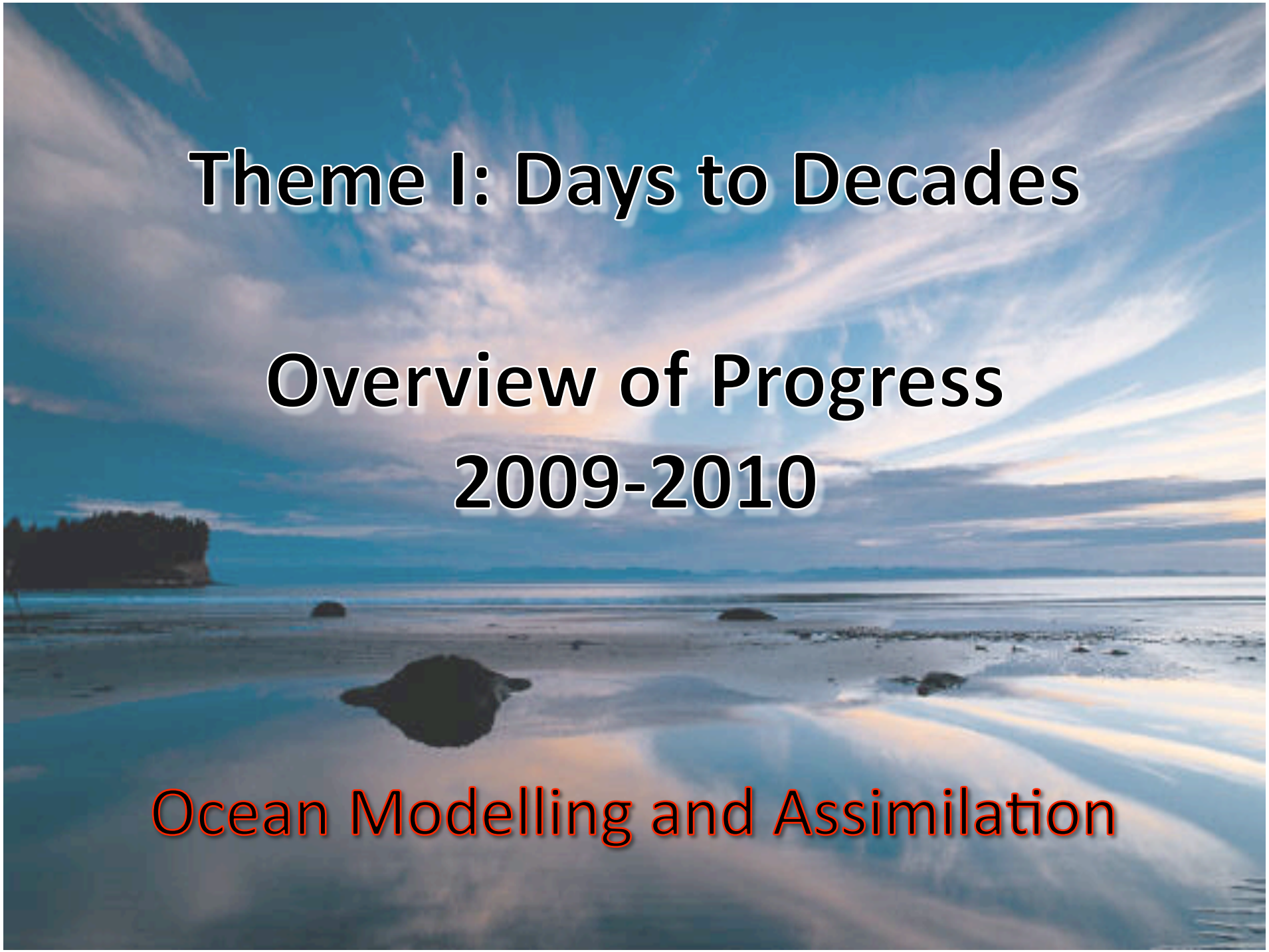

Theme I: Days to Decades
Overview of Progress
2009-2010
Ocean Modelling and Assimilation

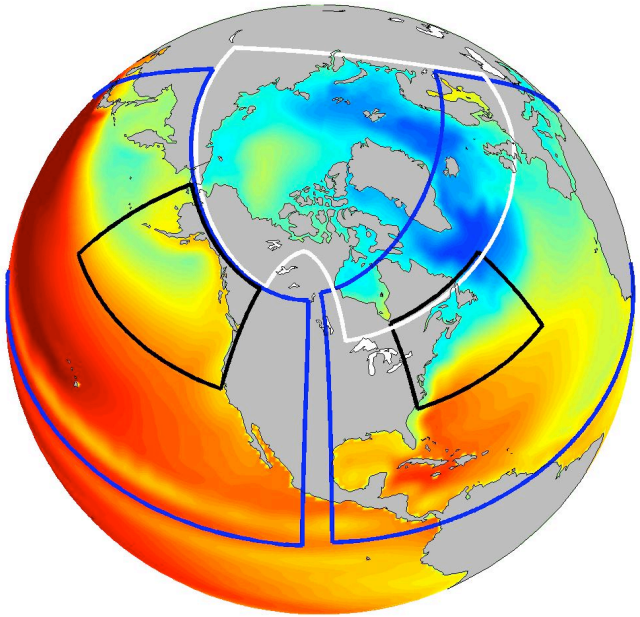
Theme I Projects: Days to Seasons

Two clusters of projects focused on

- **Ocean Modeling and Assimilation**
- **Coupled Modeling and Assimilation**

This talk covers the oceans projects.

Common Ocean Modelling Framework
Nested Models All Based on NEMO



The Ocean Modeling and DA Projects

- ✓ **Suppressing model bias and drift**
- ✓ **Model validation and improvement**
- ✓ **Assimilation of altimeter, Argo data**
- ✓ **Reanalysis and forecasting**
- ○ **Modelling and assimilation of sea ice**
- ✓ **Downscaling from ocean to shelf**

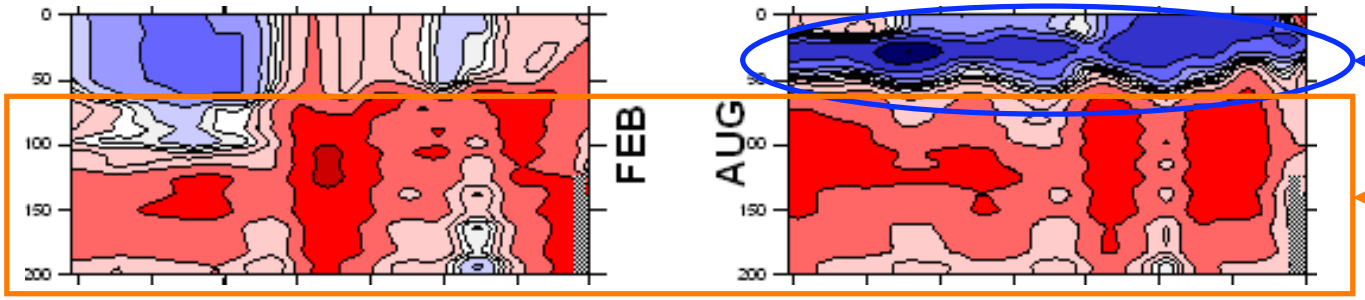
NEMO: Nucleus for European Modelling of the Ocean

1.1 Suppressing Bias and Drift

- ✓ New way of spatially smoothing the nudges
- ✓ Semi-prognostic/spectral nudging hybrid
- ✓ Quantifying and understanding bias
  - Global ocean, 1/4° and 1/12° output from Mercator
  - North Atlantic
  - Labrador Sea

Bias Along Line P in North Pacific

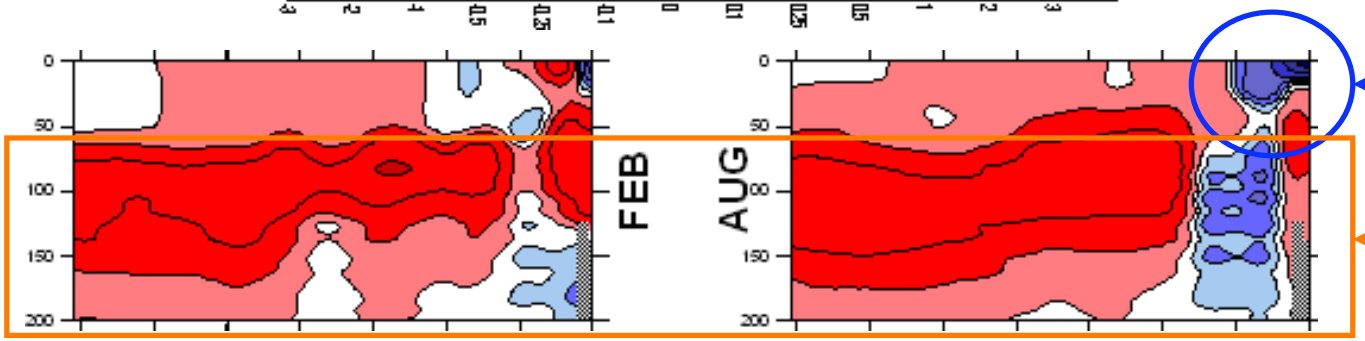
- ✓ Mercator global hindcasts (no assimilation, ¼° and 1/12°)
- ✓ observed T and S, 2001-7



too cold (-1C)

too warm (2C)

2005 Temperature Anomalies (OPA minus observed)
Along Line-P, Surface to 200 m Depth

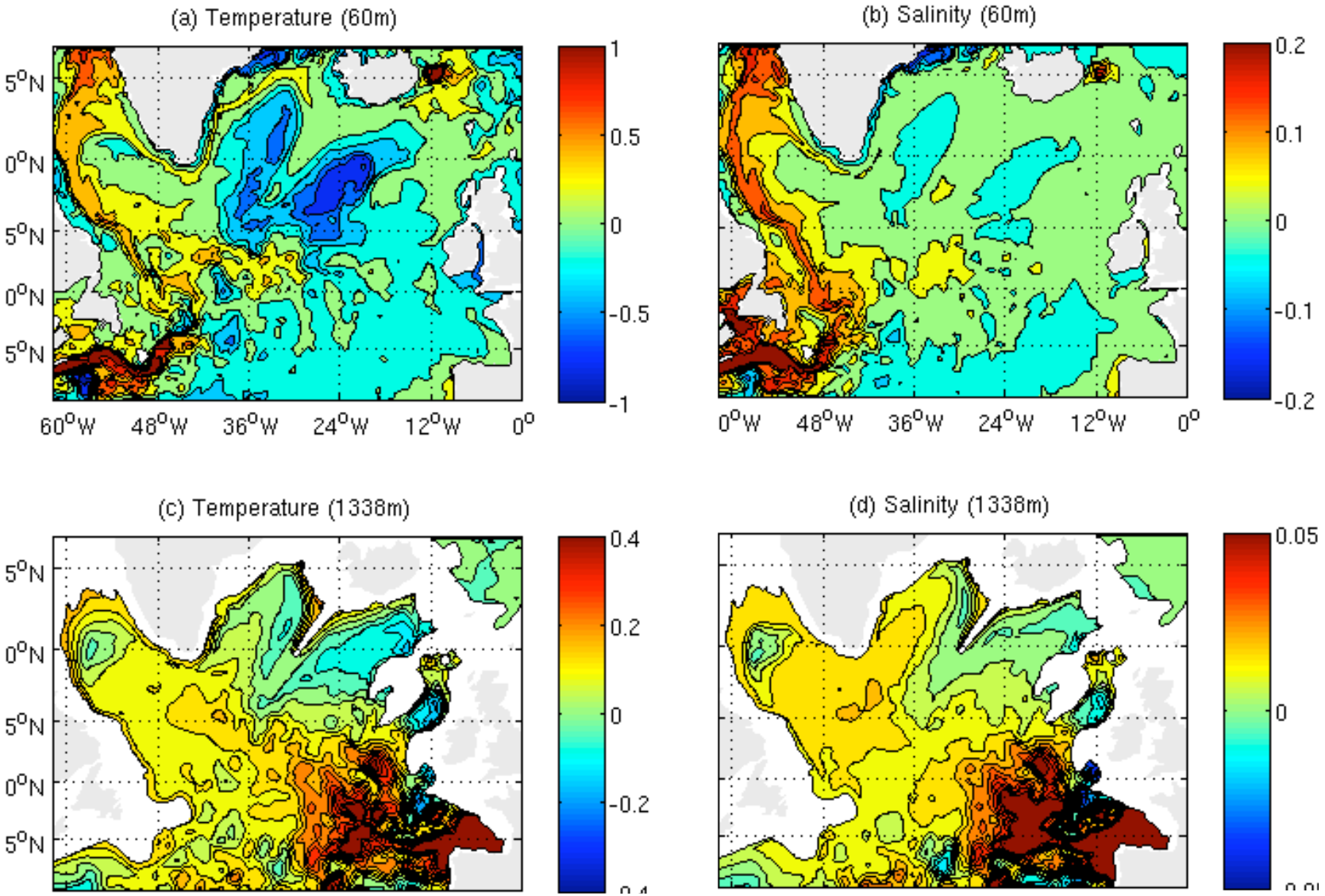


too fresh (-1psu)

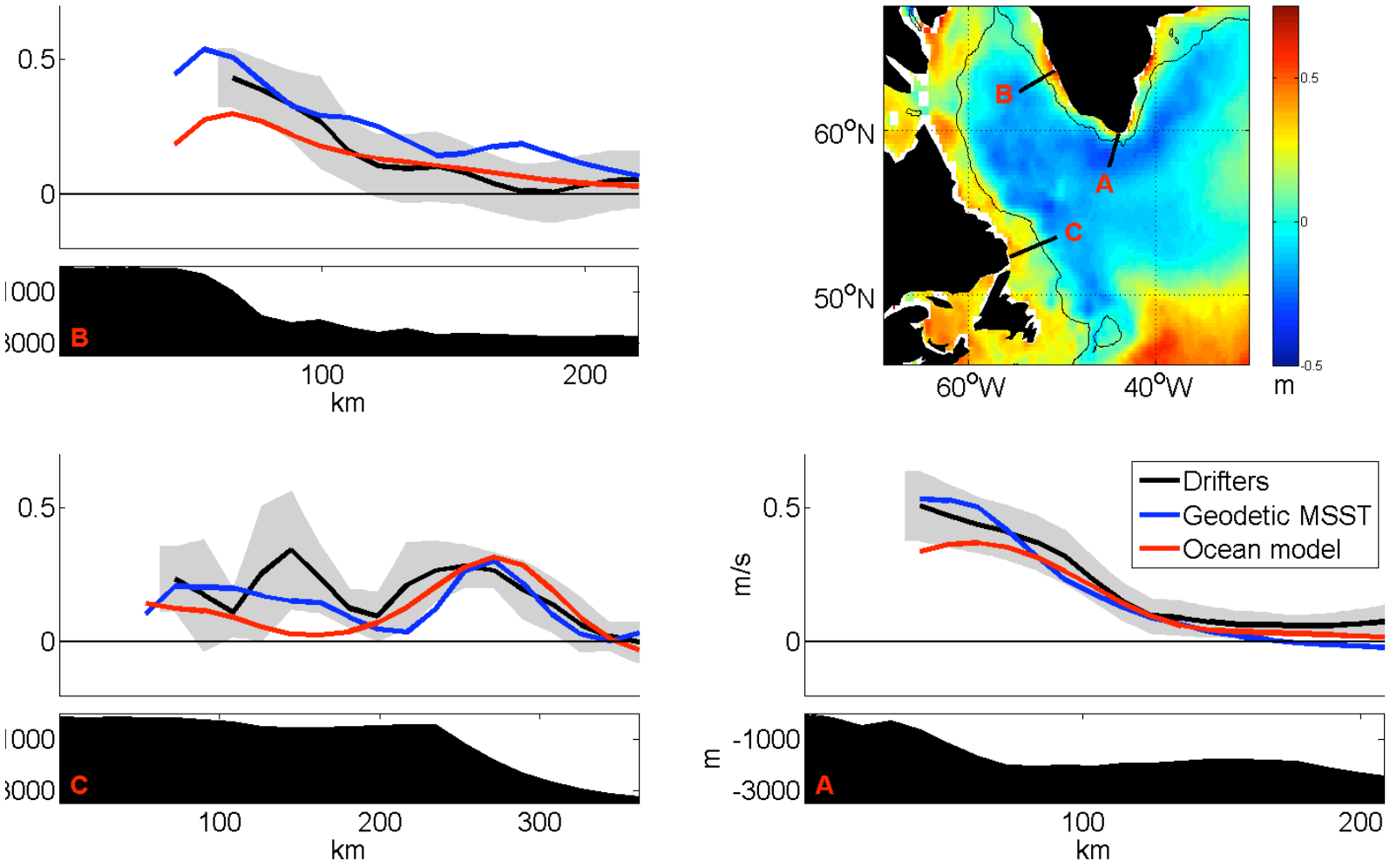
too salty (1psu)

2005 Salinity Anomalies (OPA minus observed)
Along Line-P, Surface to 200 m Depth

Bias of 1/4° North Atlantic Model



1.2 Model Validation and Improvement



Courtesy Simon Higginson, PhD student, Dalhousie

1.3 Assimilation of Altimeter and Argo

New Techniques

- ✓ Optimizing parameters using Green's functions. Applied to NEMO.
- ✓ Calculating observable modes in 4D-VAR analyses. Tested using wind-driven, quasi-geostrophic model. Plan to test on NEMO.

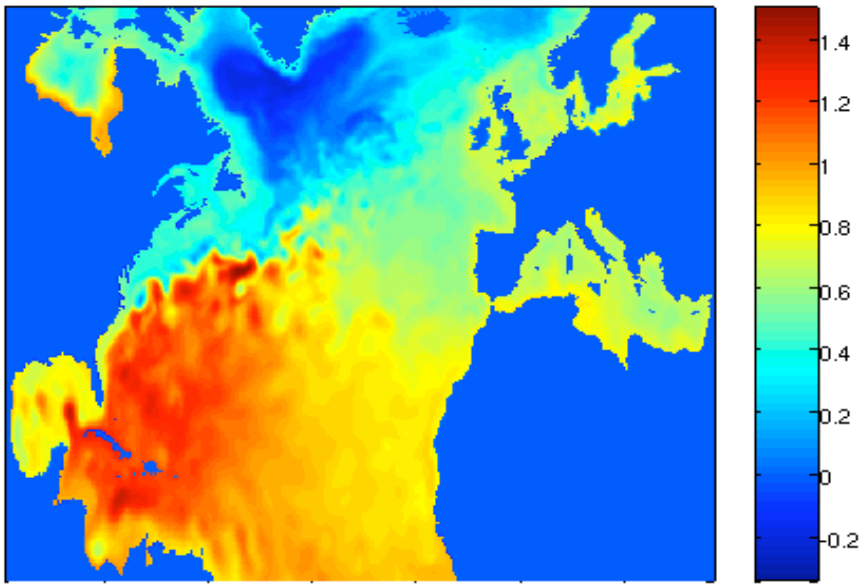
Operational Schemes

- ✓ Implemented BODAS into coastal model at Dalhousie. Will apply to North Atlantic model (Vasily Korabel).
- ✓ Identified weaknesses in SEEK/EKF applied to North Atlantic. Developing ensemble-based way of estimating error covariances. Preliminary results encouraging.

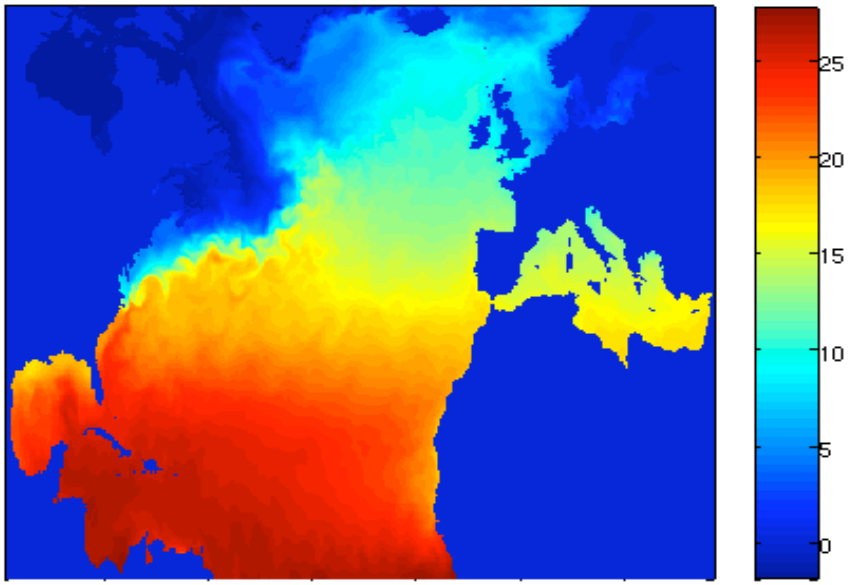
Assimilation of Using the SEEK Filter

Snapshots of sea level and SST from new, ensemble-based assimilation scheme:

Sea level



Surface temperature



1.4 Ocean Reanalysis and Forecasting

Technical Developments:

- ✓ Two-way nesting (global to ¼°, ¼° to 1/12°)
- ✓ Tides added to deep ocean NEMO
- ✓ High-resolution Arctic ocean and sea-ice model

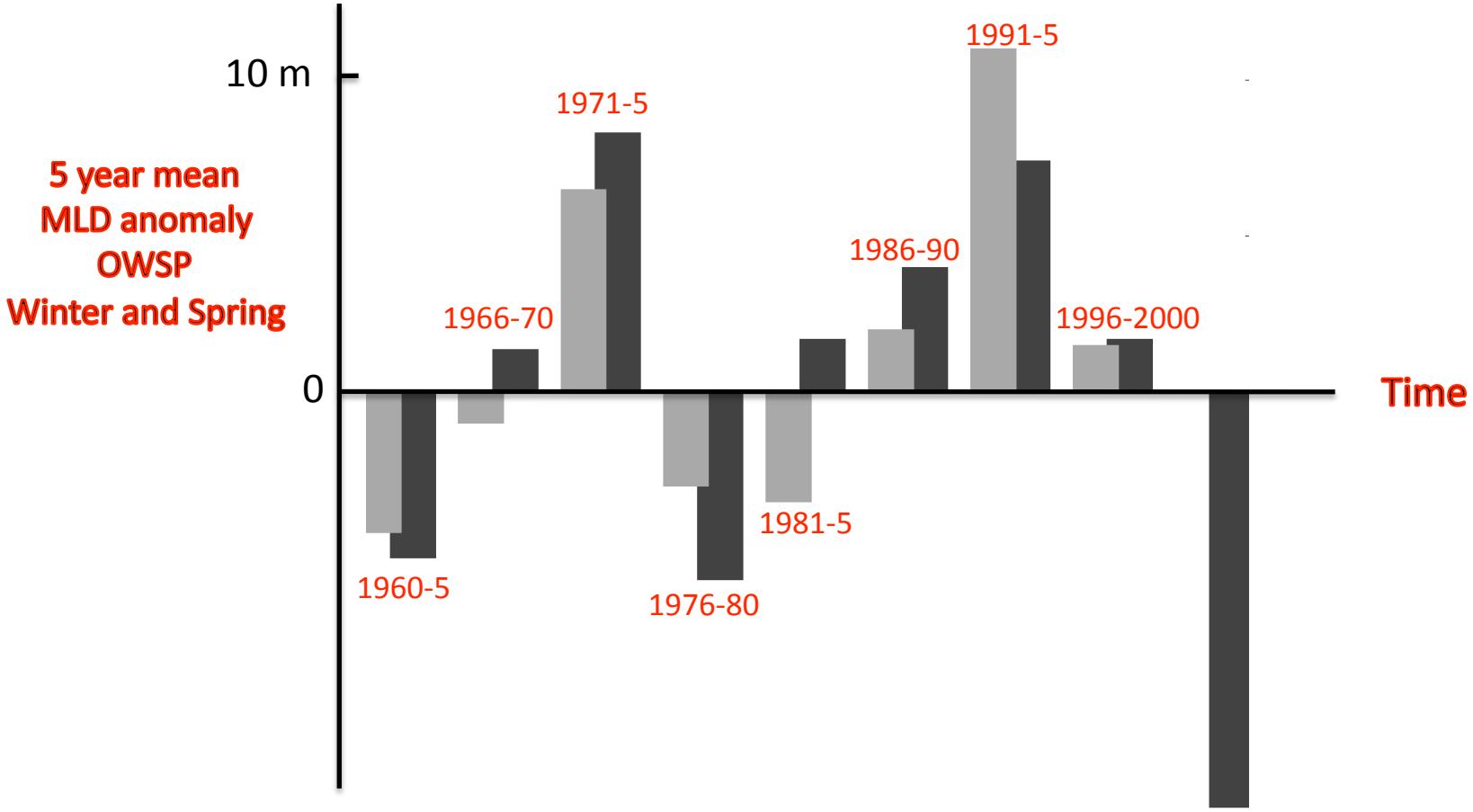
Regional Studies:

- ✓ Location and strength of North Pacific Current
- ✓ Cold water intrusion to Northeast Pacific, 2001-2

Historical Reconstructions:

- ✓ North Atlantic ¼°, 1948-2005 (MUN) and 1958-2004 (Dal)
- ✓ Labrador Sea (1/16°)
- ✓ Arctic Ocean, 1960-2005
- ✓ Pacific Ocean, 1960-2000

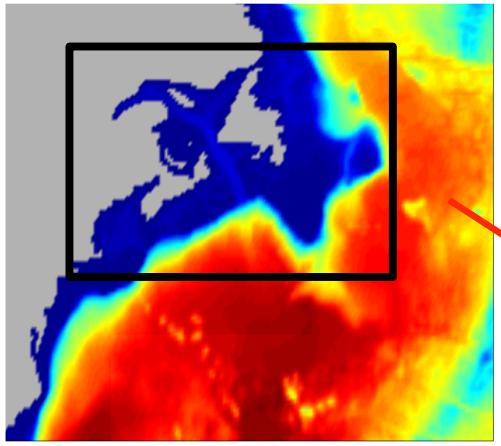
Predicting Mixed Layer Depth



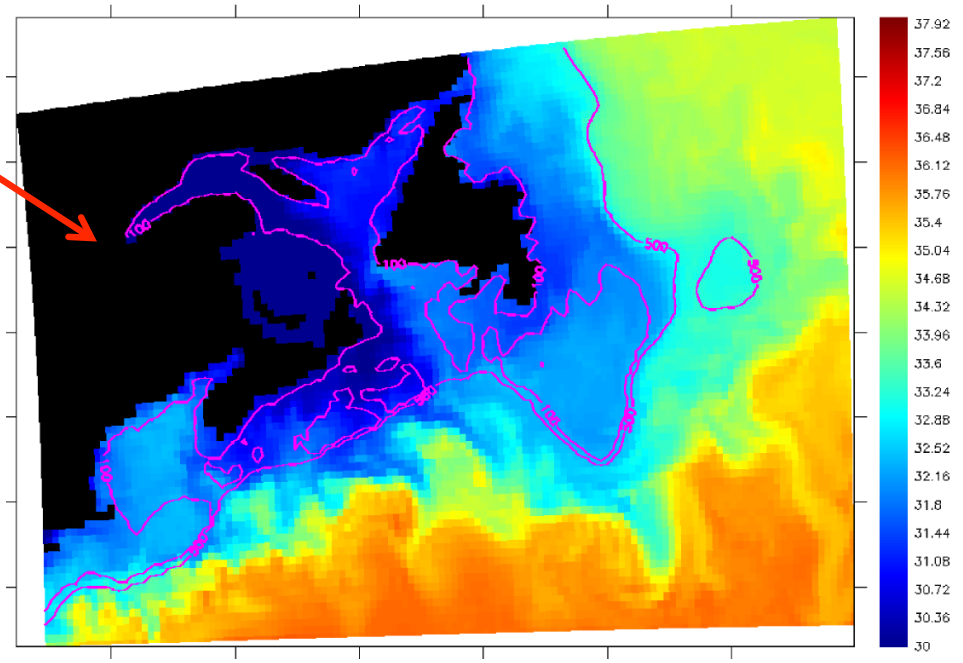
Light Gray: Based on Observations (Li et al, 2005)
Dark Grey: Prediction from POP Ocean model

1.6 Downscaling from Deep Ocean to Shelf

Model Domain and Topography



Simulated Sea Surface Salinity (12:00 20-Oct-2001)



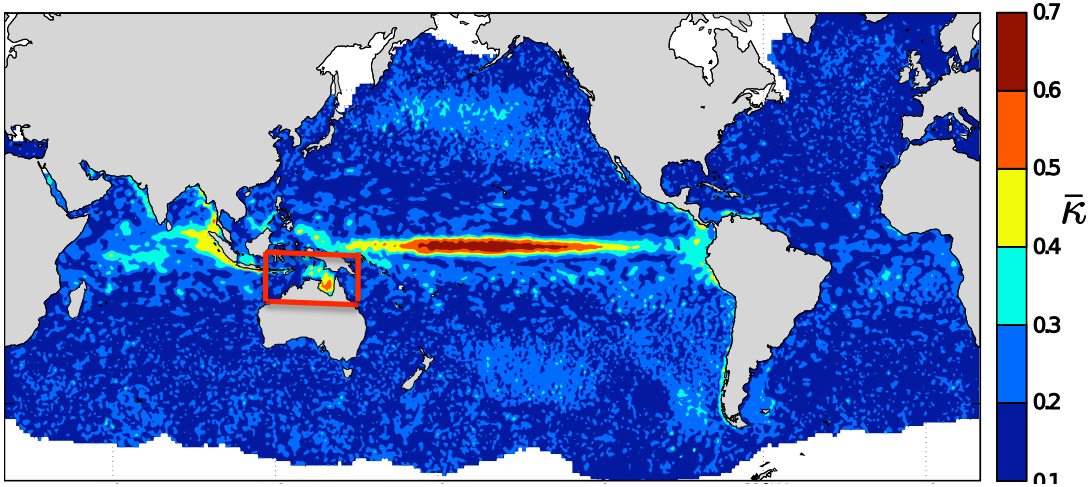
- Coupled to North Atlantic model
- New bias suppression method
- Inner model to be 1/12°
- Causes of interannual variability

New Research Directions

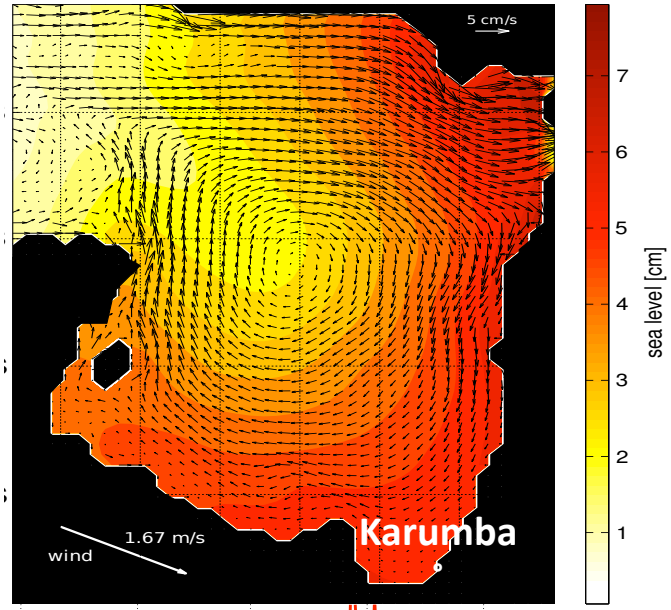
- ✓ Focus on Madden Julian Oscillation and global expression in both ocean and atmosphere.
- ✓ Driven by graduate students: Eric Oliver, Xu Zhang and Yang Zhou.
- ✓ Three papers accepted, two under review.

Coastal Expression of the MJO and Implications for Predictability

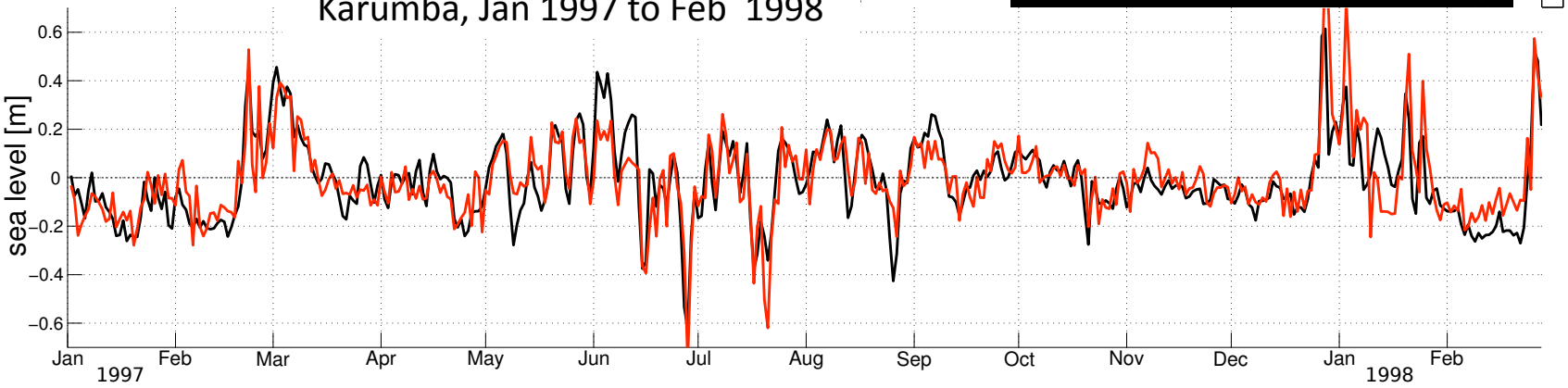
Coherence between MJO and Sea Level from Altimeters



Response of GoC to Local Wind



Observed and Predicted Sea Level
Karumba, Jan 1997 to Feb 1998



Courtesy Eric Oliver, PhD student, Dalhousie