Regional FOAM Configurations

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Overview

The Met Office's Forecasting Ocean Assimilation Model (FOAM) system has recently undergone large-scale modifications. The model component has been changed to use the NEMO model and the resolution of the global system has been increased from a 1° standard grid to a 1/4° tri-polar grid (ORCA025) with 50 vertical levels. Within this global FOAM-NEMO 1/4° domain are three nested, higher resolution, regional models in the North Atlantic Basin, the Indian Ocean and the Mediterranean Sea on a more detailed 1/12° grid (called NATL12, IND12 and MED12 respectively). These regional configurations use the same NEMO model with 6 hourly UKMO surface fluxes as used in the global FOAM model and take boundary conditions direct from the global model, using the NEMO BDY code. A range of satellite and in-situ observations are assimilated into the system using an Optimal Interpolation type method as described in the poster by Matt Martin (S2.14-44). The bias correction scheme detailed in Dan Lea's poster (S2.12-26) is used to correct for biases in the MDT.

Here we provide descriptions of the regional FOAM configurations along with plots of SST and SSH fields obtained from recent hindcast runs performed for the period 1st April 2005 to 31st March 2006. Model validation statistics are given for each model in the form of comparisons with in-situ and satellite observations, along with a comparison to the parent 1/4° FOAM system.

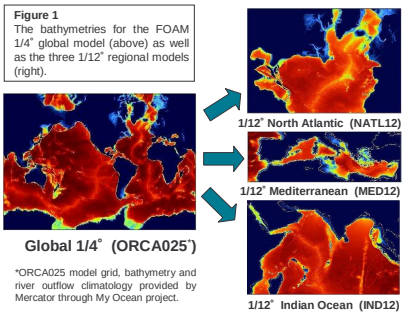
FOAM operational system

The FOAM 1/4° global model (ORCA025) runs in an early morning slot and produces a 5-day forecast.

The 3-D temperature, salinity and current fields are then used as input data for the regional models using the unstructured open boundaries code (NEMO BDY).

The regional FOAM models run together in an evening slot and forecast to T+144. The open boundary data fields used for day 5 are persisted for the 6th day.

Figure 1
The bathymetries for the FOAM 1/4° global model (above) as well as the three 1/12° regional models (right).



*ORCA025 model grid, bathymetry and river outflow climatology provided by Mercator through My Ocean project.

Mediterranean Sea 1/12° model (MED12)

The FOAM Mediterranean Sea model grid consists of a standard latitude-longitude grid with 1/12° horizontal resolution.

The domain runs from 13° West, 30° North in the southwest corner to approx 37° East, 46° North in the northeast corner. The MED12 model bathymetry is shown in Figure 1.

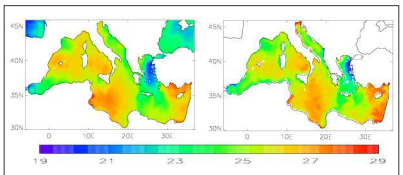


Figure 2
Sea surface temperature plots comparing monthly mean OSTIA (left) and FOAM Mediterranean Sea 1/12° model fields towards the end of the hindcast, March 2006.

Comparisons between the Mediterranean and global models

	SST (°C)	SSH (m)	MLD (m)	T-Prof (°C)	S-Prof (PSU)
ORCA025	**0.795** (0.052)	**0.080** (-0.039)	**37.087** (-3.280)	**0.716** (0.042)	**0.091** (0.001)
MED12	**0.730** (0.011)	**0.068** (-0.002)	**30.371** (0.130)	**0.687** (-0.003)	**0.086** (-0.001)

Table 1
Comparisons between the Mediterranean and global models over the Mediterranean Sea domain for the hindcast period 1st April 2005 to 31st March 2006.
Showing RMS errors (in bold) and mean errors (in parenthesis) for Sea Surface Temperature (SST), Sea Surface Height (SSH), Mixed Layer Depth (MLD), depth averaged Temperature (T-Prof) and Salinity (S-Prof) Profiles.

The Black Sea is not included.

To improve the transports across the Straits of Gibraltar a section of the North Atlantic Ocean has been included.

Therefore the Mediterranean Sea model contains open boundaries to the north, south and east in the North Atlantic region.

The model is not expected to be very good as we move away from the Straits of Gibraltar into the North Atlantic. Therefore the output fields are masked to include only the true Mediterranean Sea region (as per the right hand plot in Figure 2) and the comparison statistics in Table 1 correspond to this new region.

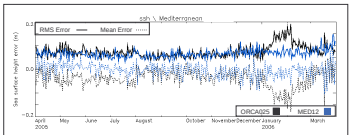


Figure 3
Time series plot of Sea Surface Height (SSH) RMS and mean errors (shown solid and dotted respectively) for the ORCA025 global model (black lines) and the FOAM North Atlantic 1/12° model (blue lines).

North Atlantic 1/12° model (NATL12)

The FOAM North Atlantic model uses a standard 1/12° horizontal resolution latitude-longitude grid, rotated to have its North Pole at 42° East, 160° West.

The domain extends from 122° West to 50° East and runs from just below the equator in the southwest to 67° North in the northeast. The NATL12 bathymetry is shown in Figure 1.

Comparisons between the North Atlantic and global models

	SST (°C)	SSH (m)	MLD (m)	T-Prof (°C)	S-Prof (PSU)
ORCA025	**0.836** (-0.050)	**0.099** (0.010)	**40.102** (-0.500)	**1.045** (0.020)	**0.231** (0.010)
NATL12	**0.946** (-0.040)	**0.109** (-0.008)	**41.769** (-0.050)	**1.063** (0.066)	**0.209** (-0.000)

Table 2
Comparisons between the North Atlantic and global models over the North Atlantic domain for the hindcast period 1st April 2005 to 31st March 2006.
Showing RMS errors (in bold) and mean errors (in parenthesis) for Sea Surface Temperature (SST), Sea Surface Height (SSH), Mixed Layer Depth (MLD), depth averaged Temperature (T-Prof) and Salinity (S-Prof) Profiles.

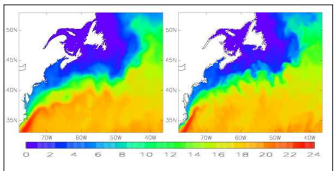


Figure 4
Plots comparing monthly mean SST fields for OSTIA (left) and the FOAM North Atlantic 1/12° model (right) in the vicinity of the Gulf Stream towards the end of the hindcast, March 2006.

The Mediterranean Sea has been omitted from the model and the behaviour through the Straits of Gibraltar is approximated by relaxing temperature and salinity fields to WOA05 climatology values.

NATL12 has open boundaries to the north and south.

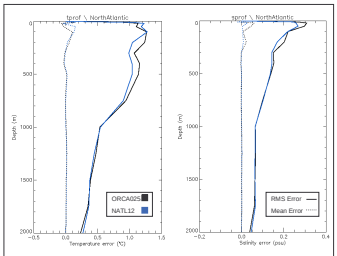


Figure 5
Profile plots comparing temperature (left) and salinity (right) errors for the ORCA025 global model (black lines) and the FOAM North Atlantic 1/12° model (blue lines) averaged over the North Atlantic domain. Solid lines show RMS errors and dashed lines mean errors.

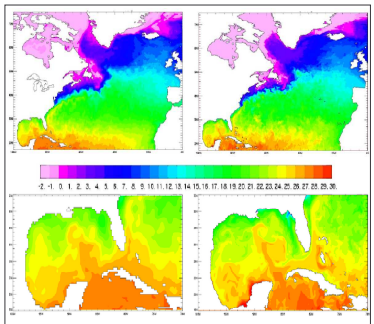


Figure 6
SST comparisons between OSTIA (left) and FOAM North Atlantic 1/12° model (right) daily mean fields. The top row shows the North Atlantic basin whilst the bottom row shows enlargements of the Gulf of Mexico region.

Indian Ocean 1/12° model (IND12)

The FOAM Indian Ocean model grid consists of a standard latitude-longitude grid with 1/12° horizontal resolution.

The domain runs from 33° East, 25° South in the southwest corner to approx 106° East, 31° North in the northeast corner. The IND12 model bathymetry is shown in Figure 1.

Comparisons between the Indian Ocean and global models

	SST (°C)	SSH (m)	MLD (m)	T-Prof (°C)	S-Prof (PSU)
ORCA025	**0.586** (-0.075)	**0.069** (-0.018)	**26.745** (1.215)	**0.561** (0.023)	**0.116** (0.003)
IND12	**0.730** (-0.134)	**0.068** (-0.002)	**27.858** (2.968)	**0.605** (0.003)	**0.115** (0.004)

Table 3
Comparisons between the Indian Ocean and global models over the Indian Ocean domain for the hindcast period 1st April 2005 to 31st March 2006.
Showing RMS errors (in bold) and mean errors (in parenthesis) for Sea Surface Temperature (SST), Sea Surface Height (SSH), Mixed Layer Depth (MLD), depth averaged Temperature (T-Prof) and Salinity (S-Prof) Profiles.

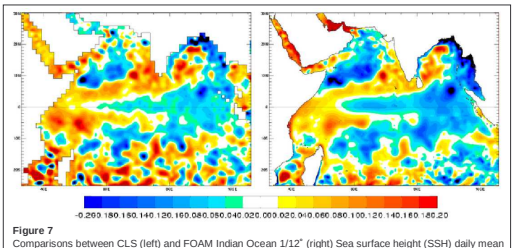


Figure 7
Comparisons between CLS (left) and FOAM Indian Ocean 1/12° (right) Sea surface height (SSH) daily mean fields for mid May 2005.

IND12 contains open boundaries to the south and east.

The model is cut off at the southeastern corner of the Andaman Sea where the, relatively shallow, waters of the Strait of Malacca and the Gulf of Thailand have been masked out.

Summary/discussion points

In general, the high resolution regional FOAM model Sea Surface Temperature (SST) and Sea Surface Height (SSH) fields compare well, visually, with the OSTIA and CLS datasets and appear to reproduce the key fronts and features adequately (see Figures 2,4,6 and 7).

The statistics for the Mediterranean model show that, unlike the other two models, it performs better than the global model across the board (see Table 1). This is most likely owing to the way the open boundaries are implemented in the model.

All three of the regional models resolve SSH better than the global ORCA025 model with lower RMS errors and significantly lower mean errors, as exemplified by the dotted line on the time series in Figure 3. Additionally salinity profile statistics are also better for the regional models than for the global model.

There is obviously some kind of a problem in the Indian Ocean model with the surface temperature, particularly in the summer months, which will require further investigation. This was unexpected because the SST error stats from a previous IND12 hindcast run were consistently lower than the global model with SST RMS errors well under half a degree C!

Finally we note that all of these new FOAM-NEMO 1/12° regional configurations are in their infancy and so there will be plenty of time to tweak them over the coming years.

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