UK Environmental Prediction – Integration and evaluation at the convective scale

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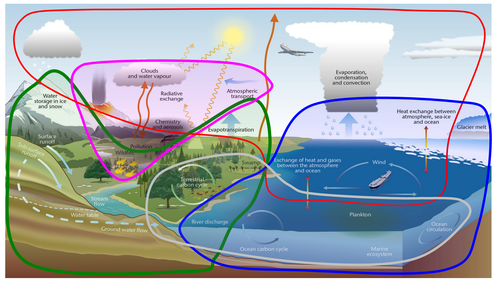
Towards UK coupled prediction?

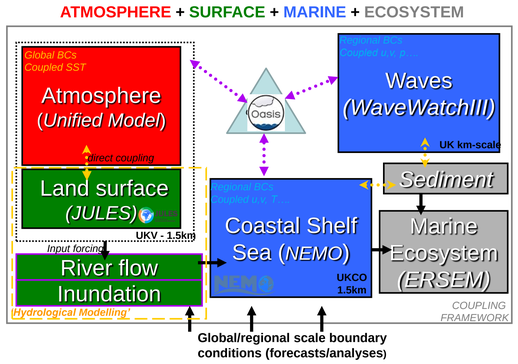
Accurate prediction and warning of the impacts of severe weather requires an **integrated approach** to forecasting. We develop the first coupled high resolution prediction system for the UK at km-scale. The key components include atmosphere, land surface, ocean, wave and marine ecosystems. The benefits of this approach relative to current uncoupled systems and tools to

i) improve the accuracy and skill of predictions
ii) provide more relevant hazard advice to users
iii) better understand the known feedbacks

are to be proven in the UK context.



COMPOSITION LAND SURFACE ECOSYSTEMS ATMOSPHERE MARINE



The 'challenges of evaluation'

Understanding the responses to feedbacks
Sensitivity to methods of coupling and forcing

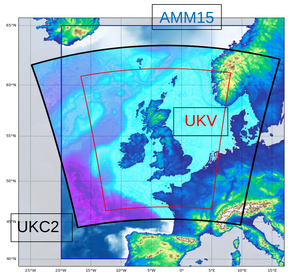
Defining test cases
Variety of meteorological, ocean and hydrological conditions for sampling coupled model performance

Control run sensitivity experiments
Ocean-only and wave-only runs to understand value of atmospheric forcing resolution, ocean initialisation

Evaluation of model output
Suitable obs. data sources and evaluation strategy

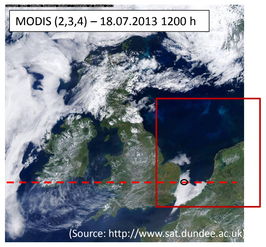
The Prototype modelling system

- Fully coupled ocean-wave-atmosphere-land prototype system (UKC2)
- **convective scale** atmospheric model, coupling via OASIS 3-MCT - **extended UKV domain (1.5 km)**
- new eddy permitting NEMO ocean component in the **AMM15** domain
- **ocean initialisation**:
  - Operational analysis of the SST around the UK using the North Atlantic Model at 1/12° (~9km) (NATL12) → **'inits'**
  - 4 year hindcast of the SST using the NATL12 model → **'restart'**
- JULES land surface model with **river routing** to close the water cycle
- wave interaction with **WAVEWATCH III model** on the AMM15 domain

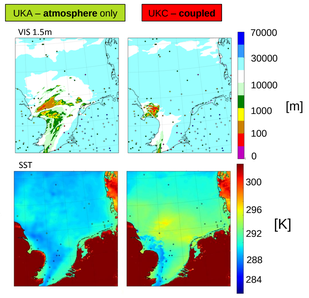


Test Case – Fog formation in the English Channel July 2013

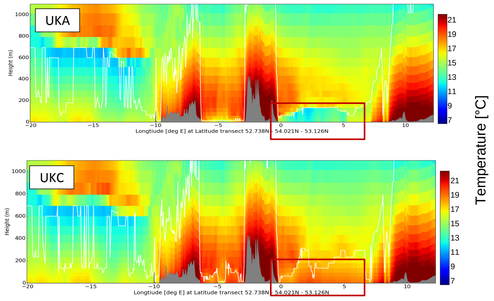
"persistent high pressure, frontal systems steered northwards; low clouds/ sea fog over the North Sea running westwards"



MODIS satellite image (VIS) showing the British Isles (algal blooms and fog cover) combining Channel 2,3,4 - 18.07.2013 1200 h (circle: profile location, dashed line: cross section, square: zoom)

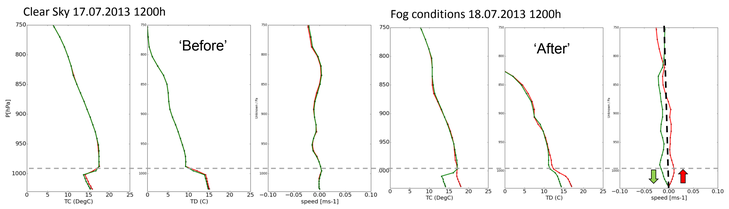


Model output for 18.07.2013 1200h showing visibility and sea surface temperature for uncoupled atmosphere only (UKA) and coupled (UKC) run with OSTIA ocean initialisation - buoy observed values (dots) overlaid

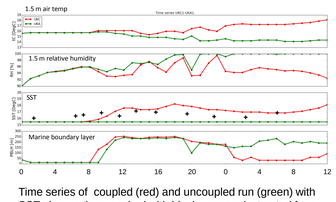


X-Z cross section (Latitude 52.78 N – 54.02 N) as indicated in the satellite image for potential air temperature within the first ~1000m. Boundary Layer Height is shown in white.

Vertical profiles and time series for grid cell located in the 'fog' (53°N, 3.0°E) - Coupled (UKC) and atmosphere only (UKA) run valid for 17. -18.July 2013



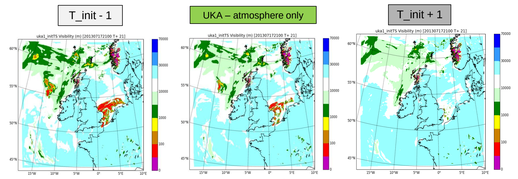
Vertical profiles of dry – and dew point temperature, vertical velocity on a clear day (left) and during foggy conditions (right), location of the profile indicated in satellite image above comparing UKA (green) and UKC (red). Dotted line indicates the height of the fog layer, arrows uplift and downdraft.



Time series of coupled (red) and uncoupled run (green) with SST observations marked with black crosses (extracted from buoy measurements) – location indicated in satellite image

Sensitivity to initial sea surface temperature (SST)

- Varying the initial temperature by +/- 1 K leads to significant generation or dissipation of fog
- change in near surface visibility (1.5 m) reflects ocean-atmosphere feedback in the coupled system



1.5 m Visibility UKA atmosphere only run with initialised SST -1 K (left), control run (middle) and +1 K (right) for 17.07.2013 2100h

Open research questions

- How does coupling with the ocean and waves impact the atmospheric model representation of weather ?
- How does coupling with the atmosphere and land surface impact the ocean model representation of ocean dynamics and heating (SST) ?
- How does coupling impact the wave model representation of surface waves ?

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