

Combining Observations and Models to Understand Climate Change

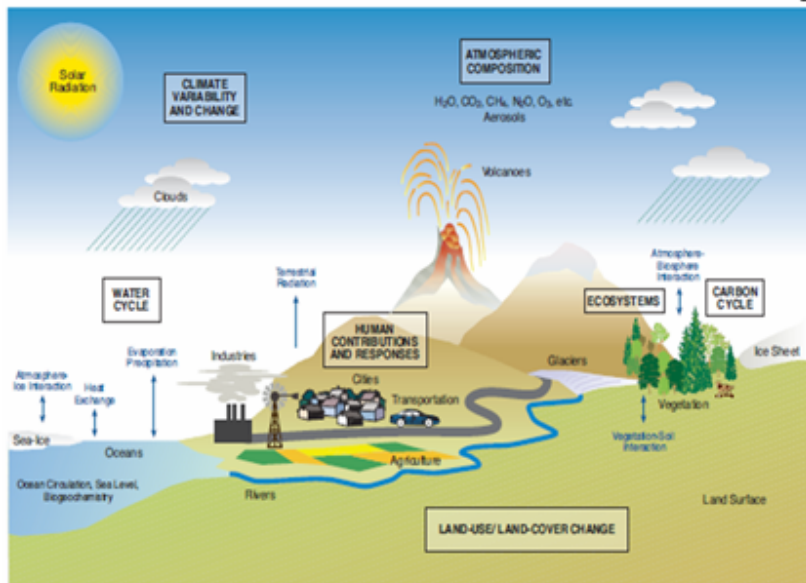
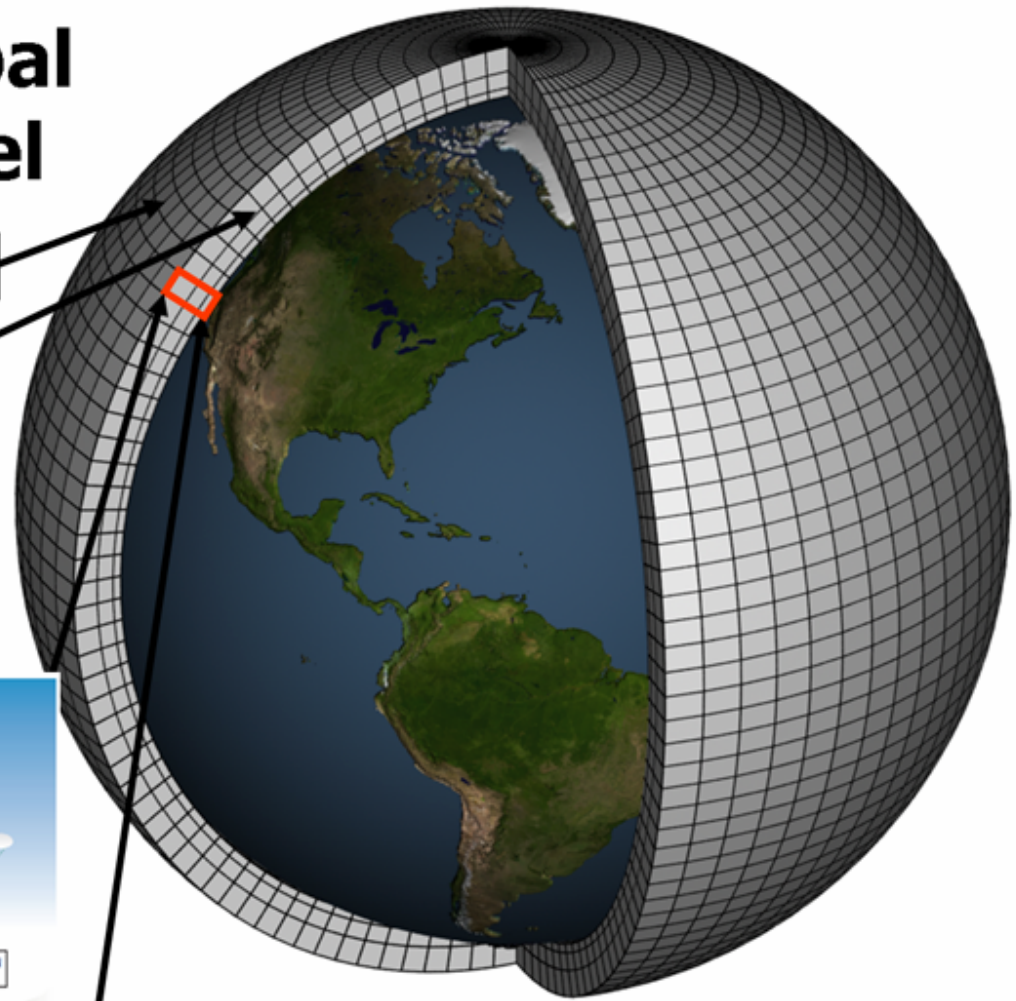
A white twin-engine propeller aircraft is parked on a runway. The aircraft is viewed from the front, showing its two engines, wings, and tail. The runway is paved with concrete and has yellow lines. The background shows a grassy field and a cloudy sky.

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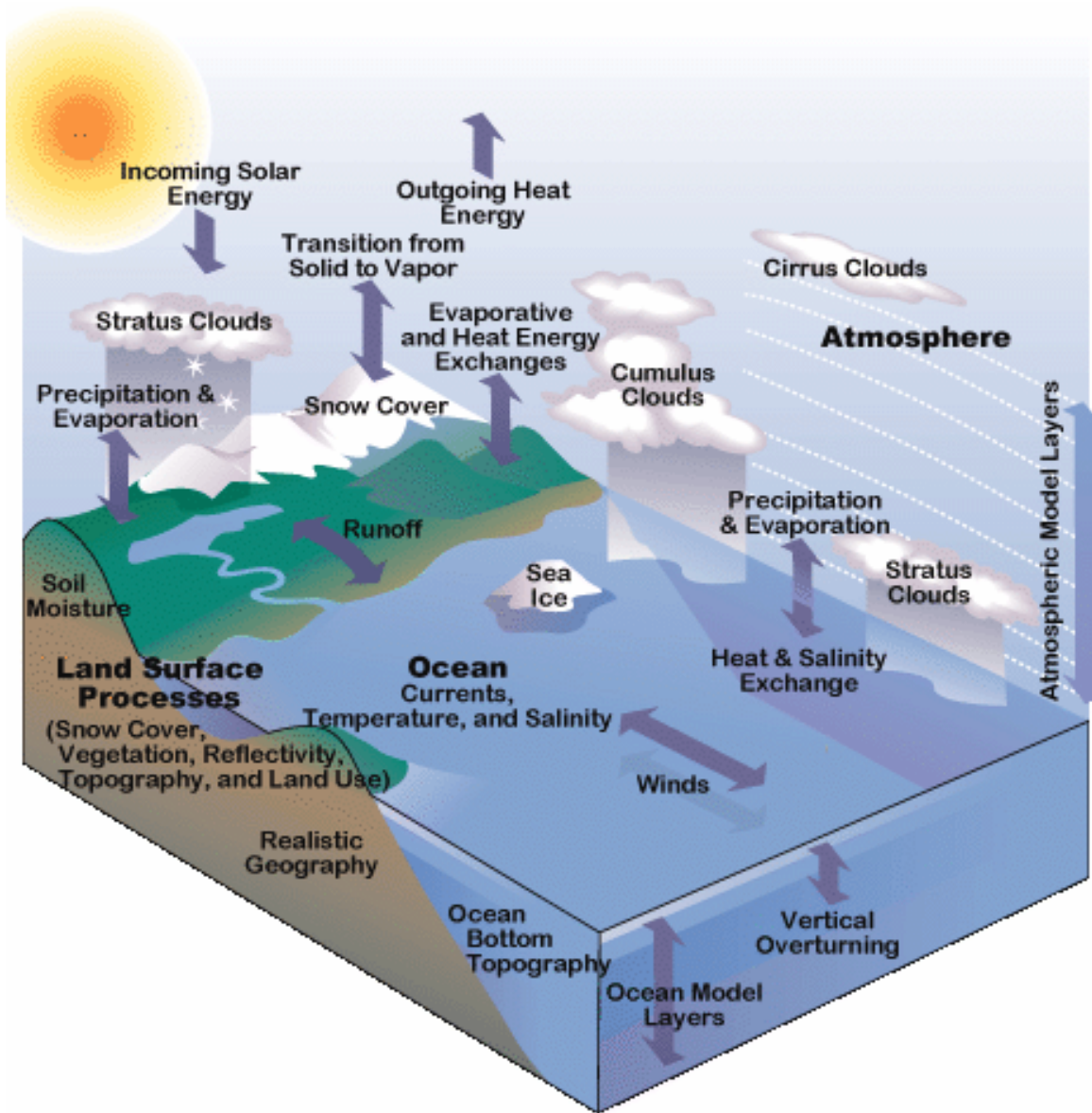
Schematic for Global Atmospheric Model

Horizontal Grid (Latitude-Longitude)

Vertical Grid (Height or Pressure)

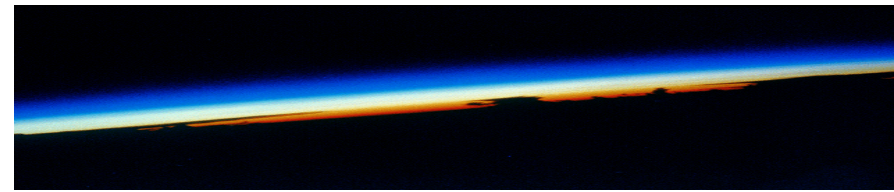


Climate models are systems of differential equations based on the basic laws of physics, fluid motion and chemistry.



Cumulus clouds are puffy clouds are linked to strong updrafts and the showers and thunderstorms that result. Cumulus are difficult to represent in models because each cloud covers only a small part of Earth's surface, but when taken together, cumulus clouds have a large influence on global circulation. Models depicts cumulus clouds through parameterization. Paramaterizations are developed by tracking the conditions that result in different types of cumulus clouds.

What is the Atmosphere?



The atmosphere seen from space.

- Gaseous Envelope Surrounding the Earth
- Mixture of gases, also contains suspended solid and liquid particles (*aerosols*)

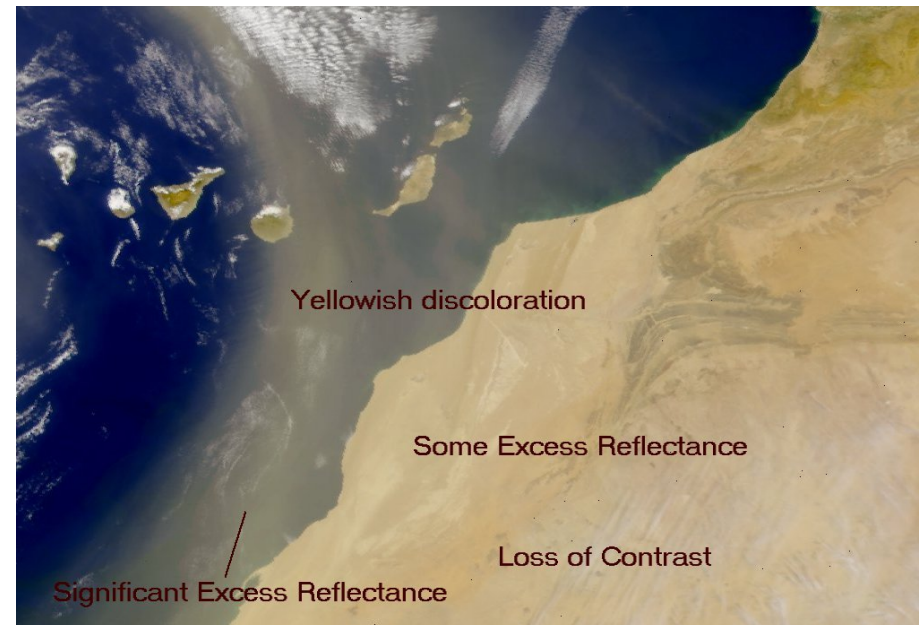
Aerosol = Dispersed Condensed Phase Suspended in a Gas

Aerosols are the “visible” components of the atmosphere

Pollution Haze over East Coast

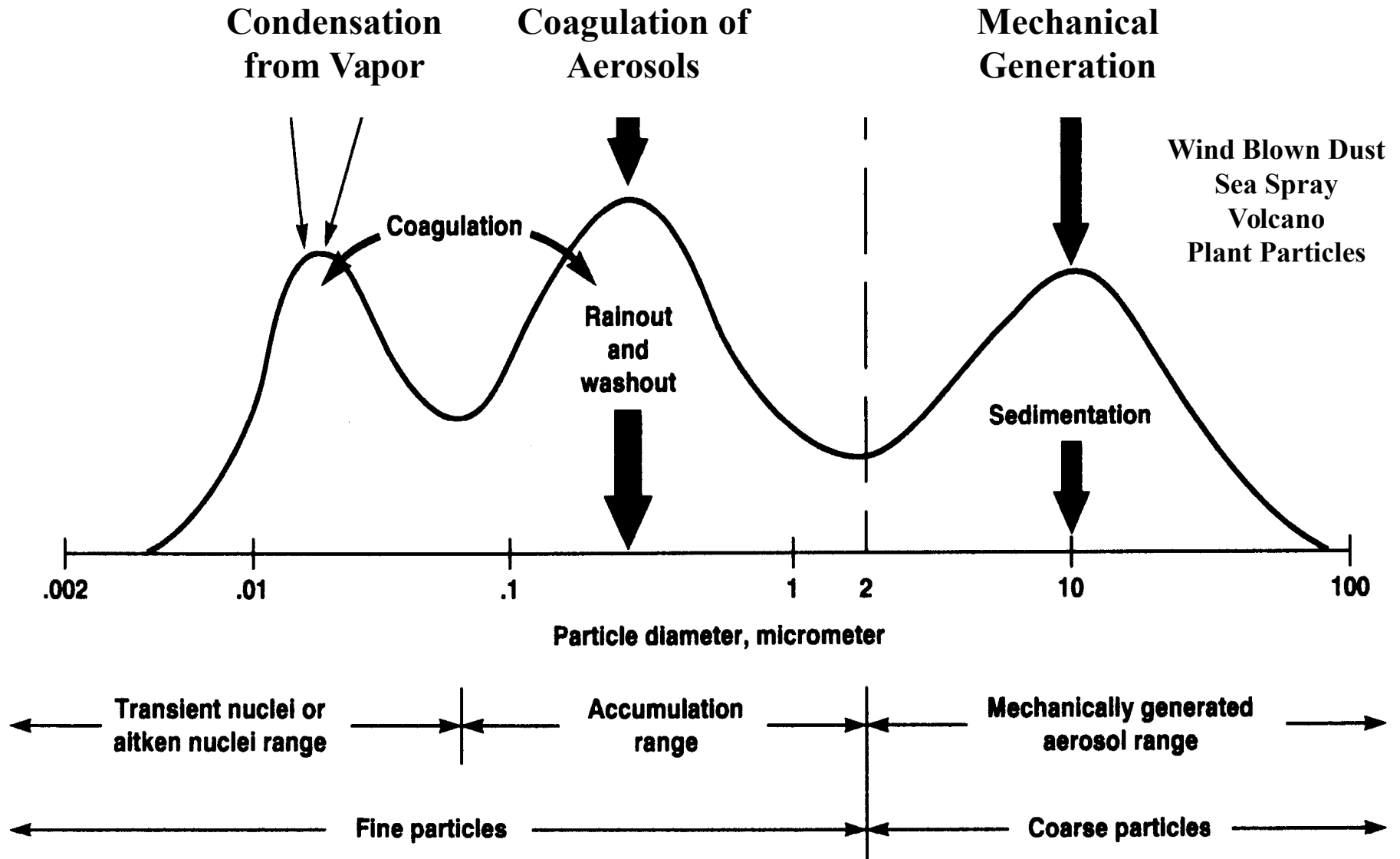


Dust off West Africa



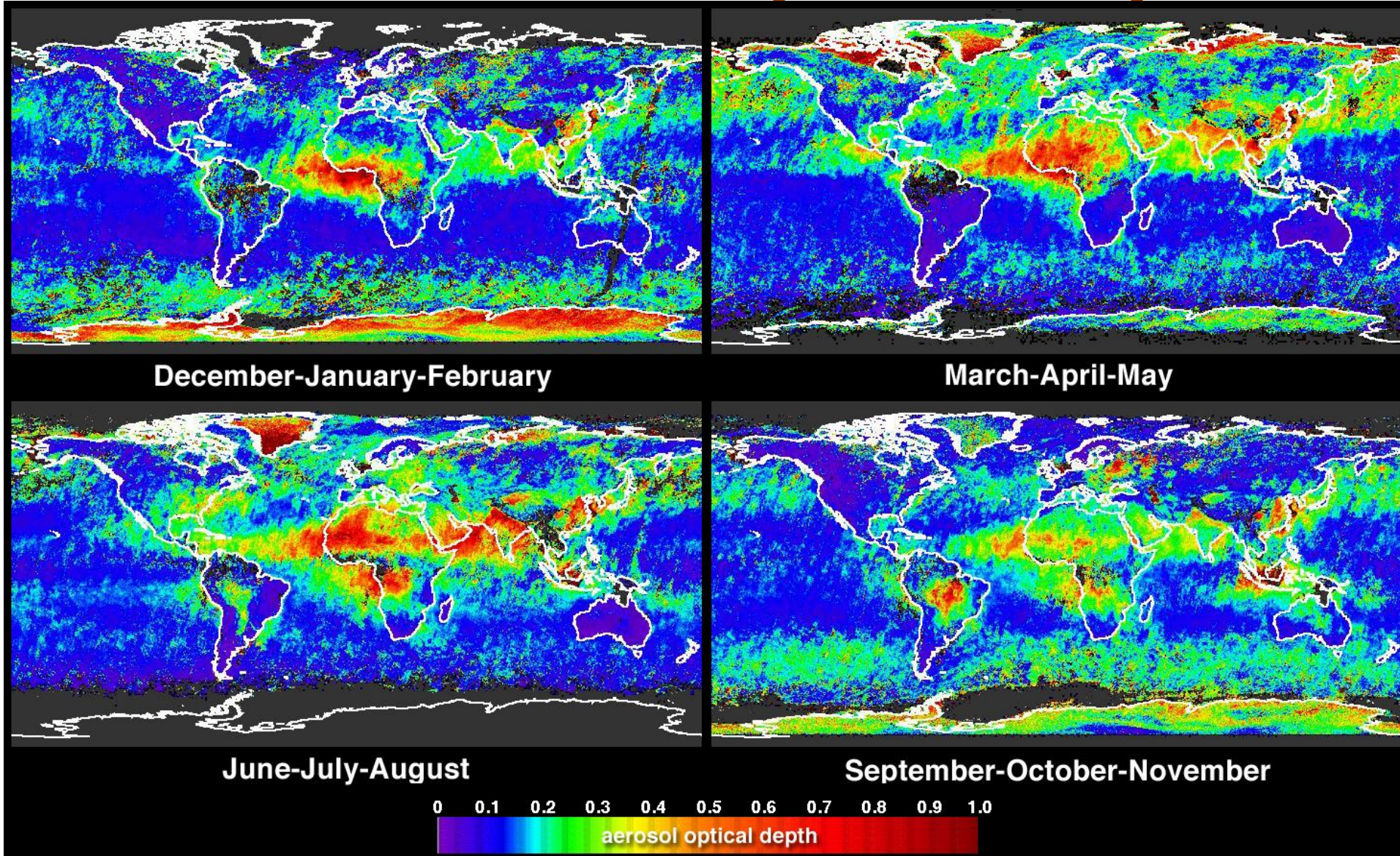
Courtesy of Daniel J. Jacob

Major Aerosol Modes



Courtesy of Singh: Figure 5.4

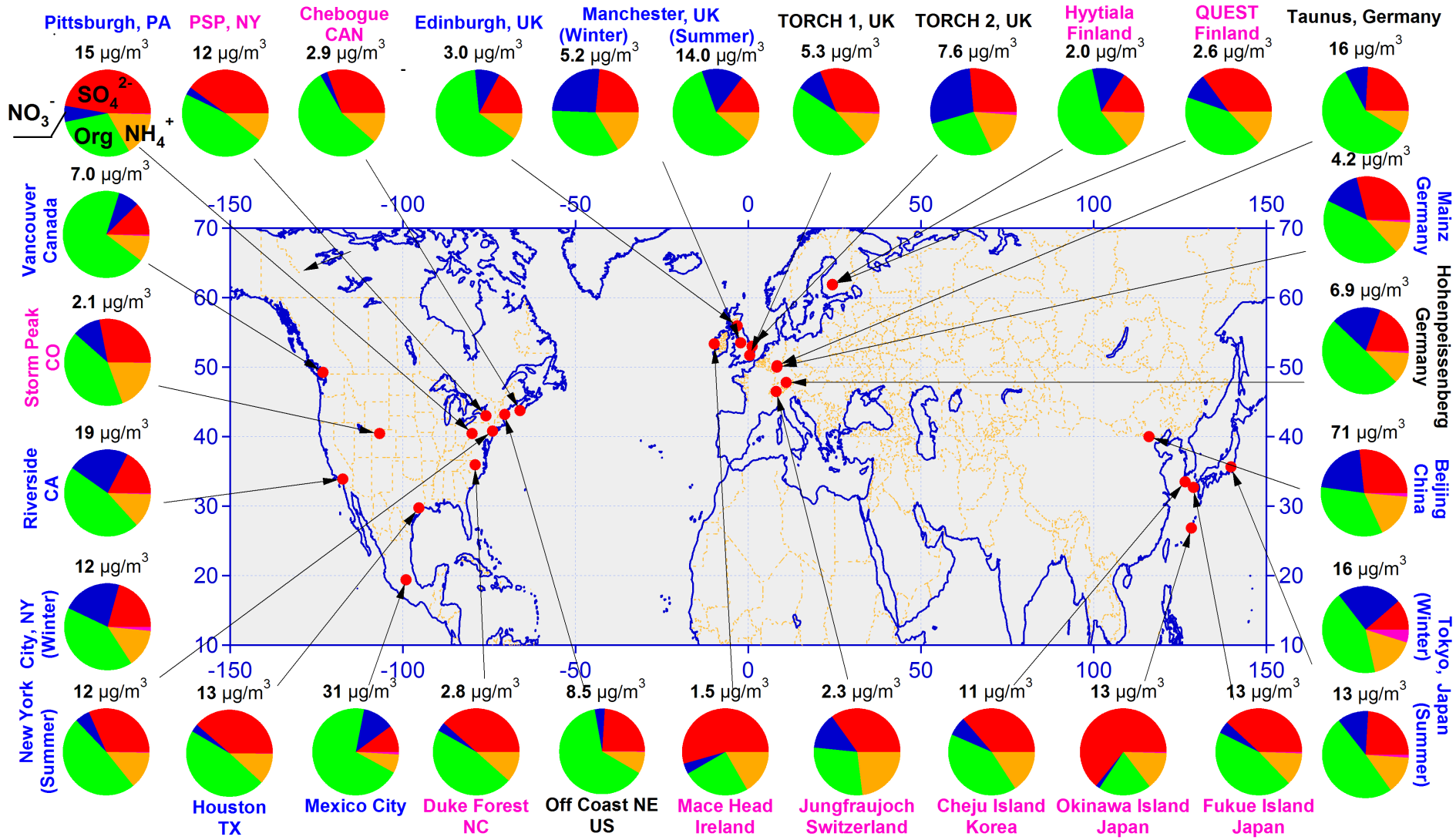
MIRS Aerosol Optical Depth



What about surface PM measurements in North Dakota?

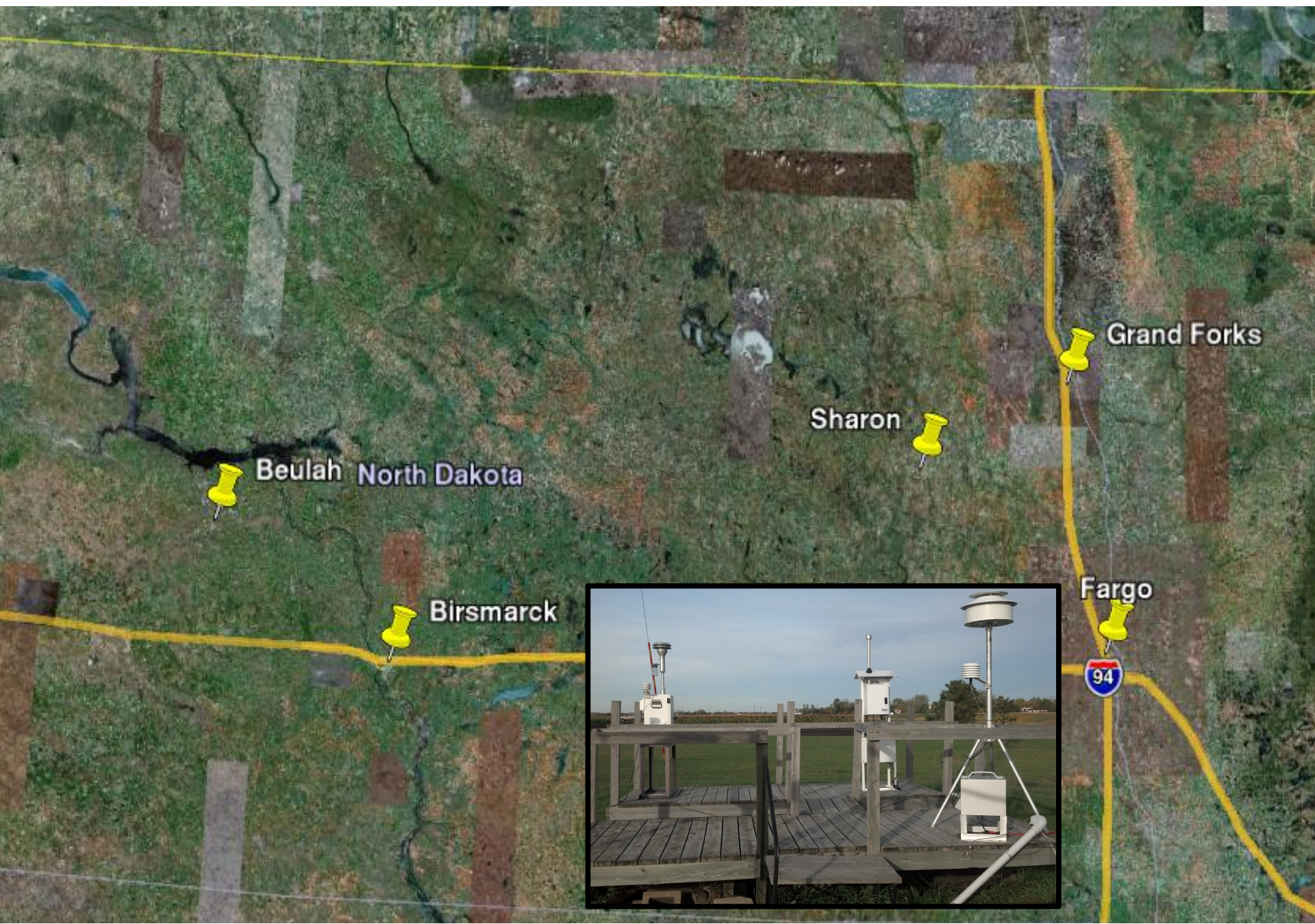
Source: <http://photojournal.jpl.nasa.gov/catalog/PIA04333>

Fine Aerosol Composition

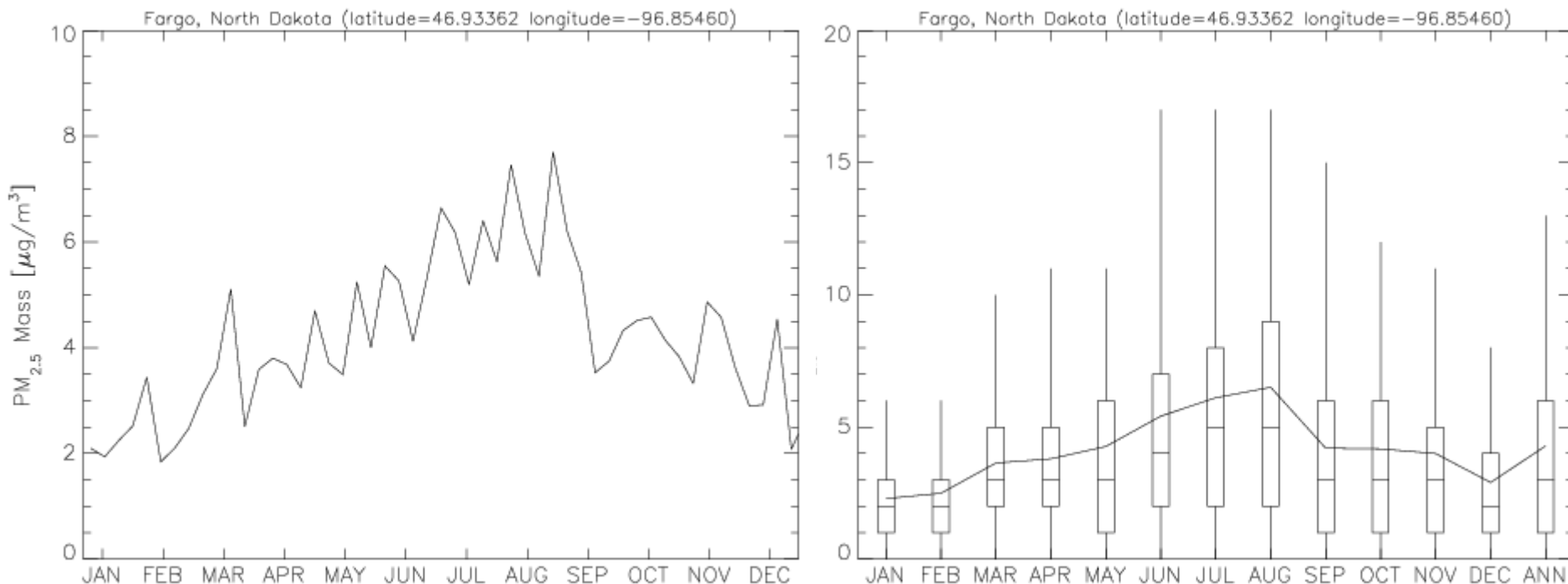


Zhang, Jimenez et al., *GRL*, 34, L13801, 2007

Particular Matter Monitor Sites

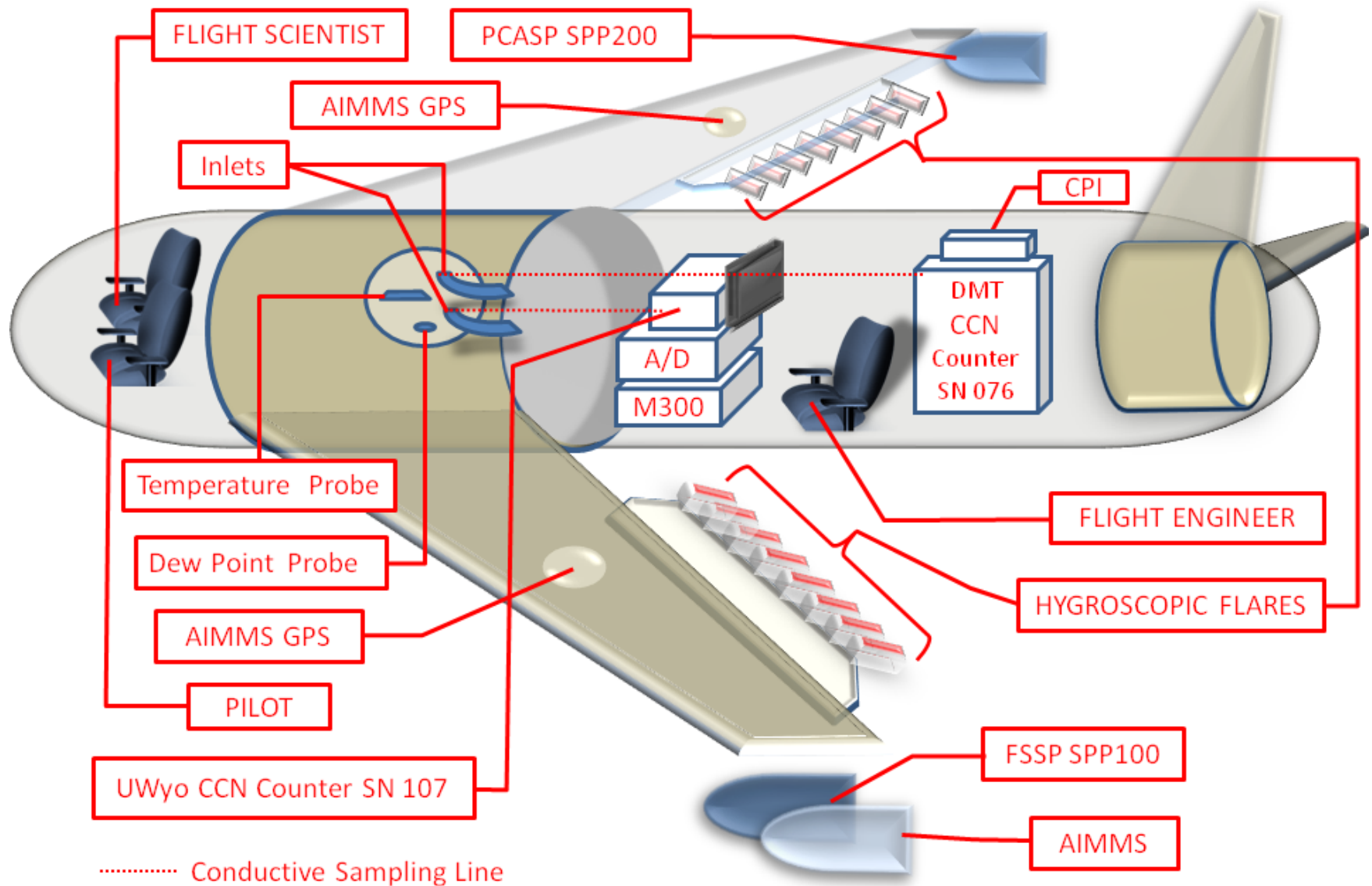


PM_{2.5} in Fargo, North Dakota

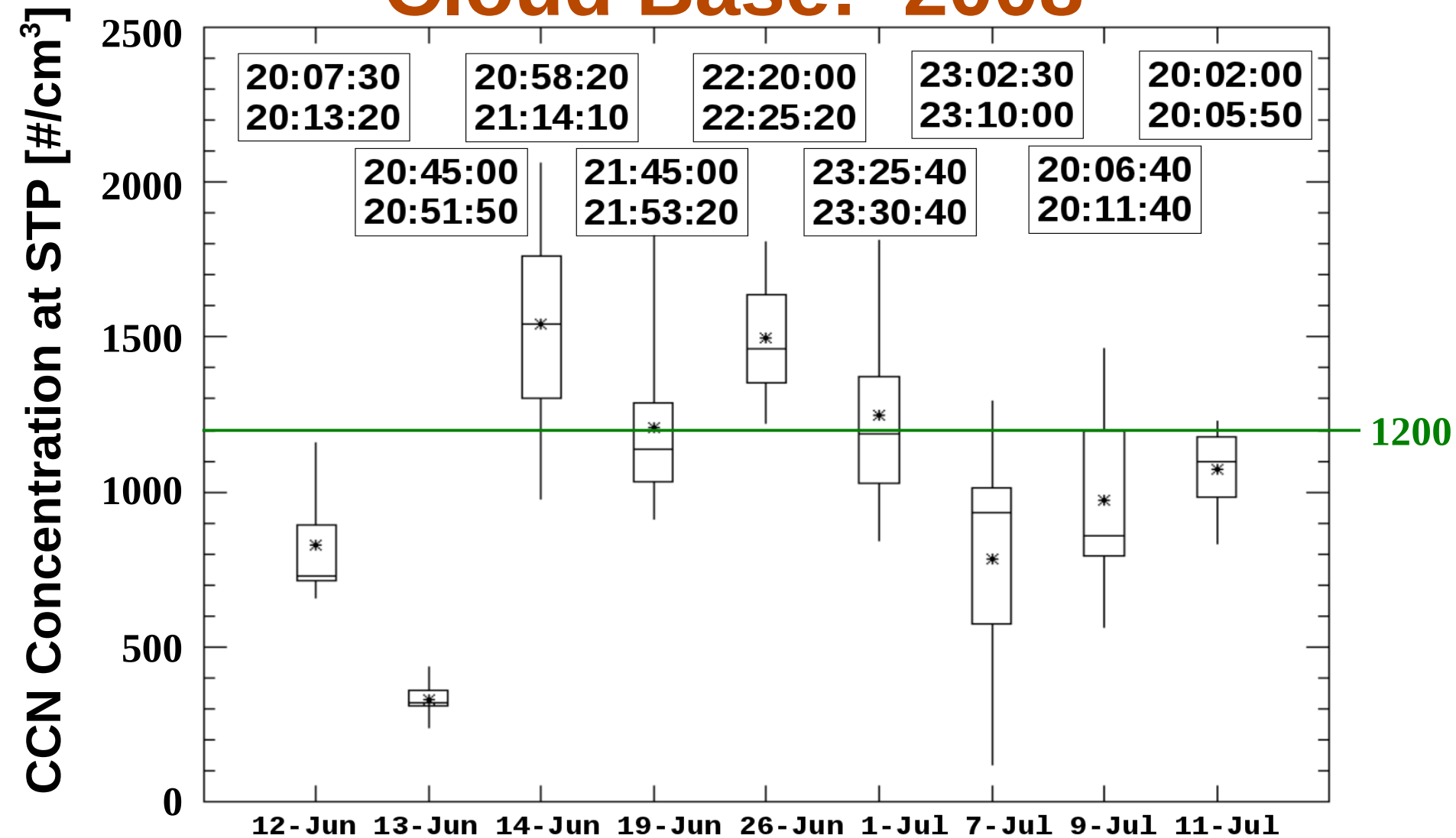


Fine aerosol mass (2.5 μm particulate matter) measured in Fargo, North Dakota by month of the year. The box and whiskers give the 5, 25, 50, 75, and 95 percentiles. The solid line represents the monthly mean. The x axis denotes the month of the year, with the last box-and-whisker denoting the percentile for the whole period. The statistics are based on all valid, hourly averaged data from June 2000 through December 2003. The data are from the Air Quality System PM_{2.5} Mass Federal Reference Method (Hourly) program and were obtained from the VIEWS website (<http://vista.cira.colostate.edu/views/Web/Data/>). Creation of these plots and data is part IDL Simple example located at <https://learn.aero.und.edu/pages.asp?PageID=162649>.

POLCAST4 Aircraft Instrument Configuration

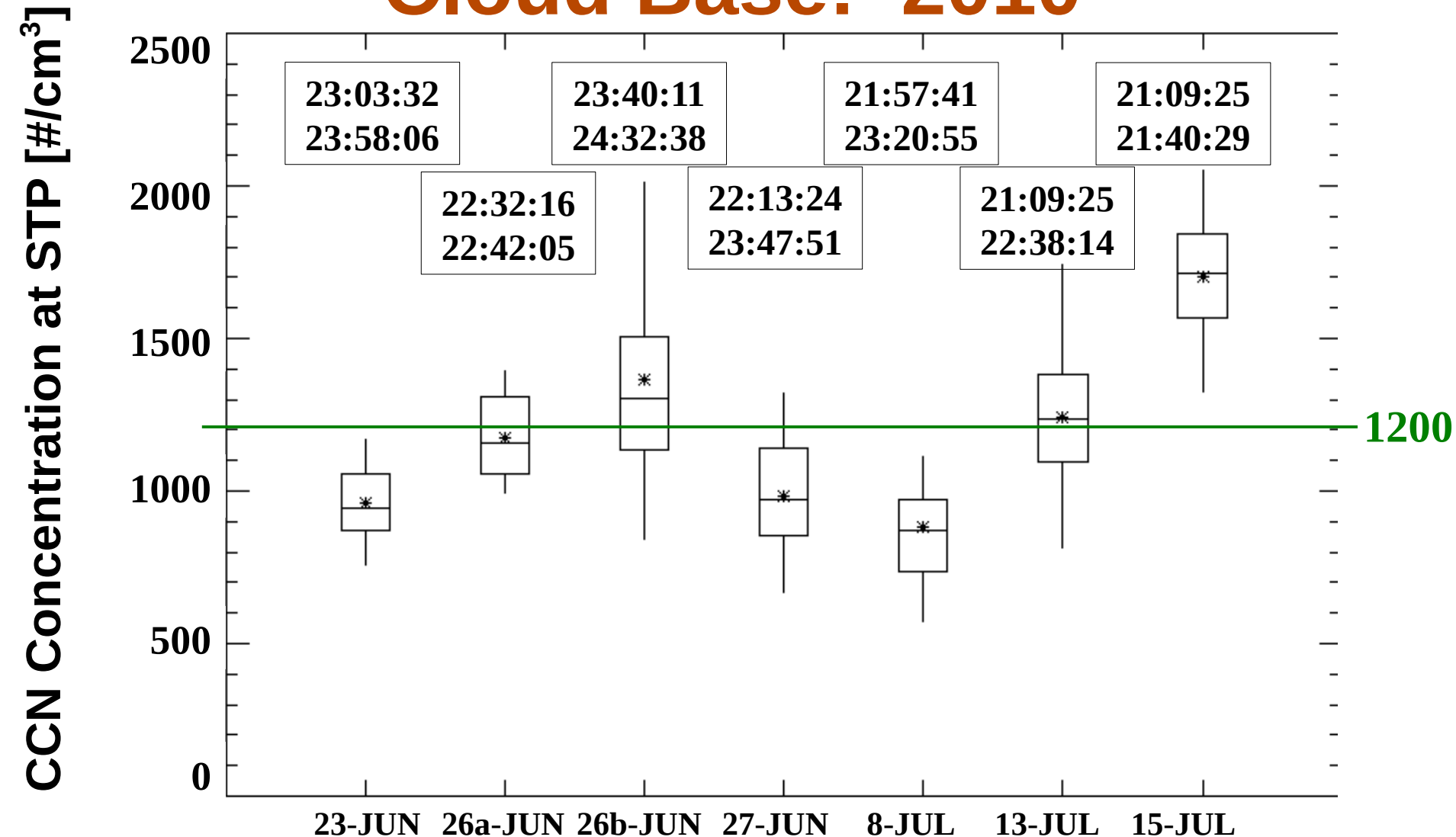


Cloud Base: 2008



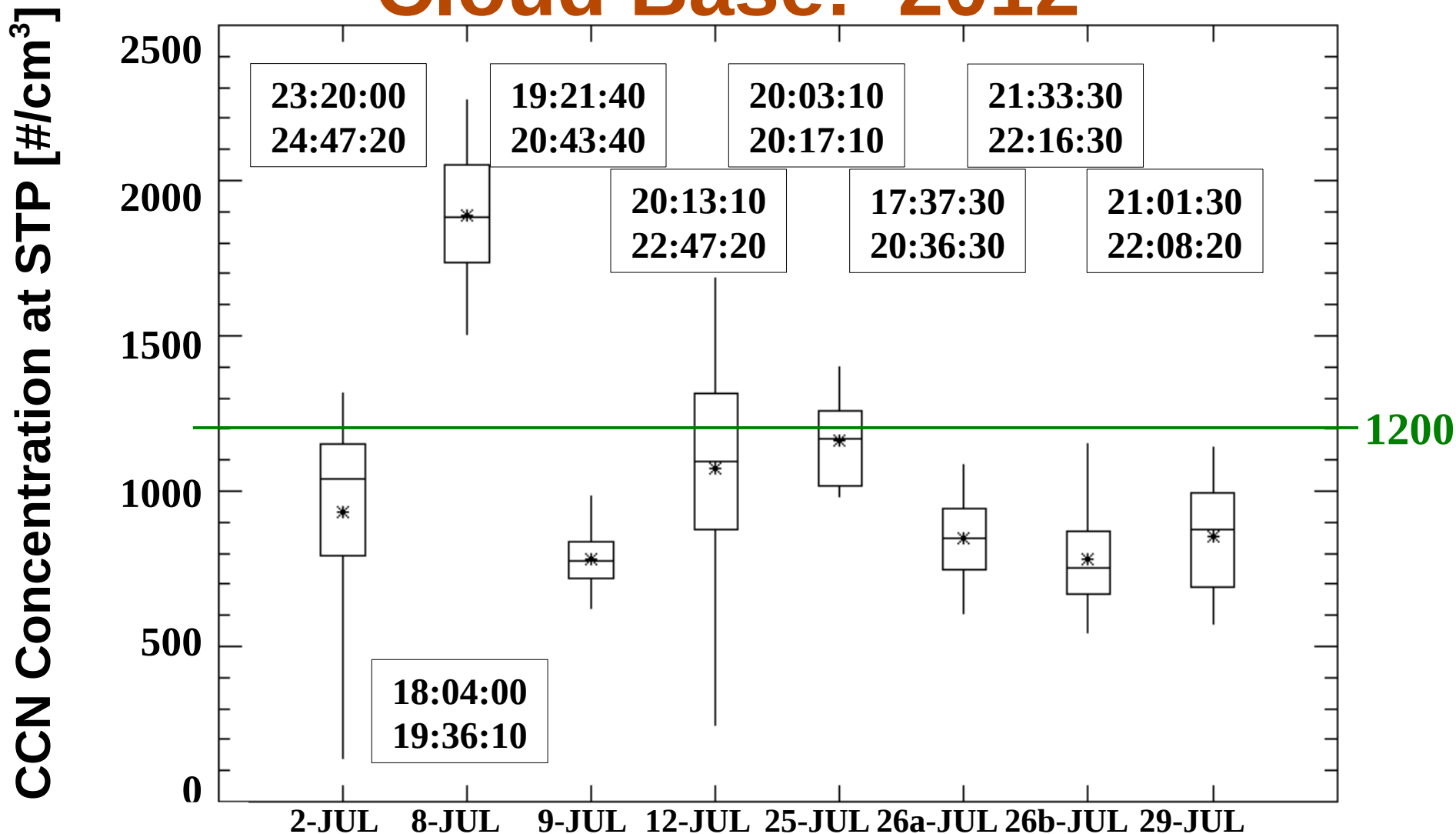
Statistical distributions of 30 s 0.6 % ambient supersaturation Cloud Condensation Nuclei (CCN) adjusted to standard temperature and pressure. The solid circle is the mean value, the horizontal line is the 50th percentile, the top of the box is the 75th percentile, the bottom is the 25th percentile, and the top and bottom of the whiskers are the 95th and 5th percentiles, respectively.

Cloud Base: 2010

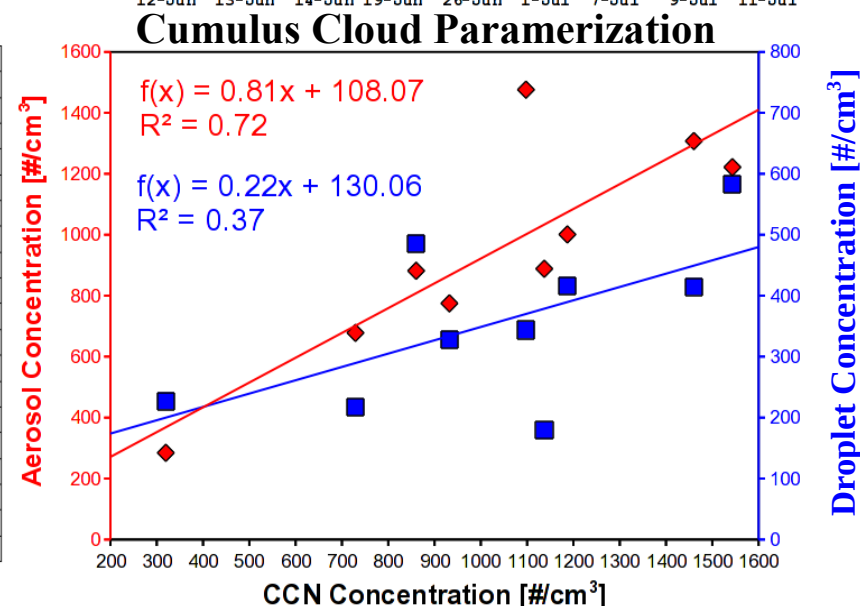
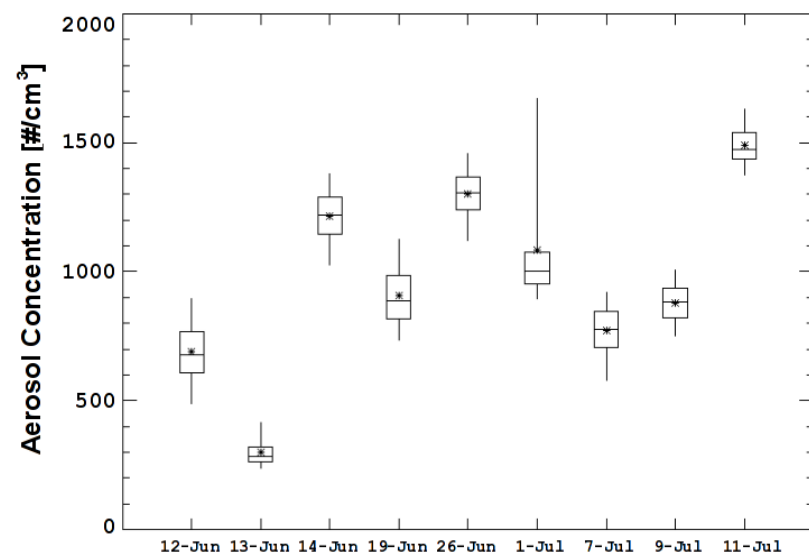
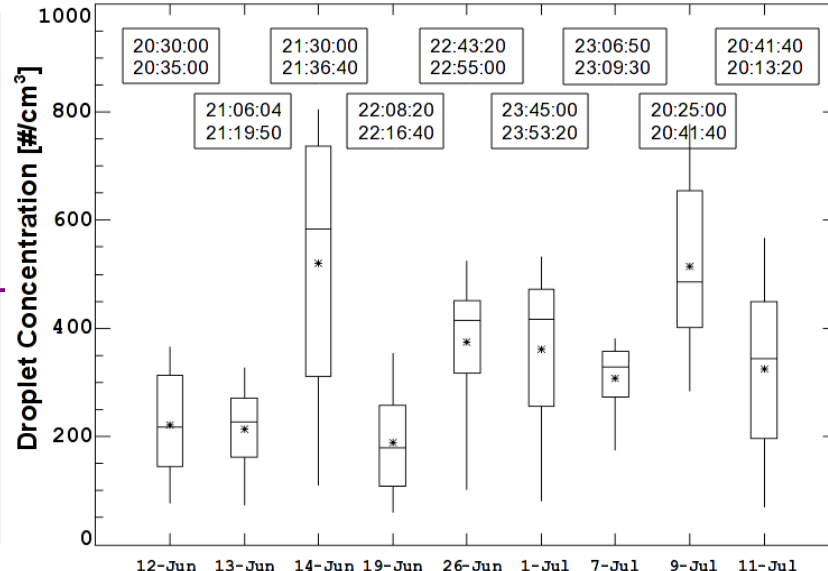
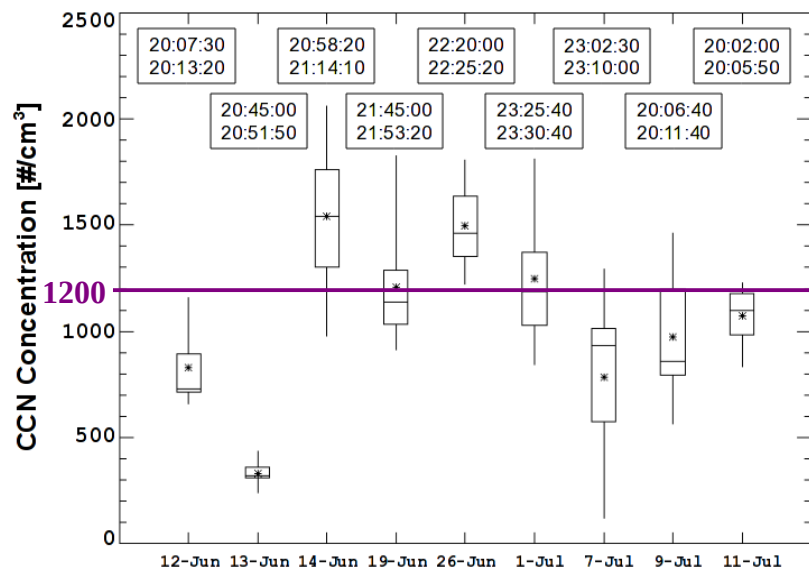


Statistical distributions of 30 s 0.6 % ambient supersaturation Cloud Condensation Nuclei (CCN) adjusted to standard temperature and pressure. The solid circle is the mean value, the horizontal line is the 50th percentile, the top of the box is the 75th percentile, the bottom is the 25th percentile, and the top and bottom of the whiskers are the 95th and 5th percentiles, respectively.

Cloud Base: 2012



Statistical distributions of 30 s 0.6 % ambient supersaturation Cloud Condensation Nuclei (CCN) adjusted to standard temperature and pressure. The solid circle is the mean value, the horizontal line is the 50th percentile, the top of the box is the 75th percentile, the bottom is the 25th percentile, and the top and bottom of the whiskers are the 95th and 5th percentiles, respectively.



Statistical distributions near cloud base of 30 s Cloud Condensation Nuclei (CCN), 1 Hz cloud droplet and 1 Hz Passive Cavity Aerosol Spectrometer Probe (PCASP) aerosol measurements for flights during the 2008 POLCAST2 field project. All concentrations are adjusted to standard temperature and pressure conditions. The solid circle is the mean value, the horizontal line is the 50th percentile, the top of the box is the 75th percentile, the bottom is the 25th percentile, and the top and bottom of the whiskers are the 95th and 5th percentiles, respectively.

Questions and Discussion

