Theme Session B – Integrating observations and models to improve predictions of ecosystem response to physical variability

Conveners: Elizabeth W. North (USA), N. Penny Holliday (UK), Sarah Hughes (UK), Skip McKinnell (PICES)

Understanding and managing an ecosystem without knowledge of circulation patterns and hydrography would be like trying to diagnose a patient without taking their pulse and temperature. In order to improve our understanding and prediction of ecosystem dynamics, we must improve our knowledge of the processes and mechanisms that link changes in the physical environment to biological variability. This understanding first starts with knowledge of physics, from small to large scales. In this theme session, presenters examined observations to describe the changing oceans and seas, employed observations to validate oceanographic predications, and integrated observations and models in case studies that enhanced our understanding of species and ecosystem dynamics. An underlying objective of this session was to support ecosystem-based management by providing a venue for researchers who 'take the pulse of the ocean' (i.e., observational oceanographers) to those who build tools for predicting and mitigating ecosystem response to climate change (i.e., bio-physical modelers).

Speakers in the morning described various forms of natural variation in the physical and biological world and reflected on what has been learned from these observations. Highlights from the morning session include:

- Trends in surface temperatures in the North and Baltic Seas now exceed those at any time since instrumented measurements began in 1861 and 1880. The appearance of anchovy in the North Sea is related to the increasing temperatures.
- Trends in temperature near Korea have increased by 1.3ºC over land and 1.0ºC in the sea since 1968. Analysis of fish species composition indicates that the community changes occurred during regime (1976–77, 1988–89, 1997–98) and ENSO (1982–83) events.
- The *ICES Report on Ocean Climate* indicates that all regions in the eastern North Atlantic have become warmer and saltier during the last 10 years. High salinities indicate a period of weak subpolar circulation as more subtropical water enters the subpolar gyre. As the Rockall Trough is currently warm and salty, Fram Strait likely will be warmer and saltier 4 years hence.
- Ferrybox data is being used to link physical conditions to spring bloom dynamics, correct satellite algorithms for mapping chlorophyll fluorescence, assess water quality, and, when coupled with bio-physical models, predict the trajectories of phytoplankton blooms.

Clear evidence for warming seas is mounting and two important predictions were reported during the morning session, although at very different space and time scales. In the first case, the empirically-based prediction that temperature and salinity at Fram Straight will increase during the next 4 years has important consequences for species (e.g. *Calanus*, cod) and ecosystems in the North and Barents Sea over the next 4 years. Secondly, the combined use of Ferrybox data, satellite data, and bio-physical models shows great promise for parameterizing ecosystem models and predicting the trajectories and dynamics of harmful algal blooms.

In the afternoon session, presenters focused on using observations to validate hydrographic and biological model predictions. Highlights included:

- A new method was presented to validate systematically an operational hydrodynamic model with temperature and salinity profile data from ARGO floats, surface water temperature data from Irish weather buoys, SST satellite microwave radiometer data and along-track data from altimeters. Validation metrics indicate that a model that makes robust predictions of temperature does not necessarily capture sea surface height or salinity with equal skill.

- Coupled 3D biophysical models of lower trophic level ecosystems (NPZ models) often suffer from difficulties in predicting the timing of spring phytoplankton blooms. A combination of changes to freshwater input, background and coastal mixing coefficients, enhancing grid resolution, and use of improved initial conditions may be remedies.
- Comparisons of Continuous Plankton Recorder data to bio-physical model predictions of zooplankton are challenged by aliases arising from differential coverage (different routes in different years) and mismatches between the "currency" used by the model and observation (i.e., g-C vs. numbers of individuals). Nevertheless, CPR data is a valuable resource for model validation (esp., for adult copepods).
- Comparison of drifter trajectories with a particle tracking model showed major discrepancies within a fjord where the geographic scale is small and physical boundaries are more important than in the open sea. Drogues travelled much further/faster than particle predictions. As particle tracking models provide the basis for many individually-based models of larval fish, further research is clearly needed.

Solutions to challenging issues can only come after the problem is clearly articulated. Although many presenters described problems with model predictions/formulations rather than demonstrating solutions, it is important to acknowledge that their focused attention on model-data discrepancies provides a clear road map for improving our understanding of coupled physical-biological systems and our predictive capabilities.

During the last session, speakers described case studies to demonstrate how numerical models can be applied to improve our understanding of species and ecosystem variability. Highlights included:

- Differences in temperature and circulation patterns between cold/warm years in the Bering Sea can control the spatial distributions of snow crab settlement. These kinds of interannual environmental variability affect both the drift trajectories of larvae and the habitat where they settle, giving rise to variable survival of larvae among sub-regions where they were spawned.
- Significant freshening of the Northwest Atlantic occurred after 1990. A bio-physical model simulates the general westward propagation of the bloom into the Gulf of Maine and indicates that the freshening can enhance the spatial gradients in the timing of the bloom by promoting earlier blooms upstream.
- Blue whiting have a preferred temperature and salinity range, which when coupled with changes in ocean circulation, likely result in different spawning areas and spatial patterns in harvest of adults. Strong blue whiting recruitment is thought to be related to the weakening of the sub-polar gyre. A gyre strength index was created with an ocean circulation model, and then related to measurable observations that enable prediction (e.g., heat flux over Labrador sea, strength of the wind forcing south of the Rockall Trough). The authors tentatively predict high recruitments in 2007/08 as the gyre index will continue to be low.

These presentations clearly demonstrated that advection influences fisheries recruitment as well as ecosystems dynamics, and that 3D circulation models can be used to understand processes that cannot be easily observed or interpreted.

The general goal of the session was to promote a better understanding and prediction of bio-physical processes through the use of both models and observations. In this general sense, the objective of the session was certainly accomplished. Collectively session speakers clearly demonstrated the potential of integrating models and observations for improving our understanding of ecosystem dynamics, and showed that progress is being made in identifying and solving challenges posed by model-data comparison. The intersection of models and data is a critical nexus in science, and sessions like this should be continued.

Despite the overall success of the session, several specific expectations of the Chairs were not met. Few presenters made specific recommendations regarding the most important observations needed to validate models. In addition, no standardized sets of validation metrics were proposed, nor were the issues of model sensitivity and complexity systematically addressed in the context of model-data comparisons. These omissions do not reflect on the individual presenters; rather, it is a sign that the integration of observations and models is a discipline in its formative stage and that we should expect significant progress in the future.

Contributions to the session included 15 oral presentations and 7 posters; each speaker was given 20 minutes including time for questions. Authors of posters were given a few minutes each to introduce their work. Summaries of presentations can be found in Appendix A.

Appendix A. Summary of presentations, questions (Q), and answers (A)

Skip McKinnell, Rapporteur, with additions by Sarah Hughes

B:02. *Daily ocean monitoring since the 1860s shows record warming of northern European seas.* Authors: Brian R. MacKenzie and Doris Schiedek

Brian McKenzie studied the results of ocean monitoring since the 1860s to determine whether the recent record warm ocean temperatures in Europe had occurred before and to determine how the warming patterns may have varied by season. Data sources included lightships, lighthouses, and harbour sampling at four sites: two in Denmark, one in Norway and one in the Netherlands. These were combined with opportunistic data that were available from the Hadley Centre since 1880 for the North Sea and the Baltic Sea. Trends in these long timeseries were calculated with GAM and linear models. There was a general warm period in the 1860–1880s, a relatively warm period from the 1920–1940s, especially in summer, followed by the most recent warm period. The GAM model fit indicated the most recent period is warmer than any seen in past 120–140 years. Furthermore, the rate of increase since 1985 is greatest in summer (JAS), at 2–3 times the annual rate. Compared with expectations from climate models, the annual rate of warming is about what is expected however, the seasonal differences will have variable effects on ecosystems. The probability of an extremely cold year dropped after the 1930s and the probability of extremely warm years is much higher in the 1990s-2000s. These changes will have huge effects on biota. The appearance of anchovy in the North Sea is related to the increasing temperature. They also appeared in the warm period of the 1920–1930s and their bones are found in archaeological digs during other periods of warmer temperature.

Q: What are the dominant spectral frequencies of these timeseries? A: The analysis has not been done.

Q: Was there any attempt to relate these results to large-scale climate indices? A: For the Baltic, the NAO is very highly correlated with SSTs in Bornholm Basin, even at depth.

Q: If the anchovy distribution is a temperature signal, are there even longer anchovy records? A: Indeed, fish bones have been found in archaeological digs during periods when the climate was known to be in a warm phase.

B:01. *Spatial variability in oceanographic conditions of sea waters off Korea in relation to the regional climate changes during the past 40 years.* Authors: Sukgeun Jung, Young Shil Kang, Young-Sang Suh, Joon-Yong Yang, Jinyeong Kim, and Yeong Gong

Korea has a continental, temperate climate and is surrounded by 3 seas. The main ocean currents are the Kuroshio and Tsushima. The Chang-jiang River is a major influence on Korean marine ecosystems. Total fisheries catches have been relatively stable but the dominant fishes have changed over time. To establish an ecosystem approach to fisheries, there is a need to understand how the physical world changes the biological world. Various agencies have been collecting data around the Korean peninsula since 1948 but the data used in this talk were those obtained since 1968. The linear trends in temperature have increased by 1.3ºC over land and 1.0ºC in the sea. The rate of increase in air temperature is greatest where the amount of industrial activity has occurred. In August, there is a cooling trend in ocean temperature around the peninsula. There is a strong relation between the ocean temperature and air temperature during the previous month. Precipitation has increased only slightly over the land. Over the ocean, salinity has decreased generally, with no change in the East Sea. By month, the decrease in salinity was greatest in August. Three Gorges dam began filling in 2003 and there is ongoing research to understand its influence. The declining salinity is the opposite of what was expected from the influence of Three Gorges dam. The dam did not change the total discharge. The declining salinity was greatest in the East China Sea. Since 1989, zooplankton biomass has been increasing steadily. Analysis of fish species composition indicates that the community changes occurred on regimes (1976–77, 1988–89, 1997–98) and ENSO (1982–83) events. A fisheries community change occurred between 1990 and 1991 to a common squid regime. This lagged the physical change by one year but this can be attributed to the life history characteristics. Large increases in anchovy appear in Chinese catch statistics after 1988. Short-lived species have become dominant in the region.

Q: Perhaps the changes in salinity have arisen from changes in precipitation over the Yellow Sea? A: Yes, perhaps but I'm also looking at getting information about the river discharge data.

Q: How will you forecast the next regime shift? A: It can be predicted by looking at temperatures and be used, potentially, to warn fishermen.

B:03. *Sea surface warming in the southern Bay of Biscay modulated by oceanic advection*. Authors: Marcos Llope and Ricardo Anadón

Monthly hydrographic sampling has occurred since 1993 on the Cantabrian Sea off the Nalőn River. Hydrographic data provide the basis of an examination of changes at depth. The 12.5ºC isotherm varies from the surface in summer to 250 m depth in winter as the region is influenced by both subtropical and subarctic ocean circulation, plus a strong continental influence along the European coast. This sampling revealed the presence of different water masses. Subtropical waters from the southern Iberian peninsula appear as a poleward winter current at 50–300 m depth with higher salinity. Using the timeseries data, there was a significant positive trends in temperature near the surface. The linear trend has increased in the last few years. A spline term was added to the regression analysis revealing a period of no change during the middle of the timeseries. Water column stability over the period was largely affected by water mass changes. The region is affected by general Atlantic circulation that enhances or modifies the global warming signal.

Q: Were there significant changes in primary production among years? A: We have not looked at that yet.

Contributed (to replace a withdrawn talk): *Reversal of the 1960s–1990s Freshening Trend in the North Atlantic and Nordic Sea.* Authors: N. Penny Holliday, Hughes, S. L., S. Bacon, A. Beszczynska-Möller, B. Hansen, A. Lavín, H. Loeng, Mork, K. A., S. Østerhus, T. Sherwin, W. Walczowski.

The N. Atlantic has freshened dramatically since the 1950s with changes arising from different elements of the physics of the freshwater system. While there are many reports of warming of the Atlantic inflow, the most recent picture is a reversal of this trend. In 2002, Dickson et al. reported a freshening of the N. Atlantic deep water that evolves in the overflows enhanced by the surface freshwaters that they mixed with. People are looking at the changes in freshwater in the N. Atlantic because it has the potential to affect the Atlantic overturning circulation. The most recent observations are very different from the dogma. In 2006, the seas were warmer and more saline than the long-term average. The ICES Report on Ocean Climate synthesizes information up to 2006. The entire decade just passed indicates that the upper ocean is warming and is saltier. From 1950–2006, all regions in the eastern North Atlantic, especially during the last 5 or so years, are warmer and saltier. Is it advection? Although the Bay of Biscay is a source, the changes do not really resemble the variability along this pathway. This is because of the influence of the other water masses along the path. The anomalies at Fram Strait tend to lag those observed at Rockall Trough by 3–4 years. Examining the fate of extreme events reveals that they evolve over a period of about 4 years. There is a multi-year coherence along the inflow pathway. They also show about the same high frequency changes. Large changes in salt must have subtropical sources. East-west changes in major currents can affect the mix of waters moving northward. There is no direct response in water properties to the NAO as a result of wind stresses. Over the longterm, periods of weak circulation coincide with high salinity as more subtropical water enters the subpolar gyre. As the Rockall Trough is currently warm and salty, one might expect that Fram Strait will be warm and saltier in 4 years.

Q: How is it related to the NAO? A: It's not always a good indicator of atmospheric circulation so use of the NAO is not a good predictor of the ocean currents.

Q: BIO measures the deep convection of the Labrador Sea each year would that help? A: Yes perhaps.

Q: Are cod stocks associated with changes? A: Another speaker will deal with this.

B:14. *Improvement of process understanding through the use of high frequent Ferrybox observations*. Authors: Henning Wehde, Dominique Durand, Jo Høkedal, Pierre Jackard, and Kai Sørensen.

Ferrybox data are being used to validate satellite sensors, to make comparisons with numerical models and to provide recommendations on the use of these systems. Ferryboxes are mainly used along the Norwegian coast with routes to Denmark and England and the Russian border at various frequencies. There are plans to add a line on the Tromso/Svalbard route and one to Iceland. These high resolution measurements provide good support for understanding ocean variability. Basic measurements include T, S, chl-*a* fluorescence, turbidity, O2. Satellite communication with the systems allows access to the data for immediate retrieval and for communication with automatic water samplers. The Oslo, Norway to Hirtshals, Denmark ferry found that high resolution bloom features can be coupled to high resolution salinity data that indicated how freshwater appearance in spring generates the stability for a bloom. Winter nutrient conditions are related to upcoming spring bloom results. The system can be used to categorize water quality. Turbidity data can be used for particle tracking and transport estimates and the data can be compared with satellite images. There are good relationships between the sensors and water turbidity samples processed in the lab. MERIS products are overestimating chlorophyll fluorescence in the region. This discrepancy was used to correct the MERIS algorithms for this region. 3D lagrangian transport models are checked against these ferrybox observations. In summary, we want to use the ferrybox data network, with in vitro control, and satellite data, and models to give an integrated system

Q: There are plans to start a CPR between Bode and Svalbard. Has any attempt been made to compare the ferrybox data with CPR data collected in the region? A: There has not yet been an attempt to compare the CPR/ferrybox data but it is coming.

Q: Are the data available? A: See www.ferrybox.no

B:08. *Operational oceanography and numerical models in the Basque Coast (SE Bay of Biscay). New implementations and future work.* Authors: V. Valencia, A. Fontán, L. Ferrer, J. Mader, and M. González.

Two offshore buoys were established off the northern coast of Spain. Additionally, there are 6 coastal stations with air temperature, pressure, wind, solar and net radiation plus scalar wave. Current profiles in the upper 25 m are of interest so there is a thermistor chain in the upper 25 m. The offshore buoys have the same meterological sensors but the oceanographic buoy data also include a directional wave sensor, surface current sensor, current profiler in upper 200 m, and t and s from 10–200 m. These data provide improved inputs to models of wind and current fields. The data are used to validate velocity fields in models. Models of lagrangian transport have been developed as well as IBM models for anchovy eggs and larvae. Better coupling of mechanisms and processes by linking real time hydrographic data and atmospheric data has been possible. The models are being improved through data assimilation.

Q: Are the data from the two deepwater buoys online? A: These buoys provide data in almost real-time so we're checking on this possibility. Currently the data are transmitted once per hour.

Q: What do you use for open boundaries for your model? A: Boundaries are provided by other agencies with large-scale models.

B:17. *Near-real time validation of an operational hydrographic model*. H. Cannaby, M. Cure, K. Lyone, and G. Nolan.

The physical model is a ROMS 2.5 km model of a portion of the Northeast Atlantic. The model produces forecast/hindcast runs each week. The results can be found at ftp.discover-earth.org/sst/daily/tmi_amsre. The process is controlled by MATLAB scripts that download and analyze the data. Model-satellite comparisons are made, along with diagnostics. SSTs have a mean error <0.4ºC (RMS errors<1.6ºC) and the models are highly correlated with the observations. Correlations and errors worsened after March. Irish weather buoys are being used to calibrate models. Good T/S results for the west of Ireland but there is some bias in Irish Sea, perhaps arising from rivers. Errors in temperature were as much as -0.95ºC and -0.7ºC in the Celtic and Irish seas. There have been good comparisons between model and data measured by Argo floats. Mediterranean salinity signals more prominent in data than in the model. SST correlations from Argo data are 0.96 but salinity is only 0.74. SSH comparisons were made with data from Jason1, and demonstrate obvious need for improvement. More work to do but it is potentially a useful tool for model validation.

Q: How long have you been running this? A: The operational model started on Jan.1, 2007.

Q: Does the model assimilate data? A: It does not.

Q: How are the boundaries conditions established? A: Boundaries are determined once per week from Mercator.

Q: Who are the clients for this operational model? A: The clients so far have been search & rescue operations.

B:13. *Sensitivity of the timing of the phytoplankton bloom in a 3D biophysical model of the Gulf of Alaska (GOA) to salinity stratification*. Authors: Sarah Hinckley, Hermann, A. J., K. Coyle, and W. Cheng

The model focuses on the coastal Gulf of Alaska, primarily to investigate why a primarily downwelling ecosystem is so productive. The objective was to model the lower tropic level ecosystem. The model was based on a ROMS nested grid: 10 km for the Northeast Pacific domain and 3 km for coastal Gulf of Alaska, forced by NCEP reanalysis. The prediction of bloom timing is problematic because it is very sensitive to the onset of stratification. The model water column stabilizes about 1–1.5 month too early. After some investigation, it was determined that it was not a biological model problem but a physical problem arising, perhaps, from inadequate topography (deep narrow fjords are not resolved). Surface runoff at the coast yields stratified water. We should like to overcome this problem without reparameterizing mixing. The fluorometer has its first peak in mid-May 2001 but the model bloom happens too early by 1 month. Annual primary production across the Seward line was estimated at about 100 g c m^2 y-1 which is about 40% too low.

B:15. *Creation of synergy effects for understanding long-term ecosystem variability: ECOSMO model results vs. Continuous Plankton Recorder data*. Authors: Irina Alekseeva, C. Schrum, R. Diekmann, and M. St. John.

The ultimate objective is to understand climate-induced ecosystem variability and to develop predictive capacities utilizing models and observations. To do this, it is important to assess model uncertainties and to identify their strengths. ECOSMO, a North Sea/Baltic Sea physical model, coupled with an NPZD model, tends to underestimate inflows from the Atlantic. Compared with CPR data but spent most of the time describing the data collection and model. Can CPR data be used for model verification? There are aliases arising from differential coverage of different routes in different years. Problems with mismatches between the "currency" used by the model and the currency used in the CPR observations. Plus, how representative are the samples given potential size and species selectivity? CPR data can be used for model validation. Modelled data are similar to CPR adult copepods.

B:05. *Validating particle tracking models of sea lice dispersion in Scottish Sea Lochs*. Authors: Trisha L. Amundrud and A. G. Murray.

The study area is a small fjord, Loch Torridon in Scotland, where there is no spring freshette and no strong seasonal signal in precipitation. High counts of sea lice have been observed during periods of stronger NW winds. The physical model of this loch had a 100 m grid scale with tides, rivers, local winds, and coastal density. Model validation was attempted with surface drifters where it became evident that the drifters ranged much farther than the circulation model could achieve, and for no obvious reason. A second physical model gave the same simulation results. Experiments with particle tracking led to the conclusion that interactions with coastlines are important features to study. The presenter was interested in hearing of opinions for why such strong deviations between models and observations might occur. Some of the comments included:

- You should consider direct wind driven transports.
- There should be a size dependence of the size of the particle in relation to the coastline.
- Your interpolation mechanism in the model may be a factor in particle tracking errors.

B:07. *Predicting recruitment of 0-group gadoids in the Barents Sea – critical interaction between models and observations.* Authors: Johansen, G. O., M. Skogen, O. R. Godø, and T. Torkelsen.

Juvenile gadoids are carried from the spawning grounds along the coast of Norway into the Barents Sea by the currents along the Norwegian coast. During the first month the juveniles are surface oriented, descending to depth as they age. Cod were observed in the Barents Sea using a stationary platform with an upward-looking acoustic system that sat on the bottom. It was placed out for 48 hours while the vessel occupied other stations. It was found that 0-group gather in schools at the surface during the day but during the night they are distributed throughout the water column. Model predictions of distribution are based on drifting particles and it was found that including the vertical behaviour provides more accurate locations of the cod. These observations of ecosystem processes are valuable as input to models. Stationary platforms enable quantification of temporal dynamics so an observation program with extended coverage in time/space is recommended.

Q: Have the particle tracking models been compared with drifter tracks? A: This is unknown at this time.

B:12. *Settlement patterns of snow crab associated with warm and cold years in the Eastern Bering Sea*. Authors: Sarah Hinckley, C. Parada, B. Ernst, L. Orensanzs, D. Armstrong, E. Curchitser, and A. Hermann.

The model of the eastern Bering Sea appears to reflect the differences between warm and cool years regarding near-bottom temperature. Simulated snow crab larvae were released in the model from May to July and were caused to settle on the bottom from August to October. To compare the consequences of settlement patterns in cool and warm years, IBM simulations were forced by the physics of 1979 and 1990, respectively. For survival of snow crab, cooler temperatures are better than warm. They are usually found at bottom temperatures from 0–2ºC but it is not known why. Is it a preferred range or is it a predator-avoidance mechanism? We are not sure at this time. In 1979, the region within this temperature range was located in the northwest Bering Sea. In 1990, this region of potentially good temperatures was much larger. The model was used to examine the locations of origin of the individuals that arrived in the 'preferred' locations. For the warm year, only two areas within the spawning grounds were important whereas in the cold year, a much larger number of spawning areas contributed recruits to the preferred region of settling. More simulations with new factors are planned.

Q: Were the scales of model and observations different? A: Yes but the interannual difference was consistent.

Q: Should you consider the implications of warming and what might occur with the preferred region? A: It has already shifted northward.

B:11. *Modeling the influence of North Atlantic freshening on phytoplankton dynamics in the Nova Scotian Shelf and Gulf of Maine region*. Authors: Rubao Ji, Cabell Davis, Changsheng Chen, David Townsend, David Mountain, and Robert Beardsley

Significant freshening of the Northwest Atlantic occurred after 1990. The source of the freshening appears to be from higher latitudes. This presentation will focus on the period from 1998–2006. Freshening was associated with changes in zooplankton biomass. The speaker discussed a conceptual model of the Gulf of Maine and noted that freshening of the E. Scotian Shelf water causes earlier blooms. Controlling for this effect with models shows that freshening can enhance the general westward propagation of the bloom by promoting earlier blooms upstream.

B:06. *Environmental influence on the spawning distribution and migration pattern of northern blue whiting* (*Micromesistius poutassou*). Authors: H. Hatun, J. Arge, and A. B. Sandø.

Analysis of fishery data reveled an interesting pattern of distribution of post spawning blue whiting. Some years the fish migrate to the east of Faroe and catches are smaller (probably but not necessarily linked to smaller stocks – could be that catchability is lower). Other years fish migrate west of Faroe and catches are higher. Using observations and an ocean circulation model, these fishery changes have been linked to changes in ocean circulation. Most importantly rather than depending on simple correlations the authors have investigated the mechanism which can cause the changes in stock and migration. The hypothesis is that blue whiting have a preferred temperature and salinity range for spawning and that changes in ocean circulation cause changes in bottom temperature/salinity over the Rockall Bank and subsequently the areas suitable for spawning are different. In warmer years good spawning areas are up on Rockall Bank and post-spawners subsequently migrate west of Faroe. In colder years, good spawning areas are deeper in Rockall trough and so fish then head off into Faroe Shetland Channel.

Another aspect of this paper was to investigate some simple indices that can help describe these changes in ocean circulation. The NAO was rejected as a useful indicator and instead a gyre index (strength of sub-polar gyre) that is derived from an ocean circulation model was shown. The gyre index cannot be predictive as model is only hindcast, so other parameters were investigated. It was shown that both the heat flux over Labrador sea and strength of the wind forcing south of the Rockall Trough may also be good indicators of the strength of the sub-polar gyre.

Blue Whiting recruitment has been high since around 1996, and this is thought to be related to the weakening of the sub-polar gyre. Poor recruitment of blue whiting was observed during 05/06 and this may have been due to a temporary strengthening of the gyre (as observed in the wind forcing). On strength of this study the authors make a tentative prediction of a return to high recruitment as gyre index will continue to be low.

B:10. *Mechanisms of bio-physical coupling at submarine bank ecosystems*. Authors: Christian Mohn and Martin White

Rockall and Porcupine Bank slopes at the European continental margin host reef-forming cold-water corals. 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 for possible feeding mechanism for benthic communities in these regions. (Text from abstract).

B:04. *Predictive modelling of subtidal kelp forests. Brittany coast (France) case study*. Authors: Vona Méléder, Jacques Populus, Anouar Hamdi, and Brigitte Guillaumont.

Local topology explains the variability of kelp distribution above a depth where light and temperature are sufficient to keep kelp distribution on rock substrata stable. Below distribution decreases until the disappearance of kelps at a depth limit. Variability between depths is mainly explained by the turbidity, or by the temperature when no turbidity data are available. The maximum current velocity during the mean spring tide, from hydrodynamic model simulations, also explains kelp distribution over the Brittany coast. (Text from abstract).

Posters

B:20. *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.* Authors: Eckhard Bethke, Anne Sell, and Hans-Joachim Rätz

B:21. *Long-term variations in the Barents Sea frontal zones according to the data on oceanographic observations and model calculations.* Authors: Oleg V. Titov, Victor A. Ivshin, Alexander G. Trofimov, and Vladimir K. Ozhigin. Title:

B:22. *The influence of water dynamics on the distribution of 0-group herring in the Barents Sea.* Authors: Alexander G. Trofimiv, Tatiana A. Prokhorova, and Vladimir K. Ozhigin

B:23. *Catch per unit of effort and growth of flounder (Platichthys flesus): impact of temperature.* Authors: Tenno Drevs, Andres Jaanus, and Arno Põllumäe

B:24. *Key processes driving benthic-pelagic coupling in the North Sea: linkages between fieldwork and modelling for a new observational programme.* Authors: John Aldridge, S. Painting, R. Parker, D. Mills, and P. Kershaw

B:25. *Physical variability in the northern North Sea: model validation*. Author: Sarah L. Hughes

B:27. *Real-time analysis and visualization of complex marine ecosystem relationships: a case study using North Sea historical data*. Authors: Langston, M. A., D. Beare, K. Brander, A. Kellermann, Kenny, A. J., Perkins, A. D., and G. L. Rogers