2011 Layered Ocean Model Users' Workshop

Miami, Florida

February 7 - 9, 2011

Outline

The Workshop Organizers

Rainer Bleck	*NASA / GISS*
Eric Chassignet	*Florida State University*
Zulema Garraffo	*IMSG at NOAA/EMC*
Robert Hallberg	*NOAA / GFDL Princeton University*
Harley Hurlburt	*Naval Research Laboratory*
Mohamed Iskandarani	*RSMAS / University of Miami*

http://lom.rsmas.miami.edu/

Agenda for Monday, February 7, 2011

8:15-8:45		**Registration**
8:45-9:00		**Welcome** *Eric Chassignet*
9:00-9:20	041	**In memory of Claes Rooth** Rainer Bleck *NASA Goddard Institute for Space Studies*
9:20-9:40	004	**Adiabatic density surfaces – the only truly neutral surfaces** Rui Huang *South China Sea Institute of oceanology*
9:40-10:00	012	**The icy demise and revamping of GFDL's ESM2G Earth System Model** Robert Hallberg, Alistair Adcroft, John Dunne, Stephen Griffies, John Krasting *NOAA/GFDL*
10:00-10:20	030	**The ocean component of the Norwegian Earth System Model** Mats Bentsen, Helge Drange, Ingo Bethke *Uni Bjerknes Centre for Climate Research*
10:20-11:00		**Coffee Break**
11:00-11:20	035	**Climate sensitivity of coupled models with differing ocean components** Alex Megann, Adam Blaker and Adrian New *National Oceanography Centre, Southampton*
11:20-11:40	037	**Is the Atlantic MOC in a climate model with a Layered Ocean more stable than one with z-coordinates?** Adam Blaker, Alex Megann, Adrian New, Peter Challenor *National Oceanography Centre, Southampton, UK*
11:40-12:00	032	**Transport balance of the subpolar North Atlantic circulation: insights from an eddy-resolving simulation** Xiaobiao Xu, Harley Hurlburt, William Schmitz *Department of Marine Science, University of Southern Mississippi*
12:00-1:30		**Lunch Break**
1:30-1:50	017	**Overview: Concurrent simulation of eddies and tides in global 1/12 degree HYCOM** Brian K. Arbic, E. Joseph Metzger, James G. Richman, Robert B. Scott, Jay F. Shriver, Patrick G. Timko, Alan J. Wallcraft *University of Michigan*
1:50-2:10	016	**The vertical structure of the baroclinic tidal currents: assessing the skill of a global ocean model** Patrick G. Timko, Brian K. Arbic, James G. Richman, Robert B. Scott, E. Joseph Metzger, Alan J. Wallcraft *COAPS/FSU*
2:10-2:30	027	**A validation of the internal tides in 1/12 degree global HYCOM** J.F. Shriver, B.K. Arbic, J.G. Richman, E.J. Metzger, P.G. Timko and A.J. Wallcraft *Naval Research Laboratory*
2:30-2:50	018	**IMPACT OF TIDES ON THE WAVENUMBER SPECTRA OF AN EDDYING GLOBAL OCEAN CIRCULATION MODEL** James Richman, Brian Arbic, Alan Wallcraft1, Joseph Metzger

		Naval Research Laboratory
2:50-3:30		**Coffee Break**
3:30-3:50	005	**Overview of Polynomial Chaos Methods for Uncertainty Quantification with Application to HYCOM** Mohamed Iskandarani, Ashwanth Srinivasan, Carlisle Thacker, Omar Knio *University of Miami*
3:50-4:10	040	**Quantifying uncertainty in the fate of oil discharged from the Deep Water Horizon accident using Polynomial Chaos expansions** A. Srinivasan, M. Iskandarani, W. C. Thacker, O. M. Knio *University of Miami*
4:10-5:00		**Posters**
4:10-5:00	038	**WBC transports at 26N: model and observations** xiaobiao xu, Harley E. Hurlburt, William J. Schmitz *University of Southern Mississippi*
4:10-5:00	015	**HYCOM simulations with NRL source at EMC.** Z. Garraffo, H-C Kim, D. Iredell, A. Mehra, C. Lozano, G. Halliwell *IMSG at NOAA/EMC*
4:10-5:00	019	**INTERNAL TIDES IN A GLOBAL OCEAN CIRCULATION MODEL** James Richman, Brian Arbic, Patrick Timko, Robert Scott, Alan Wallcraft, Joseph Metzger, Jay Shriver *Naval Research Laboratory*
4:10-5:00	029	**An efficient approximation of thermodynamic functions used in layered ocean models.** I. Rivin, V. Krasnopolsky, C. Lozano *IMSG at EMC/NCEP*
5:30-6:30		**Reception Cash Bar**
6:30-9:00		**Dinner Reception**

Agenda for Tuesday, February 8, 2011

8:40-9:00	034	**Impact of Topography on Circulation and Water Mass Transformation in 0.72 HYCOM-CICE Arctic Ocean** Dmitry Dukhovskoy, Eric Chassignet, Joseph Metzger, Pam Posey, Alan Wallcraft *FSU*
9:00-9:20	022	**The ocean and sea ice in the Nares Strait** Till Rasmussen, Nicolai Kliem, Eigil Kaas *Danish Meteorological Institute*
9:20-9:40	003	**Validation of the 1/12 degree Arctic Cap Nowcast/Forecast System (ACNFS)** O. M. Smedstad(1), P.G. Posey(2), R.A. Allard(2), E.J. Metzger(2), A.J. Wallcraft(2), M.W. Phelps (3) *(1)QinetiQ North America, (2)Naval Research Laboratory, (3)Jacobs Engineering*
9:40-10:00	008	**A pilot reanalysis of TOPAZ system (2003-2008)** Francois Counillon, Pavel Sakov, Laurent Bertino *Mohn Sverdrup Center/NERSC*
10:00-10:40		**Coffee Break**
10:40-11:00	006	**Sea level modelling using HYCOM in the bay of Biscay : introduction of atmospheric pressure effects.** Cyril Lathuiliere, Remy Baraille, Lucia Pineau-Guillou, Yves Morel *SHOM*
11:00-11:20	014	**Real time modeling of the bay of Biscay** Stephanie Louazel, Cyril Lathuiliere, Annick Pichon, Remy Baraille, Yves Morel *SHOM*
11:20-11:40	023	**Modeling of homogenized waters dispersion in coastal areas: the Ushant Front.** Audrey Pasquet , Yves Morel , Rémy Baraille *SHOM/LEGOS*
11:40-12:00	024	**Ocean Surface Dynamics in the Bay of Biscay** Flavien Gouillon, Yves Morel, Rémy Baraille *SHOM*
12:00-1:30		**Lunch Break**
1:30-1:50	002	**What does HYCOM tell us about submesoscale processes?** Jean A Mensa, Zulema Garraffo, Annalisa Griffa, Tamay Ozgokmen, Angelique C. Haza, Milena Veneziani *Rosenstiel School - University of Miami*
1:50-2:10	020	**THE ENERGETICS OF THE GLOBAL OCEAN: THE IMPACT OF MODEL RESOLUTION AND DATA ASSIMILATION** JAMES RICHMAN, PATRICK HOGAN, PRASAD THOPPIL *Naval Research Laboratory*
2:10-2:30	007	**Dynamics of a dense gravity current flowing over a corrugation** Mehmet Ilicak,Sonya Legg,Alistair Adcroft,Robert Hallberg *AOS, Princeton University*
2:30-2:50	009	**An eddy resolving tidal-driven model of the South China Sea assimilating along-track SLA data using the EnOI** Francois Counillon, Jiping Xie, Laurent Bertino *Mohn Sverdrup Center/NERSC*

2:50-3:30		**Coffee Break**
3:30-3:50	036	**HYCOM performance in the Gulf of Mexico During the DWH Oil Spill** George Halliwell, Nick Shay, Debra Willey, Ole Martin Smedstad, Patrick Hogan, Gustavo Goni, Robert Atlas *NOAA/AOML/PhOD*
3:50-4:10	028	**Impact of frontal eddy dynamics on the Loop Current variability during free and data assimilative HYCOM simulations** Matthieu Le Henaff, Villy Kourafalou, Ashwanth Srinivasan, George Halliwell *RSMAS*
4:10-4:30	010	**Impact of Power Extraction on the Florida Current/Gulf Stream System** Alexandra Bozec, Eric P. Chassignet, Howard Hanson *Center for Ocean-Atmospheric Prediction Studies, Florida State University, Tallahassee, FL, USA.*
4:30-4:50	011	**On the interactions between the Mississippi River plume and the Gulf of Mexico offshore circulation** Rafael Schiller, Villy Kourafalou, Patrick Hogan, Nan Walker *University of Miami - RSMAS*
4:50-5:10	025	**Toward the real-time South Florida and Florida Straits (SFFS) system** HeeSook Kang and Villy H. Kourafalou *RSMAS/University of Miami*
5:10-5:30	021	**Numerical simulation of circulation in the Yellow Sea and the East China Sea** Yihua Lin, Xiaobao You *Institute of Atmospheric Physics, Chinese Academy of Sciences*

Agenda for Wednesday, February 9, 2011

9:00-9:20	013	**Dropping ice shelves onto an ocean model; Moving grounding lines** Robert Hallberg *NOAA/GFDL*
9:20-9:40	031	**Progress toward a NOAA-ESRL earth system model: coupling an atmosphere to an ocean** Shan Sun, Rainer Bleck *NOAA/ESRL*
9:40-10:00	039	**Design and early results from a coupling of HYCOM and OLAM** Robert L. Walko, Roni Avissar *Rosenstiel School, University of Miami*
10:00-10:40		**Coffee Break**
10:40-11:00	001	**An ocean reanalysis using the 1/12° global HYbrid Coordinate Ocean Model (HYCOM)** E.J. Metzger, R.A. Allard, R. Broome, D.S. Franklin, O.M. Smedstad and A.J. Wallcraft *Naval Research Lab*
11:00-11:20	033	**Circulation in the Philippine Archipelago simulated by 1/12 and 1/25 global HYCOM and EAS NCOM** Harley E. Hurlburt, E. Joseph Metzger, Janet Sprintall, Shelley N. Riedlinger, Robert A. Arnone, Toshiaki Shinoda, and Xiaobiao Xu *Naval Research Laboratory*
11:20-11:40	026	**New Features of HYCOM** Alan Wallcraft *Naval Research Laboratory*
11:40-12:00	042	**Toward a unified HYCOM code** Flav Gouillon, Yves Morel, Remy Baraille, and Eric Chassignet *SHOM-Toulouse*
12:00-1:30		**Lunch Break**
1:30-5:30		**HYCOM Group discussion** Eric Chassignet *COAPS*

Abstracts for Monday, February 7, 2011

(in order of presentation)

041

Isopycnic modeling – the early years

Rainer Bleck
NASA Goddard Institute for Space Studies, New York
(Abstract received 02/07/2011)

This talk, given in memory of Claes Rooth who passed away on January 17, closely adheres to material presented at a 2006 symposium at RSMAS honoring Dr. Rooth. It touches upon the early aspirations of the isopycnal modeling team that formed at RSMAS in the late 1970s with strong encouragement and never-ending intellectual guidance by our now-deceased senior colleague. Material extracted from anonymous NSF proposal reviews and from "grilling" sessions with ONR program mangers provides the background for a discusssion of the pros and cons of layered ocean modeling.

004

Adiabatic density surfaces - the only truly neutral surfaces

Rui Huang
South China Sea Institute of Oceanology
(Abstract received 12/15/2010)

A new family of surface, the adiabatic density surface, is introduced for the world ocean. This surface is defined as the depth at which the given water parcel can arrive through adiabatic movements, without changing its salinity and entropy. For a water parcel taken at a given station and pressure level, the corresponding adiabatic surface can be defined through very simple calculation. This family of surface is the only neutrally buoyant surface in the world ocean, and other surfaces different from this family of surface are not truly neutrally buoyant. However, even on this surface, only the water parcel sits on the origin can travel to other parts of this surface. Other water parcels sitting on locations other than the origin of this surface cannot exchange their positions through adiabatic and isentropic movements. If two water parcels on this surface exchange their position, the total gravitational potential energy in the ocean must be changed. In this sense, thus, neutral surfaces on which parcels can freely exchange their positions do not exist in the world ocean. The similarity and differences of the adiabatic density surface, the potential density surface, and the so-called neutral density surface are compared in details.

012

The icy demise and revamping of GFDL's ESM2G Earth System Model

Robert Hallberg, Alistair Adcroft, John Dunne, Stephen Griffies, John Krasting
NOAA/GFDL
(Abstract received 12/17/2010)

GFDL is preparing two new 1-degree ocean resolution coupled earth-system models for submission to the IPCC AR5 - ESM2M and ESM2G - both based on the atmospheric model from of GFDL's CM2.1 coupled climate model. The ESM2G differs ESM2M only in their ocean components - an isopycnal coordinate Generalized Ocean Layered Dynamics (GOLD) configuration in the case of ESM2G, compared with a Z*-coordinate MOM4.1 configuration for ESM2M. Because the biogeochemistry takes so long to come into equilibrium, these models were spun up for more than 2000 years with preindustrial forcing. This was the first time that a GOLD-based coupled model was run for such a long time. Despite an attempt to use similar diapycal diffusivities, the abyssal oceans in ESM2M and ESM2G drifted significantly in opposite directions. In the case of ESM2G, the cold abyssal drift eventually led to such large surface cooling that the climate state became problematic. This talk documents the importance of the interior-ocean diapycal diffusivity to the long-term ocean evolution, and describes the changes to a second long run of ESM2G that might have led to a viable Earth System Model.

030

The ocean component of the Norwegian Earth System Model

Mats Bentsen, Helge Drange, Ingo Bethke
Uni Bjerknes Centre for Climate Research
(Abstract received 12/22/2010)

The Norwegian Earth System Model (NorESM) is the Norwegian model contribution to the ongoing CMIP5. The ocean component is based on MICOM and will be described in this talk. Special emphasis will be put on the representation of the Southern Ocean, tropical Pacific, and the Atlantic meridional overturning circulation. Results from a pre-industrial spinup/control experiment will be shown.

Coffee Break

035

Climate sensitivity of coupled models with differing ocean components

Alex Megann, Adam Blaker and Adrian New
National Oceanography Centre, Southampton
(Abstract received 01/06/2011)

The responses of two IPCC-class coupled climate models to climate perturbations are compared. The first is the HadCM3 model of the UK Meteorological Office,Äôs Hadley Centre, while the second, the Coupled Hadley-Isopycnic Model (CHIME), is identical to the first except for the replacement of its ocean model by the Hybrid-Coordinate Ocean Model, HYCOM. The models are first forced by atmospheric CO2 increasing at 1% per year until the concentration is four times that in the control experiment: the Atlantic meridional overturning circulation (AMOC) reduces by ~20% in both of the models. Although similar overall warming results in both models, there are significant regional differences: in particular, the large reduction in precipitation over the Amazon region seen in HadCM3 does not occur in CHIME, and we will show that this is related to differences in the models,Äô representation of ENSO and to changes in the SST and the ITCZ in the tropical Atlantic. The models are then forced for 100 years with an additional surface freshwater ‚Äúhosing‚Äù flux of 0.1 Sv into the North Atlantic between 50° and 70°N to assess their stability with respect to the enhanced hydrological cycle that is expected under global warming. The AMOC decreases by a similar amount in HadCM3 as with increasing CO2, but in CHIME after an initial decrease the AMOC recovers before the hosing is removed. We find that variations in AMOC match closely changes in the upper ocean salinity in the hosing region; by analysing the salt budget in the subpolar region we show that the increased surface freshwater input is balanced by horizontal advection, and the differences in advection in the models therefore explain the different sensitivities observed.

037

Is the Atlantic MOC in a climate model with a Layered Ocean more stable than one with z-coordinates?

Adam Blaker, Alex Megann, Adrian New, Peter Challenor
National Oceanography Centre, Southampton, UK
(Abstract received 01/07/2011)

RAPIT (Risk Assessment, Probability and Impacts Team) is a UK NERC funded project which is part of the wider RAPID-WATCH programme, which maintains the observational mooring array across 26.5N in the Atlantic. The main aim of the project is to estimate the risk of collapse of the Atlantic meridional overturning circulation (MOC) using modern statistical methods for the analysis of coupled climate models. The main focus of the project will be analysis of large parameter and CO2 scenario perturbation ensembles of the UK Met Office HadCM3 coupled climate model and CHIME (Coupled Hadley Isopycnal Model Experiment). The two models are identical apart from the ocean component, where in CHIME the z-layer ocean of HadCM3 has been replaced with HYCOM, the Hybrid Coordinate Ocean Model. We will also be using FAMOUS, a low resolution version of HadCM3 to explore the effects of resolution. In order to run sufficiently large ensembles we will be using the climateprediction.net framework. We know from transient increasing CO2 experiments of HadCM3 and CHIME conducted under a previous project that the maximum Atlantic MOC in the two models respond similarly to the same forcing, although they responded differently to a 0.1 Sv hosing over the North Atlantic between 50N and 70N.

032

Transport balance of the subpolar North Atlantic circulation: insights from an eddy-resolving simulation

Xiaobiao Xu, Harley Hurlburt, William Schmitz
Department of Marine Science, University of Southern Mississippi
(Abstract received 12/28/2010)

A quantitative knowledge of the North Atlantic subpolar gyre is fundamental for a general description of the meridional overturning circulation in the Atlantic Ocean. In this presentation, the subpolar circulation based on a climatologically forced, basin scale model is compared to observational database in the Labrador Sea, along the western boundary, and across the Mid-Atlantic Ridge. The comparisons suggest that the model contains temperature and salinity biases and that the baroclinic vertical structure of the western boundary current is not well presented. Nevertheless, the model-based circulation is approximately consistent with the observations, and an overall quantitative picture of three-layer subpolar North Atlantic circulation is presented by combining the model results and available observations.

Lunch Break

017

Overview: Concurrent simulation of eddies and tides in global 1/12 degree HYCOM

Brian K. Arbic, E. Joseph Metzger, James G. Richman, Robert B. Scott, Jay F. Shriver, Patrick G. Timko, Alan J. Wallcraft
University of Michigan
(Abstract received 12/20/2010)

Until recently, global modelling of the eddying general circulation and internal tides have been done separately. Recently these two threads of research have been brought together (Arbic, Wallcraft, and Metzger 2010, Ocean Modelling). In this talk, we 1) briefly discuss some of the technical obstacles that we faced in the development of tides in a general circulation model, 2) briefly review some of the recent progress made in the HYCOM tide simulations, which will be reported on in detail by co-authors, and 3) discuss some of the important challenges and opportunities the ONR-funded HYCOM tides project faces over the near future, as we strive towards a near-real-time 1/25 degree operational model with tides included. Particular attention in this talk will be paid to the astronomical tidal forcing, the self-attraction and loading, and especially the topographic wave drag, all of which still need to be improved in our HYCOM tide simulations.

016

The vertical structure of the baroclinic tidal currents: assessing the skill of a global ocean model

Patrick G. Timko, Brian K. Arbic, James G. Richman, Robert B. Scott, E. Joseph Metzger, Alan J. Wallcraft
COAPS/FSU
(Abstract received 12/20/2010)

Tidal forcing plays an important role in many aspects of oceanography. Mixing, transport of particulates and internal wave generation are just three examples of local phenomena that may depend on the strength of local tidal currents. Advances in satellite altimetry have made an assessment of the global barotropic tide possible. However, the vertical structure of the tide may only be observed by deployment of instruments throughout the water column. Typically these observations are conducted at pre-determined depths based upon the interest of the observer. The high cost of such observations often limits both the number and the length of the observations resulting in a limit to our knowledge of the vertical structure of tidal currents. One way to expand our insight into the baroclinic structure of the ocean is through the use of numerical models.

We compare the vertical structure of the global baroclinic tidal velocities in 1/12 degree HYCOM (HYbrid Coordinate Ocean Model) to a global database of current meter records. The model output is a subset of a 5 year global simulation that resolves the eddying general circulation, barotropic tides and baroclinic tides using 32 vertical layers. The density structure within the simulation is both vertically and horizontally non-uniform. In addition to buoyancy forcing the model is forced by astronomical tides and winds. We estimate the dominant semi-diurnal, and diurnal tidal constituents of the model data using classical harmonic analysis. We compare the modelled tides to the tidal constituents estimated from an archive of current meters spanning 4 decades and present skill tests for assessing the model performance based upon both parametric and non-parametric statistical analysis. The skill tests are independent of both the current meter archive and the model and can be used with other observations and models. In regions where current meter record coverage is adequate, the model skill in replicating the vertical structure of the dominant diurnal and semi-diurnal tidal currents is assessed based not only upon the strength of the tidal currents but also on the orientation and phase of the tidal ellipses.

027

A validation of the internal tides in 1/12 degree global HYCOM

J.F. Shriver, B.K. Arbic, J.G. Richman, E.J. Metzger, P.G. Timko and A.J. Wallcraft
Naval Research Laboratory
(Abstract received 12/21/2010)

This work examines results from a five-year global simulation of the HYbrid Coordinate Ocean Model (HYCOM) that simultaneously resolves the eddying general circulation, barotropic tides, and baroclinic tides with 32 layers in the vertical and 1/12.5 degree (equatorial) horizontal grid spacing. The modeled sea surface signature of internal tides globally is compared to the signature seen in along-track satellite altimeter data. This work examines all eight (4 largest semidiurnal and 4 largest diurnal) of the tidal constituents implemented in global HYCOM. The magnitude of the internal tide perturbations in sea surface elevation amplitude and phase globally are found to be quite similar to that observed in satellite altimeter data. The largest differences are found in areas of high mesoscale variability (e.g., Kuroshio, Gulf Stream, Antarctic Circumpolar Current), with the satellite data exhibiting larger magnitude perturbations. These areas are problematic in the satellite data due to time sampling that is not sufficient to resolve the variability.

018

IMPACT OF TIDES ON THE WAVENUMBER SPECTRA OF AN EDDYING GLOBAL OCEAN CIRCULATION MODEL

James Richman, Brian Arbic, Alan Wallcraft1, Joseph Metzger
Naval Research Laboratory
(Abstract received 12/20/2010)

Tidal potential forcing has been added to a realistic eddy-resolving (1/12.5° equatorial resolution) six year simulation, 2003-2009, of global Hybrid

Coordinate Ocean Model (HYCOM). The model resolves the eddying general circulation and the barotropic and low mode baroclinic internal tides. The dynamics of the low-frequency upper ocean are thought to be quasigeostrophic, which suggests that the wavenumber spectrum of the sea surface height at scales shorter than the Rossby deformation radius should be very steep, varying with wavenumber as k-5. Altimeter observations in the regions of large kinetic energy suggest a less steep slope approaching k-11/3, which is consistent with surface quasigeostrophic theory. In the mesoscale-to-submesoscale wavenumber band between 300 km and 20 km, we find that the spectral slopes are strongly impacted by the presence of internal tides. For instance, in the North Pacific near Hawai‚Äôi where intense beams of internal tides are generated, the wavenumber spectrum shows peaks near the mode-1 internal tide wavelength and a much flatter spectrum at shorter wavelengths. If we separate the high-frequency internal tidal motions from the low-frequency motions, we find a low-frequency wavenumber spectrum consistent with the surface quasigeostrophic theory with a distinctly different wavenumber spectrum for the internal tides. In lower tidal energy regions such as the eastern South Pacific, the high and low frequency spectra remain distinct, but the internal tides do not dominate the wavenumber spectrum. This study has important implications for the planned wide-swath satellite altimeter, which will measure sea surface height at much higher horizontal resolution than current-generation satellite altimeters. In regions of high internal tide activity, tidal corrections will need to be accurate at short scales in order for wide-swath data to be adequate for the study of low-frequency motions.

Coffee Break

005

Overview of Polynomial Chaos Methods for Uncertainty Quantification with Application to HYCOM

Mohamed Iskandarani, Ashwanth Srinivasan, Carlisle Thacker, Omar Knio
University of Miami
(Abstract received 12/15/2010)

We present a novel application of Polynomial Chaos (PC) methods to represent uncertainties in HYCOM simulations. The PC approach is based on parameterizing the uncertainty in the input using suitable random variables, and expressing the solution as a truncated series of orthogonal polynomials in these random variables. This approach recasts a probabilistic problem into an approximation problem where the expansion coefficients are the primary unknowns. Once these are determined the various statistical moments of the observables can be computed with little extra cost. We use a non-intrusive approach to determine these coefficients via ensemble-like simulations sampled at pre-determined points. Applications to various flow conditions in the Gulf of Mexico will be presented, and the potential advantages and limitations of the approach will be discussed.

040

Quantifying uncertainty in the fate of oil discharged from the Deep Water Horizon accident using Polynomial Chaos expansions

A. Srinivasan, M. Iskandarani, W. C. Thacker, O. M. Knio
University of Miami
(Abstract received 01/10/2011)

An estimate of the confidence in model predictions is vital for decision support in environmental disasters such as the Deep Water Horizon accident. We present an application of the Polynomial Chaos approach to quantify uncertainty in the modeled time history of oil discharged as a result of the Deep Water Horizon accident. Using Polynomial Chaos expansions the solution to a stochastic system with uncertain inputs is obtained as functionals of input (parameterized as random variables) using which the true distribution of the solution can be approximated. In this application, uncertainties in currents and turbulent diffusivities derived from a HYCOM configured for the Gulf of Mexico are propagated through a 3D oil model using the polynomial chaos approach. The results from the polynomial chaos solutions are presented and compared with a Monte Carlo solution.

Posters

038

WBC transports at 26N: model and observations

xiaobiao xu, Harley E. Hurlburt, William J. Schmitz
University of Southern Mississippi
(Abstract received 01/07/2011)

To evaluate the model performance on simulating the Atlantic meridional overturning circulation (AMOC), mean transports determined from a climatologically forced, eddy-resolving simulation is compared to the database near 26°N. Within the Florida Strait, the model-based Florida Current has a mean transport of 29.6 Sv and with temperature and salinity structure approximately consistent with observation. East of Abaco, Bahamas, the model results yield a northward transport of about 9 Sv for the Antilles Current above 1000 m and a southward transport of about 23 Sv for the deep western boundary current below 1000 m, both cumulative from Bahamas escarpment to 72°W. Integrated across the Atlantic basin, the mean transport of the upper limb of the AMOC (0-1100 m) is

about 18 Sv, compared to 18.5 Sv based on observation. The modeled transport of the lower limb (1100-4800 m), however, is more concentrated above 3000 m than observed. Expressing the AMOC stream function in density space yielded a slightly higher (19 Sv) maximum¬†overturning as in z-space.¬†It however¬†provided a clearer picture of the transport partition: The model-based 19 Sv northward transport consists of 12.5 Sv surface water, 6.5 Sv Antarctic Intermediate water, and zero thermocline water. 16 Sv out of the 19 Sv is carried north within the Florida Current.

015

HYCOM simulations with NRL source at EMC.

Z. Garraffo, H-C Kim, D. Iredell, A. Mehra, C. Lozano, G. Halliwell
IMSG at NOAA/EMC
(Abstract received 12/20/2010)

A series of simulations were done using the NRL hycom code on two domains in use in NOAA/EMC: 1) Atlantic domain, variable grid size, equal to 0.04 to 0.08 deg in the western Atlantic. 2) Global 1/4th degree (in a setup by NRL). The objective of the Atlantic simulations is for short term prediction, while for the global 1/4th deg simulation, the objective is for seasonal climate prediction, in coupled simulations like Coupled Forecast System (CFS). Preliminary results are discussed. In both domains the forcing used here is from NOAA's Global Forecast System.

019

INTERNAL TIDES IN A GLOBAL OCEAN CIRCULATION MODEL

James Richman, Brian Arbic, Patrick Timko, Robert Scott, Alan Wallcraft, Joseph Metzger, Jay Shriver
Naval Research Laboratory
(Abstract received 12/20/2010)

Tidal potential forcing has been added to a realistic eddy-resolving (1/12.5° equatorial resolution) six year simulation, 2003-2009, of global Hybrid Coordinate Ocean Model (HYCOM). The model resolves the eddying general circulation and the barotropic and low mode baroclinic internal tides. The barotropic tides for the eight largest constituents have been compared to the 102 pelagic tide gauges and the TPXO7.2 inverse tidal model, capturing approximately 90% of the sea surface height variance with a rms error of about 7 cm. The internal tides in the model are generated by the interaction of the barotropic tide with bathymetry. The internal tides radiate away from the generation regions as beams of propagating waves, which travel for long distances (thousands of kms). Interference patterns between interacting beams are frequently observed. The kinetic energy in the tides is compared to historical current meters and the barotropic currents of TPXO7.2. The semi-diurnal tidal currents compare well with the observations and the barotropic model, while the diurnal tidal currents are much weaker.KE

029

An efficient approximation of thermodynamic functions used in layered ocean models.

I.Rivin, V. Krasnopolsky, C. Lozano
IMSG at EMC/NCEP
(Abstract received 12/21/2010)

An efficient and accurate scheme of calculating transformations between potential density, potential temperature and salinity is suggested. The scheme is based on an analytical Pade approximation and allow to increase computational efficiency of the layered ocean model (HYCOM). An efficient approximation of thermodynamic functions used in layered ocean models.

034

Impact of Topography on Circulation and Water Mass Transformation in 0.72 HYCOM-CICE Arctic Ocean

Dmitry Dukhovskoy, Eric Chassignet, Joseph Metzger, Pam Posey, Alan Wallcraft
FSU
(Abstract received 01/06/2011)

The numerical simulation of the Arctic Ocean is challenging due to the complex processes that control the ocean flow and water mass transformation within the basin. Topography of the Arctic Ocean and adjacent basins plays a major role in determining the flow field and thermohaline structure in the Arctic Ocean. Coarse resolution models of the Arctic Ocean simplify topography either by closing off the Arctic shelves and Bering Strait, or by closing narrow straits in the Canadian Arctic Archipelago, or both. A suite of numerical experiments is run with 0.72-degree resolution HYCOM-CICE modeling system (ARCc0.72) in order to analyze sensitivity of model solutions to topography representation in the Arctic Ocean. Results from ARCc0.72 model experiments with closed/open Bering Strait, channels of the Arctic Archipelago, and Barents Sea shelf are discussed.

022

The ocean and sea ice in the Nares Strait

Till Rasmussen, Nicolai Kliem, Eigil Kaas
Danish Meteorological Institute
(Abstract received 12/21/2010)

A three dimensional coupled ocean (HYCOM) and sea ice model (CICE) is applied

to a regional setup of the Lincoln Sea, the Nares Strait, and the Baffin Bay. As the sea ice model is originally developed for global simulations, boundary conditions have been implemented for the regional setup. The model results are compared with satellite images and with the large scale simulation that is specified for the boundary conditions. The Nares Strait is one of the main gateways of sea ice and fresh water from the Arctic. Observations show that the magnitude of the sea ice area flow through the Nares Strait varies from year to year. This is mainly due to the formation and the stability of an ice arch in the southern part of Kanes Basin which blocks the flow of sea ice through the strait. Just south of the ice arch is the location of the North Water, which is one of the largest polynyas in the world. Recent years has shown a large increase in the sea ice area flow through this strait due to the absence of the ice arch. This influences the opening of the North Water and thereby the conditions for the inhabitants of the area. This makes it important to be able to model the properties of the ocean and the sea ice. The main focus in this talk is on the simulated variations of the modeled sea ice flux and oceanic volume flux through the Nares Strait. Included in this is the coupled models ability to describe the ice bridge and the opening of the North Water.

003

Validation of the 1/12 degree Arctic Cap Nowcast/Forecast System (ACNFS)

O. M. Smedstad[(1)], P.G. Posey[(2)], R.A. Allard[(2)], E.J. Metzger[(2)], A.J. Wallcraft[(2)], M.W. Phelps[(3)]
[(1)]QinetiQ North America, [(2)]Naval Research Laboratory, [(3)]Jacobs Engineering
(Abstract received 12/13/2010)

The Naval Research Laboratory (NRL) has developed a two-way coupled ice-ocean system based on the HYbrid Coordinate Ocean Model (HYCOM) coupled via the Earth System Modeling Framework (ESMF) to the Los Alamos Community Ice CodE (CICE). The data assimilation capability consists of the Navy Coupled Ocean Data Assimilation (NCODA) 3DVAR system. NCODA assimilates observations from satellite altimeter tracks, SST, sea ice concentration and in situ observations, including profile data from BT's and Argo floats. The Arctic Cap Nowcast/Forecast System (ACNFS) is configured on a 1/12 degree grid with resolution of ~3.5 km near the pole. Both the ocean and ice model use the Fleet Numerical Meteorology and Oceanography Center 3 hourly 0.5 degree atmospheric forcing from the Navy's Operational Global Atmospheric Prediction System (NOGAPS). Boundary conditions are provided by the real time 1/12 degree global model. The system has been validated against unassimilated observational data sets of ice drift, ice thickness and ice edge location. ACNFS provides the Naval Oceanographic Office with an improved ice modelling capability until the global 1/12 degree HYCOM nowcast/forecast system is coupled to CICE.

008

A pilot reanalysis of TOPAZ system (2003-2008)

Francois Counillon, Pavel Sakov, Laurent Bertino
Mohn Sverdrup Center/NERSC
(Abstract received 12/17/2010)

The TOPAZ system constitutes the Arctic forecasting system of the MyOcean project. Monitoring the dynamics in the Arctic is complex because the ocean mesoscale is small and the ice behaves non-linearly

and quickly. This justifies the use of advanced ensemble-based data assimilation methods like the Ensemble Kalman Filter. In 2010, a new version of the TOPAZ system has been developed with improvements of the HYCOM model parameterization, dynamics, and resolution as well as in the data assimilation setup. A pilot reanalysis of 5 years is proceeding. The system assimilates observations of SST, along-track SLA, ice concentrations, icedrift and Argo, ITP, and Nansen database T/S profiles. The along track SLA and ice drift data are assimilated in asynchronous mode. The system shows satisfactory skill, and some limitations that lead to modification of our data assimilative system. First, the model shows a bias in SST and mean Sea Surface Height that were estimated with the EnKF. Second, unrealistic updates were obtained in areas where the error was larger than ensemble spread. This issue was handle using a moderation technique.

Coffee Break

006

Sea level modelling using HYCOM in the bay of Biscay : introduction of atmospheric pressure effects.

Cyril Lathuiliere, Remy Baraille, Lucia Pineau-Guillou, Yves Morel
SHOM
(Abstract received 12/16/2010)

The SHOM develops a predicting system over the north east Atlantic ocean (15W - 2E, 43N - 51N). Recent storm events have highlighted the need of accurate sea level forcasts. Developpements were carried out to include the atmospheric pressures effects on the regional modelling systems. The open boundary conditions have been updated to prevent any long-term sea level drift. A storm event is analysed and the different contribution to the sea level variations are detailed.

014

Real time modeling of the bay of Biscay

Stephanie Louazel, Cyril Lathuiliere, Annick Pichon, Remy Baraille, Yves Morel
SHOM
(Abstract received 12/20/2010)

A real time system based on HYCOM has been set up for the bay of Biscay at a resolution of 1.7 km. The model uses atmospheric forcings from M√©t√©o-France (Arp√®ge model) and tidal barotropic forcings (coming from the MOG2D model) superimposed on Mercator fields at open boundary. There is no data-assimilation. The system is run daily. The purpose is to describe all the processes which occur in this area : the large scale and the mesoscale circulation (eddies, thermal fronts,...), the tidal circulation (barotropic tide but also internal tide associated with the stratification), the mixing processes, ...
The system provides everyday forecasts of temperature, salinity, currents and sea surface height. Moreover, the system includes a validation component. This validation is automatically done everyday. In term of temperature and salinity, the model is compared with in-situ profiles, the modeled sea surface height is compared with tide gauges data and the modeled currents are compared with HF radar data in the Iroise sea.

023

Modeling of homogenized waters dispersion in coastal areas: the Ushant Front.

Audrey Pasquet , Yves Morel , R√©my Baraille
SHOM/LEGOS
(Abstract received 12/21/2010)

High frequency processes on the shelves and shelf breaks of the Bay of Biscay and the English Channel are key in shaping the local dynamics. This study aims to a better understanding of one of these processes: the Ushant Front extension, using idealized and realistic numerical experimentation. To perform the numerical experiments, the Miami Isopycnic Coordinate Ocean Model (MICOM) is used in an adiabatic configuration. Both intensity and direction of dispersion of homogenized waters emerging from a frontal, circular dynamical system are investigated. The baroclinic instability is responsible for the production of hetons that advect the mixed waters, while the ondulatory processes and autopropagative mechanisms (due to the sloping bottom and the vertical wall) are the drivers of dispersion. The topography, the stratification, the diapycnal mixing magnitude and the bottom friction are found to have a great impact on the dispersion properties of the baroclinic structures. A sensitivity study on these initial configuration parameters is conducted in order to assess their effects on the extension of homogenized waters. Preliminary results of a realistic configuration of the Ushant front using HYCOM are presented. The results of the model on representing the front are compared to satellite data.

024

Ocean Surface Dynamics in the Bay of Biscay

Flavien Gouillon, Yves Morel, R√©my Baraille
SHOM
(Abstract received 12/21/2010)

The mixed layer is a key component in studies of climate, biological productivity and marine pollution. Thus, achieving an accurate representation of the mixed layer depth (MLD) is of particular importance in ocean numerical modeling. This study focus on an

abnormal deepening of the MLD at the end of summer in the Bay of Biscay using the HYCOM model for the SHOM North East Atlantic configuration. The inaccurate representation of the MLD can be attributed to the physics of the vertical mixing scheme (e.g., KPP), the numerics (e.g., vertical grid discretization), and the uncertainties in the atmospheric forcing. Idealized 1D (i.e., no advection) experiments are used to investigate which parameter is dominant on controlling the MLD. Preliminary results showing the impact of the model vertical grid resolution on the MLD are shown. Future work to tackle the problem are also presented.

Lunch Break

002

What does HYCOM tell us about submesoscale processes?

Jean A Mensa, Zulema Garraffo, Annalisa Griffa, Tamay Ozgokmen, Angelique C. Haza, Milena Veneziani
Rosenstiel School - University of Miami
(Abstract received 12/12/2010)

In recent years, there has been significant interest in the existence and potential role of submesoscale processes in the oceans. Submesoscale process may play an important role in the context of energy balance, mixing and eddy fluxes. With this motivation we performed a one year simulation of the Gulf Stream in HYCOM with 1/48th degree resolution to investigate the presence and role of submesoscale processes. Positive Okubo-Weiss parameter and spectra of kinetic energy and enstrophy are then used as metrics of the submesoscale activity. Submesoscale activity presents a seasonal periodicity, which seems to be correlated with the depth of the mixed layer, inspiring different hypothesis about the formation of the small scale features.

020

THE ENERGETICS OF THE GLOBAL OCEAN: THE IMPACT OF MODEL RESOLUTION AND DATA ASSIMILATION

JAMES RICHMAN, PATRICK HOGAN, PRASAD THOPPIL
Naval Research Laboratory
(Abstract received 12/20/2010)

We examine the energetics of a series of twin experiments using global Hybrid Coordinate Ocean Model (HYCOM) forced by the Navy Operational Global Atmospheric Forecast System (NOGAPS) and compare the model energetics with altimeter, surface drifter and deep current meter moorings. We use three simulations and a hindcast for our analysis, a multi-year global simulation at $1/12^\circ$ resolution, a multi-year hindcast with the same $1/12^\circ$ resolution model and data assimilation, a doubled resolution ($1/25^\circ$) global model and a new $1/12^\circ$ global model with tidal potential forcing in addition to the NOGAPS forcing. We find that the resolution of the present generation of ocean general circulation models of $\sim 1/10^\circ$ is inadequate to establish a vigorous abyssal circulation and the surface eddy kinetic energy (EKE) is only about 85% of the observed. Adding tidal forcing has a minimal impact on the surface circulation but increases the deep EKE by 12% and the kinetic energy of the mean flow (KEM) below 3000m by 25%. Doubling the horizontal resolution of the model increases the surface EKE to levels comparable to the drifter observations and increases the surface KEM by 40%, which is greater than the drifter estimates. The deep EKE and KEM also are increased to levels consistent with the deep current meters. Data assimilation increases the surface EKE to levels consistent with the drifter observations and increases the deep EKE and KEM. Surprisingly, data assimilation weakens the KEM at the surface and upper thermocline to levels below the $1/12^\circ$ simulation. The increases in the surface EKE are dominated by the major current systems with the corresponding increases in the deep EKE below the surface EKE consistent with barotropic transfers of EKE from the surface to the deep by the enhanced surface eddy variability.

007

Dynamics of a dense gravity current flowing over a corrugation

Mehmet Ilicak, Sonya Legg, Alistair Adcroft, Robert Hallberg
AOS, Princeton University
(Abstract received 12/17/2010)

In this study, we investigate the dynamics of a dense gravity currents over different sizes of ridges and canyons. We employ a high resolution idealized isopycnal model and perform a large number of experiments changing the aspect ratio of a ridge/canyon, the Coriolis parameter, the reduced gravity, the background slope and initial overflow thickness. Our experiments show that corrugations steer the plume downslope, and that ridges are more effective than canyons in transporting the overflow to the deep ocean. We find that a corrugation Burger number (Bu-c) can be used as a parameter to describe the flow over topography. In addition, we propose a new parameterization of mixing as a function of Bu-c that can be used to account for unresolved shear in coarse resolution models.

009

An eddy resolving tidal-driven model of the South China Sea assimilating along-track SLA data using the EnOI

Francois Counillon, Jiping Xie, Laurent Bertino
Mohn Sverdrup Center/NERSC
(Abstract received 12/17/2010)

The upper ocean circulation in the South China Sea (SCS) is driven by the Asian monsoon, the Kuroshio intrusion through the Luzon Strait, strong tidal currents, and a complex topography. Here, we demonstrate the benefit of assimilating along-track altimeter data into a nested configuration of the HYbrid Coordinate Ocean Model that includes tides. Including tides in models are important because they interact with the main circulation. However, assimilation of altimetry data into a model including tides is challenging because tides and mesoscales features contribute to the elevation of ocean surface at different time scales and require different corrections. To address this issue, tides are filtered out of the model output and only the mesoscale variability is corrected with a computationally cheap data assimilation method: the Ensemble Optimal Interpolation (EnOI). The EnOI uses a static ensemble and allows for multivariate updates. The data assimilative system is tested for the period 1994-1995, during which time a large number of validation data are available. Data assimilation reduces the Root Mean Square Error of Sea Level Anomalies from 9.3 cm to 6.9 cm and improves the representation of the mesoscale features. With respect to the vertical temperature profiles, the data assimilation scheme improves the results at intermediate depth, but a slight degradation of the results at the surface is noted. The comparison to surface drifters shows an improvement of surface current by approximately 8.3%, with largest improvements in the northern SCS and east of Vietnam. In addition, some new features to the original EnOI scheme are proposed: a static ensemble composed of a running selection of members to handle the strong seasonal variability and a formulation for the ageing of the observation error that is dependent on space and time. These two features lead to slight improvements of the multivariate properties of the method.

Coffee Break

036

HYCOM performance in the Gulf of Mexico During the DWH Oil Spill

George Halliwell, Nick Shay, Debra Willey, Ole Martin Smedstad, Patrick Hogan, Gustavo Goni, Robert Atlas
NOAA/AOML/PhOD
(Abstract received 01/06/2011)

During the Deepwater Horizon oil spill, nine synoptic aircraft surveys were conducted in the eastern Gulf of Mexico from a NOAA P3 aircraft using AXBTs, AXCTDs, and AXCPs between 8 May and 9 July. This unprecedented dataset provides an opportunity to evaluate the performance of ocean nowcast-forecast systems in a dynamically active region and to quantify the impact of such synoptic surveys on the accuracy of data-assimilative ocean analysis products. This presentation focuses on three topics: First, a large error reduction in HYCOM analyses was achieved by changing the vertical projection algorithm used in altimetry data assimilation from Cooper-Haines to MODAS synthetics. Second, the performance of HYCOM products (1/12-degree global and 1/25-degree GoM) are evaluated against several other ocean nowcast-forecast products, specifically NCEP RTOFS HYCOM, NRL IASNFC NCOM, SABGOM ROMS, and NOAA/NOS NGOM POM. Ocean analyses that did not assimilate the P3 aircraft profiles produced by all five of these models demonstrate that the HYCOM analysis is equal to or superior to the other model products. Finally, the impact of assimilating the P3 profiles is quantitatively assessed by performing an Observing System Experiment using the 1/25-degree GoM HYCOM, one that assimilated all observations and another that denied the P3 profile observations. Assimilation of P3 observations reduced bias and RMS errors in upper-ocean temperature by 20-40% at the P3 profile locations. Further evaluation of these OSE results is being conducted using observations (e.g. Nancy Foster DWH cruise) and analyses (e.g. tropical cyclone heat potential) available from AOML PhOD and other sources that were not assimilated by either experiment.

028

Impact of frontal eddy dynamics on the Loop Current variability during free and data assimilative HYCOM simulations

Matthieu Le Henaff, Villy Kourafalou, Ashwanth Srinivasan, George Halliwell
RSMAS
(Abstract received 12/21/2010)

The Loop Current (LC) is connecting the Caribbean basin to the Atlantic through the Gulf of Mexico (GoM). It has a highly variable northern and western extension in the GoM, from a port-to-port configuration, where the current flows straight from the Yucatan to the Florida Straits, to a very extended configuration where it reaches the Northern GoM shelf. At this point, the current forms an anticyclonic loop that eventually closes itself to form a warm core ring that then drifts westward inside the GoM, while the LC retracts to its original southern position. A 1/25¬∞ free-running GoM-HYCOM simulation has

been set up to study the LC dynamics, with a focus on the role played by frontal dynamics, especially cyclonic eddies, in the LC variability. Such eddies are known to be involved in the separation of the warm-core ring from the current. Our results provide insights on how frontal cyclones intensify along the northern edge of the LC. Frontal cyclones appear to interact with each other to lead to a ring separation. A 1/50¬∞ data assimilative GoM-HYCOM simulation has been recently set up in the follow-up of the 2010 BP oil spill disaster. Preliminary results with the Singular Evolutive Extended Kalman (SEEK) filter will be shown, with a focus on the impact of DA on the preservation and realism of frontal dynamics.

010

Impact of Power Extraction on the Florida Current/Gulf Stream System

Alexandra Bozec, Eric P. Chassignet, Howard Hanson
Center for Ocean-Atmospheric Prediction Studies, Florida State University, Tallahassee, FL, USA.
(Abstract received 12/17/2010)

The main objective of the research is to investigate the local energetic of the Florida Current and the potential impacts of turbines on the Florida Current/Gulf Stream system. A first series of simulations using HYCOM in a periodic channel configuration forced by a baroclinic flow are performed. An enhanced drag coefficient is applied at defined locations to account for the moored turbine. The impact of the intensity and the location of this drag on the circulation of the channel are assessed for this idealized case. A second series of simulations using a $1/12^{\circ}$ Atlantic configuration of HYCOM analyze the impact of such turbines on the Florida Current-Gulf Stream System. Running each simulation for 1 year starting from year 10 of a climatological run, several values of drag coefficient (CT = 0.1; 1; 5) are tested. Diagnostics of kinetic energy, transports (upstream and downstream of the turbine location) and power are analyzed.

011

On the interactions between the Mississippi River plume and the Gulf of Mexico offshore circulation

Rafael Schiller, Villy Kourafalou, Patrick Hogan, Nan Walker
University of Miami - RSMAS
(Abstract received 12/17/2010)

The Mississippi River (MR) is the major source of freshwater, nutrients and pollutants for the Gulf of Mexico (GoM). The MR plume influences both the ecosystems of the northern GoM region and remote coastal areas (Florida Keys), the latter due to interactions and offshore removal by the GoM mesoscale circulation. In this study, we investigate the dynamical processes controlling the fate of the MR plume, in particular the conditions that favor cross-marginal transport. A high resolution (1/50 deg) model of the northern GoM region was developed using HYCOM. A realistically-forced simulation (nested in a data-assimilative regional GoM-HYCOM model) reveals that the offshore removal is a frequent plume pathway. Eastward, wind-driven currents promote large freshwater transport towards the shelfbreak and the DeSoto Canyon, where mesoscale eddies interact with the buoyant plume and effectively entrain the riverine waters. Freshwater transport estimates show that the offshore removal by eddies can be as large as the wind-driven shelf transport. The proximity of eddies to the shelfbreak is a sufficient condition for offshore removal, and shelf-to-offshore interaction is facilitated by the steep bottom topography near the MR Delta. Strong eddy-plume interactions were observed when the Loop Current System impinged against the shelfbreak, causing the formation of coherent, narrow low-salinity bands that extended toward the Gulf interior. The offshore pathways depend on the position of the eddies near the shelf edge, their life span and the formation of eddy pairs that generate coherent cross-shelf flows.

025

Toward the real-time South Florida and Florida Straits (SFFS) system

HeeSook Kang and Villy H. Kourafalou
RSMAS/University of Miami
(Abstract received 12/21/2010)

Two different continental shelves are separated by the Florida Keys: the Southwest Florida shelf and the Keys Atlantic coastal zone. These two shelf regions interact with each other through the tidal channels between the Keys and with strong offshore boundary currents at their outer edges, the Loop Current and the Florida Current on the Gulf and Atlantic sides of the Keys. The high resolution ($1/100^{\circ}$) SFFS-HYCOM has been embedded within the data assimilative GOM-HYCOM ($1/25^{\circ}$) model to form a system that properly represents the complex coastal to offshore interactions. In order to better simulate the exchanges through channels, eight tidal constituents have been added. Tides come from a local tidal potential directly computed in HYCOM and from the remote tide coming from outside the domain through the open boundaries. Sea surface height and barotropic velocities are extracted from the Egbert TPX tidal model for eight tidal constituents. SFFS simulations forced with high resolution/high frequency atmospheric forcing (COAMPS-27km) have revealed, for the first time, not only mesoscale, but also sub-mesoscale eddy passages (known from high frequency radar WERA data) during a targeted 5-year simulation period (2004-2008). These eddies were validated with high resolution SeaWiFS chlorophyll-a images. The

SFFS-HYCOM has been running in near real time since July 2010, with GFS atmospheric forcing.

021

Numerical simulation of circulation in the Yellow Sea and the East China Sea

Yihua Lin, Xiaobao You
Institute of Atmospheric Physics, Chinese Academy of Sciences
(Abstract received 12/20/2010)

A three-dimensional primitive equation coastal ocean circulation model with free surface and blocking topography coordinates has been developed and applied in the Yellow Sea and the East China Sea with high horizontal resolution of 5' x 5' lon x lat and 20 vertical layer. With the consideration of the real coasts, bottom topography, density gradient forcing and winds stress, and the reasonable treatment of the water exchange at the open boundaries, i.e. Taiwan Strait, Yonaguni Strait, Tsushima Strait and Yangtze River Mouth, the circulation and its seasonal variation in the Yellow Sea and the East China Sea are numerically investigated. Some basic features and the seasonal variation of the circulation in the Yellow Sea and the East China Sea have been obtained which are well consistent with the previous observed evidences and studies. The Kuroshio, the Taiwan Warm Current, the Tsushima Warm Current are relatively stable over the whole year, wind-induced current can weaken them in winter, and enhance them in summer. The Yellow Sea and the East China Sea flows northward into the middle Yellow Sea, and two coastal currents flows along the shoreline at two sides of the sea in winter, while in summer, the Yellow Sea Cold Water Mass circulation dominates. The seasonal circulation patterns are mainly determined and forced by monsoon wind, the open boundary forcing (especially, the Kuroshio) also plays an important role on the formation of the current system.

Abstracts for Wednesday, February 9, 2011

013
Dropping ice shelves onto an ocean model; Moving grounding lines
Robert Hallberg
NOAA/GFDL
(Abstract received 12/17/2010)

The moving grounding line of ice-shelves is critical to studies of sea-level rise, but requires that ocean models are able to gracefully handle wetting and drying. This talk describes a number of changes to the baroclinic / barotropic splitting and other physical parameterizations that seem to enable GOLD to gracefully handle dynamic coupling with an ice-sheet and -shelf with a moving grounding line. This new capability is tested by dropping an ice shelf onto an dealized ocean from several meters above its resting position and watching the ocean model's response.

031
Progress toward a NOAA-ESRL earth system model: coupling an atmosphere to an ocean
Shan Sun, Rainer Bleck
NOAA/ESRL
(Abstract received 12/27/2010)

A long-range global weather prediction model developed at ESRL is
currently being coupled to a HYCOM-type ocean. The atmospheric model (http://fim.noaa.gov) uses an icosahedral horizontal grid and a hybrid-isentropic vertical coordinate, also reminiscent of HYCOM. Grid nesting is common in weather modeling, but grid discontinuities are usually kept away from the region of interest. To avoid joining disparate grids at the ocean-atmosphere interface (arguably the region of interest in coupled modeling), HYCOM is currently being re-coded for an icosahedral grid. With FIM being run operationally at mesh sizes of 15km and 30km, an ocean component sharing the FIM grid will therefore be eddy-permitting. Interseasonal forecasts at that resolution may not be feasible in near future, however. The mathematical similarity of the two models (same number of variables and equations, same vertical coordinate) allows them to share the dynamic core and software engineering innovations developed for FIM. A numerical problem in the barotropic-baroclinic mode splitting scheme, originally developed for HYCOM, forces us to run the icosahedral HYCOM in unsplit mode for the time being. Preliminary results from the coupled model will be discussed.

039
Design and early results from a coupling of HYCOM and OLAM
Robert L. Walko, Roni Avissar
Rosenstiel School, University of Miami
(Abstract received 01/10/2011)

The Ocean-Land-Atmosphere Model (OLAM) is a global model that features locally-refinable unstructured atmospheric and terrestrial grids and a detailed representation of cloud-scale atmospheric moist physics. Its initial development focused on the atmospheric and land components, and until recently the oceans were represented solely in terms of their impact on the atmosphere via their surface temperatures and roughness. Now, a coupling has been developed between OLAM and HYCOM, which enables a fully interactive climate system. We will present details of the coupling, some preliminary results, and plans for the future.

Coffee Break

001
An ocean reanalysis using the 1/12 global HYbrid Coordinate Ocean Model (HYCOM)
E.J. Metzger, R.A. Allard, R. Broome, D.S. Franklin, O.M. Smedstad and A.J. Wallcraft
Naval Research Lab
(Abstract received 12/01/2010)

Both the European Centre for Medium-Range Weather Forecasts and the National Centers for Environmental Prediction (NCEP) have performed multiple atmospheric reanalyses using a static model and assimilation scheme while ingesting all available quality controlled observational data. However, no long-term reanalysis using a high horizontal and vertical resolution ocean model currently exists that is a corollary to the atmosphere. To fill this void, the Naval Research Laboratory is performing a 1993-2009 ocean reanalysis using the 1/12 global HYbrid Coordinate Ocean Model (HYCOM) fully two-way coupled to the Community Ice CodE (CICE) and employing the Navy Coupled Ocean Data Assimilation (NCODA) scheme. The system will be forced with atmospheric output from the NCEP Climate Forecast System Reanalysis and the observations. The reanalysis will begin in 1993 because of the advent of satellite altimeter data that will constraint the oceanic mesoscale.

033

Circulation in the Philippine Archipelago simulated by 1/12 and 1/25 global HYCOM and EAS NCOM

Harley E. Hurlburt, E. Joseph Metzger, Janet Sprintall, Shelley N. Riedlinger, Robert A. Arnone, Toshiaki Shinoda, and Xiaobiao Xu
Naval Research Laboratory
(Abstract received 12/29/2010)

In the Philippines Experiment (PhilEx) 1/12 and 1/25 global HYCOM and 1/12 EAS NCOM nested in global NCOM provided a global context for the Philippine Archipelago circulation. This archipelago provides two secondary routes for both the Indonesian throughflow and the western boundary current of the Pacific northern tropical gyre. The deeper route enters from the north via Mindoro Strait, after passing through Luzon Strait and the South China Sea. The second route enters directly from the Pacific via the shallow Surigao Strait. Both pathways exit via Sibutu Passage at the southern end of the Sulu Sea and both are deeper than the pathway into the Indonesian Archipelago via the Java Sea. The Sulu Sea outflow contributes to the flow through Makassar Strait, the primary conduit of the Indonesian throughflow, at all depths above the Sibutu Passage sill. In the model simulations 2004 and 2008, 2008 the central year for PhilEx observations, are extreme opposite anomalous years with strong southward Mindoro transport in 2004 and mean northward transport in 2008, but with little effect on the Surigao-Dipolog transport. The associated HYCOM sea surface height anomalies in the western tropical Pacific and the South China Sea during these extreme years were verified by satellite altimetry. A PhilEx mooring in Mindoro Strait and 1/12 global HYCOM were used to estimate mean transports of 0.24 Sv northward over the anomalous observational period and 0.95 Sv southward over 2004-2009. Only 1/25 global HYCOM simulated the observed four-layer flow in Dipolog Strait and the persistent cyclonic gyre in the western Bohol Sea, observed in all four PhilEx cruises and in ocean color imagery. A 1/12 global HYCOM simulation with tides generated the hydrostatic aspect of the internal tides within the Philippine Archipelago, including a strong internal tidal beam observed crossing the Sulu Sea, which was generated at Sibutu Passage.

026

New Features of HYCOM

Alan Wallcraft
Naval Research Laboratory
(Abstract received 12/21/2010)

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

042

Toward a unified HYCOM code

Flav Gouillon, Yves Morel, Remy Baraille, and Eric Chassignet
SHOM-Toulouse
(Abstract received 02/07/2011)

[no text submitted]

Author Index

Workshop Attendees

Name	*Institution*
A	
Brian Arbic	*University of Michigan*
B	
Mats Bentsen	*Uni Bjerknes Centre for Climate Research*
Adam Blaker	*National Oceanography Centre, Southampton, UK*
Rainer Bleck	*NASA Goddard Institute for Space Studies, New York*
Alexandra Bozec	*Center for Ocean-Atmospheric Prediction Studies / FSU*
Cesar Bulhoes de Morais	*Brazilian Navy Hydrographic Center*
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Eric Chassignet	*COAPS/FSU*
Victoria Coles	*UMCES/HPL*
Francois Counillon	*Mohn Svervrup Center/NERSC*
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Zengan Deng	*National Marine Data and Information Service*
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Robert Hallberg	*NOAA/GFDL*
George Halliwell	*NOAA/AOML/PhOD*
Rui X. Huang	*South China Sea Institute of Oceanology / WHOI*
Harley Hurlburt	*Naval Research Laboratory*
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Mehmet Ilicak	*AOS, Princeton University*
Mohamed Iskandarani	*University of Miami*
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Heesook Kang	*RSMAS/University of Miami*
Kathiravan Karthikeyan	*ANNA UNIVERSITY, CHENNAI, INDIA*
Hae-Cheol Kim	*IMSG at EMC/NCEP/NOAA*
Omar Knio	*The Johns Hopkins University, Mechanical Engineering*
Villy Kourafalou	*UM/RSMAS*
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Cyril Lathuiliere	*SHOM*
Yihua Lin	*Institute of Atmospheric Physics, Chinese Academy of Science*
Stephanie Louazel	*SHOM*
Jianhua Lu	*COAPS, FSU*
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Gustavo Marques	*RSMAS*
Michael McDonald	*COAPS/FSU*
Alex Megann	*National Oceanography Centre, Southampton*
Raquel Mello	*REMO/CHM - Oceanographic Modeling Network*
Joe Metzger	*Naval Research Lab*
Yves MOREL	*SHOM*

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Fabrício Oliveira	*REMO/USP - Oceanographic Modeling Network*
Tamay Özgökmen	*RSMAS*

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Claire Paris	*RSMAS*
Audrey Pasquet	*LEGOS/SHOM*
Rich Patchen	*NOS/Office of Coast Survey/Coast Survey Dev Lab*

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Till Rasmussen	*Danish Meteorological Institute*
NELLY FLORIDA RIAMA	*BMKG*
James Richman	*Naval Research Laboratory*
Ilya Rivin	*NCEP*
Mitchell Roffer	*ROFFS*

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Rafael Schiller	*University of Miami - RSMAS*
Paul Schopf	*George Mason University*
Jay Shriver	*Naval Research Laboratory*
Ole Martin Smedstad	*QinetiQ North America*
Tony Song	*JPL*
Ashwanth Srinivasan	*RSMAS, University of Miami*
Shan Sun	*NOAA/ESRL*

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