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Validation of the CONCEPTS 1/12° ice-ocean model: Water masses and transports

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Introduction

Validation is a key step in the development of an ice-ocean model. Here we show some examples of the validation undertaken during the development of the 1/12° CONCEPTS Arctic and North Atlantic ice-ocean prediction system.

The CONCEPTS project

Canada requires ice-ocean forecasts for functions including weather prediction, navigation, fisheries management, risk assessment for extreme events and emergency response.

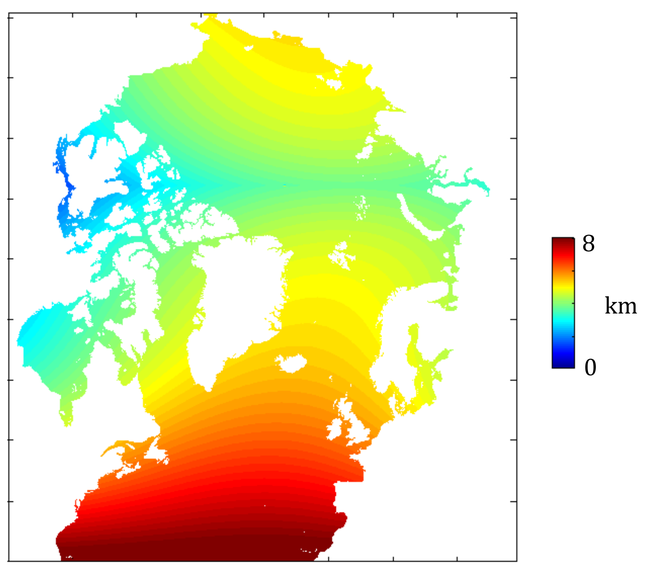
CONCEPTS (Canadian Operational Network for Coupled Environmental Prediction Systems) is a collaboration between Fisheries & Oceans Canada, Environment Canada, the Department for National Defence, and Mercator Ocean to develop a hierarchy of systems, including a global 1/4° and a regional Arctic 1/12° ice-ocean prediction system.

The 1/12° system is run in hindcast mode (2003-2009) during development, and validation against ice and ocean observations is used to refine the system.

The model

- Version 3.1 of NEMO with the CICE sea-ice model.
- Configured on a tripolar grid extending from 26N in the Atlantic to Bering Strait.
- Horizontal 1/12° grid spacing.
- 50 z-levels in the vertical, with partial cells.
- Initialization and open boundary conditions from a global 1/12° model.
- Atmospheric forcing from the Canadian GDPS reforecasts.

Figure 1: The model domain, with the effective horizontal resolution (km).



Pacific water in the Beaufort Sea

Waters of Pacific origin form a layer of relatively low salinity in the Arctic, contributing to the transport of freshwater to the North Atlantic (e.g. *Steele et al, 2004*).

Long-term moored profilers provide a simple validation of temperature in the southern Beaufort Sea (Figure 2). This highlights an apparent absence of Alaskan Coastal Water (ACW) around 60m depth in the model at a mooring located in the deep Beaufort Sea.

A map of model temperature bias at 60m, the depth of the ACW layer, shows a cool anomaly at this depth in the deep waters but not in shallower shelf regions (Figure 3).

A particle-tracking experiment using the model (Figure 4) shows that in the model the Pacific waters enter the Arctic via the northern Chukchi Sea. Transport that is initially directed westward along the coast of Alaska is advected back eastwards, away from the deep Beaufort Sea.

Figure 2: Multiyear mean summer temperature profiles

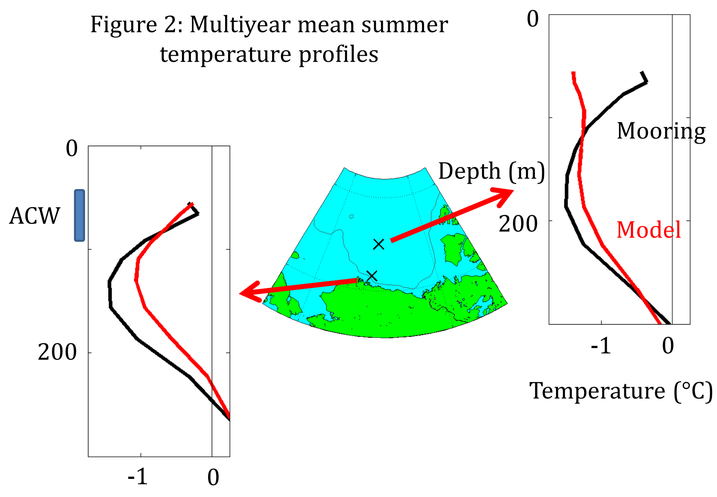


Figure 3: Model–observation summer temperature bias at 60m depth, and mean profiles at these locations

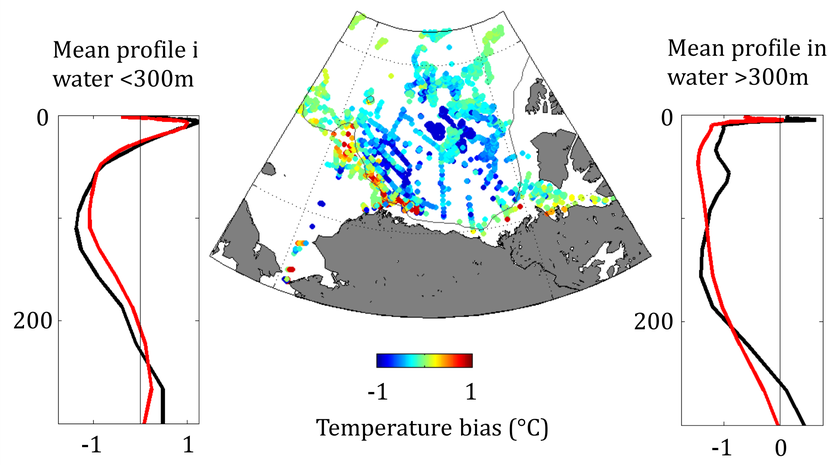
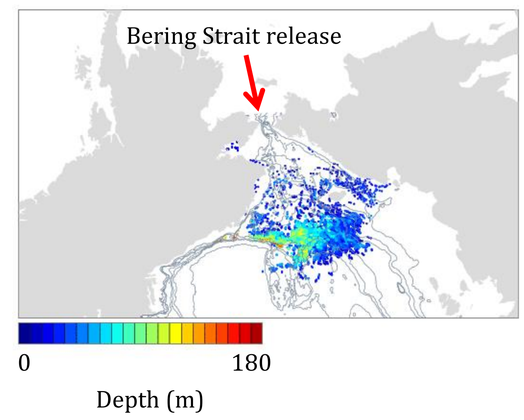


Figure 4: Particle tracking results, 8 months after release at Bering Strait



Volume transports through Barrow Strait

Barrow Strait forms one of the main pathways for freshwater transport from the Arctic to the North Atlantic. A mooring array was deployed from 1998 to 2011 (*Peterson et al., 2012*). Volume transport estimated by the model is a little high (Figure 5). Comparison of the model with the mooring measurements(Figure 6) shows that the model current is too fast in the southern part of the channel.

Figure 5: Volume transport estimates at Barrow Strait

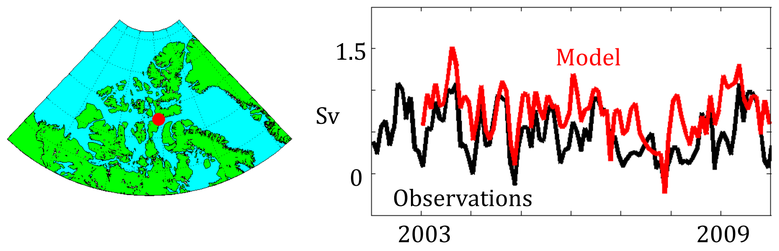
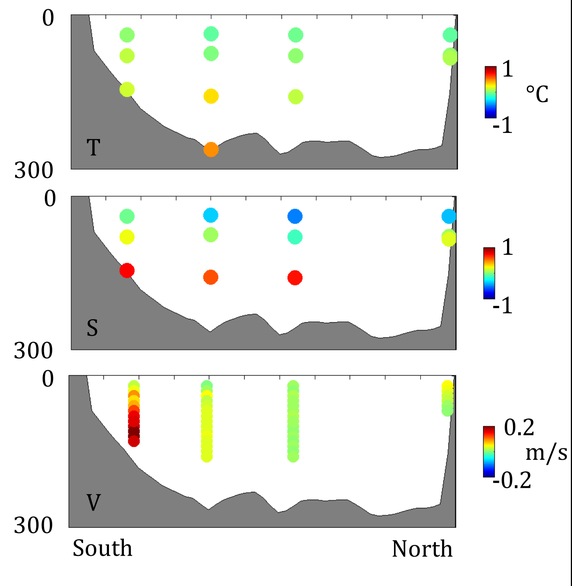


Figure 6: Multiyear mean T, S, and along channel velocity bias at mooring locations



References

Peterson, I., J. Hamilton, S. Prinsenberg and R. Pettipas (2012), Wind-forcing of volume transport through Lancaster Sound, *J. Geophys. Res.*, 117, C11018, doi:10.1029/2012JC008140.

Steele, M., J. Morison, W. Ermold, I. Rigor, and M. Ortmeyer (2004), Circulation of summer Pacific halocline water in the Arctic Ocean, *J. Geophys. Res.*, 109, C02027, doi:10.1029/2003JC002009.

Acknowledgments

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