Ocean Currents at the Met Office

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Contents

This presentation covers the following areas

- Introduction to Met Office Ocean Forecasting systems:

  - ➢ The FOAM deep ocean system

  - ➢ The FOAM shelf seas system

- Wave modelling systems

- Validation of FOAM current forecasts

- FOAM current requirements

FOAM : Forecast Ocean Assimilation Model

A brief introduction

Forecasting Ocean Assimilation Model (FOAM)

- Daily analyses and forecasts out to 7 days

- Data assimilation using a multi-scale Analysis Correction scheme

- Velocity fields provided operationally to a number of users including:

  - Naval operations

  - Shipping

  - Offshore commercial

  - Search & rescue/safety at sea

  - Oil spill monitoring

- Provides lateral boundary conditions to ocean forecasting models run at external organisations

- Will provide currents for Met Office Wavewatch III wave forecasts (in the near future)
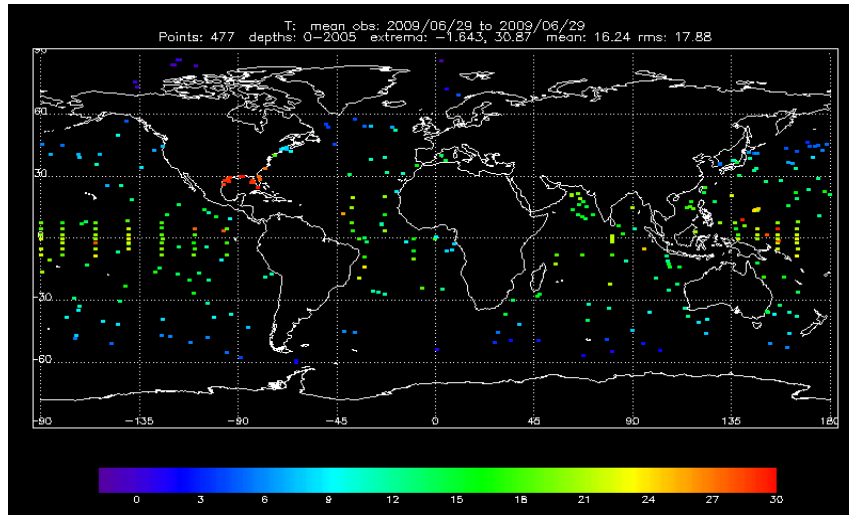
FOAM System overview
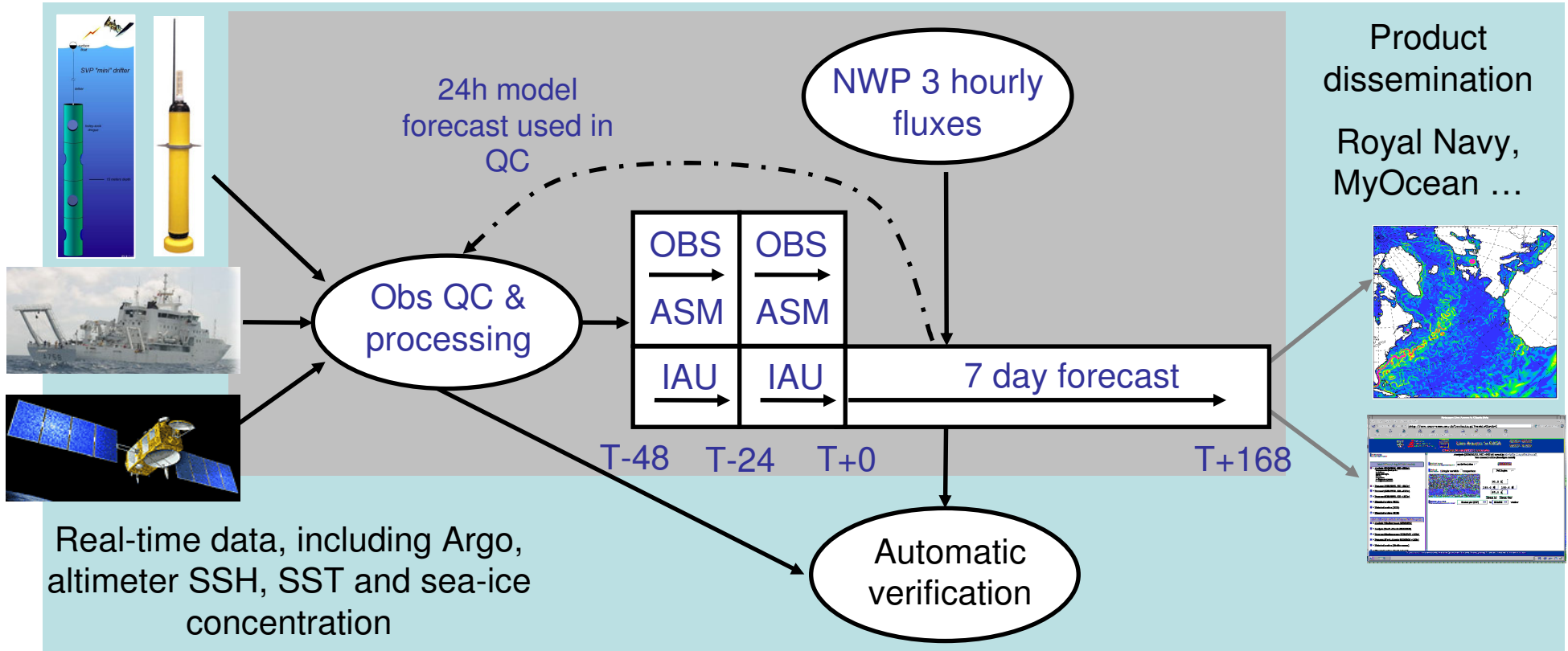
- 48-hour observation window allows us to include much more data into the FOAM system
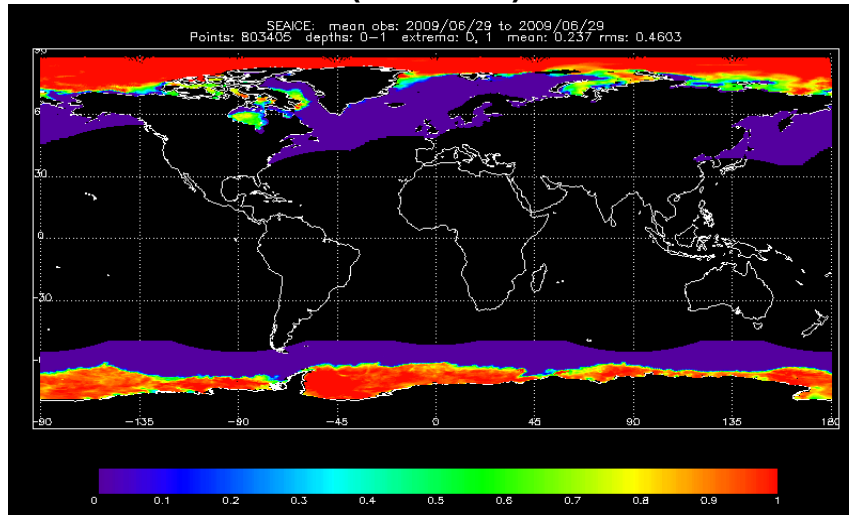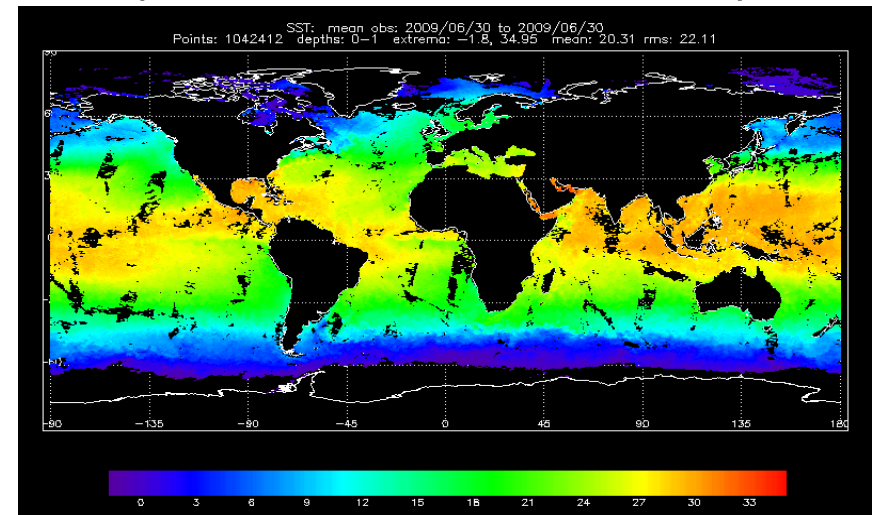
FOAM Data assimilation

Temperature and salinity profiles
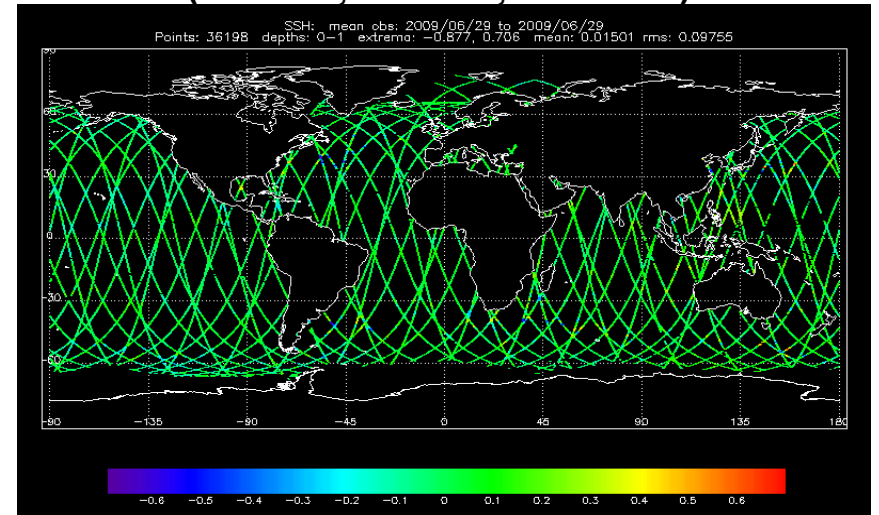**(Argo floats, XBTs, CDTs, buoys,…)**

Satellite and in-situ SST
(AATSR, AVHRR, AMSRE, METOP)
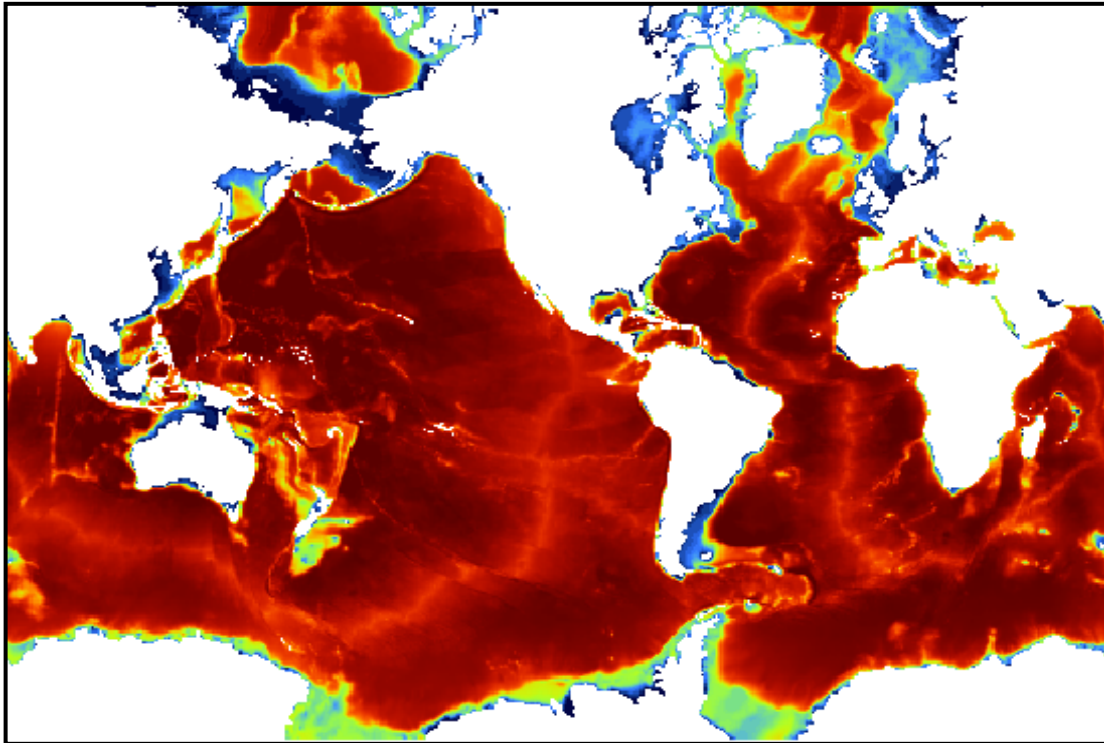

Sea-ice concentration
(OSI-SAF)

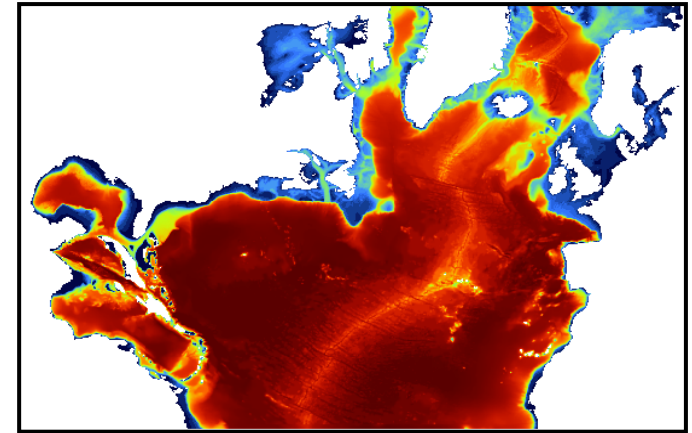**Satellite Altimeter SSH**
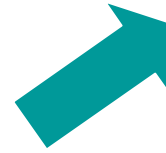**(Jason 1, Jason 2, ENVISAT)**

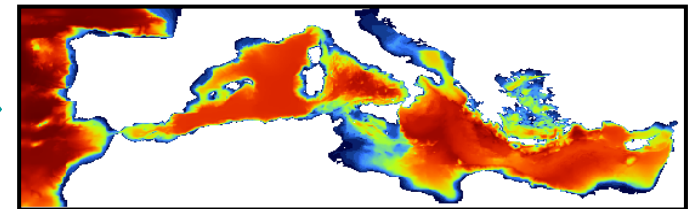# FOAM Deep Ocean Configurations

1/4° Global (**orca025**)

Provides lateral boundary conditions for the regional models

1/12° North Atlantic

1/12° Mediterranean
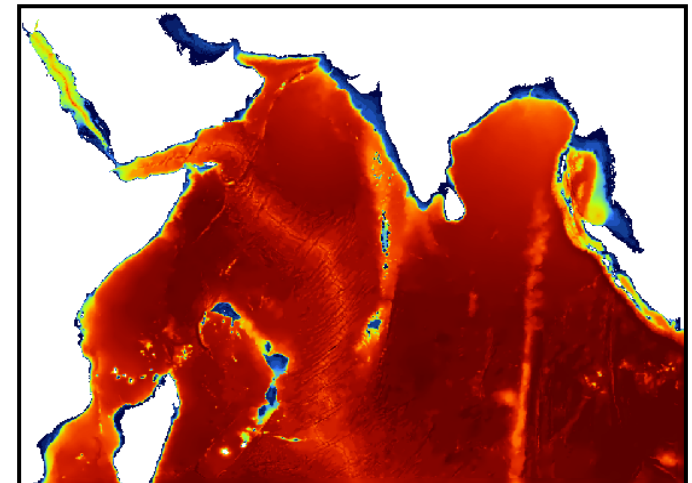
1/12° Indian Ocean

FOAM Deep Ocean Models

- NEMO ocean model (with a linear free surface) coupled to LIM2 sea-ice model

- 50 constant depth vertical levels (z-levels)

- Surface forcing using 3-hourly NWP fluxes

- Assimilation of satellite and in-situ observations of temperature, salinity, SSH and sea-ice concentration

- Provides lateral boundary conditions for the UK shelf seas models as well as other external organisations

- Producing the following current products:

  - Daily mean 3D currents ($1/4^\circ$ and $1/12^\circ$ models)

  - 12-hourly instantaneous 3D currents ($1/4^\circ$ and $1/12^\circ$ models)

  - 3-hourly instantaneous surface currents ($1/4^\circ$ model)

FOAM Shelf Seas Configurations

1/12° North Atlantic

1-way nesting

7km Atlantic Margin Model

1/12° Indian Ocean

1-way nesting

4km Arabian Gulf Model
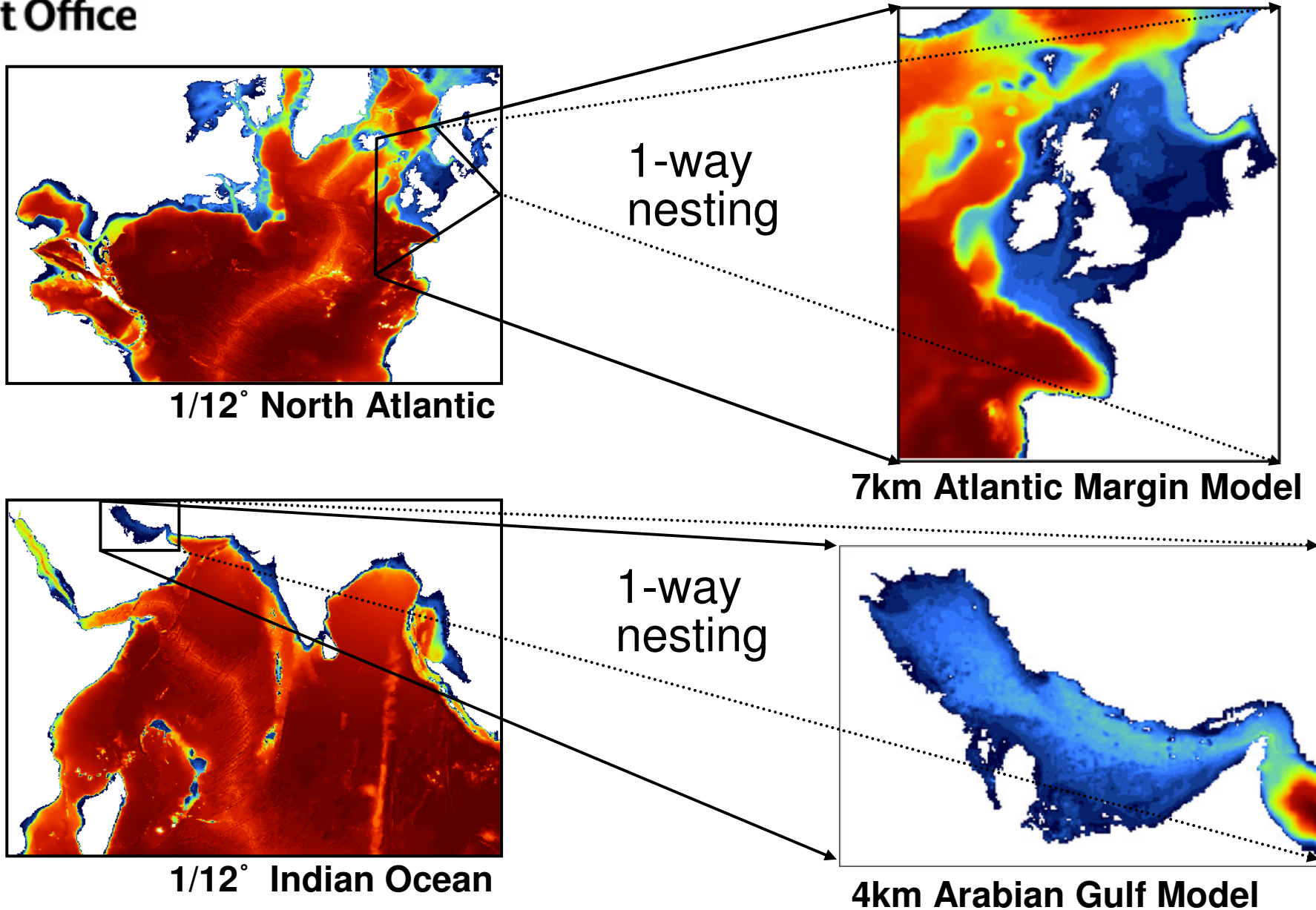
FOAM Shelf Seas Models

- NEMO ocean model with a non-linear free surface

- 33 terrain following vertical levels (hybrid sigma-s levels)

- Tidal harmonics with 15 constituents

- Surface forcing using a combination of 3-hourly and hourly NWP fluxes

- Assimilation of satellite and in-situ Sea Surface Temperature (SST) observations

- 6-hourly boundary inputs from the deep ocean $1/12°$ regional models

- Producing the following current products:

  - 25-hourly mean 3D currents

  - hourly instantaneous 2D currents (surface, middle, bottom levels)

Met Office Wave Modelling Systems

- Global model ~35km resolution

- North Atlantic European (NAE) model ~12km resolution

- Persian Gulf model ~18km resolution
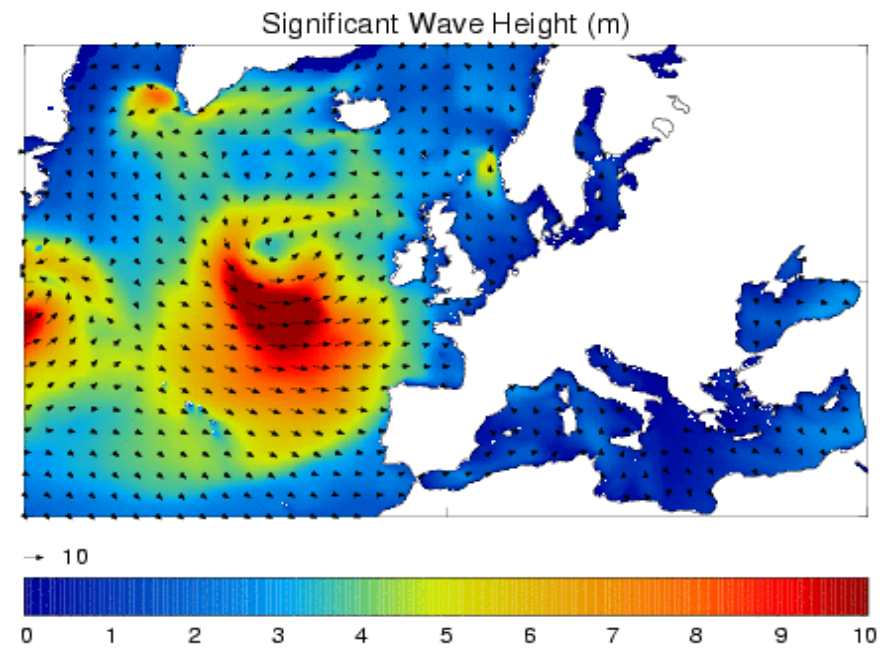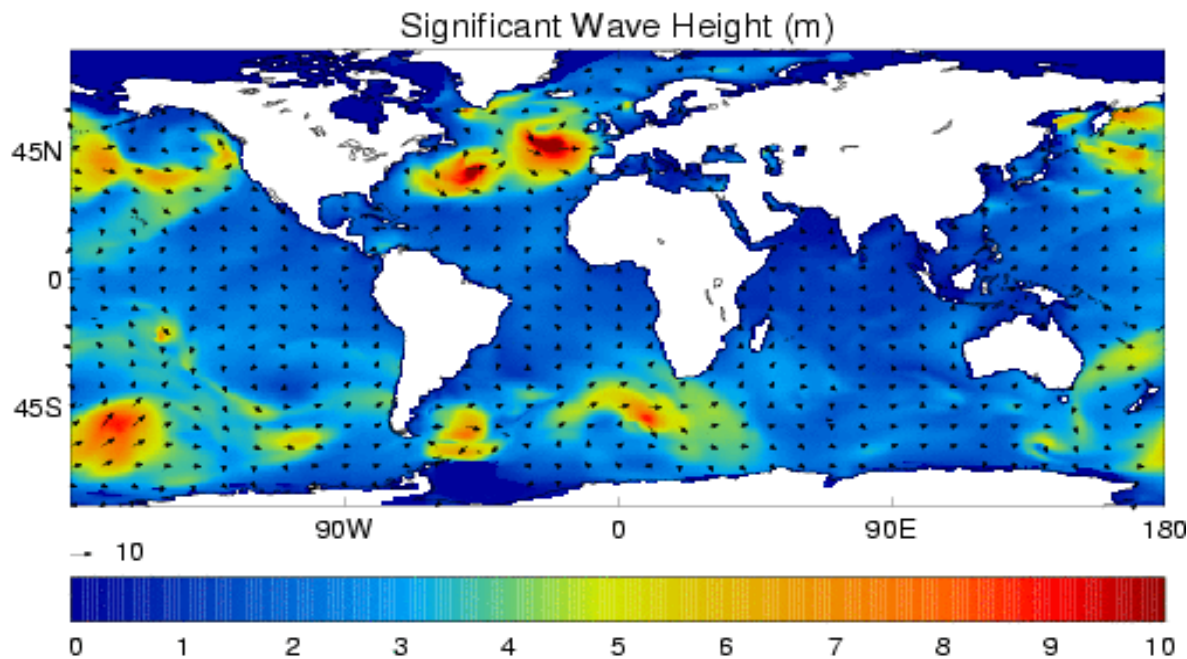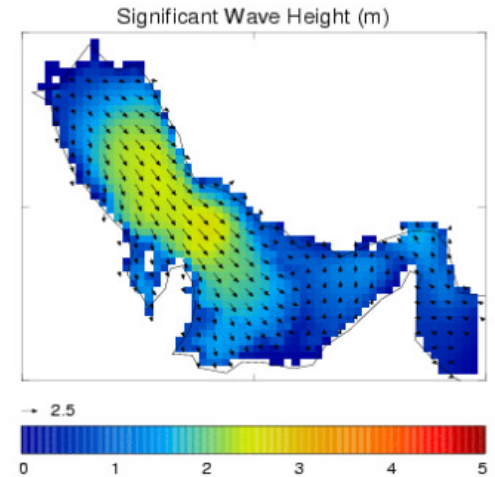
Wave Modelling Systems

- Global model

  - 30km horizontal resolution

  - Runs twice daily, out to 5 days with 3-hourly outputs

- North Atlantic European model

  - 12km horizontal resolution

  - Four times daily, out to 36 hours at hourly resolution

  - Twice daily, out to 5 days at 3-hourly resolution

- Future regional models will be 4-8km resolution and will use FOAM surface currents

Validation of FOAM current forecasts

Validating FOAM current forecasts

- Recent validation of FOAM current forecasts has been performed using the following data sources:

  - Velocities derived from the positions of Global Drifter Program Lagrangian drifting buoys

  - Velocities observed by the Global Tropical Moored Buoy Array (TAO/TRITON, PIRATA, RAMA)

  - Surface and subsurface moorings aboard off-shore drilling platforms

- Mean errors (biases), Root-Mean-Square (RMS) errors and correlation coefficients are briefly presented here

Drifting buoy statistics: Zonal velocity

	mean	RMSE	correlation	norm. s.d.	obs/day
Global	-0.004	0.21	0.57	0.70	653
North Atlantic	-0.003	0.21	0.49	0.68	179
Tropical Atlantic	-0.004	0.21	0.60	0.80	40
South Atlantic	0.009	0.22	0.48	0.68	99
North Pacific	-0.022	0.21	0.66	0.72	139
Tropical Pacific	-0.051	0.21	0.70	0.81	91
South Pacific	0.000	0.20	0.56	0.64	135
Indian Ocean	-0.021	0.23	0.62	0.77	79
Southern Ocean	0.064	0.24	0.35	0.68	130

Drifting buoy statistics: Meridional velocity

	mean	RMSE	correlation	norm. s.d.	obs/day
Global	0.001	0.19	0.45	0.67	653
North Atlantic	0.002	0.19	0.43	0.64	179
Tropical Atlantic	0.006	0.16	0.51	0.80	40
South Atlantic	-0.001	0.20	0.34	0.66	99
North Pacific	-0.009	0.19	0.55	0.69	139
Tropical Pacific	-0.004	0.17	0.55	0.80	91
South Pacific	0.006	0.17	0.40	0.63	135
Indian Ocean	0.013	0.21	0.55	0.74	79
Southern Ocean	-0.007	0.22	0.31	0.66	130

Moored buoy statistics in the tropics

	mean	RMSE	correlation
Zonal Velocity			
10S – 10N	0.13	0.30	0.78
2S – 2N	0.22	0.37	0.77
Meridional Velocity			
10S – 10N	-0.004	0.19	0.55
2S – 2N	0.006	0.20	0.56

Met Office current requirements

For FOAM validation and/or assimilation purposes

FOAM current requirements

- Global/deep ocean models

  - 1-hourly (or 3-hourly) temporal resolution

  - At most 1/4º horizontal resolution

  - Uncertainty/error <0.1m/s (0.2m/s useful)

- Global climate models

  - Daily-mean temporal resolution (although monthly or seasonal means possibly of use)

  - 1/4º horizontal resolution (although 1º possibly useful)

- Shelf Seas/tidal models

  - 30 minute temporal resolution

  - 1.5km horizontal resolution

  - Uncertainty/error <0.1m/s

Wave model requirements

- Global wave model

  - 3-hourly temporal resolution

  - 20km horizontal resolution

  - Uncertainty/error <0.25m/s*

- Regional wave models

  - 30 minute temporal resolution

  - 2km horizontal resolution

  - Uncertainty/error <0.25m/s*

- Coastal wave models

  - 15 minute temporal resolution

  - Horizontal resolution 1km (max) down to 10m

- *location of features/fronts more important for wave modelling than site-specific accuracy
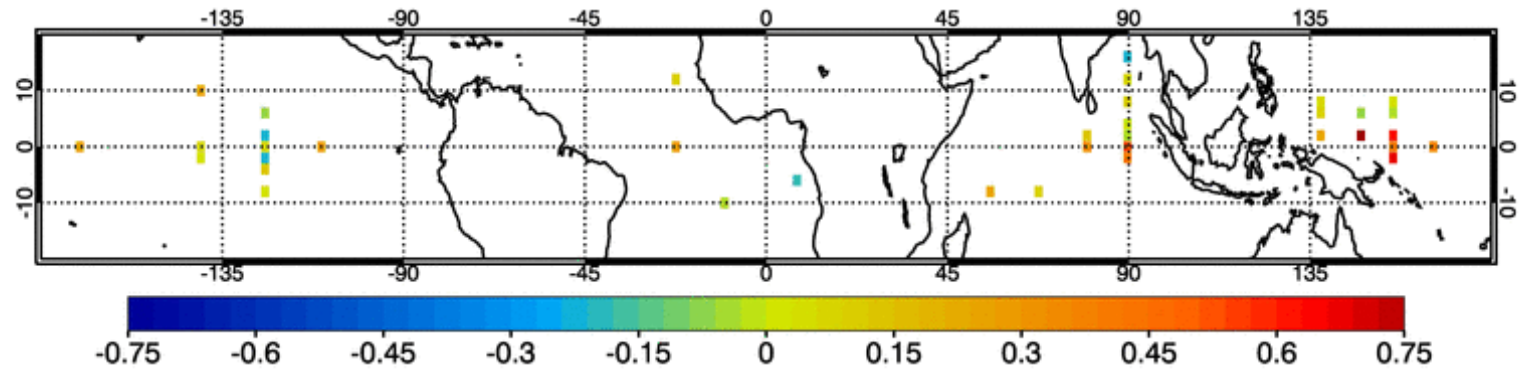
Questions and answers

FOAM Deep Ocean Models

- In Autumn FOAM changes to use the following:

  - bulk formulae surface boundary conditions with a mixture fo 3-hourly and hourly inputs

  - the CICE sea-ice model

  - NEMOVAR variational data assimilation scheme

  - 75 depth levels

Tropical comparisons

Moored Buoys

Drifting Buoys