Automated algorithm for remote sensing of aerosols and trace gases using MFRSR measurements

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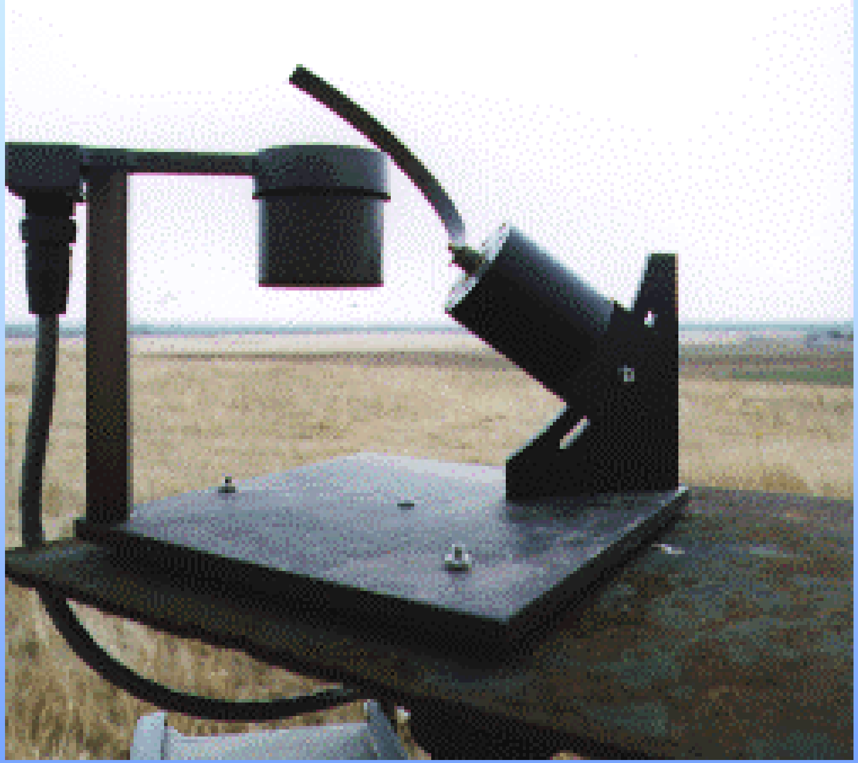
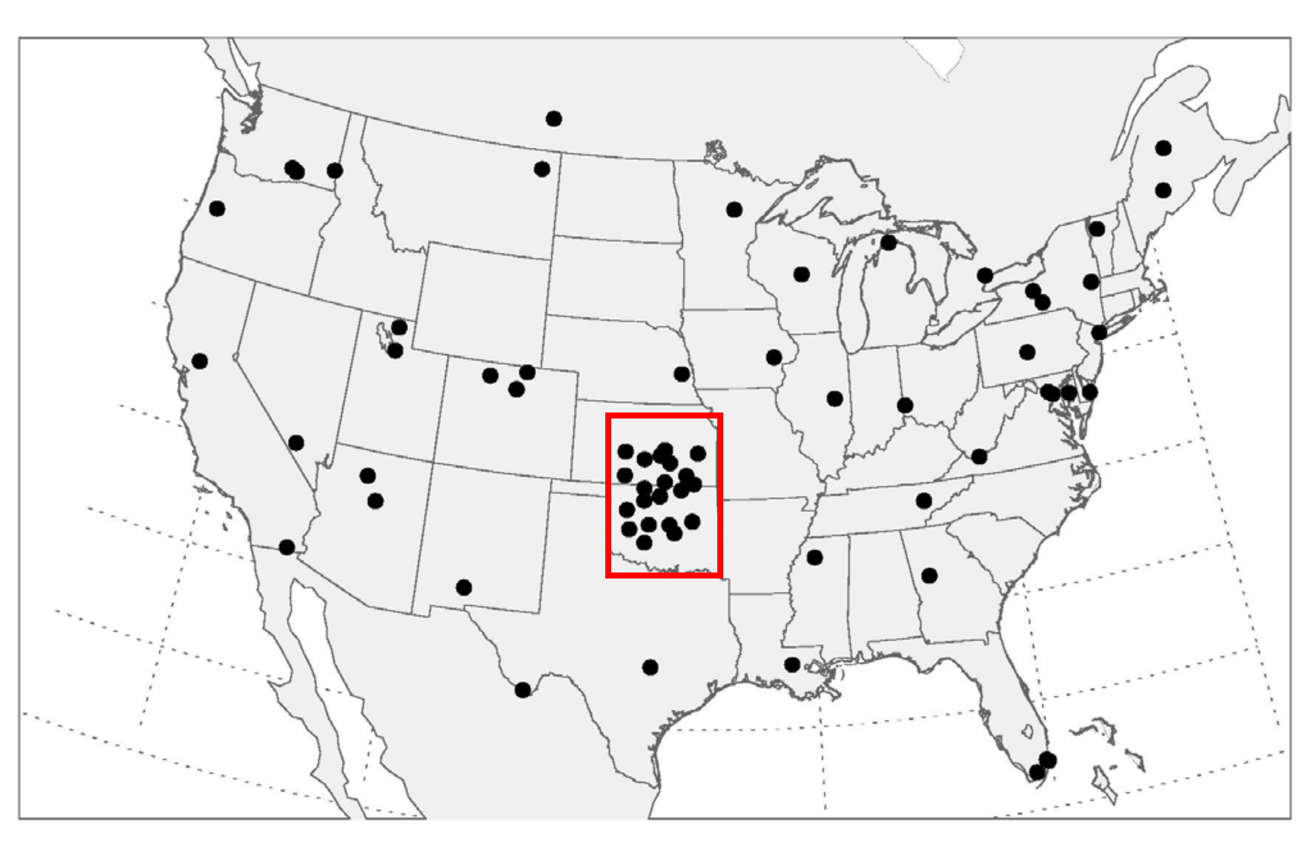
Overview

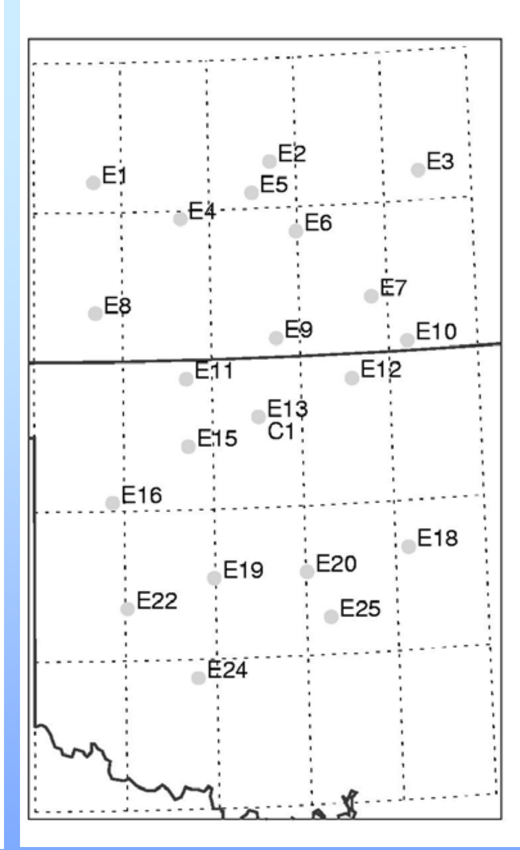
- MFRSR instrument
- Automated cloud screening
- Retrieval algorithm
- Aerosol mode separation examples

MFRSR instrument



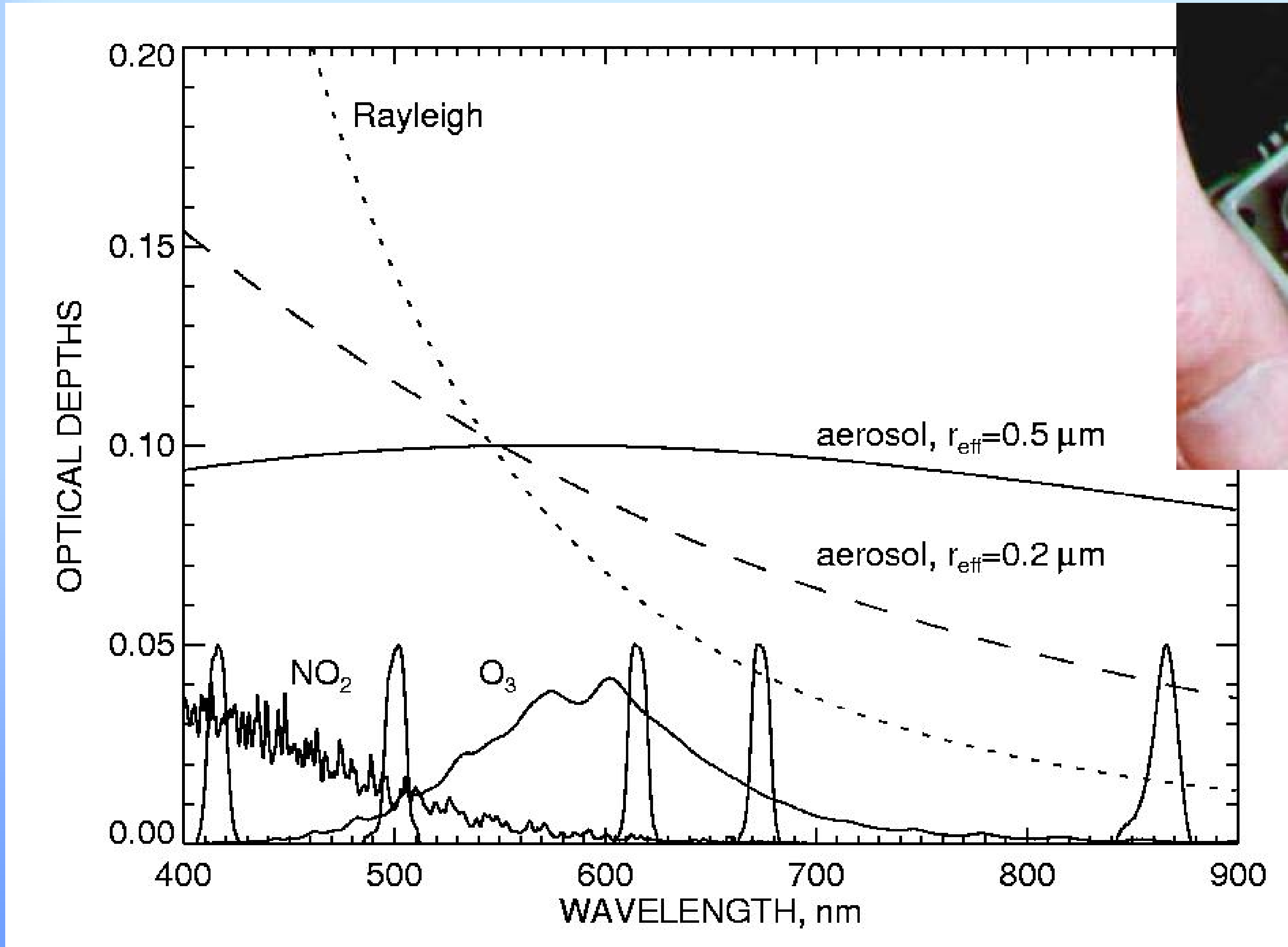
MFRSR networks

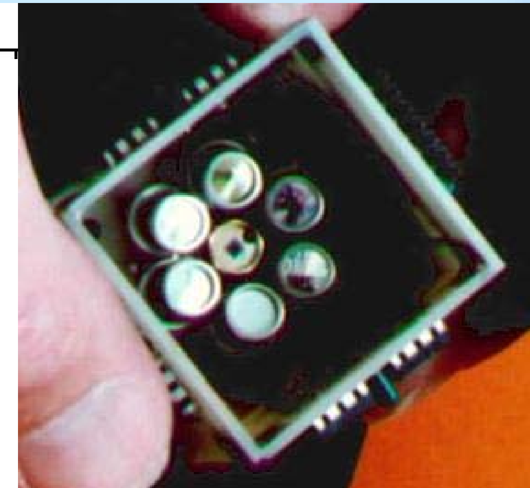




Southern Great Plains Network (DOE ARM)

MFRSR spectral sensitivity



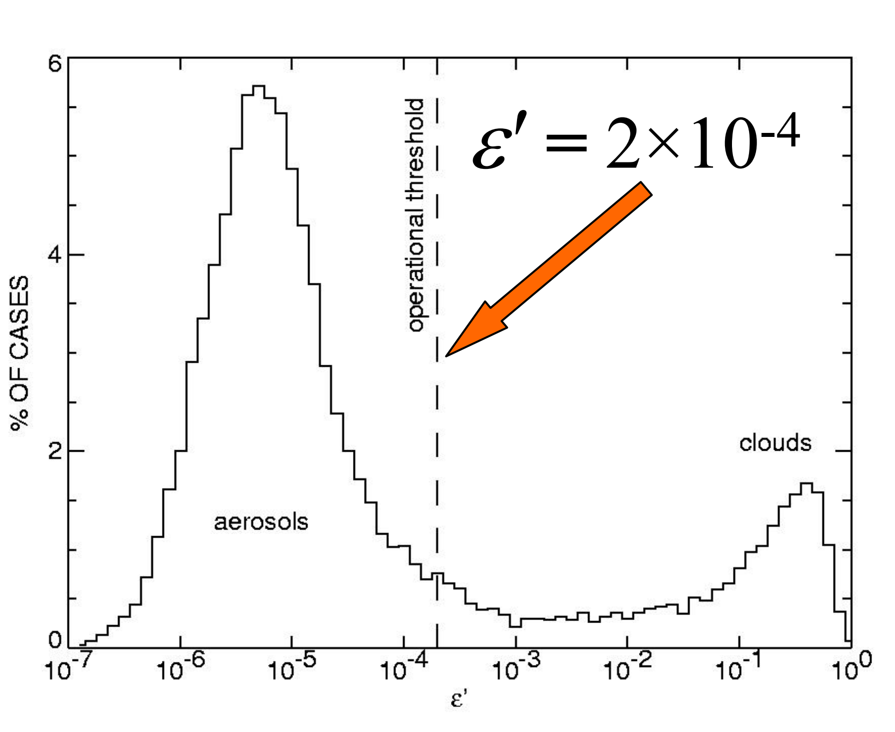


Automated cloud screening

Screening parameter:

$$\varepsilon' = \frac{\exp(\overline{\ln \tau'})}{\overline{\tau'}}$$

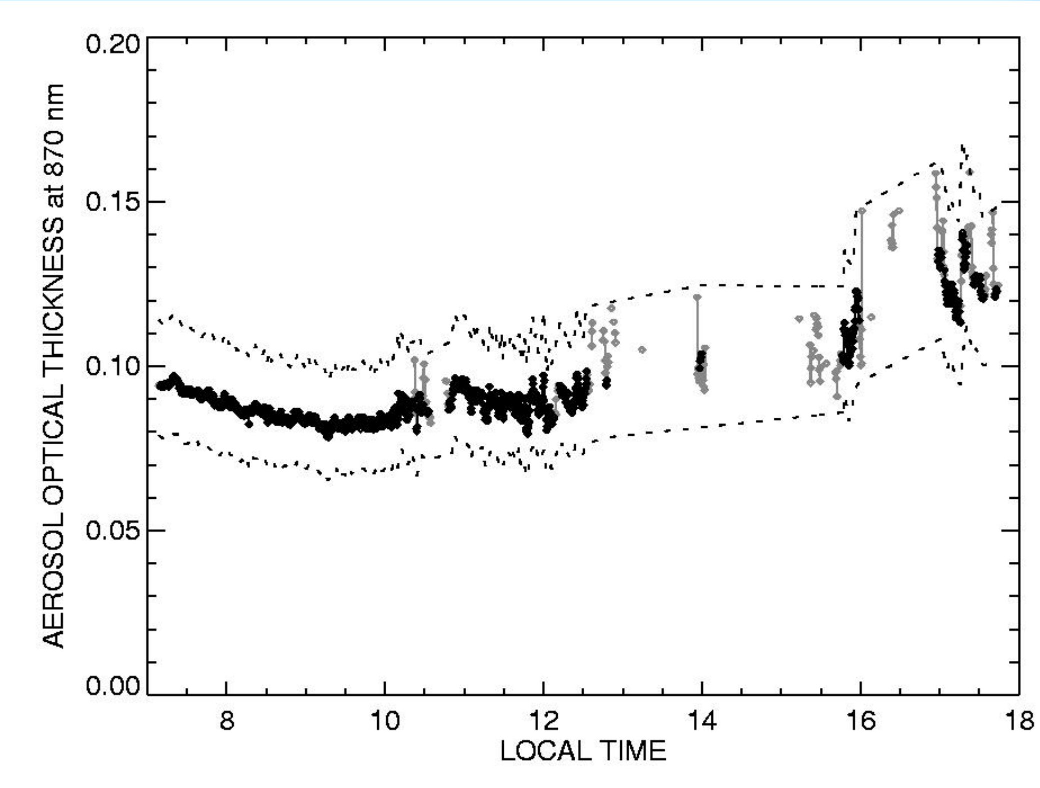
$$\tau' = \tau - \overline{\tau} + \tau_{const}$$



τ – optical depth at 870 nm, τ_{const} = 0.2
overbar = 5 min moving average

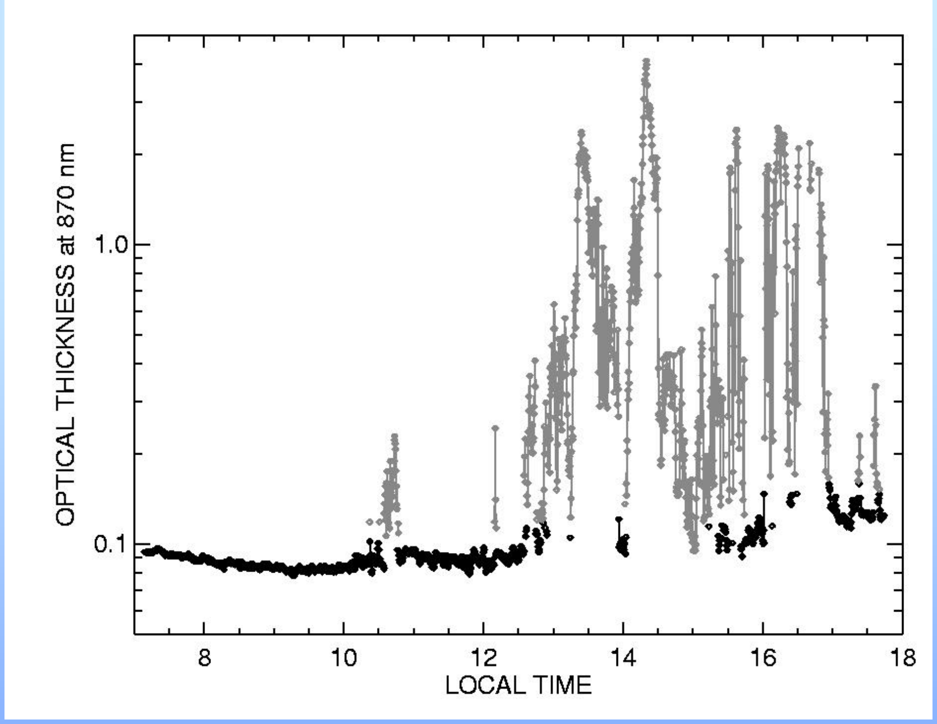
Automated cloud screening II

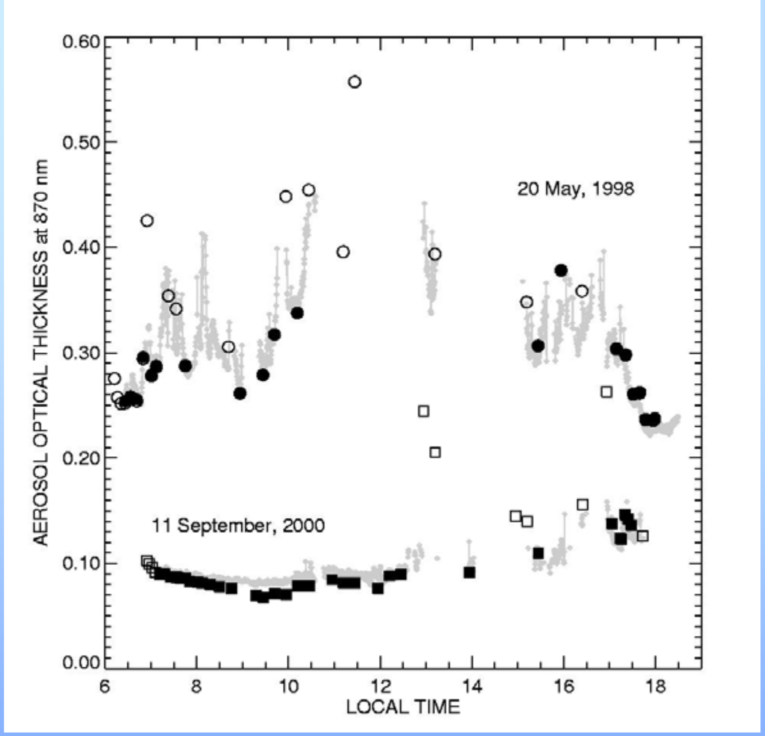
Enveloping technique to include data points between the initially selected that show similar optical depth values.



Upper curve:
local maxima $\times$ 1.2,
Lower curve:
local minima / 1.2

Automated cloud screening III





11 September 2000 at SGP's E13

Comparison with AERONET

Retrieval algorithm

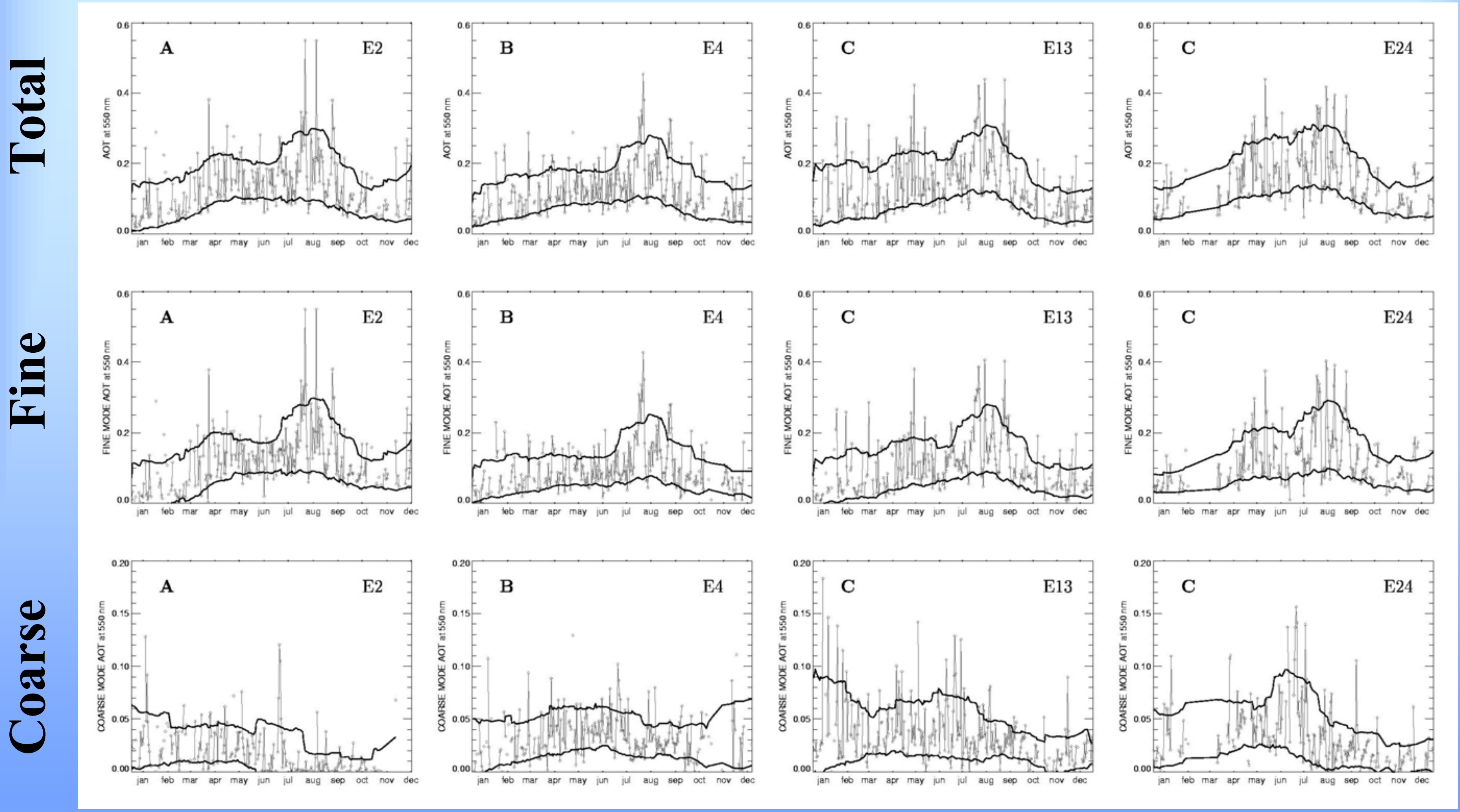
Aerosol size model: *bimodal Gamma*

V_{eff}=0.2 both modes

Retrievals:

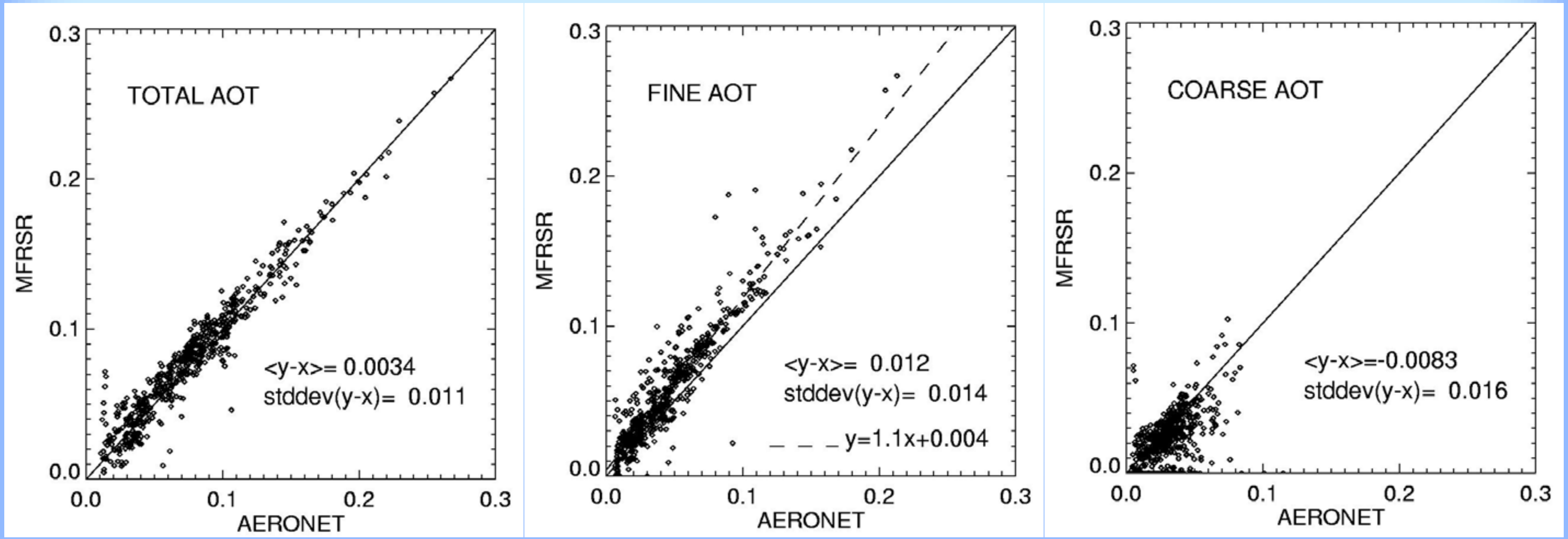
- Fine mode AOT and R_{eff}
- Coarse mode AOT (fixed R_{eff}=1.5μm)
- O_3 column
- NO_2 column
- Instrument calibration constants

Fine and coarse mode AOT



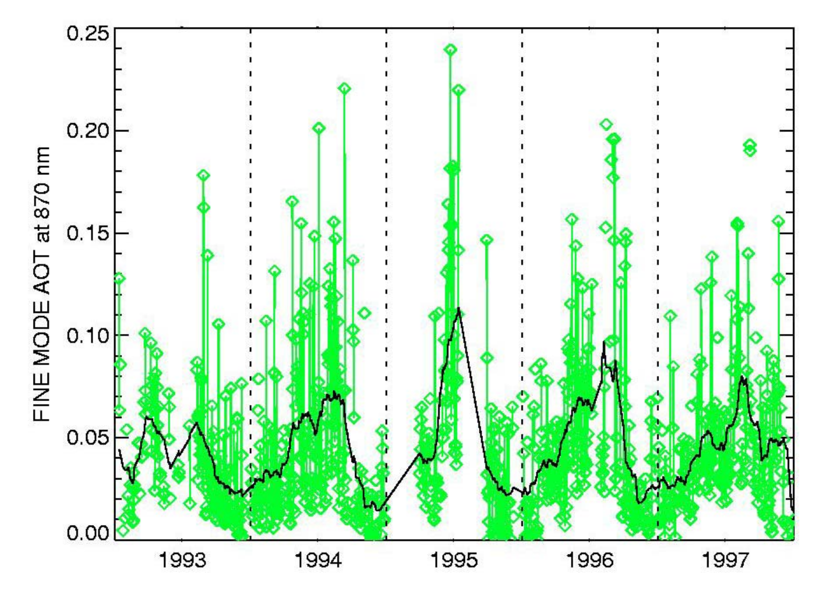
AOT retrievals (@ 870 nm) for 4 SGP EFs, Jan.-Dec. 2000.

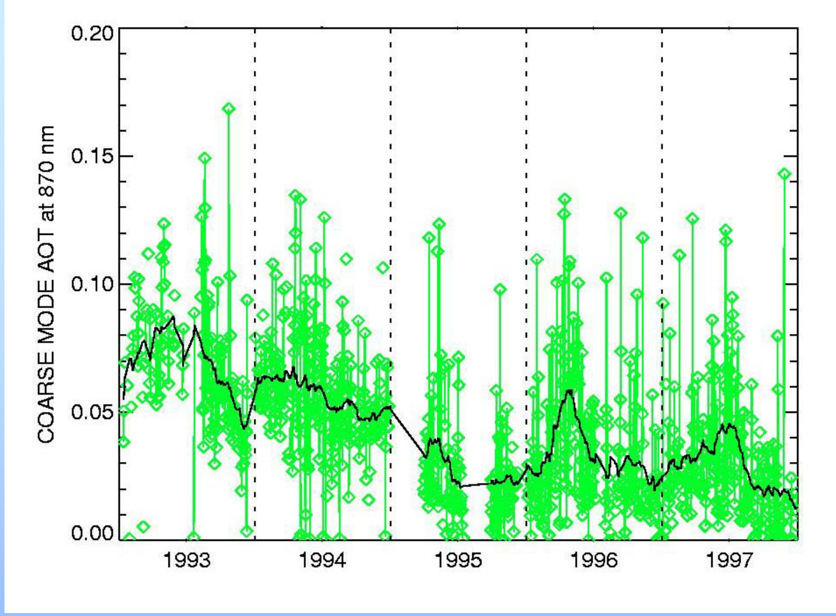
Aerosol mode separation



Comparison with AERONET almucantar scan analysis at 870 nm (May 1998 to September 2000, 576 datapoints, SGP site Central Facility).

Pinatubo aerosols in 1993-97

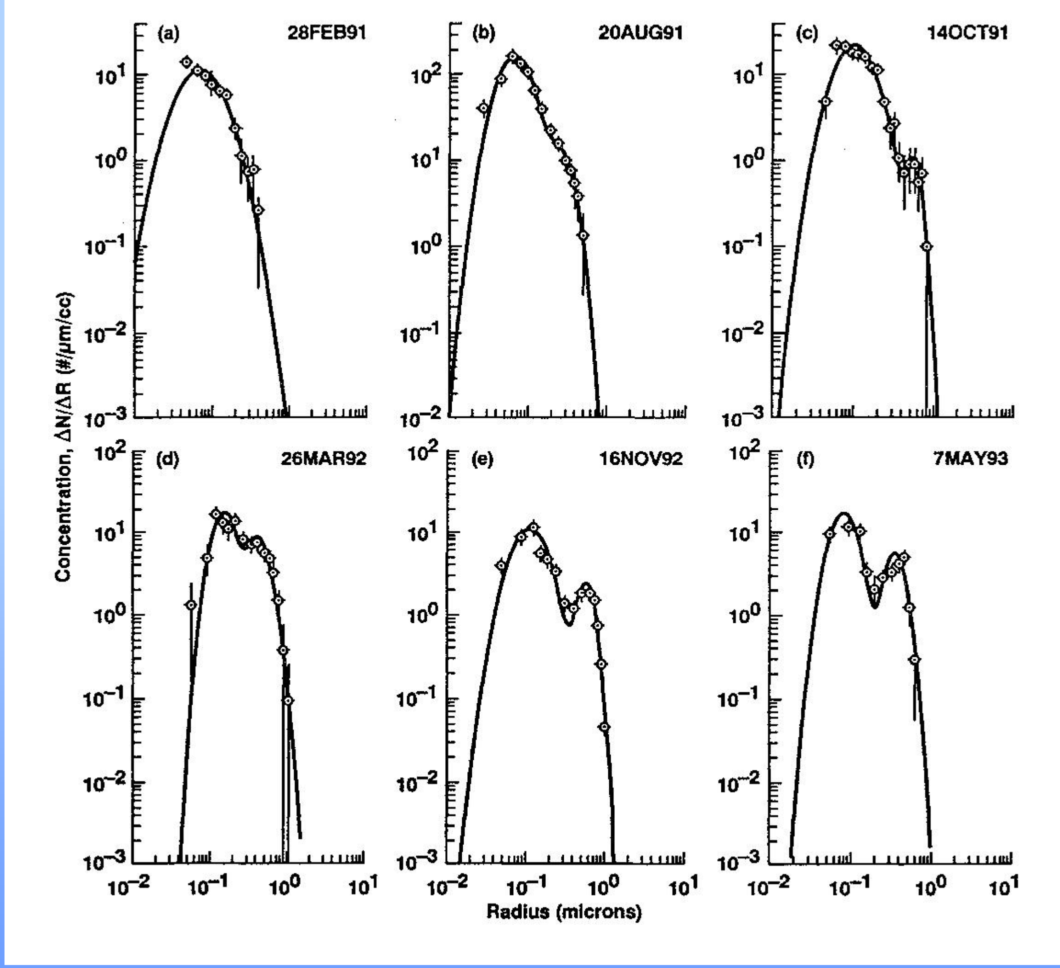




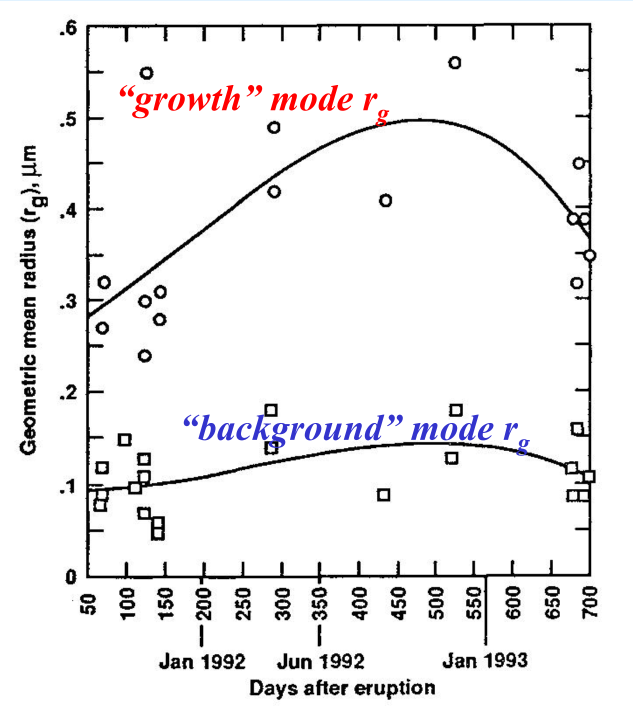
Fine mode AOT (at SGP CF):
• strong seasonal variations;
• no interannual trend.

Coarse mode AOT:
• weak seasonal variations;
• strong trend in 1993-1995 due to fallout of volcanic aerosol particles injected in stratosphere during 1991 Mt. Pinatubo eruption.

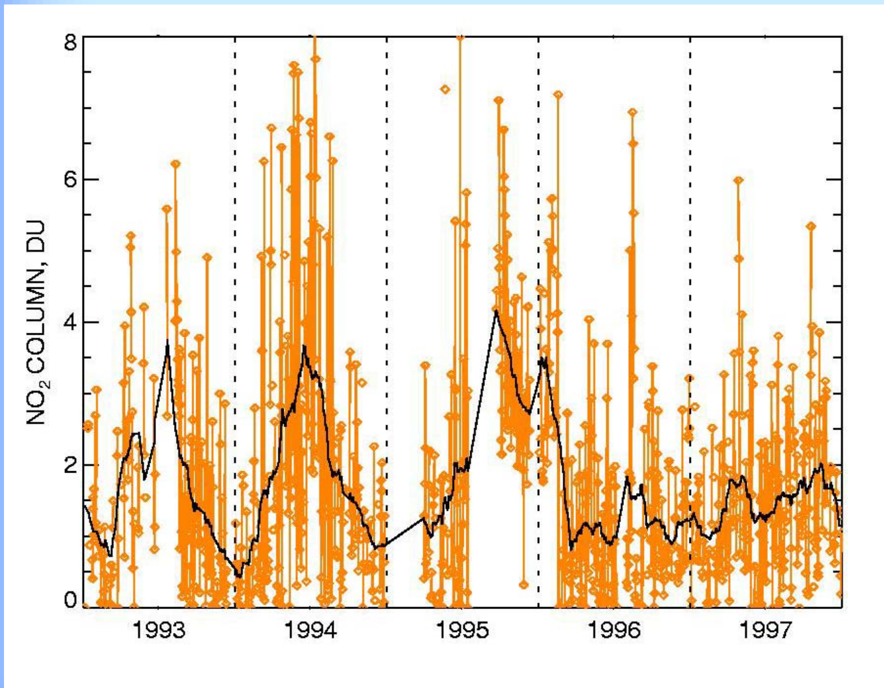
Pinatubo aerosol is bimodal

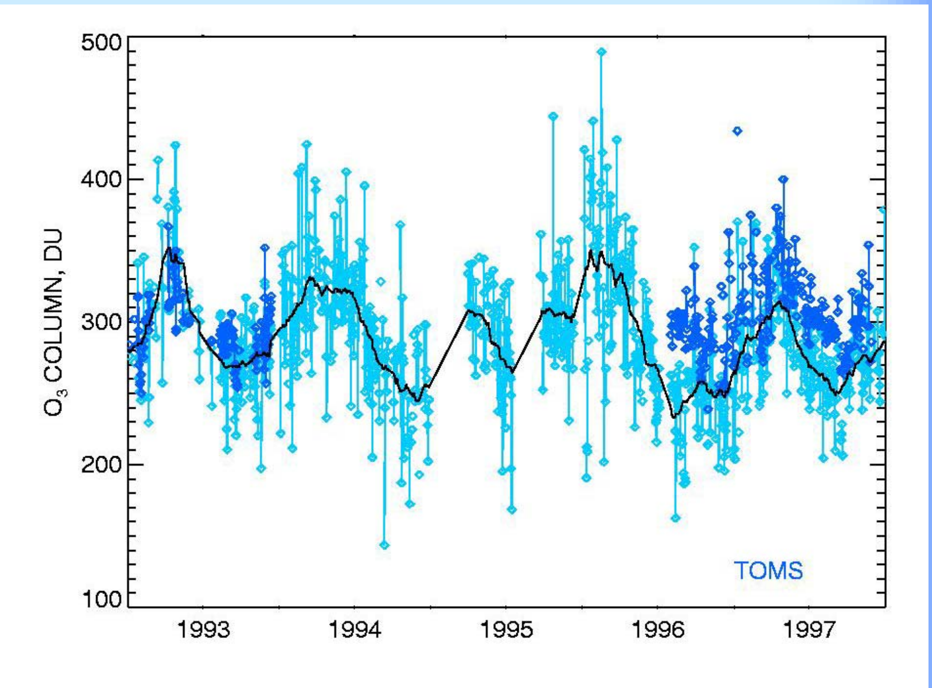


J. Goodman et al. (1994), **Evolution of Pinatubo aerosol near 19 km altitude over western North America, *JRL, 21, 1129-1132***



NO_2 and ozone

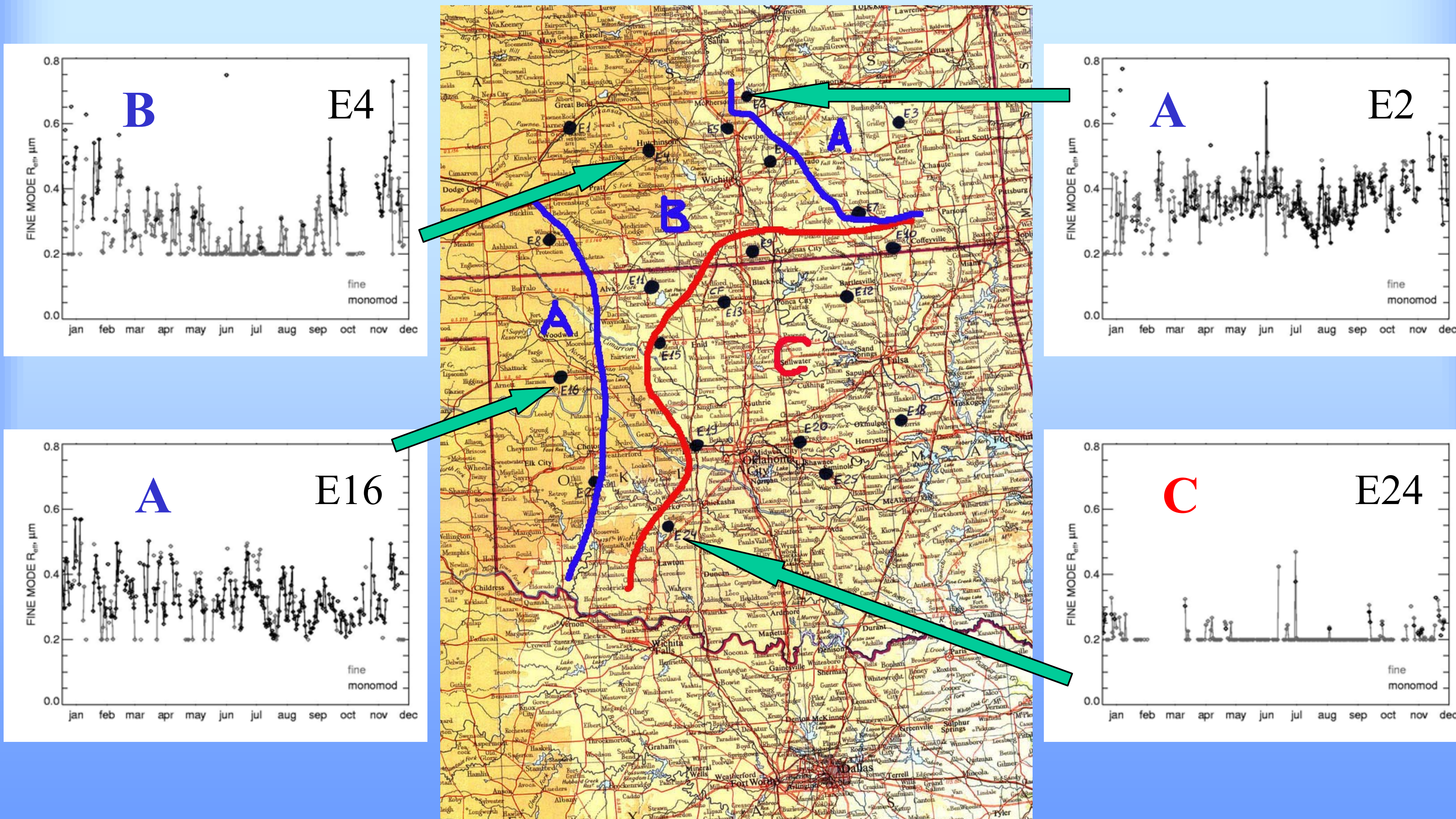




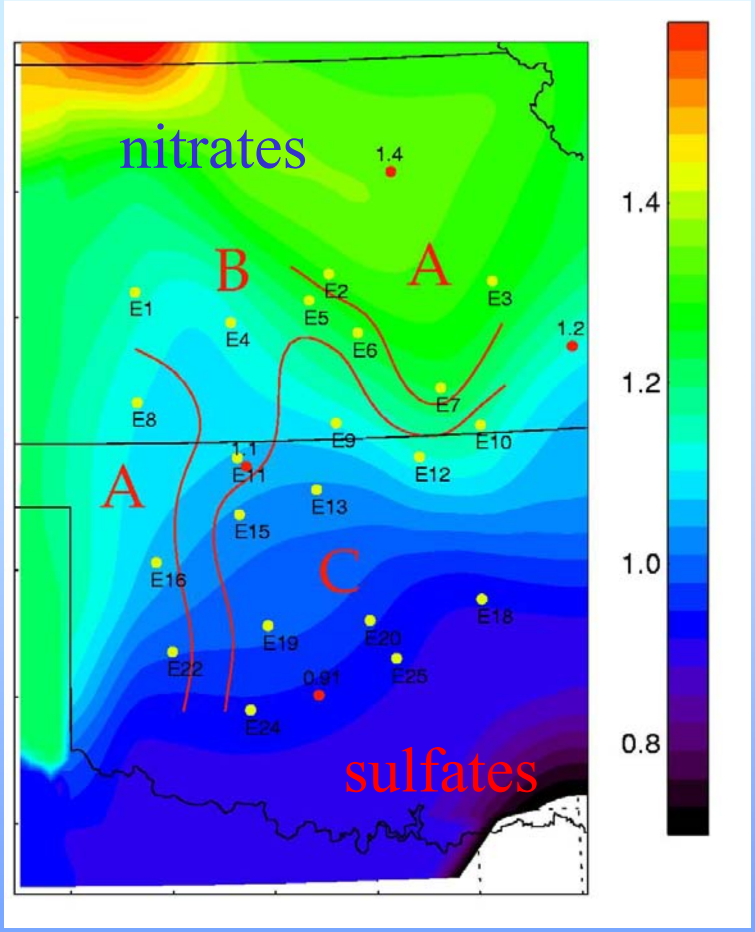
NO_2 column amount (DU) for SGP CF 1993-1997

Ozone column amount (DU)

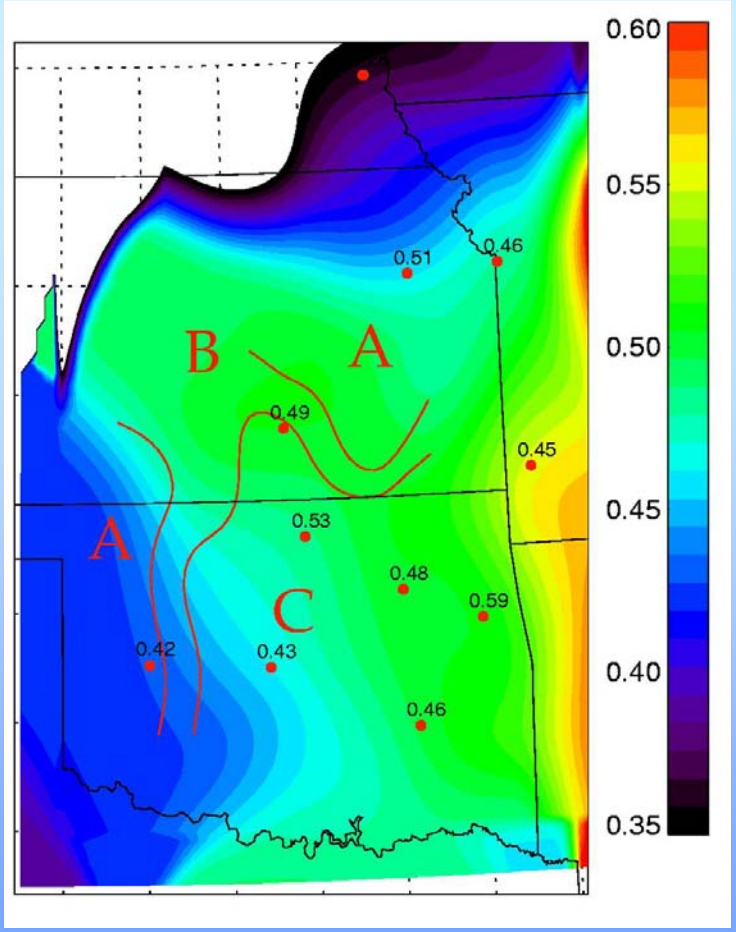
Spatial variations of fine R_{eff}



Correlative sampling data

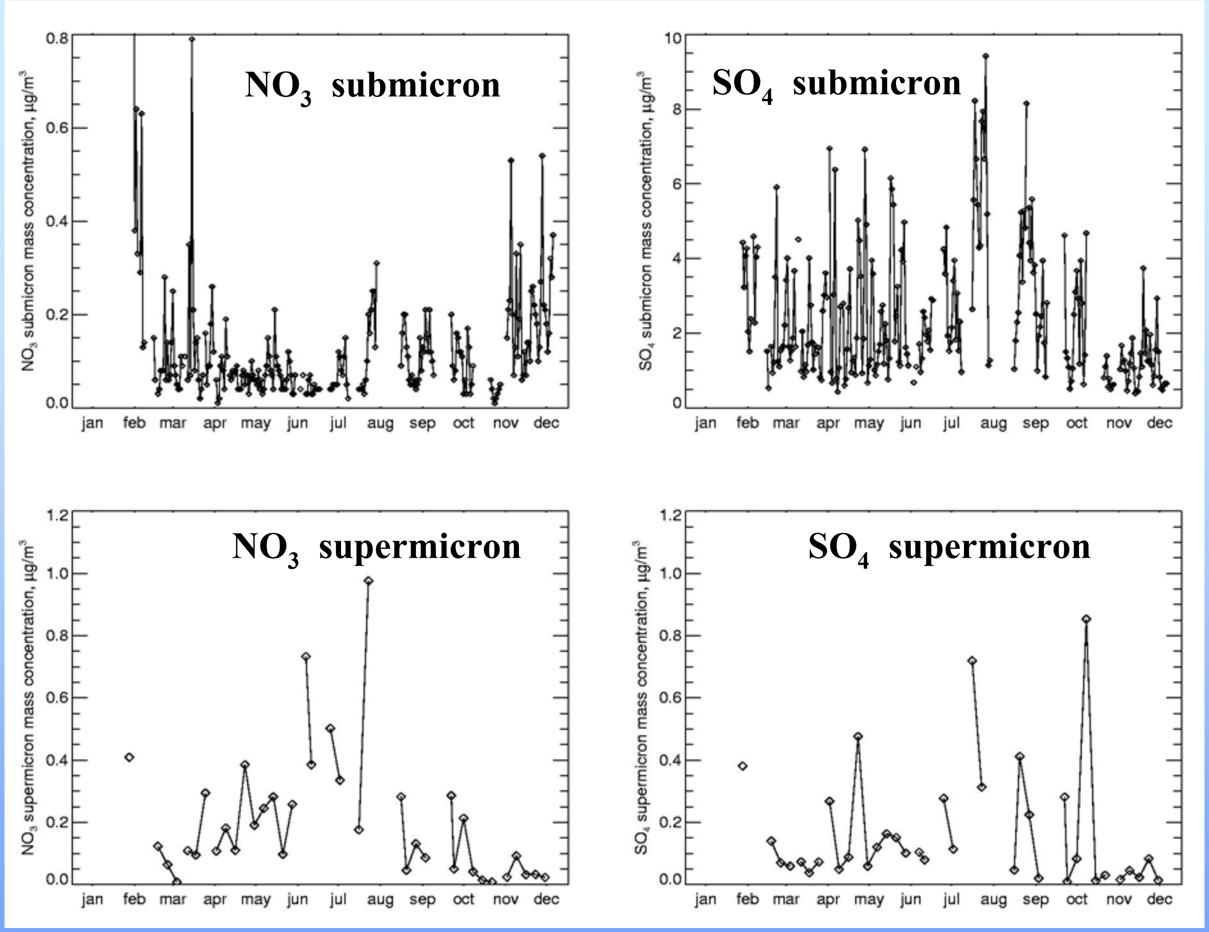


NO_3/SO_4 ion concentration ratios (year 2000) from NADP/NTN precipitation monitoring sites.



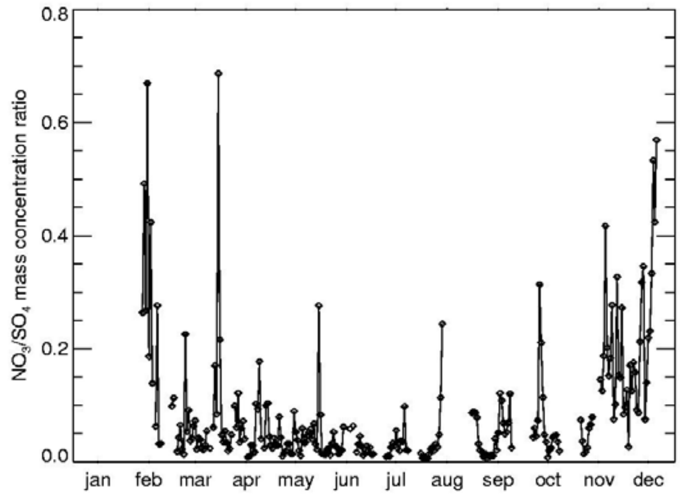
PM2.5/PM10 ratios (year 2000) from EPA monitoring sites.

NO_3 and SO_4 concentrations

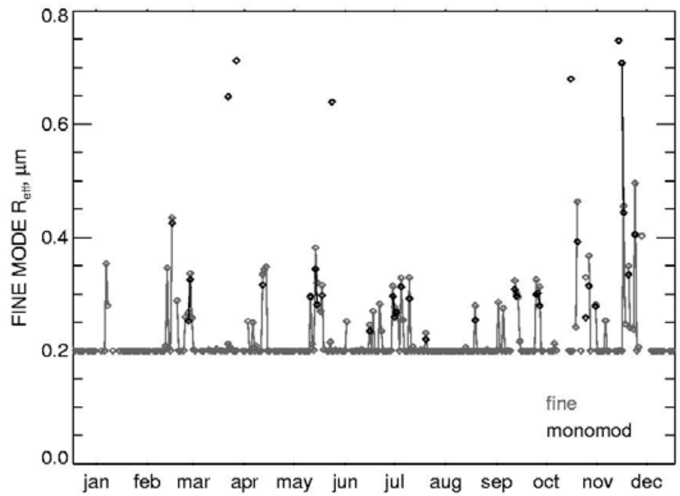


NO_3 and SO_4 ion mass concentrations measured at SGP CF in 2000 by NOAA Pacific Marine Environmental Lab (PMEL)

NO_3/SO_4 conc. ratios v.s. R_{eff}



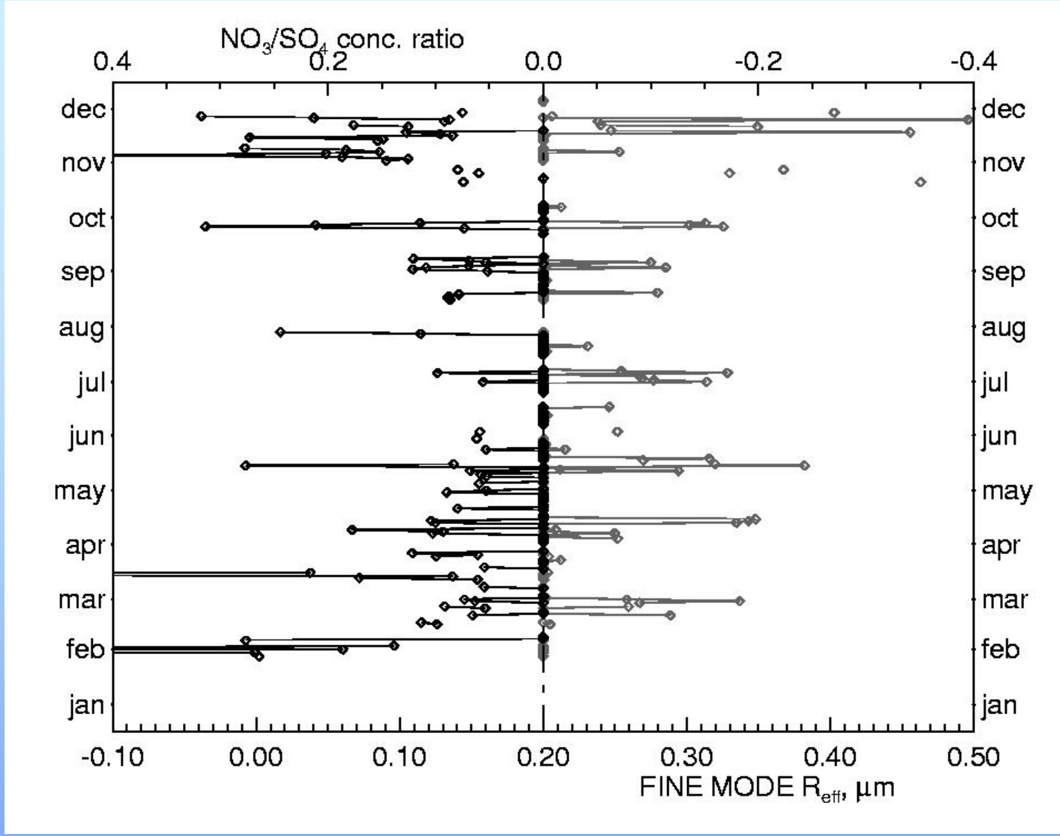
NO_3/SO_4 submicron mass concentration ratios (SGP CF, 2000).



Fine mode aerosol effective radius retrievals from E13, 2000 MFRSR dataset (0.2 μm is the detection limit).

NO_3/SO_4 conc. ratios v.s. R_{eff}

NO_3/SO_4



R_{eff}

NO_3/SO_4 submicron ion mass concentration ratios v.s. fine mode aerosol R_{eff} retrieved from MFRSR data. Ion mass ratios less than 0.05 are set to zero to reflect 0.2 μm limit in size retrievals.

Conclusions

Features of automated algorithm for MFRSR data:

- ***Automated cloud screening***
- ***Separation between fine and coarse aerosol modes***
- ***Estimation of fine mode effective radius***
- ***NO_2 and O_2 column retrievals***
- ***Planned addition of Water Vapor retrievals***
- ***Instrument calibration is determined from the data***
- ***Output in ARM-like netCDF format***