Preliminary case-study experiments with a global ocean-atmosphere coupled model configuration on NWP timescales

Ann Shelly, Tim Johns, Dan Copsey, Catherine Guiavarc'h
Met Office, Fitzroy Rd, Exeter, EX1 3PB, United Kingdom
(Email: ann.shelly@metoffice.gov.uk)

1. Introduction

A recent international workshop on ocean-atmosphere interaction held at the Met Office (Dec 2009), reviewed the current state of knowledge based on world-wide research activities in the field and set the background for the ongoing research in the Met Office. In bringing the community working actively in this area together to discuss the latest research, this workshop sought to identify which aspects of upper ocean-atmosphere interaction need to be included and what level of modelling complexity and initialization methods are most appropriate for different prediction timescales in global model systems for NWP through medium range to seasonal and decadal forecasting. It was decided to explore the potential for ocean-atmosphere coupling to deliver improved skill on NWP to monthly forecasting timescales.

2. Experimental design

A preliminary series of coupled atmosphere-ocean-sea ice experiments has been completed using a Met Office Unified Model (MetUM) configuration. In planning the initial research phase, the choice of ocean model configuration was of primary concern. A major strategic consideration was to move as close as possible towards scientific traceability between NWP forecast, seasonal and climate models, which are starting to converge within the MetUM environment. Thus the initial experiments were based on coupling to a fully 3-dimensional ocean model (NEMO) closely related to that used in Met Office seasonal forecast and climate model applications. In addition to coupled experiments, parallel atmosphere and ocean (including sea ice) control configurations were also developed and run. These were configured with identical physics and resolution and initialised in a similar way to the coupled experiments. In combination, this set of experiments permits the benefit from including the interactive ocean model and air-sea interactions to be analysed relatively cleanly. The experimental setup is summarised in Table 1. A set of 6 winter (DJF) and 6 summer (JJA) test cases were chosen to correspond to the FOAM (ocean forecast model) hindcast period (2007-2008). Each case was run in forecast mode for 30 days as a standalone MetUM job, the cases being run separately for the coupled, atmosphere and ocean configurations.

3. Results

Figure 1 depicts the growth of Root Mean Square Error (RMSE) over the 30 day forecast period for the coupled and atmosphere control runs as compared with the MetUM analyses averaged over 6 winter cases for the global region (surface temperature). It suggests that the initial configuration of the experimental coupled model configuration compares favourably in terms of skill with atmosphere control run, with more skill than the control in the tropical region (not shown).

Initial results demonstrate relatively consistent biases and drifts compared to other Met office models such as FOAM and GloSea4 (coupled seasonal forecast model).Figure 2 shows that the coupled configuration, ocean control and GloSea4 all demonstrate similar SST drift in the Arabian sea compared with the FOAM analysis. Figure 3 shows mean GloSea4 DJF biases compared with day 5 coupled forecast errors. An equatorial cold tongue, Maritime Continent warm bias and cold Arabian Sea bias are visible at early lead times and further worsen with lead time.

4. Concluding remarks

The preliminary results are promising and work is underway to understand the mechanisms involved. This initial study contributes to the development of a seamless approach to weather, seasonal and climate forecasting, using the shorter range 1-15 day timescale to explore coupled model errors that are potentially important on the longer timescale.

Table 1: Outline of experimental setup for the coupled, atmosphere and ocean forecasts. Model sub-components are denoted **A** – atmosphere, **O** – ocean and **I** – sea ice

	Coupled	Atmosphere control	Ocean control
Components and resolution	**A** – MetUM N216L85 **O** – ORCA 0.25° L50 **I** – CICE 0.25°	**A** – MetUM N216L85	**O** – ORCA 0.25° L50 **I** – CICE 0.25°
Air-sea boundary conditions	Interactively coupled every 3 hours (resolving diurnal cycle)	Daily SST and sea ice from OSTIA analyses, time-interpolated to 3-hourly (but without a diurnal cycle)	3-hourly mean fluxes from corresponding atmosphere control
Initialisation	**A** - operational NWP analysis (N320L50), interpolated to N216L85 **O** - FOAM analysis (ORCA0.25L50) **I** - Monthly mean climatology from HadGEM3 pre-industrial control run	**A** - operational NWP analysis (N320L50), interpolated to N216L85	**O** - FOAM analysis (ORCA0.25L50) **I** - FOAM sea ice analysis

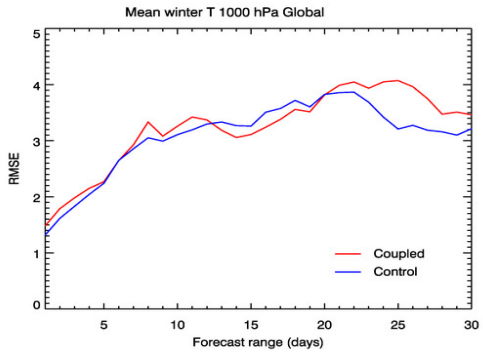

Figure 1: Mean DJF temperature rmse for coupled and atmosphere control runs calculated against MetUM analysis over Global region

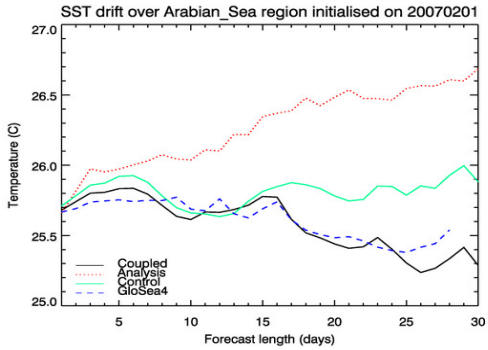

Figure 2: SST drift in Arabian Sea region for the coupled run, ocean control, GloSea4 and FOAM operational analysis for a single case study initialised on the 01/02/2007

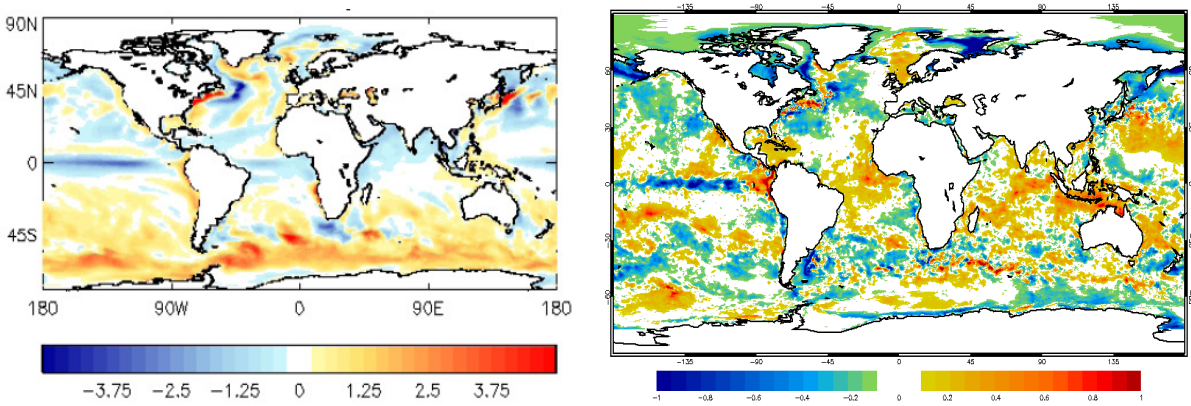

Figure 3: Mean Glosea4 DJF SST biases calculated against climatology (left). Mean DJF coupled model forecast errors at day 5 lead time calculated against FOAM operational analysis (right).