remote sensing characteristics
  - Color: f(size and composition)
  - Directional Scattering efficiency: f(size)
  - Absorption: f(composition)
- Lifetime: 5 to 14 days (tropospheric)
  years (stratsopheric)