

the Spanish Institute of Oceanography, the Laboratory of Atmospheric Physics Siméon Fongang, the University of Miami Rosenstiel School of Marine and Atmospheric Science, the University of Washington Applied Physics Laboratory, NASA Goddard Space Flight Center, the NOAA Cooperative Institute for Meteorological Satellite Studies at the University of Wisconsin-Madison, NASA Jet Propulsion Laboratory, and the NOAA/NESDIS Office of Research and Applications. This collaboration provides unique atmospheric and oceanic observations across the North Tropical Atlantic during eastward and westward tracks during a period of nearly one month. Characterization of microphysical properties of Saharan dust aerosol is done through direct observations of mass, size, and particle number distributions, chemical composition, spatial distributions, and air chemistry. Aerosol radiative properties are studied through a suite of sensors that include a Multi-Angle Absorption Photometer (MAAP), the Marine-Atmosphere Emitted Radiance Interferometer (M-AERI), sunphotometers, and an assortment of other radiometers. Characterization of atmospheric conditions is done through a combination of over 250 radiosonde and ozonesonde launches at 3 to 5 hour intervals during the duration of the cruise and in coordination with satellite overpasses. AEROSE is also supporting the collection of bio-optics and oceanographic observations including water sampling, spectroradiometry, and continuous in-water optical measurements using an under-tow undulating instrument aimed at investigate deposition rates of aerosol and the response of oceanographic systems. Additionally, the cruise effort provides complementary in-situ and remote sensing observations that support the validation and improvement of AVHRR SST corrections under tropospheric aerosol conditions, the validation of MODIS aerosol and oceanographic data and products, the validation of AIRS soundings, and the validation of ICESat aerosol observations, among other activities. An overview of the cruise, available datasets, preliminary results, and follow-on research plans are presented in this paper.

URL: <http://orbit35i.nesdis.noaa.gov/orad/sar/oceansar/AEROSE2004/>

#### A21D-05 0935h INVITED

### The Seasonal Cycle of the Transport of African Dust Across the Tropical and Equatorial North Atlantic: An Overview

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Many studies have shown that large quantities of African dust are carried out over the Atlantic Ocean every year. Most of these have focused on the summertime transport which carries dust into the Caribbean and the southeastern United States. However during the winter and spring satellites show huge aerosol plumes extending from Africa across the equatorial Atlantic to South America. These plumes are comprised of dust from the Sahel region of North Africa and of smoke from fires in the Soudano region to the south. The dust and smoke has been shown to affect the satellite retrievals of sea surface temperature and ocean color. Aerosols could also contribute to the observed discrepancy between satellite and in-situ measured tropospheric ozone column during the Northern Hemisphere winter and summer. In this presentation I review the current state of our knowledge of dust transport over the tropical and equatorial Atlantic and the temporal and spatial variability of this transport. I will emphasize conditions during the less-studied winter-spring months. Although the data available for these seasons are limited, they suggest that dust concentrations in the western equatorial Atlantic are comparable to those measured during the summer months in the tropical North Atlantic. A special focus will be on dust sources in North Africa that are believed to be most important during the winter-spring transport period. My review will be placed in the context of the African Monsoon Multidisciplinary Analysis (AMMA) field experiment to be held in 2005/2006 in West Africa and the tropical-equatorial North Atlantic. AMMA is an international project to improve our knowledge and understanding of the West African monsoon, the link to the meteorology of the tropical-equatorial Atlantic, and its variability on daily-to-interannual timescales. Dust is believed to play an important role in many monsoon-related processes.

#### A21D-06 0950h INVITED

### The Saharan Air Layer- Insights From the 2002 and 2003 Atlantic Hurricane Seasons

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Recently developed GOES split window IR satellite imagery now provides the capability to continuously track the mineral dust and dry air contained in the Saharan Air Layer. This has permitted monitoring of the SAL's interactions with Atlantic tropical cyclones (TCs) and African easterly waves since the 2001 hurricane season. This imagery has revealed that when the SAL engulfs tropical waves, tropical disturbances, or pre-existing TCs, its embedded dry air, temperature inversion, and strong vertical wind shear can inhibit their ability to strengthen. The SAL's influence on TCs may be a factor in the TC intensity forecast problem in the Atlantic and may also contribute to this ocean basin's relatively reduced level of TC activity. More recent research of the SAL has been focused on various aspects of how its embedded dry air influences TCs and lower tropospheric moisture in the tropical North Atlantic. These efforts include re-examining the Jordan mean tropical sounding and how the SAL may have influenced the results of this 1958 study, as well as utilizing GPS sondes launched from NOAA aircraft to investigate the SAL's low humidity and how effectively this dry air is being represented in the global models. The original work by Jordan in 1958 included the calculation of a climatological sounding for the West Indies during the "hurricane season" (July-October). In light of recent advances in our understanding of the SAL and its ability to advect extremely low humidity as far west as the western Caribbean Sea (7,000 km from its source over northwest Africa), the Jordan sounding may need to be revisited. Jordan's study was replicated for the 2002 "hurricane season" using data from 4 West Indies and Caribbean raob stations. GOES SAL tracking imagery was used to target raobs taken in SAL versus non-SAL environments. The results of this study show evidence of the existence of a bi-modal climatological moisture sounding for the tropical North Atlantic. 2003 Hurricanes Fabian and Isabel marked the first ever attempts to target SAL regions in the TC environment with GPS dropsondes launched from the NOAA G-IV reconnaissance jet. The results of comparisons between these first ever targeted SAL drops and GOES SAL tracking and SSM/I satellite imagery, as well as disparities between the GPS soundings and initial fields from the GFS and NOGAPS models will be discussed.

URL: <http://cimss.ssec.wisc.edu/tropic/real-time/wavetrak/sal-atl.html>

#### A22A CC: 520 F Tuesday 1030h

### Bioaerosols: Measurement, Laboratory, and Modeling Studies I (joint with B, OS, GC)

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

#### A22A-01 1030h

### Intact and Fragmentary Plant and Fungal Bioaerosols

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Primary bioaerosols include those that evolved to enable reproduction and propagation (pollen, spores, bacteria, viruses, etc.) and fragmentary particles whose origins are often linked to anthropogenic activities such as agriculture, waste processing, roadway abrasion. Natural fragmentation processes have often been linked to dispersal from water surfaces by wave breaking and bubble bursting. Fragmentation also occurs as part of natural plant processes. Exposure of live pollen to water, or even high humidity triggers osmotic shock and subsequent pollen rupture and release of cytoplasmic debris. Release of paucimicron and submicron aerosols follows this rupture under special circumstances that have been identified by inducing rupture in controlled laboratory experiments. Evidence that these processes occur naturally is provided by observations of pollen allergen proteins in fine (respirable) fractions of the atmospheric aerosol, and of ruptured pollen in atmospheric samples. The release mechanisms and rates vary among plant species. Related mechanisms have been observed for release of fragmentary particles from a number of fungal species.

#### A22A-02 1055h

### Ground Based Aerosol Measurements: Applications, Methods and Plans

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Anthropogenic and naturally occurring aerosols are linked to visibility degradation, changes in the earth's radiative balance, human health issues, acid rain, and the introduction of pollutants and/or nutrients to sensitive ecosystems. Understanding aerosols requires knowledge of the chemical constituents, sizes, the location and strength of sources, and the transport of the generated aerosols. Remote sensing techniques are used to study aerosols on large scales but are unable to retrieve the exact size distributions and chemical compositions of the observed aerosols. In situ measurements are required to interpret and understand the remotely sensed data. Details of a developing program for in situ aerosol measurement will be presented. A brief description of new aerosol sampling equipment being acquired for use in field campaigns will be given. The equipment being acquired for field campaigns are improved 8-stage rotating drum impactors designed and manufactured at the University of California, Davis. Results from previous measurement programs involving similar instruments will be presented to illustrate how these data can be utilized. Initial plans for using the instruments in measurement campaigns will be discussed.

#### A22A-03 1110h

### Mercury Cycling At the Snow-Air Interface: Role of Bioaerosols

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Recent studies have shown that newly deposited mercury (Hg) undergoes a series of oxidation-reduction reactions initiated by solar radiation. These transformations profoundly alter the fate of Hg, dictating whether or not it evades to the atmosphere or is transported to lakes and soils. Here we present a case for the potential role of bioaerosols deposited at the snow-air interface on these reactions. In addition to modulating these redox processes by altering the pool of reductants and oxidants, these bioaerosols can potentially assimilate Hg in snow. Indeed, preliminary results indicate that Hg in snow is highly bioavailable.

#### A22A-04 1125h

### Bioaerosols Over the World's Oceans

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An interdisciplinary group led by Professor Caroline Leck of Stockholm University, studied aerosols, trace gases, the surface microlayer of the open water between ice floes, and the biology of water and snow in the central Arctic Ocean region during July and August 2001. Insoluble particulates similar to the "microcolloids" found in lower latitude oceans were numerous in the microlayer, and were linked by a gel-like polymer. Bacteria, viruses, and other microorganisms were also present. On many occasions, each of these biological materials formed a significant proportion of the overlying aerosol, presumably being injected into the atmosphere by bubble bursting. In the atmosphere, the polymer gel had a short lifetime, but appeared to be important in the formation of sulfur-containing particles, and possibly also in the formation of new particles. Examination of electron microscope photographs of particles collected over the equatorial eastern Pacific, tropical western Pacific, South Indian, Southern, and North Atlantic Oceans during the previous 30 years showed a similar polymer gel to be attached to recently produced particles. As in the Arctic, it appeared to influence production of larger sulfur-containing particles and may also have been involved in new particle formation. Microorganisms, or fragments of them, were also

common at times in the aerosol over these oceans. It is generally believed that the numerous sulfate-containing particles in the atmospheric boundary layer at remote marine sites were formed by homogeneous nucleation of sulfuric acid in the free troposphere. In the absence of cloud removal processes, they there grew large enough to act as CCN. It is assumed that air interchanges between free troposphere and boundary layer account for their presence in the latter. Aqueous oxidation of sulfur dioxide in cloud drops would add to their sulfur content. The identification in the boundary layer of airborne particles and polymer gels clearly of marine origin, suggests an additional, and more direct, pathway to CCN formation. Because CCN concentrations may have a strong influence on climate, the relative importance of these two methods of CCN formation requires further study. In the central Arctic in summer, the lack of communication between the free troposphere and the surface air means that the marine bioaerosol will be the more important source.

**A22A-05 1150h INVITED**

**Investigation of Electrobiological Properties of Bioaerosols**

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Exposure to bioaerosols, especially to pathogenic or allergenic microorganisms, may cause a wide range of respiratory and other health disorders in occupational and general populations. One of bioaerosol characteristics - electric charge - can greatly influence their deposition in sampling lines and collection devices. The magnitude of electric charge carried by inhaled particles can have a significant effect on their deposition in the lung. In addition, electric charge may affect role of bioaerosols as ice and cloud condensation nuclei; charge (or electrical mobility) can control bioaerosol movement in electrical fields, such as created by power lines. Electrical charge is also important for the development of bioaerosol samplers that utilize electrostatics for particle collection - this technique has been shown to be more "gentle" collection method than traditionally used impactors and impingers. Our previous studies have shown that airborne environmental bacteria, such as *Pseudomonas fluorescens* and *B. subtilis* var. *niger*, have a net negative charge, with individual cells carrying as many as 10,000 elementary charge units, which sharply contrasted with low electrical charges carried by non-biological test particles. We have also found that magnitude and polarity of electrical charge can significantly affect viability of sensitive bacteria, such as *P. fluorescens*. In our continuing exploration of electrobiological properties of bioaerosols, we investigated application of electrostatic collection method for concurrent determination of total and viable bioaerosols, and also analyzed the effect of electrical fields on microbial viability. In our new bioaerosol collector, the biological particles are drawn into the sampler's electrical field and are concurrently deposited on an agar plate for determining viable microorganisms, and into a ELISA plate for determining total collected microorganisms. Experiments with *B. subtilis* var. *niger* and *P. fluorescens* vegetative cells have shown that on average 80 percent of airborne bacteria entering the sampler were removed from the air onto the plates when the sampler operated at 8 L/min and used collection voltage of -1,500V. From 15 to 25 percent of all bacteria entering the sampler were enumerated by the culture technique. Use of electrostatic analysis techniques may require application of strong electrical fields which could be damaging to biological particles. In our experiments, the airborne *P. fluorescens* bacteria were exposed to electric fields of 10kV/cm for 30 seconds, which did not result in viability reduction. In contrast, more than 90 percent of the *P. fluorescens* cells have been killed when the microorganisms were first deposited on filters and then exposed to positive electrical field of 15 kV/cm for at least 15 minutes. Electrical fields of 5 and 10 kV/cm also achieved similar effect when bacteria were exposed for 120 min. The exposure of bacteria to negative electrical fields resulted in even higher rates of inactivation. The *B. subtilis* var. *niger* bacteria proved to be harder and 10 percent viability reduction was achieved with the use of 15kV/min for 2 hours. The obtained results demonstrate the importance of electrical charges and fields in behavior, collection and control of bioaerosols. The field studies will have to be performed to confirm laboratory findings.

**A22B CC: 520 D Tuesday 1030h**

**Tropical Water Vapor: New Understanding and New Challenges II (joint with H, OS, GC)**

**Presiding: A Gettelman, National Center for Atmospheric Research; S Sherwood, Yale University**

**A22B-01 1030h INVITED**

**Tropical tropopause water isotopes in a GCM: Sensitivity to cloud processes and stratosphere-troposphere exchange**

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Water isotopes ratios ( $\delta^{18}O$ ,  $\delta D$ ) are very sensitive tracers of the history of the water in the atmosphere. For example, depletion of heavy isotopes in convective plumes can be extreme and thus isotope ratios can be used to discriminate between upwelled and in-situ condensation. We present results with state-of-the-art GCMs that include water isotopes in every aspect of the modelled water cycle, including the relatively sophisticated prognostic cloud water scheme. These models also have reasonable representations of the stratospheric circulation and so can be used to look at the processes involved in stratosphere-troposphere exchange. We demonstrate that the models show a similar range of variability near the tropical tropopause to that seen in recent data, and that the zonal mean values are less depleted than a simple Rayleigh distillation column would suggest. Importantly, we show that the isotopes can be sensitive to uncertain details of the cloud parameterizations and thus may help in improving and validating cloud schemes in models.

**A22B-02 1050h**

**The Lofting and Sublimation of HDO-Rich Ice in Cumulonimbus Anvils**

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We employ a three-dimensional large eddy simulation with bin-resolved microphysics to simulate the distribution of water isotopomers within deep convective clouds. Deep convection produces vertical profiles of HDO vapor that deviate significantly from the Rayleigh distillation model. These deviations are caused by the lofting of HDO-rich cloud ice within convective updrafts and the subsequent sublimation of this lofted ice in cumulonimbus anvils. The model results agree qualitatively with in situ measurements obtained during the CRYSTAL/FACE field campaign. Together, the in situ measurements and simulation results provide a key step to understanding the isotope ratios of water vapor in the stratosphere and the dehydration mechanisms operating during stratosphere/troposphere exchange.

**A22B-03 1105h**

**Dehydration in the Tropical Tropopause Layer: Implications from UARS MLS**

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Measurements of H<sub>2</sub>O from the Microwave Limb Sounder (MLS) on the Upper Atmosphere Research Satellite (UARS) are used to investigate the structure of H<sub>2</sub>O in the near tropopause region and dehydration mechanisms in the tropical tropopause layer (TTL). The new MLS data are consistent with convective input of H<sub>2</sub>O into the bottom of the TTL followed by slow ascent with a maximum relative amplitude in the seasonal cycle occurring near the tropopause nearly in phase with the tropopause temperature seasonal cycle. The relative amplitude of the seasonal cycle shows a minimum at 121 hPa in the upwelling moist phase. These features are reproduced with the 'cold-trap' dehydration hypothesis. Seasonal maps show wettest tropical 100 hPa H<sub>2</sub>O co-located with continental convection.

**A22B-04 1125h**

**What are the changes in stratospheric water vapor?**

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Increases have been noted in Northern Hemisphere middle latitude stratospheric water vapor over an extended period of time in a variety of instrument records. However, the changes are neither linear nor continuous. In particular, since 2000, a significant decrease has been observed in tropical HALOE water vapor measurements in the 100-70 hPa layer. Similar decreases in the lower stratosphere are also seen in the frost balloon observations taken by the NOAA Climate Monitoring and Diagnostics Laboratory in Boulder, Colorado, USA. (40N) and the POAM and SAGE-II satellite records. In this presentation, data from these varied instrument records will be shown, and possible mechanisms for the observed temporal changes discussed.

**A22B-05 1140h**

**Dehydration at the Tropical Tropopause Over the Indian Ocean**

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During the APE-THESOO campaign in February/March 1999 high-resolution in-situ measurements were carried out onboard the Russian M-55 Geophysica high altitude aircraft, based on the Seychelles (-4.7° N, 55.3° E) in the western Indian Ocean. In the potential temperature range from 340 - 430 K, 36 individual (quasi)-vertical profiles of temperature, the gas-phase and total water cloud particles, and ozone were obtained. The height of the tropopause and the hypogopause were highly variable for the investigated period. We attribute this to short and local perturbations to the seasonal cycle. The cold point tropopause was located at a potential temperature range from 365 - 403 K. Minimum temperatures were very low (183 - 194 K), leading to saturation mixing ratios at the tropopause of