Abstracts … submitted for the **12th AeroCom meeting**

(in alphabetical order)

Allen, R.

(P) **Evaluation of multi-decadal variability in CMIP5 surface solar radiation and inferred underestimation of aerosol direct effects over Europe, China, Japan and India**

Observations from the Global Energy Balance Archive indicate regional decreases in all sky surface solar radiation from 1950s-1980s, followed by an increase during the 1990s. These periods are popularly called dimming and brightening, respectively. Removal of the radiative effects of cloud cover variability from all sky surface solar radiation results in a quantity called "clear sky proxy" radiation, in which multi-decadal trends can be seen more distinctly, suggesting aerosol radiative forcing as a likely cause. Prior work has shown climate models from the Coupled Model Intercomparison Project 3 (CMIP3) generally underestimate the magnitude of these trends, particularly over China and India. Here, we perform a similar analysis with 173 simulations from 42 climate models participating in the new CMIP5. Results show negligible improvement over CMIP3, as CMIP5 dimming trends over four regions−Europe, China, India and Japan−are all underestimated. This bias is largest for both India and China, where the multi-model mean yields a decrease in clear sky proxy radiation of −1.3±0.3 and −1.2±0.2 W m−2 decade−1, respectively, compared to observed decreases of −6.5±0.9 and −8.2±1.3 W m−2 decade−1. Similar underestimation of the observed dimming over Japan exists, with the CMIP5 mean dimming ∼20% as large as observed. Moreover, not a single simulation reproduces the magnitude of the observed dimming trend for these three regions. Relative to dimming, CMIP5 models better simulate the observed brightening, but significant underestimation exists for both China and Japan. Overall, no individual model performs particularly well for all four regions. Model biases do not appear to be related to the use of prescribed versus prognostic aerosols, or to aerosol indirect effects. However, models exhibit significant correlations between clear sky proxy radiation and several aerosol-related fields, most notably aerosol optical depth (AOD), and absorption AOD. This suggests model underestimation of the observed trends is related to underestimation of aerosol direct radiative forcing and/or deficient aerosol emission inventories.

Aoki, K.

(P) **Aerosol optical characteristics over the Japan measured by sky radiometer**

Aerosol optical characteristics are studied using data from sky radiometer (POM series: Prede Co. Ltd., Tokyo, Japan) measurements in the world (Aoki and Fujiyoshi, 2003, Aoki, 2008, 2013). We started the monitoring of aerosols optical characteristics since 1994, by using a sky radiometer (http://skyrad.sci.u-toyama.ac.jp/) over the land and ocean (on-board Ship). The sky radiometer is an automatic instrument that takes observations only in daytime under the clear sky condition without cloud. Observation of direct and diffuse solar intensity of interval was made every ten or five minutes by once (direct measurement every one minute). There were used to analysis direct solar irradiance and diffuse solar radiance at five wavelengths (0.4, 0.5, 0.675, 0.87, 1.02 μm). The aerosol optical characteristics were computed using the SKYRAD.pack version 4.2 developed by Nakajima et al. (1996).

Apituley, A

(P) **iSPEX: First Results of Aerosols Measured by Smartphones in the Netherlands**

An increasing number of people carry a smartphone with internet connection, a camera and considerable computing power. iSPEX, a spectro-polarimetric add-on with complementary App makes use of this opportunity, and turns a smartphone into a scientific instrument to measure dust and other aerosols in our atmosphere. A measurement involves scanning the blue sky, which yields the angular behavior of the degree of linear polarization as a function of wavelength, which may be interpreted in terms of size, shape and chemical composition of the aerosols in the sky. The measurements are automatically tagged with location and pointing information, and submitted to a central database where they will be interpreted. Together with observations from other users at random locations, the data are compiled into a map. Through crowd sourcing, the general public will thus be able to contribute to a better assessment of the presence of different types of aerosols in the atmosphere.

Arola, A.

(P) **Influence of observed diurnal cycles of aerosol optical depth on aerosol direct radiative effects**

The diurnal variability of aerosol optical depth (AOD) can be significant, depending on location and dominant aerosol type. However, these diurnal cycles have rarely been taken into account in measurement-based estimates of aerosol direct radiative forcing (ADRF) or aerosol direct radiative effect (ADRE). The objective of our study was to estimate the influence of diurnal aerosol variability on the top of the atmosphere ADRE estimates. By including all the possible AERONET sites, we wanted to assess the influence on global ADRE estimates, while by focusing also in more detail on some selected sites of strongest impact, our goal was to also see the possible impact regionally. We calculated ADRE with different assumptions about the daily AOD variability: taking the observed daily AOD cycle into account and assuming diurnally constant AOD. Moreover, we estimated the corresponding differences in ADREs, if the single AOD value for the daily mean was taken from the Moderate Resolution Imaging Spectro-radiometer (MODIS) Terra or Aqua overpass times, instead of accounting for the true observed daily variability. The mean impact of diurnal AOD variability on 24 h ADRE estimates, averaged over all AERONET sites, was rather small and it was relatively small even for the cases when AOD was chosen to correspond to the Terra or Aqua overpass time. This was true on average over all AERONET sites while clearly there can be much stronger impact in individual sites. Examples of some selected sites demonstrated that the strongest observed AOD variability (the strongest morning afternoon contrast) does not typically result in a significant impact on 24 h ADRE. In those cases, the morning and afternoon AOD patterns are opposite and thus the impact on 24 h ADRE, when integrated over all solar zenith angles, is reduced. The most significant effect on daily ADRE was induced by AOD cycles with either maximum or minimum AOD close to local noon. In these cases, the impact on 24 h ADRE was typically around 0.1 to 0.2 W/m2 (both positive and negative).

Baltensperger, U.

(O, ACTRIS) **Aerosol life cycles: what to learn from high altitude sites ?**

Bellouin, N.

(O) **Trends in aerosol optical depth in AeroCom 2 Hindcast and CMIP5 simulations compared to satellite retrievals and AERONET measurements**

The general circulation models GISS-MATRIX, GISS-modelE, HadGEM2, and SPRINTARS include interactive representations of atmospheric aerosols and have simulated the period 1980-2006/2010 as part of the AeroCom 2 Hindcast and CMIP5 protocols. In this study, we present trends in total and component aerosol optical depths in those simulations, with a focus on model diversity, impact of the emission dataset, and regions where the trend in optical depth differs from that in anthropogenic emissions. Modeled trends are also compared against an analysis of SeaWIFS (1998-2010), MODIS and MACC (2003-2012), and AERONET aerosol products.

Bergman, T.

(P) **The Enhancement of Atmospheric Aerosols and Particle Growth by Amines**

In recent studies gaseous amines have been shown to have a role in atmospheric nucleation. Specifically, the results from the CLOUD experiment indicate that amines enhance sulfuric acid-water nucleation significantly. Amines are emitted to atmosphere by a variety of anthropogenic and biogenic processes. Animal husbandry and the ocean produce aliphatic amines while various industrial operations produce aromatic amines. In gas-to-particle conversion amines have two pathways: direct dissolution and acid-neutralizing reactions. However, thus far amines have been incorporated into very few atmospheric models. Therefore their importance in aerosol formation and growth is poorly known. We examine the impact of the most commonly emitted amines on new particle formation and growth. To evaluate the importance of amines in particle growth we have implemented a simple description of amines to aerosol-climate model ECHAM5-SALSA. The oceanic emissions of amines are calculated using wind speeds and chlorophyll-A concentrations on the surface. The spatial patterns of emissions over land are approximated using the GEIA inventory for NH3. The major

processes accounted for the amines in the model are OH scavenging, dry and wet removal, condensation (an approximation of dissolution and acid-neutralizing reactions) and nucleation. The nucleation is implemented assuming that the enhancement is caused by two amine molecules attaching to sulfuric acid cluster consisting of two molecules. The study comprises of three simulation runs with amines and a control run with kinetic nucleation. Of the simulation runs with amines one is without OH scavenging and the other two runs have OH scavenging. The scavenging OH is either climatological OH concentrations or calculated using OH-proxy. We will study how amines affect the number concentration of all particles and cloud droplet number concentration (CDNC). Also the effect of OH scavenging on the CDNC and particle concentrations is scrutinized.

Bian, H.

(O) **Investigation of atmospheric nitrate using GMI model constrained by an integrated measurements from ground stations, aircrafts, and satellite**

This talk focuses on the evaluation of the simulations by NASA global modeling initiative (GMI) model by using various measurements. We use ground station networks, CastNet, IMPROVE, AMoN, and EMEP, to examine the model simulation in terms of its surface concentrations. The ground station networks CastNet and NADP/NTN are used to evaluate GMI dry and wet depositions. Aircraft measurements (INTEX-B and ARCTAS) are analyzed and interpolated into 1-km vertical bins and the data are used to evaluate the model simulations that are sampled correspondingly following the aircraft measurements. We also analyze satellite AURA TES NH3 retrieval and reprocess the model simulation with TES average kernel to compare the two products. The species that are relevant to nitrate simulation, e.g. SO2, SO4, NH3, NH4, NO3, and HNO3, are analyzed. We are proposing to use aforementioned measurements and more to conduct an AeroCom multi-model study to investigate the current status of nitrate simulation.

Block, K.

Can, O.

Carslaw, K.

(O) **Proposal for joint sensitivity and uncertainty analysis experiments**

There has been very little activity related to the sensitivity of models to perturbations in processes and emissions. Understanding the diversity of model responses to perturbations will help to understand the uncertainty in the near-term trend in forcing as well as potential long term natural aerosol feedbacks. Models, in particular those that include microphysics, can differ significantly in their responses to emission perturbations, even when climate feedbacks are neglected. Secondly, the response to perturbed processes can be used to quantify the model parametric uncertainty and help to direct research efforts towards the most important uncertainties. The idea in this joint initiative is to quantify and intercompare model responses to key perturbations using a combination of emulator approaches and simpler one-at-a-time tests. This presentation summarizes this proposal and will lead to a discussion of priorities.

(P) **The Global Aerosol Synthesis and Science Project (GASSP)**

GASSP is a UK project involving the universities of Leeds, Manchester and Oxford. The aim is to combine an extensive synthesis of aerosol microphysics measurements with a full statistical evaluation of a global model to derive bottom-up best estimates of aerosol process parameters and emissions.
This approach, based on in situ data, will complement other approaches in which global aerosol has been derived from AOD assimilation. GASSP exploits the emulator approach developed by Lee et al., which enables the full uncertainty space of a complex global aerosol model to be quantified. We can then 'calibrate' the model by rejecting implausible parts of the parameter space and by detecting genuine model bias when observations lie outside the maximum uncertainty range of the model. We present the methodology and first results.

Chin. M.

(O) **AeroCom hindcast experiments status and action items**

I would like to give an update on the current status of the AeroCom hindcast experiment, showing GOCART evaluation as an example, and discuss action items. I would also like to talk about a proposal for the HTAP model experiments.

Daskalakis, N.

Damico, G.

Diehl, T.

(O) **Computing model-based clear-sky quantities for multi-model comparisons and evaluation with satellite data**

Traditionally, temporal averages of quantities such as AOD and radiative fluxes have been computed in models by averaging over all model time steps, and by setting cloud fraction to zero for the calculation of clear-sky fluxes. However, this method is inconsistent with satellite retrievals, where averages are derived only from a subset of observations labeled as clear-sky according to some cloud fraction threshold. Some models have used a definition of clear-sky quantities similar to that used for satellite retrievals, so that multi-model comparisons are becoming more difficult due to different definitions of clear-sky. We would like to initiate a discussion within the AeroCom community on how to address these issues. As a first step within this process, we have implemented a new method to compute clear-sky AOD and fluxes in the GOCART model. We will discuss differences of model results based on the new and traditional clear-sky definitions, and discuss the pros and cons of the method.

O'Donnel, D.

Doppler, L.

(P) **Absorbing aerosols, influence of the microscopic properties on the direct radiative forcing**

Absorbing aerosols have a real influence on climate because of their direct radiative forcing. The most important component of absorbing aerosols regarding their radiative properties is soot (or black carbon). In the databases, soot aerosols have often a very low single-scattering albedo. These values are obtained for mixtures with very high amount of small particles or with a high imaginary part of the refractive index. In this presentation, we propose to compare the radiative forcing of absorbing aerosols using microscopic properties (refractive index and size distribution) from different databases, and from different measurement campaigns. We will point out the variability of the resulting SSA and radiative forcings.

Dunne, E.

(P) **Comparison of AEROCOM simulations with marine observational data**

Accurately modeling the concentrations of marine aerosol is important, in part due to the strong radiative effect of marine stratocumulus clouds. Remote marine regions represent some of the most pristine boundary layer conditions, where a small perturbation in aerosol concentration will have the largest effect. However, long-term aerosol measurements in marine regions are rare, and model validation has been limited by this fact. I will gather as many data sets of marine aerosol observations as possible, and compare them with a subset of AEROCOM simulations. The data sets already acquired include long-term measurements at coastal sites, and shipboard campaigns. The set of measurements could potentially represent a new marine aerosol climatology.

Fiebig, M.

(O, ACTRIS) **Using Ground Station Data for Improving Model Accuracy**

The WMO GAW World Data Centre for Aerosol (WDCA), in collaboration with the ACTRIS project, has a long standing collaboration with AeroCom in providing ground station in situ observations of aerosol properties, such as particle size distribution, aerosol scattering / absorption, and chemical composition. The presentation will give an update on recent extensions in coverage and near-future plans in extending the set of covered parameters relevant for validating climate models. Focus will be placed on recent results of the ESA aerosol Climate Change Initiative (CCI) project that question the possibility of validating remote sensing products with ground station data. This in turn highlights a strategic weakness of climate models that are validated exclusively with (non-validated) remote sensing products. Strategies for overcoming this problem will be discussed, including practical aspects of properly comparing ground station data with model results.

Fillmore, D.

(P) **Regional Aerosol Optical Depth trends and inter-annual variability with MATCH, CCCM and MODIS**

We examine global and regional aerosol optical depth trends and inter-annual variability from 2000 - present with the Model for Atmospheric Transport and Chemistry (MATCH). MATCH assimilates MODIS AOD and thus augments the satellite data with model information on aerosol type and vertical distribution. With the MATCH assimilation we reduce the effects of MODIS spatial sampling on the trend analysis. The merged CERES CALIPSO CloudSat MODIS (CCCM) A-Train dataset provides aerosol layer distributions from 2007 through 2010. Over this time period we examine the seasonal and inter-annual variability in the vertical distribution of AOD for select regions of interest. We also discuss the potential of CCCM for aerosol transport model validation, using MATCH as an example.

Ghan, S.

(O) **Constraining Estimates of Aerosol Effects on Clouds: First Results from the Next AeroCom Indirect Effects Study**

Recent comparisons of the sensitivity of warm cloud precipitation probability to aerosol optical depth retrieved from satellite to the sensitivity simulated by two global models, the Community Atmosphere Model CAM5 and a super-parameterized version SPCAM, suggests that CAM5 overestimates the sensitivity much more than SPCAM, and that the overestimate explains the much larger estimate of the aerosol indirect effect by CAM5. In this presentation we will extend this analysis to other global aerosol models to see if the excessive sensitivity can be explained by an excessive contribution of droplet auto-conversion to stratiform precipitation in the other models.

Ginoux, P.

(O) **Contribution of land-use to the variability of dust properties**

Estimations of land-use to dust emission vary between 10 and 50%. The use of MODIS Deep Blue aerosol products suggests an actual contribution of 25% globally with large regional variations. As an example of the importance of anthropogenic dust sources, we will present a case study of a continental scale dust plume produced from croplands in the US Midwest in 2012. Using such results to calibrate a new dust emission scheme in the GFDL coupled climate models we were able to simulate globally dust from natural and anthropogenic dust sources for the last 140 years. We will show that some very large variations in ground-based data may be related to land-use and vegetation changes. Our results imply the need to incorporate these changes for accurate climate simulations.

Griesfeller, J.

(P) **Update on the AEROCOM infrastructure**

My poster will show the recent updates of the AeroCom IT infrastructure.

Haustein, K.

Holzer-Popp, T.

(O) **First products from ESA Aerosol_cci**

Within the ESA Climate Change Initiative (CCI) the Aerosol_cci project (mid 2010 – mid 2013, phase 2 proposed 2014-2016) has conducted intensive work to improve algorithms for the retrieval of aerosol information from European sensors AATSR (3 algorithms), PARASOL, MERIS (3 algorithms), synergetic AATSR/SCIAMACHY, OMI and GOMOS. Whereas OMI and GOMOS were used to derive absorbing aerosol index and stratospheric extinction profiles, respectively, Aerosol Optical Depth (AOD) and Ångström coefficient were retrieved from the other sensors. Global datasets for 2008 were produced and validated versus independent ground-based data and other satellite data sets (MODIS, MISR). An additional 17-year dataset is currently generated using ATSR-2/AATSR data. During the three years of the project, intensive collaborative efforts were made to improve the retrieval algorithms focusing on the most critical modules. The retrieval results for AOD, Ångström exponent (AE) and uncertainties were evaluated by comparison with AERONET sun photometer data and with satellite data available from MODIS and MISR. The validation shows that most of the datasets used in the Aerosol-cci project have improved significantly with respect to their baseline at the start of the project. In particular PARASOL (ocean only) provides excellent results, while AATSR (land and ocean) datasets are similar to those of MODIS and MISR, with AATSR better in some land regions and less good in some others (ocean). However, AATSR coverage is smaller than that of MODIS due to the limited swath width of 500 km. MERIS and synergetic AATSR / SCIAMACHY datasets have lower quality and require further work. The evaluation of the pixel uncertainties shows first good results but also reveals that more work needs to be done to provide comprehensive information for data assimilation. The paper will present and discuss the datasets from Aerosol_cci, their validation status and benefits and limitations.

Huneeus, N.

(O) **Anthropogenic SO2 emissions from an atmospheric inversion for the decade 2001 to 2010**

We present here the first multi-year inverse estimate of monthly SO2 emissions generated for the years 2001-2010 by assimilating total and fine mode MODIS AOD at 550 nm into an aerosol model of intermediate complexity. The estimated emissions have been validated indirectly by assessing the performance to simulate the assimilated observation with respect to the independent AERONET AOD. Both, total and fine mode AOD, are improved in terms of RMS error and correlation by the assimilation. The consistency of the inverted emission estimates was also checked by comparing them with traditional bottom-up inventories. This consistency check revealed important differences in terms of magnitude and trends. To explore the impact on the resulting emissions of the simplified representation of aerosol processes in the model, the inverted estimates were used as input in a model with an increased level of complexity. Years 2001, 2005 and 2010 were simulated with two different emission configurations.

Huttunen, J.

(P) **Aerosol direct radiative effect efficiency, aerosol optical properties and surface albedo - comparison between simulations of models and results derived with measurements**

The Aerosol Direct Radiative Effect, attenuation of the solar flux due to scattering and absorption of aerosols, normalized by the Aerosol Optical Depth (AOD), the ADREE, is simulated by several models and the estimates are compared with the results based on measurements. AODs are collected from the Aerosol Robotic Network (AERONET) and solar flux measurements are from Solar Radiation Network (http://solrad-net.gsfc.nasa.gov/) and Baseline Surface Radiation Network (http://www.bsrn.awi.de/). The models are from the Aerosol Comparisons between Observations and Models (AeroCom, aerocom.met.no) Phase II experiment. The ADREE is defined for clear sky and daily averaged

ADREEs at the surface are determined at over 20 stations. The stations are selected from various parts of the earth, covering different aerosol optical properties. For the same stations, aerosol optical properties for few wavelength bands are compared between models and products based on the AERONET.

Ichoku, C.

(P) **Lessons from coherent uncertainty analysis of aerosol observ. from multiple satellite sensors and implications for model evaluation**

Atmospheric aerosols are being extensively observed and measured globally using both ground-based and satellite instruments, including the worldwide ground-based Aerosol Robotic Network (AERONET) of sun-photometers and such powerful spaceborne sensors as MODIS on the Terra and Aqua satellites, MISR on Terra, OMI on Aura, POLDER on PARASOL, CALIOP on CALIPSO, and SeaWiFS on SeaStar. These aerosol measurements have been carefully and uniformly analyzed and inter-compared relative to AERONET, in order to understand their uncertainties and limitations. In this presentation, we will show results of this coherent comparative uncertainty analysis and demonstrate how these sensors perform in different parts of the world over different land-cover types as well as their performance relative to one another, in order to facilitate product selection and integration for specific research and applications needs, including their potential utility for model evaluation.

Kahn, R.

(O) **We are Getting Better at Aerosol Type**

From MISR we can retrieve AOD over many surface types and obtain aerosol plume heights from hyper-stereo. The AeroCom community makes good use of these products, and might continue doing so, especially with the new wildfire smoke injection height and source strength inventory activities we are proposing. Aerosol type is a third MISR product, a categorical variable derived by combining aerosol “size” (three-to-five bins under good retrieval conditions, e.g., “small,” “medium,” “large”), SSA (two-to-four bins), and spherical vs. non-spherical

particle shape. For modelers, using this product, can be challenging: it is categorical rather than quantitative, and the quality varies more with retrieval conditions than AOD. However, global aerosol type measurements are currently not available from any other source. This presentation will cover how MISR aerosol type is being applied, and what we are doing to make it easier.

Kaiser, J.

(O) **Fire emission products from MACC-II and how to use them**

The MACC-II project provides global daily fire emissions from 2003 and onwards in real time with the GFAS system, and contributes to the developments of retrospective fire emissions in GFED. We present the current and future planned MACC-II fire products along with an overview on how they are being used in the global and some regional aerosol models in MACC-II and outside the project.

Kanakidou, M.

Kilping, Z.

(O) **Can specific processes explain inter-model diversity for vertical profiles?**

The vertical profile of aerosol is important for its effects on climate, but weakly constrained by observations on the global scale, and highly variable between different models. In this study, we look at the diversity of aerosol vertical profiles amongst the AeroCom Phase II models, and investigate the extent to which this diversity can be reproduced in a single model (HadGEM3-UKCA) by switching off individual processes. In this way we show that (in this model at least) the vertical profile is controlled by a relatively small number of processes, and that sufficiently-coarse variations in these processes can produce a similar diversity to that between the different models in respect of the global and annual mean vertical profile. However, there are features of the meridional variation in many

models that cannot be reproduced in this way, suggesting that further structural differences between models play a significant role in controlling the vertical profile.

Kinne, S.

(P) **the MPI Aerosol Climatology (MAC)**

Kirkevag, A.

Koffi, B.

(P) **Evaluation of aerosol vertical profiles from AeroCom Phase II simulations using a global gridded CALIOP product**

This study assesses the ability of 11 state-of-the-art AeroCom Phase II models in simulating the aerosol vertical distribution from regional to global scales. It makes use of a 2007-2009 3D global gridded dataset of aerosol extinction profiles that we built on purpose from the CALIOP Layer 5-km product. The evaluation is based on an extinction height diagnostic Zα (km) established for each region and season. The performance of the models over the 0-6 km altitude range is first evaluated and compared to AeroCom Phase I results over 12 sub-continental regions. We find that the models generally perform well in simulating the Zα inter-regional diversity (for 8 out of 11 models) and the regional seasonality. Compared to AeroCom Phase I (8 common models), five models improved whereas three degraded in reproducing the mean annual Zα 0-6 km height diagnostic. The seasonal biases in Zα 0-6 km have generally decreased in the occidental industrial and downwind maritime regions, and the ability in identifying the Zα 0-6 km peak season over the different regions has increased for all but two models. On the other hand, a general underestimation, by more than 20% in model mean, of the Zα 0-6 km seasonal peak is now obtained over the dust and biomass burning source regions of Asia and Africa. From the evaluation of AeroCom Phase II simulations at global scale, we find a better model performance over ocean than

over land. However, a significant positive or negative bias is obtained over oceanic latitudes for 7 out of the 11 models. First analyses suggest that the AeroCom I versus AeroCom II, and the land versus ocean differences, as well as the spread between the individual models cannot only be attributed to changes and differences in the aerosol scheme, but also to input emissions and transport patterns.

Kokkula, H.

(P) **explaining secondary organics underestimates in global modeling**

Large-scale atmospheric models, which typically describe secondary organic aerosol (SOA) formation based on chamber experiments, tend to systematically underestimate observed organic aerosol burdens. Since SOA constitutes a significant fraction of atmospheric aerosol, this discrepancy translates to an underestimation of SOA contribution to climate. We use chamber experiments of alpha-pinene ozonolysis to show that the underestimation of SOA burden can be partly explained by wall-losses of SOA forming compounds during chamber studies. Theoretical analysis of new particle formation and growth during the experiment indicates rapid formation of oxidized organic compounds of very low volatility; however, the majority of their mass is depleted to the chamber walls. Because of this, these low volatility compounds may have previously gone undetected leading to significant underestimation of SOA yields.

Kuehn, T.

(P) **Impact of aerosol emissions in China and India on climate**

Existing surface temperature records show warming in the beginning of last century, followed by cooling starting from1940 and again strong heating from 1975 until recent years. This behavior has been attributed to increases in the greenhouse gas and anthropogenic aerosol emissions as well as to natural variability of climate. Making a difference between these is crucial as climate predictions and international policy related to emission reductions are based on

the models that are mainly evaluated against the historical temperature records. While in Europe and North America anthropogenic aerosol emissions have decreased since the late 1970s, the emissions in China and India have started to increase dramatically at about the same time and have only recently started to stagnate due to new regulations in China. Here we use emission scenarios for the years 1996 through 2010 to assess how these changes in aerosol emissions affect the global and local climate.

Kulmala, M.

Laj, P.

Lee, L.

(O) **A statistical framework to quantify model uncertainty**

Model uncertainty arises in any computer model but can broadly be defined in terms of parametric and structural uncertainty. Within AEROCOM, a lot of progress has been made in quantifying the effect of structural uncertainty on aerosol model predictions. We propose to study the two sources of uncertainty together and in this talk I will explain the statistical methods that have been applied in the AEROS project to help us understand and quantify parametric uncertainty in the GLOMAP aerosol model. They will be illustrated using a two dimensional example designed to understand the relationship between boundary layer nucleation and biogenic secondary organic aerosol. I will then show some of the results we have from applying these methods to study 28 uncertain parameters in GLOMAP. To finish I will show preliminary results in which we constrain our model to observations considering the parametric uncertainty which have been made possible due to statistical emulation.

Leeuw, G.

(P) **A new advanced sea-spray source function (OSSA) and applications in the ECHAM model**

A new sea spray aerosol (SSA) source function (SSSF), termed Ocean-flux Sea Spray Aerosol or OSSA, was derived based on in-situ sea spray measurements along with meteorological/physical parameters. Submicron sea spray fluxes derived from particle number concentration measurements at Mace Head, at the west coast of Ireland, were used together with open-ocean eddy correlation flux measurements from the Eastern Atlantic (SEASAW cruise). In the overlapping size range, the data for Mace Head and SEASAW were found to be in good agreement, which allowed deriving a new SSSF from the combined dataset which covers the dry diameter range from 15 nm to 6 µm. The sea spray production was parameterized in terms of the Reynolds number.

Levy, R.

(O) **MODIS collection 6 dark target aerosol products as target for AeroCom studies**

We have upgraded the MODIS 'dark-target' (DT) aerosol retrieval algorithm over ocean and vegetated/dark-soiled land, and soon will start processing Collection 6 (C6). We have updated the radiative transfer assumptions, improved cloud masking, fixed bugs in quality assurance (QA) logic, and added new diagnostic parameters. For DT-land, we have fine-tuned the assignments for expected aerosol type and corrected an error in the surface reflectance parameterization. For DT-ocean, we included wind speed dependence in the retrieval. At the same time, we accounted for "upstream" changes such as instrument calibration and land/sea flagging. Compared to sun-photometer data, the C6, Level 2 (along swath) DT-products are better than C5. Globally, C6 shows reduced AOD (by 0.02) over ocean and increased AOD (by 0.02) land. We expect to see reduced differences between Terra and Aqua time series. All together, the new, C6 MODIS data will be a more stable "target" for AEROCOM studies.

Liu, X.

(O) **AeroCom Inter-comparison of Aerosol Indirect Effect Through Cirrus (Ice) Clouds**

Aerosol indirect effect (AIE) on climate remains one of the large uncertainties in the future climate change projection. Among various AIE mechanisms, aerosol indirect effect on cold cirrus (ice-AIE) has never been assessed in previous IPCC reports. We proposed a set of sensitivity experiments for present and pre-industrial conditions to estimate the ice-AIE under AeroCom. In this presentation we report progress of this ice–AIE inter-comparison. We will highlight some results from several climate models from CAM5, CAM5-PNNL, ECHAM5, and CAM5-UMich. This inter-comparison of ice-AIE will be a useful contribution to the next IPCC assessment.

Lund-Myhre, C.

(O, ACTRIS) **On the application, use and access to ground based aerosol observations**

The aim of this presentation is to contribute to the use of observational data for understanding of aerosol trends and refining aerosol forcing estimates. There is also an aim to discuss possible collaboration on the use of observations to evaluate and improve aerosol models. EBAS is a database infrastructure were the main objective is to handle, store and disseminate atmospheric composition data generated by international and national frameworks like long-term monitoring programs and research projects. Currently EBAS hosts atmospheric data from more than 1050 sites distributed worldwide, and almost 50 projects and frameworks. The oldest times series in EBAS range back to 1971, and the last years also near real time aerosol observations is available for ~ 45 sites, globally distributed. Examples of relevant networks and projects submitting data to EBAS are EMEP (European Monitoring and Evaluation Program), GAW-WDCA (GAW World Data Centre for Aerosols), and ACTRIS (Aerosols, Clouds, and Trace gases Research InfraStructure Network).
The presentation will include examples on the use of EBAS data, and provide a brief overview of relevant variables, data and time series. Furthermore, the presentation will explain the quality procedures and documentation of the data, including the use and interpretation of flags and metadata. Finally, an important

issue is to explain how the data can be accessed and used by the model community, and discuss possible collaboration on model validation. The presentation will also introduce the various data produced within ACTRIS, and how these can be accessed. ACTRIS variables includes in situ aerosol optical, physical and chemical properties, short-lived trace gases, aerosol scattering and extinction profiles, and cloud profiles. Not all these data are stored in EBAS, and the ACTRIS data center allows users to search for atmospheric data from a multitude of data archives through a single user interface.

(P) **ACTRIS Data Centre: An atmospheric data portal - actris.nilu.no**

ACTRIS (Aerosols, Clouds, and Trace gases Research InfraStructure Network) is a European Project aiming at integrating European ground-based stations equipped with advanced instrumentation for studying aerosols, clouds, and short-lived gas-phase species. The ACTRIS activities result in improved atmospheric measurements data made at more than 60 European sites, from numerous instruments and includes variables measured by ground based in situ and remote sensing technologies. Core variables are in situ aerosol optical, physical and chemical properties, short-lived trace gases (volatile organic carbon and nitrogen oxides), aerosol scattering and extinction profiles, and cloud properties.
The ACTRIS data centre (ACTRIS DC) is giving free and open access to all data resulting from the activities of the infrastructure network, complemented with data from other relevant networks and data bases. The backbone of the ACTRIS DC is the three core data bases:
- EARLINET Data Base hosting aerosol profiles from more than 35 European sites
- EBAS hosting ground based atmospheric in situ data from more than 1000 sites
- Cloudnet hosting cloud profile data and products from 7 European sites
The ACTRIS Data Centre offers a web portal that allows users to search for atmospheric composition data from a multitude of data archives through a single user interface. Examples of data bases and frameworks included in the portal are EMEP, the GAW-world data centres, EARLINET, NDACC, HTAP, AMAP amongst others. Currently the portal provides an overview of more than 50 000 data sets, 1263 sites and more than 20 data bases/frameworks globally. For some of the databases included in the portal, the interface allows you to download data directly through the portal. A map functionality is implemented facilitating the identification of data and making it possible to search for collocation of observations, variables and sites both in time and space.

Mann, G.

(P) **Global distributions of cloud droplet number concentrations and cloud albedo effects from AeroCom models of a range of complexity**

Many of the next generation of climate models will include aerosol schemes which explicitly simulate microphysical processes such as new particle formation, coagulation and cloud processing. These global aerosol microphysics models simulate aerosol optical properties and cloud condensation nuclei concentrations consistently with the dynamically varying size distribution, which should lead to improved fidelity of simulated aerosol radiative forcings. As part of the AeroCom aerosol microphysics working group, 3D global fields of size-resolved particle number concentrations and composition have been derived for 12 global aerosol microphysics models. Taken as a whole, considering the central two-thirds range, the models have been shown to have a good degree of skill in reproducing the main features of the global variation in the particle size distribution compared to several benchmark observational datasets. However, the assessment highlighted that some models are in poor agreement with the observations, and there are important biases common to many of the models in some regions and seasons. We derive global 3D fields of cloud droplet number concentration (CDNC) from each of these models' monthly-mean all-aerosol-tracer output for theAeroCom-2 control simulations. We will then use an established technique to quantify the present-day aerosol indirect radiative effect for each model based on their CDNC distribution using an offline radiative transfer model with prescribed satellite climatologies of cloud properties. We present initial results from this work by assessing the diversity in simulated CDNC among the models and investigate whether there are any fundamental differences between the CDNC fields from the aerosol microphysics schemes compared to those simulated by mass-based aerosol schemes that prescribe the particle size-distribution.

Miatselskaya, N.

Mona, L.

(O, ACTRIS) **ACTRIS aerosol vertical profiles: advanced data and their potential use in an aerosol observations/models combined approach**

The ACTRIS research infrastructure is built on the basis of a consortium joining existing networks/observatories providing consistent datasets of observations using state-of-the-art measurement technology and data processing. In particular, EARLINET (European Aerosol Research Lidar Network), which is now integrated in ACTRIS, is the network which has been providing aerosol optical properties vertical profiles over Europe since May 2000. All EARLINET stations perform almost simultaneously measurements three times per week following a scheduling established in 2000. Besides these climatological measurements, additional measurements are performed in order to monitor special events (as volcanic eruptions and desert dust intrusion), for satellite data evaluation and integrated studies and during intensive measurements campaigns. Aerosol optical properties vertical profiles are freely available at www.earlinet.org and through ACRIS data center http://www.actris.net/. Long-term aerosol observations performed within EARLINET allows a climatological study of aerosol properties over Europe. In particular, EARLINET Raman stations provide direct measurement of extinction profiles, and therefore of the aerosol optical depth (AOD), a key parameter for understanding the aerosol role on radiation budget. The free troposphere contribution to AOD and altitude of lofted layers are provided thanks to the vertical profiling capability of lidar technique. EARLINET products and advanced data are particularly suited for linking in situ and columnar data to satellite observations and aerosol models. In particular, the representativeness of aerosol measurements from satellite borne instruments and a suitable methodology for aerosol models evaluation will be presented.

Neubauer, D.

(P) **Impact of the representation of stratocumulus clouds on the anthropogenic aerosol effect**

Simulations of the anthropogenic aerosol effect can be expected to depend on the representation of stratocumuli as they have a strong cooling effect but are difficult to represent in a GCM because of their small vertical extension.
We address the representation of several of the physical processes that have to be accounted for when modeling stratocumuli. Similar to previous studies we have observed increases in stratocumulus cloud cover and liquid water path using a 'sharp' stability function in ECHAM6-HAM2. We also study the impact of increased vertical resolution in the lower troposphere in ECHAM6-HAM2. The recently implemented in-cloud aerosol processing in stratiform clouds in ECHAM6-HAM2 leads in the global, annual mean to an increase of the lifetime of stratiform clouds by 27%. First results for the impact of changing the vertical resolution, a different stability function and in-cloud aerosol processing in ECHAM6-HAM2 on the aerosol effect will be presented at the workshop.

Ogren, J.

(O) **Comparison of aerosol absorption optical depth from remote-sensing and in-situ measurements**

The aerosol absorption optical depth (AAOD) product derived from AERONET sun/sky radiometer measurements has been widely used to evaluate model predictions of black carbon (BC) and its radiative forcing. Most recently, the Bounding BC assessment (Bond et al., 2013) used the AERONET AAOD retrievals to justify adjusting modelled BC column burdens upwards by a globally-averaged factor of 2.6, leading to the conclusion that BC is the #2 most important climate-warming agent (behind CO2), with an average forcing of +1.1 W m-2 (90% uncertainty bounds +0.17 to 2.1 W m-2). However, the verification of the AERONET AAOD retrievals relies primarily on short-term aircraft studies done under conditions of very high aerosol loadings (biomass burning, dust), and the retrievals have not been evaluated under the low optical depth conditions that prevail over most of the globe. In this paper, we report comparisons of AERONET

AAOD with in-situ measurements of aerosol light absorption coefficient obtained over the SGP CART and BONDVILLE sites in the US.

Olivie, D.

(P) **Estimates of aerosol radiative forcing from regional emission**

We present estimates of the present-day aerosol radiative forcing, calculated using the Norwegian Earth System Model (NorESM). The aerosol scheme in NorESM describes the evolution of black carbon, organic carbon, dust, sea-salt, and sulfate aerosol, and is here coupled with the tropospheric chemistry scheme MOZART. By reducing the emissions of aerosols and aerosol-precursors regionally by 20 percent, we derive radiative forcing estimates from emissions in Europe, South-East Asia, and the rest of the world. Estimates of the instantaneous and effective radiative forcing from black carbon, organic carbon, and sulfate aerosol are presented. The simulations are performed within the framework of the ECLIPSE project (Evaluating the CLimate and Air Quality ImPacts of Short-livEd Pollutants).

Palanisamyg, G.

Pan X.

(P) **Evaluation of aerosol simulations in multi-models over South Asia**

Atmospheric pollution over South Asia has attracted special concern due to its increasing anthropogenic emission tendency, and potentially large effects on regional climate, water cycle and air quality. In this study, the simulations of spatio-temporal and vertical aerosol distribution of aerosol optical depth (AOD) are examined in AeroCom multi-models and NASA GEOS5. NASA satellites sensors (e.g. MODIS, MISR and CALIPSO), ground-based network (e.g. AERONET) and local in-situ measurement are used for evaluation of model simulations. Substantial underestimations in AOD, AAOD and BC are found in most models compared with

the observations, in particular over northern India during post-monsoon and winter time when the local anthropogenic and biomass burning emissions are confined near surface and dominate over the dust emission transported from desert regions. The outcomes of this study significantly contribute to our understanding of the aerosol distribution over South Asia.

Pappalardo, G.

Partridge, D.

(P) **Aerosol cloud droplet concentration closure for marine stratocumulus clouds: Comparison of two parameterizations using an inverse modeling framework**

In this work we couple two droplet activation parameterizations (Abdul-Razzak and Ghan, 2000; Barahona et al., 2010) and an adiabatic cloud parcel model (Roelofs and Jongen, 2004) to a Markov Chain Monte Carlo (MCMC) algorithm, and invoke posterior probability density functions of key input parameters used to describe the meteorological and aerosol physiochemical conditions. This posterior distribution allows us to in a statistically robust manner provide a measure of the discrepancy between the model and in-situ measurements of droplet number as a function of the model input parameters over the entire feasible parameter space. Simulations are performed for a marine aerosol environment using observations from three flights from the Marine Stratus/Stratocumulus Experiment (MASE II) campaign.

Peers, F.

(O) **Aerosols in cloudy scenes: properties and impacts**

Satellite aerosol retrievals are now used to constrain increasingly sophisticated aspect of global aerosol numerical models such as the vertical profile. However, the radiative effects of aerosols located above clouds, which is typically positive

and associated with a large diversity in the AeroCom models, remains unconstrained because most current satellite retrievals are limited to cloud-free scenes. An operational algorithm, using POLDER's polarized radiances with collocated MODIS' information about clouds, has been developed to retrieve the scattering aerosol optical depth above clouds. After a short description of the method, results for 2008 will be shown. In a second part, an estimate of the impact, in terms of both radiative forcing and cloud retrieved parameters biases, will be presented for a case study. Finally the impact of en error in the aerosol absorption will be discussed.

Penner, J.

(O) **Aerosol Effects in Cirrus Clouds**

Radiative forcing by anthropogenic aerosols in large-scale cirrus clouds has been estimated to be both positive and negative. Here we use an improved aerosol model together with a global climate model that ties the predicted cirrus cloud fraction to ice nucleation to estimate anthropogenic forcing in large-scale clouds. We explore how different assumptions for the effects of anthropogenic aerosols on ice formation alter the radiative forcing, depending on the deposition of sulfate to aerosols as well as the treatment of organic aerosols. We compare our results to observations and discuss measurements that would be useful to narrow the predicted range of forcing.

Pinnock, S.

(O, AEROSAT) **ESA and Aerosols**

A review of current ESA activities on aerosol remote sensing, including results of the first phase of the Climate Change Initiative - Aerosol project, the focus and objectives of the upcoming second 3-year phase, and the capabilities of ESA's current and planned earth observation satellites.

Pitkanen, M.

(P) **Estimate of the radiative effect of brown carbon using AERONET products**

The AErosol RObotic NETwork (AERONET) provides aerosol size distributions and complex refractive index at four wavelengths (440, 675, 870, and 1020 nm). This information is used in the method of Schuster et al. 2013 to retrieve the relative proportions of absorbing OC, BC, free iron and scattering host, separately for fine and coarse modes. We estimated the direct radiative effect of absorbing OC (Brown Carbon, BrC) by using the volume fractions of BrC retrieved by Schuster et al. 2013 for all available AERONET sites. The effect of BrC at TOA was estimated as the difference between net fluxes for all aerosols and non-BrC aerosols using the radiative transfer package libRadtran. The non-sphericity of mineral dust was taken into account using the spheroid model by Dubovik et al. (2006).

Povey, A.

(P) **Retrieval of aerosol and volcanic ash properties from Raman lidar with optimal estimation**

Optimal estimation retrieval is a form of non-linear regression which determines the most probable circumstances that produced a given observation, weighted against any prior knowledge of the system. The technique is applied to the estimation of aerosol extinction and backscatter from two-channel Raman lidar observations. It produces results from simulated and real data consistent with existing methods of analysis and additionally returns a more rigorous estimate of its uncertainties. Backscatter is retrieved at the minimum resolution considered with an uncertainty between 2% in ideal circumstances and 20% in the least. Extinction is less well constrained, retrieved at a resolution of 0.1-1 km depending on the quality of the data. Importantly, the retrieval automatically selects the appropriate resolution without the imposition of artificial constraints. The uncertainty in extinction is greater than 15%, in part due to the consideration of short one minute integrations, and is comparable to (or smaller than) fair estimates of the error resulting from the standard Raman lidar technique. The retrieval was then applied to several hours of observation on 19 April 2010 of ash

from the Eyjafjallajokull eruption. A highly depolarizing ash layer was observed with a lidar ratio of 20-30 sr, much lower than observed in the free troposphere by previous studies and potentially indicating a growth of the particles after 12-24 hours within the planetary boundary layer. More dispersed ash within a residual layer exhibited a backscatter of 10 Mm-1 sr-1 and lidar ratio of 40 sr.

Randles, C.

(P) **The impact of southern African biomass burning aerosols on temperature tendencies in the GEOS-5 Earth System Model**

In this study we use the NASA GEOS-5 Earth System Model (ESM) and Data Assimilation System (DAS) to examine the direct and semi-direct impacts of absorbing biomass burning aerosols over southern Africa. Biomass burning aerosols dominate aerosol loading over much of southern Africa from August through October. These aerosols both warm the atmosphere and cool the surface through the direct effect. They also have a thermodynamic effect on cloud cover through the semi-direct effect. Heating of the atmospheric column tends to increase the saturation water vapor pressure and reduce the ambient relative humidity (RH), effects that in turn tend to increase low-level stability and act to reduce cloud formation. Removal of reflective clouds tends to contribute to a radiative warming of the climate system. Over land, there is generally sparse cloud cover during this season. Despite a persistent stratocumulous cloud deck off the western coast of the continent, the transported biomass burning aerosol layer tends to be well-separated from the clouds below. Microphysical interactions between aerosols and clouds (aerosol indirect effects) are thus limited in this season and region. Here, the GEOS-5 DAS analysis update (AU) -- the difference between the meteorological analysis and the model forecast -- provides an observational constraint on our simulations. The AU represents the complex combination of all model errors due to inadequate representation of physical processes (model parameterizations), numerical errors, and processes that have been omitted from the model. By examining the AU for temperature we demonstrate that there is a clear correlation between the AU and AOD over southern Africa during the biomass burning season, indicating that the effects of aerosols are contributing to the model error for temperature. In a series of sensitivity studies in which we vary aerosol parameters (amount, absorption), we

examine the effect of aerosols on temperature tendencies and the AU. We show that, in combination with comparisons of aerosol properties to observations (e.g. from MODIS), analysis of these tendencies can be a useful metric for tuning aerosol properties to minimize the AU.

Righi, M.

(P) **The global impact of the transport sectors on atmospheric aerosol and climate**

We use the EMAC-MADE global aerosol model to quantify the impact of transport emissions (land-based transport, shipping, and aviation) on global aerosol for present-day (2000) and future (2030) scenarios under RCPs. We consider transport-induced changes in aerosol mass, number and size distributions and also estimate the resulting radiative forcings. Additional sets of model experiments are performed to further characterize: (i) the uncertainties deriving from the assumptions on the size distribution of transport-emitted particles; (ii) the non-linearity of the aerosol response to the transport-emission perturbations for different compounds; (iii) the changes in aerosol-induced climate forcings resulting from small changes in aerosol (and precursors) emissions.

Russchenberg, H.

(O, ACTRIS) **An observational framework for the study of cloud-aerosol interaction**

One of the least understood aspects of the climate system is the role of clouds. An increase of the aerosol concentration, by human activities for instance, may lead to a larger number of cloud particles and longer cloud lifetime; the resulting cloud reflects more solar radiation. Clouds may even be modified to cool the atmosphere and counteract greenhouse warming. Although the cloud-aerosol effects are conceptually understood, their quantification has proven to be very difficult as the effects are often cluttered by concurrent atmospheric processes and the technological means to unravel those do not exist yet. The need for unambiguous measurements of the indirect aerosol effects challenges the state-

of-the-art remote sensing technologies of today. Consequently, the quantitative impact of the indirect aerosol effects is still highly uncertain. The presentation will address the observational aspects of studying the effect, using examples of stations in the ACTRIS network.

Saini, R.

(P) **Particulate Matter and Ozone distributions in the urban environment of Agra during summer months**

The linked issues of ozone and particulate matter pollution have been important problem in the field of tropospheric chemistry for many years. Surface ozone concentrations along with NO2, SO2, CO and PM2.5 were measured in a kerbsite at Agra, during summer season of 2012. The obtained results display similar behaviour of SO2, NO2, CO, PM2.5 opposite from that of O3. The maximum hourly levels of these pollutants exceeded 116 ppb for O3, 96 ppb for NO2, 16 ppb for SO2, 4.6 ppm for CO and 203 μg/m3 for PM2.5. However the mean values for O3, NO2, SO2, CO and PM2.5 were 33.84ppb, 10.66 ppb, 4.84 ppb, 0.56 ppm and 55.76 μg/m3 respectively. There is a marked diurnal variation in the concentration of surface ozone which clearly follows the diurnal variation of surface temperature. The meteorological conditions and air masses have been studied using the HYSPLIT. In addition, we studied the daily variation of the temperature, relative humidity and wind speed associated with each air pollutant.

Samset, B.

(O) **Black Carbon radiative forcing – a comparison of AeroCom models with HIPPO and A-FORCE flight data**

AeroCom models exhibit a wide variability in predicted vertical profiles of black carbon (BC) loading. Combined with the fact that BC radiative forcing efficiency rises sharply with altitude, this diversity is thought to contribute significantly to the current intermodel spread in estimated anthropogenic BC forcing. Comparing AeroCom model predictions to measurement data, both in remote and emission regions, is therefore of high relevance. In this talk, we utilize a procedure for

estimating radiative forcing from concentration profiles, outlined e.g. in Samset et al., ACP, 2013, to compare AeroCom phase to BC radiative forcing to that measured by the HIPPO and A-FORCE flight campaigns. Data from all five HIPPO campaigns are included. We show and discuss the absolute values, vertical profiles and model variability of BC forcing over Japan, and through a series of pole-to-pole latitude bands in the remote Pacific Ocean. Flight data kindly contributed by S. Schwarz, N. Oshima and Y. Kondo.

Schulz, M

(O) **AeroCom summary and new activities**

Schuster, G.

(O) **Remote sensing of the relative concentrations of carbonaceous aerosols and dust**

We discuss methods to separate absorbing carbonaceous aerosols and dust in the AERONET database, including using the imaginary refractive index and the absorbing Angstrom exponent (AAE). Carbonaceous aerosols can be separated from dust in imaginary refractive index space because 95% of biomass burning aerosols have imaginary indices greater than 0.0042 at the 675--1020 nm wavelengths, and 95% of dust has imaginary refractive indices of less than 0.0042 at the 675--1020 nm wavelengths. Alternatively, about 25% of the AAE histogram for pure dust; overlaps with 75% of the biomass burning AAE histogram, and unique identification of carbonaceous and dust species through AAE analysis is not possible for data in the overlap region.

(P) **Comparison of Level 1.5 and Level 2.0 AERONET Absorption Products**

Schutgens, N.

(P) **A global view on aerosol micro- and macrophysical processes**

Although budgets for aerosol emission and deposition (macrophysical fluxes) have been studied before, much less is known about the budgets of e.g. nucleation, coagulation and condensation (microphysical fluxes). A better understanding of their relative importance would help understand aerosol model structural errors and imply simplifications for faster, leaner aerosol models that allow climate simulations with interactive aerosol at reduced cost. We present a complete budget of all aerosol processes in the aerosol-climate model ECHAM-HAM including the M7 microphysics. This model treats aerosol as 7 distinct but interacting two-moment modes of mixed species (soot, organic carbons, sulfate, sea salt and dust). We will show both global budgets as well as regional variations in dominant processes. Our results provide an objective way of complexity analysis in a global aerosol model and are currently used to reduce this complexity in ECHAM-HAM.

Schwarz, J

(O) **The full HIPPO black carbon aerosol vertical profile dataset compared to AeroCom Phase II**

We have completed a comparison of the full HIAPER Pole-to-Pole Observations (HIPPO) mission data set to AeroCom Phase II model fields. Over 700 vertical profiles of BC MMR obtained from 85N to 67S in five seasons and three years reveal climatological features of the BC distribution of particular significance for evaluating model performance. These include low variability in BC MMR in the lower stratosphere, and minima in tropical BC MMR near 200 hPa altitude pressure consistent with convective outflow. The comparison expands earlier results focused on only the first 1/5th of the data set, and more clearly and robustly identifies systematic model biases in the remote regions. Individual and ensemble model skill will be presented by both season and geographic location as a function of altitude. We anticipate and encourage discussion about the significance and implications of this work, as well as potential collaboration on a manuscript for publication.

Singh, P.

(P) **Composition of PM in low- mid- and high income households in Agra City**

The massive growth in socioeconomic status and the size of cities over the past few decades has led to serious deterioration in the indoor air quality. Accumulation mode particles are the important constituents of airborne pollutants which has major health hazard. The present study shows the current scenario of aggregate relation between income and pollution at household level. The indoor sampling of particulate matter was conducted in Low, Middle and High Income groups homes located in Agra, the north central region of India. The average indoor concentrations of PM2.5 and PM1.0 in low, middle and high income homes were (60.39 ± 44.44 μg/m3, 39.15 ± 36.85 μg/m3 and 26.52 ± 31.21 μg/m3) and (42.84 ± 32.47 μg/m3, 28.15 ± 27.79 μg/m3 and 21.84 ± 27.33 μg/m3). The full day variations of particulate matter concentrations with meteorological parameters were also monitored. Scanning electron microscopy coupled with energy dispersive spectrometer (SEM-EDS) was used to understand the differences.

Stevens, B.

(O) **New ideas for AeroCom experiments**

Stier, P.

(O) **Intercomparing data and models in AeroCom and beyond**

The large uncertainties in global aerosol models demand for the confrontation of the latest model with observations. AeroCom has facilitated this approach through harmonized model simulations, which have been extensively analysed and evaluated in more detail than any of the individual models. Nonetheless, the uncertainties remain persistently large (Myhre et al. 2013). We have made progress with e.g. radiative transfer (Randles et al., 2013) or host model parameterizations (Stier et al. 2013), yet we are a long way from understanding

the sources of uncertainty in global aerosol models.One of the main reasons is that models have only been confronted with a fraction of available observations because i) many measurements have not been harmonized and ii) the heterogeneity of data acts as barrier. In this presentation I will review some of the achievements made in AeroCom to introduce ways forward towards addressing some of the key bottlenecks in current data and model intercomparison.

Takemura, T.

(O) **Recent topics related with aerosol-climate models in Japan**

Another 10th anniversary AeroCom Workshop was held in Fukuoka, Japan after about a half year from the Great East Japan Earthquake in 2011. A field of modeling for atmospheric aerosols is still making an advance rapidly. Therefore some topics related with aerosol-climate models in Japan after the 10th AeroCom Workshop are introduced. For example, the new supercomputer K installed in Kobe, Japan has been operated since 2012, in which a global non-hydrostatic model, NICAM, coupled with an aerosol climate model, SPRINTARS, are being developed and used. One of the other topics is that almost public in Japan learned of a word PM2.5 this year because most Japanese news media have reported trans-boundary air pollution from the Asian continent. Access to websites of aerosol forecasting systems has greatly increased since then. Also, with regard to direct concern of public, inter-comparisons on transport and deposition of radioactive materials with multiple regional and global models are ongoing activities.

Timmreck, C.

(O) **A possible joint WCRP-SPARC SSiRC /AeroCom initiative on stratospheric sulfur**

The stratospheric aerosol layer plays an important role on the radiative and chemical balance of the atmosphere that needs to be better understood. Thus, the WCRP-SPARC Stratospheric Sulfur and It role in Climate (SSiRC) activity was created to address fundamental questions on how future climate changes may

affect the budget of sulfur in the stratosphere and how changes in the stratospheric aerosol burden may in turn influence the earth radiative forcing and global surface temperature. The purposes of SSiRC include: (i) providing a coordinating structure for the various individual activities already underway in different research centers; (ii) encouraging and supporting new instrumentation and measurements of sulfur containing compounds, such as COS, DMS, and non-volcanic SO2 in the UT/LS globally; and (iii) initiating new model/data inter-comparisons. We will present the recent implementation plan associated with SSiRC and how it can provide support to AeroCom activities.

(P) **The WCRP-SPARC Stratospheric Sulfur and It role in Climate (SSiRC) activity**

Tsigaridis, K.

(O) **An AeroCom intercomparison exercise on organic aerosol global modeling**

Comparisons of individual models with organic aerosol (OA) measurements have shown a large underestimation of the OA component by the models, especially during winter. The formulations used by individual models are very different, since OA simulations have many degrees of freedom due to the missing knowledge on the behavior and fate of both primary OA (POA) and secondary OA (SOA) in the troposphere. On top of that, several assumptions need to be made and are translated to model tuning parameters that vary greatly from one model to the other. Trying to bridge the gap between models and observations, several recent model developments account for SOA, intermediate volatility organics, multiphase chemistry, oceanic fluxes and semi-volatile POA. In addition to the different processes included in various models, the different emission inventories and meteorological fields adopted make a comparison with other models and measurements even more challenging. The organic aerosol inter-comparison AeroCom exercise aims to evaluate the actual status of global modeling of the OA occurrence in the global troposphere and analyze discrepancies between models as well as between models and observations. 31 global models participate in this exercise that aims to quantify the uncertainties and attribute them to major contributors. It also tries to identify and analyze potential model systematic

biases. The ensemble of the simulations is used to build an integrated and robust view of organic aerosol sources and sinks in the troposphere. The year 2006 was selected as the base year for the study. New results from the inter-comparison will be presented together with a compilation of the final dataset of field data that is being used for the evaluation of the models results. The similarities and differences between models will be highlighted, in an attempt to evaluate and understand the model-measurements comparison. Future directions beyond the present study will also be advertised.

Veira, A.

Voigt, A.

(O) **Easy Aerosols - a modeling framework to identify and study robust aerosol-induced circulation changes**

A number of recent studies highlighted the potential of aerosols to induce local as well as large-scale changes of the atmospheric circulation and precipitation. Easy Aerosols, a project organized within COOKIES & CREAM as well as the WCRP Grand Challenge on Clouds, Circulation, and Climate Sensitivity, aims to identify and study robust aerosol-radiation effects on the large-scale circulation. To this end, Easy Aerosols subjects climate models to the same aerosol perturbations, which will also offer a possibility to pinpoint sources of model uncertainties. Easy Aerosol uses idealized aerosol perturbations that are designed based on the aerosol climatology HACv1.0 by Kinne et al. (2013). To mimic the gravest mode of anthropogenic aerosols, the aerosol perturbation is centered in northern hemisphere mid-latitudes and follows a Gaussian bellcurve in meridional direction. In the zonal direction, the perturbation either is prescribed as zonally-symmetric or is concentrated in three regional plumes over South-East Asia, Europe and North America. The former allows us to study changes in the mean-meridional circulation, the latter to investigate aerosol-induced changes in planetary waves. To isolate how the response to an aerosol perturbation is mediated by other atmospheric quantities such as clouds and water vapor, sea-surface temperatures are held fixed. By doing so, Easy Aerosols also clarifies how much of the response from more complex model simulations can be explained in

terms of the response to the atmospheric heating and changes in the surface energy budget over land. The contribution presents the design of the idealized aerosol perturbations and initial results with the atmosphere general circulation models ECHAM6 and LMDz5. Both models consistently report a reduction of precipitation in northern hemisphere mid-latitudes and a northward shift of the tropical rainbelt. The contribution also includes a detailed description of the experimental protocol and its technical implementation. We hope to thereby encourage other groups to participate in Easy Aerosols.

Voulgarakis, A.

(P) **Regional aerosol emissions and their effects on precipitation**

Aerosol forcing is highly inhomogeneous and can therefore affect regional circulation and precipitation in a much more complicated way than the forcing of well-mixed greenhouse gases. However, such effects have not been examined thoroughly and systematically from a global point of view. Here, after outlining some key past work in this area, preliminary results from recent atmosphere-only simulations with the HadGEM3-UKCA global composition-climate model will be presented in which emissions of black carbon and sulphur dioxide in key regions have been scaled. An analysis of the linkages between emissions, concentrations, radiative forcing, and temperature and precipitation response will be discussed. A particular emphasis will be placed on non-local effects, i.e. how emissions over a certain region can affect other areas remotely.

Voyles, J.

(P) **Aerosol Measurements of the ARM Climate Research Facility**

The ARM Climate Research Facility provides ground based in-situ measurements of aerosol absorption, scattering, concentration and composition at fixed, mobile, and aerial facilities. Column measurements of aerosol optical depth, extinction, and scattering are available at select facilities. Over the past several years the aerosol measurements of ARM have been enhanced and we are adding additional capabilities during FY2014 and FY2015 at Oliktok Point, AK and the Azores.

This poster is an overview of current and future aerosol measurement capabilities of the ARM Climate Research Facility.

Wandlinger, U.

(O, ACTRIS) **Aerosol typing and microphysical properties from advanced lidar/radiometer observations**

Advanced multi-wavelength Raman polarization lidars as applied in EARLINET allow a comprehensive, vertically resolved characterization of aerosol optical and microphysical properties. Natural and man-made aerosols such as mineral dust, biomass-burning smoke, volcanic ash, anthropogenic pollution, or marine particles can be identified and their radiative properties can be quantified. Based on these sophisticated measurements, it is also possible to evaluate aerosol transport and forecast models with respect to specific aerosol components and sources, e.g., Saharan dust. Furthermore, within ACTRIS, the combined use of multi-wavelength lidars and AERONET sun photometers for an improved characterization of aerosol properties is investigated. We will review the state of the art of aerosol characterization with lidar and combined lidar/radiometer measurement techniques and discuss their potential for model evaluation based on illustrative examples of network observations over Europe.

Wang, J.

(P) **Constraints on aerosol sources using the GEOS-Chem adjoint and MODIS radiances, and evaluations with multi-sensor (OMI, MISR) data**
(presented by M.Chin)

We present a new top-down approach that spatially constrains the amount of aerosol emissions using satellite (MODIS) observed radiances with the adjoint of a chemistry transport model (GEOS-Chem). This paper aims to demonstrate the approach through applying it to April 2008. Compared to the prior simulation, the posterior simulation shows a much better agreement with the following independent measurements: aerosol optical depth (AOD) measured by AERONET sun-spectrophotometers and retrieved from (MISR), atmospheric NO2 and SO2

columnar amount retrieved from OMI (Ozone Monitoring Instrument), and in situ data of sulfate-nitrate-ammonium and PM10 (particular matter with aerodynamic diameter less than 10 μm) mass concentrations over both anthropogenic pollution and dust source regions. The results suggest that continuous efforts are needed toward a holistic and comprehensive inversion of emission using multi-sensor remote sensing data (of trace gases and aerosols) at various scales.

Wang, Z.

(P) **Radiative forcing and climate response due to the presence of black carbon in cloud droplets**

Optical properties of clouds containing black carbon (BC) particles in their water droplets are calculated by using the Maxwell Garnett mixing rule and Mie theory. The obtained cloud optical properties were then applied to an interactive system by coupling an aerosol model with a General Circulation Model. This system is used to investigate the radiative forcing and the equilibrium climate response due to BC in cloud droplets. The simulated global annual mean radiative forcing at the top of the atmosphere due to the BC in cloud droplets is found to be 0.086 Wm-2. The global annual mean surface temperature is shown to increase by +0.08 K. The local maximum changes are found to be as low as -1.5 K and as high as +0.6 K. Our results show that this effect could lead to an increase (a decrease) of vertical ascending motion and precipitation on the south (north) side of the equator, which could induce a southward shift in the tropical rainfall maximum related to the ITCZ.

Weigum, N.

(P) **Effect of sub-grid variability on aerosol processes**

Spatial scales of aerosol processes range from sub-micron lengths for nucleation events to several hundred kilometres for cloud interactions and dynamical transport. These scales are largely unresolvable in global climate models (GCM), with typical grid spacings from 100 to 400 km. In GCMs, spatial variations of aerosol parameters are averaged over grid cells so that the variability in the

distribution and microphysical evolution of aerosols may not be properly represented. In this study, we aim to explore the impact of this averaging on key aerosol microphysical properties. Using the chemistry version of the Weather Research and Forecasting Model (WRF-Chem), we isolate the impact of model resolution by simulating aerosol concentrations at varying resolutions while maintaining a constant resolution in meteorological fields. This novel technique enables us to determine which aerosol processes are most affected by sub-grid variability. This study focuses on the effect of varying the resolution of aerosol concentrations on aerosol optical thickness (AOT) and cloud condensation nuclei (CCN). Preliminary results show significant differences in both AOT and CCN between the high and low resolution simulations due to changes in aerosol water content and aerosol number concentrations, respectively. These results shed new light on the importance of specific aerosol processes and their representation in global climate models.

Wiedensohler, A.

Yu, F

(P) **Inclusion of an advanced particle microphysics (APM) in the NCAR Community Atmosphere Model version 5.3 (CAM5.3)**

The aerosol indirect radiative forcing (IRF) remains the single largest uncertainty in assessing the climatic impact of anthropogenic emissions. Most (if not all) of IPCC (2007) and post-IPCC2007 aerosol IRF studies are based on global models with simplified chemistry and aerosol microphysics. We have developed a sectional advanced particle microphysics (APM) model for 3-D applications and implemented a number of schemes/algorithms. The computationally efficient APM model has been implemented into GEOS-Chem and WRF-Chem. We have recently integrated the same APM into the Community Atmosphere Model (CAM) v5.3. Compared to CAM5.3-MAM3, the integration of APM increases the number of transported tracers from 20 to 114 but the computing cost only increases by ~ 110%. Aerosol properties simulated by CAM5.3-APM will be compared with

observations, simplified model approaches will be presented and implications will be discussed.

Zhang, H.

(P) **Application and evaluation of a two-moment cloud microphysics scheme in the global climate model BCC_AGCM2.0.1 coupled with aerosol model CUACE/Aero**

A two-moment cloud microphysical scheme that can predict both cloud liquid and ice numbers and mixing ratios is implemented into the GCM BCC_AGCM2.0.1 coupled with an aerosol model CUACE/Aero. Then, the simulated performance of the new model on aerosol, cloud properties as well as meteorological fields is evaluated in detail. The global burdens of sulfate, BC, OC, dust and sea-salt simulated by the new model with two-moment cloud scheme are 3.2, 0.17, 1.6, 43.0 and 14.1 mg m-2, respectively. The global annual mean of simulated AOD is 0.11 at 550 nm. These results are more consistent with the surface and satellite observations than those by the original model with one-moment cloud microphysical scheme. The simulated cloud droplet number concentration (effective radius) peaks at 20-70 cm-3 (6-10 μm) and 20-50 cm-3 (7-11 μm) over land and ocean, respectively. The results are comparable with corresponding aircraft observations and ground-based remote retrievals.