Exploring the potential for a North West European shelf seas ecosystem seasonal forecast

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NW European Shelf Seas are broad continental shelf seas; seasonally stratify with large tides so typically poorly modelled in global ocean models

Bounded by a number of (populous) European countries. Economically, culturally, environmentally important.

5 day operational forecasts; Climate Projections (e.g. Tinker et al. 2016) but user interest in seasonal forecasts for NWS

Is there seasonal predictability for the NWS?
Global Seasonal Forecasting System: GloSea5
Based on a coupled climate model HadGEM3, 60km atmos, 0.25° Ocean
Full field initialisation, Assimilates LOTS of obs.
Skilful prediction of DJF NAO
Models

**Global Seasonal Forecasting System: GloSea5**

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GloSea5 runs a (lagged) ensemble of 6 month forecasts every day/week.
Removing model drift requires a forecast climatology
A set of hind casts, to match the start dates of the forecast, for every year between 1993 and the present day.
Constant updating the hindcast clim allows regular updates to GloSea5.
Models

Global Seasonal Forecasting System: GloSea5
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Shelf Seas Model Nemo Shelf (CO6)
7km horizontal resolution 51 terrain following s-levels, Tides
Not assimilation 1-coupled (forced) with GloSea5
Initialised from CMEMS reanalysis

Reanalysis CMEMS V2 AMM7 reanalysis
NEMO Shelf (CO5) 7km, 51 s-levels, Tides, Assimilates SST,
Driven by ERAI
Evaluated by CMEMS Considered Truth
Experimental Design

Can we model the difference between years? Does this compare to the observed differences?

Downscale 2 contrasting case studies
  - Winter (Nov) 2010/2011 and 2011/2012 (12 member ensemble with 4 start dates)
  - Spring/Summer (April) 2003 and 2007 (9 member ensemble with 3 start dates)

Also:
  - Reduced winter “hindcast” 1993-2013 - one start date, one member PPE
  - Spring/summer Biogeochemistry with ERSEM
Results
2011-2010 difference region mean time series for North Sea
(CMEMS rean in green)
Comparison of CMEMS Rean and GloSea5 Ens 201111-201011 Anomaly. Per = DJF
Comparison of CMEMS Rean and GloSea5 Ens 201111-201101 Anomaly. Per = DJF

- sst Rean
- nbt Rean
- sss Rean

- sst GSfc
- nbt GSfc
- sss GSfc

$r = 0.820$
$r = 0.816$
$r = 0.909$
How representative are these exemplars?
SST CMEMS and Gc DJF reanalysis 1995-2012
(GloSea5 k; CMEMS green)
SST CMEMS and Gc DJF reanalysis 1995-2012
(GloSea5 k; CMEMS green)

- **Shelf**
  - \( r = 0.61; p = 0.01 \)
  - bias = -0.40; rsd = 1.01

- **North Sea**
  - \( r = 0.59; p = 0.01 \)
  - bias = -0.52; rsd = 1.15

- **Celtic Seas**
  - \( r = 0.55; p = 0.02 \)
  - bias = -0.20; rsd = 0.91

- **Outer Shelf**
  - \( r = 0.63; p = 0.00 \)
  - bias = -0.41; rsd = 0.90

- **Skag/Kat**
  - \( r = 0.54; p = 0.02 \)
  - bias = -0.59; rsd = 1.45

- **Correlation**
  - Region number
  - Correlation coefficient range from 0.6 to 0.8

SSS CMEMS and Gc DJF reanalysis 1995-2012
(GloSea5 k; CMEMS green)

Shelf
- \( r = 0.78; p = 0.00 \)
- bias = 0.01; rsd = 1.30

North Sea
- \( r = 0.80; p = 0.00 \)
- bias = 0.03; rsd = 1.41

Celtic Seas
- \( r = 0.66; p = 0.00 \)
- bias = -0.05; rsd = 1.47

Outer Shelf
- \( r = 0.67; p = 0.00 \)
- bias = 0.04; rsd = 1.13

Skag/Kat
- \( r = 0.42; p = 0.00 \)
- bias = 0.07; rsd = 1.73

Correlation
- Region number
SST Region mean time series for North Sea with 1995-2012 baseline

CMEMS Reanalysis 2003

- Abs

CMEMS Reanalysis 2003

- Anom

GloSea FC 2003

- Abs

CMEMS Reanalysis 2007

- Abs

CMEMS Reanalysis 2007

- Anom

GloSea FC 2007

- Abs
2007-2003 difference region mean time series for North Sea
(CMEMS rean in green)
Comparison of CMEMS Rean and GloSea5 Ens 200704-200304 Anomaly. Per = 05

- sst Rean
- nbt Rean
- sss Rean
- sst GSfc
- nbt GSfc
- sss GSfc

$r = 0.773$
$r = 0.733$
$r = 0.873$
Conclusions

Evidence suggests GloSea5-CO6 is able to predict the difference between NWS winter conditions in different years.

There is potential for the NWS summer predictability on shorter lead times.

Not able to assess skill with only two case studies.

BGC needs much more work!
Further Work

Complete analysis

Improve methodology
(ask GloSea5 team to run some specific test cases for me?)

Methodical!
Assess GloSea5 directly for skill in NWS
Assess persistence
Assess skill

BGC!
What are the prospects for seasonal prediction of the marine environment of the Northwest European shelf?
How important is downscaling?
Met Office

DJF

2011-2010 (Nov start)

Difference Maps
Assessment of Persistence
Persistence
Oct. vs DJF
2011-2010
(Nov start)
Persistence
Mar. vs May
2007-2003
(Apr start)
Difficulties with BGC