



Marine Climate Change Program

Oceanographic Services Section
Marine Institute

Ocean Numerical Modelling at the Marine Institute

Sinan Husrevoglu

Collaborators:

Marcel Curé

Kieran Lyons

Heather Cannaby

EPA Climate Change Research Adaptation Workshop

Dublin, 17 June 2008



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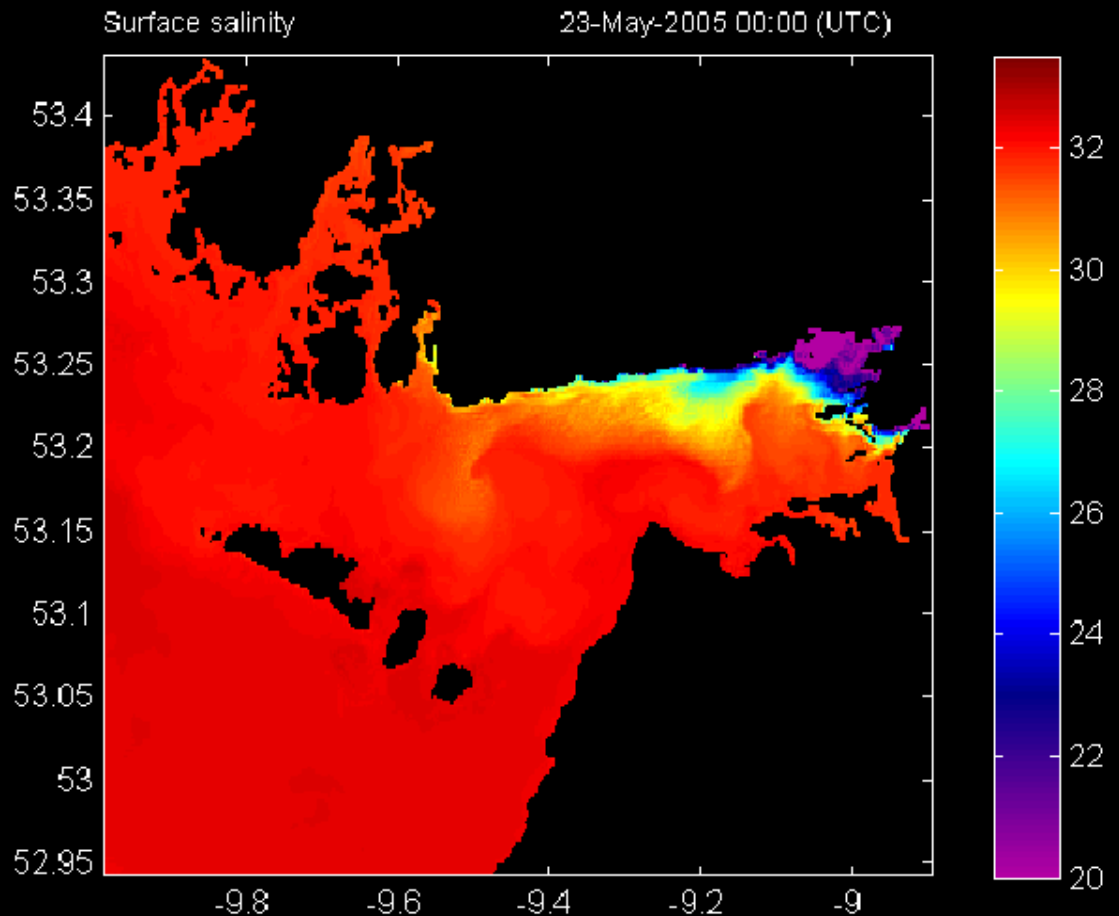
Outline

- Existing ocean modelling capacity at the MI
 - Operational, ecosystem, regional and wave models
- Current Analysis
 - Model verification and data availability
- Modelling in climate change context
 - Proposed downscaling climate models
- Outcomes of future climate change research



Operational model:

- Every 2.5km
- 40 levels in water column
- Temperature, salinity, currents (all levels)
- Surface height
- Astronomical tides
- 35 rivers



Created on 04-Dec-2007

(c) Marine Institute, 2005

gb_salt_highres

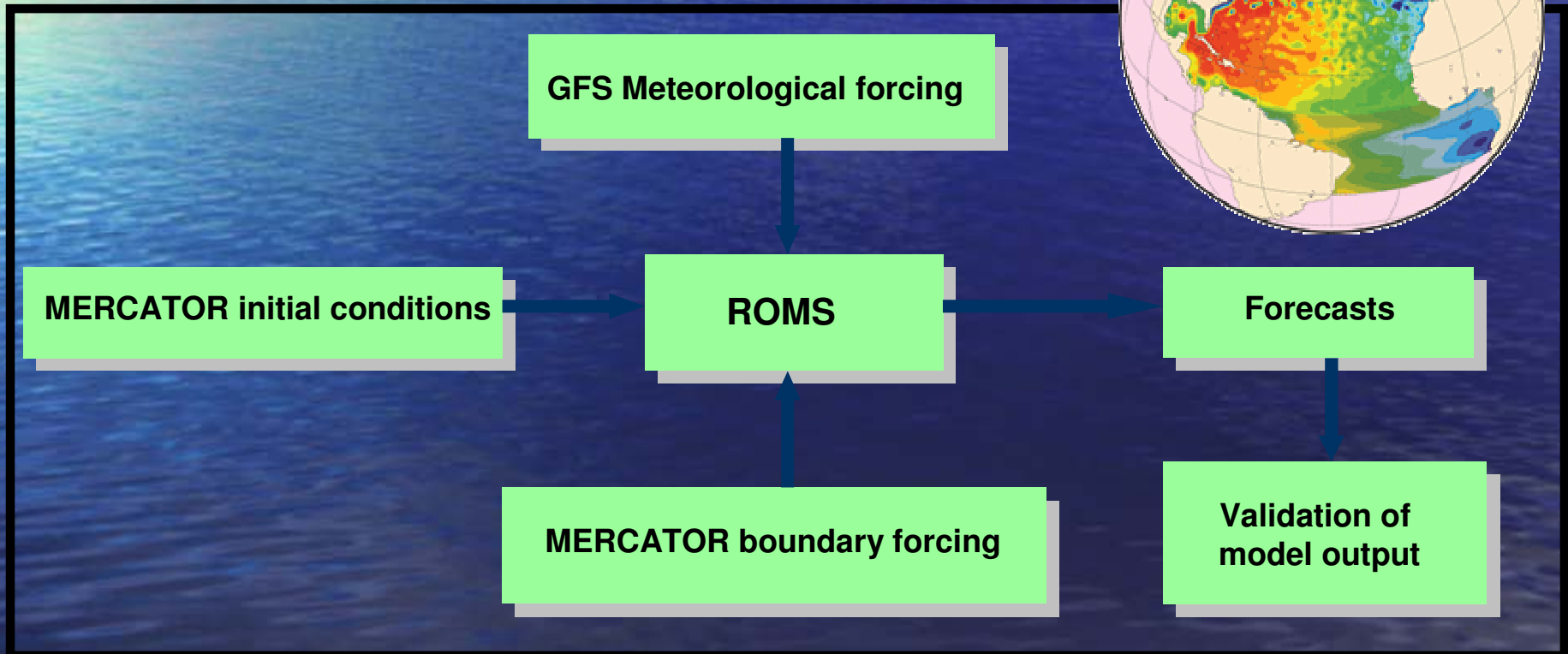
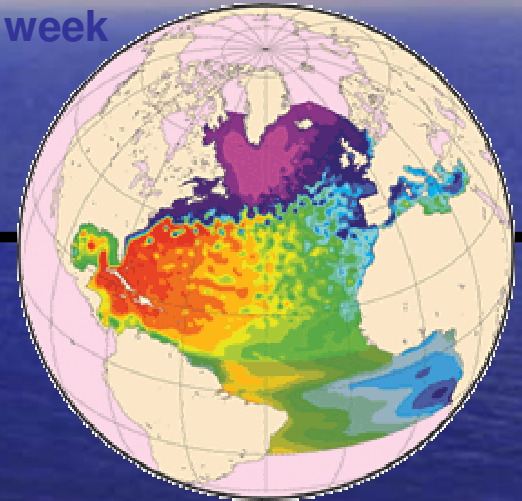
-25 -20 -15 -10 -5 0 5

(c) Marine Institute, 2007

Current operational status

Each week:

- New forcing and boundary files produced from latest GFS & MERCATOR forecasts
- New hindcast and forecast model runs conducted 3 times a week
- Model results validated against measured data
- ENTIRE PROCESSES AUTOMATED**

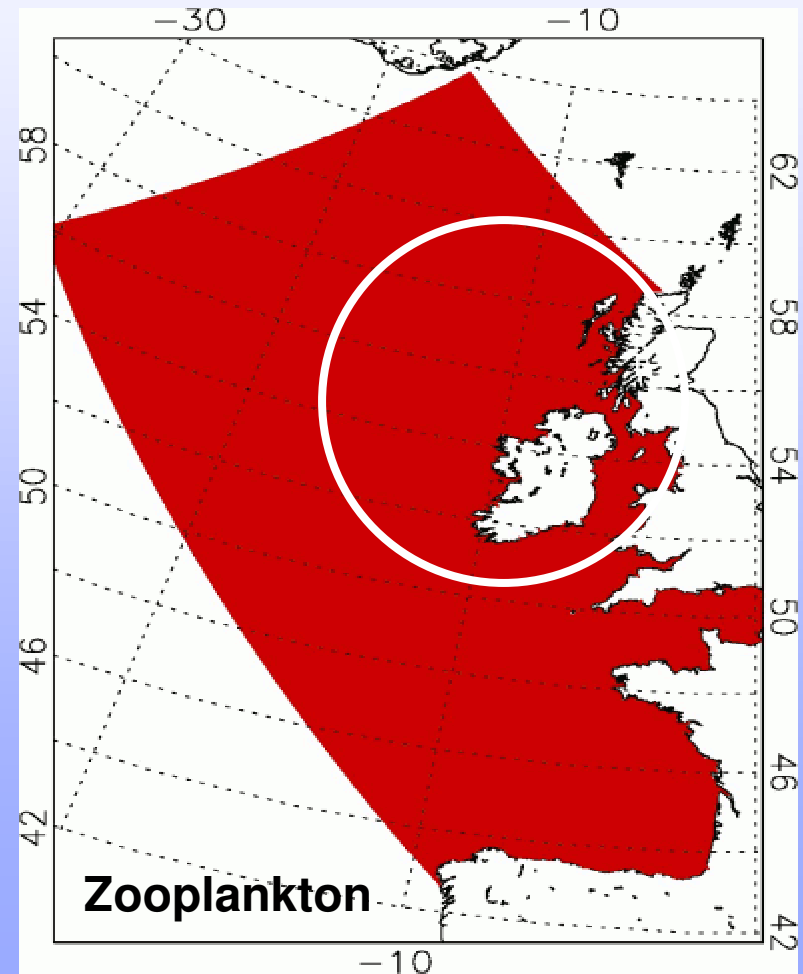
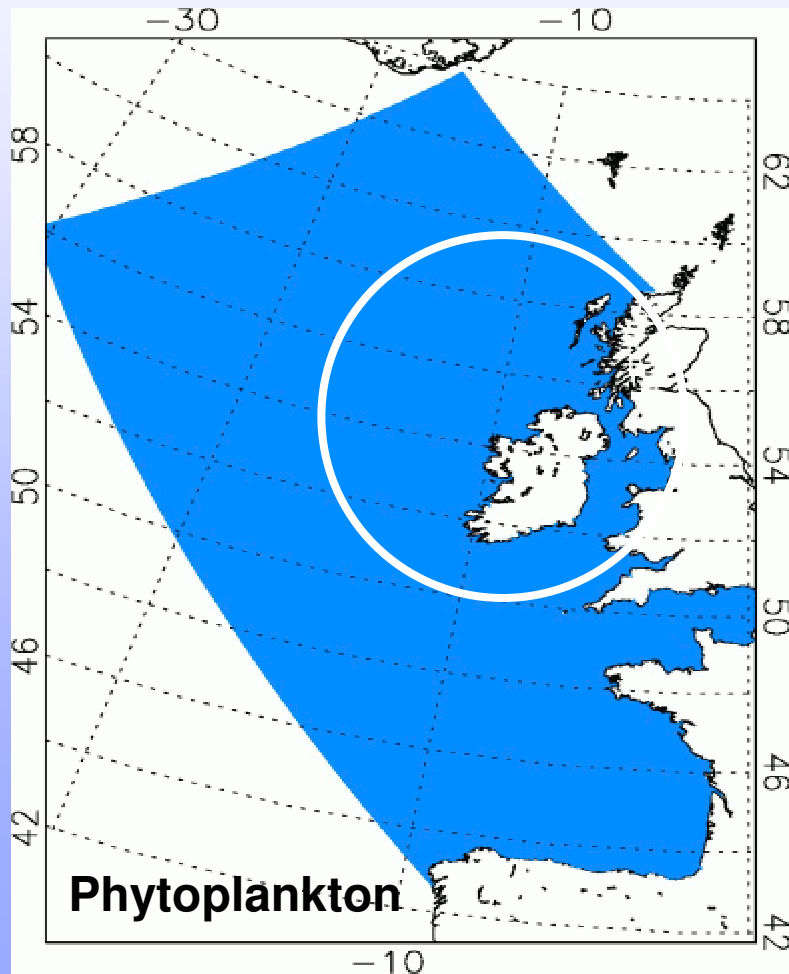




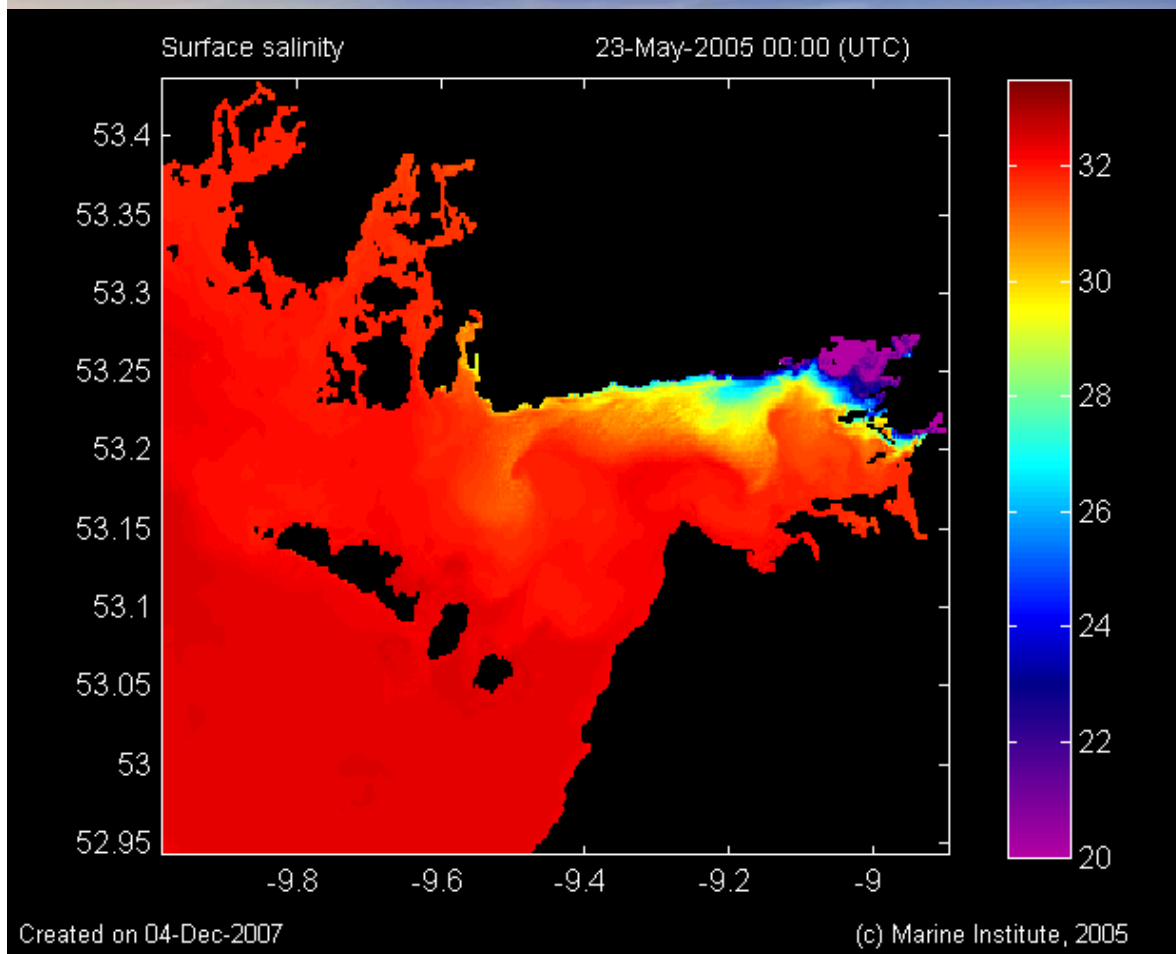
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Ocean-ecosystem model (ROMS-Fasham NPZD) test run



Galway Bay ROMS model



200 m resolution

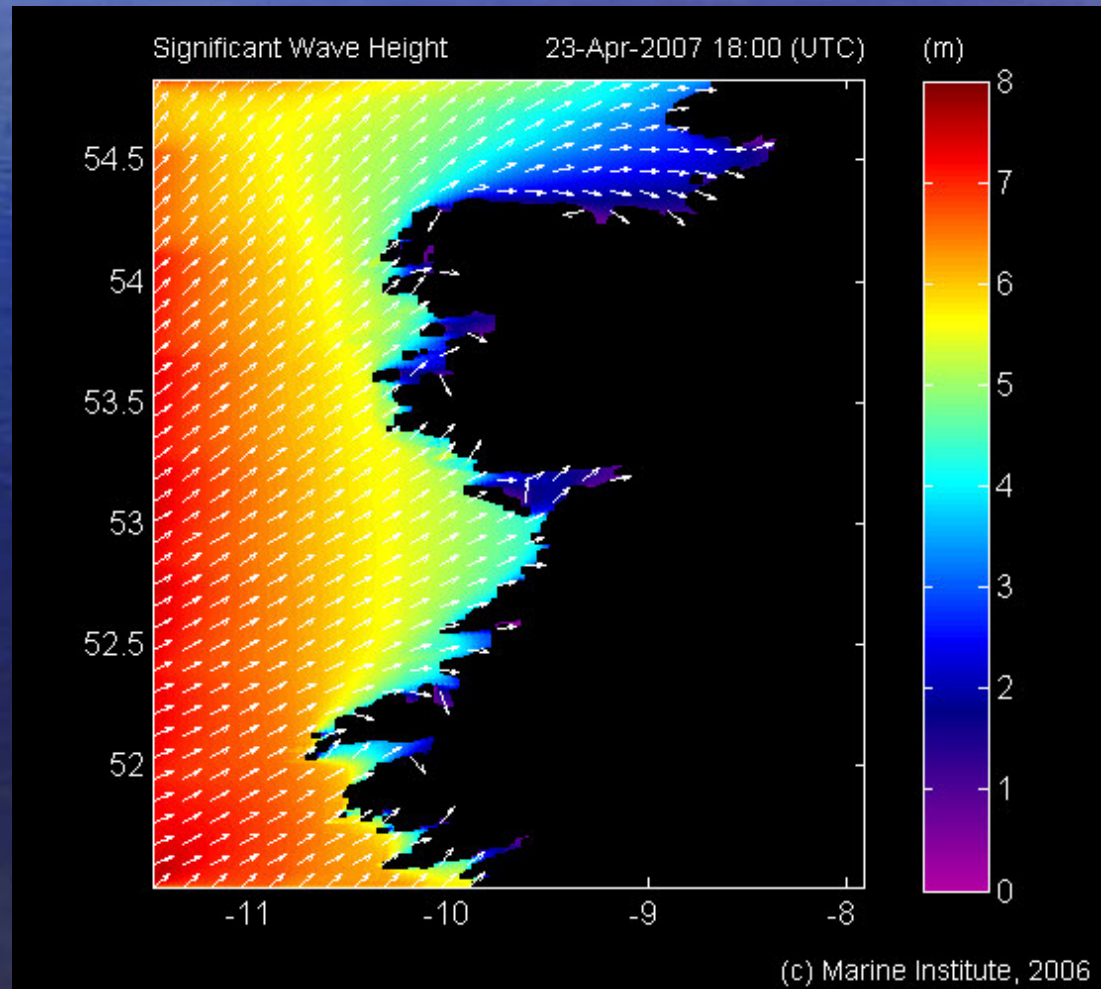
20 vertical levels

**Model to form
part of
SMARTBAY**

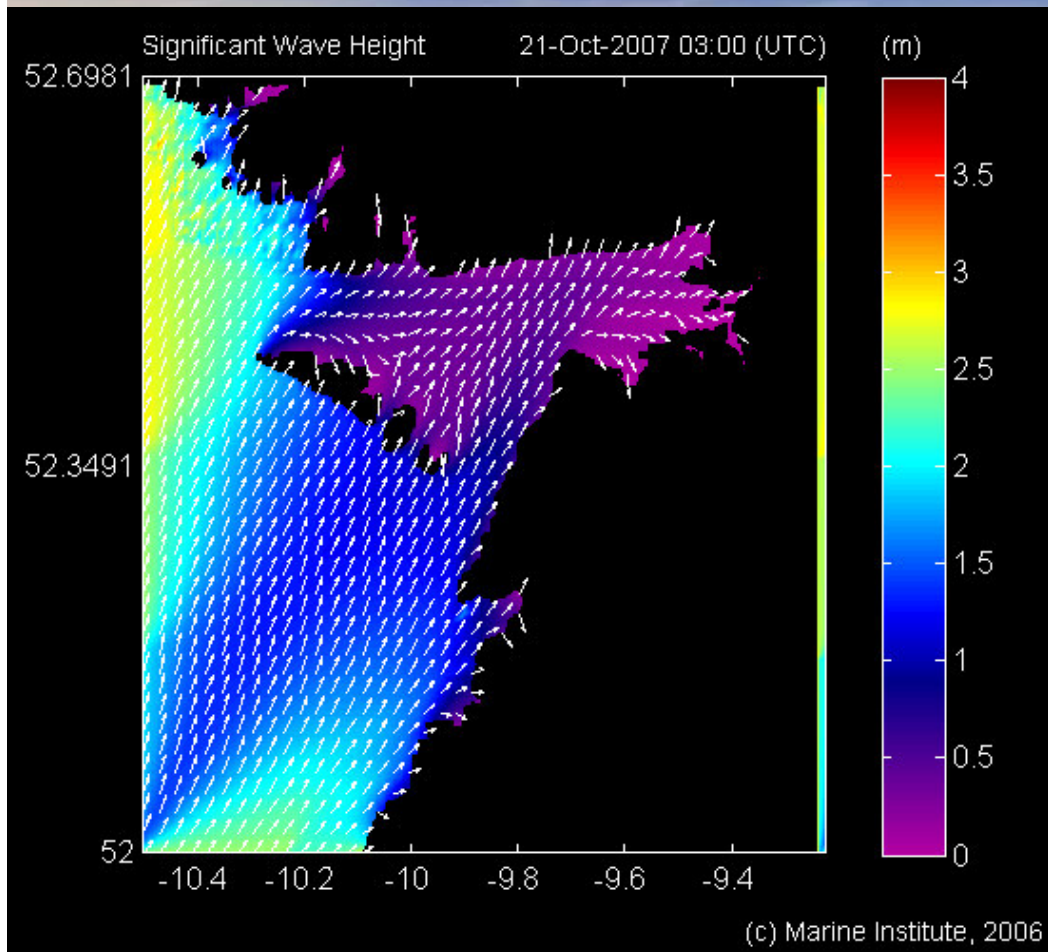


Wave modelling (forecasts)

- **West Ireland domain**
- **SWAN model**
- **Validated with weather buoys offshore**
- **Available as 6 day forecast**
- **Model run 3 X week**
- **www.marine.ie/services/operational.oceanography/waveforecast**



Galway Bay SWAN wave model

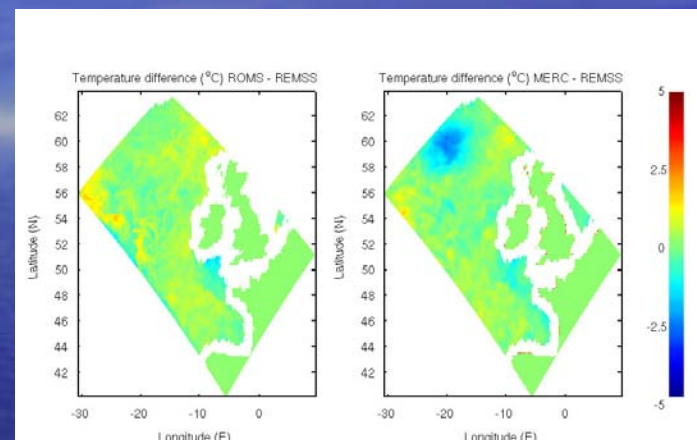
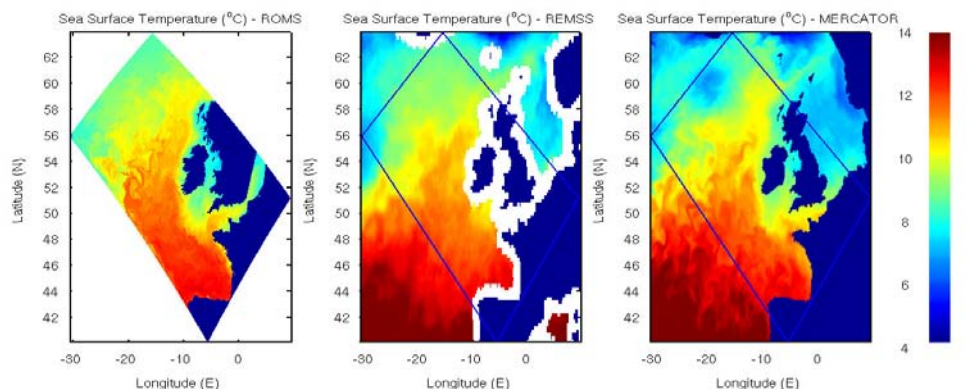


200 m resolution

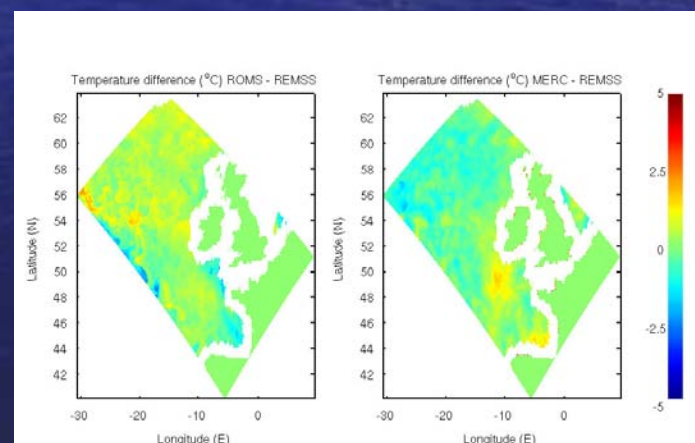
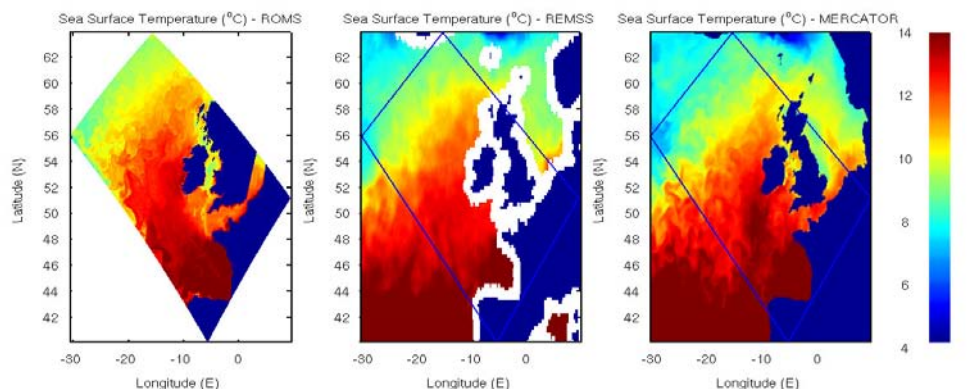
**Model to form part
of SMARTBAY**

SST validations – Microwave Sea Surface T satellite data

4th April 2007



2nd May 2007



↑
ROMS
(daily mean sea surface temperature)

↑
satellite

↑
MERCATOR

↑
ROMS
(model SST - satellite SST)

↑
MERCATOR

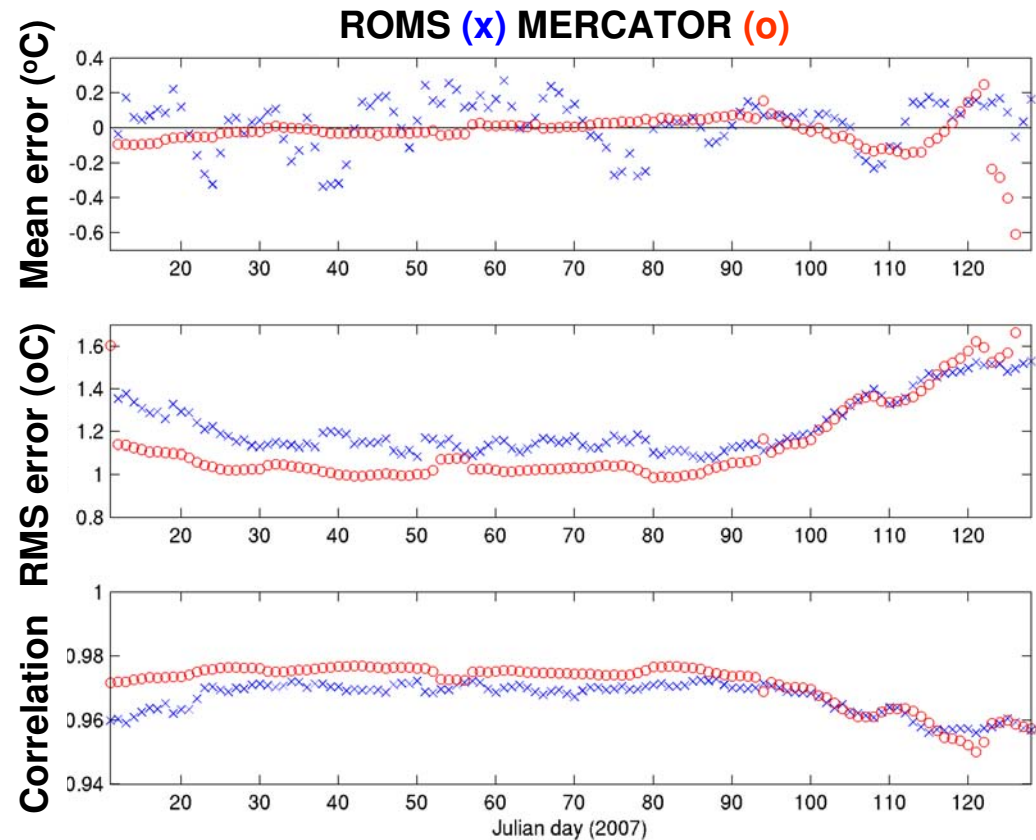
Sea surface temperature statistics

MODEL PERFORMANCE

- Both model data sets highly correlated with satellite data
- RMS errors < 1.6 °C
- No systematic temperature differences in any region of domain
- Effect of shelf edge current on SST clearly evident

PROBLEMS

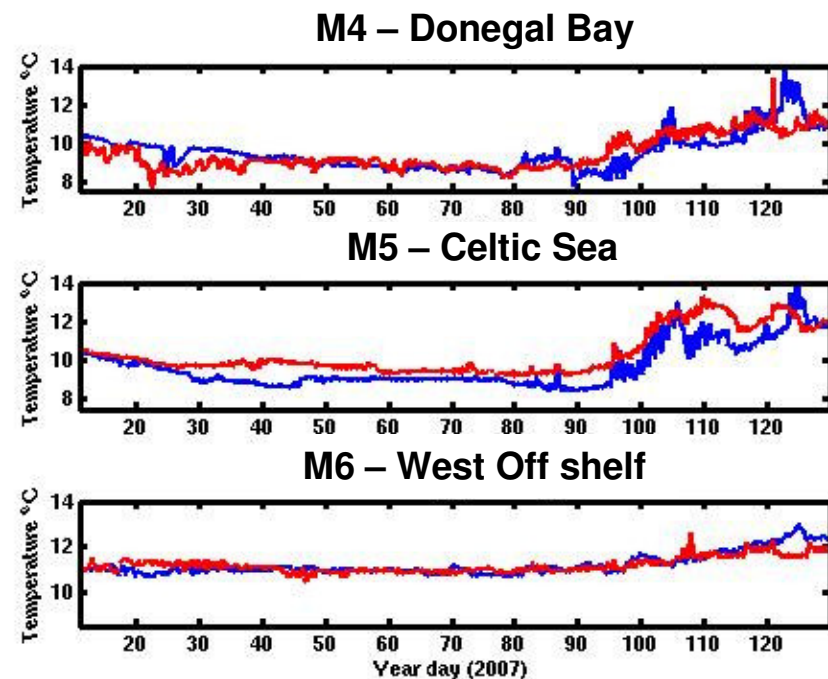
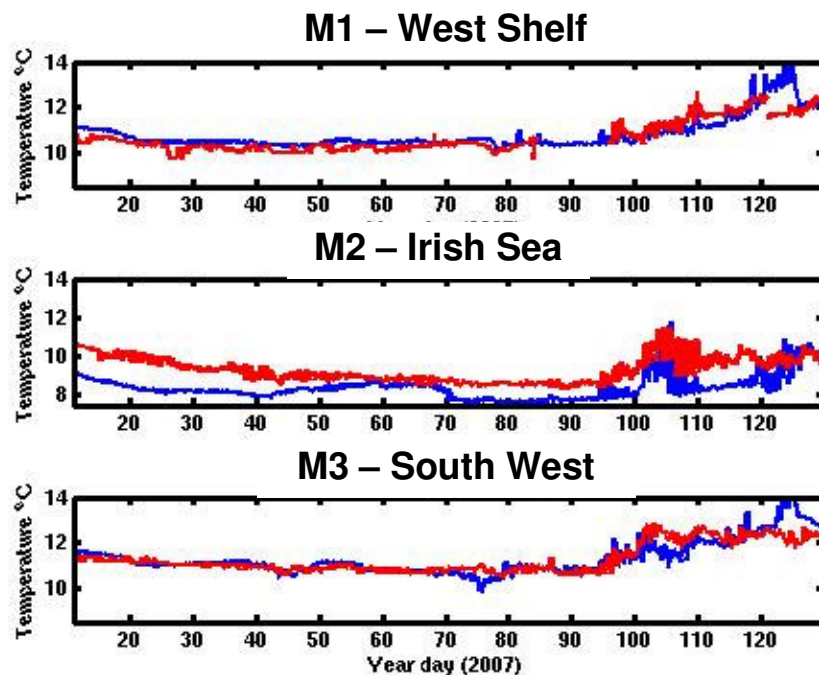
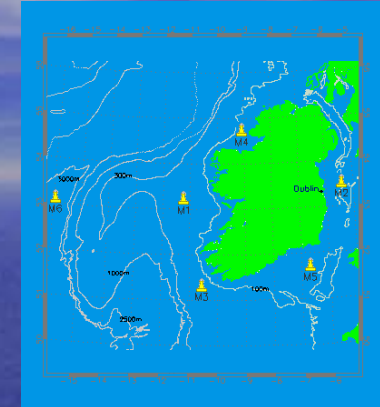
- Correlations and errors have worsened since end March – due to shallowing of surface mixed layer
- ANSWER :- couple with high resolution weather model WRF



Comparisons between modelled SST data and satellite microwave radiometer data.

Irish Meteorological M buoys

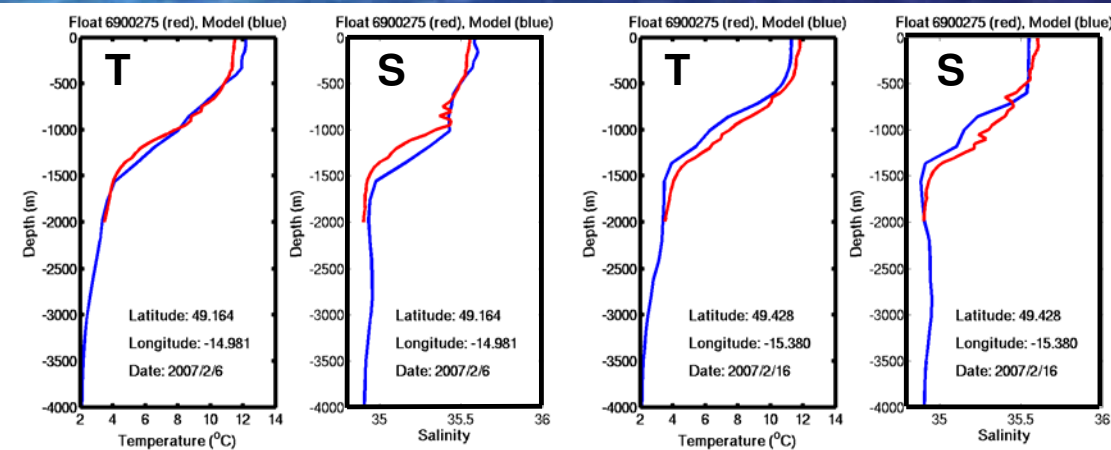
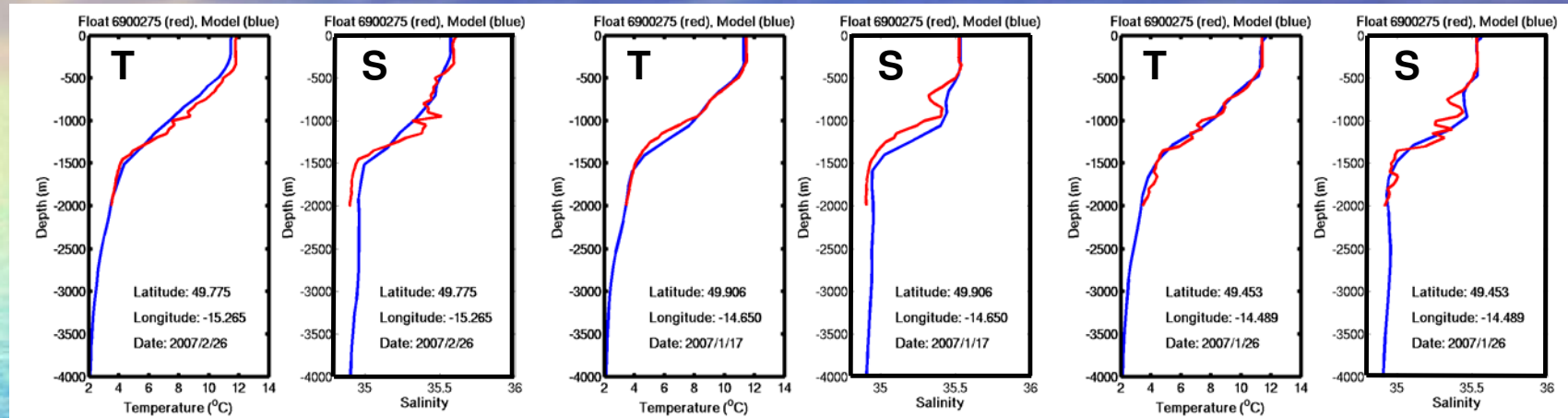
- Temperature data available in near real time
- Accuracy: Temperature 0.1 °C, Salinity 0.01
- Good model performance indicator (esp on shelf)



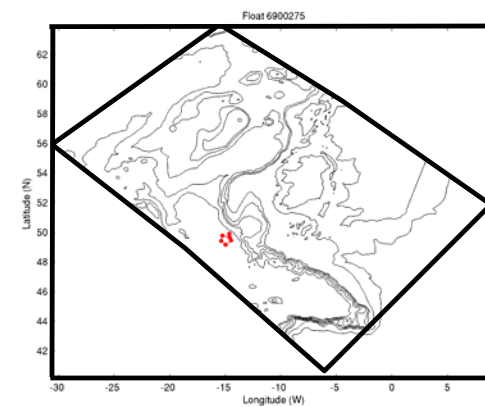
Time series of near surface temperature from ROMS (blue) and Met. Buoys (red)

Argo float CTD profiles

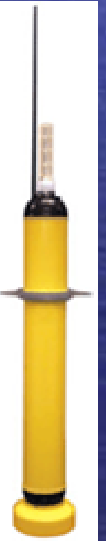
Float 6900275 - Porcupine Abyssal Plain



— = model — = float



Float trajectory

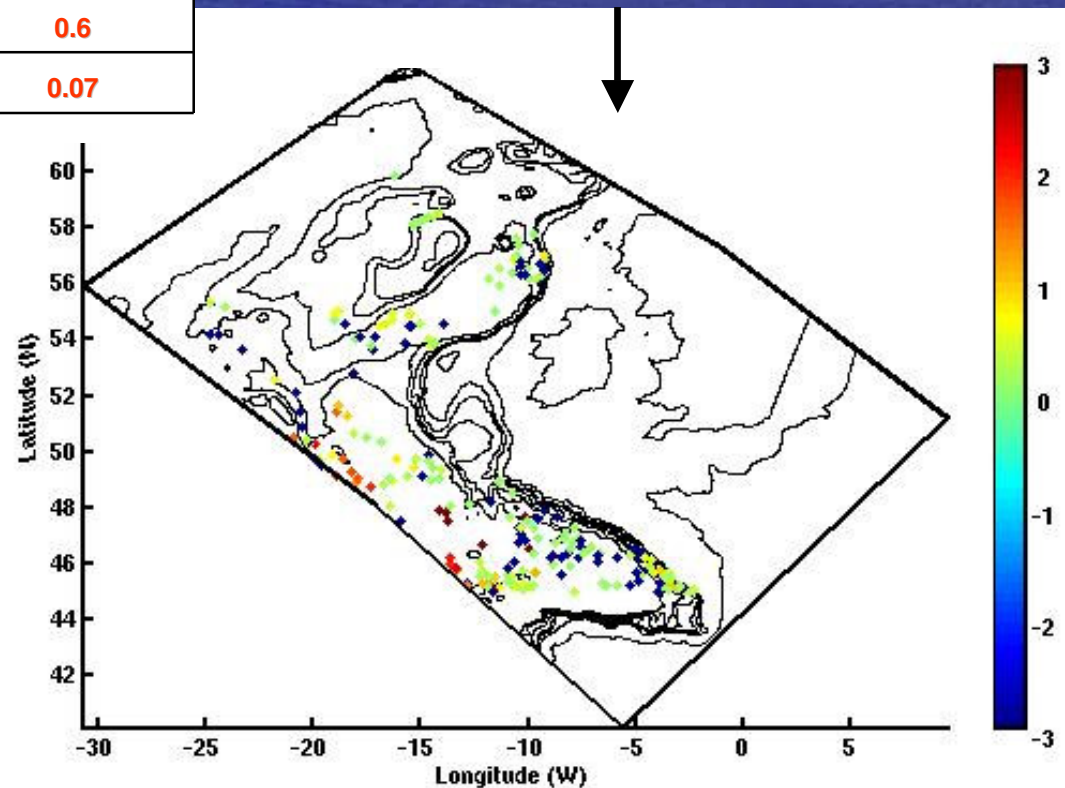


ARGO statistics

Comparison of ROMS and ARGO float CTD profiles

	Temperature (C)	Salinity
Mean error	-0.32	0.22
RMS error	0.67	0.33
Correlation	0.96	0.74
Standard deviation (ARGO)	4.08	0.6
Standard deviation (ROMS)	1.19	0.07

*Map of depth mean errors
(Temperature, °C) between ARGO and
ROMS temperature profiles*



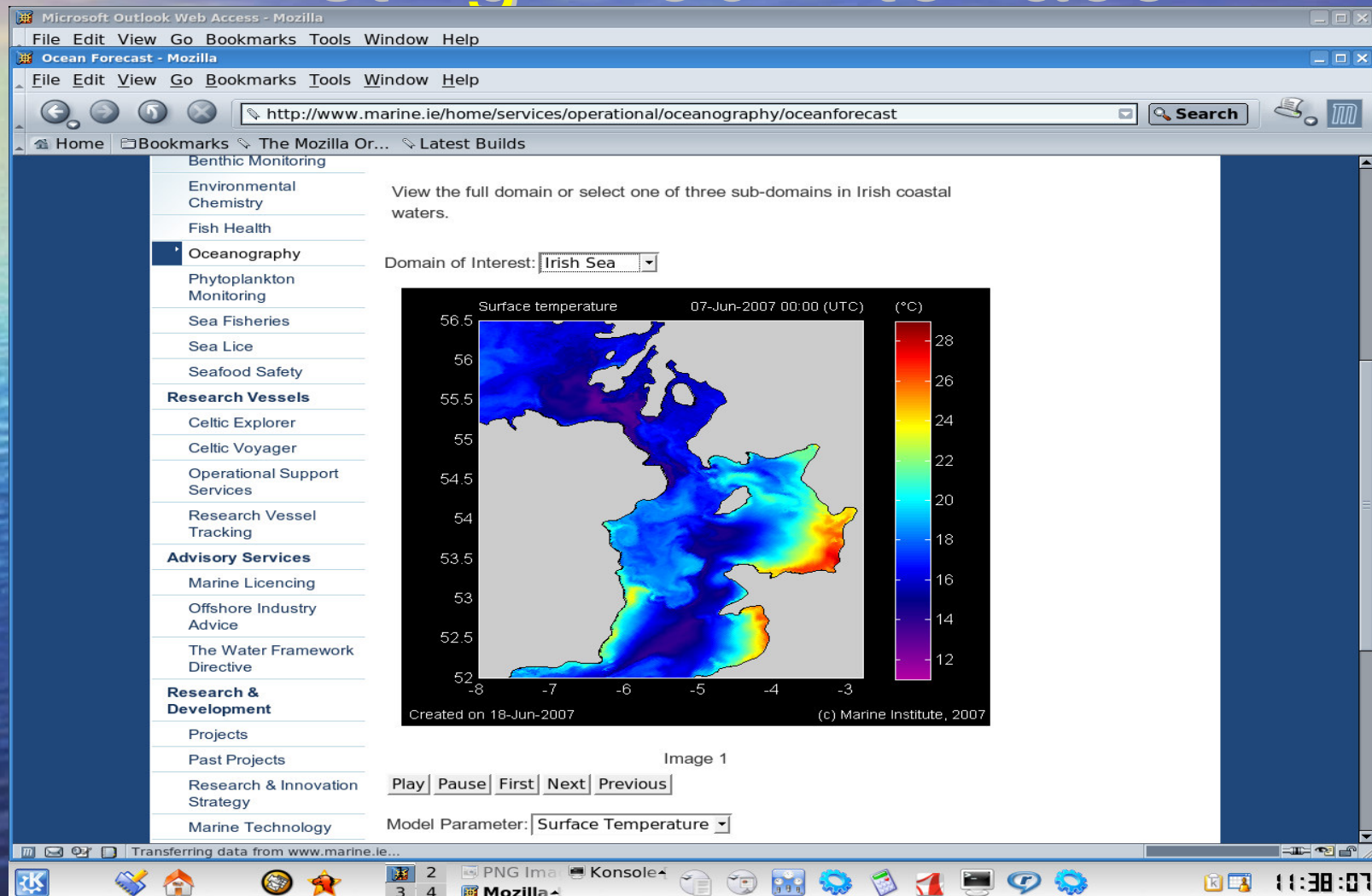
MODEL PERFORMANCE

- Temperature profiles highly correlated
- Salinity profiles less correlated
- Model represents distribution of water masses very well

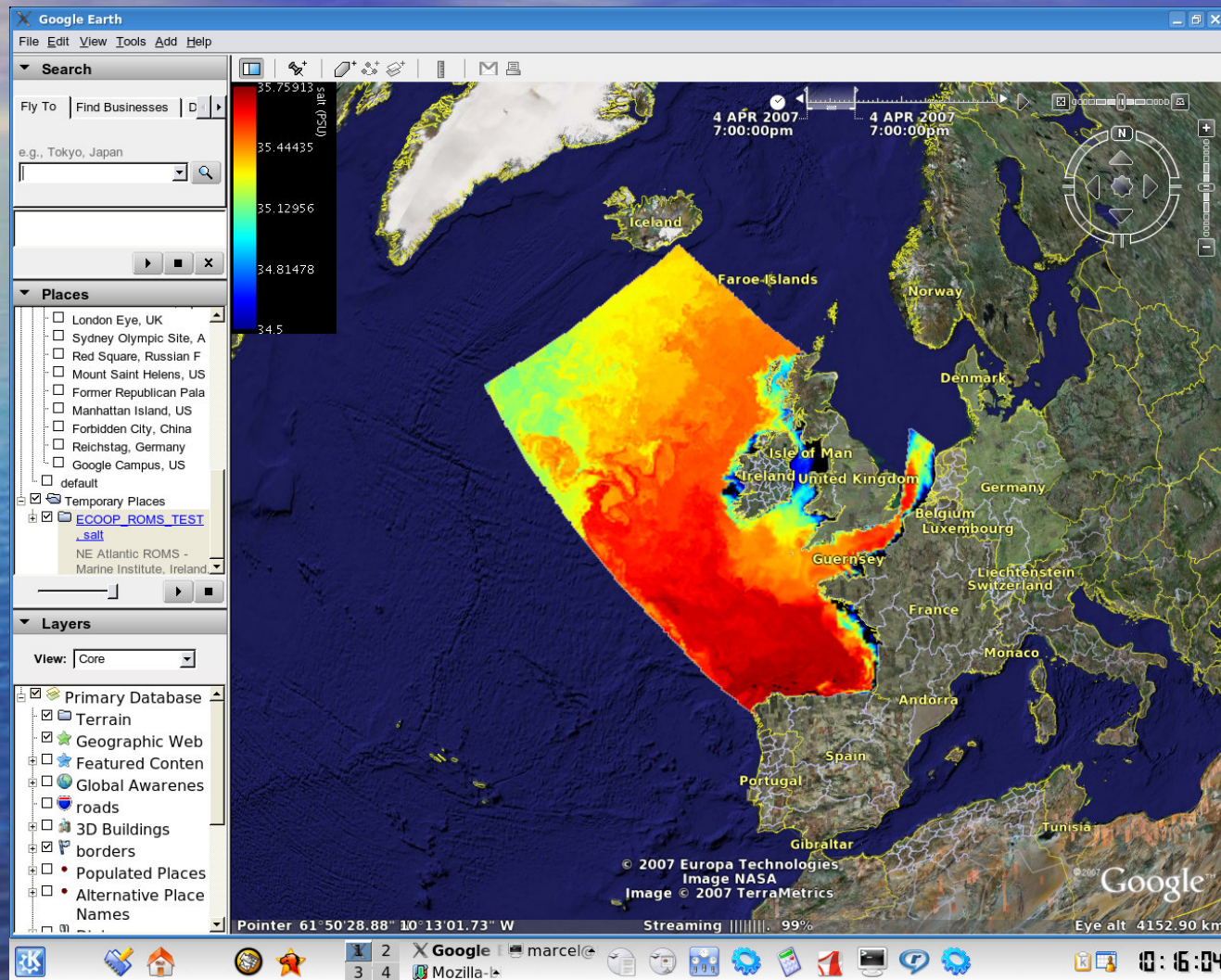
PROBLEMS

- Need better river fluxes

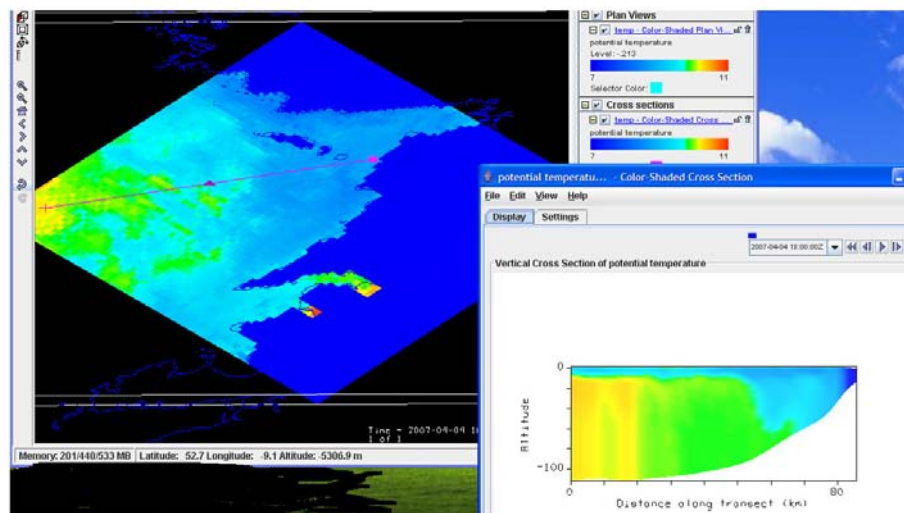
Existing Web Interface



Example of data export : Export the data to GoogleEarth



Example of data export : The freely available IDV from Unidata



Proposed New Data Service

- OpenDAP
- THREDDS Server
 - - Seamless availability of sub-setted model data, fully described.
 - User can combine data from different sources.
- WMS/WCS service for clients such as GoogleEarth, NASA Worldwind, UNIDATA-IDV etc.

Some developments underway :-

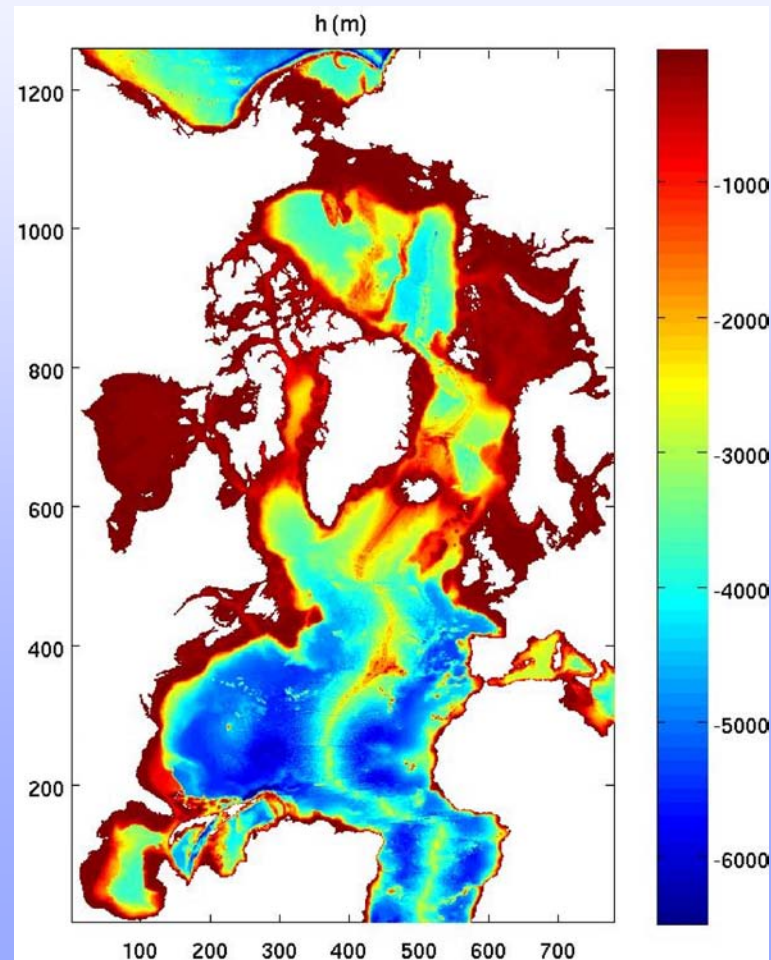
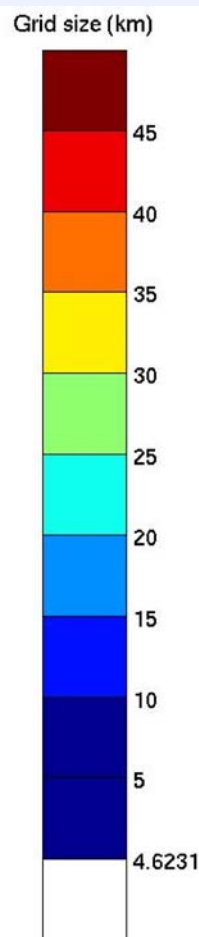
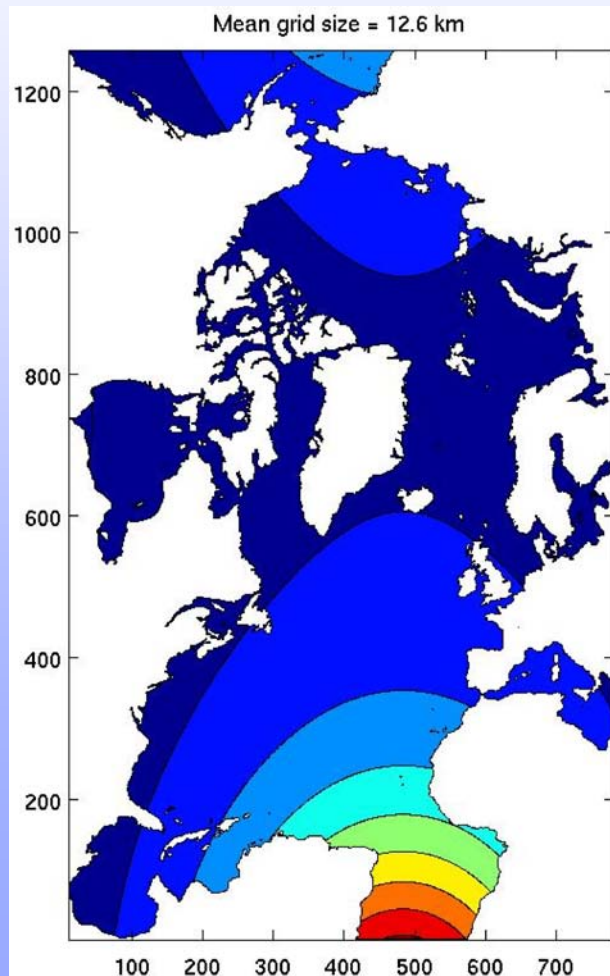
- New Supercomputer to be commissioned by August 2008. 560 high performance processors dedicated to hydrodynamic and wave modelling
- SWAN wave model to be extended to cover same area as ROMS (August 2008)
- Biogeochemical models to be incorporated into suite (December 2008)
- Integration of our models with European partners in France, Spain and Portugal (project EASY www.project-easy.info)
- New data feed service from models (November 2008)



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**Arctic-Atlantic 10km model for climate downscaling
(20 yr hindcast / 2x20 yr A1B scenario forecast)**





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Outcomes of future climate research

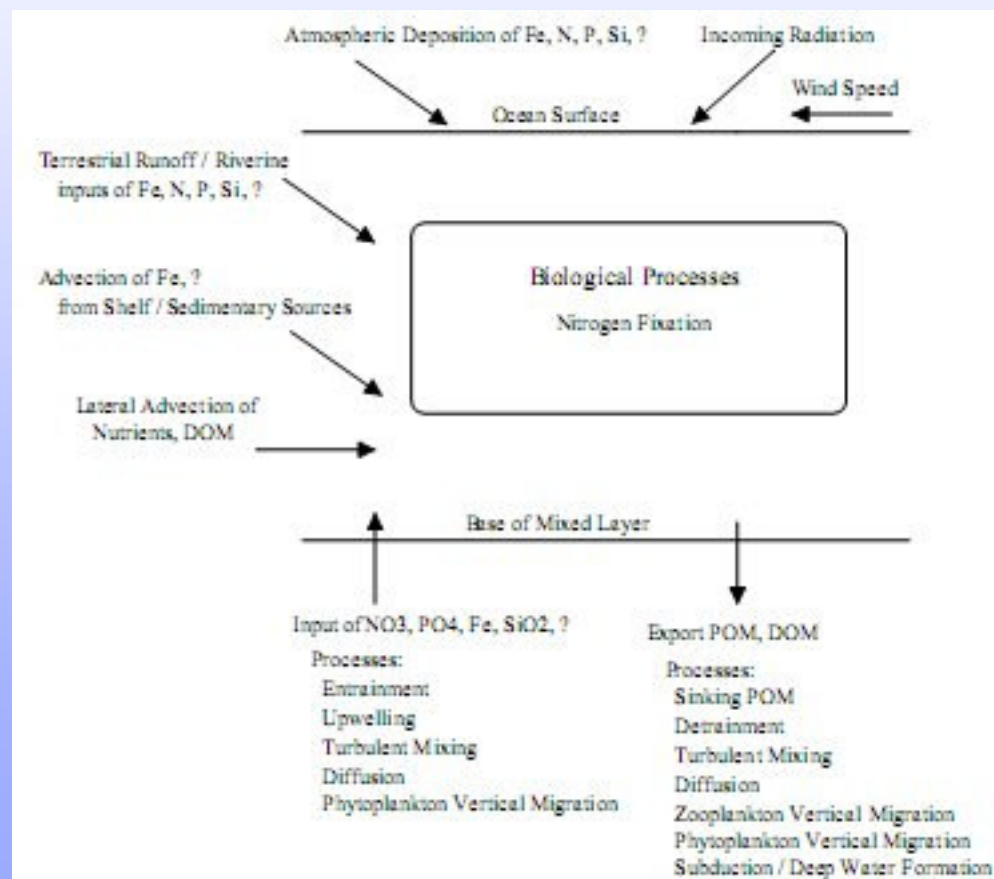
- High-resolution downscaled models capable of forecasts
- Better understanding of ocean-driven climate effects for Ireland
- Storm surge modelling and forecast
- Implications of climate change for the ocean ecosystem: lower trophic levels
- Linkages of ocean biogeochemistry to fisheries modelling and management
- Fully coupled climate models: ocean, ecosystem, waves





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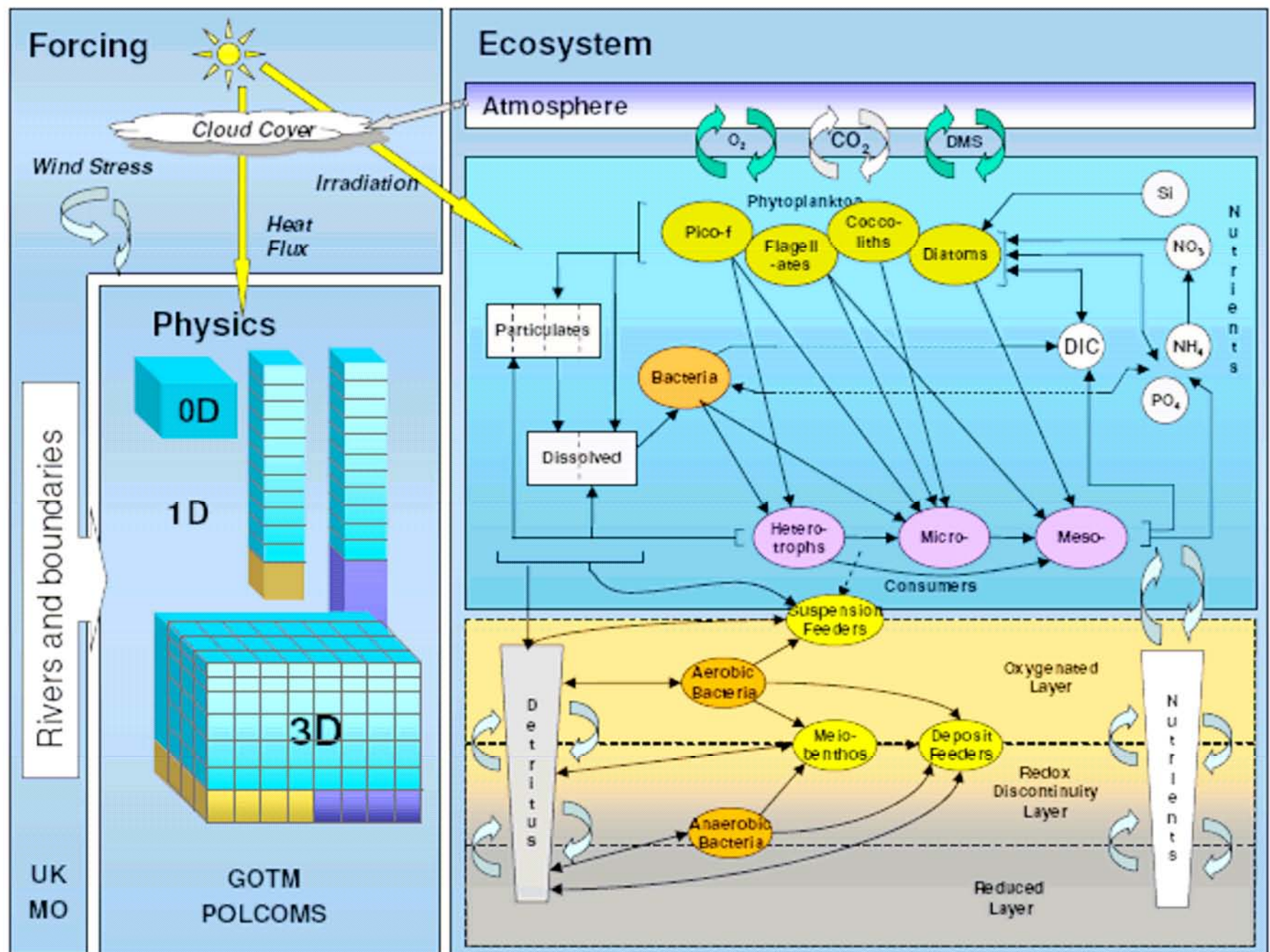


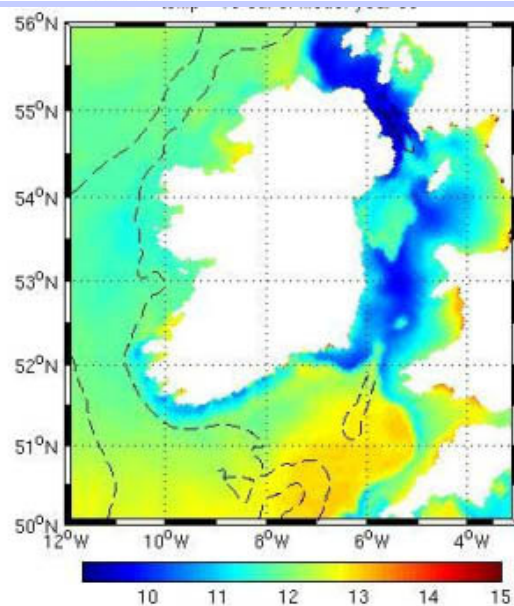
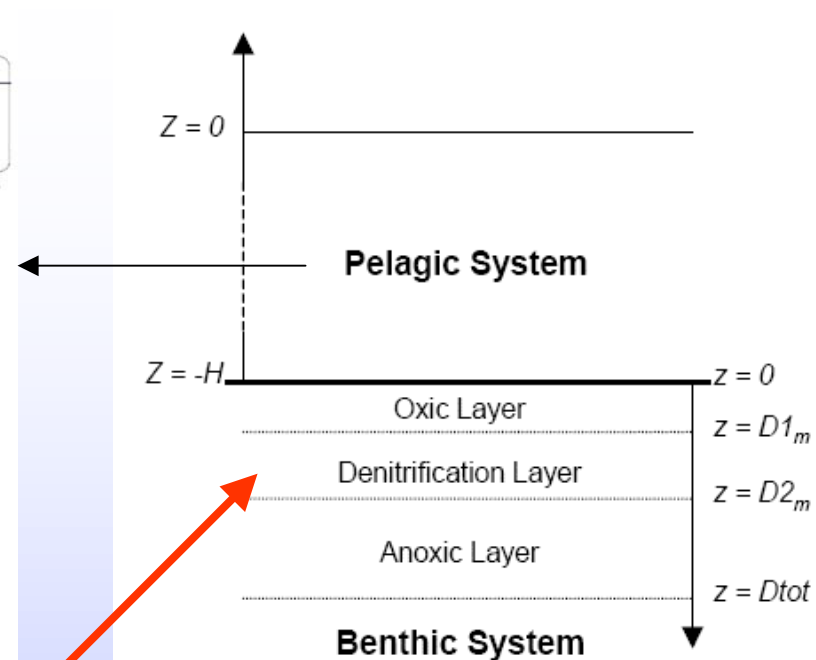
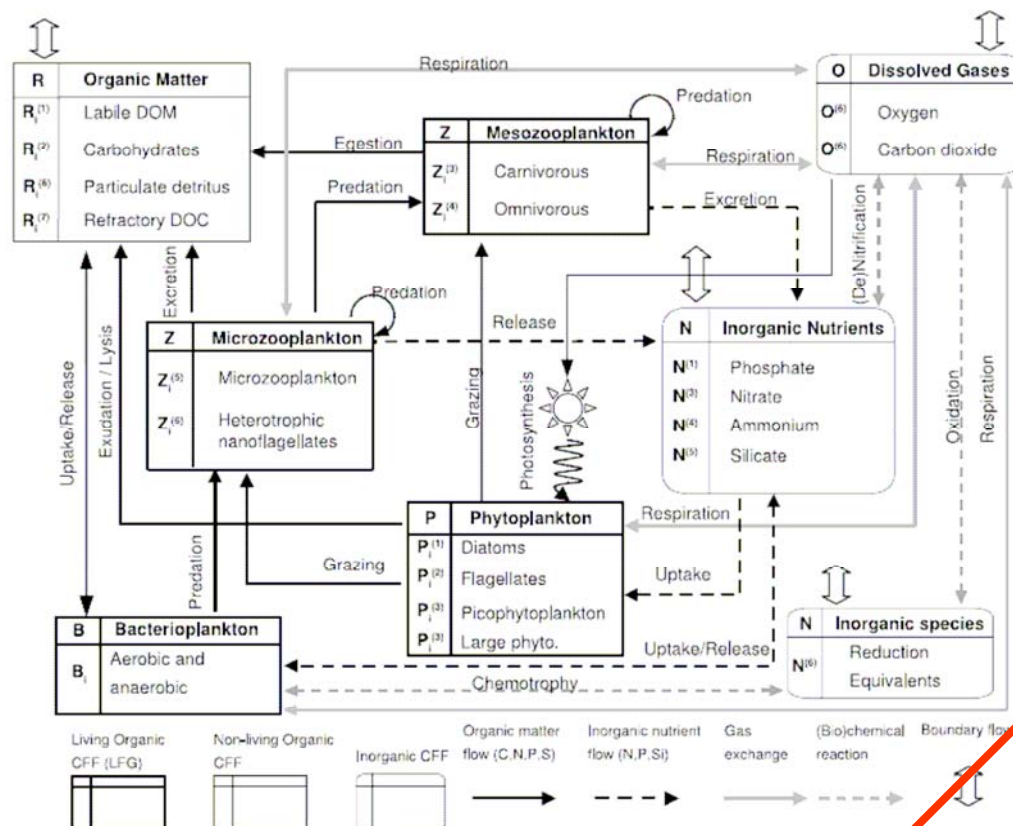
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Ecosystem models coupled to ROMS

1. Franks et al, 1986 and Powell et al., 2006:
 - 4 tracers: NPZD (Nitrate only)
2. Fasham et al., 1990:
 - 9 tracers: Phytoplankton; Chlorophyll; Zooplankton; NO_3 , NH_4 ; Small and large nitrogen detritus; Small and large carbon detritus
 - Total inorganic carbon and diagnostic/prognostic alkalinity
 - Remineralization of sediments
 - (De)Nitrification
 - Surface O_2 and CO_2 exchange
3. Nemuro (Kishi et al., 2007):
 - 11 tracers: Nanophytoplankton; Diatoms; Microzooplankton (ciliates); Mesozooplankton (copepods); Predator zooplankton; NO_3 ; NH_4 ; PON, DON; $\text{Si}(\text{OH})_4$; Particulate organic silica
 - Remineralization of sediments
4. EcoSim (Bissett et al., 1999a, 1999b): Bio-optical carbon cycling
 - Tracers: 7x7 phytoplankton-pigment matrix; Nutrients (6), Bacteria (1), DOM (2), and fecal (2) bio-optical constituents from C, Fe, N, P, Si
 - 60 spectral bands







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