The Forecasting Ocean Assimilation Model (FOAM) System

M. J. Bell, A. Hines, P. Holland,
M. J. Martin, M. E. McCulloch and D. Storkey

Met Office, London Rd, Bracknell, Berks, RG12 2SZ, U K.

Email: mike.bell@metoffice.com

Introduction

The aim of the FOAM system is to provide real-time, operational, analyses and forecasts of the three-dimensional structure of the deep ocean and of sea-ice. The ocean fields that are forecast are the temperature, salinity, currents and mixed layer depth. The concentration and depth of sea-ice are also forecast. The primary objectives are to forecast the surface mixed layer to 3-5 days ahead and the mesoscale structure (perhaps up to 10-20 days ahead).

A global version of the FOAM system has run each day in the Met Office's operational suite since it was introduced in 1997. The system is described in detail in Bell et al. (2000). It is based around a z co-ordinate, primitive equation ocean model on a grid with 1^o spacing in the horizontal and 20 levels in the vertical. The model is forced by 6-hourly surface fluxes from the Met Office's numerical weather prediction (NWP) system and assimilates thermal profile and surface temperature data. This report outlines the main developments made to the system since 1997.

Development of Hindcast and Rapid Response Nested Model Capabilities

An accessible archive of 6-hourly surface fluxes from the Met Office's NWP system has been established back to May 1996. The suite control system (SCS) used for operational NWP is used for the FOAM operational forecasts and for long period (e.g. 3 year) hindcasts, using the 6-hourly fluxes, to test new versions of the FOAM system.

The facility to nest higher resolution, limited area models inside lower resolution larger area models has been developed. The nesting is one-way and uses the flow relaxation scheme (Davies 1983). A model covering the Atlantic and Arctic oceans with a 35-km grid was added to the operational suite in January 2001.

A system to set up new model configurations, to spin them up to real-time, and to produce daily pre-operational forecasts has been developed and used to support the Royal Navy's Saif Sareea exercise in the Arabian Sea using models covering the Arabian Sea with a 13 km grid and the Indian Ocean with a 35 km grid nested inside a 1^o global model.

The dependence of the model integrations on the choice of harmonic and biharmonic viscosities, thermal diffusivities and upwind advection schemes has been explored in models of widely varying horizontal resolutions.

A model covering the North Atlantic with a 13-km grid has been established. After 1 year of integration the separation of the flow at Cape Hatteras is good given the resolution (see figure), though the separated path appears to be too variable.

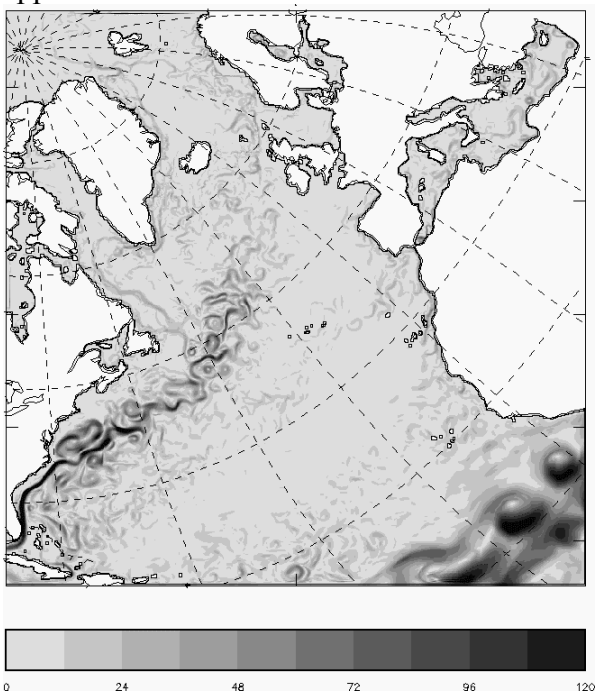

Figure: Five-day mean surface current speeds (cm/s) in North Atlantic FOAM model after 15 months of spin up using monthly mean fluxes and no data assimilation

Developments to observations assimilated

Fields of sea-ice concentration received from the Canadian Meteorological Center have been assimilated into the FOAM operational model since 6 July 1999.

The FOAM group has experimented with the assimilation of altimeter data for many years. Routine (weekly) delivery of altimeter data from CLS (Centre Localisation Spatiale) in Toulouse however was only established in August 2001. These data have been assimilated in the operational Atlantic model since 25th Sept. 2001.

Developments to the techniques used for data assimilation are described in a separate contribution.

Distribution of products and GODAE

Gridpoint data from the operational FOAM system are available through the Met Office's Data Products Distribution Server (DPDS). During the main phases of the Global Ocean Data Assimilation Experiment, gridpoint data from high resolution FOAM systems run on a daily pre-operational basis will be available through the Live Access Server at http://www.nerc-essc.ac.uk/las

References

Bell, M. J., R. M. Forbes, A. Hines 2000 Assessment of the FOAM global data assimilation system for real-time operational ocean forecasting. J. Mar. Sys., 25, 1-22.

Davies, H. C. 1983 Limitations of some common lateral boundary schemes used in regional NWP models. Mon. Weather Rev., 111, 1002-1012.