Studies of dust and Aspen fire smoke in Tucson

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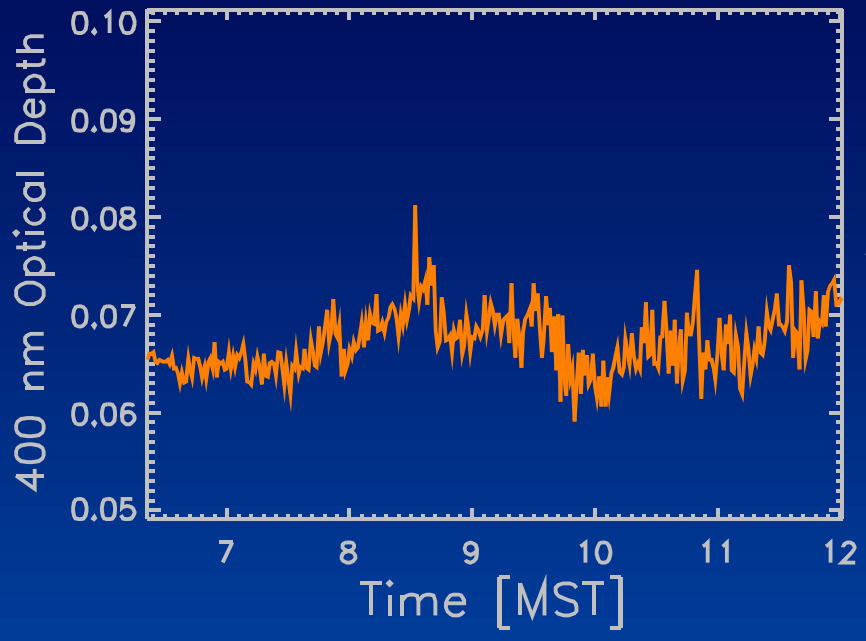
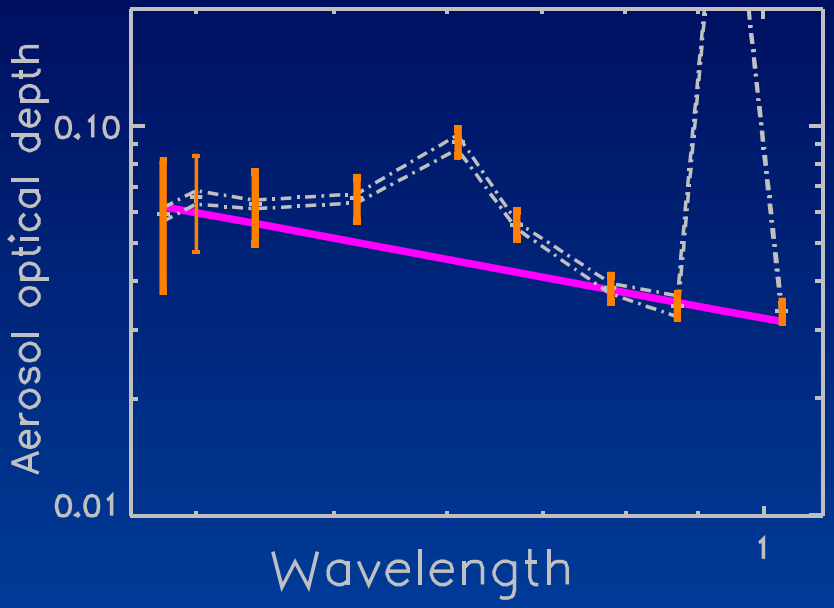
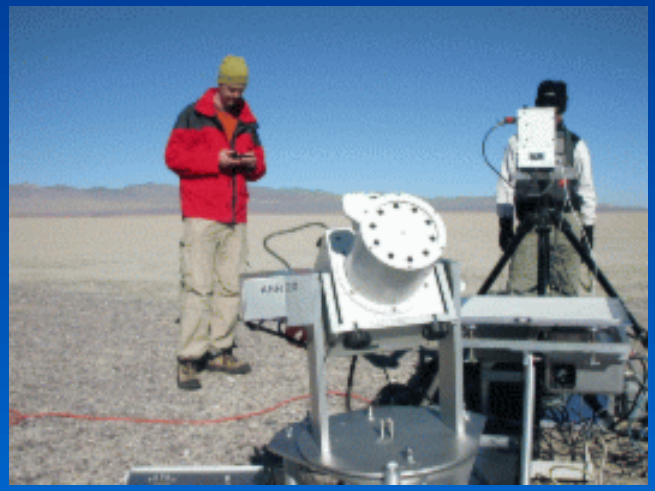
Atmospheric Measurements

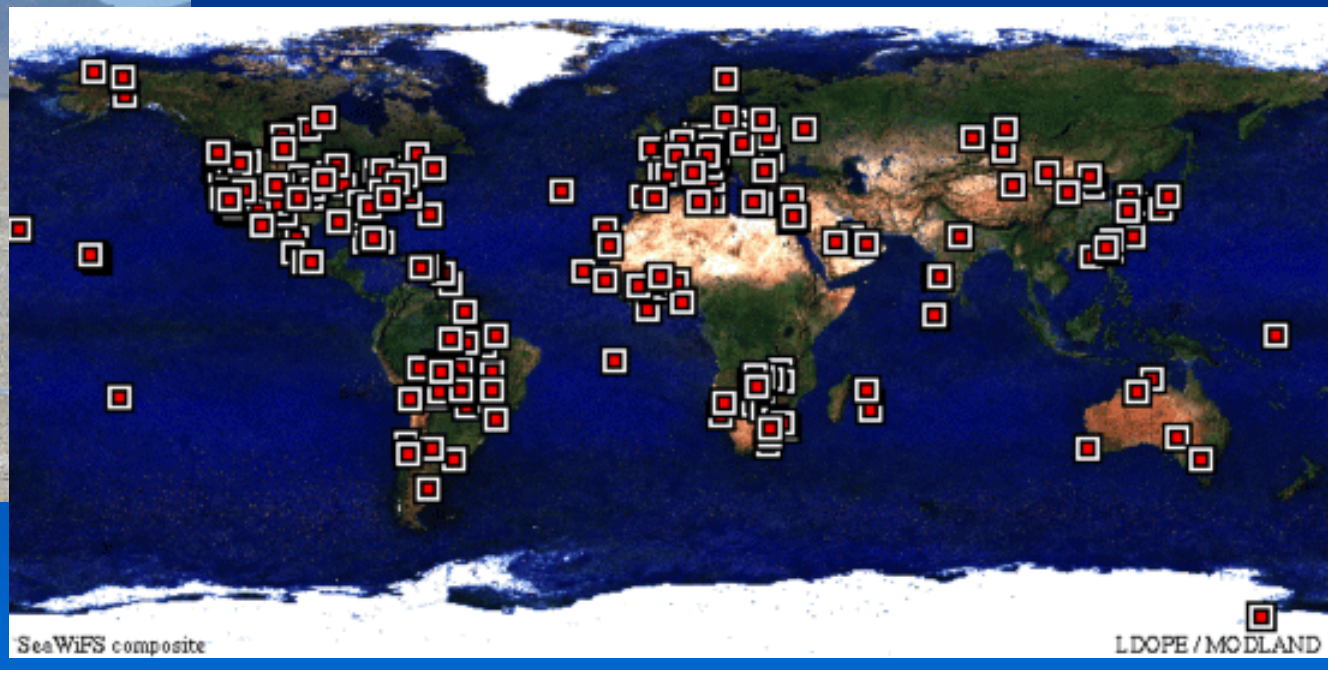






Aeronet

- Aeronet is a collection of ground-based radiometers viewing the sun and sky to derive information about dust content
- Goal is to assist in global assessment of dust composition and amount
- Serve as ground truth for satellite-based measurements



Aeronet at the University of Arizona

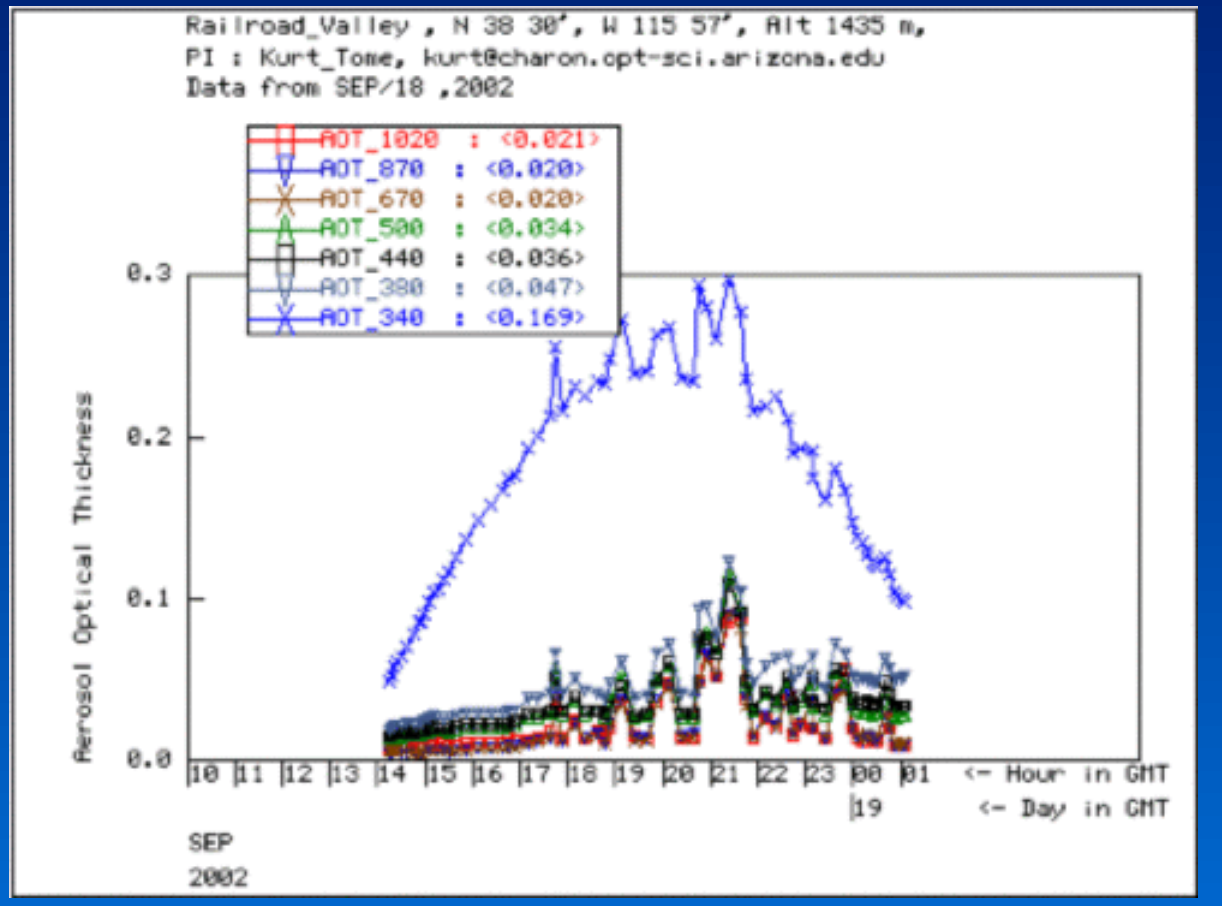
RSG has two Aeronet radiometers

- One is deployed at the group's calibration site in central Nevada
- The other is deployed on the roof of the Optical Sciences Center

Optical depth

The radiometers are built in France by the Cimel Corporation

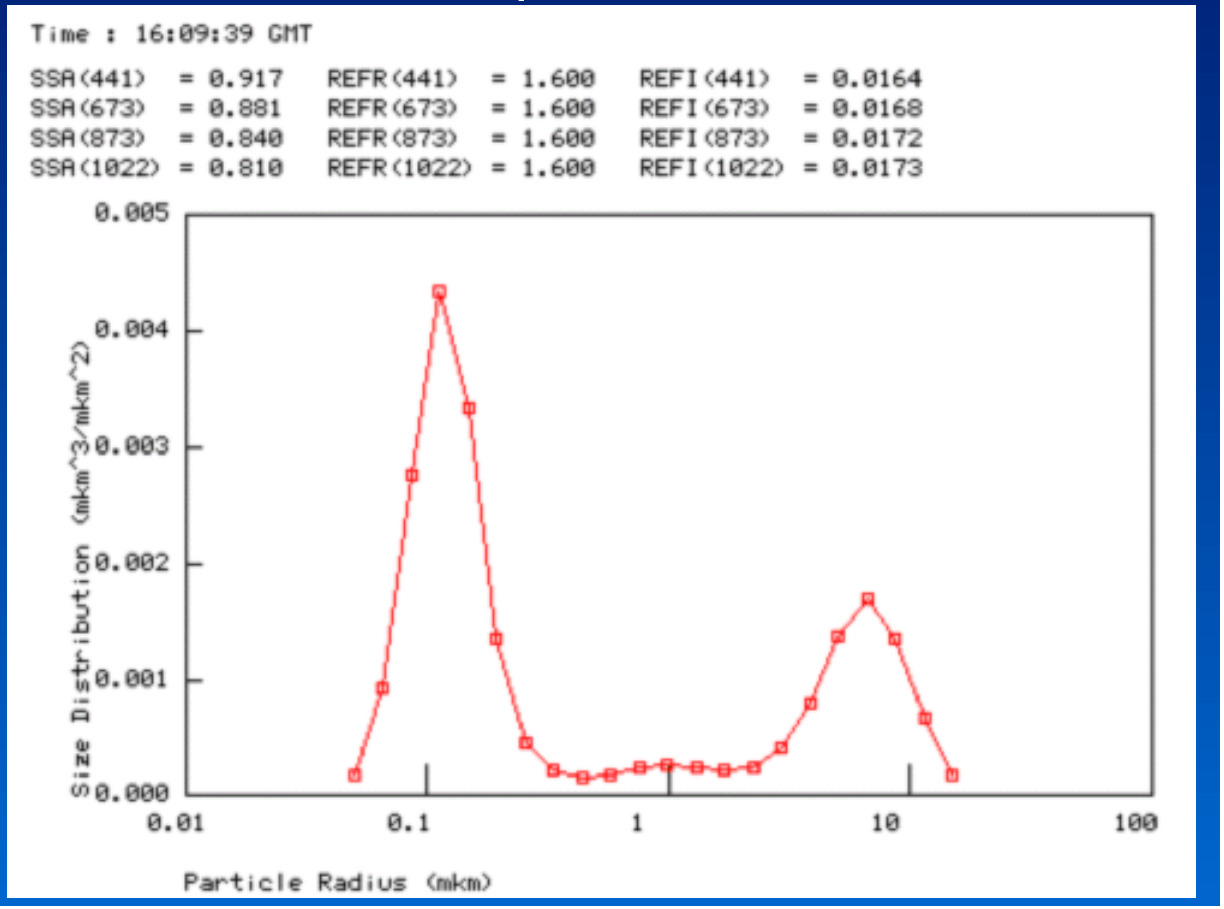
- Viewing the sun directly allows the parameter called optical depth to be derived
- Optical depth is a surrogate for the concentration of the amounts of particles in the atmosphere
- Also related to how well a given particle type can absorb and scatter



Size distribution

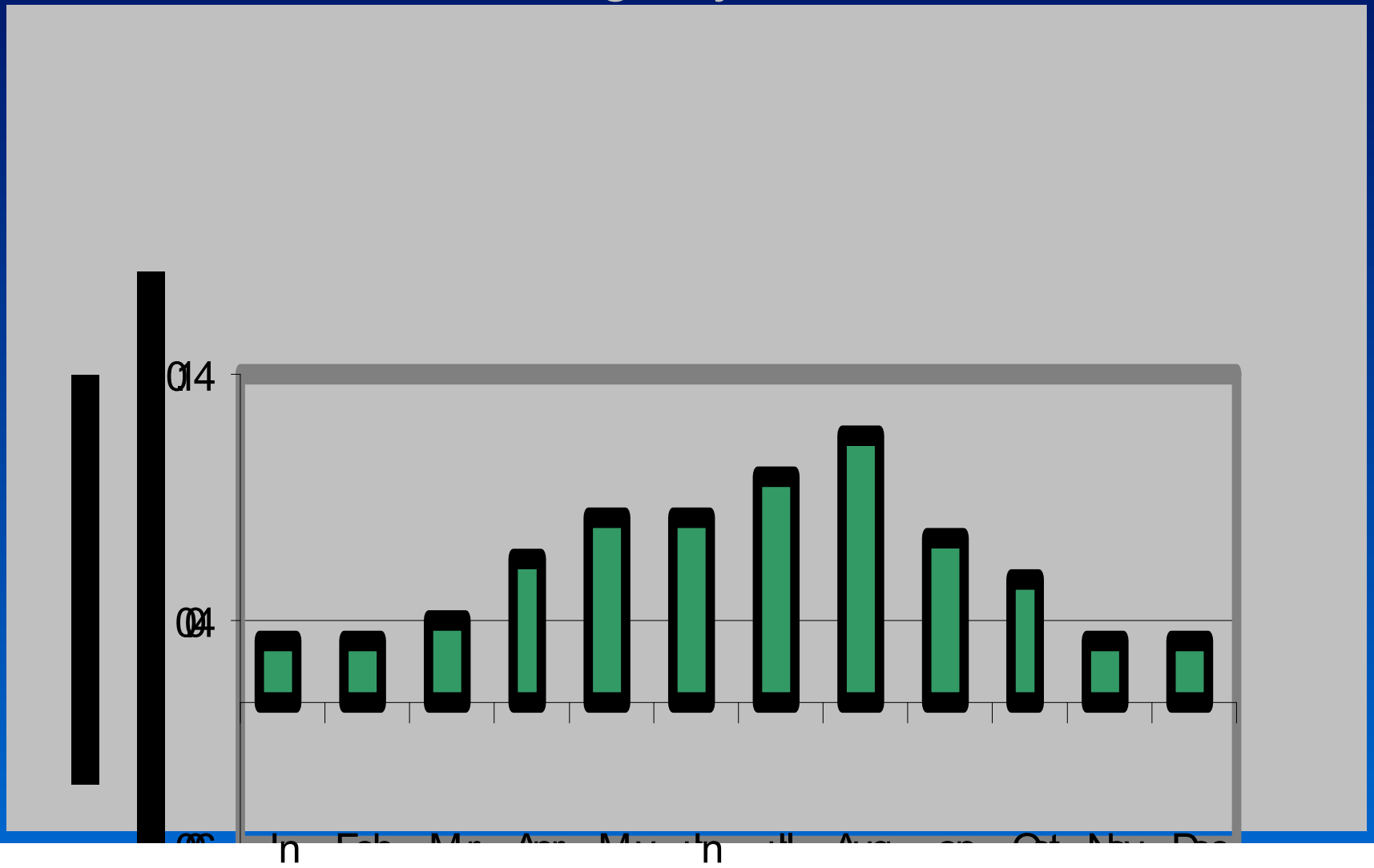
Cimel radiometers can also scan the sky and measure brightness changes of the sky

- The angular distribution of the sky brightness indicates the sizes of the particles in the atmosphere
- Also referred to as the size distribution
- This can also be derived from the measurements of the solar transmittance as a function of wavelength



Year 2000 Aeronet results for Tucson

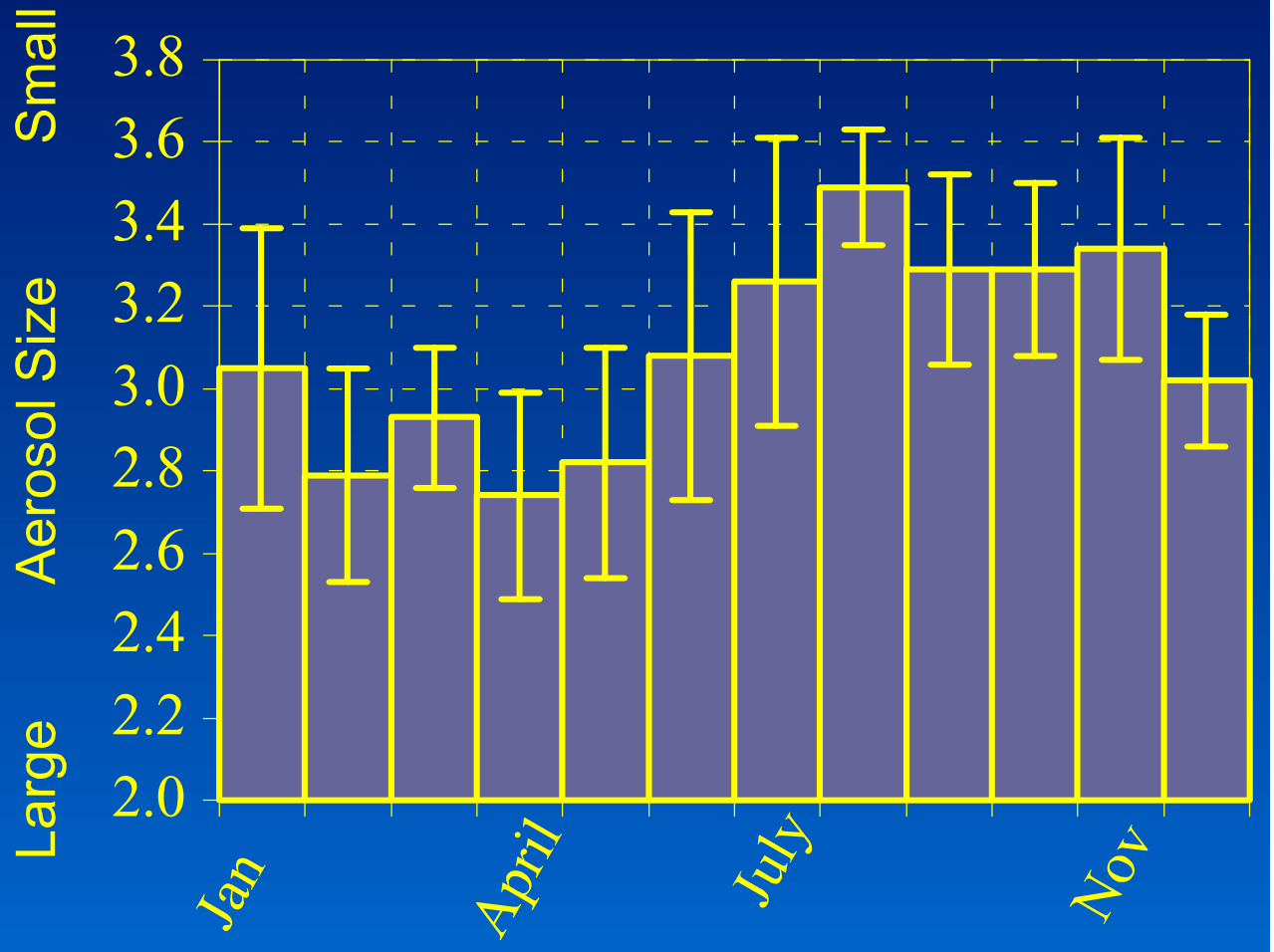
Cimel radiometer collected data throughout the year 2000 and the average by month is shown here



Year 2000 aerosol sizes

The aerosol size has also been evaluated for the year 2000 by month based on the solar transmittance

- Larger particles are seen in spring
- Smaller particles typical in during wet season
- Makes some sense since wind conditions tend to pick up large dust particles



Comparisons to earlier data

Similar study was done in 1975

- Far fewer data sets
- Data tended to be collected on clear and optically stable days (little change in dust content)
- Earlier data set showed more large particles relative to small particles
  - More paved roads means less airborne dust
  - More paved roads means more cars which tend to create smaller particles

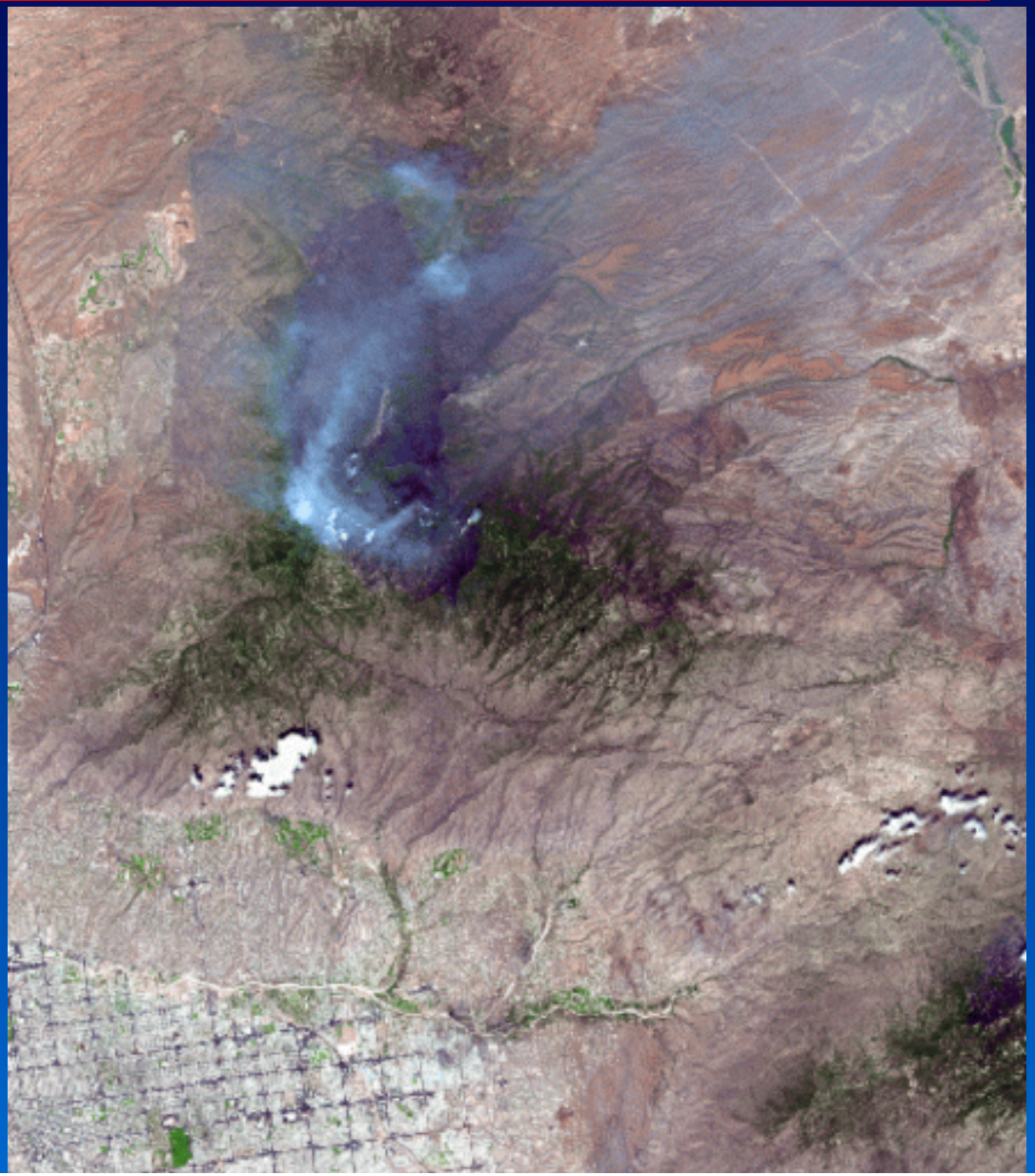
Smoke studies

Ability to study particle concentration and size leads to the conclusion that rare events can be studied

- Requires a combination of routine measurements as well as “fortuitous” winds to bring the smoke to the instrument
  - Cimel radiometer was not in operation in Tucson until July 15
  - Other RSG radiometers have been operated on a regular basis since February 2003
- Aspen fire started June 10, 2003
  - Prevailing winds kept most of the smoke to the north and east of the Catalinas
  - Could have chased the smoke, but logistics and travel restrictions prevented this
  - Wind shift in late June brought the smoke into the Tucson valley

ASTER data on June 26, 2003

- ASTER is also on the Terra platform with MODIS
- Much smaller swath width
- Much higher spatial resolution



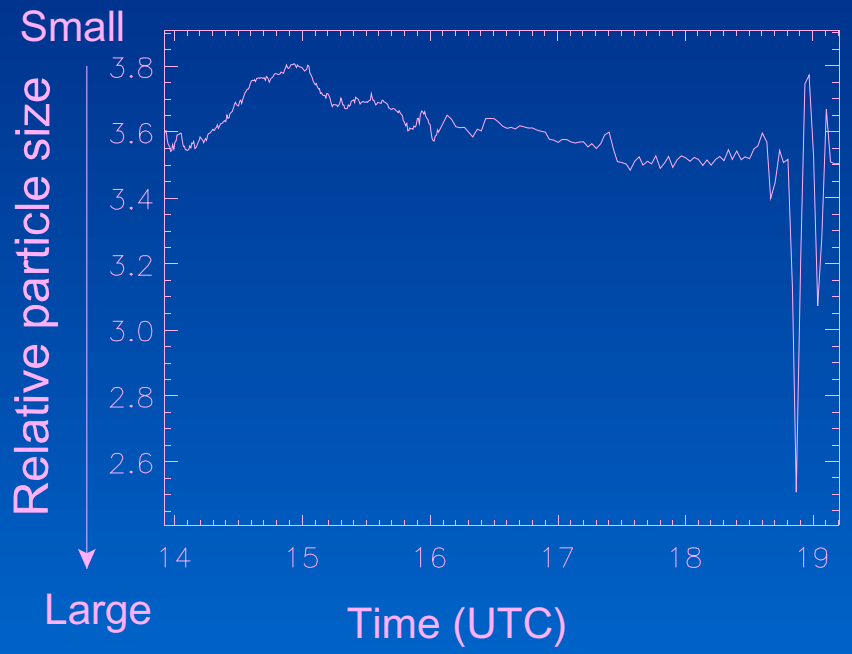
Aqua June 29

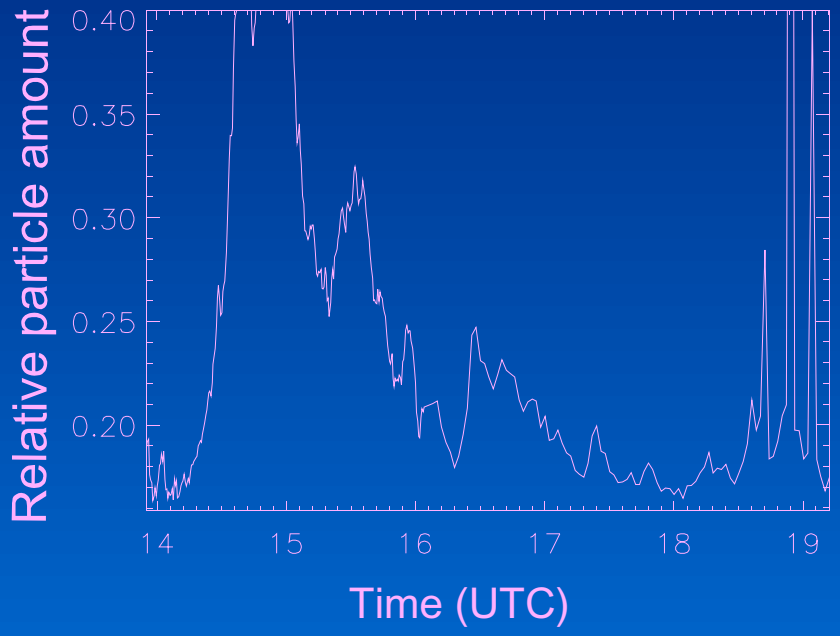
Morning of June 30, 2003

Smoke data

Results here are from measurements that were made on June 30 near downtown

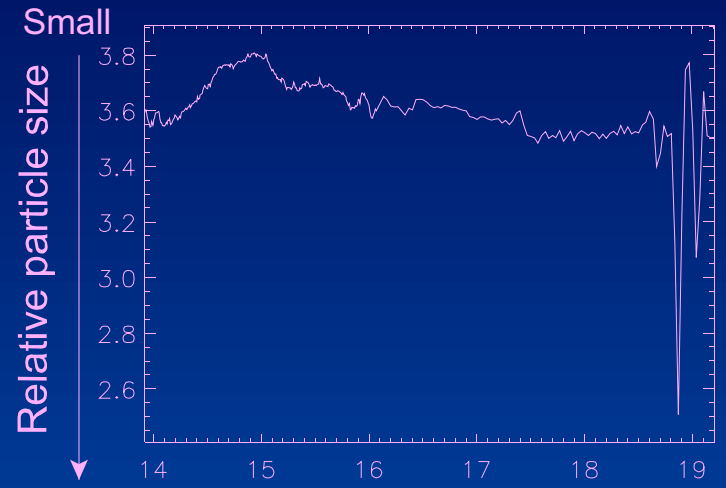
- Graph on the left shows the relative concentration of particles
- Graph on right is related to particle size

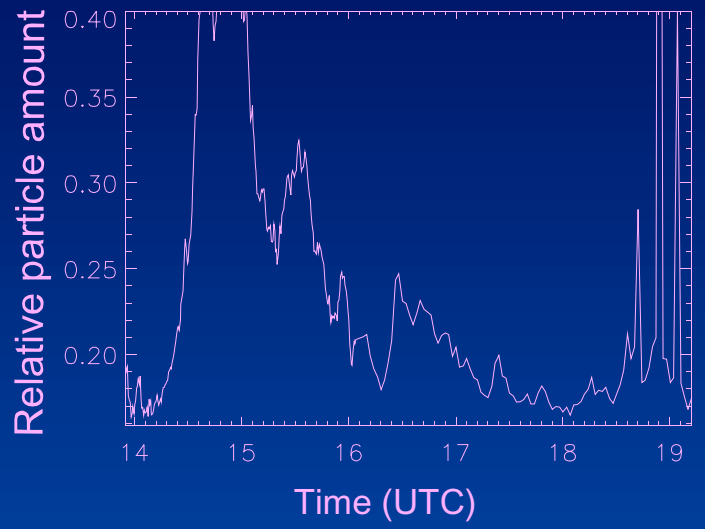


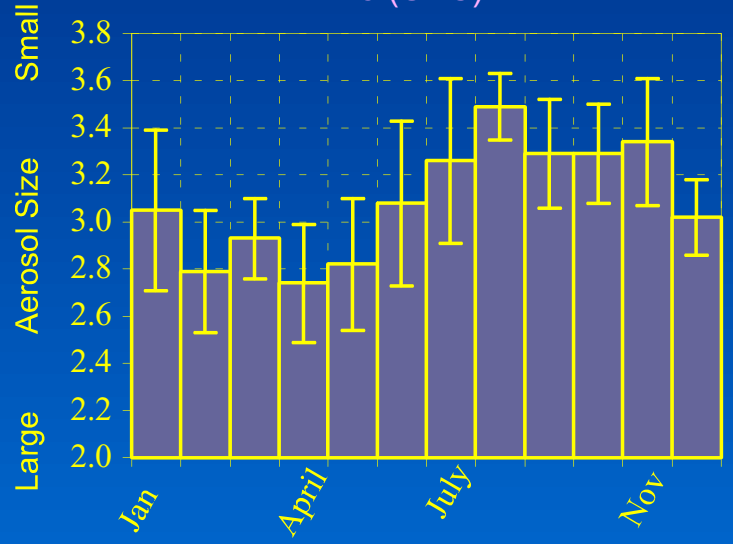


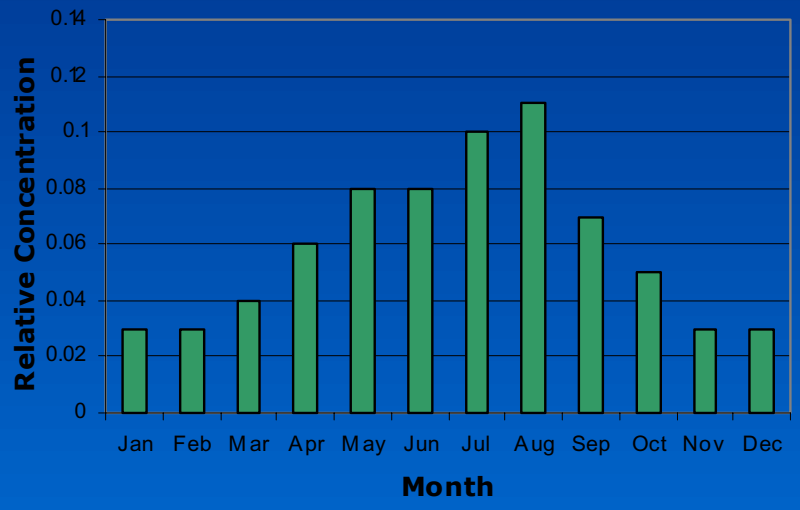
Smoke data

The historical data shows how rare these results are





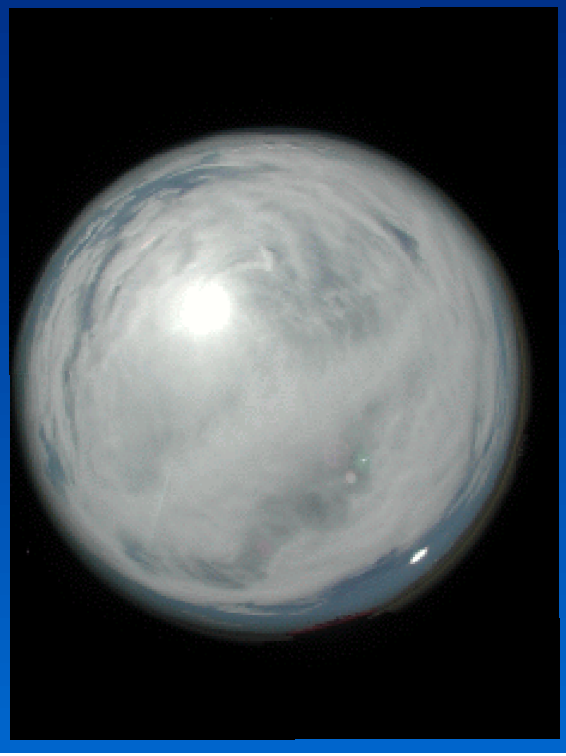


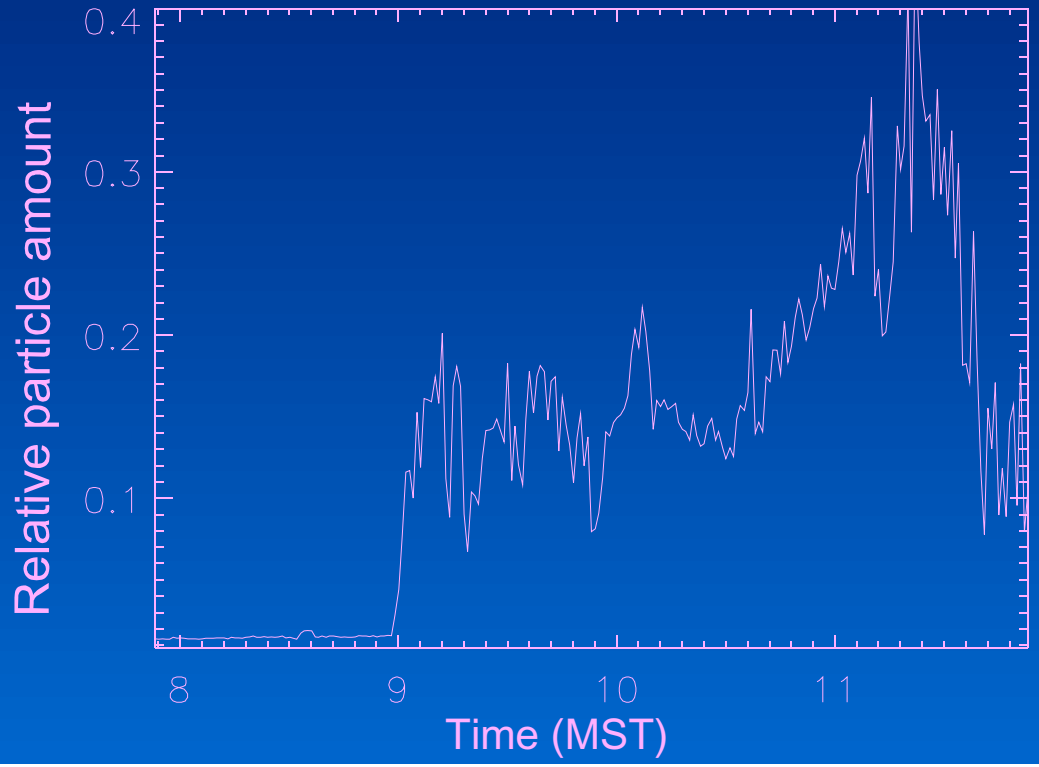


Cirrus clouds as contrast

Is it possible that the data are contaminated by clouds?

- As an example consider one date that provided a unique opportunity with clear skies early and cirrus clouds later in the day
- Clear change in the particle amount

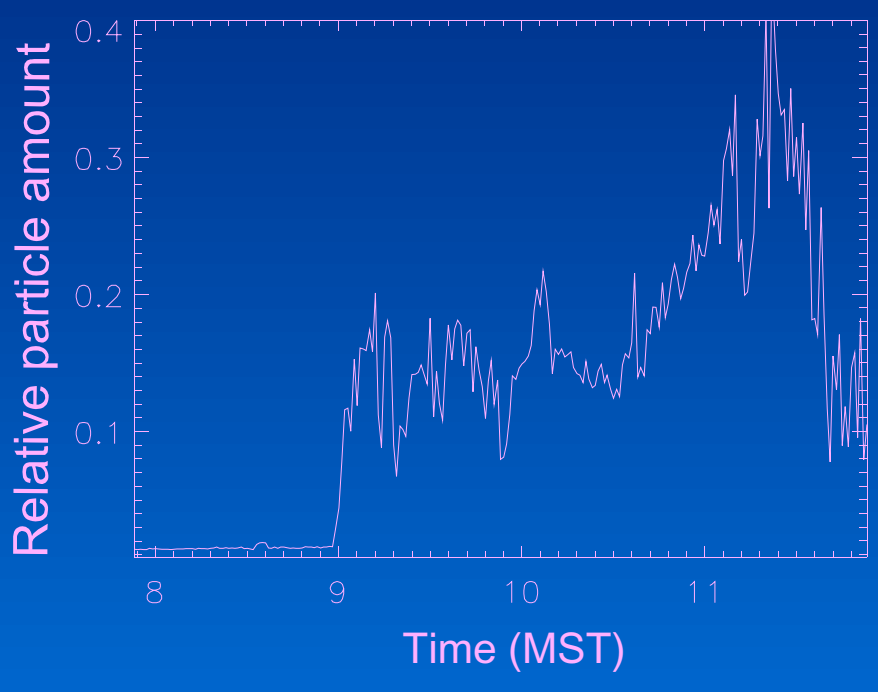


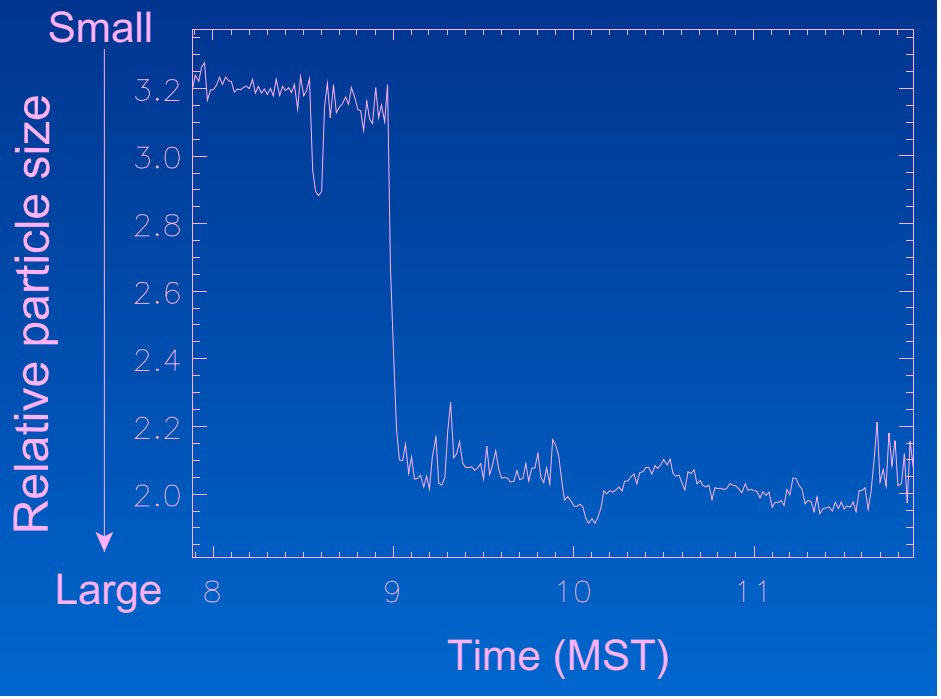


Cirrus-cloud study

Change in amount of particles coincided with a change in the size

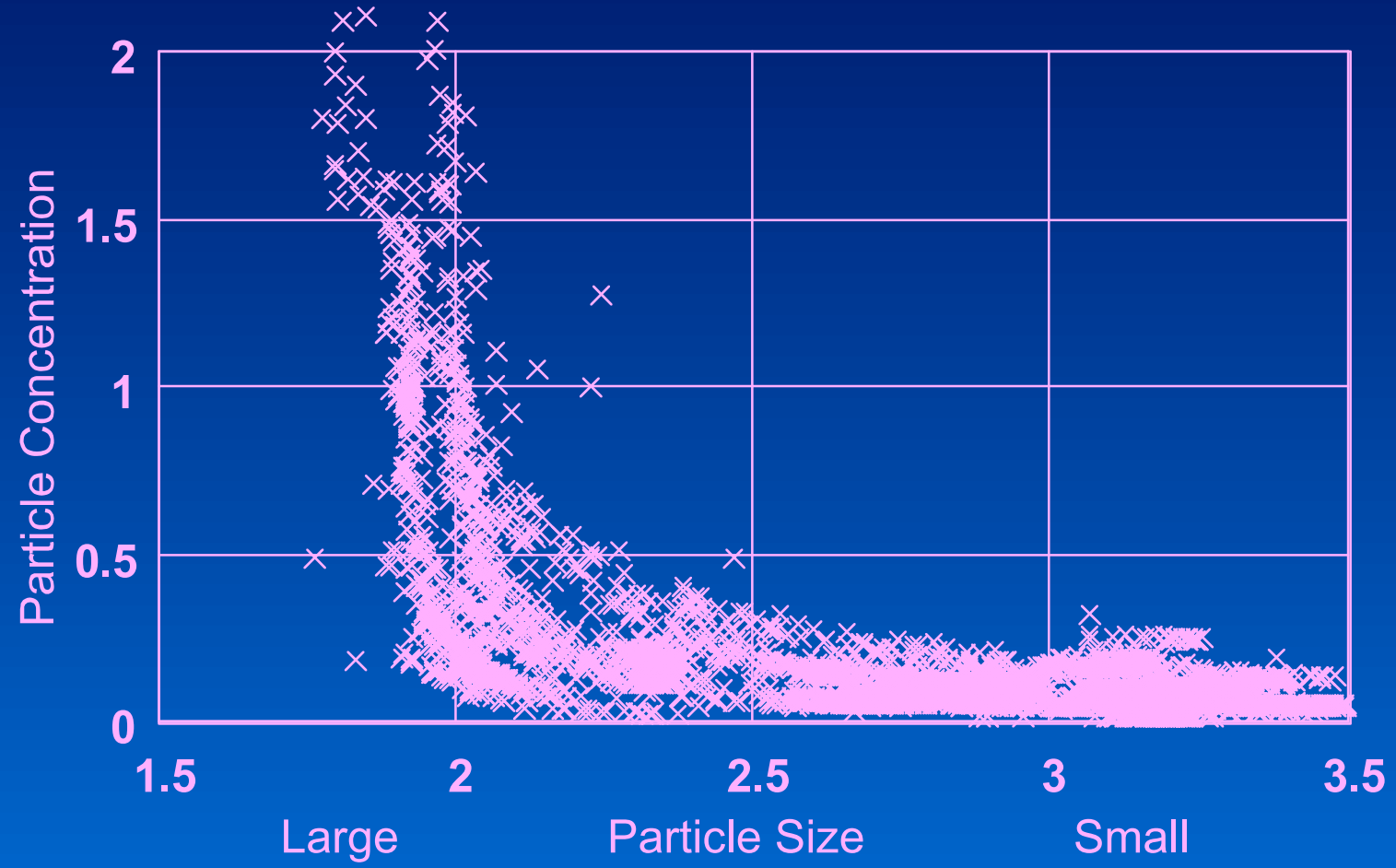
- Ice crystals larger than dust and thus the inferred size increases with presence of cirrus
- One outcome of this result is that the scattering by clouds tends to be white



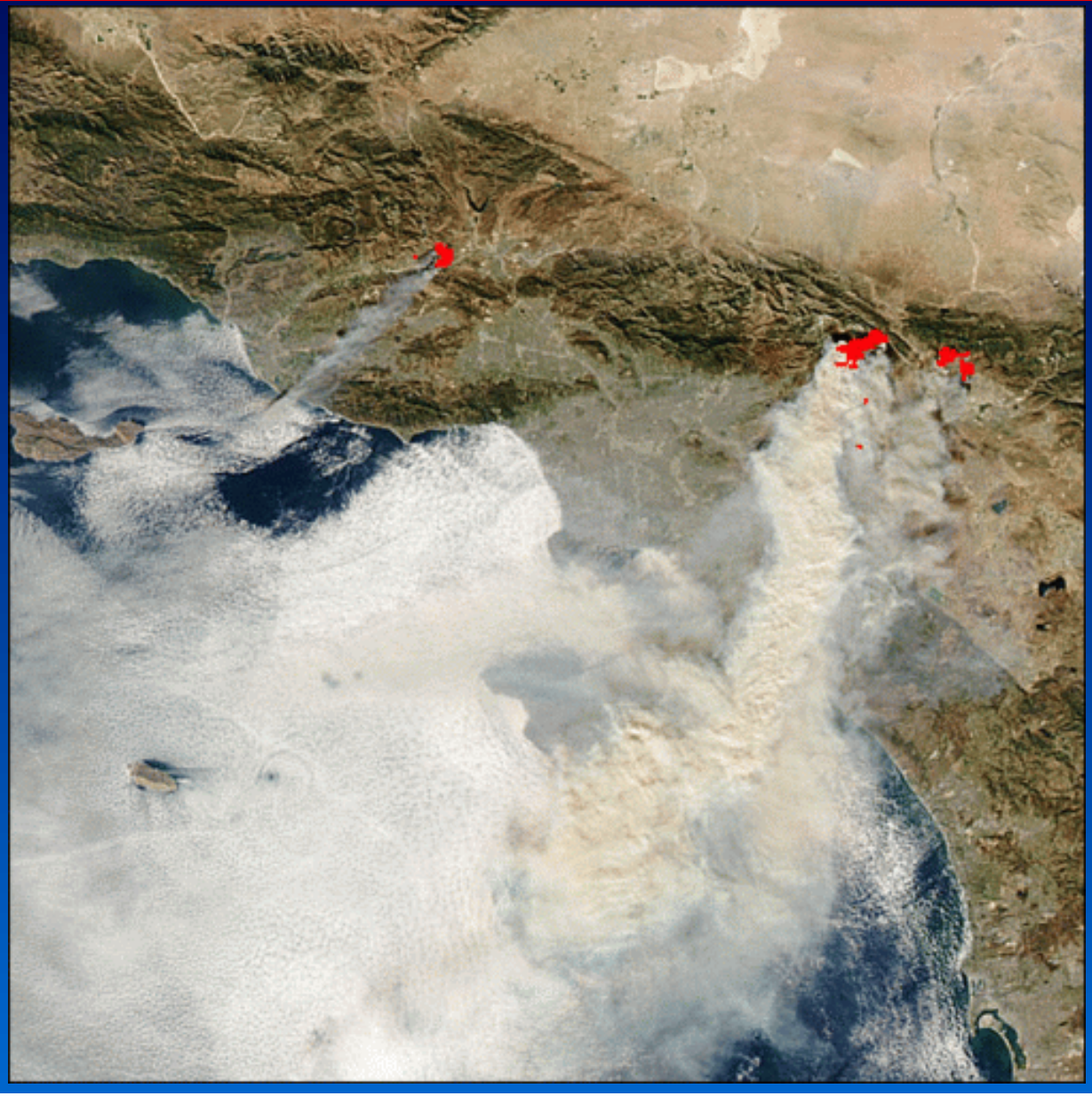


Cirrus-cloud studies

This behavior is consistent for data sets that include cirrus clouds



California wildfires - October 26

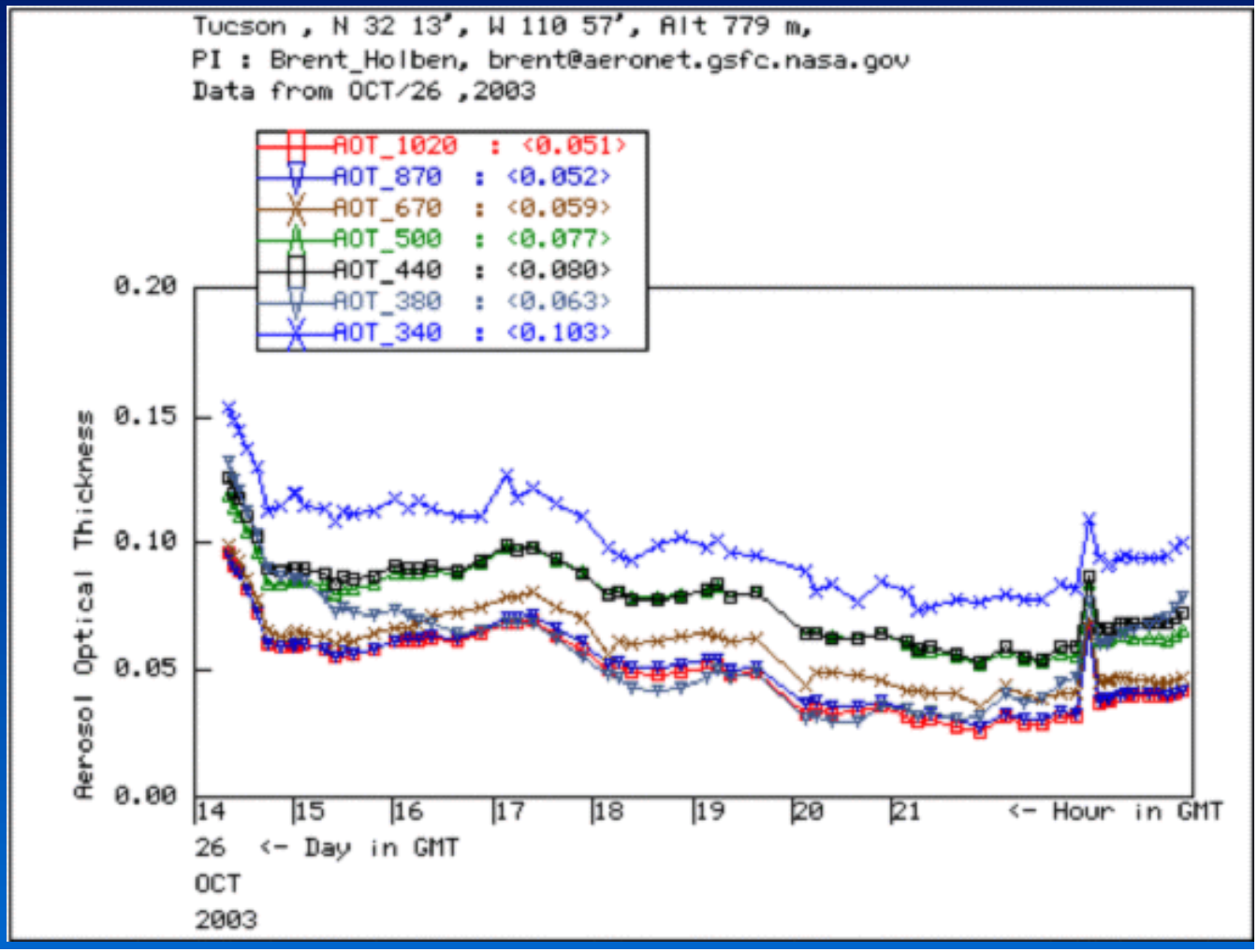


California wildfires - October 27

California smoke in Tucson?

Can examine the results of the Cimel data to determine whether smoke was a factor in Tucson

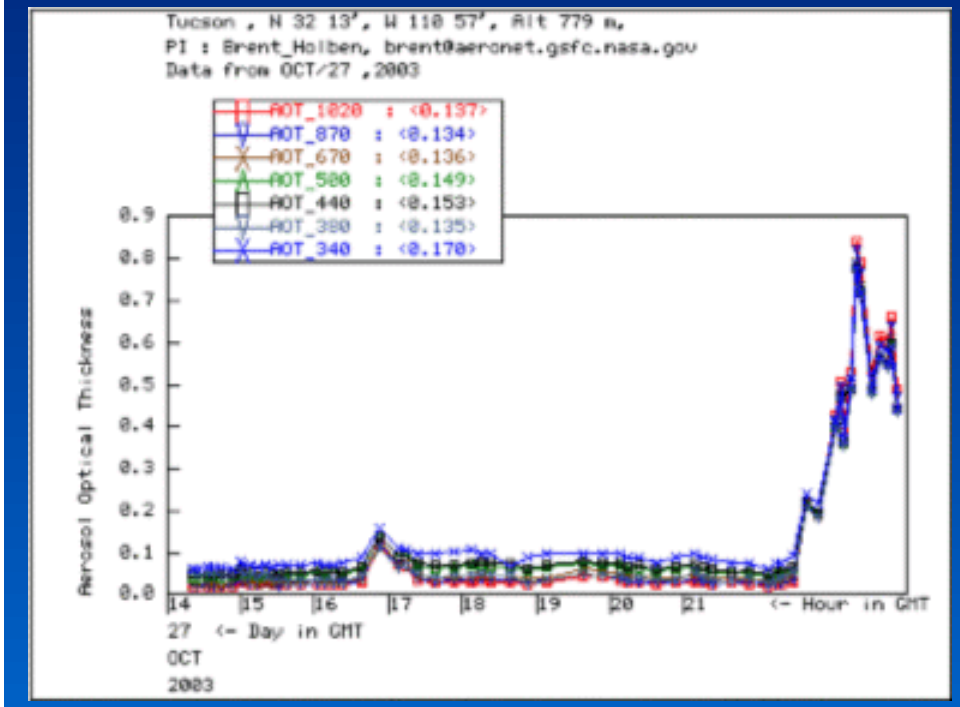
- Optical depth data from 10/26
- Clear skies with small amounts of aerosols

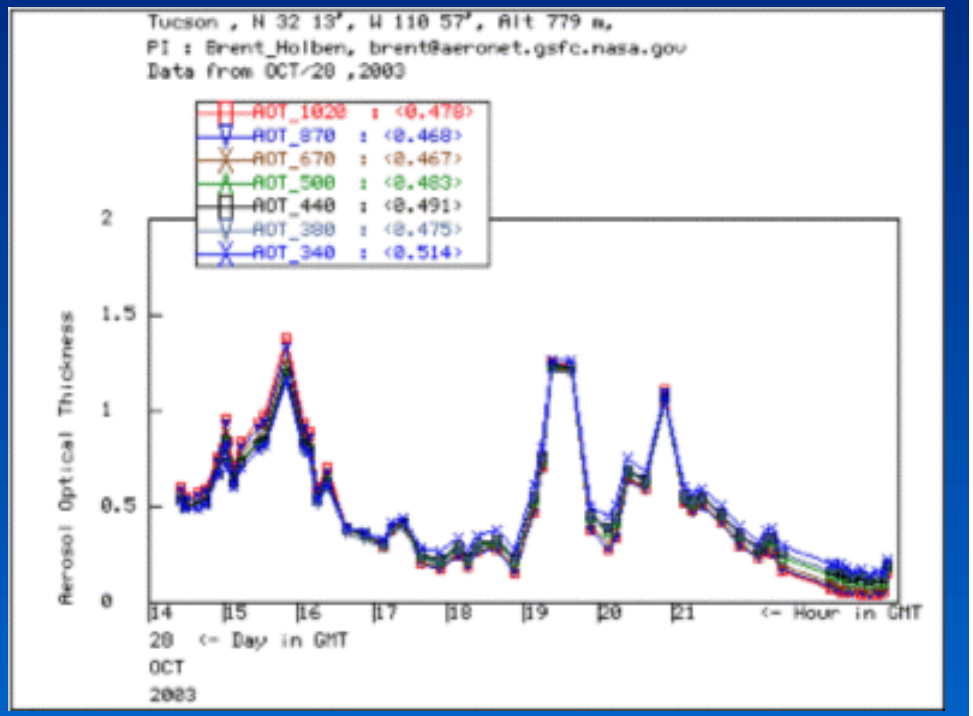


Optical depth data on Oct. 27-28

Frontal system moved in with strong winds and clouds

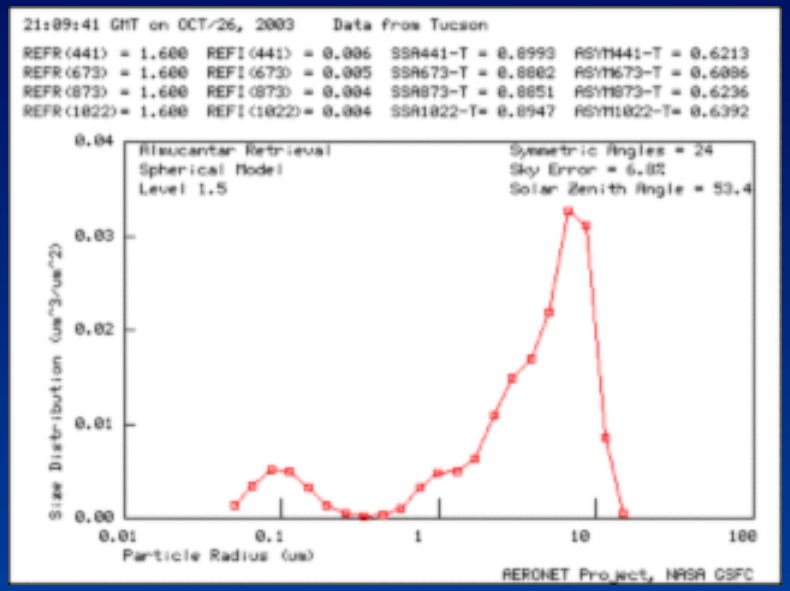
- Aerosol amount goes up due to blowing dust and clouds
- What about smoke?

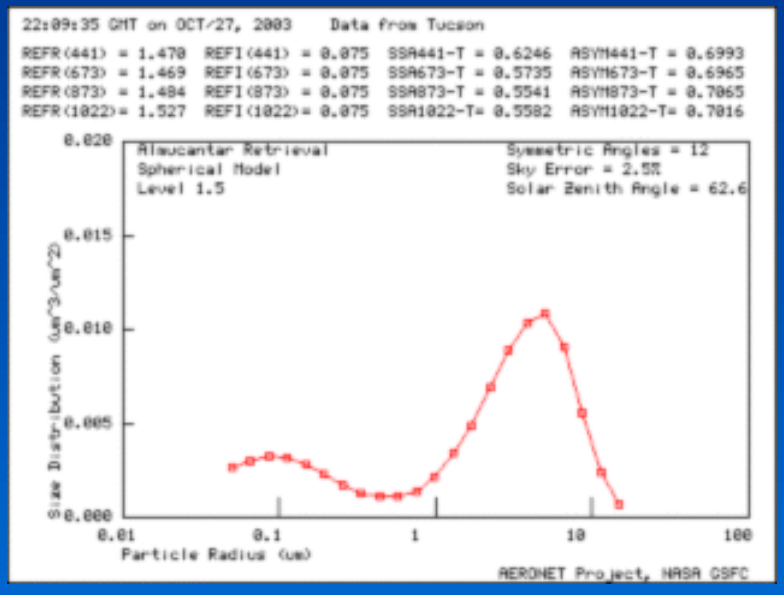


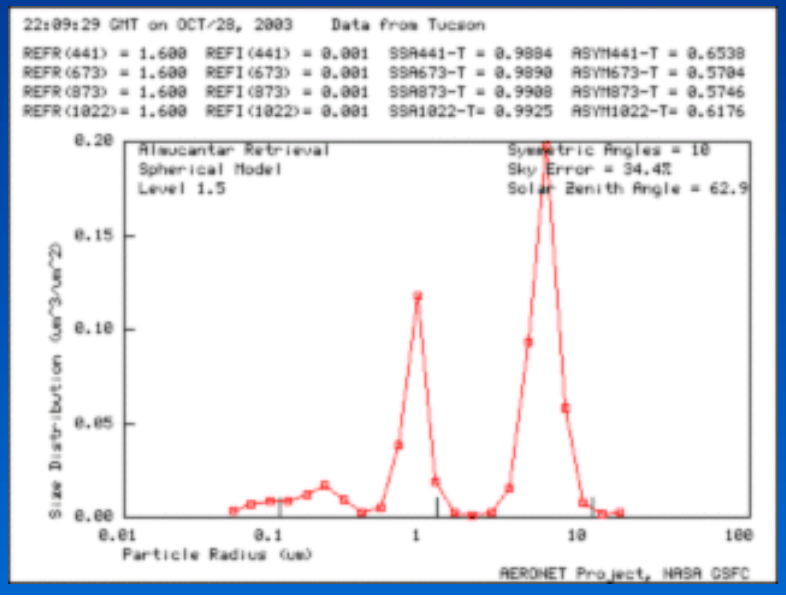


Size distributions from Oct. 26-28

- Plots here are the number densities for given particle sizes
- Upper right is Oct. 26 and shows a dominance of large particles as does Oct. 27 below
- Note odd peak on Oct. 28

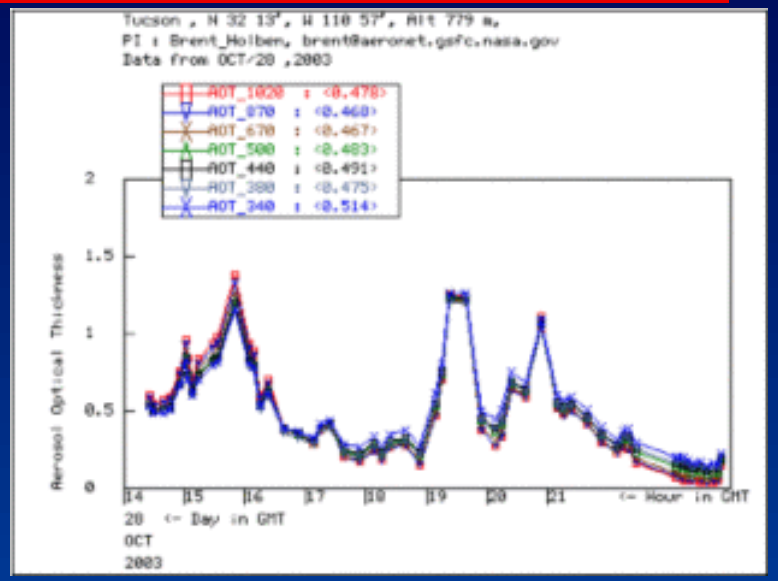


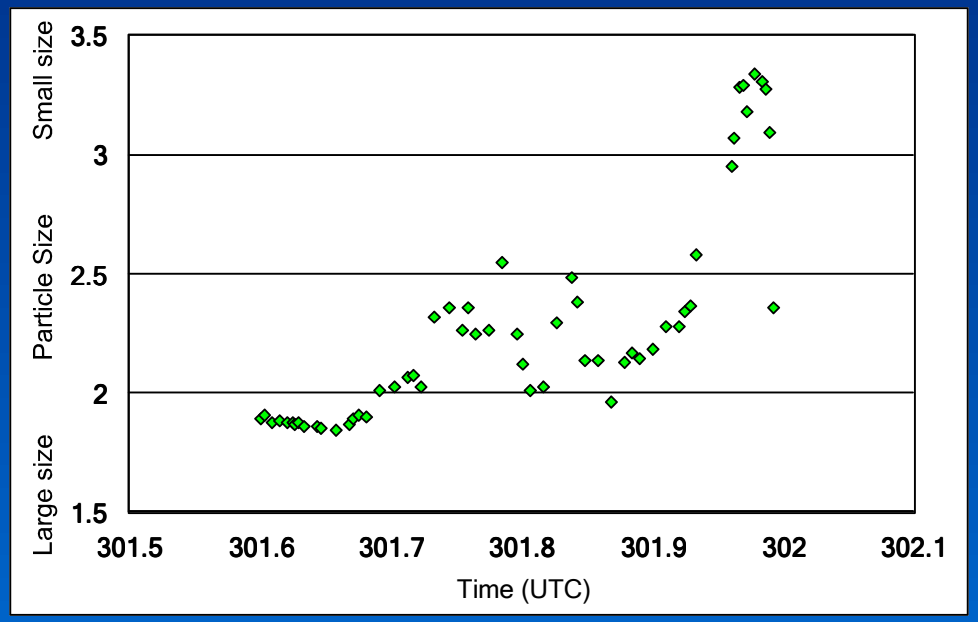


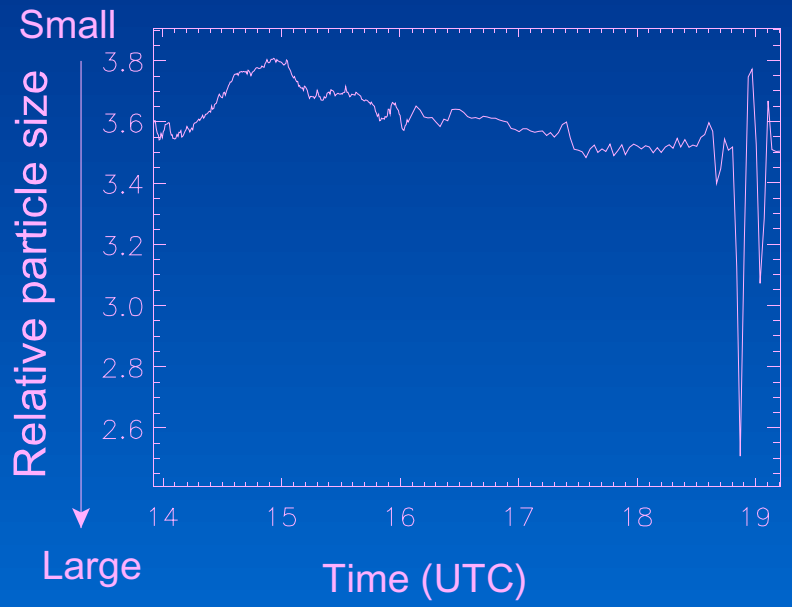


Size distributions - Oct. 28

The claim was that smoke was present on Oct. 28 is not shown to be definite

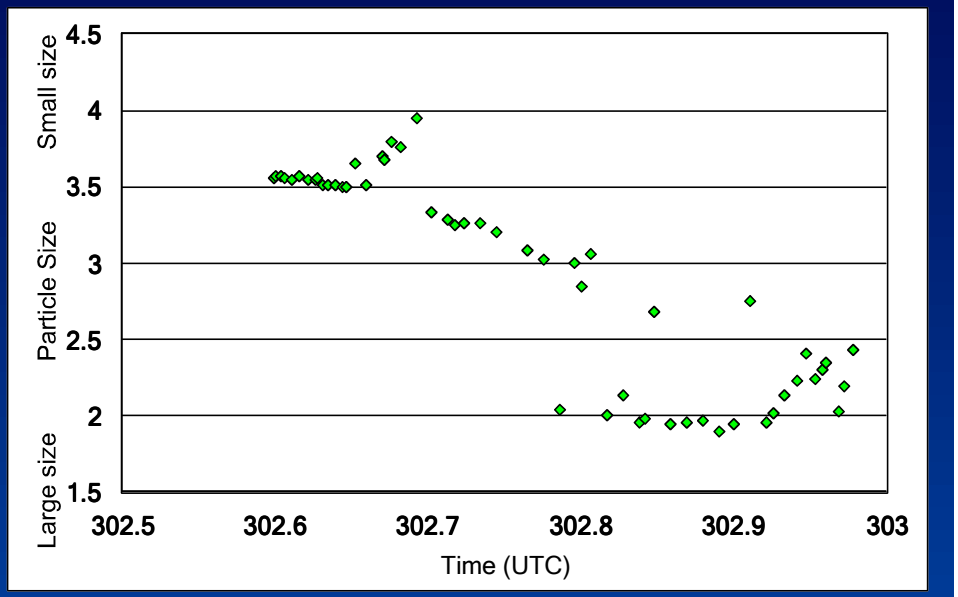


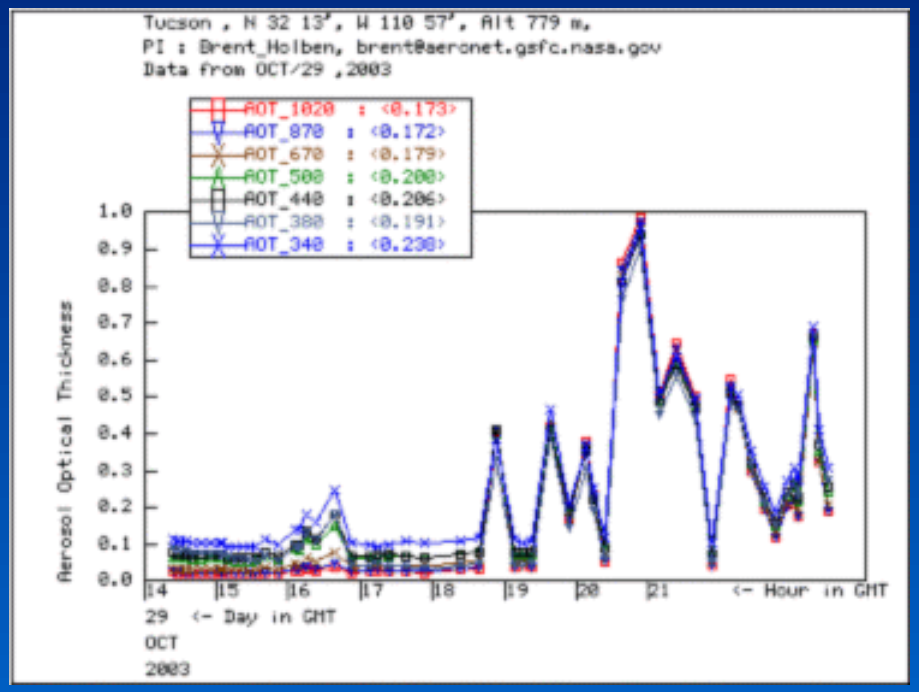


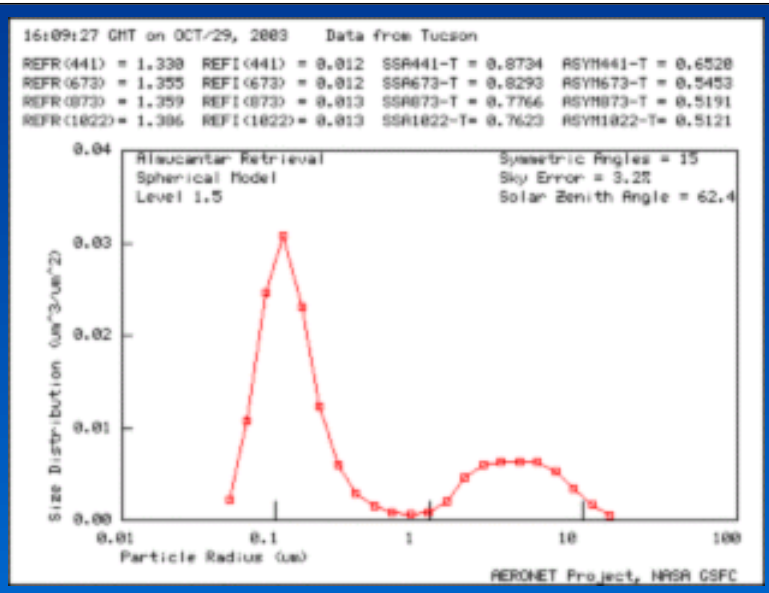


Size distribution on Oct. 29

The following day, however, looks to be a better possible case







Final comments

Recent launches of earth-imaging sensors offers a unique view of the surface and atmosphere

- Ground-based measurements are still useful for understanding the satellite data
  - Provides a check on the results
  - Offers added data to improve the satellite retrievals
  - Ground data allow better temporal sampling (at the cost of poorer spatial sampling)
- University of Arizona plays a leading role in this validation of satellite retrievals
  - Remote Sensing Group in Optical Sciences one of these groups
  - Hope to continue to play a key role in the calibration of sensors as well as with atmospheric studies