HYCOM Consortium for Data Assimilative Modeling

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8th HYCOM NOPP GODAE Meeting

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Abstracts

Abstracts in order of proposed agenda

Update on U.S. Navy Ocean Analysis and Prediction: Existing and Future Plans
Harley E. Hurlburt, *NRL/Stennis*

A brief summary of existing and future U.S. Navy global and basin-scale ocean analysis and prediction products will be presented. This includes the role that the data-assimilative global ocean models used in Navy systems, particularly HYCOM, will play in providing boundary conditions for coastal and regional models. High interest in ocean products has been demonstrated. During 2003 the NRL Oceanography Division web pages experienced 18.3 million hits or an average of 50,211 per day, most of these to real-time global and basin-scale ocean products such as satellite altimetry, model independent analyses of sea surface height and sea surface temperature, and to nowcasts and forecasts from data assimilative global and basin-scale ocean models, including 1/12 degree Atlantic HYCOM.

NCEP Atlantic Ocean Forecast System
Carlos Lozano, *MMAB/EMC/NCEP/NOAA*

A high resolution Atlantic Ocean Forecast System for real-time short term forecasts is described. This system is now under development at NCEP. Some initial results and issues related to modeling, forcing and data assimilation will be presented.

The TOPAZ forecasting system
Laurent Bertino, *NERSC*, and Dave Szabo, *GEOS/Fugro*

The TOPAZ forecasting system is using HYCOM implemented on an Atlantic and Arctic grid. It assimilates remote sensing data with the EnKF and runs nested high-resolution models in the Gulf of Mexico, in the North Sea and in the Barents Sea. The assessment of a recent HYCOM upgrade - v2.1 against v1.3 - and the modeled currents associated with hurricane Ivan are presented.

Global HYCOM
Alan Wallcraft, *NRL/Stennis*

Global HYCOM-CICE-CSM coupled system
Dave Bi, Ge Peng, and Eric Chassignet, *RSMAS/UM*

A global coupled ocean-ice system has been developed within the framework of

NCAR's Climate System Model (CSM). The ocean component is HYCOM and the ice model is after the Los Alamos sea ice model (CICE). The climate model components are linked through the coupler which is part of CSM.

A 100-year run has ben carried out with the atmospheric forcing from NCAR normal year corrected forcing (CNYF) dataset developed by Large and Yeager (2004).

Efforts are underway to estimate model drifts and assess model behaviour for this 100-year HYCOM-CICE-CSM/NCAR-CNYF run. With no salinity relaxation, the sea surface temperature fields are fairly stable maintaining its structure and intensity, while the sea surface salinity becomes noticeably fresher with time. The Atlantic MOC decreases dramatically. The maximum Atlantic MOC reduces from its initial value of nearly 40 sv to about 12.93 sv at the end of the 100-year run, while there is only a 10-sv drop in the maximum north hemisphere meridional overturning streamfunction. The time evolution of cross-sections in the Atlantic ocean and of global ice area coverage will also be discussed.

Basin-scale Prediction with the HYbrid Coordinate Ocean Model

Joe Metzger, *NRL/Stennis*

One aspect of the FY02-04 "Basin-scale Prediction with the HYbrid Coordinate Ocean Model" HPC challenge project was development of 1/12 deg basin-scale Pacific HYCOM. A synopsis of this work will be presented including results from both the climatological and interannually forced simulations. In addition, interest by the oceanographic community in using this output will be discussed.

1/12 deg North Atlantic HYCOM Development

T.L. Townsend (1), A.J. Wallcraft (1), Z.D. Garraffo (2), H.E. Hurlburt (1), E.P. Chassignet (2), and L.T. Smith (2)
(1) *NRL, SSC, MS*, (2) *RSMAS/UM, Miami, FL*

In sigma-0 .08 deg Atlantic HYCOM simulations, reducing the numerical noise by employing the 2nd-order FCT scalar advection eliminated the excessive vertical mixing and stratification loss in the high latitudes and led to a much more realistic meridional overturning cell (MOC) and vertical structure and surface circulation in the subpolar gyre region, as previously shown. The resulting MOC amplitude is in excellent agreement with the observationally-based estimate of ~14 Sv for the northward upper branch (Schmitz and Richardson, 1991). In simulations using MPDATA it was much too strong at approximately twice the observed value. However, in the sigma-0 simulations, the depth of the switch from net northward to net southward flow was still too deep, (>1200m) south of 20N. In more recent sigma-2* simulations with 2nd-order FCT for scalar advection, the depth of this switch in direction of flow in the MOC is much closer to what it should be to allow the upper northward portion of the MOC to flow into the Caribbean Sea as observed. It was also previously shown with the sigma-0 simulations that implementing different Lagrangian layer target densities in the Mediterranean Sea from those in the Atlantic Ocean vastly improved the model circulation within the Mediterranean Sea. While spatially-varying target densities have not yet been implemented in the sigma-2* simulations, the Mediterranean results are also significantly improved over the original sigma-0 results due to a different z-level distribution (down to nearly 1500m instead of only down to about 250m). Following these significant improvements in .08 deg Atlantic HYCOM development, a new interannual (July 1998-present) simulation was completed and has been shared with consortium partners working on advanced data assimilation techniques in HYCOM and improvements to the current .08 deg Atlantic HYCOM data-assimilative nowcast/forecast system.

Comparison of results from high resolution hycom simulations with observed sections in the north and tropical Atlantic

Zulema Garraffo, Linda Smith, Ole Martin Smedstad, Tammy Townsend, Alan Wallcraft, Harley Hurlburt, and Eric Chassignet, *UM/RSMAS* and *NRL/Stennis*

Results from North Atlantic high resolution simulations (in sigma-theta with data assimilation, and in sigma 2* vertical coordinates) are discussed in comparison with observed sections in the western Atlantic, at 11S and 5S, in the Equatorial Atlantic at 35W, and at 43N.

Barotropic transports from MICOM and HYCOM for some North Atlantic MERSEA sections
Linda Smith, *UM/RSMAS*

NOAA Ocean Prediction Center: HYCOM Evaluation
J.M. Sienkiewicz (*NOAA/Ocean Prediction Center*) and J.A. Morgan (*I.M. Systems Group, Inc.*)

The NOAA Ocean Prediction Center (OPC) is an operational forecast center responsible for forecasts of winds and waves for a large portion of the Northern Hemisphere's ocean areas. The OPC and its wide variety of marine customers are interested in the location and strength of several persistent ocean features including: the Gulf Stream, its associated warm and cold rings, and the shelf break front. Accurate ocean model fields such as sea surface temperature (SST) and near surface current are needed for the protection of life and property at sea and the enhancement of economic opportunity. The OPC hopes to use the Hybrid Coordinate Ocean Model (HYCOM) output fields to improve existing forecasts of winds and waves, and as a basis for an expanding suite of oceanographic products.

The OPC will be evaluating HYCOM for operational use by the National Centers for Environmental Prediction (NCEP) and the National Weather Service using the National Centers Advanced Weather Interactive Processing System (N-AWIPS) workstation environment. The initial focus of the evaluation will be on SST and ocean features. The OPC is working with NCEP Environmental Modeling Center and NESDIS Office of Research and Applications to make model output and new satellite fields (such as GOES and POES infrared SST, microwave SST, and merged SST products) available for this evaluation. The evaluation process will require comparison of HYCOM output to both satellite-based SST observational data as well as various existing models, including the NCEP Regional Ocean Forecast System (ROFS), the NCEP Global Forecast System (GFS), and Eta models. For the evaluation, we are developing a variety of products including N-AWIPS fields and web-based image comparisons; these will aid in examining ocean features across multiple datasets. The status of our overall progress will be given. In addition, examples of SST fields to be used in the evaluation process will be shown.

Description of recent updates to the NRL Coupled Ocean Data Assimilation System
James A. Cummings, *Oceanography Division, NRL/Monterey*

The NRL Coupled Ocean Data Assimilation (NCODA) is a fully three dimensional multivariate optimum interpolation system. NCODA is designed to cycle with a ocean forecast model in a sequential incremental update cycle. This talk will provide a brief overview of NOCDA and describe some recent upgrades to the system, including new analysis capabilities and assimilation of new ocean observing systems.

The implementation of the MVOI assimilation scheme in HYCOM
Ole Martin Smedstad, James Cummings, HeeSook Kang, Carlisle Thacker, Harley E. Hurlburt, Alan Wallcraft, Eric Chassignet, *NRL/Stennis*, *UM/RSMAS*, and *NOAA/AOML*

The multivariate optimal interpolation scheme (MVOI) developed by Jim Cummings is in the process of being implemented in HYCOM. The technique is being tested in a 1/12 degree Gulf of Mexico configuration. The MVOI assimilates the satellite track data, available MCSST and in situ observations. The "old" assimilation technique using the gridded MODAS field and a Copper and Haines vertical projection is used as a baseline experiment.

An update of the latest developments and results from the near real-time 1/12 degree Atlantic system will be given.

Handling salinity when assimilating XBT data
Carlisle Thacker, *NOAA/AOML*

When assimilating XBT data, in order to insure that the model's density field is not adversely impacted, it is important to correct salinity as well as temperature by exploiting empirical TS relationships. Results for the Gulf of Mexico and for the Northwestern Atlantic are presented.

Progress on the implementation of the Seek filter with the 1/12-deg North Atlantic configuration of the HYCOM model
Laurent Parent and Jean-Michel Brankart, *Sverdrup Technology Inc./ NRL Stennis*, and *LEGI-CNRS, Grenoble, France*

Last fiscal year, the task was to duplicate the results obtained by the Legi staff during the european Topaz project (1/3-deg resolution). Since this summer, the implementation of this new assimilation scheme with the 1/12-deg North Atlantic configuration is underway.

The prototype uses the sigma2* vertical coordinate and covers the North Atlantic ocean with the Mediterranean Sea. The assimilated SST data come from AVHRR satellites and the altimetric data come from the Topex/Poseidon, ERS2, GFO, Jason-1 and Envisat satellites. Moreover, to obtain a better estimation of the surface dynamics, the sea surface salinity from the GDEM3 climatology is assimilated. The analysis algorithm is the same as with the 1/3-deg. configuration, but some parameters have been changed.

Preliminary results of a hindcast experiment will be presented.

Implementation of the EnKF at NRL-Stennis
Hans E. Ngodock, *USM*, and Ole M. Smedstad, *Planning Systems Inc.*

The Ensemble Kalman filter is being implemented at NRL-Stennis, for use with a 1/12th degree resolution of the Gulf of Mexico. Several minor modifications were made to the bulk package downloaded from the EnKF website. The system addresses the need of advanced data assimilation methods with high resolution regional models for cycles of analysis-and-prediction, and will be used to assimilate MODAS SST and SLA, as well as in-situ data. Preliminary results will be presented. A comparison between the EnKF and the EnOI will be conducted for the GOM, as well as an inter-comparison with other methods, namely MVOI, SEEK and ROIF. After the comparison exercises, the system will be used with a higher resolution nested model in the northern GOM, where boundary conditions will be supplied by the assimilative 1/12th degree GOM or NATL.

Nested Gulf of Mexico Modeling with HYCOM
Pat Hogan, *NRL/Stennis*

A series of 0.04 degree (~4 km) nested gulf of Mexico simulations have been performed with HYCOM. The simulations accept boundary conditions from a 0.08 degree North Atlantic HYCOM simulation and are forced with NOGAPS surface fields. Different mixed layer formulations (KPP, Mellor-Yamada 2.5, GISS) are used to investigate the impact on coastal circulation and cross-shelf exchange. Comparison to similar 0.08 degree nested Gulf of Mexico simulations reveal the benefit of higher horizontal grid resolution. The character of shelf-break jets and instabilities, cross-shelf break exchanges, and Loop Current Eddy shedding dynamics are discussed. Preliminary results show that wind and salinity driven flows are the dominant mechanisms for cross-shelf flows from the shelf to the deep water and that there are very few events from the deep water that impact the shelf.

Validation of a HYCOM Forecast Model for the Gulf of Mexico
David Szabo, *Fugro GEOS/Ocean Numerics*

Ocean Numerics has been operating the TOPAZ system described by Laurent Bertino to support a forecast service for deepwater oil and gas operators in the Gulf of Mexico. Validation of the HYCOM system in this project is based on the model's ability to predict events of interest to clients such as the shedding of rings from the Loop Current and their subsequent size and motion characteristics. The ongoing validation is based on comparison of model results to altimeter derived sea surface height and in-situ data where available.

Atlantic Ocean Forecasting System at NCEP: Coastal Ocean Simulations
Chandrasekher Narayanan, Carlos Lozano, Avichal Mehra and Ilya Rivin, *NOAA/NCEP*

A monthly climatology for the Atlantic Basin developed at NCEP by melding historical data sets with other available climatologies is used for the initialization of ocean temperature and salinity for the NCEP 1/12 grid. We compare different climatologies (GDEM, Levitus, Yashayaev, Hydrobase and NCEP) by evaluating the stability of the water column, phenemenology of coastal oceans, mean dynamic heights and T-S diagrams. The NCEP domain for the Atlantic has a resolution of 4-5km in the US coastal regions. Simulations for two different periods (Winter and Fall) are analysed with special emphasis on the coastal oceans in the western boundary. We examine dependencies on initialization, forcing and data assimilation.

Operational ocean modeling in the South Atlantic Bight: A finite element regional scale model as a coastal client of HYCOM/GODAE.
B. Blanton, C. Werner, H. Seim (*UNC-Chapel Hill*)

The need to provide nowcasts and forecasts of the coastal ocean state has motivated much activity and research. The coastal ocean, however, does not exist in isolation. It is typically influenced by tidal signals that propagate shoreward from the deep ocean, remotely propagating waves generated by far-field meteorological forcings, and by cross-shelf fluxes of mass and momentum along the continental shelfbreak. While none of these mechanisms are particularly easy to model, the latter presents a formidable challenge to coastal ocean models since there is generally not enough observations to define an appropriate mass field initialization.

This is particularly true in regions like the South Atlantic Bight (SAB) of the southeastern US coast. The SAB shelf is strongly influenced by the Gulf Stream. Frequent meanders and filaments transport GS waters on to the shelf, and the GS imposes a strong barotropic pressure signal along the shelfbreak. We use the operational HYCOM model nowcasts to initialize a regional/coastal scale finite element model (QUODDY) on a domain that includes the deep-ocean as well as the estuaries and tidal inlets along the Georgia/South Carolina coast. The QUODDY model has been used in operational demonstrations in the South Atlantic Bight (SABLAM, SEACOOS) in barotropic modes only. This nesting HYCOM represents our initial steps toward integrating larger-scale modeling efforts into the regional, limited-area coastal modeling arena.

A regional HYCOM model for the US West coast
John Kindle (*NRL*), Josefina Olascoaga (*RSMAS*), Sergio deRada (*NRL*) and Brad Penta(*NRL*)

Regional Modeling of the West Florida Shelf Circulation
Robert H. Weisberg, *College of Marine Science, University of South Florida*

Regional applications of POM, FVCOM, and ROMS are presented for hindcast studies of the West Florida shelf circulation in response to local and deep ocean forcing. Each of these models has certain attributes that are useful for specific topics. Plans are underway for HYCOM applications for the purposes of improving upon the interactions between the deep-ocean and the shelf.

High-Resolution Nested HYCOM Simulations of the West Florida Shelf
George Halliwell, *UM/RSMAS*

High-resolution nested simulations of the West Florida Shelf are performed to determine HYCOM sensitivity to vertical coordinate resolution, vertical coordinate type, and vertical mixing choice in the coastal ocean. The larger-scale simulation within which the WFS runs are nested has coarse vertical resolution over the middle and outer shelf due to the strategy of maximizing the thickness of the isopycnic coordinate domain over the open ocean. A nested simulation using this coarse resolution is compared to two simulations with six additional layers added at the top of the water column: one with level coordinates over the shelf and the other with terrain-following (sigma) coordinates. These three simulations all use the KPP mixing submodel with a new bottom boundary layer parameterization included. A fourth experiment repeats the high vertical resolution sigma coordinate experiment using the Mellor-Yamada level 2.5 turbulence closure. The two high resolution simulations with KPP mixing that used the different vertical coordinate types produced the most similar results. Plots of components of the pressure gradient term of the HYCOM momentum equation (barotropic plus baroclinic) suggest that the pressure gradient error associated with sigma coordinates does not have a large negative impact. The solutions are more sensitive to reducing vertical resolution (because the seasonal thermocline and bottom boundary layer are not adequately resolved), and to changing the vertical mixing submodel. Strong atmospheric and offshore forcing events are analyzed to illustrate these results.

Perpetual year simulation with the IAS-South Florida regional HYCOM nest
Villy Kourafalou and Roland Balotro, *UM/RSMAS*, Tammy Townsend and Alan Wallcraft, *NRL/Stennis*

A three-year perpetual year simulation has been completed with the South Florida (SF) regional HYCOM which is nested within the Intra-Americas Seas (IAS) HYCOM. The simulation for both SF and IAS is initialized with the 8th year North Atlantic perpetual year simulation. The SF has added coastal features, such as detailed shallow water bathymetry and implementation of the Caloosahatchee and Shark rivers. Several experiments have taken place in the parameterization of river input in both the SF domain and an idealized "Box model" configuration. These include the vertical distribution of the riverine low-salinity water, the number of fixed near-surface z-layers in the low salinity area near the rivers and the treatment of E-P as a mass flux.

Vertical Circulation along the Florida Keys
G. Halliwell and J.F. Willemsen, *UM/RSMAS*

Halliwell's new calculations of w have been implemented in a domain previously supplied by Alan Wallcraft along the Florida Keys. Movies of preliminary results will be presented.

Hurricane simulations with HYCOM
Shuyi Chen and Wei Zhao, *UM/RSMAS*

Comparing North Atlantic HYCOM output with In-Situ Observations
Steven Anderson, *Horizon Marine*

HYCOM Consortium Data Service

Ashwanth Srinivasan and Eric P. Chassignet, UM/RSMAS, Steve Hankin and Kevin O'Brien, *NOAA/PMEL*

The Hybrid Coordinate Ocean Model (HYCOM) consortium's data service (http://hycom.rsmas.miami.edu/dataserver) provides easy and fast access to near real-time 1/12 Atlantic Ocean prediction system output via the Internet, facilitating data sharing between research collaborators and the general public. The system makes available nowcasts and forecasts within a day after the outputs become available. In addition to the latest outputs, approximately 1.5 TB of archived best estimates, images, movies, and data from other simulations are also available through this service. Users can interactively browse the entire archive online, examine arbitrary subsets, and download data in a variety of formats (e.g. netCDF, binary, etc.). This service can deliver near real-time model outputs to coastal and regional modeling sites through a format-neutral strategy via batch jobs that automatically download data subsets immediately prior to initiating a model run. Additionally, for certain data analysis applications, the service also provides scripts that permit a scientist to go smoothly from browsing the data to a more detailed analysis with selected desktop tools (e.g., IDL and Ferret).

The data service is built upon two existing open source components: the Open Project for a Network Data Access Protocol (OPeNDAP, http://www.opendap.org) and the Live Access Server (LAS, http://ferret.noaa.gov/Ferret/LAS/). In the current setup, the OPeNDAP component provides the middleware necessary to access distributed data, while the LAS functions as a user interface and a product server. In addition to these existing components, a new OPeNDAP server called the Ferret Data Server (FDS, http://www.ferret.noaa.gov/Ferret/FDS/) is under development to generalize the support for curvilinear horizontal and hybrid vertical coordinates. This capability can expose the physics of HYCOM model runs in great detail, facilitating an unprecedented community-based analysis of the model's performance. Furthermore, development of an interface that meets the needs of scientists and the general public is a continual process. Towards this end several enhancements to the LAS are currently underway. These enhancements are being made to a) support model-data and model-mode l comparisons on the Web, b) provide HYCOM subsets to coastal or regional nowcast/forecast partners as boundary conditions, and c) increase the usability of HYCOM results by "application providers".

In the near future, outputs from the HYCOM ocean prediction system will be integrated with observations from the U.S. GODAE server in a single virtual server from the data user's point of view. The GODAE server will make these data available through an interface that shares a common look and feel both for gridded outputs and for observations. The fused GODAE/HYCOM server will include the ability to perform on-the-fly model-data comparisons. Two modes of model-data comparison will be implemented: 1) by sampling (point-wise interpolating) of the gridded field, and 2) (for dense fields of observations) by on-the-fly gridding of observations. Such a comprehensive virtual site could be the uniform portal into the data contents of the entire International GODAE project.

HYCOM and GODAE Product Server activities at the IPRC: A status report
Peter Hacker, *IPRC, University of Hawaii*

The Asia-Pacific Data-Research Center (APDRC) at the International Pacific Research Center (IPRC), University of Hawaii, has implemented product server technology and procedures to allow web-based access to a broad range of atmospheric and oceanic data and products by the user community. Web-based access is provided by LAS, EPIC, GDS and OPeNDAP servers. In the GODAE context, the APDRC is implementing a GODAE Product Server for the Pacific Islands region. We are doing this in partnership with a network of product providers, servers and users. At the present time the APDRC serves a broad range of data sets and products, delayed-mode GODAE products, and near-real-time products including the Naval Research Laboratory (NRL) Layered Ocean Model (NLOM) global surface-layer product. We plan to assist in the serving of HYCOM products in the future for the Indo-Pacific region. The APDRC website is at http://apdrc.soest.hawaii.edu/. In addition, the APDRC is implementing a regional, high-resolution ocean model (HYCOM), which will eventually use the operational HYCOM output for the Pacific Ocean to supply the open ocean boundary conditions. The regional model will be used to downscale the operational model products for the nearshore regions of the Hawaiian Islands and other Pacific islands. The model is presently being implemented for the Hawaiian Islands where we have substantial data for model evaluation. Once the model is evaluated, we plan to use it in other Pacific Island regions (Guam, Samoa, Fiji, etc.) as well, to meet regional users' needs.

Plans for Using HYCOM Data to Force Unstructured Grid Coastal Models
Cheryl Ann Blain, *NRL/Stennis*

Details regarding plans for the application of a model of the Mississippi River and its outflow forced by data from the 4 km resolution Gulf of Mexico, data assimilative HYCOM model will be presented.

An Update on the HYCOM Solar Radiation Penetration Scheme
A. Birol Kara, Alan J. Wallcraft, Harley Hurlburt and ZhongPing Lee
Naval Research Laboratory (NRL), Stennis Space Center

Shortwave radiation attenuation into the upper ocean is parameterized using two exponential terms, one for the visible spectrum (350-700 nm) and the other for the infrared spectrum (700-2400 nm). The former is also called Photosynthetically Active Radiation (PAR). This differs from the previous HYCOM dual-band formulation in two ways: a) the bands represent fixed frequency ranges rather than a turbidity dependent split into "red" and "blue" fractions, and b) in the visible band the attenuation coefficients vary with depth, and potentially solar zenith angle. In addition, the new scheme requires only remotely-sensed diffuse attenuation coefficient at 490 nm (k490) which can be directly obtained from satellite observations such as Sea-viewing Wide Field-of-view Sensor (SeaWiFS). The formulation presented here is based on a radiative transfer model, hydrolight, and is applicable to all types of water. Therefore, it can be used for global ocean model studies.

Diagnostics of Available Potential Energy in the Ocean
Rainer Bleck, *LANL*, and Shan Sun, *NASA/GISS*

Isopycnal interface smoothing, originally proposed by Gent and McWilliams, has become a widely accepted technique for parameterizing the effect of baroclinic instability on the large-scale mass field in coarse-mesh ocean models. The theme of the present talk is to present a method for determining

(a) the magnitude of APE in the world ocean (which is found to be approximately 1.6 x 10^21 J, several times larger than the atmospheric APE); and
(b) the prevailing balance of APE sources and sinks in near-steady coarse-mesh ocean simulations.

Topics of special interest are the magnitude of APE destruction by GM-type interface smoothing (which turns out to be of order 1 Terawatt) and the magnitude of APE changes brought about by vertical regridding in HYCOM (found to have typical values of 0.3 TW). The latter topic is particularly relevant in light of concerns in the HYCOM user community about the diffusive effect of the grid generator presently used in HYCOM.

The good, the bad and the ugly in HYCOM/FSU global coupled model
Sophie Wacongne-Speer, William Dewar, Steve Cocke, Tim LaRow, FSU,
Rainer Bleck, *LANL*, Shan Sun, *MIT*

The overall performance of a 30 year long run of the current version of the HYCOM/FSU global coupled model will be presented, with an equal emphasis on satisfactory and unsatisfactory features.

Atmospheric Forcing Issues Near Land/Sea Boundaries
A. Birol Kara, Alan J. Wallcraft and Harley E. Hurlburt

Naval Research Laboratory (NRL), Stennis Space Center

Surface atmospheric fields from operational weather centers are essential inputs to ocean models. However ocean models want over-ocean atmospheric conditions and these are not necessarily provided near the land sea boundary both because the atmospheric grid is typically much coarser than the ocean grid and because the atmospheric products need to provide good results over land as well as over the ocean. HYCOM has traditionally ignored the land-sea boundary when interpolating atmospheric fields to the ocean grid. We show that using only over-ocean values can significantly improve near-coast fields. However problems remain with the wind fields (speed, stress, and curl), which will require additional correction.

Geostrophic Adjustment Process experiments with HYCOM
Avichal Mehra, Carlos Lozano & Chandra Narayanan, *NOAA/NCEP*

The accurate representation of the adjustment processes in the ocean from a realistic ageostrophic state is an important attribute of a numerical model. Numerical experiments using the hybrid coordinates in HYCOM are carried out to study the geostrophic adjustment after a quick release of a fixed volume of fresh water, initially confined in a cylinder, in a dense rotating fluid. The numerical simulations are designed to reproduce some of the laboratory experiments of Stenger et al (JFM, 2004).

Particular attention is given to the evolution of the adjustment process and the final adjusted state. Some of the dependencies on the selection of numerical schemes and parameters are investigated. Comparisons are made with Laboratory experiments and adjustment theory.

HYCOM Code Development
Alan J. Wallcraft, *NRL/Stennis*

The HYbrid Coordinate Ocean Model (HYCOM) is an open source community ocean model. The performance and features of HYCOM 2.2 will be described, as will plans for future development.

Testing of the Pressure Gradient Error in a Terrain-Following Hycom
Valerie Garnier, Mohamed Iskandarani and Eric Chassignet, *UM/RSMAS*

We present the results of our testing of the hydrostatic inconsistency and ensuing baroclinic pressure gradient errors in HYCOM. The tests were conducted for a variety of process-oriented problem, most notably the seamount test case. The flexibility inherent in HYCOM's vertical coordinate system gives the users wide latitude in configuring the vertical structure in the model, and the latter has a direct impact on the pressure gradient errors. Our tests have shown that the errors are negligable when the terrain-following layers are restricted to shallow depths; the errors increase with the bathymetric slopes and when deeper layers are turned into terrain-following mode. Thus, the errors can be controlled either by increasing the horizontal resolution, or by confining the sigma-layers to shallow depths, the latter being a unique feature of HYCOM. We are currently experimenting with an alternate formulation for the baroclinic pressure gradient error that will enable HYCOM to cope with steeper bathymetric slopes and deeper terrain-following coordinate surfaces.

Overflow representation in HYCOM using K-profile and Turner parameterization
Xiaobiao Xu, *UM/RSMAS*

K-profile parameterization (KPP) and Turner parameterization (TP) are compared using idealized configurations. In HYCOM, these two diapycnal mixing schemes are implemented in HYBRD mode and MICOM mode, respectively, thus performance of these two different modes under the same parameterization is examined first. These comparisons suggest, a) the HYBRD and MICOM mode work similarly, but difference exist, especially when a number of very thin layers packed together, the HYBRD mode could not move the interface efficiently to restore their reference ispycnals; b) big difference exists between KPP and TP although both using Richardson number as an important parameter to specify the diapycnal mixing. The eddy coefficient in KPP is 2 order smaller than implied in TP in our idealized 2-D like experiment. A modification, namely, setting the maximum eddy coefficient as function of slope, has been made to KPP in response to this. The results from Mediterranean outflow experiments suggest that the original KPP contains too weak mixing for overflow, and the modification improves KPP's performance in representing overflow. Further study regarding on the overflow representation in HYCOM is planed.
