OS42F-163 1330h POSTER

A Non-Stationary Riverine Tidal Model to Assess Impacts of Historical Changes in Columbia River Discharge on Juvenile Salmonid Habitat

Tobias Kukulka[1] (kukulka@ese.ogi.edu)

David A. Jay[1] (djay@ese.ogi.edu)

[1]OGI School of Science & Engineering, Oregon Health & Science University, 20000 NW Walker Rd., Beaverton, OR 97006-8921, United States

Tides, river stage (S) and river flow control current velocities and the extent of shallow-water habitat and tidal wetlands in the Lower Columbia River (CR), playing a major role in juvenile salmonid habitat. Since CR discharge has changed historically, due to hydroelectric regulation and climate variability, there is a need to assess changes in salmonid habitat coupled to hydrodynamic changes. Varying river discharge causes tidal propagation to be non-stationary, rendering the tidal prediction via harmonic analysis unsuitable. As an alternative, we have developed a river flow dependent model for the diurnal (D1), semidiurnal (D2) tidal species and tidal range (R) based on solutions to the linearized St. Venant equations. The wave number of D1 and D2 and the damping modulus of D1, D2, and R were shown to linearly depend to first order on two inputs: a) river flow and b) the square of incoming tidal ocean amplitude divided by the square root of river flow. A simple first order model relates S linearly to river flow. These models were calibrated and verified using a linear regression of the normalized tidal phases, amplitudes, and S. With an optimized filter bank, time-series of D1, D2, R, and S were retrieved from tidal height data collected (1980 -2001) at gauging stations below Bonneville Dam (230 km from the ocean). In contrast to harmonic tidal analysis, our model accounts for non-stationary tidal phases and amplitudes under the restriction that their time changes are small within a tidal wave period. The model was capable of predicting D1, D2, and R amplitudes with an average root mean squared error of 2.5, 2.8, and 3.0 cm respectively. Our method has offered a new view of the prediction of riverine tides, enabling us to reconstruct historical CR tidal properties. Historical tides in the Lower CR were larger than at present, except during spring freshets. Further, tides were historically much smaller and river stage much higher during the downstream migration of juvenile salmonids than at times of modern flow regulation. Modern flow regulation reduces overbank flow and access to previously available salmonid habitat.

OS42F-164 1330h POSTER

A Hydrodynamic Model for Free-Swimming Copepods: The Significance of Being Self-Propelled

Houshuo Jiang[1] (508 289 3641; hsjiang@whoi.edu)

Thomas R Osborn[2] (410 516 7039; osborn@jhu.edu)

Charles Meneveau[3] (410 516 7802; meneveau@jhu.edu)

[1]Dept of Applied Ocean Physics and Engineering, Woods Hole Oceanographic Institution, MS #9, Woods Hole, MA 02543, United States

[2]Dept of Earth and Planetary Sciences, The Johns Hopkins University, 3400 N. Charles Street, Baltimore, MD 21218, United States

[3]Dept of Mechanical Engineering, The Johns Hopkins University, 3400 N. Charles Street, Baltimore, MD 21218, United States

The classic solutions for the Stokes flow around a translating sphere are often used to calculate the flow field around a sinking copepod or the flow field of a copepod feeding current. Comparison with published observations show that the Stokes solutions for a translating sphere do not correctly model the flow field around free-swimming copepods. Theoretical considerations show this failure is due to the fact that a free-swimming copepod is a self-propelled body, i.e. the copepod beats its cephalic appendages to gain thrust from the surrounding water in order to counterbalance the drag force by water as well as its excess weight. The wake of a self-propelled body decays much quicker (in both space and time) than the wake of a translating body which is moving due to an external force.

Here, we propose a simple, self-propelled model for the free-swimming copepods. We employ this model to understand the relationship between copepods swimming behavior, flow geometry, feeding efficiency and sensory mechanisms in detecting prey particles.

OS42F-165 1330h POSTER

Mechanosensitivity of Dinoflagellate Flow-Induced Bioluminescence: Role of the Actin Cytoskeleton

Carrie A McDougall[1] (mcdougal@lifesci.ucsb.edu)

James F Case[1] (case@lifesci.ucsb.edu)

[1]Marine Science Institute, University of California, Santa Barbara, CA 93106, United States

Bioluminescent dinoflagellates are remarkably sensitive to fluid motion, responding to disturbances with bright flashes of light nearly instantaneously. Previous studies have indicated that bioluminescent dinoflagellates are most sensitive to shear forces. Above threshold, shear-stimulated bioluminescence (BL) is directly related to the magnitude of shear stress. Thus, BL is an excellent indicator of flow sensation in a single cell. Because measuring and quantifying BL is relatively easy, bioluminescent dinoflagellates can be used as a model to study the cellular mechanisms that underlie flow sensing and mechanosensitivity. The mechanisms linking fluid motion detection to light emission in dinoflagellates are poorly understood. The same is true for the cellular mechanisms underlying any flow-induced response, particularly those of a free-floating cell. A cells internal skeleton is believed to play a role in mechanosensitivity in two ways: (1) modifying mechanosensitivity by affecting cell stiffness, or (2) imparting mechanosensitivity through force-transferring linkages to membrane-embedded receptors or channels. By modifying the cytoskeleton, we can examine its role in flow sensation. This study focuses on the role of one component of the cytoskeleton: the filamentous actin (f-actin) in flow-induced BL. We report the response of a population of cells as well as individuals of the species, *Pyrocystis fusiformis* (a large, autotrophic, non-motile dinoflagellate), to levels of steady-state fluid shear between 0.75-4.65 dynes/cm^2 following treatments with f-actin-inhibiting cytochalasin-D. Approximate Couette-flow conditions were created within the gap between a stationary vial and a rotating inner cylinder. BL measurements were made with an integrating sphere photometer. The effect of different concentrations of the drug on mechanosensitivity was determined. We found that *P. fusiformis*, as reflected by its BL response, retains mechanosensitivity to fluid shear following treatment with high doses of f-actin-inhibiting drug. These results show that the f-actin cytoskeletal element is not necessary in *P. fusiformis* for reaction to flow and suggest that bioluminescent dinoflagellates are an excellent model for investigating the cellular mechanisms of mechanosensation.

OS42G HC: Hall III Thursday 1330h

Circulation in Marginal and Semienclosed Seas II

OS42G-166 1330h POSTER

Observations of Internal Waves in the Strait of Georgia

Caixia Wang[1] (1-604-822-3911; cxwang@ocgy.ubc.ca)

Richard Pawlowicz (1-604-822-1356; rich@ocgy.ubc.ca)

[1]University of British Columbia, Department of Earth and Ocean Sciences, 6339 Stores Road, Vancouver, BC V6T 1Z4, Canada

The propagation and interaction of internal waves moving in different directions is an important but not well studied topic. Although in general observations of subsurface motions are difficult, near surface internal waves often have a surface expression which is visible to the eye. Observations suggest that the Strait of Georgia has many such internal wave packets close to the surface, and hence might be an ideal geophysical laboratory to study these processes. Some preliminary work was carried out in the summer of 2001 in this region. Ocean surface images were taken by digital cameras in an airplane. A hovercraft with an Acoustic Doppler Current Profiler (ADCP) and a CTD was guided by the airplane to a wave packet. By combining the surface visual observations with the subsurface current and stratification data, we are able to practically follow one wave packet, keeping track of individual wave crests to provide a more complete picture of wave propagation and evolution. On July 4th, we observed internal waves with a wavelength of 50-100 m, an amplitude of up to 4 m, and a phase speed of 1 m/s. The observed phase speeds, wave length and the orientation of wave propagation were obtained from a time series of photogrammetrically rectified surface slick images. The wave amplitudes and periods are provided by the ADCP data. By combining both data sets we have a unique set of observations of wave propagation, evolution, and wave-wave interaction.

OS42G-167 1330h POSTER

Observation and Modeling of the Circulation in the Gulf of Elat

Tal Berman[1,2] (972-4-9679104; tal@nmos.org.il)

Steve Brenner[1] (972-4-8515202; sbrenner@mail.biu.ac.il)

Nathan Paldor[3] (972-2-6584924; paldor@vms.huji.ac.il)

Amatzia Genin[3,4] (972-8-6360124; amatzia@vms.huji.ac.il)

[1]Israel Oceanographic and Limonologic Research, P.O. Box 8030, Haifa 31080, Israel

[2]Israel National Museum of Science, P.O.Box 44927, Haifa 31448, Israel

[3]The Hebrew University of Jerusalem, The Hebrew University of Jerusalem, Jerusalem 91904, Israel

[4]H. Steinitz Marine Biology Laboratory, The Interuniversity Institute, P.O.Box 469, Elat 88000, Israel

Since 1988 long-term observations employing current meters have been concentrated at two stations at the northern end of the Gulf of Elat: one near the northern tip of the Gulf (NT) and the second 11 km from the gulf's north end along the western shore (MBL) where a very complicated circulation pattern with velocities exceeding 15-20 cm/sec were observed. The current varies in both space and time and its direction nearly follows the local bathymetry. During February of each year the progressive vector diagram of the daily averaged velocity at 12 m near MBL indicates a peculiar reversal of the current direction. This reversal of flow is not observed along the Gulfs northern end. In addition to the current reversal, a conspicuous disappearance of the semidiurnal signal in the power spectrum of the currents in winter was observed during all of these years. This disappearance of the semidiurnal signal in the long-shore velocity was not accompanied by an observable decrease in the M2 component of the sea surface height.

In order to supplement and further understand the field measurements, a three dimensional numerical model have been applied (the Princeton Ocean Model, POM) to study the relative roles of the wind, tidal forcing, and seasonal stratification in driving circulation in the entire Gulf. The model was adapted to the Gulf by imposing the local topography, tidal and wind forcing, and initializing it with seasonal hydrographic profiles. The results indicate that the circulation consists of a series of gyres that occupy the entire width of the gulf and that are aligned along the main axis of the basin. Their locations and number are determined primarily by the shape of the coastline and the bathymetry while their diameters are determined by the seasonally changing depth of the thermocline. The MBL is close to the transition point between the northernmost gyre and the next gyre to the south. As the northern gyre contracts in winter and expands in summer the direction of the simulated currents near the MBL reverses with the seasons. Similarly, the disappearance of the semidiurnal peak in the current power spectrum in winter is related to the deepening of the thermocline in winter. As the mixed layer deepens, the effects of the barotropic tidal flux through the southern entrance to the Gulf (Straits of Tiran) are distributed over a thicker layer so the signal in the velocity power spectrum at a particular depth weakens. While the model appears to successfully simulate the large-scale circulation patterns of the Gulf, it does not properly reproduce the current direction fluctuations observed near the north beach.

OS42G-168 1330h POSTER

Evolution of the Open-Sea ALGERS98 Eddy in the Algerian Basin: from Lagrangian trajectories and Sea Surface Temperature

Jose de Jesus Salas[1] (34 93 230 95 12/00; psalas@icm.csic.es)

Jordi Font[1] (34 93 230 95 12/00; jfont@cmima.csic.es)

[1]ICM-CSIC, Institut de Ciencies del Mar, Physical Oceanography Group CMIMA - CSIC, Barcelona 08003, Spain

For the fist time the westward evolution of an open-sea anticyclonic eddy along the Algerian basin (Western Mediterranean Sea) was tracked with in-situ observations (15 buoy trajectories and CTD transects) complemented with daily composite infrared images. Initially the eddy was located (1.8°E-38°N) in front of the Ibiza Island. The buoy trajectories described more than 45 loops at periods of 4 to 21 days, for about 3 months. Along the Spanish continental shelf, some buoy trajectories were released from the eddys flow, describing a predominantly south-southwest mean flow. The eddys movement, translation and swirl velocities around the eddy center, were separated with a kinematic model.The mean translation speed of the eddy was 2 km/day, showing well agreement with the value

of the self-propulsion speed induced by the β term on theoretical models for isolated eddies. Fluctuations of that translation speed were associated with the mean flow which advected the eddy along the Spanish coast, and with topographic steeps which slowed the speed of the eddy. The eddy shape was mainly influenced by the interaction with the bottom topography and with the mean flow coming from the north, inducing changes of its shape from circular to elliptical. It was observed that the swirl velocity of eddy becomes a linear function at radius lesser than 60 km. A preliminary hypothesis about the origin of that eddy, related it with a coastal anticyclonic eddy detached near of the Sardinia channel, as usually occurred on that area. A retrospective analysis with infrared images for the period between January to May 1998, confirms that the eddy generation took place on the western part of the Algerian basin (3^o-4^oE), as a result of a frontal instability generated by the mixing between offshore resident waters, and coastal waters deflected to the north by a big quasi-stationary coastal eddy. The deflected flow under the Coriolis effect acquired anticyclonic relative vorticity, forming an isolated asymmetric dipole, with a small cyclonic eddy and a large anticyclonic eddy. The cyclonic eddy decayed, while the anticyclonic eddy increased its size, On its first days of life the anticylonic eddy was shallow as is corroborated with the Rossby number, about 0.9. As the time goes the eddy reaches a diameter of about 150 km and a vertical structure of 3 km (Rossby number 0.1). Its decay began by interaction with a coastal instability generated at the entrance of the Algerian basin and attached to the African coast. The eddy had a long life-time 10 months. Our data confirmed that the eddy followed a westward "eddy corridor" correlated with the isolines of maximum eddy kinetic energy. Finally the eddy completed an anticlockwise circuit not reported previously in this area. Initially the heat content of the eddy was about 1.63×10^{19} Joules, changing along its westward journey, such as estimations of the heating rate following clusters of buoys trajectories showed. Future studies of Algerian Open-sea eddies will be focused with ocean numerical simulations, developing an anticyclonic eddy with the strength and nature of the described in this study.

OS42G-169 1330h POSTER

Study of the Circulation in the Gulf of Mexico with a High Resolution Numerical Model and Observations

Tanahara Sorayda[1] (+33.1.44.27.72.75; tana@lodyc.jussieu.fr)

Crepon Michel[1] (+33.1.44.27.72.74; mc@lodyc.jussieu.fr)

Candela Julio[2] (+52.61.74.50.50; jcandela@cicese.mx)

[1]LODYC (Universite Paris VI), Tour 26 4eme etage Boite 100 4 Place Jussieu, Paris 75005, France

[2]Depto.Oceanografia Fisica CICESE, Km. 107 Carretera Tijuana-Ensenada, Ensenada Baja Cfa. 22860, Mexico

A three dimensional Ocean Global Circulation Model (OGCM) was used to study some characteristics of the seasonal and interannual circulation in the Gulf of Mexico and Caribbean Sea. Realistic bathymetry and climatology hydrographic data of Reynaud *et al* (1998) are used in all experiments. The atmospheric forcing is comming from ECMWF 1979-1993 re-analysis. The model uses a second order centered advecting scheme. It is used a quadratic bottom friction with a variable background kinetic energy based on the energy of tidal currents. A standard equation of state is considered in the simulations.

In order to study the contribution of topography two different experiments were carried out using free-slip lateral boundary condition.

In the first experiment the horizontal grid resolution was $\frac{1}{3}^o$ in an isotropic mercator grid. The results show the formation of the Loop Current in the interior of the Gulf of Mexico. This loop originates an anticyclonic eddy northward to the plataform of Yucatan Peninsula. The eddy has a mean radio of 270 Km and 800 m depth. The gyre is shed from the Loop Current every 4 months which is smaller than observation period.

In the second experiment the horizontal resolution was increased to $\frac{1}{6}^o$. This experiment also originates a Loop Current with the well known anticyclonic gyre northern to Yucatan Channel. The size of the eddy is also close to 290 Km and 1000 m depth. The eddy shedding periodicity is approximately 7 months. The boucle begins to grow up at 23.5^oN and sometimes when the loop arrives at 26^oN an anticyclonic eddy is propagated to the West coast of the gulf. The Loop Current sometimes arrives at mean latitude of 27^oN but not all the time an eddy is shed off by the current.

Because topography the anticyclonic eddy comes down at West coast of Gulf of Mexico. A second and third anticyclones are observed in the southwest and northwest coast of the gulf at 23^o and 28^oN because dissipation of the anticyclone detached from the loop. The northwest eddy is not present at any time and is much more little than the other ones.

OS42G-170 1330h POSTER

Three-Dimensional Numerical Simulation of The Western Gulf of Mexico Climatological Ocean Circulation

Francisco V. Vidal[1] (52-7-319-8527 x103; fvvidal@infosel.net.mx)

Victor M.V. Vidal[1]

Tal Ezer[2]

Lorenzo Zambrano[1]

Josue Portilla[1]

[1]Instituto Politecnico Nacional, P.O. Box 5-128, Cuernavaca, Mor 62051, Mexico

[2]Princeton University, P.O. Box CN710, Princeton, NJ 08544-0710, United States

The three-dimensional climatological ocean circulation of the western Gulf of Mexico is simulated with a sigma coordinate, free surface numerical model that uses the Mellor-Yamada turbulence scheme. The 110 x 220 horizontal grid employs a rectangular orthogonal system with a variable resolution ranging from 2-5 km. The vertical sigma grid has 16 levels, with a higher resolution in the upper mixed layer and lower resolution in the deep Gulf. The deepest bottom topography in the model is set to 3740 m; at this depth there are five layers in the upper 100 m, and proportionately higher vertical resolution is obtained in shallower regions. The shallowest depth in the model is 10 m. The eastern lateral open boundary conditions for temperature and salinity are provided by three 0.05^o wide buffer zones, where the model fields are relaxed toward observed monthly climatological fields. Inflow/outflow on the eastern open boundary are imposed from the annual mean velocities derived from the whole Atlantic model of Ezer and Mellor (1997). Monthly climatological surface wind stress derived from the Comprehensive Ocean-Atmosphere Data Set (COADS) are used to force the surface wind induced ocean circulation. The simulations reproduce the observed principal and most energetic ocean circulation features of the western Gulf, namely: (1) the southwestward migration of anticyclonic Loop Current eddies, their generation of cyclonic vortices in their periphery via viscous coupling, their collision against the western Gulf's continental shelf slope, their subdivision, and their relative influence on the generation of the Gulf's western boundary current and deep ocean circulation, and; (2) the wind induced ocean circulation, its relative importance as the principal forcing mechanism that drives the Gulf's continental shelf circulation, and its relative importance as a driving force of the Gulf western boundary current.

OS42G-171 1330h POSTER

Mesoscale Eddy Interactions and Western Boundary Current Evolution in the Gulf of Mexico During 1985 Deduced From Concurrent Hydrography and Geosat Altimetry Data

Victor M.V. Vidal[1] (52-7-319-8527 x104; vidalvictor@infosel.net.mx)

Francisco V. Vidal[1] (52-7-319-8527 x103; fvvidal@infosel.net.mx)

Josue Portilla[1]

Lorenzo Zambrano[1]

[1]Instituto Politecnico Nacional, Apartado Postal 5-84, Cuernavaca, Mor 62051, Mexico

Linear regression analyses between sea surface dynamic heights (referenced to 1000 dbar) and GEOSAT altimetry data for two sets of concurrent measurements made in March-April and July-August 1985 reveal correlation coefficients greater than 0.8. Given this high correlation we have estimated the magnitude of the western Gulf baroclinic circulation from the hydrography calibrated 1985 April-December GEOSAT altimetry sequence. The results of this exercise document the evolution of a western boundary current and counter current which were set up by the collision, deformation and initial subdivision of a March 1985 antcyclone. During this ring-slope interaction, two cyclonic rings were shed as the anticyclone transfered vorticity to the surrounding slope water. At this time an off shelf western boundary current and an along-shelf countercurrent were formed. During July-August 1985, the ring triad weakened and evolved into a $\sim$1000 km along-shelf western boundary current which extended from the southernmost part the Bay of Campeche(18.5° N) to 28° N, hugging the Texas continental shelf and slope. At this time cyclonic-anticyclonic ring pairs distributed throughout the central and western gulf. The western boundary current attained maximum northward flow speeds in excess of 25 cm s^{-1} and an 8.3 Sv mass transport between 94°-96° W at 25° N. The southward countercurrent is driven by an along-shelf cyclonic eddy centered at 21° N and -96° W. This southward current extends $\sim$220 km, from 21° to 22° N. It describes jet-like characteristics and denotes a western boundary intensification effect, since its flow increases from 3 cm s^{-1} to 30 cm s^{-1}. Its corresponding southward transport intensifies from 0.56 to 2.71 Sv. The southward cyclonic countercurrent transport is equivalent to 60% of the western boundary currents total northward transport at the same latitudinal tansect. This southward-flowing western boundary current is steered by the bathymetry, traverses parallel to the continental slope and originates the cyclonic mesostructure that dominated the Bay of Campeche during March-April 1985. Thus it appears that an important forcing mechanism for the origin and evolution of the Bay of Campeche cyclone may be attributed to Loop Current ring collisions and to the magnitude of these anticyclones' southward diverging transports.

OS42G-172 1330h POSTER

Vertical Current Structure in the Deep Water of the Gulf of Mexico

Steven F DiMarco[1] (979-862-4168; sdimarco@tamu.edu)

Robert O Reid[1] (979-845-4089; rreid@ocean.tamu.edu)

Worth D Nowlin[1] (979-845-3900; wnowlin@tamu.edu)

Ann E Jochens[1] (979-845-6714; ajochens@tamu.edu)

[1]Department of Oceanography, Texas AM University, 3146 TAMU, College Station, TX 77843-3146

We examined over eight million hours of current meter records and the model outputs of the University of Colorado Princeton Ocean Model hindcast (1993-1999) to describe the vertical current structure in the deep regions of the Gulf of Mexico. We analyzed both databases using statistical and spectral methods and empirical orthogonal function (EOF) analysis.

Statistical and spectral analyses generally show surface-intensified currents with maximum speeds reaching 200 cm/s in association with energetic events such as the Loop Current and the passage of atmospheric storms. Minima in mean, standard deviation, and maximum current speeds are seen in the depth range 800-1000 m. Below 1000 m currents appear barotropic with some indications of bottom intensification.

The results of the EOF analysis at several locations in the Gulf of Mexico were similar. We analyzed datasets consisting of observations of simultaneous point measurements of current velocity of 4 or more distinct depths and which lasted at least 4 months. In addition, we analyzed a year-long current meter record with much higher (10 m) vertical resolution in the upper 750 m and six point current velocity measurements in the lower 1000 m. The vertical structure of the modes, generally, showed a surface-intensified mode, a bottom-intensified near-barotropic mode beginning at roughly 800 m and extending to the bottom ($\sim$2000 m), and a sub-surface intensified mode with a peak between 150 and 500 m depth.

The results of the EOF analysis were compared with a dynamical calculation of vertical modes over a sloping bottom following the method of Charney and Flierl (1981, Evolution of Phys. Ocean.) and using estimated physical parameters of the Gulf of Mexico. The dynamic modes closely resemble the EOF modes estimated from observations and model outputs. To quantify the percentage of variance in each dynamic mode, the EOF modes were regressed onto the dynamic modes. Percentage of variance in the bottom-trapped (gravest) mode are 23.4 based on model outputs (18.7% based on obs.), while the percentage in the most energetic surface-trapped mode is 61.3 (70.7% obs.). Higher order modes account for 15.3 (10.6% obs.) of the variance.

This study was funded by the U.S. Minerals Management Service under OCS contract 1435-01-98-CT-30910.

OS42G-173 1330h POSTER

Volume anomaly in the Gulf of Mexico and its relation to deep flows in the Yucatan Channel

Lucia Bunge[1] ((52-646)-174-5050; lbunge@cicese.mx); Jose Ochoa[1] (jochoa@cicese.mx); Julio Candela[1] (jcandela@cicese.mx); Antoine Badan[1] (abadan@cicese.mx); Julio Sheinbaum[1] (julios@cicese.mx); Robert R Leben[2] ((303) 492-4113; leben@boulder.colorado.edu)

[1]DOF/CICESE, Km. 103, Carretera Tijuana-Ensenada, Ensenada, B.C 22800, Mexico

THU

[2]CCAR/University of Colorado, Dept. of Aerospace Engineering Sciences, Boulder 80309-0431, United States

The Gulf of Mexico is a semi-enclosed sea with two connections: one with the Caribbean Sea trough the Yucatan Channel and the other with the Atlantic Ocean through the Florida Straits. There is a significant difference between the sill depths at both connections, 2040m and 730m respectively, which implies that the only entry or exit of waters deeper than 730m, should only take place through the Yucatan Channel. This characteristic permits a division of the waters from the Gulf of Mexico into two layers, with the lower layer from the bottom up to the Florida sill and the upper layer from that depth to the surface. Although the Gulf of Mexico water volume remains almost constant, the variations of the volume of each layer may be significant. These volume anomalies may be estimated using altimeter data because sea surface topography is a reduced mirror-image of the interface topography between water layers. On the other hand, changes in the water volume of the lower layer must be reflected in the deep transports through the Yucatan Channel. These transports were computed from the data of eight moorings of ADCPs, current meters and thermometers deployed across the Yucatan Channel from September 8th 1999 to June 17th 2000 (10 months). The correlation coefficient between the volume anomaly in the Gulf of Mexico (which is proportional to the lower and upper layer volume) and the deep transports in Yucatan is r=0.68 (0.34<r<0.86 at 80% of confidence). During the measurement period, the mean deep transport at the Yucatan Channel was approximately -0.8 Sv, which implies that the volume of the lower layer was reduced. The series suggest that fluctuations between the volumes of the layers also occur at very low frequencies, on the order of several months or years.

OS42G-174 1330h POSTER

Major Changes in the Mediterranean Surface Circulation From Seven Years of TOPEX-Poseidon and ERS1/2 Altimetry

Gilles Larnicol[1] (+33 5 61 39 47 53; gilles.larnicol@cls.fr)

Nadia K Ayoub[2] (+33 5 61 33 29 24; nadia.ayoub@cnes.fr)

Pierre-Yves Le Traon[1] (+33 5 61 39 47 58; Pierre-Yves.Letraon@cls.fr)

[1]CLS - Space Oceanography Division, 8-10 rue Hermes Parc Technologique du Canal, Ramonville 31526, France

[2]LEGOS/CNRS, 18 avenue Edouard Belin, Toulouse 31401, France

Combined maps of TOPEX/Poseidon and ERS1/2 altimeters data are used to describe the surface circulation variability in the Mediterranean Sea over the period 1993-1999. We focus on seasonal and interannual changes at basin and sub-basin scales. The strongest signals are found in the Eastern basin. In the Ionian Sea, an intensification of the cyclonic circulation in the northern and central regions is observed since 1997. In the Cretan Sea, the Ierapetra anticyclone exhibits a clear seasonal cycle with an intensification in summer, between 1993 and 1995. After 1995, large anticyclones develop in the southern part of the Levantine basin whereas the Ierapetra eddy is not clearly detected. We suggest that the observed small-scale variability in the Levantine Sea is linked to the meandering path of the Mid-Mediterranean Jet while the cyclonic signal in the Ionian indicates a shift to the south of the Ionian Stream.

OS42G-175 1330h POSTER

Numerical Study of Interanual Climatic Variability of H_2S zone in the Black Sea

Dimitur I Trukhchev[1] (359-52-774183; truhi@io-bas.bg)

Detelina P Ivanova[2] (831- 656 3226; dpivanov@nps.navy.mil)

Denis V Ivanov[1]

[1]Department of Marine Physics, Institute of Oceanology, Bulgarian Academy of Sciences, P.O. Box 152, Varna 9000, Bulgaria

[2]Department of Oceanography, Naval Postgraduate School, 833 Dyer Road, Monterey, CA 93943, United States

A 3-D coupled hydrodynamical and chemical model are implemented to study the interanual climatic variability of Oxic/Anoxic layers in the Black Sea. The hydrodynamical model consists of 3-DPE of ocean hydrothermo-dynamics and uses Richardson number dependent parameterization of vertical turbulent mixing and nonlinear horizontal mixing. A 3-D two-component chemical model including both oxygen and hydrogen sulfide is considered for investigation. The interaction between O_2 and H_2S is parameterized with a kinetic reaction of second order. Two historical climatic data archives comprising a significant number of observations from 30-ies (O_2) and 60-ies (H_2S) till 1986 are used for model initialization and validation. The main aim of the study is to achieve better understanding of the role of physical mechanisms as basin circulation from different scales, specifics of the stratification, termohaline structure, vertical mixing on the dynamics of the anoxic zone. Numerical simulations are conducted to examine various kind of hypotheses about H_2S production and origin. The results reveal strong seasonal variability of the oxygen and hydrogen sulphide distributions.

OS42G-176 1330h POSTER

Generation of translating Somali Current rings during the southwest monsoon

David M Fratantoni[1] (508-289-2908; dfratantoni@whoi.edu)

Deborah A Glickson[1] (508-289-3636; dglickson@whoi.edu)

Amy S Bower[1] (508-289-2781; abower@whoi.edu)

[1]Woods Hole Oceanographic Institution, Physical Oceanography Dept, MS21, Woods Hole, MA 02543, United States

During the southwest monsoon a portion of the Somali Current accelerates as it squeezes through the 1000 m deep passage between the Socotra shelf and the Somali peninsula. Recent observations using SeaWiFS ocean color imagery and TOPEX/Poseidon altimetry indicate the occasional formation of westward-translating anticyclonic current rings from this accelerated offshoot of the Somali Current. The rings are comparable in overall diameter to the width of the Gulf of Aden (220 km) and move westward into the Gulf following formation. Southwestward-traveling cyclonic features are evident along the Omani coast north of the Gulf of Aden during the same period. We will summarize four years of remote observations of mesoscale features near the mouth of the Gulf of Aden and contrast them with rings observed using a similar methodology in the western low-latitude Atlantic.

OS42H HC: Hall III Thursday 1330h

Phytoplankton Distribution and Physiology

Presiding: **V Franck,** Marine Science Institute

OS42H-177 1330h POSTER

Non-indigenous phytoplankton in the Great Lakes: NOBOBs ships as potential vectors

Gary Fahnenstiel[1] (231-759-7824; fahnenstiel@glerl.noaa.gov); Ying Hong[1] (231-759-7824; hong@glerl.noaa.gov); Dave reid[2] (734-741-2235; reid@glerl.noaa.gov); Tom Johengen[3] (johengen@umich.edu); Hugh MacIsaac[4] (hughm@uw.ca); Fred Dobbs[5] (dobbs@glerl.noaa.gov); Greg Ruiz[6] (ruiz@serc.si.edu)

[1]LMFS/GLERL/NOAA, 1431 Beach St, Muskegon, MI 49441, United States

[2]GLERL, NOAA, Ann Arbor, MI 48105, United States

[3]CILER, Univ. Michigan, Ann Arbor, MI 48109, United States

[4]Dept. Biology, Univ. Windsor, Windsor, On, Canada

[5]Dept. Biol., Univ. Windsor, Norfolk, VA, United States

[6]Smithsonian Environmental Research Center, Smithsonian Institute, Edgewater, MA, United States

The discharge of ballast water from ships entering the Great Lakes has been a significant source of non-indigenous species to the Great Lakes. In the past few years the majority of ships entering the Great Lakes have been in the NOBOB (no ballast water on board) status. During this past year 17 international ships in NOBOB status were sampled at ports in the Great Lakes. Sampling consisted of collected water and sediment (if possible) from empty tanks on each ship. These water/sediment samples were then analyzed for presence of live phytoplankton and resting stages (cysts, spores, etc.). Also, germination experiments were conducted. These germination experiments consisted of small water/sediment inocula placed in five different types of growth media; Guillard's seawater media, Guillard's freshwater media, modified WC freshwater media, filtered Lake Michigan water and filtered Grand River water . In all 17 ships, phytoplankton resting stages were found in water/sediment samples. Moreover, in all 17 ships phytoplankton were able to germinate and grow from at least one experimental treatment. These results suggest that NOBOBs ships are a potential vector for the introduction of non-indigenous species into the Great Lakes.

OS42H-178 1330h POSTER

The Effects of Hypersaline Conditions on Phytoplankton Primary Productivity, Biomass, and Community Composition in a Semi-tropical Coastal Wetland

Elizabeth M Fejes[1] ((979)847-9328; fejese@neo.tamu.edu); Yesim Buyukates[1] (y0b0855@labs.tamu.edu); Justin Murdock[1] (jmurdock@neo.tamu.edu); James L Heilman[2] (j-heilman@tamu.edu); Kevin McInnes[2] (k-mcinnes@tamu.edu); Daniel L Roelke[1] (droelke@tamu.edu)

[1]Wildlife and Fisheries Sciences , 2258 TAMUS, College Station, TX 77843-2258, United States

[2]Soil and Crop Sciences, 2474 TAMUS, College Station, TX 77843-2474, United States

In the light of increasing atmospheric CO_2 concentrations, it is necessary to improve our understanding of the role of wetlands in the global carbon cycle, e.g., how carbon source-sink relationships and primary productivity are altered in response to environmental change. The upper Nueces Delta, northwest of Corpus Christi, Texas, frequently experiences wet winters where salt concentrations in the wetlands are diluted. Summers are hot and often suffer from drought that leads to hypersaline conditions. Preliminary results from three sampling trips (30 May, 6 June, and 13 June 2001) indicate that water column primary productivity and standing biomass were drastically reduced after a critical salinity concentration was reached, negatively affecting the ability of the wetland's phytoplankton to produce labile organic carbon. Salinities during these trips were 190 ppt, 220 ppt, and 300 ppt respectively, and mid-day water temperatures ranged from 35°C to 39°C. A traditional light-dark bottle method was used to measure water column primary productivity at eight stations within the wetland. Average gross water column primary productivity among the stations was 122 mg-C m^{-3} hr^{-1} on 30 May, but was undetectable for 6 June and 13 June. Chlorophyll *a* data, averaging 15 mg L^{-1} for 30 May, 1.2 mg L^{-1} for 6 June, and 0.96 mg L^{-1} for 13 June, also showed a notable reduction after 30 May. The community composition, initially dominated by large diatoms, cyanobacteria filaments, and picoplankton, gave way to a community dominated by picoplankton, then dominated by cyanobacteria filaments. Inorganic nutrients generally showed a non-conservative increase in concentration suggesting a source from the dying phytoplankton. Preliminary examination showed a zooplankton community comprised mainly of the protozoa. Bacteria concentrations increased from 30 May to 6 June, potentially following a phytoplankton die-off that might have released a large pulse of labile organic carbon, and then dramatically decreased from 6 June to 13 June. Higher trophic levels including fish and invertebrates are virtually absent from this system. Future studies will include quantification of total CO_2 exchange at the ecosystem level, and benthic and emergent plant primary productivity.

OS42H-179 1330h POSTER

Phytoplankton Spatial Distribution Across a Tortugas Eddy, May 1999.

Gary Hitchcock[1] (ghitchcock@rsmas.miami.edu)

Tom Lee[1] (tlee@rsmas.miami.edu)

Peter Ortner[2] (Peter.Ortner@noaa.gov)

Christopher Kelble[1] (ckelble@rsmas.miami.edu)

[1]University of Miami/RSMAS, 4600 Rickenbacker Cswy., Miami, FL 33149, United States

[2]NOAA/AOML/OCD, 4301 Rickenbacker Cswy., Miami, FL 33149, United States

Large cyclonic eddies are dominant mesoscale features in the Florida Current system that play an important role in larval recruitment to the Florida Reef Track. Mesoscale cyclonic eddies, such as the Tortugas eddies, also influence phytoplankton productivity through eddy pumping and thereby potentially affect