generated in the Sahara, suggesting that the anthropogenic influence in the area is negligible. Saharan dust was suggested to be the main source of nutrients to the Amazon forest. Here we are also showing that these South Saharan sources around the Bodele depression are very active in the winter and rather passive in the summer, suggesting that the type of dust reaching Brazil, and its mineral content from these sources may be different from the dust that arrives to North America and Europe emitted in the summer from different sources.

A31A-07 0930h

Quantitative Constraints on Aerosol Optical Properties Over Dark Water from MISR Multi-angle Imaging

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Prior to the NASA Earth Observing System (EOS) satellite launchs, a broad picture of global aerosol distributions was already emerging, from the combination of earlier in situ and satellite measurements with transport modeling. One goal of the instruments aboard the EOS satellites is to quantitatively improve our knowledge of the aerosol radiative impacts and transport budgets developed from the pre-launch picture, by better constraining aerosol amounts and types, globally. To address this goal, details of low-light-level instrument calibration, as well as assumed aerosol properties and other attributes of the satellite aerosol retrieval algorithms, must be understood, within a few percent accuracy. We identified 14 occasions when the Multi-angle Imaging SpectroRadiometer (MISR) instrument aboard the EOS Terra satellite took high-quality data over islands hosting operational AERONET sun photometers, under relatively cloud-free conditions, at times when aerosol optical thickness (AOT), AOT variability, wind speed, and ocean surface reflectance were low. We simulated top-of-atmosphere equivalent reflectances in all 36 MISR channels using AERONET-derived AOT and particle properties, and compared with MISR radiance products. The details of these comparisons raise interesting questions that bear upon the quality of satellite instrument calibration, the nature of data sets required to validate satellite aerosol retrieval algorithms, and about the combinations of measurements needed routinely to achieve quantitative improvements in the aerosol picture over global oceans. This work is performed at the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

URL: http://www-misr.jpl.nasa.gov

A31A-08 0945h

Comparison of MISR and MODIS Aerosol Optical Depth.

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The Multi-angle Imaging SpectroRadiometer (MISR), aboard NASA's Terra Spacecraft is making measurements of the Top-of-Atmosphere radiance in four spectral bands, centered at 446, 558, 672 and 866 nm, at nine view angles (70.5, 60.0, 45.6, and 26.1 degree, forward and aftward of nadir and nadir). The MODerate resolution Imaging Spectroradiometer (MODIS), also aboard the Terra platform, is making observations of the upwelling earth radiance in a wide spectral range (36 channels). Aerosol optical depths over land and ocean are derived from the measurements of the two instruments. A study was performed to compare MISR and MODIS aerosol optical depths with those derived from simultaneous measurements made by sunphotometers at several AERONET sites. Sources of disagreements between the two instruments are explored in this study. The results are presented in this paper.

A31B MCC: 3018 Wednesday 0800h

Chemistry and Dynamics of the Upper Troposphere and Lower Stratosphere I *(joint with SA, AE)*

Presiding: **D J Cziczo**, NOAA Aeronomy Laboratory; **O Cooper**, NOAA Aeronomy Lab and CIRES

A31B-01 0800h INVITED

Chemistry of Cosmogenic Radioisotopes in the Stratosphere

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Bombardment of Earth's atmosphere by Gev cosmic ray protons produces two neutrons/cm^2/second, which react with ^{14}N nuclei to form ^{14}C. The initial stratospheric reaction of the bare ^{14}C atom with O_2 forms ^{14}CO, which is subsequently oxidized to $^{14}CO_2$ by HO. The $^{14}CO_2$ is then the basis for age-dating studies of inorganic carbon, and of organic carbon after incorporation by photosynthesis. Proton spallation of light nuclei (chiefly ^{14}N, ^{16}O) produces various isotopic fragments, many of them radioactive, containing 8 or fewer protons and 10 or fewer neutrons. For geophysical studies, the most important of the radioisotopes so produced are ^{3}H, ^{7}Be, and ^{10}Be. Proton spallation of ^{40}Ar produces many isotopes with atomic weight less than 40, including ^{34}Cl, ^{36}Cl, ^{38}Cl, ^{39}Cl, ^{35}S, ^{38}S, ^{22}Na, ^{24}Na, ^{32}Si, ^{32}P, and ^{33}P, all of which have been detected in the atmosphere. The "million year" isotopes (^{10}Be, ^{36}Cl) are useful for geological dating. The short-lived isotopes were collected both from rainwater captured at ground level, and on filter paper at 18 kilometers altitude carried by an RB-57 aircraft (**1970**, J. A. Young, C. W. Thomas, N. A. Wogman and R. W. Perkins, *JGR*, 75, 2385). The radioisotopes were measured with multidimensional gamma ray spectroscopy, which was able to detect ^{24}Na and ^{38}Cl without prior chemical separation. Count rates as low as 0.1 count/minute were monitored, even in the presence of 10^7 counts/minute of fallout fission products from nuclear testing in the atmosphere. This fallout background is now greatly reduced because of the four decades old ban on nuclear testing in the atmosphere. The stratospheric collection of ^{24}Na (15 hour half-life) was interpreted as scavenging of the radiosodium by particulate matter, and retention on filter paper with an efficiency of 100 percent within the statistical accuracy in comparison with its production in argon tanks carried on the aircraft. The efficiency of collection of radiochlorine atoms was only about 1/3, which was suggested as incomplete transfer to particles in the much shorter time available before radioactive decay. The chemistry of chlorine atoms such as ^{38}Cl (37 minute half-life) and ^{39}Cl (55 minutes) is probably still homogeneous gas phase in nature. Only small fractions might have reached H^{38}Cl or H^{39}Cl in the time available since nuclear creation of these atoms. Because cosmic ray intensity does not vary diurnally, the atmospheric chemistry of atomic radiochlorine atoms could be investigated under the very different free radical conditions found during night-time.

A31B-02 0815h

Large-Scale Equatorward Transport of Ozone in the Subtropical Lower Stratosphere

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Anomalous vertical profiles of ozone were observed in the sub-tropical lower stratosphere (near South Florida) in July 2002 during the NASA sponsored Cirrus Regional Study of Tropical Anvils and Cirrus Layers - Florida Area Cirrus Experiment (CRYSTAL-FACE) measurement campaign. It is shown that there is an enhancement of ozone (initially $>$ 150 %) above the tropopause extending up to 410 K potential temperature. This ozone increase is the result of recent transport of mid and high latitude lower stratospheric air into the sub-tropics. This meridional transport was a consequence of a geostrophic flow pattern established by a quasi-stationary anticyclone centered over the South-central US that persisted for much of July 2002. We show the spatial and temporal extent of meridional isentropic transport into the sub-tropics by examining the ozone vertical profiles in combination with the O3:NOy correlations as well as isentropic back trajectory calculations. The anomalous ozone profiles are also reproduced in a global chemical transport model.

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A31B-03 0830h

Radiative Forcing Associated with Changes in Upper Tropospheric Ozone Resulting from Deep Convection

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Deep convection transports large quantities of ozone precursors from the boundary layer to the upper troposphere. Once in the upper troposphere, ozone is produced efficiently and can be transported large distances. The 3-D University of Maryland Chemical Transport Model (UMD-CTM), driven by meteorological data from the NASA GEOS-3 Data Assimilation System, was run for the month of June 1985, encompassing a portion of the Kansas/Oklahoma PRESTORM experiment. In addition, the UMD-CTM was run for several 3 to 4 day periods during the same month but without convective transport. Upper tropospheric ozone downwind of major Central U.S. convective episodes was enhanced by as much as 20 ppbv in the model run with convection over the run without convection. Plumes of convectively enhanced ozone were noted exiting the east coast of the U.S. The radiation code from the GEOS-3 GCM was used to compute longwave and shortwave radiative fluxes at all model levels over a domain that included the U.S. and Western Atlantic. The radiative forcing associated with this increased upper tropospheric ozone was computed by subtracting the fluxes calculated using the ozone field from the CTM run without convection from the one run with convection. The results illustrate the importance of parameterizing convective transport properly in regional and global models.

A31B-04 0845h

Heat Balance in the Tropical Tropopause Layer

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Using a cloud resolving model, we show that the heat balance in the tropical tropopause layer (TTL) is between convective cooling and the combined heating effect of radiation and large scale heating/cooling. As expected, large scale dynamical cooling in the TTL such as due to the Brewer-Dobson circulation lifts and cools the TTL. The opposite effect is observed when dynamical heating is applied. In all cases, however, significant convective cooling exists in the TTL. Our results are in contrast to a recent suggestion by Thuburn and Craig (2002) based on a 1D radiative-convective model that the TTL (their substratosphere) is a stratospheric feature decoupled from convection.

A31B-05 0900h

On the Remarkable Cooling of the Tropical Lower Stratosphere Since 1990

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Radiosonde measurements of temperature and geopotential height from several island stations in the tropical western Pacific have been used to look for long-term trends in the tropopause region and the lower stratosphere. The time period studied was up to 43 years in length, beginning in 1960 and extending through 2002 in some cases. Trends prior to about 1990 were small, in agreement with previous results and with model predictions of the effects of long-term ozone depletion and greenhouse-gas enhancements, but a steep cooling trend has taken place throughout the decade of the 1990s and appears to be continuing unabated to the present. The cooling appears to maximize between pressures of 80 and 30 hPa, and is small at the tropopause level, indicating a decrease in the stability of the lowermost stratosphere. The cooling trend is steepest in the northern-hemisphere winter and early spring, and weakest in the northern early summer months, suggesting that it is dynamical in origin, and related to the meridional Brewer-Dobson circulation of the lower stratosphere. The results and their interpretation will be discussed.

A31B-06 0915h

POAM III Ozone and Water Vapor in the Upper Troposphere and Lower Stratosphere

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We present Upper Troposphere/Lower Stratosphere (UT/LS) observations from the Polar Ozone and Aerosol Measurement (POAM) III instrument. POAM is a remote sensing instrument that uses the solar occultation technique to measure trace gas species and aerosol extinction at high latitudes. POAM began measurements in April 1998 and is still operational. Ozone and water vapor observations on potential temperature and potential vorticity surfaces will be presented, in order to study seasonal and interannual variability in the abundance of these species in the UT/LS. Isentropic stratosphere-troposphere exchange is examined by means of ozone/water vapor correlations. We find evidence of isentropic exchange from the upper troposphere at lower latitudes to the lower stratosphere at high latitudes during summer and fall. We also use POAM observations in conjunction with isentropic advection calculations of ozone, water vapor, and tracer-derived equivalent length to study seasonal variability in isentropic transport in the lowermost stratosphere.

A31B-07 0930h

Warming of the Arctic Lower Stratosphere by Light Absorbing Particle

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Light absorption by particles such as soot and dust change the thermodynamic structure of the atmosphere and contribute to regional and global climate change. The lower stratosphere is particularly sensitive to the presence of light absorbing particles (LAP) since particles in this region can reside from months to years, in contrast to upper tropospheric lifetimes of days to weeks. The source of particles in the lower stratosphere may be aircraft, meteorites or transport from tropospheric sources. There is a serious deficiency of accurate and quantitative measurements of these particles that limits our understanding of the origin and lifetime of aerosols in this region of the atmosphere and how their presence alters radiative fluxes that lead to climate change. Here we present measurements in the Arctic lower stratosphere with a new, single particle soot photometer (SP2) that has detected black carbon (BC) mass concentrations of 20-1000 ng m^{-3}. These concentrations are 10-1000 times larger than those reported in previous experimental studies and are at least 30 times larger than predictions based on fuel consumption by commercial aircraft. The comparison of the measurements of BC with published 3D model predictions suggests that particles transported from the troposphere are the likely source of LAP in the Arctic lower stratosphere. Radiative transfer calculations that include the presence of a layer of LAP between 9 and 12 km, indicate an increase in the localised heating of this layer by approximately 25%.

A31B-08 0945h

Nitric acid depressions in and near midlatitude cirrus clouds during TRACE-P

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Cirrus cloud ice particles have been implicated in scavenging a wide variety soluble and semisoluble species. Species removed by an ice surface can undergo a number of significant processes including heterogeneous reactions with other adsorbed species, vertical redistribution in the troposphere from sedimenting particles, or modifying the microphysical properties of the ice particle. Nitric acid (HNO3) has been shown in the laboratory to readily adsorb onto ice surfaces, and modeling studies suggest significant perturbations to its distribution can result. Unfortunately, field observations of HNO3 within and near cirrus clouds have shown mixed and sometimes contradictory results. The NASA P-3B aircraft sampled numerous upper tropospheric, mid-latitude ice clouds during Flight 24 of the NASA TRACE-P field experiment. In contrast to tropical cirrus clouds, the cirrus ice clouds sampled by the P-3B were at warmer temperatures of -17 to -32 degrees Celsius and at pressures of 365-436 mb. The clouds' origins ranged from jet stream induced cirrostratus clouds to convectively-induced cirrus anvils. Nitric acid levels decreased 60-70 pptv (35-60%) within the clouds compared to areas just outside of it. Slight asymmetries in the HNO3 profiles around the cloud were noted, with the lee or downwind sides of clouds containing more gradual returns from inside cloud levels to "background" levels, potentially due to greater mixing as the cloud evaporated. If HNO3 removed inside the cloud were distributed evenly onto ice surfaces, approximately one tenth of a monolayer of HNO3 was adsorbed onto ice (based on estimates of ice surface area density of 5000 microns squared per cubic centimeter). The incorporation of HNO3 into existing liquid quaternary NH3/H2SO4/HNO3/H2O aerosols within the cloud could also be important due to the sampling location over central North America where elevated NH3 emissions exist. The midlatitude HNO3/cirrus cases observed on the P-3B will be contrasted to liquid water clouds sampled elsewhere during TRACE-P (only slight depressions observed), recent field results of tropical cirrus clouds, and laboratory and modeling studies.

A31C MCC: Level 1 Wednesday 0830h

Atmospheric Dynamics and Transport Posters *(joint with SA, AE)*

Presiding: **E Ray,** NOAA Aeronomy Laboratory**; E Richard,** NOAA Aeronomy Laboratory and CIRES

A31C-0036 0830h POSTER

The Equations of Motion in PV-coordinates

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The importance of potential vorticity (PV) for the global circulation of the atmosphere is now well recognized. This quantity captures all relevant information about balanced flows in a single scalar field, and therefore many aspects of the general circulation can be described compactly in terms of potential-vorticity dynamics. The dynamical equations governing the atmospheric flow can be transformed into a system of coordinates that uses PV as the meridional coordinate. We are exploring the utility of this coordinate for modeling the zonal-mean flow. The technique relies on the fact that PV is materially conserved in adiabatic, frictionless flow. We have constructed a shallow-water model on a sphere in which the meridional coordinate is the potential vorticity. In this model, (i) the mass flows in only one direction, parallel to the latitudinal circle on a surface of constant potential vorticity, (ii) the zonally averaged mass-weighted angular momentum changes only in response to the net form drag acting on a PV contour, (iii) in a time average or steady state the form drag is the same on all PV contours. We have also generalized the model to three dimensions, using potential temperature coordinates.

A31C-0037 0830h POSTER

Statistical Characterization of Stably Stratified Atmospheric Boundary Layer Turbulence

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In comparison with convective and neutral boundary layers, stable boundary layer (SBL) turbulence has not received much attention despite its scientifically intriguing nature and practical significance (e.g., numerical weather prediction and pollutant transport). This might be attributed to the lack of adequate field or laboratory measurements, to the inevitable difficulties - arising from small scales of motion due to stratification - in numerical simulations and to the intrinsic complexity of its dynamics (e.g., intermittency). Fortunately, the contemporary literature is witnessing a brisk surge in the SBL research. Field campaigns like SABLES 98, CASES-99 and high-quality wind-tunnel experiments geared towards comprehensive investigation of SBL are being carried out. In the case of numerical modeling, a handful of partially successful Large-Eddy Simulations (LES) and a few Direct Numerical Simulations (DNS) were also attempted. Despite all these synergistic efforts in understanding the SBL, several outstanding issues still remain. It is the purpose of this paper to address some of these (seemingly controversial) issues, such as the validity of Monin-Obukhov similarity under very stable stratified condition, existence of local scaling in non-traditional top-down boundary layers and the characteristics of probability density functions of turbulence in SBL. This is accomplished through extensive analysis of turbulence data from several field experiments. Wherever possible, support of our claims is provided by further analysis of wind-tunnel data and also by comparison with reported LES and DNS results.

A31C-0038 0830h POSTER

Turbulence Modeling of GABLS Stable Atmospheric Boundary Layer Intercomparison Case

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The GABLS arctic stable boundary layer intercomparison case is simulated using the One-Dimensional Turbulence (ODT) model. ODT is a single-column simulation in which vertical turbulent transport is represented by an unsteady, stochastic advective process, rather than the customary representation by a diffusive process. Unlike conventional single-column models, ODT resolves small-scale, unsteady motions and transport processes in the stable atmospheric boundary layer. In the GABLS intercomparison case, it captures small sporadic turbulent bursts that are not resolved by conventional single-column models or by large-eddy simulations. Strong property gradients in the shear-dominated near-surface boundary layer are resolved to the roughness scale, so a Monin-Obukhov-type near-surface parameterization is not needed. Results presented here include instantaneous and time-averaged vertical profiles of velocity components and