UK Activities in ocean model development

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Summary

Many ocean modelling activities in the UK are transitioning to use the NEMO ocean model; this includes operational ocean forecasting at the Met Office and National Centre for Ocean Forecasting, climate modelling at the Met Office Hadley Centre and as part of the NERC QUEST project, Arctic modelling at the Centre for Polar Observations and Modelling. New NERC funded strategic research programmes are also encouraging this transition and the UK has taken a lead in developing a global 1 degree configuration of NEMO (ORCA1) with enhanced resolution in the Tropics. The UK is also contributing to the development of NEMO for Shelf Seas applications building on experience with the widely-used POLCOMS model. ICOM is an adaptive mesh model which is being developed by Imperial College and Oxford University.

Introduction

Ocean modelling activities in the UK are a combination of both operational capability on all timescales and research activity. For many years the number of models used has been diverse with little transferable code between research and operational facilities. The UK strategy has now shifted towards a common shared code with transition to the NEMO (Nucleus for European Modelling of the Ocean) code taking place at the Met Office, NERC institutes and Universities. In parallel with this transition, an adaptive mesh capability is being developed by Imperial College and Oxford University.

Existing models

Work has continued to take place on existing models. The highlights are:

- OCCAM: NERC's high resolution global ocean modelling capability is being replaced by NEMO based models. However, analyses of key integrations of the OCCAM model with high frequency surface forcing will continue and will be used for early comparisons with the NEMO models. Important legacy datasets from the OCCAM project include a global simulation for 1985 to 2004 at $1/12^{o}$ degree resolution. A typical example of the ongoing analysis of this dataset involves the diagnosis of effective eddy diffusion from passive tracer fields stored at 5 day intervals.
- Coupled climate models: analysis of the HadGEM1 climate model has demonstrated the importance of resolving the Agulhas current. The Agulhas retroflection is not present in HadGEM1 and this leads to warming and salting in the Atlantic with an eventual impact on the thermohaline circulation.
- High resolution coupled models: the HiGEM (90km-1/3 degree) model has shown a much improved ENSO simulation compared to lower resolution models using

the same basic model. The enhanced zonal resolution near the equator seems to be important in signal propagation. Figure 1 shows the DJF precipitation anomalies associated with ENSO events from a model matrix comprising 135km and 90km atmosphere models, and 1-1/3 degree (varying, HadGEM) and 1/3 degree (uniform, HiGEM) ocean models.

- A NUGEM (60km-1/3 degree) model has also been developed, and shows promise of reducing/removing the warm SST bias associated with stratocumulus regions on the eastern boundaries of the Pacific and Atlantic Oceans.

NEMO transition

The Met Office and the NERC community (through Oceans2025) are committed to transitioning ocean modelling activities to use the NEMO (Nucleus for European Modelling of the Ocean) model. The status of the transition is:

- The Met Office operational forecast system FOAM is in the advanced stages of transitioning all operational models to NEMO. The first FOAM-NEMO configuration is now running operationally as a trial system. Work is underway to scope the feasibility of sharing model configurations with the French operational ocean modelling centre Mercator.
- The Met Office is contributing towards work to develop NEMO for shelf seas applications. Developments carried out by European partners are being tested at the Met Office in a tides-only configuration of the NW European Shelf (see figure 2), and a formal assessment of the tidal simulations against observations will be carried out by POL. Progress towards full baroclinic simulations is expected in the second half of the year.
- NOCS and ESSC are collaborating with DRAKKAR on high resolution modelling. Under the Oceans2025 programme NOCS will extend the DRAKKAR ORCA025 model ($1/4^{o}$) to include biogeochemistry and models of the carbon cycle. Higher resolution regional models of the North Atlantic will also be developed embedded in the global models using the two-way nesting options provided by the AGRIF features of NEMO. A global 1/12o NEMO model is planned during the latter part of the Oceans2025 programme.
- CPOM-UCL have developed a NEMO-CICE configuration for the Arctic Ocean which is forced by reanalysis and will be used for intercomparison with IPY observations.
- The Met Office, NOCS and ESSC have jointly developed the ORCA1 configuration of NEMO (nominal 1 degree ocean with enhanced resolution on the Equator).
- The Met Office Hadley Centre are building a new climate model (HadGEM3-AO) which will be based on the NEMO ocean model coupled to the UM atmosphere and CICE sea ice model.

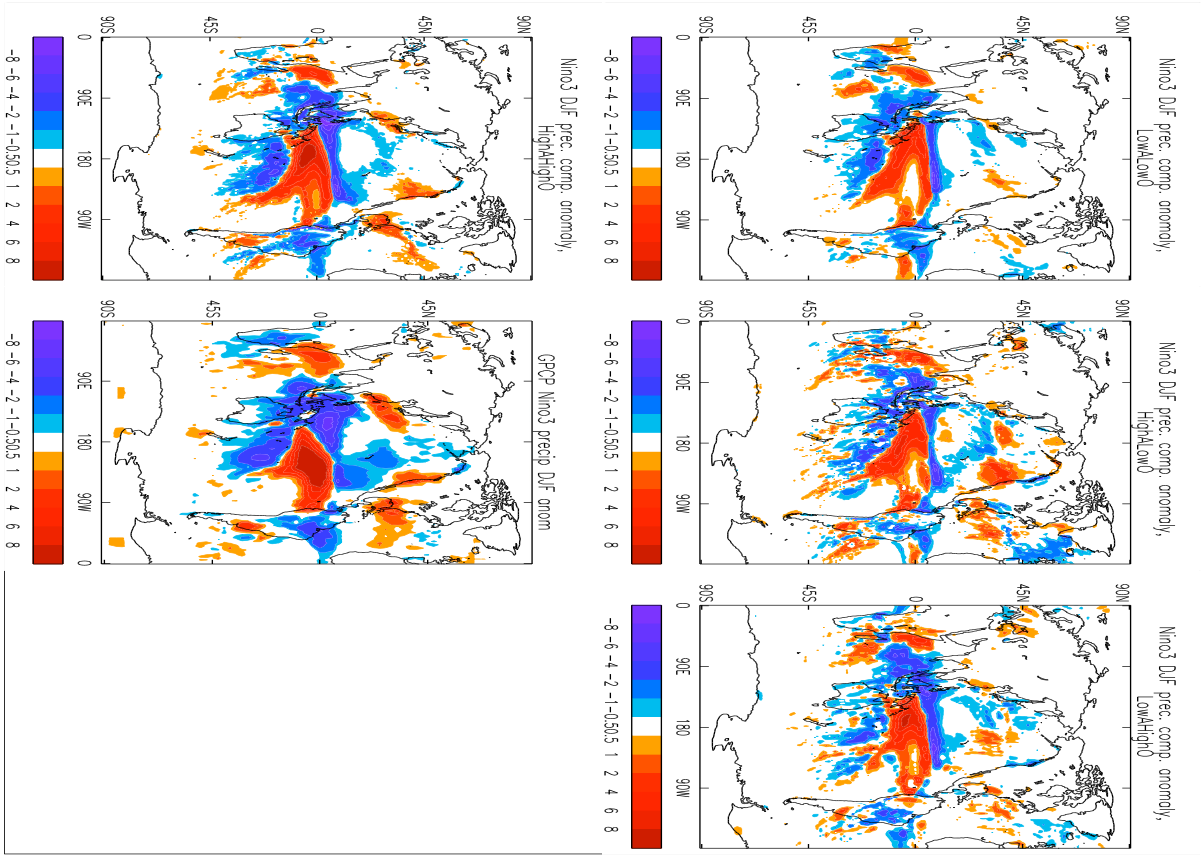

Figure 1: Precipitation anomalies with different ocean and atmosphere resolutions

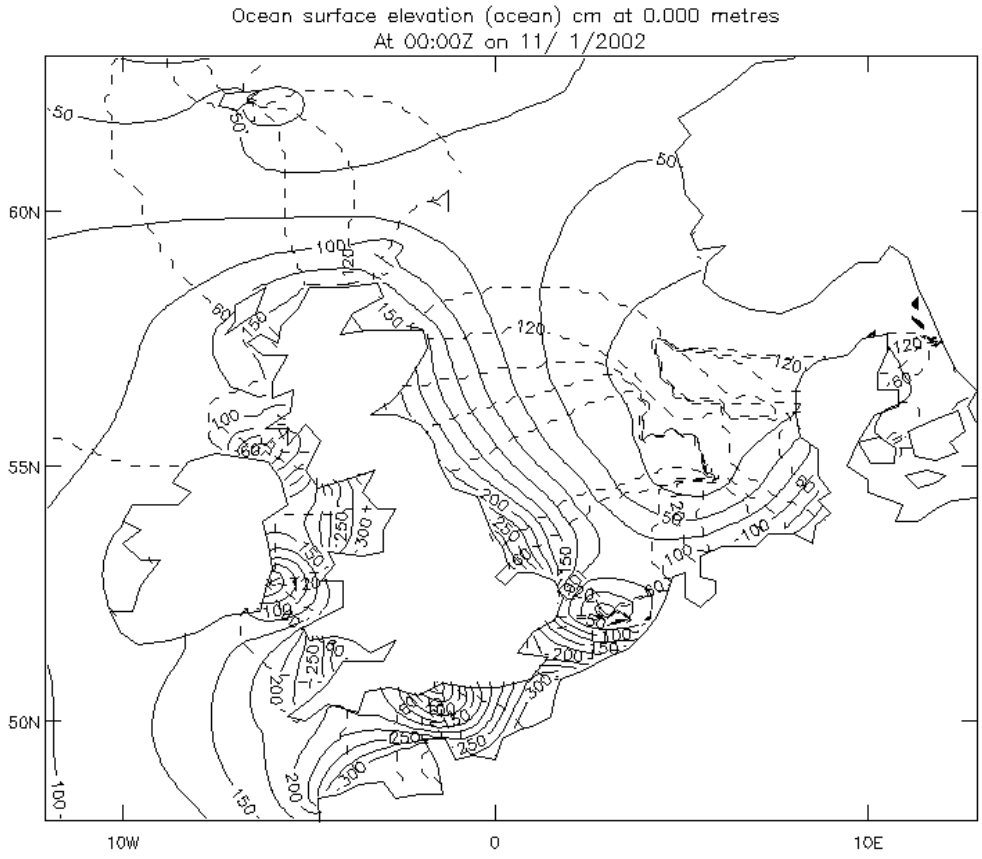

Figure 2: Cotidal plot showing amplitude (cm) and phase (deg) of tidal elevation for M2 semidiurnal tide in test configuration of NEMO for the NW European Shelf