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The UK's next generation operational storm surge forecast model

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The UK's next generation operational storm surge forecast model

- Current operational system
- NEMO-Surge setup
- First winter trial results
- What next?





Current Operational system

- Barotropic (2D), 12 km CS3X model for north-west European shelf developed by NOC
- 24-member ensemble predictions generated using MOGREPS-G NWP model
- Plus deterministic
 - Includes nested models
- Runs 4x per day
- Residual calculated by removing tide-only run
- Harmonic tide added back to get total water level









Tide predictions + observations

- Observations of total water level from class A tide gauge network
- Tide predictions from harmonic analysis of long observation series
- Residual calculated by removing tide prediction from observed total (assumes tide prediction is perfect – it isn't!)







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NEMO-surge project

- CS3X is becoming more difficult to maintain. Can we set up a NEMO based model to replace it?
- Easier to add future developments
 - More in-house expertise
 - Community model, active development
- Harmonise the models run at the Met Office FOAM ocean models all use NEMO
- Aim at this stage is to match CS3X





NEMO-surge

- Based on FOAM AMM7 model higher resolution than CS3X (~7km vs ~12km)
- Barotropic (2D), no temperature/salinity
- New bathymetry (EMODnet)
- Inputs:
 - Tides at open boundaries, applied as harmonic constituents
 - 10m Wind and surface air pressure from NWP (global models)
- Ensemble + deterministic, but no nested models any more







NEMO-surge

- Sensitivity testing conducted to optimise various parameters (bottom friction, # tidal constituents, wind parameterisation)
- Hindcast run tested in 2 stages: tide only, and with atmospheric forcing

Oover

• See Met Office Weather Science tech reports #610 & #619



Residual		
CS3X	NEMO- Surge	Diff
0.098	0.096	-0.002
-0.036	-0.036	0.000
0.568	0.582	0.014
0.431	0.419	-0.012
0.994	0.976	-0.018
0.902	0.904	0.003
	Resid CS3X 0.098 -0.036 0.568 0.431 0.994 0.902	Residual CS3X NEMO-Surge 0.098 0.096 -0.036 -0.036 0.568 0.582 0.431 0.419 0.994 0.976 0.902 0.904

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-15 -20 -25 -30 -35 -35



NEMO-surge

 Added to operational forecast system Nov 2016 – running alongside CS3X





Case studies

- 2016-2017 not particularly busy surge season, but some notable events
- East Coast
 - December 26th/27th (storm Conor)
 - January 13th largest event
- West Coast
 - December 23rd (storm Barbara)
 - February 23rd & 26th (storms Doris & Ewan)

See: "NEMO-Surge: Forecast performance during 2016-2017 winter trial" Met Office Weather Science technical report 622



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Jan 13th East Coast surge

- Coincided with spring tides
- Forecasts indicated high residuals coinciding with high tides







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Zoom into the map to see the areas covered by flood warnings and alerts.



Severe Flood Warnings SEVERE FLOODING DANGER TO LIFE

13



Flood Warnings FLOODING IS EXPECTED IMMEDIATE ACTION REQUIRED



Flood Alerts FLOODING IS POSSIBLE BE PREPARED







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Jan 13th East Coast surge



• Whitby forecast





Jan 13th East Coast surge

Flooding at Whitby







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Jan 13th East Coast surge

Cromer

Lowestof
Harwich
Sheerness







Feb 26th West Coast surge

- Coincided with spring tides
- Not as severe as 13th January





Ens mediar

Astro Tide

FEC threshold level

FC threshold level

EEC threshold level

FFC threshold level 4

Ens percentiles 10-9

Ens percentiles 0-100





Overall comparison

 Statistics calculated over December 2016 – May 2017 for each port location, then averaged over locations







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What's next?

- Trial continuing
- Getting customers ready for the change
 - Data delivered as netcdf
 - Replacing the product post-processing system
- Model development
 - 1.5km AMM15 version (deterministic), including wetting and drying





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Longer term...

- Try and address some of the tide/observation issues?
 - Needs customer involvement
- Lots of potential for future science changes:
 - Varying bottom roughness
 - Wave coupling
 - Density effects
 - Data assimilation
 - Rivers
 - ...





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Summary

- First configuration of NEMO-Surge successfully running operationally
- Analysis of winter case studies shows performance comparable to CS3X
 - Minor differences only in event details, general forecast picture the same
 - Statistical performance indistinguishable
- Much more scope for future developments with the new model



Questions?



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