A51H-09 1050h

Upper Tropospheric-Lower Stratospheric In-Situ Measurements Over Hurricane Floyd: The Impact of Tropical Cyclones on Stratosphere-Troposphere Exchange

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The structure of hurricanes from the surface up to 200 mb (12 km) has been extensively studied. However, because of operational limitations of aircraft, very little in-situ information has been obtained within the hurricane environment in the upper troposphere-lower stratosphere (UT/LS). During the ACCENT experiment the WB-57 overflew Hurricane Floyd as it made landfall near the Georgia-South Carolina coastal boarder. High time resolution in-situ chemical measurements of ozone, methane and water vapor as well as meteorological data were obtained over a large area above Floyd, including regions of the eye-wall and eye. Two days prior, a similar flight track was followed by the WB-57 allowing for a comparison study of the influence of Floyd on the UT/LS region. In the UT/LS, ozone and methane serve as conserved tracers of stratospheric and tropospheric air, respectively and are used to compare the characteristics of the air masses. A comparison of the vertical profiles between the tropopause and 80 mb (18 km) for these two days shows lower water vapor, lower ozone and higher methane mixing ratios during the Floyd overflight. The results are consistent with local dehydration occurring above the storm, while the lower ozone and higher methane are indicative of upward transport of ozone poor and methane rich tropospheric air. In an attempt to quantify the mass flux into the stratosphere induced by Floyd we have performed an NCAR Mesoscale Model 5 (MM5) simulation. These results are compared with the in-situ data to assess the influence of Floyd on the stratosphere above the 400 K potential temperature level. Additionally, these results allow us to address the validity of the satellite results from the Total Ozone Mapping Spectrometer (TOMS) where local changes in the total ozone column have been used to elucidate hurricane evolution.

A51H-10 1105h

Horizontal variability 1-2 km below the tropical tropopause

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On 19990920 and 19990921 the WB-57F aircraft flew horizontal legs between the subtropics and the tropics at pressures near 120 hPa, 1-2 km below the tropopause at longitudes between 85°W and 95°W. The ozone varied between 10 and 125 ppbv, the total water varied between 5 and 20 ppmv. The ITCZ was situated near 15°N, with the flights extending between 5°N and 30°N, and was locatable by cloud images. We examine structure in tracers along these flight tracks, with lifetimes ranging from 2 days (methyl iodide) to decades (trichlorofluoromethane). Analyses are performed to partition the recent history of the air between troposphere and stratosphere, from both sides of the ITCZ.

A51H-11 1120h

Dynamical Contributions to Midlatitude Ozone Trends

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A number of mechanisms have been proposed by other researchers to explain the 7-percent per decade decrease in column ozone in the northern hemisphere midlatitudes over the last twenty years. The mechanisms most commonly cited are (a) in-situ heterogeneous chemistry, (b) the thinning of the midlatitude ozone layer by peel-off from the wintertime stratospheric vortex, and (c) the dilution effect when polar and midlatitude air masses mix during late winter and spring. However, a significant contribution to this trend may be ascribed to dynamical changes linked to the large-scale meteorology of the atmosphere. These changes may be entirely natural, or partially exacerbated by anthropogenic climate change.

In the lower stratosphere, where the ozone trend is greatest, parcels of subtropical air, naturally-poor in ozone, are regularly transported into midlatitudes. Seen against the ambient midlatitude ozone field, these air parcels are apparent in vertical ozonesonde profiles as ozone minima, not to be confused with ozone mini-holes which may arise from a number of causes (e.g., from the passage of cyclonic and anticyclonic systems affecting the altitude of the tropopause, or from chemical ozone loss in the middle stratosphere). Nevertheless, ozone minima can reduce the total column by up to 20-percent over areas in excess of a million square-kilometres. We demonstrate that variations in the number of ozone minima seen over Europe since 1968 correlate strongly with the phases of the NAO. Using NCEP reanalysis potential vorticity as a surrogate for ozone mixing ratio, on the 380K isentropic surface where ozone minima are most prevalent, we show that minima in PV most commonly occur in midlatitudes when the NAO phase is positive, and that their increased frequency since 1987 produces a significant northern hemisphere midlatitude trend.

A contribution to the trend may also arise from small-scale transport out of the stratospheric polar vortex during winter. Using a special version of the Lagrangian particle dispersion model FLEXPART, driven with global model-level data from the European Centre for Medium-Range Weather Forecasts, we have simulated the exchange of air across the vortex boundary. The ECMWF data used for this study have a horizontal resolution of one degree, 60 vertical levels and a time resolution of three hours, achieved by combining analyses and forecasts. The study focuses on 11 March 2000, and falls within the SAGE III Ozone Loss and Validation Experiment (SOLVE), a measurement campaign designed to examine the processes controlling ozone levels at mid- to high latitudes. Model results are accompanied by, and compared with, in-situ data collected by NASA's ER-2 and DC-8 aircraft.

URL: http://www.stephenjreid.com

A52A MC: Hall D Friday 1330h

Diagnosing Systematic Errors in Numerical Models of the Climate System II

Presiding: **G L Potter,** Lawrence Livermore National Laboratory

A52A-0146 1330h POSTER

AMIP II Evaluation of the Continental Component of the Global Energy and Water Cycles

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We have analysed global land-surface energy and water budget components for the period 1979-1995 simulated by 10 AGCMs participating in the second phase of the Atmospheric Model Intercomparison Project (AMIP II). The simulations are compared with three reanalysis products (NCEP/DOE, NCEP/NCAR and ECMWF) and with the global land-surface simulations by the Variable Infiltration Capacity (VIC) land surface scheme. A lack of adequate observational data at the land surface is a limiting factor for evaluation of the land-surface climate in global climate models and it is anticipated that until such data becomes available, the model derived estimates such as are produced by the reanalysis is the best available option for model validation. Results underline a number of problems in some model simulations such as non-conservation of water and energy and problematic simulation of surface evapotranspiration This is in some degree related to poor initialisation and/or bad parameterisation of soil moisture. In a comparison of three reanalysis products and VIC land surface simulations we find large differences among the AMIP II models, among the reanalyses, and between models and reanalysis in simulating surface fluxes. The simulation of latent heat flux by different models relative to each other and relative to different reanalyses estimates vary in different climate zones and the differences among reanalyses are of the same order as differences between the model simulations and reanalyses estimates. The mean latent heat flux over all land surfaces ranges from 42.1 W m^{-2} to 56.8 W m^{-2} among the validation data sets, comparable to that among the AMIP II models. Compared to ECMWF reanalysis, the mean absolute deviation latent heat flux of the two reanalyses is 6.8 W m^{-2}, much larger than the mean absolute deviation of 3.2 W m^{-2} for the AMIP II models. Use of reanalyses for model evaluation of the continental component of the global water cycle is therefore problematical. Until reliable global land-surface observational data sets become available, it may be more appropriate to consider the ensemble of the available reanalysis data sets a the best validation tool.

A52A-0147 1330h POSTER

Sensitivity of the Canadian RCM to the Surface and Atmospheric Initial Conditions

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In a Regional Climate Model simulation it is usually assumed that for a given set of lateral boundary conditions (LBC) and a given model configuration, a unique simulation is produced. In other words, for a given grid location and size, the simulation of a RCM is expected to be strongly controlled by the LBC and should be independent of the initial conditions (IC). In this study we look further at this assumption.

The experimental set-up is built as follow. A one-month long Canadian RCM (CRCM) December simulation is performed followed by three 12-month CRCM simulations starting the following January 1st. All simulations are performed on the same grid and use identical time-dependent lateral boundary conditions supplied by a GCMii current climate simulation. The only difference between the three CRCM simulations is in the prescription of the IC for the atmospheric and surface fields. For the first simulation the IC for both atmospheric and surface fields were taken from the December simulation. In the second simulation atmospheric IC were taken from the GCMii simulation and surface IC from a climatological database. For the third simulation, atmospheric IC were again taken from the GCMii simulation but surface IC were taken from the December CRCM simulation. By comparing the results of the different experiments it is possible to look at the sensitivity to surface and/or atmospheric IC fields.

The results show that during the first few months every CRCM simulations follow each other closely until the beginning of summertime when there is an increase of the discrepancies between all the simulations. This increase is observed for all simulations. However, simulations sharing the same surface IC take longer before developing differences. After summertime the level of similarity between the simulations reaches values comparable to the first few months. Preliminary analysis suggests that the level of control exerted by the LBC and the more stochastic activity of parameterised subgrid scale processes are responsible for this behaviour.

A52A-0148 1330h POSTER

Zonal Mean Diagnostics of the Transport Properties of GCMs and DASs

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The chemistry transport models (CTMs) aim to reproduce the observed distributions of the long-lived and short-lived species in the troposphere and stratosphere, including their annnual and interannual variations and long-term trends. Various archived dynamics have been used by modellers to drive CTMs, including 3-D transport fields from general circulation models (GCMs) and data assimilation systems (DASs). We briefly review our zonal mean diagnostics package for evaluation of the transport properties of GCMs and DASs, highlighting some results that can be seen from the annual evolution of the monthly mean transport parameters. The package includes the trajectory code for particles dispersion and estimation of the zonal mean transport circulation and large-scale eddy mixing using the Eulerian tracer model.Comparative examples will be presented for the 2000 NCEP and ECMWF DASs, and MACCM2-95 GCM. The tracer model itself can be used to diagnose some subgrid vertical transport parameters from the global meteorological fields (e.g., convection and diffusion of tropospheric pollutants). We compare the first tropospheric CO retrievals from the MOPITT instrument on the Terra satellite with the CO-tracer simulations driven by the NCEP large-scale dynamics and convective transports that are estimated by different convective schemes from the NCEP archived history tapes.

A52A-0149 1330h POSTER

Systematic Errors in NOGAPS: Improvements to the Cloud and Turbulence Parameterizations

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Turbulence, convection and clouds have a strong impact on the Earth's climate system. However, these processes are often active at scales smaller than the horizontal grid size of climate or numerical weather prediction models. Parameterization schemes are necessary in order to describe the impact of these sub-grid scale mechanisms on the large scale flow of the atmosphere. Improvements to the parameterization schemes can have significant effects on the reduction of systematic errors in climate models. A review of improvements to the cloud and turbulence schemes in NOGAPS and its impact on systematic errors will be presented.

A52A-0150 1330h POSTER

Application of Methods of Systematic Initial Model Tendency Error Detection to the Deduction of Underlying Sources of Systematic Errors

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The causes of systematic errors in the time mean fields of a GCM are difficult to detect from an analysis of the errors themselves. Direct estimates of systematic initial tendency errors (SITEs) determined by assimilation of reanalysis data will on the other hand point more directly to the model components causing the errors. The ECMWF Reanalysis (ERA-15) data for the period 1982 until 1994 were assimilated in different ECHAM versions using different techniques, the SNMI with window, nudging and for a part of the period using the Total Insertion (TI) with window methods, introduced and validated in an accompanying presentation. The techniques uncover SITEs of the model in question, visible as rather similar structures. In the TI experiments, the SITEs are generally less weakened than in the SNMI experiment by balancing during the assimilation, in particular at upper levels, but contains more unbalanced spurious SITEs, caused by truncation and interpolation errors.

Using these methods assimilation runs were made and SITEs were determined. These were analysed with the purpose to deduce the causes of the systematic mean errors found in AMIP runs with the model. To try to distribute the total SITEs on different model processes we use methods based on comparisons of the three dimensional structure of the SITEs and the three dimensional structure of the time mean tendency fields of each of the model processes in question. This reviles deficiencies in the representation of key physical processes in the climate model, which together form a basis for improvement of the model.

A52A-0151 1330h POSTER

Spectral EOF Analysis: Another Way to Compare the General Circulation Model With Observation

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Spectrally resolved outgoing radiance could be a potentially powerful tool for testing climate models, especially testing the variability of models. To show how it can be used to evaluate the simulation of clouds in models, which is the major uncertainty in current climate models, we apply spectral empirical orthogonal function (EOF) analysis to observed outgoing radiance spectra and synthetic spectra derived from a general circulation model (GCM). The observation data were collected by IRIS (InfraRed Interferometer Spectrometer) aboard on Nimbus4. The modeled vertical profiles of temperature, water vapor and cloud optical depth were imported to MODTRAN (MODerate resolution TRANsmittance code) to compute the synthetic spectra. We focus our study on tropical oceans because they have smaller diurnal and seasonal cycle than other regions. The issues of different spatial and temporal sampling patterns of observation and GCM are carefully studied. It turns out that proper averaging over correct timescale before applying spectral EOF analysis is necessary because sampling patterns of GCM and observation are difference. For both observation and GCM output, cloud is the dominant contributor to the first principal component that accounts for more than 90% of the total variance. However, the amplitude of the first principal component derived from the IRIS is 2-3 times greater than that of the GCM simulation. This suggests that cloud variability in GCM is much less than the real atmosphere.

A52B MC: Hall D Friday 1330h

Chemistry and Transport Near the Tropopause: Results From the 1999 and 2000 ACCENT WB-57F Field Campaigns II

Presiding: **R Friedl,** Jet Propulsion Laboratory**; K Rosenlof,** NOAA**; M Ross,** The Aerospace Corporation

A52B-0152 1330h POSTER

Overview of ACCENT Near Tropopause Measurements

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The Atmospheric Chemistry of Combustion Emissions Near the Tropopause (ACCENT and ACCENT 2) missions were multi-agency sponsored efforts to investigate the chemistry of rocket and aircraft emissions in the upper troposphere (UT) and lower stratosphere (LS). The missions utilized the NASA WB-57F aircraft and were based at Ellington Field in Houston, Texas during April and September, 1999 and August 2000. During ACCENT extensive sampling was conducted in the vicinity of the Dallas-Fort Worth airport where meteorological forecasts predicted accumulation of aircraft exhaust. The gaseous tracer data obtained during the Dallas flight indicate that the sampled air was substantially impacted by recent and aged aircraft exhaust. The ACCENT mission also collected near tropopause gaseous and aerosol data in the tropics and near and above hurricane Floyd. In this overview presentation we will describe the mission objectives regarding the impacts of aviation on the global atmosphere and the meteorological planning tools applied to flight planning. A number of key chemical and aerosol observations will be highlighted.

A52B-0153 1330h POSTER

Transport in the Region of the Subtropical Jet Deduced From WB-57 Measurements and Mesoscale Modeling

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Recent WB-57 missions have provided a wealth of long-lived tracer and aerosol measurements in the upper troposphere and lower stratosphere. In this study we use in situ water vapor, ozone and meteorological measurements as well as vertical sounding data to investigate transport in the region of the subtopical jet. In addition, mesoscale model simulations from the NCAR MM5 are utilized to attempt to reproduce the observations and help determine possible mechanisms of transport. We focus on the flight of May 7, 1998 since it has several interesting features in the measurements taken as the flight crossed a jet exit region at roughly the 370 K level. On the tropical side of the jet, low water vapor and relatively high ozone mixing ratios were measured suggesting the air in this region had stratospheric characteristics. Yet according to MM5 output this region is well within the troposphere. Within the jet the water vapor mixing ratios are highly variable, with some mixing ratios higher than those measured on either side of the jet at the same isentropic level. This suggests that perhaps there was more vertical mixing within the jet than on either side of the jet. A third interesting feature in the measurements is seen several hundred km north of the jet just as the plane began to rise in altitude. Between 370-390K the water vapor increased sharply and the ozone decreased sharply at the same time the MTP instrument indicated the tropopause level had risen from 345 K to 370 K in less than 50 km. This feature is highly suggestive of a small filament of upper tropospheric air which has been transported to the north side of the jet. Each of these features is compared to MM5 output and trajectory analyses.

A52B-0154 1330h POSTER

Mass Spectra of Individual Aerosol Particles Acquired During Intercepts of a Space Shuttle Exhaust Plume

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The WB-57 aircraft accomplished fourteen distinct stratospheric intercepts of the exhaust plume from a space shuttle during ACCENT 2000. Liftoff of the shuttle Atlantis for STS-106 occurred at 8:46 am local (12:46 UTC) with intercepts occurring from 5 to 90 minutes afterward. The Particle Analysis by Laser Mass Spectrometry (PALMS) instrument, mounted in the nose of the aircraft, was used to acquire individual mass spectra of over 2500 particles during these intercepts. The majority of positive mass spectra indicate the presence of the metals Al, Fe, Zn, Ga, and V, all components found in the solid rocket fuel. Organic material, presumably from binding and curing agents, was also present. Negative mass spectra showed Cl from the oxidizer, ammonium perchlorate, as well as water. Rare exotic particles, for example those containing Ti and Ag and possibly formed during engine or seal ablation, were also detected. Particles originating from shuttle exhaust but also containing significant sulfuric acid were common toward the outer edge of the plume, especially during late encounters, suggesting that deposition or aerosol collision had occurred.

URL: http://www.al.noaa.gov/PALMS/

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