ABSTRACTS

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in alphabetical order by presenter

ORAL title
POSTER title

Aoki, Kazuma

Local and long-range transport of dust aerosols over the Japan by using sky radiometer

Dust aerosols play an important role in the earth climate change of the atmosphere. We are often influenced by natural aerosols over the Japan. Especially, it is observed long-range transport of dust aerosols in spring and autumn season, so called "Asian dust event". However, on May 20, 2019, the Himawari-8 (JMA) and GCOM-C (JAXA) satellite have an image of a different type of dust aerosols in eastern Hokkaido, Japan. In this time, numerous car accidents were reported these area, as strong winds swept over the local region, blowing huge amounts of local dust due to likely dried out the land surface by dry weather this season. We provide the information, in this presentation, on the aerosol optical properties of local and Asian dust events with respect to their optical properties of dust in Abashiri (44.02N, 144.28E) and Sapporo (43.08N, 141.34E), Hokkaido, Japan by using sky radiometer (POM-02: Prede Co. Ltd., Japan). We report the results of comparison between local and long-range transport of dust aerosols. Large aerosol optical thickness (AOT) at 0.5 µm with small Ångström exponent (Alpha) frequently occurs in both dust events. However, local dust event blown from dry land surface after the snow thaws were responsible for the spring increase in AOT and more decrease Alpha (< 0). Furthermore, the large particle peak was more large (> 5 µm) in local dust. This project is validation numerical models and satellite (e.g. GCOM-C/SGLI, JAXA).

Bian, Huisheng

Improve aerosol simulation over Amazon

Aerosols over the Amazon biome regulate regional weather, forest growth, and global climate interactively. Aerosols there have distinctive features with major aerosol types including secondary organic aerosols (SOA), Africa dust, and BC and OC from biomass burning. The former is formed by chemical oxidation of various volatile organic carbon (VOC) emitted by the world largest rain forest year -round. The latter ones exhibit a strong seasonal enhancement with trans-Atlantic transport of Africa dust favored during September-November and local intensive biomass burning during August-October. Simulations of all these Amazon aerosol types have been improved in the NASA GEOS GOCART model recently. Specifically, for SOA, instead of using a climatologic monthly terpene emission, we implemented MEGAN terrestrial ecosystem model to calculate time-varying VOCs to improve biogenic SOA calculation. A further SOA improvement was obtained by introducing atmospheric SOA formations from anthropogenic and biomass burning VOCs. The dust source algorithm of Kirk et al., (2014) was implemented and gave a better picture of trans-Atlantic transport of Africa dust compared with that of Ginoux et al., (2001). To overcome a significant underestimation of simulated aerosol during local biomass burning season, sensitivity experiments were conducted by turning biomass burning emission to match model-observation AOD over the Amazon at fires.

Bowdalo, Dene

GHOST: A framework for the harmonization of global surface atmospheric observations

For evaluation of their models, modelers rely on observational data. However, a large number of different observational networks exist, providing data in a plethora of formats and differing levels of detail. Owing to the complexities of combining data from multiple networks, modelers often use data from one or a couple of networks when evaluating their models. On the occasion that data from multiple networks is used, there is typically little to no detail given about the methodology used in combining data/metadata from the different networks, or regarding the quality assurance or station classifications employed to subset the data. Therefore evaluation efforts from different groups, which handle observations in differing manners, are often incomparable. GHOST (Globally Harmonized Observational Surface Treatment) is a project dedicated to the harmonization of global surface atmospheric observations and metadata, from all major public reporting networks, for the purpose of facilitating a greater quality of observational/model comparison in the atmospheric chemistry community. Each processed measurement is additionally associated with quality assurance/classification flags which pertain to a plethora of documented quality control checks/metadata groupings, providing users a way to subset data in a flexible and reproducible manner. In this way also, any subsets of observations used in model evaluation efforts can be traced directly back to a documented project, and cross-group evaluation efforts can be directly compared. Currently data for >150 measured gas/aerosol/meteorological components from the EBAS/EEA AQ e-Reporting/NCDC ISD networks has been processed under the GHOST framework (from 1970-present day). Efforts are currently ongoing to process data from AIRBASE/CAPMON/CASTNET/EANET/EPA AQS/NAPS/SEARCH/WMO GAW. In this contribution, key details of the processing efforts will be outlined, and some of the major advantages of such a major harmonization effort will be demonstrated.

Bruehl, Christoph

Radiative forcing by volcanic and mineral dust aerosol in the stratosphere, a transient simulation from 1990 to 2017 with the CCM EMAC using satellite data

The chemistry climate model EMAC with interactive modal aerosol scheme nudged to observed tropospheric meteorology (ERA-Interim) is used for a transient simulation from 1990 to 2017. The model considers SO_2 injections from about 500 explosive volcanic eruptions derived from limb satellite observations. The model contains a sophisticated desert dust scheme and indicates that a significant fraction of fine particles from Asian deserts can penetrate to the lower stratosphere via the Asian summer monsoon. This is supported by OSIRIS data indicating a seasonal cycle in Northern Hemispheric stratospheric optical depth and by IASI data showing a peak in dust optical depth over Taklamakan and western India in early summer every year. The strongest volcanic radiative forcing besides Pinatubo in 1991 is calculated for 2006, 2009, 2011 and 2015.

Burgos, Maria

Effect of water uptake on aerosol light scattering: comparison of a new in-situ benchmark dataset to six Global Climate Models

The uptake of water will change size and chemical composition of atmospheric aerosol particles, directly influencing their optical properties such as the particle light scattering coefficient. This phenomenum has consequences on the calculations of the Earth's radiative budget. Recently, we have developed a new benchmark dataset of particle light scattering enhancement, which consists of surface-based hygroscopicity measurements from various field campaigns and long-term monitoring activities carried out over the last 20 years at 26 sites around the globe. The present work is carried out within the framework of the in-situ project of the AeroCom Phase III experiment (task: evaluation of hygroscopicity of aerosol optical properties). We show a first assessment on how well six different Global Climate Models (GCM's) represent the aerosol water uptake. Modelled and measured scattering enhancement factors f(RH) (defined as the ratio between particle light scattering coefficient at a given relative humidity (RH), 85% for this study, and at dry conditions) are compared for 20 coincident sites, representative of a wide range of aerosol types. In a first step, three temporally collocated sites - representing Arctic, marine and rural conditions - were compared in more detail to the output of the six GCM's. A large diversity among the different models and distinct differences to the in-situ measurements were found with respect to magnitude and seasonal behavior. In a second step, and to allow for a greater spatial coverage, all 20 sites were compared for the same seasons and months but ignoring inter-annual variability as the measurement years and simulations years did not necessarily overlap. Our results show that all models generally tend to overestimate f(RH) for most sites. Relative differences between models and measurements vary from 25% to 75%, with the differences being larger for urban and rural sites and lower for desert and Arctic sites. We see significant variations in f(RH) depending on the definition of dry RH. Additionally, imperfect temporal and spatial collocation may contribute to the observed model/measurement differences.

Chin, Mian

Aerosols in the upper troposphere and lower stratosphere: A much needed multi-facet study, a powerful diagnostic for model processes, and a bridge to connect multiple research communities

This presentation is focused on the proposed AeroCom Phase III UTLS model experiment and its applications. We will present the simulations (2002-2018) with the NASA GEOS model and satellite data on the UTLS aerosol trends and inter-annual variability, and demonstrate the tools to diagnose the causes of the variability due to emission, convective transport, and removal processes. Furthermore, we will show the multi-model diversity in the UTLS region and argue the need to understand the diversity via the AeroCom model experiment. Finally, we will show the desire of coordinated analysis among AeroCom, CCMI, and ACAM communities.

Atmospheric Composition and Asian Monsoon: A coordinated modeling and analysis with ACAM, AeroCom, and CCMI communities

The Asian monsoon system is a major climate component on Earth. With rapid population and economic growth across the Asian monsoon region, it has become a serious concern that the monsoon system coupled with surface emissions is playing an increasingly significant role in affecting not only the regional air quality but also the global atmospheric composition. This project is to form a coordinated modeling and analysis effort among AeroCom, CCMI, and the ACAM communities to study the interactions between Asian air pollution and the Monsoon system and their effects on atmospheric composition. We will first introduce the IGAC/SPARC supported ACAM project, and then show results from the NASA GEOS model on aerosol composition at the surface and UTLS that are affected by the Asian monsoon activity. We will also demonstrate the multi-model diversity related to Asian monsoon circulations and convective transport from a subset of the AeroCom models. Finally, we will present our proposed AeroCom and CCMI activities, which involves (1) model evaluations with a suite of multi-platform observational data, (2) model analysis of pathways of trace gas and aerosols in the Asian UTLS region via transport by monsoon anticyclone, large scale transport, and atmospheric chemistry, and (3) assessment of interactions between Asian pollution and monsoon meteorology. For AeroCom, the analysis will use the model output from other relevant model experiments (e.g., HIST, ACRI, UTLS) and does not require additional model simulations.

Cho, Nayeong

A global perspective on detecting aerosol-cloud interaction signals

The presentation will examine the prevailing responses of clouds to aerosol variability at global scales. We will present results from an extensive satellite-focused analysis of potential responses of clouds and related quantities ("cloud affected quantities" – CAQs) like radiation (observed by CERES) and precipitation (observed by TRMM) to aerosol loading variations expressed in terms of aerosol optical depth (AOD).

Christensen, Matt

Following Clouds: Seeking Causal Relationships in Aerosol-Cloud Interactions

Anthropogenic aerosols are hypothesized to enhance Earth's planetary albedo through their ability to create more clouds with smaller droplets and less precipitation. However, aerosol-cloud interactions involve many feedbacks that can either enhance or decrease the climate response. In order to untangle the web of feedbacks we shift from the traditional approach of correlating daily static images of clouds to the aerosol field to quantifying time-resolved budgets of these quantities along Lagrangian trajectories. Thousands of Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT) model trajectories spanning several days along the classic stratus-to-stratocumulus transition zone are combined with multiple geostationary satellite instruments and polar orbiting satellites. We retrieve radiative flux and cloud retrievals from the Optimal Retrieval of Aerosol and Cloud (ORAC) product applied to the Spinning Enhanced Visible InfraRed Imager (SEVIRI) as well as observations from the temporally resolved Clouds and Earth's Radiant Energy System (CERES) SYN1deg1hr and aerosol and precipitation data from the A-Train constellation of satellites. Clouds forming in relatively polluted trajectories tend to have lighter precipitation rates, longer lifetimes, higher cloud albedo and cloud fraction compared to unpolluted trajectories. These responses are robust across three separate oceanic basins exhibiting diversity in meteorology and absorbing aerosol conditions. Furthermore, elevated aerosol levels are found to enhance cloud longevity and extend the stratus-to-stratocumulus transition zone. While liquid water path variations are found to be negligible on average the Twomey and lifetime effects are found to significantly contribute (42% and 55%, respectively) to the total change in planetary albedo.

Chubarova, Natalia

Aerosol-cloud interaction and its influence on solar irradiance and cloud transmittance according to the INMCM5 climate model

The influence of various parametrizations of aerosol-cloud-interaction on the global solar irradiance and cloud transmittance at the earth's surface was analyzed according to the Russian INMCM5 model (Volodin et al., 2017) with the aerosol module described in (Volodin and Kostrykin, 2016). Several 10-year numerical experiments were carried out with different parametrizations and without their application. We showed that the account for the aerosol-cloud interaction led to an increase in cloud amount by an average of 0.1 and a decrease in the global irradiance by 25 W/m2. In addition, we estimated the changes in global solar irradiance and cloud transmittance due to different emissions of aerosol precursors for 1980 and for 2005. Numerical experiments revealed that at lower emissions rates a decrease in cloud transmittance was observed. We discussed the probable causes of the observed effect

Colarco, Peter

Development of the NASA GEOS Chemical Transport Model (CTM) Capability for Evaluating and Deconvolving Aerosol Simulation Sensitivity to Meteorology and Core Aerosol Physics

The Aerosol Comparisons between Observations and Models (AeroCom) project was initiated nearly twenty years ago to cope with the massive diversity in outcomes of aerosol models used in climate research. Since then, a new revolution in operational medium-range and seasonal aerosol prediction modeling has occurred, and integration of aerosol data assimilation techniques into simulations has resulted in a number of aerosol reanalysis products. Owing to the availability of global aerosol optical depth (AOD) observations, AOD error statistics dominate model development. A variety of aerosol physics parameterizations are tuned to minimize AOD error statistics, including source and sink functions, optical properties, chemical transformation rates, and data assimilation configurations. Such tuning is constrained by the underlying model meteorology, whose biases may lead to contradictory aerosol physics. In this study we present preliminary work with a new chemical transport modeling

(CTM) tool we are using to understand the sensitivity of modeled aerosol lifecycle to diversity in the driving input meteorological data. The CTM capability is based on the NASA Goddard Earth Observing System (GEOS) model, which incorporates the Goddard Chemistry, Aerosol, Radiation, and Transport (GOCART) module for prognostic aerosols. We drive the GEOS CTM simulations with meteorology provided by different weather centers, here focused particularly on input meteorology the US Navy NAVGEM operational fields. Results of the GEOS CTM simulations driven by NAVGEM are compared to the same simulations driven with the GEOS-produced MERRA-2 reanalysis data, and some analyses are presented to illustrate preliminary results aimed as assessing where particular aerosol model sensitivities lie in these configurations. Future work incorporating additional weather center meteorology from the International Cooperative for Aerosol Prediction (ICAP) models, ensemble approaches, and use of alternative aerosol modules is discussed.

Dawson, Matthew

Chemistry Across Multiple Phases (CAMP): A novel flexible treatment for multiphase chemistry in atmospheric models

Advances in computational capacity have made possible the inclusion of complex chemical processes in regional and global atmospheric models. However, this complexity often leads to significant development efforts, particularly when new chemical processes span gas and condensed phases. In addition, compartmentalized treatments of gas- and aerosol-phase processes make the inclusion of chemistry involving mixed-phase reactions with similar rates difficult. We will present results from the development of the Chemistry Across Multiple Phases (CAMP) framework, which has been designed to achieve the three following goals: (1) to ease the porting of chemistry code to host models with different aerosol representations (bulk, modal, binned, etc.), (2) to permit the incorporation of multiphase chemistry without modification of model source code and (3) to allow multiphase chemistry to be solved as a single system. We apply an object-oriented approach to describing chemical systems that allows CAMP to extend a simple API that permits rapid deployment to new host models. Configuration of the chemical system, including gas- and aerosol-phase reactions, partitioning, and a description of the aerosol representation used by the host model, is done at runtime using a set of JSON input files. This allows users to include new multiphase processes in chemical mechanisms without modifying source code. The object-oriented approach also allows multiphase processes to be solved as a single system by treating the system as a collection of gas and aerosol phases that are implemented based on the specified aerosol representation. The CAMP framework is being developed as part of the PartMC library. Deployment to the NMMB-MONARCHv2.0 chemical weather prediction system will be discussed along with the porting of the framework to mixed CPU/GPU architectures.

Deaconu, Lucia

Constraining aerosol radiative forcing using aerosol absorption

Absorbing aerosols affect the climate system (radiative forcing, cloud formation, precipitation and more) by interacting with incoming shortwave radiation. The environmental impacts of an absorbing aerosol layer are influenced by its absorptivity, the albedo of the underlying surface, and also by the atmospheric residence time and column concentration of the aerosols. Black-carbon (BC), the collective term used for strongly absorbing, carbonaceous aerosols, emitted by incomplete combustion of fossil fuel, bio-fuel and biomass, is a significant contributor to atmospheric absorption and probably a main-driver in inter-model differences and large uncertainties in estimating the total aerosol radiative forcing. Best estimates of BC direct radiative forcing suggest a positive effect of +0.71 Wm-2 with large uncertainties [+0.08, +1.27] Wm-2. These uncertainties result from poor estimates of BC atmospheric burden (emissions and removal rates) and its radiative properties. The BC experiment aims to address the uncertainty in the direct radiative forcing of anthropogenic BC via a multi-model perturbed parameter ensemble (MMPPE). As a precursor to this experiment, we developed a PPE for the ECHAM-HAM climate model with three perturbed parameters and 39 simulations of the present-day and pre-industrial atmospheres that will simultaneously sample the uncertainty. The perturbed parameters are the mass flux of BC carbonaceous emissions, the removal of aerosol through in-cloud and below-cloud scavenging and the imaginary part of the refractive index (ni). We developed an emulator in order to fully explore the relationship between the perturbed parameter range and the model output and also applied an implausibility metric (Johnson et al, 2019, in prep.) to retain the plausible parameter combinations. Previous work done using a PPE with 26 climate model parameters, including processes and emissions related to aerosols and clouds emphasized the importance of including also aerosol absorptivity perturbations. Most of the parameters linked to aerosol absorption were inadequately constrained by the observations due to poor model representation of situations with high emission and low removal (and vice-versa) and aerosol optical properties. In our methodology we focus on constraining the aerosol direct radiative forcing using different observations. We use high-temporal resolution aerosol absorption optical depth (AAOD) measured with AERONET sun-photometers (for near-source columnar information of aerosol absorption) and airborne black-carbon in-situ measurements from the Global Aerosol Synthesis and Science Project (GASSP) (for optical properties of long-range transported aerosols). Measurements from the airborne campaigns CLARIFY and ORACLES that were employed over Southeast Atlantic are also considered in our study. This region is of main interest due to the large biomass-burning emissions from the African continent and long-range transport of these aerosols over the bright surface of stratocumulus clouds. By exploring the uncertainties in the dominant emission and removal processes, and in the key radiative property and comparing with a variety of observations we hope to better constrain the radiative forcing.

Descloitres, Jacques

A validation tool for satellite aerosol data sets

Comparing ground-based measurements to geophysical variables retrieved from satellite observations is the basis of most calibration and validation studies. This can be a complex task, because of the inherent complexity of the satellite data sets, and because one has to deal with instrumental characteristics, viewing geometry, spatial and temporal resolution and orbital patterns to co-locate data sets. Most studies define their own validation subset (temporal and spatial) and their own colocation scheme to produce match-up data sets. Publications often emphasize validation results while providing little documentation about the colocation process that often lacks traceability, which makes it hard to reproduce. In this context, the AERIS/ICARE Data and Services Center developed a tool to facilitate comparison of aerosol satellite products to ground-based data sets for calibration and validation studies. It supports several standard satellite data sets archived at the ICARE data center (e.g., MODIS, PARASOL, AATSR, MERIS, SEVIRI) and co-locates them with AERONET observations. ICARE ensures full traceability of all input data sets, which can also be accessed directly by any user once registered. Optimized data processing allows on-demand retrieval of co-located data sets over long time periods. Input data sets and optional sub-setting options (geographic area, time period, subset of ground stations, coastal filter, etc.) can be selected through a web-based interface. Colocation criteria (sampling distance to AERONET sites and sampling time window) are tunable. A major advantage of centralizing such a tool in one facility is to apply exactly the same colocation scheme to various data sets with adequate traceability. Also it saves significant data handling effort when repeating match-up retrievals for several input data sets and/or colocation parameters. Users can easily reproduce a given match-up retrieval. Finally, ICARE makes this tool available to algorithm developers who want to submit experimental data sets to the same validation bench as standard data sets.

DiBiagio, Claudia

Contribution of the laboratory experimental simulation activity within EUROCHAMP-2020/ACTRIS to the aerosol retrieval from satellite observations

no abstract

DiTomaso, Enza

Towards the production of a high-resolution regional dust reanalysis for Northern Africa, the Middle East and Europe

This contribution will describe work done within the DustClim project towards the production of a dust reanalysis over the domain of Northern Africa, the Middle East and Europe. DustClim is a project of the European Research Area for Climate Services (ERA4CS), and aims to produce a regional dust reanalysis at an unprecedented high spatial resolution using the state-of-art MONARCH model and its data assimilation capability. We will report here on the optimal configuration for the model and data assimilation scheme that has been identified for the reanalysis' production. Satellite observations with specific observational constraint for dust are considered for assimilation over land surfaces, including source regions. In particular, we will report on the settings for the representation of model and observation uncertainty, which are key factors in the estimation of the dust reanalysis. MONARCH ensemble has been generated by applying multi-parameters, multi-physics, multi-meteorological initial and boundary conditions perturbations. Solutions have been sought also in terms of length and resolution of the assimilation window, observation spatial influence, observation operator, and balanced observation uncertainty with the aim to have the most effective assimilation of satellite observations. We will show here simulation results over one of the yearly periods spanned by the reanalysis obtained by assimilating MODIS Deep Blue dust AOD. The evaluation of the simulation is performed through data assimilation internal diagnostics, and through the agreement with independent AERONET observations. Additionally, we will report on the technical solutions adopted in order to run computational-intensive high-resolution ensemble simulations and assimilation in a feasible way.

Doherty, Sarah

Observational constraints on aerosol forcing over the Southeast Atlantic

From approximately August through October a widespread plume of biomass smoke from agricultural fires in central and southern Africa covers much of the Southeast Atlantic. This smoke plume overlies and interacts with a persistent and also wide-spread stratocumulus and cumulus cloud deck. The direct radiative effect of aerosols contained in this plume is potentially large, but is highly uncertain in both sign and magnitude; the indirect effects very likely produce negative forcing, but also of very uncertainty magnitude. Leading sources of these uncertainties include the aerosol amount, aerosol single scatter albedo, the sub-plume albedo (determined largely by cloud fraction), and when and how often the smoke mixes down from the free troposphere into the marine boundary layer clouds. Recent observations as part of the NASA ORACLES campaign (2016-2018) provide new constraints on these and other properties. Aircraft observations in all three years of ORACLES included repeat measurements along "routine" flight tracks, with the intention of building sufficient statistics for robust comparison of measured smoke properties to those in models. We show the results of comparisons between these observations and several models along several comparison tracks; describe the ORACLES datasets available to test other models; and briefly overview how the ORACLES observations are being used to estimate the direct aerosol radiative effect over the SE Atlantic region. Two approaches are taken in the comparisons. Box-whisker plots of aerosol parameters are compared for three altitude bins: the cloud-topped marine boundary layer (MBL), the layer from cloud top to 3 km, and the 3-6 km layer. In addition, vertical profiles of aerosol properties are compared for data within 500m resolution altitude bins, and 2D cloud fraction and optical depths are compared. In general, the models under-estimate both aerosol concentrations, with extinction biased low by tens of percent, and underestimate the plume height. Single scatter albedo varies widely across the models, yielding both high and low biases when compared to observations.

Escribano, Jeronimo

Overview of the need and status of aerosol data assimilation and uncertainty estimates

This talk will describe the pivotal role that observation uncertainty has in the solution of the aerosol data assimilation problem. We will give an overview on the need and status of data assimilation and uncertainty estimates including the expertise and experience from the major centres taking part in the International Cooperative for Aerosol Prediction (ICAP) and providing global aerosol prediction operationally or quasi-operationally. We will focus in particular on the use that these centres make of uncertainties, and on whether they have experimented with physical-based estimates of uncertainties (pixel-level uncertainties), estimates based on data assimilation diagnostics or derived through other statistical models and assumptions (typically a constant or a linear function of aerosol optical depth).

Gharibzadeh, Maryam

Study of correlation between aerosol optical properties and ozone over Zanjan, Iran

Aerosol is one of important parameters in climate studies. It comprises a major source of uncertainty in climate models and in Earth's atmosphere studies. Aerosols have influenced radiative processes and climate change, whether directly, semi-directly or indirectly. Presence of aerosols in the atmosphere can also lead to climate change through influencing the behavior of some tropospheric trace gases, like ozone. Atmospheric aerosols can absorb or scatter solar radiation and cause a positive or negative radiative forcing. In addition they can reduce photolysis rate, while preventing the production of ozone. In fact, in the lower layers of the atmosphere aerosol may strongly influence the balance among atmospheric trace gases, including ozone. For example, coarse mode particles with large surface area such as dust can play an important role as a reactive surface with heterogeneous chemical reactions. In many researches, tropospheric ozone reduction due to increase in dust concentrations has been observed. In this study, in order to better understand the effects of aerosols on ozone, aerosol optical properties, role of various types of aerosols and particle size on ozone, have been studied over Zanjan, Iran. In this regard, correlation between aerosol optical properties like Aerosol Optical Depth (AOD) and tropospheric ozone, as well as the particulate matter (PM10) are carefully examined. The other data that are needed to study the optical properties of aerosols are Single Scattering Albedo (SSA), Aerosol Index (AI) and Fine Mode Fraction of AOD (FMF AOD).

Gliß, Jonas

First results from the ongoing AeroCom 2019 control experiment: Evaluation of modelled aerosol optical properties using ground and space based observations from AERONET, EBAS, MODIS and ENVISAT

Aerosol optical properties such as AOD, scattering and absorption coefficients or the Angstrom exponent are closely linked with the direct aerosol radiative forcing, which remains one of the largest uncertainties in current climate research. Modelling of these radiative properties is challenging since many of the associated processes cannot be resolved by the models and requires parameterizations (e.g. transport, humidity, hygroscopic growth, dry/wet deposition). Here, we are investigating modelled AODs (total, fine and coarse mode, AAOD) and Angstrom exponents (AE) as well as surface dry scattering and absorption coefficients from the ongoing AeroCom 2019 control experiment, on a global scale. Currently available models include GFDL-AM4 (3 runs), BCC-CUACE (1 run), OsloCTM3v1.01 (2 runs) and CAM5-ATRAS (2 runs). We use ground based observations from EBAS and AERONET and space based observations from MODIS and ENVISAT (AATSR) for the evaluation. The results are available at https://aerocom-evaluation.met.no. The new interface provides the possibility to interactively explore different statistical performance parameters (e.g. biases, correlation coefficients) as well as time series between different model / observation / variable combinations, including interactive overall performance matrix tables for different regions. First results indicate a spread of the model bias (MNMB) between -33% to +4% (AOD), -21% to +27% (fine mode AOD), -30 to -17% (coarse mode AOD), -

16% to -4% (AAOD) and -14% to +5% (AE) between the individual models, as compared with AERONET data (mostly over land). Among the different observation networks (i.e. AERONET and satellites), we find significant variations of the average model biases of up to 40% (AOD), 10% (fine AOD), 50% (coarse AOD), 45% (AAOD) and 56% (AE), whereas CAM5-ATRAS tends to show the largest diversities in the columnar variables when compared to different observation datasets. Surface scattering coefficients seem to be underestimated by about -70% to -50% (only 2 models available so far) compared with EBAS data. This contradicts the observed AOD results that agree better with the observations. Surface absorption coefficients seem to be slightly overestimated by about 10% in GFDL and OsloCTM3 (showing a large scatter between different stations) and underestimated in CAM5-ATRAS (-58%). We will discuss these results and elaborate reasons that may explain the observed diversity between the individual models but also between different observations. We will consider differences in spatial and temporal sampling, as well as model specific parameters such as emissions and lifetimes of individual aerosol species.

Ginoux, Paul

Analysis of the simulations associated to the AeroCom Anthro-Dust experiment

Agricultural practice has been the key factor of the infamous Dust Bowl of the 1930s (Lee and Gill, 2015), and through positive feedback may have amplified the drought in the Midwest (Cook et al., 2008). There are widespread evidence of wind erosion from anthropogenic emissions from cropland and pasture, but its contribution to global emission is highly uncertain. Model based estimations vary from negligible to 60% globally. Satellite based estimation is around 25% (Ginoux et al., 2012). But in this last study, the contribution to dust emission from agriculture is determined by distinguishing locations where landuse fraction of pasture and cropland greater than 30%, based on HYDE-2 database (Klein Goldwijk, 2001). Considering the potential impact of agricultural dust on air quality and climate and the current uncertainty in term of its emission, transport, deposition and forcing, an "Anthropogenic Dust Experiment" was proposed to the AeroCom community. The concept of this experiment is to simulate 3 years (2010-2012) of dust distributions using a common inventory of agricultural dust sources based on Ginoux et al. (2012), and by varying the threshold of wind erosion over land use, which is poorly constrained by data. The results of simulations by 4 different global models, which participated to the experiment, will be discussed.

Goncalves, Maria

Modelling dust mineralogy with MONARCH

Earth System Models usually represent dust as a globally homogeneous species, although observations evidence significant local and regional variability in its composition, and dust-climate interactions depend on the physicochemical properties of the minerals present. For instance, iron oxides efficiently absorb radiation in the short-wave, while clay minerals, quartz or carbonates increase absorption in the long-wave. Heterogeneous chemistry and the formation of coatings that happen during dust transport are also sensitive to dust composition. The presence of calcium-rich minerals increases hygroscopicity, enhancing cloud formation, and k-feldspars constitute efficient ice nuclei, thus affecting the indirect effect. Finally, dust constitutes a source of micro-nutrients in the form of bio-available iron, for some ocean ecosystem, altering the carbon cycle. This work presents the implementation of the atmospheric cycle of dust mineral species in the fully coupled chemical weather prediction model MONARCH, developed at the Barcelona Supercomputing Center. The emission and size distribution of the mineral species depend upon global atlases of soil composition and extensions to brittle fragmentation theory. A multi-year simulation at the global scale has been performed and the regional differences in the mineral species distribution analyzed. These developments will allow more detailed investigations of dust interaction with radiation, chemistry and clouds with the MONARCH model.

Grell, Georg

Development and Application of Global Aerosol Forecasts using NCEP's Online Coupled Model GEFS-Aerosol

FV3GFS, NCEP's Next Generation Global Prediction System, was coupled online with aerosol modules from the Goddard Chemistry Aerosol Radiation and Transport model (GOCART) as well as WRF-Chem's biomass burning plume rise model. This online modeling system will replace the current operational NEMS (NOAA Environmental Modeling System) GFS Aerosol Component (NGAC) at NCEP (planned in 2020). It will be placed as an ensemble member in the Global Ensemble Forecast System (GEFS), and is named GEFS-aerosols. At NOAA ESRL, real-time experimental aerosol forecasts are produced and evaluated at ~25km horizontal resolution globally from the surface to the top of atmosphere. We have tested two different global anthropogenic emission inventories from Community Emissions Data System (CEDS) and Hemispheric Transport of Air Pollution (HTAP) v2. During the fire season of 2019, we also apply different fire emissions and plume-rise configurations to investigate the fire event and the pollution transport of smoke plumes. Real-time forecast experiments are evaluated using satellite observations and AERONET data, as well as aircraft measurements from the Atmospheric Tomography Mission (ATom-1) field experiment. This talk will introduce the modeling system and show initial evaluation results.

Gryspeerdt, Edward

Decomposing the aerosol radiative forcing in atmospheric models

The aerosol radiative forcing is the most uncertain human forcer of the climate system, with much of this uncertainty coming from the aerosol impact on cloud properties. Previous studies have typically found larger radiative forcing in model based studies when compared to observational studies. Although the small temporal and spatial scales of clouds leads to difficulties simulating them and the aerosol impact, biases in the observations of clouds and aerosols can lead to uncertainties in the observational estimates, such that it is not clear these methods are more reliable. In this work, we demonstrate a method to decompose the aerosol radiative forcing in models that more closely replicates observations-based techniques. Displaying a close agreement to the accurate partial radiative perturbations method, the decomposition shows that observations and models estimate similar values for the Twomey effect (RFaci). Although Cloud adjustments remain a large source of uncertainty, by separating them, they are shown to be of a similar magnitude to the current observational uncertainty. We also demonstrate that the ratio of the forcing from cloud adjustments to the RFaci is independent of the aerosol perturbation, leading to improved methods for constraining the aerosol radiative forcing from aerosol cloud interactions.

Guevara, Marc

HERMESv3: a stand-alone multiscale atmospheric emission modelling framework

We present the High-Elective Resolution Modelling Emission System version 3 (HERMESv3), an open source, parallel and stand-alone multiscale atmospheric emission modelling framework that computes gaseous and aerosol emissions for use in atmospheric chemistry models. HERMESv3 is coded in Python and consists of a global regional module (HERMESv3_GR) and a bottom-up module (HERMESv3_BU), which can be combined or executed separately. The HERMESv3_GR module is a customizable emission processing system that combines existing gridded inventories with user-defined vertical, temporal and speciation profiles for the generation of global and regional air quality model-ready emission files. The selection and combination of emission inventories and databases is done through detailed configuration files providing the user with a widely applicable framework for designing, choosing and adjusting the emission modelling experiment. On the other hand, the HERMESv3_BU module is an emission model that estimates anthropogenic emissions at the source (e.g. road link, industrial facility, crop type) and hourly level combining state-of-the-art estimation methods with local activity and emission factors along with meteorological data. The model covers the estimation of bottom-up emissions from point sources, road transport, residential and commercial combustion, other mobile sources and agricultural activities, and it also provides several functionalities for automatically manipulating and performing spatial operations on georeferenced objects. HERMESv3 can estimate emissions on several user-defined grids, mapped to multiple chemical mechanisms and adapted to the input requirements of different atmospheric chemistry models (i.e. CMAQ, WRF-Chem and MONARCH) as well as a street-level dispersion model (i.e. R-LINE). We conceive HERMESv3 as a flexible multiscale modelling framework that allows integrating and combining different emissions estimation approaches, so that the emission related outputs can be as detailed and specific as possible for the different domains (global, regional or local) involved in the corresponding application (i.e. air quality research and forecasting and environmental management).

Hoepfner, Michael

Aircraft- and space-borne infrared remote sensing observations of ammonia (NH3) and solid ammonium nitrate aerosols in the upper troposphere during Asian monsoons

Strong convection within the Asian monsoon system quickly transports polluted air masses from the boundary layer into the upper troposphere where secondary aerosol formation can take place. Here we present remote sensing observations by limb sounding systems providing vertical and horizontal distributions of ammonia and ammonium nitrate aerosol particles. Beside the identification of trace-gases, characteristic signatures in the mid-infrared spectral region are used to infer information about composition and phase of the aerosol particles. We will show an analysis of ammonium nitrate aerosols and NH3 in the Asian monsoon upper troposphere from a combination of two satellite limb sounders, CRISTA on SPAS in August 1997 and MIPAS on Envisat, from 2002-2011. In addition, limb-imaging measurements obtained with the GLORIA instrument on board the Geophysica high-altitude aircraft during the Asian monsoon field campaign of the StratoClim project in summer 2017 provided the opportunity to obtain vertical profiles of aerosol mass and trace gases from similar spectral information as the satellite observations - but with strongly improved vertical and horizontal resolution. We performed experiments at the AIDA cloud and aerosol chamber laboratory of the Karlsruhe Institute of Technology to support the analysis of the aerosol infrared spectral signature as well as to investigate the conditions leading to the unexpected solid phase of ammonium nitrate particles. Further, we analyzed the airborne dataset with the help of trajectory calculations combined with temporally and locally connected satellite data of nadir-pointing instruments, like IASI, to infer the underlying composition in the lower troposphere, as well as geostationary satellites to deduce the presence of convective influence.

Hsu, Christina

New “Deep Blue” aerosol products from LEO and GEO satellites

The impacts of natural and anthropogenic sources of air pollution on climate and human health have continued to gain attention from the scientific community. In order to facilitate these effects, high quality consistent long-term global aerosol data records from satellites are essential. Several EOS-era instruments (e.g., SeaWiFS, MODIS, and MISR) are able to provide such information with a high degree of fidelity. However, with the aging MODIS sensors and the launch of the VIIRS instrument on Suomi NPP in late 2011, the continuation of long-term aerosol data records suitable for climate studies from MODIS to VIIRS is needed urgently. In addition, with the advent of the geostationary satellite sensors on Himarai-8 and GOES16/17 in the last few years, high temporal resolution satellite measurements now become available to shed light on the diurnal cycles of aerosols. To answer the need for construction of the coherent long-term aerosol dataset derived from the LEO sensors in conjunction with the high temporal resolution GEO sensors, we have successfully ported our MODIS Deep Blue algorithm to process data from VIIRS (for LEO) as well as AHI and ABI (for GEO) sensors. Extensive works were performed in refining the surface reflectance determination scheme to account for the wavelength differences between MODIS, VIIRS and AHI/ABI. Better aerosol models (including non-spherical dust) are also now implemented in our VIIRS as well as AHI/ABI algorithms compared to the MODIS C6 algorithm. We will compare the distributions of retrieved AOD over land and ocean between MODIS, VIIRS and AHI/ABI. The preliminary validation results of these new LEO and GEO Deep Blue aerosol products using data from AERONET sunphotometers over land and ocean will be discussed.

Julsrud, Ingeborg

Analysis of historical variations in surface solar radiation, cloud cover and aerosol emissions

Solar radiation travels through all of the atmosphere's layers and constituents before reaching the surface, and therefore a world of questions are raised when we observe trends in the surface solar radiation (SSR). What part of the radiation's journey has caused the trend? Since variations in SSR have effects on a variety of atmospheric processes, it is crucial that we understand what can cause these variations - especially to improve climate models. A negative trend in global SSR was observed from the 1950s to the 1980s (global dimming), and a positive trend has been observed since the 80s (global brightening). However, climate models are not able to reproduce these results. Studies have concluded that the dimming and brightening are caused by trends in aerosol emissions. I am examining this assumption by performing statistical analyses on station observations of SSR, cloud cover data, and historical aerosol emission estimates. This is the initial part of my master project, which seeks to examine the role of cloud cover changes in global dimming/brightening in observations and climate models.

Kahn, Ralph

AeroSAT perspective on collaborations with modeling

Most In the past few years, AeroSat has initiated a number of experiments, similar to the AeroCom experiments. Several of these are specifically relevant to model-measurement collaboration. We will review the goals of the AeroSat part of this year's meeting, with emphasis on those aspects that are likely of greatest interest to the AeroCom modelers.

Kalashnikova, Olga

Analysis of L3 MISR V23 aerosol products over the ocean, and comparison with MODIS

Level 3 (L3) aerosol products are often used in a variety of regional and global studies, and gridded products from various satellites are often intercompared and evaluated on daily, monthly, and seasonal scales without taking into account sampling and Level 2 (L2) data coverage. Such L3 comparison approaches can result in apparent biases that are not present in L2 validation studies that rely on more direct and careful comparisons. As an example, we take the new MISR Version 23 (V23) L3 aerosol products. Various algorithmic changes were made relative to the Version 22 (V22) aerosol product and these were assessed through careful L2 comparisons. One consequence of the V23 changes is a significant reduction in the aerosol optical depth (AOD) over the global oceans due to corrections for instrument veiling light and the introduction of a term to account for the effect of chlorophyll, especially in the red and near infrared MISR bands. Subsequent validation of the MISR L2 products shows a significant improvement in the retrieved AOD relative to Maritime Aerosol Network (MAN) and AERONET coastal sites. However, the effects of these changes in the MISR L3 products have not been fully assessed. Here we evaluate the performance of new MISR V23 L3 products over global oceans by comparing AOD and aerosol particle property information between V22 and V23 on daily, monthly, seasonal, and annual scales, and inter-compare these results with the L3 MODIS products, both with and without subsampling to the MISR coverage. The results are interpreted relative to the L2 validation and analysis recently performed by the MISR team.

Khan, Aman Waheed

Real-time forecasting of air pollution using WRF-Chem model over New Delhi

Metro cities of India (e.g. New Delhi, Mumbai, etc.) have become one of the most polluted cities in the world, with air pollution affecting the health of millions living in these mega cities. Atmospheric aerosols have a large influence on air quality and, also in the well-being of human and ecosystem. Very few studies are available in which chemical observations available from space borne sensors are used in the numerical model, and these studies are very rare over India. The Weather Research and Forecasting (WRF) model with chemistry (WRF-Chem) model has wide applications in various fields like regional air quality monitoring, emissions from mega-cities, heat wave prediction, aerosol direct effect on air quality, and many others. Aerosol optical depth product is retrieved from the Indian National Satellite (INSAT-3D/3DR) at every 15 minutes and MODIS AQUA at ~09 UTC daily over Indian region. Ground based chemical observations (like carbon monoxide, nitrogen dioxide, ozone, sulphur dioxide and particulate matter, PM2.5 and PM10 are available in real time with frequency of few minutes, from various locations over India under the National Air Quality Monitoring Programme (NAMP) by Central Pollution Control Board (CPCB). We assimilated these chemical observations (satellite and in-situ) in near real-time in the WRF-Chem model to improve the forecast accuracy for regional air pollution during winter time. The model predictions are discussed and evaluated over New Delhi.

Kim, Dongchul

Assessment of dust source contribution to the global land and ocean regions

Dust is known to interfere with incoming or outgoing radiative flux and dust is also known as an effective ice nucleus for cirrus cloud formation. The source of global dust is well established as most of them are originated from a few major source regions of North Africa, Middle East, and Asia which accounting for more than 80% of global dust emission. However, it is more difficult to attribute the source contribution when they are mixed during the inter-continental long-range transport. This work will present a preliminary result of the source-receptor relationships including trans-Pacific and trans-Atlantic transported dust with the NASA GEOS model. A series of runs with 8 tagged regions were made to estimate the contribution of East- and West-Africa, Central- and East-Asia, and the Southern Hemisphere. A few major hot spots of the Bodele, Middle East, and Taklimakan Deserts are further masked. We propose an experiment to investigate the source-receptor relationships over land where affected by both local and transported dust; and remote- and ocean-regions where only contributed by long-range transport, including Arctic, Antarctic, Tibetan Plateau, Mid-Pacific, Mid-Atlantic, and Upper Troposphere. We will also analyze the change of simulated dust sizes (PM2.5, PM10, and size distribution) in different receptor regions.

Kim, Paul

AeroCom Trajectory Experiment (GCMTraj): Progress and Initial Results

The AeroCom Trajectory Experiment (GCMTraj) aims to perform a multi-model evaluation against reanalysis meteorological fields combined with ground-based observations of aerosol properties in a trajectory-based Lagrangian framework. Linking GCM or reanalysis derived trajectories to GCM aerosol properties and measurement station observations respectively facilitates a highly transparent means for evaluating the discrepancies between models and observations as a function of aerosol source/sink pathways during transport to a measurement station. To streamline the computationally intensive nature of this analysis, a 6 month ‘development’ simulation is initially completed in order to set out the post-processing frameworks and submission requirements for participants before starting longer ‘core’ simulations. In this presentation I will discuss the results from the development stage of the experiment and outline the principal techniques for investigation which will be applied in the core stage. Air mass footprint and potential source contribution analysis of aerosol number concentrations at the Zeppelin measurement station in Ny-Ãlesund, Svalbard was successfully carried out as well as Eulerian size distribution comparisons to observations. An important result of the development experiment is the validation of the trajectory calculations and nudging schemes for all participating models by performing air mass footprint analyses. A source contribution analysis shows that background source location and magnitude vary significantly between models, despite agreement in sources local and strength and specific, high-concentration events. We demonstrate that all models underestimate the number concentration of larger particles (250-630nm) whereas there are large inter-model variations in the representation of smaller particles (10-20nm) when compared with observations. These short 6 month development simulations are useful indicators of GCM biases, however, future analysis of the ‘core’ simulations are required for statistically robust evaluation. In the core experiment, due to start September 2019, 10 year simulations (with finalized configurations based on the development experiment) will be used to perform a comprehensive study into aerosol life cycle processes during transport. The results from this experiment will be used to answer key questions regarding the effect of model representations and parameterizations of aerosol source and sink processes on aerosol concentration and how these, in combination with transport, affect simulated aerosol burdens. These techniques will be applied to a global set of measurement stations to provide metrics for evaluating simulated aerosol life cycle and transport processes against observations and reanalysis across different environments. These metrics will be used to provide a better understanding of aerosol processes and subsequently facilitate rigorous Lagrangian constraints for the improvement of the representation of these processes in GCMs. In order to better understand the causes of these differences, further analysis of aerosol life cycle processes during transport, such as removal via precipitation, must be undertaken.

Kinne, Stefan

Aerosol radiative effects over time with IPCC6 aerosol emissions

Based on anthropogenic emissions for IPCC6 (by S.Smith) and their application in transient simulations for fine-mode aerosol optical properties (by G.Myhre) an new scaling procedure to current aerosol optical properties of the MACv2 aerosol climatology have been applied to estimate aerosol radiative effects during the anthropocene (from 1750 to 2100). An updated scaling now considers not only changes to anthropogenic (fine-mode) AOD but also to (fine-mode) aerosol composition.

MPI-M/NASA collaborations to provide aerosol properties of oceans

For more than a decade a sub-group of the land-based AERONET network (lead by A. Smirnov) provides calibrated sun-photometer instruments for the sampling of aerosol (and water vapor) column properties over oceans. For ca 50 voyages of (mainly German) research vessels, the MPI-M has either staffed these voyages or distributed instruments to participating staff of other institutes or the DWD, to sample in a labor-intensive handheld mode at times when the sun is not obstructed by clouds data on aerosol amount, typical aerosol size and atmospheric water vapor content. As all sampled data were almost immediately transferred into the MAN data-base and quality controlled data are quickly available for their use, such as comparisons in order to evaluate assumption in (retrieval and global) modeling.

Kipling, Zak

Introducing IFS-CB05-BASCOE-GLOMAP (ICBG): a coupled tropospheric and stratospheric aerosol and chemistry option for the ECMWF IFS

As part of the Copernicus Atmosphere Monitoring Service (CAMS), operated by ECMWF on behalf of the European Commission, the Integrated Forecasting System (IFS) is run with a tropospheric chemistry scheme and a hybrid bin/bulk aerosol scheme, to produce both operational forecasts and reanalysis of atmospheric composition. The meteorological host model is the same as that used at ECMWF for operational weather forecasting, albeit at a lower resolution. As part of the further development within CAMS, the model has been extended with the possibility to include stratospheric chemistry via a coupling of the BASCOE scheme with the existing CB05 tropospheric chemistry at the tropopause (in place of the linear Cariolle scheme normally used for stratospheric ozone). Continuing work started some time ago under MACC, the GLOMAP-mode aerosol scheme (version 8.3) has also been integrated into the main code as an option, including support for stratospheric aerosol. This has made possible a merged configuration where the combined CB05-BASCOE chemistry is coupled with the GLOMAP-mode aerosol to represent both aerosols and chemistry, including their interactions, throughout both the troposphere and stratosphere. The system, labelled IFS-CB05-BASCOE-GLOMAP (ICBG) is still evolving, but is already able to represent the stratospheric sulphate burden quite well for example. We present here an overview of this combined system, which allows for online stratosphere–troposphere composition simulations drawing on the solid base of the IFS and CAMS with the additional schemes which have been well tested elsewhere. We will show evaluation results demonstrating the system's performance both in volcanically quiescent conditions and in the context of the Calbuco and Pinatubo eruptions, and setting them in the context of other models and observations. In particular, for Calbuco the combined ICBG gives a clear improvement in AOD compared both standalone IFS-GLOMAP (without chemistry) and the operational CAMS configuration using bulk aerosol and tropospheric-only chemistry.

Kirkevag, Alf

How do clear-sky vs. all-sky assumptions affect aerosol hygroscopic swelling, optical properties and subsequent effective radiative forcing estimates in NorESM2?

Model estimates of water uptake by aerosols and subsequent effects on aerosol optical properties and radiative effects depend on ambient relative humidity (RH) as well as model assumptions about aerosol hygroscopicity, size and state of mixing. Light scattering and absorption by aerosols also depend on whether the calculations are performed for all-sky or clear-sky conditions with respect to cloud cover, and what modeled relative humidity is tacitly assumed to be representative for the atmospheric conditions in which the observations (used for validation) have been made. Most, but not all AeroCom models calculate clear-sky values for aerosol optics, in the sense that the RH from the cloud-free fraction of each grid cell (RHcf) is used when calculating hygroscopic swelling. NorESM1 and NorESM1.2 compute all-sky optical properties using the grid cell average RH (RHga), while the corresponding clear-sky properties are represented by a cloud-free fraction-weighted average of the all-sky properties. Test simulations with an early version of NorESM2 indicate that the choice of method for calculation of optical properties can give rise to big differences, up to 20% for aerosol optical depth at 550 nm, globally averaged. We here present results from a set of NorESM2 AMIP type experiments for present-day (PD) and pre-industrial (PI) aerosol conditions, inter-comparing all-sky and clear-sky PD optics based on the two different assumptions on hygroscopic growth (RHcf vs. RHga) as well as comparing with satellite and ground-based remote observations. Subsequent effects on anthropogenic (PD – PI) effective radiative forcing (ERF) are also addressed.

Klose, Martina

Soil mineral dust: Natural and anthropogenic aerosol

Anthropogenic changes in land use due to, for example, cultivation and grazing, can enhance the emission of soil mineral dust, the most abundant aerosol in mass originating from land sources, and thereby affect weather and climate. The contribution of anthropogenic sources to global soil dust emission is still uncertain due to (1) deficits in the representation of small-scale anthropogenic dust sources (agricultural lands), (2) a lack of data available to constrain the global dust load, and (3) deficits in the model representation of parameters and processes affecting dust emission. Here we examine the effect of land-use (cropland, pasture, and rangeland), vegetation cover, and dust emission parameterization on the global anthropogenic emission fraction and its uncertainty. We conduct global model simulations using MONARCH, the Multiscale Online Nonhydrostatic AtmospheRe CHemistry model. We thoroughly evaluate and constrain the model results based on measurements of dust concentration, deposition, and optical depth to obtain a model best estimate and to quantify the global natural and anthropogenic emission and deposition. Our preliminary results demonstrate that anthropogenic sources contribute to the global dust loading and that soil mineral dust cannot be considered only a pure natural aerosol. When assigning cropland and pasture to anthropogenic dust sources, the global anthropogenic emission fraction is about 10%, i.e. on the lower edge of existing estimates, with little seasonal variability. When including rangeland in addition, the anthropogenic contribution to the global dust cycle increases to about 40% and shows much stronger seasonal and spatial variability. We will further refine our estimate of natural and anthropogenic dust emissions in the future, by (a) conducting higher-resolution global model runs, (b) implementing a representation of moist convective dust storms, and (c) expanding the use of observational constraints to calibrate and evaluate modeled dust loadings.

Kok, Jasper

Climate models miss most of the warming coarse dust in the atmosphere

The atmospheric loading of desert dust dominates the total loading of atmospheric aerosols. This dust loading has changed substantially over both the observational and geological records, making it critical to determine the net direct radiative effect of desert dust on the climate system. This direct radiative effect is set by the balance between cooling fine dust (diameter D ≤ 5 um) and warming coarse dust (D ≥ 5 um). However, measurements consistently show that current models substantially underestimate the prevalence of coarse dust. Here, we estimate the global atmospheric loading of coarse dust using a framework that leverages available measurements of atmospheric dust size distributions. We find that the atmosphere contains 16 (9 – 29) Tg of coarse dust and thus that approximately half of atmospheric dust is coarse. In contrast, current atmospheric models account for only 4 (2 – 12) Tg and thus omit most of the coarse dust. Accounting for this missing coarse dust adds a warming effect of 0.15 (0.10 – 0.26) W/m2 and increases the likelihood that dust net warms the climate system. This could challenge current interpretations of the climatic effect of past and future increases in dust loading.

Kühn, Thomas

The volatility basis set in ECHAM-HAM-SALSA

The influence of secondary organic aerosol (SOA) on climate is still poorly constrained, thus SOA contributes a large amount of uncertainty to current climate projections. To improve our understanding of the role of SOA in the atmosphere, further measurement campaigns and modelling studies will be necessary. Here we introduce a volatility basis set (VBS) SOA scheme to the aerosol-climate model ECHAM-HAM-SALSA, which models the oxidation of volatile organic compounds (VOC) to form SOA precursor gases and their successive partitioning into the aerosol phase. Both biogenic and anthropogenic VOC sources are considered. We evaluate our model results against a wide range of observational data, including ground-based and airborne mass spectrometry data and find generally good agreement between model and observations. Also the modelled AOD agrees better with satellite retrievals in regions where large amounts of organics are emitted. We further performed several sensitivity studies with the model to investigate how SOA volatility affects SOA burden and CCN concentrations. Interestingly, decreasing the SOA volatility leads to a larger SOA burden, but does not necessarily increase CCN concentrations.

Lee, Huikyo

Satellite observations of ammonia and aerosol optical properties during the 2015 Southeast Asian haze

Wildfire-induced smoke aerosols can significantly influence air quality and climate at a regional scale. However, there remains large uncertainty in the optical properties and transport of primary and secondary aerosols in smoke plumes. Here, we examine observations of gaseous ammonia, aerosols, and motion of smoke plumes from the three satellite-based instruments during the catastrophic wildfire over Indonesia in 2015 and analyze potential impacts of the wildfire-induced ammonia on optical properties of aerosols. For the first time, the current study utilizes both aerosols and cloud motion vectors from the Multiangle Imaging Spectrometer (MISR) instrument and investigates the ammonia impact in the downwind zone of smoke plumes. Due to its lifetime shorter than a day, high concentrations of ammonia are observed only near burned areas. When ammonia emissions peaked in late October 2015, the aerosol optical depth around downwind of smoke plumes increased along with higher than average single scattering albedo. The lagged response of aerosols and their optical properties are explained by our trajectory modeling constrained by satellite observations.

Lee, Jaehwa

Aerosol plume height climatology derived from synergistic use of UV-VIS sensors

The Aerosol Single-scattering albedo and Height Estimation (ASHE) algorithm applied to satellite sensors making measurements in ultraviolet-visible (UV-VIS) wavelength range provides the height of UV-absorbing aerosols, such as biomass burning smoke and mineral dust, over much broader areas than ground-based or spaceborne lidar measurements. A combined use of the Visible Infrared Imaging Radiometer Suite (VIIRS) and the Ozone Mapping and Profiler Suite (OMPS) aboard the same platforms (S-NPP or NOAA-20) can fulfill the requirement for ASHE retrievals, with a constraint on aerosol height over certain portion of the plume of interest by the Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP). With an increased length of data record of ASHE, this study presents a statistical analysis of the aerosol plume height over various source regions as well as where influenced by long-range transport. We will discuss the characteristics of the height of smoke plumes over various source regions, relationship between smoke aerosols and surface particulate matter (PM) as a function of the height, and spatiotemporal patterns of Saharan dust layer height during transport.

Lipponen, Antti

Information content analysis: Combination of satellite and ground-based observations enables more accurate aerosol SSA retrievals at low aerosol loadings

Aerosol single scattering albedo (SSA) is a crucial parameter for climate studies. Currently typical aerosol SSA retrieval algorithms use either ground-based or satellite data, and ground-based retrievals are considered more reliable. The SSA retrievals are, however, shown to be highly uncertain especially in cases of low aerosol loadings. In AERONET, SSA is considered to be of the best quality class only for AODs larger than 0.4 (at 440 nm). At most AERONET stations AOD is typically lower than this threshold value and therefore, regardless of the vast AERONET network, accurate global information about aerosol absorption through AERONET observations is usually not available. We use statistical information content analysis and radiative transfer simulations to study if different types of observations actually contain enough information to accurately retrieve the SSA under low aerosol loadings. We study three different cases: bottom-of-atmosphere (BOA) AERONET retrievals, top-of-atmosphere (TOA) MODIS retrievals, and retrievals with collocated BOA and TOA data. Results show that current retrieval algorithms could do better in SSA retrievals and by further developing the retrieval algorithms accurate SSA information would be available also in cases of low aerosol loadings. The preliminary results indicate that even though the TOA observations do not have much information content of SSA there may be significant benefits in combining TOA and BOA observations in the retrievals. If BOA and TOA observations are combined, SSA could be retrieved with an accuracy similar to current AERONET level 2.0 even in cases with AOD as low as 0.2. The statistical information content approach we have taken is a general and useful tool for retrieval algorithm developers to assess theoretical limits of retrieval accuracy set by the information content of the observation data.

Liu, Xiaohong

Aerosol indirect effects by glaciating mixed-phase clouds

Mixed-phase clouds are frequently observed in high latitudes and midlatitude storm tracks, and have important impacts on the surface energy budget, precipitation and regional climate. Aerosol can modify the microphysical properties of mixed-phase clouds by acting as ice nucleating particles (INPs), thereby changing the cloud phase (liquid versus ice), and cloud radiative forcing. In this study, we investigated two types of aerosols: mineral dust and marine organic aerosol (MOA), their roles as INPs and impacts on mixed-phase clouds. Global distributions of INPs concentrations from dust and MOA are calculated based on different ice nucleation parameterizations implemented in the Community Atmosphere Model version 6 (CAM6), and are also compared with the observations. Through glaciating low-level mixed-phase clouds, we find that dust INPs induce a global mean net cloud radiative effect of +0.06 to +0.25 W/m2 with the predominant warming appearing in the NH midlatitudes. However, a cooling effect is found in the Arctic due to reduced longwave cloud forcing. INP concentrations of sea spray aerosol vary with time and geographic location with the maximum contribution within the boundary layer over the Southern Ocean, where dust has a limited influence. The INP effects of MOA are further quantified. Similar framework can be applied to other AeroCom models to quantify aerosol indirect effects on mixed-phase clouds.

Liu, Yawen

Seasonal difference of the long-term trend of aerosols over the Eastern U.S.

With the implementation of Clean Air Act Amendments, aerosol concentrations and aerosol optical depth (AOD) have decreased significantly over the eastern U.S. Previous studies indicate a stronger decline trend of AOD in summer than in winter, and mainly contribute this to higher sulfate production rates in summer. Here we performed a comprehensive analysis of different aerosol properties including surface concentrations, AOD as well as radiation to provide an overall picture of the aerosol response to emission reductions. We found the seasonal difference is enhanced when comparing the long-term trend of AOD to that of sulfate concentrations, indicating the influence of other factors. Further analysis show that changes of organic aerosols and relative humidity also play a role in shaping the seasonality of AOD trend. Evaluations of CMIP6 historical simulations show a general underestimation of the magnitudes of the seasonal difference of the long-term trend of AOD and clear-sky radiative flux.

Lufarelli, Marta

Towards a consistent retrieval of cloud/aerosol single scattering properties and surface reflectance

The CISAR (Combined Inversion of Surface and AeRosols) algorithm is exploited in the framework of the ESA-SEOM CIRCAS (ConsIstent Retrieval of Cloud Aerosol Surface) project, aiming at providing a set of atmospheric (cloud and aerosol) and surface reflectance products derived from S3A/SLSTR observations using the same radiative transfer physics and assumptions. CISAR is an advance algorithm developed by Rayference originally designed for the retrieval of aerosol single scattering properties and surface reflectance from both geostationary and polar orbiting satellite observations. It is based on the inversion with a fast radiative transfer model (FASTRE). The retrieval mechanism allows a continuous variation of the aerosol single scattering properties in the solution space. The latter is defined by three aerosol vertices with different single scattering properties. In order to extend the retrieval with CISAR to clouds, cloud vertices (water and ice clouds) are also considered. The aerosol (cloud) properties are retrieved as a combination of the aerosol (cloud) vertices. Traditionally, different approaches are exploited to retrieve the different Earth system components, which could lead to inconsistent data sets. The simultaneous retrieval of different atmospheric and surface variables over any type of surface (including bright surfaces and water bodies) with the same forward model and inversion scheme ensures the consistency among the retrieved Earth system components. Additionally, pixels located in the transition zone between pure clouds and pure aerosols are often discarded from both cloud and aerosol algorithms. This "twilight zone" can cover up to 30% of the globe. A consistent retrieval of both cloud and aerosol single scattering properties with the same algorithm could help filling this gap. The CIRCAS project ultimately aims at overcoming the need of an external cloud mask, letting the CISAR algorithm discriminate between aerosol and cloud properties. This would also help reducing the overestimation of aerosol optical thickness in cloud contaminated pixels. The surface reflectance product is delivered both for cloud-free and cloudy observations. First results on SLSTR data will be presented and evaluated against independent datasets.

Ma, Xiaoyan

Aerosol microphysical properties and their impact on radiation: simulations of GEOS-Chem-APM

Aerosol particles increase dramatically over industrial regions during past few decades, which probably influence the radiation and energy budget given their complex micro-physical properties, such as chemical composition, mixing state, and size distributions. For example, sulfate, nitrate and sea salt are mostly scattering particles while black carbon and mineral dust have more strong absorption. Physical and chemical properties of aerosol particles could change significantly depending on the processes, and thus influence the radiation and energy budget. In this study, we explore the impact of these properties on radiation at top of atmosphere (TOA) and surface, by employing a global chemical transport model (GEOS-Chem) coupled with a size-resolved aerosol module (APM), i.e. GEOS-Chem-APM. The detailed quantitative analysis and discussion will be presented.

Malavelle, Florent

Update on the Volcanic ACI experiment (VolcACI)

Recent works (e.g. Yuan et al, 2011, Malavelle et al, 2017) have shown the utility of large effusive volcanic eruptions such as the 2008 & 2018 eruptions at Kilauea (Hawaii, USA) and the 2014-15 eruption at Holuhraun (Iceland), in constraining the representation of aerosol-cloud-interactions in climate models. During the Holuhraun eruption for instance, a reduction in the size of liquid cloud droplets was found but impacts on cloud liquid water path were muted, suggesting potentially weaker ERF then that predicted by many climate models. The VolcACI is designed to utilize these rare opportunities to quantify aerosol-cloud interactions and model errors (details available at https://wiki.met.no/aerocom/phase3-experiments#volcanic_aci_experiment_volcaci). The VolcACI experiment is currently ongoing and aiming to extend the number of participating models to 10+ GCMs running in configurations as close as possible to those used in the CMIP6. Here, we will present early analysis from a limited set of multi-model simulations that has already been submitted to the experiment. We will first focus on discussing how the prescribed SO2 emissions from the Holuhraun and Kilauea eruptions form sulphate aerosols in the atmosphere and assess commonalities (and differences) in each model in terms of aerosol distributions, horizontal and vertical transport or CCN budget. We will then quantify the impacts of the volcanic plumes on cloud properties, precipitation and energy balance. Attention will be paid to separating the effects of the volcanic plumes from natural variability. The difference between nudged simulations with and without volcanic emissions (i.e. the 'aerosol impact') will be evaluated against the difference between nudged simulations with volcanic emissions compared to the long-term mean (i.e. the 'aerosol impact' + the 'meteorological impact') which can directly be compared to long-term satellite observations. Finally, we will identify aerosol-influenced clouds through tracking the plume using gas and aerosol-based thresholds. Gas-based thresholds e.g. column SO2, are readily available in both cloud-free and cloudy conditions utilising UV sensors such as the OMPS satellite sensor. Initial tests show an SO2 threshold clearly demonstrates potential in comparing observations and models and may serve some purpose as traditional aerosol thresholds based on AOD suffers from the mutual exclusivity of aerosol and cloud retrievals.

McCoy, Daniel

A new technique to constrain aerosol-cloud adjustments using idealized modelling experiments

Aerosol-cloud interactions represent the leading uncertainty in our ability to infer climate sensitivity from the observational record. The radiative forcing from changes in cloud albedo driven by increases in cloud droplet number (Nd) (the first indirect effect) is confidently negative and has narrowed its probable range in the last decade, but the sign and strength of the radiative forcing associated with changes in cloud macrophysics in response to aerosol (adjustments) remains highly uncertain. Here, we propose a new technique to infer aerosol-cloud adjustment strength from observations. Application of this technique to HadGEM3-GC3.1 GCM data reproduces the true model adjustment strength. Comparison to observations shows that HadGEM3-GC3.1 overestimates adjustments by a third, but agree in predicting a negative forcing due to aerosol-cloud adjustments. Uncertainty in the radiative forcing due to aerosol-cloud adjustments reflects our inability to accurately quantify the variability not associated with a causal link flowing from the cloud micro-physical state to cloud macro-physical state and thus our ability to constrain models using observed cloud behavior. Covariance between the liquid water path averaged across cloudy and clear regions (LWP, here, characterizing the macro-physical state) and Nd (characterizing the microphysical) is contributed to by two causal pathways linking Nd to LWP: Nd altering LWP (adjustments) and precipitation scavenging aerosol and thus depleting Nd. Only the former term is relevant to constraining adjustments, but disentangling these terms from one another and from covariance induced by external factors in the observational record is challenging. Here we propose a new technique to extract covariance between cloud microphysical and macro-physical properties that is induced by adjustments from other sources of covariance utilizing idealized global climate model (GCM) simulations.

McCoy, Isabel

Hemispheric contrasts in satellite-derived cloud microphysical properties constrain aerosol forcing

The change in planetary albedo due to aerosol-cloud interactions (aci) during the industrial era is the leading source of uncertainty in inferring Earth's climate sensitivity to increased greenhouse gases (GHGs) from the historical record. The variable of state governing aci is cloud droplet concentration (Nd). Global climate models (GCMs) show that the hemispheric contrast in Nd of liquid clouds between the pristine Southern Ocean (SO) and the polluted Northern Hemisphere (NH) observed in the present can be used as a proxy for the increase from the pre-industrial (PI) to the present-day (PD) Nd. We show that to be consistent with the satellite-observed hemispheric contrast in remotely sensed Nd, the change in global mean Nd between the PI and PD predicted by a perturbed parameter ensemble within a state-of-the-art GCM is between 6 to 29 cm-3 (5-24% of observed global-mean Nd), and the radiative forcing due to the first aerosol-cloud indirect effect (RFaci) is between -1.70 to -0.40 Wm-2 with 95% confidence. The hemispheric difference constraint and observations from the MODIS instrument suggest that PI Nd may have been higher than previously thought. This constraint depends in part on the pristine SO, which is considered a proxy for the PI atmosphere as a whole. Further examination of observed liquid clouds in the SO shows that Nd increases towards Antarctica poleward of the storm track as precipitation scavenging of aerosol decreases, revealing Nd comparable to the polluted outflows of East Asia and the United States. Nd near Antarctica is strongly seasonal, consistent with enhanced summertime biological activity in the marginal-ice zone. This high Nd in one of the most pristine regions in the world may be key in understanding the processes that lead to consistently high Nd across the SH as a whole, in both the PD and PI, motivating further investigation of the mechanisms driving Nd in the real world and better inclusion of the mechanisms in models.

Mei, Linlu

A new aerosol optical thickness research product over Cryosphere

In this talk, the eXtensible Bremen Aerosol/cloud and surface Retrieval algorithm (XBAER) has been applied to derive Aerosol Optical Thickness (AOT) over Cryosphere using both Advanced Along-Track Scanning Radiometer (AATSR) and the Sea and Land Surface Temperature Radiometer (SLSTR) instruments. The algorithm utilizes the differences of anisotropic properties of aerosol and snow surface at thermal channels. The coarse-mode dominated (dust and sea salt) AOT research product is then derived over the Arctic. A full sensitivity study to understand the impact of aerosol typing, surface parameterization, snow emissivity, and potential cloud contamination are detailed discussed. The XBAER derived above-snow-AOT for full AATSR mission is then compared with Aerosol Robotic Network (AERONET) sites over Greenland and promising agreement is obtained. The monthly mean AOTs over Greenland show consistent patterns between XBAER derived above-snow-AOT and Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) aerosol product, the Mineral Aerosols Profiling from Infrared Radiances (MAPIR) derived Infrared Atmospheric Sounding Interferometer (IASI) AOT research product and Modern-Era Retrospective analysis for Research and Applications, Version 2 (MERRA-2) simulations. Two aerosol events over snow have been well-captured by the new research product derived from both AATSR and SLSTR instruments.

Mielonen, Tero

Are Biogenic Aerosols Climatically Significant in the Boreal Region?

The magnitude of aerosol radiative effects remains the single largest uncertainty in current estimates of anthropogenic radiative forcing. One of the key quantities needed for accurate estimates of anthropogenic radiative forcing is an accurate estimate of the radiative effects from natural aerosol. The dominant source of natural aerosols over Earth’s forested regions is biogenic volatile organic compounds (BVOC) which, following oxidation in the atmosphere, can participate in new particle formation or condense onto aerosols to form secondary organic aerosol (SOA) which in turn can modify cloud properties. Consequently, BVOC emissions could introduce a regionally relevant cooling feedback in a warming climate. The main objective of this study is to provide a quantitative estimate of the regional radiative effect caused by the temperature-dependent biogenic emissions over the boreal forests in present day conditions and in a warmer future. The study is done using a combination of climate modeling and satellite data. The aerosol-chemistry climate model used is ECHAM-HAMMOZ, which describes the relevant atmospheric aerosol processes. The BVOC emissions are computed online using the MEGAN model, which enables the simulation of the effects of temperature changes on atmospheric aerosol load. Key remote sensing data used are the MODIS based aerosol optical depth (AOD) and cloud effective radius (CER) and 2-meter air temperature from the MERRA-2 reanalysis. Our analysis shows that there is a small temperature dependence in AOD over the boreal forests but it appears to be caused by both biogenic and biomass burning aerosols. CER also exhibits temperature dependent behavior but the dependence is region specific and appears to be governed by meteorology. In a warmer future the clear-sky radiative forcing caused by biogenic aerosols will increase, following the increase of BVOC emissions, but if anthropogenic emissions will decrease at the same time the total clear-sky forcing will also decrease.

Mortier, Augustin

Are the AeroCom phase III models reproducing the observed trends in aerosols over the last two decades?

This study aims to investigate the most robust aerosol trends over the last two decades, using both columnar optical properties (AOD, AE, ...) and surface concentrations (PM10, PM2.5, SO4) as well as dry aerosol scattering coefficient measurements. The different parameters are aggregated over predefined regions. The trends are then computed in each of these regions, when the coverage is sufficient, in order to provide a global picture of regional aerosol trends and their differences from ca 1996 to up to 2018. By using both models and observations, we also inspect consistence between them and the relevance of the observation networks for the evaluation of trends. Finally, we propose an assessment of the ability of the models, taking part of the historical experiment of the AeroCom phase III and in CMIP6, in reproducing the observed trends over the last two decades. The underlying data are also accessible and visualized in a highly new interactive way via a constantly updated website (https://aerocom-trends.met.no). The work shall be transformed into a joint AeroCom model intercomparison publication in autumn 2019.

Muelmenstaedt, Johannes

Base state vs susceptibility: which is more important for ERFaci?

In an attempt to formulate an observational constraint on the LWP rapid adjustment component of the ERFaci, we vary a number of parameters in the autoconversion parameterization in ECHAM-HAM to achieve agreement between process observables in the model and in a satellite climatology. Surprisingly (or perhaps not), the parameters that affect the precipitation base state control the ERF more strongly than the process susceptibility, suggesting that we need to divide our attention more evenly between improving the base state and estimating susceptibilities like Spop. If August and September are productive months for the MMPPE team, we will put these ECHAM-HAM results into context using other models.

Myhre, Gunnar

AeroCom historical experiment

An overview of the submissions for the AeroCom historical experiment for the time period 1750 to 2014 will be provided together with a status for other AeroCom groups. Description will be given for the change in spatial and temporal aerosol composition and aerosol optical depth among the AeroCom models. Where available the time evolution of the radiative forcing of aerosol-radiation interaction will be presented.

Onsum Moseid, Kristine

Using global dimming to disentangle the aerosol forcing history

The Earth's surface energy balance is heavily affected by incoming solar radiation and how it propagates through our atmosphere. Selected observation stations show a remarkable decline in surface solar radiation between 1950 and 1980, followed by an increase in surface solar radiation the following two decades. This is known as global dimming and brightening, respectively. Anthropogenic aerosol emissions increased during the dimming period, and decreased during the brightening period, making the anti-correlation to surface solar radiation apparent. Climate models in CMIP5 do not exhibit the decrease and following increase in surface solar radiation when given the assumed to be correct aerosol emissions in historical simulations. The investigation of what causes modern models to misinterpret the effects of aerosol emissions will have the possibility to constrain aerosol forcing estimates. Such a constraint will make projections of a future climate more certain and credible. This PhD project seeks to understand the aerosol forcing history by investigating global dimming and brightening using observations and state of the art climate models.

North, Peter

New Products of Global Atmospheric Aerosol for Sentinel-3

We present new products of global atmospheric aerosol from the Copernicus Sentinel-3 mission intended to provide climate-quality long term datasets, and for assimilation in meteorological, atmospheric transport and air quality models. The parameters retrieved include aerosol optical depth (AOD), fine mode fraction, dust AOD, Angstrom exponent and retrieval uncertainty. A single-instrument product makes use of the SLSTR dual view over land, and full swath retrieval over ocean. In addition, a non-time critical (NTC) product makes synergistic use of the two optical sensors, OLCI and SLSTR to provide potential for greater coverage and retrieval stability. The method for global aerosol retrieval using SLSTR is based on algorithms developed under ESA Aerosol Climate Change Initiative (CCI), to develop and evaluate retrieval of aerosol properties and their uncertainties. This has led to generation of the first 17 year dataset from global aerosol retrieval from ERS-2 and ENVISAT (1995-2012), and evaluated using the global AERONET sun photometer network. Validation of the (A)ATSR record shows high correlation (R=0.8-0.9) of optical depth when compared against global AERONET measurements, and low bias. A version of the (A)ATSR record has been accepted under the Observations for Model Intercomparisons Project (OBS4MIPS) to provide datasets suitable for climate model intercomparison, and both (A)ATSR and SLSTR datasets provide a contribution to the Copernicus Climate Change Service (C3S). First results of testing new products on Sentinel-3 against AERONET and inter comparison with MODIS, along with analysis of product uncertainty will be presented.

Pan, Xiaohua

Biomass Burning Emission Injection Height Experiment (BBEIH)

The environmental impact of smoke aerosols depends not only on the emitted mass, but also on the injection height. This is especially true for large boreal forest fires that often emit smoke above planetary boundary layer (PBL) into the free troposphere and even the lower stratosphere. However, most atmospheric chemistry transport models (CTMs) assume that fire emissions are dispersed only within PBL, or use simple plume-rise parameterizations. In order to test the sensitivity of model results to biomass burning smoke injection height, we introduced into the NASA GEOS model biomass burning injection heights based on MISR stereo-derived plume-height retrievals (Val Martin et al., 2010; 2018). In comparison with the BASE run (emissions injected within PBL), we address the following scientific questions, e.g.: 1) To what extent are model simulations sensitive to the assumed biomass burning injection height? 2) In which regions/seasons/surface-types are the aforementioned sensitivities most important? We will focus on near-source characteristics and downwind plume evolution of vertical aerosol distribution, near-surface aerosol concentration, aerosol optical depth, and more generally BB-related aerosol transport time in the atmosphere. With the results from this preliminary study using a single model, we encourage other models in AeroCom community join in this experiment, which is described with implementation methods and input data in https://wiki.met.no/aerocom/phase3-experiments#biomass_burning_emission_injection_height_experiment_bbeih.

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

Aerosols from biomass burning (BB) emissions are poorly constrained in global and regional models, resulting in a high level of uncertainty in understanding their impacts. In this study, we compared six BB aerosol emission datasets for 2008 globally as well as in 14 sub-regions. The six BB emission datasets are: (1) GFED3.1 (Global Fire Emissions Database version 3.1); (2) GFED4s (Global Fire Emissions Database version 4 with small fires); (3) FINN1.5 (Fire INventory from NCAR version 1.5); (4) GFAS1.2 (Global Fire Assimilation System version 1.2); (5) FEER1.0 (Fire Energetics and Emissions Research version 1.0), and (6) QFED2.4 (Quick Fire Emissions Dataset version 2.4). Although biomass burning emissions of aerosols from these six BB emission datasets showed similar spatial distributions, their global total emission amounts differed by a factor of 3-4, ranging from 13.76 to 51.93 Tg for organic carbon and from 1.65 to 5.54 Tg for black carbon. In most regions, QFED2.4 and FEER1.0, which are based on the satellite observations of fire radiative power (FRP) and utilize the aerosol optical depth (AOD) from the Moderate Resolution Imaging Spectroradiometer (MODIS), yielded higher BB emissions than the rest by a factor of 2-4. In comparison, the BB emission from GFED4s and GFED3.1, which are based on satellite retrieval of burned area and no AOD constraints, were at the low end of the range. In order to examine the sensitivity of model simulated AOD to the different BB emission datasets, we ingested these six BB emission datasets separately into the same global model, the NASA Goddard Earth Observing System (GEOS) model, and compared the simulated AOD with observed AOD from the AErosol RObotic NETwork (AERONET) and MODIS in 14 sub-regions during 2008. In Southern hemisphere Africa (SHAF) and South America (SHSA), where aerosols tend to be clearly dominated by smoke in September, the simulated AOD were underestimated in all experiments. More specifically, the model-simulated AOD based on FEER1.0 and QFED2.4 were the closest to the corresponding AERONET data, being about 73% and 100% of the AERONET observed AOD at Alta-Floresta in SHSA, 49% and 46%

at Mongu in SHAF, respectively. The simulated AOD based on the other four BB emission datasets accounted for only ~ 50% of the AERONET AOD at Alta Floresta and ~ 20% of at Mongu. Overall, during the biomass burning peak seasons, at most of the selected AERONET sites in each region, the AOD simulated with QFED2.4 were the highest and closest to AERONET and MODIS observations, followed closely by FEER1.0. The differences between these six BB emission datasets are attributable to the approaches and input data used to derive BB emissions, such as whether AOD from satellite observations is used as a constraint, whether the approaches to parameterize the fire activities are based on burned area, FRP, or active fire count, and which set of emission factors is chosen.

Peng, Yiran

Key processes responsible for uncertainties in aerosol simulation with two aerosol modules in the Community Atmosphere Model version 5.3

Simulations of aerosol and aerosol effects on climate with Global Climate Models (GCMs) still have large uncertainties. In this study, two aerosol modules, the Piecewise log-normal approximation Aerosol Module (PAM) and 7-mode version of Modal Aerosol Module (MAM7) are run in the Community Atmosphere Model version 5.3 (CAM5.3). By unifying the atmospheric driving fields and aerosol emission datasets, differences in the simulated aerosol mass, number and size can be clearly attributed to distinct parameterizations of chemical and physical aerosol processes. In CAM5.3, these two modules produce comparable aerosol mass amounts. However, there are noticeable differences in simulated aerosol number concentrations, especially for tiny particles (with radius in the range of 10 to 100 nm). To explore these differences, we conducted a series of 12 sensitivity experiments by separately turning off individual aerosol processes in each module. Our analysis shows that in-cloud scavenging of aerosol by large-scale and convective clouds, and gravitational dry deposition are major sink processes for total aerosol mass in both modules. However, the major process responsible for the number of tiny particles and the mass concentrations of sub-micron particles in PAM is coagulation, but in MAM7 is condensation. The different treatment of coagulation and condensation is the key reason for discrepancy in the simulated aerosol number concentration of the two modules. This study identifies the important sources of uncertainty, especially uncertainties in particle number and size. This may have implications for aerosol simulations with other GCMs.

Perez, Carlos

Perspectives on modeling dust mineralogical composition and its effects upon climate

Soil dust aerosols are mixtures of different minerals, whose relative abundances, particle size distribution (PSD), shape, surface topography and mixing state influence their effect upon climate. At present, Earth System models represent poorly the local/regional variations in dust mineral composition mainly because 1) our knowledge of the global soil-surface mineralogical composition is limited due to a lack of observations, and 2) there is an incomplete understanding of the emitted dust PSD in terms of its constituent minerals that results from the fragmentation of soil aggregates during wind erosion.

The first challenge is being tackled by the NASA-funded Earth Surface Mineral Dust Source Investigation (EMIT), which will mount a hyperspectral sensor to the exterior of the International Space Station to determine the mineral composition of natural sources that produce dust aerosols around the world. The second challenge is being tackled by FRAGMENT, a European Research Council Consolidator Grant started in October 2018 whose main goals are to 1) understand the emitted dust PSD and mineralogy and its relationship with the parent soil, 2) anticipate new methods to efficiently use in models the wealth of surface mineralogical information that will be provided by EMIT in the near future, and 3) contribute to understand the role of mineralogy on climate through modeling. During my presentation, I will overview the state-of-the art on the subject and describe the on-going and future activities in both projects.

Popp, Thomas

Propagating sophisticated FCDR uncertainties for AVHRR to Aerosol Optical Depth CDRs

AVHRR AOD is inverted from measured reflectances in the red band using a statistical correlation of surface reflectance with mid-infrared channel reflectances and a modelling climatology of aerosol type. For such a sensor not designed for AOD retrieval propagating uncertainties is crucial. This is particularly important, since the sensitivity of the retrieved AOD to the measured signal varies largely with retrieval conditions (AOD itself, surface brightness, aerosol optical properties / aerosol type, observing geometry). In the H2020 Project FIDUCEO a thorough analysis of the retrieval operator and its sensitivities to the used input and auxiliary variables was made to quantify the different contributions to the AOD uncertainties. Uncertainties are propagated from measured reflectances to geophysical retrieved AOD datasets at (super-) pixel level and further to gridded daily and monthly products. In the propagation, uncertainty correlations of separate uncertainty contributions from the FIDUCEO easyFCDR level1b products (common fully correlated, independent random and structured parts) and estimated uncertainty correlation structures of other major effects in the retrieval (surface brightness, aerosol type ensemble, cloud mask) are taken into account. We will show the propagation of uncertainties through the processing steps with concrete example AOD retrieval results over Europe.

Povey, Adam

A new perspective on satellite data

In the aerosol-cloud community, most researchers use satellite data that has been averaged onto a regular spatio-temporal grid (known as Level 3 data) as it is easy to manipulate and understand while more closely resembling typical model outputs. The limitations of such data have been discussed extensively at previous AEROCOM meetings: linear averaging of log-normally distributed quantities, biases from spatio-temporal sampling, and the masking of regional effects. This talk outlines an alternative approach that avoids many of these issues by using statistics to describe the distribution of the observed data. Five satellite datasets of aerosol optical depth are compared to an Earth System Model using these new statistics. In many areas of the world, the data is best represented by a bi- or tri-modal distribution. By reporting the properties of each mode rather than an overall mean, a more physically motivated comparison can be made between different methods and scales. For example, the positive bias of ORAC retrievals relative to Dark Target can be explained by different flagging of high AOD events, with the two datasets otherwise exhibiting similar behavior. Bulk statistics can be recovered from the new parameters, while being less cumbersome than providing users with a full histogram.

Aerosol and cloud products from SLSTR with ORAC

As part of the Copernicus Climate Change Service (C3S), the Optimal Retrieval for Aerosol and Cloud (ORAC) produces an aerosol optical depth product from observations of the Sea and Land Surface Temperature Radiometer (SLSTR), continuing the heritage of our ATSR-2/AATSR dataset. This poster presents recent results, evaluating the performance of the new dataset and assessing the change in uncertainty caused by the switch from a forward to a rear view on the sensor. A cloud product is also generated using the same algorithm. The strengths and weaknesses of a CDNC product derived from that data are discussed.

Samset, Bjorn

The AeroCom Phase III Absorption experiment: First results

Aerosol shortwave absorption affects precipitation and other atmospheric phenomena, through local heating, altering lapse rates and affecting cloud formation. Presently, however, absorption from BC, brown carbon (absorbing OC) and dust is very diversely quantified among AeroCom models. There is also no strong observational constraint on the total, global (or regional) aerosol absorption (see paper linked below). Further, BC - the most strongly absorbing anthropogenic aerosol species - has been shown to cause significant spread in predicted precipitation change under global warming between recent Earth System Models. In response, this AeroCom Phase III experiment aims to better quantify the sources of inter-model spread in (total and per-species) short wave aerosol absorption. We show the results based on the submissions available at the time of the AeroCom 2019 workshop, and also compare to some early CMIP6 results.

Schulz, Michael

Historical aerosol forcing diagnosis and analysis in CMIP6, AerChemMIP and AeroCom models

A new generation of aerosol models has been implemented in state of the art CMIP6 models. At the same time CMIP6 and AerChemMIP experiments are for the first time coordinated with detailed aerosol modeling in AeroCom models. Refined diagnostics in CMIP6 experiments and a new set of AeroCom simulations shall allow for an understanding of bias in aerosol forcing and associated aerosol parameters. The aerosol forcing history in available CMIP6 output is documented and analyzed as a function of emissions, aerosol mixing ratios, optical properties and cloud properties. AeroCom phase III historical fixed SST simulations are investigated to see if coupled AOGCM's are significantly different in describing aerosol forcing history. Observational data available in the AeroCom database (see also abstract A. Mortier and J. Gliss) are used to evaluate these parameters and any bias against observations. The consequences of bias for the uncertainty in aerosol forcing history are discussed.

Schuster, Greg

Retrieving Black Carbon AAOD from Refractive Index for the AERONET Retrievals

We have previously described a method of using the Aerosol Robotic Network (AERONET) size distributions and complex refractive indices to retrieve the relative proportion of carbonaceous aerosols and free iron minerals (Schuster et al, ACP 2016). Expanding upon Schuster et al, (ACP 2016), we compute the AAOD attributable to each absorbing aerosol component at several wavelengths (440, 500, 550, 675, 870, and 1020 nm) for all AERONET retrievals (through Feb 11, 2017), taking into account that all aerosols are internally mixed in the AERONET retrieval products. We used 7253 retrievals at the Beijing AERONET site to test the sensitivity of our retrieved BC AAOD to the range of BC refractive indices recommended by Bond and Bergstrom, 2006 (i.e., $m_{bc} = 1.75 - 0.63i$ to $1.95 - 0.79i$); we found an absolute bias of 0.00024 and a relative bias of 0.46% in BC AAOD(550). Thus, we conclude that the BC AAOD that we retrieve with this technique is not sensitive to the complex refractive index of BC.

Schutgens, Nick

AEROCOM/AEROSAT remote sensing experiment

This talk will summarize results from three papers that will be submitted this year. Those papers concern the recent remote sensing experiment performed for AEROCOM models, using AEROSAT observations.

- The first paper is an evaluation of satellite AOT and its usefulness for model evaluation. Satellite AOT from 14 different products is evaluated with AERONET (and MAN) data as well as inter-compared to other satellite datasets, at both daily and multi-year time-scales. The diversity amongst these products is analyzed and shown to depend strongly on AOT magnitude and uncertainty in cloud masking. Regions of large diversity are identified, e.g. Australia, western North America and eastern South America. It is shown that satellite AOT contains regionally coherent biases (vs AERONET) that differ amongst products. Two groups of products exist: one with lower typical biases and one with typical biases 25-50% higher.
- The second paper is an evaluation of satellite AAOT and SSA. Four different satellite products are inter-compared and evaluated with AERONET. While large differences exist between products, they yield broadly similar results when used to evaluate AEROCOM models. Hence it is often possible to use these satellite products to identify regions where models over or underestimate AAOT (or SSA). Moreover, combined with AEROCOM models, it becomes possible to estimate global dust emissions and regional black carbon emissions from satellite AAOT.
- The third paper is a study of the representativity of AERONET observations for e.g. model evaluation. Using a high-resolution global simulation (7 km near equator), an Observing System Simulation Experiment was conducted that takes into account the different spatial extent and temporal sampling of AERONET observations as compared to model grid-boxes. The OSSE allows us to explore representation errors as a function of model grid-box size, station altitude, monthly or yearly averages, etc. A list of AERONET and GAW sites ranked according to representativity is also presented.

Sogacheva, Larisa

Can the merged AOD L3 monthly product (1996-2017) be extended back to 1979 with TOMS AOD?

The merged AOD L3 monthly product (1996-2017), which has been developed from 15 available AOD products retrieved from 11 satellites, was introduced and validated in Sogacheva et al. (2019, ACPD). Considerable offset (up to 0.5 AOD) was recognized between the TOMS and merged AOD products. Can the merged AOD L3 monthly product (1996-2017) be extended back to 1979 with TOMS AOD?
To answer that question, we studied the temporal and spatial offsets by comparing TOMS and merged L3 AOD monthly products during the collocated period 1996-2001, looking also at the AERONET AOD and Angström averaged monthly to 1-deg cells.

Takemura, Toshi

Difference in sensitivities to climate change between black carbon and sulfate aerosols

Climate change is generally driven by an imbalance in the radiation budget. Therefore the radiative forcing is one of the major indices to discuss the climate change. The 5th Assessment Report of the Intergovernmental Panel on Climate Change evaluated the global mean radiative forcing of the aerosol-radiation interaction by anthropogenic black carbon is comparable to that by anthropogenic sulfate with opposite sign. This might have implied that reducing emission of black carbon brings mitigation of an increase in the surface air temperature. This study evaluated the climate sensitivities of black carbon and sulfate aerosols with a coupled-ocean general circulation model, MIROC-SPRINTARS, by varying anthropogenic emission amounts within the realistic range. The simulated results show that the sensitivity of surface air temperature to the instantaneous radiative forcing at the top of the atmosphere, i.e., climate sensitivity parameter, is weaker for black carbon (0.16 K m2/W) than that for sulfate aerosols (1.3 K m2/W) (Takemura and Suzuki, 2019, doi:10.1038/s41598-019-41181-6). This is because the rapid adjustment due to changes in clouds and precipitation counteracts instability due to weaker absorption of solar radiation with reduced BC emissions (Suzuki and Takemura, 2019, doi:10.1029/2018JD029808). More detailed analysis will be needed to investigate the effects of aerosols on changes in other meteorological parameters and regional climate change.

Torres, Omar

The OMPS_LP Stratospheric Aerosol Record

The Limb Profiler (LP) instrument is part of the Ozone Mapping and Profiler Suite (OMPS) flying on the SNPP (Suomi National Polar-orbiting Partnership) satellite. The spacecraft, launched in October 2011, is in a sun-synchronous ascending orbit with a 13:30 equator crossing time and mean altitude of 833 km above the Earth's surface. The LP sensor measures a series of simultaneous radiance profiles of the Earth's entire sunlit limb through three vertical slits at several wavelengths in the 290-1000 nm range at 1 km altitude intervals between 0 km and 80 km. The current OMPS_LP (V1.5) aerosol algorithm uses the Chahine (1970) nonlinear relaxation method to retrieve the vertical profile (resolution ~1.8 km) of aerosol extinction (km-1) from OMPS LP radiance measurements at 675 nm. Under cloud-free conditions, aerosol extinction retrievals are carried out, from the surface up to 40 km at a 1.8 km vertical resolution. In this presentation I will introduce the 8-year OMPS_LP global record of stratospheric aerosol extinction to the AeroCom community. The inter-annual variability of the stratospheric aerosol load associated with volcanic eruptions and tropospheric aerosol injections will be discussed.

Tsay, Si-Chee

A satellite-surface-modeling perspective of light-absorbing aerosols over Himalaya-Nepal: Results from the RAJO-MEGHA project

The objectives of the RAJO-MEGHA (Radiation, Aerosol Joint Observation-Modeling Exploration over Glaciers in Himalayan Asia; Sanskrit for Dust-Cloud) project are to exploit the latest developments of satellite, ground-based networks, and modeling capabilities in addressing the overarching scientific question: What are the spatiotemporal properties of light-absorbing aerosols and their relative roles in causing accelerated seasonal snowmelt in High Mountain Asia (HMA)? Comprehensive regional-to-global climate models, advancing in lockstep with satellite observations and complementary surface network measurements, are playing an ever-increasing role in better understanding the changes of our environment. However, the complex characteristics of HMA, such as its rugged terrain, atmospheric inhomogeneity, snow susceptibility, and ground-truth accessibility, introduce daunting challenges for the aforementioned research tools to retrieve/assess radiative effects on snowmelt with a high degree of fidelity. The phase-I RAJO-MEGHA project started in the fall of 2017 and is scheduled to end prior to the onset of Asian summer monsoon in May 2020. In this paper, we present a satellite-surface-modeling perspective of RAJO-MEGHA and highlight key scientific findings concerning: (1) multi-year/multi-sensor, spatiotemporal variability of atmospheric aerosol (e.g., aerosol optical depth, Ångström exponent) and surface snow (e.g., fraction, grain size, impurity, albedo) properties over the region conducive to snowmelt (dust and/or soot dominant); (2) aerosol diurnal characteristics and seasonal snow properties at newly established long-term sites operated by ICIMOD-NASA in High Himalaya-Nepal at an elevation close to the recently discontinued EvK2-Pyramid observatory; (3) syntheses of high-temporal measurements of radiance/irradiance from strategically distributed surface networks -along airmass inflows from the Indo-Gangetic Plains to High Himalaya- to provide key linkage of transported aerosols on snowmelt, as well as validation of satellite retrievals and model simulations; and (4) GEOS-5 simulation analyses on the role of various competing factors (e.g., snow darkening, atmospheric warming, sea surface temperature anomaly) in the processes of snowmelt over HMA and comparison of resulting macro-/micro-scale properties of aerosol/snow with satellite/surface observations.
Large-scale satellite (e.g., MODIS-like observations and retrievals) and uniquely distributed ground-based network measurements, synergized with modeling results, establish a critically needed database to advance our understanding of changes in snowmelt processes over HMA due to the presence of light-absorbing aerosols.

Tsigaridis. Kostas

modeling clear-sky vs. all-sky aerosol optical depth and radiative effects

Atmospheric aerosols, especially the hygroscopic ones, drastically change their optical properties in the presence of clouds, due to the near-100% relative humidity in cloudy air. Remote sensing techniques, like satellite retrievals and AERONET sun photometers, are not able to see aerosols inside clouds, and they thus only provide information during cloud-free conditions. This is a major challenge for global models, whose grid sizes represent large areas where both cloudy and cloud-free conditions can coexist (a state frequently termed "all-sky"), and the distinct separation between cloud-free and cloudy conditions becomes a challenge. In addition, separate cloud layer overlapping in the column is mostly statistically represented in models, which does not always capture the vertical overlapping of cloud decks in the real atmosphere. This presentation will provide the initial grounds for a deeper understanding of what is the definition in different models regarding cloud-free/cloudy skies, the model assumptions on hygroscopic growth due to the varying relative humidity in the subgrid scale, and the resulting differences in the calculated aerosol optical depth and radiative effects under clear-sky and all-sky conditions. An AeroCom intercomparison on this subject will be proposed in the very near future.

Thanos Tsikerdekis

Assimilating aerosol optical properties related to size (ANG) and species (SSA) from POLDER/PARASOL with an ensemble data assimilation system

Although atmospheric aerosol is an important factor that regulates the energy budget of the planet, their actual concentration in the atmosphere bare high uncertainty. In this study we assimilate Aerosol Optical Depth (AOD) along with Angstrom Exponent (ANG) and Single Scattering Albedo (SSA) using a global coupled climate-chemistry model (ECHAM-HAM), multi-angle photopolarimetric remote sensing measurements from PARASOL/POLDER and the Local Ensemble Transform Kalman Filter (LETKF). Our approach combines an ensemble of forward perturbed simulations from ECHAM-HAMMOZ. The aerosol emissions and the u and v wind components of each member of the ensemble is perturbed using spatial correlated perturbation, which creates diverse scenarios of aerosol concentration. The mean and the standard deviation of this perturbed ensemble defines our background estimation and uncertainty (error) of the atmospheric state. The ensemble is then spatiotemporally collocated with the remote sensing measurements that are too come in pairs of an estimate and an error. The final step is to combine all of these information with the LETKF, that solves a cost function that defines the new better estimate (analysis) by minimizing simultaneously the distance between the analysis and forecast and the distance between analysis and observations, taking also into account the errors in the forecast and the observations. The new improved state is closer to reality and provides a better estimate of aerosol concentration. Our result indicate the importance of providing information about the total amount of aerosol (AOD) combined with indirect information about aerosol size (ANG) and aerosol species (SSA).

Vazquez-Navarro, Margarita

PMAp version 2: synergistic global Aerosol Optical Depth retrieval over land and ocean from Metop.

Atmospheric aerosols cause significant effects on the Earth's radiation budget, however they are still considered one of the major uncertain parameters in the prediction of future climate scenarios. Satellite remote sensing is an excellent tool to study the global distribution, transport and characteristics of the different aerosol types. The PMAp product is a multi-sensor algorithm that retrieves globally aerosol optical depth (AOD) at 550 nm and related aerosol parameters at the spatial resolution of the GOME-2 Polarisation Measurement Devices (PMDs) on Metop. It combines information provided by GOME-2, AVHRR and IASI. The radiances and Stokes fractions measured by the GOME-2 PMDs are used to retrieve aerosol optical properties directly. The higher spatial resolution of AVHRR provides information about sub-pixel cloud coverage, and the use of the split-window technique informs about the dust/ash presence. The fine structure of the IASI spectra is used to detect SO2 plumes and discriminate between dust and ash layers. The different spatial resolutions of the three instruments also allow for a cloud correction, in which an AOD is derived for partially cloud-covered GOME-2 PMD pixels. The PMAp is a level 2 NRT product at the following spatial resolutions: 40 km x 5 km for PMAp Metop-A (960 km swath), 40 km x 10 km for PMAp Metop-B and C (1920 km swath). Here we present the main upgrades of the latest version of PMAp, among others: the better identification of aerosol in the presence of clouds, a lambertian equivalent reflectance database that accounts for the angular dependency of the surface reflectance and a better categorisation of the aerosol types. Additionally we show that following the launch of Metop-C in late 2018 , the improved coverage of the three-satellite constellation has greatly enhanced the potential for exploitation of the products. The combined PMAp product now provides daily almost full global coverage of AOD measurements over land and ocean.

Wang, Minghuai

Cloud water adjustment to anthropogenic aerosols in climate models

Aerosol indirect effects remain one of the largest uncertainties in our estimate of anthropogenic forcing. Radiative forcing associated with cloud water adjustment to aerosols often dominates this uncertainty. In this talk, we use instantaneous aerosol-cloud relationship and long-term aerosol and cloud trends in satellite observations to evaluate cloud water adjustment to aerosol perturbation in several climate models. We found that in two versions of CESM examined, cloud fraction in one version shows strong dependence on cloud droplet number concentration, while this dependence is weaker in the other version. The implication of this discrepancy for aerosol indirect forcing is discussed. The long-term trend in cloud water adjustment in climate model are further examined and compared with observations.

Watson-Parris, Duncan

Constraining parametric uncertainty in aerosol direct forcing

The uncertainty in present-day anthropogenic forcing is dominated by uncertainty in the strength of the contribution from aerosol. Much of the uncertainty in the direct aerosol forcing can be attributed to uncertainty in the anthropogenic fraction of aerosol in the present-day atmosphere, due to a lack of historical observations. Here we present a robust relationship between total present-day aerosol optical depth and the anthropogenic contribution across two multi-model (CMIP5 and AeroCom phase II) ensembles and a large single-model perturbed parameter ensemble. Using observations of aerosol optical depth we determine a reduced likely range of the anthropogenic component and hence a reduced uncertainty in the direct forcing of aerosol.

Welton, Ellsworth

The NASA Micro Pulse Lidar Network: Overview of the new Version 3 release

The NASA Micro-Pulse Lidar Network (MPLNET) is a global federated network of polarized Micro-Pulse Lidar (MPL) systems running continuously. Most sites are co-located with AERONET providing joint data on column and vertically resolved aerosol and cloud information. MPLNET began in 2000, and there have been over 70 sites deployed worldwide, with 23 sites currently active and a few more planned over the next year. Seven of the long-term sites have 10+ years of data, and many more have 5+ years. This presentation will provide an overview of the new Version 3 MPLNET data to be released in Fall 2019. All sites in the network are now polarized, providing information on particle shape. Other changes include enhanced cloud products, a new PBL height product, and inclusion of the AERONET lunar AOD into MPLNET aerosol retrievals. A new quality flag process will be used to better describe the data products. Finally, a new data portal will provide near-real-time (NRT) access to all data products, including new quality assured NRT L1.5 products. Custom products developed for model specific applications will also be provided.

Williamson, Christina

Global Remote New Particle Formation: an experiment to compare AeroCom models with observations from the NASA Atmospheric Tomography Mission

New particle formation in the remote free troposphere and marine boundary layer is under-constrained in models and yet is a globally important source of cloud condensation nuclei (CCN). These aerosol formation processes in remote locations are particularly important for understanding the pre-industrial climate where the effect of newly formed particles on climate is amplified compared with the present day atmosphere. We are running an AeroCom experiment comparing detailed in-situ measurements of the global distribution of newly formed particles and calculated coagulation and condensation sinks from the NASA Atmospheric Tomography Mission (ATom) with model outputs. Flights covered the Pacific and Atlantic basins from ~80°N to ~86°S latitude, constantly profiling between 0.2 and ~13km altitude over different seasons. The DC-8 aircraft was equipped with instrumentation for measuring various aerosol properties as well as greenhouse, reactive and trace gases. We discuss the observations used in this study, as well as a preliminary look at submitted model outputs. We present the observed spatial and seasonal distributions of particles, which will be used to discern the importance and accuracy of different nucleation and growth mechanisms. Accumulation and coarse mode particle act as sinks for newly formed particles and condensable vapors, thus influencing the number of particles that form and grow to CCN sizes. We will use the spatial distribution of these larger particles to assess model skill in representing how they are transported and processed by clouds, and the effect this has on modeled new particle formation and its contribution to CCN.

Winker, Dave

A lidar aerosol simulator for the COSP 2.0 Framework

The "lidar simulator" in the COSP simulator package, simulating cloud observations from the CALIOP lidar, has been widely used in the cloud feedback community. We report on ideas for a corresponding COSP lidar simulator for aerosols, simulating CALIOP aerosol profile observations, developed at a meeting in Paris last June. This talk will present a summary of the thinking leading to the June meeting and the motivations for developing an aerosol simulator. We present several options for the simulator, involving different levels of complexity and present pros and cons. The purpose of the presentation will be to solicit feedback from the Aerocom community on the utility and preferred design of the simulator.

NASA's emerging vision for the ACCP mission

The 2017 Earth Science Decadal Survey (DS) recommended science and applications priorities to be pursued by NASA during the 2017-2027 time period. Aerosols (A) and clouds, convection, and precipitation (CCP) were identified as essential observables requiring additional capabilities beyond those planned in the current Program of Record. The DS recommended NASA develop a medium-to-large mission to address these observables, which would represent foundational elements of the future observing system. In fall 2018, NASA initiated a 3-year study of a combined ACCP observing system, including identification of science goals and objectives, desired geophysical variables, and observing system capabilities. The goal of the study is not to define a single mission concept but to explore a range of potential concepts and recommend a set of concepts with different levels of capability. The study is currently exploring instrument and orbit concepts that would provide desired observational capabilities, within the context of the planned international Earth observation program. This talk will present a summary of currently defined ACCP science objectives and approaches envisioned, with the goal of informing and soliciting comment and feedback from the aerosol community.

Wittek, Marcin

Oceanic aerosol loading derived from MISR's 4.4 km (V23) Aerosol Product

A new version (V23) of the Multi-angle Imaging SpectroRadiometer (MISR) Level 2 (swath-based) aerosol product was publicly released in mid-2018. V23 has seen many updates to the retrieval process, most notably over dark water (DW), which applies over the global oceans and other deep bodies of water. Here, the quality of the new MISR DW retrievals is assessed using surface-based Aerosol Optical Depth

(AOD) observations from the Maritime Aerosol Network (MAN) and island/coastal sites within the AErosol RObotic NETwork (AERONET). 406 MISR/MAN and 11,015 MISR/AERONET collocated observations were identified. Comparison against MAN reveals the unparalleled accuracy of the V23 AOD retrievals: the correlation coefficient is 0.98, the root mean square error is 0.041, and the mean bias is -0.002. Aerosol spatial heterogeneity negatively affects comparison statistics against AERONET observations—applying stricter collocation criteria drastically improves agreement between MISR and AERONET. The reported AOD uncertainties realistically represent retrieval errors as they exhibit behavior similar to that of the standard deviation of a Gaussian distribution. Over the 18 years of MISR data analyzed, the global area-weighted average AOD over oceans is 0.103; it becomes 0.151 when the averaging is restricted to locations where MAN observations are available. The AOD uncertainties are generally higher than average in offshore areas dominated by anthropogenic and biomass burning aerosols, and lower than average in regions with mineral dust outflows. These results suggest future directions for improving the predefined aerosol mixtures used in the MISR aerosol retrieval look-up tables.

Yu, Yan

Disproving the Bodélé depression as the primary source of dust fertilizing the Amazon Rainforest

Motivated by the ongoing debates about the relative contribution of specific North African dust sources to the trans-Atlantic dust transport to the Americas, the current study integrates a suite of satellite observations into a novel trajectory analysis framework to investigate dust transport from the leading two North African dust sources, namely the Bodélé depression and El Djouf. In particular, this approach provides observation-based quantification of the dust's dry and wet deposition along its transport pathways and is validated against multiple satellite observations. The current large ensemble trajectory simulations identify favorable transport pathways from the El Djouf across the Atlantic Ocean with respect to seasonal rain belts. The limited potential for long-range transport of dust from the Bodélé depression is confirmed by the observed evolution of dust vertical structures and attributed to the currently identified extensive near-source dust removal primarily by dry and wet deposition during boreal winter and summer, respectively.

A Global Analysis of Dust Diurnal Variability Using CATS Observations

The current study investigates the diurnal cycle of dust loading across the global tropics, sub-tropics, and mid-latitudes by analyzing aerosol extinction and typing profiles observed by the Cloud-Aerosol Transport System (CATS) lidar aboard the International Space Station. According to the comparison with ground-based and other satellite observations, CATS aerosol and dust loading observations exhibits reasonable quality and insignificant day-night inconsistency, thereby supporting the current analysis of dust diurnal cycle using CATS data. Based on an analysis of variance analytical framework, statistical significant diurnal variability in dust loading is identified over key dust sources, including the Bodélé depression, West African El Djouf, Rub-al Khali desert, and western and southern North America, confirming the previous observation-based findings regarding the diurnal cycle of dust emission and underlying meteorological processes in these regions. Insignificant annual mean dust diurnal variability is identified over the Iraqi, Thar, and Taklamakan deserts. The currently identified significant diurnal cycle in dust loading over the rainforests in Amazon and tropical southern Africa, and drylands in the central Australia, are hypothesized to be driven by enhanced dust emission due to wildfires and enhanced frontal winds, respectively.

Xue, Young

Hourly Remote Sensing Monitoring of Global Aerosol Optical Depth over Land Using Data from Three Geostationary Satellites: GOES-16, MSG-1, Himawari-8

Due to the limitations of satellite numbers and orbital width, it is almost impossible to monitor global aerosol distribution using polar orbiting satellites at high frequency. This greatly limits the application of Aerosol Optical Depth (AOD) datasets in many fields, such as atmospheric pollutant monitoring and climate change research. Although geostationary satellites have a very high temporal resolution and very large observation range, three or more satellites are still needed to achieve rapid monitoring of global aerosols. In this work, we obtain hourly global aerosol optical depth dataset by integrating AOD datasets retrieved from four geostationary weather satellites (GOES-16, MSG-1, MSG-4 and Himawari-8), which will greatly expand the application range of AOD datasets. The integrated geostationary satellite AOD datasets from April to August 2018 are validated using AERONET data. The validation results are follows: the Mean Absolute Error (MAE), Mean Bias Error (MBE), Relative Mean Bias (RMB), and Root Mean Square Error (RMSE) are 0.07, 0.01, 1.08 and 0.11, respectively. The ratio of the error of satellite retrieval within ±(0.05+0.2 〖AOD_AERONET) is 0.69. As a representative of polar orbit satellites, the spatial coverage and accuracy of MODIS C61 AOD product released by NASA are also analyzed. The analysis results show that the integrated AOD dataset has similar accuracy to that of the MODIS AOD dataset and has higher temporal resolution and spatial coverage than the MODIS AOD dataset.

Zhang, Hua

Changes in Anthropogenic PM2.5 and Resulting Global Climate Effects During 1850–2010

Using an aerosol–climate coupled model, we have investigated the climate response of anthropogenic fine particulate matter (PM2.5, particle size ≤ 2.5 micrometer), and coarse particulate matter of non-PM2.5 (NPM, particle size > 2.5 micrometer). The column burden of PM2.5 has increased globally during 1850–2010, especially over South Africa and southern and eastern parts of Asia. The geographical distribution of changes in NPM was very different from that in PM2.5, with negative growth in some areas. The global annual mean effective radiative forcings (ERFs) were –2.34 W m–2 and 0.01 W m–2 caused by the changes in PM2.5 and NPM, respectively. Increases in PM2.5 resulted in significant cooling effects on the climate, whereas the changes in NPM created small and opposite effects. The global annual mean surface air temperature (SAT) decreased by 2.26 K. Cooling was more apparent over Northern Hemisphere terrain and ocean at mid- and high latitudes by the increased PM2.5, whereas the changes of SATs by increased NPM were found to be positive over North America, the Indian Peninsula, South Asia, and Europe. Strong cooling due to increased PM2.5 caused a southward shift of the Intertropical Convergence Zone (ITCZ), and the southward-shift sign was also found in that caused by NPM. The global annual mean precipitation decreased by approximately 0.18 mm day–1 due to the increased PM2.5. Generally, the PM2.5 concentration changes contributed to more than 92% of the variations caused by all anthropogenic aerosols in ERF, SAT, cloud fraction, and precipitation.

Zhang, Kai

Regime-dependent anthropogenic aerosol effects on different types of clouds in the AeroCom models

A recent AeroCom study found that the characteristics of the simulated aerosol indirect effect on liquid clouds are strongly dependent on the dynamical regime. However, monthly mean fields were used in that study and the impacts on other cloud types were not discussed. Here we analyze the anthropogenic aerosol effect on different types of clouds using high frequency data (every 3h) from the AeroCom indirect inter-comparison project and from the E3SM global atmosphere model. We classify the clouds into three categories based on the cloud phase (liquid, ice, and overlapped liquid-ice clouds) and investigate the anthropogenic aerosol effect by conditionally sampling the data for different cloud types under different dynamical regimes. Results show striking differences in the simulated aerosol effects on the individual types of clouds in different models. The regime-dependent characteristics in the models are even more diverse for ice-containing clouds. Some of the differences between models can be explained by the different cloud formation pathways considered.

Zhao, Shuyun

The effects of ENSO on the winter haze pollution of China

Winter haze pollution has been a serious problem for China in recent decades. Except for the increase in anthropogenic emissions, natural climate change can also exert influence on the haze pollution in China. ENSO is a predominant signal of natural variation on inter-annual scale, which can influence not only the summer monsoon but also the winter monsoon over East Asia. Thus, we explored the effects of ENSO on the winter (from December to February) haze pollution of China statistically and numerically. Generally, we found that the El Nino index (nino3.4) had a significant negative correlation with the winter haze days of Southern China, but the simulated aerosol load over this region in El Nino winter is heavier than normal winters. The nino3.4 had no significant correlation with the winter haze days or the simulated aerosol load over Northern and Eastern China, but when separating ENSO events into Eastern (EP) and Central Pacific (CP) events and into different intensities, the correlation between ENSO and the winter haze pollution over Northern and Eastern China can become significant.