A24A CC: 520 F Tuesday 1530h

Stratospheric Composition and Dynamics II

Presiding: **E C Weatherhead,** Cooperative Institute for Research in Environmental Sciences (CIRES)**; J de Grandpre,** McGill University

A24A-01 1530h

Mission Simulation and Error Analysis for the Stratospheric Wind Interferometer For Transport Studies (SWIFT)

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The Stratospheric Wind Interferometer For Transport studies (SWIFT) is a Canadian satellite instrument designed to measure stratospheric winds and ozone densities. The measurement technique is known as Doppler Michelson Imaging Interferometry. This paper describes a mission simulation for SWIFT which includes the instrument simulation, simulation of the measurement along the orbit and performing the data processing accordingly. The mission simulation is carried out to assess instrument performance and test the SWIFT data reduction algorithms. The mission simulation also includes error analysis. One of the aspects of the error analysis is to evaluate the impact of the instrument characteristics on wind error. The error analysis can be used to assess different instrument configurations and measurement scenarios and can serve to suggest optimum ways for processing the data. The simulations and error analysis are repeated for various design options in order to quantify the expected SWIFT wind errors.

A24A-02 1545h

Retrieval of atmospheric ozone and nitrogen dioxide vertical distribution from SAGE III limb scattering measurement

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SAGE III has been making a series of Earth limb radiance measurements over the past year. The paper will present an analysis and a discussion of the data. Since SAGE III was not designed to operate in this mode, instrument issues such as stray light and altitude registration, need special attention, and methods to deal with these issues will be first described. The methodology used to retrieve gas density profile will be explained. Two algorithms are used, the first one being based on Flitner's triplet method, and the second one relying on spectral fitting. Sample of retrieved ozone and nitrogen dioxide vertical profiles will be presented and discussed. Comparison of the retrieved profiles with measurements from other methods will be shown for validation: ozone sonde, lidar, other space borne instruments. The results will show the potential of SAGE III to operate in limb scattering mode and provide accurate determination of atmospheric ozone and nitrogen dioxide vertical distribution.

A24A-03 1600h

Formation of large NAT particles and denitrification in polar stratosphere: Possible role of cosmic rays and effect of solar activity

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Polar stratospheric clouds (PSCs) are crucial to the ozone depletion because of their well-recognized role both in activating chlorine (through heterogeneous reactions on the surface of PSC particles) and denitrifying the lower stratosphere (through gravitational settling of large HNO3-containing PSC particles). The formation of large nitric acid trihydrate (NAT) particles (i.e., type 1a PSC particles) has important implications for denitrification and ozone depletion. Existing theories can't explain the recent observations of large NAT particles over wide Arctic regions at temperature above ice frost point. Climate models predict that the increased concentrations of greenhouse gases and depletion of the ozone layer may lead to lower stratospheric temperatures and more widespread PSC formation and denitrification in the Northern Hemisphere. Modeling simulations show that widespread denitrification could enhance future Arctic ozone loss. To evaluate properly the consequences of future lower stratospheric temperatures on the arctic ozone layer, details about the formation of large NAT particles must be known. Our analyses reveal that high-energy comic rays may induce the freezing of supercooled HNO3-H2O-H2SO4 droplets when they penetrate these thermodynamically unstable droplets. The cosmic ray-induced freezing (CRIF) is consistent with the observed highly selective formation of NAT particles. We suggest that the physics behind the CRIF mechanism is the reorientation of polar solution molecules into the crystalline configuration in the strong electrical fields of moving secondary ions generated by passing cosmic rays. Our simulations indicate that strong solar proton events (SPEs) may significantly enhance the formation of large NAT particles and denitrification. The CRIF mechanism can explain the high correlations between the thin nitrate-rich layers in polar ice cores and major SPEs. The observed enhancement in aerosol backscattering ratio at PSC layers shortly after an SPE and the significant precipitation velocity of the enhanced PSC payers also provide strong support for the CRIF mechanism.

URL: http://www.albany.edu/~yfq

A24A-04 1615h

Comparisons of the MANTRA Balloon Campaign Measurements of Stratospheric Constituents with the Canadian Middle Atmospheric Model.

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MANTRA (Middle Atmosphere Nitrogen TRend Assessment) is a series of high-altitude balloon campaigns conducted in late summer over Saskatchewan to measure stratospheric trace gases from a float altitude of about 35 km. Previous flights have occurred in late August or early September of 1998, 2000 and 2002. By launching in late summer, dynamical variability is minimized and the changing chemical balance of the stratosphere can be studied, with an emphasis on the nitrogen partitioning. In this talk these MANTRA measurements are compared with the Canadian Middle Atmosphere Model (CMAM), a fully interactive chemistry climate model. Such comparison of model with measurements has many benefits: it helps to validate the model under conditions where the stratosphere is largely under photochemical and radiative control, but at the same time aids in the interpretation of the measurements. In particular, the model can help assess the representativeness of the measurements and the possible impact of dynamical variability. For example, we show that the model appears to simulate a realistic 5-day wave which has an impact on the chemical fields.

A24A-05 1630h

An Algorithm for Extracting Zonal Mean and Migrating Tidal Fields in the Middle Atmosphere From Satellite Measurements: Applications to TIMED/SABER Measured Temperature and Tidal Modeling

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For a data series with grids that do not uniformly cover a whole wave cycle the traditional least squares-fitting method will lead to aliasing between the wave component and mean field. In this paper a set of regularity conditions is formally defined and used to select available grids for deriving the zonal mean and tidal components from unevenly sampled or incomplete measurements to reduce aliasing. Zonal mean and migrating tidal fields are derived from SABER temperature measurements. The measured fields are binned into a 4 degrees of latitude by 20 minutes in local time grids. The derived zonal mean temperature and wind are merged with CIRA-86 model atmosphere and can be used as input fields for tidal models. Using the zonal mean temperature and wind fields derived from the SABER measurements as input fields, we examine the effect of zonal mean fields on the amplitude variabilities of migrating tides in the upper stratosphere and the mesosphere. The model derived migrating tides are compared with those derived directly from the SABER measurements during the same periods. The model and measurement comparison shows a significant effect of the zonal mean wind on the amplitude of migrating diurnal tides.

A24B CC: 520 D Tuesday 1530h

Constraining the Global Mass Distribution of Mineral Dust Aerosol II *(joint with B, GC)*

Presiding: **R L Miller,** NASA Goddard Institute for Space Studies**; C S Zender,** University of California, Irvine

A24B-01 1530h INVITED

The Anthropogenic Contribution to Dust Aerosols

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The magnitude and distribution of atmospheric soil dust is strongly controlled by dust emissions, which depend on the extent and type of terrestrial vegetation and land use, as well as on soil properties and meteorological variables. The percentage of soil dust emissions from anthropogenically disturbed soils, which could change with changing population pressure, is not well constrained. For example, it is unclear if the increase in dust storm frequencies in China over the recent years was influenced by changes in land use. While previous estimates used a comparison of satellite retrievals with results of global dust cycle models to obtain a rough estimate of anthropogenic soil dust, which was estimated to contribute as much as 50% to the global aerosol load, we recently used a global dataset of dust storm frequency observations to obtain the revised estimate of a less than 10% contribution of agricultural soils to global dust emissions. Future dust emission changes were simulated with a global offline dust model which includes dust emissions from natural and cultivated source areas to estimated future changes in dust emissions for IPCC scenarios with increased greenhouse gas concentrations, using meteorological fields extracted from future scenario results of the ECHAM4 and HADCM3 models, and taking into account expected changes in vegetation and land use to compute dust emissions. We find that expected future changes in meteorological parameters and changes in natural vegetation cover as consequence of increased greenhouse gases have a stronger influence on dust emissions than changes in cultivation. The estimates of future changes in dust emissions are strongly

model dependent, and range from a 9% decrease to a 19% increase in global annual emissions for the different model scenarios. Apart from these discrepancies, which are the result of cancellation of positive and negative changes in dust emissions in different parts of the world, we find common features in the different model scenarios. The reliability of such future estimates depends to a large degree on the performance of the climate models that are used to produce the meteorological fields that drive dust emissions.

A24B-02 1545h INVITED

Uncertainties and constraints on estimates of the natural and anthropogenic atmospheric budget of mineral aerosols

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Estimating the global source of mineral aerosols is difficult due to the highly episodic nature of mineral aerosols and their relatively short lifetime. Comparisons with available observations suggest that models can capture the observed climatology reasonably well using several different source mechanisms and reanalysis datasets, and yet these results differ in the mass budgets. Previous studies have shown that the differences in concentration between different meteorological datasets and source parameterization are of the same magnitude as differences between including a 50 percent land use source or a 0 percent land use source, suggesting that determining the portion of land use will be difficult from concentration datasets. Simulations of the absorbing aerosol index which can be quantitatively compared with the TOMS AAI allow us to consider the source strengths close to the source regions. These results suggest that a 0-25 percent land use source is most likely in North Africa, but that uncertainties due to meteorology and source parameterization are larger than the differences in the inclusion vs. exclusion of land use sources, again frustrating our efforts to constrain anthropogenic impacts on mineral aerosols. Differences in mineral aerosol source parameterizations may also have important ramifications for feedbacks on climate. Thus efforts should be made to provide not only best estimates of mineral aerosol sources but also the uncertainties in these best estimates.

A24B-03 1600h

Constraining Dust Sources in Central and East Asia With Satellite and Ground-based Observations

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The aerosol transport models become the most comprehensive tool available for predicting the diverse impacts of dust on the climate system. Despite the recent advances in model developments, reliable prediction of the dust emission and spatio-temporal distribution of the dust burden has been proven difficult. One of the key issues is how to quantify dust emission rates from both natural and anthropogenic sources with the pertinent temporal and special resolution. Our study addresses this issue by examining the extent to which an integrated analysis of routine surface meteorological observations (including visibility) and satellite imagery helps to constrain the strength of dust sources and dust transport. We will report the results of an integrated analysis of satellite observations (MODIS, TOMS and SeaWiFS) and surface meteorological data conducted over Central and East Asia. In addition, the meteorological fields predicted by the PSU/NCAR mesoscale model (MM5) driven by NCAR NCEP reanalysis data were incorporated into several dust production schemes of different complexity. The dust emission was simulated at a range of model-grid spatial resolution (from 10 km to 200 km) to estimate the uncertainties in dust fluxes predicted by different schemes. The effects of spatial averaging for individual dust sources with different topography, vegetation cover, and surface soil properties were investigated. By relating dust modeling to observations, we attempt to identify the appropriate temporal and spatial resolution for adequate intercomparison between model results and observational data.

A24B-04 1615h

A Simulated Climatology of Asian Dust Aerosol and its Trans-Pacific Transport - Interannual Variability and Climate Connections

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A 44-year climatology of spring Asian dust aerosol emission, column loading, deposition, trans-Pacific transport routes and budgets during 1960 - 2003 was simulated with NARCM (Northern Aerosol Regional Climate Model). Interannual variability in Asian dust aerosol and transport properties simulated by the model is compared with major climate indices and variations in ground observations. For dust production from most of the source regions, the strongest correlations were with the surface wind speed in the source region, the area (AIAPV) and intensity (IIAPV) indices of the Asian polar vortex, and dust emissions were negatively correlated with precipitation and surface temperatures in spring. The strength of the East Asian Monsoon was not found to be directly related with dust production but rather with the transport of dust from the Asian subcontinent. The interannual variability of dust loading and deposition showed similar relationships with various climate indices. The correlation of Asian dust loading and deposition with the atmospheric teleconnection Western Pacific (WP) pattern and Atmospheric Circulation Index (ACI) exhibits contrasting meridional and zonal distributions. AIAPV and IIAPV were strongly correlated with the mid-latitude zonal distribution of dust loading and deposition over the Asian subcontinent and North Pacific. The Pacific/North American pattern (PNA) and Southern Oscillation Index (SOI) displayed an opposite correlation pattern of dust loading and deposition in the Eastern Pacific, while SOI correlated significantly with dust loading over Eastern China and Northeast Asia. The Pacific Decadal Oscillation (PDO) was linked to the variations of dust aerosol and deposition not only in the area of Eastern North Pacific and North America but also in the Asian dust source regions. The anomalies of transport flux and its divergence as well as dust column loading were also identified for eight typical El Niño and eight La Niña years. A shift of the trans-Pacific transport path to the North was found for El Niño years, which resulted in less dust storm and dust loading in China. El Niño- and La Niña-event had opposite effects on dust divergence in the troposphere over East Asian. On the basis of the variability of Asian dust aerosol budgets, the ratio of inflow to North America to the outflow from Asia was found to be correlated negatively with the PNA-index and positively with the WP- index.

A24B-05 1630h

Modeling Wet Removal of Mineral Dust as Hydrophobic and Hydrophilic Aerosols in the Atmosphere

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Wet removal of mineral dust particles may result from drop nucleation in clouds, depending on whether a particle is hydrophilic or hydrophobic. Hydrophilic dust particles are fully wettable, while hydrophobic particles may be partially wettable. We calculate drop nucleation and growth using a numerical model of an ascending air parcel, considering the size, chemical composition, and number density of particles. Drops nucleated on silt-sized (radius > 1 mm) particles can grow readily to the size for efficient collision and accretion. However, silt particles originating from desert regions, which dominate the mass of dust in the troposphere, may be hydrophobic and may not be removed by drop nucleation. Clay minerals, mainly silicates, are hydrophilic, although drop nucleation may be suppressed for variable portions of clay-sized (radius < 1 mm) particles due to their small size and low content of readily soluble materials. Clay particles with radii between 0.4-1 mm may be removed preferentially by cloud nucleation during rain events. Seasonal variations of dust observed over the tropical North Atlantic are best simulated in a global transport model when Saharan dust aerosols are assumed to be hydrophobic and may be transformed to hydrophilic by chemical absorption and reactions during transport.

A24B-06 1645h

Global Simulation of Mixing of Mineral Dust and Carbonaceous Aerosols With Sulfate and Effects on Their Mass Concentrations

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An aerosol dynamics module is coupled with a global chemistry and transport model (IMPACT) which is driven by the NASA Data Assimilation Office meteorological data. The aerosol module considers the major aerosol components: sulfate aerosol and non-sulfate aerosols (organic matter (OM), black carbon (BC), mineral dust, and sea salt), and includes the sulfate aerosol nucleation, condensation of H2SO4 gas on the pure sulfate aerosol and non-sulfate aerosols, and coagulation within sulfate aerosol, between sulfate and non-sulfate. Mode approach is used for sulfate aerosol (two modes: nuclei and accumulation mode; and two moments: mass and number). We compare our model calculated aerosol mass and number with surface observations and calculated aerosol optical thickness with satellite measurements. In this study we are especially interested in the interactions between sulfate and non-sulfate aerosols. Specifically the mixing status of carbonaceous aerosols and mineral dust with sulfate in the atmosphere, and how these interactions affect mineral dust and carbonaceous aerosol mass concentrations are studied. Our results show that carbonaceous aerosols are generally internally-mixed with sulfate aerosol in the atmosphere, while mineral dust is externally mixed with sulfate except for the submicron dust particles. Global model calculated mass burdens are changed by 10-20 % (increase) for mineral dust and by 20-30 % (reduction) for BC between the two runs using the realistic wet scavenging efficiencies based on the surface coating of non-sulfate aerosols by sulfate in the atmosphere and using the assumed wet scavenging efficiencies (1 for dust and 0.4 for carbonaceous aerosols). Dust and BC mass concentrations and distributions are also compared between the two runs. Dust mass concentrations are found to agree generally much better with surface observations using the realistic scavenging efficiency in sites away from the dust source regions.

A31A CC: 220 C-E Wednesday 0830h

Bioaerosols: Measurement, Laboratory, and Modeling Studies II Posters *(joint with B, OS, GC)*

Presiding: **P A Ariya,** McGill University**; G Mainelis,** Rutgers University

A31A-01 0830h POSTER

Microbial Transformation of Dicarboxylic Acids by Airborne Bacteria

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Organic aerosols are assumed to be key players in driving climatic changes and can cause health problems for human. Dicarboxylic acids (DCA) include a large fraction of identified important class of organic