Quantifying the regional variability of dissolved oxygen in the ocean

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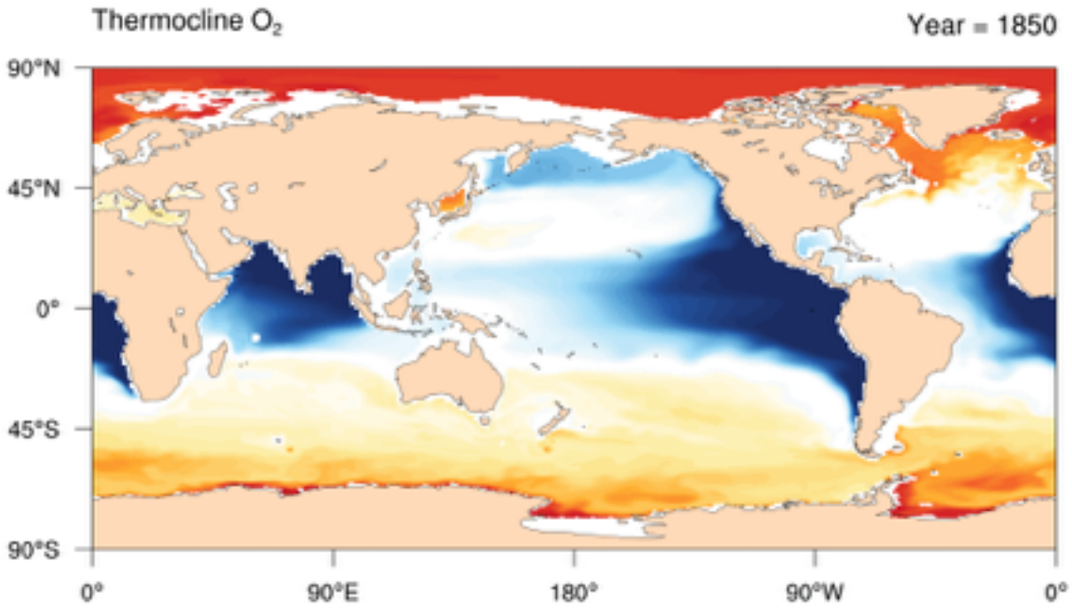
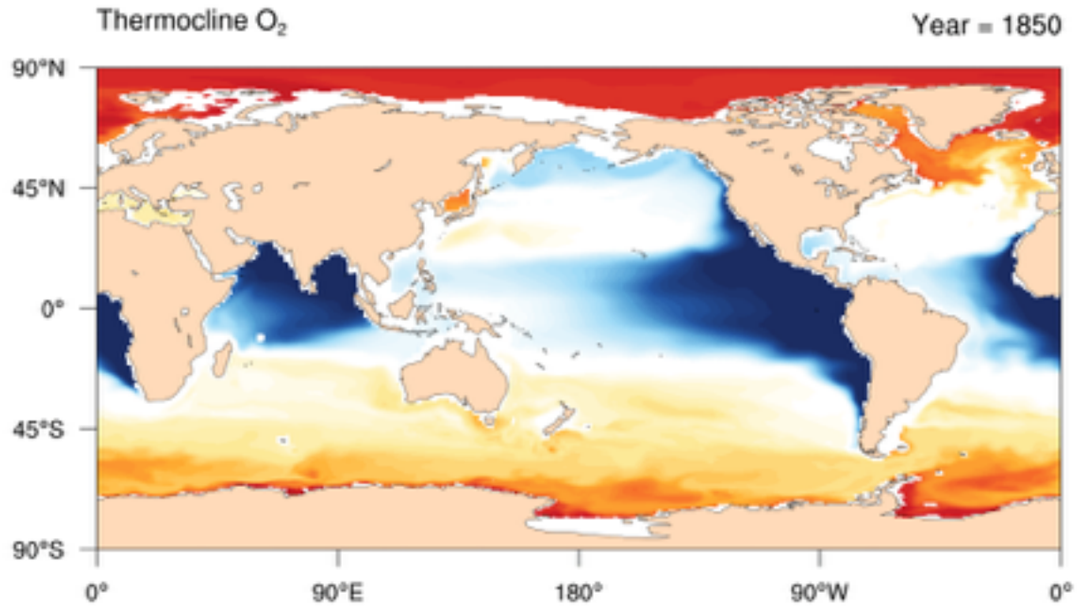
July 14th, 2016 (version 0.1)
[Note: Preliminary Results & Under Development…]

Dynamics of Oxygen Minimum Zones



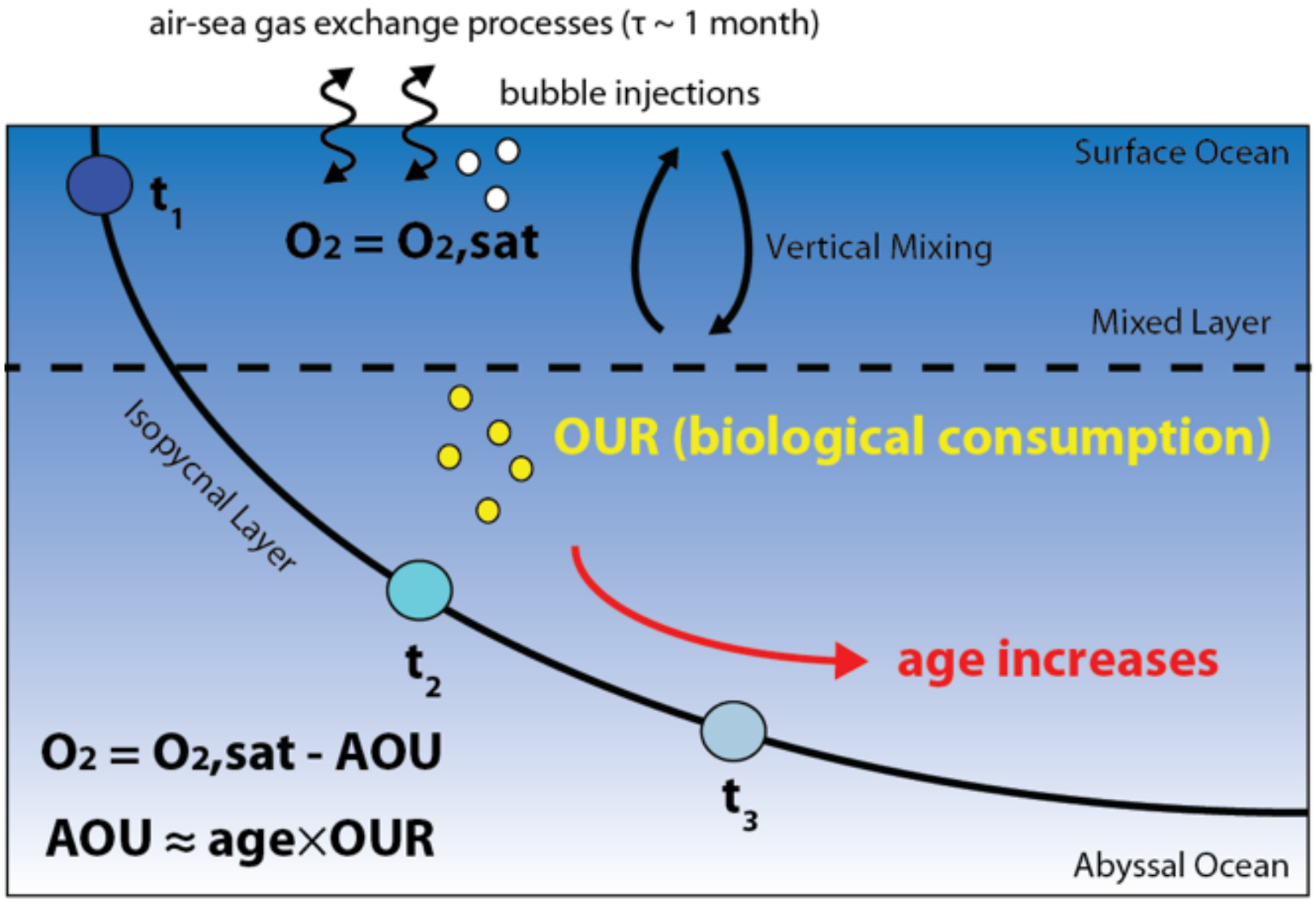
Member #10



Member #16

- What regulates the dynamics of oxygen minimum zones?
- How could we quantify the variability of dissolved oxygen under the long-term climate change (global warming)?

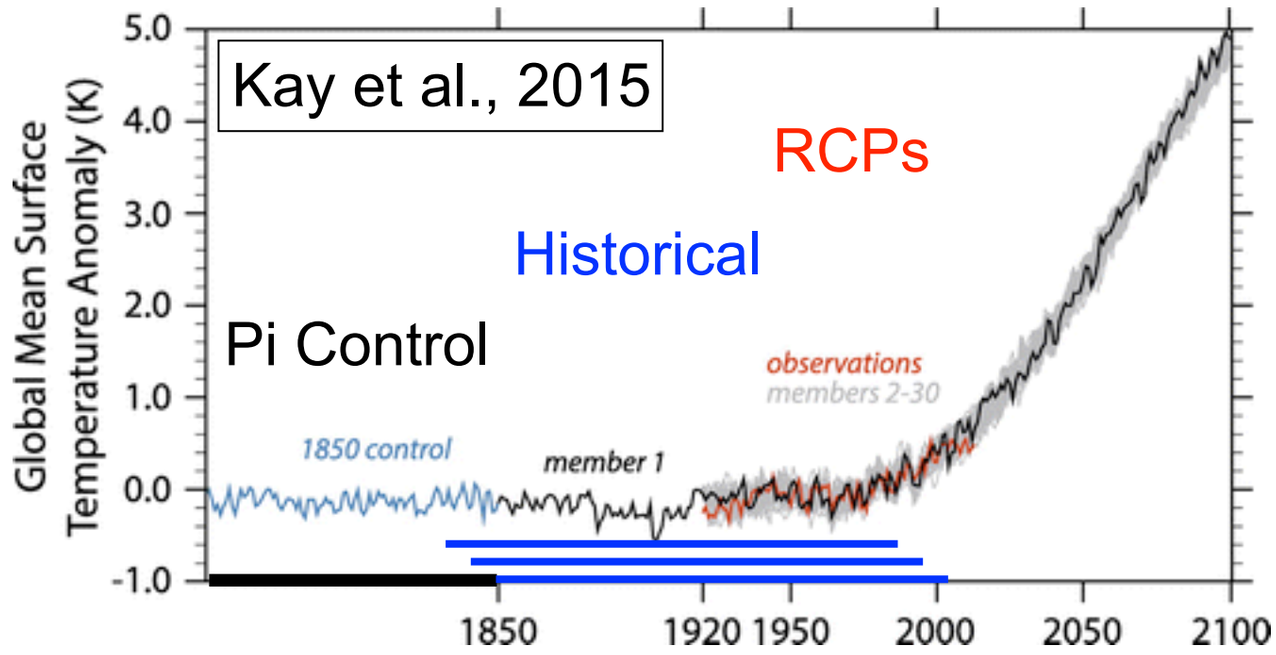
What regulates oxygen cycles?



blue gradient: dissolved oxygen
dark blue: high oxygen, light blue: low oxygen
time: t1 < t2 <t3

Takano Ph.D. Dissertation, 2016 | Ito et al., 2004

Large Ensemble Methods



signals = **forced signals** + **intrinsic (internal) variability**

"ensemble mean" "residual, noise"

Hasselmann, 1993; Deser et al., 2012; Kay et al., 2015

Also check this! (Clara Deser's Short Talk)
[https://ams.confex.com/ams/95Annual/videogateway.cgi/id/29786?recordingid=29786]

Model Data

MPI-ESM (GR15L40) Large Ensemble Experiments
Experimental Design CMIP5 [Giorgetta et al., 2013]

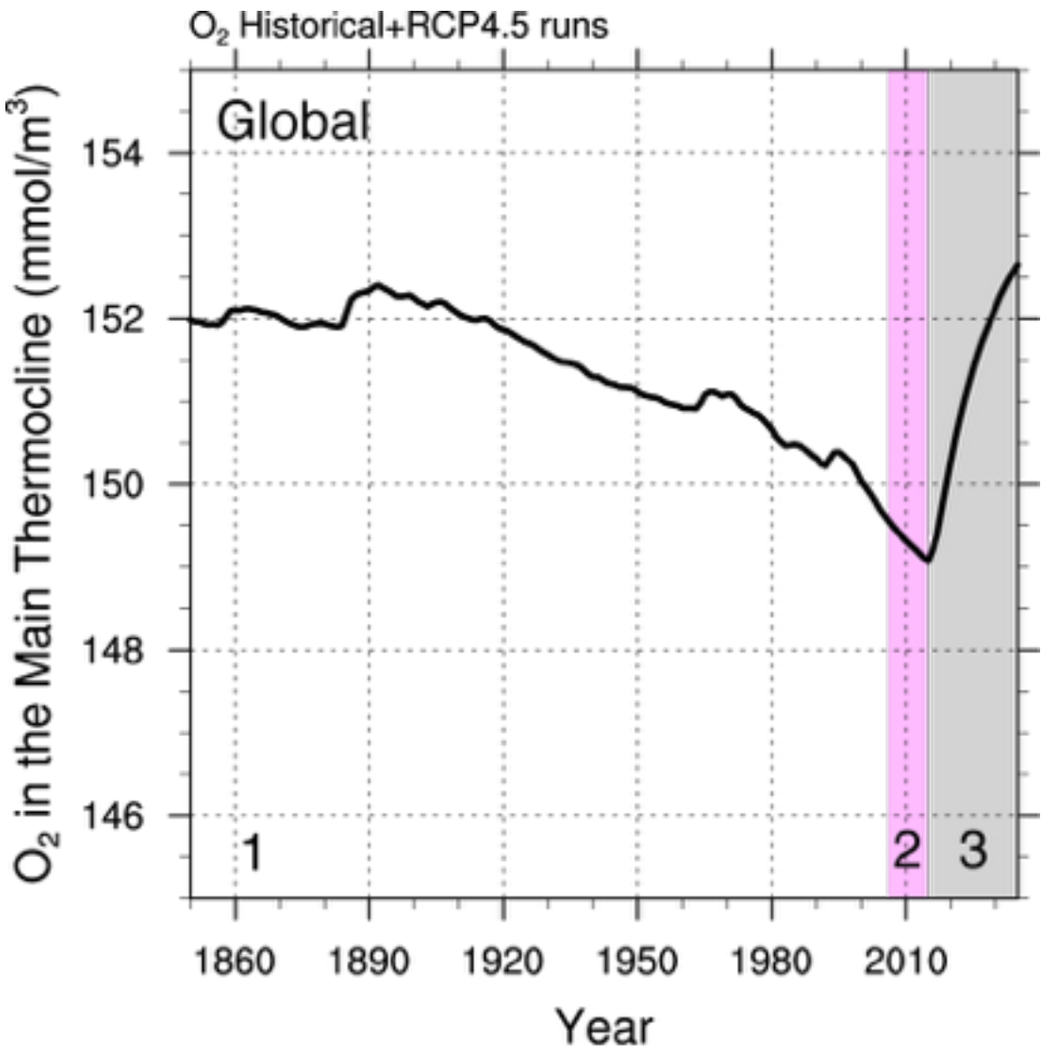
1. Pi (Preindustrial) Control: 2000 years (lkm 0001)
2. **Historical Experiments: 1850-2005 (lkm 0101-0200)**
3. RCP4.5 Extension (1): 2006-2015 (jkrcp 45101-45200)
4. RCP4.5 Extension (2): 2016-2036 (mbrcp 45101-45200)
5. 1pcCO_2 Ensembles: 1850-2005 (lkm 0401-0468)

We analyze vertical mean [220m-645m] O_2, $O_{2,sol}$ [Garcia and Gordon, 1992], and AOU

[Note: HAMOCC is using Weiss, 1970 for solubility calculation!]

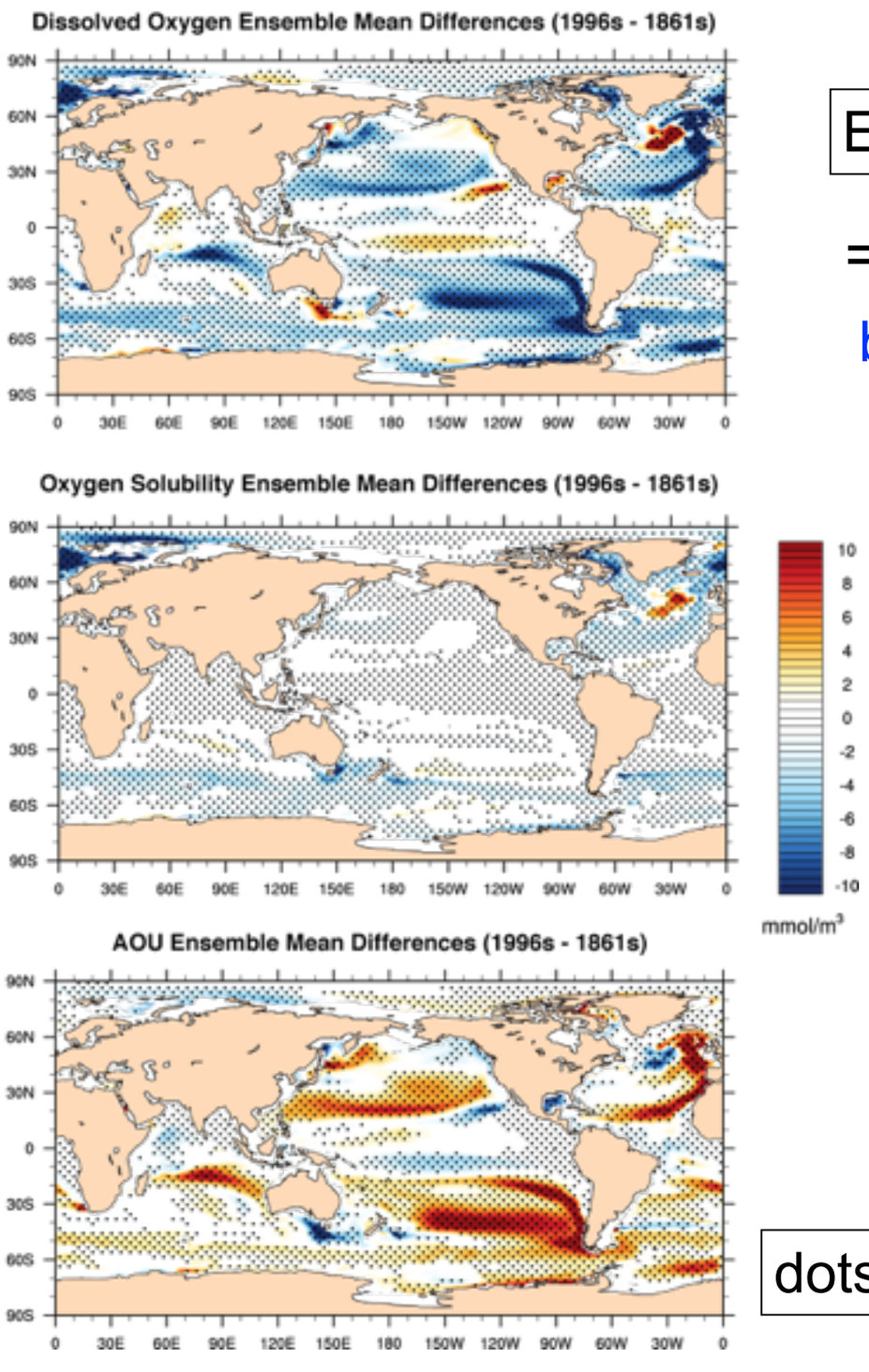
Note: Other Large Ensemble Experiments
CESM (NCAR) [Kay et al., 2015], GFDL, …

MPI-M Large Ensemble Setups



1. Luis Zone : 1850-2005
2. Juergen Zone: 2006-2015
3. Michael Zone: 2016-2035

Historical Forced Trend



Epoch Differences:

= mean (1996-2005) + mean (1861-1870)

based on ensemble mean = forced changes

Deser et al., 2012 [two sided t-test]

$$\frac{X}{\sigma} \geq \frac{\pm 2}{\sqrt{N-1}}$$

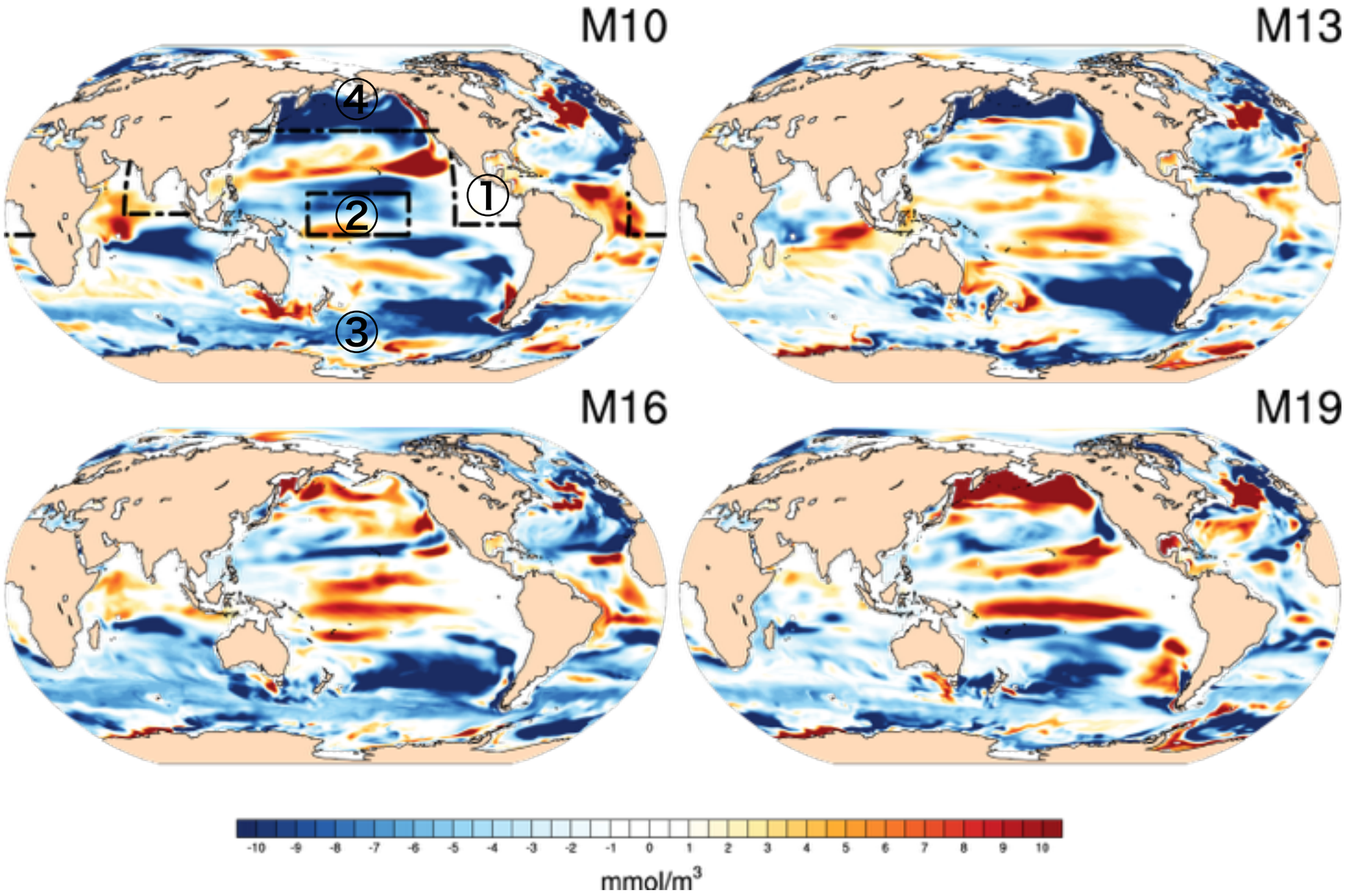
X : epoch differences

σ : standard deviation

N : 100

dots: statistically significant 95%

The Role of Internal Variability



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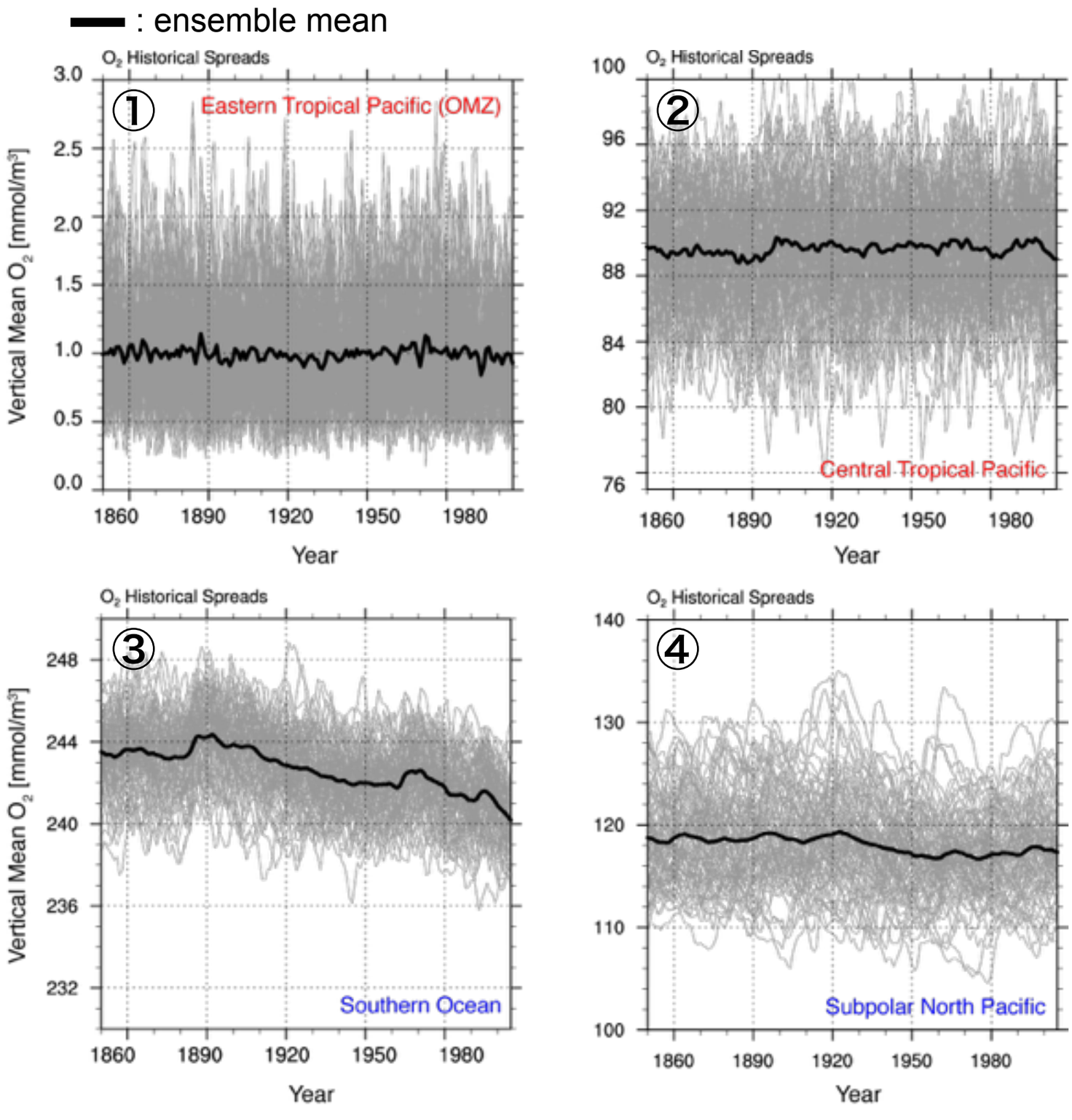
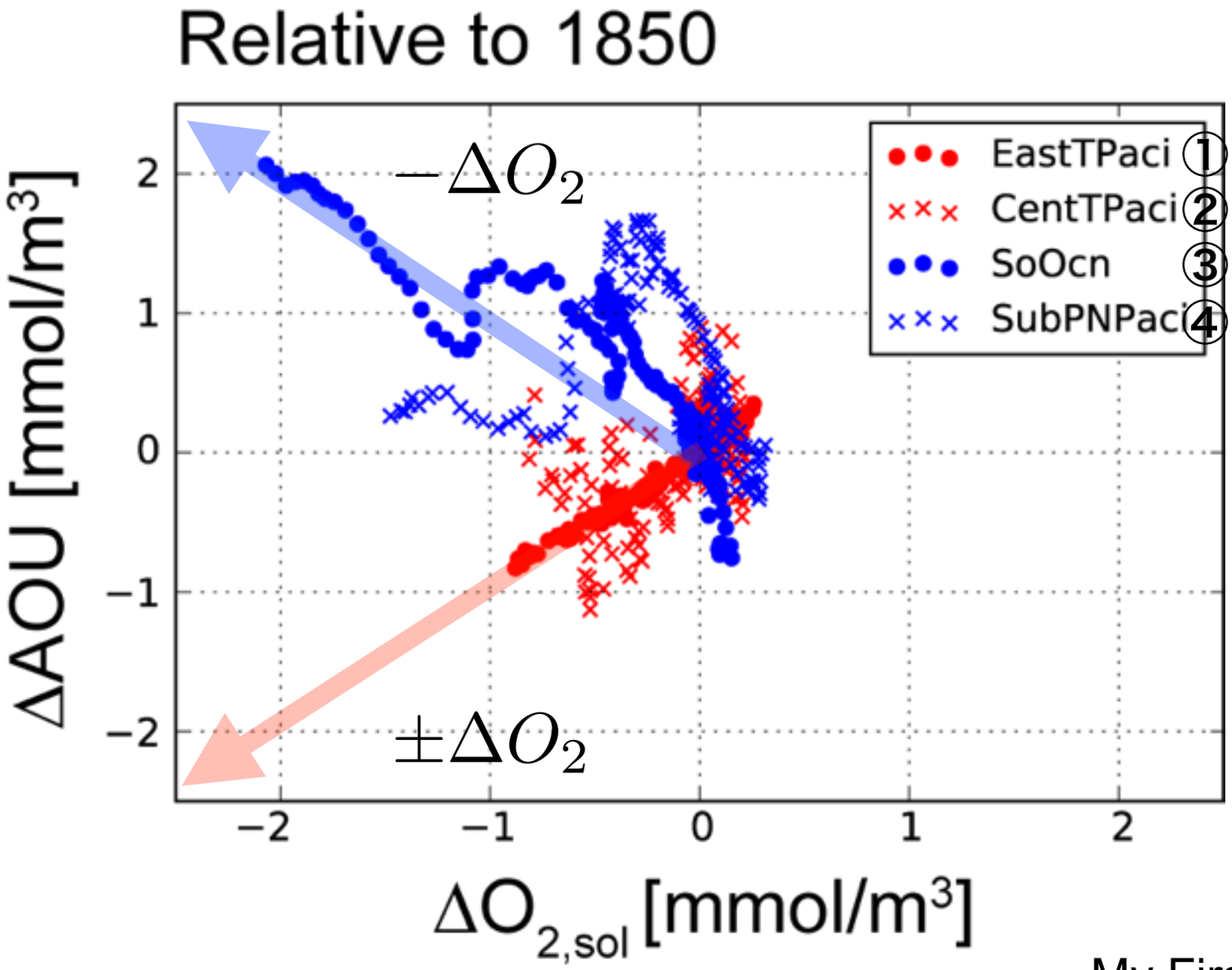


Thermodynamics vs. Biology

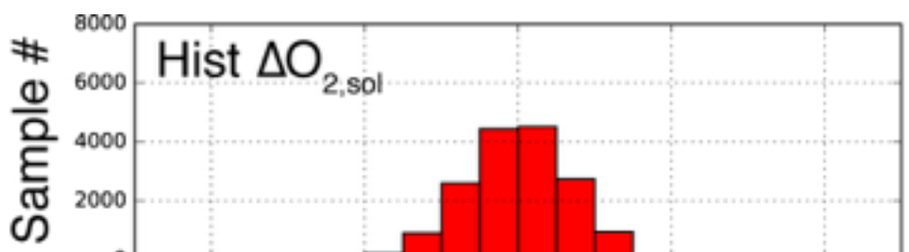
Forced Response (i.e. Ensemble Mean)



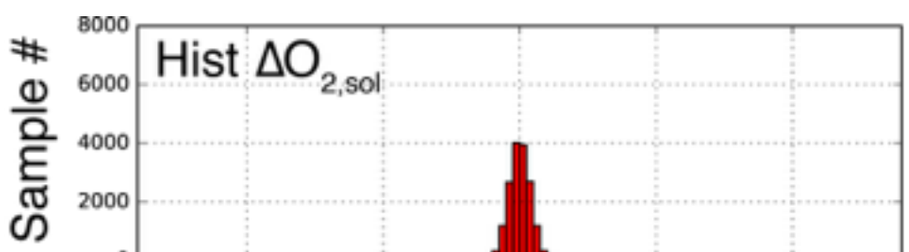
My First Python Plot!

Thermodynamics vs. Biology

Internal Variability: Tropical Pacific



2000: ~10%
4000: ~20%



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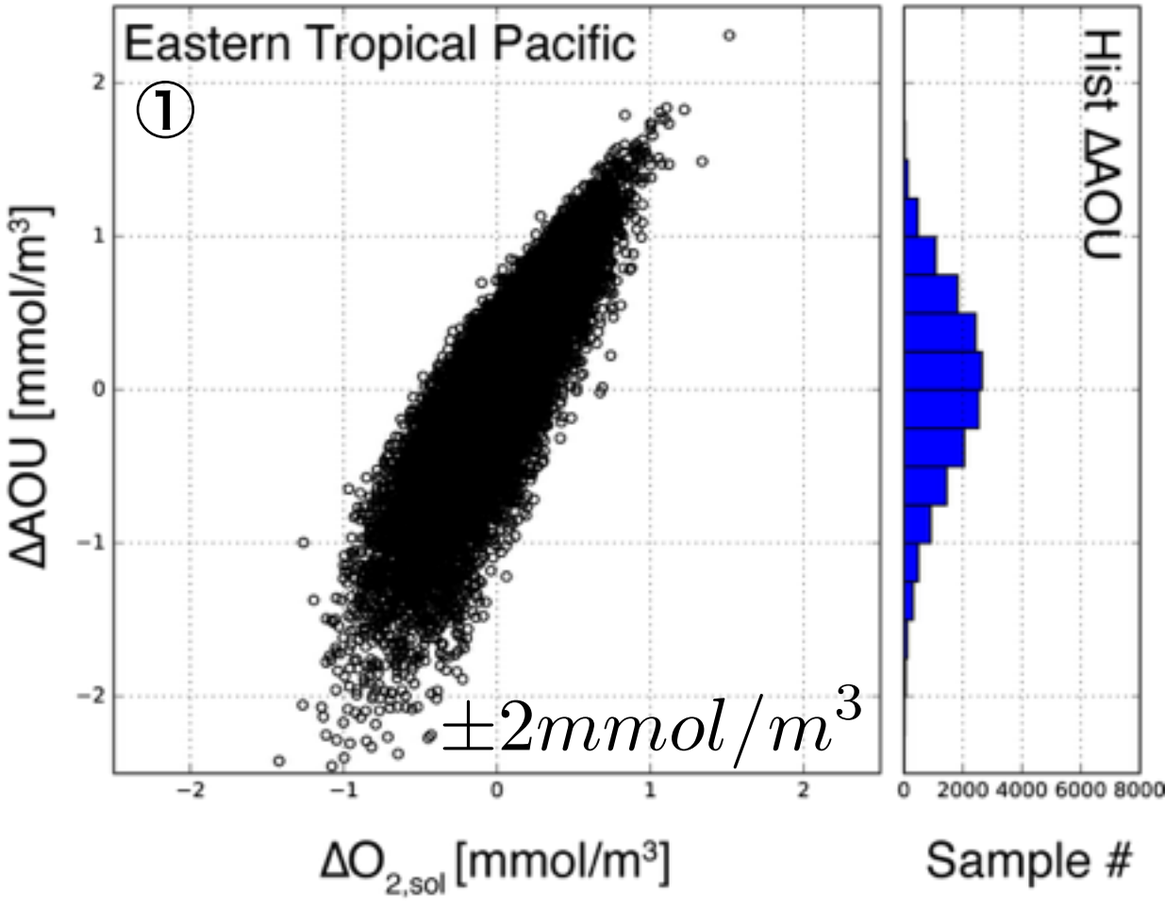
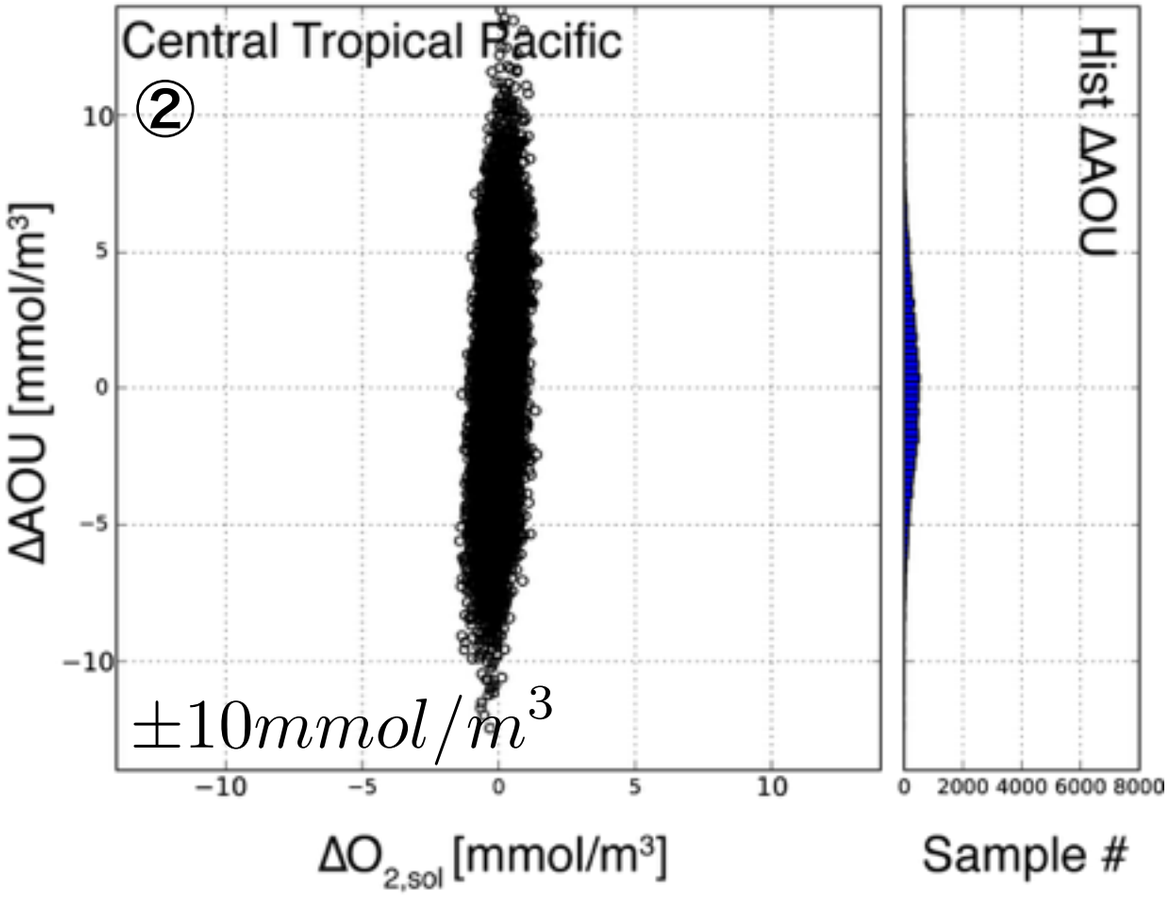
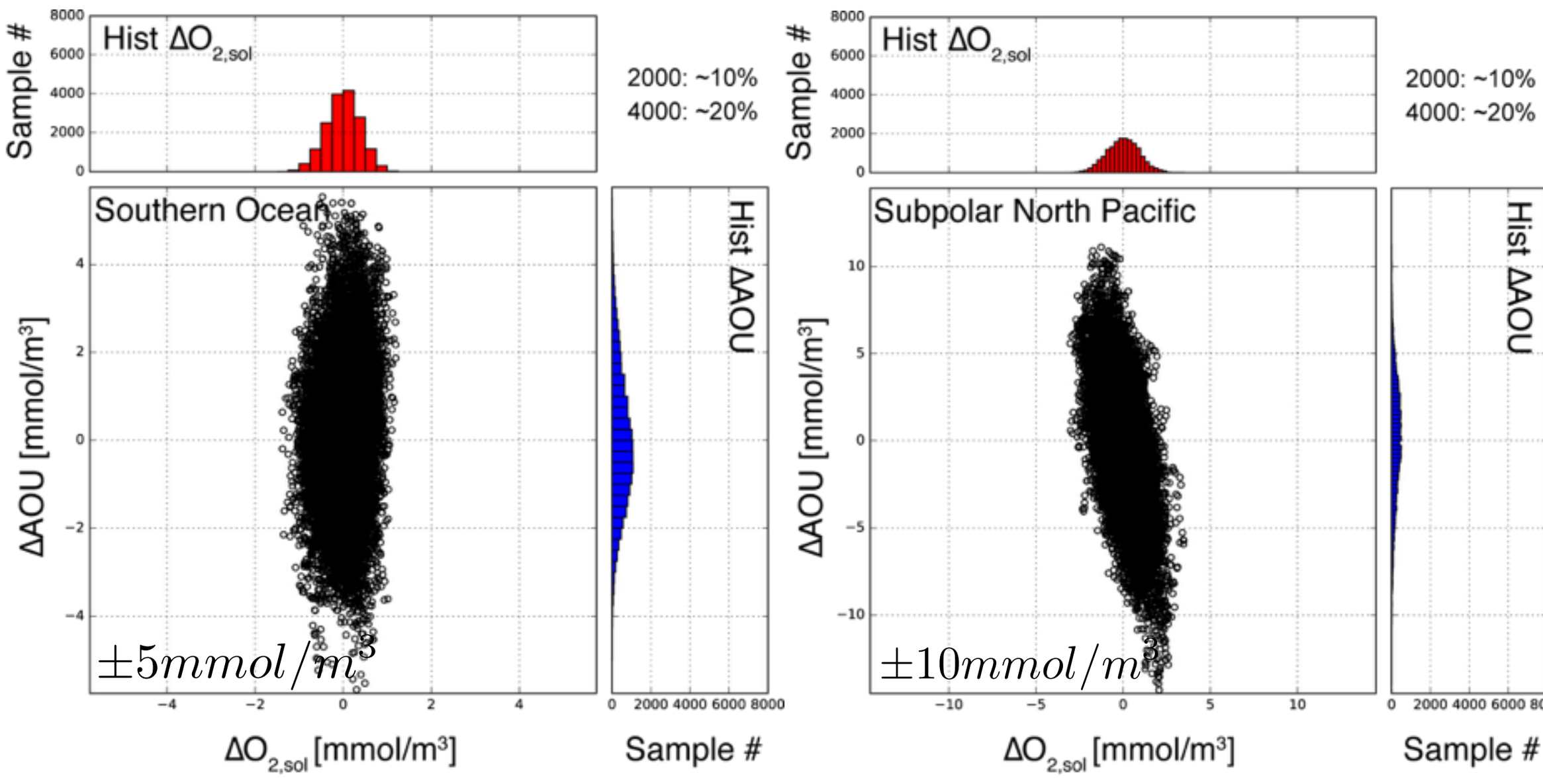




Thermodynamics vs. Biology

Internal Variability: High Latitudes



Next Step and Development

- What are the impact of **regional** climate variability and ocean internal variability on dissolved oxygen?

- Analysis of 1pcCO_2 (68) Ensembles and interpretation of CMIP5 (or next generation MIP).

- Developing descriptive tools of analyzing modern climatology of dissolved oxygen (OMZs).

- Be friendly with MPI-ESM (HAMOCC)….