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

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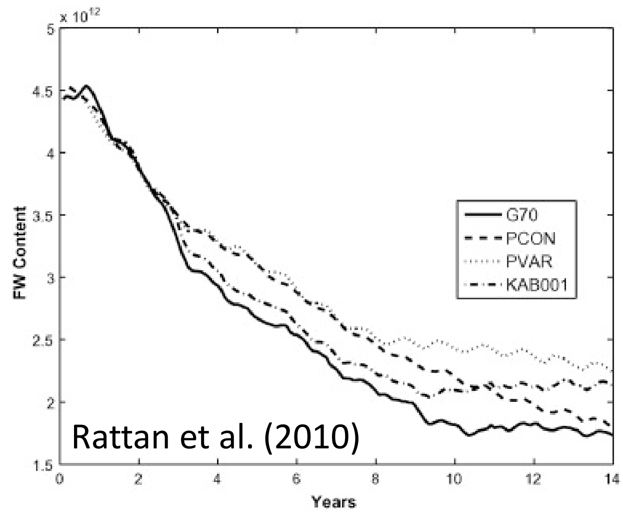
# Outline

- Context
- Data sources
- Methodology
- Comparison with other data sets
- Summary and on-going Work

# Improved T/S climatologies required in ocean modelling

Lab Sea FW Content




- 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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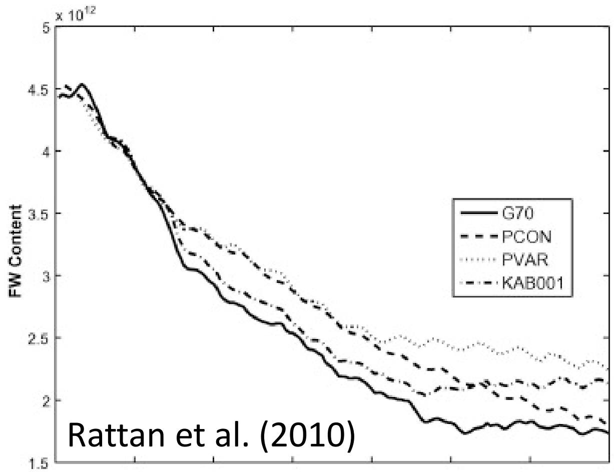
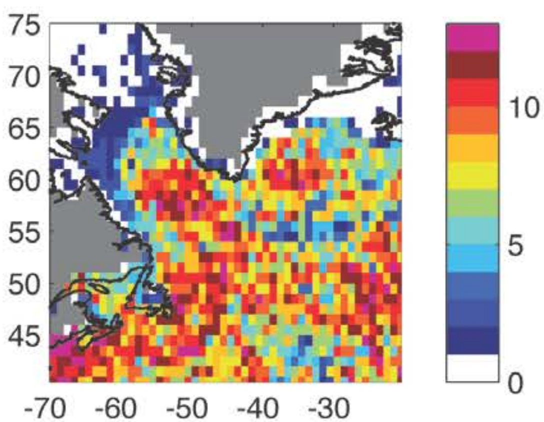



No. of Months in Year with coverage: EN3 (2004-2008)

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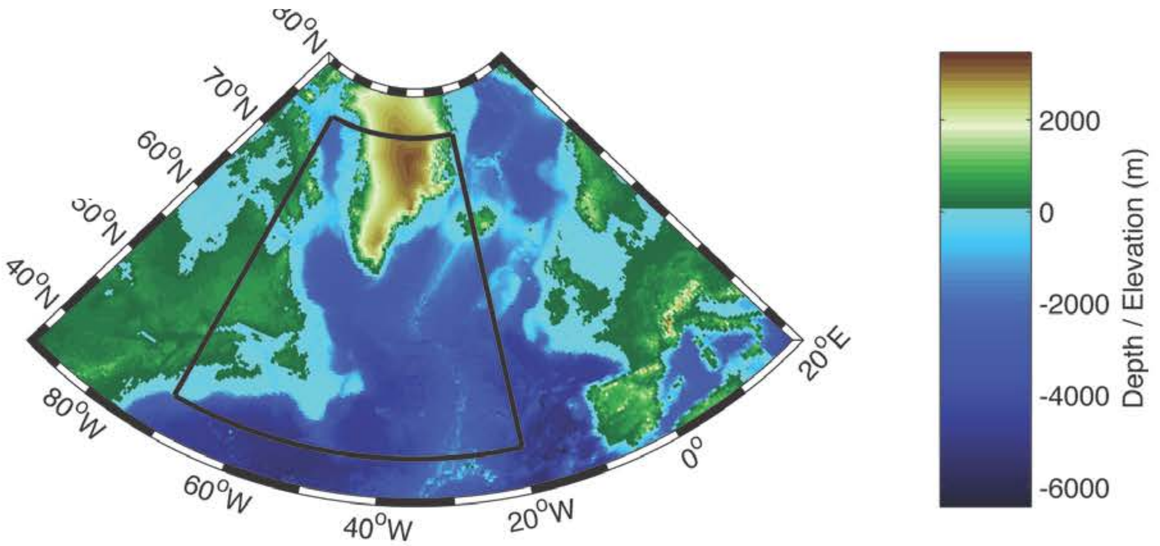
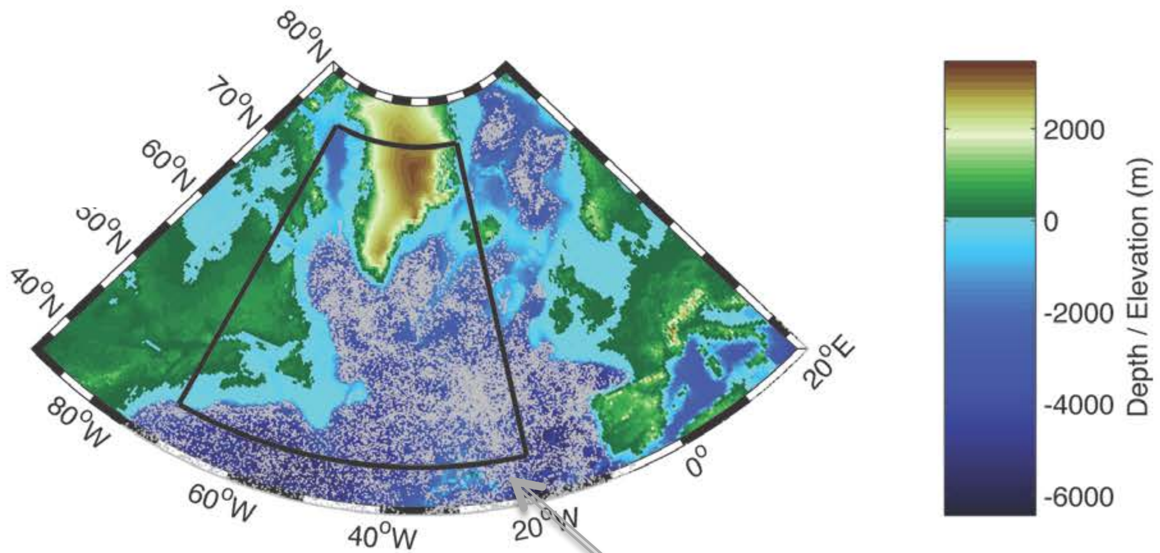
# 'ATLAS'

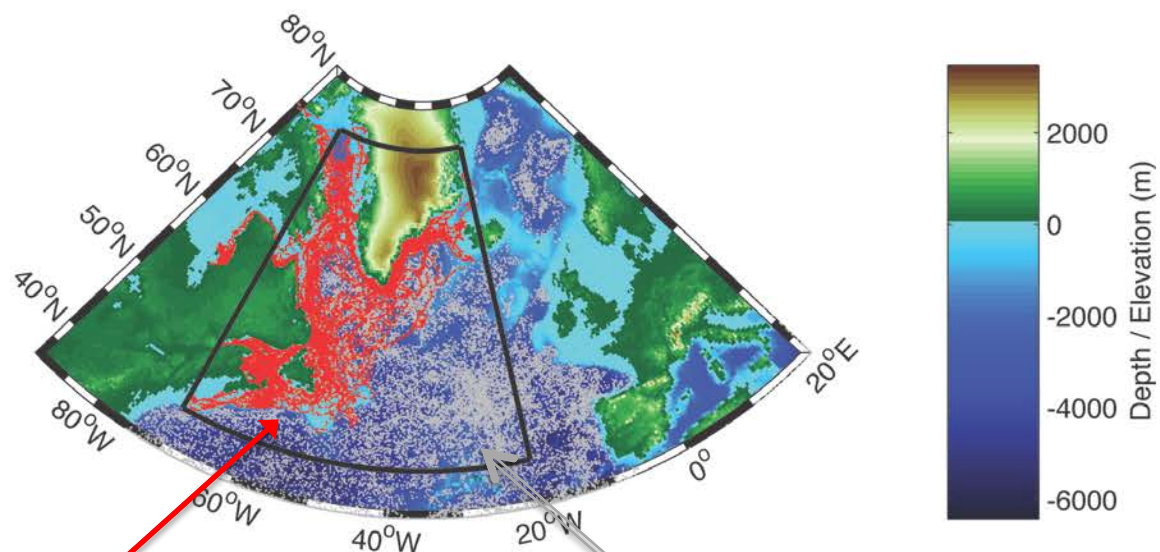

80°N
70°N
60°N
50°N
40°N
80°W
60°W
40°W
20°W
0°
20°E
2000
0
-2000
-4000
-6000
Depth / Elevation (m)

# ‘ATLAS’
# Data Coverage 2004-2008




Argo profiles

# ‘ATLAS’
# Data Coverage 2004-2008




Seal profiles


Argo profiles

# Data Processing Steps

1. Delayed Mode QC Argo is reference data

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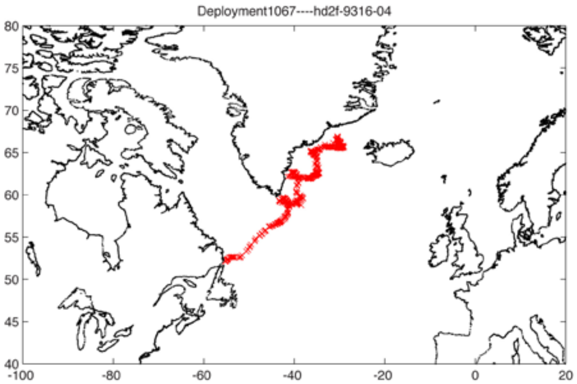
2. Identify seal track
overlapping Argo domain



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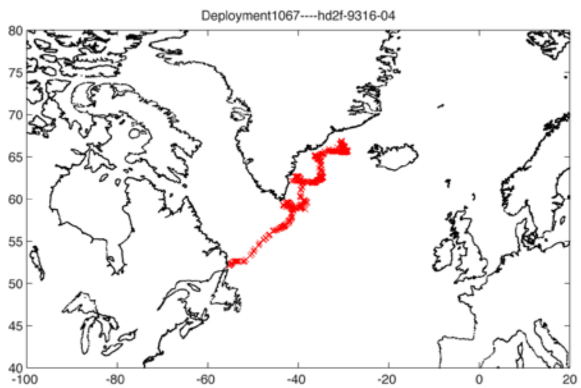
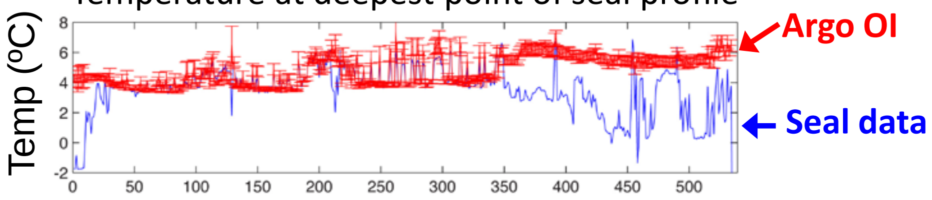



3. Check for temperature drifts & biases using method of Boehme and Send (2005)

Temperature at deepest point of seal profile



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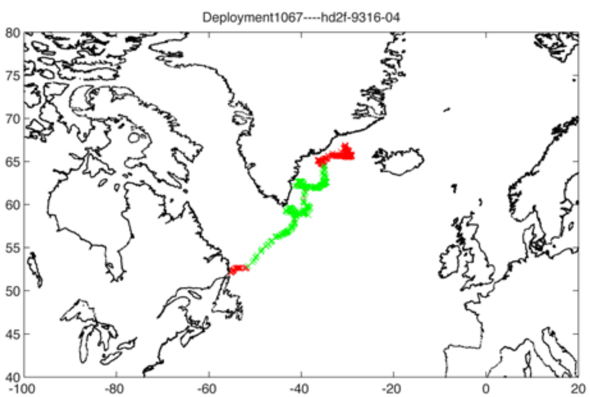


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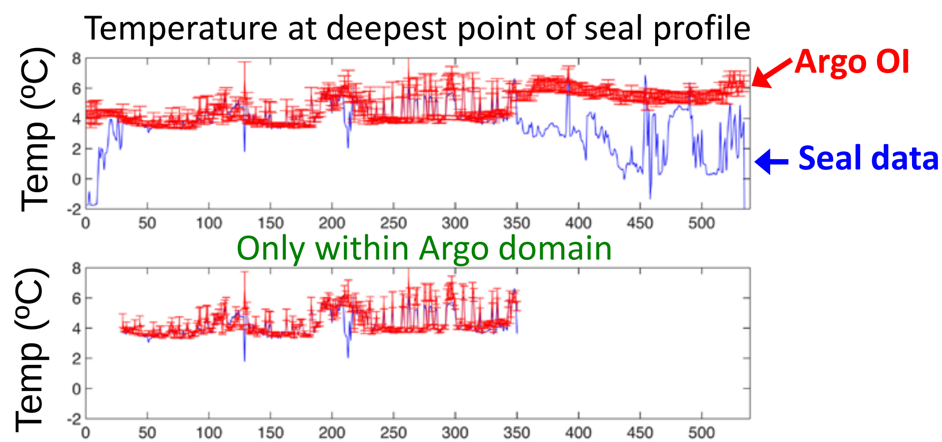

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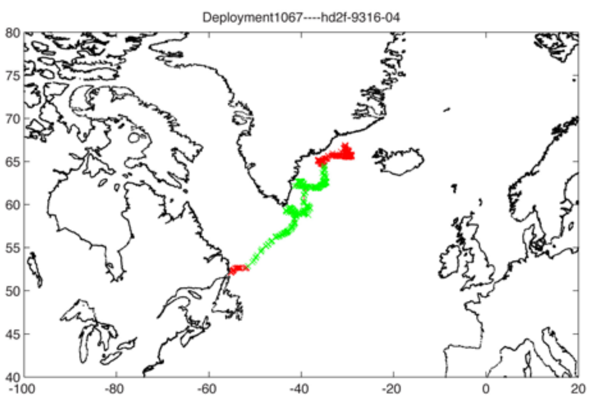
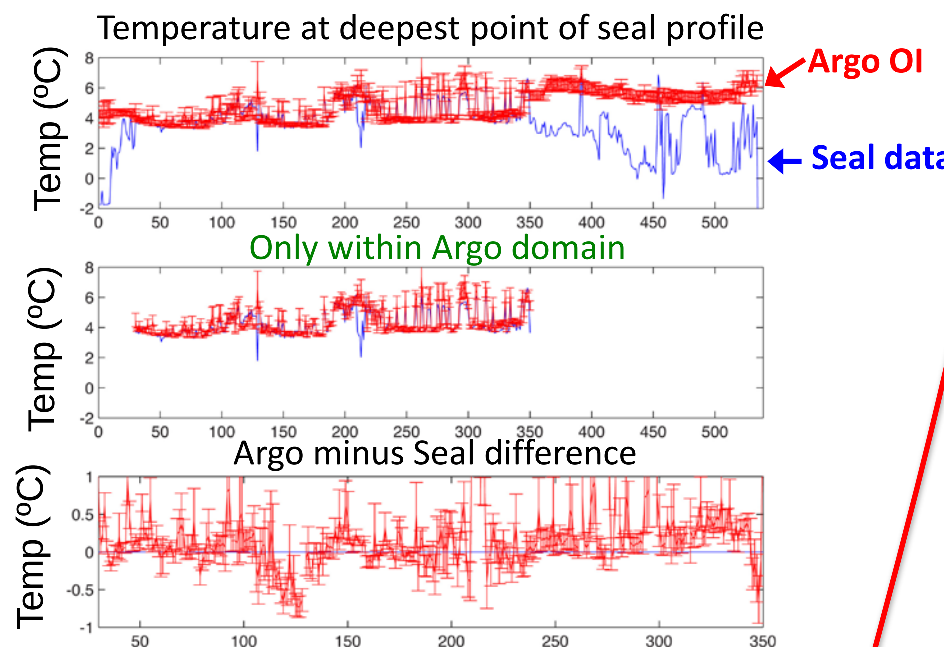


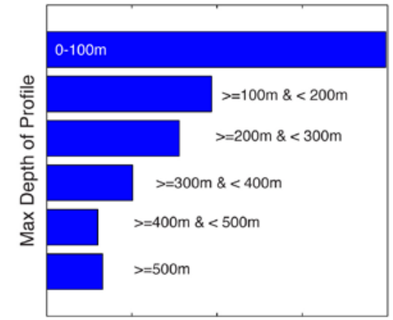




4. If RMS difference from ref data < 2x OI error, deployment joins ref data.

# ‘ATLAS’
# Data Coverage 2004-2008

96 marine-mammal borne deployments
Mean Max Depth:  197m
23% deeper than 300,
Mean length of deployment- 142 days

Frequency of max seal profile depth




0-100m
101-200m
201-300m
301-400m
401-500m
501-600m

0 5 10 15 20
No. of profiles (thousands)

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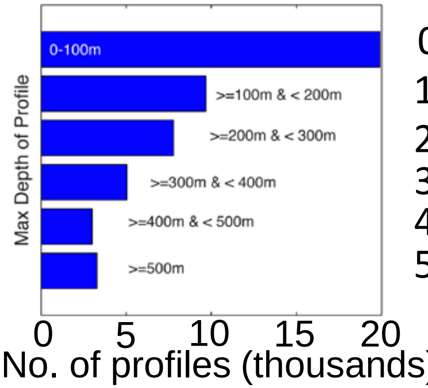
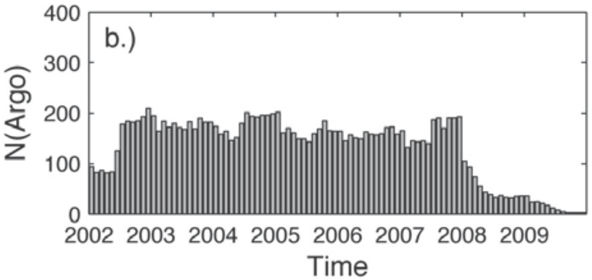
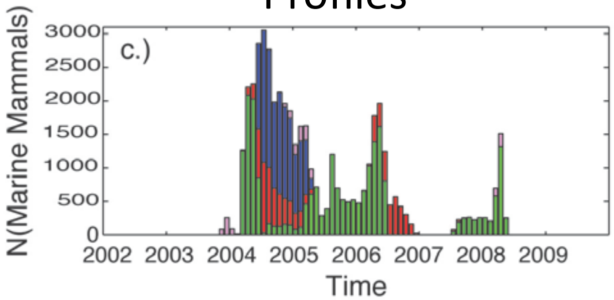



0-100m
101-200m
201-300m
301-400m
401-500m
501-600m

~13,000 Argo Profiles

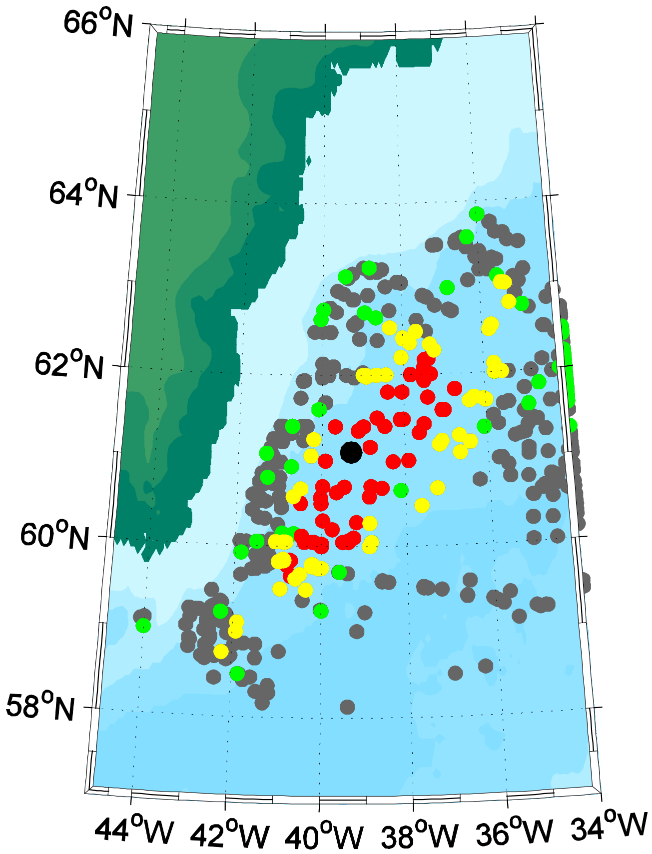



~48,000 Marine-mammal Profiles



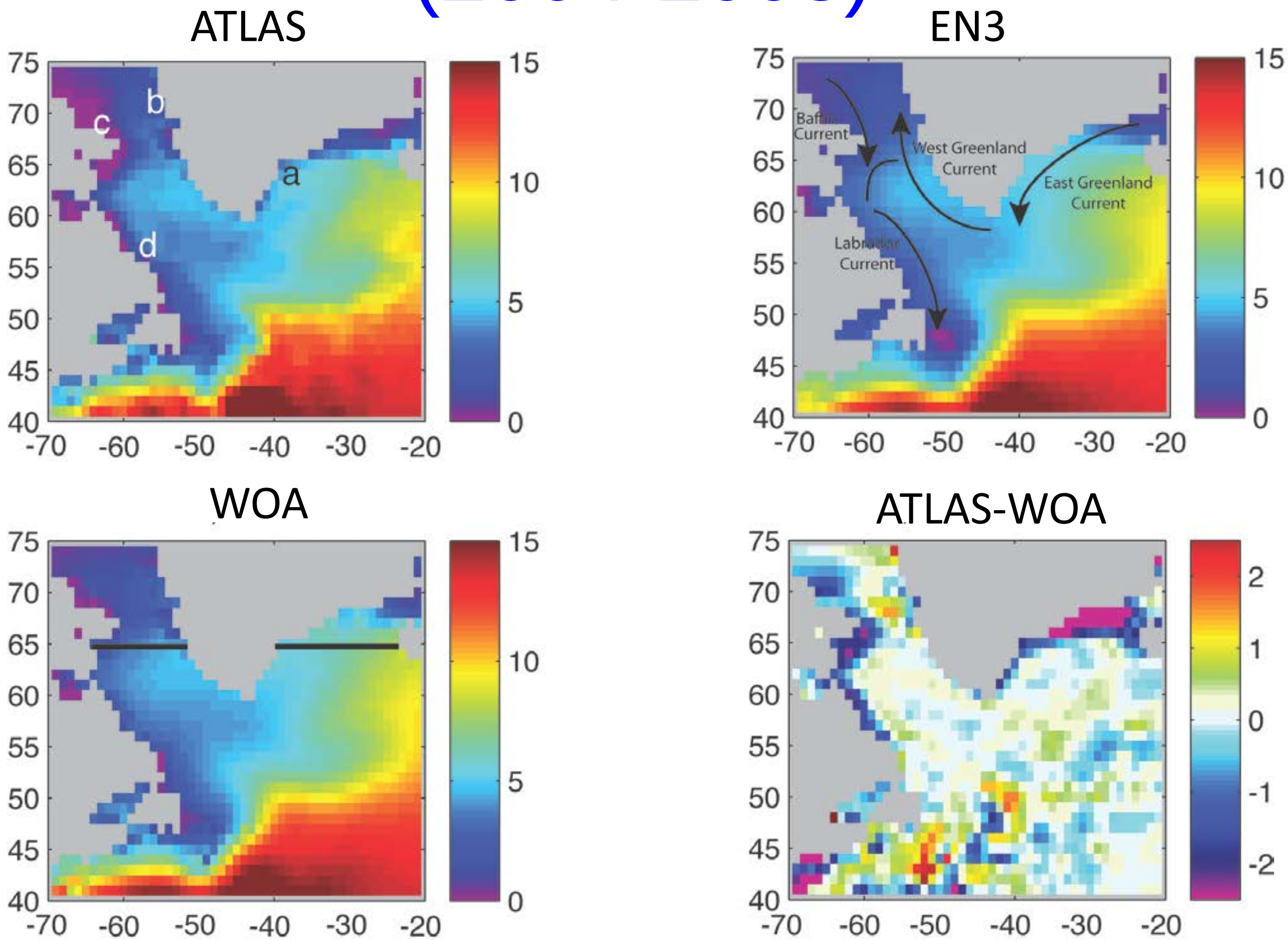

Hooded Seals
Harp Seals
Grey Seals
Beluga

# Objective Interpolation Procedure




- Jan 2004-Dec 2008 monthly gridded temperature estimates and OI error.
- 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 influence by observations beyond spatial bounds of grid cell and temporal bounds of month.

# Upper 500m Temperature (ºC) (2004-2008)



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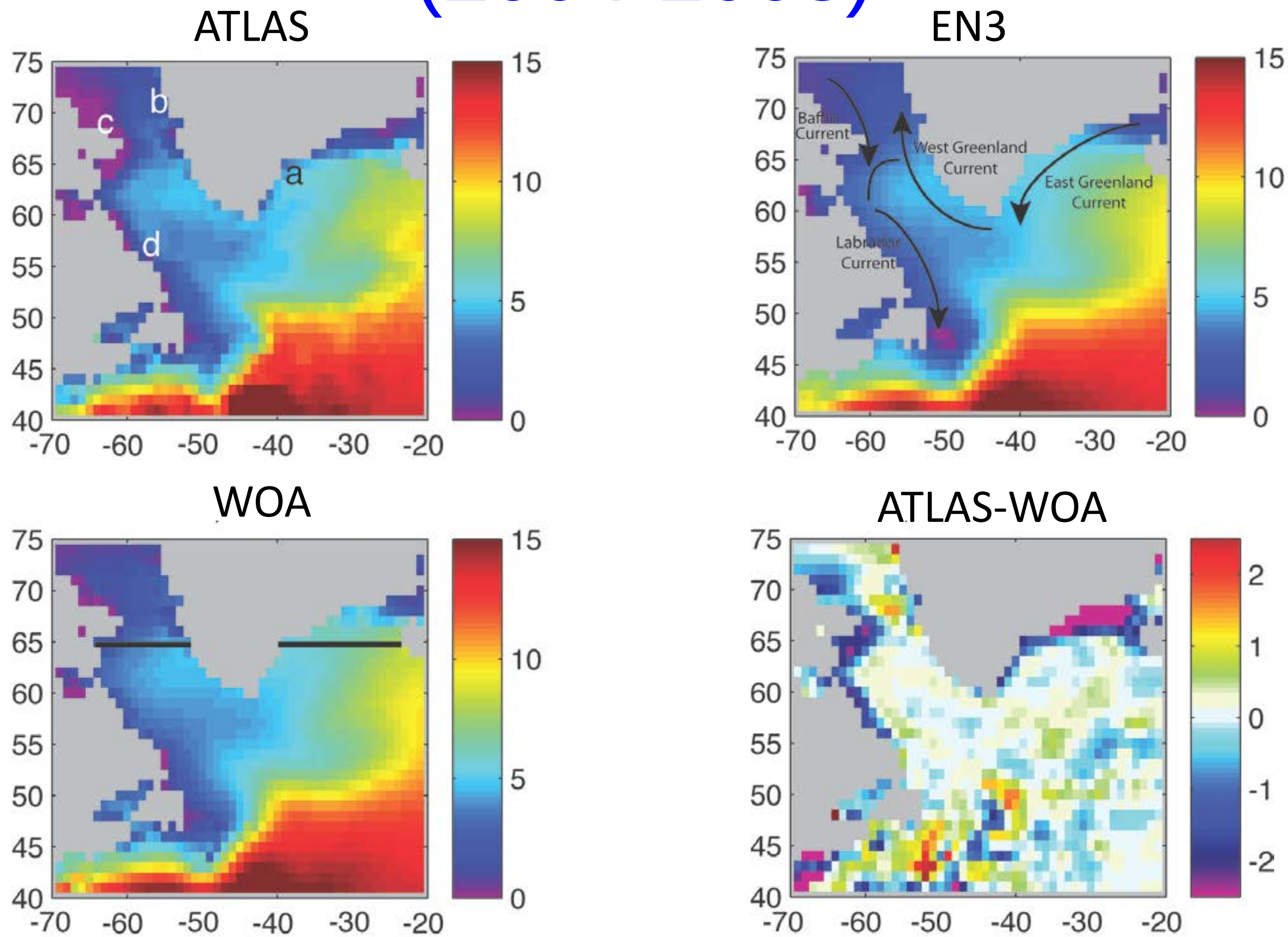
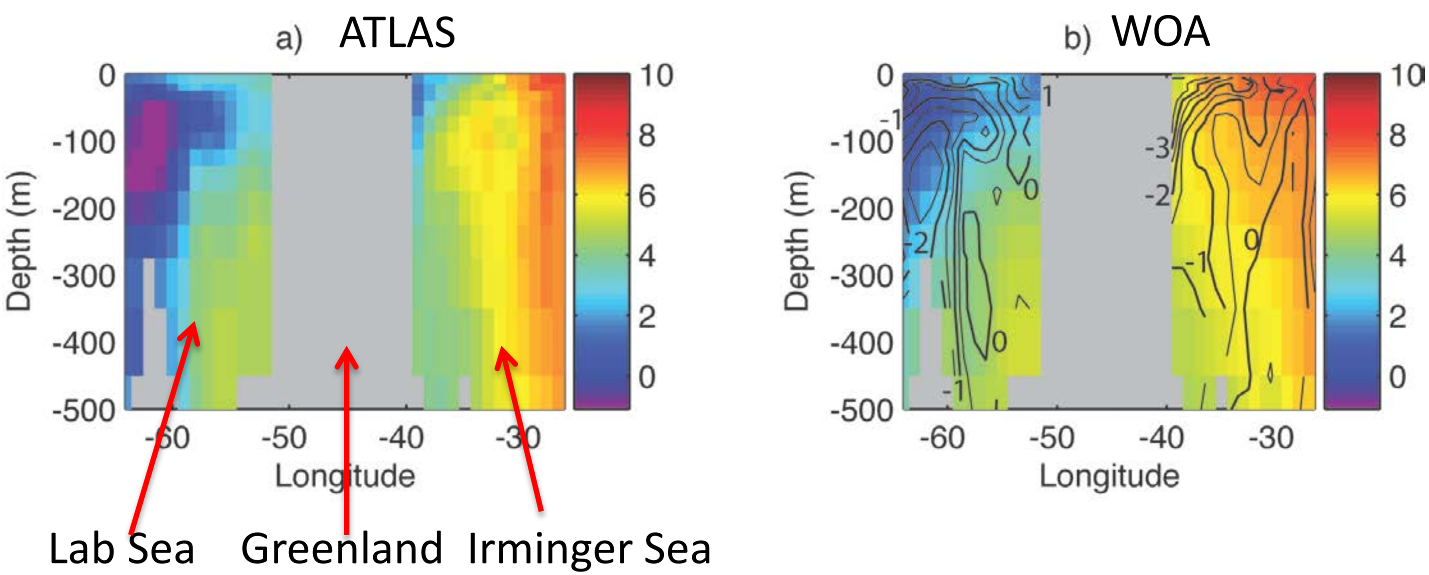


# Mean temperature (2004-8): cross-section across 64.5ºN



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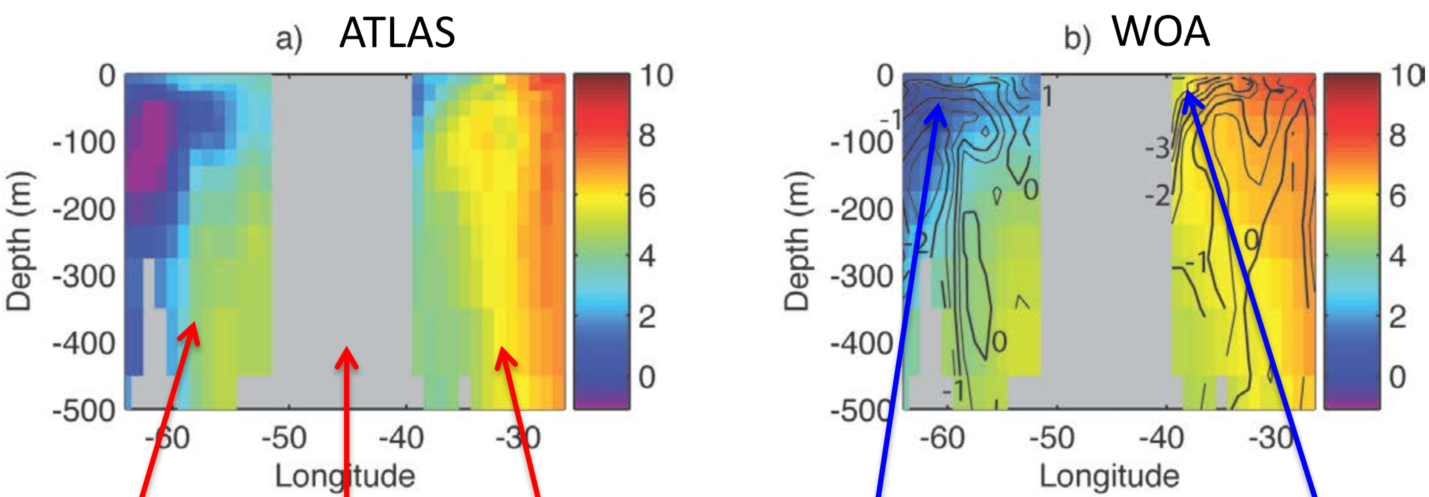


Lab Sea Greenland Irminger Sea

5.0ºC (*cf 1.8ºC ATLAS*)

-0.3.ºC (*cf -1.1 ºC ATLAS*)

ATLAS more in accord with hydrographic surveys (e.g Sutherland and Pickart 2008; Cuny et al. 2005)

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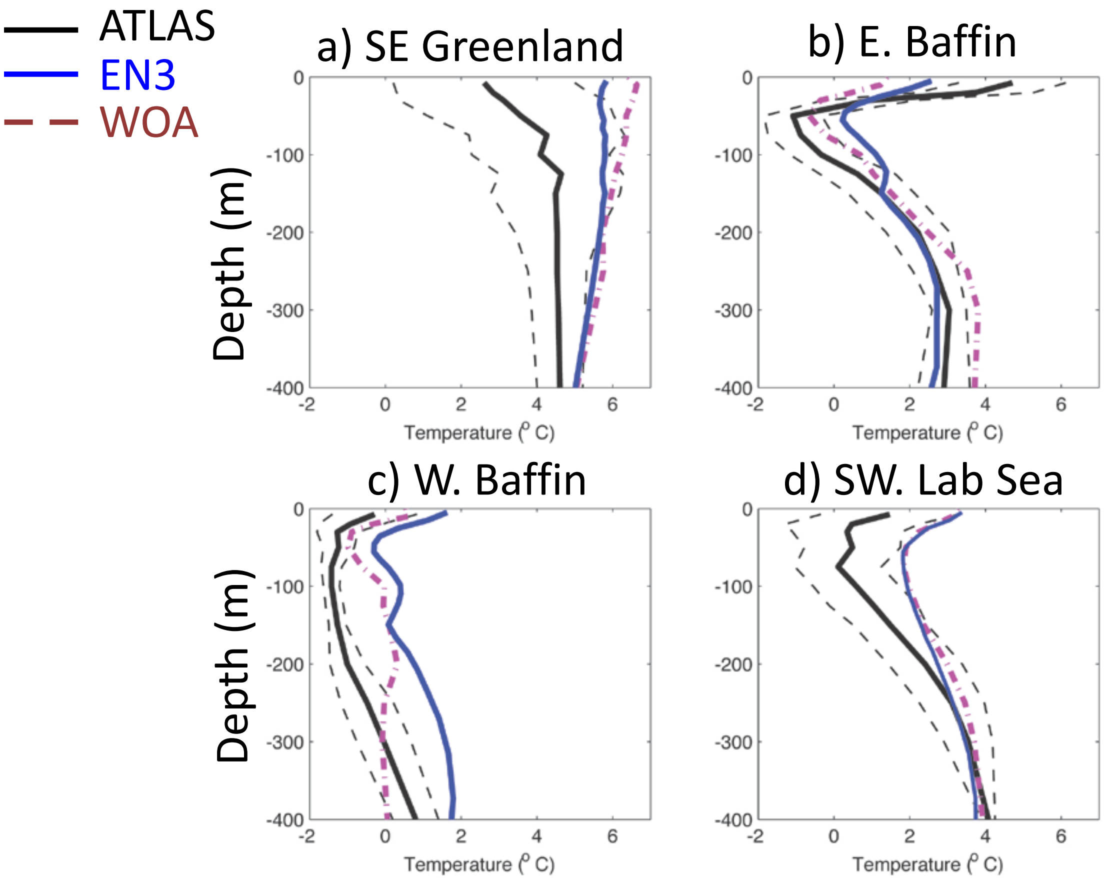
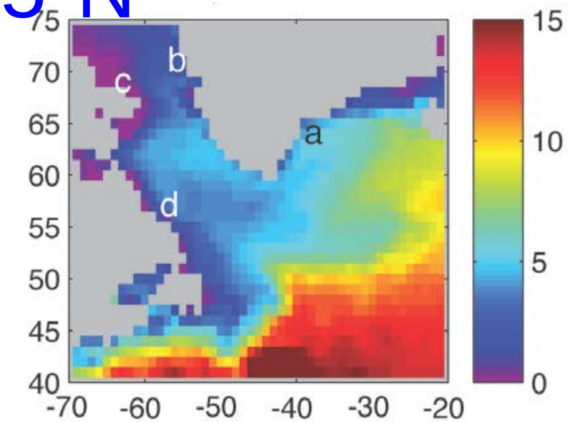
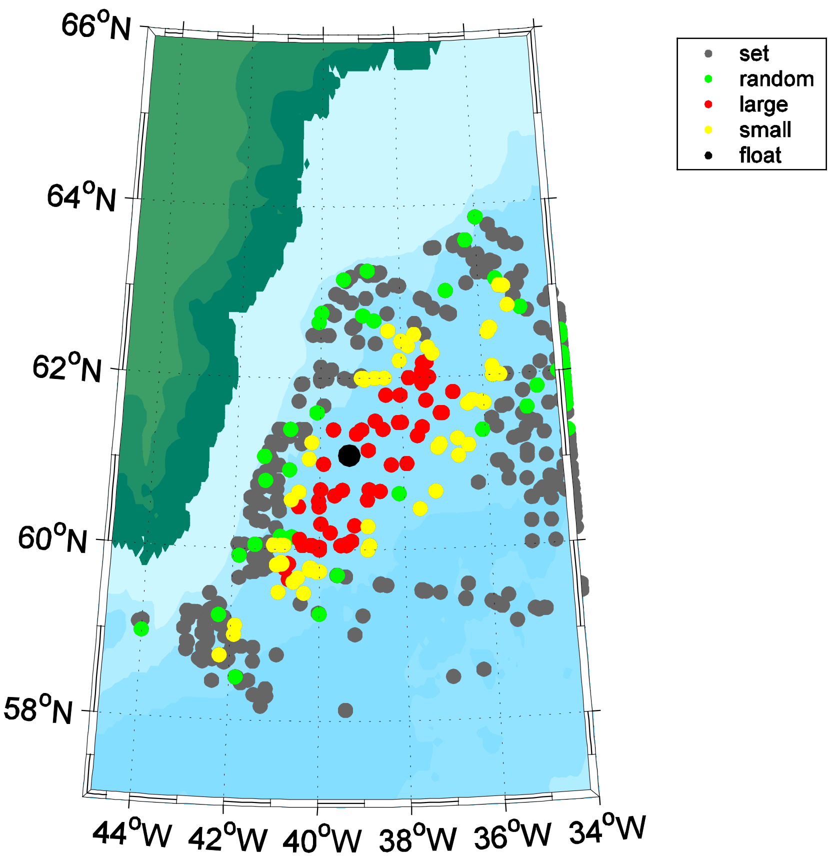


# Summary

- Data from Argo and Sea-Mammal borne sensors used to develop 1º 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.**

$$D = |\mathrm{a} - \mathrm{b}|$$

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

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

a: float position

b: historical profile position

(*Davis* ,1998

Boehme et al., 2005)

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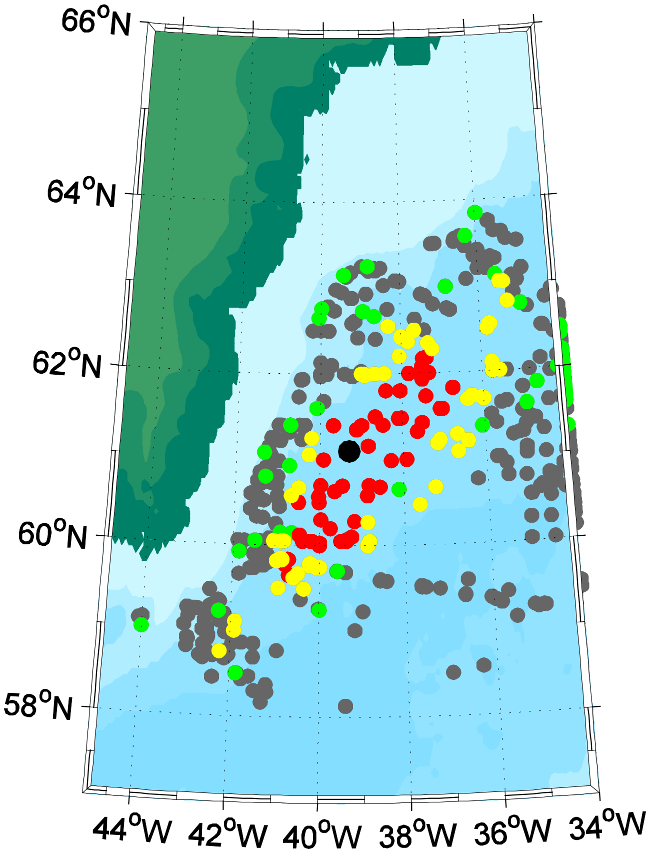


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# Mapping

**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:** $$\mathrm{C}dg_i(x,y) = exp\left\{-\left[\frac{D_{i0}}{\lambda_l} + \frac{F_{io}}{\Phi_l}\right]\right\},$$ **‚basin wide mean'**

**second stage:** $$\mathrm{C}dg_i(x,y,t) = exp\left\{-\left[\frac{D_{i0}}{\lambda_s} + \frac{F_{io}}{\Phi_s} + \frac{(t_i - t_0)^2}{\tau^2}\right]\right\}.$$ **‚residuals'**

**Short time variability (τ ~ week) => noise**

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No. of Months in Year with coverage: