Progress Report: Ocean Mixing Processes (OMIX): Impact on Biogeochemistry, climate and ecosystem (2015-2019)

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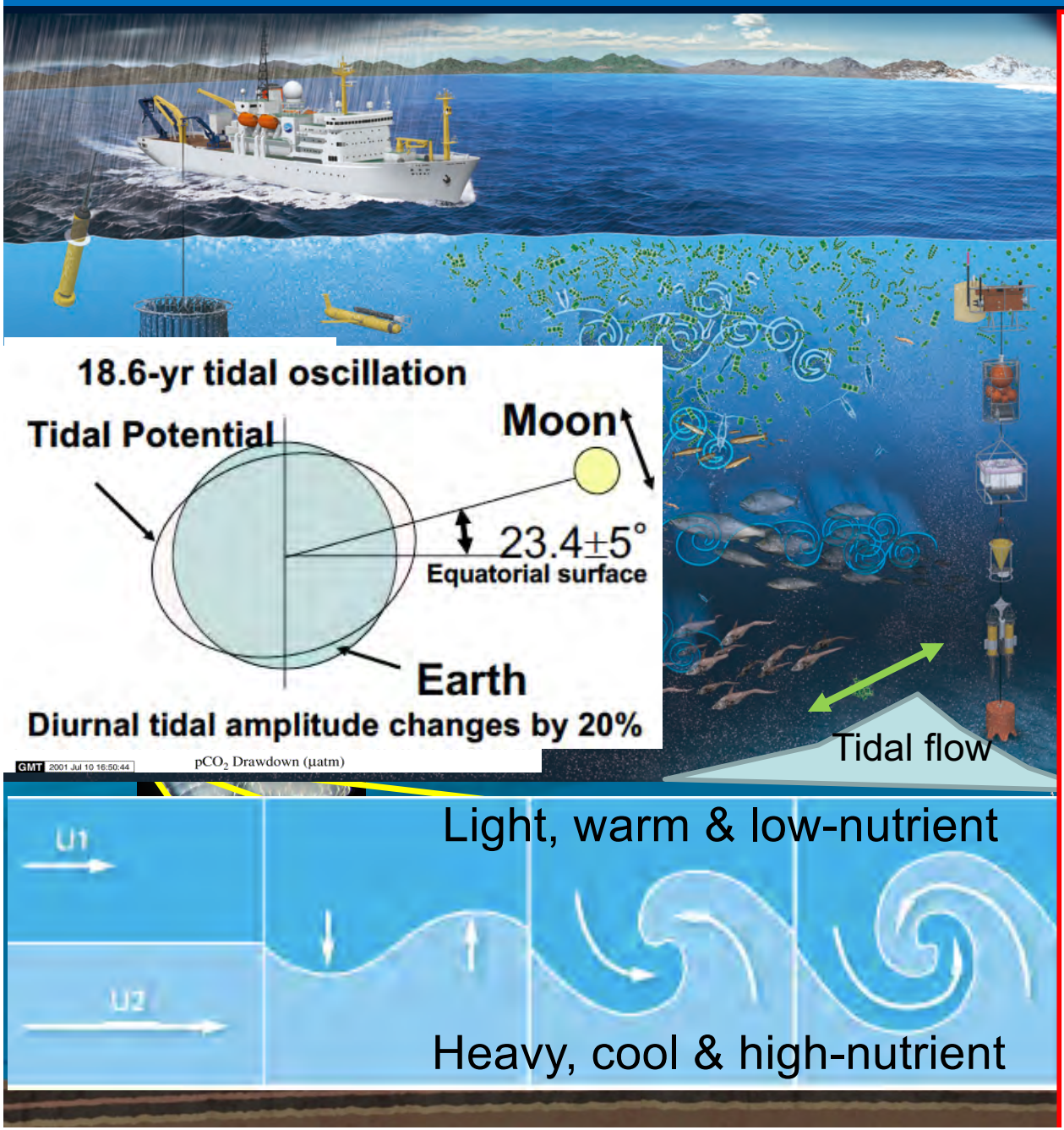


Ocean Vertical Mixing

Transport heat & material

Insufficient obs. & models

Goal: Challenge new mixing science: By integrating observations and modelling of vertical mixing, physics and biogeochemistry in western North Pacific, evaluate mixing impacts on circulation, climate and ecosystem:

- **Deep-intermediate Circulation in the N.P.**
- **Processes to sustain abundant ecosystem**
- **Long-period variability of ocean/climate/fisheries**

OMIX Research Team

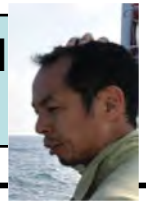
Coordination Unit

X00：Coordination Unit：


Ichiro Yasuda

WG

WG1: Mixing and circulation



WG2:Mixing and biogeochemistry / ecosystem

WG3:Impact of mixing and variability (18.6yr)


Toshiyuki Hibiya

Main Unit

A01-A03：Observation and assimilation

A04：Model with mixing and impact estimate
(7) Mixing physics & Parametrization
(8) Integrated modelling


Hiroyasu Hasumi

A01：Develop system of mixing obs. & assimilation, to estimate circulation (1)(2)

A02:Mixing and biogeochemistry in Oyashio & Kuroshio (3)(4)

A03：Process and variability of ecosystem & fisheries (5)(6)

Selected Study


Ichiro Yasuda


Shuhei Masuda


Jun Nishioka


Xinyu Guo


Naomi Harada


Shin-ichi Ito

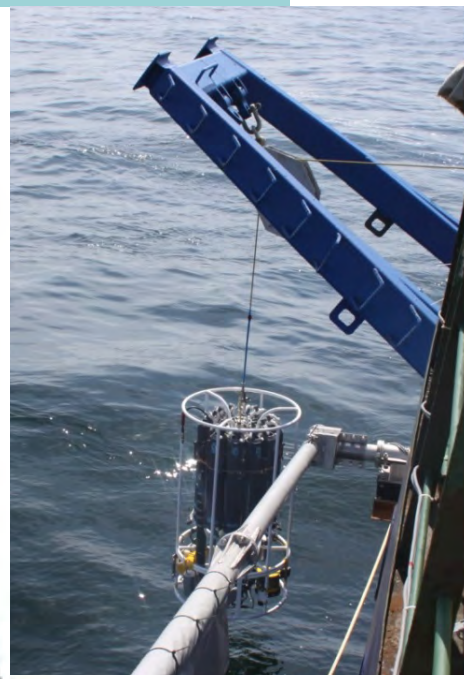
14 selected study members (2017-18)

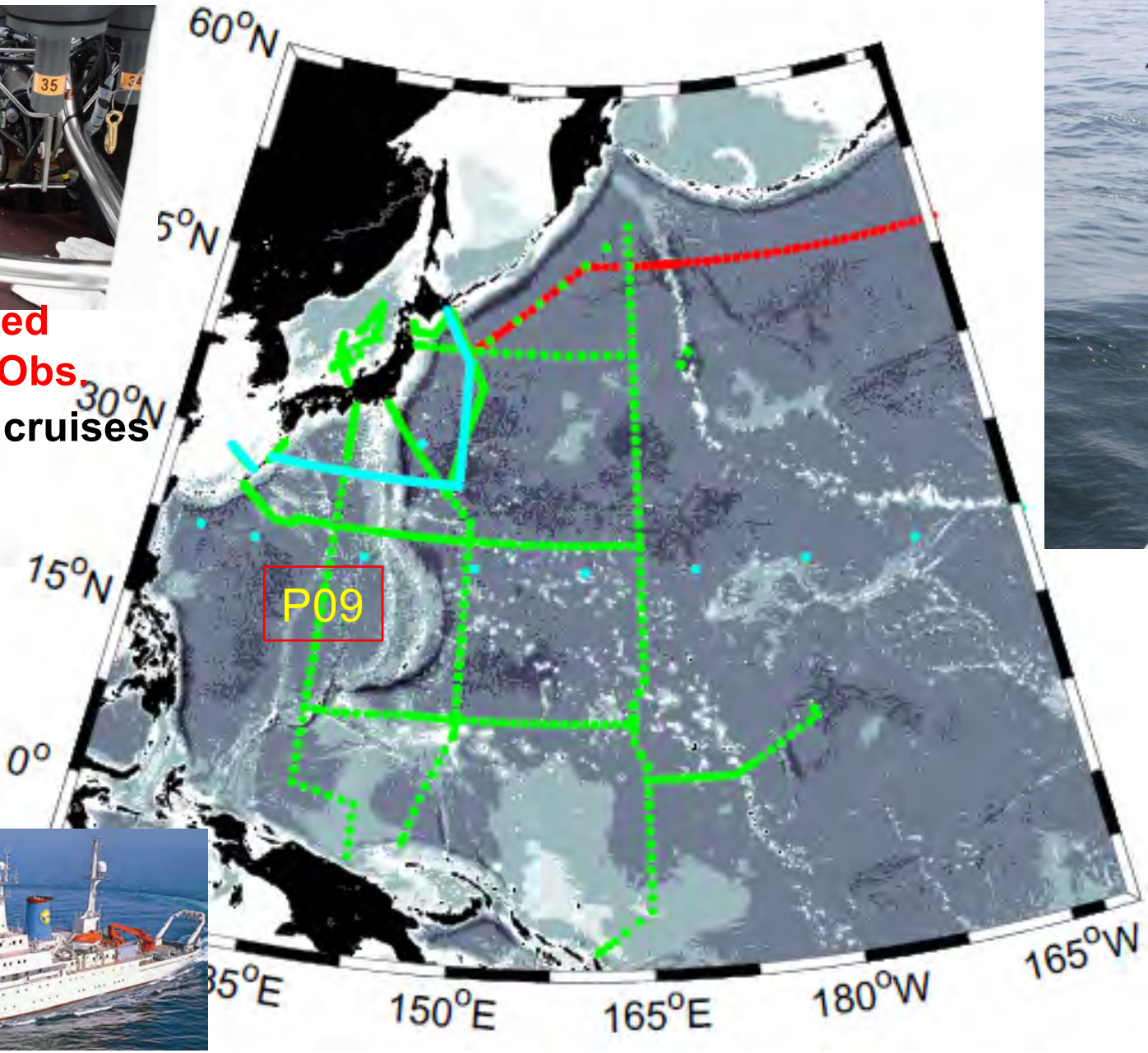
16 selected study members (2019-20)

North-western Pacific Turbulence Distribution?

CTD-attached Fast-thermistor Obs. System (Goto et al. 2016;2018 JTECH)
using CTD observation network

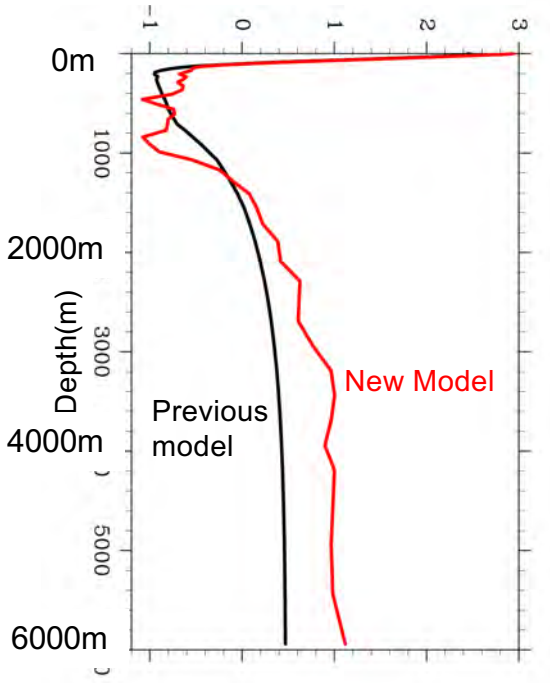
CTD-attached thermistor Obs.
2015-17:74 cruises



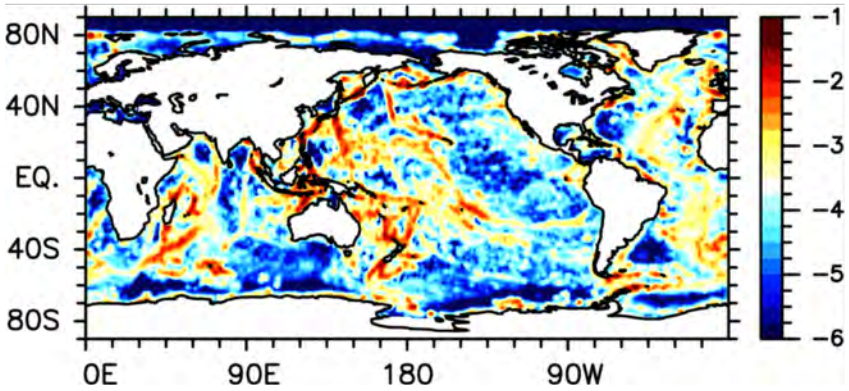


Develop models with tide-induced mixing & impact on deep circulation and climate Tatebe et al. Sci. Rep. Sept. 27, 2018

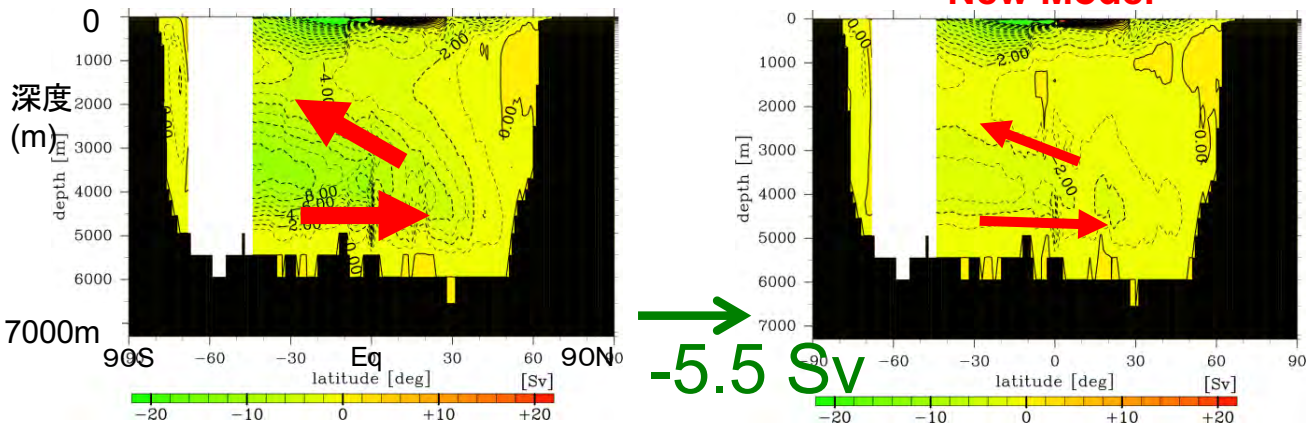
Pacific –mean vertical Diffusivity profile (Log10)



NewModelTide-induced energy dissipation(W/m²)



Pacific MOC **Previous model** **New Model**

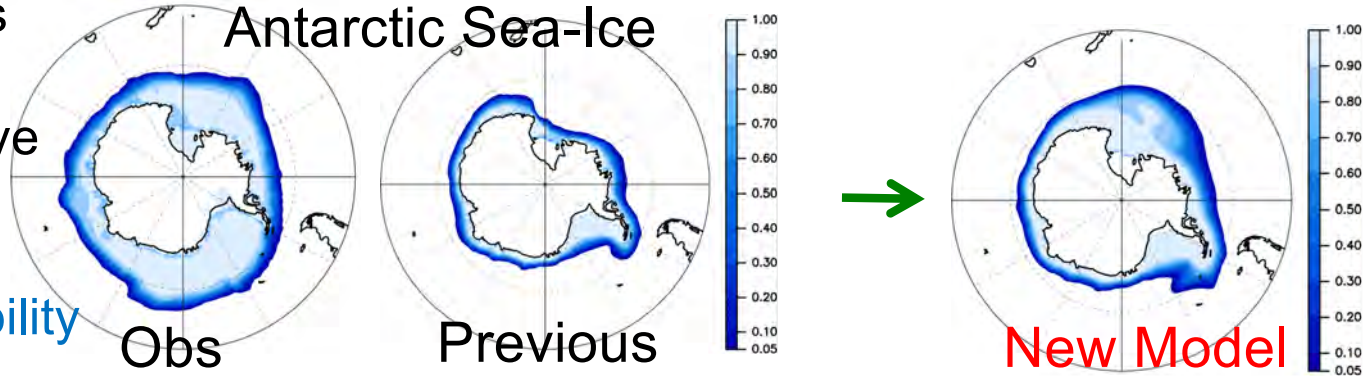


-5.5 Sv

New mixing scheme weakens Pacific deep circulation then enhances stratification and sea-ice around Antarctica (improve model bias)

Further improve mixing & introduce 18.6-yr variability

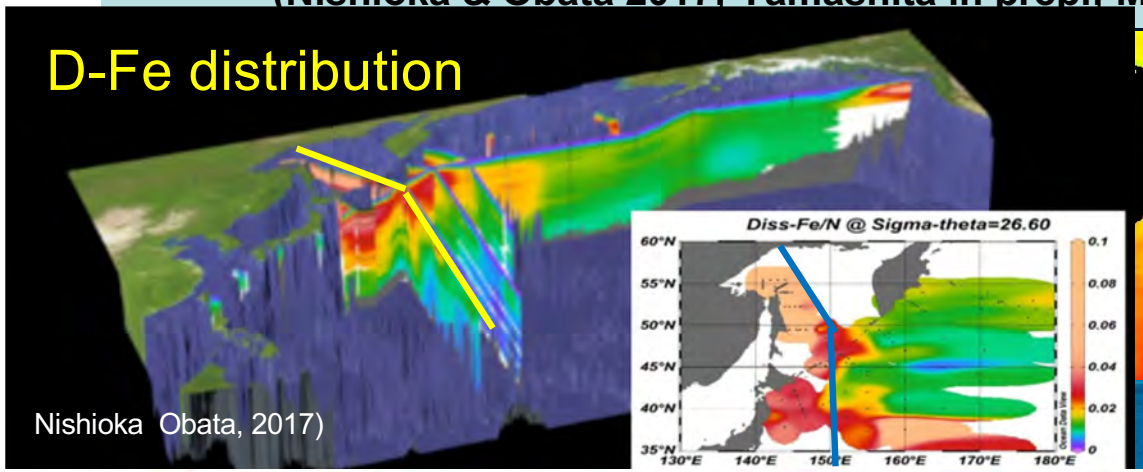
Antarctic Sea-Ice

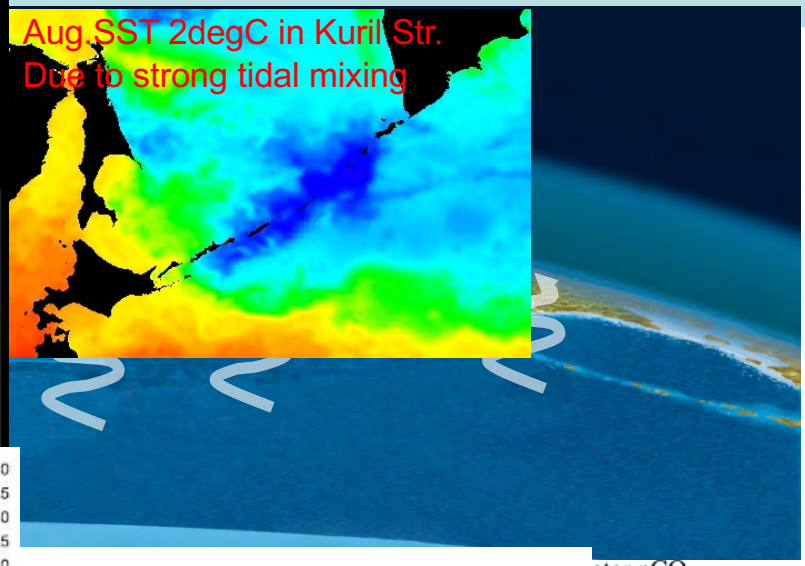


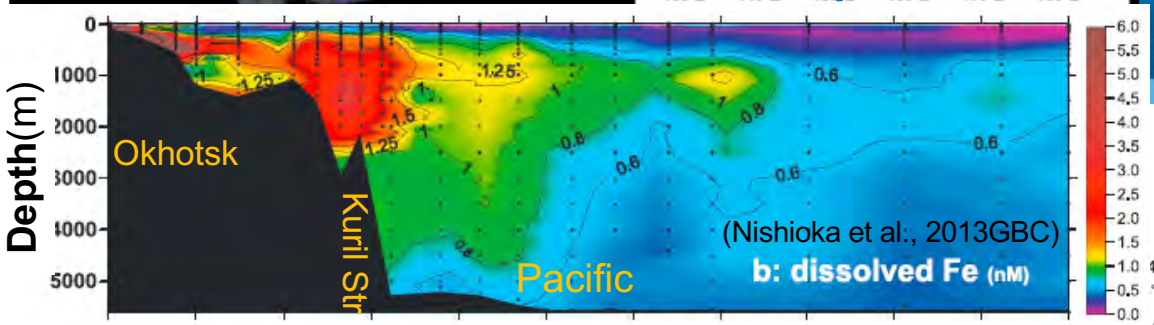
Impact on biogeochemistry: high production and CO2 absorption

Mixing hot-spots in Kuril & Aleutian and impact on high biological productivity through iron chemistry & transport

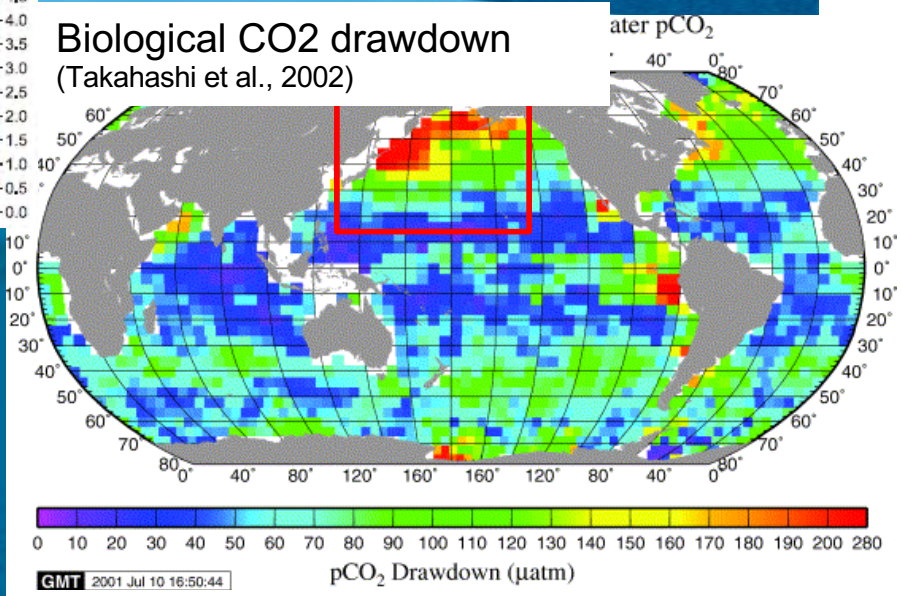
(Nishioka & Obata 2017; Yamashita in prep.; Misumi in prep; Mitsudera in prep.)







Biological CO2 drawdown
(Takahashi et al., 2002)

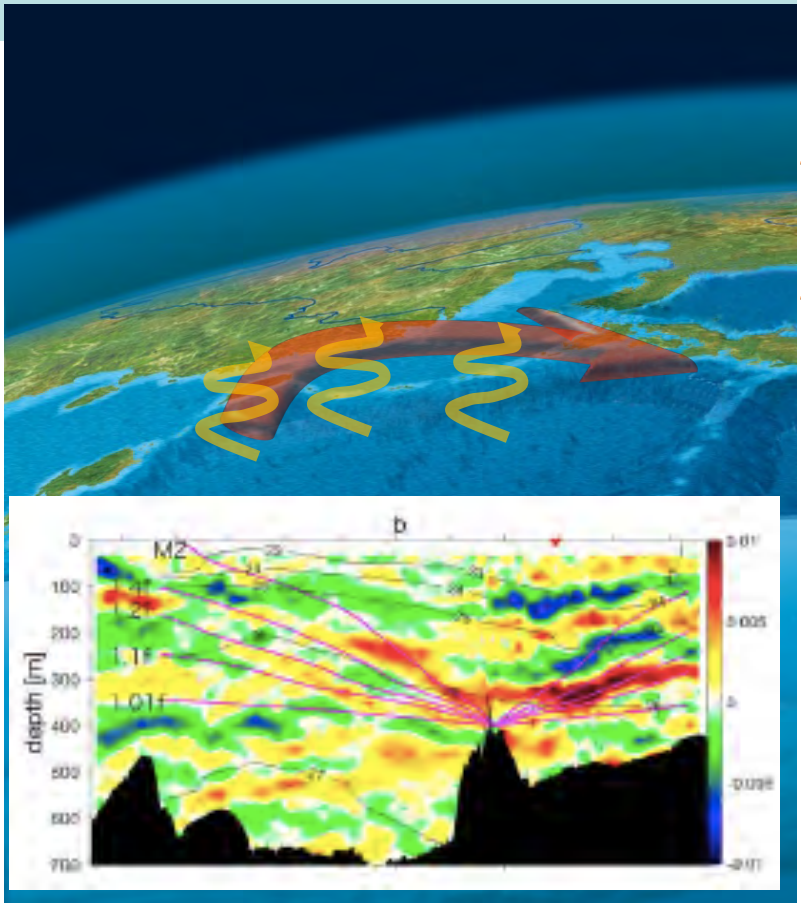


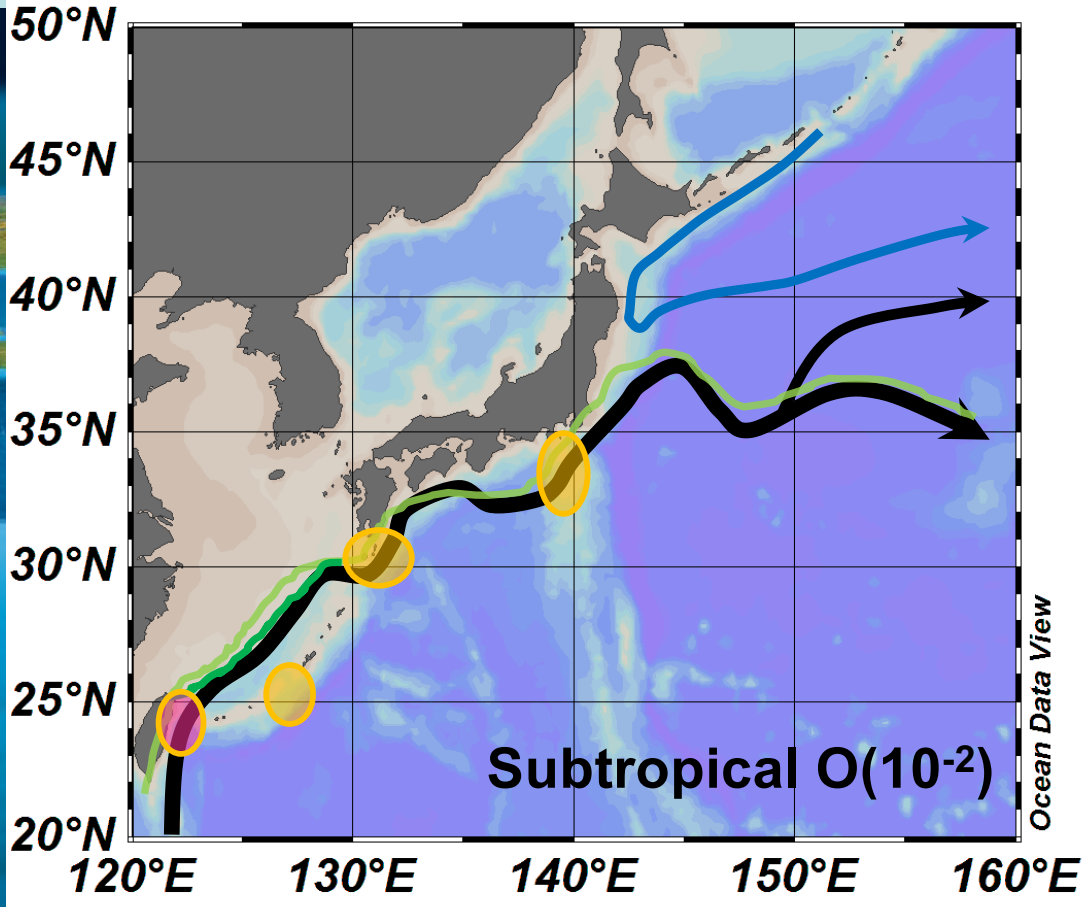
CO2 biological drawdown is max. in NW subarctic Pacific & high fisheries production

Kuroshio Paradox: Nutrient poor but fish spawning & nursery grounds

Revision of Kuroshio image : Nutrient supply by enhanced mixing

Finding mixing hotspots and large nutrient supply : Tsutsumi et al. 2017JGR; Nagai et al. 2017Sci.Rep.; Tanaka et al. 2015JO; Dr. Nagai (12:20) Dr. Kobari(17:20) Dr. Tanaka (Poster)





Turbulent nitrate flux (mmol/m^2/d) Comparison with subtropical region

Kuroshio frontal region **O(10^{-1})** X 10 (Kaneko et al. 2012;2013)

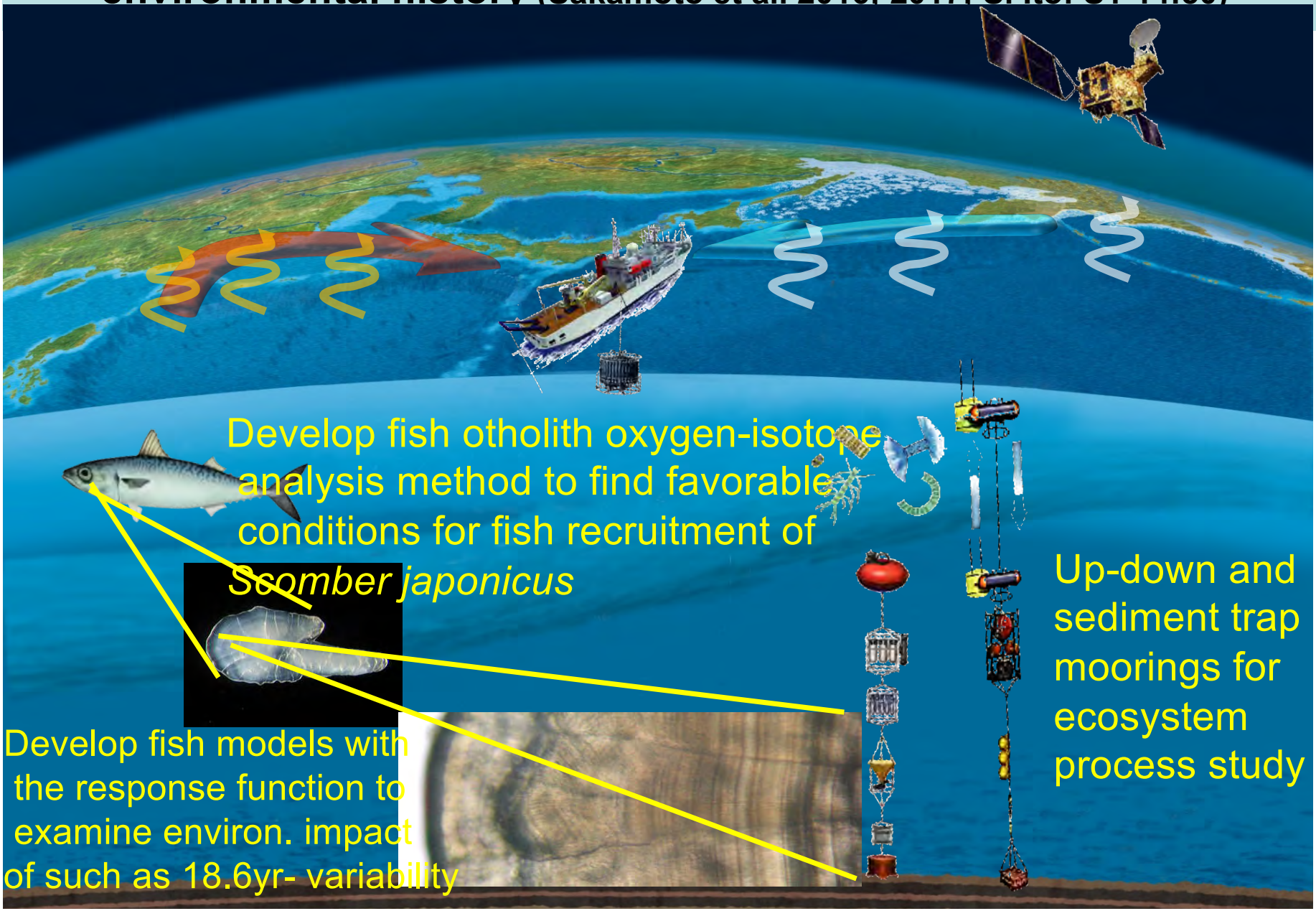
East China Sea shelf edge O(10^{-1}) **X 10 (Xin et al. 2012)**

Tokara Str., Izu Ridge, Kerama Gap Taiwan Str. O(10^{-1}-10^{1}) X10-1000

Confirm growth of plankton at Tokara Str. by nitrate injection exp. (T.Kobari)

To ecosystem and fisheries

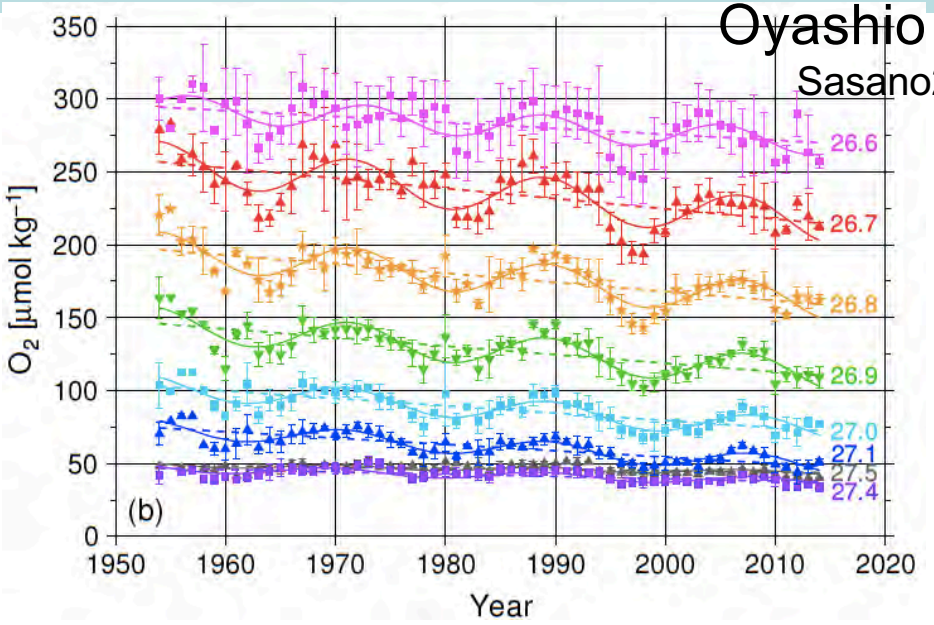
Time-series ecosystem mooring obs. and developing high-resolution otholith oxygen isotope analysis to reconstruct fish environmental history (Sakamoto et al. 2016; 2017; S. Ito: S1-14:50)



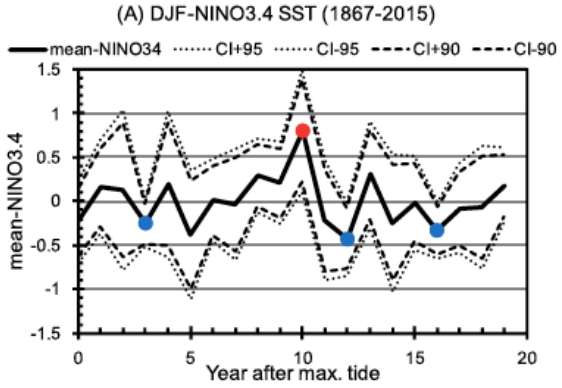
18.6-yr variability: Oxygen in Oyashio & 165E (Sasano et al. 2018GBC) & model reproduction

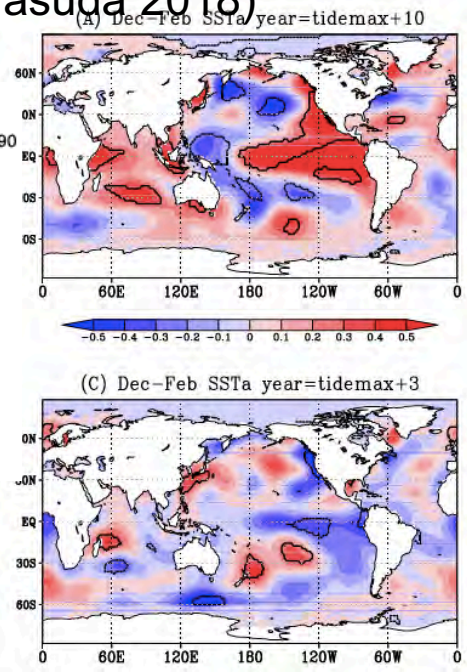
Oyashio DO

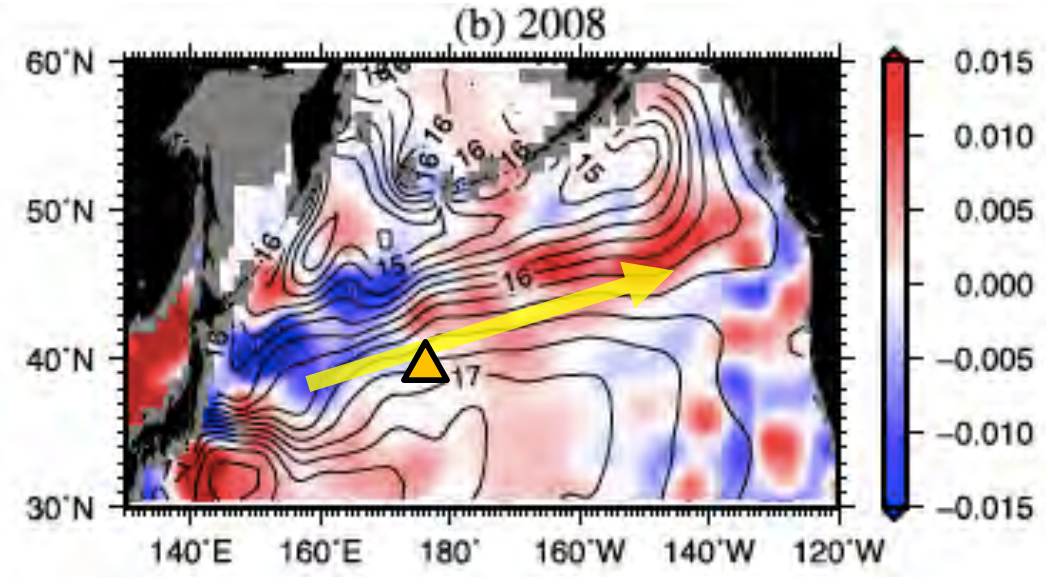
Sasano2018



ENSO-18.6-yr Relation (Yasuda 2018)

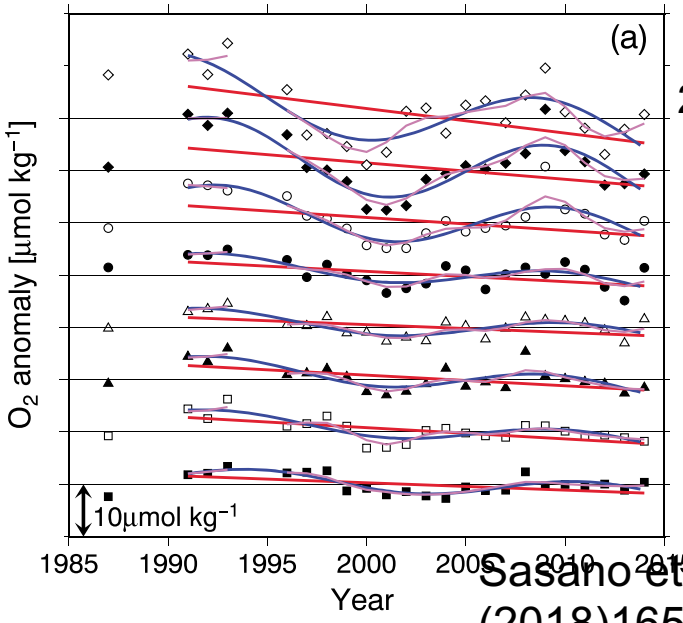






Salinity anomaly propagation at γ=27.2

（Kouketsu et al 2017）



Sasano et al. (2018)165E

Summary

- Field obs.: 74 cruises in 2015-2017
- including Joint Russia, Taiwan, Philippine & US cruises
- Basin-scale and local turbulence obs. & modelling

- Find mixing hot-spots in the Kuroshio overriding rough topography and contribution to ecosystem
- Enhanced tide-induced mixing at Straits and long-distance transport of iron enhance productivity in the western subarctic Pacific

- Pacific MOC & global climate are sensitive to mixing distribution & parameterization