A42A-0747 1330h POSTER

Prediction of Coarse Particle Nitrate From Fine Particle Measurements in a Coastal Environment

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Nutrient induced algal growth is one cause of decreased seagrass in the Tampa Bay Estuary. This influx of nutrients arises from the presence of fixed nitrogen in various flows and discharges to the estuary and from atmospheric deposition. One of the goals of BRACE (Bay Regional Atmospheric Chemistry Experiment) is to obtain improved estimates of the atmospheric nitrogen deposition to Tampa Bay. Previous estimates of atmospheric dry deposition of nitrogen to Tampa Bay have been based on Annular Denuder System (ADS) measurements of gaseous nitric acid and ammonia and fine particle (PM2.5) nitrate and ammonium, which extend back to 1996. However, recent coarse particle measurements indicate that, while ammonium primarily exists in fine particles, nitrate is preferentially found in the coarse fraction. The goal of this study is to examine whether the historical data for fine particle nitrate can be used to predict the amount of nitrate in the coarse fraction so as to obtain a more accurate estimate of dry particle deposition of nitrate to the Tampa Bay Estuary. Specifically, it is shown that averaged nitrate distributions obtained from recent micro-orifice impactor data can be used to predict the coarse to fine ratios observed for dichotomous samplers and the fine particle concentrations obtained from the Annular Denuder System. This provides some confidence that the impactor results may be used in conjunction with earlier fine particle data to obtain an estimate of coarse particle nitrate concentrations, and therefore an improved estimate of nitrate flux to the estuary.

A42A-0748 1330h POSTER

Ammonia Flux at the Air-Water Interface of Tampa Bay

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Recent nitrogen deposition research in the Tampa Bay Estuary indicates that ammonia deposition dominates the total dry nitrogen flux to the bay. Gaseous plus aerosol ammonia contribute approximately 450 tons per year or 60% of the total nitrogen deposition of 760 tons per year to the estuary. Research data also indicate that during the summer months, Tampa Bay may act as a source for atmospheric ammonia as water temperature and ammonium concentrations increase. Ammonia flux estimates will be derived from thirty days of daily summer air and water sampling at the Gandy Bridge air monitoring site located adjacent to Tampa Bay. Ammonia concentrations were measured at two heights with a URG, Inc. dual-pump annular denuder system (ADS), and water grab samples from two depths were analyzed in the laboratory for ammonium concentration. Hourly relative humidity, air and water temperature, pH and salinity were recorded at this site, and hourly wind speed and direction were obtained from the Environmental Protection Commission of Hillsborough County. Rainwater samples were obtained with a University of Michigan sequential rainwater collector and analyzed in the laboratory for ammonium concentration. The direction and magnitude for the ammonia flux will be calculated with a modified NOAA buoy model from measurements of wind speed, air and water temperature, air and water ammonia and ammonium concentrations, relative humidity, water pH and salinity. The results of this research will be used to improve the NOAA Buoy model, and to compare observed with modeled ammonia gradients.

A42A-0749 1330h POSTER

Simulation of Coarse Particle Nitrate Formations in Coastal Areas Using CMAQ-AIM

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The air quality model, CMAQ-AIM, was used to simulate the formation of coarse particle nitrate in coastal areas. CMAQ-AIM adopts USEPA's Models-3/CMAQ as the host photochemical model and employs a mechanistic, fully dynamic, internally-mixed, sectional aerosol module containing twelve aerosol species in nine size sections spanning 0.03 to 20 μm. The model's superior computational efficiency is achieved by a novel integration scheme and acid-neutrality gas-particle transport mechanisms, among which the Replacement Transport mechanism is particularly suitable for simulating the displacement of hydrochloric acid by nitric acid, or vice versa. The modeling results in Tampa Bay area from June 30 to July 14, 1999 episode (with sea-salt emission) in USEPA's Lower 49 State domain were compared to those produced by Models-3/CMAQ (without sea-salt emissions and a modal representation of the particulate matter). The preliminary comparison showed that total nitrate concentrations (gas and particle phase) were compatible between the two models, but CMAQ-AIM predicted a higher fraction of total nitrate partitioned into particle phase with over ninety percent of particle nitrate mass (about 1 μgm^{-3}) in the coarse mode, while fine particle nitrate mass was in the similar magnitude as accumulation mode particle nitrate simulated by Models-3/CMAQ. Due to CMAQ-AIM's ability to simulate sea salt and the displacement reaction, the importance of sea-salt emission in ambient air quality in coastal areas was demonstrated. Given that gas-phase nitrate deposition is usually reduced over water surface compared to that over land and coarse particle nitrate deposition remains unchanged, with high deposition velocity, our simulation indicates direct atmospheric particle nitrate deposition may significantly contribute to the total nitrate deposition into estuary habitats, which is consistent with BRACE measurement results. Since CMAQ-AIM also predicted coarse particle nitrate formation in many other coastal regions, our study suggests coarse mode nitrate needs to be measured in field campaigns in those areas; otherwise, a major fraction of total nitrate deposition would be missed.

A42B MCC: Level 2 Thursday 1330h

Ocean/Atmosphere Modeling I Posters *(joint with OS, NG)*

Presiding: **A Wallcraft,** Naval Research Laboratory**; L P Davis,** DOD High Performance Computing Modernization Program

A42B-0750 1330h POSTER

Development of Adaptive Mesh Refinement Techniques for an Ocean General Circulation Model

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A problem faced by all computational physicists is the trade off between run time and grid resolution. The number of time steps and cost per time step drastically increases as finer and finer grids are used. In effort to combat this dilemma, research areas such as fluid dynamics use a modeling technique known as Adaptive Mesh Refinement (AMR). This involves increasing grid resolution in localized areas of the domain while preserving the structured nature of the original grid. The concept of AMR has been around for nearly two decades, but only in recent years have software packages become available to aid in many of the details. Atmospheric and ocean models simulate phenomena with motion derived from fluid dynamics. This suggests AMR is feasible for global climate modeling. The success of nested regional models also supports this hypothesis. In this research, techniques are developed which will allow AMR to perform on an existing ocean model known as the Modular Ocean Model (MOM). Of particular interest is the ability to use AMR on a staggered grid with centered differencing numerics. These are two characteristics of MOM which reduce computational noise and run time respectively. To aid AMR implementation, the software package SAMRAI (Structured Adaptive Mesh Refinement Application Infrastructure) is used. Refinement is based on solution gradients and possibly other criteria as needed. In addition, regions of critical topography might be refined if necessary. Current tools include time integrators which implement Leap Frog, Predictor Corrector, and Runge Kutta numerics. Velocities are defined at nodes and all other quantities at cell centers. A bench mark simulation of a barotropic modon will be presented.

A42B-0751 1330h POSTER

A Coupled Regional Climate Simulator for the Gulf of St. Lawrence, Canada

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The climate of Eastern Canada is characterized by atmosphere-ocean-ice interactions due to the closeness of the North Atlantic Ocean and the Labrador Sea. Also, there are three relatively large inner basins: the Gulf of St-Lawrence, the Hudson Bay / Hudson Strait / Foxe Basin system and the Great Lakes, influencing the evolution of weather systems and therefore the regional climate. These basins are characterized by irregular coastlines and variables sea-ice in winter, so that the interactions between the atmosphere and the ocean are more complex. There are coupled general circulation models (GCMs) that are available to study the climate of Eastern Canada, but their resolution (near 350km) is to low to resolve the details of the regional climate of this area and to provide valuable information for climate impact studies. The goal of this work is to develop a coupled regional climate simulator for Eastern Canada to study the climate and its variability, necessary to assess the future climate in a double CO2 situation. An off-line coupling strategy through the interacting fields is used to link the Canadian Regional Climate Model developed at the "Université du Québec àMontréal" (CRCM, Caya and Laprise 1999) to the Gulf of St. Lawrence ocean model developed at the "Institut Maurice-Lamontagne" (GOM, Saucier et al. 2002). This strategy involves running both simulators separately and alternatively, using variables from the other simulator to supply the needed forcing fields every day. We present the results of a first series of seasonal simulations performed with this system to show the ability of our climate simulator to reproduce the known characteristics of the regional circulation such as mesoscale oceanic features, fronts and sea-ice. The simulations were done for the period from December 1st, 1989 to March 31st, 1990. The results are compared with those of previous uncoupled runs (Faucher et al. 2003) and with observations.

A42B-0752 1330h POSTER

Mountain Waves Forced by Narrow Topography in the Presence of Vertical Shear

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The Alps is famous for its highly three-dimensional topography that features numerous narrow peaks over 3500 m, deep valleys, and steep mountain slopes. Three research aircraft were deployed to observe modest-amplitude gravity waves over the southwestern French

Alps in the Massif du Pelvoux region on 13 November 1999 during Intensive Observation Period 13 of the Mesoscale Alpine Programme (MAP). A large-scale mid-tropospheric depression was present to the southeast over the Mediterranean Sea during this time period, which resulted in lower-tropospheric southeasterly flow of 10-15 m/s impinging on the western Alps. The observations indicate the flow was characterized by topographically blocking and stagnation below 2800 m, a layer of strong stability and reversed shear of the horizontal wind speed below 5 km that was capped by much weaker stability with relatively weak flow in the upper troposphere and lower stratosphere. The in situ vertical velocity data from the lowest-level aircraft, the NCAR Electra, indicated the presence of gravity waves at 5500 m that were characterized by relatively short horizontal wavelengths of approximately 8 km with a maximum amplitude of 3.0 m/s and a maximum vertical displacement of 800 m. Backscatter data from the downlooking SABL was enhanced by several layers of low-level clouds and moisture that suggested maximum peak-to-trough wave amplitudes of 1 km and typical horizontal wavelengths of 7-10 km present in the lee of the narrow topographic peaks. Spectral decomposition of the topography is consistent with the short wavelength gravity wave response. Two transects from the Electra indicate a sharp vertical velocity maximum and a large upward parcel displacement suggestive of wave breaking near the 5500 m level, which was located in the strong wind shear layer. The in situ vertical velocity data from the Electra, the Met Office C130 and DLR Falcon transects above 5500 m measured weak gravity waves with vertical velocities less than 1.5 m/s in the upper troposphere and lower stratosphere. Backscatter data from the downlooking DLR DIAL lidar onboard the Falcon also confirm that a rapid decrease in the wave amplitude with height was present in the layer between 5500 and 6500 m. Factors that may contribute to the rapid decay of wave amplitude include: the decrease in the Scorer parameter with height that results in an evanescent wave response and ducting of small horizontal wavelengths, gravity wave breaking in the shear layer, and a directional critical level that will partially absorb wave energy. Numerical simulation results from COAMPS using 5 nested grid meshes with a minimum horizontal resolution of 556 m and 55 vertical levels are used to diagnose the gravity wave dynamics in this case. Mountain waves with dominant horizontal wavelengths of less than 10 km are simulated, in general agreement with the in situ aircraft and lidar observations, however, some phase errors occur in the positions of the significant wave crests and troughs. Gravity wave breaking characterized by convective instability and a turbulent kinetic energy maximum is simulated in the lee of the first substantial topographic peak in the 3000-5500 m layer, in close agreement with the in situ Electra and SABL data. The relative roles of the directional critical level and the wave trapping will be further explored using three layer linear analytic solutions with an initial state based on the composite upstream dropsonde data.

A42B-0753 1330h POSTER

Performance of a Southern Ocean sea ice forecast model

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The presentation examines the forecast peformance of an oriented fracture sea ice model applied to the Southern Ocean to predict sea ice state up to five days in advance. The model includes a modified Coulombic elastic-viscous-plastic rheology, enthalpy conserving thermodynamics and a new method of parameterising thickness distribution mechanics. 15 ice thickness classes are employed within each grid cell with a horizontal resolution of 50km. The model provides considerable insight into the thickness evolution and climatology of Antarctic sea ice. To date, thickness evolution of the Southern Ocean sea ice zone has mostly been assessed using course two-category models in climate simulations and results presented in this talk provide much greater detail over some existing model output. Simulations are presented from the model driven with NCEP-2 atmospheric analyses, NOAA sea surface temperatures, and mean climatogological currents generated using an eddy resolving ocean model. Analyses are generated by nudging ice concentrations with daily satellite derived open water fractions, and simulations using this method are compared to those without. There are important considerations in assimilating passive microwave ice concentration data into thickness distribution models, and particular attention is given to the treatment of lead ice and the impact this has on estimated total Southern Ocean sea ice volume. It is shown that nudging the model with satellite derived concentrations has an impact on ice mechanics as judged from simulated buoy tracks. A comparison with sonar soundings of sea ice draft is also favourable but shows variation with location. Whilst 5 day forecasts are reasonably skilled, predictive performance changes with season. Application of this research to operational ocean data assimilation systems is discussed in the final stages of the talk.

A42B-0754 1330h POSTER

Stochastic Parameterizations of Equatorial Gravity Waves

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Deterministic parametrizations in global climate models rest on the assumption (or hope) that a statistical-dynamical equilibrium exists between the resolved and subgrid-scale unresolved flows. A particular choice of parameter values then takes into account only the mean of the unresolved quantities while intrinsically neglecting all higher order moments of the distribution. In the past some studies have suggested, that representing higher order moments in parameterizations of unresolved flows may improve GCMs. Convection is thought to be the most important source of gravity waves in the tropics. Unfortunately convectively triggered gravity waves are episodic in nature and highly variable in strength. Furthermore circulation of the tropical stratosphere is strongly affected by wave-mean flow interactions. It therefore seems reasonable to study the effects on the tropical stratospheric climate of a stochastic gravity wave scheme. A version of the Hines gravity wave scheme with a stochastic source strength is developed. The scheme is implemented in a 55 level version the Unified Model. The effects of different stochastic source strengths are examined. In some cases the source is assumed to represent the intensity distribution of equatorial convection. The effects of including higher order moments of the distribution are also examined.

A42B-0755 1330h POSTER

Effects of Shear and Wind Profile Curvature on Gravity Wave Drag

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Numerical simulations with mesoscale models indicate that surface gravity wave drag is sensitive to the shape of the wind profile. This is a well known feature of flow past large mountains, where resonant flows may be established for some background profiles of wind and stability. In the limit of linear flow, the effect of linear shear has been studied in recent years and found to lead to a reduction of drag. This paper develops an analytical model that incorporates more general wind profiles, which are characterized by both wind shear and curvature, using a linearized set of equations that treats nonlinearities associated with the vertical variation of wind speed using a WKB approximation. The results of that model indicate that curvature effects may be substantial, and lead to significant increases in the surface drag. Results of that analytical model compare very well with sets of numerical simulations with a mesoscale model. It is suggested that the simple formula that come out of the analytical model may be incorporated into parameterization schemes.

A42B-0756 1330h POSTER

Eddy-Diffusivity and Convective Boundary Layers

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Convective boundary layers are a fundamental component of atmospheric physics and dynamics. A realistic representation of the different convective boundary layers in climate and weather prediction models has been an elusive goal in atmospheric modeling research for many years. There is now the need for unified parameterizations to represent convective mixing in atmospheric models. A new eddy-diffusivity formulation based on the turbulent kinetic energy (TKE) closure is suggested as a possible alternative for such a unified parameterization. The new aspects of this scheme are: (i) a decomposition between TKE outside and within clouds and (ii) a new formulation for the mixing length that relates the mixing length to the square root of the TKE and a time scale. The new closure is shown to reproduce realistic thermodynamical structures for dry convective, stratocumulus and shallow cumulus boundary layers.

A42B-0757 1330h POSTER

High Resolution Simulation of Gravity Currents and Internal Bores on the Continental Shelf

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The propagation of gravity currents and internal bores was investigated over the flat and sloping portions of the continental shelf. The generation of the bores was effected by the collapse of a lock-exchange configuration, with the heavier fluid initially in the shallow region. Interest was focused on the 5-50 km coastal dynamic scales, as many motions on these scales exhibited nonhydrostatic effects. Model resolutions ranged from 1-5 m in the vertical and 1 to 50 m in the horizontal. Besides the standard shallow ocean (H) and standard nonhydrostatic (NH) deep convection models, we also examined a type of so-called quasi-hydrostatic (QH) model in which the vertical pressure gradient is balanced by a sum of the buoyancy and inertial terms. The final vertical velocity and pressure are determined by an iteration procedure. The simulated Froude numbers and Richardson numbers agreed within 10 % of those found in applicable laboratory experiments. In general, the NH models tended to exhibit the full spectrum and amplitude of the Kelvin-Helmholtz (K-H) instabilities that grow on the plume- ambient fluid interface, and treated the advancing bore front and the rotor situated behind it correctly. The QH model developed K-H instabilities for smaller diffusivities and further back behind the front, with little rotor action behind the bore edge. Both the NH and QH models were found to be sensitive to the grid ratio $r = dx/dz$ and behaved like hydrostatic models for $r > 5$. In addition, all three classes of models have exhibited strong sensitivity to the size of the time step and diffusivity.

A42B-0758 1330h POSTER

Carbon Cycle Sensitivity to Climate Change: Results from a Comprehensive GCM-Based Climate and Carbon Cycle Model

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We use an interactive global climate and carbon cycle model to perform simulations of climate change from 1870 AD to 2100 AD forced by anthropogenic emissions of greenhouse gases. The goal of this effort is to include and better understand feedbacks between the climate system and the carbon cycle. We use the Parallel Climate Model 2 (PCM-2) developed at NCAR as our climate model. The PCM-2 includes a version of NCAR's CCM3 for the atmospheric GCM and a version of the POP model for the ocean GCM. The horizontal resolutions for atmosphere and ocean are T42 truncation (about 280 km) and 0.7 degrees (about 75 km), respectively. The ocean carbon model is based on OCMIP protocols, but modified to eliminate the phosphate-restoring restriction. The terrestrial biosphere model is IBIS-2 which simulates biophysical and biogeochemical surface fluxes and includes a dynamic vegetation model. The model is integrated to a pre-industrial

equilibrium using a prescribed atmospheric CO2 concentration of 290 ppmv. This equilibrated state serves as the starting point for three transient simulations. The Control Case assumes historical greenhouse emissions up to year 2000, then uses SRES A2 emissions up to year 2100. A Double Sensitivity Case is the same as the Control case, except that the greenhouse radiative forcing of climate is doubled so that the climate response is doubled. In Zero Sensitivity Case, the greenhouse radiative forcing is held fixed at preindustrial value so that there is no climate response to greenhouse forcing. The range of global- and annual-mean surface warming in these 3 experiments encompasses the range projected by IPCC for a doubling of atmospheric CO2. We will discuss the sensitivity of modelês carbon cycle for this range of global climate change. We will specifically discuss the sensitivity of terrestrial carbon uptake to changes in the magnitude of global warming.

A42B-0759 1330h POSTER

3D Staggered-Grid Finite-Difference Simulation of Acoustic Waves in Turbulent Moving Media

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Acoustic wave propagation in a three-dimensional heterogeneous moving atmosphere is accurately simulated with a numerical algorithm recently developed under the DOD Common High Performance Computing Software Support Initiative (CHSSI). Sound waves within such a dynamic environment are mathematically described by a set of four, coupled, first-order partial differential equations governing small-amplitude fluctuations in pressure and particle velocity. The system is rigorously derived from fundamental principles of continuum mechanics, ideal-fluid constitutive relations, and reasonable assumptions that the ambient atmospheric motion is adiabatic and divergence-free. An explicit, time-domain, finite-difference (FD) numerical scheme is used to solve the system for both pressure and particle velocity wavefields. The atmosphere is characterized by 3D gridded models of sound speed, mass density, and the three components of the wind velocity vector. Dependent variables are stored on staggered spatial and temporal grids, and centered FD operators possess 2nd-order and 4th-order space/time accuracy. Accurate sound wave simulation is achieved provided grid intervals are chosen appropriately. The gridding must be fine enough to reduce numerical dispersion artifacts to an acceptable level and maintain stability. The algorithm is designed to execute on parallel computational platforms by utilizing a spatial domain-decomposition strategy. Currently, the algorithm has been validated on four different computational platforms, and parallel scalability of approximately 85% has been demonstrated. Comparisons with analytic solutions for uniform and vertically stratified wind models indicate that the FD algorithm generates accurate results with either a vanishing pressure or vanishing vertical-particle velocity boundary condition. Simulations are performed using a kinematic turbulence wind profile developed with the quasi-wavelet method. In addition, preliminary results are presented using high-resolution 3D dynamic turbulent flowfields generated by a large-eddy simulation model of a stably stratified planetary boundary layer. Sandia National Laboratories is a operated by Sandia Corporation, a Lockheed Martin Company, for the USDOE under contract 94-AL85000.

A42B-0760 1330h POSTER

Model Investigations Into Bimodal Arctic Surface-Atmosphere Interaction

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Observations at the SHEBA (Surface Heat Budget of the Arctic Ocean) site revealed that the Arctic ocean-surface-atmosphere system displays two stable states of behavior. The state dominant during winter is an atmospherically quiescent one, characterized by the presence of clear skies (or optically thin clouds), by -40 W/m**2 surface net longwave radiation, and by surface temperatures that the ocean's constant upward heat flux anchors near 235K. The secondary mode, one of surface-atmosphere equilibrium, occurs in association with the advection of moisture and temperature from lower latitudes, and is characterized by the presence of optically thick clouds in the lowest few kilometers of the atmosphere, and by surface temperatures near 250K. ARM NSA/AAO (Atmospheric Radiation Measurement Program, North Slope of Alaska/Adjacent Arctic Ocean) observations exhibit modal behavior similar to that at SHEBA, although with differing magnitude and persistence. In addition, NSA exhibits interannual variability, during which the surface net longwave modes shift by 10 W/m**2, and in some winters NSA has but a single mode in the surface net longwave distribution. The goal of the research presented is to develop a deeper understanding of the physical mechanisms that maintain the Arctic ocean-surface-atmosphere in the two observed states. Preliminary results show that the Goddard Institute for Space Studies (GISS) Global Climate Model (GCM) exhibits the same discrete surface net longwave modes over the SHEBA ice-covered ocean site as do the observations, while the GCM only exhibits one of the net longwave modes observed at the NSA coastal continental site. The GISS Single Column Model (SCM), derived from the GISS GCM, is used here to determine the conditions required to attain and to maintain these stable modes over sea ice, and to investigate why the GCM was unable to reproduce the behavior observed over land. The SCM is also used to ascertain the conditions required for each equilibrium state to exist, and hence whether the ice-covered Arctic Ocean can be expected to exhibit the same two stable states every winter.

A42B-0761 1330h POSTER

On the Low-frequency North Pacific Climate Modulations Induced by the Mid-latitude Mixed Layer Heat Flux Convergence Anomalies.

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In order to determine the role of the mid latitude mixed layer heat flux convergence anomalies in maintaining the observed low frequency climate variability we used the climate system that hindcasted anomalies of heat flux convergence of the tropical and North Pacific oceanic mixed layer and converted them into the northern hemisphere climate anomalies. The underlying philosophy states that North Pacific/North American climate anomalies on time scales of years to decades result from anomalous conditions in the Pacific equatorial upwelling regions, and the North Pacific Kuroshio-Oyashio extension (KOE), where anomalies in the ocean's thermocline are efficiently coupled to the surface. In response to this forcing, the coupled atmosphere - ocean mixed layer system adjusts and generates anomalies over the entire Pacific. We hindcasted the air-sea heat flux by forcing the ocean general circulation model (MIT OGCM) with the NCAR/NCEP reanalysis wind stress, while relaxing sea surface temperature (SST) and sea surface salinity (SSS) to their climatological values. The hindcasted monthly oceanic heat flux convergence anomalies for the period of January 1960 to December 1999 in the KOE region and in the tropical Pacific were then applied as anomalous forcing to the coupled CCM3/slab ocean (SOM) model. We performed a 40-year integration of the five-member ensemble of the CCM3/SOM forced with heat budget anomalies (the Delta Q forcing in the tropical Pacific and in the KOE region) obtained from the ocean hindcast. To identify the atmospheric response to the mid-latitude forcing and to validate the statistical analysis, we repeated the five-member CCM3/SOM ensemble integration, but applied the Delta Q forcing in the tropics only. We will discuss the differences between this integration and the corresponding CCM3/SOM integration with both tropical and KOE forcing. These differences indicate the effect of the KOE Delta Q forcing on the mean atmospheric state and on the pdf of the intrinsic atmospheric modes. As expected, the anomalous Delta Q forcing over the tropical Pacific sets the global anomalous climate patterns over North Pacific/North America. These patterns include the SST and air-sea heat flux anomalies over North Pacific. Over the KOE region the SST and heat flux anomalies are strongly correlated with the heat flux forcing of the tropical Pacific. However, when the KOE forcing is added, the relationship between the SST and air-sea heat flux anomalies changes. The air-to-sea heat flux anomalies over the KOE region are not correlated with the tropical heat flux anomalies. Our findings show that the mid-latitude forcing augments the teleconnection patterns from the tropics. In particular, it intensifies the regression patterns of the 500 mb geopotential height and surface pressure onto the tropical mixed layer heat flux convergence anomalies (though the anomalies themselves are identical in both cases). We will show the changes exhibited in the surface variables as well as in the free atmosphere. We will also discuss the changes in the storm tracks and the role of the transient eddy forcing in maintaining the mean atmospheric patterns.

URL: http://meteora.ucsd.edu/~yulaeva/CM/coupled.html

A42B-0762 1330h POSTER

Parallel Computation of Ocean-Atmosphere-Wave Coupled Storm Surge Model

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Ocean-atmosphere interactions are very important in the formation and development of tropical storms. These interactions are dominant in exchanging heat, momentum, and moisture fluxes. Heat flux is usually computed using a bulk equation. In this equation air-sea interface supplies heat energy to the atmosphere and to the storm. Dynamical interaction is most often one way in which it is the atmosphere that drives the ocean. The winds transfer momentum to both ocean surface waves and ocean current. The wind wave makes an important role in the exchange of the quantities of motion, heat and a substance between the atmosphere and the ocean. Storm surges can be considered as the phenomena of mean sea-level changes, which are the result of the frictional stresses of strong winds blowing toward the land and causing the set level and the low atmospheric pressure at the centre of the cyclone can additionally raise the sea level. In addition to the rise in water level itself, another wave factor must be considered. A rise of mean sea level due to white-cap wave dissipation should be considered. In bounded bodies of water, such as small seas, wind driven sea level set up is much serious than inverted barometer effects, in which the effects of wind waves on wind-driven current play an important role. It is necessary to develop the coupled system of the full spectral third-generation wind-wave model (WAM or WAVEWATCH III), the meso-scale atmosphere model (MM5) and the coastal ocean model (POM) for simulating these physical interactions. As the component of coupled system is so heavy for personal usage, the parallel computing system should be developed. In this study, first, we developed the coupling system of the atmosphere model, ocean wave model and the coastal ocean model, in the Beowulf System, for the simulation of the storm surge. It was applied to the storm surge simulation caused by Typhoon Bart (T9918) in the Yatsushiro Sea. The atmosphere model and the ocean model have been made the parallel codes by SPMD methods. The wave-current interface model was developed by defining the wave breaking stresses. And we developed the coupling program to collect and distribute the exchanging data with the parallel system. Every models and coupler are executed at same time, and they calculate own jobs and pass data with organic system. MPMD method programming was performed to couple the models. The coupler and each models united by the separated group, and they calculated by the group unit. Also they passed message when exchanging data by global unit. The data are exchanged every 60-second model time that is the least common multiple time of the atmosphere model, the wave model and the ocean model. The model was applied to the storm surge simulation in the Yatsushiro Sea, in which we could not simulated the observed maximum surge height with the numerical model that did not include the wave breaking stress. It is confirmed that the simulation which includes the wave breaking stress effects can produce the observed maximum height, 450 cm, at Matsuai.

URL: http://rcde2.dpri.kyoto-u.ac.jp/~kokim/agu.htm

A42B-0763 1330h POSTER

Testing the EDMF Parameterization in the ARM Convective Diurnal Cycle Case

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An integrated scheme for describing the dry and shallow cumulus boundary layer is here presented. The approach is based on the concept that in the convective boundary layer the main mechanisms of mixing are: local mixing that can be parameterised by an eddy-diffusivity scheme and non-local mixing performed by the mass-flux associated with thermals. This eddy-diffusivity/mass-flux scheme (EDMF) was implemented in the research model MesoNH (Lafore et al., 1996), taking advantage of the eddy-diffusivity closure based on the TKE budget equation to parameterise the local transport by smaller eddies. In the sub-cloud and in the cloud layers the mass-flux term represents the effect of strong updrafts. These are modelled by a simple entraining rising parcel, which determines the boundary layer height and, if present, the lifting condensation level and cloud top. The new scheme is tested against observations from the ARM dataset (Brown et al., 2002) corresponding to a diurnal cycle of a convective boundary layer with shallow cumulus development.

A42B-0764 1330h POSTER

Estimates of the Atmospheric Water Balance Over the Oceans

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With the availability of global re-analysis and global satellite observations, the study of the global water balance has received renewed interest. In this study, we have focused on calculating flux divergence and residual evaporation rates over the oceans using observed data sets where available. To calculate these terms, we are using 6-hourly global winds and pressure fields from NCEP/DOE Reanalysis II, moisture fields from NVAP (National Aeronautical and Space Administration Water Vapor Project), a satellite and in situ water vapor set, and precipitation from GPCP (Global Precipitation Climatology Project) and CMAP (Climate Prediction Center Merged Analysis of Precipitation), both a satellite and in situ precipitation data set. All data sets are from the time period 1988-1992 and the height dependent variables are vertically integrated for the first 18 sigma levels representing pressure levels over the oceans from the surface to approximately 200 mb. These data sets were used in various combinations to compute flux divergence, which is essentially equal to evaporation minus precipitation (E-P) since the storage term is small, and evaporation as a residual using the GPCP and CMAP precipitation data. We also calculated the water balance from the NCEP/DOE re-analysis for comparison. The evaporation minus precipitation fields are compared to other independent calculations, such as HOAPS (Hamburg Ocean-Atmosphere Parameters and Fluxes from Satellite Data), NODC (National Oceanographic Data Center), and SOC (Southampton Oceanographic Centre). Comparisons to these data sets show that our method produces similar patterns as those of the other data sets. The main differences are in the magnitude of the flux values and some regions of maxima and minima, but none of the four results agree completely in that regard. The evaporation was calculated as a residual by taking the flux divergence values and adding precipitation estimates to obtain evaporation values. Evaporation calculations were made using various combinations of input data; 1) NVAP water vapor, GPCP precipitation, and NCEP re-analysis II wind, 2) NVAP water vapor, CMAP precipitation, Re-analysis II winds, and 3) Re-analysis II water vapor, precipitation, and winds. These were compared to independent evaporation estimates from SOC, NODC, HOAPS, and Reanalysis II, and the results were evaluated.

A42B-0765 1330h POSTER

An Analysis and Model Evaluation of the Marine Boundary Layer Height in the Eastern Pacific

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The atmospheric boundary layer (ABL) couples ocean surface processes with clouds and convection over the eastern Pacific. The determination of the boundary layer height is therefore crucial in the parameterization of the ABL in numerical weather prediction and climate models. Here, a method to determine the boundary layer height h objectively for clear and cloudy conditions and for stable and unstable cases from sounding data is developed. Using this technique, h is thus determined from about 1000 radiosondes taken between 1995 and 2001 during 11 cruises in the eastern Pacific Ocean. An analysis of this data reveals seasonal, interannual, meridional, and zonal variations in h in the cold tongue region, the intertropical convergence zone, and the subtropical stratocumulus region off of the coasts of California and Mexico. Furthermore, it will be shown that this method can also be used in other regions such as the central and western Pacific and over land. Additionally, the marine boundary layer height in the eastern Pacific determined by the Community Climate System Model version 2 (CCSM2) is compared to the objective h determined from radiosondes. Both model results and output from an offline version of the model's parameterization are overall underestimated. It is thus found that a doubling of the model's resolution in approximately the lowest 2 km (from 5 to 10 layers) as well as the adjustment of h within clouds to cloud base or top would significantly improve the determination of h by the model.

A42C MCC: Level 2 Thursday 1330h

Contributions to Middle Atmosphere Science by Solar Occultation Instrumentation II Posters *(joint with SA)*

Presiding: **L W Thomason,** NASA Langley Research Center**; R Bevilacqua,** Naval Research Laboratory**; A Eldering,** Jet Propulsion Laboratory, California Institute of Technology

A42C-0766 1330h POSTER

Ground-based measurements of NO3 column abundance over Table Mtn, California

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The nitrate radical, NO3, which is being monitored by Meteosat/SAGE III, is an important intermediate in the transformation of NOx to NOy. Better characterization of the diurnal, seasonal and interannual variation of NO3 is important in characterizing the role of NOx-catalyzed ozone depletion in the stratosphere. In this work the nighttime variation of the NO3 column abundance has been studied over Table Mountain, California beginning in June 2002 We collected lunar occultation data around full moon with a grating spectrograph which utilized a CCD detector. NO3 column abundances were retrieved from lunar spectra using the differential optical absorption spectroscopy (DOAS) technique. A significant problem in the retrieval is the interference of water vapor and O2 in the NO3 visible absorption bands. To minimize these interferences, retrievals were carried out on both the 662 and 623 nm NO3 bands. Comparisons between the observed nighttime temporal profiles of NO3 and the predictions of a one-dimensional photochemical model will be discussed.

A42C-0767 1330h POSTER

Rocket sounding of stratospheric ozone density profile by UV radiometer onboard KSR-III

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The UV radiometer payload was launched from the west coastal area of Korea Peninsula on a KSR-III (Korea Sounding Rocket-III), third generation Korean sounding rocket launched at 14:52 LST on 28 Nov 2002. The ozone experiment payload consists of UV and visible radiometers to measure the direct attenuation of solar UV at four wavelengths centered at 255, 290, and 310nm, respectively. Visible channels centered at 450nm are used for rocket attitude correction. The filter transmission and phototube response characteristics of each channel were calibrated with the monochromator system at the optical laboratory in KARI (Korea Aerospace Research Institute). Measured solar UV attenuation is converted into ozone column density as a function of altitude and the vertical profile of ozone number density is obtained. This result was compared with other observations such as ozonesonde, Umkehr, and satellite measurements of POAM-III and HALOE. Reasonable agreements were found among the measurements. The sensitivity of the retrieval algorithm is investigated for errors in parameters where absorption cross section and wavelength bias are found to be significant error sources.

A42C-0768 1330h POSTER

Intercomparison of Simultaneous Laboratory Gas Absorption Measurements With ACE-FTS and MAESTRO

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