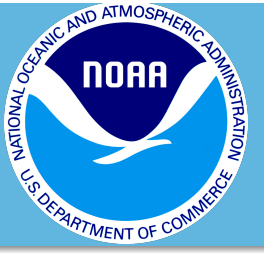
Scripps O_2 Program
Atmospheric Oxygen Research

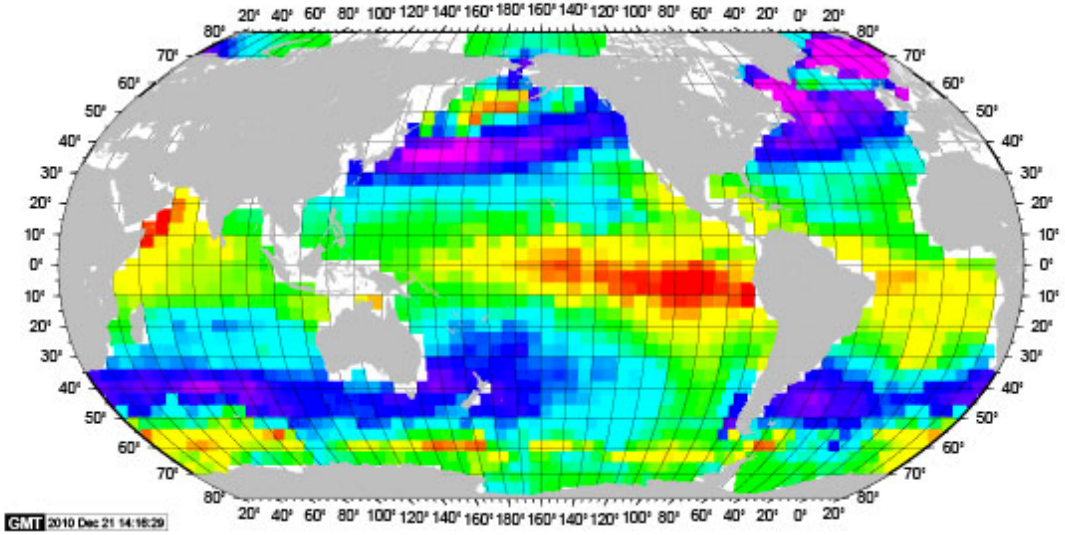


Constraints on air-sea carbon fluxes from atmospheric potential oxygen

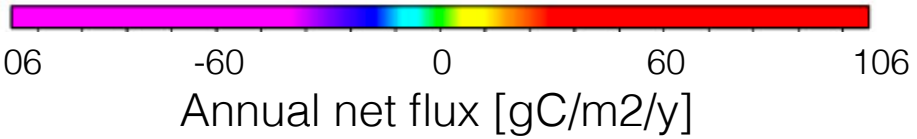
Laure Resplandy
Scripps Institution of Oceanography

R. Keeling (Scripps); A. Jacobson (NOAA); B. Stephens, J. Bent (NCAR)
S. Khatiwala (Oxford, UK); C. Rödenbeck (MPI, Germany)

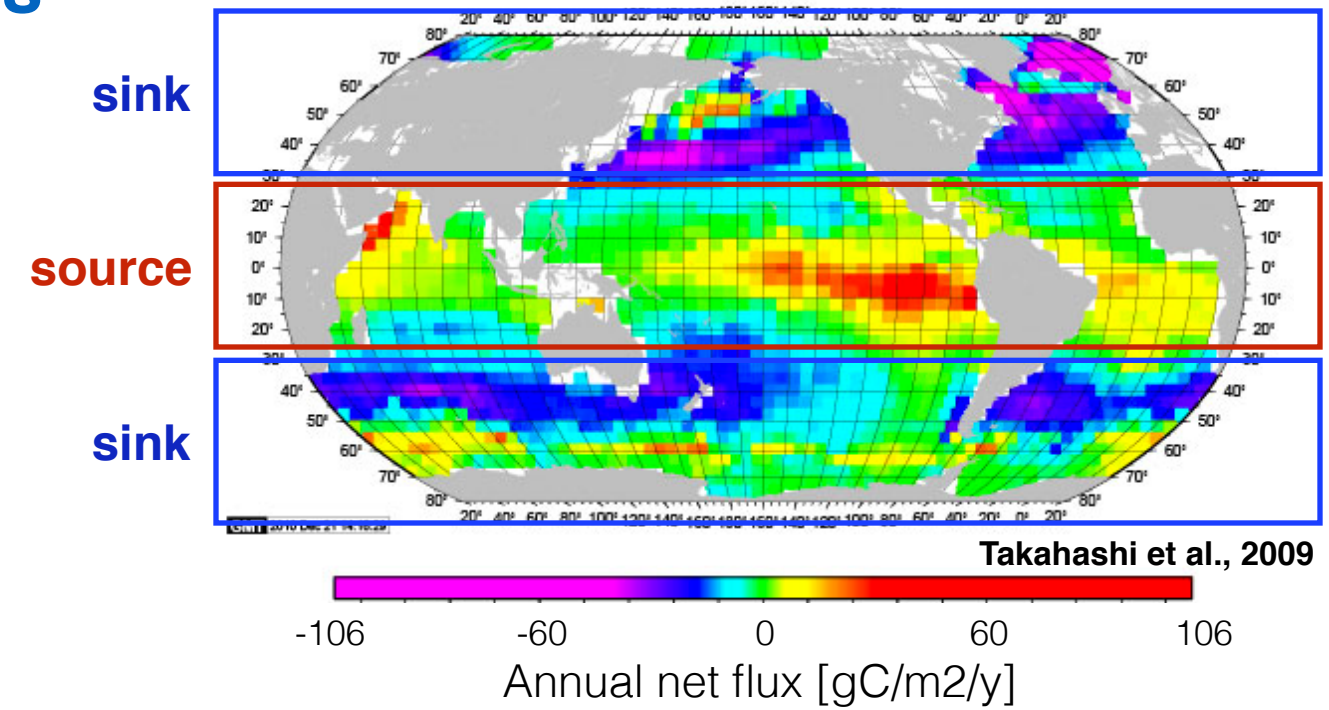
Air-sea CO_2 fluxes



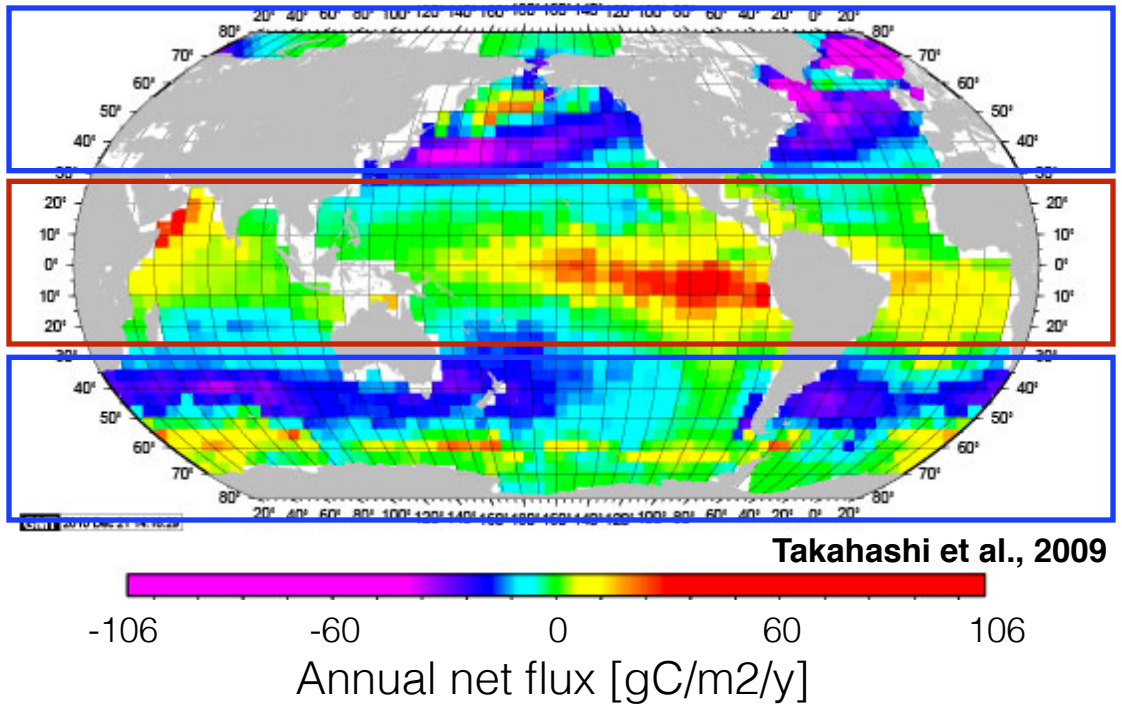
Takahashi et al., 2009



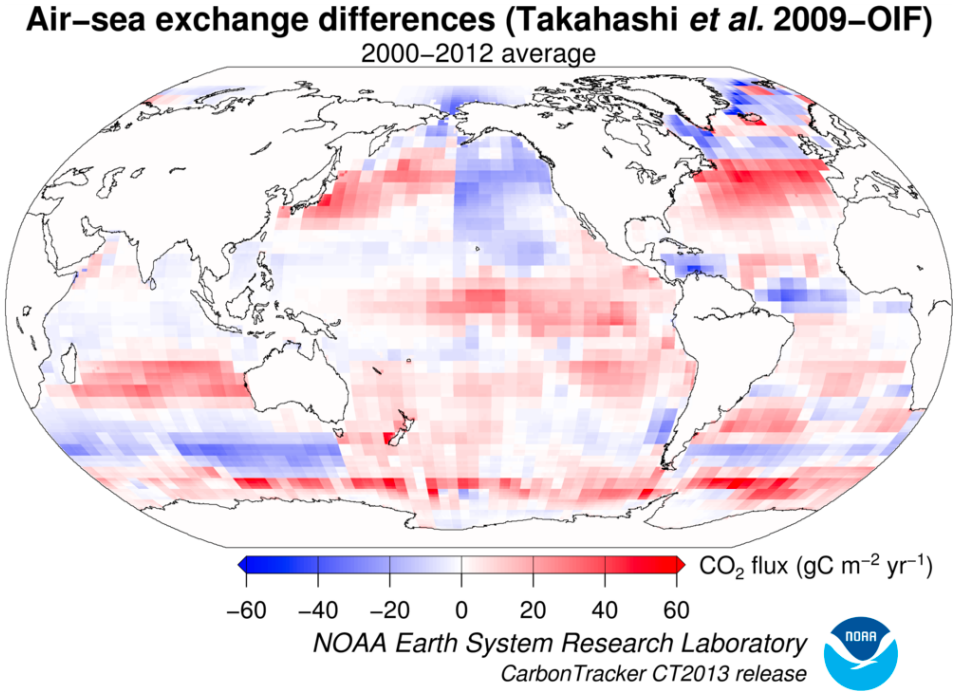
Air-sea CO_2 fluxes



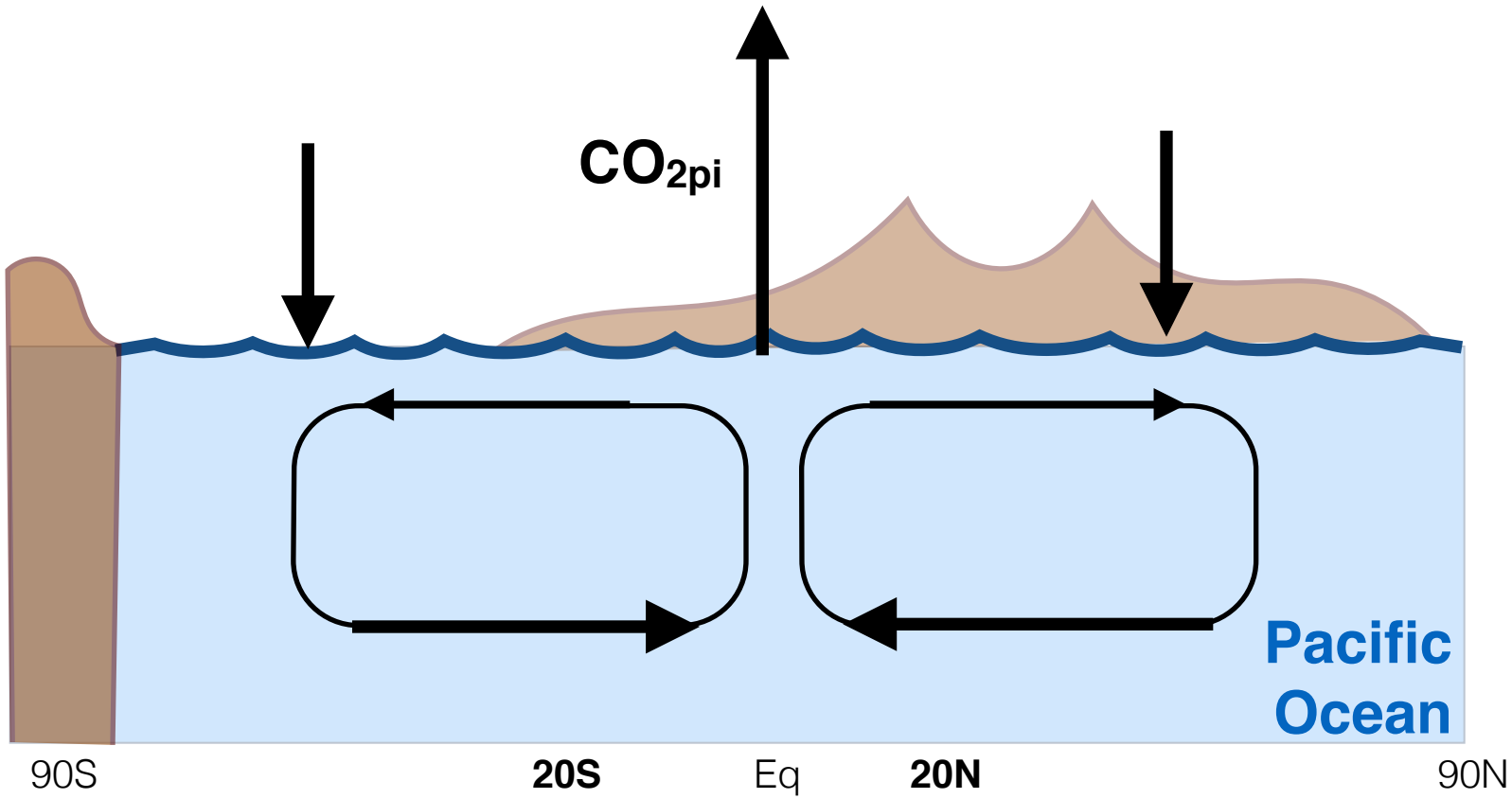
Air-sea CO_2 fluxes



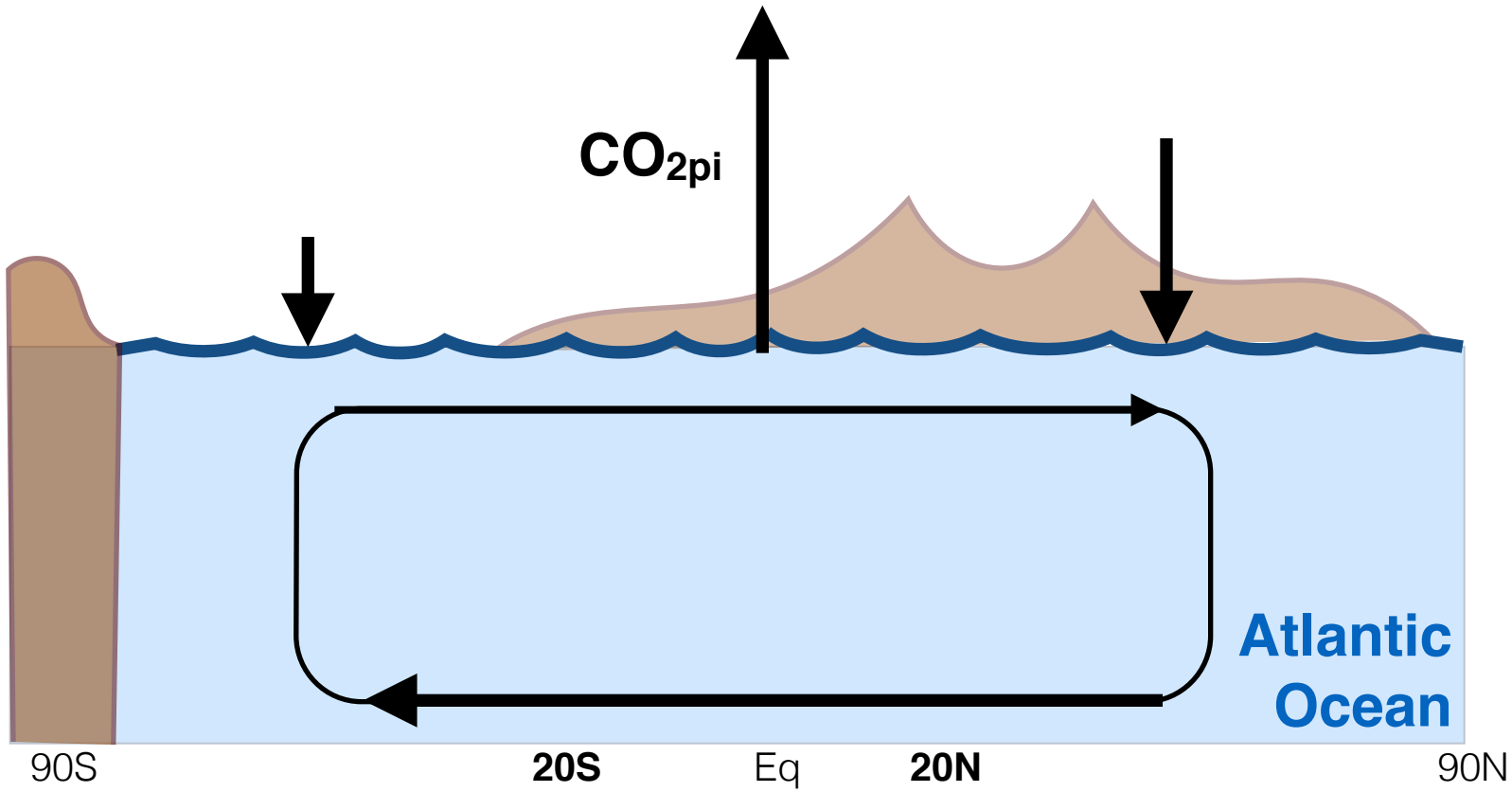
Ocean interior inversion
(Jacobson et al., 2007)
Ocean surface pCO_2
(Takahashi et al., 2009)



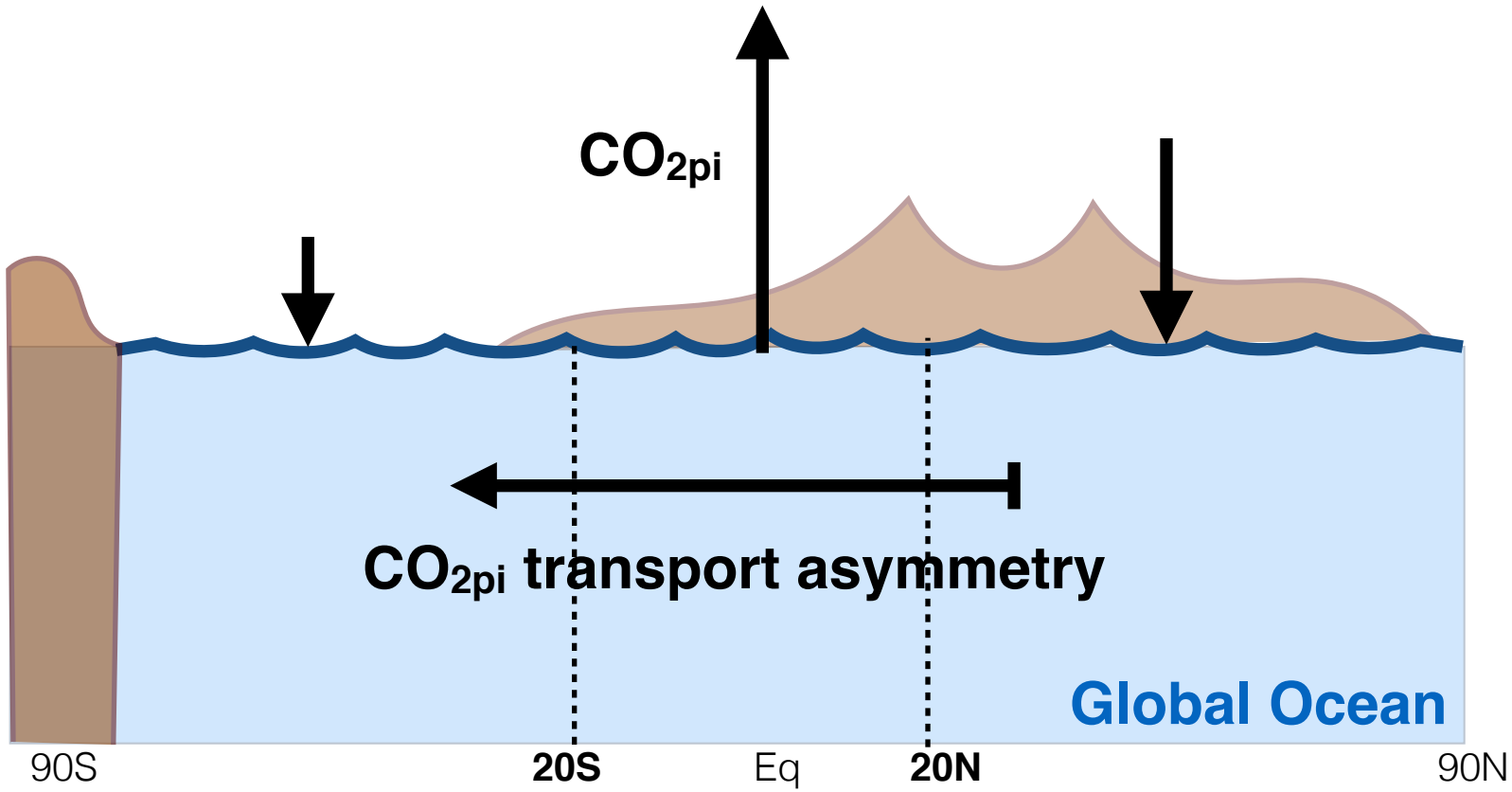
Air-sea CO_2 fluxes (a)symmetry



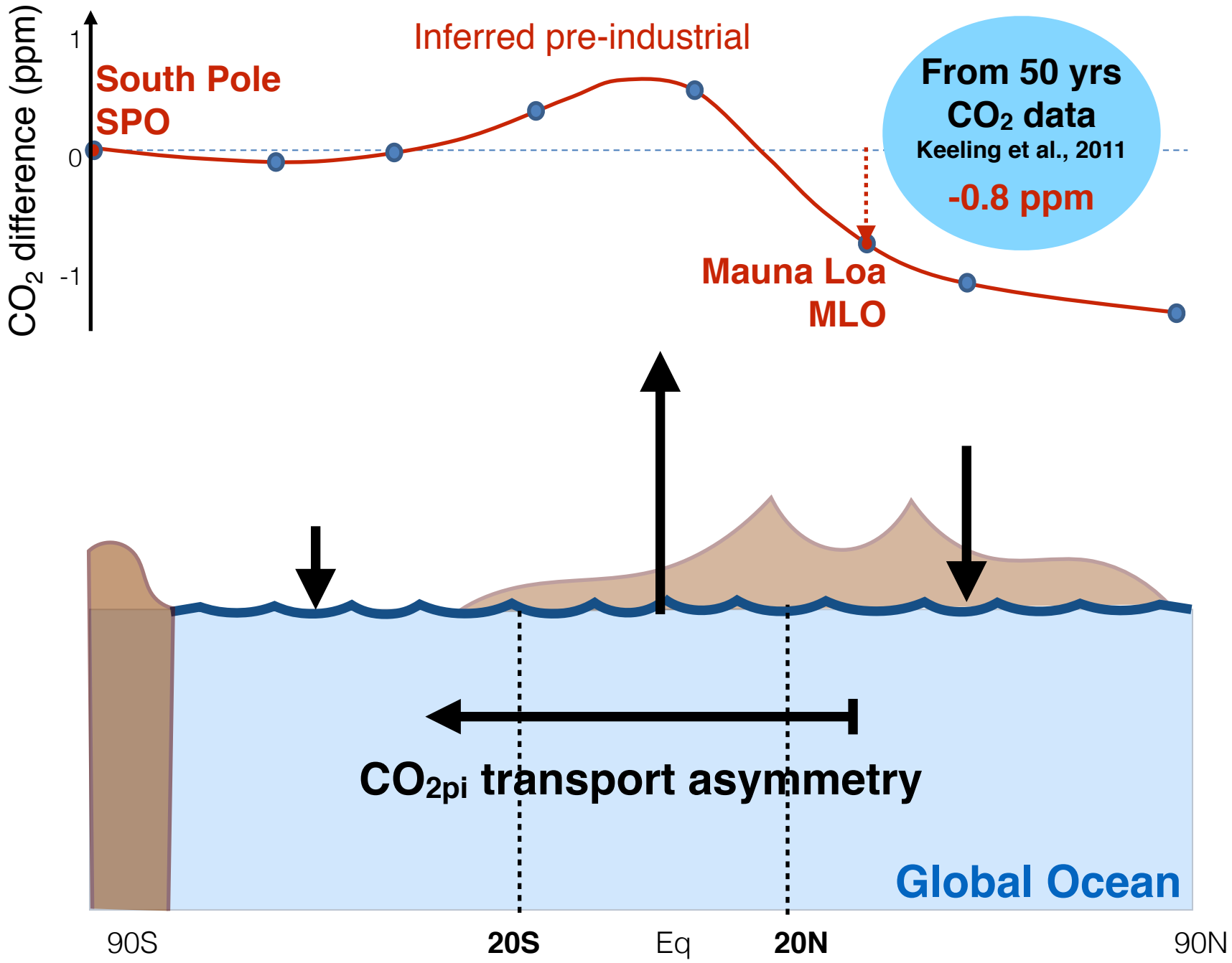
Air-sea CO_2 fluxes asymmetry



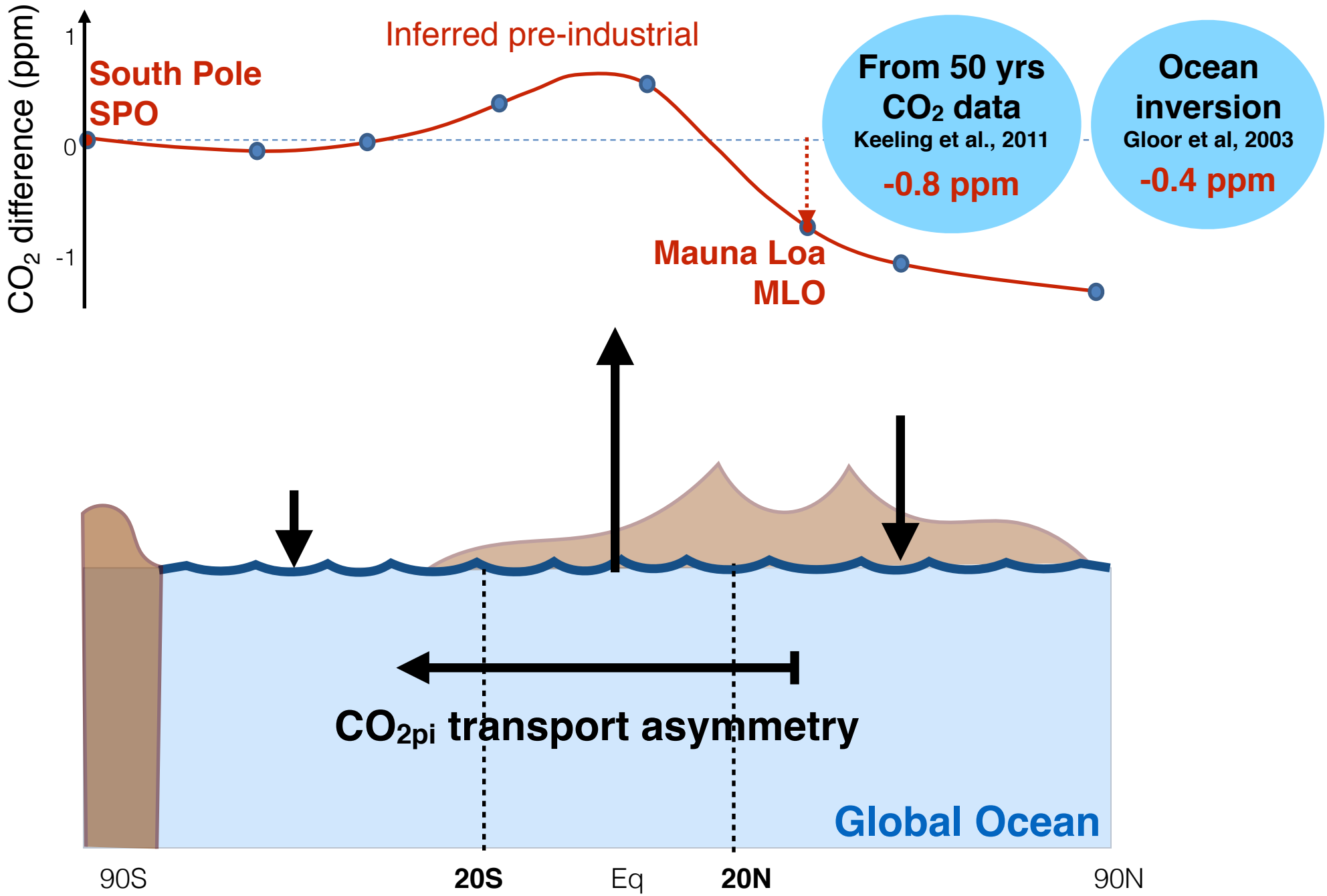
Air-sea CO_2 fluxes asymmetry



Air-sea CO_2 fluxes asymmetry



Air-sea CO_2 fluxes asymmetry



1 **Can we further constrain the hemispheric asymmetry?**

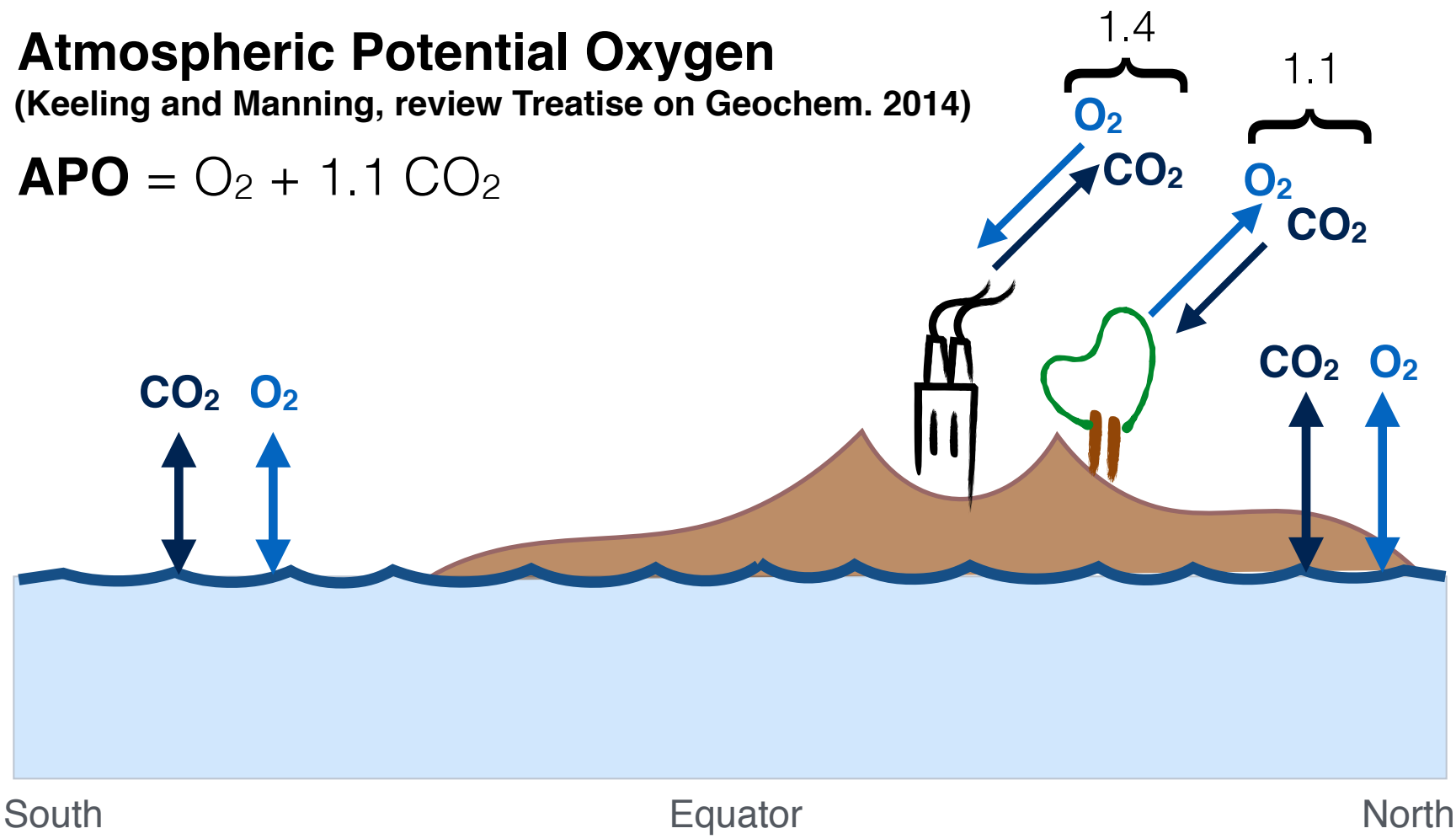
Atmospheric data: potential oxygen

2 **Where do the biases come from?**

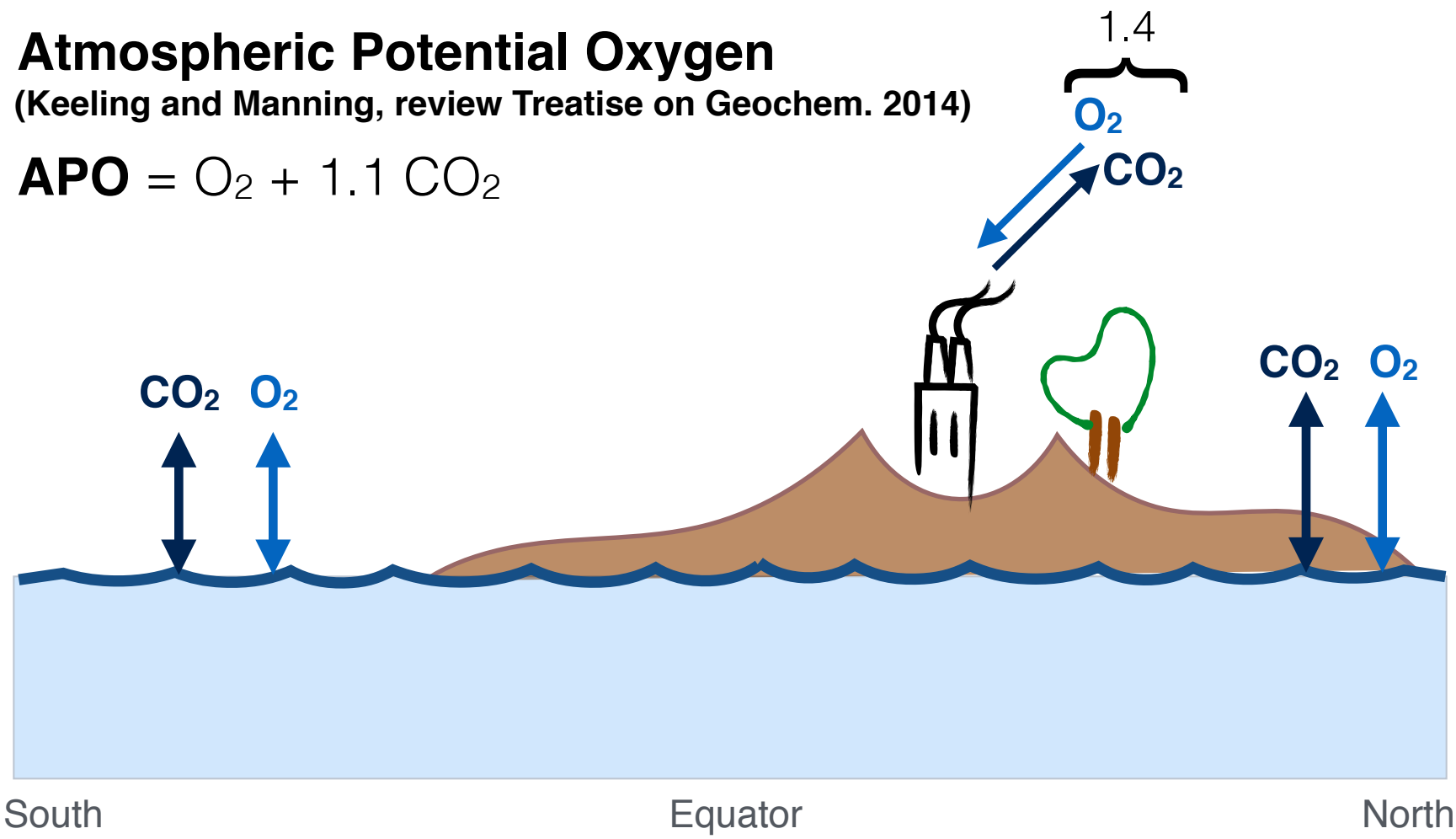
Link between heat and carbon ocean transport

... **Can we improve the air-sea flux prior?**

Atmospheric Potential Oxygen tracks air-sea flux



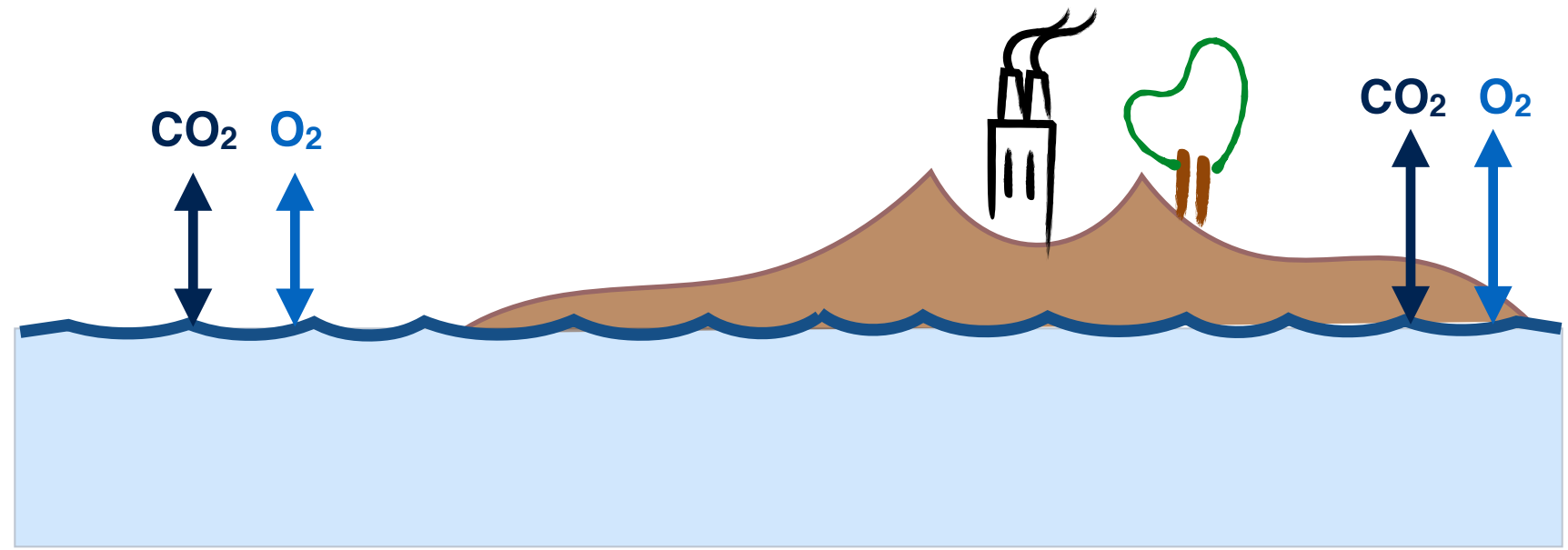
Atmospheric Potential Oxygen tracks air-sea flux



Atmospheric Potential Oxygen tracks air-sea flux

Atmospheric Potential Oxygen
(Keeling and Manning, review Treatise on Geochem. 2014)

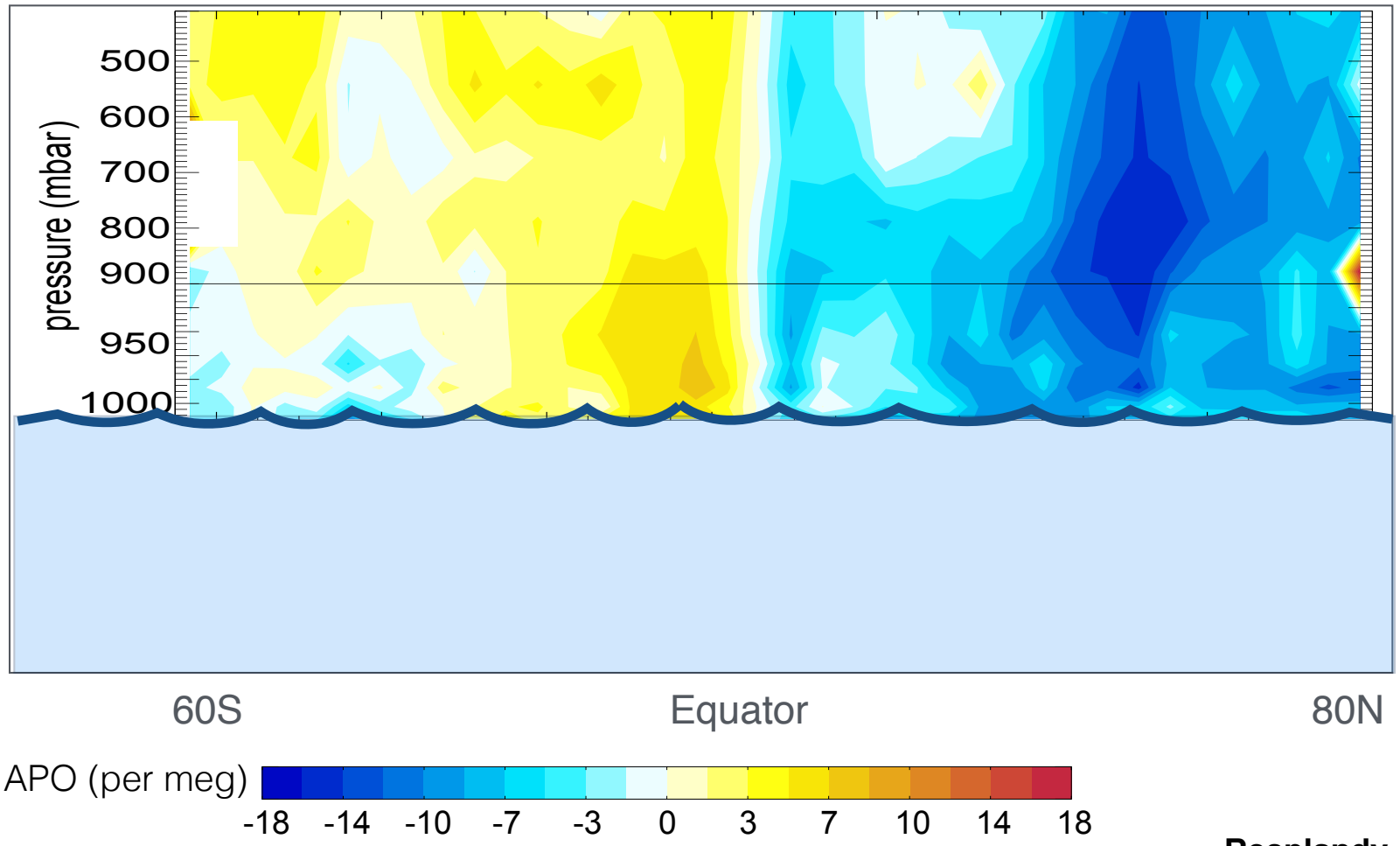
APO = O_2 + 1.1 CO_2 - fossil fuel



Airborne atmospheric potential oxygen data

B. Stephens, J. Bent (NCAR)
1600 observations
~500 hours of flight

Wofsy et al., 2011



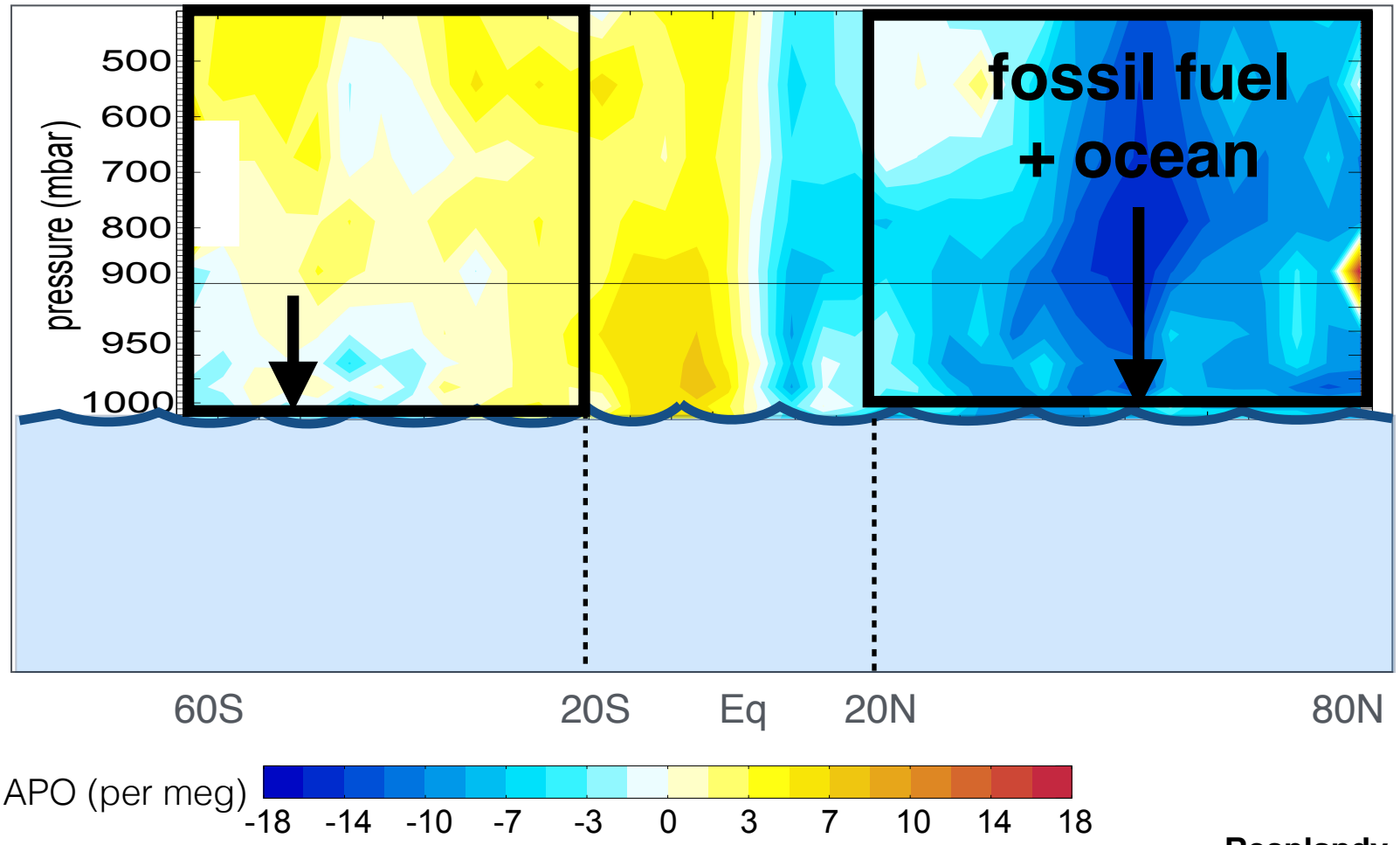
Resplandy et al., in prep

Airborne atmospheric potential oxygen data

B. Stephens, J. Bent (NCAR)
1600 observations
~500 hours of flight

Wofsy et al., 2011

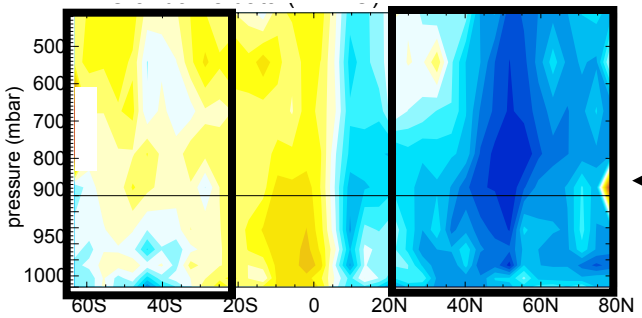
northern deficit ~ 8 per meg



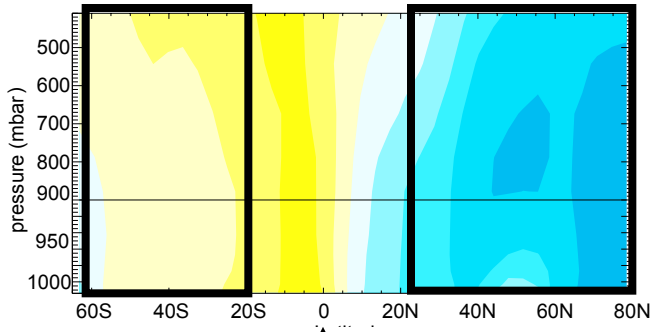
Resplandy et al., in prep

Combine atmospheric and oceanic data to constrain ocean transport

DATA
atmospheric
potential oxygen



PREDICTION
atmospheric
potential oxygen



atmospheric transport

ocean transport

ocean DATA
O_2*, C*, T
(~60 000 obs.)

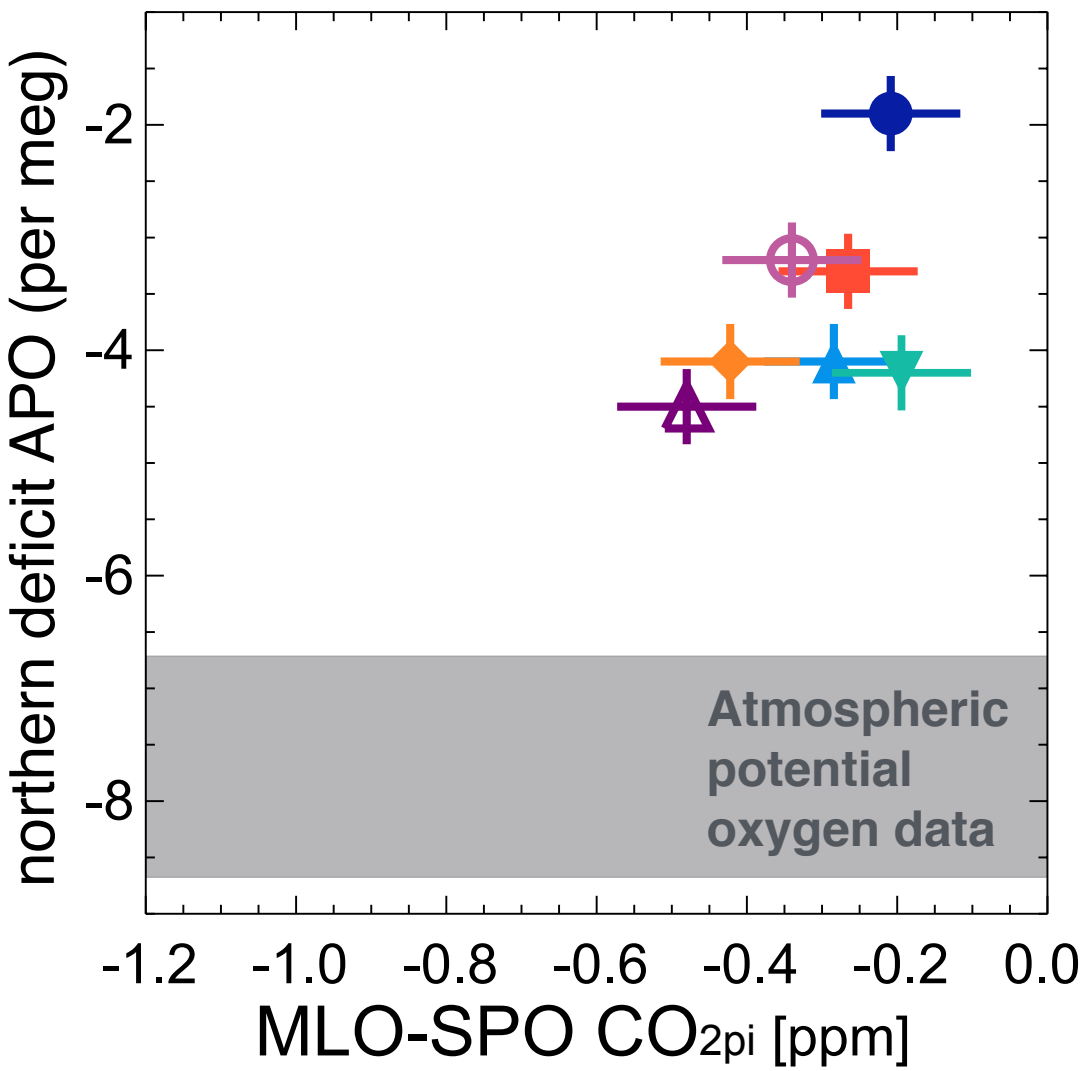
air-sea fluxes

+ Cant (Khatiwala, 2009)
+fossil fuel (EDGAR)

ocean inversion (Gloor et al., 2001; Gruber et al., 2001; MikaloffFletcher 2007; Jacobson et al., 2007)

Resplandy et al., in prep

1 Potential oxygen to constrain CO_2 asymmetry



Ocean inversions

- MOM-HH
- MOM-LHS
- MOM-LL
- MOM-PSS
- MOM-RDS
- MITgcm-2.8
- MIT-ECCO

Resplandy et al., in prep

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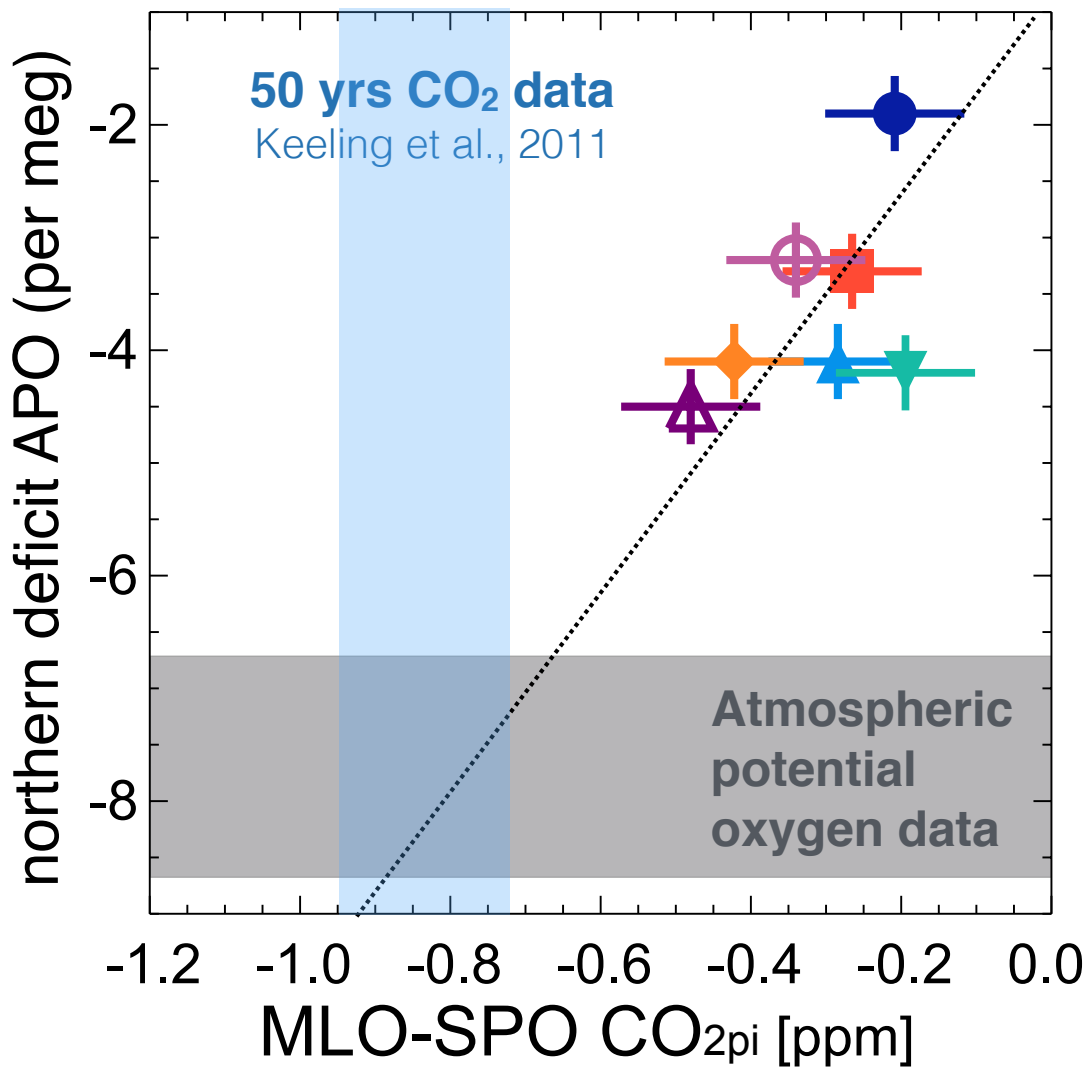

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Resplandy et al., in prep

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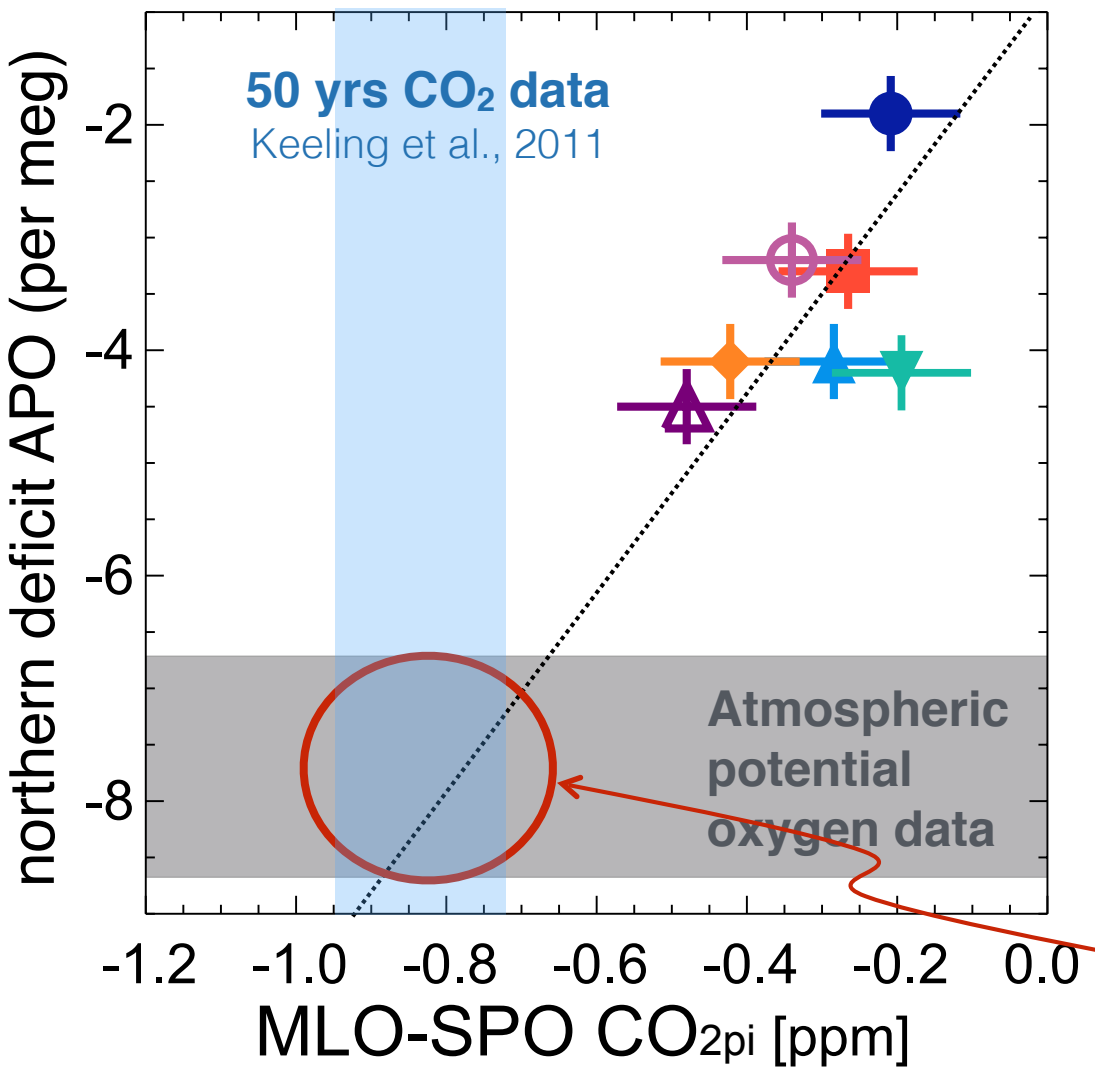

Ocean inversions

- MOM-HH
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- MITgcm-2.8
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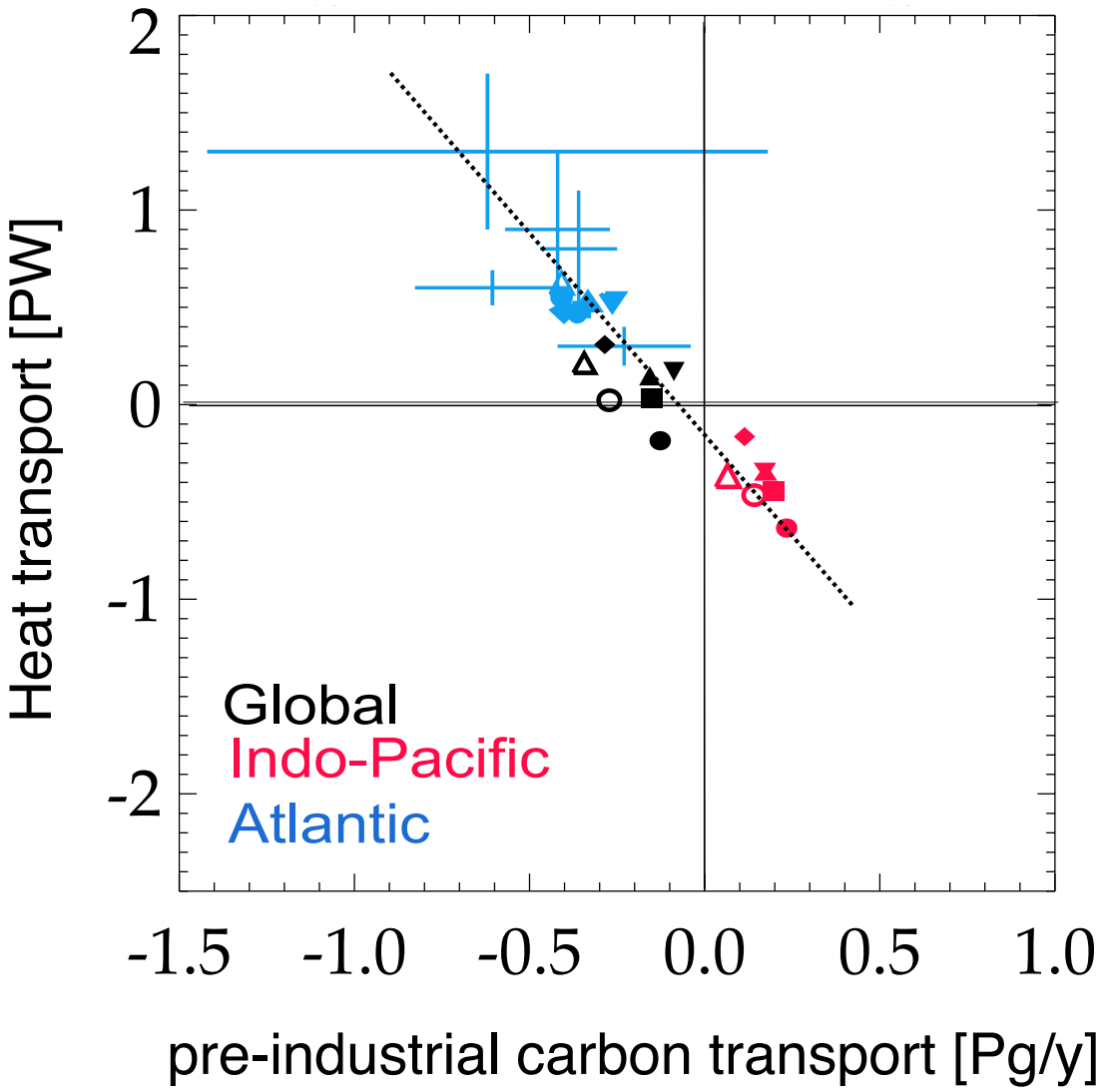
observational target?

CO_{2pi} ocean transport ~ -0.6 PgC/y

Resplandy et al., in prep

2 Link between carbon and heat ocean transports



Ocean inversions

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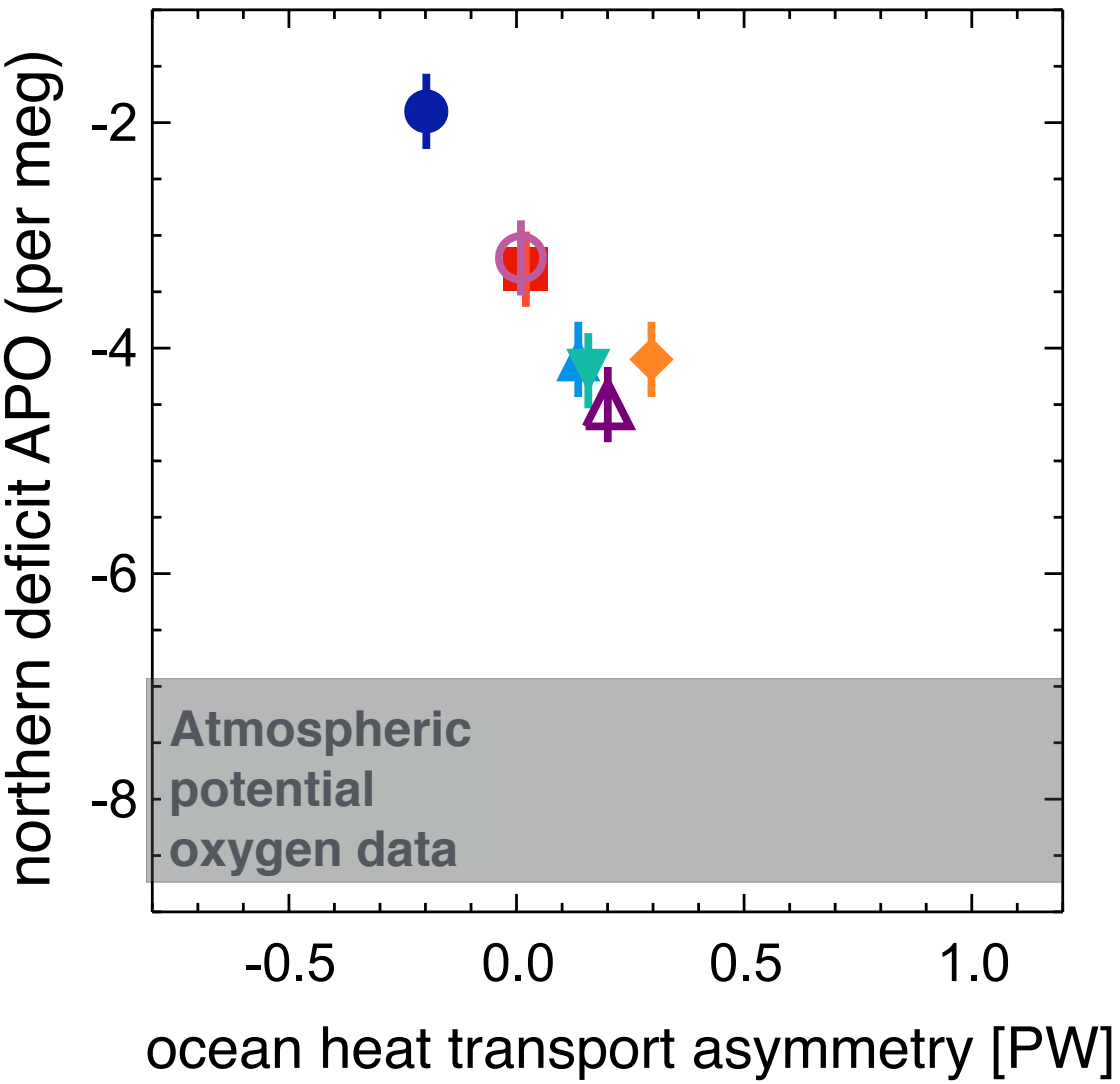
- MOM-PSS
- MOM-RDS
- MITgcm-2.8
- MITgcm-ECCO

Atlantic hydrographic sections

Ganachaud & Wunsch, 2003; Macdonald et al., 2003; Alvarez et al., 2003; Holfort et al., 1998; Lundberg & Haugan, 1996

2 Ocean transport asymmetry is underestimated



Ocean inversions

- MOM-HH
- MOM-LHS
- MOM-LL
- MOM-PSS
- MOM-RDS
- MITgcm-2.8
- MIT-ECCO **v1**

Resplandy et al., in prep

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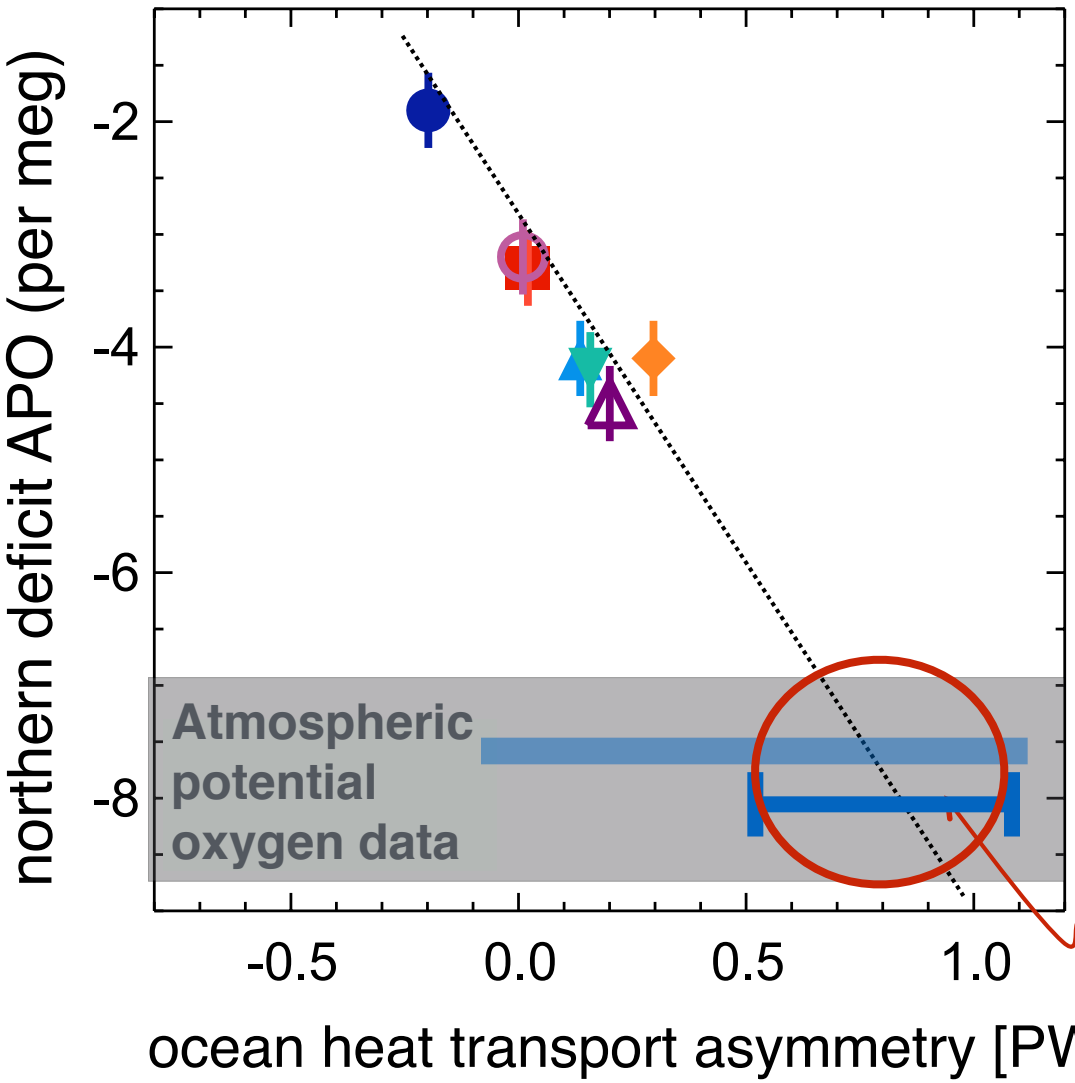

Ocean inversions

- MOM-HH
- MOM-LHS
- MOM-LL
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- MOM-RDS
- MITgcm-2.8
- MIT-ECCO **v1**

Previous estimates

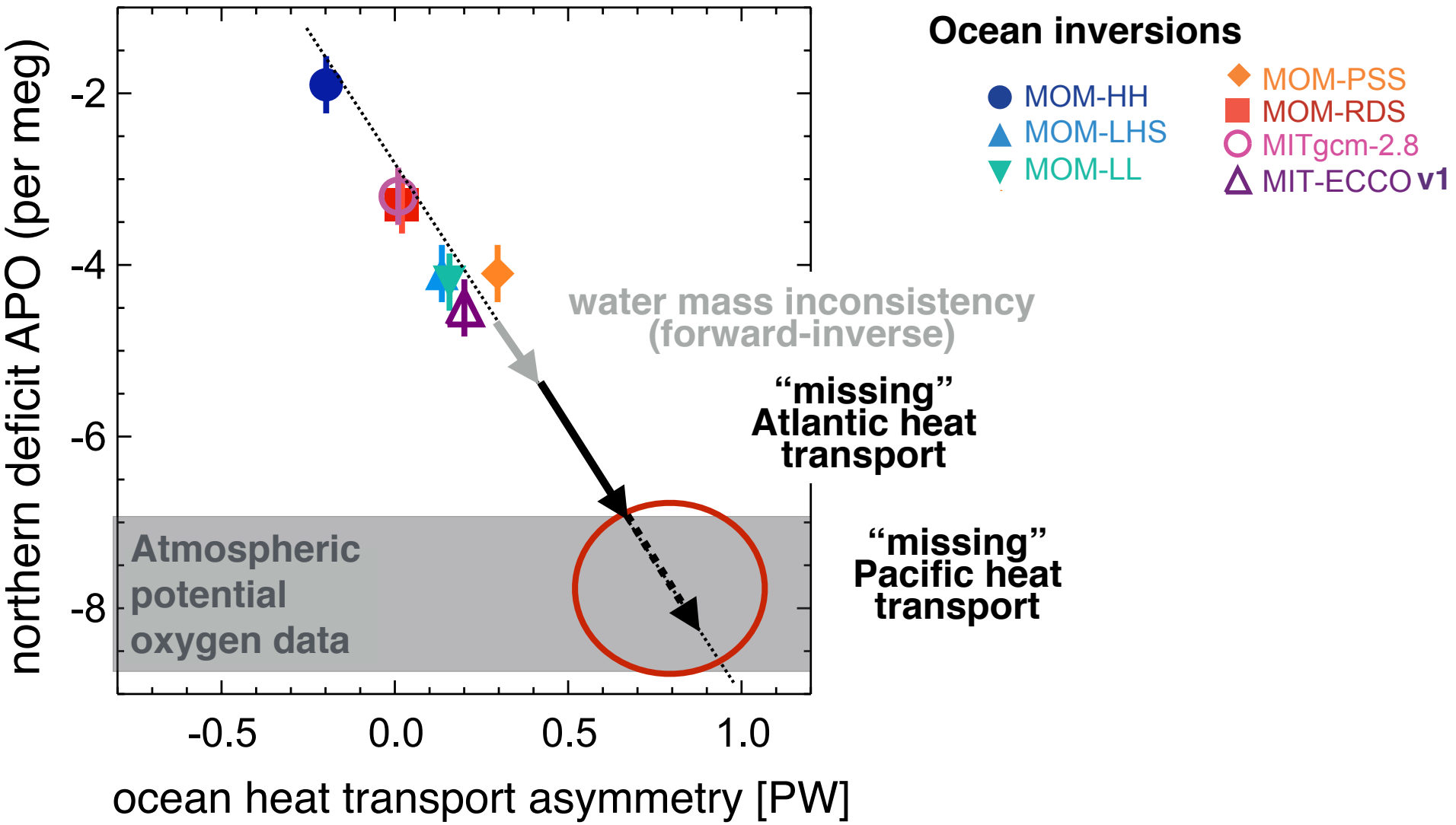
Ocean sections
Ganachaud and Wunsch, 2003

Air-sea flux climatology
CORE2 Large and Yeager, 2009

observational target 0.5-1 PW

Resplandy et al., in prep

2 Ocean transport asymmetry is underestimated



Resplandy et al., in prep

Discussion and prospects

- Potential oxygen is a valuable new constraint on air-sea flux
- southward transport of 0.6 PgC/y necessary to explain APO data
- Higher resolution ocean: weak impact on inversion
- Ocean models underestimate transports of carbon, heat and oxygen.
- Possible impact on land carbon sinks?