Decadal variability of Subtropical Mode Water subduction and its impact on biogeochemistry

(Oka et al., 2015, Journal of Oceanography)

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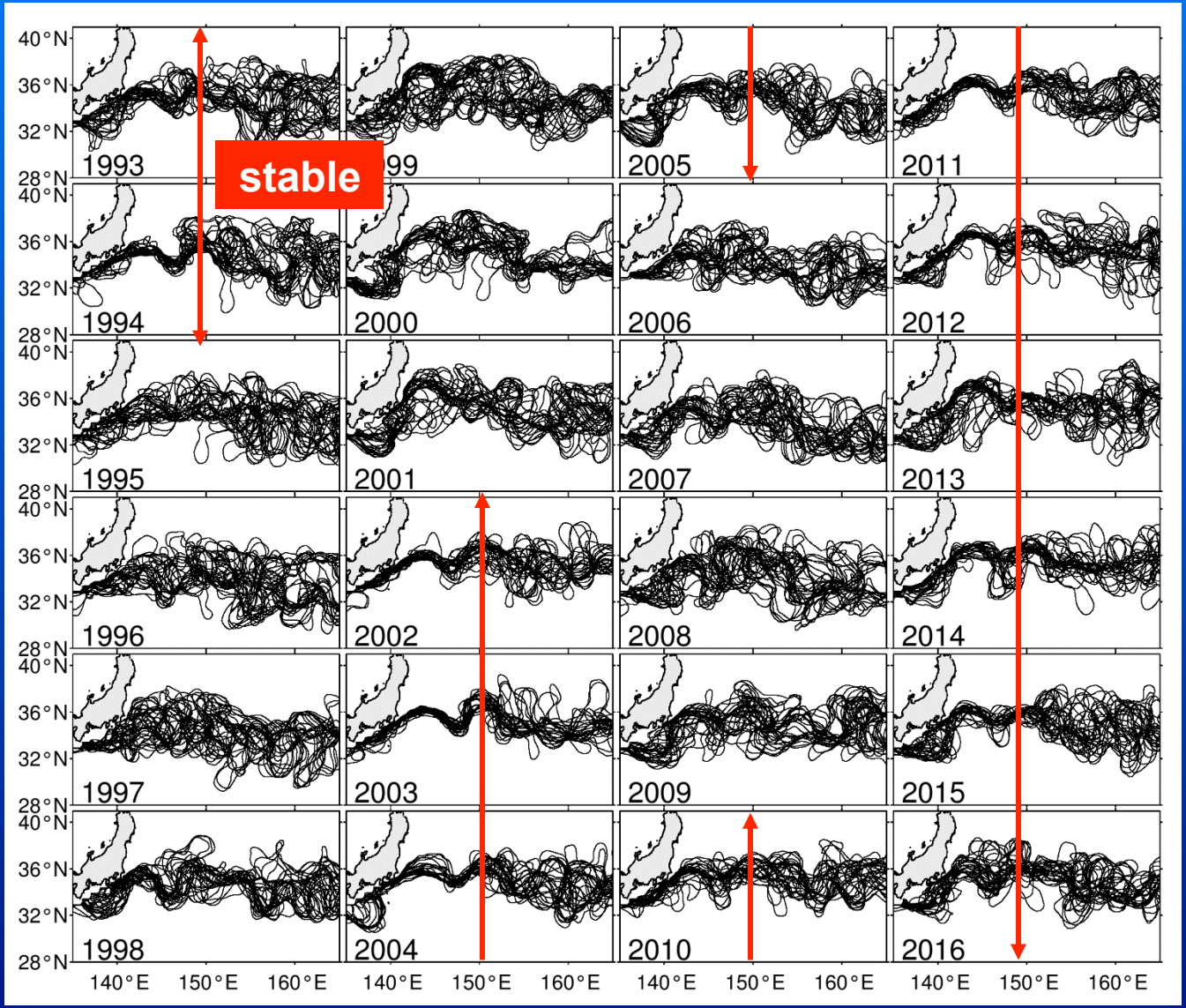
Decadal variability of the Kuroshio Extension (KE) (Qiu and Chen, 2005)



KE paths every 14 days for each year (Qiu et al., in prep.)

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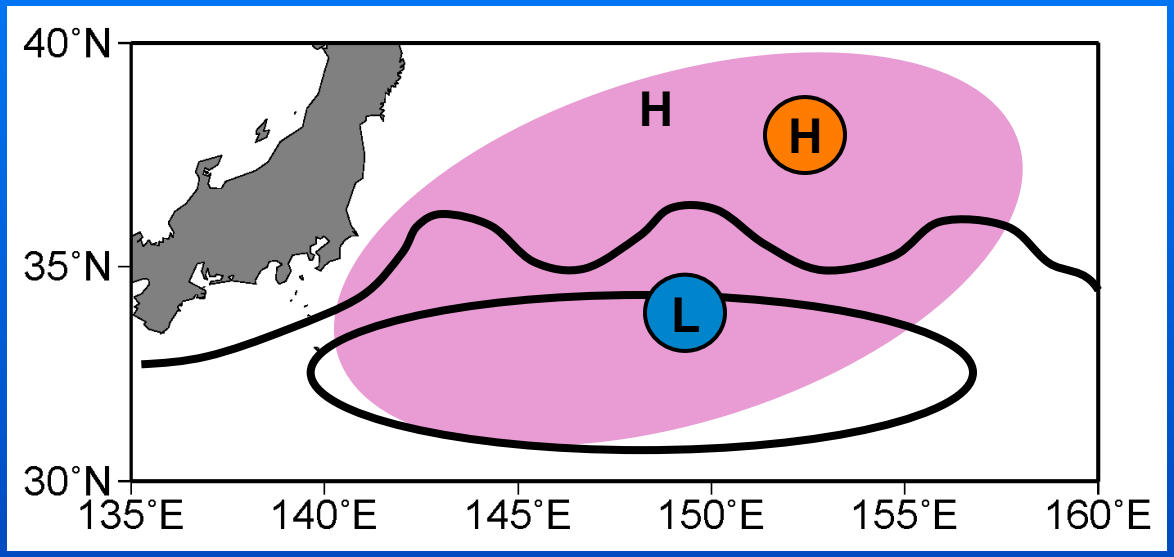
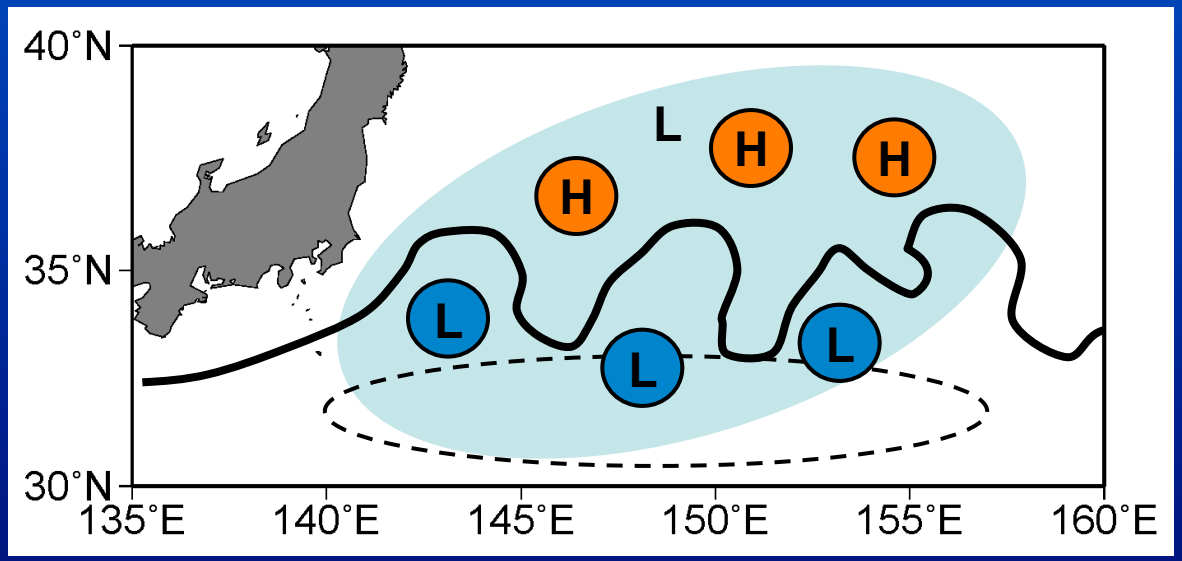


positive SSHA arrival

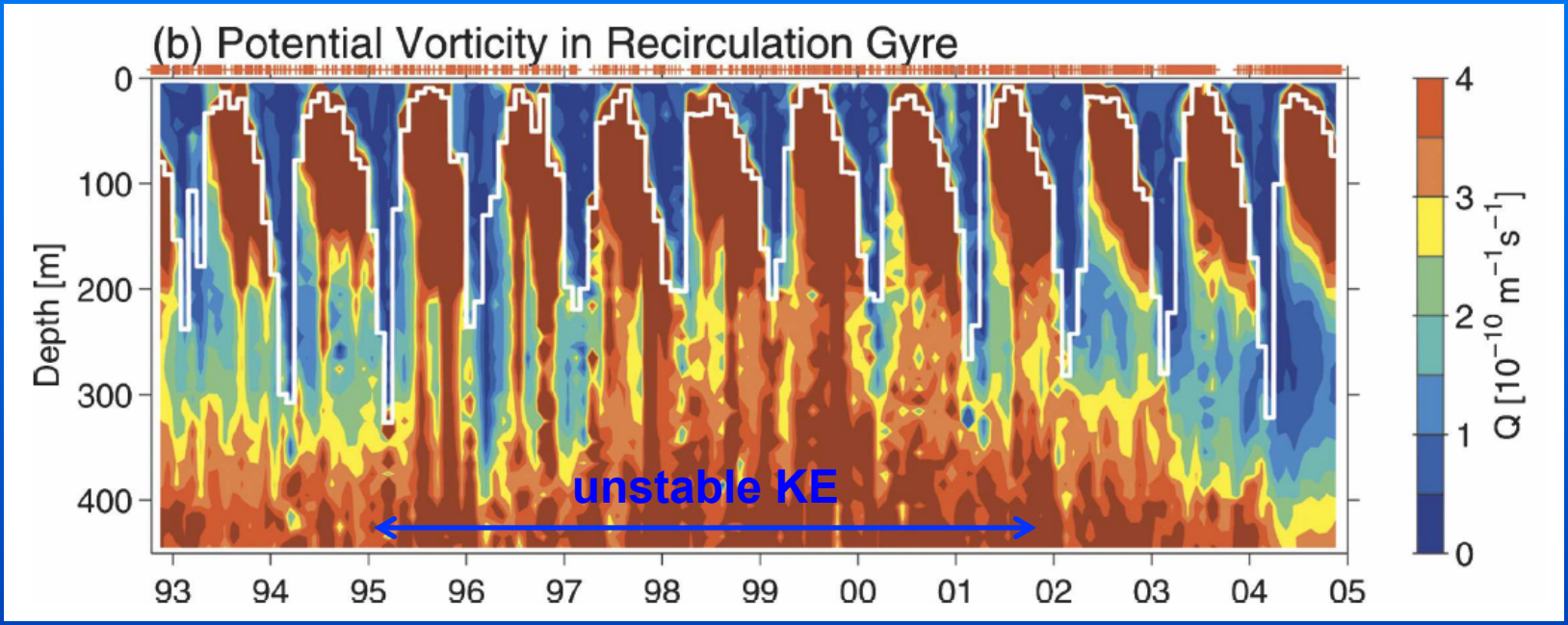
- stable KE
- low EKE
- strong RG



negative SSHA arrival

- unstable KE
- high EKE
- weak RG

Impact on STMW formation south of KE (Qiu and Chen, 2006)



Thick (thin) STMW is formed during the periods of stable (unstable) KE

during the unstable KE period, high-PV water input from north of KE by eddy activity hinders deep winter mixed layer formation

"Oceanic control" vs "atmospheric control" until 1990s

interdecadal change around ~1990 ? (Sugimoto and Kako, 2016)

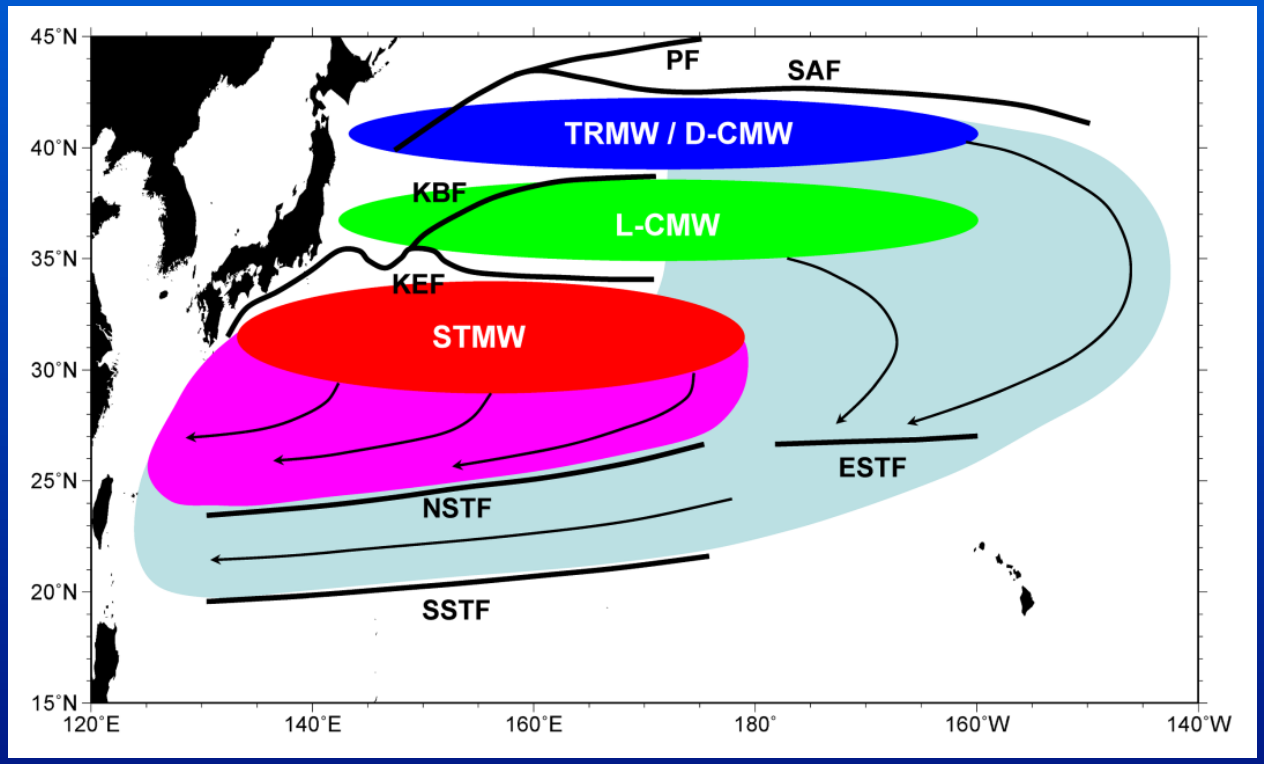
Questions

· How DV of KE impacts STMW distribution in the downstream region?

(large formation rates in stable KE period vs

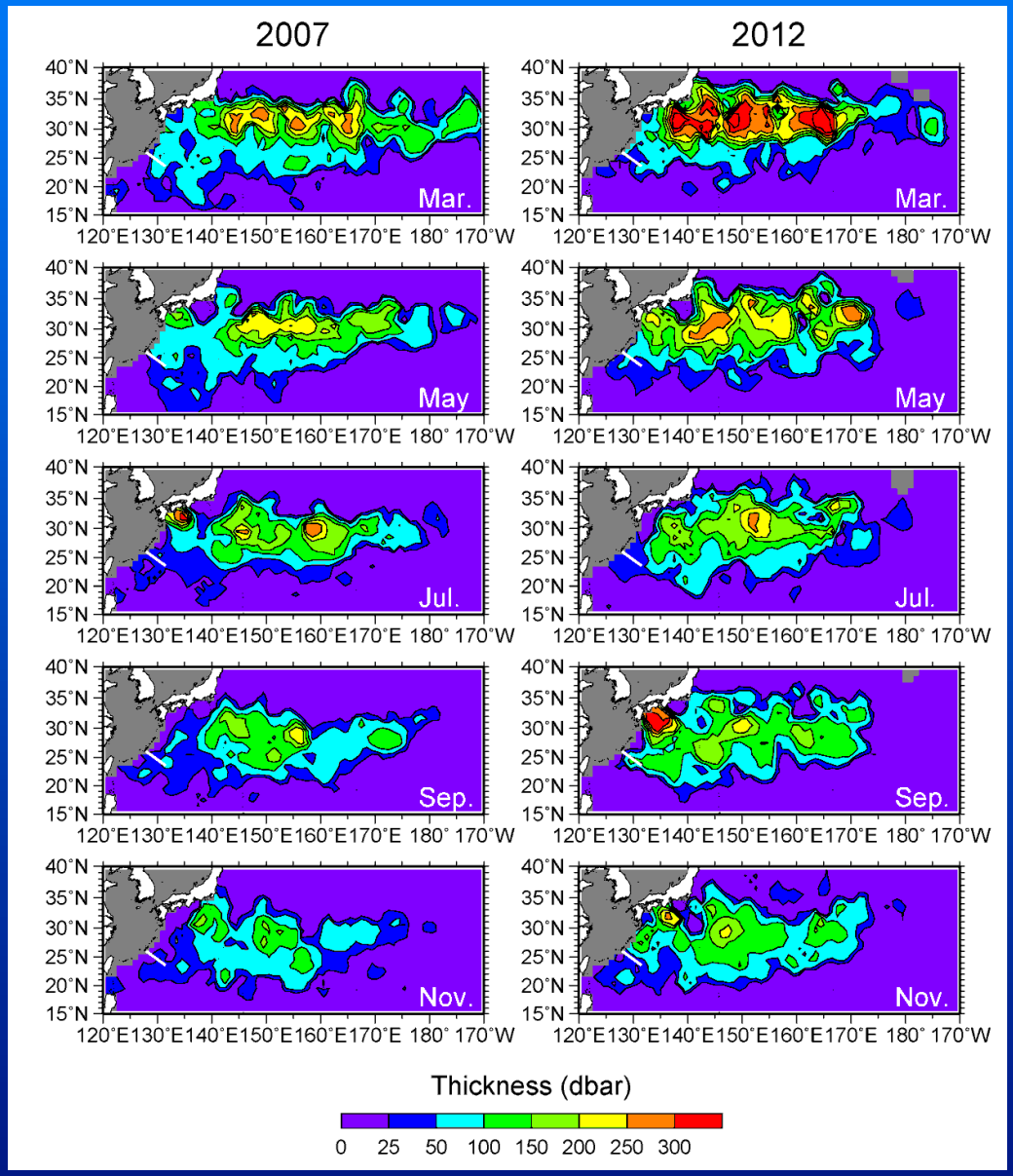
possible large eddy subduction in unstable KE period)

· and how it impacts biogeochemical properties there?



Circulation of NP mode waters in relation to fronts (Oka and Qiu, 2012)

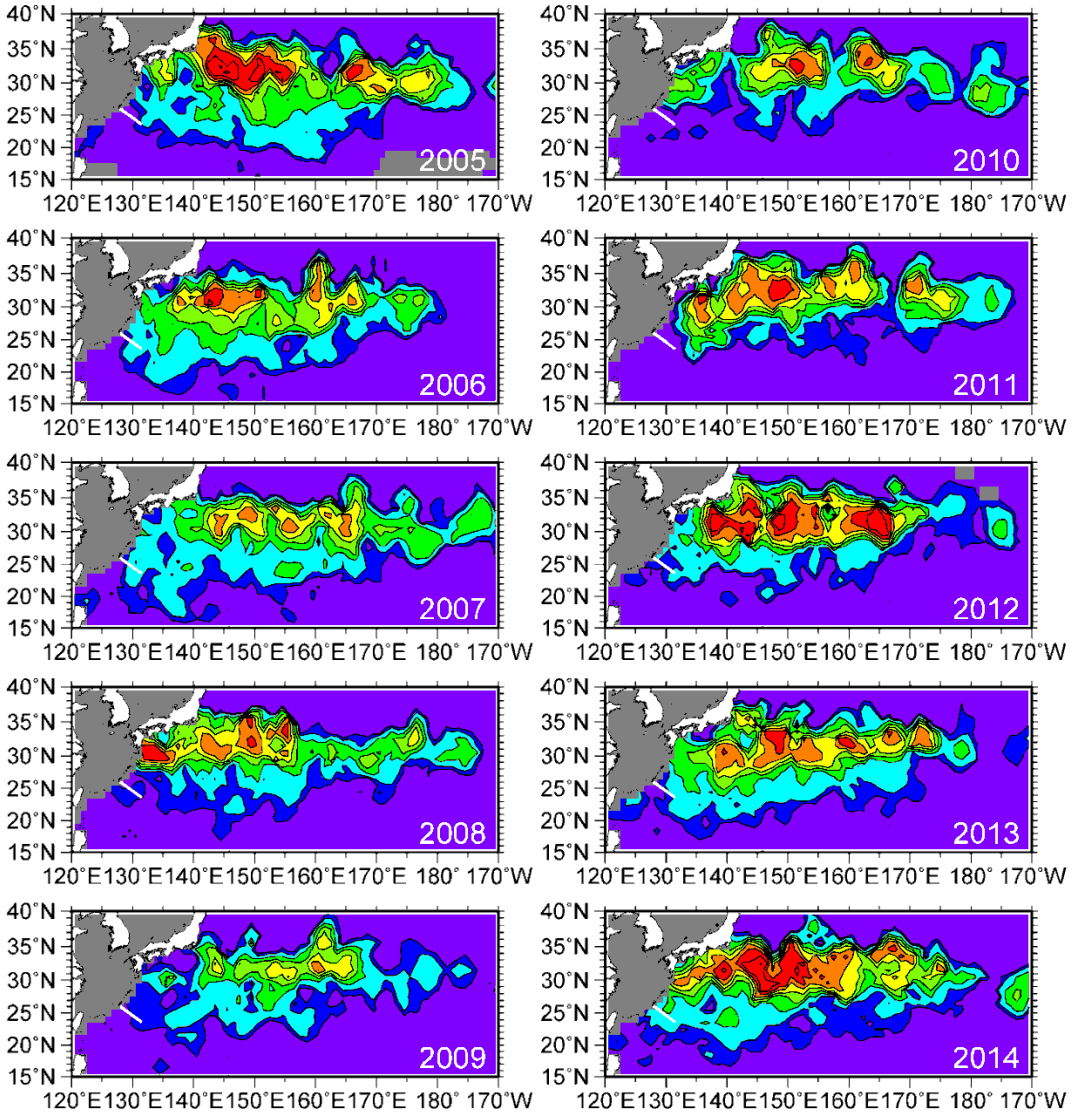
Argo data analysis (2005~2014)



Seasonal evolution of STMW thickness

unstable KE

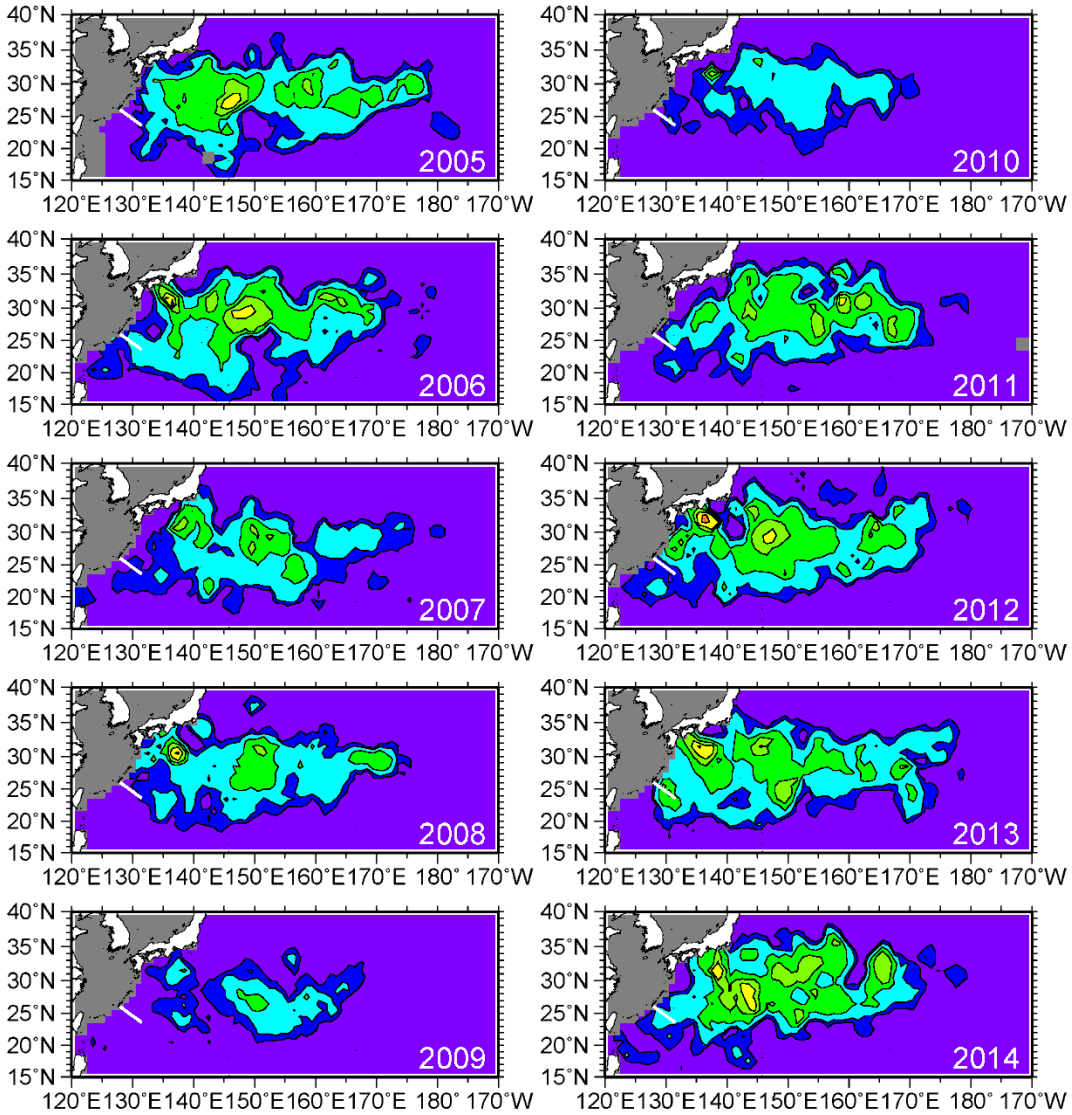
(2006-2009)



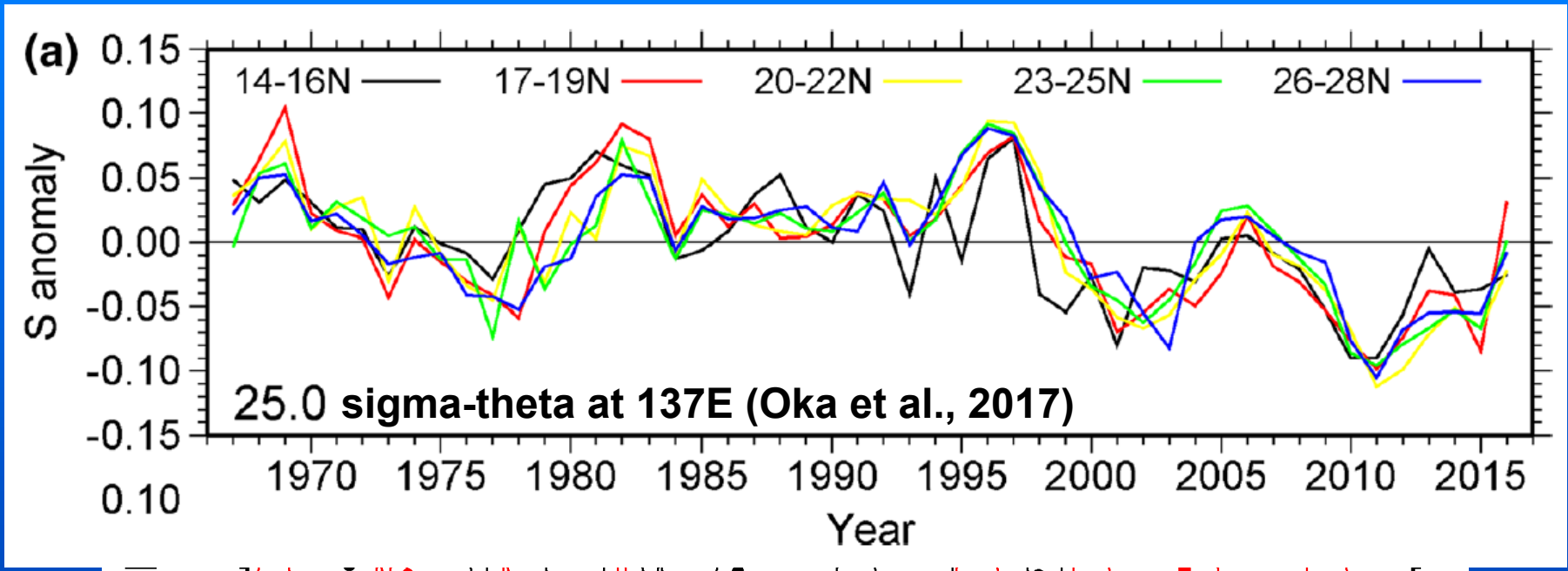
STMW thickness in March

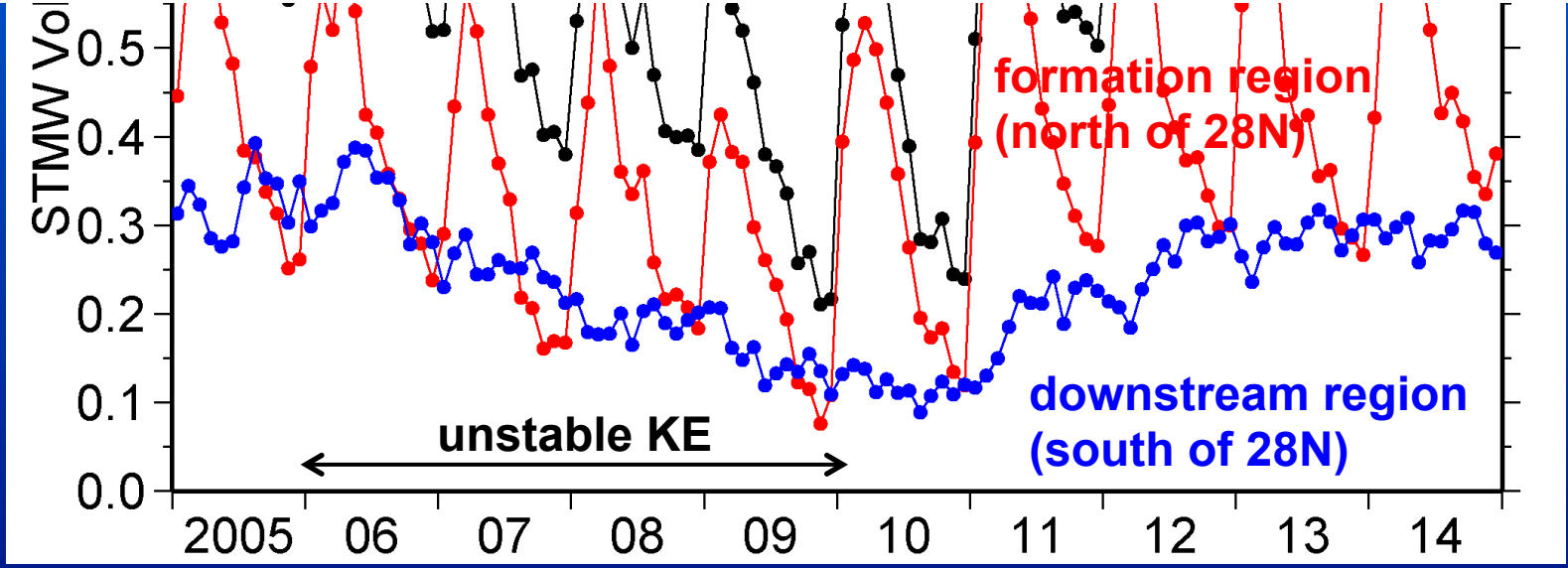
unstable KE

(2006-2009)

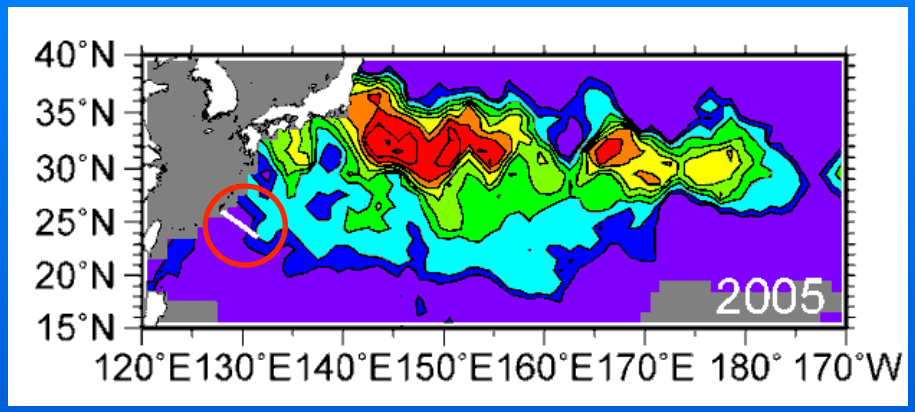


STMW thickness in November

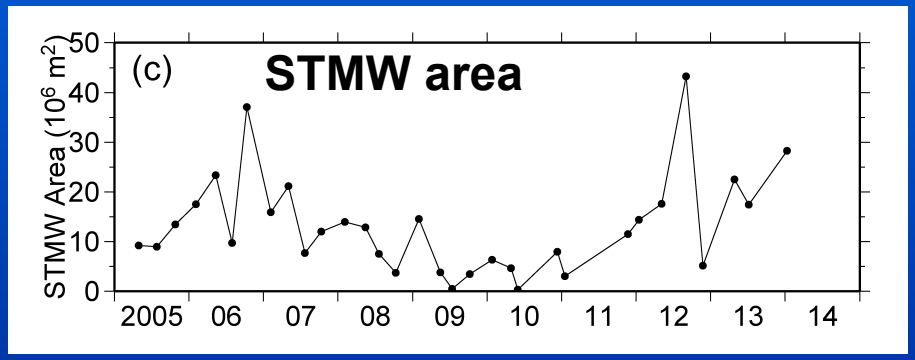




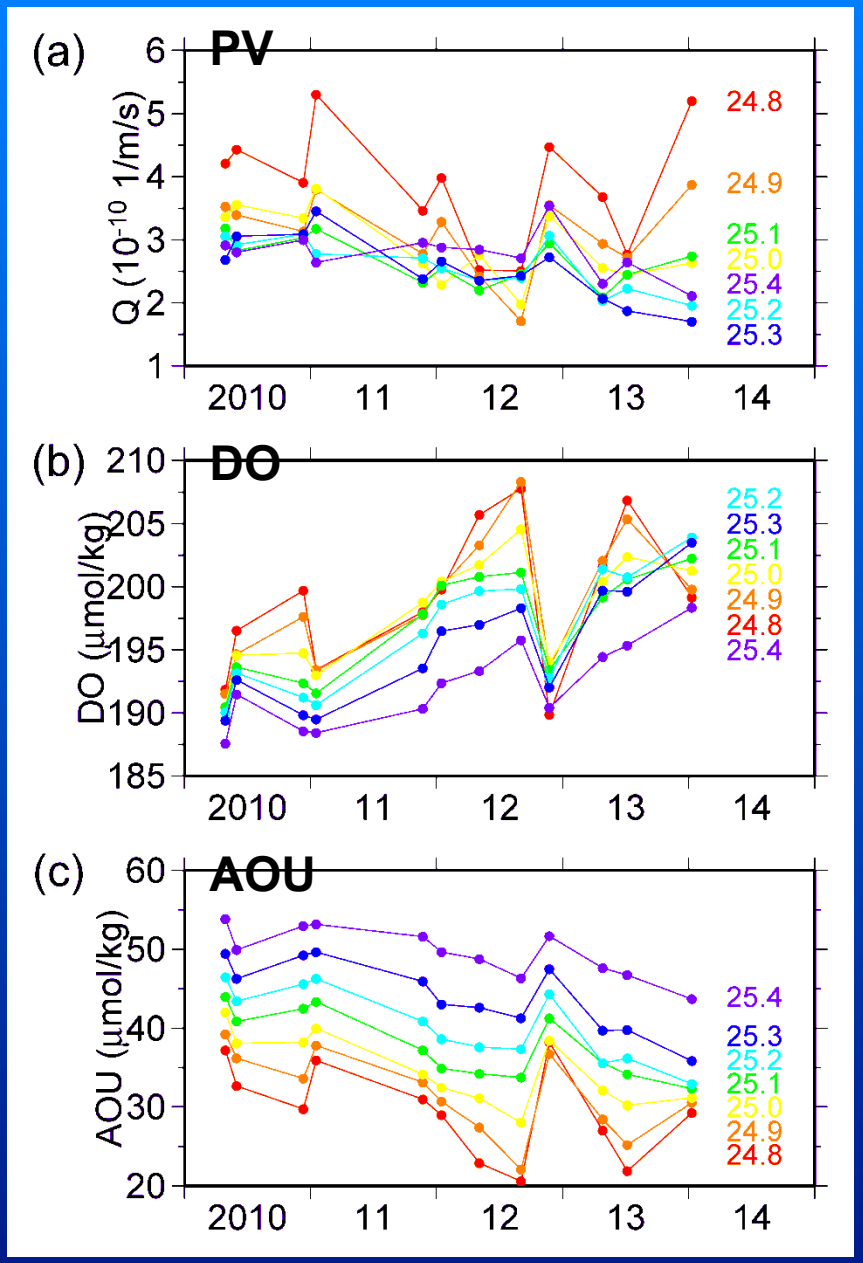
monthly STMW volume (north of 28N, south of 28N, total)



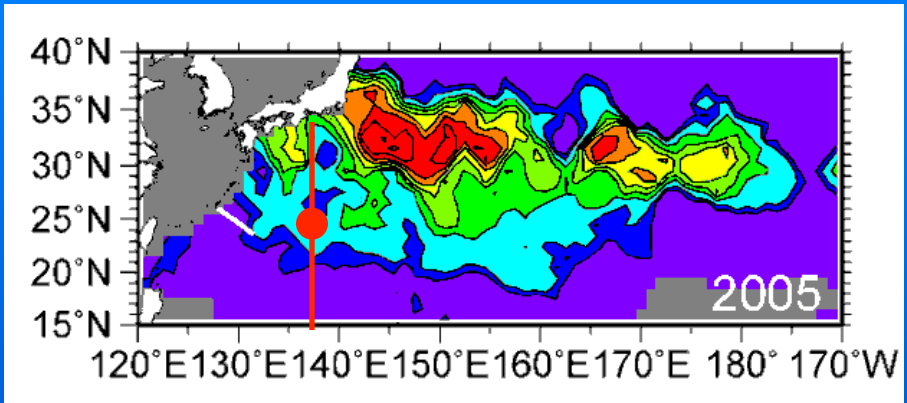
OK line by JMA



unstable KE

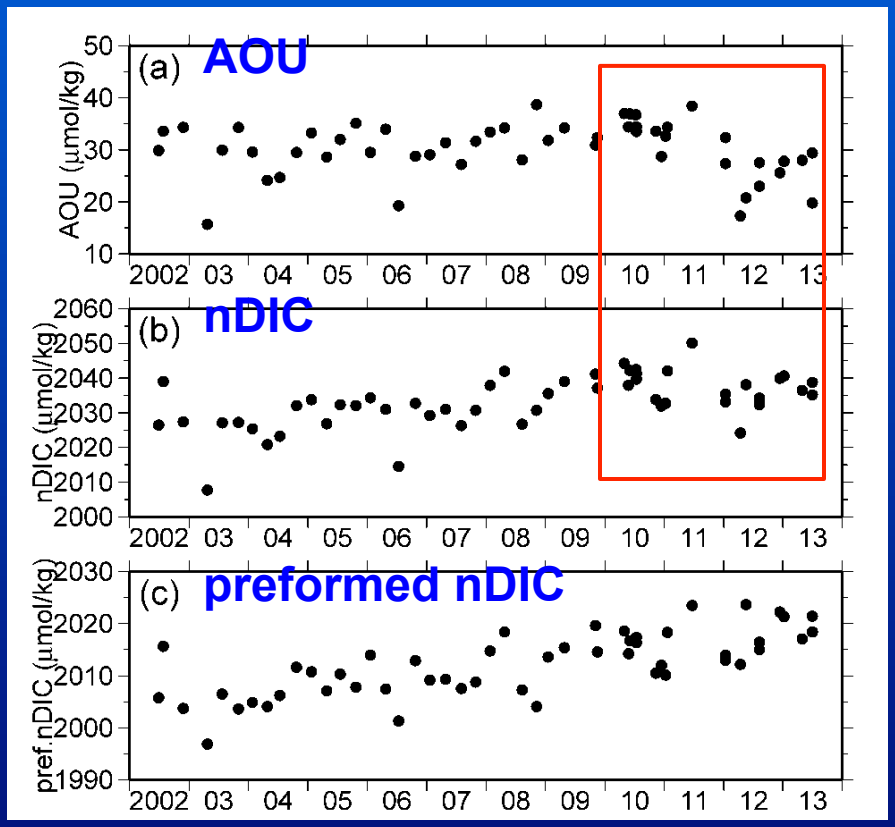


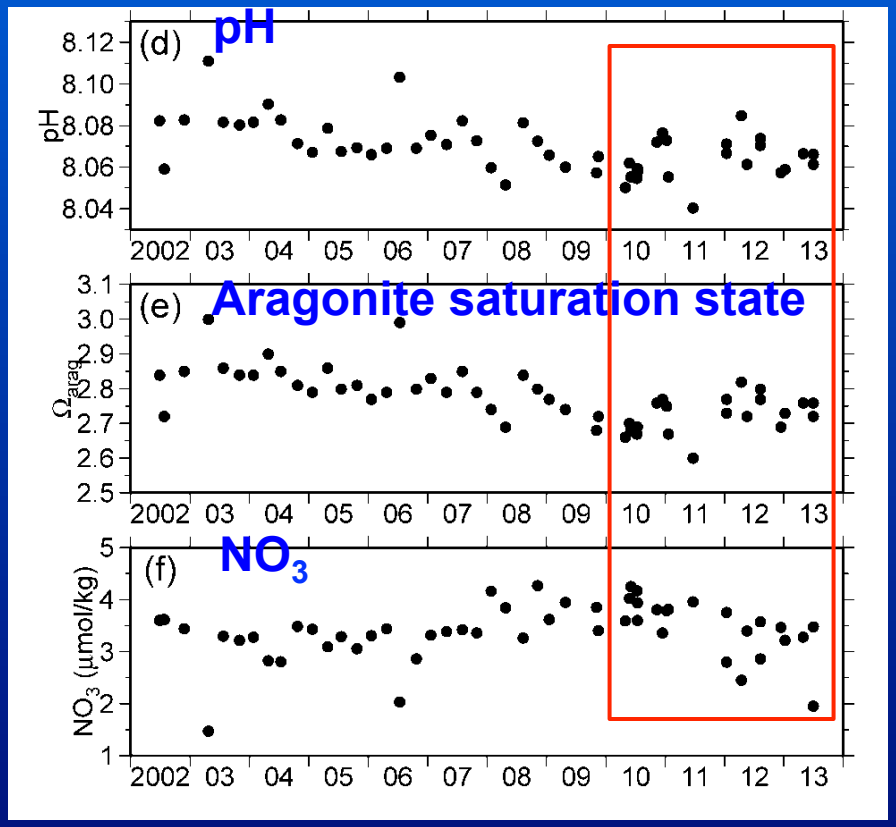
isopycnal changes at OK line



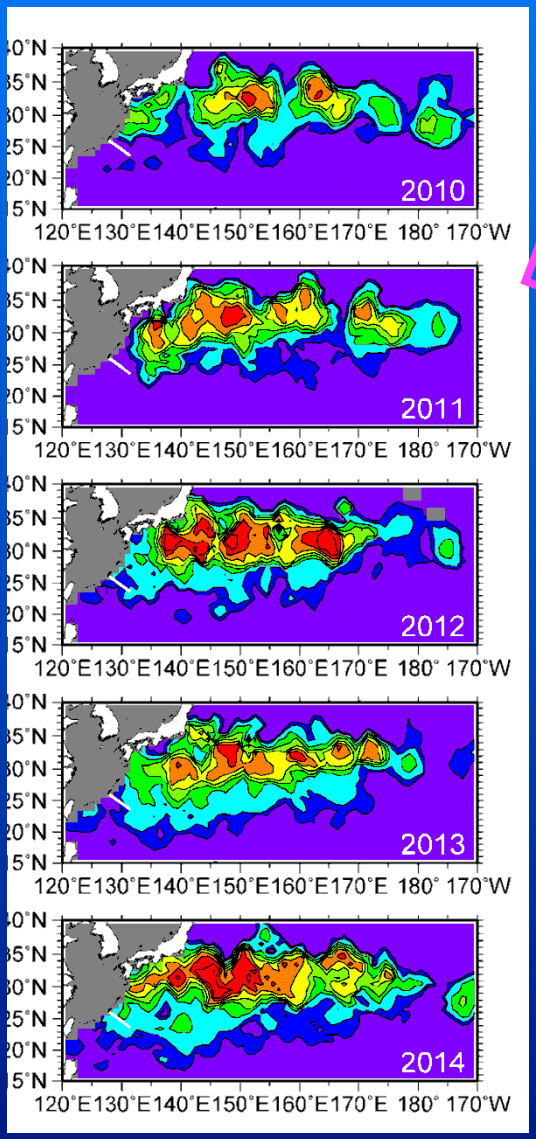
25N at JMA 137E line

variation on σ_θ=25 isopycnal

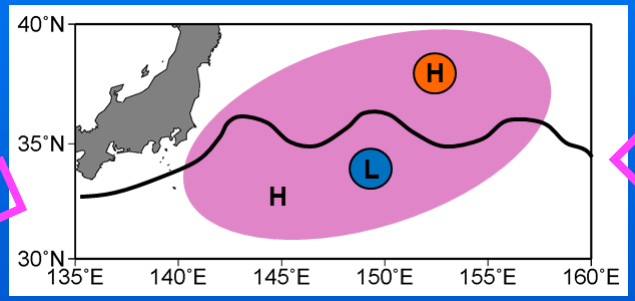




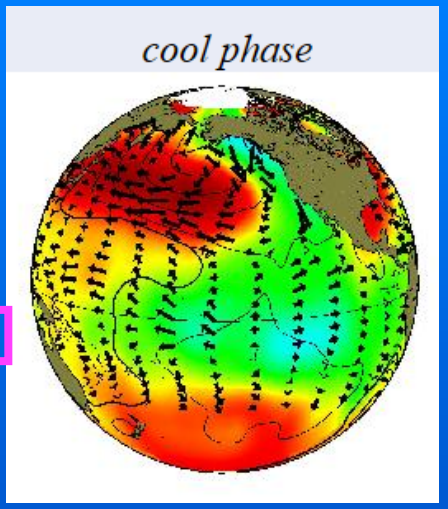
Summary of change since 2010



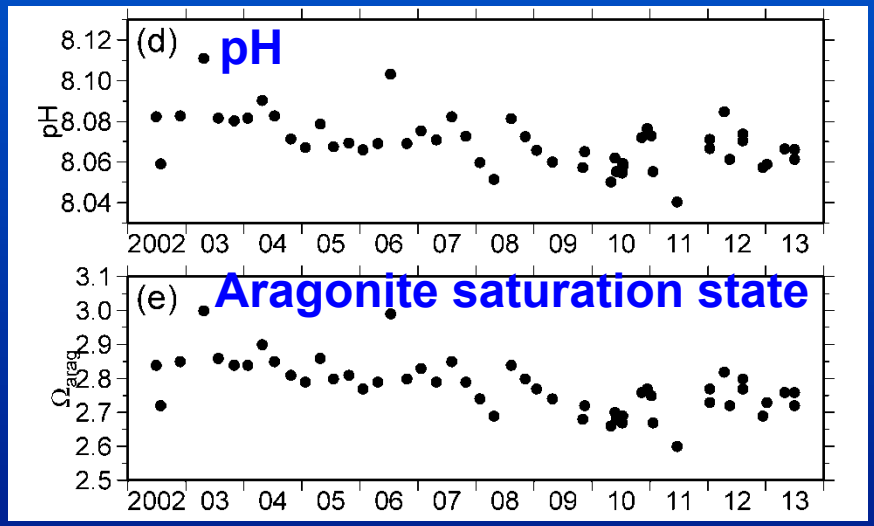
increased STMW formation & subduction



stable KE (2010～)



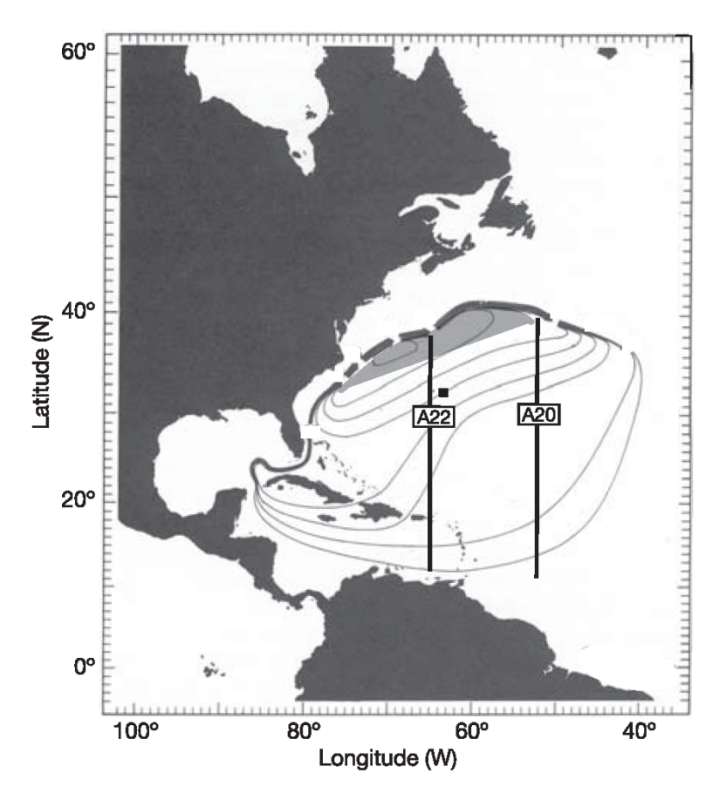
weak westerlies (2007～)

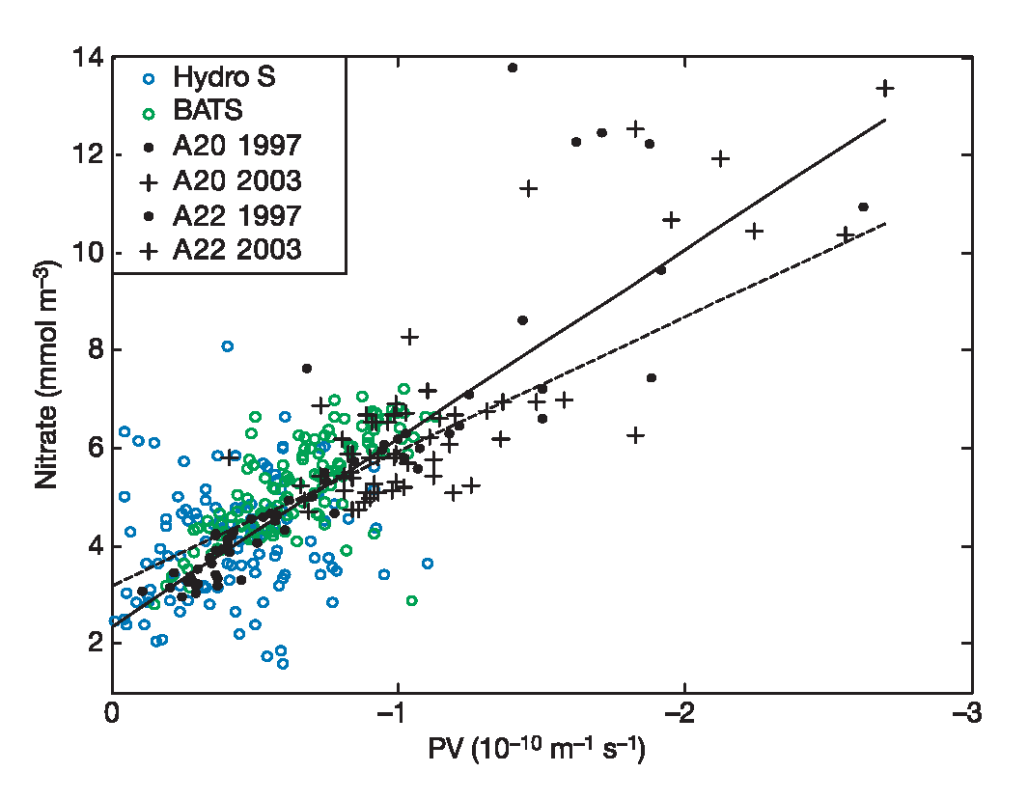


subsurface acidification near Okinawa slowed down

→ Reverse in the coming unstable KE period?

Similar relation between STMW and NO_3 in NA (Palter et al., 2005)





Relation between core PV of NASTMW and NO_3 at Hydrostation S (1958-1963) and BATS (1988-2001)

Summary

"Wind north of H

We found a clima

which contains v

and STMW forma

Future directions

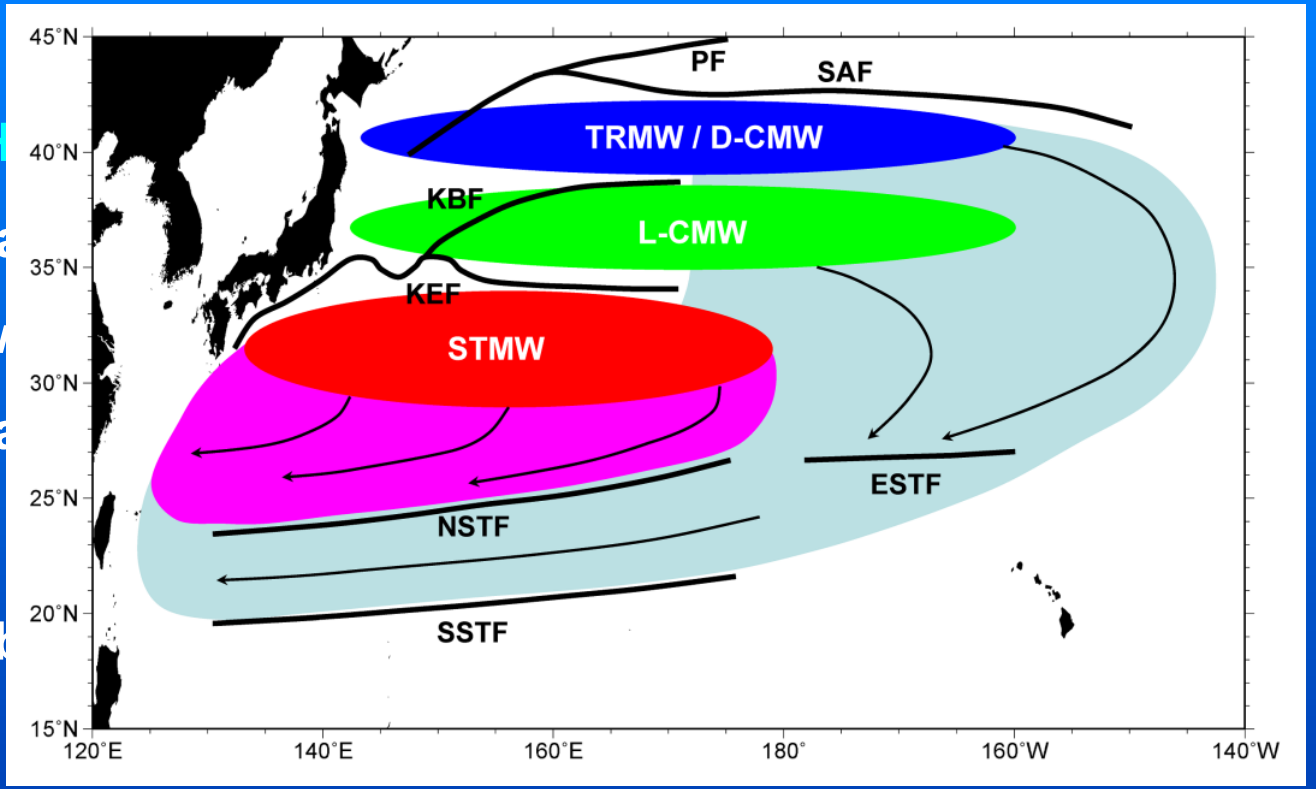
· How subsurface b

· NO_3 variability

· nDIC variability on surface acidification … maybe not because nDIC variability is associated with that of NO_3

· impact of clear STMW DV on UOHC or SST via STCC

· similar link in other mode water areas, particularly CMW



Acknowledgment

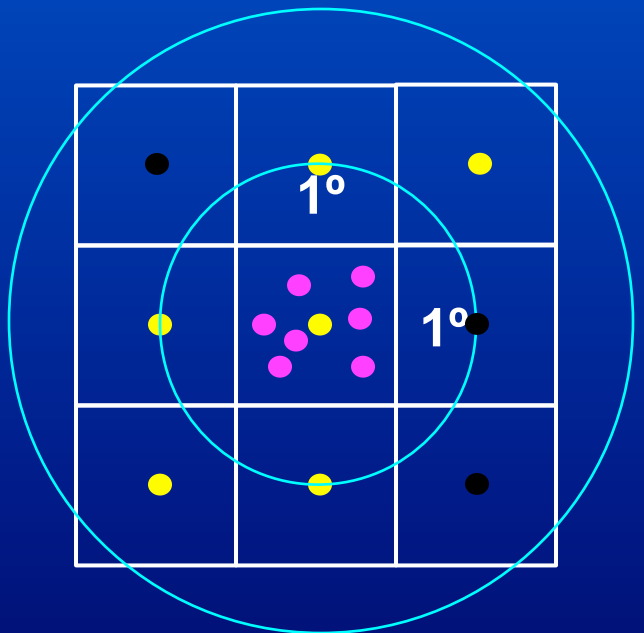
Long-term obs. by satellite, Argo, and JMA ships enabled this study

STMW thickness was mapped using a procedure similar to HydroBase (Macdonald et al., 1999)

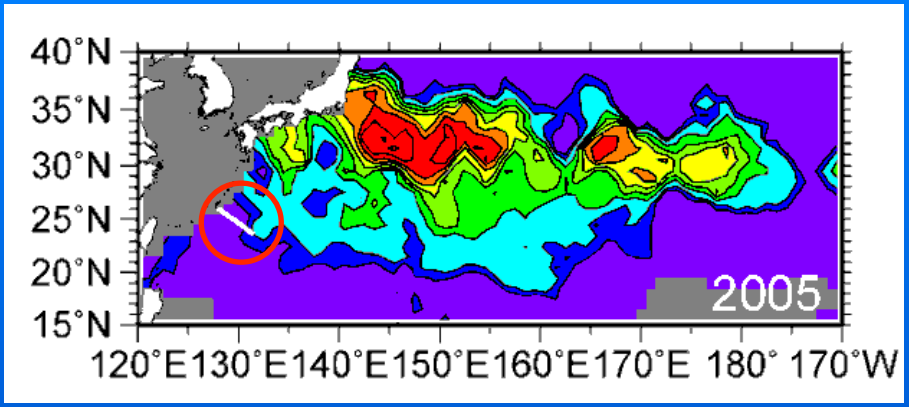
· cal STMW (Q < 2, core θ = 16-19.5ºC) thickness from each float prof.

· average all STMW thicknesses for each 1º grid box for each month to obtain representative value at the center of grid box (grid point)

· For each grid point, average STMW thicknesses at grid points within a 1º radius, if 2 or more values exist. Otherwise, increase radius by 1º, up to a maximum of 5º.
(If radius > 1º, use weight of d^{-2} for averaging, where d is distance)



Advantage: water mass structure near front is well expressed



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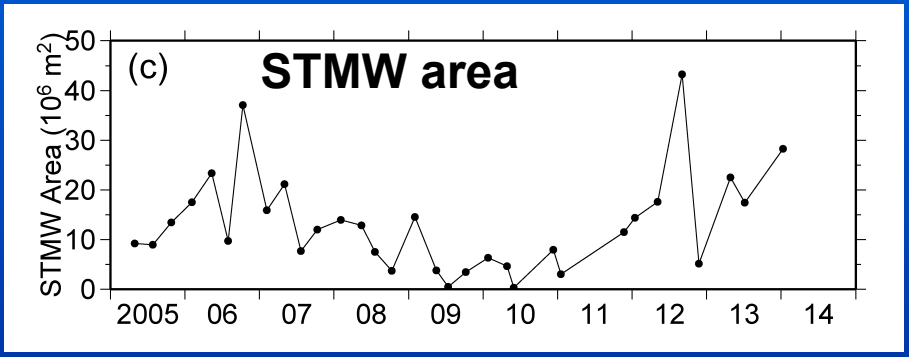
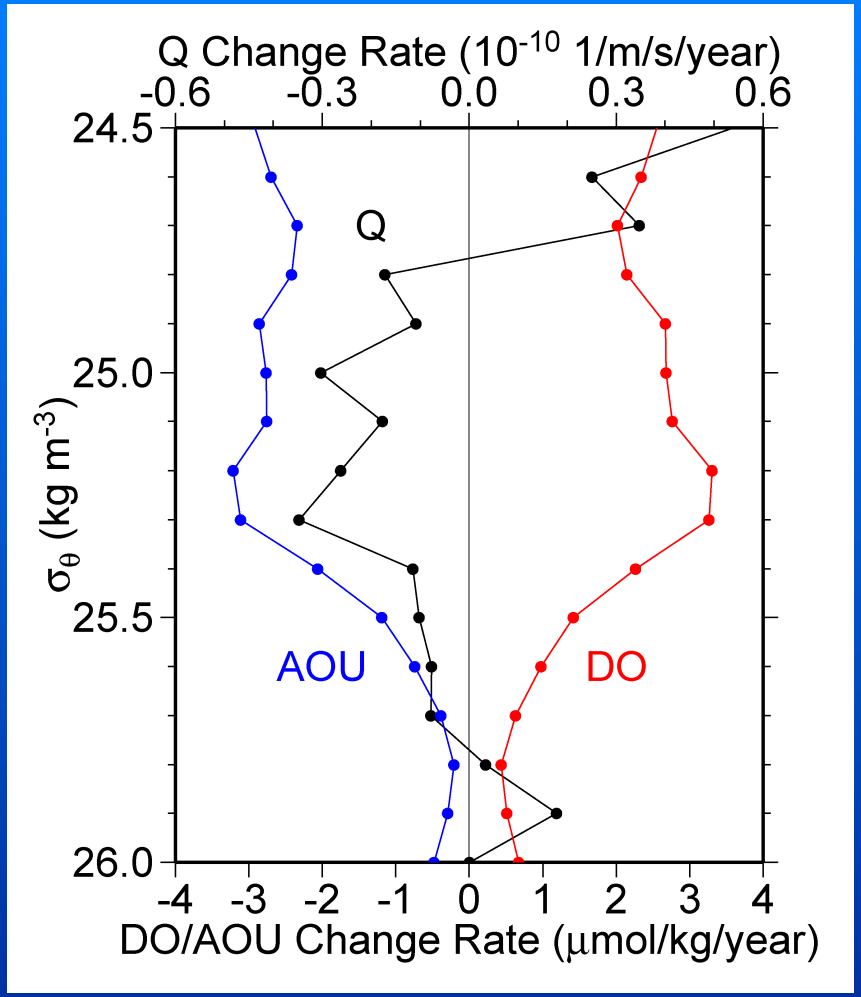


unstable KE



trend of isopycnal change at OK