Calibration of a global tide & surge model during tropical cyclone conditions in Northeast Australia

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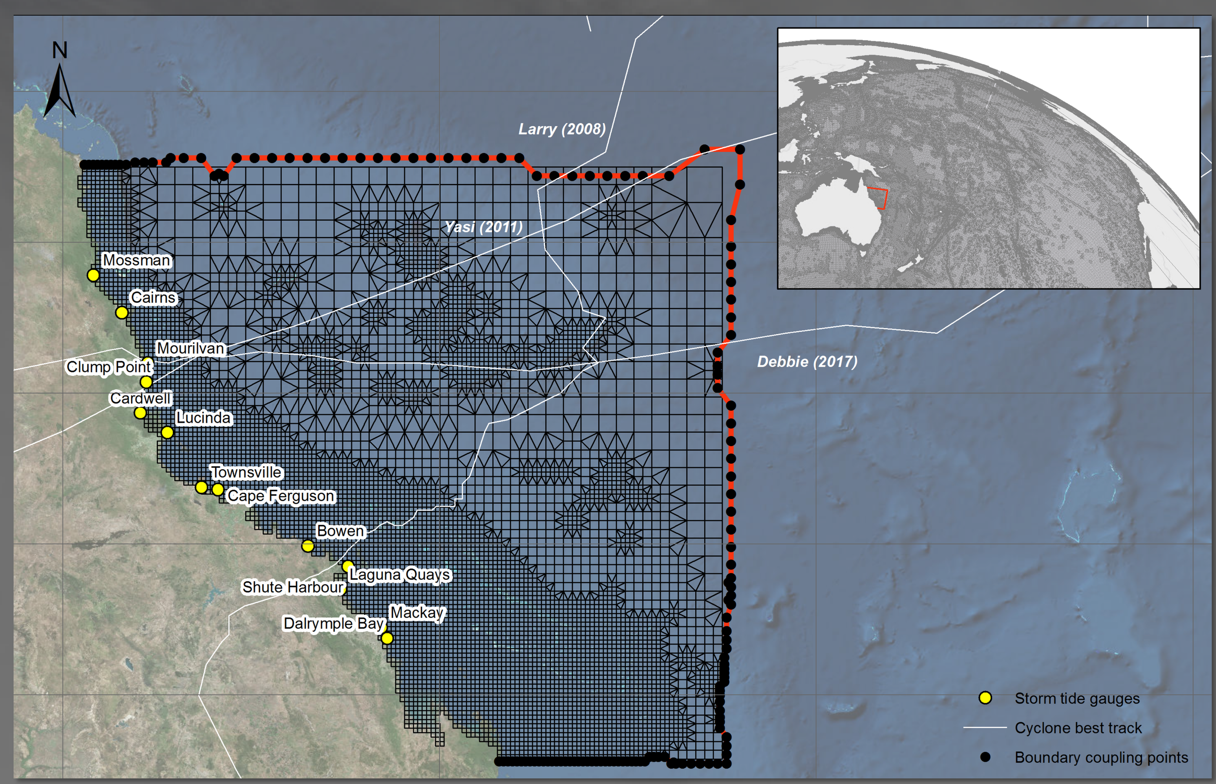
Data Rich vs. Data Poor

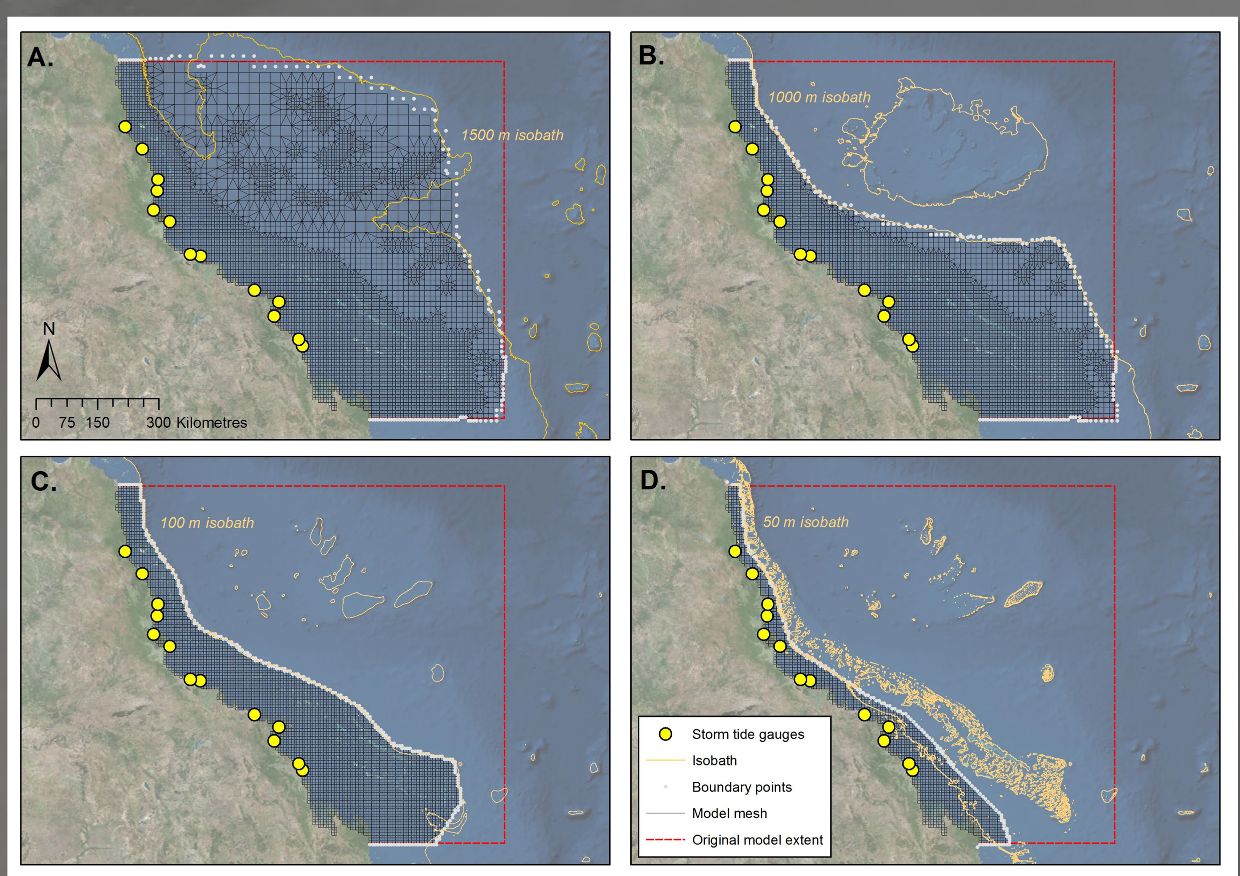
- Tropical cyclones (TC) impact global coastal areas with low observational data and high exposure
- Global storm surge models can be used for early warning and risk reduction in these areas
- Validation in data rich settings is vital to informing model applications for data poor areas
- This study uses a network of storm tide gauges along the Great Barrier Reef coast, Australia, to examine the performance of a global tide and storm surge model during extreme TC conditions

GTSM and GLOSSIS Global Models



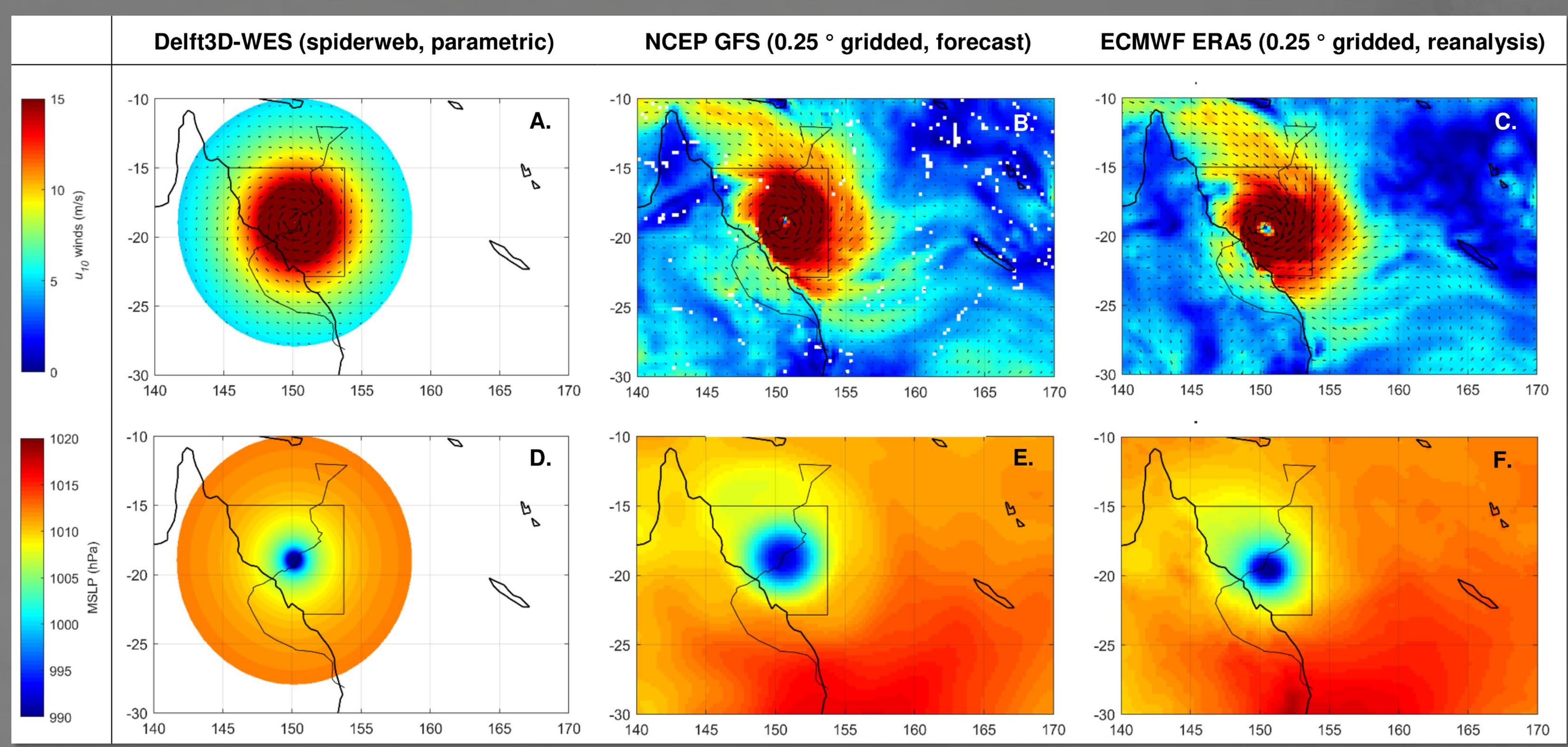
- GTSM is a Global Tide and Storm Surge Model (Muis et al., 2016)
- GLObal Storm Surge Information System (GLOSSIS) runs GTSM four times daily
- A regional cutout of the GTSM was used for sensitivity testing
- GTSM cutout was run for TC *Larry* (2006), *Yasi* (2011) and *Debbie* (2017) using a variety of different boundary water levels, grid resolutions, bathymetries, meteo forcing and flood/drying routines

Sensitivity to Boundary Water Levels



- Model domain was clipped to different isobaths to test coupling depth of boundary water levels
- Total water levels (tide + surge) were provided by GTSM; tide-only water levels were provided by FES2012 (Carrere et al., 2012)
- An Inverse Barometric Calculation (IBC) was added to FES2012 tides as a third test
- GTSM can provide total water levels to the standalone coastal model to between 50 - 100 m water depth without compromising results
- This compares to an optimal nesting of ~ 1,000 m depth when tide-only water levels are used
- Adding IBC to tides improved results for the slowest-moving cyclone due to pressure surge

Sensitivity to Meteo Forcing



- Model was run using 1) Deltares' parametric Wind Enhancement Scheme (Delft3D-WES, Deltares, 2018); 2) NCEP Global Forecast System (GFS) archive forecast, and; 3) ECMWF ERA5 reanalysis
- Delft3D-WES overpredicted coastal water levels (by 0.1 – 0.2 m); this was reduced when ERA5 and GFS were used (0.03 – 0.04 m). A tendency for WES to over-estimate wind speeds (Vatvani et al., 2012)

Conclusions

- Dynamic total water levels (tide + surge) from a GTSM represents a significant advantage over tide-only forcing, allowing coastal models to cover a thinner slide of the nearshore and focus on resolution
- Basic parametric TC wind models don't account for asymmetry and inflow, nor surrounding synoptic conditions. Delft3D WES over-estimated surge heights compared to dynamical forcing
- More studies in 'data-rich' areas are required to further inform application of global-scale storm surge models in the least-monitored and most-vulnerable areas of the world

References

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