Impact of Argo for weather, seasonal and decadal forecasting

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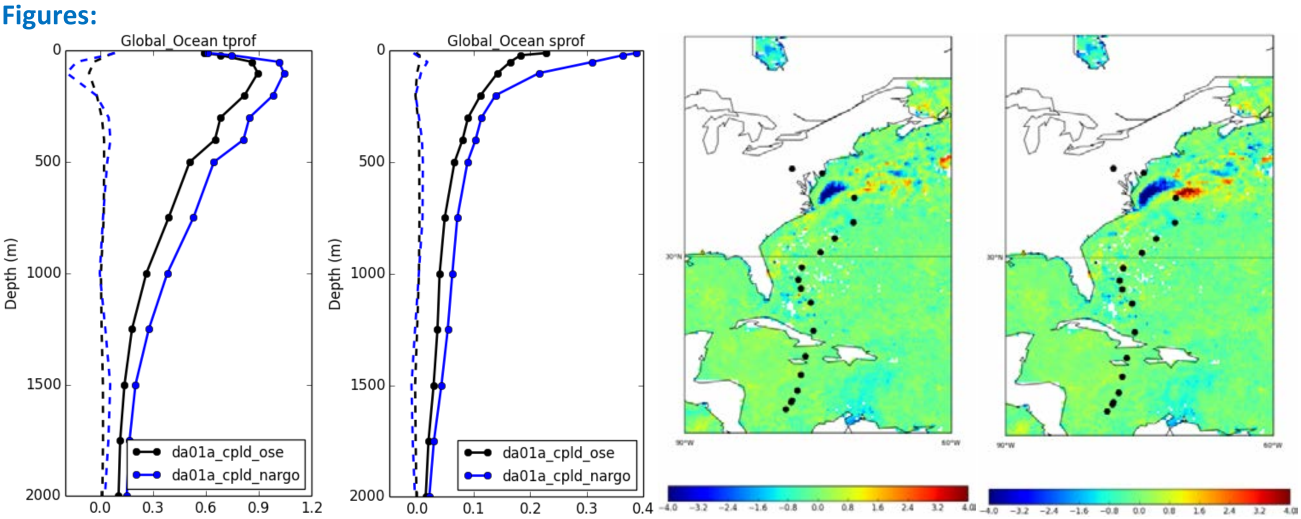
Introduction: The necessity of coupling atmosphere and ocean models is accepted on seasonal to decadal prediction timescales, but the importance at the shorter time-scales has not been extensively addressed. The development of short-range coupled prediction systems at the UK Met Office, which assimilate data into both ocean and atmosphere components of the coupled model, provide the first opportunity to assess the potential for Argo to improve weather forecasts. We have used an Observing System Experiment (OSE) and two Observing System Simulation Experiments (OSSEs) to investigate the effect of assimilating Argo profiles on coupled analyses and short-range forecasts. As with all observing system experiments, the impacts shown here are specific to the forecast model, data assimilation system and observations used, so cannot be generalised to other systems.

Results: An analysis of the ocean innovation statistics (Figure 1) has shown that removing the assimilation of Argo profiles from our system causes a large degradation in the temperature RMS error throughout the sub-surface water column and an increase in the bias, especially near the thermocline. A similar degradation in the salinity RMS error is seen throughout the water column as there are no additional surface observations with which to constrain salinity. The greatest differences in the upper ocean seem to build over the first 6-months, but it is not clear if the full effects are realised by the end of the 13-month runs. Consequently, any OSE run over a shorter period is likely to under-estimate the impact of profile assimilation, especially for the deeper ocean.

The atmosphere observation-minus-analysis statistics showed negligible systematic global impacts, although this was not unexpected due to the assimilation of all available atmosphere and SST observations in both experiments. However, case study forecasts of Hurricane Sandy highlighted that the assimilation of Argo profiles has an impact on the analysed position of the Gulf Stream (as seen in Figure 2), with consequent impacts on forecasts after the hurricane passes over the Gulf Stream. However, no systematic improvements in the hurricane position or intensity were found in a comparison against the available observations.

Results from our OSSEs indicate that there is a substantial amount of work necessary before we could make use of the extra information gathered by a greatly expanded Argo array. In particular the OSSEs have highlighted a problem in making use of a higher density of profile observations than is currently available. Although a greater density of observations should allow an improved estimate of the ocean state, and hence improve forecasts, such observations will not have an immediate impact without more effort to improve the assimilation. Given the proposed increase in profile density in particular regions, this will need to be addressed in the near future.

Figures:



(Left) Global temperature (left) and salinity (right) profile innovation statistics over the 13-month experiment (RMS solid line, mean error dashed line, control shown in black, no-Argo run show in blue). (Right) The mean SST observation-background differences binned to 0.25º for the control (left) and no-Argo experiment (right) over the period 22-30 October 2012. The best-track positions of Hurricane Sandy are show every 12 hours.