bimodal. This bimodality implies sharp gradients between dry and moist regimes in space and time. A method of testing for and quantifying bimodality is introduced. Using this method, the bimodality of water vapor is surveyed in satellite and in situ observations, as well as global model reanalysis and simulations. The bimodality suggests that the radiative drying time after an injection of moisture by convection is short (1-2 days) compared to a homogenizing time, whether physical (mixing) or mathematical (averaging). It is shown that the local bimodality found in cloud-model simulations and in situ point measurements disappears with modest time averaging (18 h and 200km), but then reappears on the global scale, where dry and moist regions are separated so widely that synoptic and large-scale mixing times exceed the drying time scale. Large discrepancies exists in the ability of reproducing the global-scale bimodality by global model reanalysis and simulations.

URL: http://orca.rsmas.miami.edu/~czhang/publications/bimodal.pdf

A21C-04 0930h

Trimodal distribution of ozone and water vapor in the UT/LS during boreal summer

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The relation of ozone and water vapor in the upper troposphere and lower stratosphere (UT/LS) is strongly influenced by the off-equatorial Asian and North American monsoons in boreal summer. Both regions experience hydration, presumably as a result of deep convection. This behavior contrasts sharply with the apparent dehydrating influence of near-equatorial deep convection in boreal winter. There is also a striking difference in ozone between Asia and North America in boreal summer. Over Asia, ozone concentrations are low, evidently a result of ubiquitous deep convection and the vertical transport of ozone-poor air, while over North America, ozone concentrations are much higher. Since deep convection also occurs in the North American monsoon, it appears that the difference in ozone concentration between Asia and North America in boreal summer reflects a differing influence of the large-scale circulation in the two regions: specifically, (i) isolation of the Tibetan anticyclone versus (ii) the intrusion of filaments of ozone-rich air from the stratosphere over North America. During boreal summer, as in winter, near-equatorial concentrations of ozone and water vapor are low near the equator. The result of these geographical variations is a trimodal distribution of ozone and water-vapor correlation. Our talk reviews the observational evidence of this trimodal distribution and possible dynamical and microphysical causes, focusing primarily on the quality and possible sampling bias of satellite and aircraft measurements. A key issue is the ability of HALOE to sample areas of ubiquitous deep convection. Other issues include the vertical structure of tracer anomalies, isentropic stirring in the UT/LS, horizontal transport of biomass burning products lofted by deep convection, and connections to the moist phase of the tropical tape recorder' signal in water vapor.

A21C-05 0945h

Intraseasonal Variations of Water Vapor and Cirrus Clouds in the Tropical Upper Troposphere

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Space-time variations of tropical upper tropospheric water vapor and cirrus clouds associated with the intraseasonal oscillation (ISO) are investigated using data from the Microwave Limb Sounder (MLS) and the Cryogenic Limb Array Etalon Spectrometer (CLAES) on board the Upper Atmosphere Research Satellite (UARS). Composite moisture and meteorological fields based on five ISO events selected in two boreal winters (1991-1993) are analyzed using 20-80 day bandpass filtered data. At 215 and 146 hPa, wet anomalies with frequent appearance of cirrus clouds exist over the convective system and move eastward from the Indian Ocean to the central Pacific, suggesting a direct effect of convective activity up to this level. At 100 hPa, however, the moisture field seems to be indirectly affected by convective activity through the dynamical response to the convective heating. Dry anomalies are observed over the Indian Ocean around the developing stage and over the eastern Pacific around the mature-to-decaying stage of the ISO. Cirrus clouds are frequently found over the cold region located to the east of the convective system. These structures around the tropopause level are closely related to the eastward moving Kelvin and Rossby wave responses to the convective heating with the equatorial cold anomaly and with the subtropical anticyclonic gyres. Between the two gyres the easterly wind blowing through the equatorial cold region may cause dehydration through cirrus formation when the convective system develops over the Indian Ocean and the western Pacific. As the northern gyre intensifies, tropical dry air is transported to the subtropical Pacific and eventually to the equatorial eastern Pacific. It is suggested that the temperature and flow variations due to the coupled Kelvin-Rossby wave structure play an important role in dehydrating air in the tropical and subtropical tropopause region.

A21D CC: 520 F Tuesday 0830h

Atmospheric Chemistry and Aerosol Processes in West Africa: Saharan Dust, Biomass Burning, and Measured Tropospheric Ozone I *(joint with U)*

Presiding: **G S Jenkins,** Howard University**; V Morris,** Howard University**; R Martin,** Dalhousie University

A21D-01 0835h INVITED

An Investigation of Tropospheric Ozone Interannual Variability over Africa Determined from Satellite Measurements

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Using measurements from the Total Ozone Mapping Spectrometer (TOMS) and Solar Backscattered Ultraviolet (SBUV) satellite instruments, we have derived nearly 20 years of tropospheric ozone monthly distributions. Previous studies have shown that the interannual variability of the amount of ozone over western Europe can be related to the intensity of the North Atlantic Oscillation (NAO) and that the amount of ozone pollution over northern India is correlated with the indices defining the strength and phase of the El Niño/Southern Oscillation (ENSO). In addition, this dataset also displays significant interannual variability over several regions of Africa. This study will focus on the ozone abundance over these regions and investigate the extent to which such variability is related to either the NAO or ENSO as a means to determine which prevailing meteorological situation is most conducive to enhanced tropospheric ozone production.

A21D-02 0850h INVITED

Satellite Observations of African Biomass Burning Emissions and Their Impact on Tropospheric Air Quality

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Satellite remote sensing offers one of the best opportunities for making global measurements of tropospheric trace gases and aerosols over extended periods of time. It provides an integrating step between observations of emission sources and subsequent in-situ measurements taken some distance away, thus allowing the the examination of the impact of intense local pollution sources on continental scale air quality. Measurements from the Terra satellite launched in December of 1999 now provide a global record of the recent inter-annual variability of tropospheric air quality: carbon monoxide (CO) from the Measurement Of Pollution In The Troposphere (MOPITT) instrument, and of aerosol optical depth from the Moderate-resolution Imaging Spectroradiometer (MODIS). In this paper we use different sensor measurements to obtain a broader picture of the processes affecting tropical tropospheric chemistry and transport over Africa and the Atlantic and Indian Oceans at different times of the year. We use the signatures of large biomass burning events to trace the long-range transport of pollutant emissions and their effect on air quality in remote regions as revealed through comparisons with in-situ measurements and satellite estimates of tropospheric ozone. We also assess the role of large-scale convection in delivering biomass burning pollutants to the upper troposphere. When used in conjunction with satellite fire detection, the availability of global CO and aerosol data from the last 3 years also allows us to study variability in biomass burning and the corresponding influence that this has on seasonal and inter-annual variability of atmospheric pollutant burdens on the global scale.

A21D-03 0905h INVITED

African Equatorial and Subtropical Ozone Plumes: Recurrence Timescales of the Brown Cloud Trans-African Plume and Other Plumes

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We have found repeated illustrations in the maps of Total Tropospheric Ozone (TTO) of apparent transport of ozone from the Indian Ocean to the Equatorial Atlantic Ocean. Most interesting are examples that coincide with the INDOEX observations of late northern winter, 1999. Three soundings associated with the SHADOZ (Southern Hemisphere Additional Ozonesondes) network help confirm and quantify degree of influence of pollution, lightning, and stratospheric sources, suggesting that perhaps 40% of increased Atlantic ozone could be Asian pollution during periods of maximum identified in the TTO maps. We outline recurrent periods of apparent ozone transport from Indian to Atlantic Ocean regions both during and outside the late-winter period. These are placed in the context of some general observations about factors controlling recurrence timescales for the expression of both equatorial and subtropical plumes. Low-level subtropical plumes are often controlled by frontal systems approaching the Namib coast; these direct mid-level air into eithier easterly equatorial plumes or westerly mid-troposphere plumes. Equatorial plumes of ozone cross Africa on an easterly path due to the occasional coincidence of two phenomena: (1) lofting of ozone to mid and upper levels, often in the Western Indian Ocean, and (2) the eastward extension of an Equatorial African easterly jet.

URL: http://www.sonic.net/~chat

A21D-04 0920h

AEROSE 2004 - An Interdisciplinary Atmosphere-Ocean Saharan Dust Expedition

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The NOAA Center for Atmospheric Sciences (NCAS) is sponsoring a Trans-Atlantic Saharan Dust AERosol and Ocean Science Expedition (AEROSE) aboard the NOAA Ship Ronald H. Brown in March 2004. The fundamental purpose of this aerosol cruise is to study the impacts and microphysical evolution of Saharan dust aerosol as it is transported across the Atlantic Ocean. The mission encompasses both, atmospheric and oceanographic components. Participating institutions include Howard University, NCAS lead institution, the University of Puerto Rico at Mayagüez, the Canary Institute of Marine Sciences,

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 trough 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 and 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 be 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