Assessment of the FES2014 tidal currents around Australia

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Introduction

The FES2014 global tidal model benefits from a **high resolution mesh, improved hydrodynamic modelling and data assimilation techniques**, as well as a 20-year-long altimeter time series and a large dataset of tide gauge observations for data assimilation. In addition to the tidal elevations, the **FES2014 global tidal atlas provides the tidal current velocity**, which is of particular interest for many scientific (ocean circulation analysis, ocean dynamics modelling…) and industrial (offshore activities, tidal energy site assessment…) applications.

Validation of the tidal currents is challenging as it requires long and accurate time series of current-meter observations. Luckily, for more than 10 years Australia has been maintaining a network of about 50 ADCP instruments all around the country, principally through its government-supported Integrated Marine Observing System (IMOS). **The Australian continental shelf has a wide range of tidal regimes ranging from macro-tidal to micro-tida**l, thus providing ideal conditions to thoroughly test a model.

This poster presents an assessment of the FES2014 tidal current atlas against the tidal constituents computed from the IMOS current meter data around Australia. The results show the **very good agreement between the FES2014 tidal currents and the measured tidal currents**, in most of the regions around Australia. Some differences have also been noticed and analyzed and **some potential improvements to the model have been identified**. This study provides new insights on the FES2014 tidal model quality and possibilities of improvements that would benefit both the tidal currents and the tidal elevations.

Comparison methodology

Datasets

- **FES2014 model tidal currents**
  - Barotropic model
  - Available as maps of tidal harmonic constituents (amplitude and phase lag) for each tidal current direction (U eastward and V northward) and for each tidal component (M2, K1, O1, S2, etc).
  - The FES2014 tidal model is available on the AVISO website (see poster by Carrère et al)
- **In situ currentmeter observations**
  - 48 stations located all around Australia, with time series measured between 2007 and 2015 (measurement period depends on the station).
  - Total current data available through IMOS website as time series in each current direction (U eastward and V northward), at various depths.
  - Specific computation of the total current at a mean depth (CSIRO).

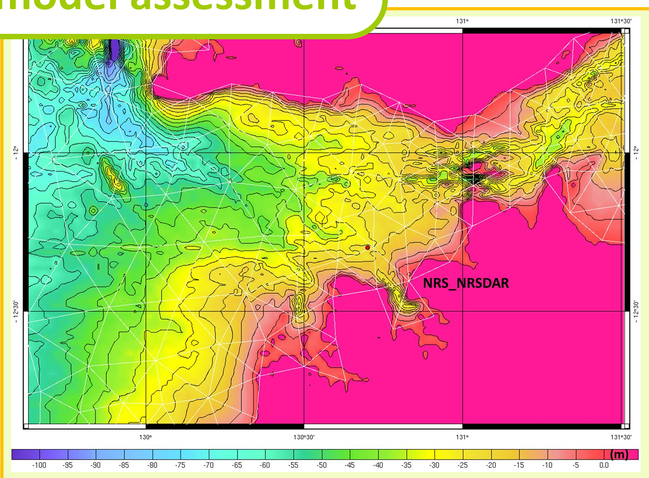
Data processing before comparison

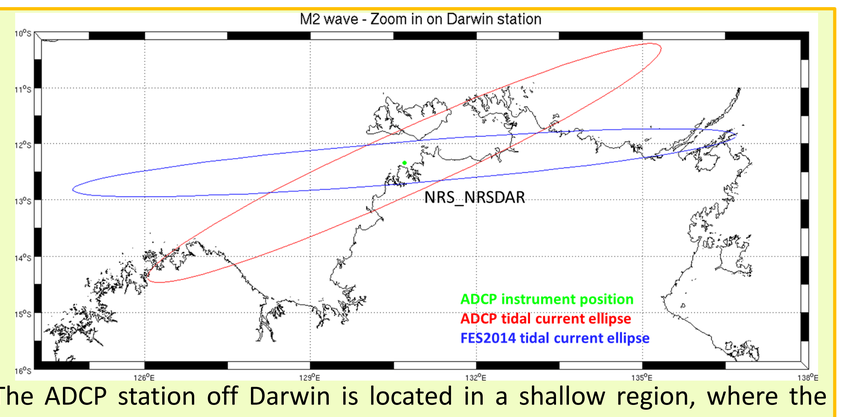
In order to compare close physical contents, the tidal signal was extracted from the in situ currentmeter data at mean depth, thanks to a harmonic analysis performed in each current direction separately. This gives tidal harmonic constituents (amplitude and phase lag) for each tidal current direction and for each tidal component, at each currentmeter station.

These in situ **tidal harmonic constituents** are directly comparable with the FES2014 model tidal currents **in the frequency domain**, through the computation of **vector differences** and **tidal current ellipses**.

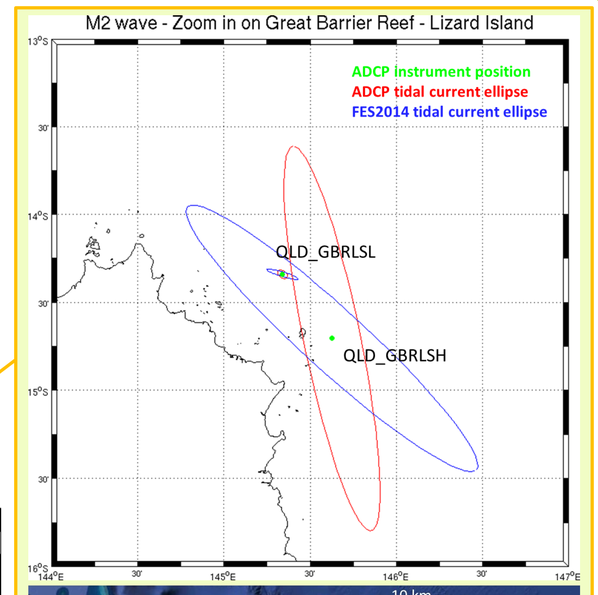
Then, the purely **tidal current velocity time series** are reconstructed for both the FES2014 model and the currentmeter data, in each direction (U and V), thanks to a prediction based on the five main tidal components in the region (M2, K1, S2, O1, N2). The inter-comparisons of these time series give an assessment of the tidal model **in the temporal domain**.

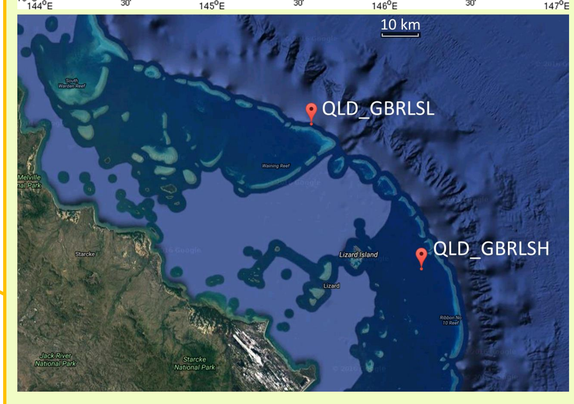
FES2014 model assessment





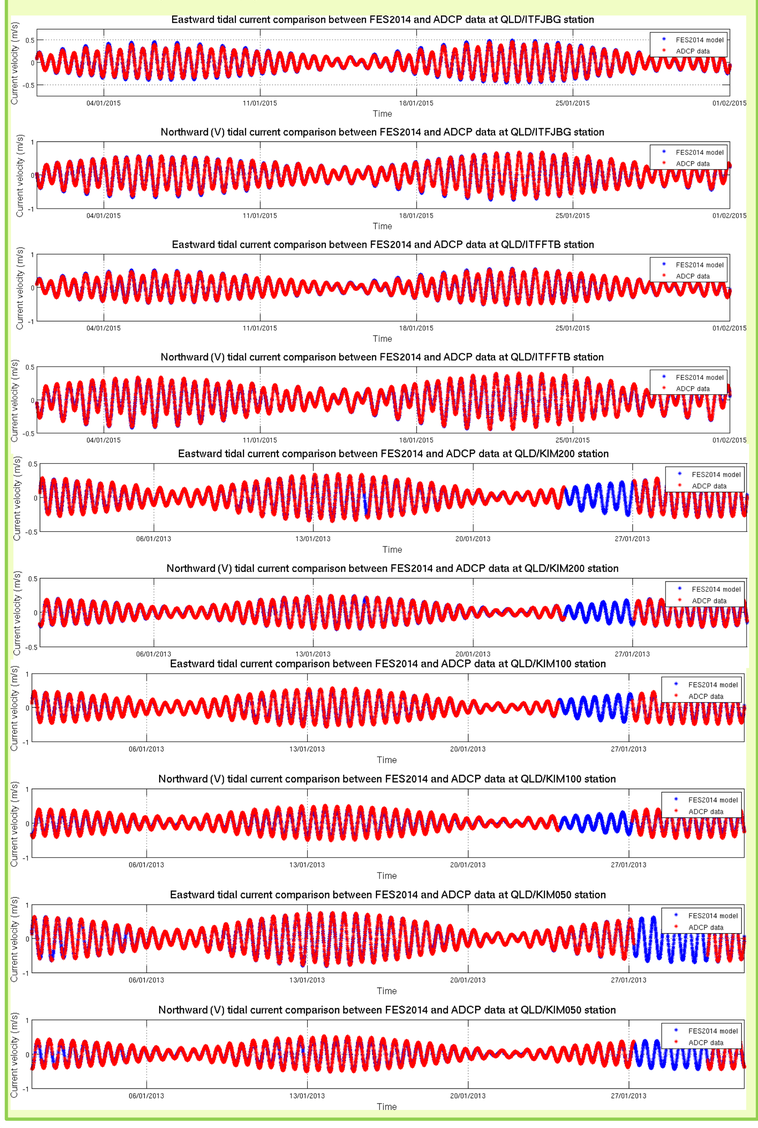
The ADCP station off Darwin is located in a shallow region, where the resolution of the FES2014 global mesh is too coarse to solve the tidal current velocities accurately.

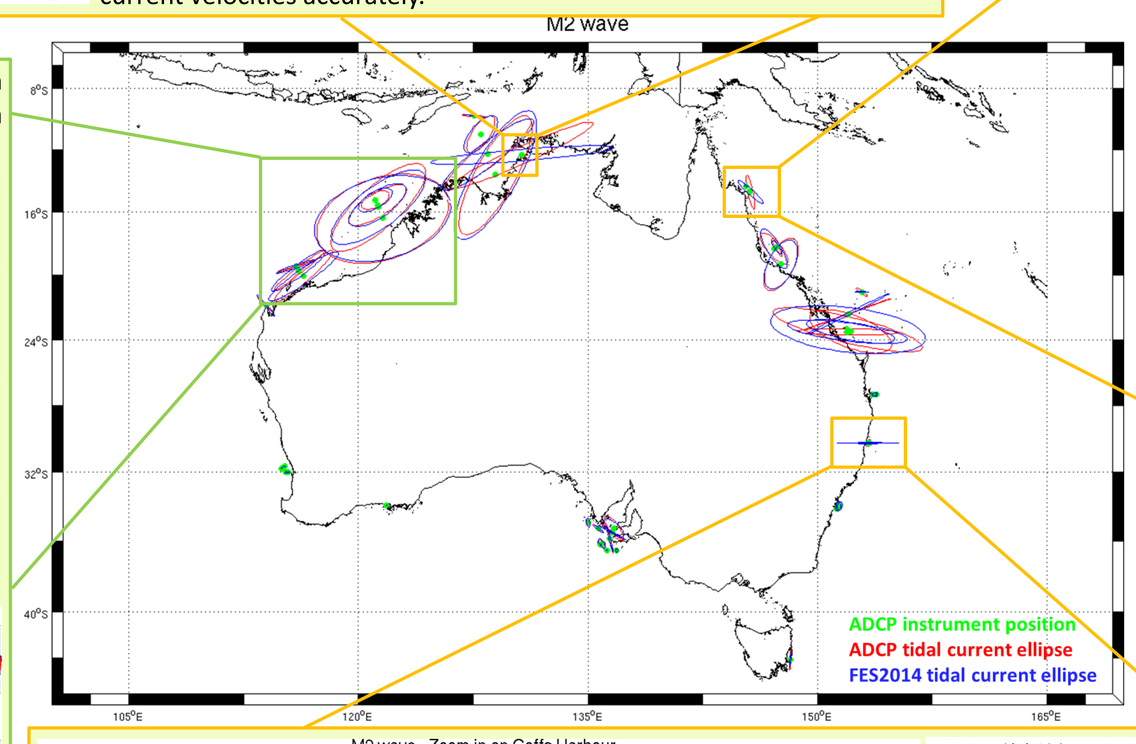


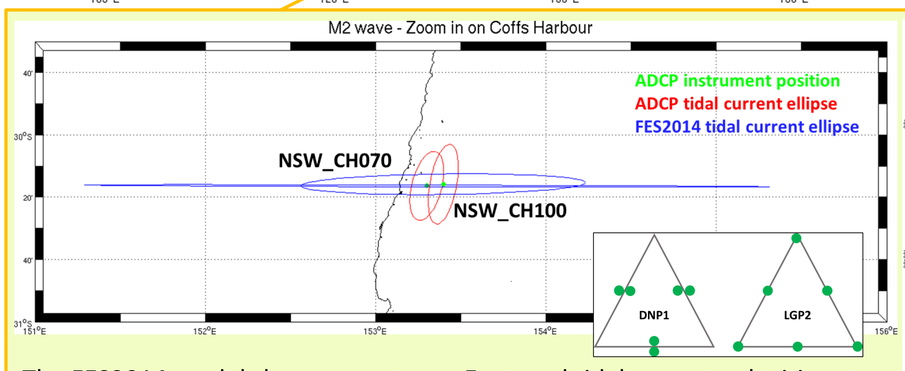


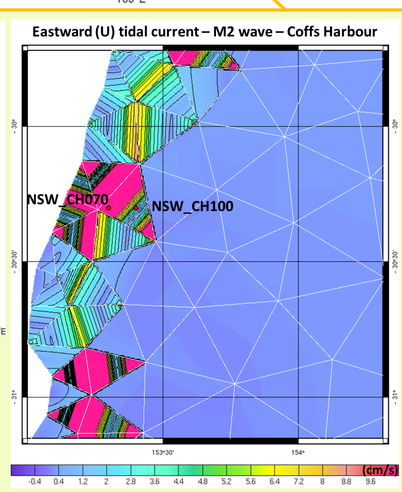
The GBRLSH station is located in a very shallow region inside the Great Barrier Reef, where the resolution of the FES2014 global model is too coarse to solve the tidal current velocities accurately.

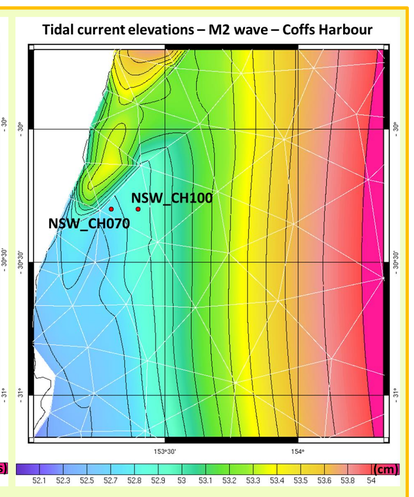
At most ADCP stations, the FES2014 model tidal currents are in very good agreement with the in situ tidal observations, in terms of amplitude, phase and direction.











The FES2014 model shows very strong Eastward tidal current velocities at the two ADCP stations located off Coffs Harbour, while the FES2014 tidal elevations are quite smooth. This is due to a local lack of resolution in the model mesh in a region of steep bathymetry slope, together combined with the use of a discontinuous discretization (DNP1) for the computation of the velocities. For the computation of the FES2014 tidal elevations, a continuous discretization was used (LGP2), which explains why these artefacts only appear on the tidal currents.

CONCLUSIONS

This assessment study shows the **very good agreement between the FES2014 tidal current atlas and the in situ currentmeter observations available around Australia**, at most of the currentmeter stations, in terms of amplitude, phase and direction. The validation was performed both in the frequency and in the temporal domains, for the five main tidal components (M2, S2, K1, O1, N2). Only the results on the M2 tidal component are presented here, but similar results were obtained with the other four.

Some large discrepancies were also identified **at a few stations**, in regions where the **mesh of the FES2014 model lacks resolution** or in very shallow regions, where a **high resolution bathymetry and a regional high resolution model would be necessary** to better solve the tidal current velocities.

These results are very encouraging and give much confidence in the FES2014 tidal current atlas. The same kind of validation could be performed in any region where good quality in situ current data are available.