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A NEW UK SCALE OCEAN-WAVE-RIVER MODELLING SYSTEM FOR PREDICTING EXTREME SEA LEVELS AT THE COAST

MICHELA DE DOMINICIS[1], JULIA RULENT[1], RYAN PATMORE[1], TOBY MARTHEWS[2], LUCY BRICHENO[1], SEGOLENE BERTHOU[3] , AND LAURENT AMOUDRY[1]

[1]NATIONAL OCEANOGRAPHY CENTRE, LIVERPOOL, UNITED KINGDOM (MICDOM@NOC.AC.UK)
[2]CENTRE FOR ECOLOGY AND HYDROLOGY, WALLINGFORD, UNITED KINGDOM
[3]MET OFFICE, EXETER, UNITED KINGDOM

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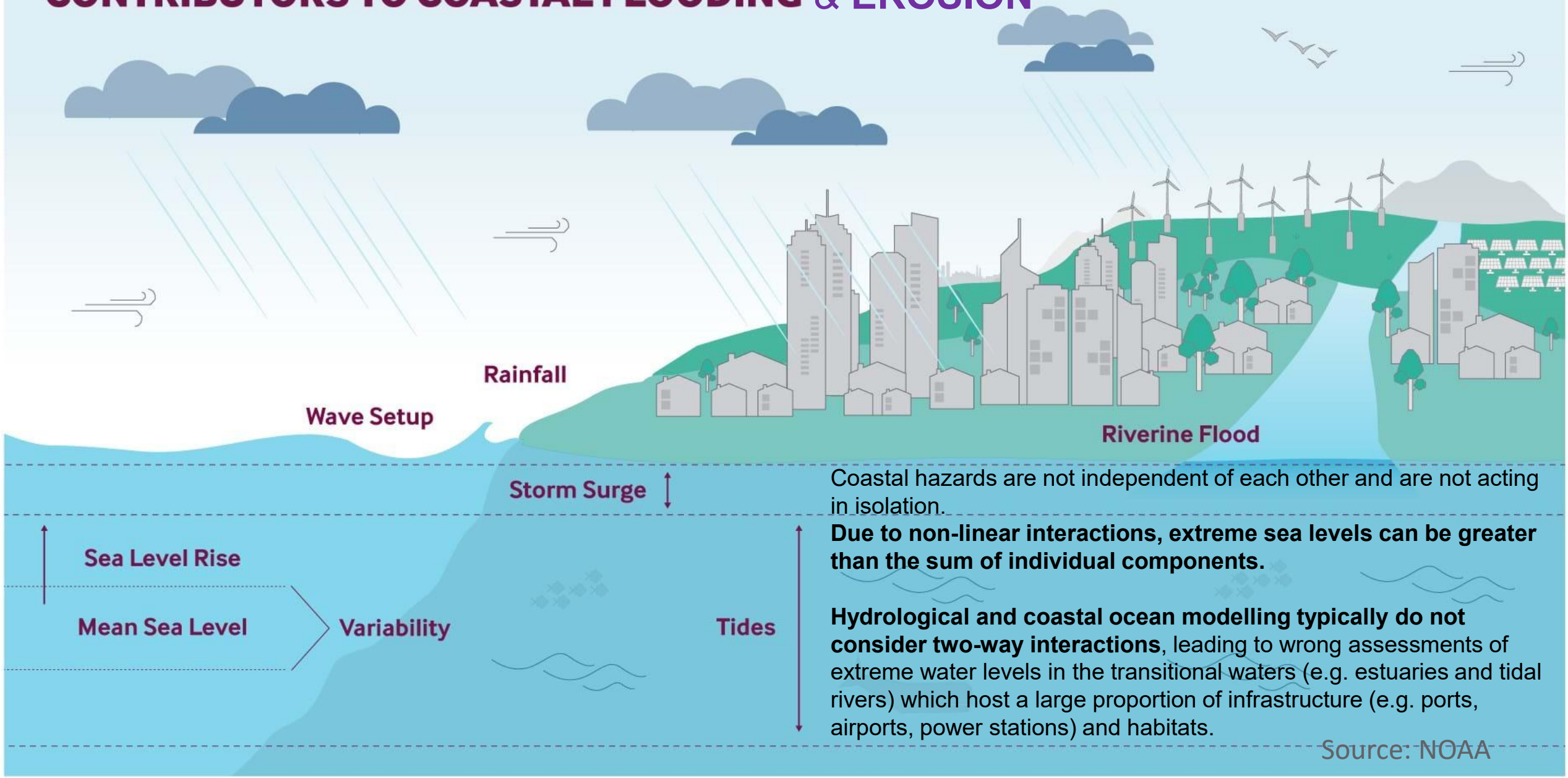
CONTRIBUTORS TO COASTAL FLOODING & EROSION



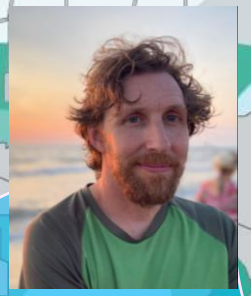
Coastal hazards are not independent of each other and are not acting in isolation.

Due to non-linear interactions, extreme sea levels can be greater than the sum of individual components.

Hydrological and coastal ocean modelling typically do not consider two-way interactions, leading to wrong assessments of extreme water levels in the transitional waters (e.g. estuaries and tidal rivers) which host a large proportion of infrastructure (e.g. ports, airports, power stations) and habitats.

Source: NOAA

CONTRIBUTORS TO COASTAL FLOODING & EROSION



Wave Setup

Riverine Flood

WAVEWATCH 3
(wave model)

NEMO
(ocean model)

JULES
(hydrological model)

Sea Level Rise

Mean Sea Level

Variability

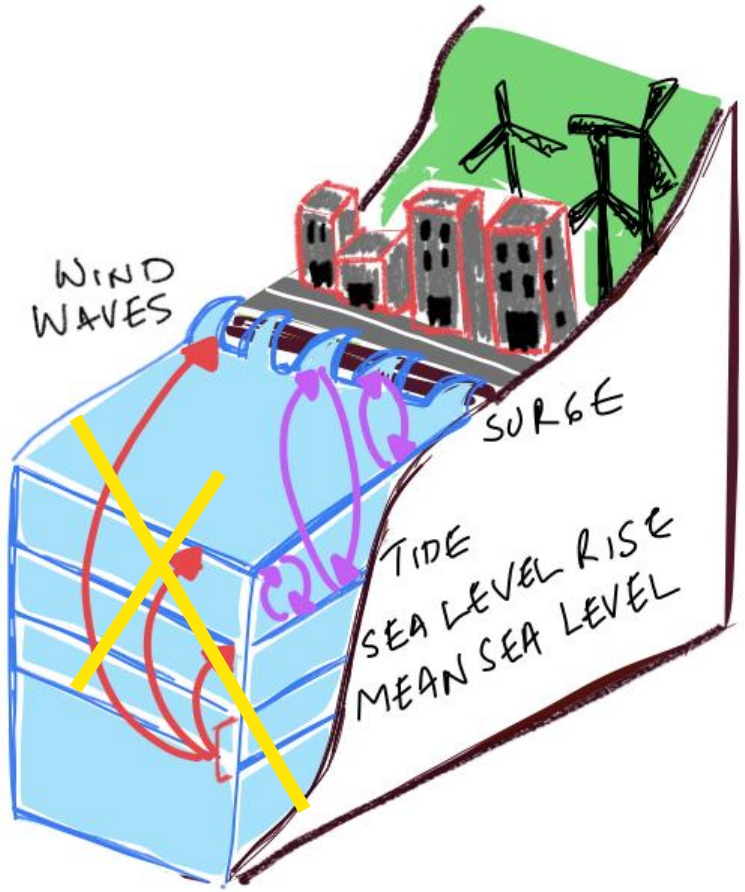
Tides

Source: NOAA

NEMO-UK500

NEMO-UK500 (500 m resolution) will include:

- intertidal areas (wetting & drying in NEMO).
- non-linear interactions between mean sea level, storm surge, tides
- sea level rise impact on tidal range/phase, storm surges

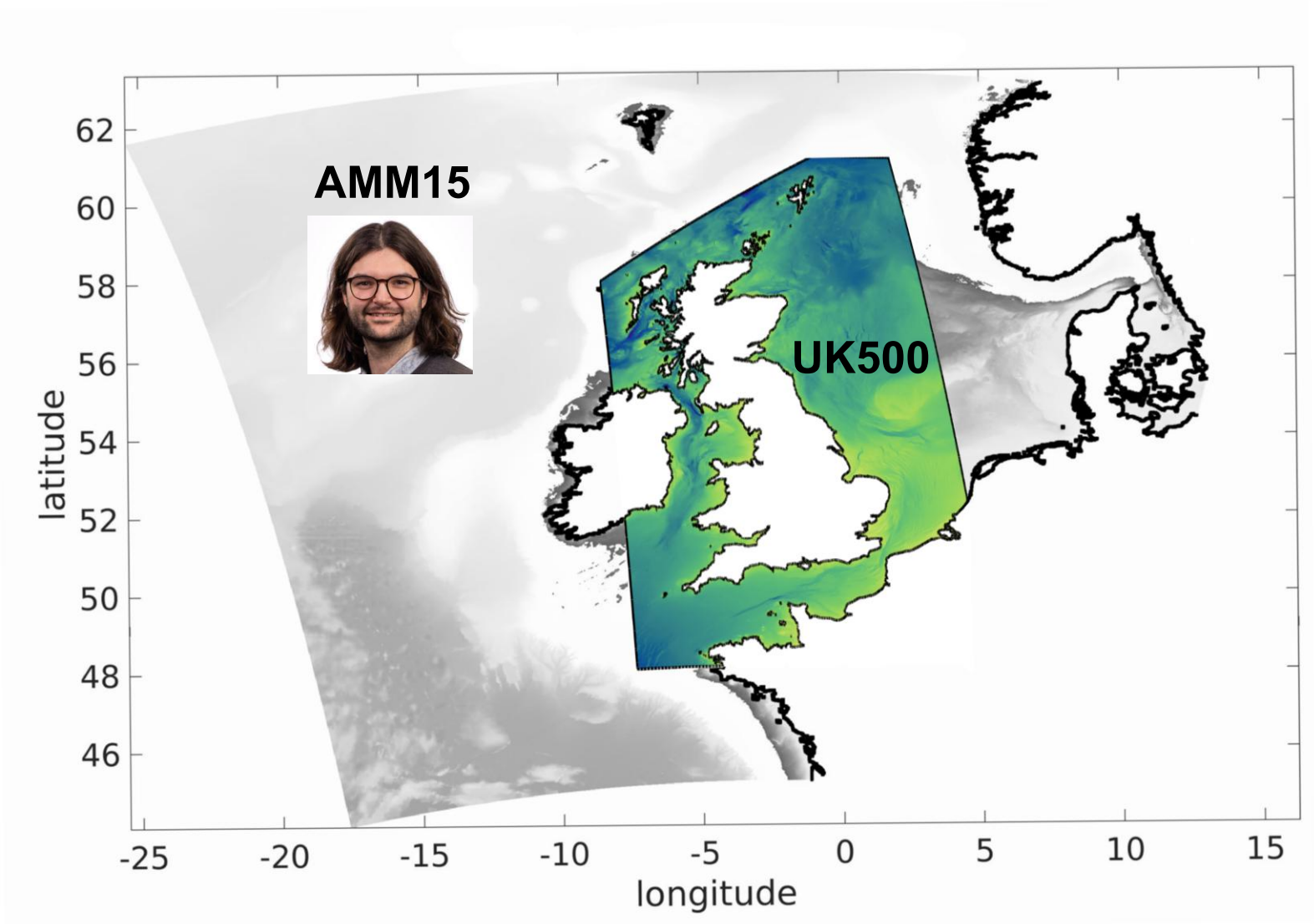


- River input is coming from JULES
- NEMO water levels will force JULES runs

Waves contribution is considered through consistent Wave-Watch III model runs at 1.5 km resolution (uncoupled).

NEMO UK500 vs AMM15

Atlantic Margin Model 1.5km (AMM15) runs for the UK500 open boundaries & initial conditions.
Model run: 1993-2022
AMM15 CO9 p2.0 [v9.2.0]



NEMO UK500 CONFIGURATION

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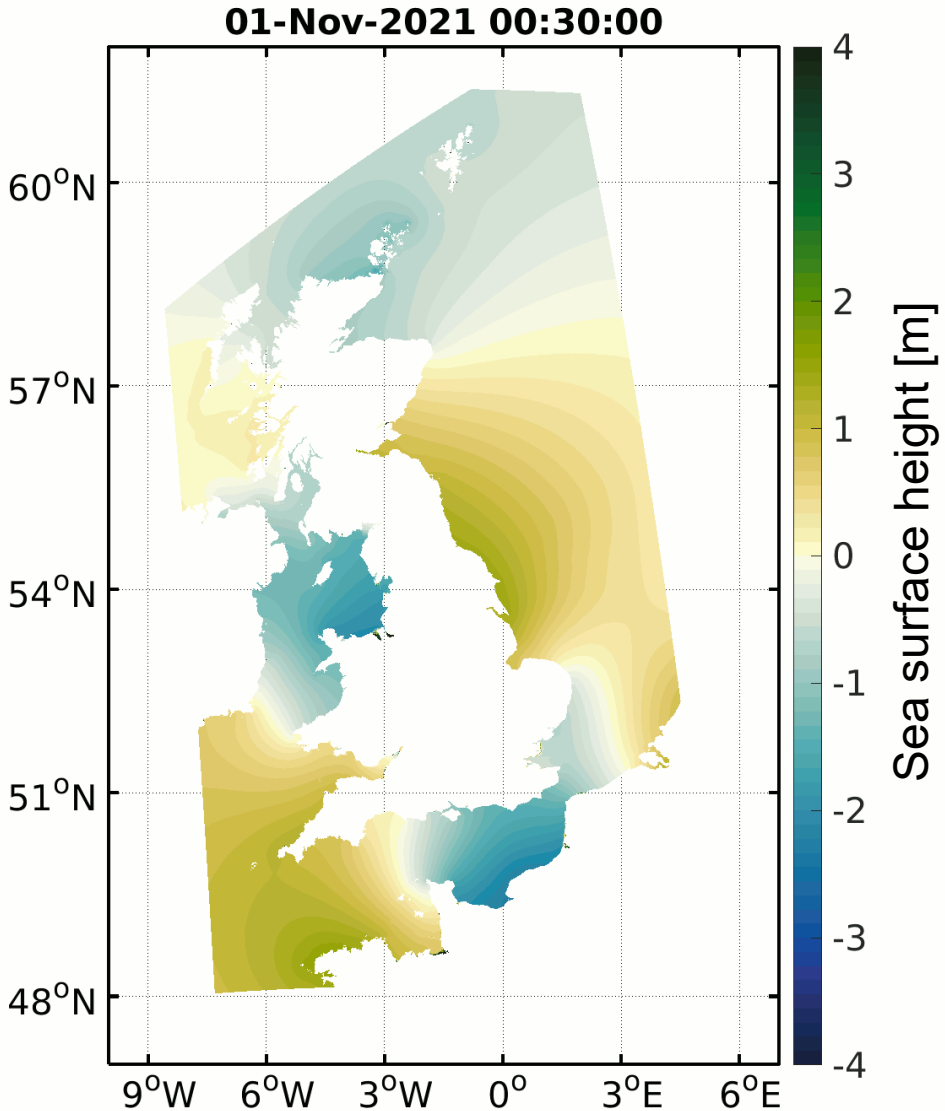
DOMAIN
- Cut-out of AMM15 domain
- It has 2.5M sea points and 30 vertical sigma levels
- Irregular boundaries: the deeper areas (> 250 m) have been cut, plus some part of the eastern part of the domain for reducing computational time

BATHYMETRY
- EMODNET 2020, original resolution 115 m, referenced to mean sea level

OCEAN BOUNDARIES:
- Tidal forcing FES14 (34 constituents)
- Daily mean temperature, salinity, currents, sea surface height from AMM15

INITIAL CONDITIONS
- from AMM15

RIVER FORCING
- from JULES



UK TIDE GAUGES NETWORK VALIDATION

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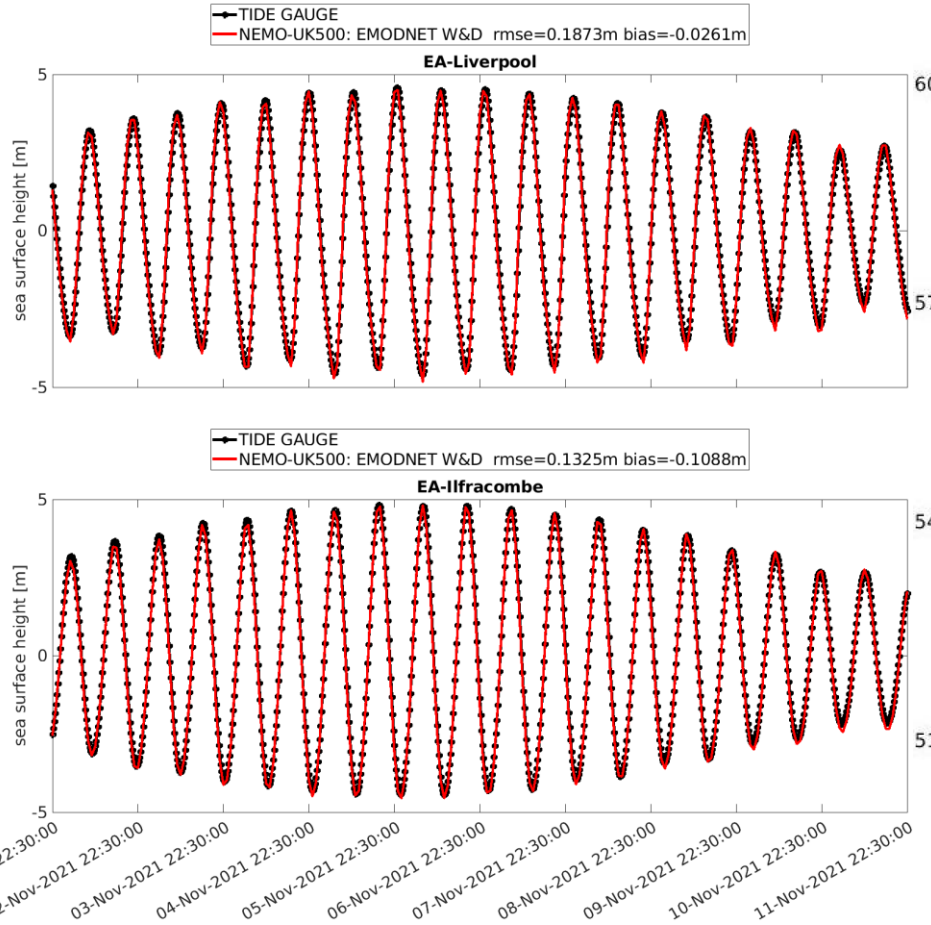
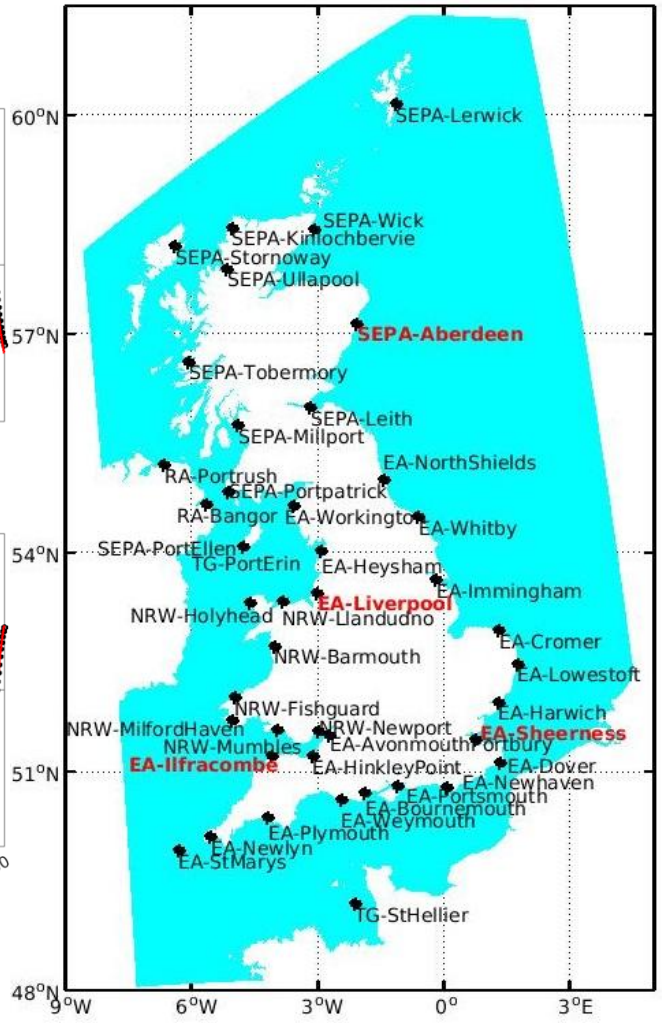
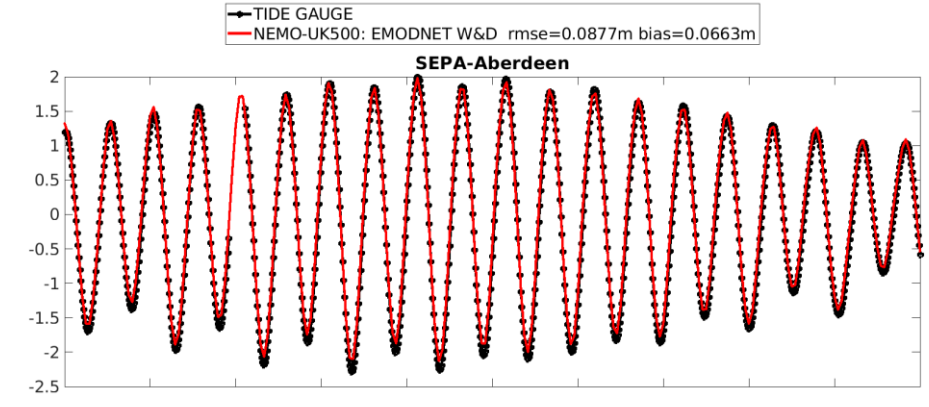
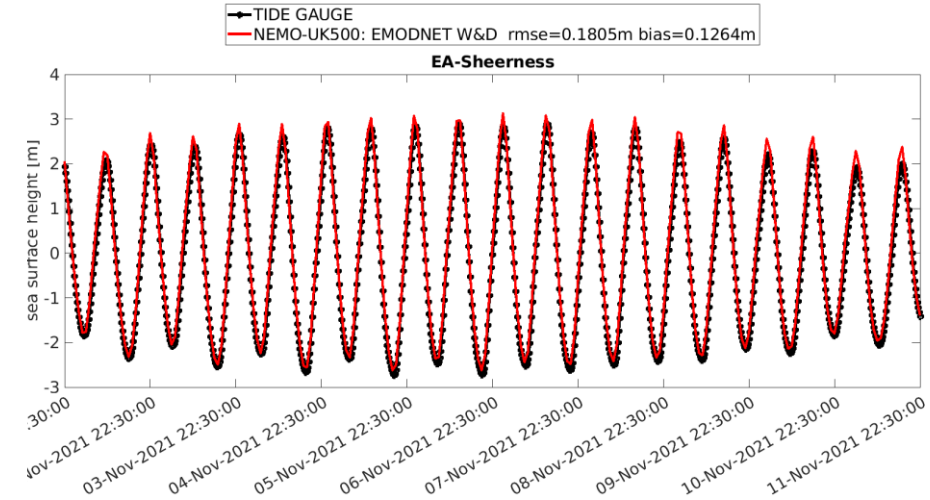


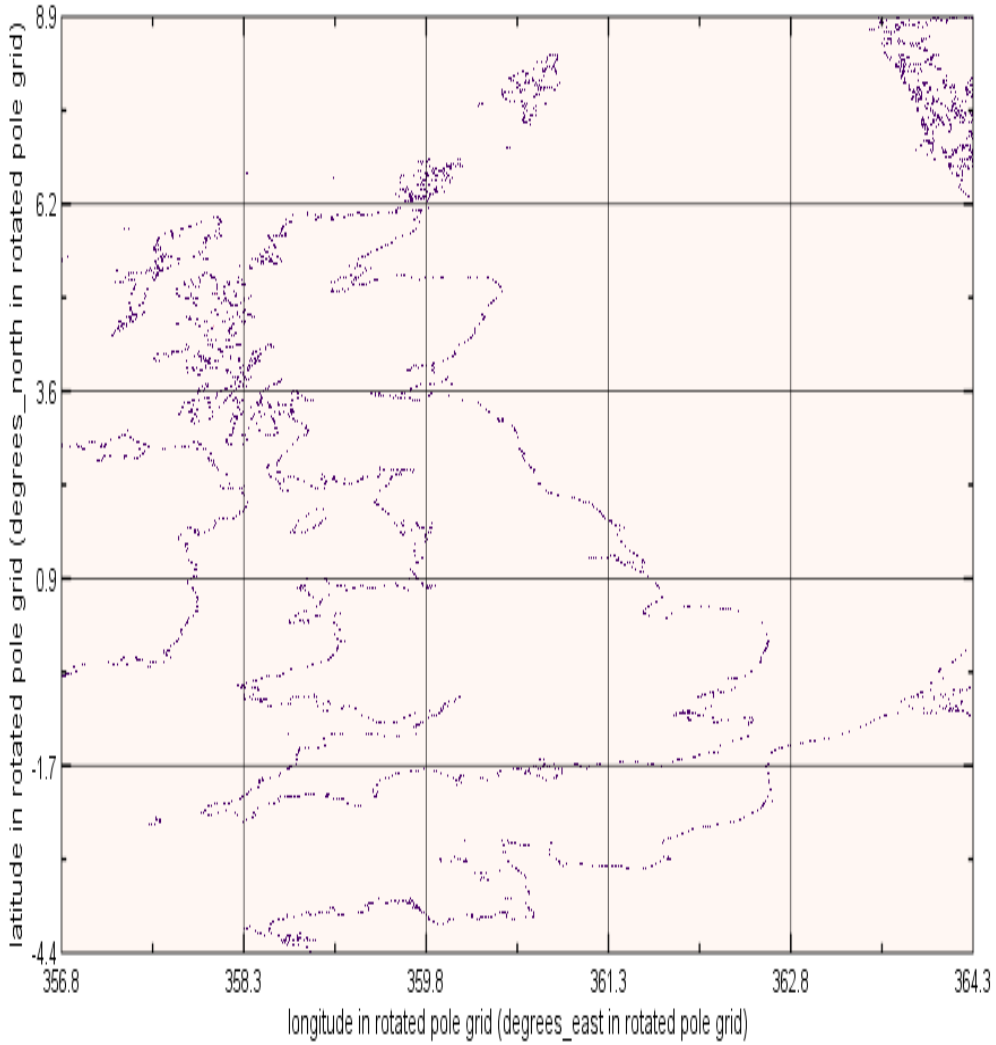






NEMO-JULES & THE BACK WATER EFFECT

- NEMO will provide water levels to JULES (hydrological model) to include the back water effect
- Coastal backwater effects are caused by the downstream river water level increase as a result of elevated sea level (due to storm surges, tides, sea-level-rise).
- Across the UK500 domain, we have 8651 coastal exchange points



CHAMFER HISTORICAL RUNS

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NEMO-UK500 & WAVEWATCH3 AMM15 & NEMO-AMM15 will provide predictions of water levels and waves conditions for present (fully validated by contemporary observations) and future scenarios

ATMOSPHERIC FORCING for HISTORICAL RUNS:

- ERA5 forced run (25 km from 1993-2022)
- UK Met Office meteorological model forced run (2.2 km, 2000-2020)

A good outcome of this comparison will be the assessment of the limitations/benefits of the different forcing. Also, the comparison between NEMO AMM15 and UK500.

CHAMFER FUTURE RUNS

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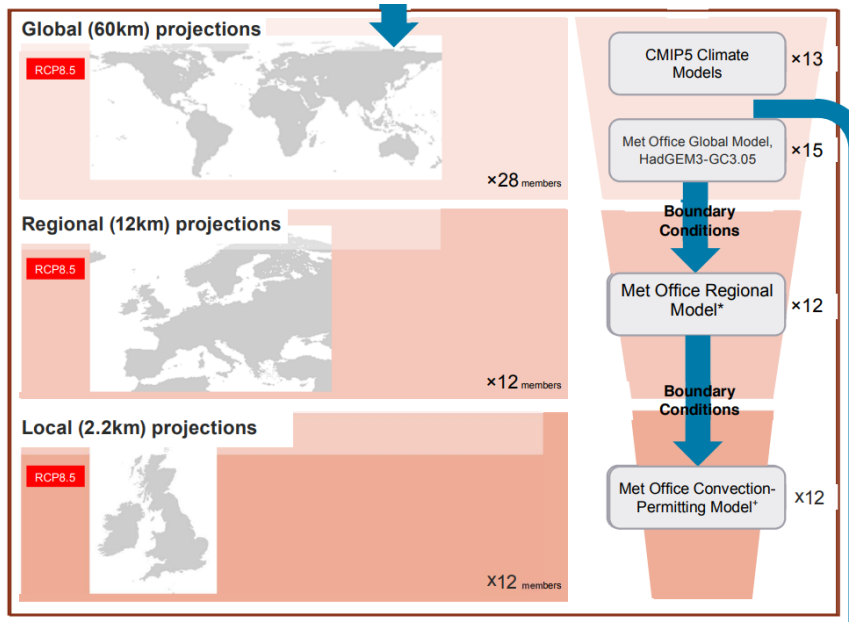
NEMO-UK500 & NEMO-WAVEWATCH3 AMM15 will provide predictions of water levels and waves conditions for present (fully validated by contemporary observations) and future scenarios

ATMOSPHERIC FORCING & SEA LEVEL RISE for FUTURE CLIMATE RUNS will be provided by the UKCP18 local projections (2.2 km) (RCP8.5 scenario):

Current plans are to have runs forced by:

- UKCP18 3 x 10 yrs: 1) **1990-2000 / 2040-2050 / 2070-2080** using 1 of the 12 ensemble members at 2.2 km RCP8.5 scenario
- Runs with different sea level rise projections at boundaries



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