

Theme Session B

Integrating observations and models to improve predictions of ecosystem response to physical variability

ICES CM 2007/B:01

Spatial variability in oceanographic conditions of sea waters off Korea in relation to the regional climate changes during the past 40 years

Sukgeun Jung, Young Shil Kang, Young-Sang Suh, Joon-Yong Yang, Jinyeong Kim, and Yeong Gong

We evaluated long-term changes in hydrological conditions in Korean sea waters in relation to the regional land climate change based on available meteorological and oceanographic data from 1968 to 2005. Results suggested that industrialization processes and related urban heat-island effects in South Korea have increased land surface temperatures by 1.267°C during the past 37 years, at least for the urban areas, and consequently increased sea surface temperatures by 0.975°C. The estimated linear trend of land surface temperature in Korea is 2.6 times higher than the global linear warming trend for the past 50 years reported by the Intergovernmental Panel on Climate Change. The increasing linear trend of the sea water temperatures diminished with waters depths < 100 m. Depth-specific salinity has decreased, but the degree of decrease diminished with water. Spatially, the decreasing trend of salinity was most visible in the East China Sea, probably related to the Changjiang diluted water. In Korean sea waters, human factors apparently have driven warming influences on regional sea waters, changing marine ecosystems and dominant species in commercial fishery catches of Korea. For example, squids, mostly *Todarodes pacificus*, and Pacific anchovy, *Engraulis japonicus*, have been dominant in fishery catches off Korea since 1990. Particularly, *T. pacificus* is a characteristic species representing the 1990-2006 period, and probably benefits by the warming sea water and increased zooplankton biomass.

Keywords: climate change, global warming, Korea, marine ecosystem, temperature, salinity, fish.

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ICES CM 2007/B:02

Daily ocean monitoring since the 1860s shows record warming of northern European seas

Brian R. MacKenzie and Doris Schiedek

Ocean temperatures in most parts of the world are increasing and are expected to continue to rise during the 21st century. A major challenge to ecologists and marine resource managers is to understand and predict how these global changes will affect species and ecosystems at local scales where temperature more directly affects biological responses and species interactions. Here we investigate historical variability in regional sea surface temperature in two large heavily-exploited marine ecosystems and compare these variations with expected rates of temperature change for the 21st century. We use four of the world's longest calibrated daily time series to show that trends in surface temperatures in the North and Baltic Seas now exceed those at any time since instrumented measurements began in 1861 and 1880. Temperatures in summer since 1985 have increased at nearly triple the global warming rate which is expected to occur during the 21st century and summer temperatures have risen 2-5 times faster than those in other seasons. These warm temperatures and rates of change are due partly to an increase in the frequency of extremely warm years. The recent warming event is exceeding the ability of local species to adapt and is consequently leading to major changes in the structure, function and services of these ecosystems. Article in press in *Global Change Biology*

Keywords: surface temperature, North Sea, Baltic Sea, warming, climate change

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ICES CM 2007/B:03

Sea surface warming in the southern Bay of Biscay modulated by oceanic advection

Marcos Llope and Ricardo Anadón

One of the consequences of climate change is the world ocean warming. All the studies carried out in the Bay of Biscay agree that the region has warmed up during the last 20 years. Interestingly, some of them also report a cyclic component. But as these studies are mainly based on sea surface temperature they are insufficient to study this process at depth and they usually tend to explain this interannual variability only in relation to atmospheric forcing.

Here we address the issue of exploring how the rate of sea warming changes in relation to the type of Central Waters found in the area at any moment. We found that during the early 2000s, the advection of a large volume of cooler and less saline waters from the inner part of the bay caused a general sinking of the isopycnals, reducing the rate of warming. During the last year, the process reversed due to the flow of warmer and saltier tropical waters which enhanced the warming. Based on these results, we propose a mechanism in which a wavering natural variability would superimpose on the steady global warming, modulating it. The combination of these two forcings would result in the non linear warming observed in the area. This interplay between the natural and the anthropogenic mode, which might be applicable to a broader area, highlights the role of the general circulation. This must be considered in order to accurately estimate the nature and rate of the sea surface warming, particularly when extrapolating into the future.

Keywords: water masses, sea surface warming, southern Bay of Biscay.

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ICES CM 2007/B:04

Predictive modelling of subtidal kelp forests. Brittany coast (France) case study

Vona Méléder, Jacques Populus, Anouar Hamdi, and Brigitte Guillaumont

This study proposes a methodology producing rules to understand kelp forest distribution according to environmental parameters and hence, predictive maps. Key parameters used to predict the presence of kelp forest are grouped into three themes concerned with: 1/ the nature of the substrate, 2/ the influence of the local environment: topology and hydrodynamics, and 3/ the nature of the water body overlying the substrate: turbidity, expressed by the attenuation coefficient of the photosynthetically available radiation, the K_{par} , calculated from SeaWiFS radiances, and temperature expressed as Sea Surface Temperature SST, from AHVRR radiances.

Kelp forest observations used to build predictive models are derived from acoustic detection of seaweeds in 5 sites from the northern and southern Brittany coasts. Kelp distribution on rock substrata remains stable in shallow water until a first depth limit, named H1. Local topology, expressed using the BPI (Bathymetric Position Index), explains the variability of kelp distribution above H1, where light and temperature are sufficient. Below H1 depth, distribution decreases until the disappearance of kelps at a depth limit named H2. The variability of depths H1 and H2 over the 5 sites is mainly explained by the turbidity, or by the temperature when no turbidity data are available. Indeed, an increase in K_{par} is responsible for raising the depth H1 and H2, whereas an increase in SST explains the deeper depth limit. The maximum current velocity during the mean spring tide, from hydrodynamic model simulations, also explains kelp distribution over the Brittany coast. For a constant turbidity, a drop in the depth limit H2 occurs in direct ratio with the power 1.5 of the velocity. This latter parameter expresses the drag pressure in relation to the flexibility of algae. Using these relationships, predictive maps are produced.

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ICES CM 2007/B:05

Validating particle tracking models of sea lice dispersion in Scottish Sea Lochs

Trisha L. Amundrud and A. G. Murray

Lepeophtheirus salmonis is a naturally occurring parasite on wild salmonids. Infestations of this sea louse pose a major economic burden to the Atlantic salmon aquaculture industry and may be linked to the decline of wild salmonid populations. Coupled models of surface circulation and louse biology have been used to understand the dispersion of planktonic larval lice from a point source, such as a fish farm. We have developed a sea lice dispersion model for Loch Torridon, a Scottish fjord-type sea loch on the west coast of Scotland, using output from two different hydrodynamic models. Surface circulation within Loch Torridon shows significant deviation across-loch from expected estuarine transport due to the complex shoreline

geometry and relatively low freshwater input. Validation of transport has been carried out with a combination of current meters and drifter studies, in order to ensure all transport patterns within the loch are represented. Simulated dispersal patterns of viable sea lice demonstrate a high dependence on wind and freshwater forcing, such that validation must be carried out under a range of environmental conditions. Further, complex coastlines of Scottish fjords mean that wall parameterizations can have significant influence on individual particle tracks. As this cannot be validated using drifter studies, a numerical exploration of the impact of varying wall parameterizations is undertaken.

Keywords: particle tracking models; sea lice; model validation.

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ICES CM 2007/B:06

Environmental influence on the spawning distribution and migration pattern of northern blue whiting (*Micromesistius poutassou*)

Hjálmar Hátún, J. Arge, and A. B. Sandø

Postspawning blue whiting migrate from the spawning grounds west of the British Isles, past the Faroe Islands and into the feeding areas in the Norwegian Sea during the spring months March to early June. The changeable migratory route through Faroese waters, as inferred from fisheries statistics, is found to be closely linked to the hydrography along the Rockall Bank, as simulated by an ocean circulation model. A variable spawning intensity around the bank is suggested as the causal mechanism for this link. The observed variability is primarily governed by the strength and extent of the subpolar gyre. Utilizing apparent links between the atmospheric forcing and the subpolar gyre dynamics, the environmental spawning and recruitment conditions for the next (2007) season is forecasted.

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ICES CM 2007/B:07

Predicting recruitment of 0-group gadoids in the Barents Sea – critical interaction between models and observations

G. O. Johansen, M. Skogen, O. R. Godø, and T. Torkelsen

The major gadoid fish stocks of the Barents Sea spawn along the coast of Norway. The eggs, larvae and juveniles are transported northwards with the coastal oceanic currents from the spawning grounds towards their nursery and feeding areas in the Barents Sea. This transport is modelled using a particle-tracking model. The hydrodynamics are stored hourly velocity fields from the MIPOM model. The particles, representing juvenile fish, have been fixed at a certain depth in the vertical dimension. In this work we define some critical observations needed for evaluating the coupled bio-physical model. An example of spatial distribution of 0-group Gadoids in the Barents Sea predicted by the hydrodynamic model compared to field observations is presented. Further, observations of vertical distribution and behaviour of the fish by a stationary acoustic system are used to modify the bio-physical coupling of the model. Based on this experience we propose an observation program for collecting the needed observations to obtain a more realistic recruitment prediction model.

Keywords: Recruitment, gadoids, hydrodynamic model, observations, fisheries acoustics.

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ICES CM 2007/B:08

Operational oceanography and numerical models in the Basque Coast (SE Bay of Biscay). New implementations and future work

V. Valencia, A. Fontán, L. Ferrer, J. Mader, and M. González

The coastal oceano-meteorological instrumentation network in the Basque Country (six coastal stations combining atmospheric and oceanographic sensors) has been recently implemented with two offshore buoys (Wavescan) moored off Cape Matxitxako and Pasaia Harbour at 550 m and 450 m water depth respectively. These buoys provide real-time data of atmospheric meteorological variables (air temperature, atmospheric pressure, vectorial wind, solar and net radiation) and oceanographic parameters (directional waves, current profile in the upper 200 m of the water column and eight temperature and salinity points from surface down to 200 m water depth). Both the coastal stations and offshore buoys belong to the Department of Transport

and Civil Works of the Basque Government. The network of sensors provides high frequency, coupled data sets of oceanographic and meteorological variables. The enlargement of the network, in distance offshore and in width of the water column covered, allows new data for both input and hindcasting calibration of hydrodynamic and dispersion models. An IBM (Individual Based Model) coupled to ROMS hydrodynamic model (Regional Ocean Modeling System) is used in the Basque Coast for descriptive and forecasting purposes upon transport of oil spills, sediments, fish eggs and larvae, etc. Moreover, high-frequency temperature and salinity profiles, in conjunction with the atmospheric and dynamic variables, permit a high resolution tracking of shelf and slope processes such as the thermocline fluctuations related with the wind fields and the Ekman transport, expansion of river plumes, etc. Examples of applications and results will be presented within this contribution.

Keywords: operational oceanography, ROMS, IBM Bay of Biscay.

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ICES CM2007/B:09

Primary production in the Southern North Sea – Estimations from continuous oxygen measurements by a FerryBox

Wilhelm Petersen

The balancing of primary production rates in the North Sea suffers on the lack of available data with high temporal and spatial resolution. The use of FerryBox systems on ships of opportunity (SoO) offers the possibility to get data with the spatio-temporal resolution required. Biological oxygen fluxes are approximately equivalent to net community production (NCP), the excess of total primary production over total community respiration. Measurements of oxygen anomaly in surface waters (5m depth) can be used in combination with a gas-exchange parameterization to estimate the new production along the track of the ship.

Continuous oxygen observations from the years 2002 to 2005 onboard of a ferry from Cuxhaven (DE) to Harwich (GB) together with wind fields derived from a regional meteorological model were used to estimate the seasonal dynamic of oxygen productivity along the track. By means of the highfrequent measurements along the track of the ferry areas of high productivity, such as fronts, can be easily detected and quantified. The new production values obtained using the oxygen flux method will be compared with net production rates provided by traditional methods and models.

Keywords: biological oxygen fluxes, new production, North Sea, FerryBox.

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ICES CM 2007/B:10

Mechanisms of bio-physical coupling at submarine bank ecosystems

Christian Mohn and Martin White

Submarine banks, like many other isolated or quasi-isolated topographic features have long been recognized as important hot spots of bio-physical interactions. At a smaller spatial and temporal scale, physical processes can have a significant effect on the chlorophyll and benthic dynamics. A sufficiently long residence time of primary production is important for any sessile benthic community resident over the topography to (i) transfer surface productivity to higher trophic levels or to (ii) transfer organic material directly to benthic communities before it is lost to the system. An important benthic ecosystem at the Rockall and Porcupine Bank slopes at the European continental margin is that of cold water corals. These reef-forming corals are generally found in regions of strong benthic currents and enhanced surface productivity. We analysed several years of remote sensing data (SST, Chlorophyll-a) to identify robust bio-physical distribution patterns. In a second step, data from recent surveys (ADCP and current meter mooring data) and results from model simulations were used to investigate the relative importance of different physical processes (rectified flow, tides, internal waves) for passive particle displacement as a possible feeding mechanism for benthic communities in these regions.

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ICES CM 2007/B:11

Modeling the influence of North Atlantic freshening on phytoplankton dynamics in the Nova Scotian Shelf and Gulf of Maine region

Rubao Ji, C. Davis, C. Chen, D. Townsend, D. Mountain, and R. Beardsley

Continental shelf waters from the Labrador Sea to the Mid-Atlantic Bight experienced significant freshening in the late 1990s, likely caused by increasing glacial melting and enhanced precipitation and river runoff at higher latitudes (as a result of climate change). The freshening of the ocean can alter circulation and stratification of shelf waters and may influence the phytoplankton dynamics and ecosystem productivity. We used a 3-D coupled biological-physical model to examine the influence of freshening on the timing and magnitude of phytoplankton blooms and primary productivity in the Gulf of Maine/Scotian Shelf region. The model captured the general pattern of westward propagation of spring phytoplankton blooms from the Scotian Shelf to the western Gulf of Maine, consistent with the observed increasing sea surface salinity and associated decreasing stability of water column. By adjusting the boundary conditions in the numerical experiments, the model showed that increased freshening can further enhance the spatial gradients in timing by stimulating earlier blooms upstream (the Scotian Shelf), but has less impact downstream (the western Gulf of Maine). The model results suggest that surface water freshening may impede winter convection and decrease nutrient supply from deep water to the surface, and thus influence the overall seasonal primary productivity. The change of water properties and nutrient concentration in the deep slope water (in response to North Atlantic Oscillation variability) may have made detecting the influence of freshening on the primary productivity more difficult.

Keywords: ocean freshening; biological-physical interaction; coupled numerical modeling; phytoplankton bloom; primary productivity.

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ICES CM 2007/B:12

Settlement patterns of snow crab associated with warm and cold years in the Eastern Bering Sea

Sarah Hinckley, C. Parada, B. Ernst, L. Orensanz, D. Armstrong, E. Curchitser, and A. Hermann

An individual-based model for snow crab (*Chionoecetes opilio*) larvae coupled with a hydrodynamic model (ROMS) was implemented to study transport and settlement patterns in warm and cold years in the Eastern Bering Sea. Modeled temperature and currents were compared to temperature and drifter observations to validate the hydrodynamic model. The simulated years showed differing temperature conditions during the crab planktonic period. The model experiments done to assess the trajectories and settlement patterns of larvae used spatially explicit initial conditions of larval release based on information on female crab reproductive output which was derived from annual bottom trawl surveys. The simulation experiments were run from May to October, with particles released based on locations and depths for each year from the data. The larvae were released at the bottom and swam up in the water column to reach the mixed layer soon after release. They stayed in the mixed layer up to the time of settlement. Settlement was considered successful if they settled in an area where the temperature was within a specified range. Simulations showed that the modeled years had very different temperature patterns, and that these were well correlated with data on temperature. Even though current patterns for both years were quite similar, the settlement patterns of successful larvae differed significantly due to the temperature differences. This study compares these differences between years and the effect of currents and temperature at settlement time on spatial patterns of assumed larval crab survival, and the implications of these differences for recruitment.

Keywords: biophysical modeling, individual-based modeling, Bering Sea, snow crab, recruitment.

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ICES CM 2007/B:13

Sensitivity of the timing of the phytoplankton bloom in a 3D biophysical model of the Gulf of Alaska (GOA) to salinity stratification

Sarah Hinckley, A.J. Hermann, K. Coyle, and W. Cheng

We have developed an 11 compartment nutrient-phytoplankton-zooplankton (NPZ) model for the GOA. The objective of this modeling work is to understand how climate change will affect biological production in this region. This model is embedded within the Regional Ocean Modeling System (ROMS) circulation model, here implemented for the GOA.

A persistent problem in this type of biophysical NPZ model is obtaining the proper timing of the spring bloom. The onset of the bloom is extremely sensitive to the onset of stratification in the water column after winter mixing. We have found that in our model the bloom occurs in March, which is too early by about a month. This was traced to excessive vertical stratification of salinity in the physical model, especially in the spring. We have focused on several processes which contribute to this discrepancy: mixing of coastal runoff with oceanic waters in small estuaries (not resolved in our circulation model); and near-surface mixing of shelf waters, driven by breaking surface waves, internal tides, and other processes not resolved (and/or incorrectly parameterized) by our model.

In this presentation, we illustrate this issue and the effects on the modeled biological system, and discuss methods to address the problem. We illustrate the use of a stability index to assess the salinity stratification in models and data, and discuss the sensitivity of the biology to this index. We explore the nonlinear sensitivity of the circulation and NPZ models to alternate mixing parameterizations, intended to better capture the unresolved physics of this region.

Keywords: biophysical modeling, NPZ models, ROMS model, stability index, vertical stratification, spring bloom.

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ICES CM 2007/B:14

Improvement of process understanding through the use of high frequent Ferrybox observations

Henning Wehde, Dominique Durand, Jo Høkedal, Pierre Jackard, and Kai Sørensen

For long time, Ships of opportunity are used to obtain oceanographic observations to improve the monitoring capabilities of the oceanic environment. Within the recent years a severe improvement of observation systems that are available especially using existing commercial ships such as ferries and cargos has taken place. Instrument packages onboard of these vessels are nowadays also referred to as Ferryboxes. A network of Ferryboxes has been established within the North Sea/Skagerrak and Norwegian Sea. Through the high frequency of repeated transects of the vessels valuable data sets are obtained, that are able to visualise the reaction of the ecosystem on changes within the physical environment. Within the presentation an overview of the obtained data from the Ferrybox network will be shown. As an additional focal point the potential of the Ferrybox data for forming the basis for the improvement of process understanding as well as for model validation and assimilation will be highlighted.

Keywords: biophysical modeling, ecosystem modeling, Gulf of Alaska, ROMS.

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ICES CM 2007/B:15

Creation of synergy effects for understanding long-term ecosystem variability: ECOSMO model results vs. Continuous Plankton Recorder data

Irina Alekseeva, C. Schrum, R. Diekmann, and M. St. John

The Continuous Plankton Recorder (CPR) survey is the only monitoring program providing internally consistent long-term measurements of plankton. Limitations of CPR data are defined by its restriction to the surface layer sampling, lack of biomass estimates, by size and species dependent avoidance and by irregular sampling in space and time. To complement the CPR data base, we employed the 3D ecosystem model ECOSMO, which provides long-term estimates of plankton dynamics in the North Sea. Limitations of the model data are obviously laying in its simplified description of ecosystem carbon flows and additional sources of errors, such as uncertainties in initial and boundary values and in numerical realizations. In this study, our primary focus was to assess validity of the model and to reject the hypothesis, that the model is unable to describe the interannual plankton variability. This part of our investigation was challenging, not only because of the weak spatial-temporal coverage of CPR data, but also due to limited comparability of these data sets. Our results indicate that model and CPR data were highly correlated (up to $r=0.8$) for the average seasonal cycle. On the long-term scales, aliasing errors arising in CPR data due to their irregular sampling significantly challenged the interpretation of the plankton dynamics and model validation. Nevertheless, it was demonstrated that the model results compared well to plankton variability derived from CPR data for certain species. Positive correlations of up to 0.7 were be obtained for the occurrence of diatoms and zooplankton spring blooms. However, more detailed investigations showed spatial and temporal dependence of the correlations. Finally, integrating model data on the CPR sampling grid, we were able to quantify aliasing errors due to the irregularity of CPR sampling.

Keywords: marine ecosystem, numerical modeling, long-term variability, the North Sea.

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ICES CM 2007/B:16**Spatial and temporal variability in the population dynamics of *Crassostrea virginica* in Chesapeake Bay as a function of salinity and weather conditions**

Jon H. Vølstad, Mary Christman, Ed Weber, Danny Lewis, and Jodi Dew

The Chesapeake Bay is a large and shallow estuary with a strong salinity gradient that is affected by runoff from more than 150 rivers and streams. The abundance of eastern oyster (*Crassostrea virginica*) in the Bay has declined to less than 1% of estimated virgin stock. To improve our understanding of the oyster population dynamics we employ a demographic model to project abundance by size in space and time, in response to changes in salinity and variable weather conditions. We incorporate empirical estimates of stock-recruitment relationships, growth, and natural mortality derived from yearly monitoring surveys that reflect variation in the environment. For years with average runoff, the estimated number of recruits per female spawner was 10 times higher than for wet years, while dry years on average had a 42-fold increase. The prevalence of oyster disease also depends on salinity and weather condition. Annual natural mortality for mature oysters ranged from 79% in the high salinity zone for years with high disease prevalence to a low of 10% in areas with low salinity and low disease prevalence. We incorporated results from hydrodynamic modeling coupled with a larval transport model to disperse yearly recruits among oyster bars in Chesapeake Bay. The demographic model accounts for natural spatiotemporal variability in mortality and recruitment due to external forcing factors such as weather and salinity, and uncertainty in the estimated model parameters themselves. We show the impact of the two sources of variability on forecasting abundance by size using Monte Carlo simulation.

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ICES CM 2007/B:17**Near-real time validation of an operational hydrographic model**

H. Cannaby, M. Cure, K. Lyons, and G. Nolan

The Irish Marine Institute maintain an operational model of the NE Atlantic from which weekly hydrographic forecasts are published on the institute's web site. A method for the systematic validation of the operational model has been developed, making use of temperature and salinity profile data from ARGO floats, surface water temperature data from Irish weather buoys, SST satellite microwave radiometer data and along track altimeter data. Near-real time data from each of these sources are automatically downloaded from public ftp sites and a statistical analysis of model performance is undertaken. Sources of error within the model are identified and where possible, reduced through fine tuning of the model. The ability of the model to represent significant hydrodynamic features such as the shelf edge current and the location of frontal systems is monitored on an ongoing basis. The reliability of model forecasts issued to date will be illustrated and the potential impact of errors within the hydrodynamic model on a coupled ecosystem model will be discussed.

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ICES CM 2007/B:18

ICES CM 2007/B:19**Some assessment of a coupled physical-biochemical model for shelf seas**

John Siddorn, Icarus Allen, Roger Proctor, Jason Holt, and Martin Holt

Routine operational running of physical models, for instance hydrodynamic or wave models, is now relatively mature within European waters. More recently operational systems have been developed to couple these hydrodynamics with ecosystem models of a range of complexities. This has been made possible by improvements in ecosystem modelling techniques and increased computing power, and is to some extent being driven by the desire for complete system knowledge (the "ecosystem approach") to assess the health of our waters.

This paper outlines an approach to complex spatio-temporal marine ecosystem modelling as applied to the North Western European Continental Shelf. The model presented here combines an eddy-permitting

(approximately 7 km horizontal resolution) baroclinic model, the Proudman Oceanographic Laboratory Coastal Ocean Modelling System (POLCOMS), with the European Regional Seas Ecosystem Model (ERSEM). This has been run for seasonal cycles within an operational framework using available high resolution atmospheric and lateral boundary forcing.

These modelling systems are complex with a large number of parameters and it is thus not straight forward to assess their skill. This paper presents quantitative methods for assessing the quality of output of the model in ways that allow both developers and users to readily determine where the skill lies, and what impacts changes to the modelling system has in underlying skill.

Keywords: ecosystem model, verification, validation, skill assessment.

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ICES CM 2007/B:20 Poster**A simple approach for the estimation of food consumption from growth rates at different environmental conditions and its application to data of juvenile cod (*Gadus morhua* L.) of a fjordic sea loch at the west coast of Scotland**

Eckhard Bethke, Anne Sell, and Hans-Joachim Rätz

It is self-evident that growth and condition of fish are functions of available food and environmental conditions. This led to the idea of using fish as a “consumption sensor” for the measurement of food intake during a certain period of time. A bio-physical model for the estimation of food consumption was developed based on the von Bertalanffy approach. Whereas some of the input variables of the model, the initial and final lengths and masses of a fish and the temperature within the time period considered can be easily measured, internal characteristics of the examined species have to be determined indirectly. Three internal parameters are used in the model: the maintenance consumption at 0 °C, the temperature dependence of this consumption and the percentage of the ingested food utilized. The values of the parameters for the examined species can be determined by feeding experiments. Literature data from feeding experiments were used here for model validation. The average of the relative error for the food intake predicted by the model for individual fish was about 21 %, indicating that fish used the food with different efficiencies. However, grouping the fish according to size classes and temperature or to different ranges of food rations lowers the relative error of the predicted food intake for the group to typically 6 % and 11 % respectively. Linking changes in the physical environment to variability in biological parameters may be used within a multi-species approach for a more accurate prediction of the ecological processes.

Keywords: cod, food consumption, feeding experiments, length growth, mass growth, temperature, von Bertalanffy approach.

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ICES CM 2007/B:21 Poster**Long-term variations in the Barents Sea frontal zones according to the data on oceanographic observations and model calculations**

Oleg V. Titov, Victor A. Ivshin, Alexander G. Trofimov, and Vladimir K. Ozhigin

A successful management of marine ecosystem resources depends on the understanding of the principles and peculiarities of its functioning. The Barents Sea, rich in different species of commercial fish, takes the intermediate position between arctic and boreal oceanic systems which causes the existence of expanded frontal zones. The data earlier published indicate that the functioning of the Barents Sea ecosystem as a unit and the crop yield variations in the most important commercial fish species of the Barents Sea are related to variations in the sharpening of the frontal zones.

In the paper we represent the results of the studies of long-term variations in the parameters of the Barents Sea frontal zones. Indexes of the frontal zones spatial extent are suggested and the model calculations of the water circulation are made. We analyzed variability in the water dynamics and characteristics of the frontal zones, as a result, we found a direct relationship between them. We also found a decrease in the extent of the frontal zones against increasing temperature in the Barents Sea in the recent decade. Based on the results received, possible consequences of the climatic variations in the ecosystem of the Barents Sea and commercial fish species are discussed.

Keywords: Barents Sea, climate variability, commercial fish species, frontal zones.

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ICES CM 2007/B:22 Poster

The influence of water dynamics on the distribution of 0-group herring in the Barents Sea

Alexander G. Trofimov, Tatiana A. Prokhorova, and Vladimir K. Ozhigin

An attempt was made in the paper to investigate the influence of the Barents Sea circulation calculated with a numerical model on the distribution and abundance of 0-group herring. The wind-driven and general circulation of the Barents Sea, as well as volume fluxes in the main currents, were calculated for every month from 1983 to 2004. The analysis of the fluxes and observed distribution of 0-group herring in the Barents Sea allowed us to choose parameters for searching for relations between dynamic conditions and a character of 0-group herring distribution. It was shown quantitatively that the Barents Sea circulation influences the character of 0-group herring distribution. The relations between the fluxes and indices of abundance (area index of abundance, index of absolute abundance, area of concentrations, northern and eastern borders of young fish distribution) were found. A possibility was noted of reconstruction of the area index of abundance for the previous years using the regression equations. Test predictions of the area index and index of absolute abundance were made for September 2005. Both predictions came true. The paper is intended to be used for comprehensive studying herring abundance formation. The necessity was noted to use hereafter not only water dynamics but also additional parameters related to the species biology.

Keywords: abundance, Barents Sea, 0-group herring, water circulation.

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ICES CM 2007/B:23 Poster

Catch per unit of effort and growth of flounder (*Platichthys flesus*): impact of temperature

Tenno Drevs, A. Jaanus, and A. Põllumäe

Temperature variability is an important source of changes in flounder behaviour. Catchability of different fishing gears as well as changes in flounder growth depends on the temperature. Extensive upwelling event that led to a significant decrease of the coastal water temperature for several weeks allowed investigation of the changes of flounder catch per unit of effort in experimental gillnet samples and otolith structure (reflecting the growth pattern) in the southern Gulf of Finland in August 2006. Statistically significant lower catch per unit of effort in gillnet experiment was registered in August 2006 as compared to August 1996-2005. The latter years are characterised by absence of long-range upwelling events during summer months. A positive correlation between the total Estonian flounder catch in the Gulf of Finland (the catch at the southern coast of the Gulf) and surface water temperature in southern coast of the Gulf of Finland (Muuga Bay, near Tallinn) was found. Extraordinarily large additional hyaline zone was registered on the majority of flounder otoliths from the southern coast of the Gulf of Finland in autumn 2006 whereas the latter was in general not registered in previous years. The variability in temperature conditions should be taken into account in stock size and fishing mortality estimations as well as in age determination.

Keywords: Baltic Sea, feeding activity, Finland Gulf, hydrodynamic models, otolith structure, stock assessment, *Platichthys flesus*, water temperature.

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ICES CM 2007/B:24 Poster

Key processes driving benthic-pelagic coupling in the North Sea: linkages between fieldwork and modelling for a new observational programme

John Aldridge, S. Painting, R. Parker, D. Mills, and P. Kershaw

A 1D version of ERSEM/BFM (Biogeochemical Flux Model) was used to identify which critical field measurements should be made during a planned field study of ecosystem structure and function in the North Sea (see poster by Painting et al). Simulations were undertaken to:

- Prepare carbon and nitrogen budgets in order to identify the main pathways for carbon and nutrient flow;
- Test the importance of benthic-pelagic coupling on productivity;
- Guide fieldwork with regard to the key process measurements required for model validation.

Results are shown for the last two years of a 12 year run, set up to reproduce conditions at the Oyster ground (summer stratified, water depth 45m). After 12 years most quantities show a repeating annual cycle. However, benthic organisms show evidence of weak cycles at longer time scales of two years or more –

possibly generated by predator prey interactions. For the purpose of presentation, ERSEM functional groups within the phytoplankton, zooplankton and benthos compartments have been summed to yield aggregated phytoplankton, zooplankton and benthic biomass and fluxes.

The importance of benthic-pelagic coupling was assessed by 'switching off' chemical and biological processes in the sea bed. When switched off, the bed acts as a passive sink for pelagic detrital material, with no return of any material to the pelagic system. This had a clear effect on primary and secondary production, with reduced biomass throughout the summer, and a much weaker autumn bloom. The annual decrease in available carbon, considering both the microbial loop and primary production, was around 15%. The same simulations were also done based on a mixed water column with the same depth of 45m. This showed an almost identical relative decrease in available carbon in the absence of the benthic recycling of nutrients. A simulation for a shallower mixed water column of 35m was also carried out. As expected, the results show a greater influence of benthic recycling of nutrients, leading to ~25% decrease in zooplankton biomass over an annual cycle

Keywords: benthic, pelagic, structure, function, observations, modelling, North Sea.

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ICES CM 2007/B:25 Poster**Physical variability in the Northern North Sea: model validation**

Sarah L. Hughes

The inflow of water from the North Atlantic to the North Sea, transports heat, salt and nutrients into the region and is thought to have a strong influence on the ecosystem of the northern North Sea. It is therefore important that this process is modelled realistically. This area is known to have a high degree of variability and complex dynamics although direct observations are relatively sparse. Previous model validation studies have focussed on regions further south in the North Sea. Direct observation of currents and physical properties in the waters of the northern North Sea have been compared with hindcast model output in order to assess the skill of the model in this region.

Keywords: North Sea, temperature, salinity, currents, hydrodynamic models.

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ICES CM 2007/B:26 Poster**Use of hydrodynamic model of mesoscale processes for investigation of pelagic fish eggs and larvae in the Canary upwelling area**

A. G. Arkhipov, P. P. Chernyshkov, N. Diansky, and E. M. Karasiova

There are several quasi-stationary spawning grounds of small pelagic fishes in the Canary upwelling area. Most larvae drift from the periphery of synoptic gyres, generated by the Canary Current, in the southern direction. This carry-over to the open ocean is one of the main factors exerting negative influence on survival of eggs and larvae. An attempt was made to calculate the trajectories of passive plankters (eggs and fish larvae) carry-over in winter-spring period of 1995 for the purpose of checking this hypothesis within the framework of mesoscale hydrodynamic model of water dynamics. The results of oceanographic and ichthyoplankton surveys made by RV "AtlantNIRO" were used. Three locations (30°10'-29°40'; 26°40'-28°10' and 25°00'-25°10' N) with higher recorded egg concentrations (>500 sp./m²) were selected. Three horizons, at which the egg and larva drift was stated, were under observation. As a result of calculation, similar trends of egg and larva carry-over at all the horizons were noted. The greatest carry-over of the larvae from the spawning grounds was observed in the second and third locations. The larvae were mainly carried over to the continental shelf areas, where higher phyto- and zooplankton concentrations were traditionally observed. It favoured their growth and development. The results of calculations agree with the fact that recruitment of sardine and horse-mackerel (*Sardina pilchardus* and *Trachurus trachurus*) in 1995 was estimated as that above the average level. It was concluded that the use of hydrodynamic model for small pelagic fish year-class abundance forecast in the Canary upwelling area could be expedient.

Keywords: hydrodynamic model, egg and larva drift, small pelagic fishes, survival.

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ICES CM 2007/B:27 Poster

Real-time analysis and visualization of complex marine ecosystem relationships: a case Study using North Sea historical data

M. A. Langston, D. Beare, K. Brander, A. Kellermann, A. J. Kenny, A. D. Perkins, and G. L. Rogers

Novel combinatorial algorithms and high-performance implementations are employed to integrate observations and uncover latent relationships in marine ecosystems data. The North Sea and its rich history of divergent data collection are used as prototypes. A web-based tool for visualization is provided, with which users may select biotic and abiotic parameters of interest. Algorithmic fine tuning is also permitted. Both spatial and temporal relationships may be viewed. With these, it is possible to estimate the main factors driving quantitative correlations. Applications for this suite of tools include establishing the significance of large-scale hydrodynamic factors such as flushing rates and other natural phenomena, and hypothesis testing for ecosystem response such as marine cyclicity as exemplified by putative regime changes. A long-term goal is to establish data dependencies and sensitivities upon which can be built integrated ecosystem assessments that may lead to conclusions about the impact of anthropogenic and other agents.

Keywords: marine data integration, ecosystem response, combinatorial analysis, high performance implementations, visualization tools.

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