Regional Coupled System Development at the UK Met Office

Met Office

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The Regional Coupled System (RCS) at the UK Met Office is a flexible regional modelling framework capability.

It enables a breadth of traceable experimental design – from fully coupled to component-only.

Further details about the technical set-up of the system can be found in the following literature:

The Regional Coupled Suite (RCS-IND1) (Castillo et al., 2022)

The UKC3 regional coupled environmental prediction system (Lewis et al., 2019).

The UKC2 regional coupled environmental prediction system (Lewis et al., 2018).

Regional Coupled System
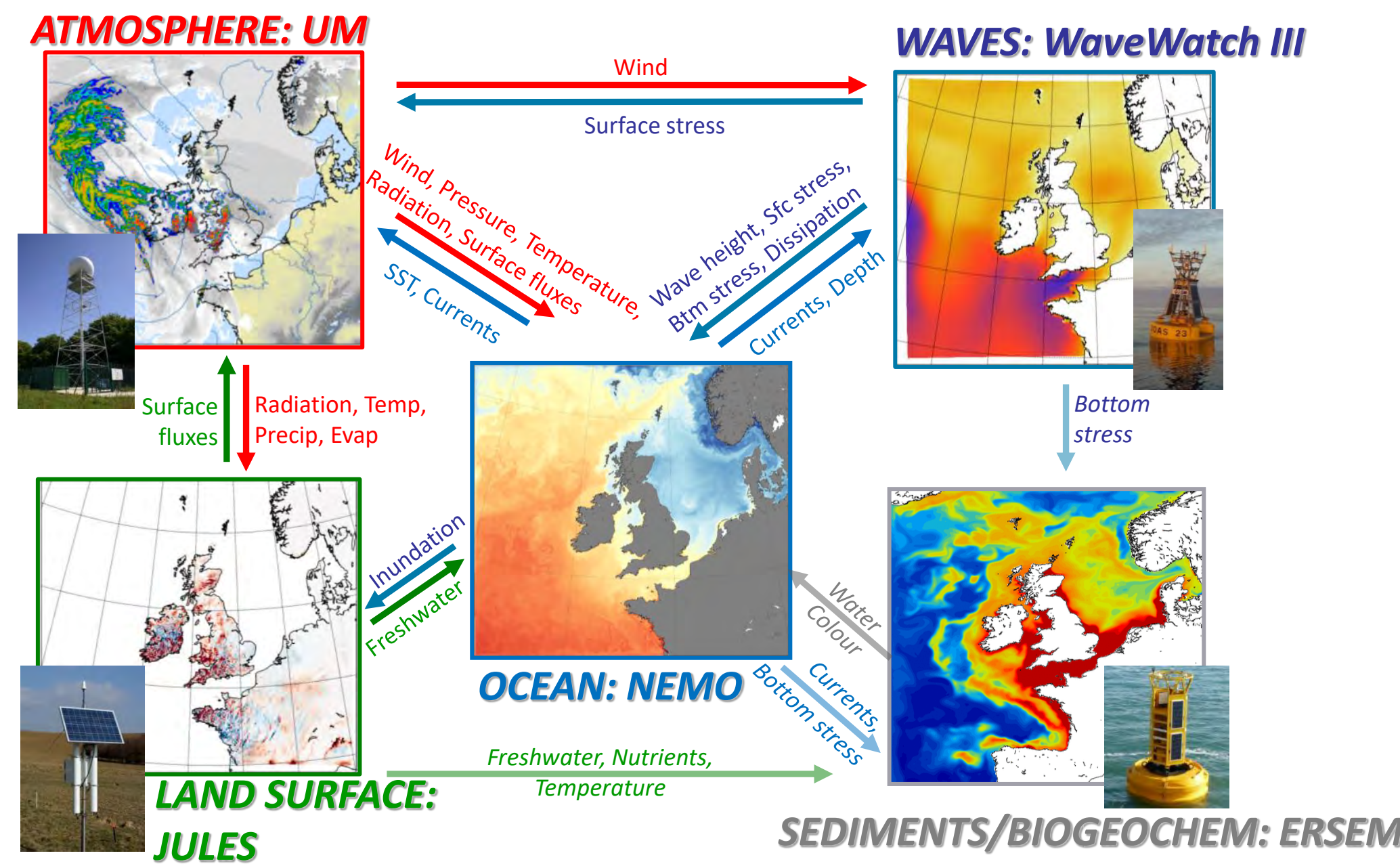
- Range of user options:
  - Model domains and grids *[UK, India, Maritime Continent, …]*
  - Deterministic and (UK) ensemble;
  - Near-real-time hazard forecasting and climate testing
  - Different science configurations
  - SST surface condition (fixed/time-varying/coupled)

- Traceable experiments:
  - Single-component runs: A, O, W
  - Partially-coupled runs: AO, AW, OW
  - Fully coupled run: AOW

- Environmental components
  - UM atmosphere
  - JULES land surface (with river routing - research)
  - NEMO ocean (with tidal forcing)
  - WAVEWATCHIII waves
  - [ERSEM marine biogeochemistry] – research
  - [UKCA atmospheric composition] – research

Air-sea interactions

### Cold air outbreaks: importance of SST finer resolution
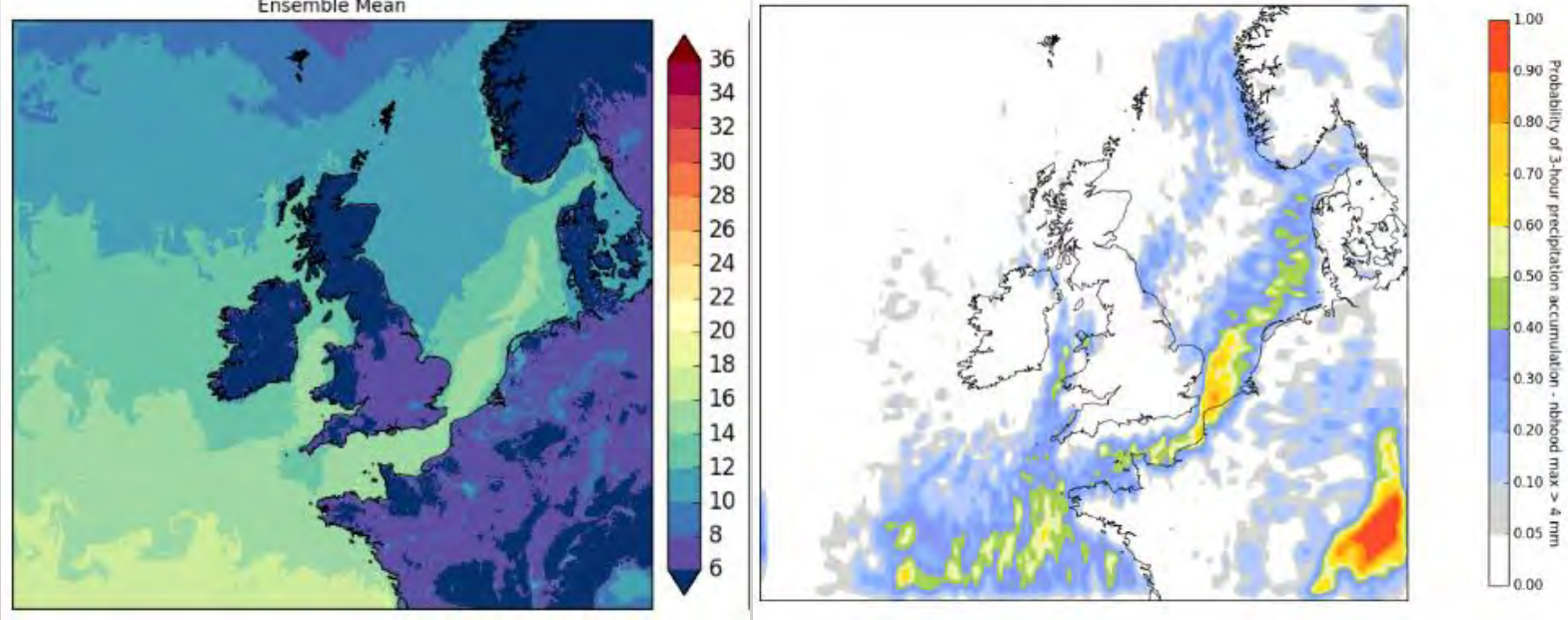
Surface Temperature (T+66) 03/11/2021 18Z

Neighbourhood precipitation max probability of >4mm/3h

**Inclusion of SST spatial details can affect meteorological fields like precipitation**

Heatwaves + light winds: importance of SST evolution

OBS
OLD (Fixed OSTIA SST)
NEW (Hourly updating AMM15)
Future (O-a-atm coupled)

Tair
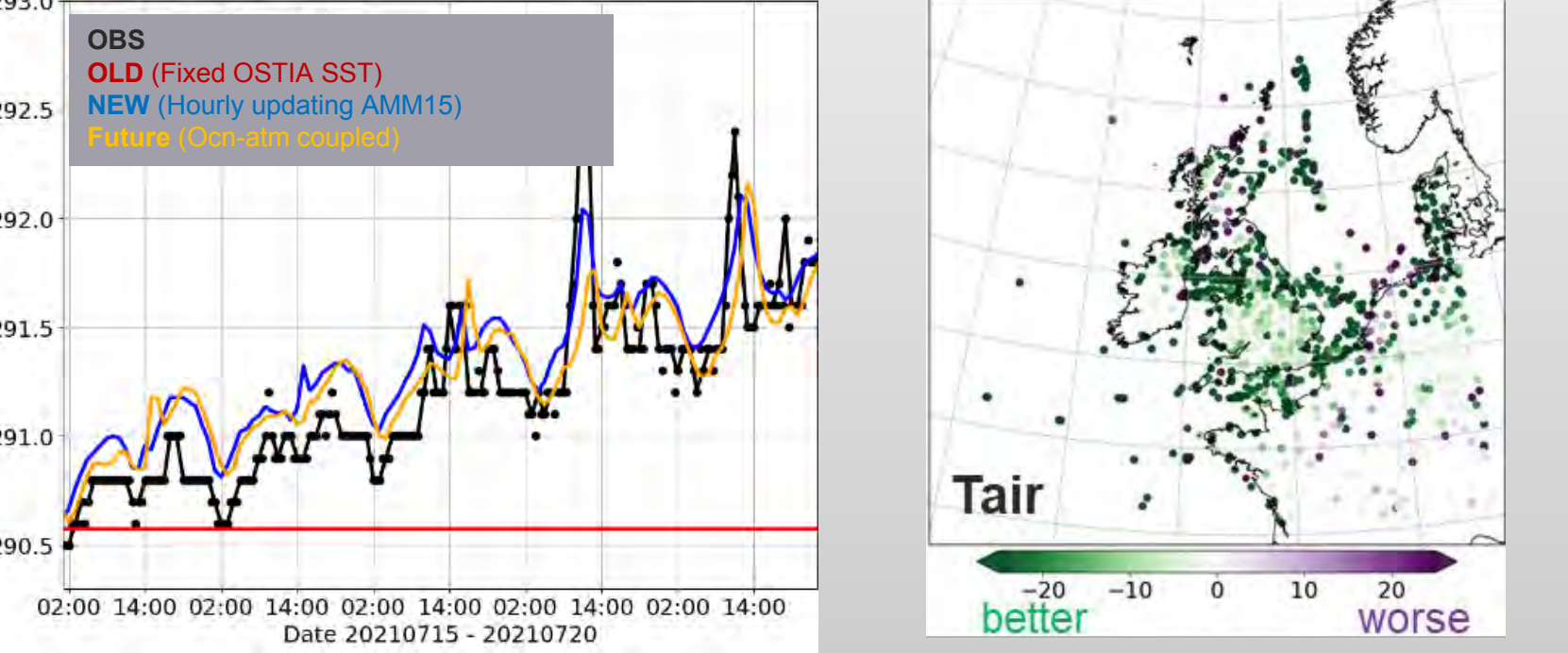
SST evolution over forecast can impact the air temperature on 5 day timescales, time varying SST are now included in operational forecast.

Mahmood et al. (2021)

Medicane forecast: importance of SST perturbations

(a) CTL 00Z 14 T+084   (b) +2K 00Z 14 T+084

+2K SST: cyclone forecast initialised one day earlier
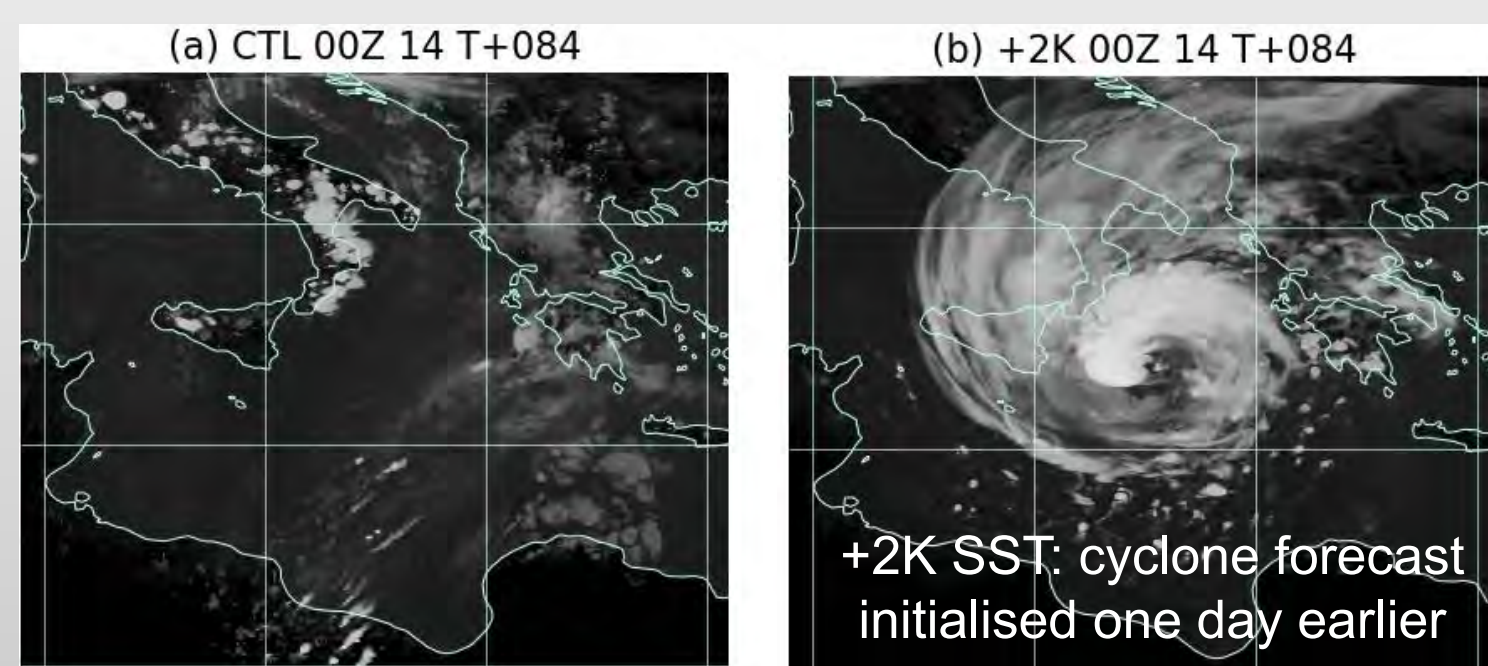
Experiments adding ± 2K SST perturbations can improve or degrade the predictability of the medicane Ianos.

Claudio Sanchez – paper in prep.

Tropical cyclones: importance of ocean coupling
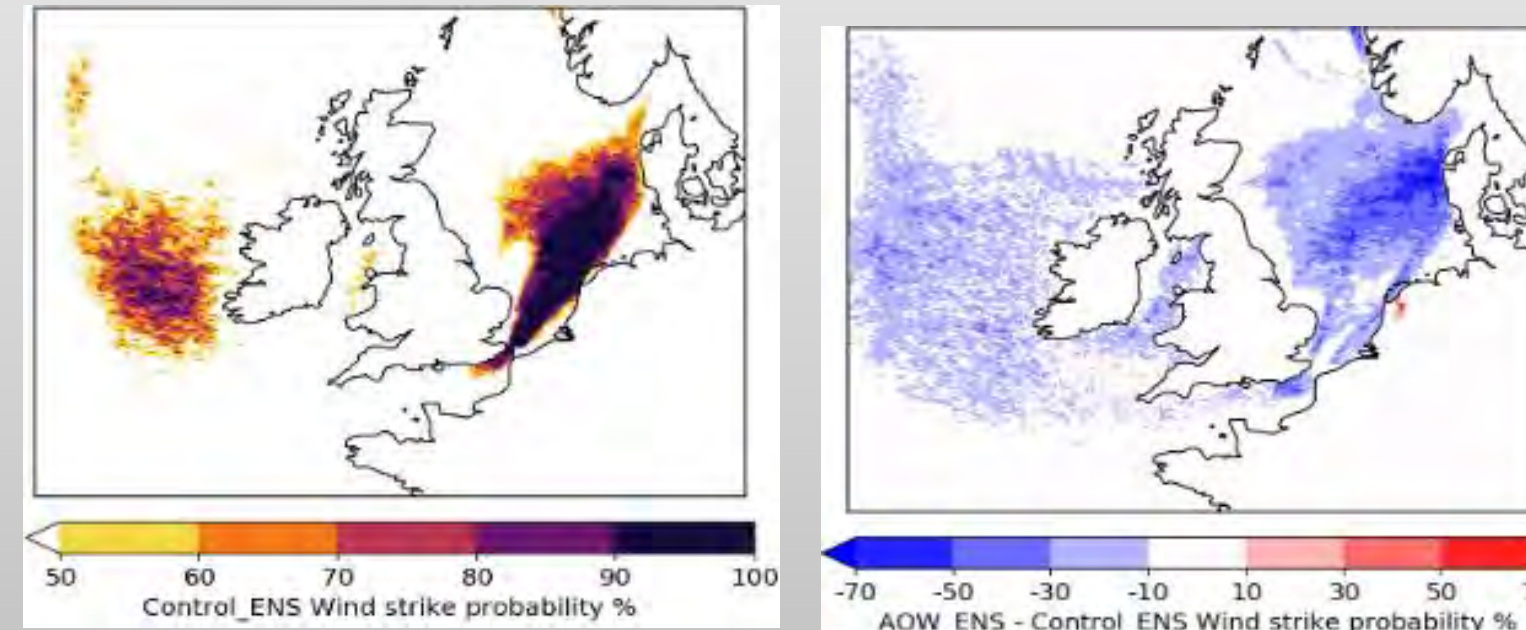

Intensity (TC Fani)

5-day cooling
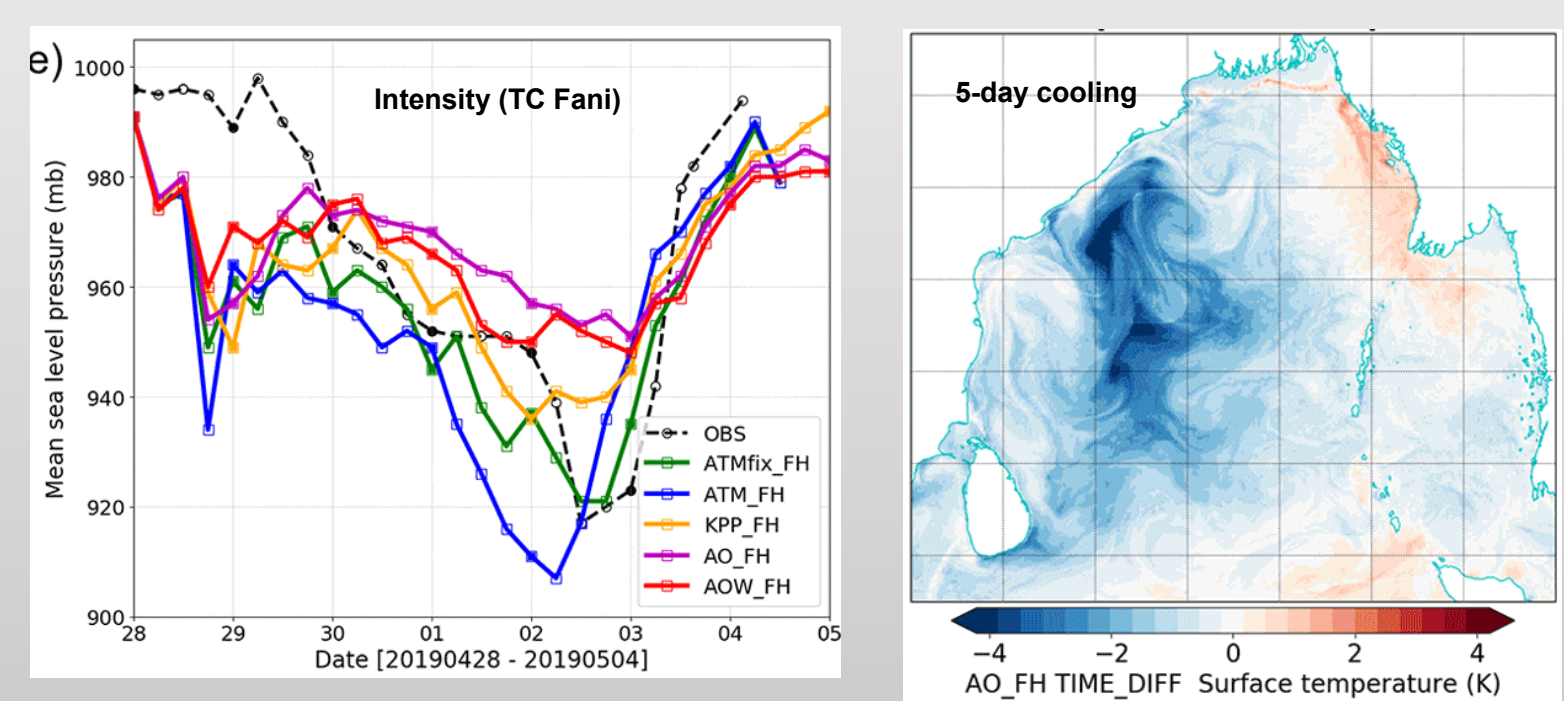
Reduction in tropical cyclone intensity from atmosphere-ocean coupling, coupled system enabling a more rigorous treatment of the near-surface energy budget

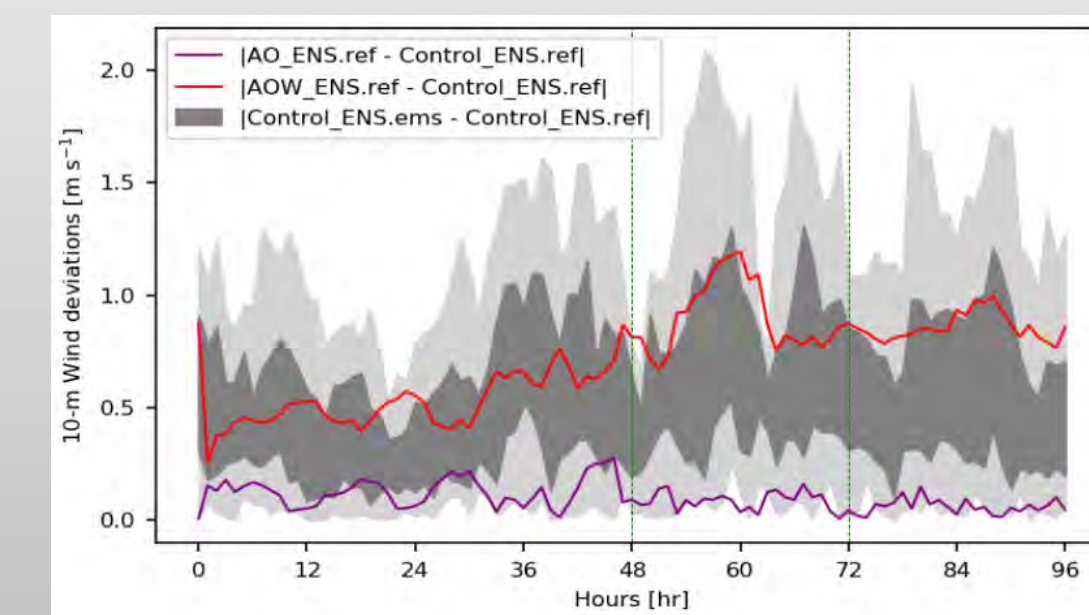*Castillo et al. (2022)*

Air-wave-ocean interactions

Young, growing wind waves reduce the wind speed by increasing the sea-surface aerodynamic roughness
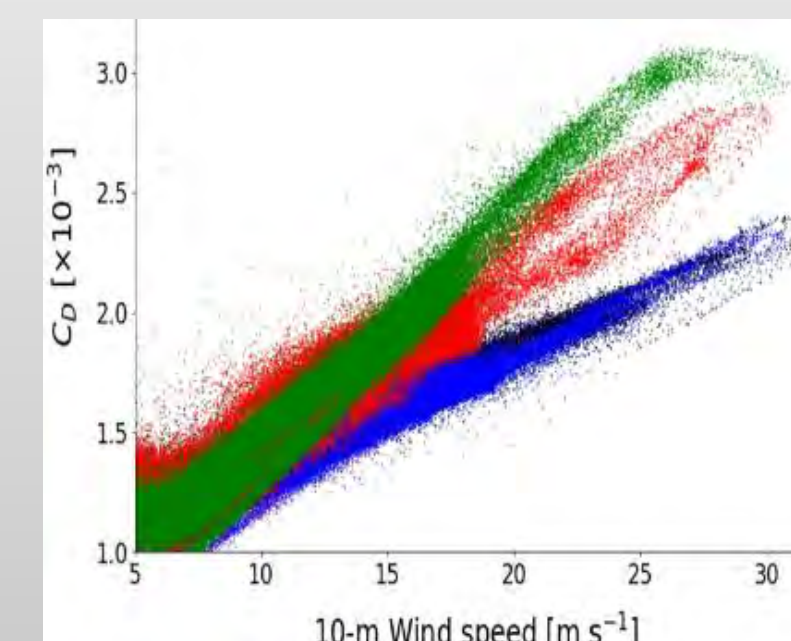

Gentile et al. (2021)

Impact of wave coupling is as large as inter-member spread in ensemble forecasting

Gentile et al. (2022)

New RAL3 drag scheme (COARE4.0+Donalan cap) more similar to wave parameterization of drag coefficient.
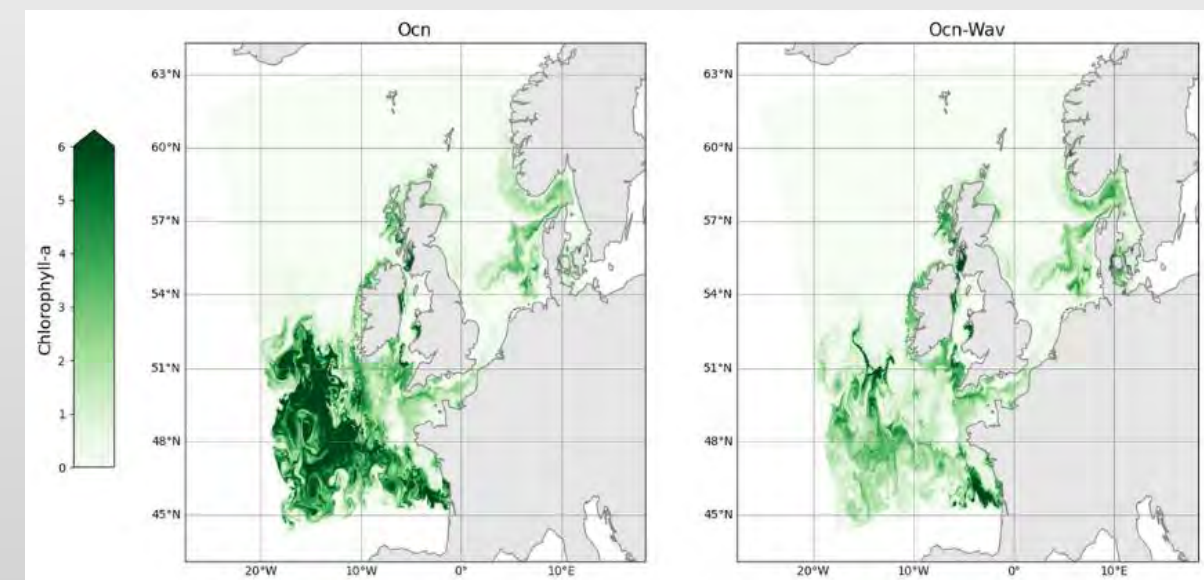
RAL3 atm config (new)
Wave config
RAL2 atm config (old)

Improvements to atmospheric winds due to better wave parameterization

John Edwards, Nieves Valiente

Biogeochemistry - ERSEM

Wave/ocean coupling reduces wave error for extremes

Wave/ocean coupling increases ocean vertical mixing, which delays the spring phytoplankton bloom when coupling to biogeochemistry (ERSEM)
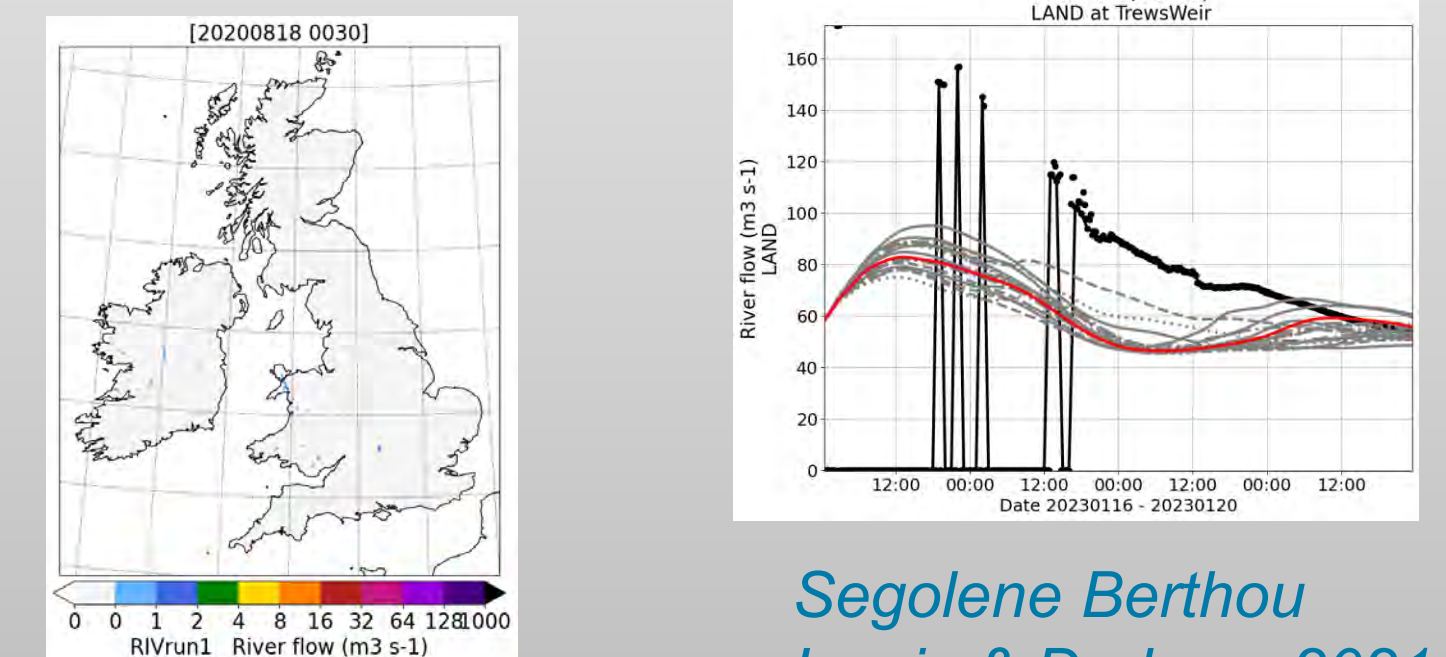
Dale Partridge, PML
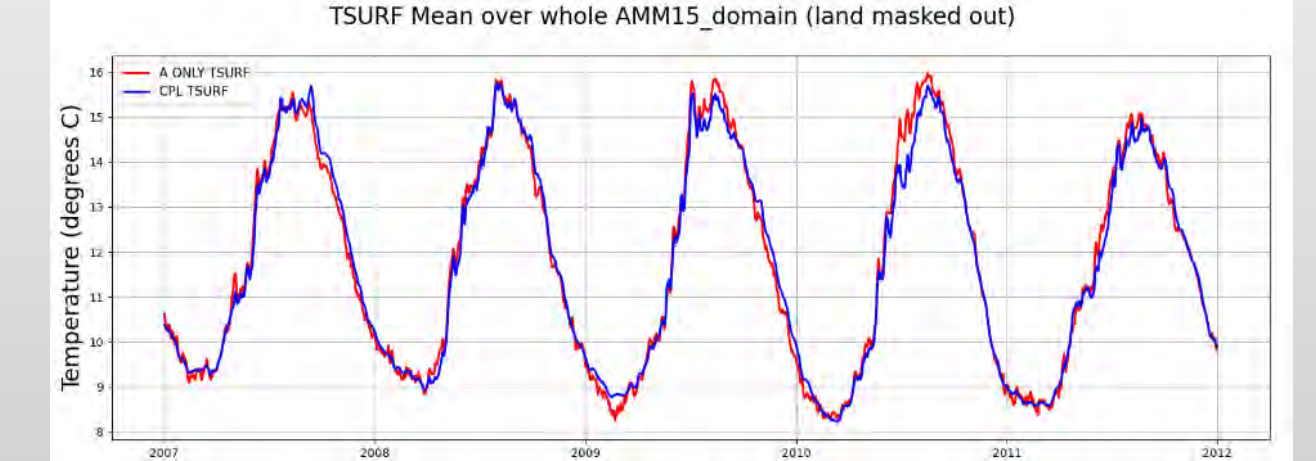
Hydrology, ensembles and climate

Hydrology
Online river routing now possible in ensemble forecast mode

Currently testing new hydro-JULES capability (groundwater model, improved ancillaries)

Segolene Berthou
Lewis & Dadson, 2021

Climate runs

5 year hindcast a-o coupled climate simulations at km scale have been run over the NW European Shelf.
Present and future 10-year time-slice runs planned, using AOW with rivers.
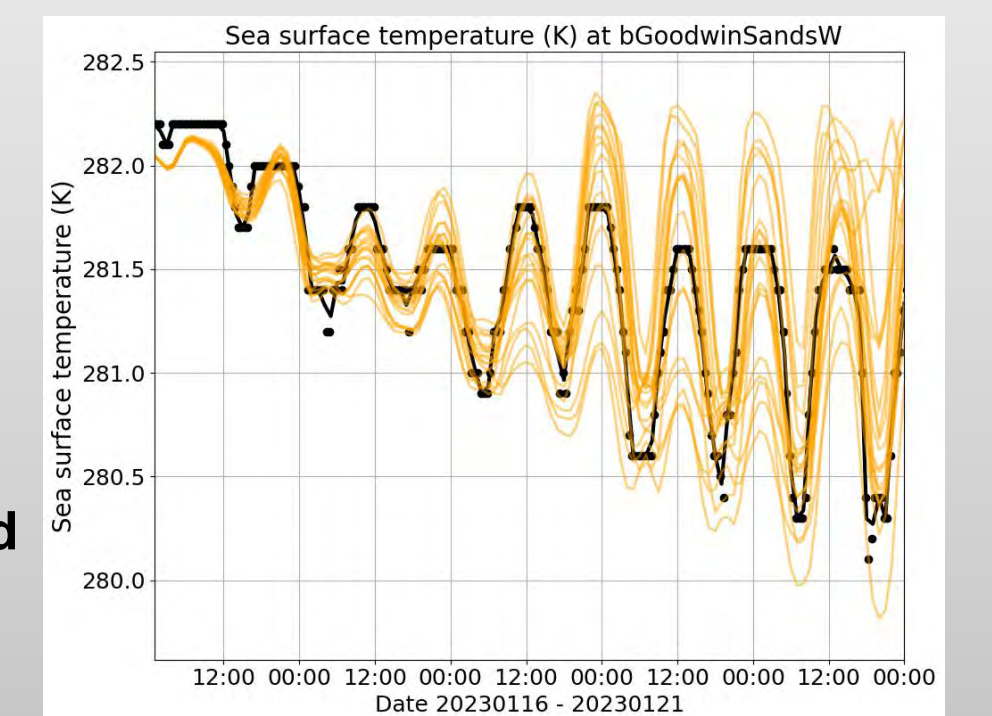
Alex Arnold

UK fully coupled ensemble

Fully coupled UK ensemble case study runs have been run to look at:

- coupling feedbacks on the atmosphere?

- how much ocean spread is generated by atmospheric spread?

Sana Mahmood

Multi-hazard prediction

Multi-hazard coastal compound event analysis at weather and climate timescales to be developed