The effects of the Tsushima Warm Current on the East Sea

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Introduction

- The through flow (Tsushima Warm Current and Tsugaru/Soya currents) supplies heat and salt to the East Sea
  - ES heat budget (Isoda, 1999)
  - Net heat loss to air: 100w/m² (Na et al., 1999)
Time Series of deep water temperature in the northern EJS (Watanabe, 2003, GRL)

Spectrum of mass transport through the Korea Strait (Takikawa & Yoon, 2005, JO)
Model

- Inflow variability could induce temperature variability of the same frequency and control deep convection (Park, 2007, GRL)
Motivation

• What are the effects of the through flow on the East Sea circulation?
  – An idealized numerical experiment is conducted to answer to the above question.
Model

- Idealized rectangular basin
  - MOM V.3
  - With or without zonal wind stress
  - With or without through flow
  - Simple linear restoring temperature
  - Temperature only
Model II

<table>
<thead>
<tr>
<th>Case</th>
<th>Channel</th>
<th>Wind</th>
</tr>
</thead>
<tbody>
<tr>
<td>CW (Channel with Wind)</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>CNW (Channel No Wind)</td>
<td>O</td>
<td>X</td>
</tr>
<tr>
<td>NCW (No Channel with Wind)</td>
<td>X</td>
<td>O</td>
</tr>
<tr>
<td>NCNW (No Channel No Wind)</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

- Horizontal resolution: 0.25 deg.
- Integrated for 500 years
  - Not sufficient for the deeper part but upper layer is in quasi-steady state.
Results
SST and FLOW

Surface Temperature and Flow
Heat Flux
Zonal Mean Temperature Difference
Inflow Transport

Channel with wind 0.94 Sv
Channel without wind 0.86 Sv
Basin wide Temperature anomaly I

Temperature variability at 90m

- CW
- NCNW
- NCW
- CNW
Basin wide Temperature anomaly II

Inflow anomaly (Sv)
Whole basin
Southern part
• Problem
  – The inflow is too weak.
    • Previous studies suggest that the strength of the inflow is determined by the strength of the wind driven gyre at the outer basin.
    • In the current experiment, the outer basin is too small so that the wind driven gyre and subsequently the through flow are weak.

• Remedy
  – Increase the size of the outer basin: CW-Large
Temperature anomaly

Inflow anomaly (Sv)
- Whole basin
- Southern part

Channel with Wind

Channel with Wind - Large
Overturning vs inflow

Cor: -0.58

Overturning
Inflow (Sv)

Cor: -0.44
Summary and Conclusion

• Through the Tsushima Current heat and variability are transferred from the outside into the East/Japan Sea.
• The warming due to the inflow is stronger at the subsurface level than the surface.
  – If you look at the surface, you may not detect the effects of the inflow on the East/Japan Sea circulation.
• The strength of the through flow is determined by sea level difference between the inlet and outlet which in turn is set by the large scale flow of the larger basin.
• The overturning in the smaller basin is negatively correlated with the strength of the through flow.