1. Introduction

• Interest in meridional overturning circulation changes (ΔMOC) derives from their role in climate through an influence on ocean meridional heat transport changes (ΔMHT).
• Past studies (Bingham et al. 2007; Blahtoch et al. 2008) elucidate low frequency ΔMOC.

2. Interannual-to-decadal meridional heat transport

• Time mean MHT ranges from 1PW at low latitude to 0.5PW at high latitude (Fig. 1a).
• Variations are of order 0.1PW at low latitude and 0.05PW at high latitude (Fig. 1b).
• Variations are 10-15% of mean (Fig. 1c).

• What are the causes of this variability?
• To address this question, we focus on ΔMHT at three latitudes (shaded bars on right), which are coherent with changes ~10° to the north and south (Fig. 1d).

3. Causes of variability

• We consider low frequency ΔMHT at three latitudes (Fig. 2 row 1). Using approximate frameworks, variable decompositions, and numerical experiments, we use model output to:
  ➢ estimate Ekman ΔMHT (Fig. 2 row 2) (Kraus & Levitus 1986);
  ➢ diagnose kinematic ΔMHT from overturning changes, gyre circulations, temperature variations, and velocity-temperature covariability (Fig. 2 row 3) (Jayne & Marotzke 2001; Bryden & Imawaki 2001);
  ➢ and assess dynamic ΔMHT due to winds, buoyancy, intrinsic variability, and nonlinear response to forcing (Fig. 2 row 4) (cf. Piecuch & Ponte 2012b).

4. Summary and prospective

<table>
<thead>
<tr>
<th>Question\Latitude</th>
<th>12°N</th>
<th>26°N</th>
<th>50°N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ekman fluxes are mostly sufficient to explain ΔMHT?</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
</tr>
<tr>
<td>Winds are the dominant forcing mechanism?</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Overturning changes most important?</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Intrinsic variability at the beginning of the period?</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Presence of low-frequency buoyancy-driven changes?</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Important contributions from nonlinear adjustment?</td>
<td>x</td>
<td>x</td>
<td>✓</td>
</tr>
</tbody>
</table>

• There are major differences between ΔMOC and ΔMHT at high latitudes.
• Thus, future studies will try to understand ΔMHT at these subpolar latitudes.

References

• Bingham, R. J., et al. (2007), J. Climate, 21, 6599-6615.

Contact

Christopher G. Piecuch | cpiecuch@aer.com | +1 781-761-2349

© Atmospheric and Environmental Research, Inc. (AER), 2012