An Ensemble Storm Surge Forecast System For Tropical Cyclones

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Two new storm surge forecast systems

**Tropical Cyclone storm surge system**
- Event-based, run on demand
- Ensemble prediction system
- Tropical region only

**National storm surge system**
- Run on routine basis
- Deterministic system
- Mid-latitude storms
- All Australian coastline
Tropical cyclone storm surge ensemble prediction system

ROMS (Regional Ocean Modelling System)
  • 2D barotropic mode
  • Ribbon domain
  • Open boundary conditions
  • Coastal spatial resolution ~2.5km

200 ensemble members
  • randomly chosen from 1000 tracks
  • subset of full grid determined by track ensemble

wave set-up estimate and tides linearly added to surge to provide storm tide at coastline.
Greenslade et al. (2018) examined the accuracy of the system’s hydrodynamics

- 7 event studies using ‘best track’ hindcast forcing
  - Best available forcing
  - Deterministic forecast
- Validated against observed residual sea-level from available tide gauges.
  - 21 separate observations of surge
  - MAE of peak surge of 26cm
  - Mean bias of -1cm
Forecasts based on ensemble prediction systems

- Tropical cyclones are unpredictable
  - OFT represents (at time of forecast) best consensus forecast
  - Forecasts can change frequently and rapidly.
  - Surge is sensitive to track location, system translation speed, intensity, etc.
- Account for uncertainty by produce ensemble of storm surge estimates
  - Storm surge forecasts should be related to existing TC forecasts
Tropical cyclone storm surge ensemble prediction system

- **Use Official Forecast Track (OFT)**
  - A track is a time series of TC vortices
- Derive ensemble of tracks (DeMaria et al., 2009)
  - Based on track errors over past 5 years
- Derive gridded forcing fields from parametric TC vortex
  - Modified Rankine vortex including asymmetry due to storm forward motion
- Run ensemble of storm surge models
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• Run ensemble of storm surge models
How does the ensemble prediction system behave?

- What is the spread of ensemble forecasts?
  - Compared to OFT
  - Compared to observations
- What is the general skill of the ensemble system?
- How stable are forecast parameters?
- Focus on TC Yasi event.
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Recurring 12-17 hr forecast
General Skill of System

- Spread-skill diagram – 6 observation locations for one event – Include surge values >0.5m only
- Skill is RMSE of ensemble mean relative to observations – Generally improves for shorter forecasts
- Spread is ensemble variance – Spread ideally should match skill – Difference decreases for shorter forecasts, but spread tends to be too low

Note that this metric is best applied to many events and observations.

Recurring 6-11 hr forecast
A key forecast parameter is maximum or peak surge. How does the peak surge vary from forecast to forecast?
Summary

- New ensemble prediction system for TC-based storm surge
  - 200-member ensemble prediction system
  - Run on demand, linked to TC forecasts
- Ensemble spread capable of capturing surge variability
  - Model skill generally improves with reduced lead time, but spread is possibly too low
- System trialed operationally in 18/19 TC season.
- Goal is to document and verify model, ready for operational use in 2019-20 TC season.
- Planned further enhancements for coming season.
Thank you

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