TCAP Breakout Session Agenda

- TCAP background (Berg)
- AMF (Nitschke/Miller)
- Mobile Aerosol Observing System [MAOS] (Springston)
- AAF (Schmid)
- 4STAR (Flynn)
- Discussion/collaborations
The Two Column Aerosol Project (TCAP)

Carl Berkowitz, Larry Berg, James Barnard, Jerome Fast, Connor Flynn, Evgueni Kassianov, Phil Rasch, Rahul Zaveri, and Alla Zelenyuk

PNNL

Daniel J. Cziczo

MIT

Rich Ferrare, Chris Hostetler, Brain Cairns, and Philip Russell

NASA

Barbara Ervens

NOAA
Overarching Goal

- To reduce modeling uncertainty associated with numerical treatment of aerosol transformation and cloud-aerosol interactions (CAI) in large-scale models.
Relevance To Climate Science: Predicted Forcing

- Large variations in the magnitude of predicted aerosol forcing

Images showing:
- (a) AeroCom Mean Anthropogenic aerosol optical depth (AOD)
- (b) AeroCom Mean Aerosol Direct Radiative Forcing (RF)
- (c) Local standard deviation of radiative forcing from AeroCom (σRF)

Transport towards Europe and proposed study region with relatively larger uncertainties among the models over and just downwind of eastern U.S. emission sources.

Schulz et al. 2006
Relevance To Climate Science: Predicted Forcing

- Large variations in the magnitude of predicted aerosol forcing

Schulz et al. 2006
Relevance to Climate Science: Cloud Aerosol Interaction

- CAI are highly uncertain
  - Cloud dynamics and aerosol loading are important

Berg et al. 2011—shallow cumuli
One-year deployment of AMF1 and MAOS starting in the summer of 2012

- Details from Kim and Mark

Two aircraft intensive operation periods (IOPs)

- One in summer
- One in winter

AOD from MVCO AERONET site
TCAP Science Goals

A number of science questions could be addressed:

- CCN Chemical Closure Study
- Local Radiation Closure Study
- Columnar Radiation Closure Study
- Cloud-Aerosol Interactions
- High Resolution Modeling
- GCM Modeling
Science Goal 1: CCN Chemical Closure Study

▶ Does size or composition matter?
▶ Single particle mass spectrometer
  ▪ Details of the composition of individual particles, including mixing state
▶ CCN counter
▶ “Internal” pumped CVI (Pekour et al. 2008) downstream of CCN counter
  ▪ Select particles that activate in the CCN counter
  ▪ Has been applied in the lab—not yet on aircraft
Science Goal 2: Radiative Closure

- Local Closure
  - Slab AOD measured by 4STAR will be compared to AOD estimates based on in situ aircraft measurements of:
    - scattering,
    - absorption,
    - size distribution and,
    - mixing state

- Columnar closure
  - Experiment 1: Integrate 4STAR AOD profiles & in situ profiles and compare to AMF MFRSR
  - Experiment 2: Determine column-integrated values of SSA to SSA derived from the MFRSR
Science Goal 3: Cloud-Aerosol Interactions

- Most past studies have been of short duration
  - AMF deployment to Azores is an exception
- Extend CHAPS analysis to observations from the AMF, MAOS and G-1
  - Long time series with detailed information about particles, cloud and cloud vertical velocity

Data from CHAPS for shallow cumuli

Cold air outbreak—1/26/07
Science Goal 4: High Resolution Modeling

- WRF-Chem and Aerosol Modeling Testbed (AMT)
  - Evolution of aerosols and its effect on CCN, aerosol direct and indirect radiative forcing
  - Emphasis on how radiative forcing within the two TCAP columns were affected by SOA, mixing state, and grid resolution

SSA (500 nm) at ~1 km AGL

- Box model of aerosol mixing state
  - Recently developed model (Zaveri et al. 2010)
Science Goal 5: Global Modeling

Two primary questions:

- How well does CAM5 represent the horizontal and vertical variability of anthropogenic aerosols and their impact on extinction and AOD?
- What are the primary factors that can be used to explain differences between CAM5 simulations of direct and indirect radiative forcing and the TCAP measurements?
PM2.5 at ~1 km AGL

SSA (500 nm) at ~1 km AGL

AOD
Deployment details: Flight pattern

~9km MSL

Cape Cod (with AMF/MAOS)  Ocean, ~240 km

G-1

start of science mission

end of science mission

~ ½ km

(~60km/10 min)

Free Troposphere

Marine Boundary Layer