Session 1: radiative effect experiments

- Myhre: historical experiment. 12 models. AOD (total+per component), vertical profiles, radiative forcing, masses and offline rad calculations.
- Schulz: historical forcing diagnostics. AerChemMIP (piCtrl and histSST)/RMFIP/AeroCom. BC forcing smaller than before, anthropogenic AOD consistent with past work. ERF across models approaches 1 W m^{-2}.
- Samset: absorption (affects precipitation and emerging Asian aerosol patterns). 7 models. Models get AOD right, but not AAOD. CESM1 large ensemble simulation results.
- Deaconu: constrain RF using absorption. PPE for sampling the uncertainty in one model, then MMPPE. Forcing went from -0.75 to -0.63 after using AERONET. Then modified aerosol amount, wet removal, and imaginary part of RI. Role of ENSO state?

- Papers. Which AeroCom papers will be reporting for IPCC? December 2019 deadline. A control paper needs coordination.
- Measurements have uncertainties and limitations. Systematic in situ measurements needed, as well as synthesis of data.
- Mixing state, density (e.g. BC). OA/OC.
- Preindustrial state. Needed for anthropogenic forcing. You can't ignore clouds, cloud fraction and COD can be extremely helpful. Do we know preindustrial clouds?

Session 2: experiments (vs observations)

Nick Schutgens:

- *Representativeness error*: Re-did analysis by Rong Wang et al., finds different conclusions.
- *Satellite AAOT*: Very narrow time colocation window required for comparisons
- *Satellite AOT*: Diversity can be taken as an estimate of uncertainty

Representativeness is challenging but crucial issue, needs to be taken better into account by our entire community. Put on internal checklist for AeroCom papers?

Jonas Gliss: *CTRL experiment.* Nice new quicklook interface, all results are available online. Focus on biases in AOD, AAOD, abs.coeff., … vs observations and between models. Identified some issues with emissions in individual models -> need to resubmit, or is it «as it should be»?
Discussion on whether it is useful to compare monthly mean AOD values from models to remote sensing which may have only two measurements over the entire month.
CTRL experiment is «first blood» in AeroCom intercomparisons. Hence it is part of submission validation, as many issues won't be seen until this stage. In Phase 2 it took us 6 months or more, and several resubmissions, to ensure that all models were fully comparable.

Augustin Mortier: *Regional trend analyses over 1995-2018.* Find statistically significant trends in observations over many regions, multiple species/components. Significant reduction in AE over Africa; why? Models nicely reproduce observed AOD trends (with some anomalies and notable quirky behaviour).
Representativeness again, for surface station trends: Can we learn from how surface temperature analyses (GISTEMP, HadCRUT…) average/grid based on spatially (and temporally) heterogeneous data series?

Session 3: Experiments (Aerosol Type and Process)

Schuster

Maria Burgos: Water Uptake on Aerosol Light Scattering, Comparison of Six Climate Models

- Revives an Important Topic (recall Kinne ~2006).
- Aerocom Phase 3 Experiments for hygroscopicity (f(RH)).
  - RH = 0, 40, 85%.
  - Benchmark dataset for 9 models.
  - Compare to some surface sites.
- Model diversity of hygroscopicity is high.
- Models hygroscopicity generally biased high of measurements.
- Would like to see ambient water uptake or water AOD from models (G.S.).
- NASA ACCP is presently seeking community feedback, and this study could be relevant for next generation of instruments if pushed by modelers (G.S).

Paul Ginoux: Analysis of Simulations Associated with the Anthro-Dust Experiment

- Land use dust is 25% of global emissions.
- Mineralogy of land-use and natural dust differs; farm dust is more absorbing than natural dust.
- Deep Blue experiments with wind thresholds.
- Increased wind thresholds for anthropogenic aerosols improves comparison with coarse mode SDA (AERONET).
- Anthropogenic contribution varies with wind threshold.
- Four Aerocom models in experiment
  - Wind threshold is main uncertainty
  - Model variability is greater than wind threshold variability in the models

Session 3 (cont): Experiments (Aerosol Type and Process)

Schuster

Mian Chin: Aerosols in the UTLS, A Powerful Diagnostic Tool for Model Proceses

- Asian Summer Monsoon (ASM) important for UTLS aerosols
- Satellites indicate hotspot of aerosols and gases above ASM in UTLS
- Questions posed (Mian):
  - Key pathways? ENSO? Which source regions are important? Aerosol composition in the important source regions?
- UTLS model experiment
  - TIER 1: Base, base no volcano, base no fire, etc.
  - TIER 2: Same, but turn off SE Asia and East Asia regions independently sometimes.
  - CO tracer for transport required; Lead 210 for removal recommended.
  - Large model diversity in AOD @ UTLS
  - Vertical profile diversity in models a longstanding problem

Xiaohua Pan: Six Global Biomass Burning Emission Datasets, Inter-comparison and Application in one Global Aerosol Model

- Scaled modeled biomass burning emissions with MISR plume heights.
- Biomass Burning plume heights are ~15 km via MISR and CALIPSO.
- 45% of of BB aerosols emitted within boundary layer, per MISR, but models prescribe 100% of BB emmisson in boundary layer
- Consequences:
  - Smoke transported further outside of boundary layer than inside BL
  - Chemistry and deposition are different above BL.
  - OC increases when MISR source profile is used in the models.
  - Aerosol-cloud interaction also affected by vertical source profile.

Session 4 : experiment updates (1)

Volcanic ACI exp:

- Reduction in the size of liquid cloud droplets vs impacts on cloud liquid water path (and weaker ERFaci)
- Hoping for 10+ GCMs close to CMIP6 configs
- Kilawea and Holuhraun S02 plumes → aerosol, CCN budget, cloud properties, precip balance
- Long term nudged simulations needed to disentangle aerosol impact from meteorological impact
- Tracking plumes based on aerosol and gas thresholds

AeroCom Trajectory Experiment *(GCMTraj):*

- Linking GCM or reanalysis derived trajectories to GCM aerosol properties and measurement station observations
- Development phase (6 months): trajectories work, underestimate of the larger particles (250-630nm), large inter-model variations in the representation of smaller particles (10-20nm)
- Comments on the representativity of the analyzed station
- To be extended to 10 years and multiple observational stations

Session 4 : experiment updates (2)

***AeroCom general aircraft experiment**:*

Compilation of aircraft campaigns
Model experiment diagnostics: aerosol, cloud, thermodynamics and radiation
Sampling issues: Using monthly mean model output can result in correlations of less than 0.7 and biases larger than 15% compared to on-line interpolation.

State of aircraft Atom experiment

Measurements of aerosol composition and microphysics, precursor gases and related species, and other
Model evaluation, investigate sources, removal, vertical distribution, new particle formation and CNN mechanisms - some examples were given

***New particle formation** (AEROCOM vs Atom):*

Impact of nucleation on CNN number conc. (nucleation on and off)
Role of different nucleation mechanisms
Anthropogenic influence on new particle formation
NPF in the tropical upper troposphere is an important source of CCN
Growth on descent may bring these particles to sizes and places where they may be influencing climate
NPF at southern high latitudes is significant and strongly seasonally dependent

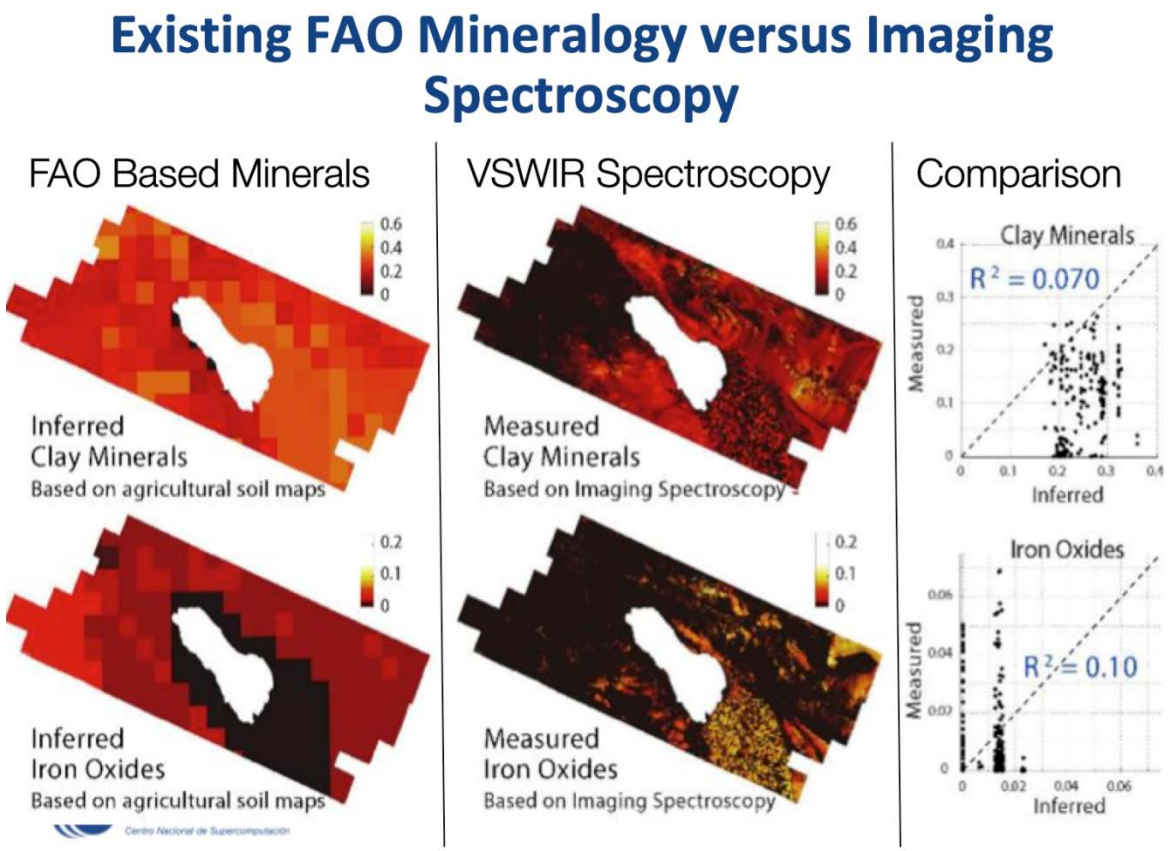
Session 5 : key presentation

The problem of dust mineralogy for a better description of dust impact on climate

by Carlos Perez

new perspective with EMIT observing ground spectrum → mineralogy of soils

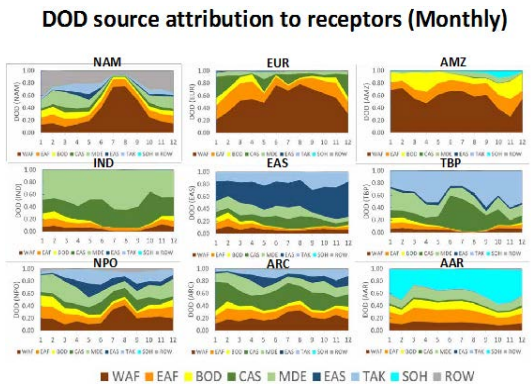
observations driven by modeling teams → requirements to action



Session 6: new experiments

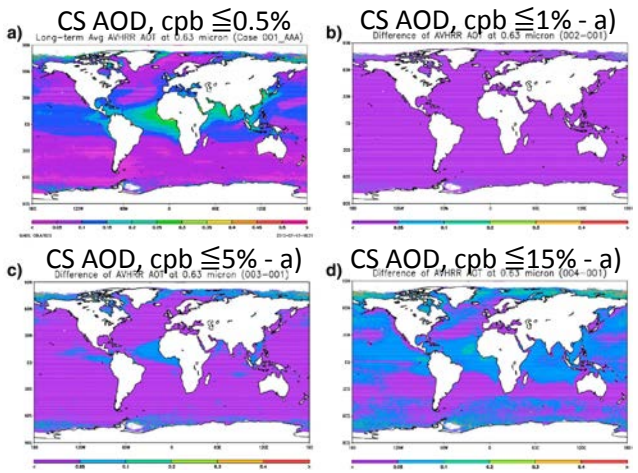
Chin

Dongchul Kim: Dust source attribution experiment - Investigate contributions of dust emitted from major source regions to global ocean and land regions



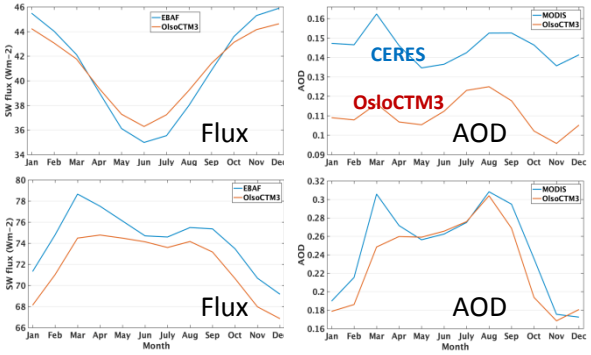
- 8 source regions, n receptor regions
- Attributions to dust AOD, surface dust PM2.5 over global and receptor regions
- Simulation years: 2009-2012 to encompass El Nino/La Nina/ neutral years, interannual variability, and statistics

Kostas Tsigaridis:
Cleary-sky vs. all-sky AOD and radiative effects



- CS criteria in satellite retrieval?
- How do models calculate CS AOD and radiative flux?
- How to convert oranges to apples?
- How does partial cloudiness affect AOD in a gridbox?
- How is total cloudiness in the column calculated?
- Need to design proper analysis

Gunnar Myhre/Wenying Su: Evaluating AeroCom phase III (OsloCTM3) TOA CS flux using the CERES EBAF product



- TOA CS flux from OsloCTM3 is higher than CERES, although the AOD is lower than MODIS
- It seems that the model bias of AOD can explain the bias of CS flux to a large degree
- Need to compare the surface albedo with observations

My thoughts

1. **Dust source-receptor experiment is straightforward to setup. Experiment description will be finalized soon. Additional benefit: evaluating particle size fractions, dust AOD at 550 nm & 10 μm, etc.**
2. **Clear sky/all sky AOD and TOA SW flux analysis should be planned, probably first use the existing high frequency model experiment output, then design additional steps**
3. **Both should be collaborated with AeroSAT (to be discussed)**

Session 7: aerosol and a clouds (1)

Matthew Christensen

Unique Lagrangian approach for cloud droplets using the HYSPRIT model to understand changes in cloud physical and microphysical parameters separating polluted and unpolluted conditions over the west coast of continents (California, Chilean, and Namibian coasts).

Edward Gryspeerdt

Decomposing the aerosol radiative forcing in climate models into clean-sky forcing, forcing of aerosol-cloud interaction separating under clear-sky and cloudy-sky, albedo change, and cloud forcing to closely replicate observations-based estimations of the radiative forcing.

Johannes Muelmenstaedt

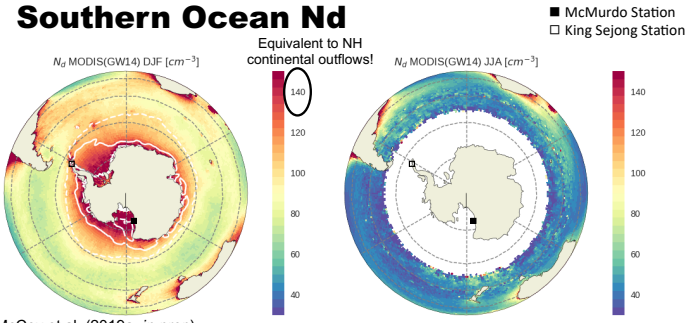
Under a hypothesis that warm-rain can serve a constraint of observational cloud lifetime effect with rapid adjustment, the autoconversion process is investigated in the ECHAM-HAM model, which suggests importance of division between improving base state and estimating susceptibility and of understanding through MMMPE.

Minghuai Wang

After the introduction of the continuing uncertainty in the aerosol-cloud interaction with past studies, a difference in the dependency of cloud fraction on cloud droplet number concentration between two versions of the CESM model are shown.

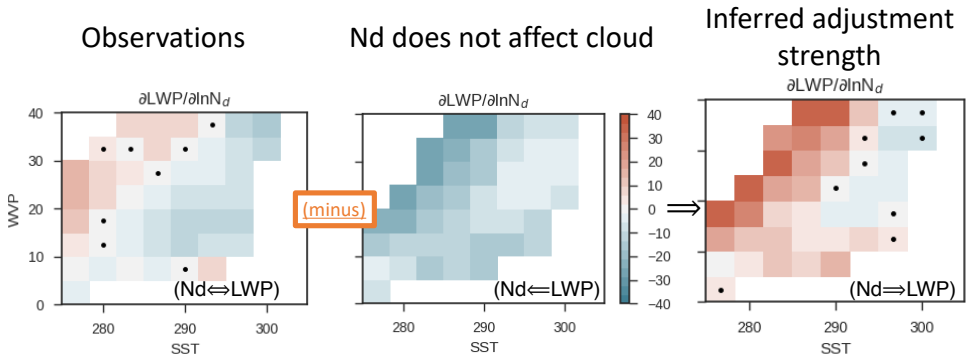
AeroCom Aerosol-Cloud-Interactions 2

Isabel McCoy et al: Remote southern ocean CDNC may be higher than assumed (and in models)

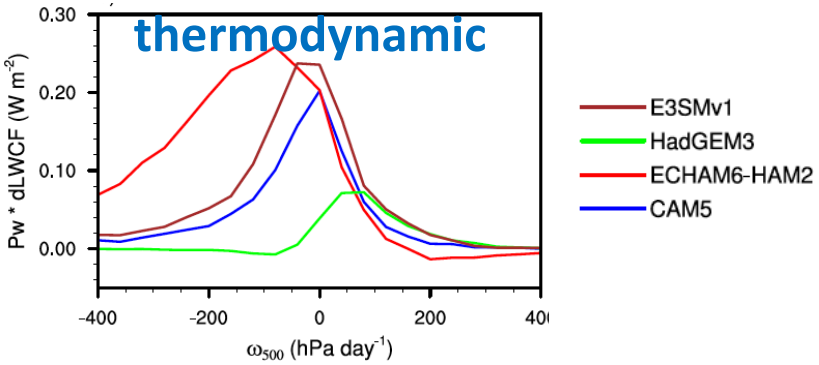


I. L. McCoy et al. (2019a, *in prep*)
Grosvenor et al., (2018); Bennartz & Rausch, (2017a); D. T. McCoy et al., (2017); Painemal et al., (2012a); Painemal & Zuidema, (2011); Witte et al., (2018); Ahn et al., (2018); D. T. McCoy et al., (2018)

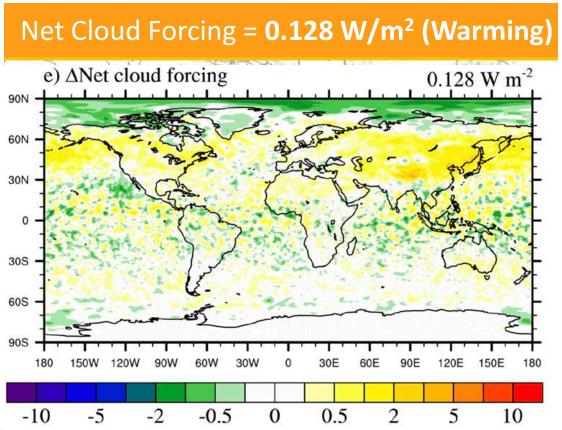
Dan McCoy et al: New method to isolate adjustment strength from models and observations



Kay Zhang et al: ERF_{aer} is highly dependent on dynamical regimes and cloud phase

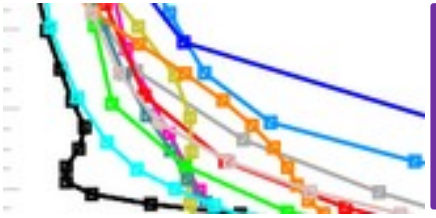


Xiaohong Liu et al.: dust as INP in E3SM model introduced net-positive cloud radiative effect of 0.13Wm^{-2}



Session 9: radiative forcing

We must work harder!



The aerosol forcing is still uncertain!

- **Anthropogenic AOD and total AOD are correlated in models and aerosol retrievals can further be used to constrained anthropogenic AOD**
  - Why? Are the total coarse mode aerosol (sea salt and mineral dust) better constrained by satellite retrievals, so uncertainties are mainly caused by aerosol species which has anthropogenic and natural contributions?
  - What is the maximum global AOD (550 nm) from satellite retrievals?

- **Black carbon has a weak surface temperature change caused by strong negative rapid adjustments**.
  - Forcing and temperature change seem to scale linearly for emissions increasing up to at least a factor of 10.

- **Aerosol forcing (ERF) stronger negative than -2 Wm^{-2} in climate model simulations**
  - Fine mode aerosols causing almost entirely the global mean forcing, but with regional variations.

- **Several studies indicate increase in dust over the industrial era.**
  - Coarse mode mineral dust strongly underestimated in climate models
  - The magnitude of the missing coarse mode of mineral dust on the (direct) radiative effect is +0.15 Wm^{-2} compared to recent estimate and even stronger than in AeroCom models.

Session 10: (constraining) observations

8:30 –8:45 Kazuma Aoki *local and long-range transport of dust aerosols over the Japan*
Surface-based sun/sky photometry to obtain dust properties for satellite & model validation

8:45 –9:00 Greg Schuster *retrieving BC AAOD from refractive indices of AERONET retrievals*
Separating particle components types in AERONET by mixing assumed end-members

9:00 –9:15 Sarah Doherty *observational constraints on aerosol forcing over the SE Atlantic*
ORACLES campaign cloud-aerosol properties, vertically and horizontally resolved

9:15 –9:30 Michael Hoepfner *aircraft/space infrared remote sensing observations of ammonia*
Nadir & limb over India & Himalaya region high-altitude NH4NO3 w/lab validation, & NH3

9:30 –9:45 Omar Torres *the OMPS_LP Stratospheric Aerosol Record*
Global stratospheric aerosol scattering data record ~10-35 km, 2012 (OMI)-ff, volcano, PyroCb

9:45 –10:00 Judd Welton *the NASA Micro Pulse Lidar Network: Overview of the new Version 3*
Focus on dust belt, global, w/LALINET, ADNET, EARLINET; PBL, cloud height, aerosol backscatt. & depol. profiles, cloud-screen AERONET

Session 11: (supportive) modeling (1)

Ginoux

- **11:00 –11:15 Winker** *a lidar aerosol simulator for the COSP 2.0 Framework*

COSP: CFMIP observations simulator package to facilitate comparison obs/climate model outputs by increasing consistency on assumptions between both. Developed since 2014 for aerosols, i.e. CALIOP profile for, att. Backcsatt scat ratio, ext. coeff., L1, L2 or L3 (monthly mean at global scale). Not decide if L3 or L2 will be final product. Solicit feedback fro AeroCOm
QA: Running COSP off line? Necessary to save many diagnostics.

- **11:15 –11:30 Bian** *improve aerosol simulation over Amazon*

Transport key to transport dust to Amazon. SOA: Biogenic emission improved by using MEGAN (Gunther' model) + update the landcover. Biobur emission: CMIP6 lowest , QFED: highest.
For comparisons with satellite use daily rather than monthly due to clouds. Fires missing in GEOS during Oct-Dec. More needs: - biobur during Oct-Dec, AOD in NW Amazon (transport from Central America), and sea-salt emission from Pacific. Validation with AERONET site ARICA not valid. Use of Angstrom could be helpful

- **11:30 –11:45 Mielonen** *are Biogenic Aerosols Climatically Significant in the Boreal Region?*

Temp dependency of AOD in Boreal region could be due to organics.
Supersite in Finland: organic mass increases with Temp. Also, CCN increases with Temp. AOD(340nm) linear dependency on Temp less at 550nm. MODIS AOD(550nm) +/- increases with Temp. Also ECHAM6-SALSA. Correlation with T-2m and MODIS AOD but no clear physical explanation for it. Negative correlation T-2m and Cloud Effective Radius.

Session 11: (supportive) modeling (2)

Ginoux

- **11:45 –12:00 Bruhl** *Radiative forcing by volcanic and dust aerosol in the stratosphere*

Model EMAC: ECHAM5+MECCA1 chemistry, dust (Astitha et al., 2012, ACP)
Strat AOD 550&750nm compared to SAGEII, OSIRIS, GOMOS. Not only source from volcanoes but monsoon injections and dust. Big differences between versions 5 and 7 for OSIRIS (realistic in between the 2 versions). DAOD dominates by insoluble coarse aerosol, SAOD by soluble accum model aerosol in lower stratosphere.

- **12:00 –12:15 Kipling** *introducing ECMWF's IFS-CB05-BASCOE-GLOMAP (ICBG)*

COPENRICUS CAMS system. Operational: Standard IFS dynamics and physics interact with AER bulk/bin aerosol (14 tracers, LMDZ) and TM5 chemistry. Extension to GLOMAP (26 tracers) moment model aerosols and coupling with BASCOE tropospheric (50+ species) stratospheric chemistry . Evaluation strat chemistry with MIPAS, MLS (HNO3, O3, ClO), balloon (sulfate) observations. Representation of Sulfur and AOD from volcanic eruptions (Pinatubo, Calbuco, Raikoke)

Discussion: Are their specific needs for prediction models different than transport/climate model that could be identified

Session 12: observing system and AeroCom

Colarco

Dave Winker representing the NASA A-CCP decadal survey response

- Multi-NASA center study to define a future observing system for Aerosols & Clouds, Convection, Precipitation
- A draft Science-Applications Traceability Matrix exists, and the public comments are solicited
- Emphasize that this mission will fly alongside Program of Record (i.e., other satellite sensors)
- How to use those together, what should A-CCP look like (one platform, multiple, constellation, precessing?)

Michael Schulz representing GCOS essential climate variables

- These are meant to be monitored, measurement agnostic (but measurable) quantities
- Aerosols are allowed six of these, currently along the lines of spectral AOD, SSA, extinction profile, size, CCN, chemical composition
- Are these the right ones?

Discussion

- CCN is highly desired by hard, spectrum of RH
- Need measurements of extinction efficiency, hygroscopicity
- If things drop from being essential climate variables to (ancillary?) status, what does that mean?