Use of Medspiration and GlobColour products in operational ocean models

Rosa Barciela, UK Met Office

Outline

- Medspiration

  - Upgrades & impact on Met Office ocean forecasting models

  - Service delivery

- GlobColour

  - Ocean colour data assimilation

  - Regional downscaling

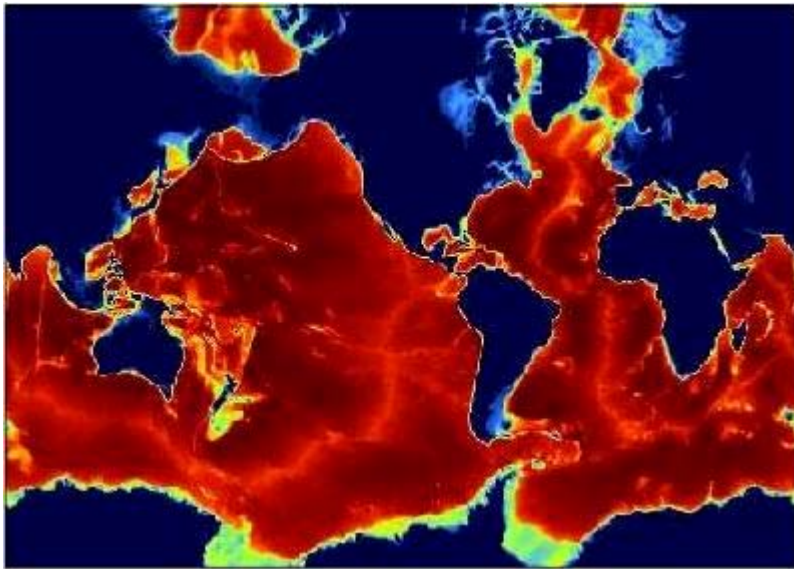 - Planned work
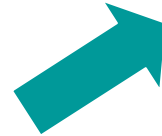
  - Future

- Summary and conclusions

Medspiration

FOAM-NEMO operational ocean models

Met Office

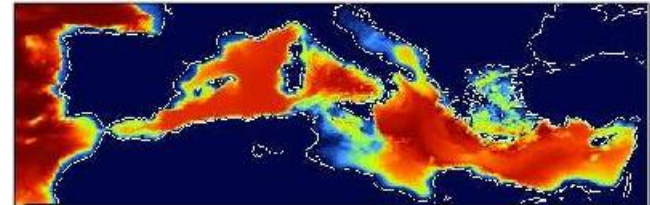All configurations have 50 levels with 1m resolution near surface.

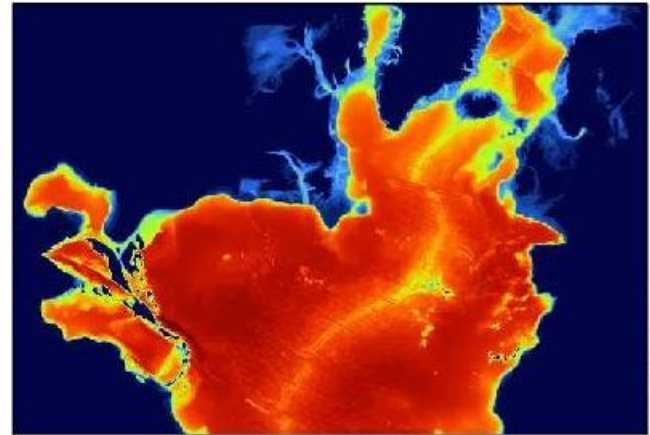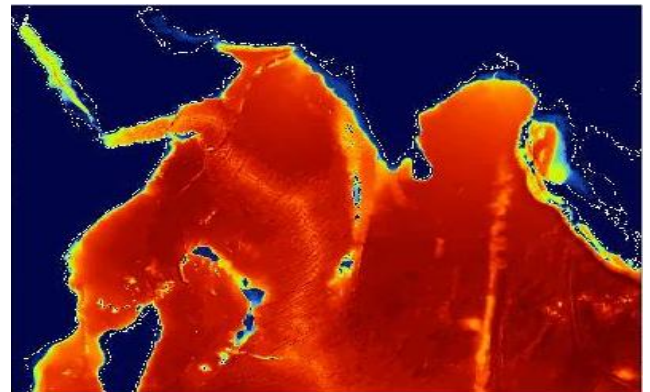**Global ¼° (ORCA025)**

grid, bathymetry and river outflow climatology provided by Mercator through My Ocean project.

1/12° North Atlantic

**1/12° Mediterranean**

1/12° Indian Ocean

Developments with FOAM-NEMO:
Assimilation of GHRSST data

• Assimilate various high resolution SST data sets from GHRSST (L2p data).

• Include bias correction scheme used by OSTIA

• AATSR and in situ data treated as reference data set in bias correction.

•~1 million data points - FOAM seems to cope well.

METOP AVHRR for 8 April 2008

NOAA AVHRR for 8 April 2008
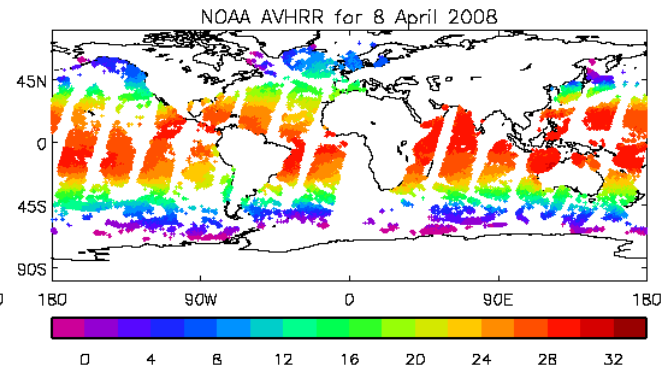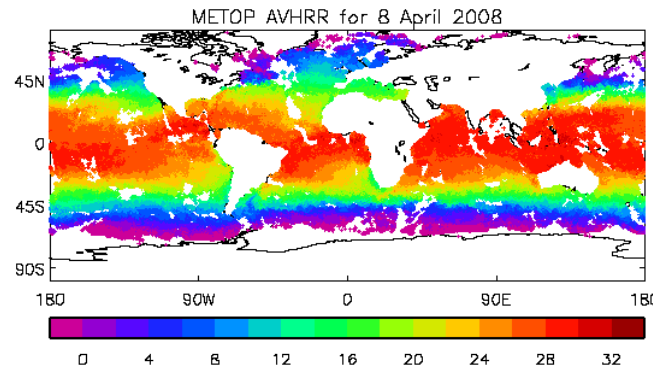
1 day of satellite data – 8th April 2008

AATSR for 8 April 2008

AMSR−E for 8 April 2008
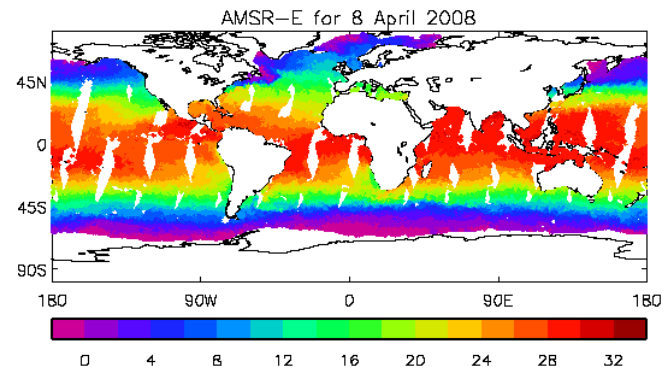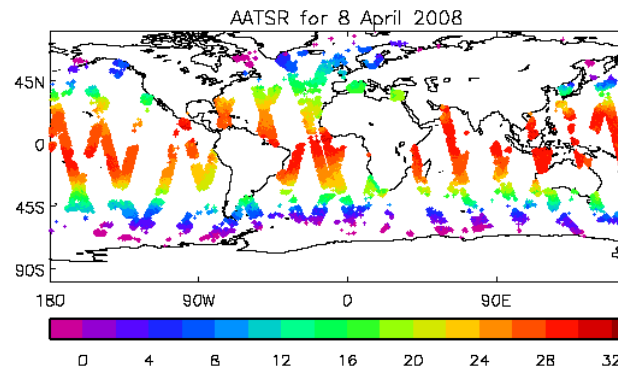
GODAE intercomparison

OSTIA
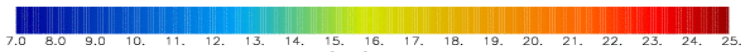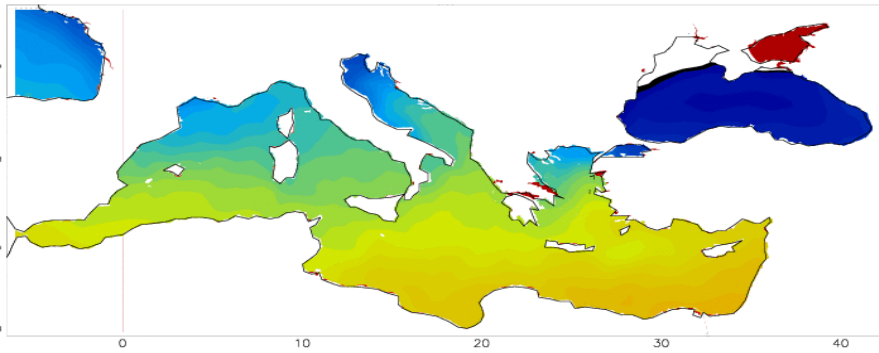
(a)

FOAM-NEMO
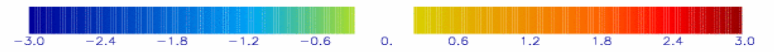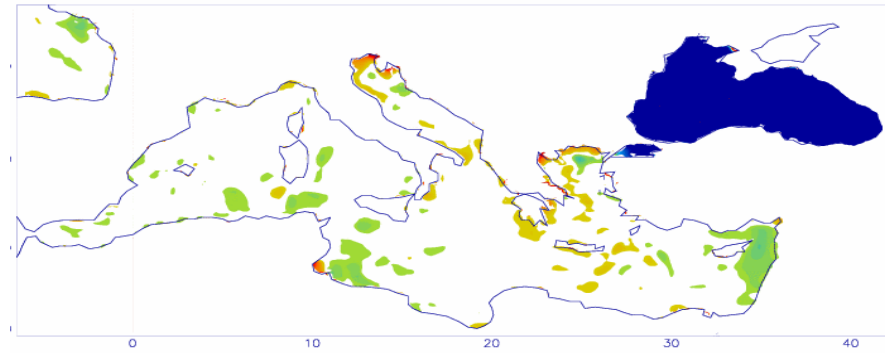
(b)

MERCATOR
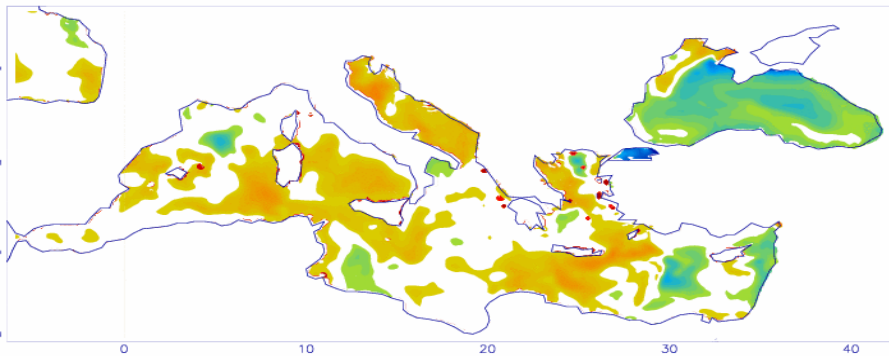
(c)

HYCOM
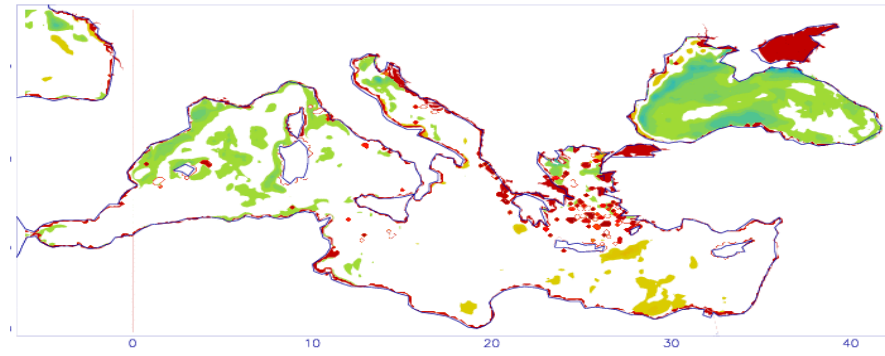
(d)

Operational service

- AATSR, NAR, SEVIRI and METOP data from Medspiration at Ifremer.

  - Recent service outages (3 failures on Saturdays within a month).

- TMI data disappeared from OSTIA data feed.

- Met Office's decision on data service based upon our requirement of a service that can provide:

  - Minimum 90% of availability.

  - Issues resolved within 1 day (even at weekends).

  - User notification of failure within a few hours.

- MyOcean will be addressing these issues through SLAs.

GlobColour

Assimilation of ocean colour in coupled physical-biogeochemical models

Met Office

■ Met Office has developed the capability for the simulation of surface and deep ocean biogeochemistry in NRT

■ unique operational system fully coupled (on-line!) to an ecosystem and carbon cycle model

■ state of the art data assimilation scheme for ocean colour/derived chl

■ hindcast capability back to 1997, which makes possible the quantification of impact of GlobColour products on variables of climate interest: air-sea CO_2 flux, carbon sequestration, acidity, PP, chl, etc.

■ well positioned to add value to the merged data by ensuring suitability for use for both operational oceanography and climate research

■ transitioning of R&D product into operations.

Ecosystem model
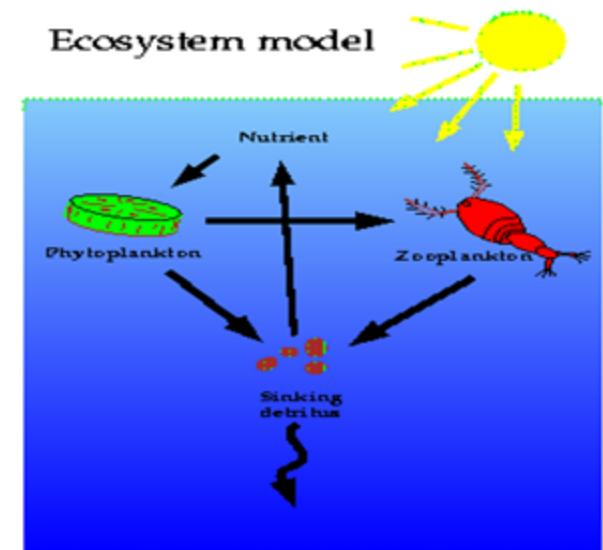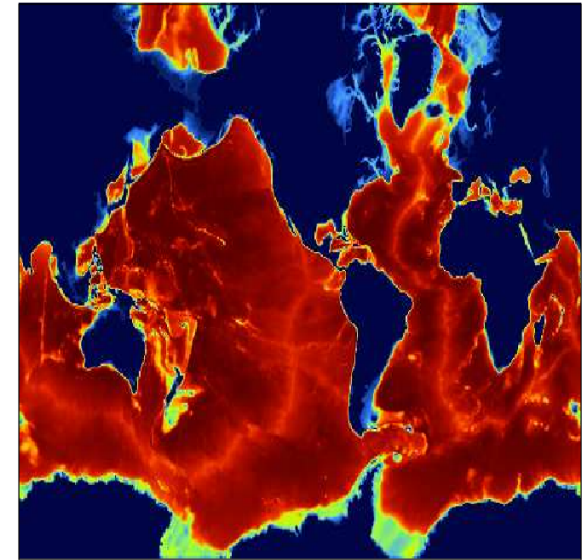
Assimilation of ocean colour in FOAM-HadOCC

▪ Aim:

- accurately quantification of air-sea fluxes of CO_2.
- global monitoring of phytoplankton biomass.

▪ Data assimilation scheme tested with SeaWiFS data. The data are global and provided at a resolution of ~9km. Target accuracy of ~35%.

▪ Assimilation of ocean colour developed jointly by NOCS and Met Office and implemented within the FOAM-HadOCC coupled physical-biological model.

▪ Hemmings, Barciela and Bell, JMR, 2008.

▪ Very few independent observations so difficult to test that the scheme works.

▪ Initial tests were therefore performed in an identical twin setting.

1/ 1/2003
SeaWiFS
Number of obs: 713348

Log_{10}(chl)
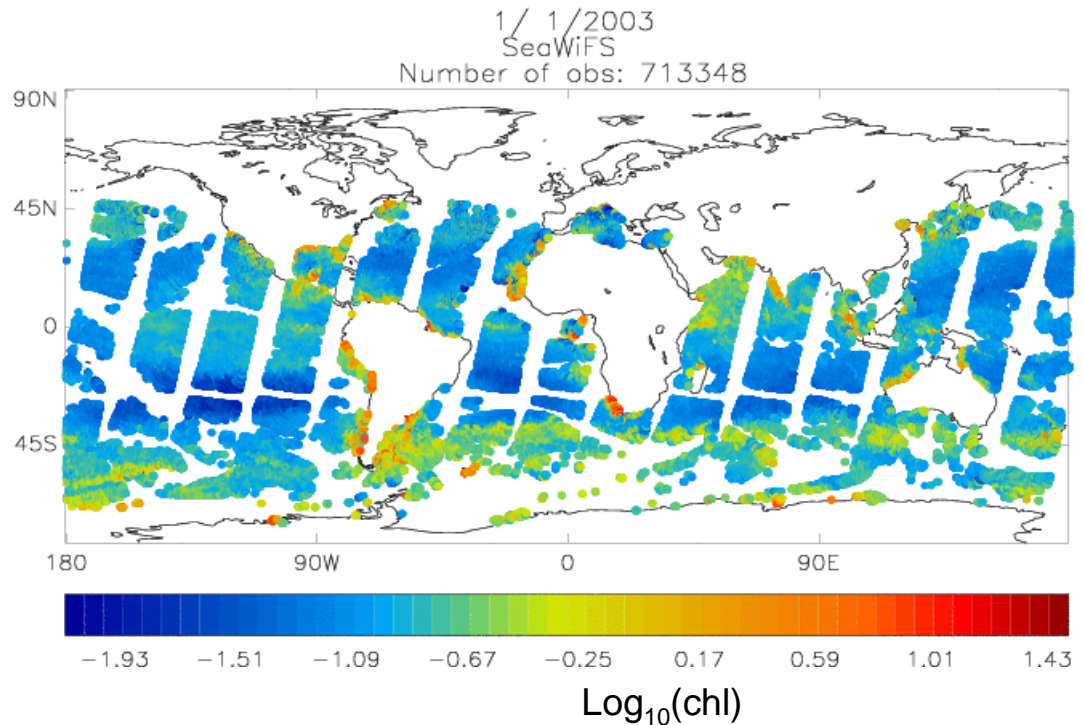
Ocean Colour assimilation experiments in an identical twin set-up

Met Office

• Start from a spun-up model state, then run the model forced by 6 hourly NWP fluxes for 1 year, with physical (T, S, SST) data assimilation . This is called the "true" run and runs from April 2003 to April 2004.

• Observations of Chl are taken from this "true" model state once a day.

• The ecosystem model variables are initialised using the fields from March 2003, with the physical fields taken from the true run.

• Starting from these new initial conditions, the model is run from April 2003 without ("control") and with ("assim") the Chl observations assimilated.
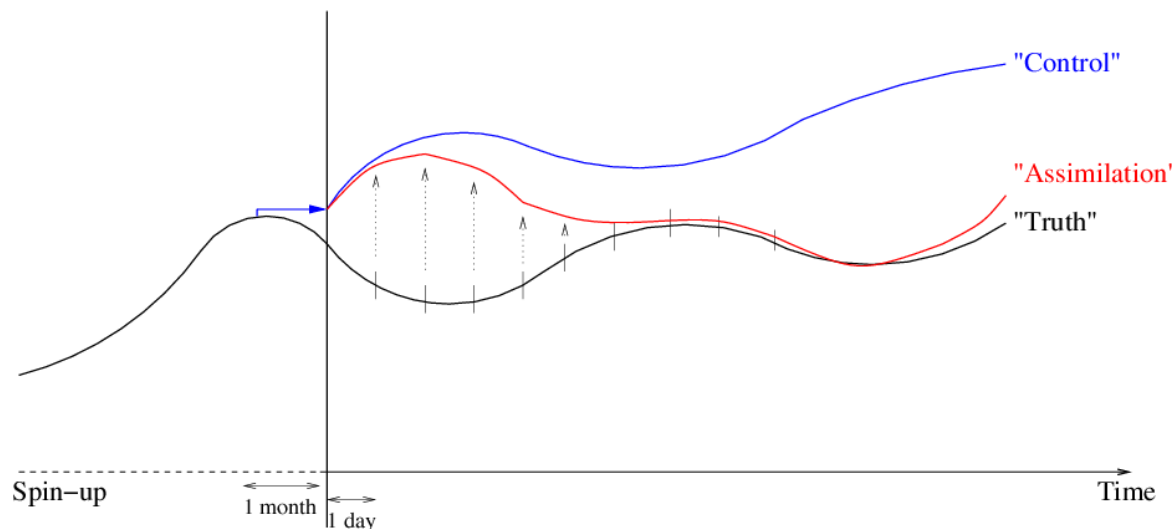
Identical twin experiments – Daily mean RMS Errors in the North Atlantic

Phytoplankton (mmolN/m^3)
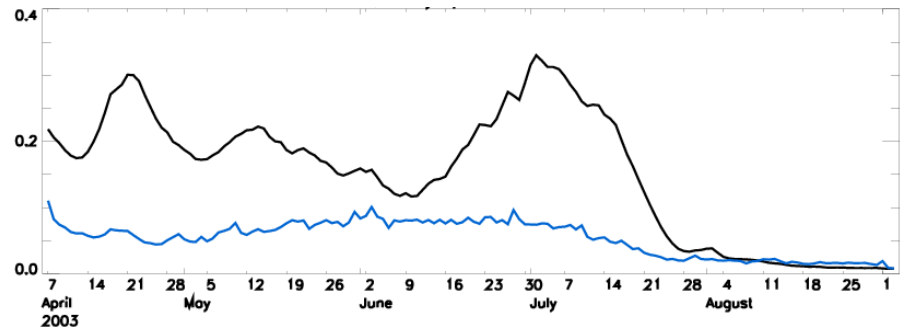
Zooplankton (mmolN/m^3)
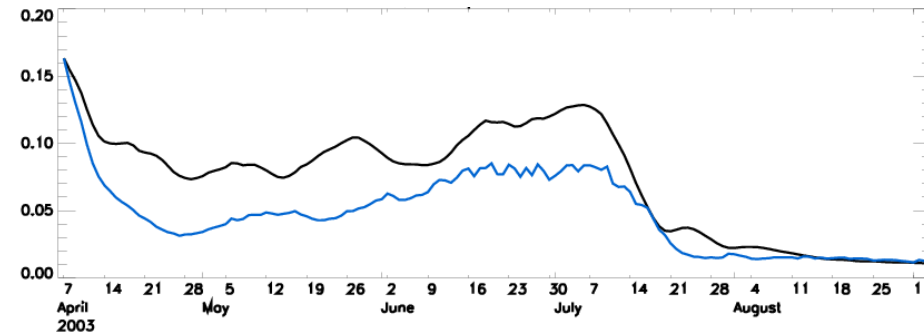
Detritus (mmolN/m^3)

Nutrients (mmolN/m^3)

Control - truth

Assimilation - truth
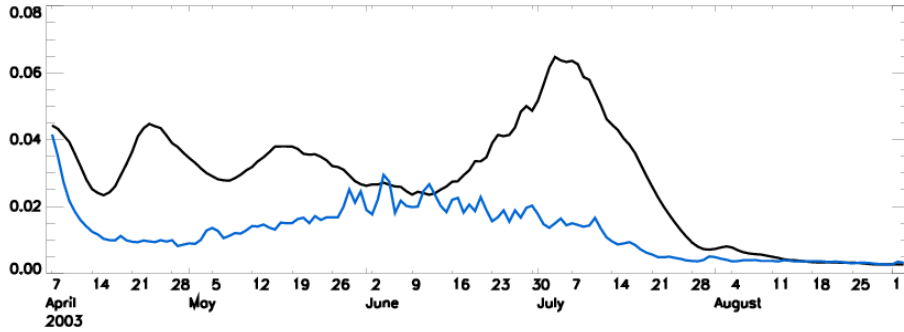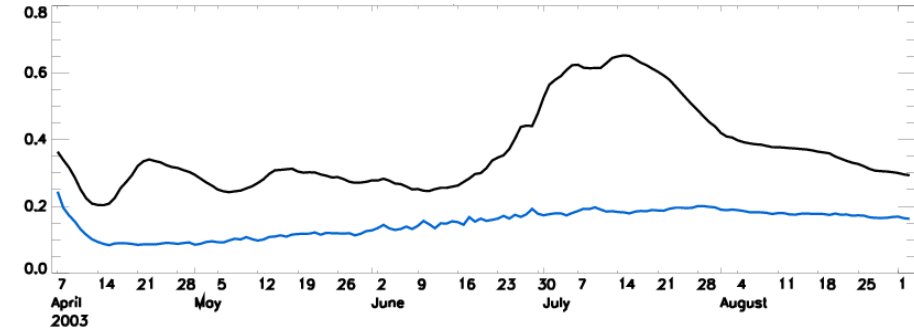
Identical twin experiments – Daily mean RMS errors in the North Atlantic

Total Dissolved Inorganic Carbon (mmolC/m^3)
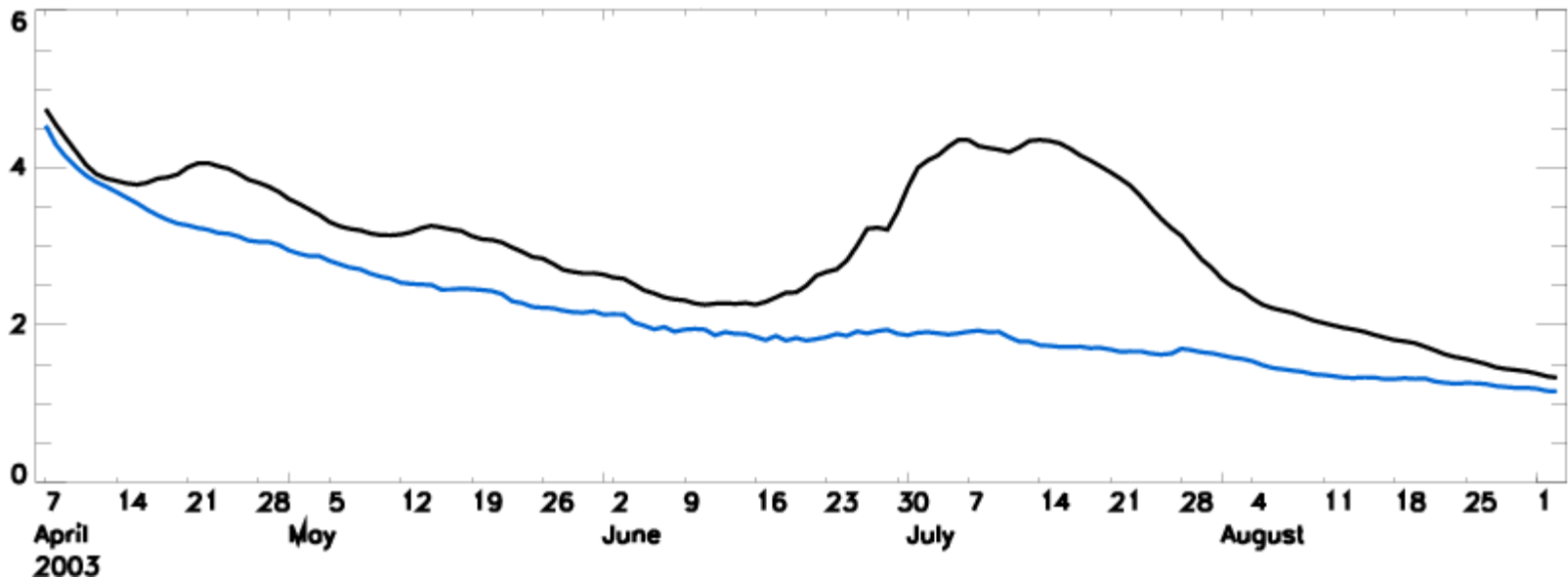
- Overall reduction in the errors in ecosystem variables.

- Air-sea exchange of CO_2 (via DIC) significantly improved after assimilating ocean colour data.

Control - truth

Assimilation - truth

Ocean Colour Data Assimilation (FOAM-HadOCC)

Log(chl) observations
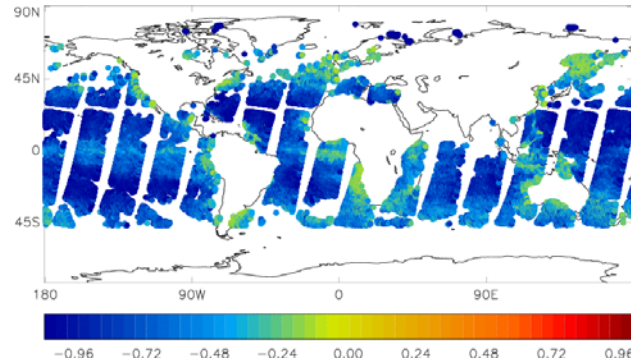
Log(chl) from model with no biological assimilation
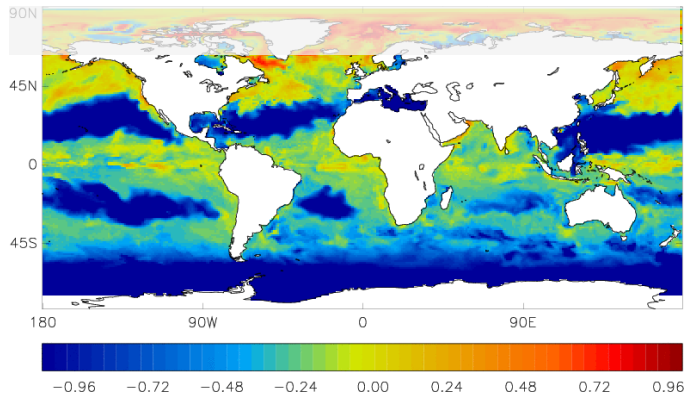
Log(chl) from model with biological assimilation
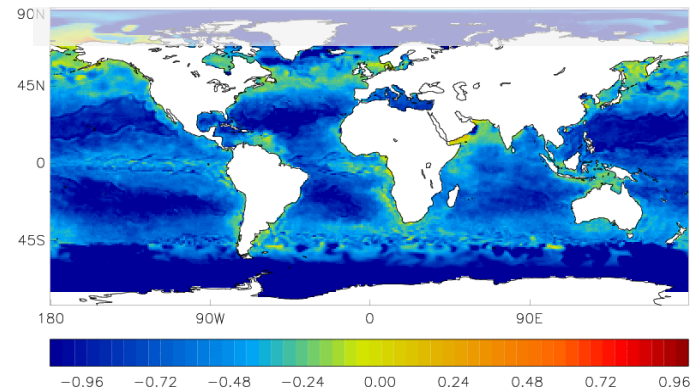
Real world experiments – on 1st July 2003

What will be doing in GlobColour?

- Assimilation of derived chlorophyll (GSM) and estimated errors in new FOAM-NEMO-HadOCC system from:

- GlobColour (merged product)
- MODIS & MERIS

-First-guess-at-appropriate-time (FGAT) which provides more accurate calculation of the model counterpart of the observation.

- Time period: short hindcast for 2008 and NRT assimilation for TOP.

- Aim is to:

- test operational capability of NRT GlobColour service (NRT).

- test impact of assimilation of GlobColour products on carbon cycle diagnostics: surface and profile chl, PP & air-sea fluxes of CO_2, pH.

- test impact on case 2 water coupled physical-biogeochemical models via provision of boundary conditions
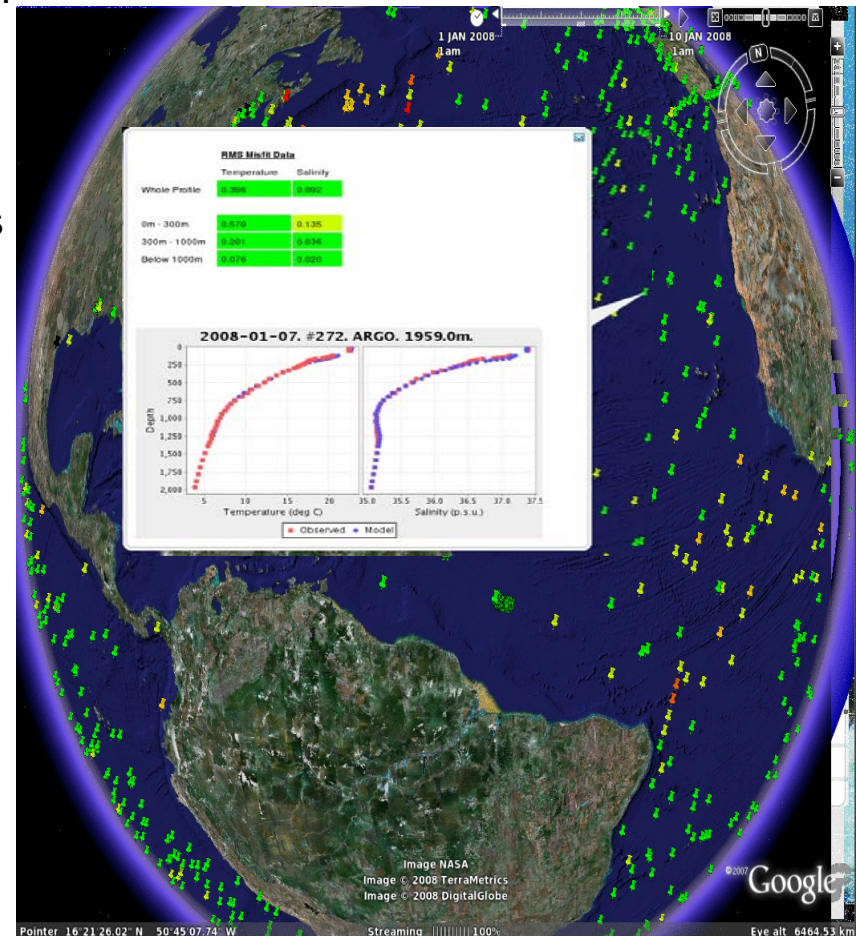
Regional downscaling - AlgaRisk08 Project

- Provision and integration of satellite and model information to the UK-Environment Agency.

- Help focus monitoring for nuisance bloom events.

- Enable EA to advise local authorities.

- Early warning for fish farming and aquaculture.

- Demonstrate potential to assist with EU Framework Directives.

- Aim in the medium term is to set up an operational forecasting system for nuisance algal blooms.

Met Office

NCOF

The National Centre for Ocean Forecasting

Environment Agency
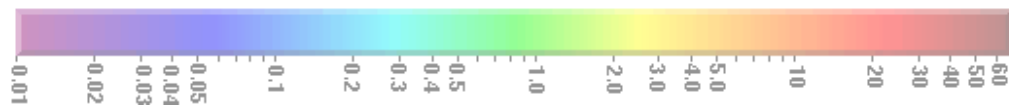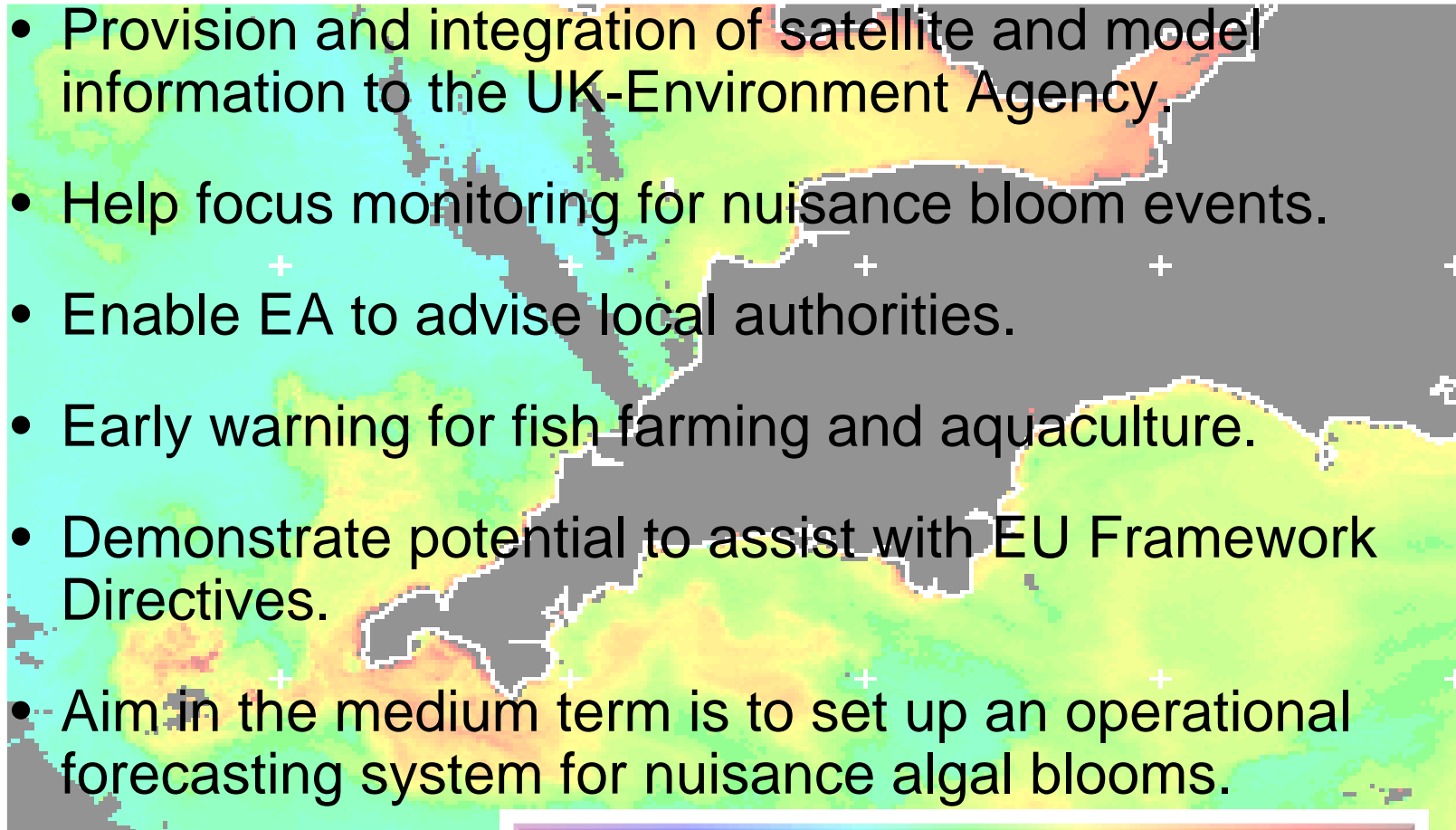
AlgaRisk08 project integrates EO with operational model (POLCOMS-ERSEM)

Met Office

Met Office Model

Back one week · Back one day · Forward one day · Go to Today

Viewing model forecast starting from: 29th May 2007

Nowcast
2 Days Ago
(29th May 2007)
00:00 (100% clear)

5 day forecast

| 1 days ago | Today | 1 days in the future | 2 days in the future | 3 days in the future |
| 30th May 2007 | 31st May 2007 | 01st Jun 2007 | 02nd Jun 2007 | 03rd Jun 2007 |

Earlier nowcasts

| 3 days ago | 4 days ago | 5 days ago | 6 days ago | 7 days ago |
| 28th May 2007 | 27th May 2007 | 26th May 2007 | 25th May 2007 | 24th May 2007 |

Select product:
Chlorophyll

Current product: Chlorophyll
Units: µg-Chl l⁻¹

0.2 0.3 0.4 0.5 0.6 0.8 1 2 3 4 5 6 7 8 9 20

▪ Daily analysis & 5 day forecast.

▪ Parameters provided:
  ▪ *physical*:
  SST, salinity, stratification, currents, PAR, wind, cloud cover.

  ▪ *biogeochemical*:
  phytoplankton biomass, flagellates, dinoflagellates, picoplankton, nutrient ratios.

▪ Predictive tool used by Environment Agency to assess prediction of nuisance bloom events on beaches (BCs from FOAM-HadOCC).

Integrate EO with operational ecosystem models
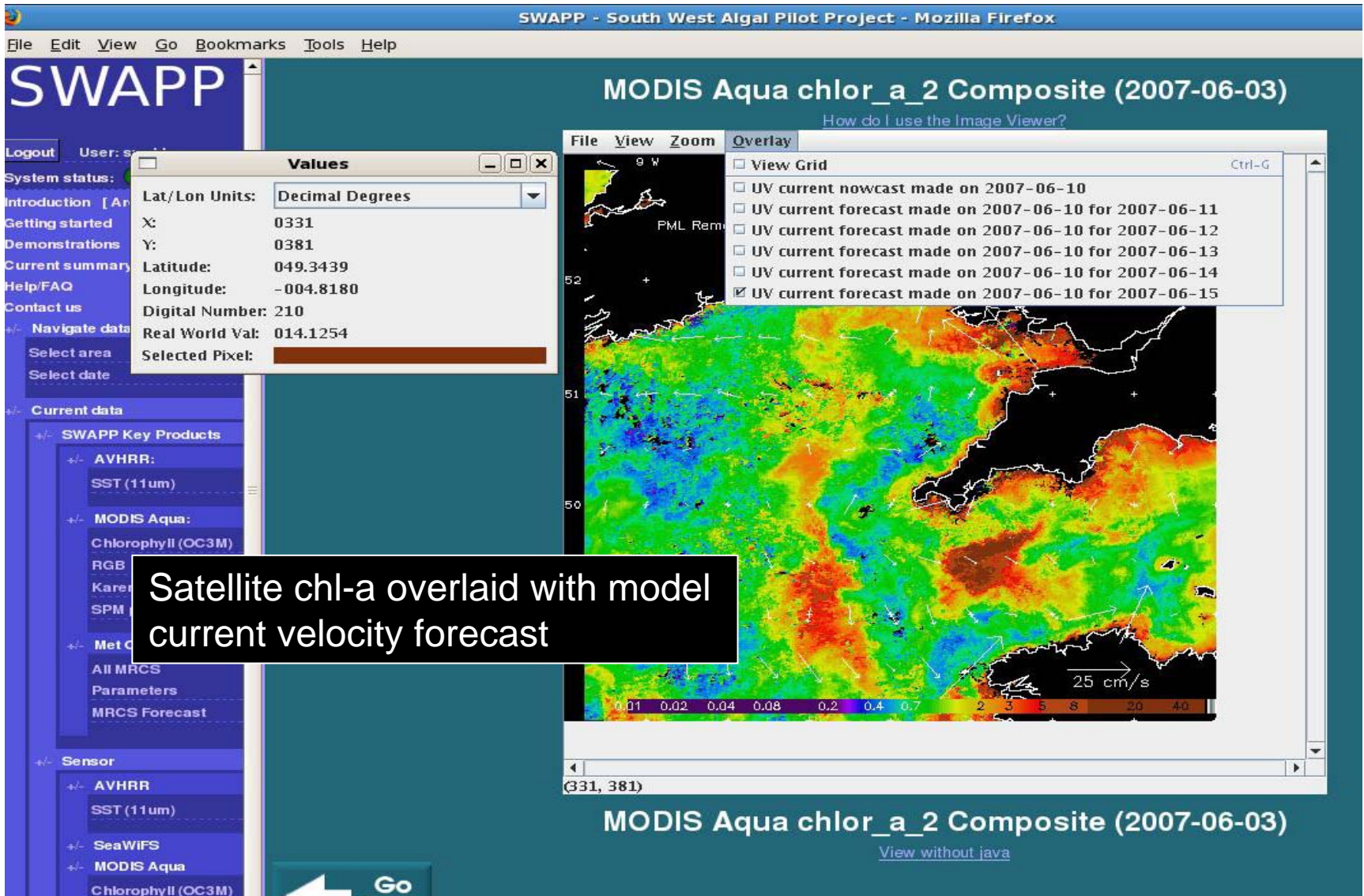
Satellite chl-a overlaid with model current velocity forecast

What next?

Product requirements for coastal applications: GlobColour 2?

- Non-phytoplankton absorption products: CDOM

- Kd_{490}

- IOPs

- Visibility (Secchi disk depth)

- Chlorophyll

- PFTs

- … plus error characterisation (critical)

- and target accuracy similar to case 1 waters (seamless transition)

Essential Climate Variables

- What is it?.

- Chl (proxy for phytoplankton biomass)

- **Drawback**:
  - chl not a tracer in biogeochemical models.
  - Need to covert P biomass by using C:Chl ratio.
  - Extremely complex

- .. so why not include Kd_{490}, **IOPs** (a, bb) as well given that:

- can be validated.

- insight into PFTs.

- potential link to HAB detection and carbon sequestration.

- no extra cost.

GCOS Essential Climate Variables

The Essential Climate Variables (ECVs) are required to support the work of the UNFCCC and the IPCC. All ECVs are technically and economically feasible for systematic observation. It is these variables for which international exchange is required for both current and historical observations. Additional variables required for research purposes are not included in this table. It is emphasized that the ordering within the table is simply for convenience and is not an indicator of relative priority. Currently, there are 44 ECVs plus soil moisture recognized as an emerging ECV. (from the WMO GCOS web site) (Reference document)

Atmospheric	Ocean	Terrestrial [2]
Surface	Surface	River Discharge
Air temperature	Sea-Surface Temperature	Water Use
Precipitation	Sea-Surface Salinity	Ground Water
Air Pressure	Sea Level	Lake Levels
Surface Radiation Budget	Sea State	Snow Cover
Wind Speed and Direction	Sea Ice	Glacier and ice caps
Water Vapour	Current	Permafrost and Seasonally-Frozen Ground
Upper-Air	Ocean Color	Albedo
Earth Radiation Budget	Carbon Dioxide Partial Pressure	Land Cover (including vegetation type)
Upper-air temperature	Sub-surface	Fraction of absorbed photosynthetically active radiation (fAPAR)
Wind Speed and Direction	Temperature	Leaf Area Index (LAI)
Water Vapour	Salinity	Biomass
Cloud Properties	Current	Fire Disturbance
Atmospheric Composition	Nutrients	Soil Moisture [3]
Carbon Dioxide	Carbon	
Methane	Ocean tracers	
Ozone	Phytoplankton	
Nitrous Oxide		
Chlorofluorocarbons (CFCs)		

Summary & conclusions

- FOAM-UM operational models transitioned to FOAM-NEMO.

- Improvements include:

  - First-guess-at-appropriate-time (FGAT) which provides more accurate calculation of the model counterpart of the observation.

  - Assimilation of GHRSST data and bias correction scheme as used by OSTIA.

- New system outperforms old system at global and regional scales largely due to improved quality of data assimilated .

- **GlobColour**

  - FOAM-NEMO-HadOCC ocean data assimilation will be used to:

    - test merged chl products versus individual data streams

    - quantify impact on carbon cycle variables

    - quantitfy impact on case 2 coupled models via supply of LBCs.

  - Test service delivery for operational purposes: robustness, timeliness.

  - Statement on requirements for GlobcColour in case 2 waters.

  - Proposed extension of ECV to include Kd and IOPs as well as chl.