Bjerknes补偿：海气耦合系统本征模

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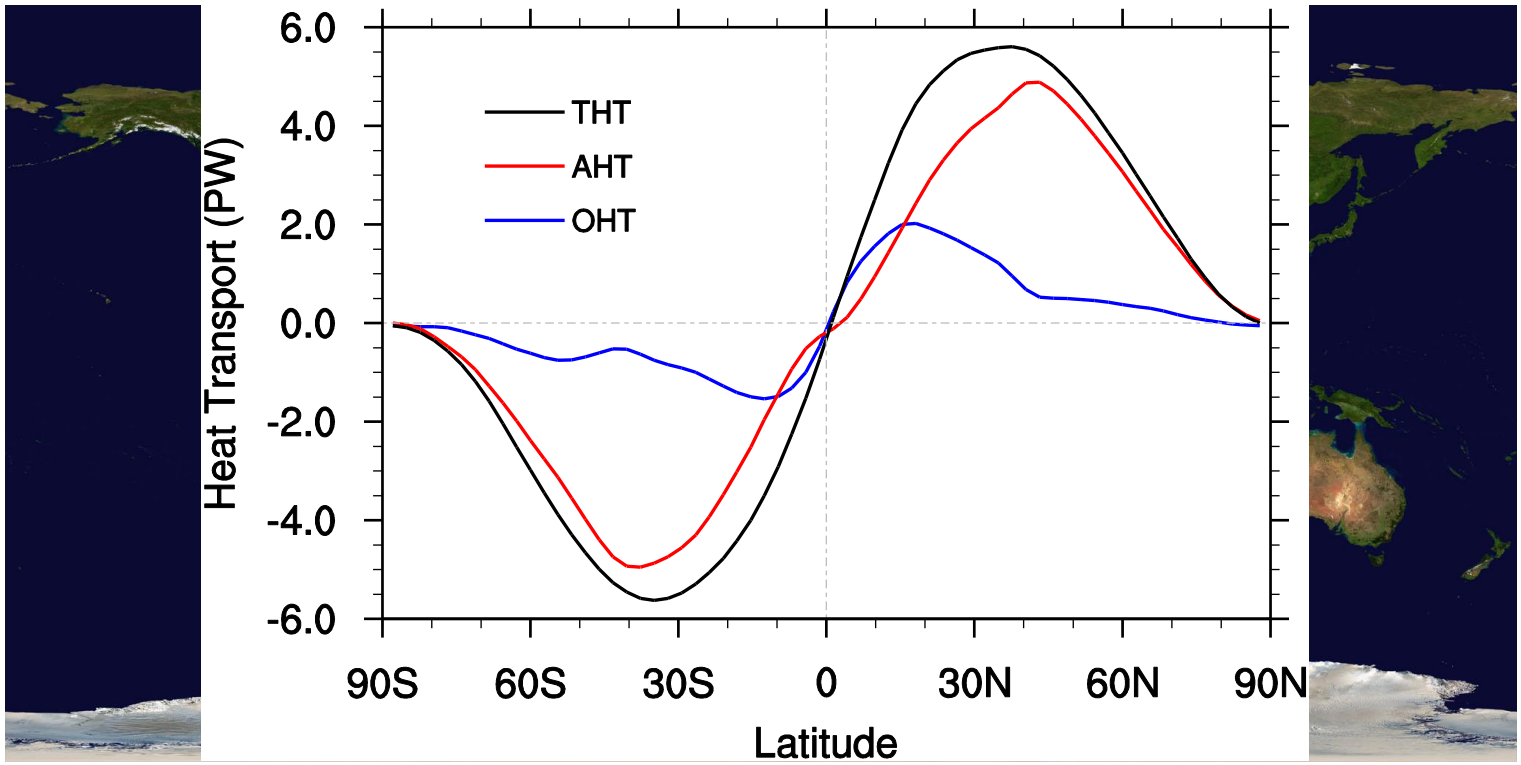
Outline

- Fundamentals
- Questions
- Hypothesis and Theory
- CGCM results
- Aquaplanet
- Summary

Fundamental Questions

1. Antisymmetric MHT?

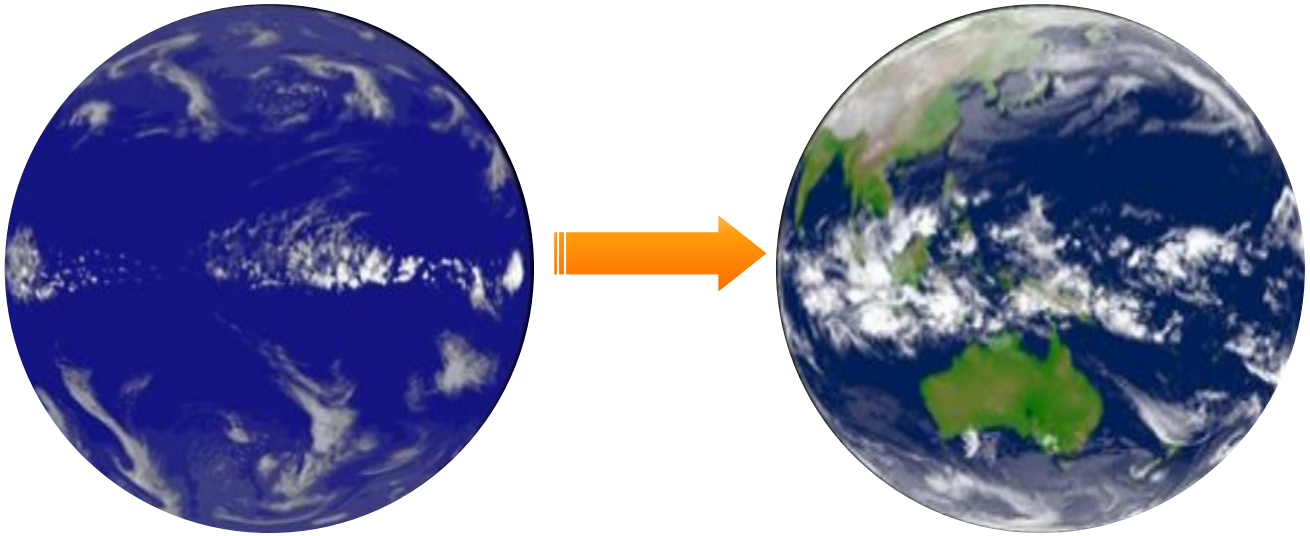


Aquaplanet ➔ Real Earth

Trenberth and Caron (2001)

Aquaplanet ➔ Real Earth

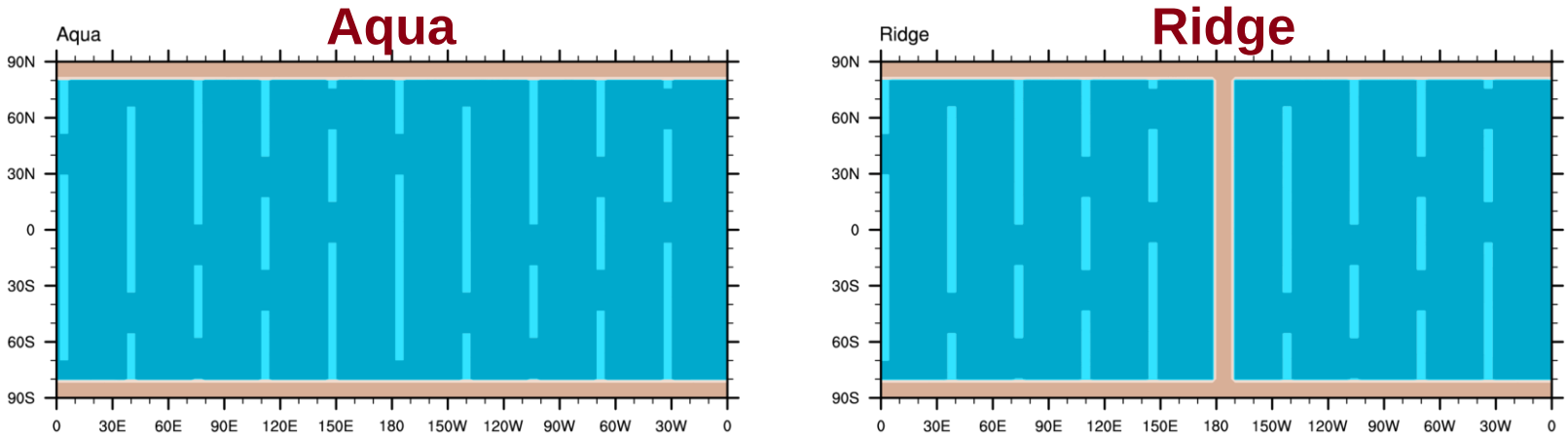
Why anti-symmetric MHT?



Try to answer this fundamental question

Topo for Aqua and Ridge

Land: 10 m; Ocean: 5000 m; Bottom random ridge: 500 m

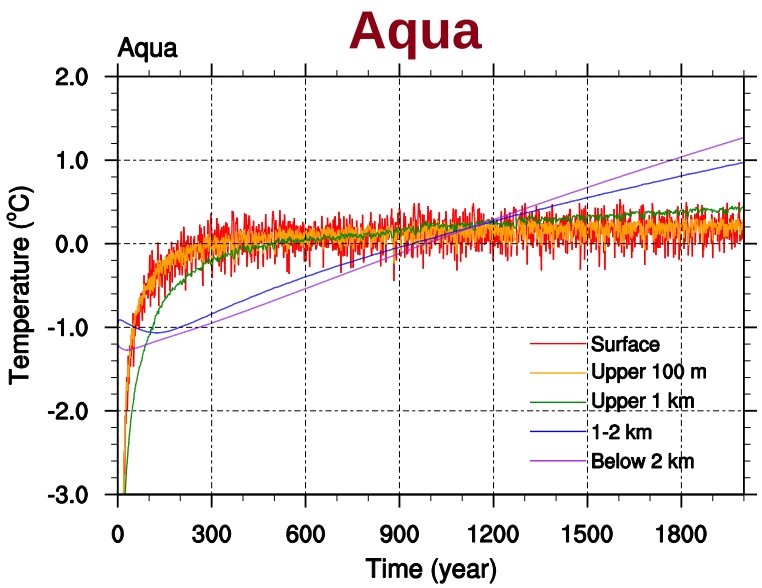


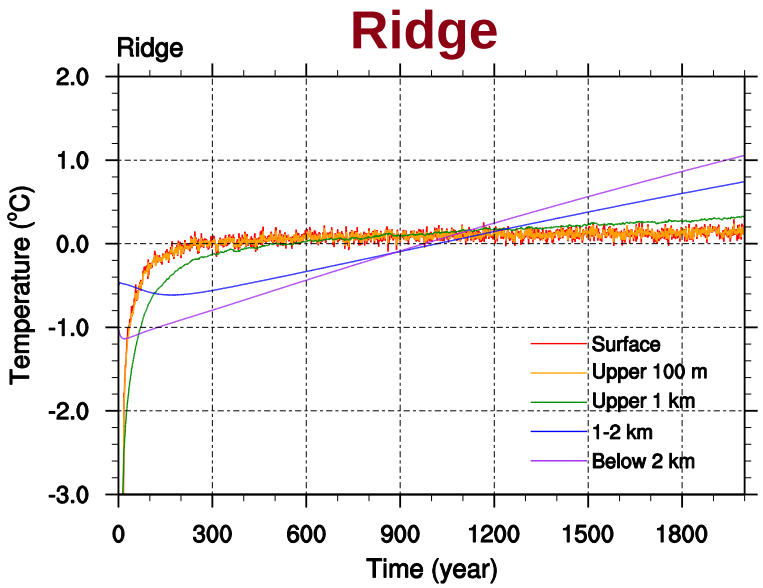
Li and Yang (2018)

Go to Summary

Hard to Reach Equilibrium

2000-year Simulation using CESM





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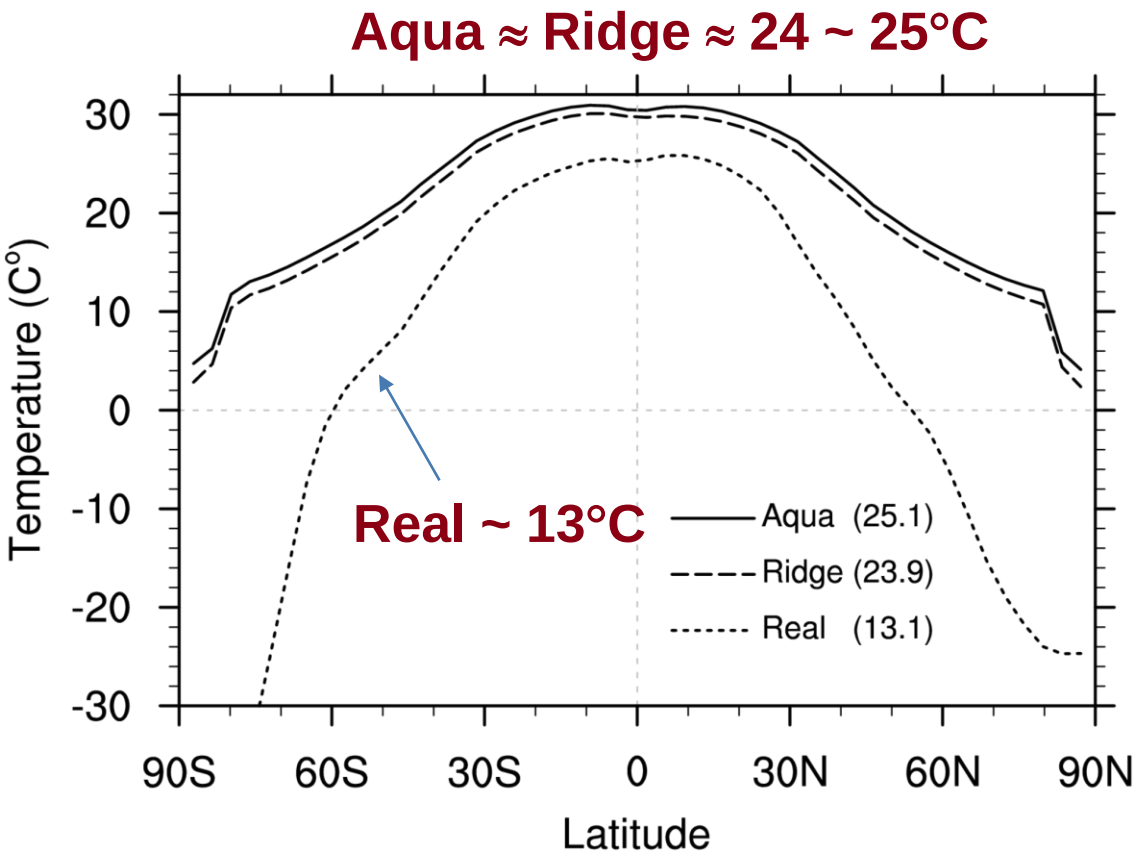
SAT: Warmer Climate



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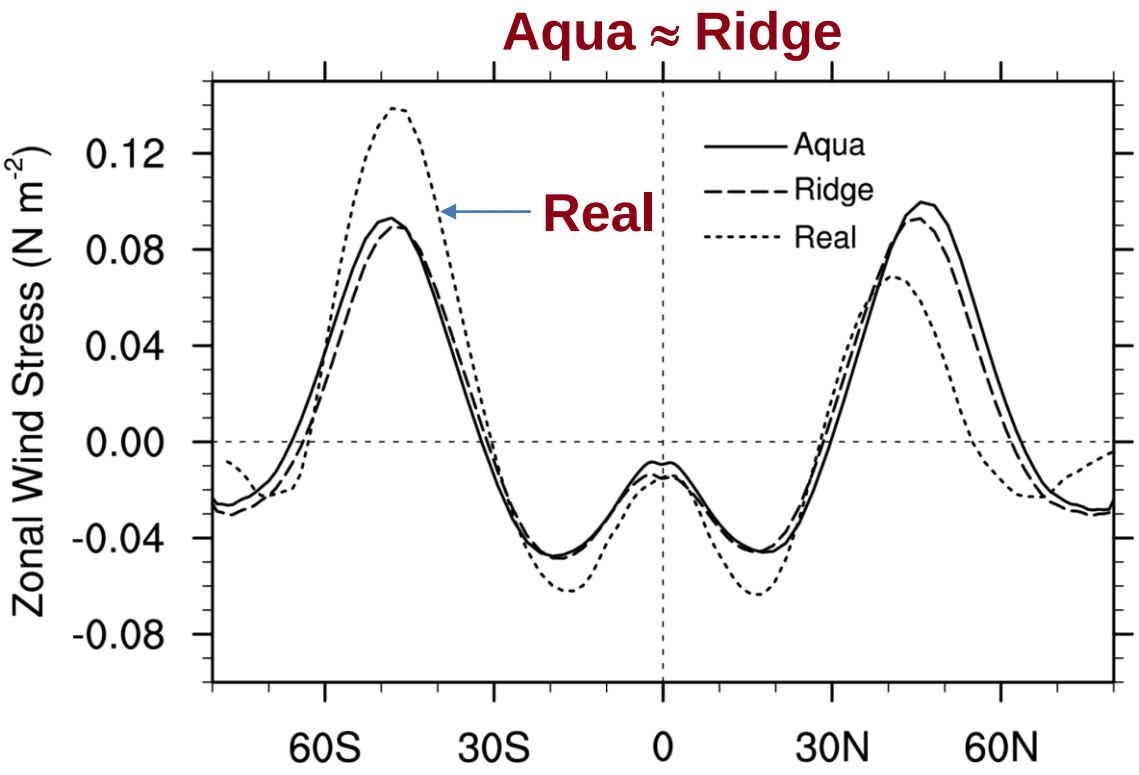
Symmetric Zonal Surface Wind Stress



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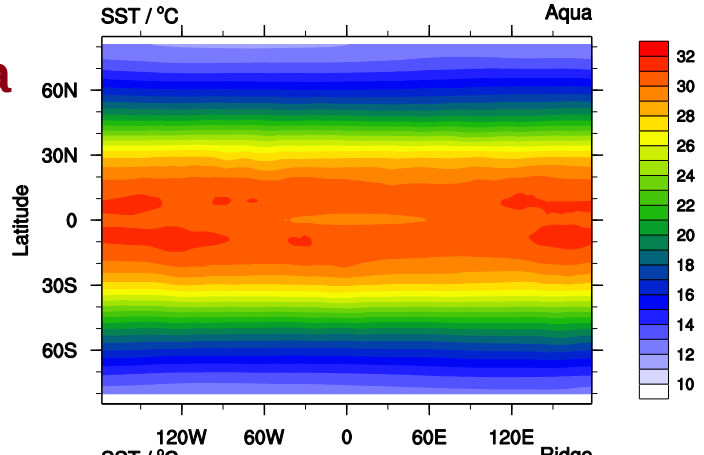
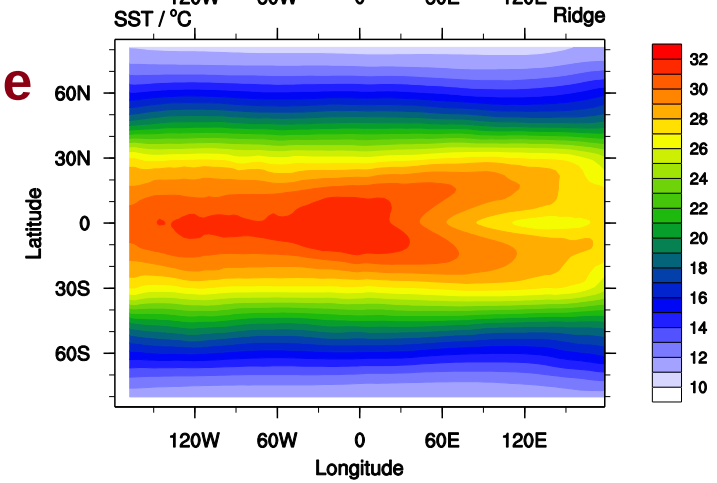
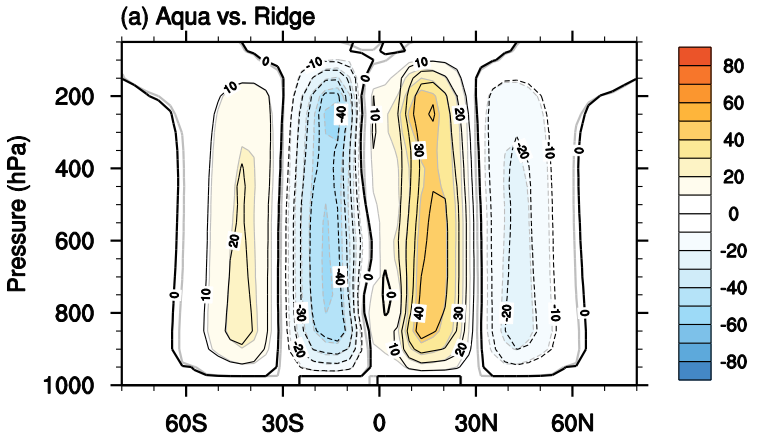
Symmetric SST and Hadley Cell

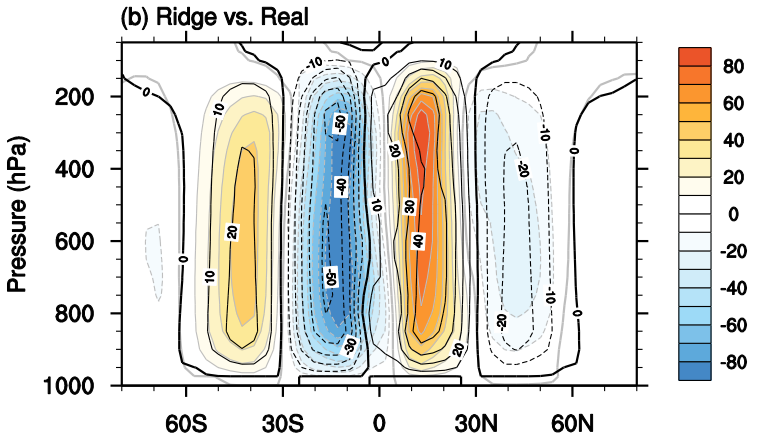
Aqua



Ridge







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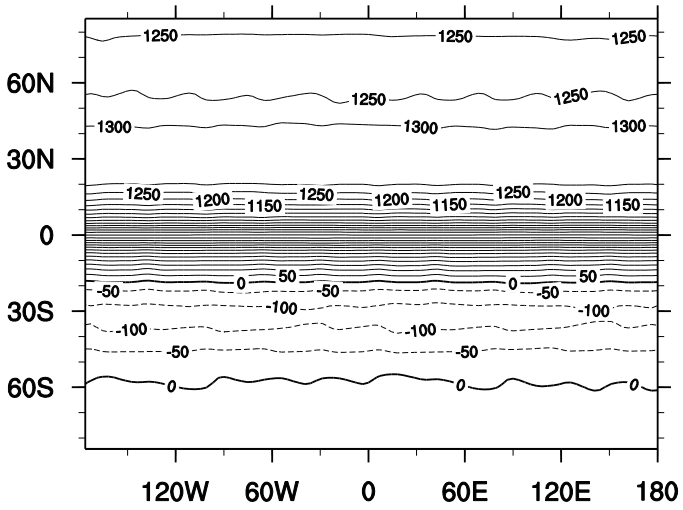
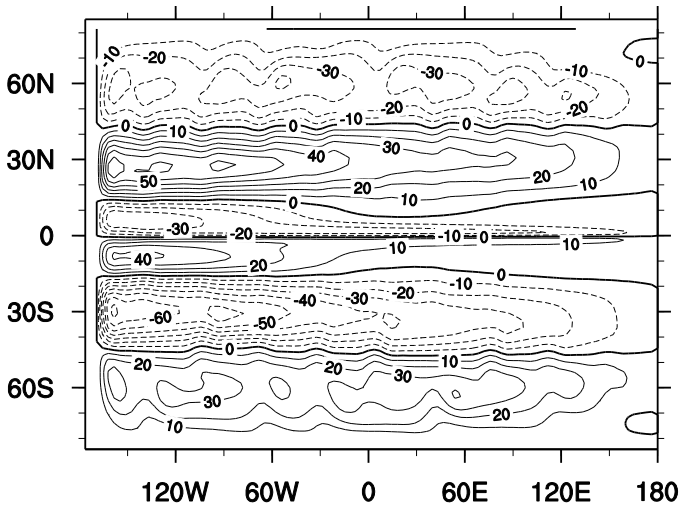
Symmetric Ocean Circulation

Barotropic Streamfunction

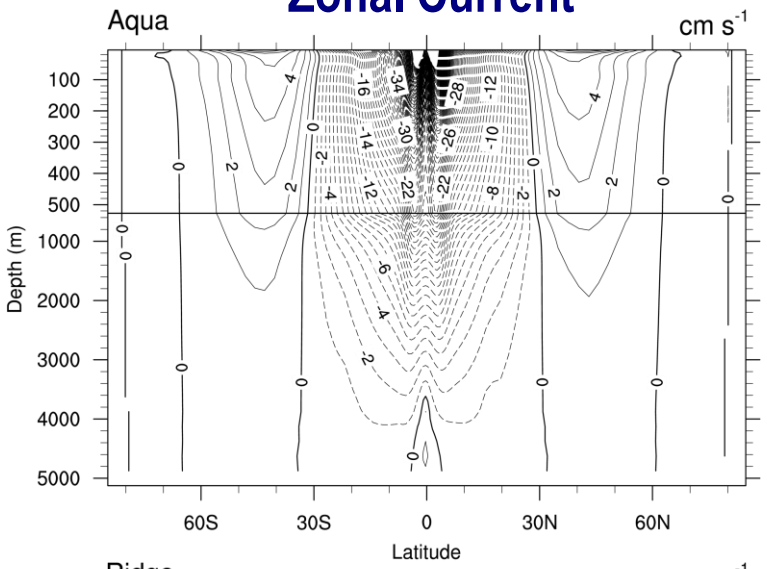
Aqua

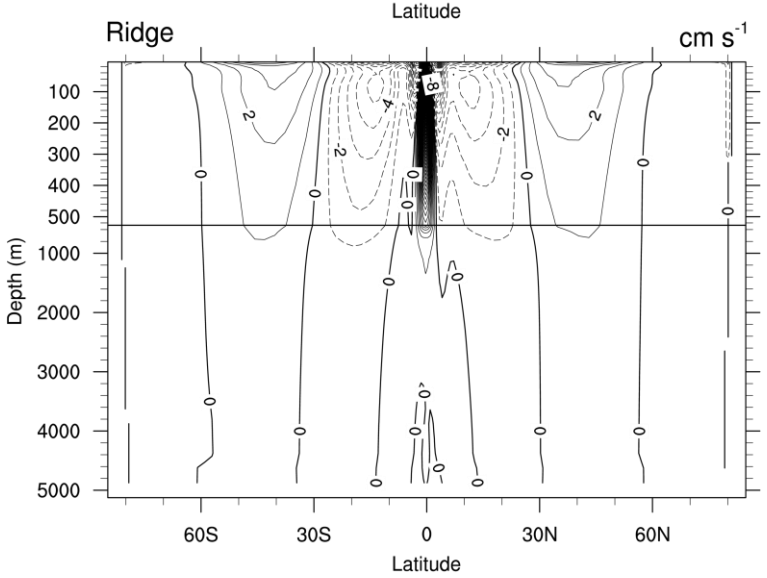


Ridge



Zonal Current





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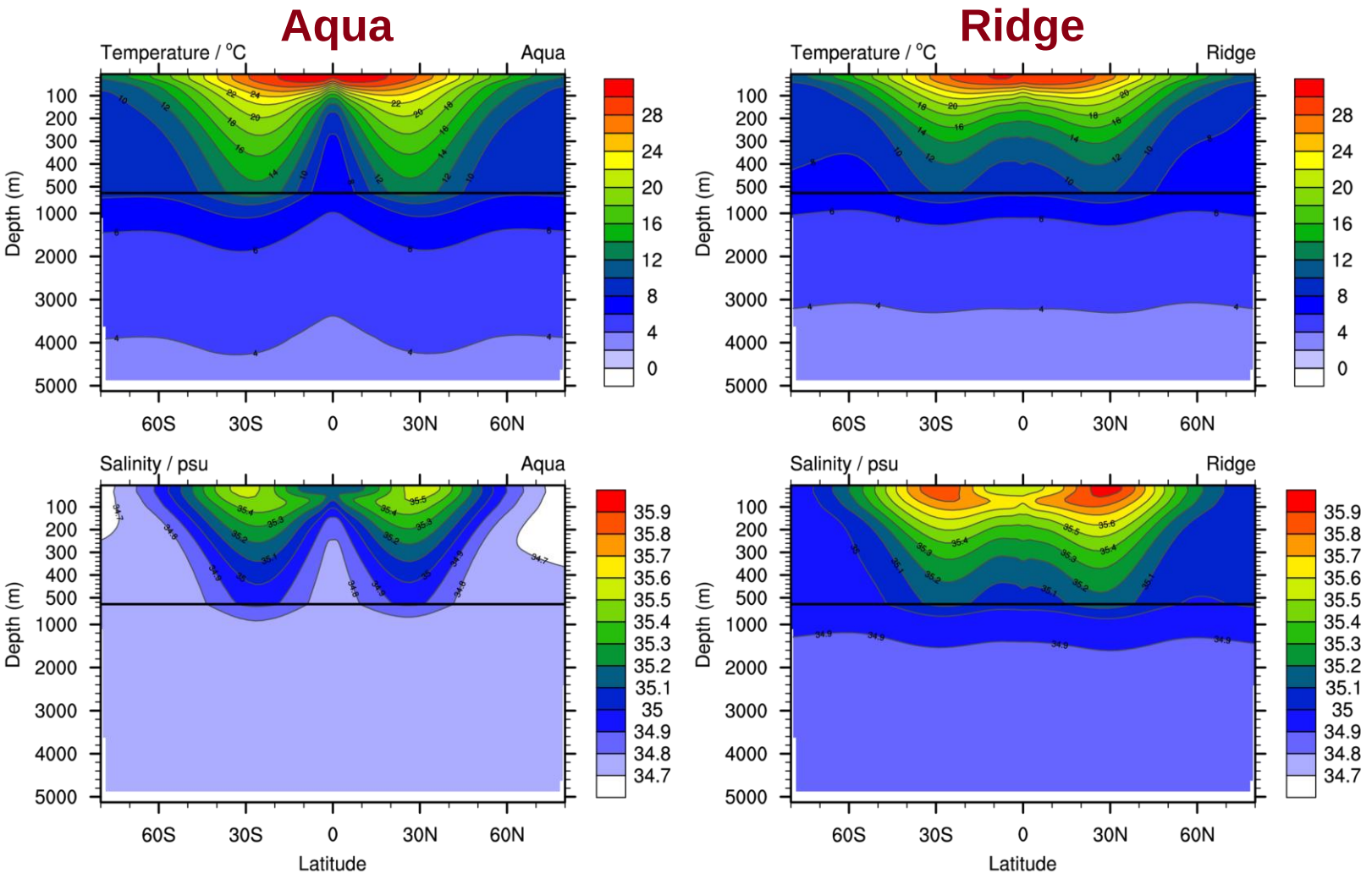
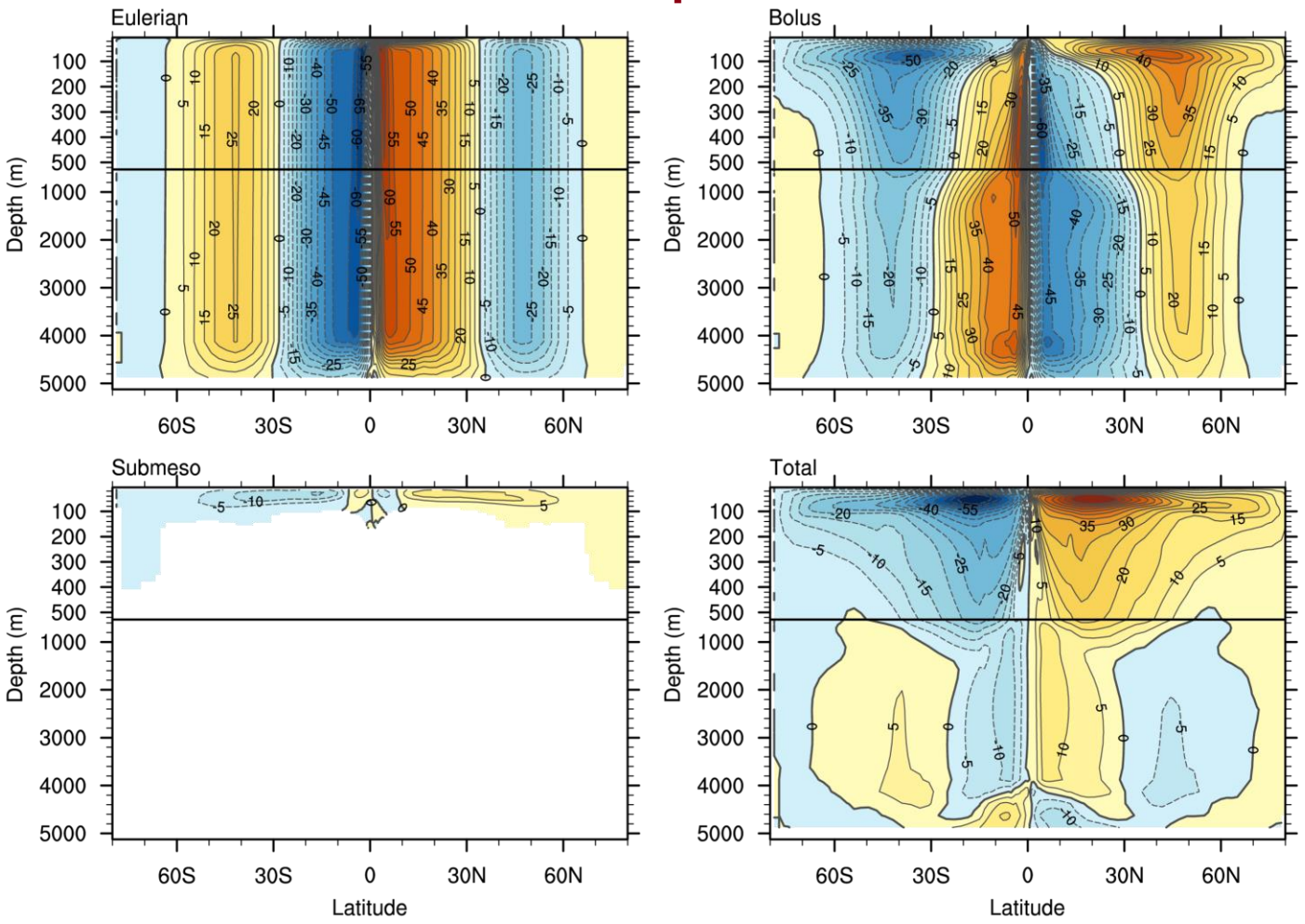
Symmetric Ocean Buoyancy



Symmetric Overturning Circulation

Aqua



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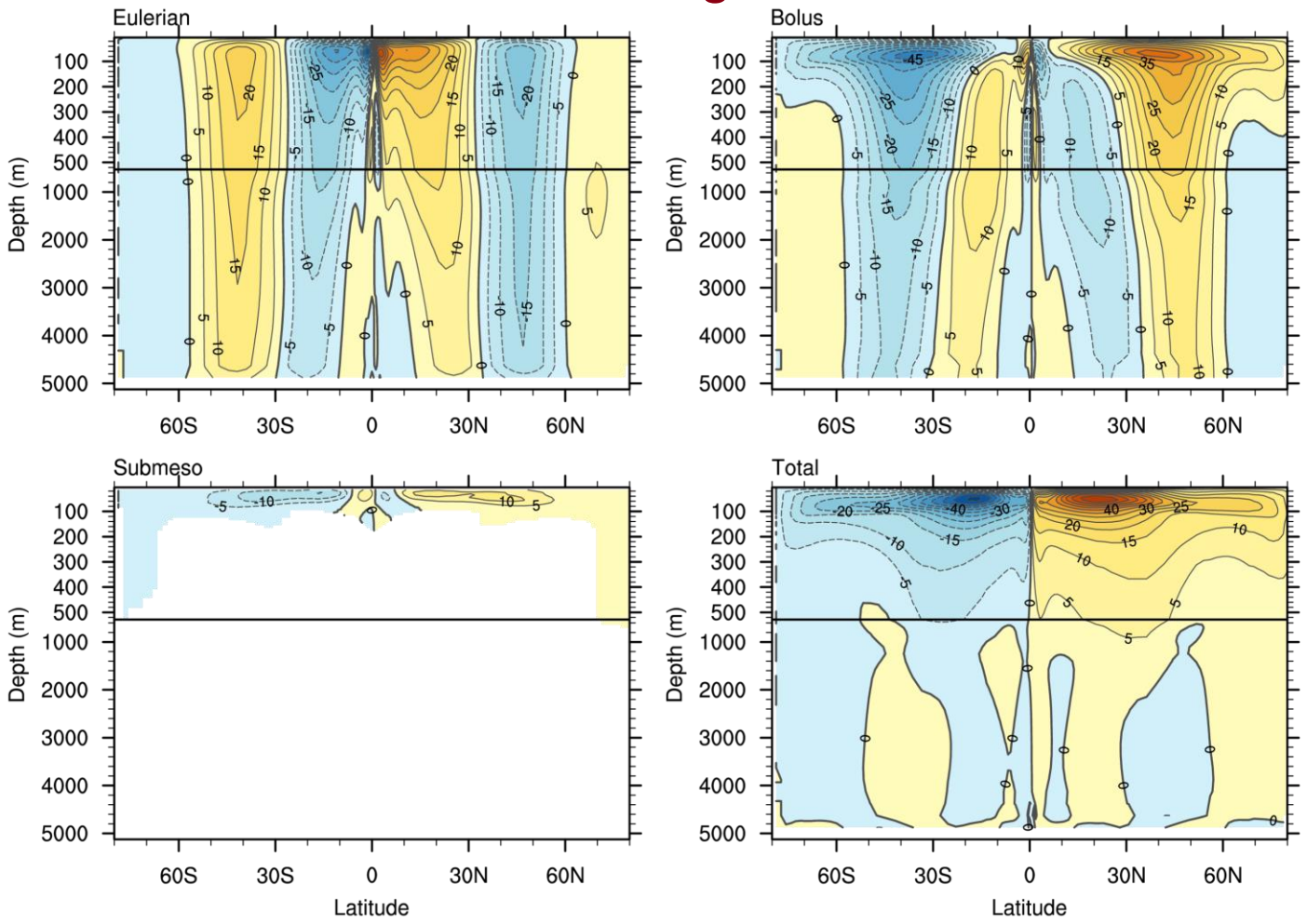
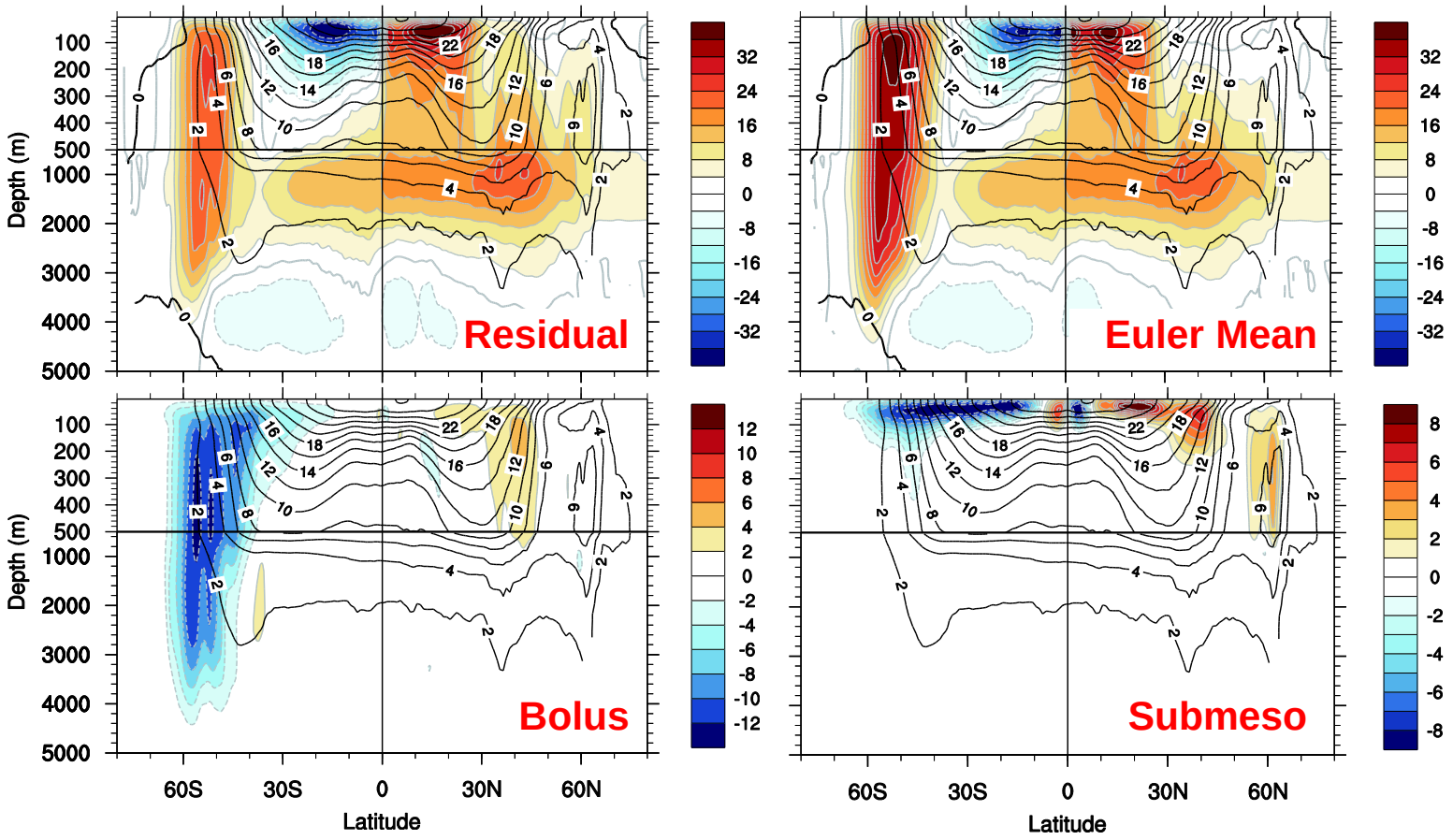
Symmetric Overturning Circulation

Ridge

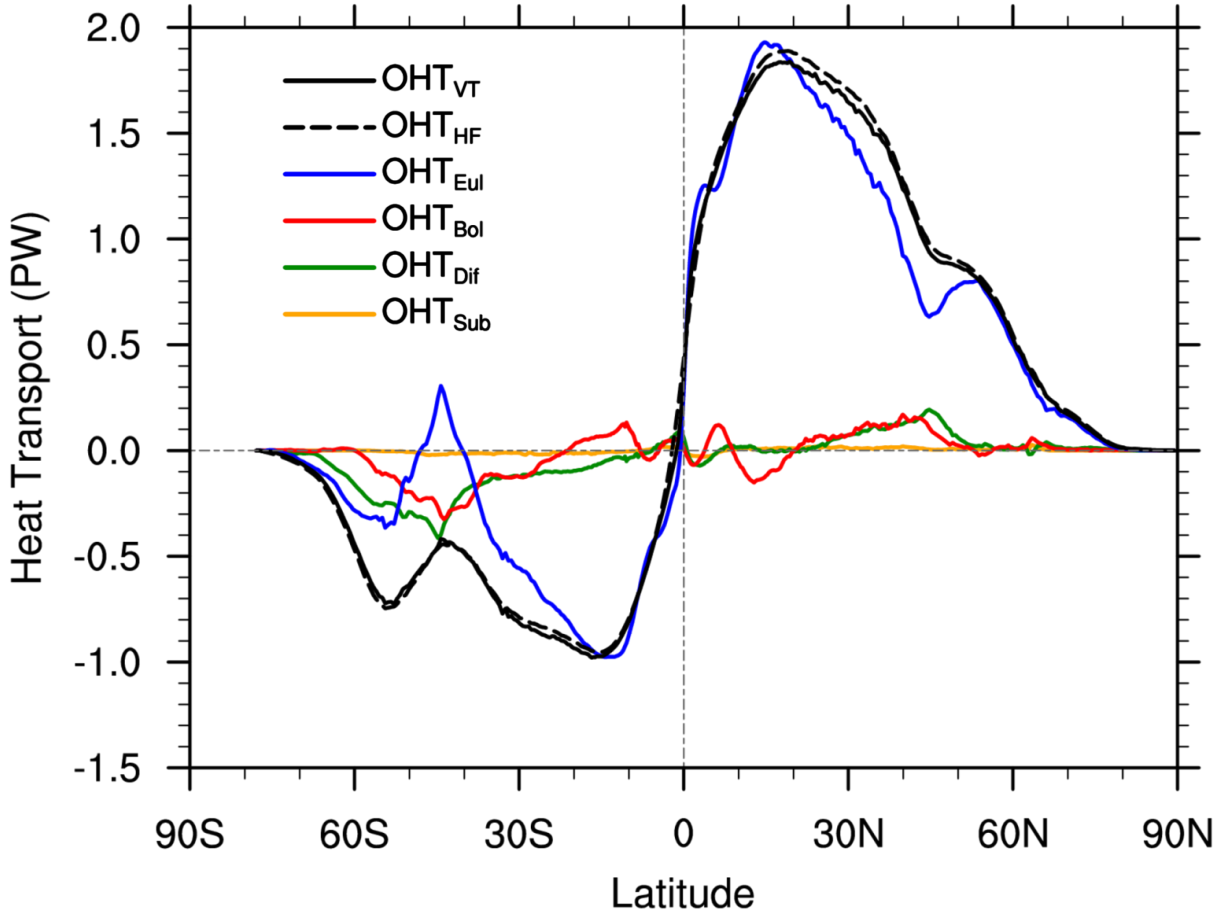


Overturning Circulation in Real World



Yang and Li (2015)

Decomposing OHT_{VT}



Consistency between OHT_{VT} and OHT_{HF} / Important role of Bolus and dissipation in ACC

Some Thoughts to ChangMing

- **Sub-mesoscale mixing – Mixed layer mixing**
  - **Window of ventilation and subduction! Very important!**
  - **Window of CO2, Oxygen and Heat uptake!**
- **From GM to mesoscale resolved model**
  - **Comparing them to get model right!**
- **In sub-mesoscale resolved model**
  - **How important the sub-mesoscale mixing**
- **Physical process:**
  - **Genesis of mesoscale and sub-meso eddies**
  - **Interaction with the largescale background**

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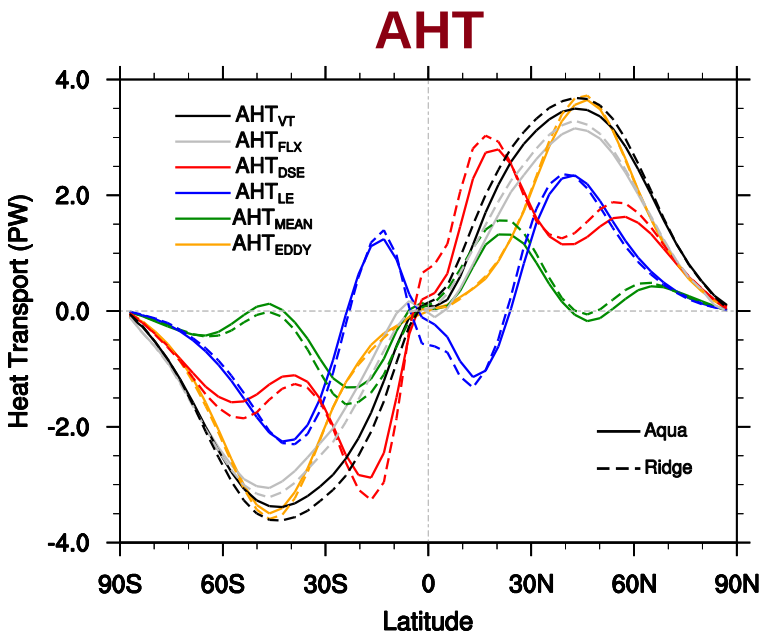
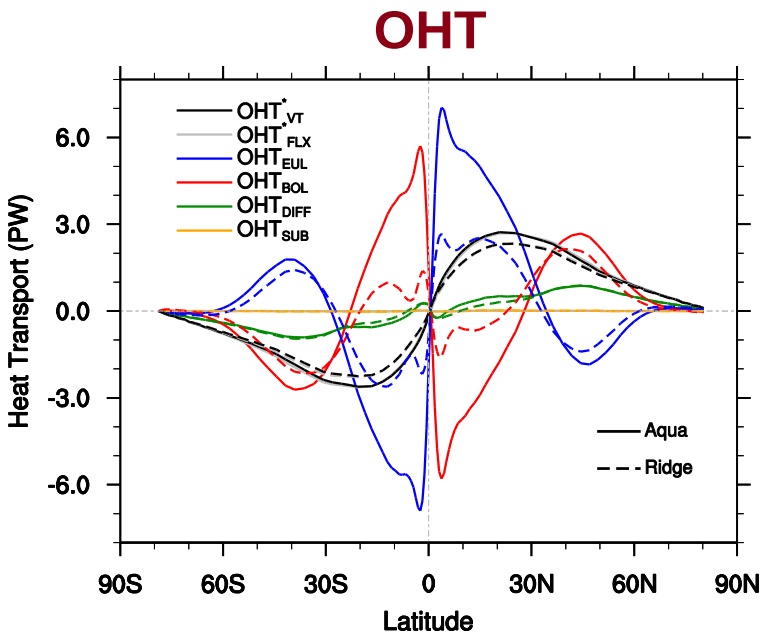
Symmetric AHT and OHT





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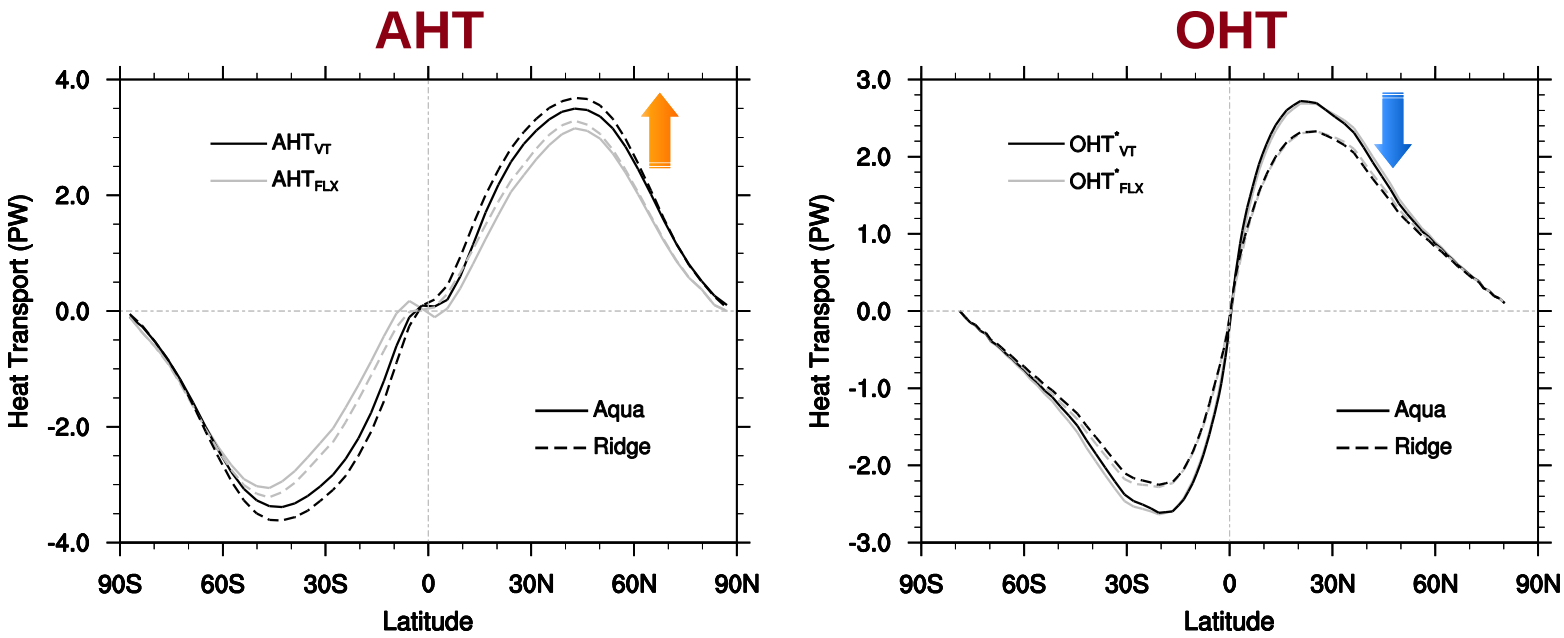
Symmetric AHT and OHT



From *Aqua* to *Ridge* ➔ OHT ⇓ and AHT ⇑

Bjerknes Compensation

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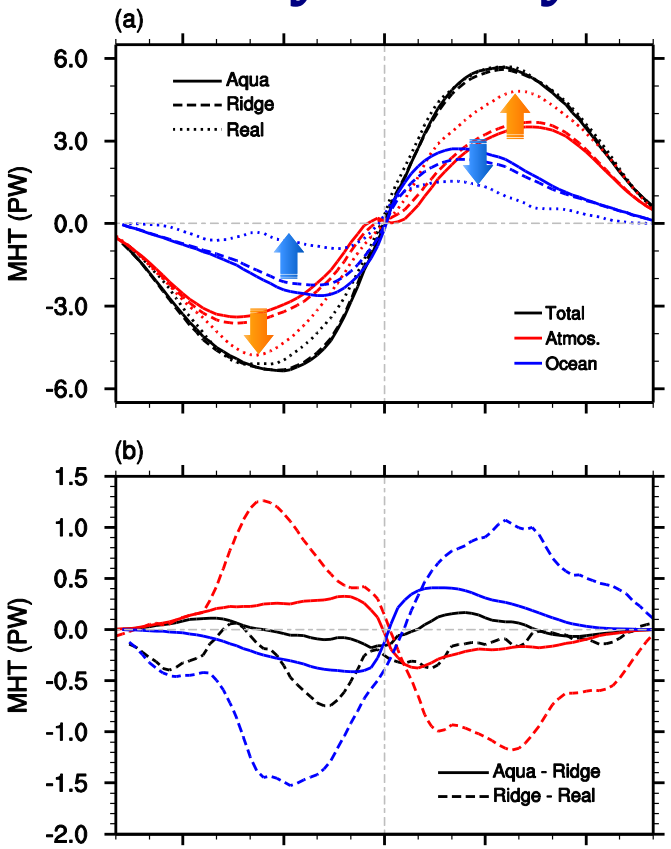
Aquaplanet → Real Earth

Why anti-symmetric MHT? Answered



From *Aqua* to *Real*

1. **OHT ⇓ and AHT ⇑**
2. **OHT → asymmetric, NH>SH, AMOC + Weaker baroclinic**
3. **AHT → asymmetric, SH>NH, Stronger baroclinic dT/dy ⇑**

→ Total MHT *unchanged*

BJC maintains antisymmetric MHT!

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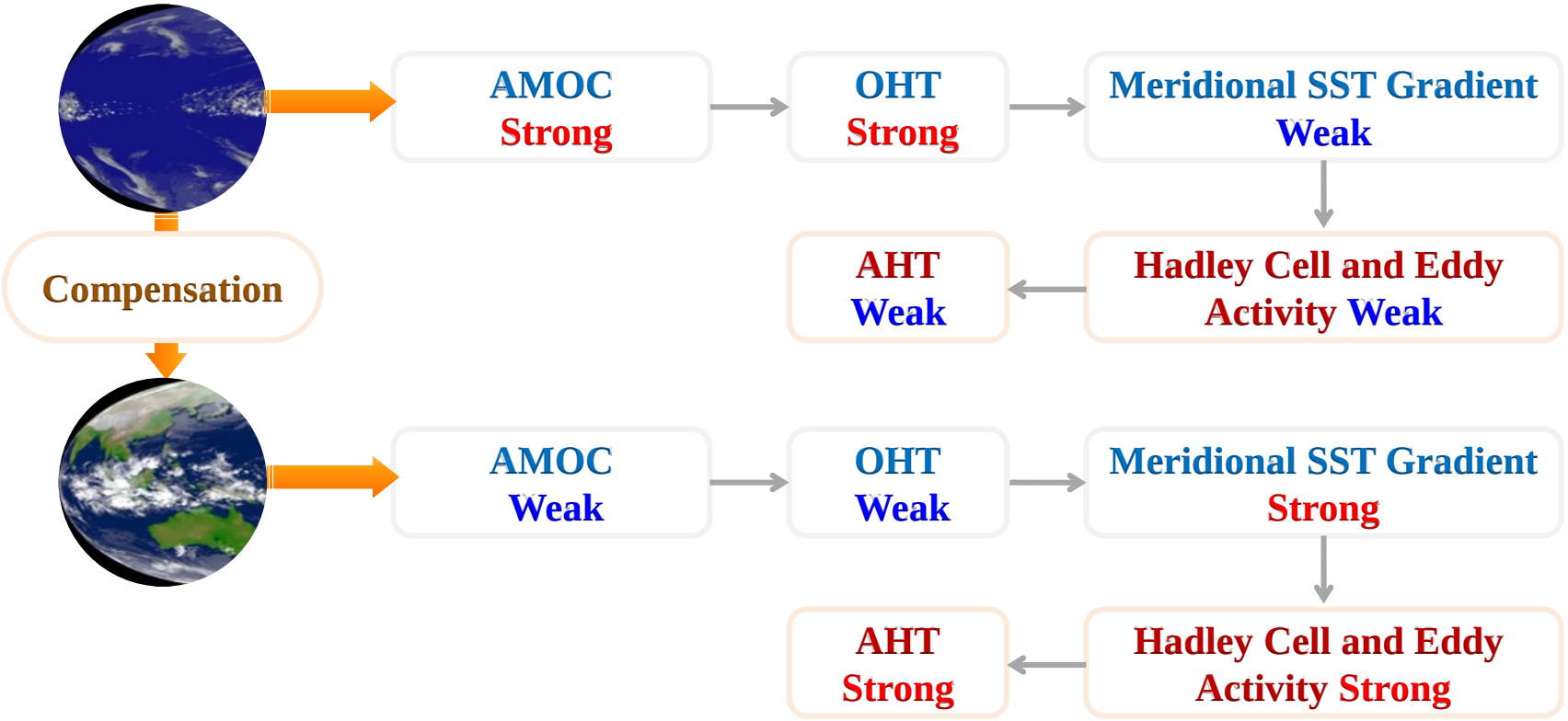
“Mechanism”



Yang et al. (2018)

Summary and Discussion

- **Bjerknes compensation**
  - Intrinsic mode
  - Atmospheric physics ⇔ Physical oceanography
    - Climate feedback ⇔ Thermohaline circulation
- **Self-constraint mechanism**
  - Climate didn't drift too much
- **If feedback → Reversibility of climate**
  - Invisible hand (?)

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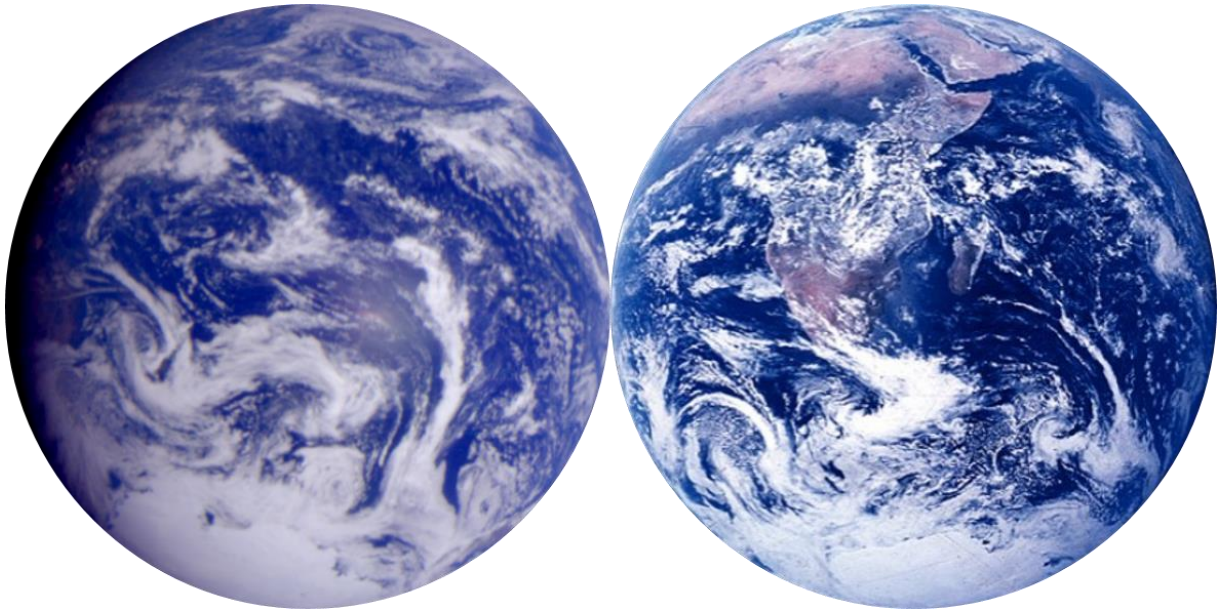
Aquaplanet ➔ Real Earth



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