

# Developments and plans for coupled climate modelling at km-scale

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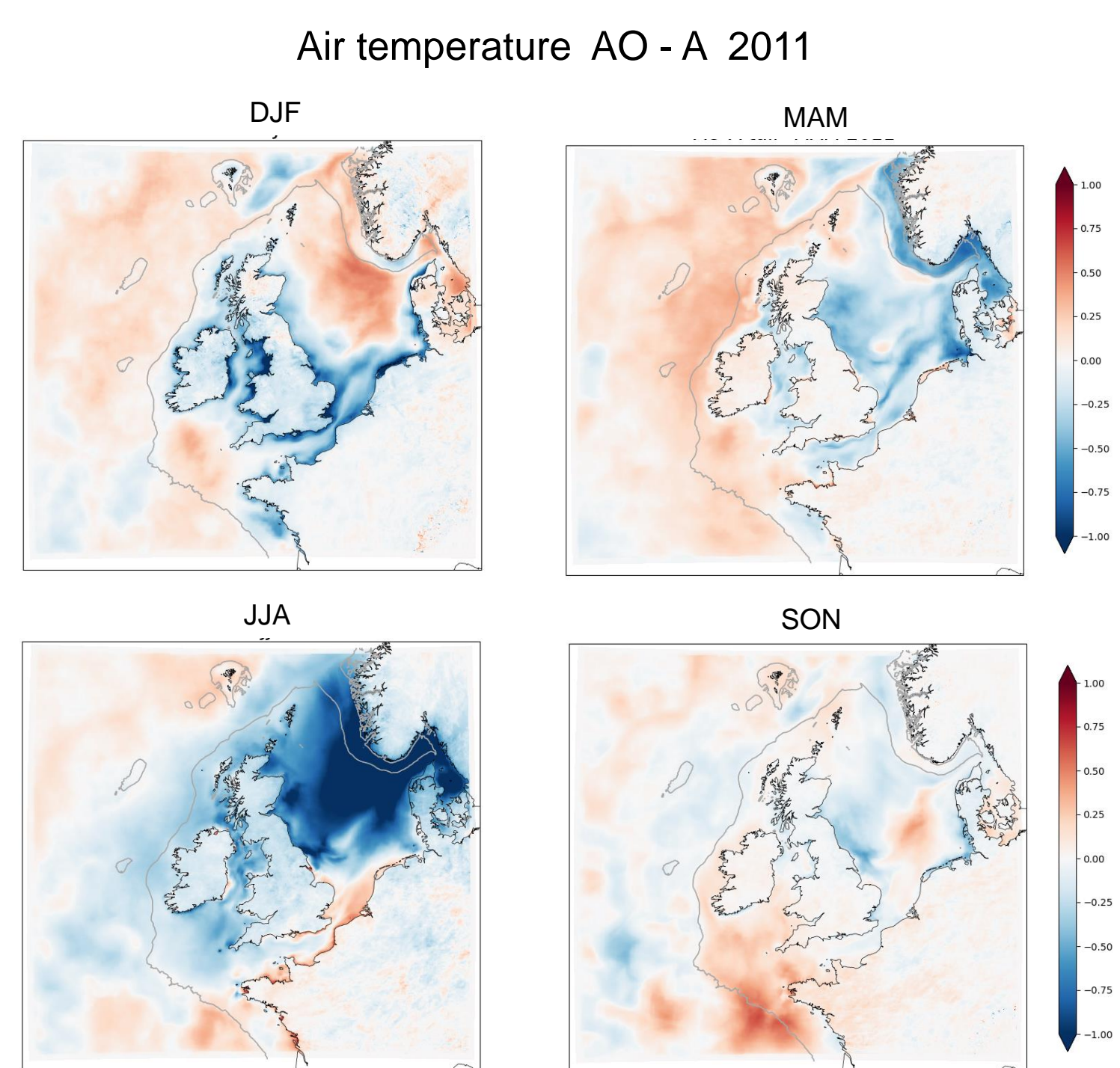
## Introduction:

Recent developments in the Regional Coupled Model at the Met Office have enabled us to run km-scale atmosphere-ocean coupled climate simulations over the North West European Shelf.

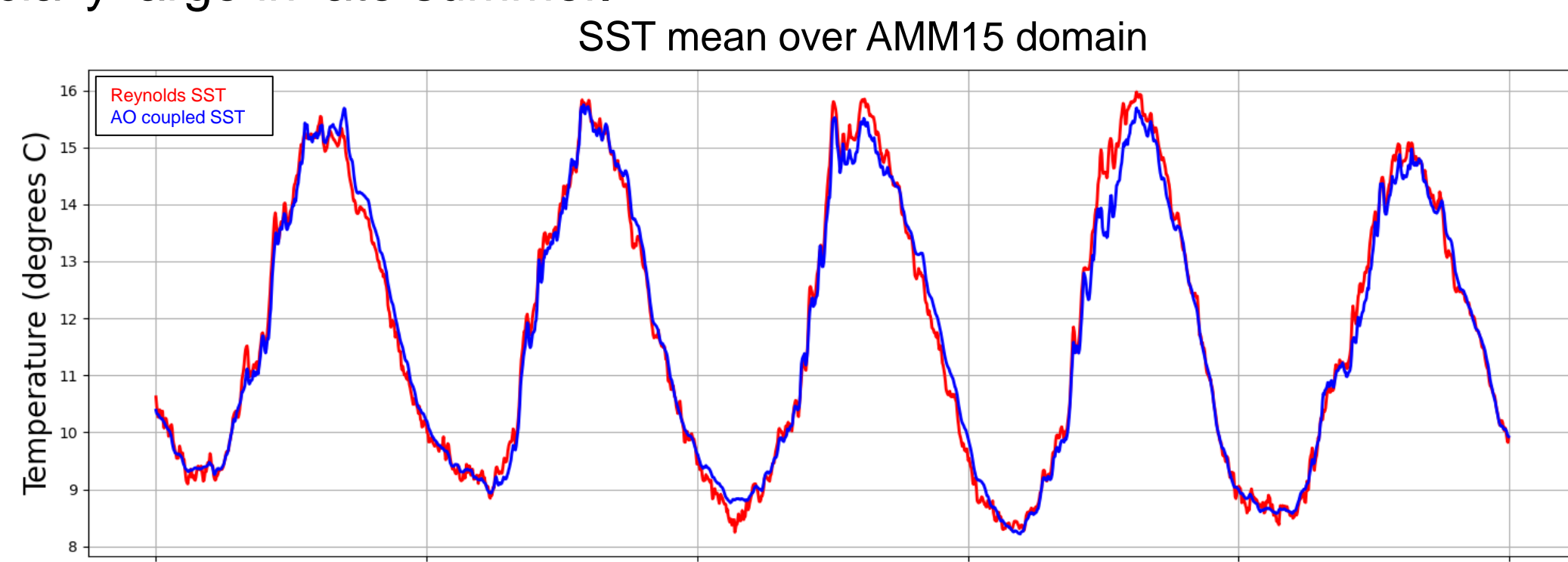
Once the wave and river models are added to these hindcast climate runs, we will begin 10-year present and future time-slice simulations. Our aim is to answer the following key questions: How will the combination of including waves and tides impact shelf seas and how will this influence the climate over land? What is the impact of climate change on multi-hazard compound events? How are marine predictions affected by being coupled to a high-resolution atmospheric model?

## Hindcast:

The Regional Coupled Model was run for 5 years 2007 – 2012 driven by ERA-Interim data, both as an atmosphere only (A) configuration, using Reynolds SST as a bottom boundary condition, and as an atmosphere-ocean (AO) coupled configuration. The atmosphere and ocean were coupled hourly. The aim was to find out if the coupled model developed a drift (the model had previously not been run for longer than a year) and to show how adding in the feedback from the ocean affects the atmosphere in climate length simulations.

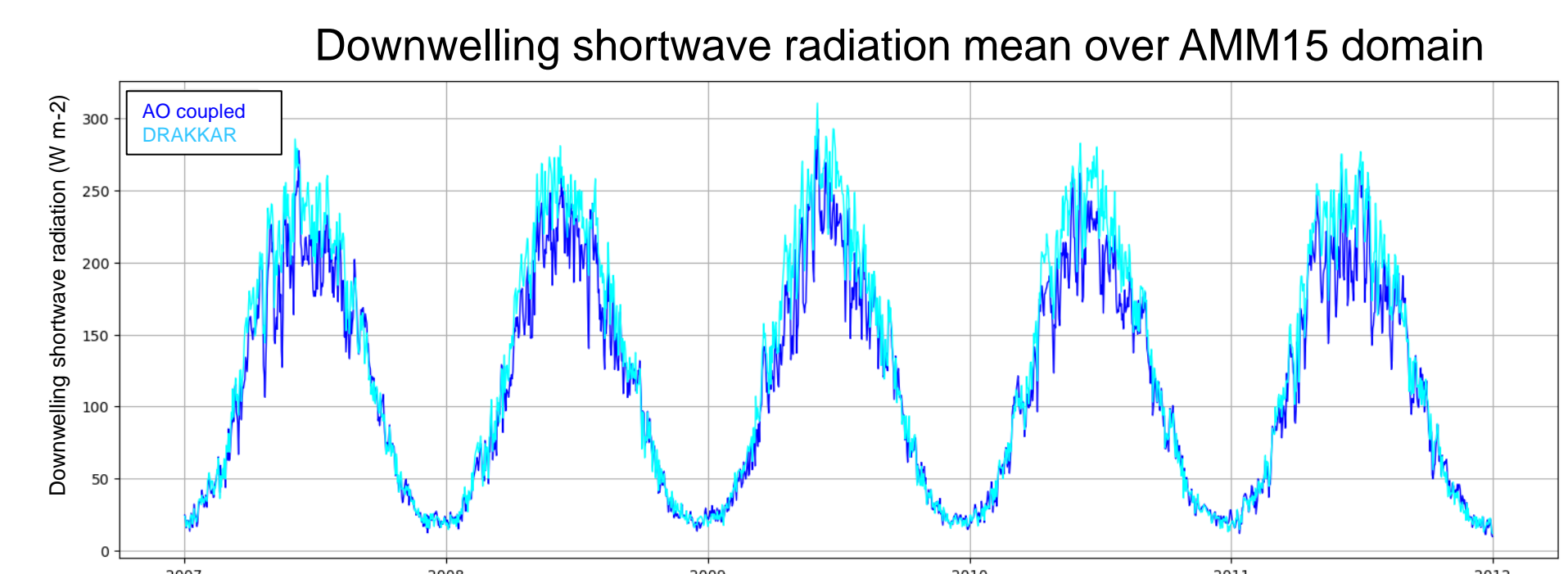


The air temperature is cooler on the shelf in the coupled model, with the bias becoming especially large in late summer.

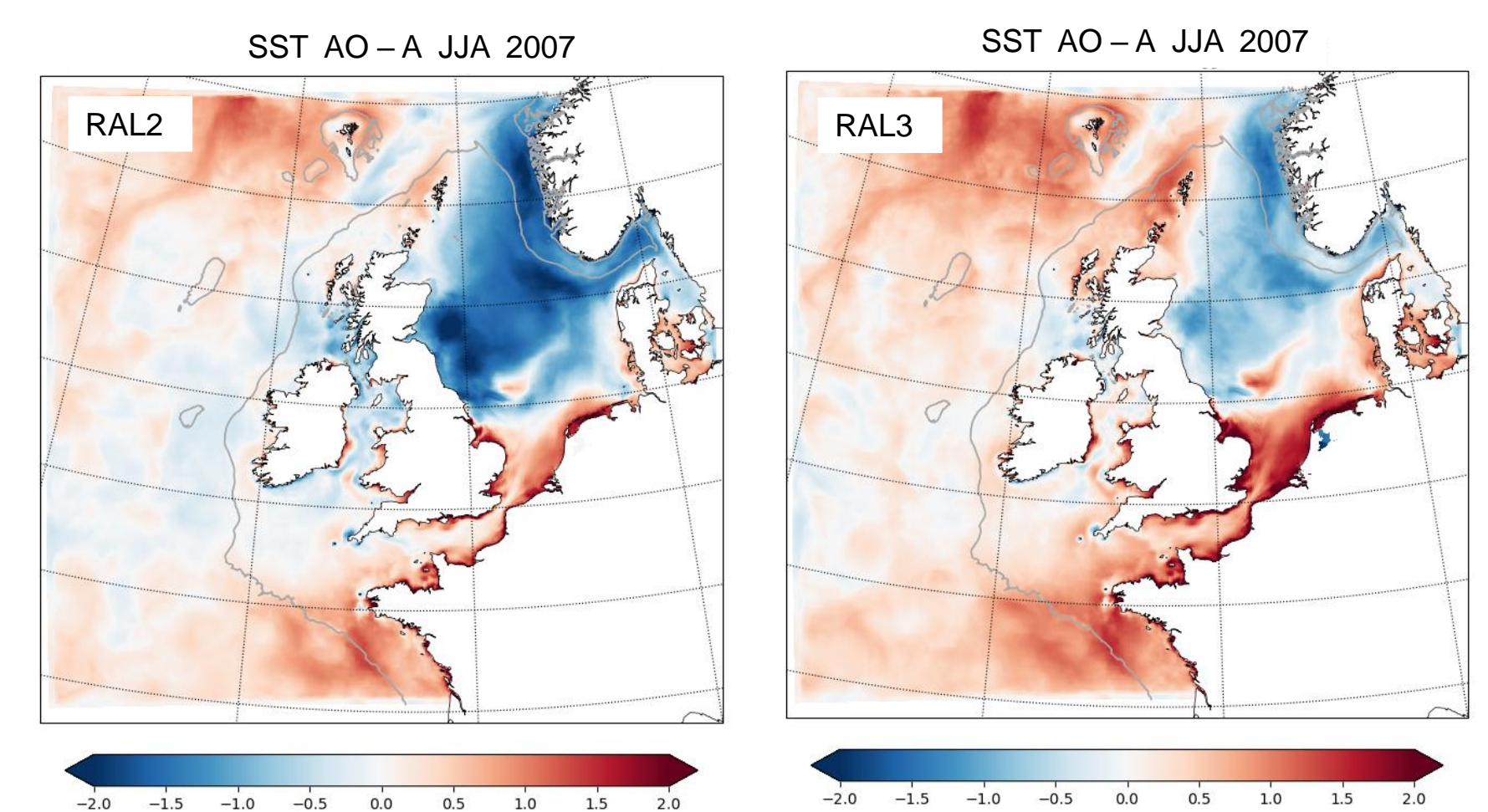


There is no evident drift in coupled runs and most seasons are close to observations, but the SST is too cool in late summer.

## Improved atmospheric physics:

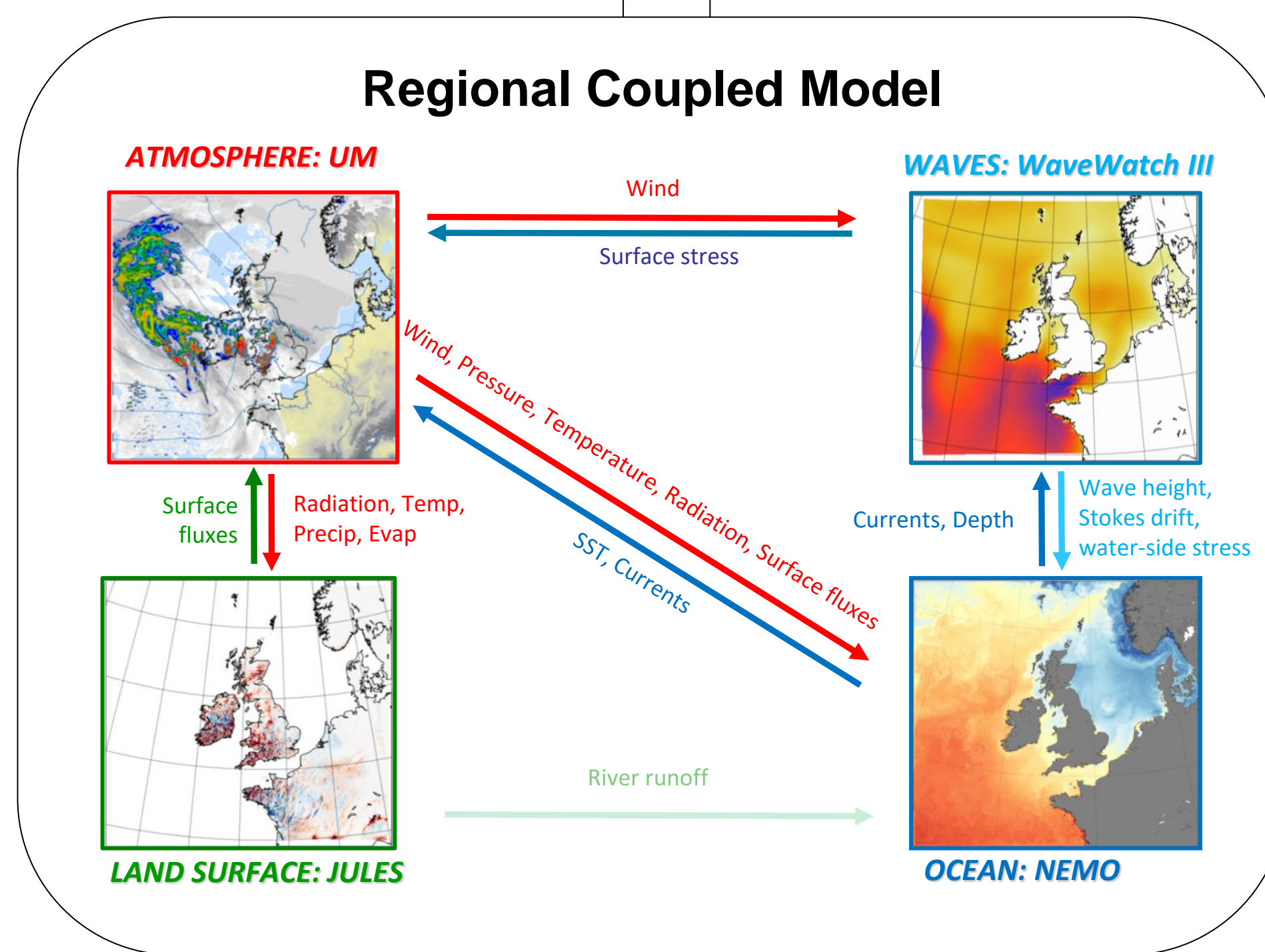


Comparing the downwelling shortwave radiation from the regional atmosphere model with DRAKKAR showed that the regional atmospheric model with the 'RAL2' science configuration has too little downwelling short wave radiation in summer, which directly impacts the coupled atmosphere-ocean model.



Using a newer, version of the regional atmospheric model, with improved cloud and microphysics, RAL3, has reduced the cold bias.

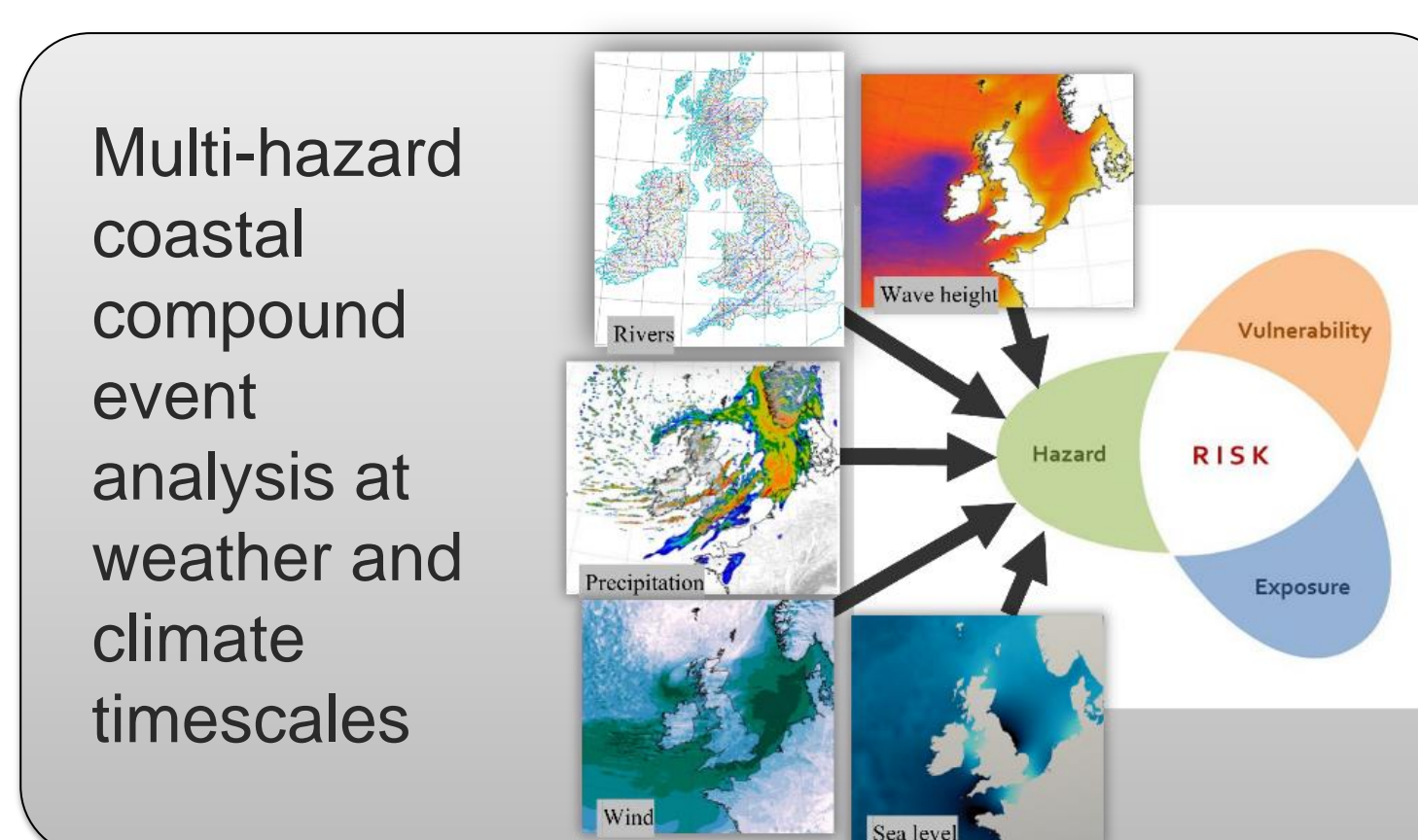
The wave model has now been introduced. The atmosphere-ocean-wave coupled model has been run for a trial period of one year, 2007. The addition of the waves appears to have improved the cold summer bias in the on-shelf stratified zones.



## Climate plans over the UK:

### Strand #1: 10-year continuous simulations Atmosphere-Ocean-Waves-Rivers

- 10-year ERA-5 driven hindcast
  - 10-year present-day (1990-2000) driven by UKCP18 standard member
  - 10-year far future (2070-2080) driven by UKCP18 standard member
  - (potentially also 2040-2050, coordinated with CHAMFER)
- How do these fully coupled simulations differ from UKCP18 local land and marine projections? (e.g. UKCP18 local used GCM SSTs)



### Strand #2: multi-hazard storm catalogue Atmosphere-Ocean-Wave-Rivers

Past storms are too small a sample of winter variability to fully characterize coastal multi-hazards. Downscaling the "synthetic" CANARI storms with the regional coupled system will answer the following questions:

- What is the probability of multi-hazard coastal events in the UK?
- When a storm is forecast, are its multi-hazard characteristics within the present-day distribution of storms or do they have climate-change characteristics?

## Conclusion:

The analysis of the initial 5-year hindcast climate runs showed reasonable performance and no evident drift but highlighted a cold bias in summer. Part of this has been attributed to too little shortwave radiation in the regional atmosphere model. Using a newer version which includes improved cloud and microphysics has helped correct this. A preliminary test run with the fully coupled atmosphere-ocean-wave model shows warmer SSTs over the shelf, further correcting the cold bias in summer. Plans are in place to begin 10-year climate time-slice runs and targeted downscaling of storms. Additionally, potential 'what if' situations may be run using the regional coupled model (e.g. investigating the dependencies between marine and land heatwaves).

*Collaborations welcome, the more eyes on these simulations, the more findings!*