The effects of the Tsushima Warm Current on the East Sea

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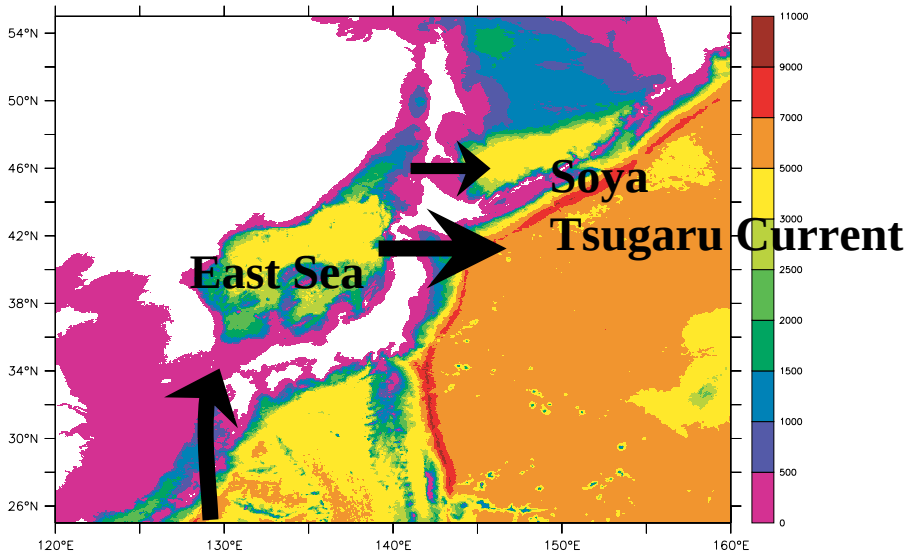
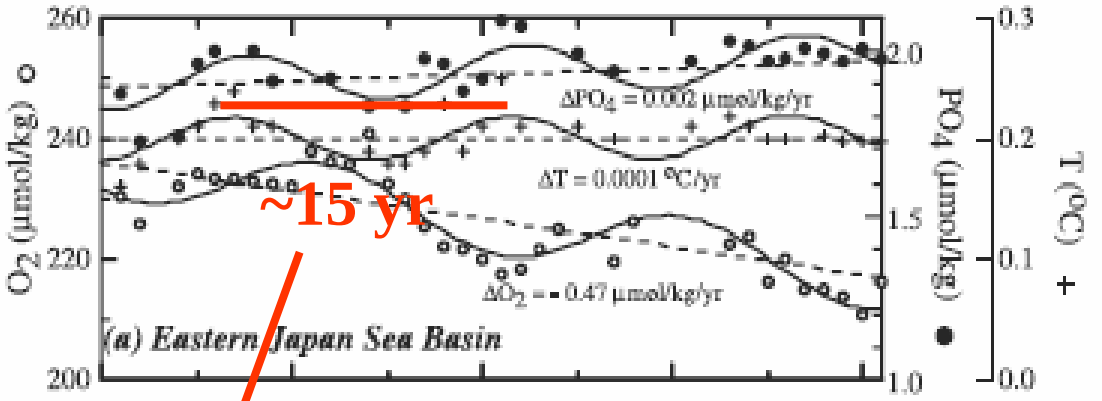
Introduction

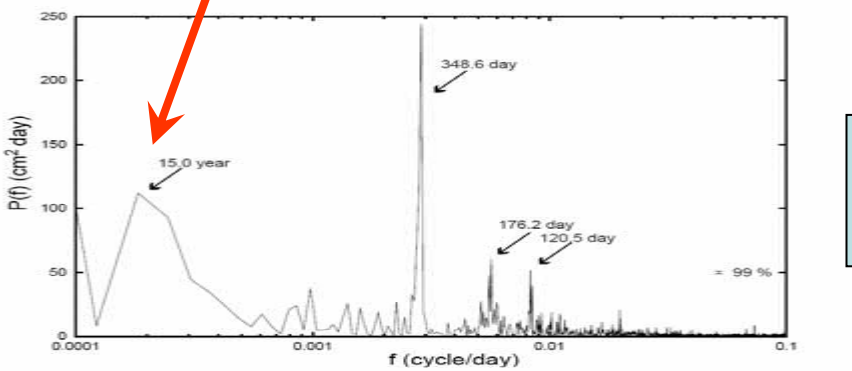
- The through flow (Tsushima Warm Current and Tsugaru/Soya currents) supplies heat and salt to the East Sea
  - ES heat budget (Isoda, 1999)
  - Net heat loss to air: 100w/m^2 (Na et al., 1999)



Tsushima Warm Current



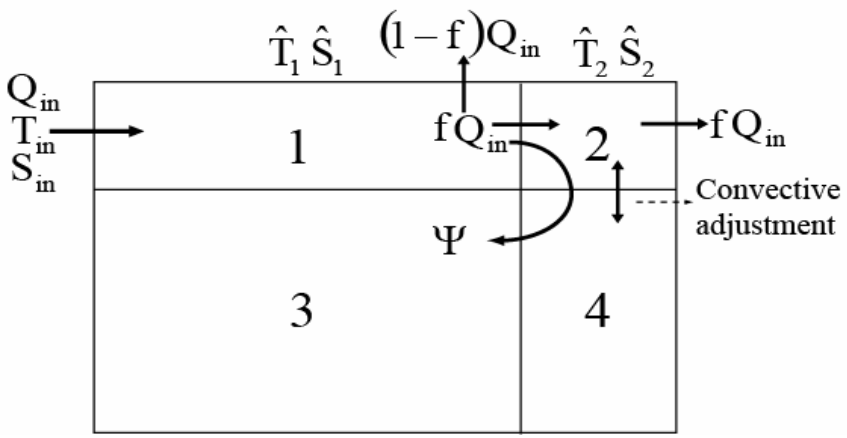
~15 yr



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



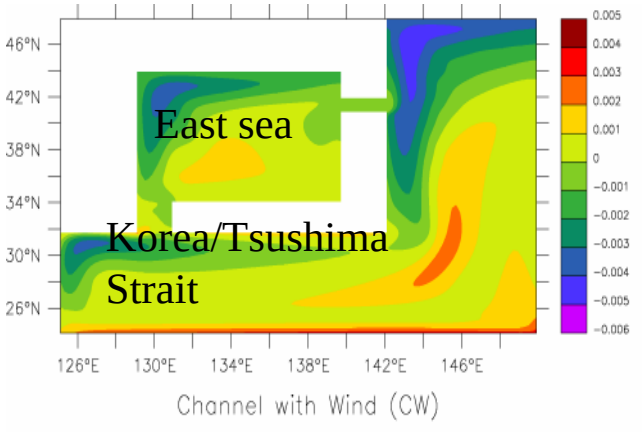
- Inflow variability could induce temperature variability of the same frequency and control deep convection (Park, 2007, GRL)

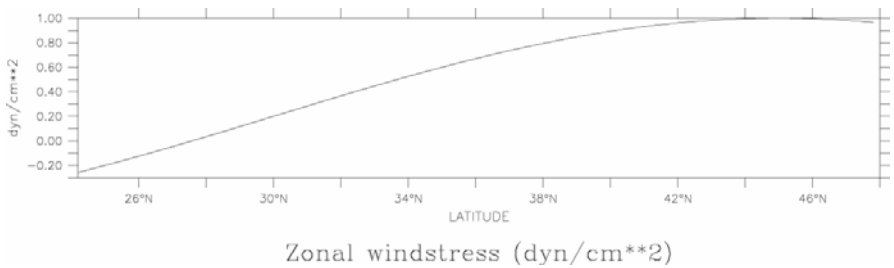
Motivation

- 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





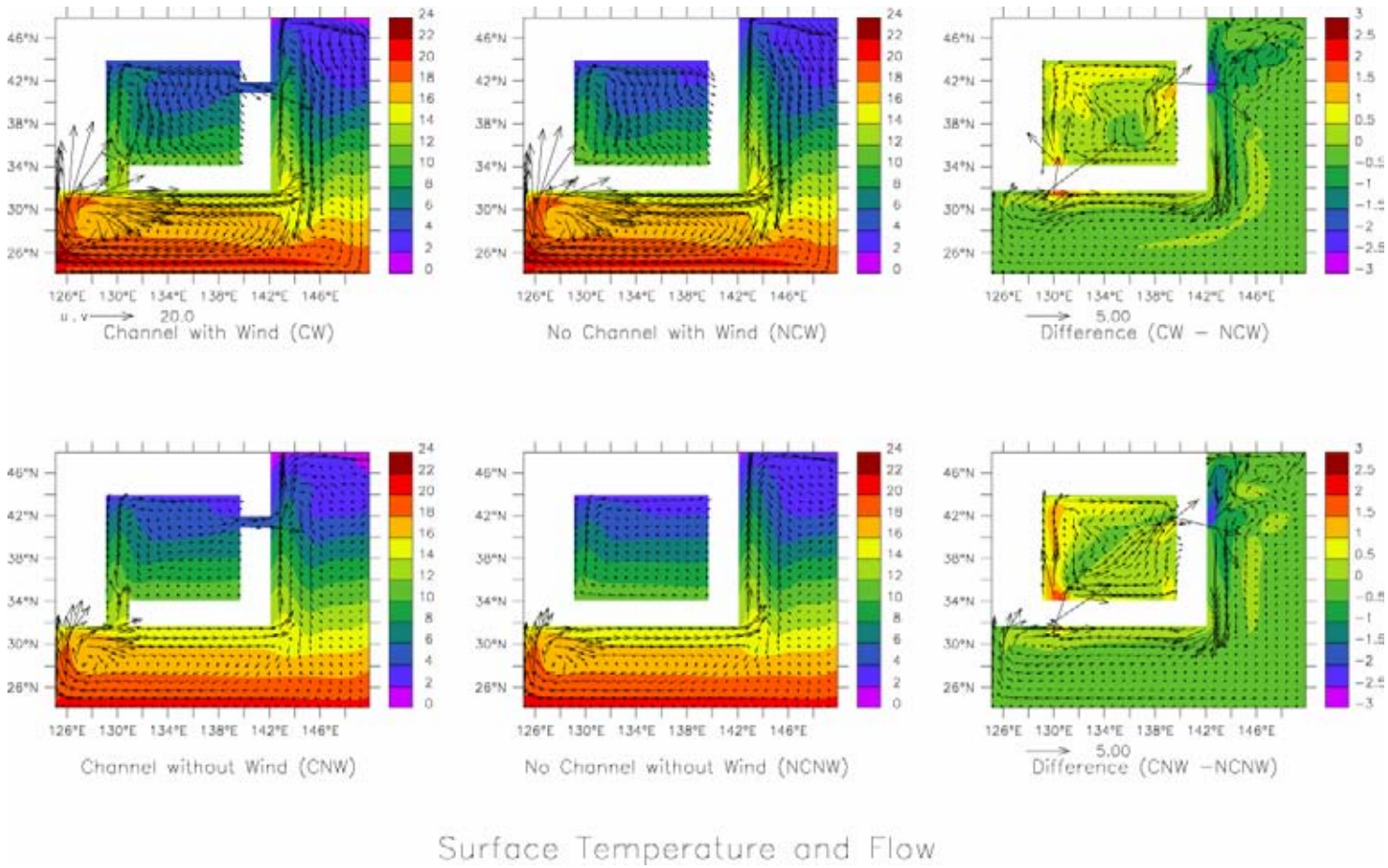
Model II

Case	Channel	Wind
CW (Channel with Wind)	O	O
CNW (Channel No Wind)	O	X
NCW (No Channel with Wind)	X	O
NCNW (No Channel No Wind)	X	X

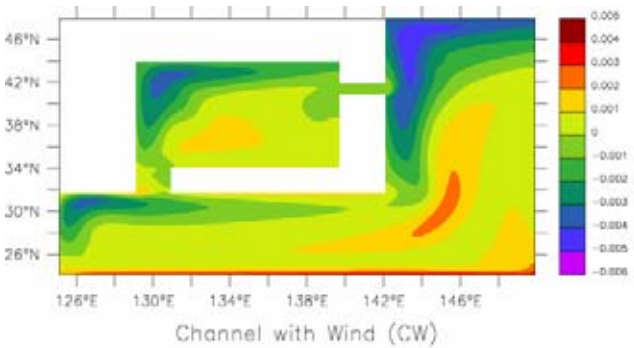
- Horizontal resolution: 0.25 deg.
- Integrated for 500 years
  - Not sufficient for the deeper part but upper layer is in quasi-steady state.

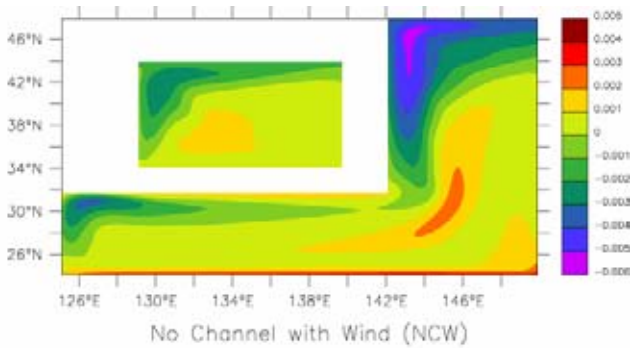
Results

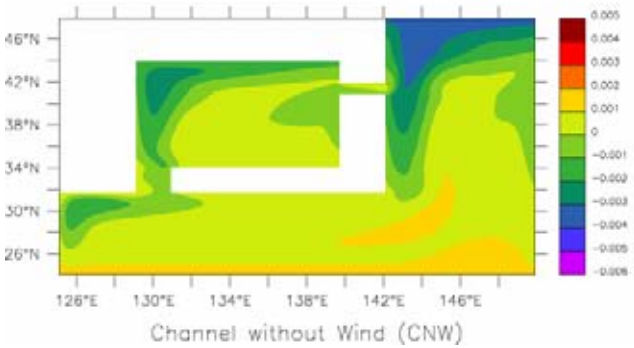
SST and FLOW


Channel with Wind (CW)
No Channel with Wind (NCW)
Difference (CW – NCW)
Channel without Wind (CNW)
No Channel without Wind (NCNW)
Difference (CNW –NCNW)
Surface Temperature and Flow

Heat Flux


46°N
42°N
38°N
34°N
30°N
26°N
126°E
130°E
134°E
138°E
142°E
146°E
Channel with Wind (CW)


46°N
42°N
38°N
34°N
30°N
26°N
126°E
130°E
134°E
138°E
142°E
146°E
No Channel with Wind (NCW)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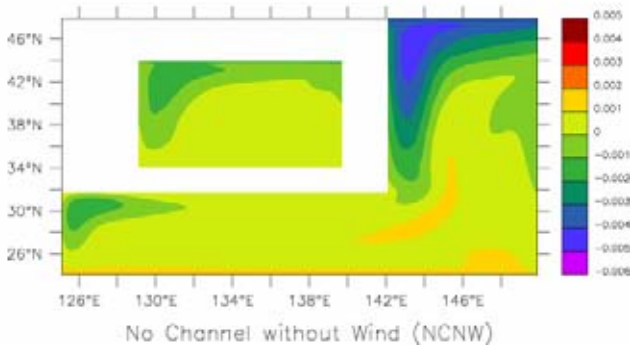
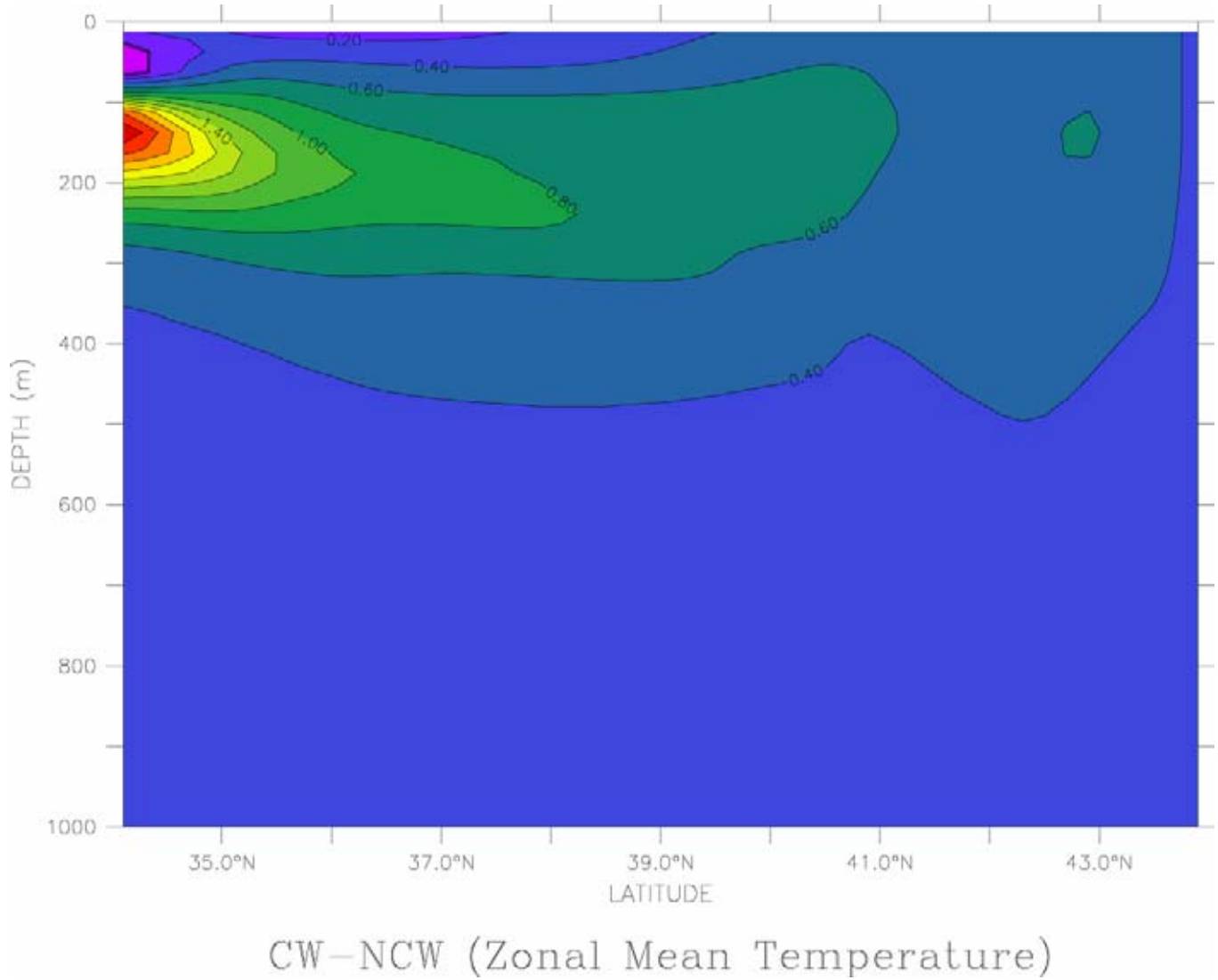
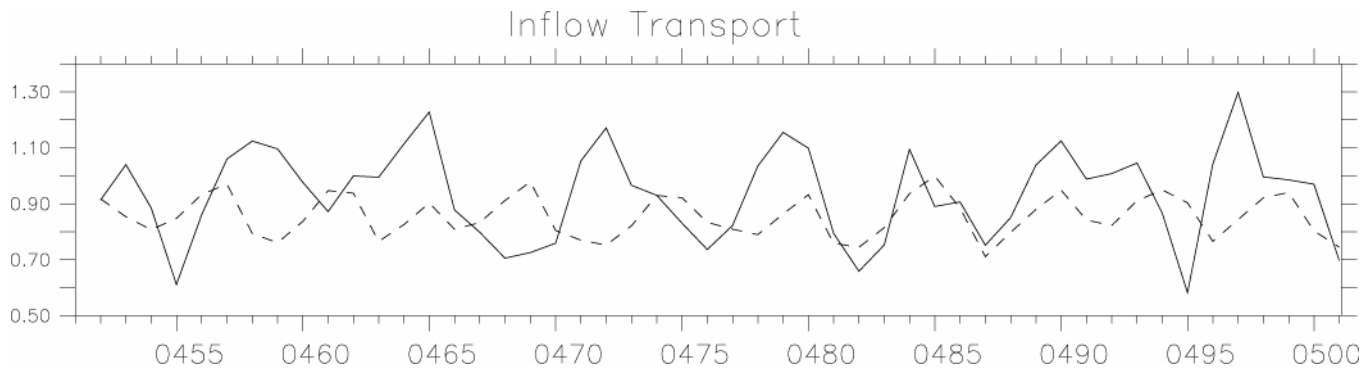
Channel without Wind (CNW)


46°N
42°N
38°N
34°N
30°N
26°N
126°E
130°E
134°E
138°E
142°E
146°E
No Channel without Wind (NCNW)

Zonal Mean Temperature Difference



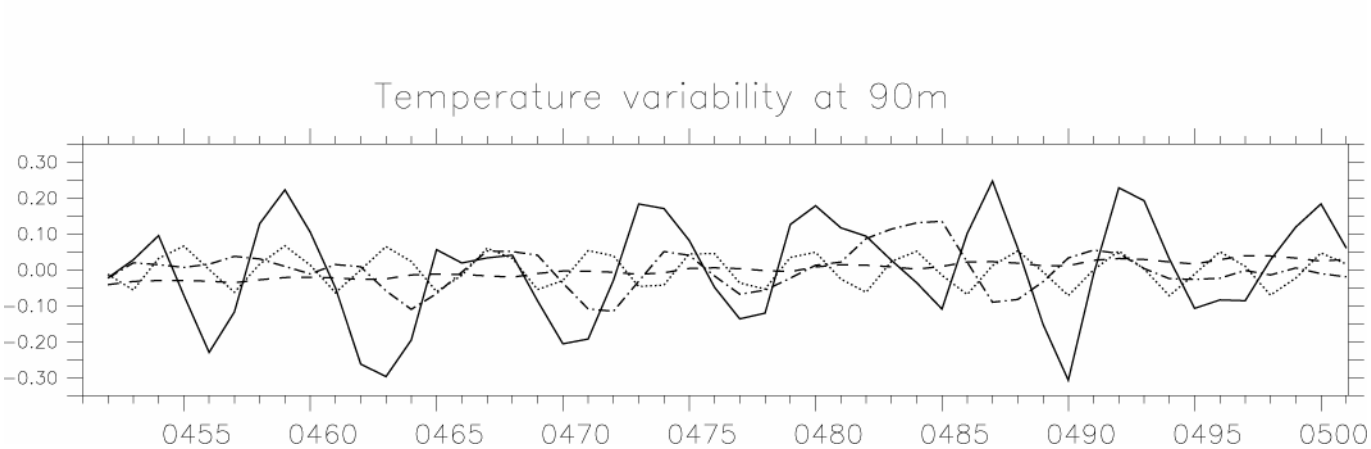
Inflow Transport



Channel with wind 0.94 Sv

Channel without wind 0.86 Sv

Basin wide Temperature anomaly I



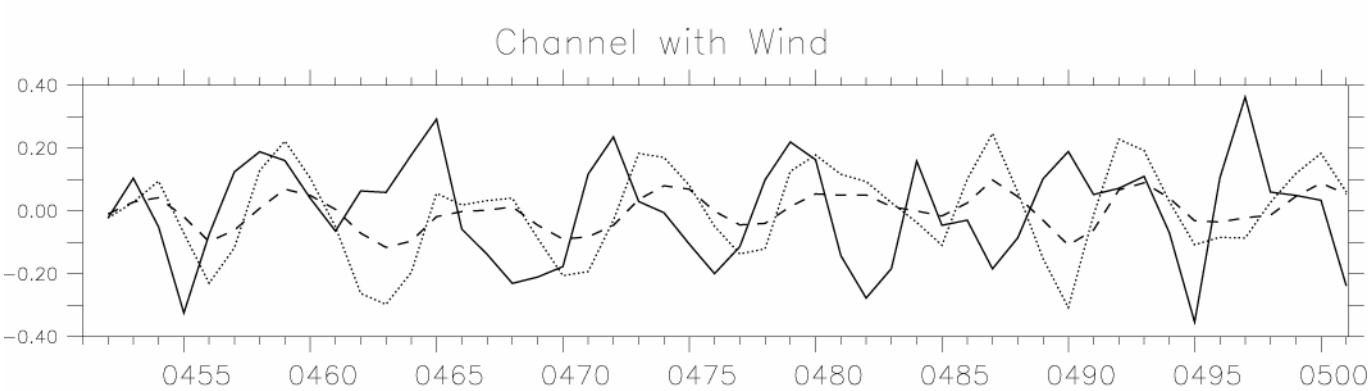
CW

NCNW

NCW

CNW

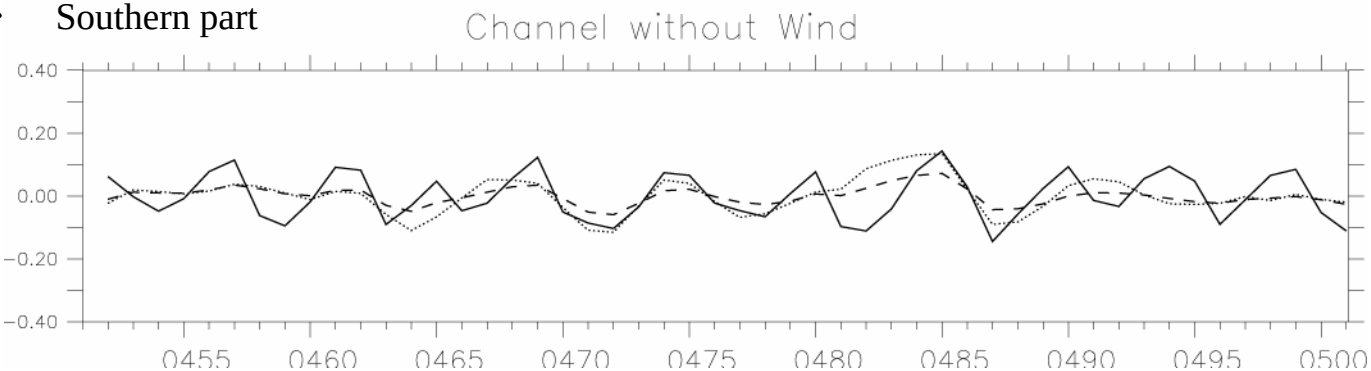
Basin wide Temperature anomaly II



Inflow anomaly (Sv)

Whole basin

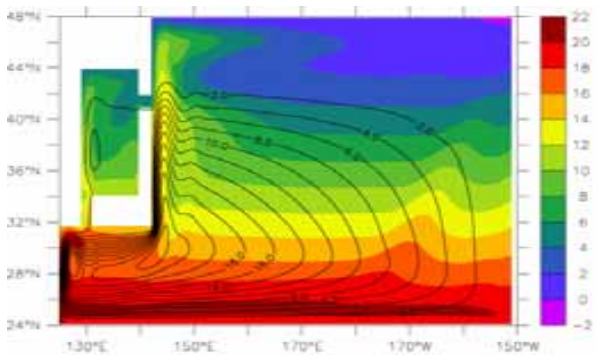
Southern part



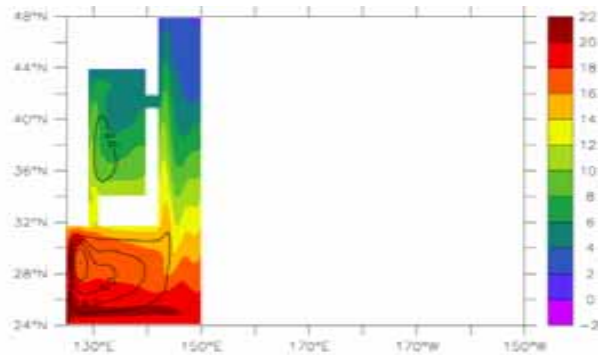
- Problem
  - The inflow is too weak.
    - Previous studies suggest that the strength of the inflow is determined by the strength of the wind driven gyre at the outer basin.
    - In the current experiment, the outer basin is too small so that the wind driven gyre and subsequently the through flow are weak.
- Remedy
  - Increase the size of the outer basin: CW-Large

Larger outer basin

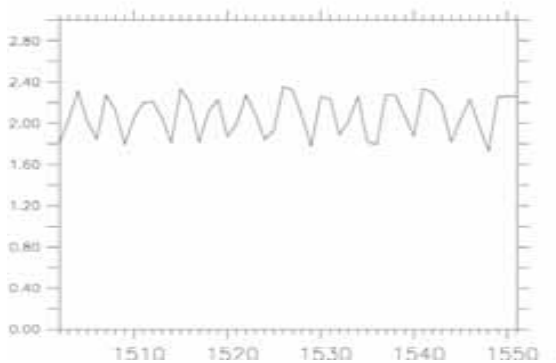
Channel with wind – Large

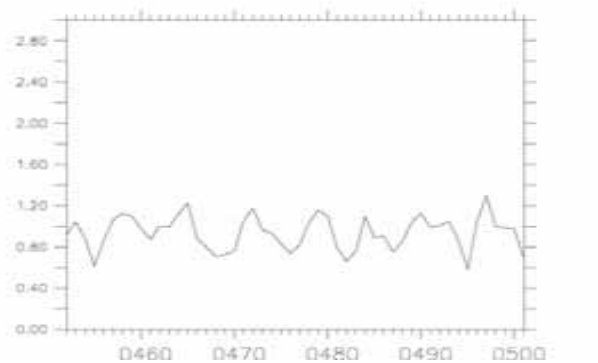


Channel with wind

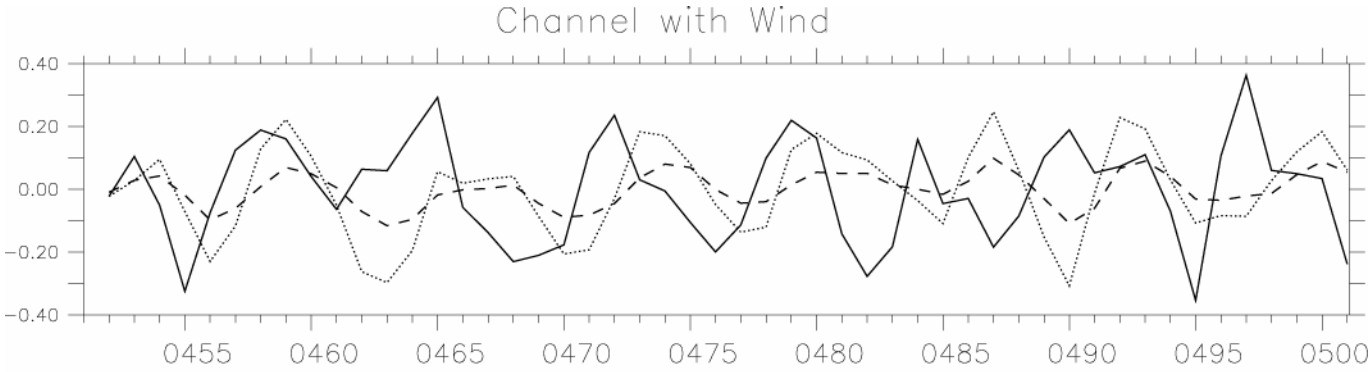


inflow





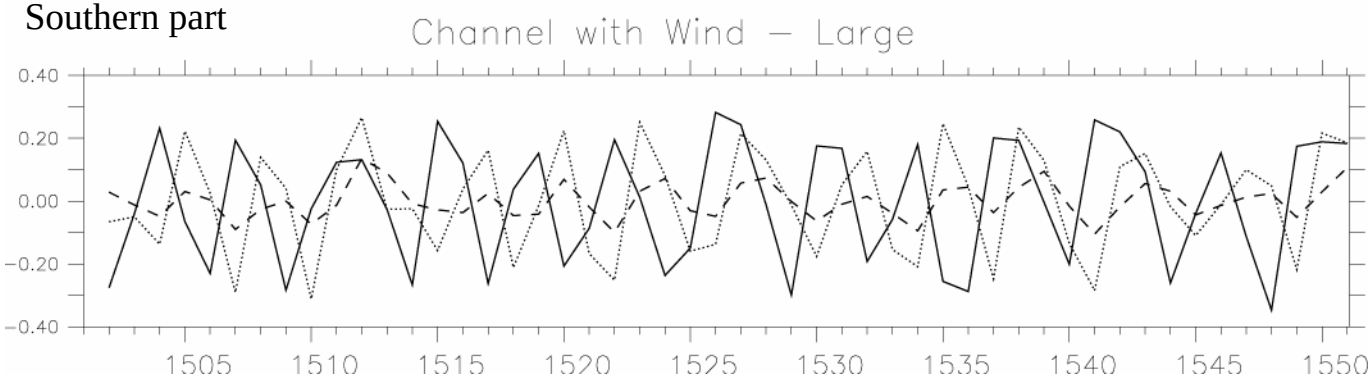
Temperature anomaly



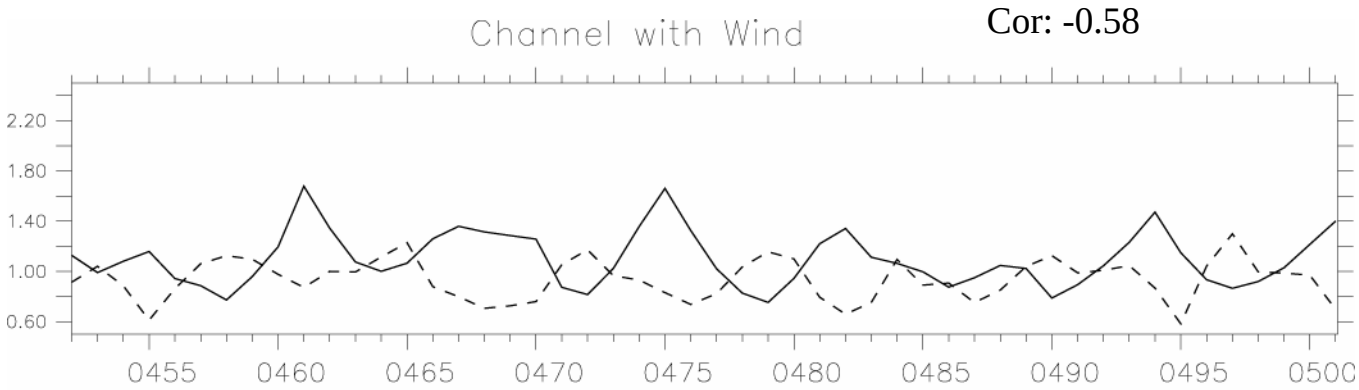
Inflow anomaly (Sv)

Whole basin

Southern part



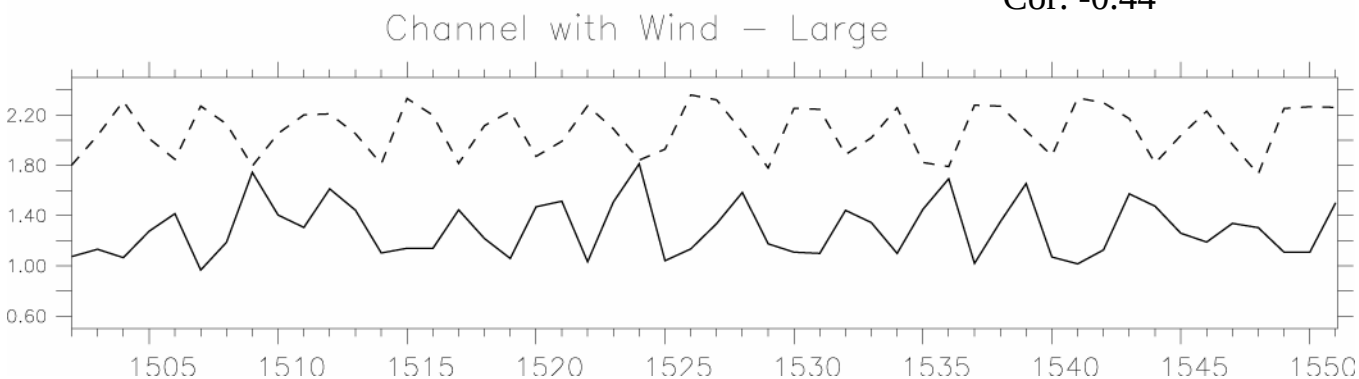
Overturning vs inflow



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.