



Australian Government

Department of the Environment, Water, Heritage and the Arts

Marine and Tropical Sciences Research Facility Milestone Report, March 2010

Program 5(i): Climate Change: Great Barrier Reef

Project 2.5i.1: Hydrodynamics at the whole-of-GBR scale

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Summary

The development of a whole-of-GBR 3D baroclinic hydrodynamic model is progressing well. A pilot 4 km resolution regional model has been established and is running in near-real-time. River inflow for a number of real-time gauged rivers (Mulgrave, Russell, North Johnstone, South Johnstone, Herbert, Burdekin, Fitzroy and Mary) has been introduced into the 4 km near-real-time model.

A pilot 2009 wet season hindcast of the 4 km resolution model is presently being undertaken. An initial run of hydrodynamics without river inflows has been performed. The hindcast including river inflows will be undertaken in March/April 2010.

The project is on track as per the project plan.

Project Results

Description of the results achieved for this milestone

A pilot 4 km resolution regional model has been established and is running in near-real-time (NRT). The regional model is forced with global ocean and atmospheric model products. The regional model is nested in BRAN2.3 (Schiller *et al.* 2008); these outputs considered the best global product to date suitable for forcing the nested suite. BRAN2.3 is a data assimilating global model with 10 km resolution in the Australasian region, using the MOM4p1 ocean model as the code base. The near real-time implementation of the models uses the operational version of BRAN operated by BoM (OceanMAPS). These data were used as initial conditions for temperature, salinity and sea level, and boundary forcing on the 4 km grid for temperature, salinity and velocity. An upstream advection open boundary condition (OBC) is used for temperature and salinity. The velocity open boundary condition follows the methodology of Herzfeld (2009), where a local flux adjustment is used to prevent long term basin-wide divergence, which may lead to filling or emptying of the domain. A tidal signal using the OTIS tidal model was superimposed on the low frequency sea level oscillation provided by BRAN2.3 on the regional grid open boundary. This tidal signal was introduced via the local flux adjustment. Atmospheric forcing products (wind, pressure, heatflux) are supplied by the MesoLAPS atmospheric model at 1/8 degree resolution. This modeled product is preferable to spatially interpolated meteorological data supplied by Bureau of Meteorology weather stations for surface forcing, since its spatial detail is superior.

MesoLAPS provides wind, mean sea level pressure, cloud amount, air temperature and dew point temperature. From these variables, bulk schemes (Kondo, 1975) are used to compute sensible and latent heat fluxes, and black body radiation may be used to compute long wave radiation (Zillman, 1972). The sum of these and computed short wave input provides a net heat budget.

The regional model grid covers the entire GBR region and extends from the Gulf of Papua southwards to the QLD/NSW border. The grid extends eastward into the Coral Sea Territories a sufficient distance to avoid the topographical complexities of the Queensland and Marion plateaus (see Figure 1). It must be recognised that the 4 km regional model is an intermediate step required to downscale the larger OceanMAPS ocean model to the shelf scale 1 km resolution model, and as such, the regional model does not attempt to reproduce the fine bathymetric and topographic detail inherent in the GBR (for example see Figure 2).

River inflow for a number of real-time gauged rivers (Mulgrave, Russell, North Johnstone, South Johnstone, Herbert, Burdekin, Fitzroy, Mary) has been introduced into the 4 km NRT model.

The pilot 2009 wet season hindcast of the 4 km resolution model is presently being undertaken. An initial run of hydrodynamics without river inflows has been performed. The hindcast including river inflows will be undertaken in March/April 2010. Rivers to be included in the 2009 hindcast are:

Burdekin River	O'Connell River
Fitzroy River	Pioneer River
Normanby River	Burnett River
Johnstone River	Barron River
Herbert River	Don River
Mulgrave-Russell Rivers	Haughton River
Tully River	Daintree River

A preliminary grid for the nested 1 km resolution model has been created (see Figure 1) but has not yet been operationally nested within the 4 km regional model.

Preliminary results from the near real-time model can be viewed at:

<http://www.emg.cmar.csiro.au/www/en/emg/projects/GBR/Near-Real-Time-Results.html>

Preliminary results from the regional model show that the dominant features of the Coral Sea circulation adjacent to the GBR are well resolved in the model simulation, including the westward flowing South Equatorial Current, the resultant poleward flowing East Australian Current and the recirculation in the Gulf of Papua (Figure 3). Spatial variability in regional SST is also captured by the regional model (Figure 4). On the shelf, although coarsely resolved, the model adequately reproduces the observed tidal sea levels (Figure 5).

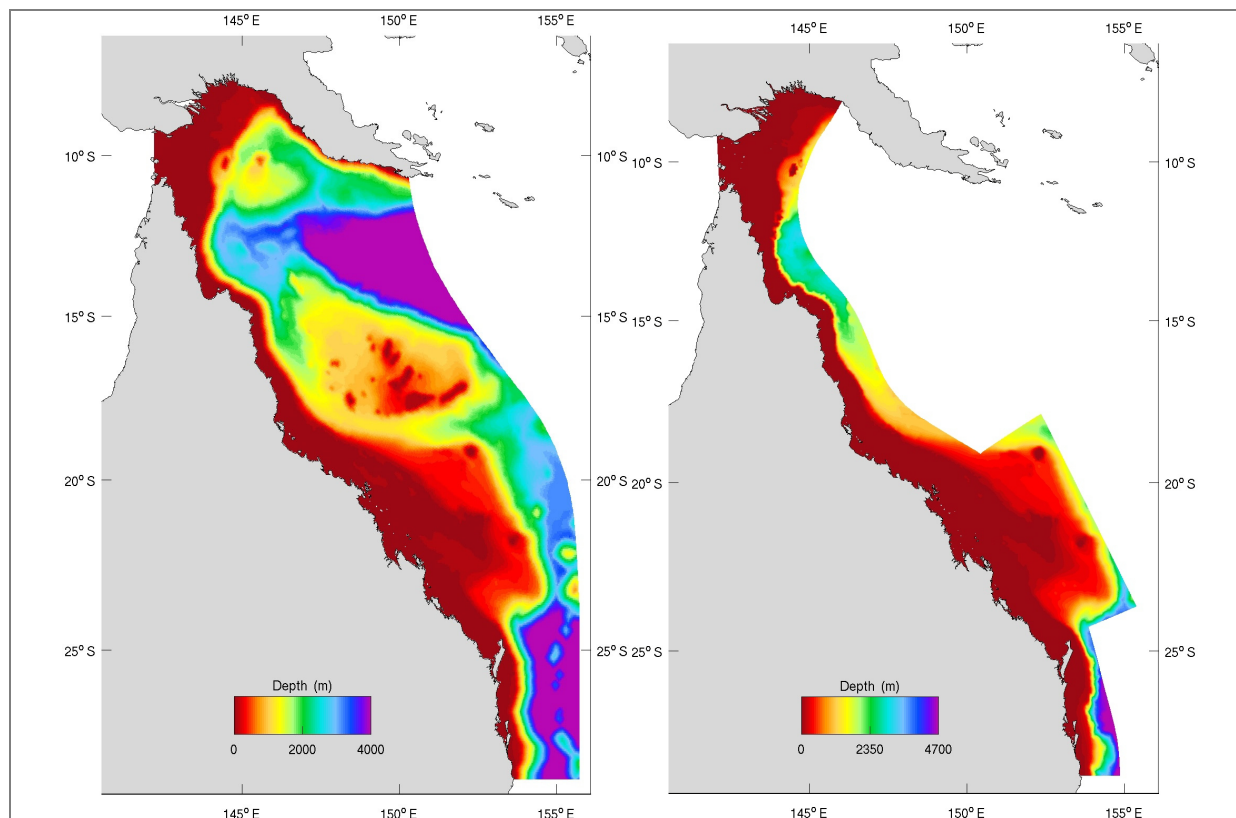


Figure 1: Model grid and bathymetry established for pilot 4 km (left) and 1 km (right) resolution model.

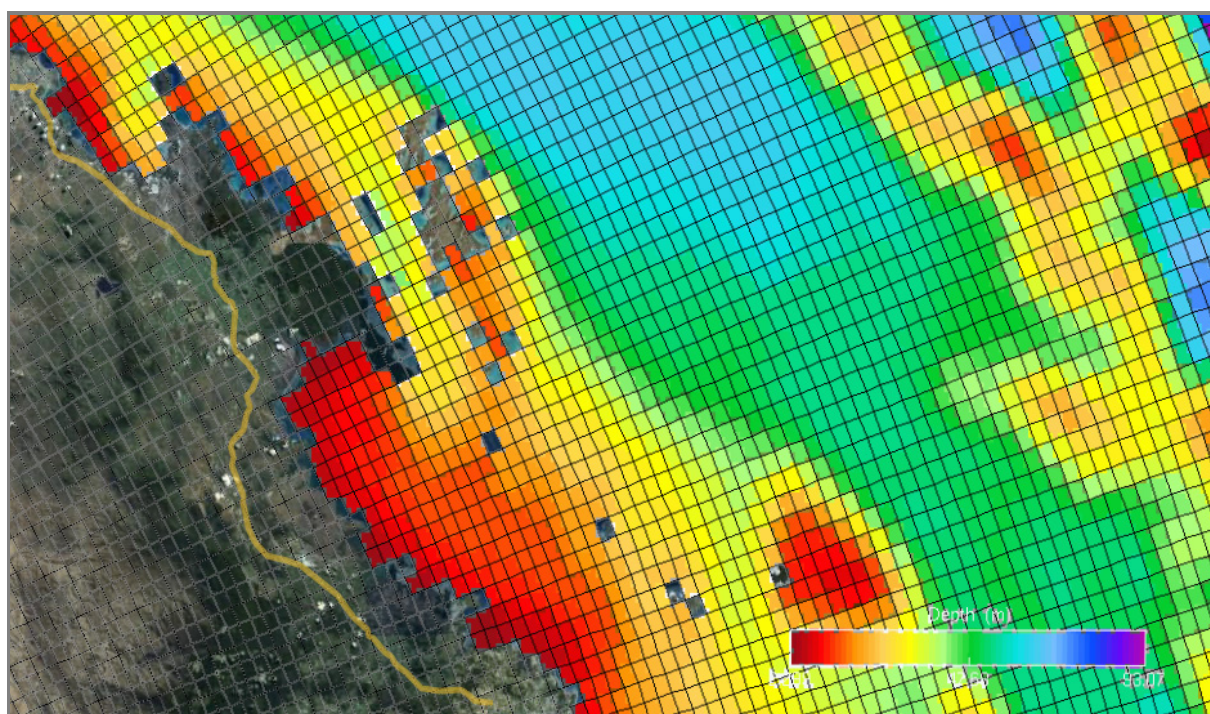


Figure 2: Regional model grid and bathymetry for pilot 4 km in the Whitsunday Islands region of the Great Barrier Reef. Note, coarseness of resolution of the Whitsunday Islands (shown centre, left) and northern Pompey Reef regions (shown top, right).

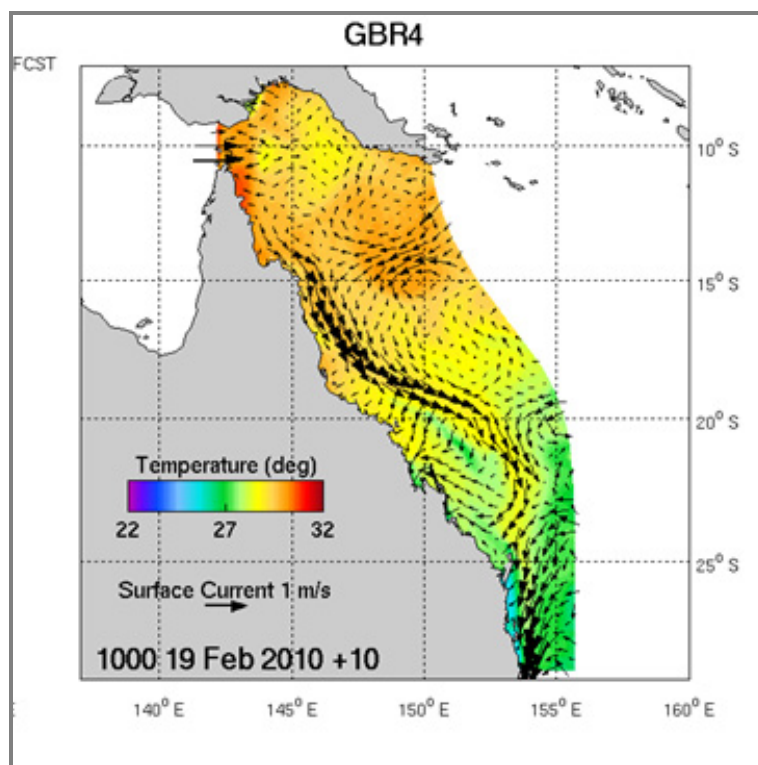


Figure 3: Preliminary model output of surface temperature with overlaid velocity vectors.

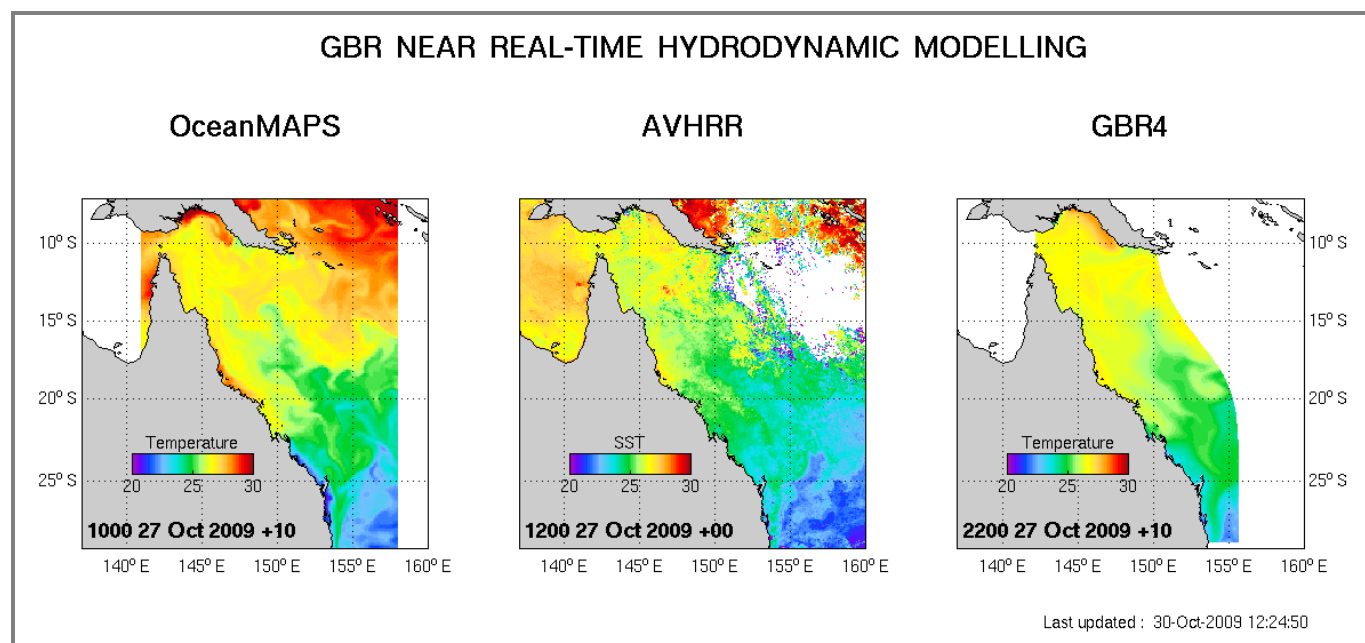


Figure 4: Comparison of large-scale prediction of sea-surface temperature (SST) (OceanMAPS), observed SST (AVHRR) and predicted SST from GBR 4 km model.

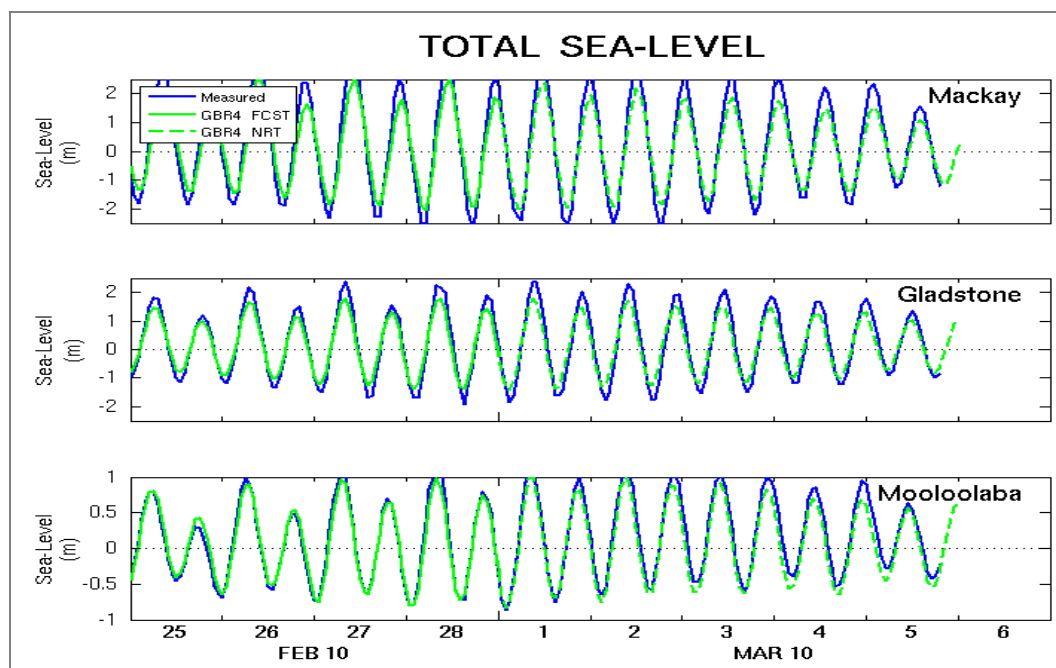


Figure 5: Observed and predicted sea levels at coastal station along the GBR and South Queensland coast (total sea-level includes contributions from tides and low frequency variability).

Activity Summary

Targeted Activity	Completion Date	Progress
Installation and testing of hydrodynamic modeling suite at AIMS	November 2009	Completed
Creation of model grid and preliminary establishment of pilot 4 km resolution hydrodynamic model	December 2009	Completed
Pilot 2009 wet season hindcast using 4 km resolution model incorporating available digital data on river inflow for catchments draining into the GBR	April 2010	On Track

References

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- Kondo, J.** (1975) Air-sea bulk transfer coefficients in diabatic conditions. *Bound. Layer Meteor.* 9: 91-112.
- Schiller, A., Oke, P.R., Brassington, G.B., Entel, M., Fiedler, R., Griffin, D.A. and Mansbridge, J.** (2008) Eddy-resolving ocean circulation in the Asian-Australian region inferred from an ocean reanalysis effort. *Progress in Oceanography* [doi:10.1016/j.pocean.2008.01.003].
- Zillman, J.W.** (1972) A study of some aspects of the radiation and heat budgets of the southern hemisphere oceans, *Meteorol. Study* 26 (Bureau of Meteorology, Dept. of the Interior, Canberra, Australia).