Aerosols, Clouds, Precipitation and Climate (ACPC)

Workshop, 8 – 10 April 2015, NASA/GISS New York
Report

Additional documents:

- participants list
- programme
- outlines for progress on deep and shallow model intercomparison and -evaluation studies
- "strawman" proposal

Conclusions and suggestions from the workshop

- There was generally support of the approach laid out in the strawman proposal
- In an iterative approach, the modelling effort should come first
- Roadmap:
  1. Initial model intercomparison and -evaluation using existing data
  2. Simulation in the models of necessary observations, of the modelling-, "noise"/weather-, and observational uncertainties
  3. Second model intercomparison on possible cases where an observation might take place
  4. Possible field campaign

Opinions on / Suggestions for modelling

- Past intercomparisons, and experiences from the modelling groups (e.g. Philip Stier) report very large discrepancies between models and specifically microphysical parameterisations in simulations of clouds and aerosol-cloud interactions. Idealised cases or "simpler" clouds might be the best way forward (e.g. Andreas Muhlbauer). "Simple" clouds to be studies could be orographic precipitation (proposition Andreas Muhlbauer) or fog (Bernhard Vogel)
- Results are largely determined by the imposed forcing. A way forward could be exploitation of the weak temperature gradient method (Shuguang Wang/Adam Sobel).
- Scales need to be large enough for systems (> $(100\ km)^2$ for deep clouds)
- Resolutions need to be high for sensible simulations (~50 m for sc, maybe ~300 m acceptable for deep clouds; Graham Feingold, Andy Ackerman). At the large domains considered here, parameterisations necessary (Annette Miltenberger)
- Pockets of open cells are interesting features of aerosol-cloud-precipitation interactions with a very large implied forcing if attributable to aerosol perturbation (Danny Rosenfeld, Rob Wood, Graham Feingold)
- Interactive aerosols, including aerosol processing, seem crucial for credible results (Annette Miltenberger)
- In a "piggybacking" approach, with a second set of aerosols/cloud microphysics/thermodynamic profiles carried passively in the model, (i) the column-physics and dynamic effects of aerosol perturbations can be disentangled and (ii) a very good signal-to-noise ratio can be obtained (Wojtek Grabowski). The exact implementation is relevant (Jiwen Fan/Wojtek Grabowski). Simple Nudging might not be a sufficient approximation.

Opinions on observations

- Fluxes, especially lateral fluxes, might be very difficult to measure (Andrea Flossmann)
- Existing datasets should be exploited first (Andrea Flossmann, Bastiaan van Diedenhoven), gathering new datasets requires a rationale for their substantial value over existing datasets (Ann Fridlind)
- Precipitation fluxes in TWP-ICE were retrieved with a relative error of ±25% (Ann Fridlind). A tenfold aerosol perturbation yielded only changes of about 7% (Graham Feingold). Best identification possible from satellite radiation fluxes (Ann Fridlind). Error margins on other quantities in TWP-ICE were +7/-15% on albedo, +9/-4% on OLR, ±20% on convective, ±5% on stratiform cloud cover, ±20% on ice water path. Surface fluxes were very uncertain. Precipitation flux error of 1 mm $hour^{-1}$ translates to enormous energy flux errors (~600 Wm^{-2}; Patrick Chuang)
- Polarimetric radar could be best for model evaluation and process understanding (Ann Fridlind/Alexander Ryzhkov)
- Satellites needed for large-scale and climatologically-relevant context (Ralph Kahn), also for aerosol type and layer identification. Sampling is an issue (Ralph Kahn/Philip Stier). Geostationary satellites, especially Meteosat, good for temporal sampling (Hartwig Deneke/Ralph Kahn)
- Radiation yields good observations and also a strong constraint on the modelling (Graham Feingold, referring to 3D radiation simulations of irradiance)
- Simulated convective invigoration very dependent on wind shear (Jiwen Fan). "Microphysical invigoration" and anvil microphysics more important than thermodynamic effects. In simulations, the radiative effect of invigoration is mostly negative at top-of-atmosphere.

Suggestions for aerosol perturbations

- A distinct aerosol perturbation is necessary for a clear identification of aerosol impact in the observations. Ideally it should not be entangled with meteorological changes (although in practice this will be difficult).
- The seasonal cycle of DMS and subsequently cloud droplet concentrations in the Southern Ocean might be exploited. The large-scale meteorological conditions are sometimes similar in summer vs. winter, but the CDNC is a factor of three or more different (Andreas Muhlbauer)
- Geoengineering marine clouds is an option and explored in their modelling simulations by KIT (Bernhard Vogel)
- Volcanic aerosol (Yuan, ACP 2011) might be exploited (cited by Danny Rosenfeld)
- Ship tracks could be useful for shallow clouds (cited by Graham Feingold)
- Latitudinal gradient e.g. in VOCALS, but due to different effects (Rob Wood)
- Identification might be facilitated by factor analysis in combination with precipitation object shift analysis (Bernhard Vogel)
- Time scales need to be considered, not only those of the clouds and precipitation, but also of the aerosol (Graham Feingold, Andeas Muhlbauer). Signals in models largest initially (Bernhard Vogel), and easiest to identify in data at early stages of deep clouds (Alexander Ryzhkov). However the signals might be wrongly interpreted (Graham Feingold), and long integrations to equilibrium are rather necessary.
- Sea breeze might be a good option for a triggering mechanism (Danny Rosenfeld)