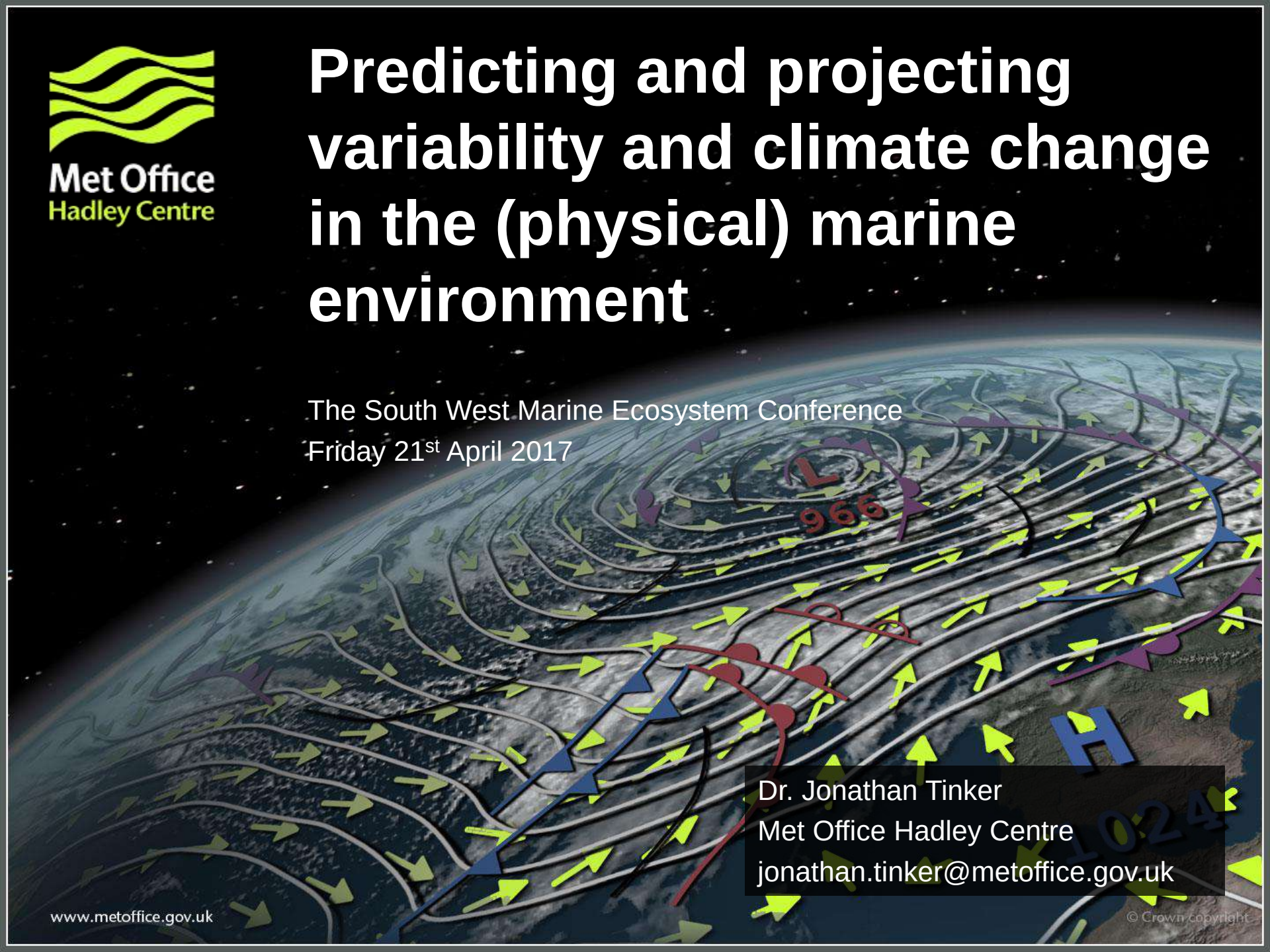
Predicting and projecting variability and climate change in the (physical) marine environment

The South West Marine Ecosystem Conference
Friday 21st April 2017



Dr. Jonathan Tinker
Met Office Hadley Centre
jonathan.tinker@metoffice.gov.uk

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Hadley Centre

Introduction

- Physical environment important for marine ecosystems
- Very complex
    - Spatial scales over 11 orders of magnitudes from 10^{-4} – 10^{6}m
    - Temporal scale from milliseconds to millennia
    - Atmosphere + ocean + cryosphere + carbon cycle + sulphur cycle + ecosystems…
    - Chaotic – ensembles!
- Approach:
    - Divide world into boxes
    - Observe what the temperature/salinity/humidity/pressure are in the boxes,
    - Use physical laws to calculate how they will change given what it is now, and what its neighbours are.

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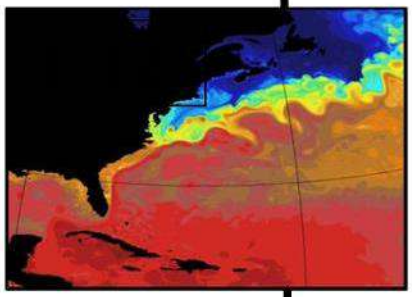
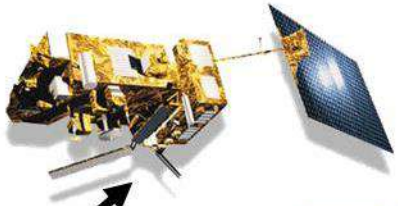
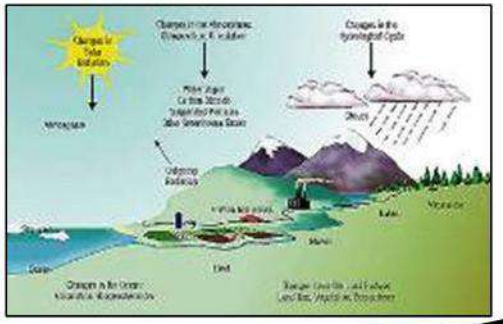






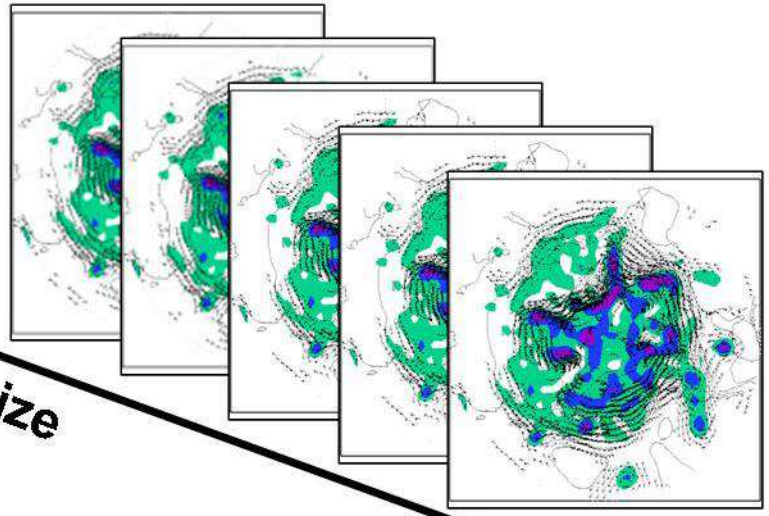
Earth Observation

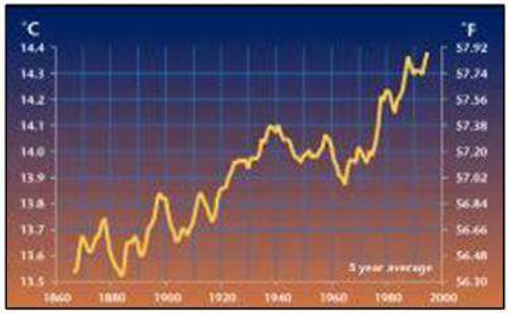
Resolution

Computing Resources

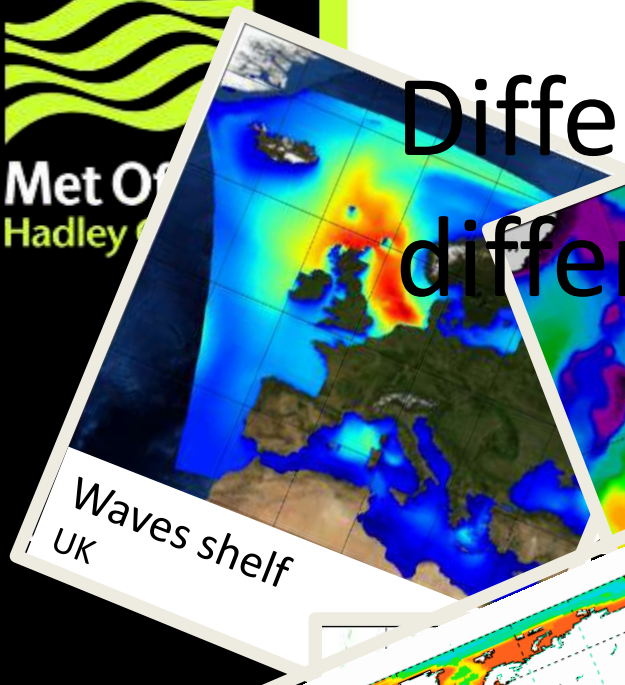
Complexity

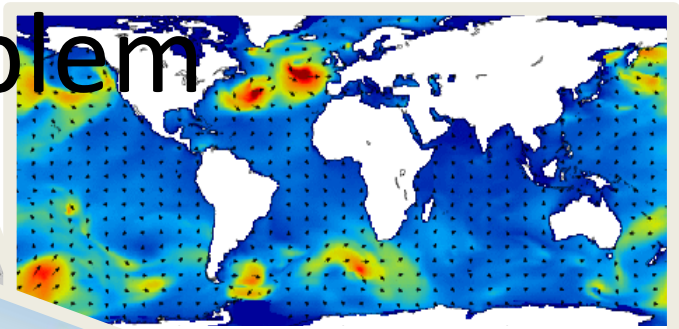
Duration and/or Ensemble size





Different solution for a different problem





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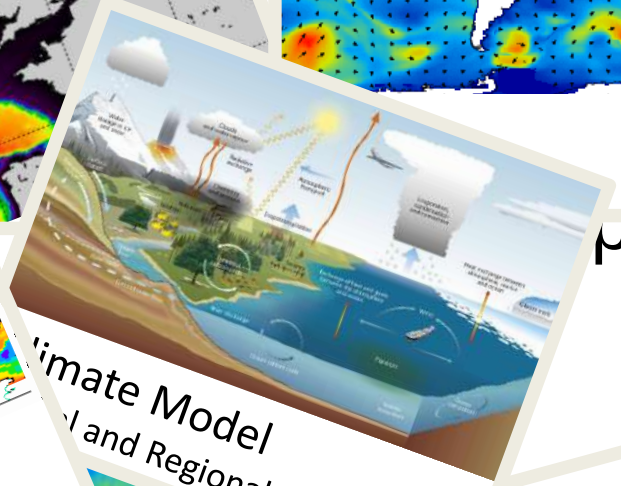

proach for a

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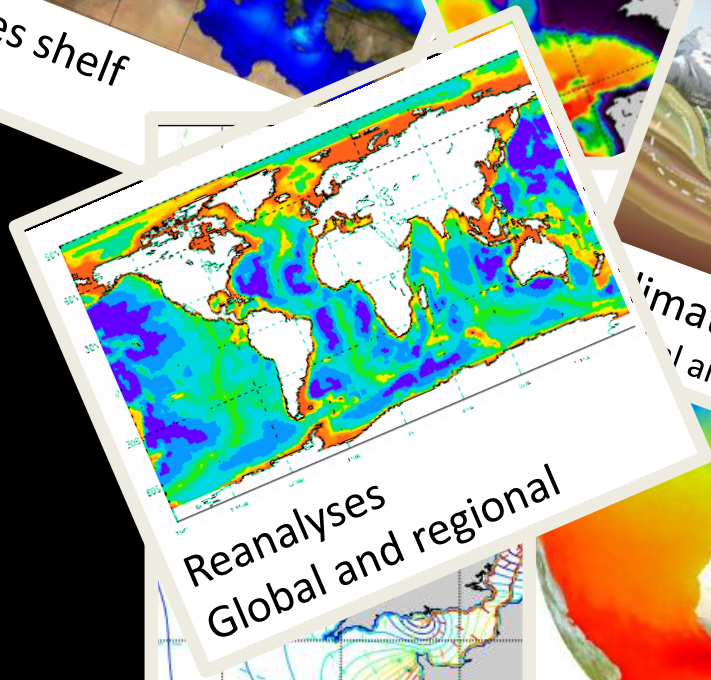

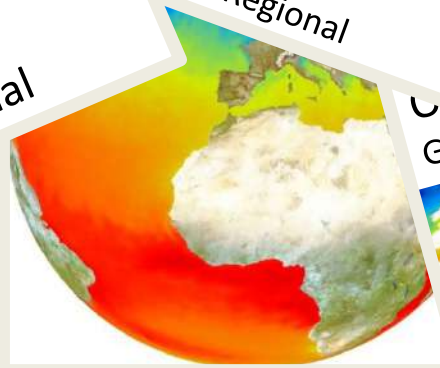

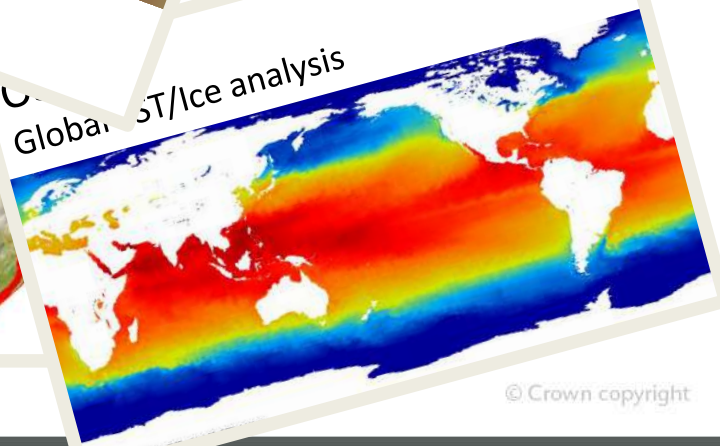

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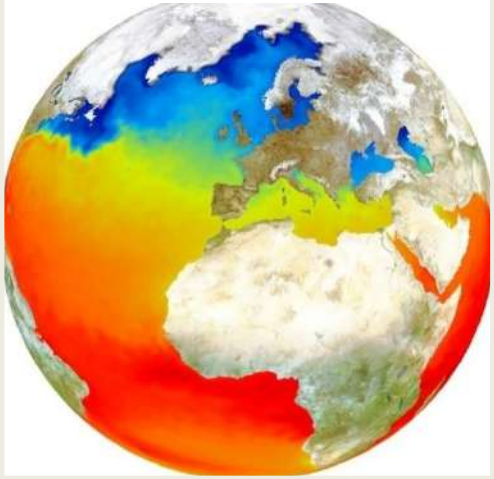
Downscaling:

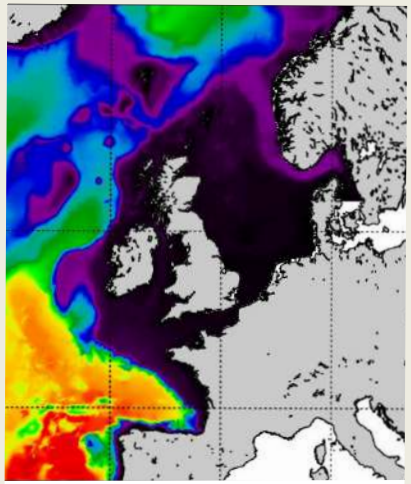
Global model too coarse

Lack important processes: Tides

FOAM

Global (coupled) forecasting





FOAM Shelf

North-West Shelf

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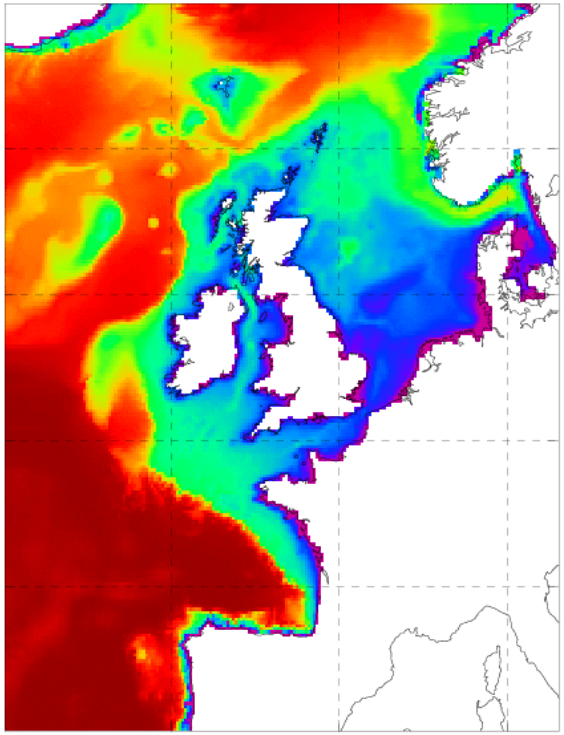
Shelf seas forecasts - NEMO/ERSEM

- NEMO Shelf Seas model
  - Temperature, salinity, currents, sea level
  - Tides, s-coordinates
- PML ERSEM Ecosystem model
  - Nutrients, phytoplankton, zooplankton
  - sediments
- Driven by NWP surface fluxes (heat, momentum, moisture), rivers & bdy data
- Assimilation of SST data
- One 5-day forecast per day
- 20+ year hindcasts of physical system



NEMO FOAM Shelf 7km including ERSEM

A range of Products for a range of time-scales

Recent Past: Reanalysis – 1980s-2014

NWS: CO6, Physics and Biology; SST DA

Near Future: Operational Forecasts: 5 days

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CMEMS

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Global, GLOSEA5, probabilistic, Winter NAO

Decadal forecasts (out to 5 years):

Global, DePreSys3, probabilistic, Sub Polar Gyre Index

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Seasonal forecasts (out to 6 months):

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Decadal forecasts (out to 5 years):

Global, DePreSys3, probabilistic, Sub Polar Gyre Index

Shelf Seas Climate Projections (out to 2098)

NWS, POLCOMS, Physics only,

Minerva/Extending UKCP09 (Tinker et al 2016)

Copernicus Marine

Copernicus Mari Environmental Monitoring Service

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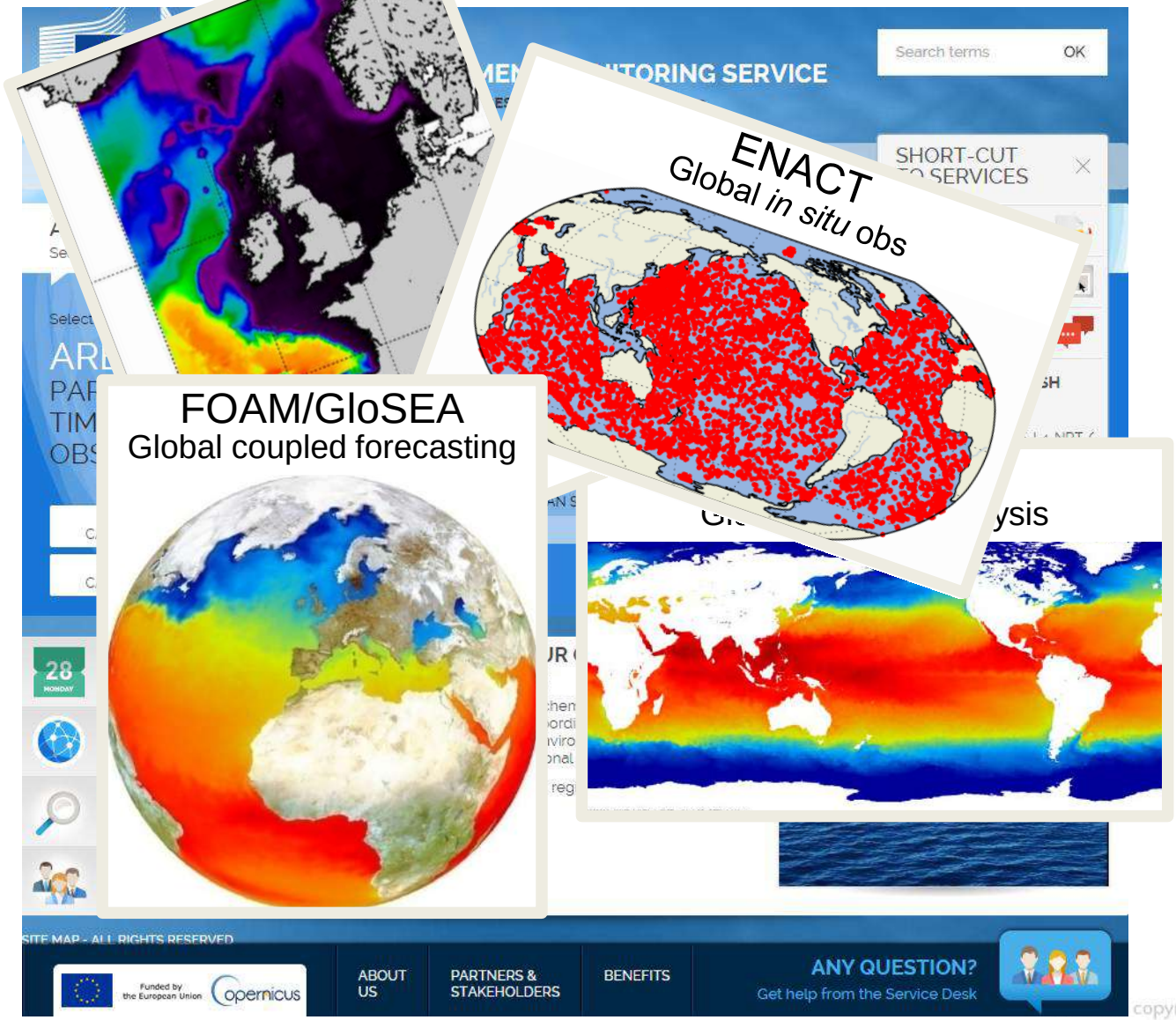
Successfully operating:

- *North-West Shelf*
- *Global SST/Ice*
- *Global In Situ*
- *Coupled global*



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Shelf Seas Climate Projections

Shelf Seas Climate Projections

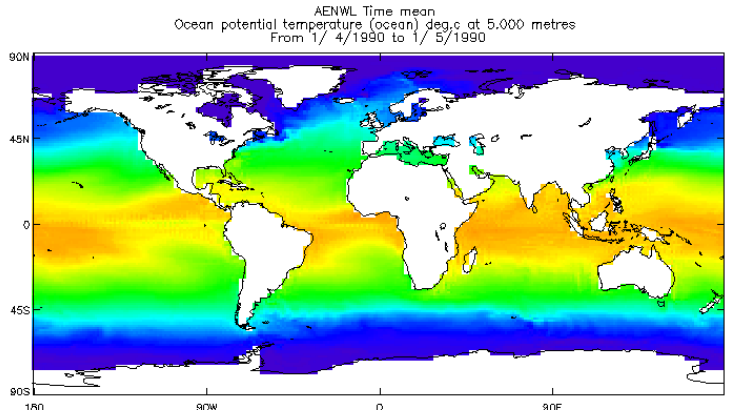
Extending the shelf seas section of UKCP09

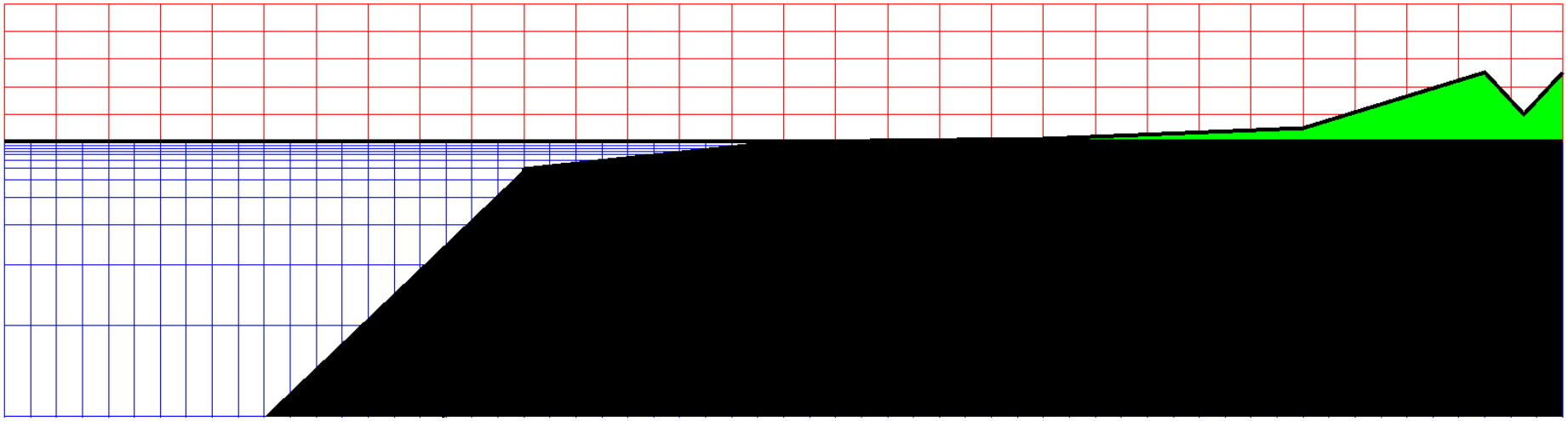
Temperature, salinity, stratification, currents

Downscale GCM (HadCM3)...

- ... using shelf seas model POLCOMS
- ... under SRES A1B BAU
- Transient Experiments (1952-2098)
- Ensemble Approach (11 members PPE)

Model setup


AENWL Time mean
Ocean potential temperature (ocean) deg.c at 5.000 metres
From 1/ 4/1990 to 1/ 5/1990
90N
45N
0
45S
90S
180
90W
0
90E



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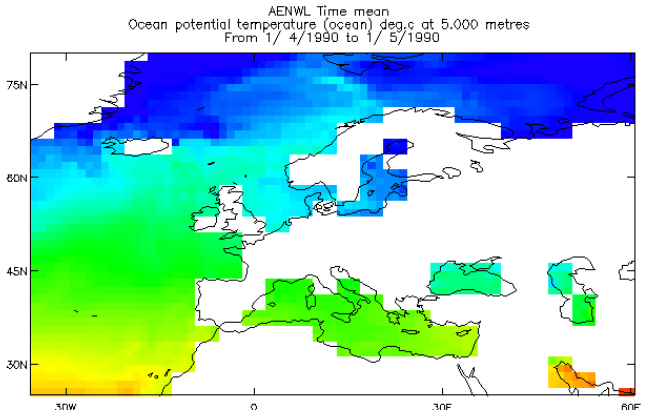
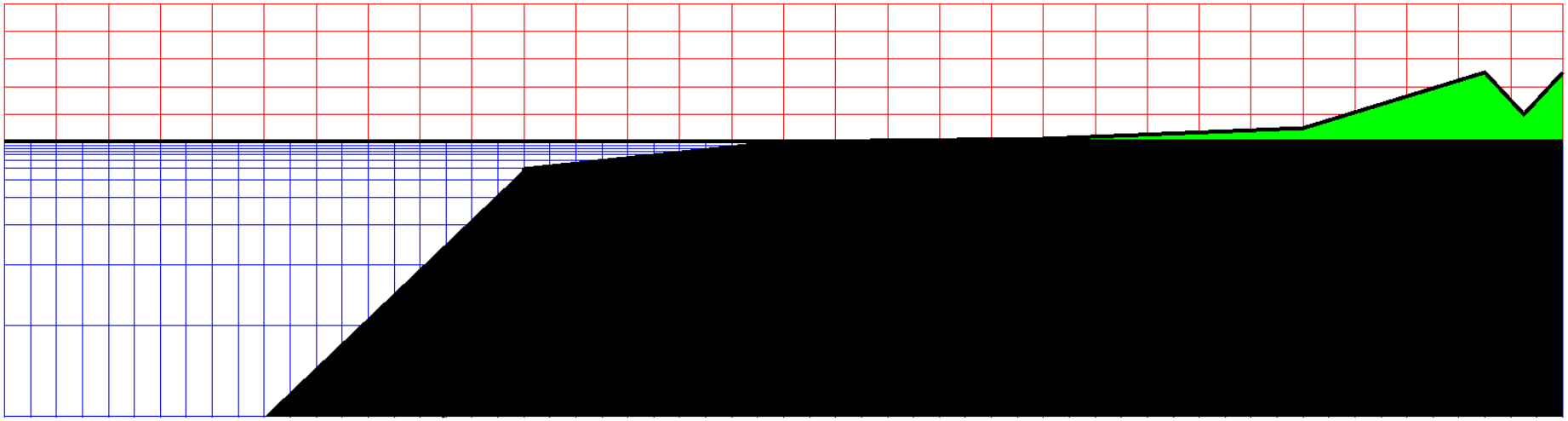

AENWL Time mean
Ocean potential temperature (ocean) deg.c at 5.000 metres
From 1/ 4/1990 to 1/ 5/1990
75N
60N
45N
30N
30W
0
30E
60E



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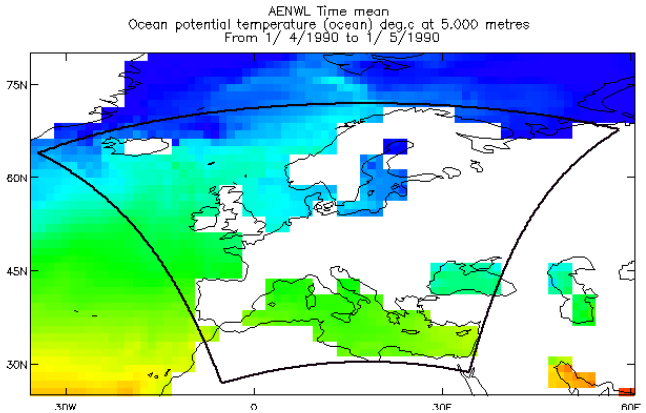
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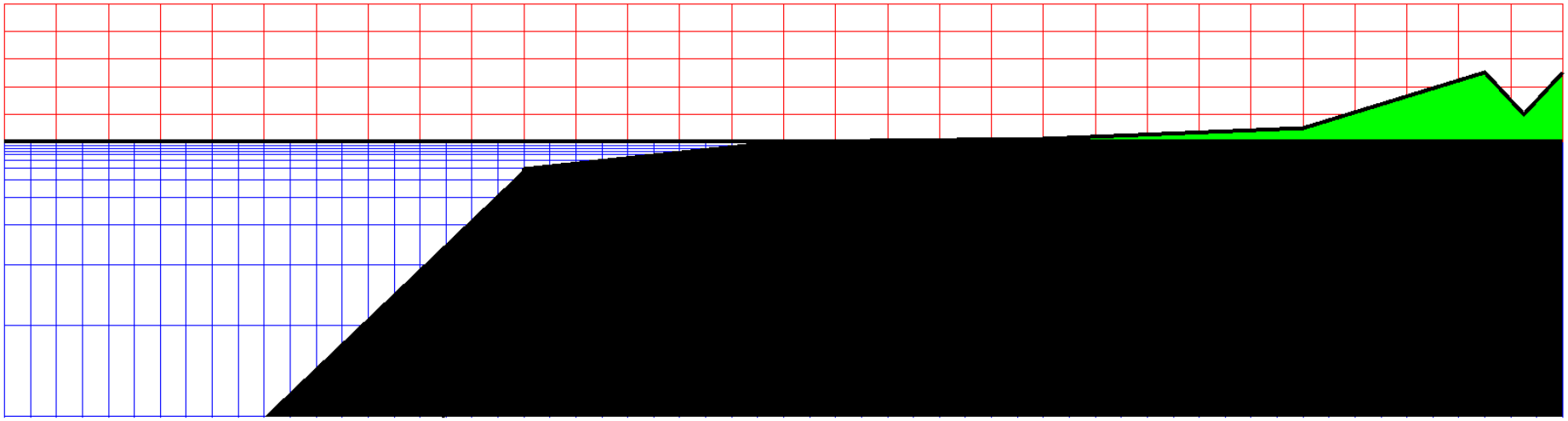

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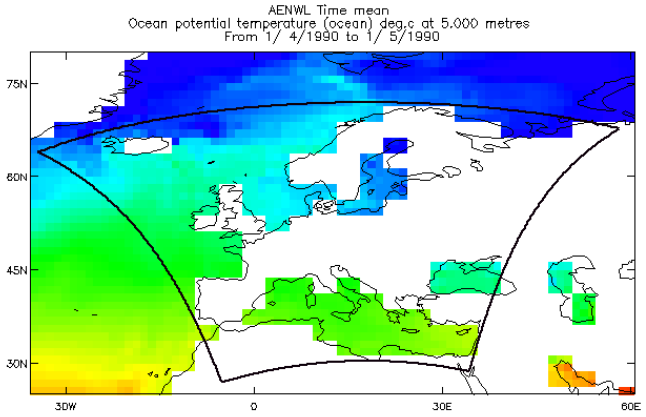
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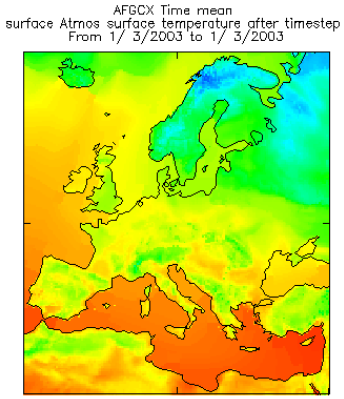
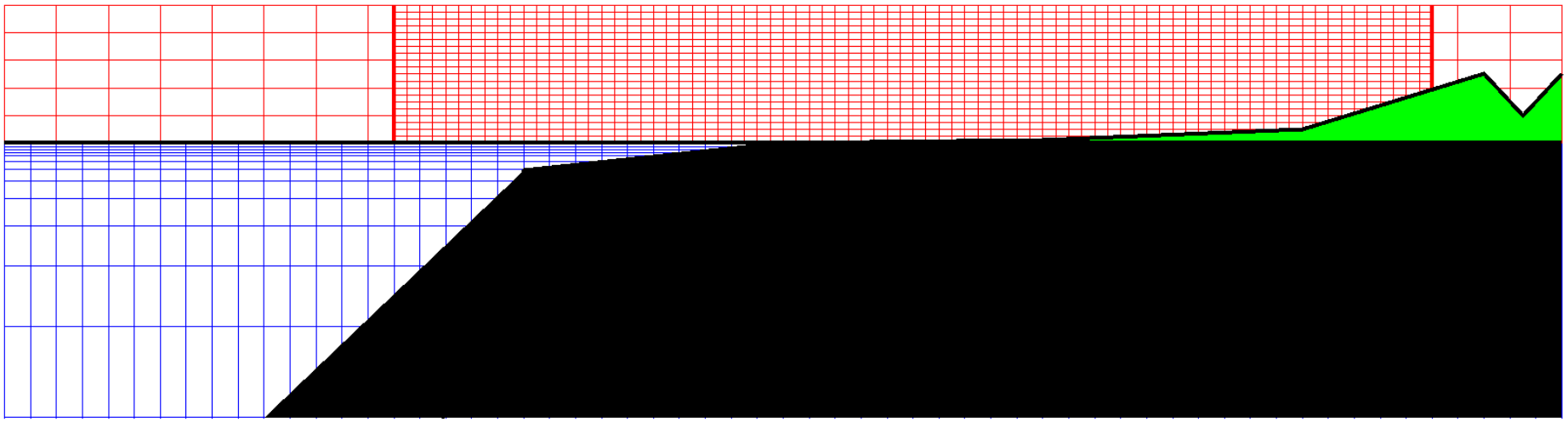

AFGCX Time mean
surface Atmos surface temperature after timestep
From 1/ 3/2003 to 1/ 3/2003



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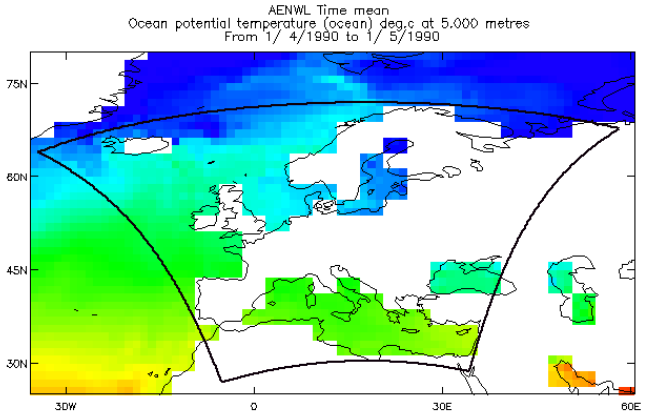
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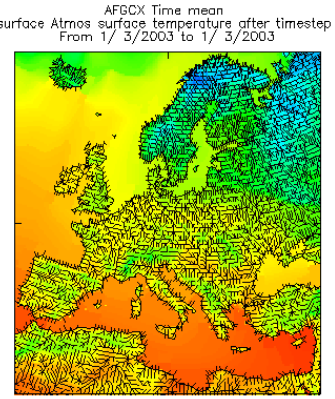
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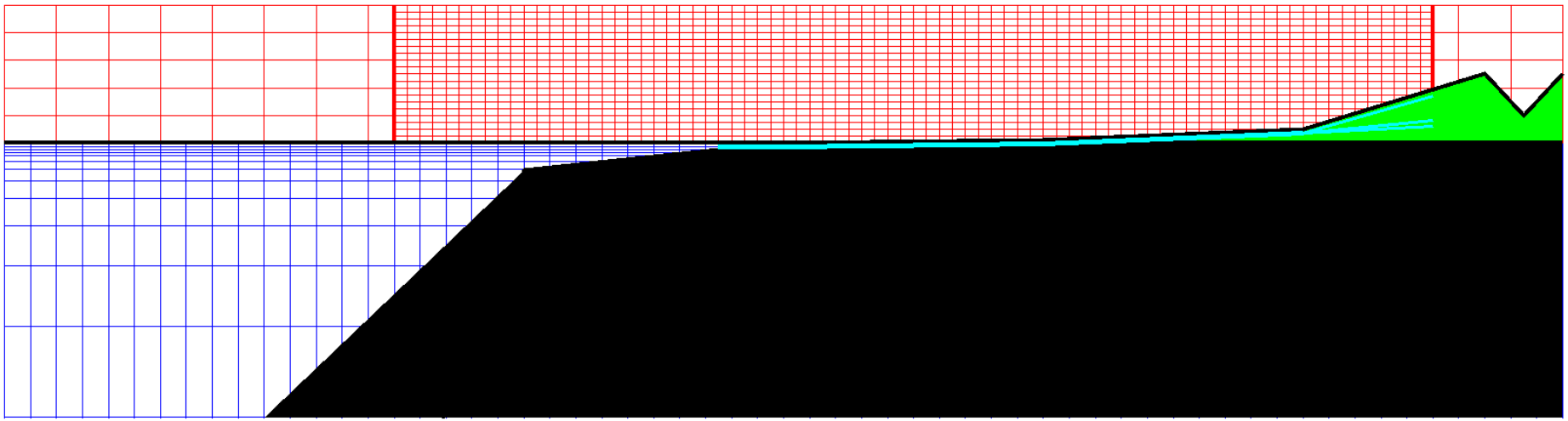

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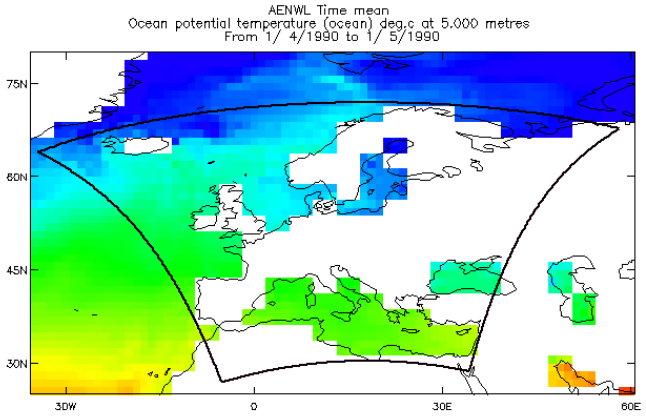
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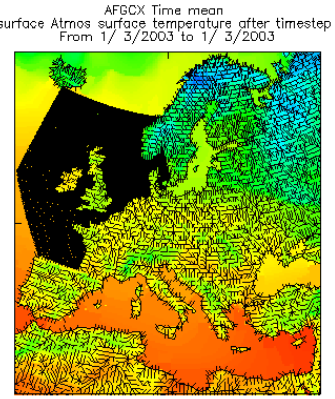
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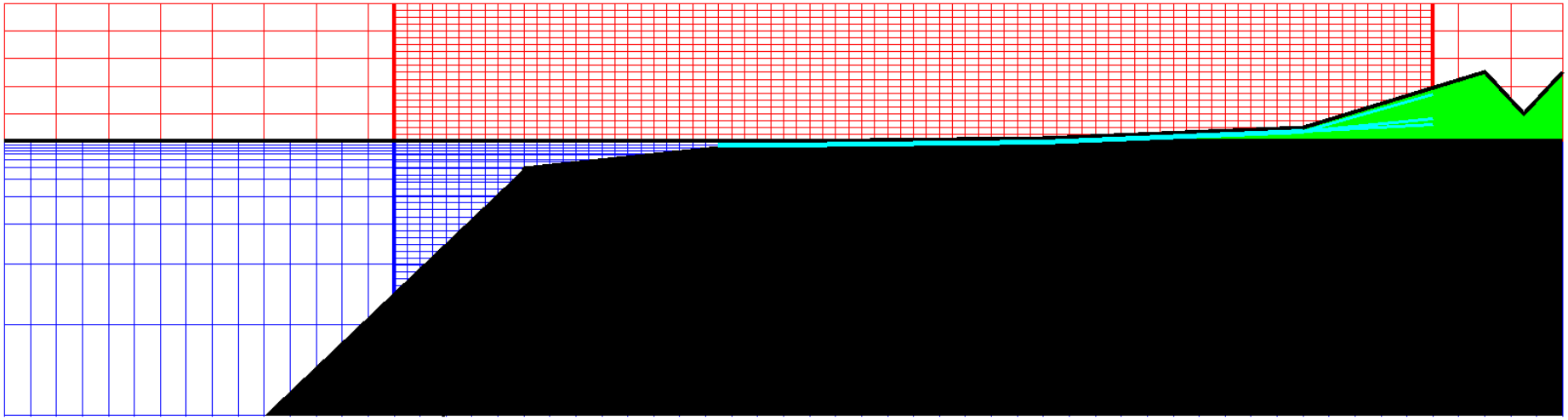
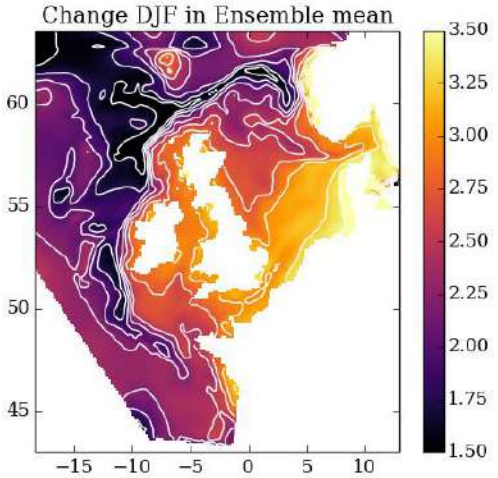
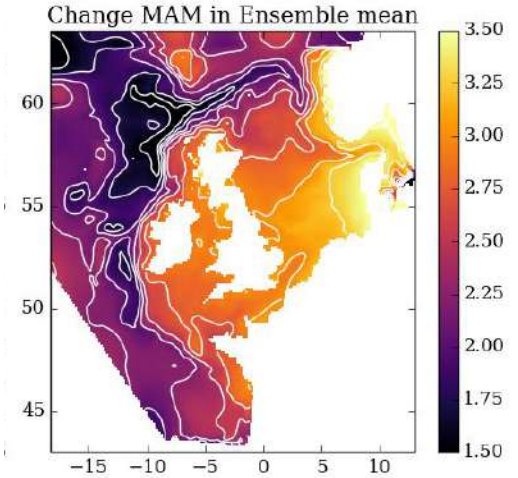
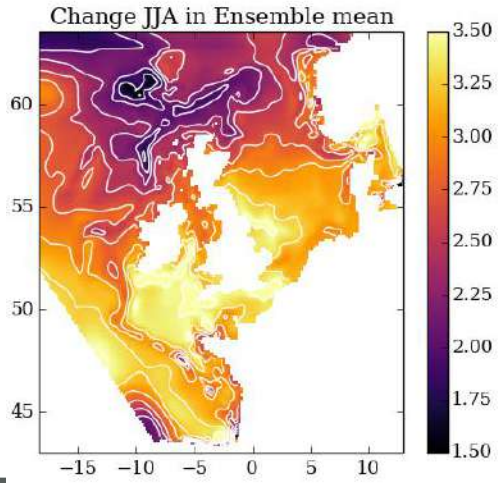


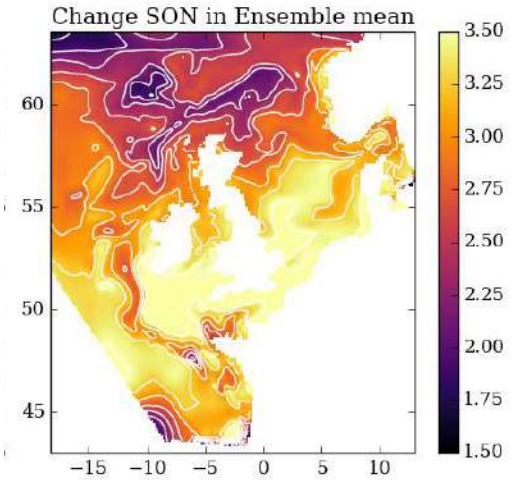
Results: SST Projections

Projected SST change (2069-2089 relative to 1960-1989) from Tinker *et al.* (2016)









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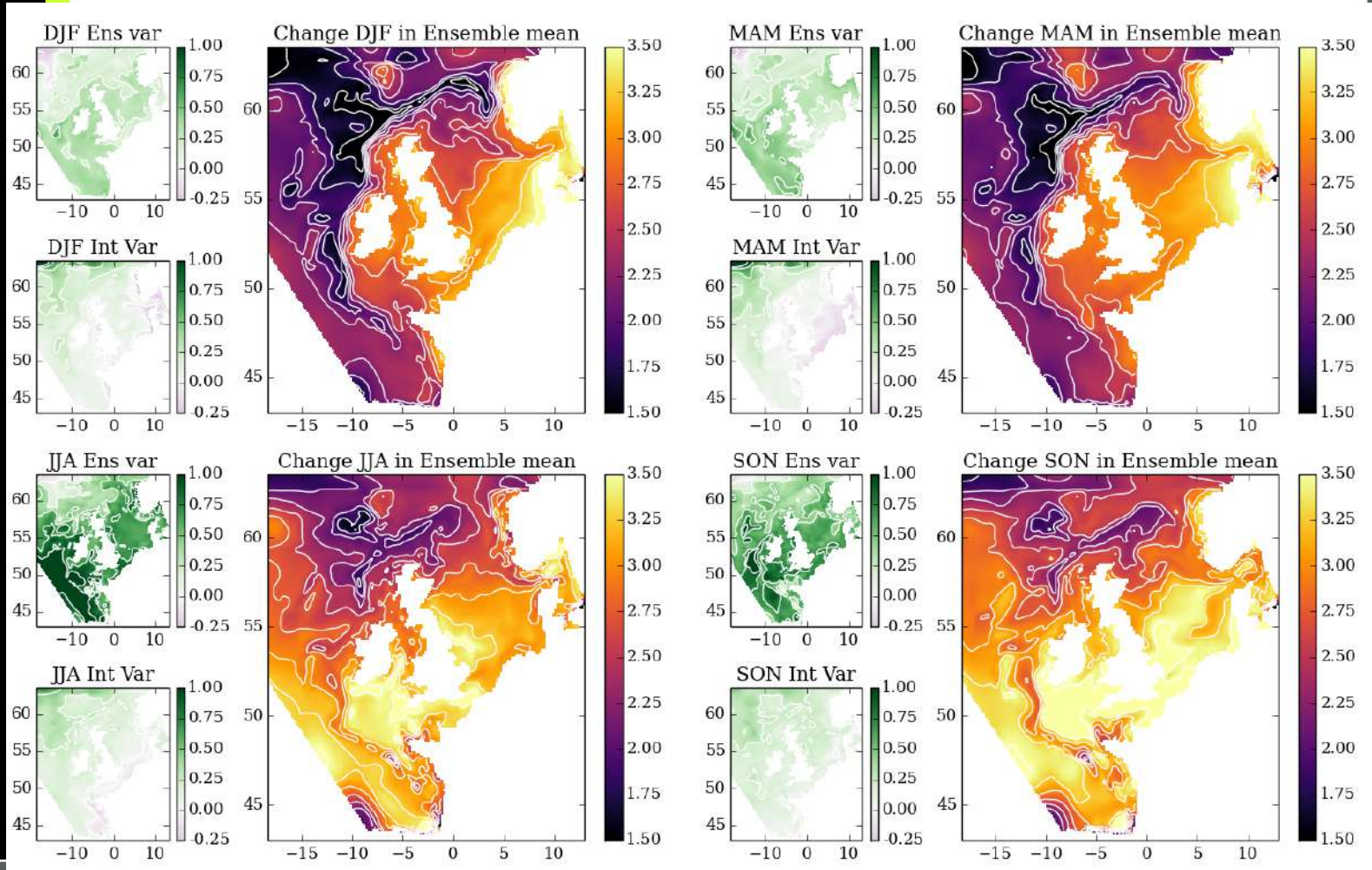

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Communication

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Marine Climate Change Impacts Partnership (MCCIP)

http://www.mccip.org.uk

- Wide range of impacts
- Annual Report Cards
- Special Report Cards
- 150 scientists
- 50 organisations

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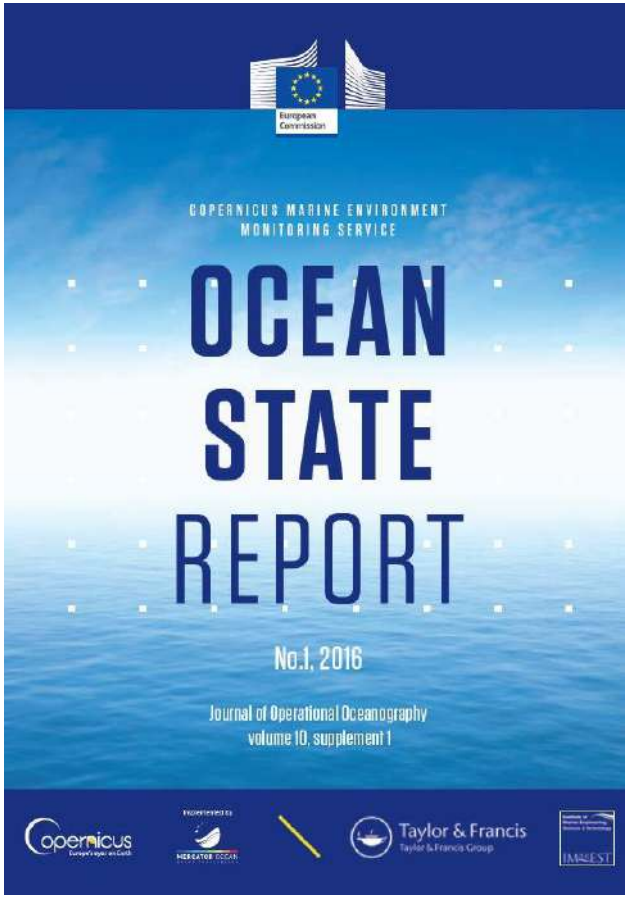
Copernicus Ocean State Report

- 2015 vs recent past
- 80 European experts
- 25 Institutions
- Global and 6 Regions



http://marine.copernicus.eu/first-issue-ocean-state-report-now-available/

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Thanks you and Questions?

jonathan.tinker@metoffice.gov.uk

http://marine.copernicus.eu/services-portfolio/access-to-products/

Minerva climate projections: https://tinyurl.com/gnxnqzy

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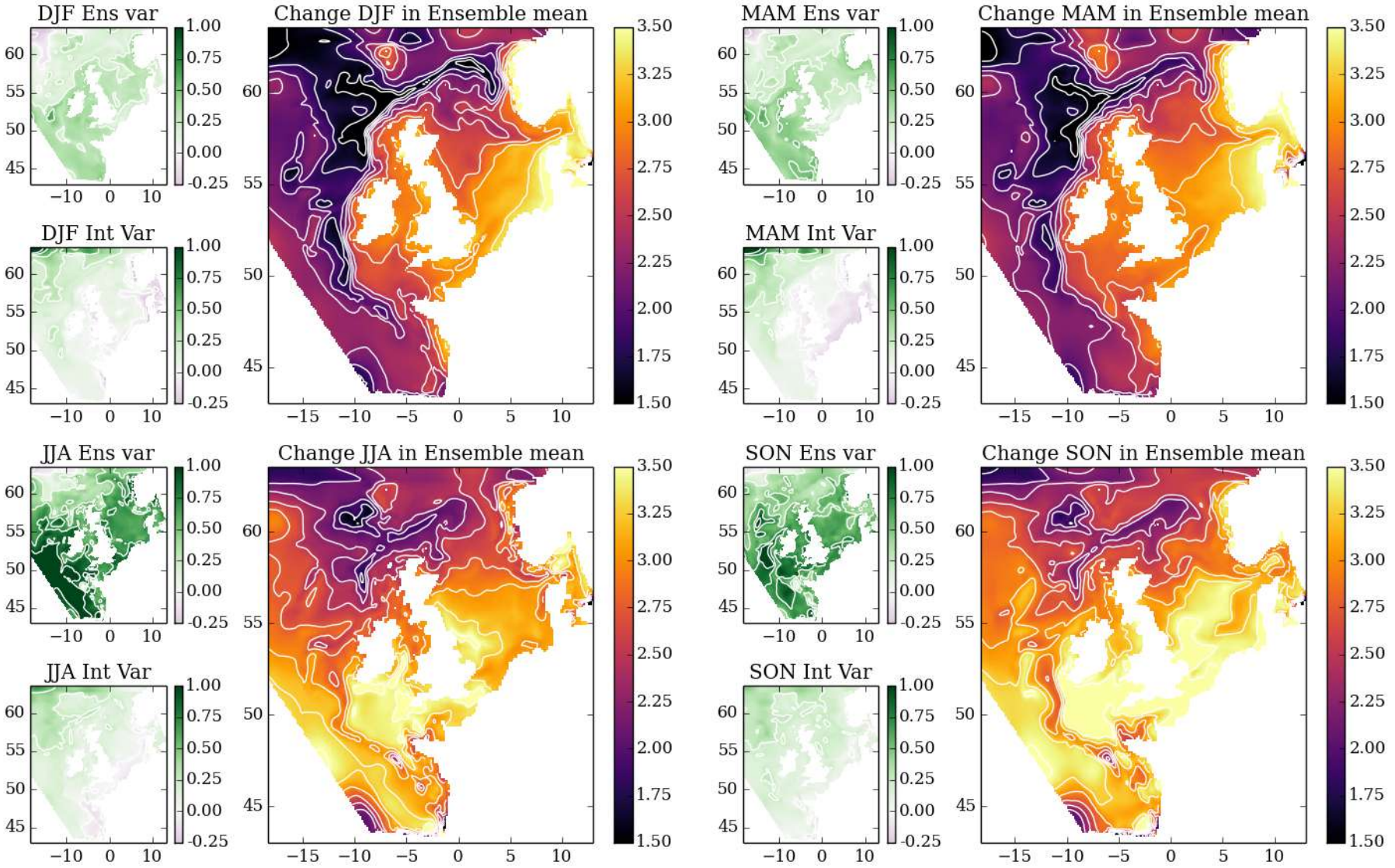

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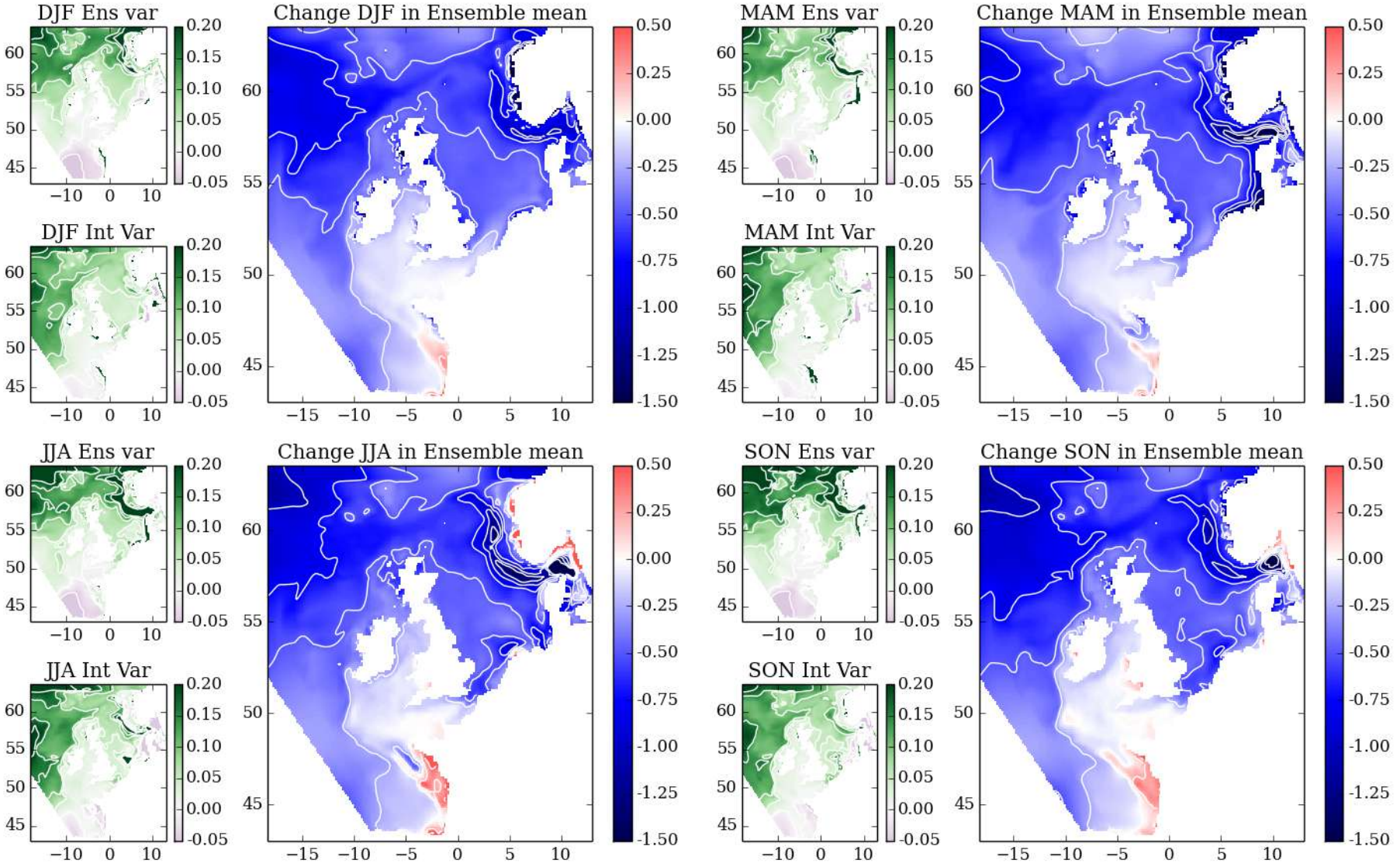

Projected NBT change (2069-2098 relative to 1960-1989) from Tinker et al. (2016)