FORECAST VERIFICATION OF AN ENSEMBLE TROPICAL CYCLONE STORM SURGE SYSTEM

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INTRODUCTION

Storm surge is the additional elevation in water level (e.g., above the normal astronomical tide levels) at the coast due to strong winds and low atmospheric pressure. Tropical Cyclone (TC) induced storm surges can be especially damaging and require emergency preparations. A unique challenge of providing TC storm surge advice to emergency services relates to the sensitivity of storm surge forecasts to uncertainty in the TC forecast. Probabilistic forecast products are a good fit for such advice, as long as forecast skill characteristics are known and understood. The Australian Bureau of Meteorology operates a dynamical ensemble prediction system to provide forecasts of storm surge driven by TCs. This is a step change from the legacy parametric and/or scenario-based techniques previously used at the Bureau.

There are a number of benefits to be gained from dynamic storm surge ensemble forecasts over more traditional systems. Most importantly, the surge forecast is very sensitive to errors in the TC location, velocity, intensity, and size. Ensemble storm surge forecasting is required in order to take account of this uncertainty in the TC forecast.

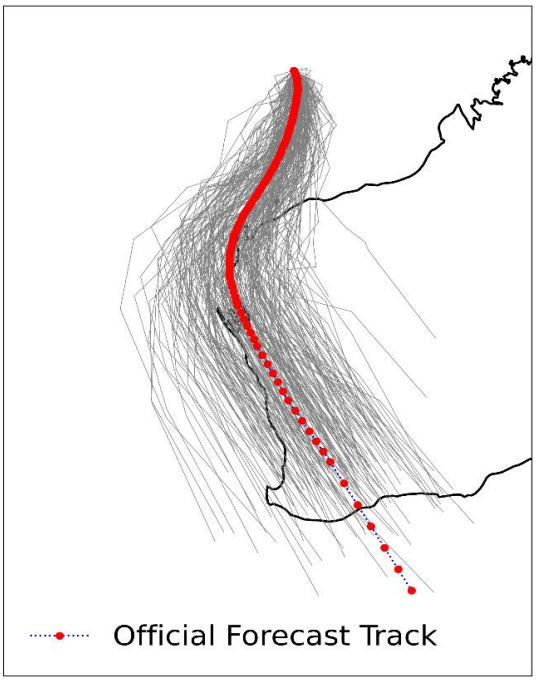

Figure 1 – An example of the Official Forecast Track (red) and 200-member ensemble (grey) for Tropical Cyclone Olwyn for the base time from 18:00 10 Mar 2015.

SYSTEM OVERVIEW

The Bureau currently produces an operational forecast of wind speed exceedance probabilities from the Official Forecast Track (OFT). The technique is based on a 1000-member ensemble of TC tracks using the 'DeMaria' method (DeMaria et al., 2009), which takes into account errors in historical TC tracks such as position errors and intensity errors.

From this 1000-member ensemble, 200 tracks (e.g., Figure 1) are randomly selected. For each track, a series of gridded forcing fields (surface winds, stress, and pressure) are produced. These are used to force a 200-member ensemble of barotropic hydrodynamic ocean models and wave models. The wave set-up contribution to water elevation is derived from the wave model via a parameterization based on bathymetric slope, significant wave height and mean wave period. Astronomical tides are linearly combined with the storm surge and wave setup to provide 72-hour ensemble forecasts of coastal sea-level at a spatial resolution of ~2 km around the Australian coastline.

FORECAST VERIFICATION

The storm surge component of the system has been previously evaluated for seven TC case studies using hindcast or 'Best Track' forcing and tide gauge observations (Greenslade et al., 2018). The focus of this presentation will be probabilistic skill. Historical sequences of TC forecasts are used to simulate storm surge forecasts and the results compared to coastal tide gauge observations. Characteristics such as ensemble skill, spread, and variability of the extremes will be quantified and presented.

REFERENCES

DeMaria, Knaff, Knabb, Lauer, Sampson, and DeMaria, (2009): A New Method for Estimating Tropical Cyclone Wind Speed Probabilities, Weather and Forecasting, 24, 1573-1591.

Greenslade, Taylor, Freeman, Sims, Schulz, Colberg, Divakaran, Velic, and Kepert, (2018): A First Generation Dynamical Tropical Cyclone Storm Surge Forecast System Part 1: Hydrodynamic model, Bureau Research Report No 31, Bureau of Meteorology, Australia.