A31E-0101 0830h POSTER

Modified Instrument ARUV for Automated Registration of Ultraviolet Radiation

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The automated instrument ARUV to measure the solar ultraviolet radiation (UV) was developed and built as a component of the multi-purpose monitoring system at the Division of Cosmic Rays of IZMIRAN. ARUV includes modules: (1) optical; (2) dispersion forming (grate and prizm); (3) guidance; (4) conversion of light to electronic signal; (5) registration. Modules 1 and 3 (celostat, astrosensor, photoelectrical unit, beam guidance) retain the light over the slit of the spectrometer. The optical system provides amplification by a factor of 400-500. The dispersion-forming block is installed on the industrially manufactured spectrometer STE-1 with the crossed dispersion (grate plus prizm). The inverse linear dispersion in wavelengths 350-450 nm is 0.47 - 0.64 nm/mm and the resolution is 0.01 nm. Registration is carried out by scanning over the spectrum with NMOS Linear Image sensors. The scanning covers two wavebands: 304.4 to 316.3 nm and 324.0 to 336.0 nm. The duration of scanning is less than 0.01 s, which allows us to neglect the time shift of processes with periods greater than 0.1 s. All microchips (guidance of the light beam, feedback, signal conversion, forming of the output signal, and data storage) are set up on a single plate together with NMOS Linear Image sensors. The plate is installed in the cassette of the spectrometer. ARUV can be used both in ground-based observatories and on moving vehicles (ship, aircraft). Reference. Steblova, R.S., A.V. Kulikov, V.G. Yanke, and V.G. Kartashev, The automated instrument to measure ultraviolet radiation (ARUV), EOS Trans. AGU, 76(46), F101, 1995.

A31E-0102 0830h POSTER

Using Environmental Variables to Distribute Human Populations Spatially With an Evaluation in California

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Climate change research, which focuses on anthropogenic factors, may be hampered by the lack of population data available at high spatial resolutions, particularly for developing countries or historical time periods. A refined model that distributes human populations spatially is developed and tested using California as the test case. The model is based on the concept of "habitability". Habitability is the propensity for a place to sustain a fixed human population. Habitability is forced by environmental factors, specifically elevation, topographic accessibility, river proximity, and annual water surplus. Model-estimated population distributions are compared to 1990 California census data at the block-group level to evaluate the efficacy of the habitability model. Results show that the model can realistically distribute California's total population based on the spatial distributions of a few environmental variables. Adding annual water surplus actually degraded the model's performance, which implies that it may not require a hydroclimatic variable. The model does not resolve well the very-high urban densities. Although further refinement is necessary to adequately represent the urban populations, the habitability model performance suggests that it is a promising approach to population mapping, as well as to quantifying population-environment variables.

A31E-0103 0830h POSTER

Prediction of Significant Wave Heights in Extreme Storms Affecting Far North Alaska

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Barrow, Alaska is located at the northernmost point of the United States on the shore of the Arctic Ocean. The area surrounding Barrow is low lying and is thus vulnerable to coastal flooding via waves and storm surges. Previous modeling of flooding resulting from a storm that affected Barrow and the rest of the North Slope coast region in October 1963 did not reproduce observed flooding, which was substantially greater than modeled. It is hypothesized that because this model only incorporated storm surge and not waves, the model was unable to simulate the total amount of flooding. The current study examines a recent storm that affected the North Slope of Alaska on July 28-30, 2003, and includes prediction of wave height using the SWAN (Simulating WAves Nearshore) model. In addition this study considers the formation and development, climatological context, and community responses for this storm. Results from the wave modeling portion of this study will be incorporated into a coastal flooding model in order to better simulate the coastal environment under extreme conditions in this area.

A31E-0104 0830h POSTER

Climate Response to Large-Scale Wind Farms

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Enhanced reliance on wind energy is one of the possible ways to solve the greenhouse gas problem. However, because wind farms modify the interaction between atmosphere and surface, there is a possibility that wind energy might also change the global climate if developed on a scale large enough to make material reductions in greenhouse emissions. To investigate possible effect of large wind farm arrays on climate, we used a version of GFDL AGCM with prescribed climatological SST and ice extent. A series of 20-year integration included a range of spatial coverage and several different parameterizations for wind farms, as well as controls. Presented here are the results of the experiments with the largest wind farm arrays considered, where significant parts of Europe,North America, and-Chinaare covered. The total wind farm area in this case is about 10% of land surface; the resulting dissipation of kinetic energy on wind farms ranges from 12 to 19 TW (compared to current global primary energy consumption of 12 TW). The results of the simulations show similar effects on climate despite differences in parameterization for the wind farms. The global-average climate reaction is negligible, but regional effects are not. The effect of wind farms on annual mean surface air temperature reaches a regional maximum of the order of 1 degree, which is smaller than the 2XCO2 signal. The temperature response is strongest inEurasia, where it is characterized by cooling in northern mid-latitudes of entire continent and warming in the South in all seasons except JJA, when the pattern is much weaker. The response of precipitation does not show an obvious large-scale pattern and is likely to be statistically not significant.

A31F MCC: 3001-3003 Wednesday 1020h

Bjerknes Lecture *(joint with B, OS, GC)*

A31F-01 1025h INVITED

What atmospheric oxygen measurements are telling us about the carbon cycle

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Direct observations of changes in the oxygen content of the atmosphere have now been underway for more than a decade. The data reveal a rich spectrum of variabilty on seasonal and interannual time scales that are diagnostic of rates of photosynthesis and respiration in the land and marine biospheres and of rates of mixing and transport in the ocean and atmosphere. This paper will discuss how the oxygen data can be utilized, together with atmospheric CO2 data, to help separate land and oceanic contributions to CO2 variability and to provide a new window for resolving secular changes in ocean biogeochemistry. The paper will also highlight the expanding experimental capabilities for measurements of oxygen and related tracers.

A31G MCC: 3018 Wednesday 1020h

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

Presiding: **M Ross,** Aerospace Corp.**; M Zondlo,** Southwest Sciences

A

A31G-01 1020h

Evidence of the Effect of Summertime Midlatitude Convection on the Subtropical Lower Stratosphere: An Analysis of Tracer Measurements From the CRYSTAL-FACE Mission

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Correlations of long-lived trace gases measured during the CRYSTAL-FACE mission are used to examine mixing in the summer subtropical lower stratosphere. A large number of particles produced by biomass burning were measured in the lower stratosphere up to potential temperatures of 390 K. The particle measurements, combined with the large scale circulation, suggests recent injection of midlatitude tropospheric air into the lower stratosphere. Fractions of midlatitude tropospheric air in the lower stratosphere are calculated based on consistency between all of the tracer-tracer correlations. The tropospheric endpoints to the mixing estimates give an indication of midlatitude continental convective input into the lower stratosphere. Radiative heating rates in the summer subtropical stratosphere above roughly 360 K are positive which suggests that this region will rise and thus, the midlatitude convective input will have an effect on the composition of the stratosphere as a whole.

A31G-02 1035h

Stratospheric Water Vapor and the Asian Monsoon: An Adjoint Model Investigation

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A new adjoint model of the Goddard Parameterized Chemistry and Transport Model is used to investigate the role that the Asian monsoon plays in transporting water to the stratosphere. The adjoint model provides a unique perspective compared to non-diffusive and non-mixing Lagrangian trajectory analysis. The quantity of water vapor transported from the monsoon and the pathways into the stratosphere are examined. The emphasis is on the amount of water originating from the monsoon that contributes to the tropical tape recorder signal. The cross-tropopause flux of water from the monsoon to the midlatitude lower stratosphere is also discussed.

A31G-03 1050h INVITED

Quantifying Transport Pathways in the Middleworld During CRYSTAL-FACE Using Tracer-Tracer Correlations and a Simple Mixing Model

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Evidence from both satellite observations and previous aircraft missions (STRAT, POLARIS, SOLVE, CRYSTAL FACE, etc.) has illustrated the importance, seasonal idiosyncrasies, and complexity of middleworld dynamics. It is therefore vital to develop a framework for quantitatively understanding transport pathways in the middleworld, the lack of which continuously frustrates our ability to predict the behavior of both midlatitude ozone and water vapor in this region over the coming decades. Toward this end, we have developed a simple mixing model that uses in situ tracer data to study the dynamics of the middleworld during CRYSTAL FACE. We consider four possible transport pathways into the middleworld: 1- diabatic descent from the tropical stratosphere, 2- quasi-isentropic transport equatorward from higher northern latitudes, 3- quasi-isentropic transport poleward from the upper tropical troposphere, and 4-convective input, either directly from below, or from other latitudes. We create initial profiles for each transport pathway using ozonesonde data and in situ measurements from previous aircraft campaigns and use a least squares fitting routine to match the measured composition of each sampled air parcel independently. We test the model using high resolution, in situ measurements of H2O, O3, CO2, CO and NOy taken aboard NASA's WB-57 during the 2002 CRYSTAL FACE mission over southern Florida. The output of the model gives the fraction of air in the parcel corresponding to each transport pathway. We compare two flights during the mission for which isentropic back trajectories indicate very different stratospheric source regions, as well as one during which air parcels sampled near the 380K isentrope contain high CO and water vapor mixing ratios indicative of midlatitude convection. We also explore the dependence of the results on uncertainties in the source profiles we use. To significantly reduce these uncertainties, and to explore the dynamics and chemical composition of the middleworld more fully, we propose that the WB57 serve as the platform to provide systematic and repetitive soundings of the latitudinal and longitudinal structure of the middleworld with the appropriate complement of instruments.

A31G-04 1105h

Stratosphere-Troposphere Mass Exchange

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Global mass exchange between the troposphere and the stratosphere can be computed simply by estimating the heating rate along the 380K surface and the time rate of change of the middle world stratosphere (region between the tropopause and 380K). However, given the heating rate at the tropopause as well, the diabatic and adiabatic mass fluxes can be computed as well. The adiabatic and diabatic fluxes at the tropopause have been computed using three different data sets: the FVGCM and two assimilation data sets, FVDAS, and UKMO. The net tropopause flux is found to be comparable to that diagnosed by Appenzeller et al. [1996]. The diabatic flux across the tropopause is usually larger than the net flux, and both are downward (exiting the middle world stratosphere). This means that the tropospheric adiabatic flux is, on the average into the middle world stratosphere. Each of the data sets agree on this point; however, but it is the opposite conclusion obtained by some earlier researchers. This result implies that the middle world stratosphere is a region which is constantly being diluted by tropospheric air.

A31G-05 1120h INVITED

Horizontal Variability in the Upper Tropical Troposphere

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Two unique flights of the WB57F high altitude aircraft 1-2 km below the tropical tropopause ranging from 30N to 5N at longitudes 85W and 95W in September 1999 are examined for ozone and total water variability in the context of a large suite of tracers having lifetimes ranging from 0.01 to 1000 years, together with mass spectra of individual aerosol particles. It is concluded that local correlations are predominant; contributing processes to the maintenance of the composition are marine convection, continental convection, in situ chemical production, biomass burning, downward transport from the stratosphere and recirculation.

A31G-06 1135h

Airborne Measurements of Dynamics and Mixing in the Tropopause Region

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The Aberystwyth Egrett Experiment was conducted to investigate the nature of mixing in the tropopause region. The main tool in this experiment was the Egrett aircraft, carrying an advanced turbulence measurement system and also instruments to measure ozone, methane and CFCs. The flights were coordinated with the extensive ground-based facilities at Aberystwyth, including radar, lidar, and balloons. This experiment has provided insight into dynamical processes across the entire range of scales that contribute to mixing: from planetary waves, through gravity waves, to turbulence. Measurements will be presented that show gravity wave breaking, Kelvin-Helmholtz billows, turbulence, and mixing in the tropopause region. The influence of these small-scale mixing processes will be discussed with regard to their relationship to the larger scale lateral stirring caused by planetary wave breaking.

A31G-07 1150h

On the Life-Cycle of a Stratospheric Intrusion and its Large-Scale Mixing with Polluted Warm Conveyor Belts

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The aircraft-based 2002 Intercontinental Transport and Chemical Transformation experiment intercepted and chemically analyzed pollution plumes transported from Asia to the western United States. The research flight on May 10-11, 2002 detected mixing between polluted and stratospheric air at mid-tropospheric levels above the California coast. This study uses a Lagrangian domain-filling trajectory technique to illustrate that this event was the result of mixing between two warm conveyor belts (WCB) containing Asian pollution and the remnants of a deep tropopause fold from a downstream mid-latitude cyclone (SCDA). Advection of the trajectory particles shows how the SCDA decayed over 7.5 days. One component mixed with a downstream WCB, while another component descended into the lower troposphere and became entrained by an upwind WCB. After 7.5 days of transport 22 percent of the SCDA mass was transported into the troposphere. The portions of the SCDA that penetrated to the lowest altitudes had the greatest likelihood of being transported into the troposphere. For example, over 90 percent of the SCDA at altitudes below the 600 hPa level was transported to the troposphere, but none of the mass at the 200 hPa level was exchanged. More than half of the exchange occurred during the first 48 hours as the deepest portions of the tropopause fold decayed over the Pacific. The rest of the exchange occurred over the following 5.5 days as the remnants of the SCDA sheared apart along the edge of the stratospheric polar vortex and became entrained into subsequent tropopause folds and vortex breakaway features. Stratosphere to troposphere exchange resulted in the transport of 0.5 Tg of stratospheric ozone to the troposphere during the 7.5 day study period. A very high percentage (65 percent) of the SCDA particles that entered the troposphere subsequently mixed with the upwind and downwind WCBs.

A31G-08 1205h

Planned Improvements for the WB-57F Aircraft

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NASA WB-57F aircraft have supported the atmospheric science community for over 30 years. Recent attention has focused on the chemistry and dynamics of the UTLS region of the atmosphere and several NASA sponsored field campaigns (ACCENT, CRYSTAL-FACE) have made critical use of the WB-57F's unique ability to carry large (3 ton) payloads during extended cruise at all altitudes from the lower troposphere to the lower stratosphere (20 km ceiling). In addition, the WB-57F's robust structure permits a large number and variety of instruments to be carried at inlet-favorable locations on the aircraft. In order to further improve the WB-57F's performance and unique utility to the atmospheric research and spacecraft validation communities, NASA is planning several upgrades to the WB-57F including state-of-the-art avionics and autopilot, landing gear replacement, maximum gross weight increase, engine replacement, and ultrapod installation. We will review the present WB-57F performance, plans for upcoming science campaigns, and plans for increased WB-57F payload, range, endurance, and ceiling resulting from the upgrades.

URL: http://jsc-aircraft-ops.jsc.nasa.gov/wb57

A31H MCC: 3001-3003 Wednesday 1145h

Carbon Cycle Modeling

A31H-01 1145h

Inverse Estimates of Anthropogenic Carbon Dioxide From Ocean Interior Carbon Measurements and Ocean General Circulation Models

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The ocean is an important sink for atmospheric carbon dioxide, and the exchange of carbon dioxide between the atmosphere and ocean plays a critical role in determining the spatial distribution of atmospheric carbon dioxide. However, there is still a great deal of uncertainty in both magnitude and regional patterns of anthropogenic uptake associated with estimates of oceanic carbon fluxes. Using a recently developed technique, exchange of anthropogenic carbon dioxide across the air-sea interface have been estimated from observations of dissolved inorganic carbon and nutrient concentrations and an Ocean General Circulation Model (OGCM) using a Green's function inverse modeling technique. Previous sensitivity studies have shown that model circulation error is an important source of error in the ocean inversion. In order to address the role of ocean circulation biases, inverse estimates of anthropogenic carbon air-sea gas exchange are presented using basis functions from a suite of seven different OGCM's. The robustness of the ocean inversion will be quantified and the effects of differences between approaches to modeling ocean circulation on the ocean carbon cycle will be explored. These results will be discussed in the context of recent atmospheric inverse estimates.

URL: http://quercus.igpp.ucla.edu/OceanInversion

A31H-02 1200h

The Atmospheric Signatures of Terrestrial Ecosystem Processes: Results From a Coupled Atmosphere-Ecosystem Model

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Global-scale analyses of weekly CO_2 flask samples have shown that a number of terrestrial regions are significantly affecting the rate at which carbon dioxide is building up in the atmosphere. However, the observations used in these studies come primarily from stations that sample the marine boundary layer in order to eliminate variance due to terrestrial fluxes, making it difficult to identify the processes responsible for the observed patterns of terrestrial CO_2 flux. To address this issue, we have developed a regional-scale, coupled atmosphere-ecosystem model capable of assimilating observations from a diverse array of data sources, including eddy-flux measurements of surface CO_2 fluxes, measurements of atmospheric CO_2 concentrations obtained from aircraft and tall towers, and observations of canopy structure and dynamics obtained from satellite observations and forest inventory data. The model consists of a newly-developed, mass-conserving version of the mesoscale Regional Atmospheric Modeling System model (RAMS) coupled to the Ecosystem Demography Model (ED), which is able to represent the influence of both long-term and short-term processes on patterns of terrestrial CO_2 flux. We are using the coupled RAMS-ED model to perform forward and inverse modeling studies of regional carbon budgets within the North American continent. Preliminary results highlight the model's ability to connect regional patterns of atmospheric CO_2 to the underlying state of the ecosystems within a region.

A32A MCC: Level 1 Wednesday 1330h

Biogenic Reactive Trace Compounds and Their Role in Atmospheric Chemistry and Climate IV Posters

(joint with B, OS)

Presiding: **I Faloona,** University of California, Davis**; J Kesselmeier,** Max-Planck-Institute-Mainz

A32A-0105 1330h POSTER

Simulation of BVOC Fluxes and Chemical Transformations with a One-dimensional Canopy Chemistry Model for the BEWA Campaigns

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Numerical modeling can help to investigate the role of the different pathways for chemical degradation of biogenic volatile organic compunds (BVOC) and the effect of chemical reactions on the net BVOC fluxes from forest canopies. Starting from specified initial conditions the one-dimensional canopy-chemistry model CACHE predicts profiles of temperature, humidity, and chemical species. CACHE includes the energy balance at the leaf surfaces, vertical turbulent transport of heat, water vapor, and gas phase chemical compounds within and above the canopy, emission of biogenic VOC, chemical transformation and deposition of chemical constituents, and heat and moisture transport in the soil. Simulations with CACHE were carried out as part of the joint project BEWA 2000 for the 22 'golden days' during the summer 2001 and 2002 field campaigns at the Waldstein site (Fichtelgebirge, Germany). For the measuring site - a 20 m high spruce forest - the observed diurnal course of temperature and ozone are reproduced well by the model. Nighttime deposition was found to have a major effect on the diurnal course of the ozone concentration. A comparison with the REA measurements during the BEWA campaigns shows that the monoterpene fluxes and concentrations are generally reproduced very well. Furthermore, the fluxes of photooxidants like H_2O_2 show good agreement between measured and modeled values. The simulations however indicate, that it is necessary to include the emission of aldehydes and acetone in order to reproduce the observed fluxes and concentrations of these species. The model results show that during the daytime the effective fluxes at the canopy top are generally about 10 % lower than the potential fluxes, i.e. the fluxes without considering chemical degradation within the canopy. It was found that even during daytime the NO_3 radical can contribute significantly to monoterpene degradation in the lower part of the canopy. For example, within the canopy NO_3 contributes 30 to 50 % to the total degradation of limonene at noontime.

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Elements of a Process-based Model of Leaf Photosynthesis

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Process-based modelling of photosynthesis requires appropriate description of leaf photosynthesis. Essential aspects are stomatal conductance and the CO_2 assimilation proper, both as affected by the environment.