GISS GCM aerosol-cloud modeling: 2003 Aerosol IOP at SGP & more

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Year 1:
Case study Aerosol IOP May 5 – 31 2003 at SGP.

- Archiving an extensive observational data set from the IOP. List of observations include: Liquid water path (microwave radiometer), atmospheric transmittance (MFRSR), retrieved cloud drop radius from MMCR (profile, day+night), MODIS, CAPS probe, SSFR cloud albedo estimate (SSFR), cloud optical depth (MODIS), aerosol extinction/scattering information from Raman Lidar, surface radiometer flux data, aerosol size information from Drum impactor, aerosol concentration, size-resolved hygroscopicity, aerosol solubility/composition, CCN concentration vs. Supersaturation, sfc (TDMA, DRI spectrometer), in situ droplet size/concentration (CAPS. FSSP, PCASP), aerosol optical depth (MFRSR, NIMFR), surface radiation fluxes, CCN concentration.

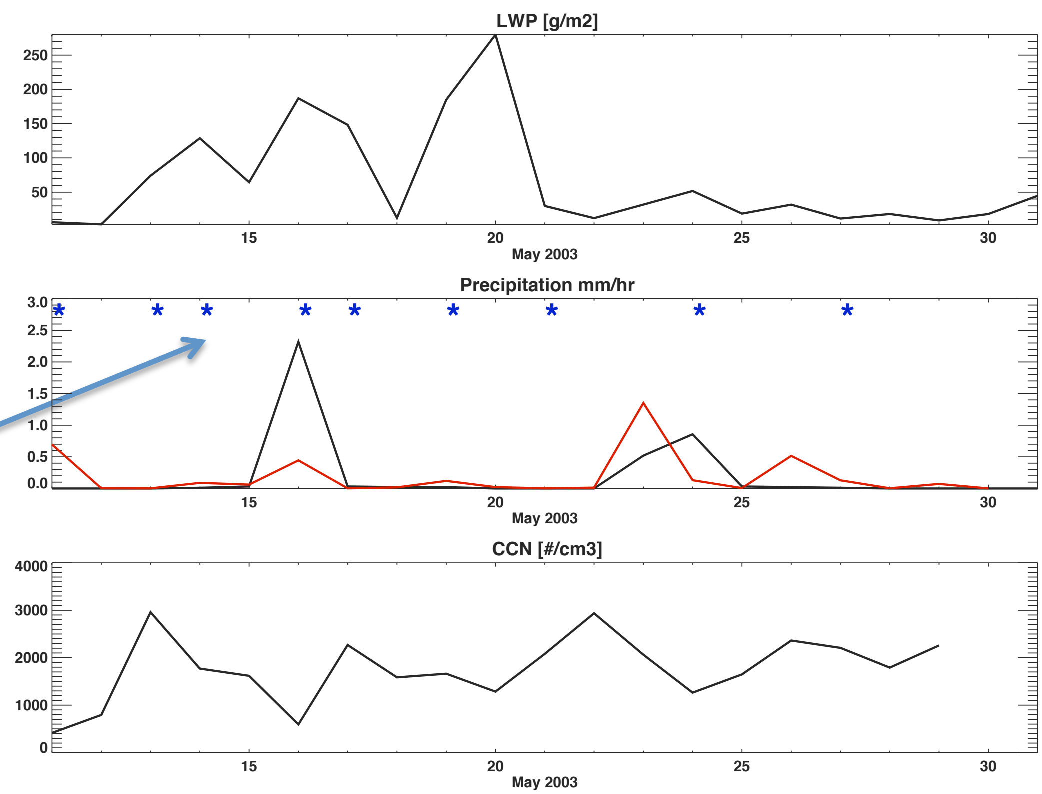
- Using the GISS GCM in the reanalysis mode (forced with forcing data) we will characterize current aerosol forcings (direct and indirect aerosol effects) predicted by the model for simulations run at different resolutions and with different schemes for nucleation and autoconversion and aerosol microphysics.

- We will compare simulated aerosol, cloud and radiative properties with available observations and evaluate the optimal scheme and resolution for the GCM to be used for future case studies.

- We will evaluate the link between aerosol mixing state and cloud activation with DOE field campaign data where single particle AMS data and CCN measurements are available. Model will be tested in reanalysis and climate mode.

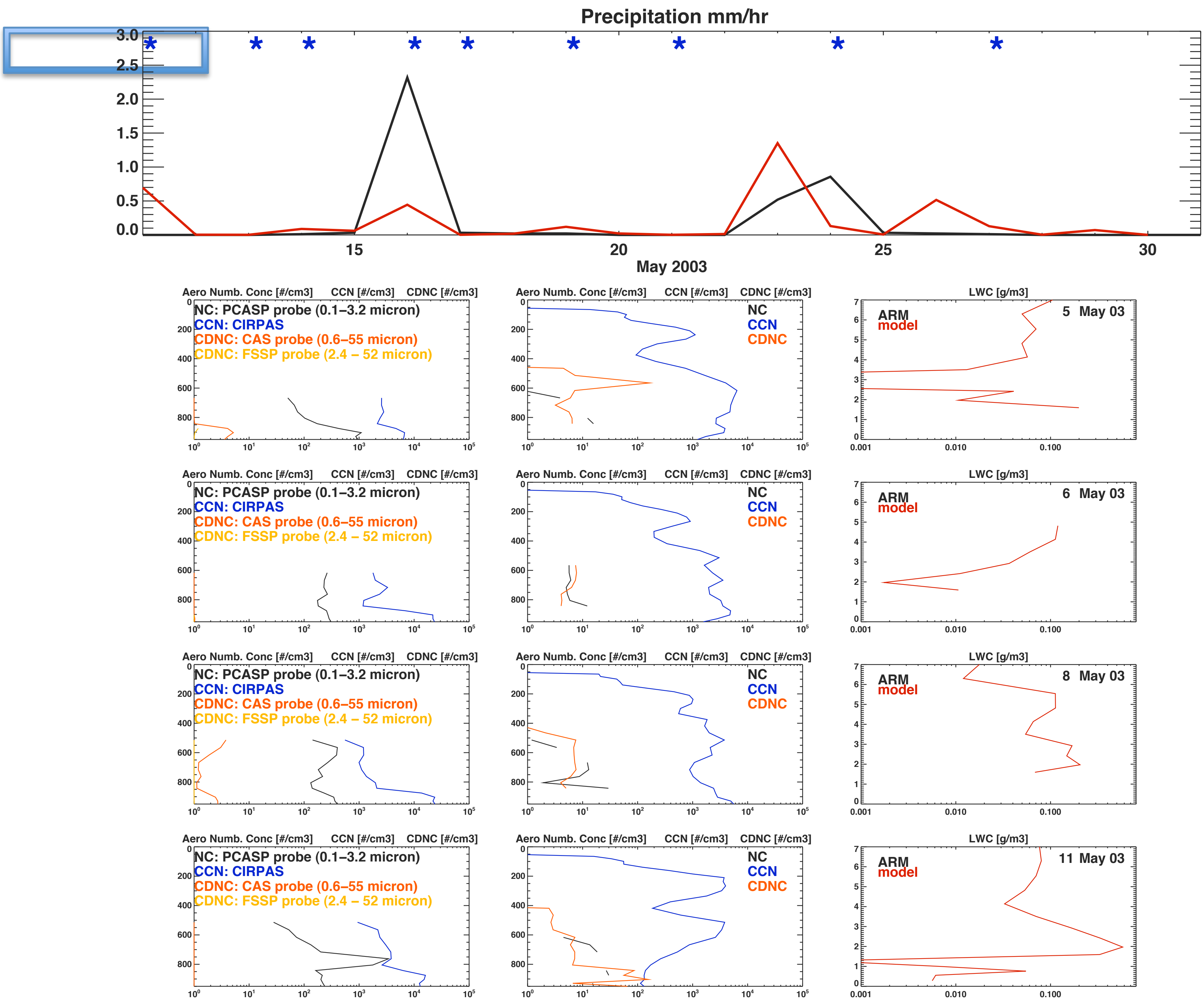
AEROSOL IOP 2003 at SGP

Vertical profiles
Available:
LWC
CCN
CDNC
NC

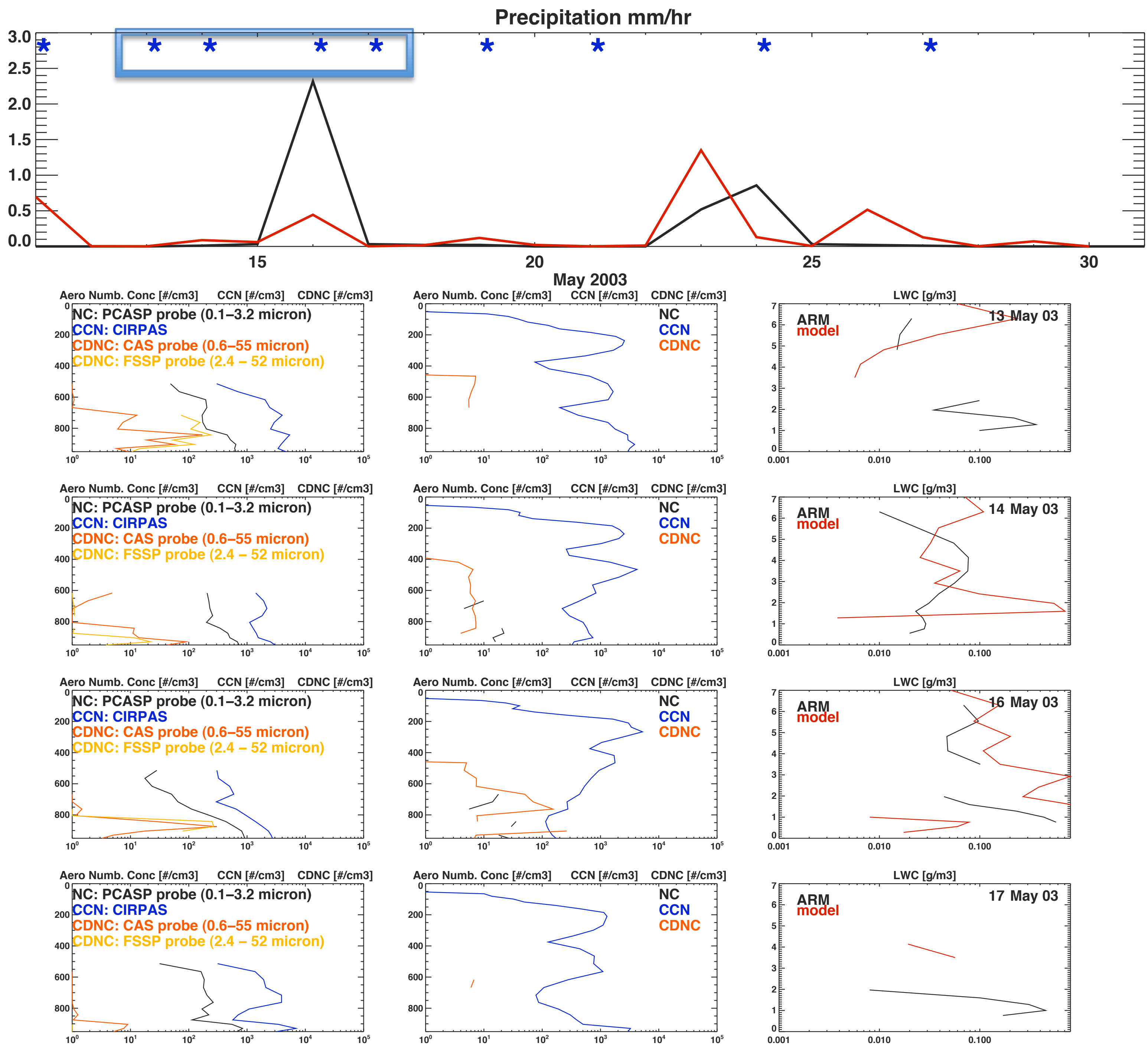


Ground Observation

Model



Precipitation mm/hr
3.0
2.5
2.0
1.5
1.0
0.5
0.0
15
20
25
30
May 2003
Aero Numb. Conc [#/cm3] CCN [#/cm3] CDNC [#/cm3]
NC: PCASP probe (0.1–3.2 micron)
CCN: CIRPAS
CDNC: CAS probe (0.6–55 micron)
CDNC: FSSP probe (2.4 – 52 micron)
NC
CCN
CDNC
LWC [g/m3]
ARM
model
5 May 03
6 May 03
8 May 03
11 May 03
0.001
0.010
0.100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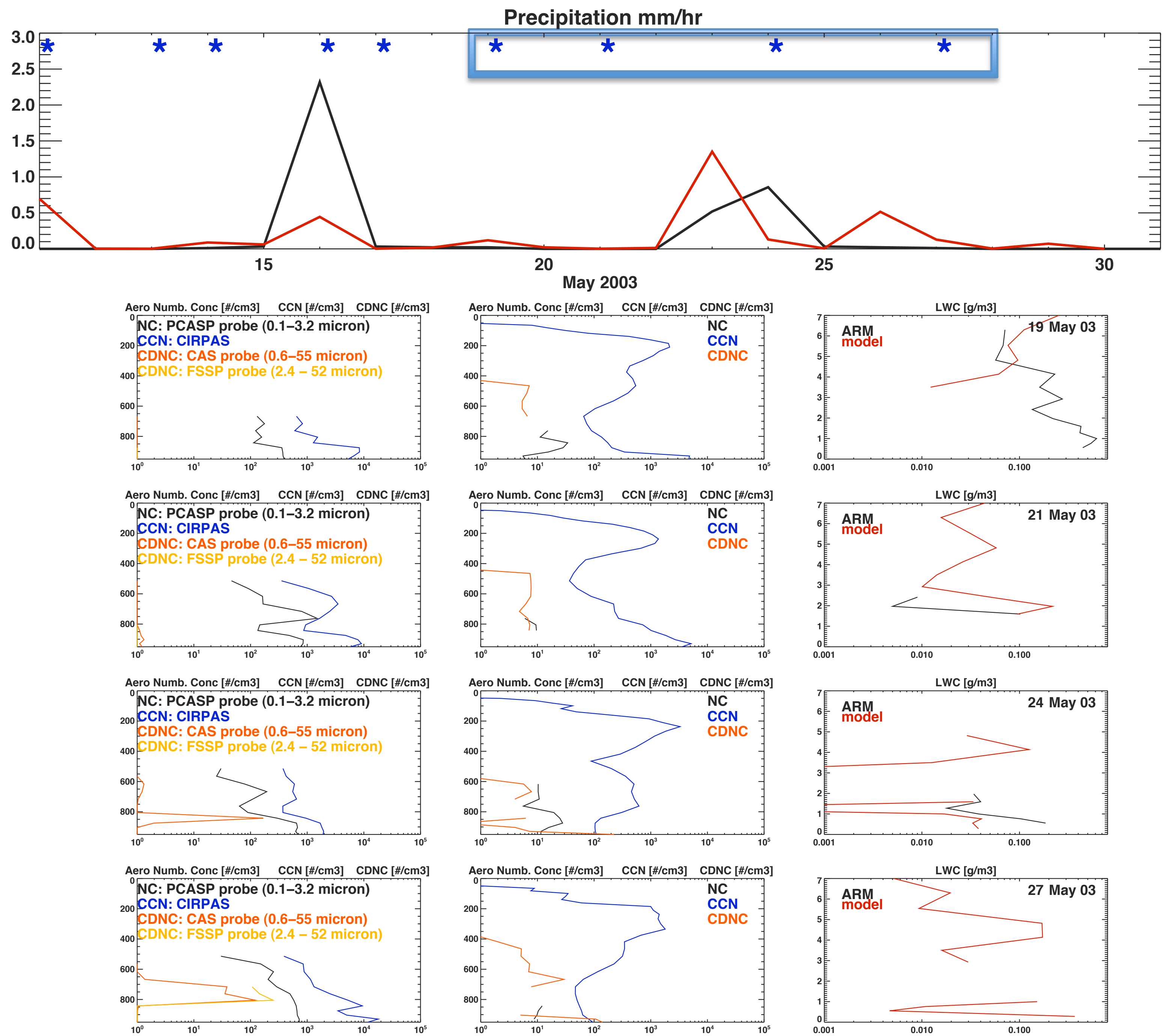
NC
CCN
CDNC
LWC [g/m3]
ARM
model
13 May 03
14 May 03
16 May 03
17 May 03



Precipitation mm/hr
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Aero Numb. Conc [#/cm3] CCN [#/cm3] CDNC [#/cm3]
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CDNC: FSSP probe (2.4 – 52 micron)
NC
CCN
CDNC
LWC [g/m3]
ARM
model
19 May 03
21 May 03
24 May 03
27 May 03

Year 1:

To begin the simulations and comparison with observations we will focus on simulating field campaigns that include both cloud and aerosol data. At first we will begin a case study using data from the May 5-31, 2003 Aerosol IOP at SGP.

- Archiving an extensive observational data set from the IOP. List of observations include: Liquid water path (microwave radiometer), atmospheric transmittance (MFRSR), retrieved cloud drop radius from MMCR (profile, day+night), MODIS, CAPS probe, SSFR cloud albedo estimate (SSFR), cloud optical depth (MODIS), aerosol extinction/scattering information from Raman Lidar, surface radiometer flux data, aerosol size information from Drum impactor, aerosol concentration, size-resolved hygroscopicity, aerosol solubility/composition, CCN concentration vs. Supersaturation, sfc (TDMA, DRI spectrometer), in situ droplet size/concentration (CAPS. FSSP, PCASP), aerosol optical depth (MFRSR, NIMFR), surface radiation fluxes, CCN concentration.

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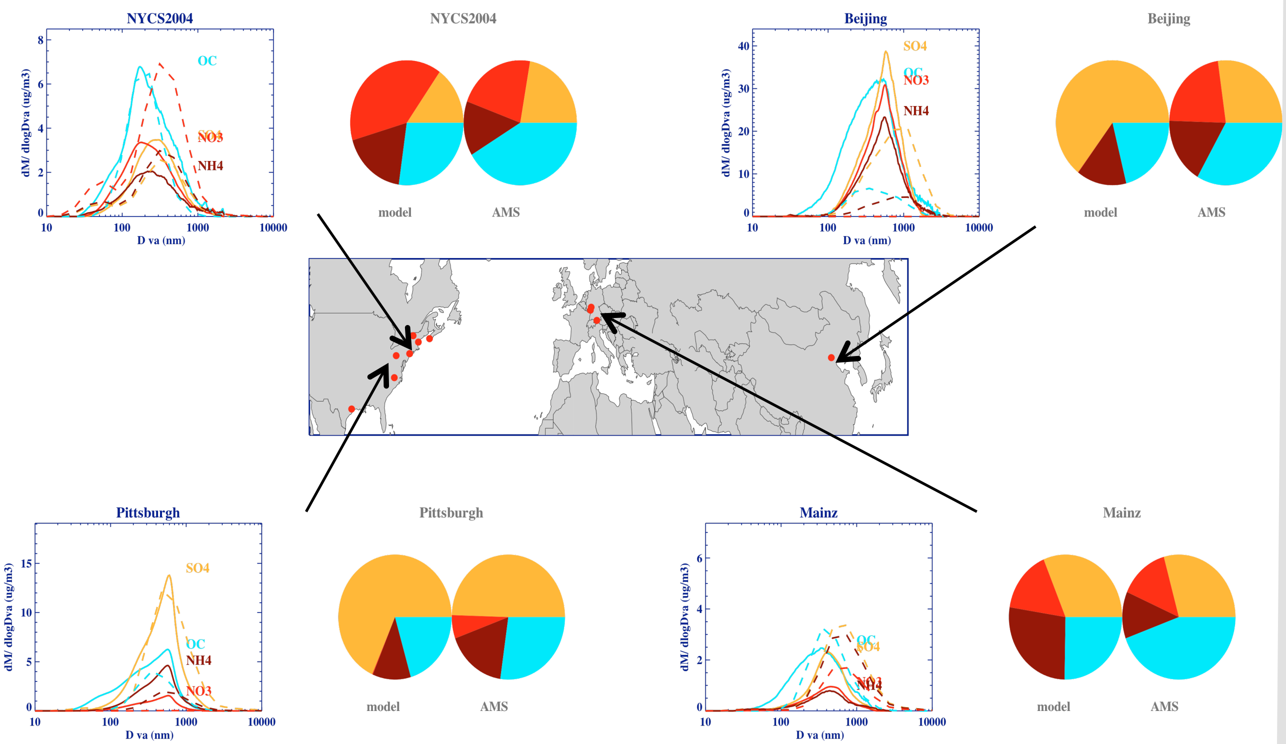
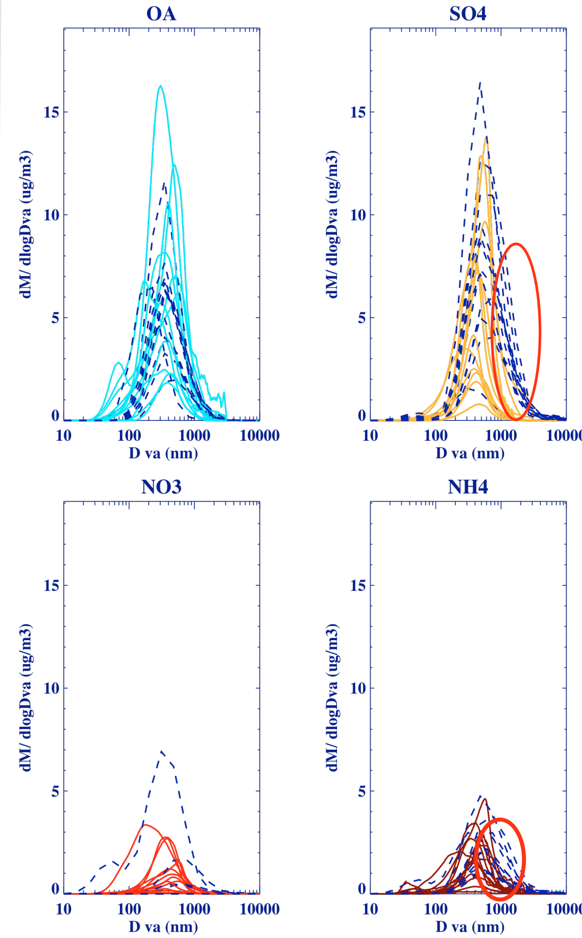
AMS aerosol mass spectroscopy



NO_3 SO_4 OA NH_4

Size distributions at
all 12 stations (excl. Beijing):

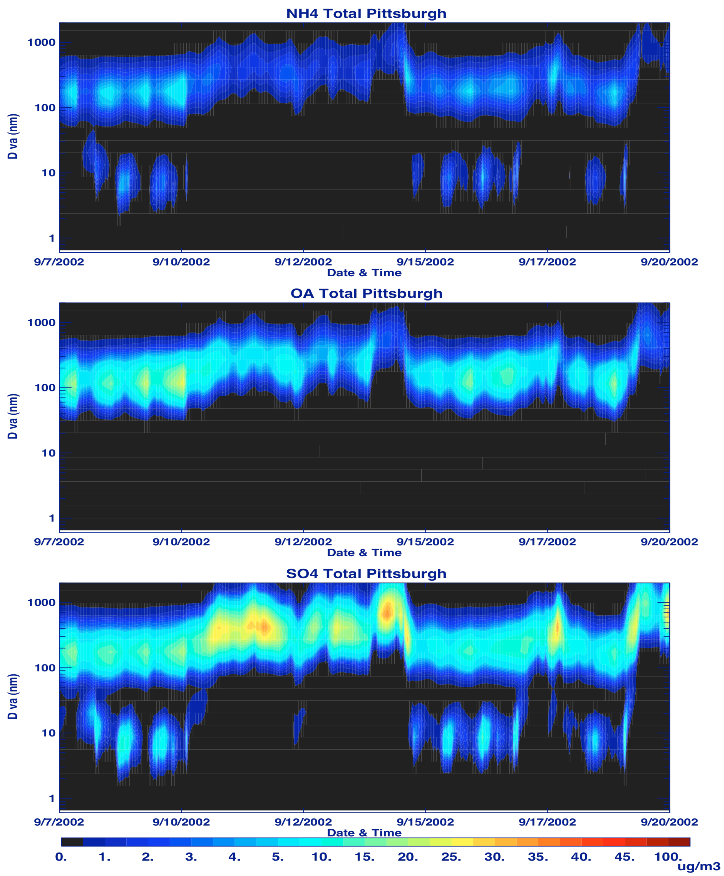


Qi Zhang's Poster: Size Resolved Chemical Composition of Aerosol Particles in Multiple Urban, Rural and Remote Atmospheric Environments: An Integrated View Via Aerosol Mass Spectrometry Analysis of global
AMS datasets was supported by a DOE ASP grant DEFG02-08ER64627

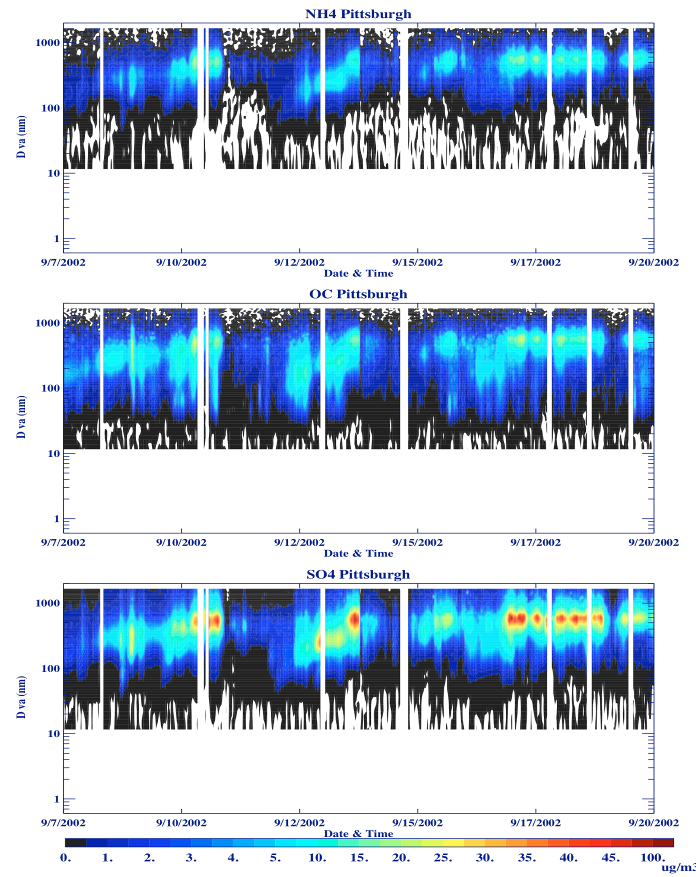
OA size is well simulated
SO4 and HN4 have large bias
NO3 concentrations are low

AMS aerosol mass spectroscopy

MATRIX



AMS



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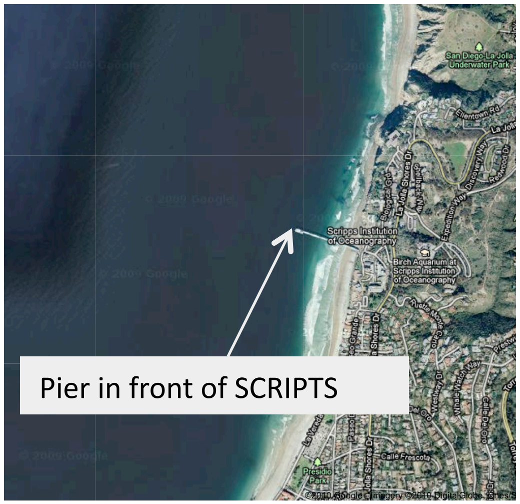

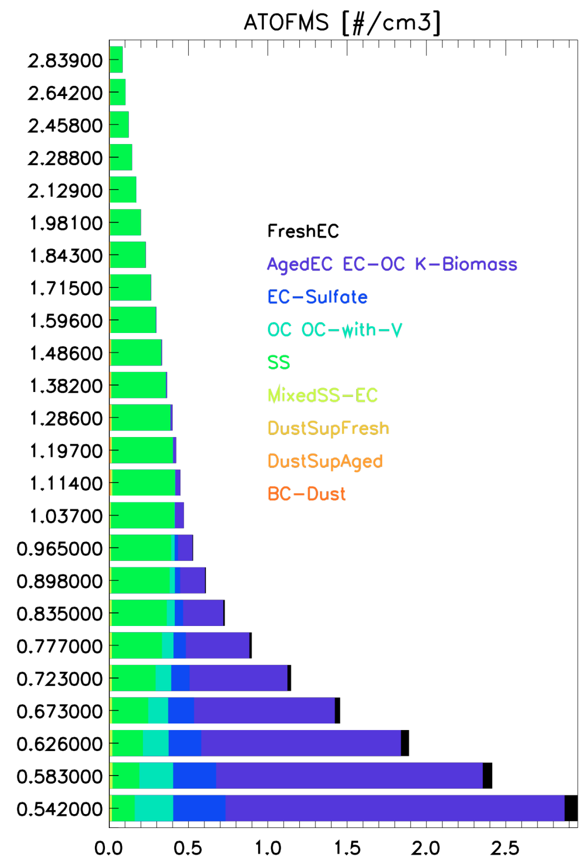

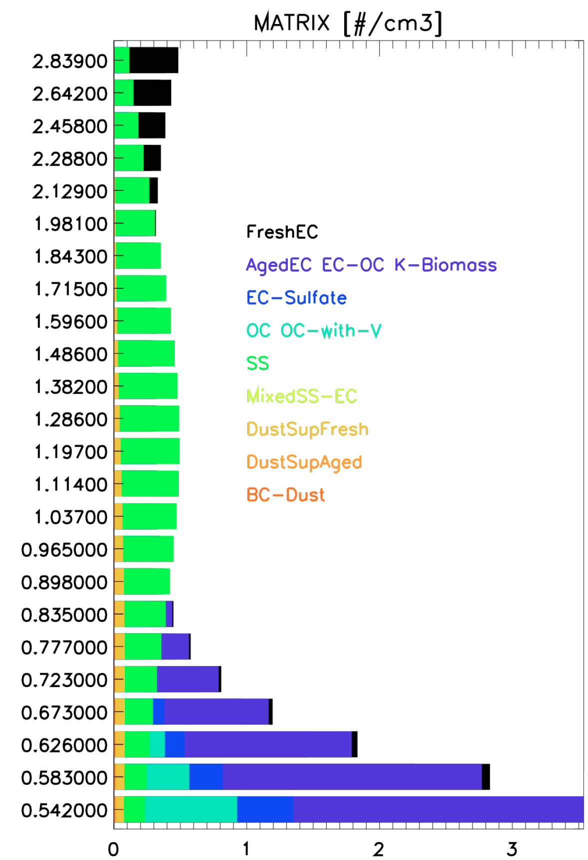

Aerosol Time of Flight Mass Spectrometer (ATOFMS) UC San Diego Kim Prather

Size resolved observation of aerosol mixing state. Observations by Kim Prather et al.: Monthly mean mixing state September 2006, La Jolla Pier.

Big Picture:

- Development of evaluation data sets with ARM observations and IOP data, applications to case studies – ?H?E?L?P?
- Testing new parameterizations, ensemble studies etc…
- Organize similar activities for the other models (CCSM and GFDL) with the help of the relevant modelers (Steve Ghan and Leo Donner)
- Last step: Climate Implications, linking our activities to AEROCOM

- Year 2:
- Perform ensemble simulations using various degrees of complexities and parameterizations with the updated GISS GCM (using updates to the cloud schemes from Del Genio et al.). For this part we will use a case study that is common to all other case studies from the consortium. The MASRAD IOP may be chosen as a potential case study;
- Organize similar activities for the other models (CCSM and GFDL) with the help of the relevant modelers (Steve Ghan and Leo Donner);
- Further development of the evaluation datasets and model diagnostic tools for aerosol – cloud activation, including ARM data and DOE field campaigns. First runs with the cubed sphere high resolution version of the GISS model.
- Year 3:
- Use long-term ARM observations (ACRF) and IOP data, as well as AEROCOM related data to constrain aerosols and cloud properties for the three models;
- Evaluate the optimal aerosol-cloud scheme in the model through rigorous process-level comparison with observations;
- Testing the higher moment QMOM scheme (Bob MacGraw) coupled to the GISS model and studying sensitivities towards cloud activation. Testing the new parameterizations against the assembled test cases from year 1 and 2.
- Year 4:
- Implement new parameterizations that may be developed once deficiencies are identified in model representation;
- Finally use the best set of model configuration and parameterizations for climate simulations, in order to calculate a best-guess radiative forcing associated with aerosols and process based uncertainties.