ATLANTIC SECTOR: PREDICTABILITY

• Explain and understand: thermohaline circulation (THC), ocean heat transport (OHT), meridional overturning circulation (MOC), Sea Surface Salinity (SSS)
• Ask questions about whether prediction is possible
• Discuss predictability of Atlantic Ocean climatology

April 16th 2008
GEOS 595c
Tyson Swetnam
Sea Surface Temperatures for one year

http://www.youtube.com/user/NASASciFiles
Phase reversal of THC

1. MOC minimum
2. Subpolar gyre maximum
3. MOC maximum
4. Subpolar gyre minimum

Dong and Sutton 2005
• Note the high correlation between OHT and MOC.

• Exhibits a 24-year oscillation, appear to be heavily damped, by what?

• Driven by thermodynamics of THC
North Atlantic Oscillation

Rodwell et al. 1999
Regression mapping: $zA(t) = t,\{1,\ldots,n(t)\} <A> = 0$

$B(x,y,t) = t,\{1,\ldots,n(t)\}, x,y,\{1,\ldots,nx,ny\}$

Field $(x,y)$ based on a time series $(t)$;
Plot a regression of $B$ on $A$ at every point in space, $m$,

$m = <A_{t}B>_{nt} / <A_{t}A>_{nt} m(nxny,1)$

what is the correlation of $A$ to $B$? $r = <A_{t}B>_{nt} / S_{a}S_{b} \Rightarrow <A_{t}B>_{nt} = rS_{a}S_{b}$

$m = rS_{a}S_{b} / <A_{t}B>_{nt} = rS_{a}S_{b} / S_{a2} = rS_{a} / S_{b}$

Rodwell et al. 1999
Comparison of Dong and Sutton to Rodwell et al.

- What are the differences?
- What are the similarities?
- How do these effect predictability?

<table>
<thead>
<tr>
<th></th>
<th>Dong and Sutton</th>
<th>Rodwell et al.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>HadCM3</td>
<td>HadAM2b</td>
</tr>
<tr>
<td>Ocean Horiz</td>
<td>1.25 by 1.25</td>
<td>N/A</td>
</tr>
<tr>
<td>Resolution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ocean levels</td>
<td>20</td>
<td>N/A</td>
</tr>
<tr>
<td>Atmo Horiz</td>
<td>2.5 by 3.75</td>
<td>2.5 by 3.75</td>
</tr>
<tr>
<td>Resolution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atmosphere levels</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>Coupled?</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Forced with observed data?</td>
<td>No</td>
<td>Yes, 0.41 corr</td>
</tr>
</tbody>
</table>

Rodwell et al. 1999, Dong and Sutton 2005
Mechanisms

- Currents
- Salinity
- Pressure
- Heat

Rodwell et al. 1999
Can we predict?

- Rodwell et al. found that with known SST you can predict sign of NAO 2/3 years; strong events 3/4
- Dong and Sutton found that THC oscillation is forced by the atmosphere, but the ocean is responsible for setting the time scale
- AMO can be predicted probabilistically; however deterministic prediction is still unavailable
- NAO is noisy with (probabilistic) predictions only capturing a fraction of the year to year variance

Rodwell et al. 1999
References

• NOAA: http://woce.nodc.noaa.gov/wdiu/diu_summaries/sss/figures/atl.htm
• NASA Science Files: http://www.youtube.com/user/NASASciFiles

Rodwell et al. 1999
1.) The **Gulf Stream** (and its extension, the **North Atlantic Drift**) bring warm, salty water to the NE Atlantic, warming western Europe.

2.) The water cools, mixes with cold water coming from the Arctic Ocean, and becomes so dense that it sinks, both to the south and east of Greenland.

3-7.) If we zoom out, we see that this current is part of a larger system, connecting the North Atlantic... ...the tropical Atlantic... ....the South Atlantic... ....the Indian and Pacific Oceans... ...and the Southern Ocean. Further sinking of dense water occurs near to Antarctica.

8.) If we look below the surface, water from the two main sinking regions spreads out in the subsurface ocean...

9.) ...affecting almost all the world's oceans at depths from 1000m and below...

10.) The cold, dense water gradually warms and returns to the surface, throughout the world's oceans.

11.) The surface and subsurface currents, the sinking regions, and the return of water to the surface form a closed loop, the **thermohaline circulation** or **global thermohaline conveyor belt**