Abstract

We have performed a preliminary intercomparison of the structure of the Beaufort Gyre (BG) in AOMIP models. We find that the freshwater pool of the BG is too shallow in some models (relative to observations) and too deep in others. The large-scale currents seem to respond to this geostrophically, i.e., the overly deep BG’s produce anticyclonic circulation to artificially deep levels. Total freshwater content in the BG seems reasonable in all models, indicating that it is a problem with the vertical distribution of freshwater. Two main factors may be contributing to these differences. First, the surface stress is different in each AOMIP run, even with the same atmospheric forcing, because of differences in the sea ice models. Second, the mixing schemes in each model are different. In particular, a very preliminary examination of AOMIP runs and also of different runs all using the UW model indicate that vertical diffusion may be a primary factor in controlling the depth of the BG and thus the sign of simulated Atlantic Water vorticity in the Canadian Basin.
Why is the Beaufort Gyre freshwater pool so shallow in some models, and so deep in others?

In the following slides, we first explore the extent of the problem, using model output available on the LAS before our workshop from AWI and LLN, and from our very recent UW run using our new POP ocean model configuration.

We will show:
- vertical salinity slices
- horizontal salinity slices
- maps of freshwater content & SSH
- horizontal ocean velocity slices

We conclude with a very brief discussion of potential mechanisms that might be causing these differences.
Salinity transect: Alaska - Franz Joseph Land

contours shoal near Alaska in
Salinity at ~200 m

AWI 34.2 –

LLN 33.3 –

UW 33.4 –

EWG 33.5 –

too salty
Salinity at ~300 m

~34.7

too salty

~34.0

too fresh

33.7

too fresh

34.0
Summary of $S(x,y,z)$

Relative to EWG:
Freshwater is too shallow

Relative to EWG:
Freshwater is too deep

(UW ~better with std./NCEP forcing)

Ditto, but worse!
Freshwater content

Not bad agreement! ⇒ differences are
► f.w. (z), & not
► f.w. content
SSH

Not bad agreement
SSH ≈ dynamic topog.
Velocity at 5 or 10 m

all anticyclonic @ surface
Velocity at 100 m

By 100 m, the differences are evident.
Velocity at 300 m

100 m – 500 m: vorticity ~constant
Velocity at 500 m

2-layer fluid (0 – 800 m)
- Top: *wind-driven* B.Gyre
- Bottom: *p.v.conserving* bound. current

The 2 current systems are (unrealistically?) vertically decoupled!

1-layer fluid (0 – 800 m)
- *wind-driven* B.Gyre

Does the anticyclone destroy the cyclonic boundary current?
Why? Why? Why?

Hypothesis #1: It’s resolution!

AWI-1: \( \Delta x = 28 \) km

AWI-2: \( \Delta x = 100 \) km

NPS: \( \Delta x = 18 \) km

UW: \( \Delta x = 40 \) km

...figures are from G. Holloway’s web page: ocean velocity at 400-500m

Nahhh...
**Why? Why? Why?**  

**Hypothesis #2: It’s mixing!**

<table>
<thead>
<tr>
<th></th>
<th>AWI</th>
<th>LLN</th>
<th>UW</th>
</tr>
</thead>
<tbody>
<tr>
<td>tracer advection</td>
<td>FCT</td>
<td>centered</td>
<td>centered</td>
</tr>
<tr>
<td>horiz. diffusion</td>
<td>none</td>
<td>isopycnal+GM</td>
<td>harmonic</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2e7 cm²/s)</td>
<td>(0.8e6 cm²/s)</td>
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<tr>
<td>vert. diffusion</td>
<td>none</td>
<td>1.5 turb. closure</td>
<td>harmonic</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(min = 0.12 cm²/s)</td>
<td>(0.25 cm²/s)</td>
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<tr>
<td>horiz. viscosity</td>
<td>biharmonic</td>
<td>harmonic</td>
<td>harmonic</td>
</tr>
<tr>
<td></td>
<td>(0.5e-21 cm⁴/s)</td>
<td>(4e8 cm²/s)</td>
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<td>1.5 turb. closure</td>
<td>harmonic</td>
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<tr>
<td></td>
<td>(10 cm²/s)</td>
<td>(min = ?)</td>
<td>(0.25 cm²/s)</td>
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<tr>
<td>mixed layer scheme</td>
<td>none</td>
<td>1.5 turb. closure</td>
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</tr>
</tbody>
</table>

**Uhhh...maybe!**  
*Preliminary runs at UW with varying vertical diffusion seem to support this idea.*
Why? Why? Why?

Hypothesis #3: It’s surface stress!
...i.e., *Ekman pumping*

Umm...
need to look at this!

The end... for now....