Temperature signature of high latitude Atlantic boundary currents revealed by marine mammal-borne sensor and Argo data

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Outline

• Context
• Data sources
• Methodology
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• Summary and on-going Work
Improved T/S climatologies required in ocean modelling

- Model runs initiated from basic state.
- Relaxed back to them to avoid excessive drift.
- *If the basic state being restored to has a poorly defined current - can promote, rather than restrict drift.*
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Data Coverage 2004-2008

Argo profiles
Seal profiles
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Seal profiles

Argo profiles
Data Processing Steps

1. Delayed Mode QC Argo is reference data
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   overlapping Argo domain
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Temperature at deepest point of seal profile

Only within Argo domain
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2. Identify seal track overlapping Argo domain
4. If RMS difference from ref data < 2x OI error, deployment joins ref data.
96 marine-mammal borne deployments
Mean Max Depth: 197m
23% deeper than 300,
Mean length of deployment- 142 days
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~13,000 Argo Profiles

~48,000 Marine-mammal Profiles

Hooded Seals
Harp Seals
Grey Seals
Beluga
Objective Interpolation Procedure

- Boehme and Send (DSR II, 2005) OI and correlation scales.
- Monthly fields averaged to produce 2004-2008 mean.
- 1°, 15 levels (0-700m) for comparison with WOA.
- Boehme and Send (2005) OI weights observations according to a) horizontal distance, b) barotropic PV (for topographic steering) and c) time from middle of the month.
- Similarly OI error estimate reflects the degree of separation (in time, distance and PV) of grid point from observations.
- Method allows estimates to be influenced by observations beyond spatial bounds of grid cell and temporal bounds of month.
Upper 500m Temperature (ºC) (2004-2008)
Mean temperature (2004-8): cross-section across 64.5°N

Lab Sea    Greenland    Irminger Sea
Mean temperature (2004-8): cross-section across 64.5°N

ATLAS more in accord with hydrographic surveys (e.g. Sutherland and Pickart 2008; Cuny et al. 2005)
Temperature (2004-8): cross-section across 64.5°N

- a) SE Greenland
- b) E. Baffin
- c) W. Baffin
- d) SW. Lab Sea
Summary

• Data from Argo and Sea-Mammal borne sensors used to develop 1° gridded Temperature data sets for NW Atlantic (ATLAS)
• Complementary spatial domain can help Argo constrain temperature structure of these important regions.
• ATLAS has greater cold temperature signals in shelf areas than WOA and EN3.
• Features consistent with high-resolution ship surveys.
• Future work will use new data to include salinity and seasonal cycle.
• Particularly relevant for ocean modelling as restoring back to a poorly defined boundary current enhances rather than constrains model drift.
Horizontal Dataselection

Based on spatial distance $D$ and fractional distance in planetary vorticity $F$.

$$D = |a - b|$$

$$F = \frac{|PV(a) - PV(b)|}{\sqrt{PV^2(a) + PV^2(b)}}$$

$$PV = \frac{f}{H}$$

$a$: float position

$b$: historical profile position

(Davis, 1998)

(Boehme et al., 2005)
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Mapping

A set of historical profile is mapped based on:

- the spatial distance $D$
- the fractional distance in planetary vorticity $F$
- the temporal distance $t$

using a two step mapping scheme.

The covariance of the $i$th profile with the float profile becomes:

**first stage:**

$$ C_{dg_i}(x, y) = \exp \left\{ - \left[ \frac{D_{i0}}{\lambda_l} + \frac{F_{i0}}{\Phi_l} \right] \right\}, \text{ 'basin wide mean' } $$

**second stage:**

$$ C_{dg_i}(x, y, t) = \exp \left\{ - \left[ \frac{D_{i0}}{\lambda_s} + \frac{F_{i0}}{\Phi_s} + \frac{(t_i - t_0)^2}{\tau^2} \right] \right\}. \text{ 'residuals' } $$

Short time variability ($\tau \sim \text{ week}$) $\implies$ noise
Objective Interpolation Procedure


Boehme and Send (DSR II, 2005) OI and correlation scales.

Monthly fields averaged to produce 2004-2008 mean.

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No. of Months in Year with coverage: