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The Role of Spiciness in North Pacific Decadal Variability

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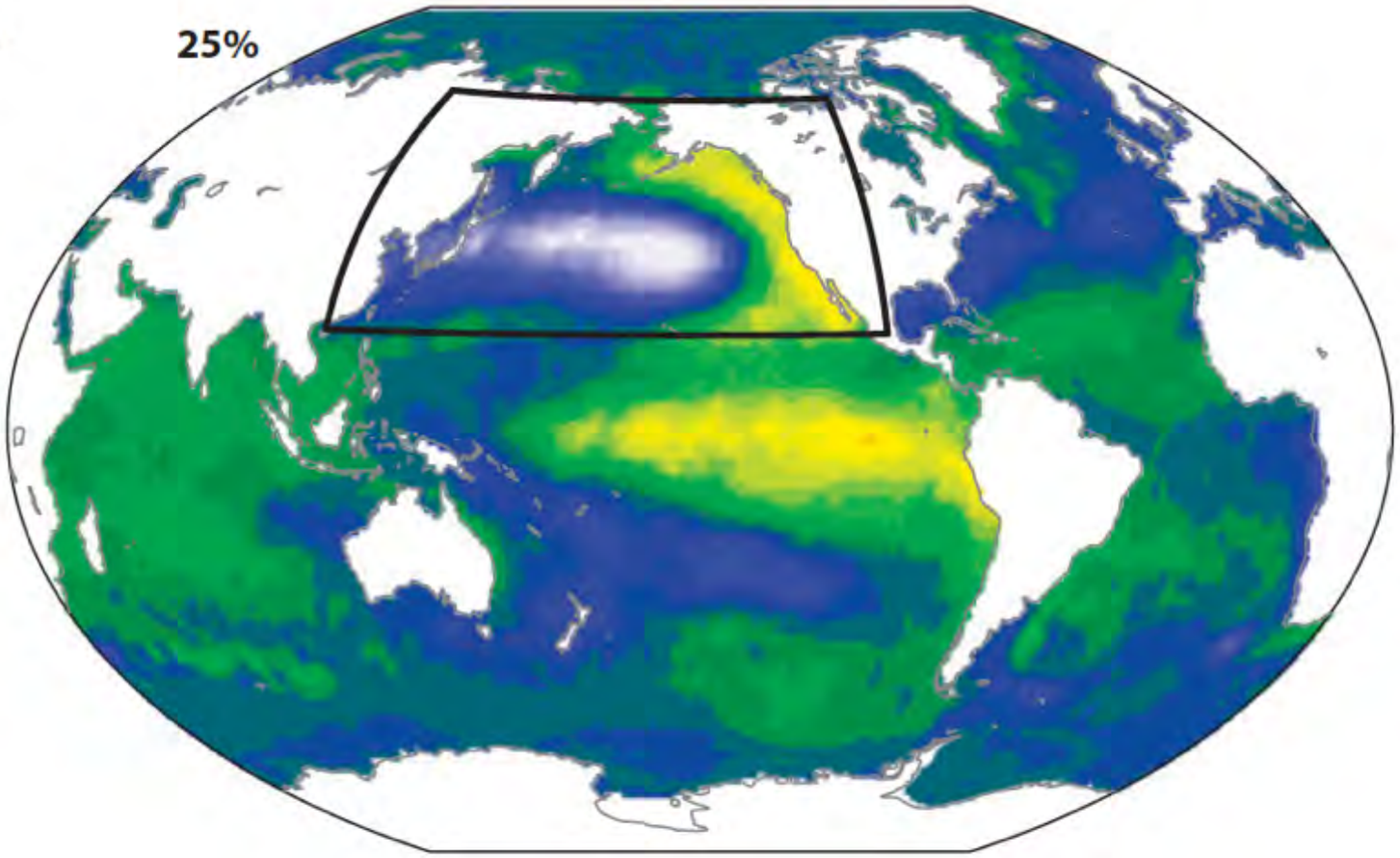
Taguchi, B. and N. Schneider, 2014: Origin of decadal-scale, eastward-propagating signals heat content anomalies in the North Pacific ocean. J. Climate, submitted.

PDO

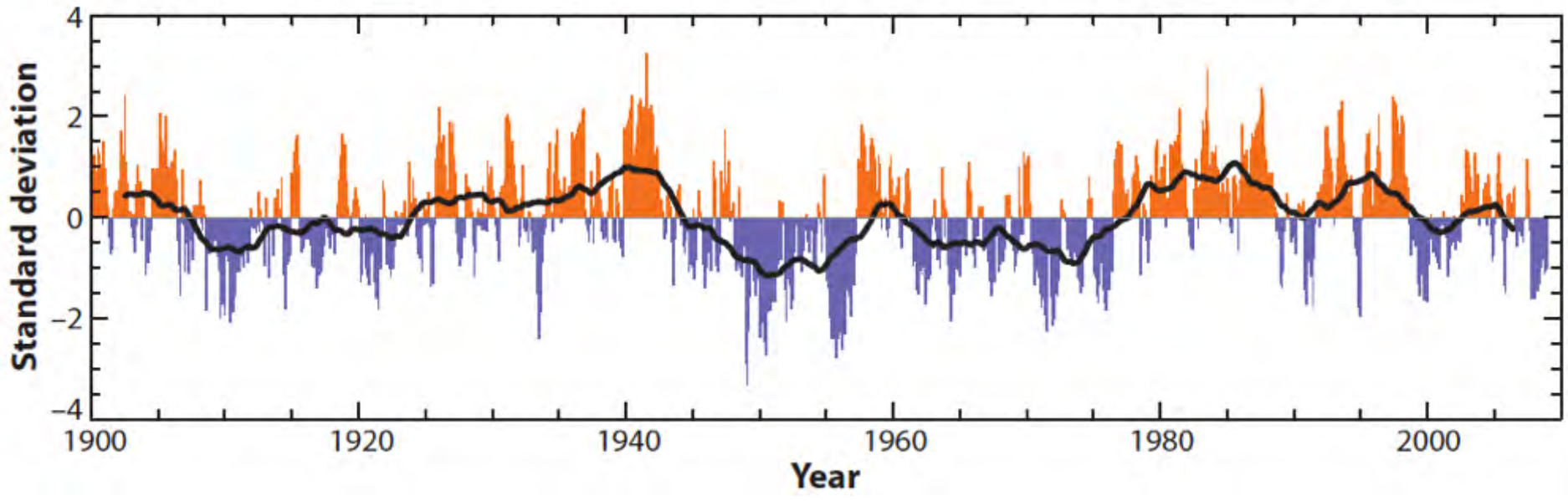
25%



−0.65 −0.55 −0.45 −0.35 −0.25 −0.15 −0.05 0.05 0.15 0.25 0.35 0.45 0.55 0.65

Temperature (°C sd^{-1})

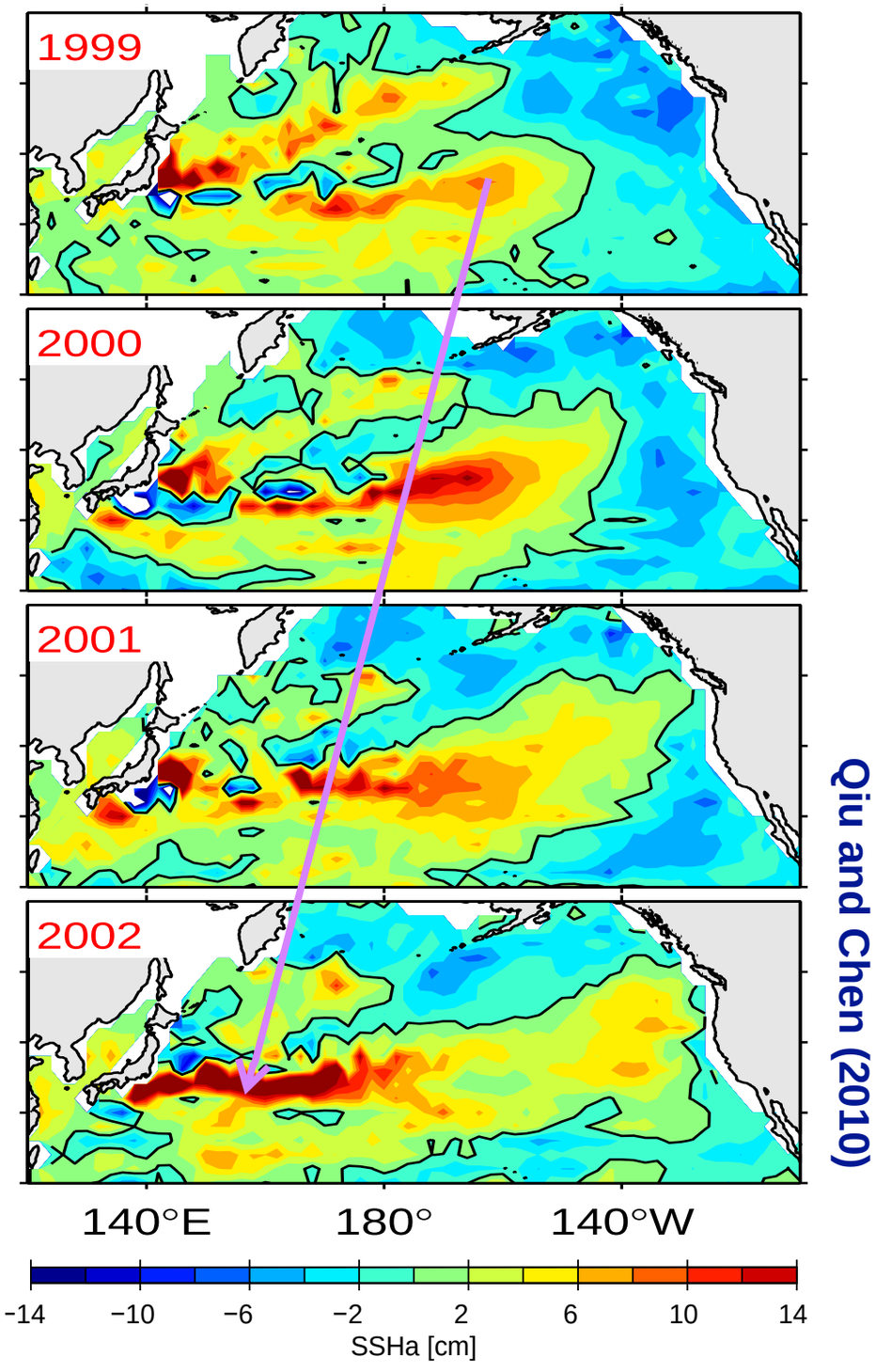
PC time series



Deser et al. 2010

Sea surface height

altimeter

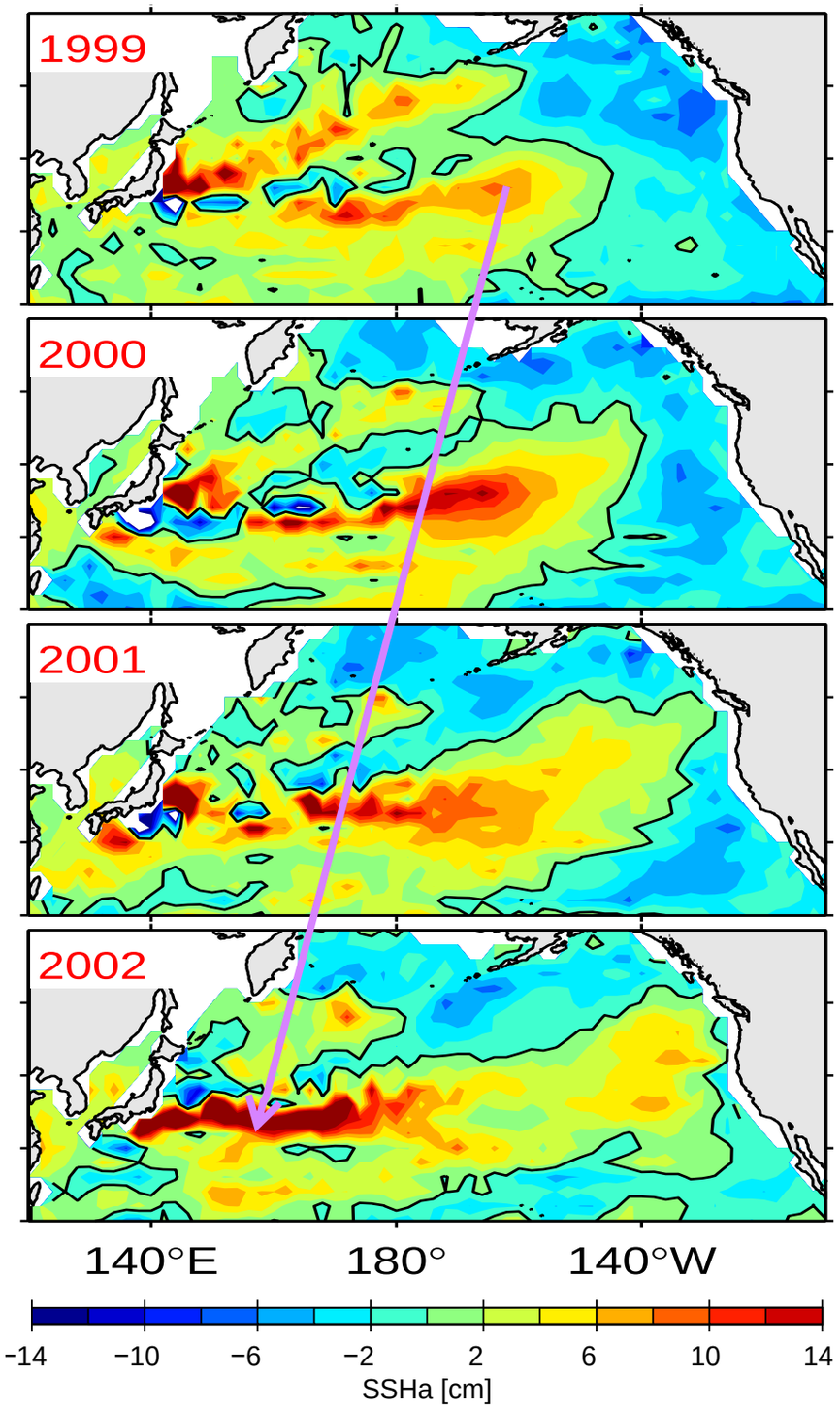


Qiu and Chen (2010)

equivalent baroclinic

Sea surface height

altimeter

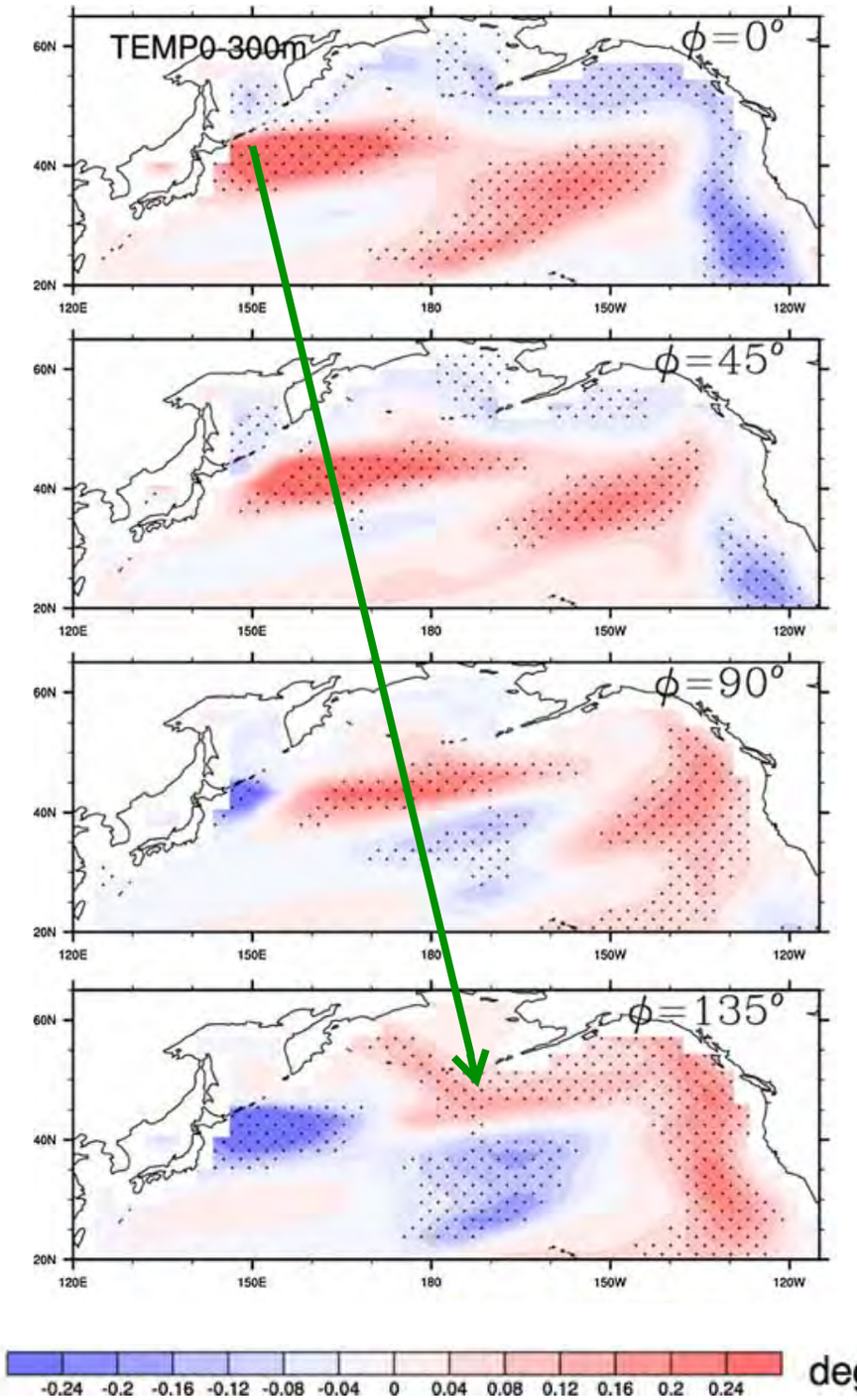


Qiu and Chen (2010)

•equivalent barotropic

Ocean heat content

0-300m, CCSM3



Teng and Branstator (2010)

• higher baroclinic mode
• density compensated

CFES

Medium resolution

A: T119 (~100 km) L48

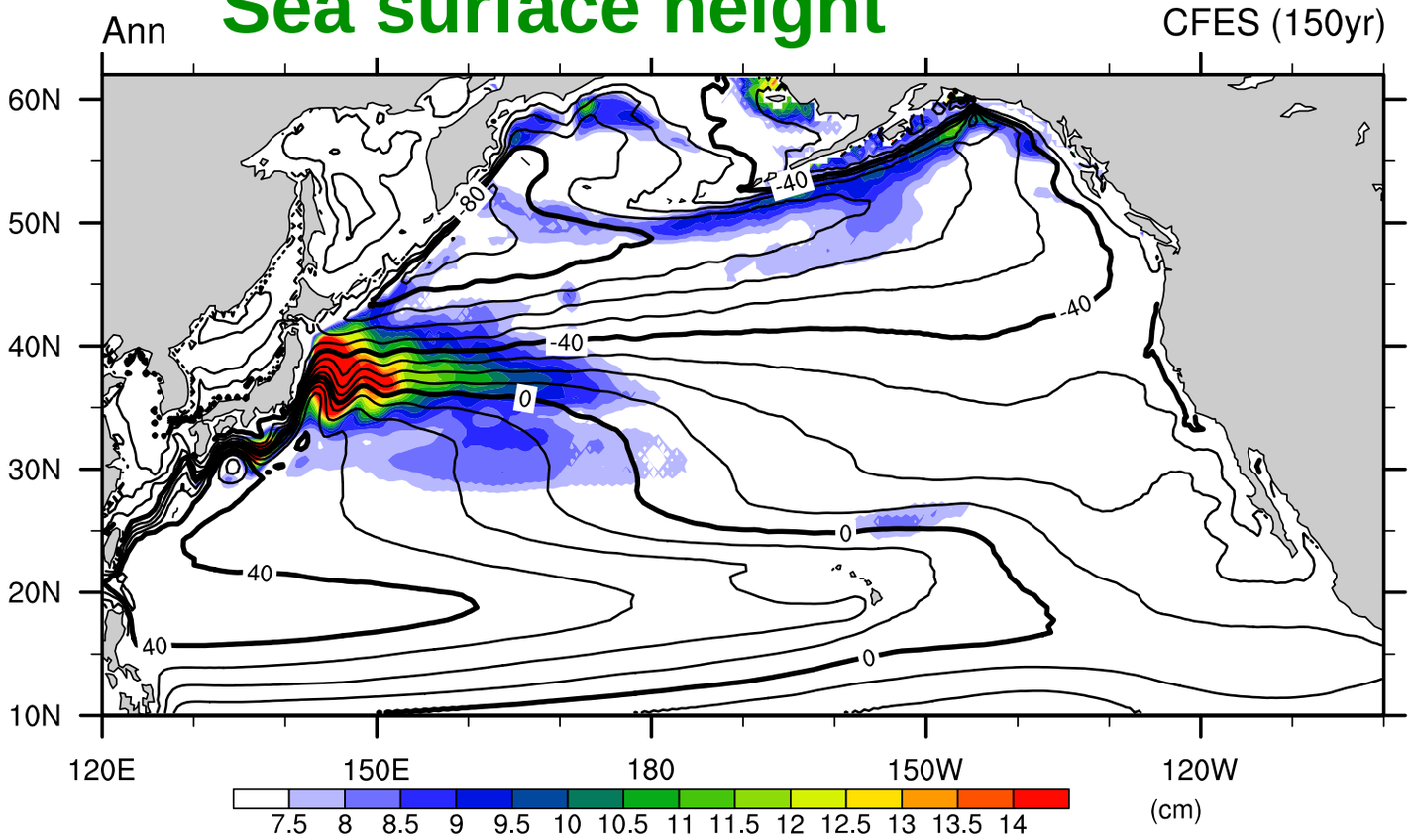
O: 0.5º L54

150 years integration

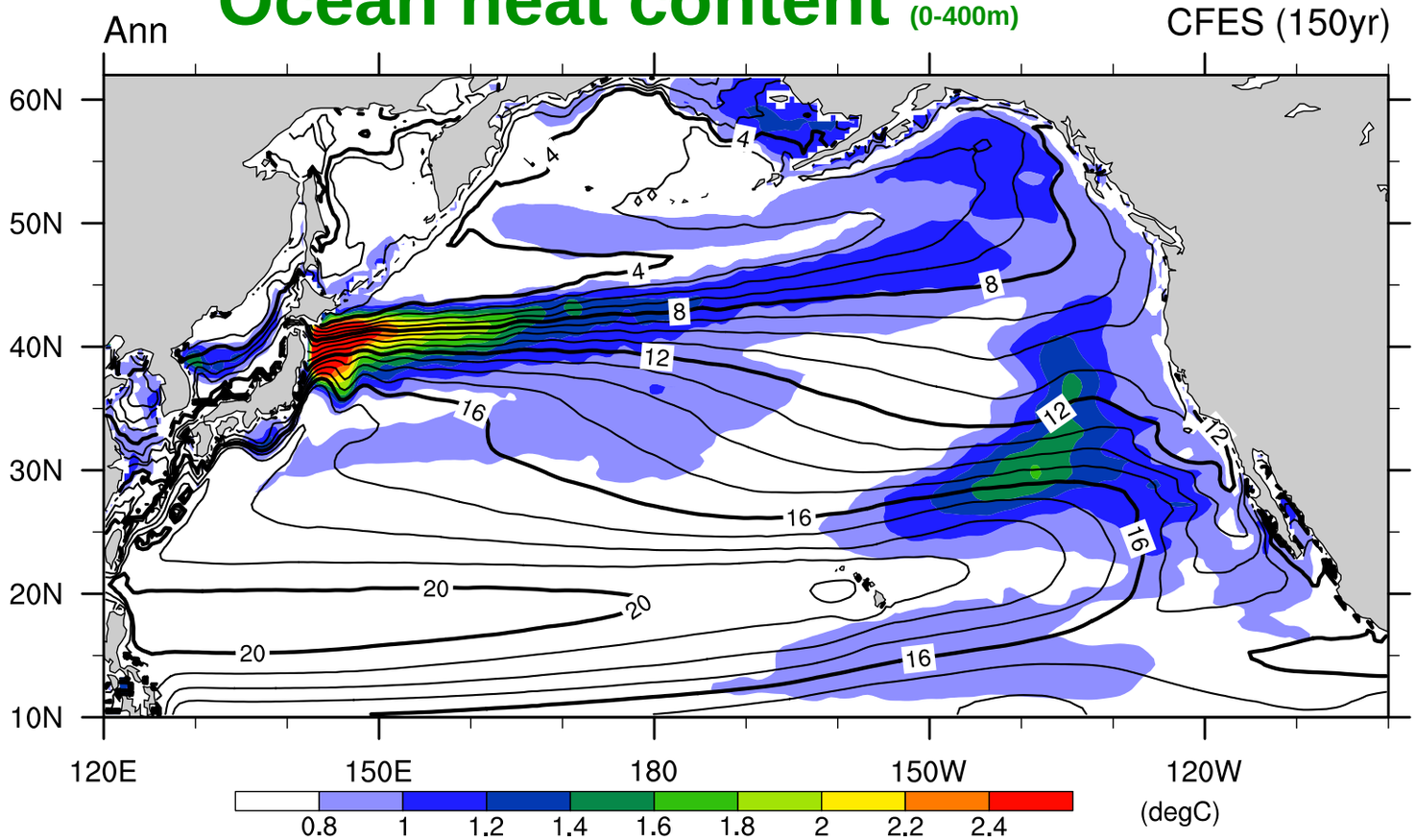
Komori et al. 2008

Taguchi et al. 2012

Sea surface height



Ocean heat content (0-400m)



contour: mean

color: standard deviation

CFES

Medium resolution

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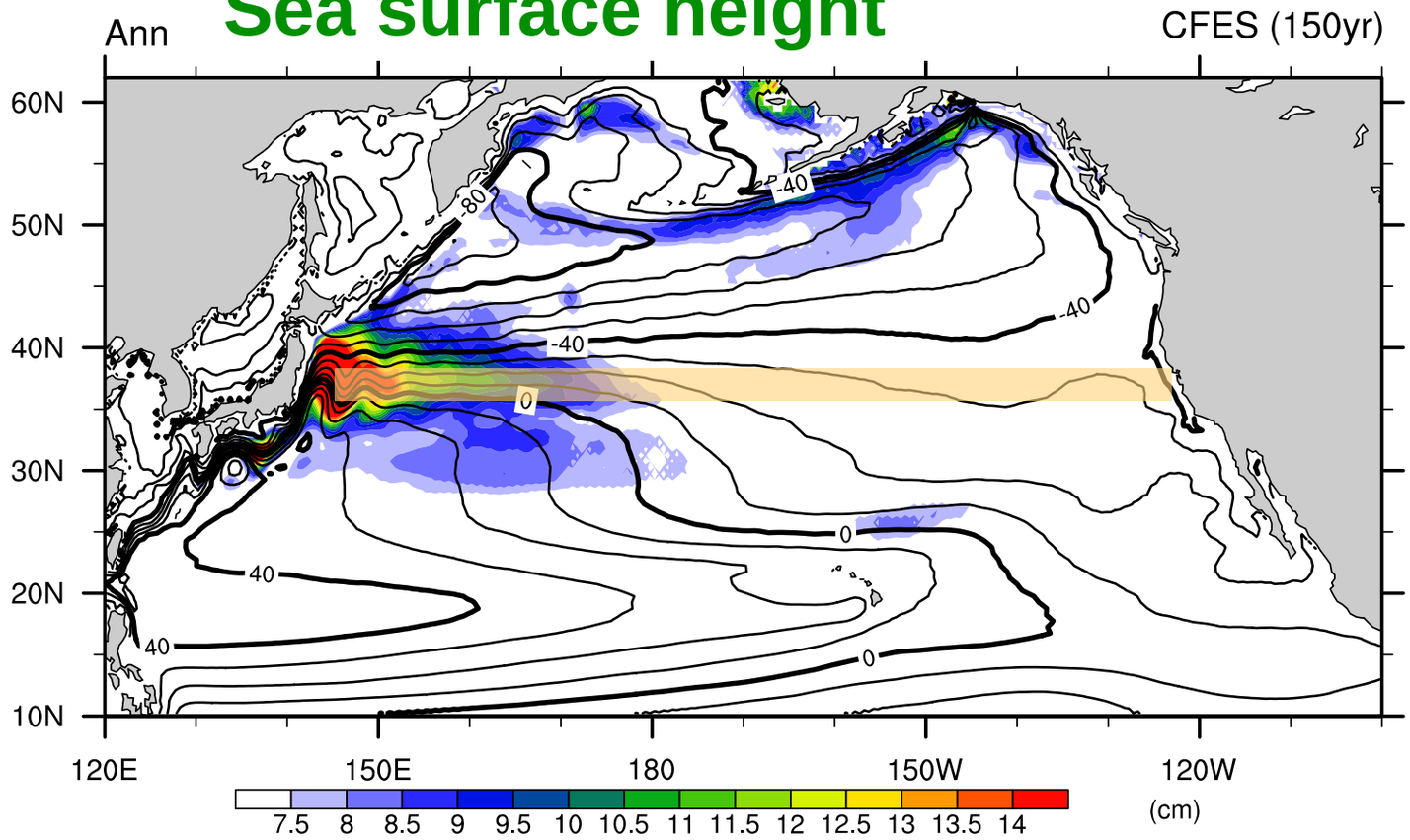
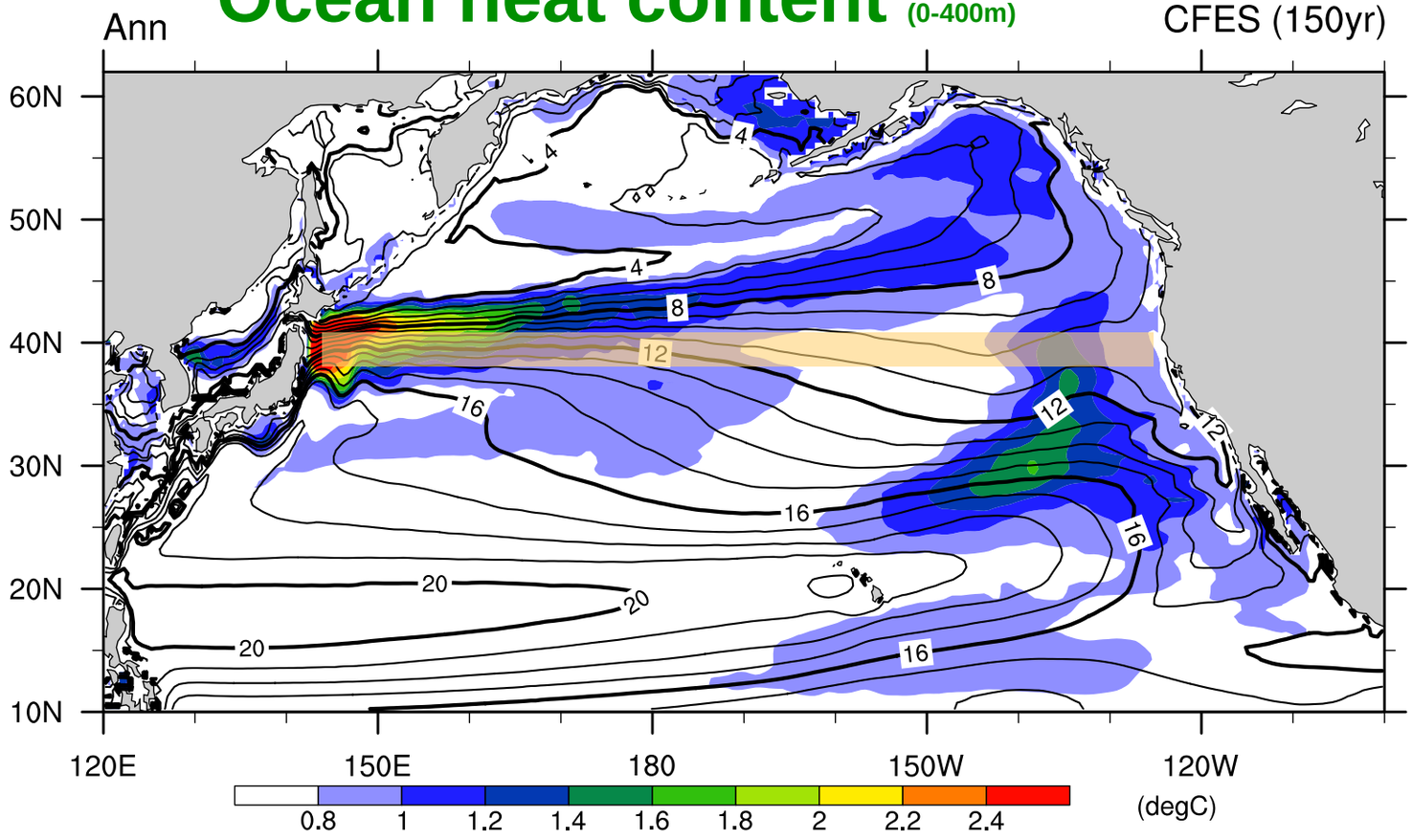
Sea surface height



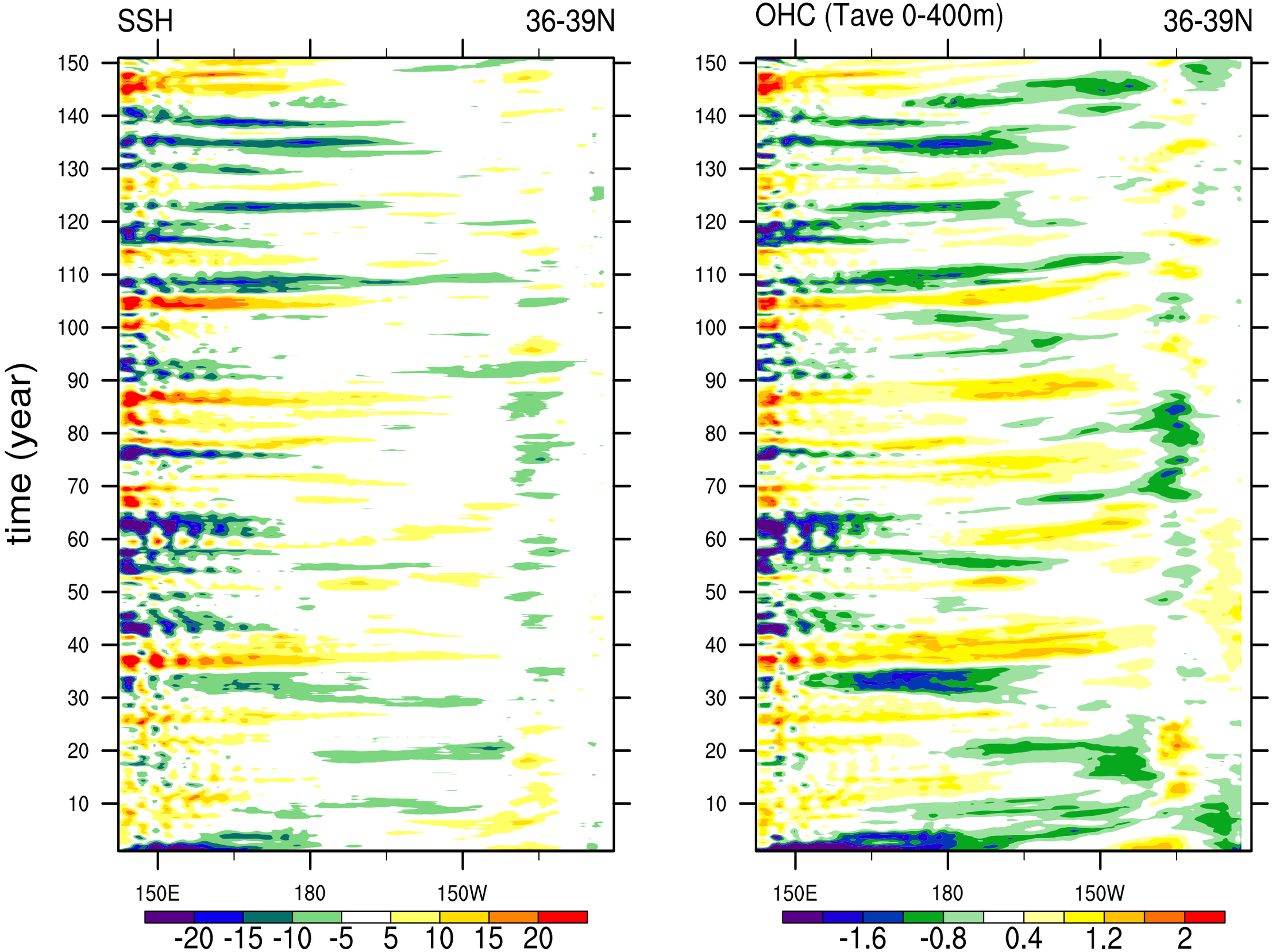
Ocean heat content (0-400m)



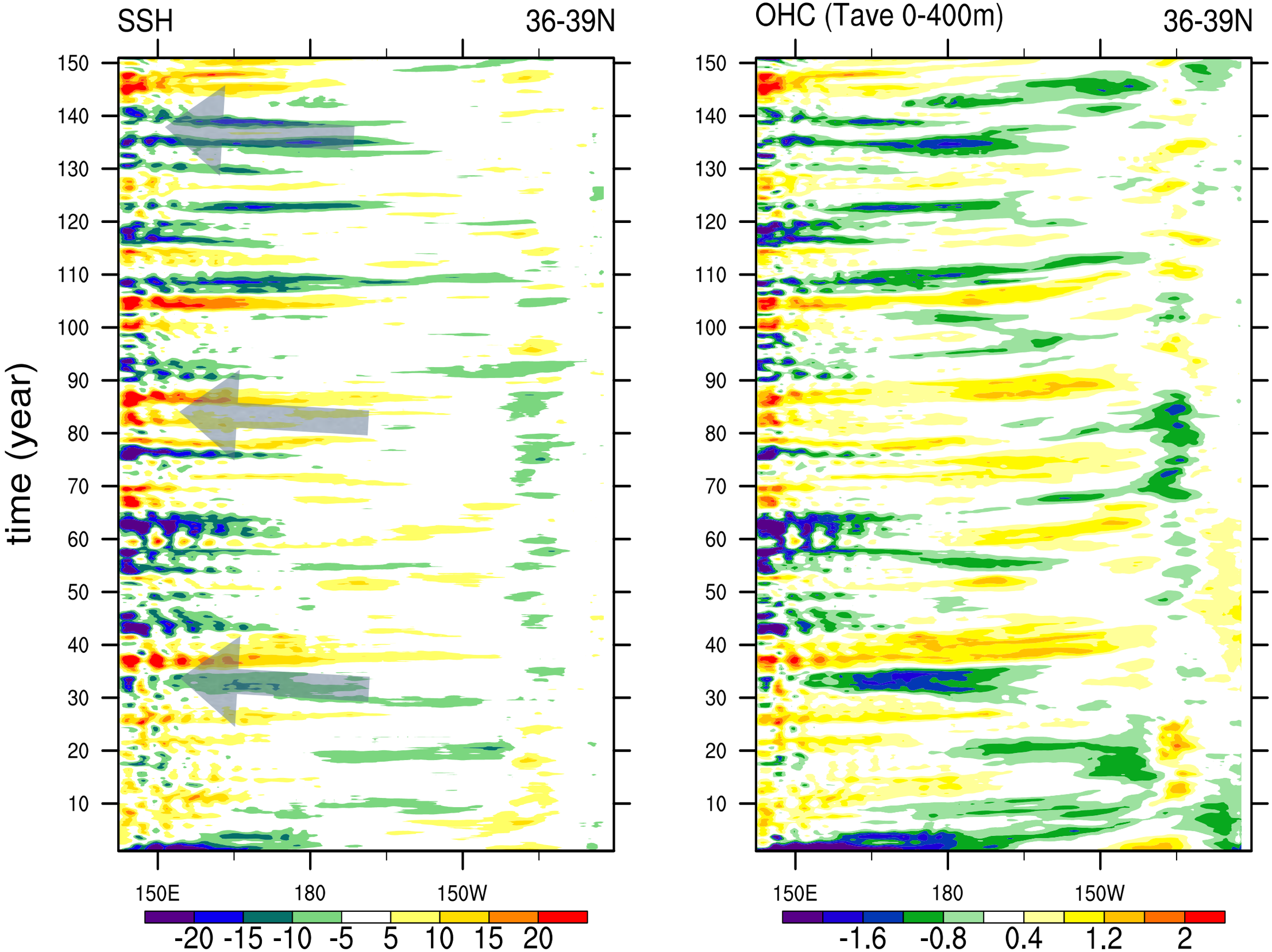
contour: mean

color: standard deviation

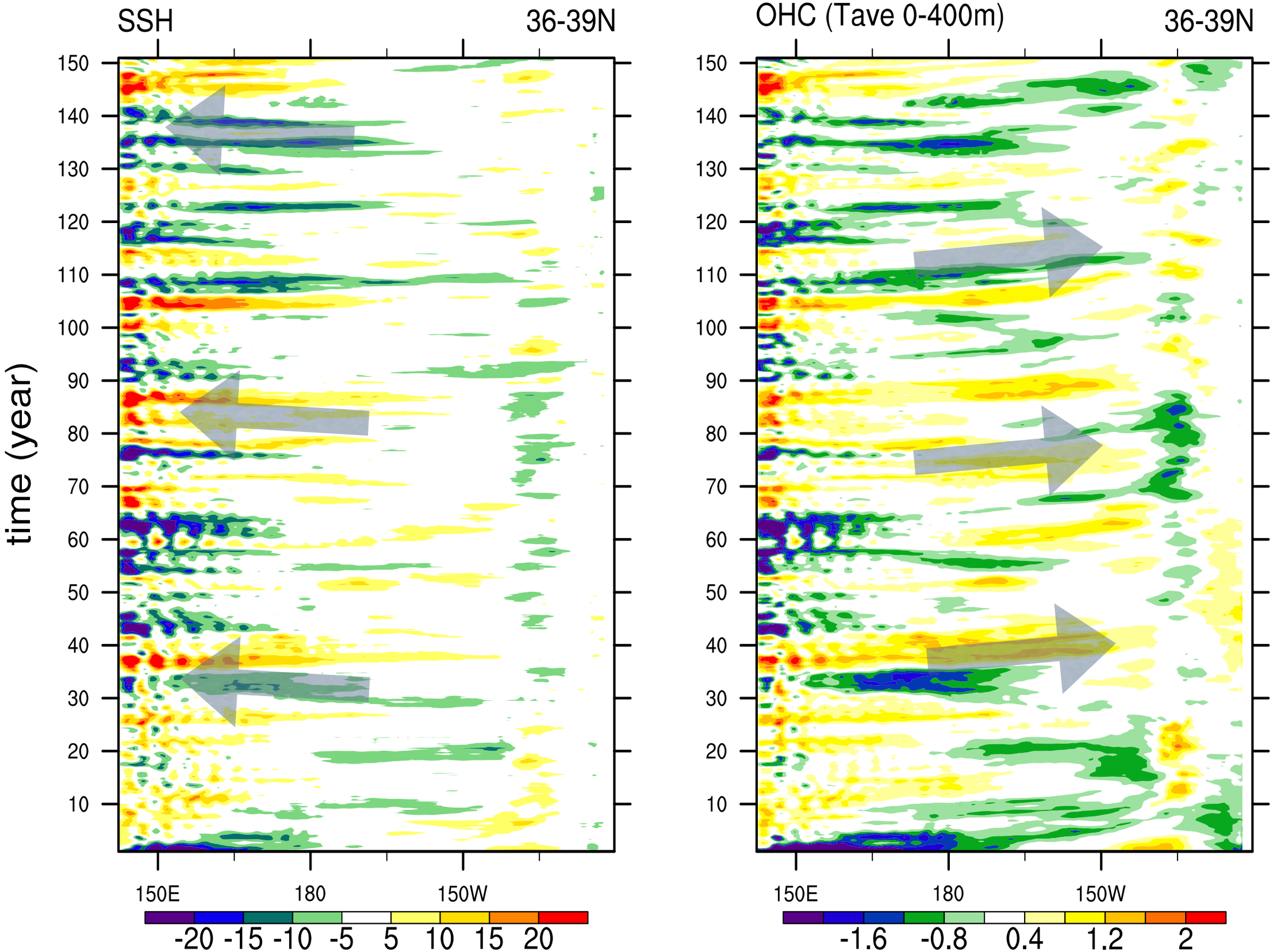
Propagation of ssh & OHC



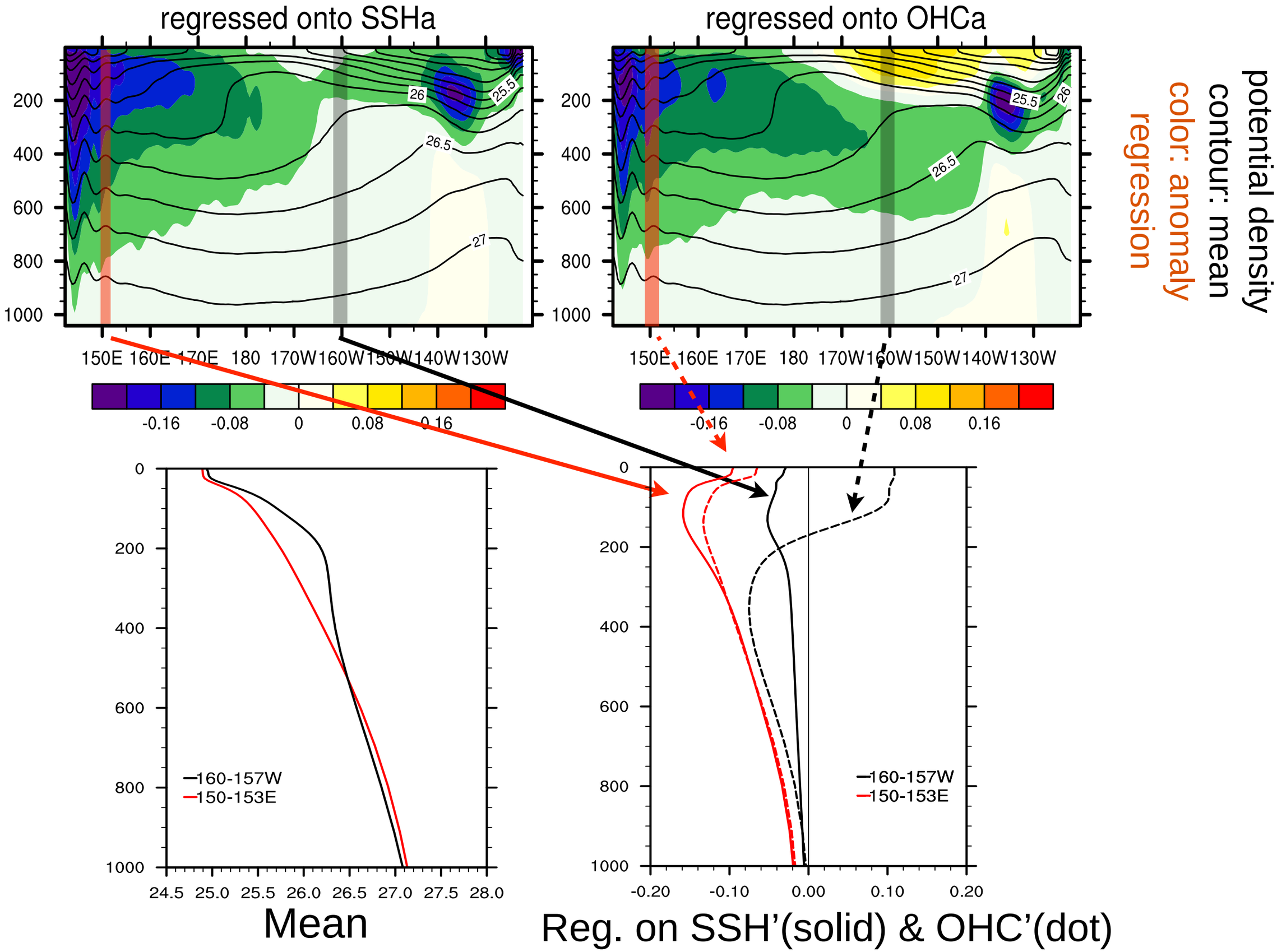
Propagation of ssh & OHC



Propagation of ssh & OHC



Baroclinic structure

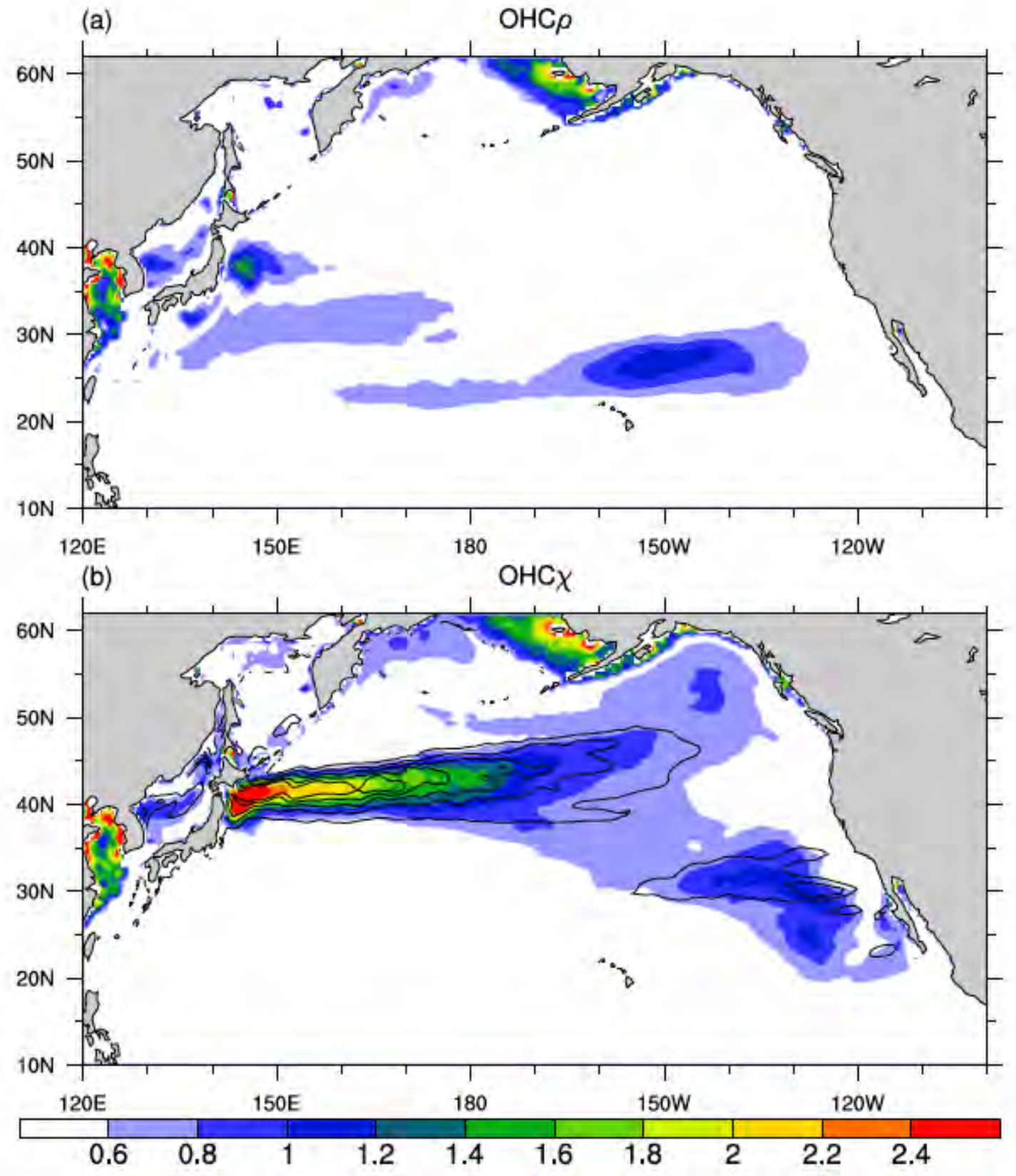


Density-spiciness split

Active and passive tracer

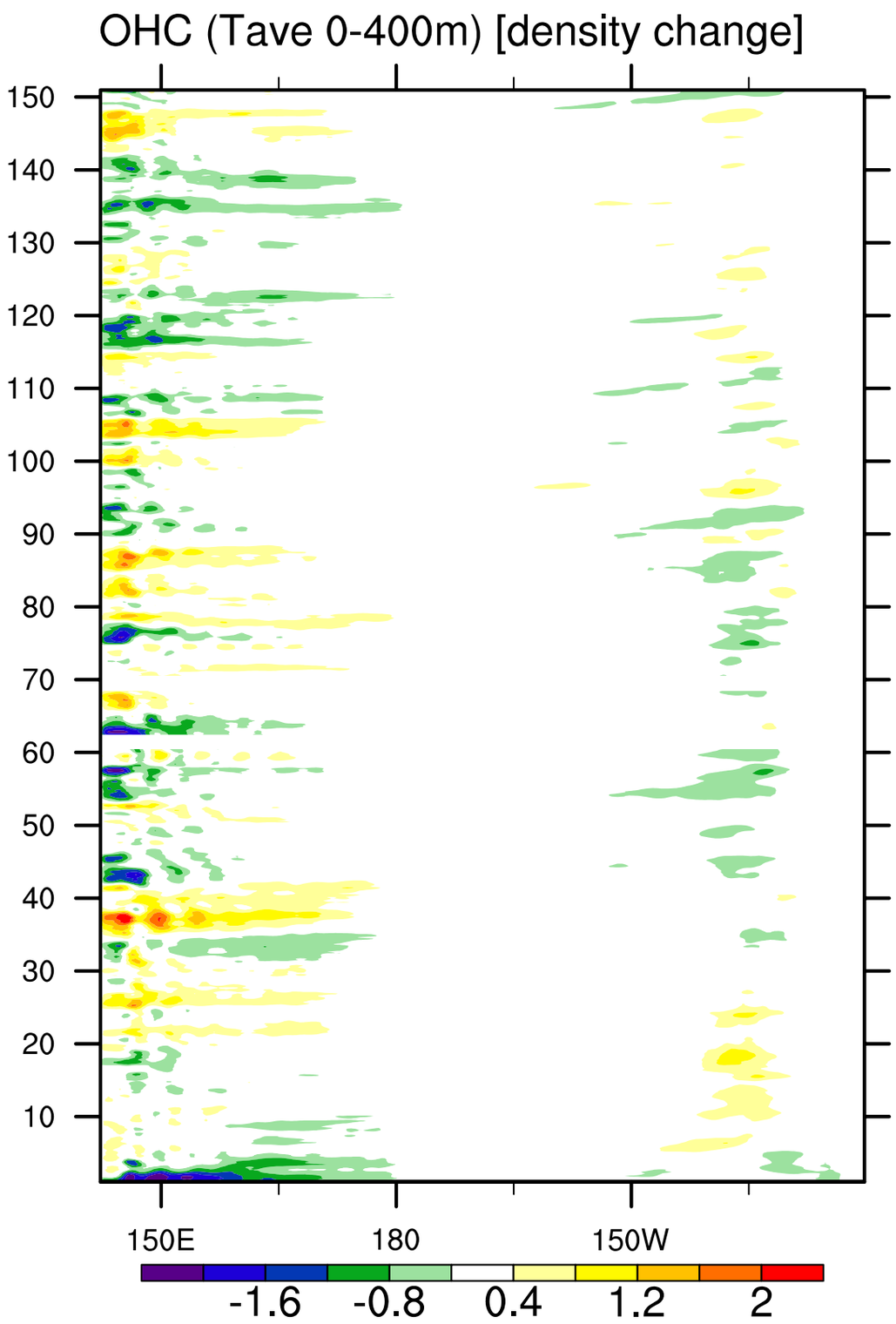
$$\delta T = \frac{d\overline{T}}{d\rho}\delta\rho + \delta T_\chi$$

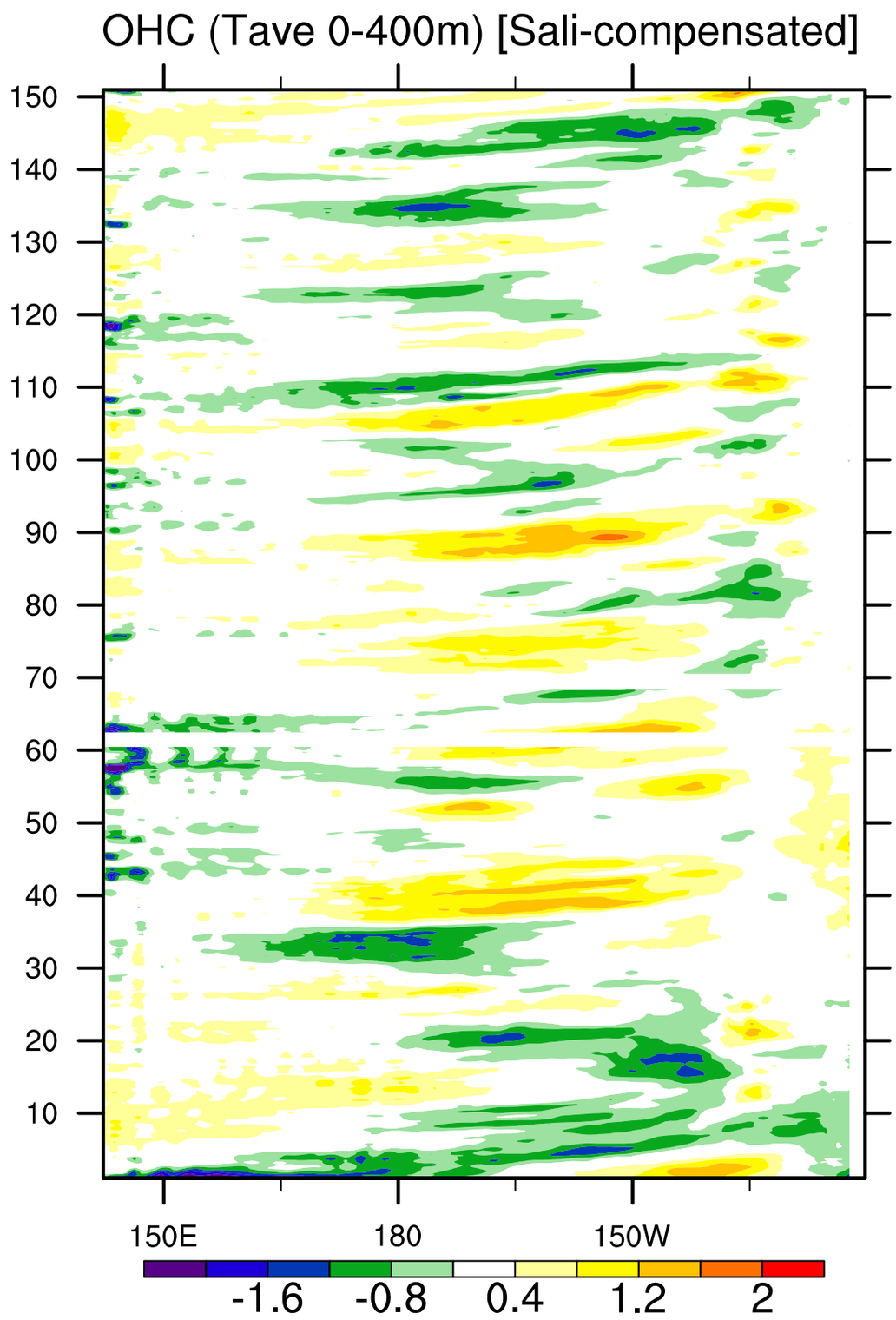
$$\frac{d\overline{T}}{d\rho} = \frac{\nabla\overline{T}\cdot\nabla\overline{\rho}}{|\nabla\overline{\rho}|^2}$$



Density and spiciness propagation

Active and passive tracer





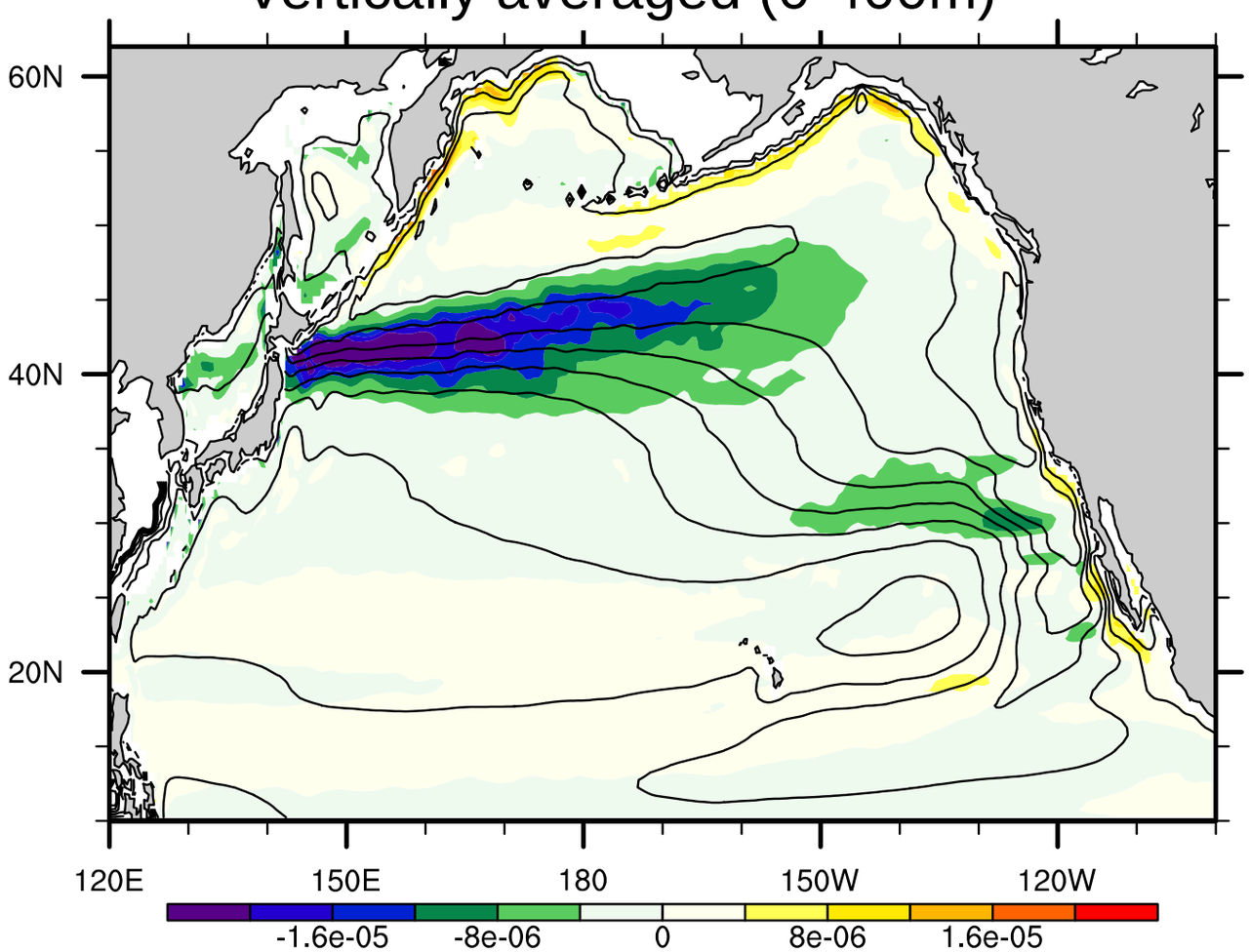
Spiciness anomaly generation

$$\nabla T = (\nabla T)_\rho + (\nabla T)_\chi$$

cross isopycnal

along isopycnal

$$(\overline{(\nabla T)_\chi})_y$$



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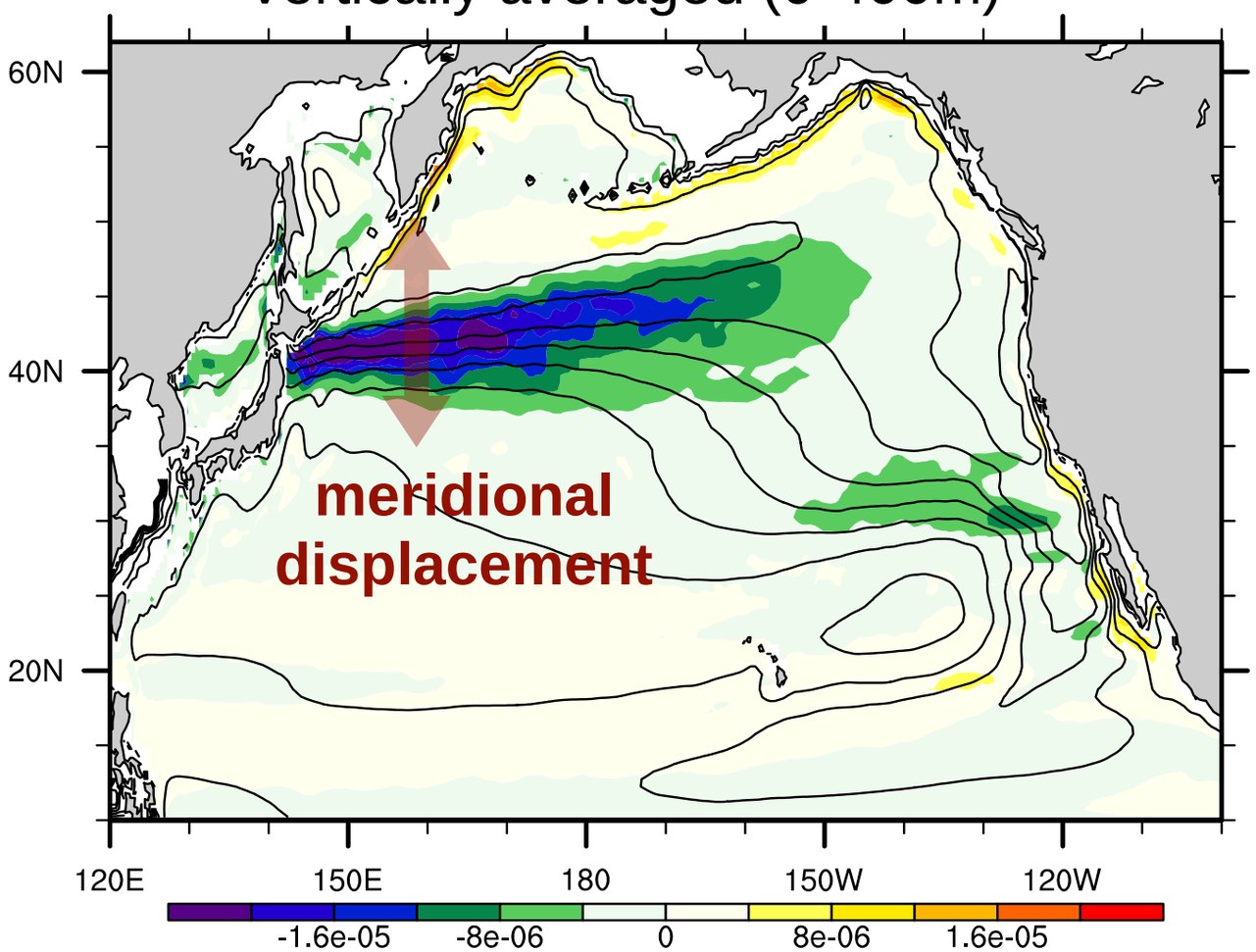

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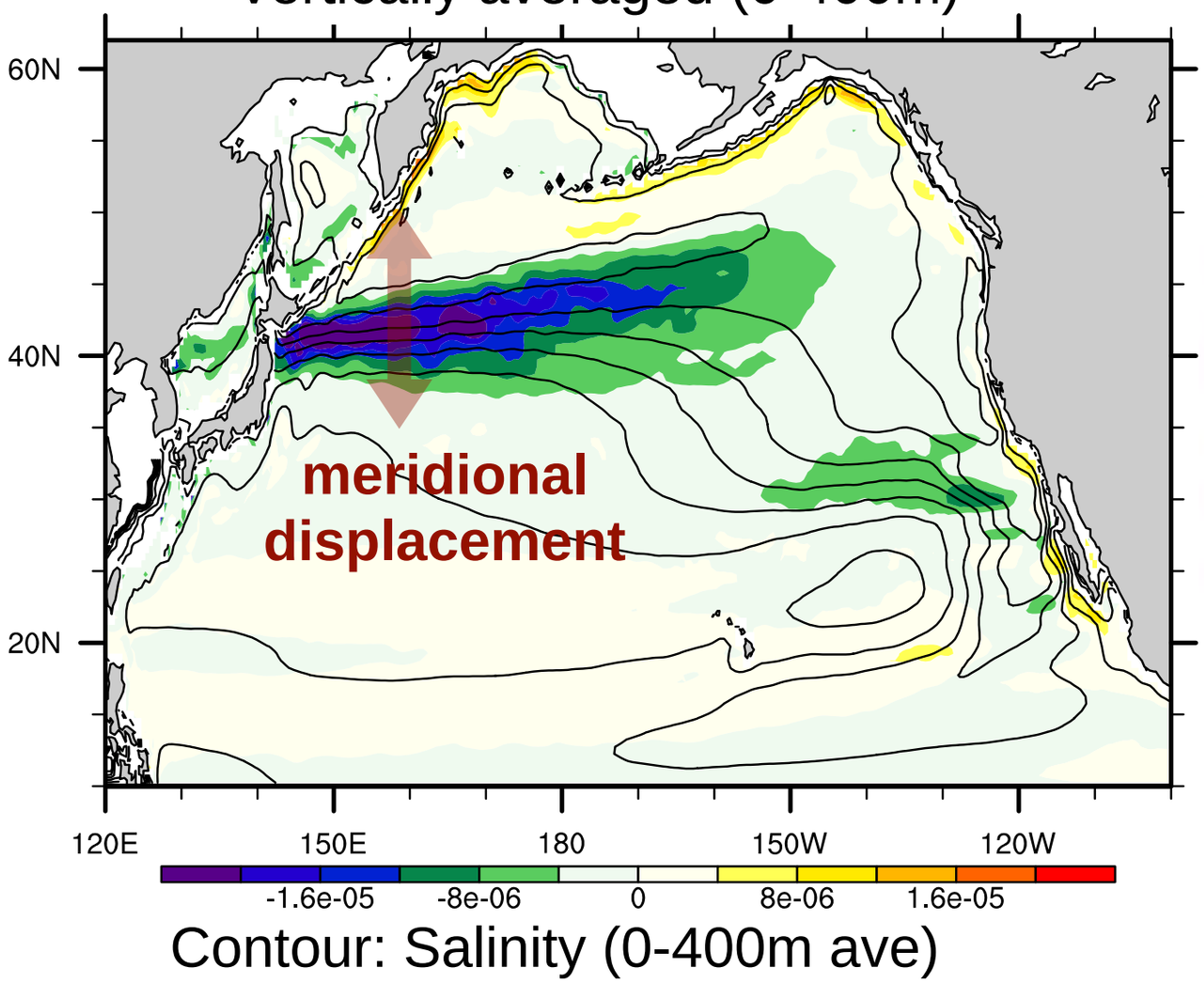
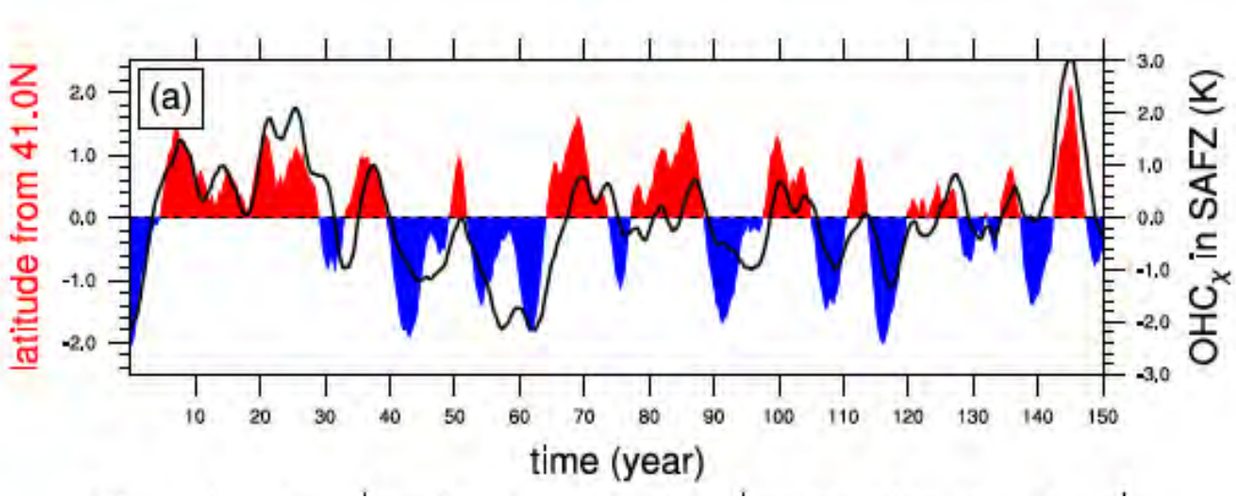
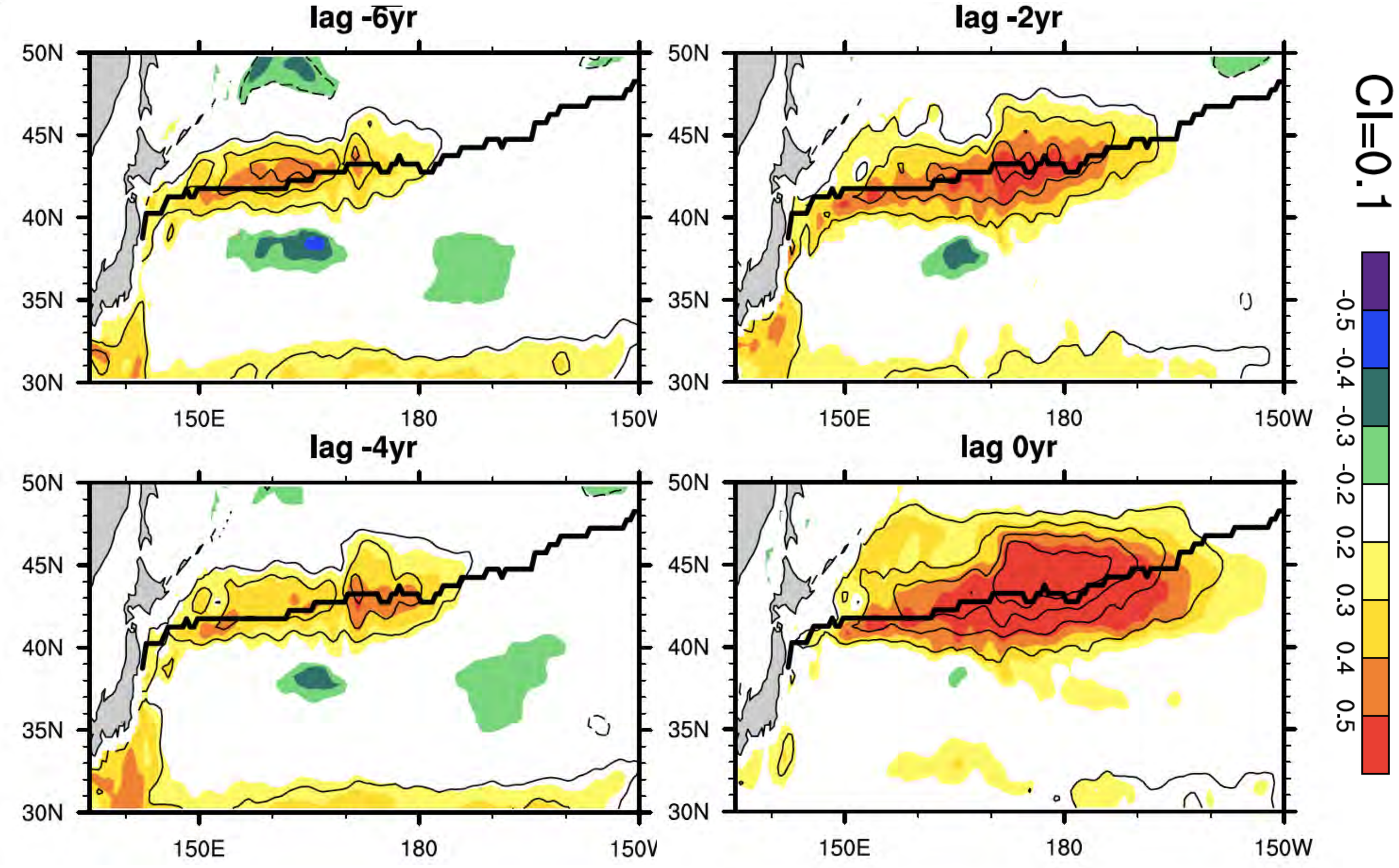


northward frontal shift advects water across mean spiciness gradient

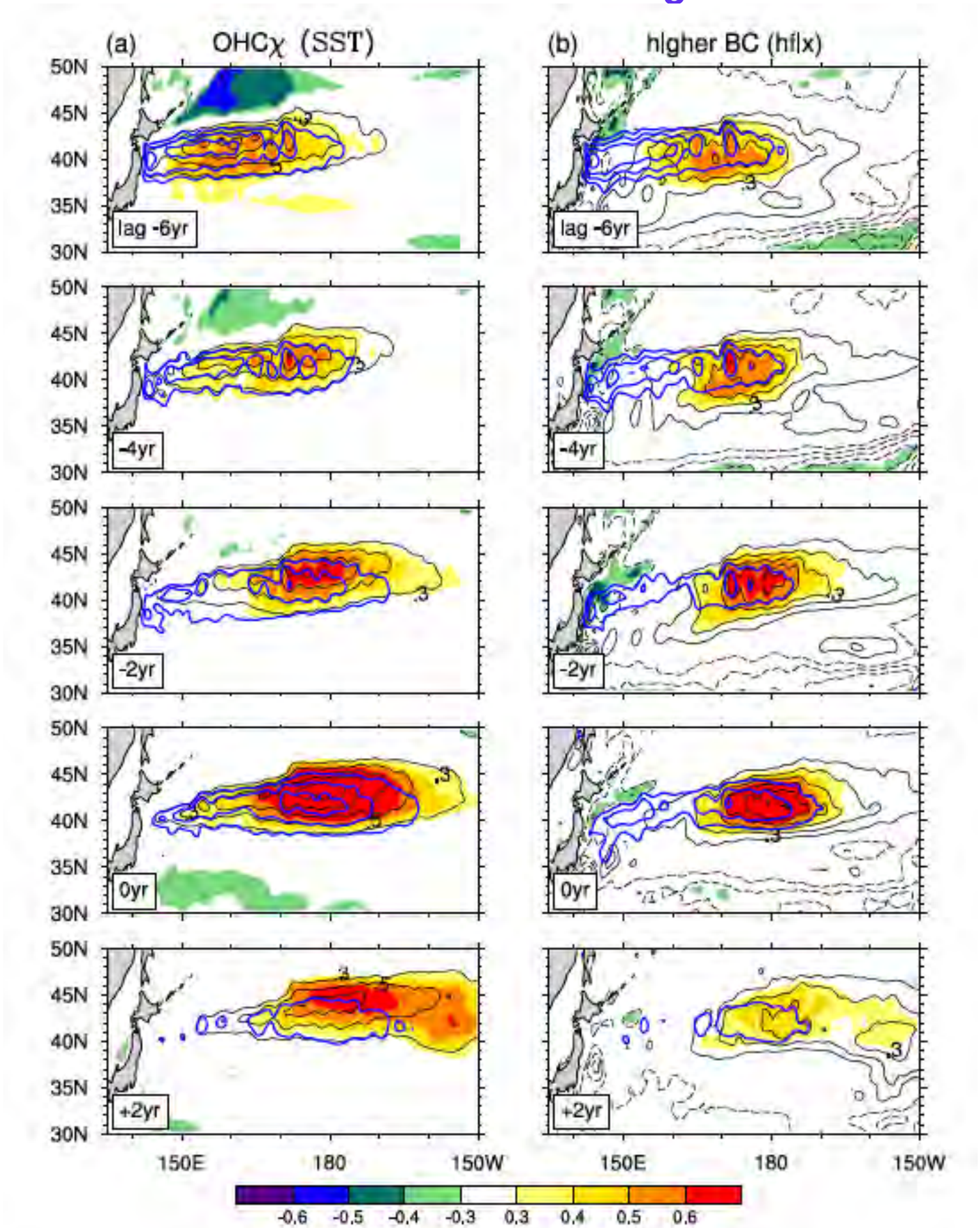


Higher baroclinic modes



Correlation with OHC at date line with of index for 2nd baroclinic mode (heat content difference of 0-200m and 200-400m)

Generation of higher baroclinic mode

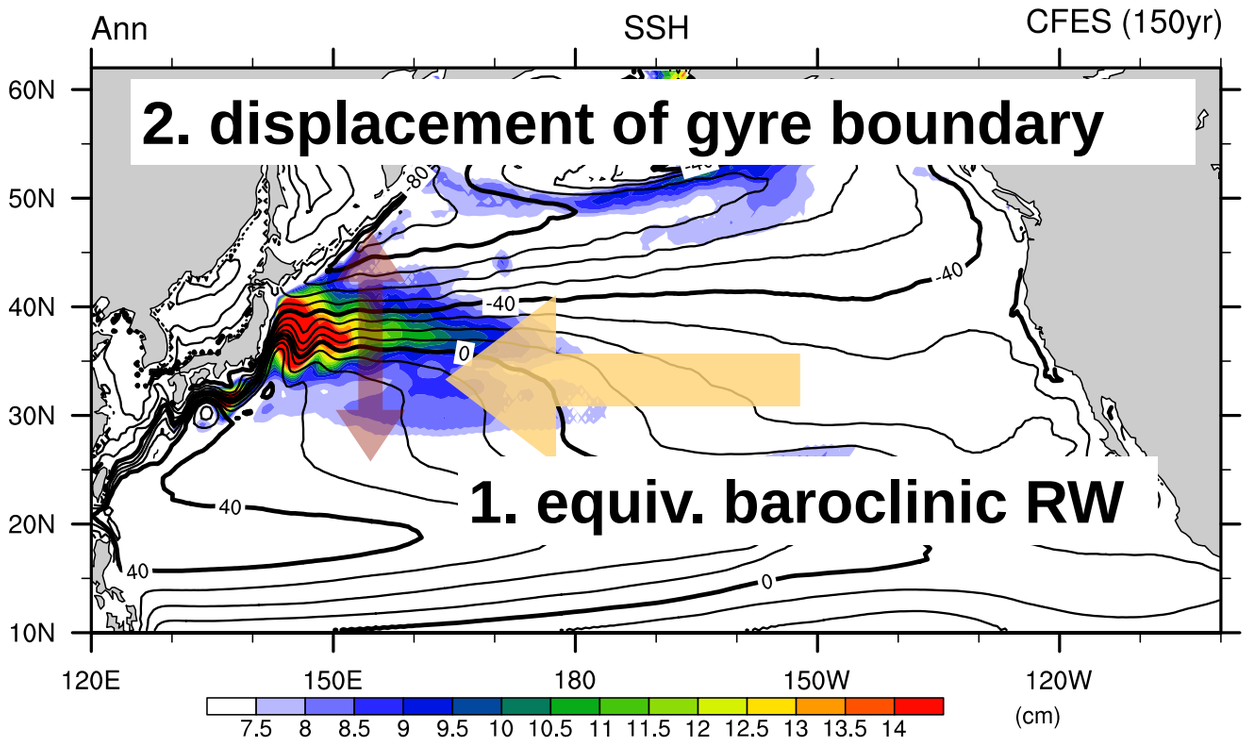


Correlation with OHC_{chi} at 180°

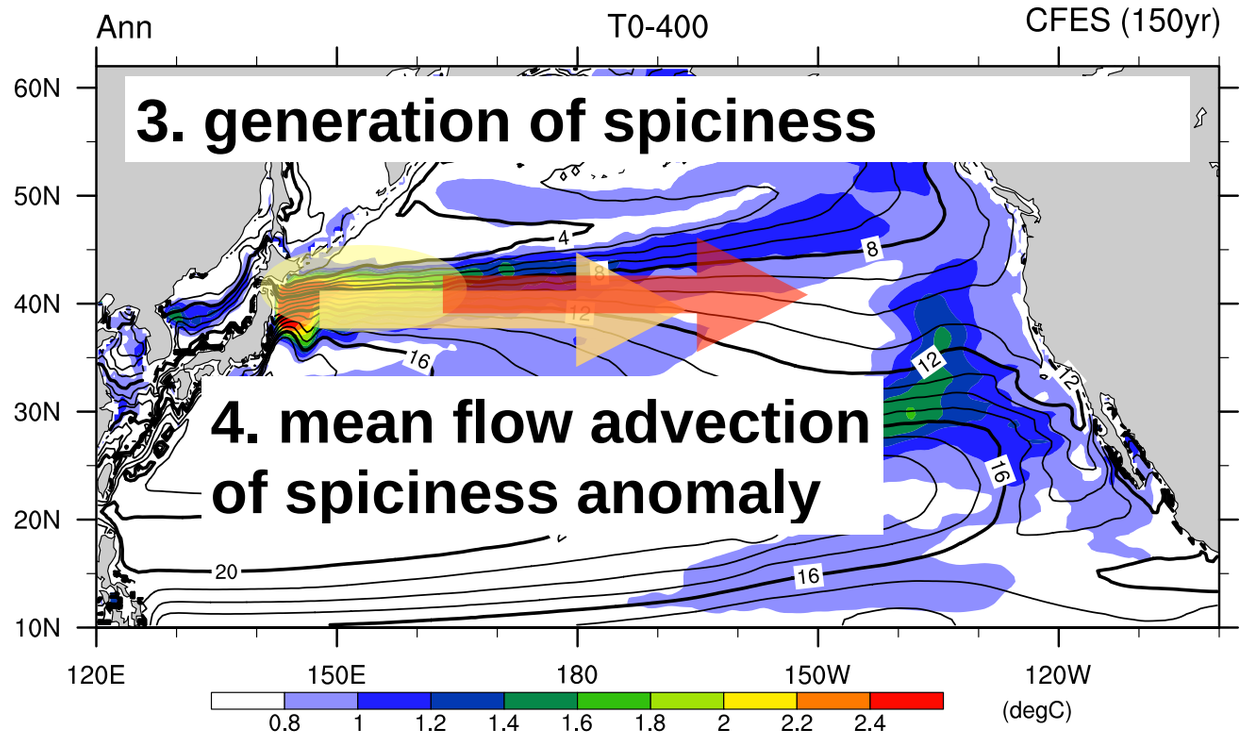
Summary

- Processes governing North Pacific decadal variability have been clarified, and the central role played by spiciness anomalies identified.

westward-propagating SSHa



eastward-propagating OHCa

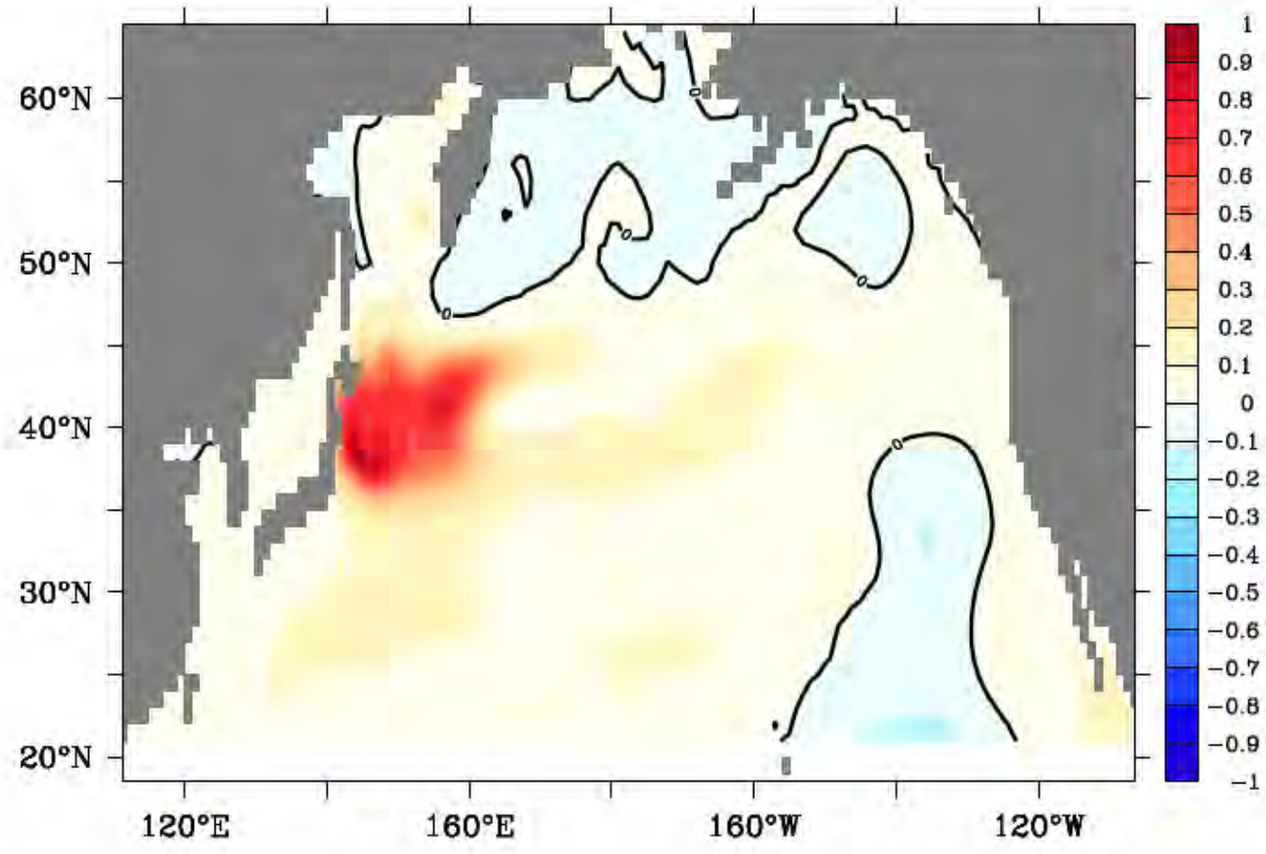


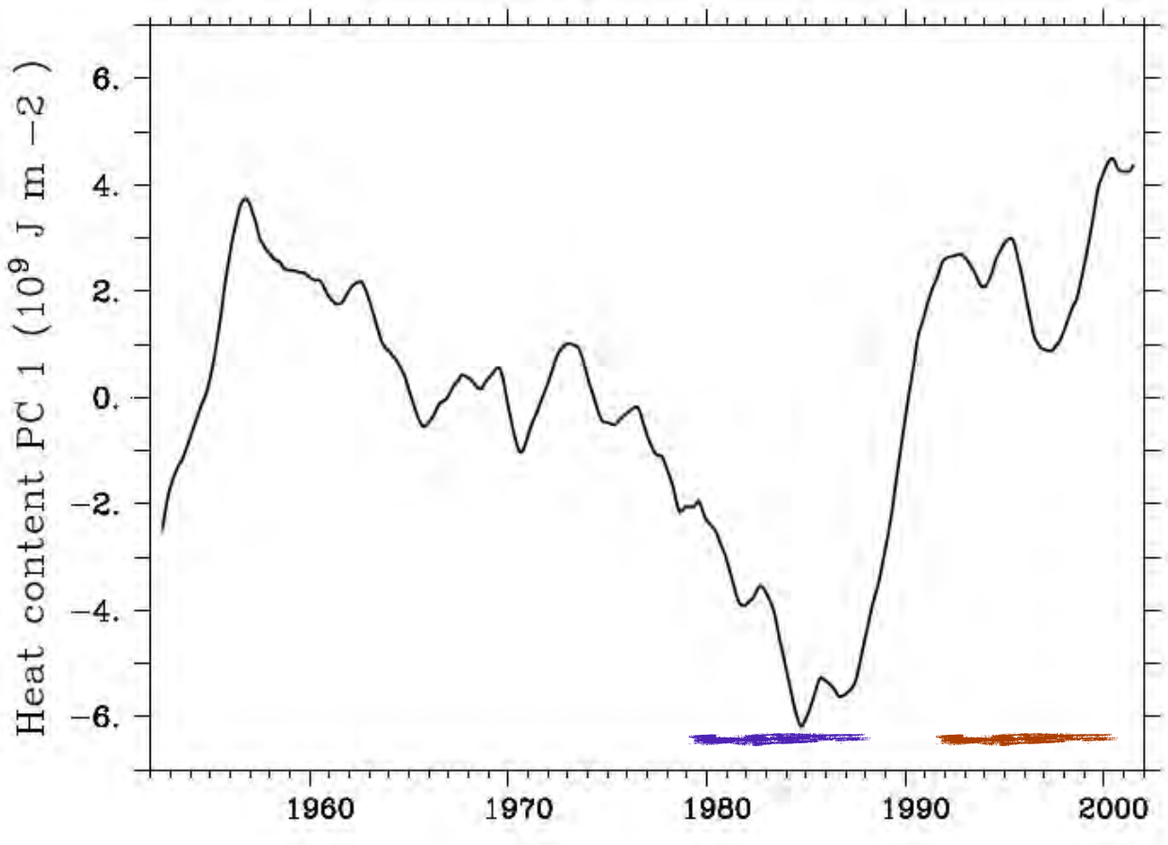
5. T' associated w/ spiciness damped by air-sea heat exchange → ρ' → higher modes RWs

The 1976/77 climate shift

GECCO 1950-2002 ocean state estimation

EOF1 of 0-300m heat content

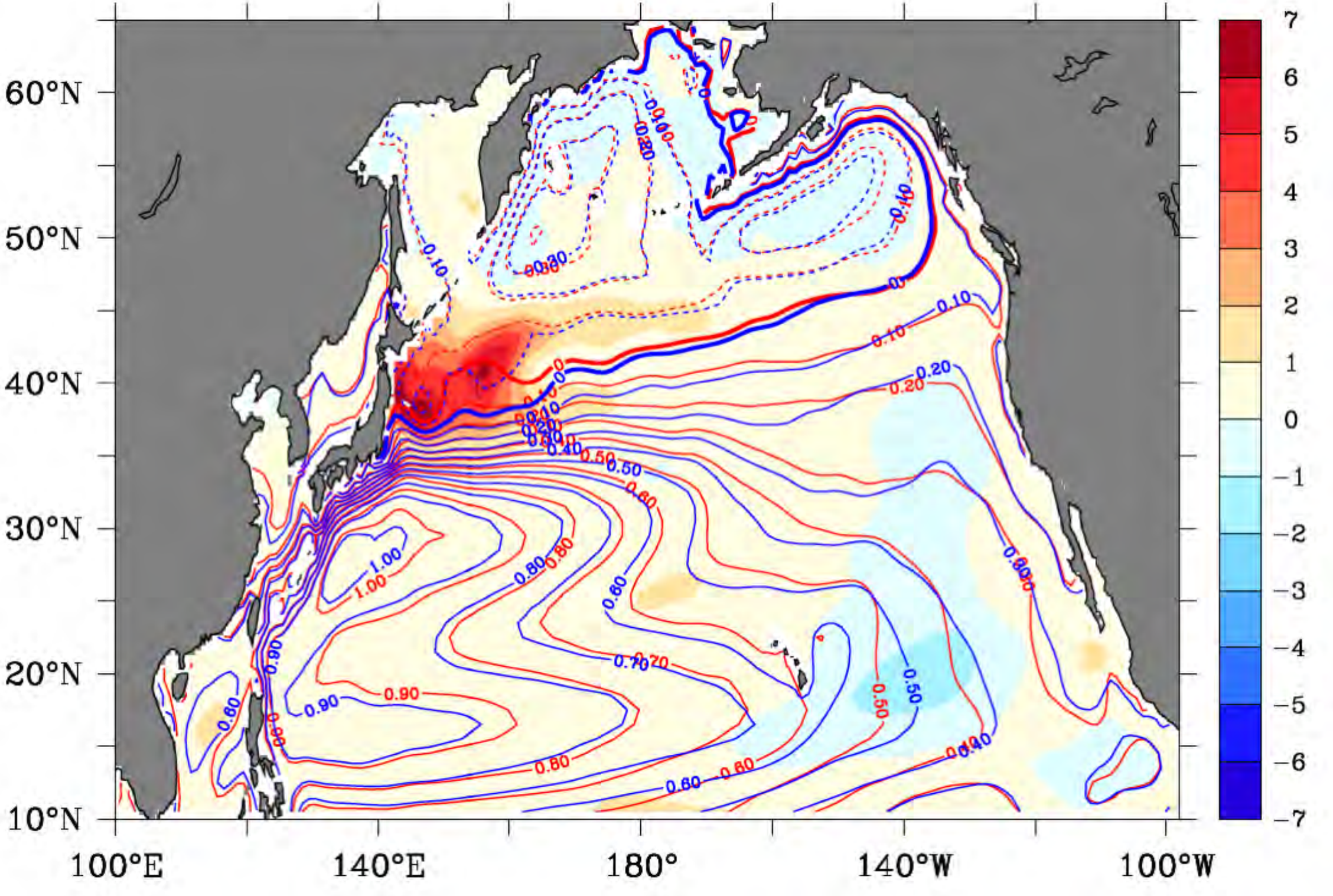




Serra, Schneider, Koehl, Stammer, in prep.

Response to the early 1990 climate shift

GECCO 1950-2002 ocean state estimation



shade: 0-300m heat content difference 1992-2001 to 1979-1988, 10^9 Jm^{-2}

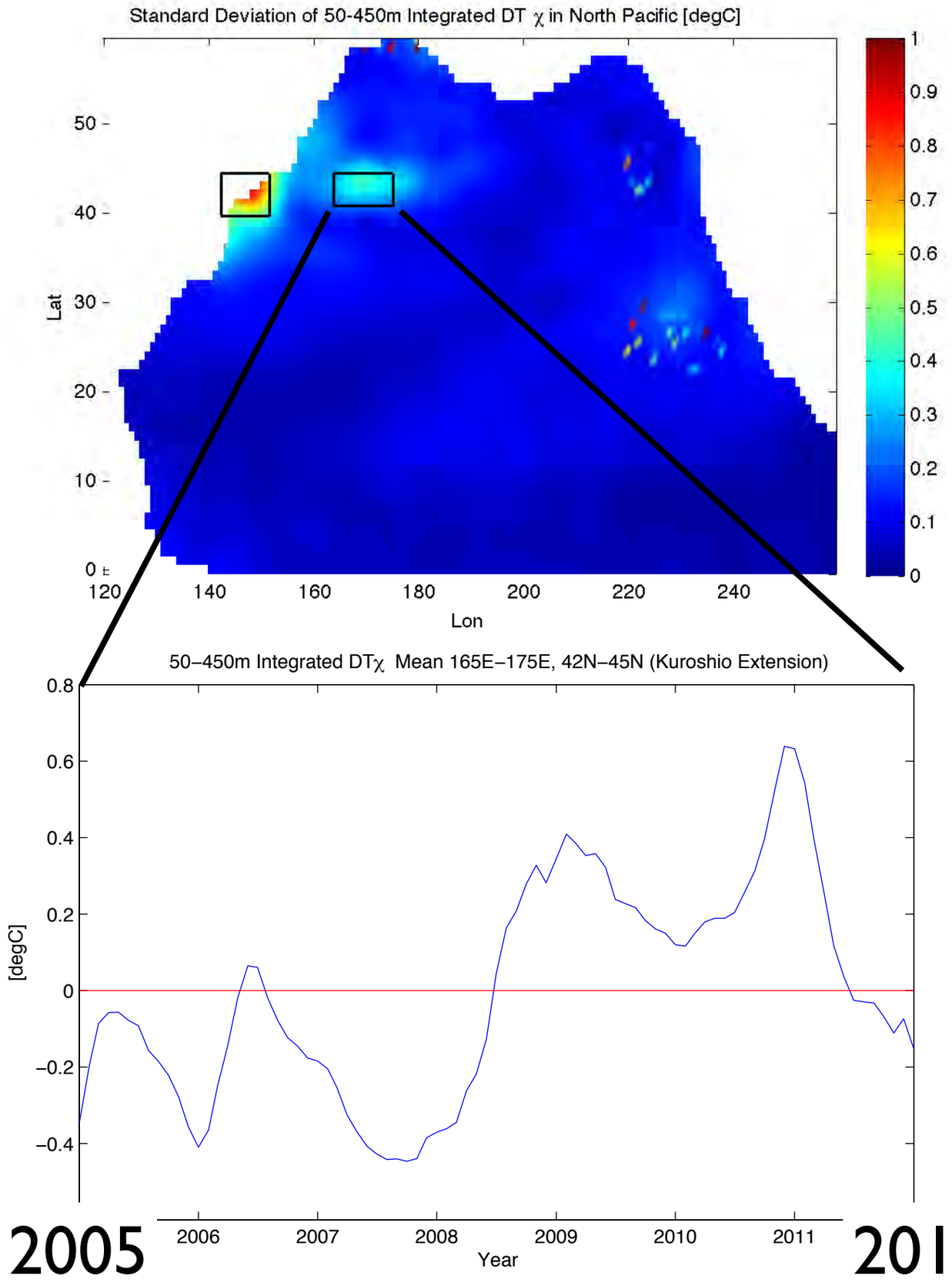
contour: ssh, 1979-1988, 1992-2001

Serra, Schneider, Koehl, Stammer, in prep.

Variability in the new millennium

Argo observations

2005-2012
standard deviation
spiciness heat content
50-450m
Argo gridding by APDRC

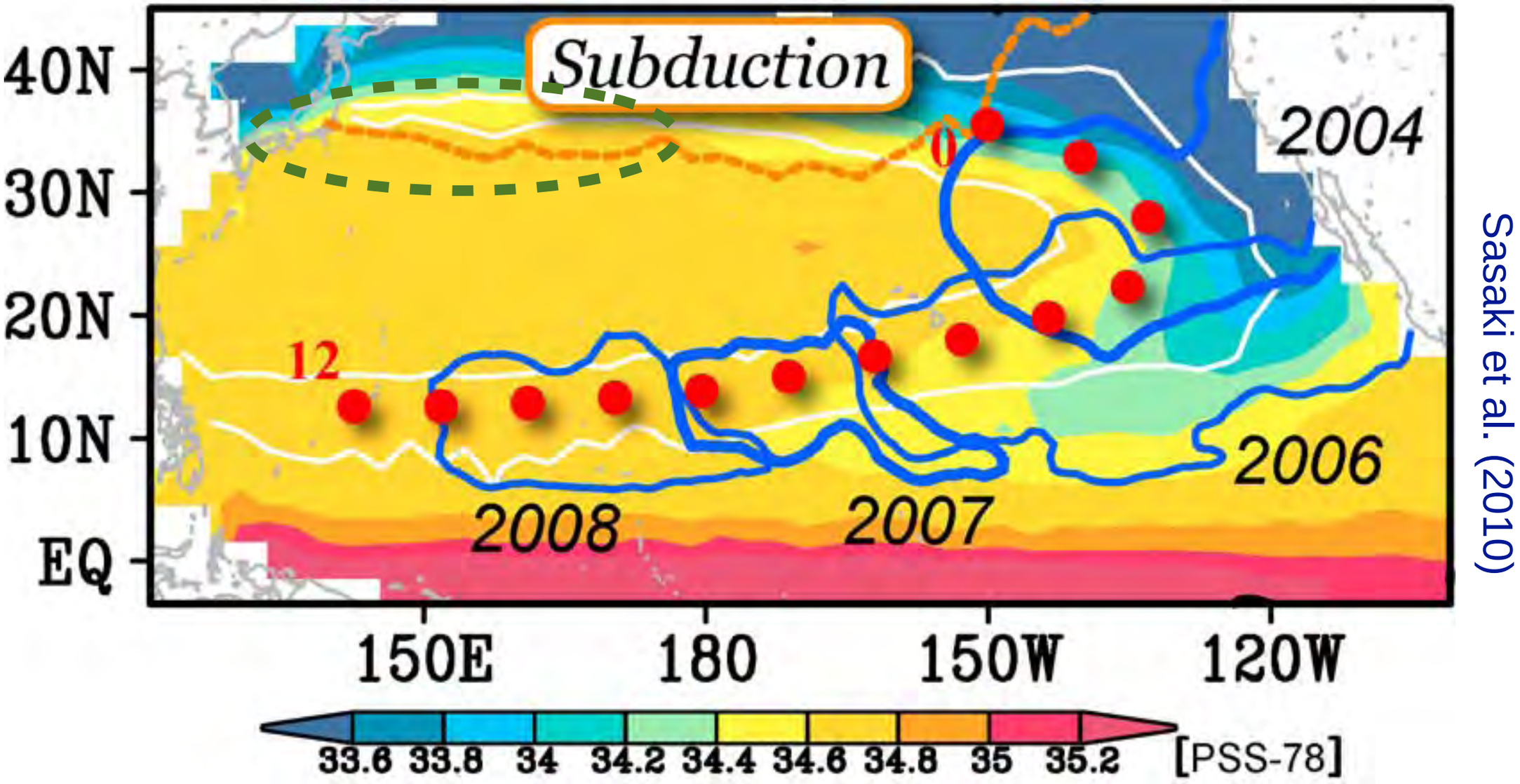


M. L. Grissom

Observed spiciness propagation

in subtropical thermocline

anomalous spiciness generation in KOE
link to anomalous mode water formation?



Sasaki et al. (2010)

25-25.5 σ_θ

PAU