



# SST changes in the Yellow and East China Seas: Warming to Cooling Trend in 1997/98



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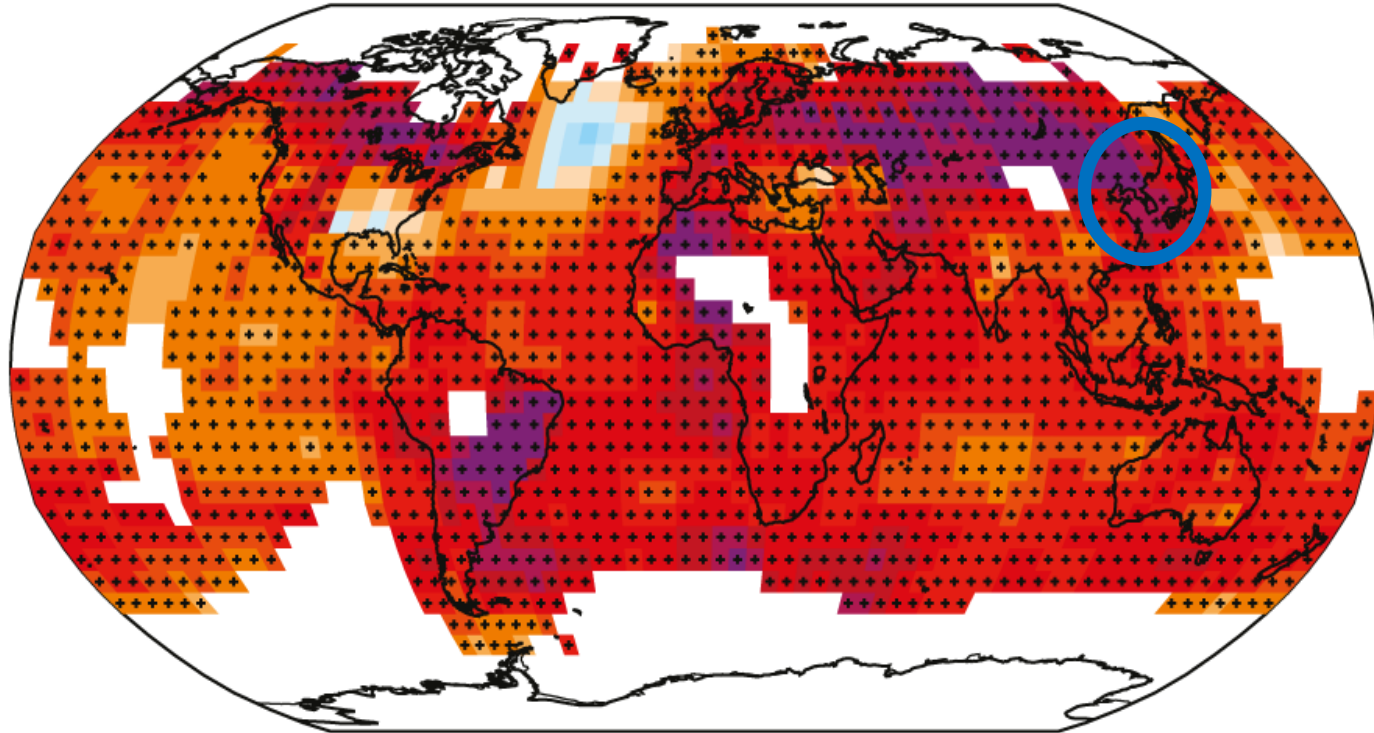
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# Surface Temperature Changes

1901 to 2012



IPCC AR5 (2014) (°C)

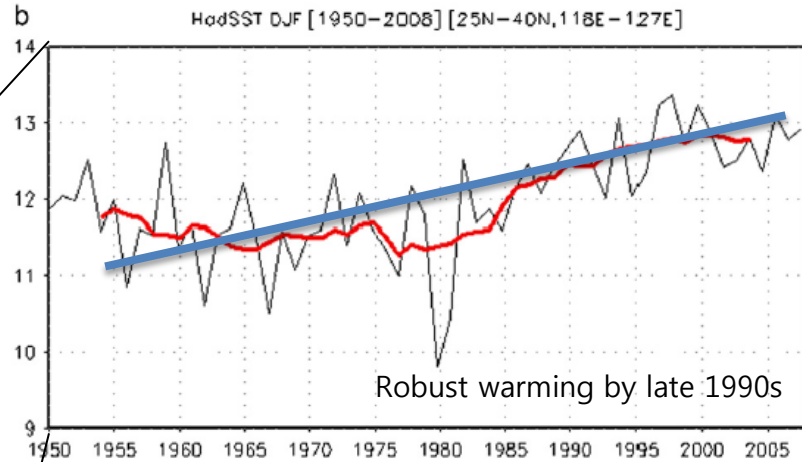
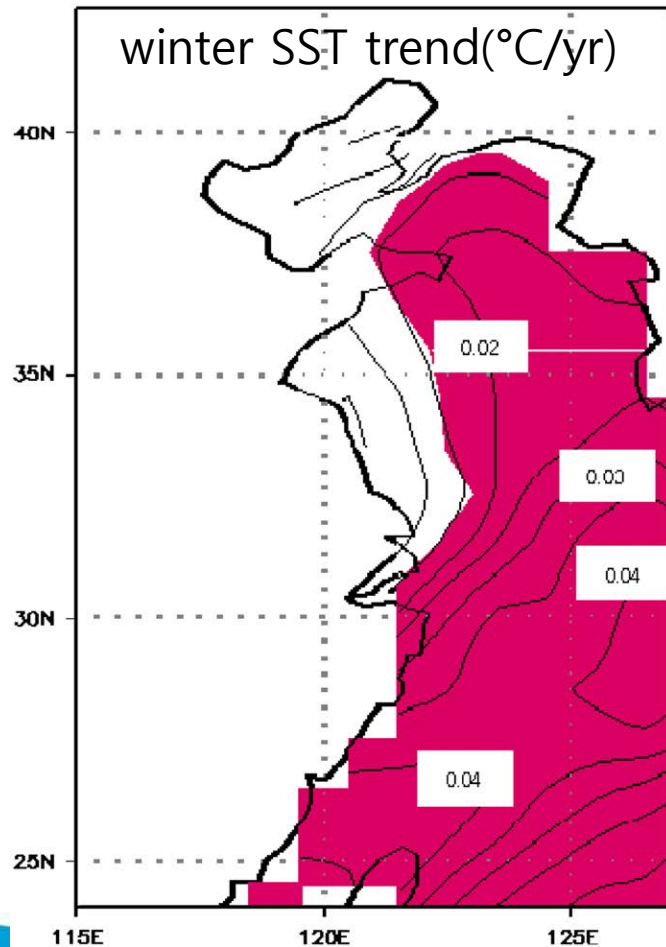
Observed surface temperature change, from 1901 to 2012, derived from temperature trends determined by linear regression from NCDC MLOST



# YECS SST change

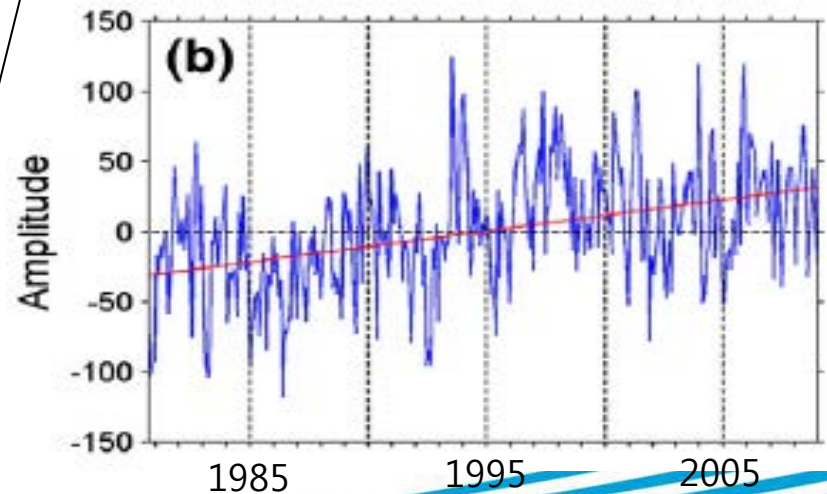
**Yeh and Kim (2010)**

Trends in winter SST(°C/yr)  
Based on HadISST (1950–2008)



**Park et al. (2015)**

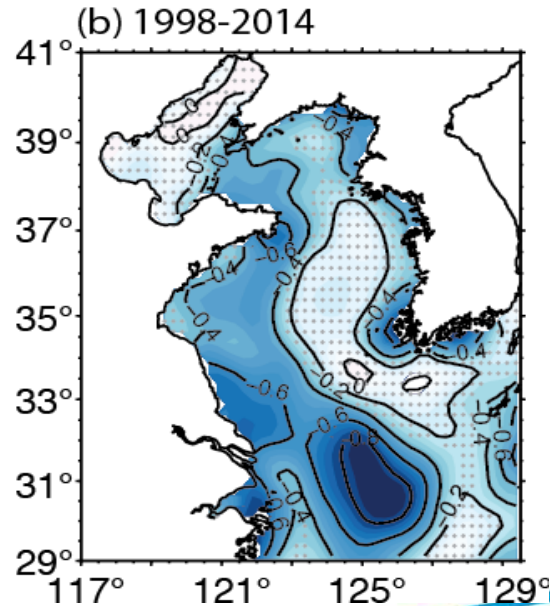
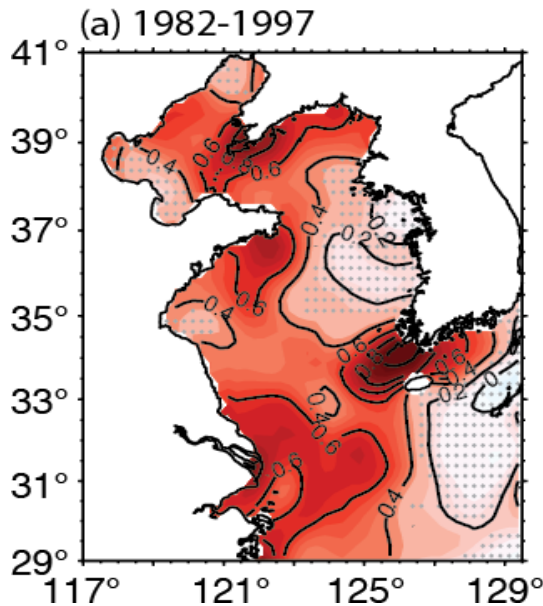
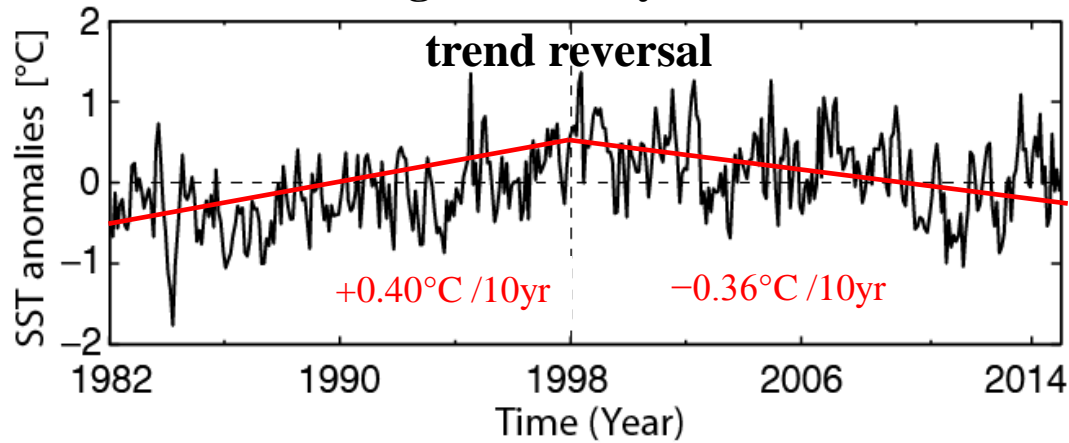
AVHRR SST anomaly (1981–2009):1<sup>st</sup> EOF amplitude





# SST Trend Shift: Warming to Cooling

YECS averaged monthly SSTa (OISST)



**Basin-scale warming turns into cooling.**

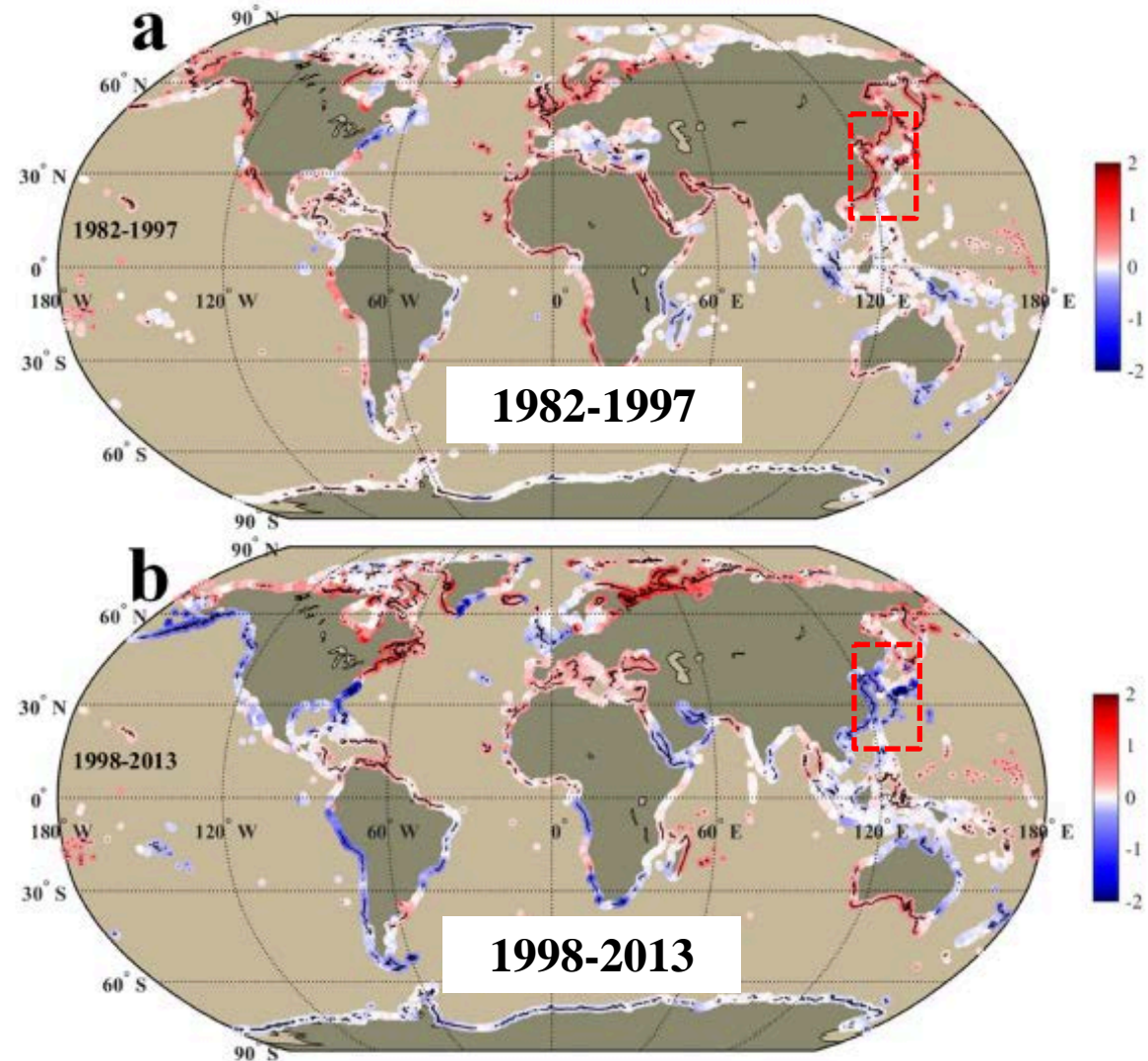
- Dynamics?
- Is it related to the regime shift in the North Pacific?

# SST trends along the coast lines

Liao et al. (2015)

The cooling of the Chinese and Japanese coasts

1. does not match with the negative phase of the PDO
2. may be related to the recent strengthening of East Asian Winter Monsoon



**Figure 2.** The linear SST trends (unit: °C/decade) along the world's coastlines in the warming (1982–1997, a) and hiatus periods (1998–2013, b). Black points/lines in the shading color indicate the trends in those locations are significant in statistics ( $P < 0.05$ ). We generated the two sub-panels (a,b) using Matlab and integrated the sub-panels into this figure.

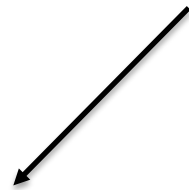


# CSEOF Analysis

Kim KY et al. (2015, ESR)

$$P(r, t) = \sum_n B_n(r, t) T_n(t)$$

$$B_n(r, t) = B_n(r, t + d)$$



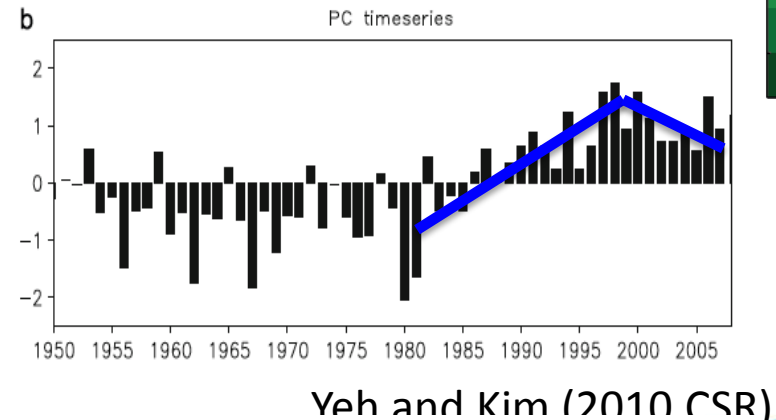
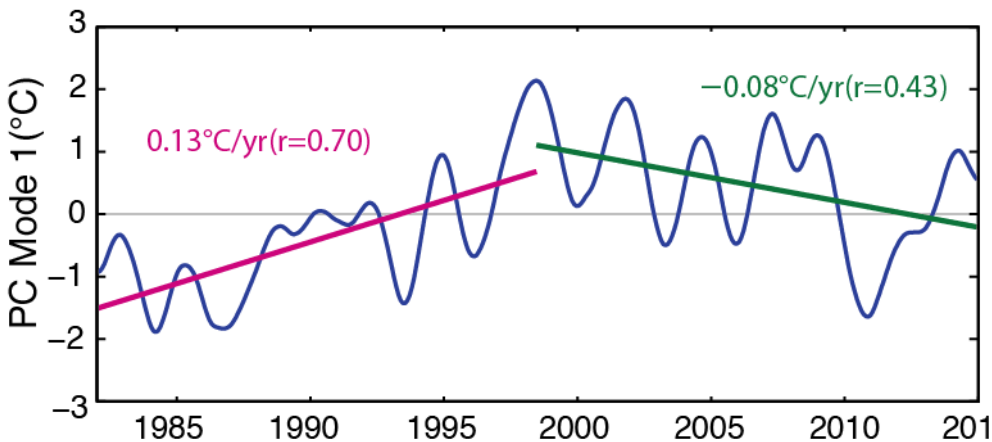
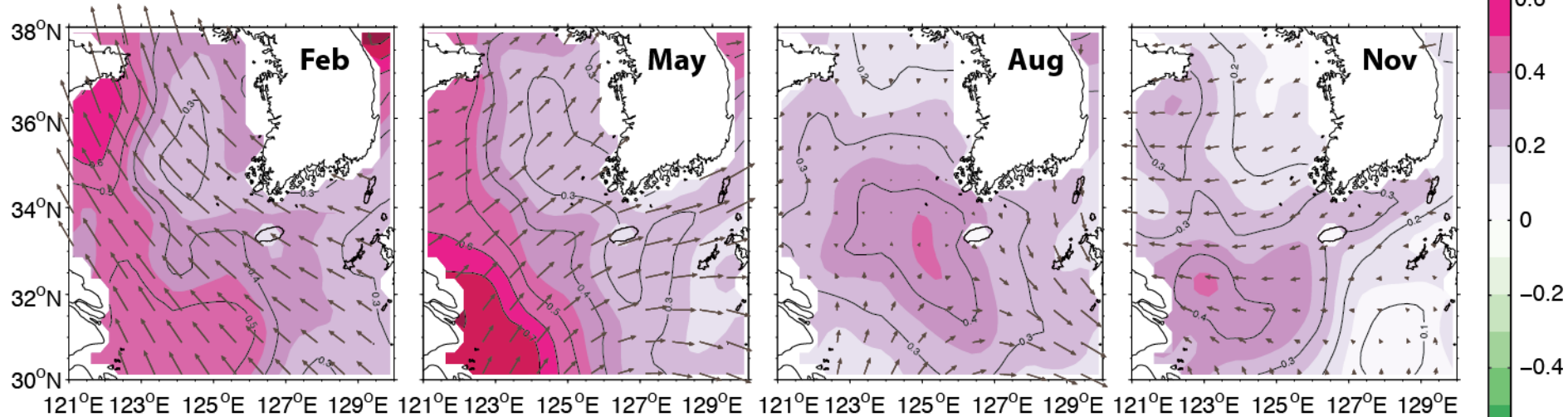
cf) EOF :  $P(r, t) = \sum_n B_n(r) T_n(t)$

- Periodic time series
- d: nested period (or seasonal period = 12)

- Target variable: monthly averaged SSTa (OISSTv2)
- Predict variable: surface winds (ECMWF Interim)

# CSEOF mode1 for YECS SSTa

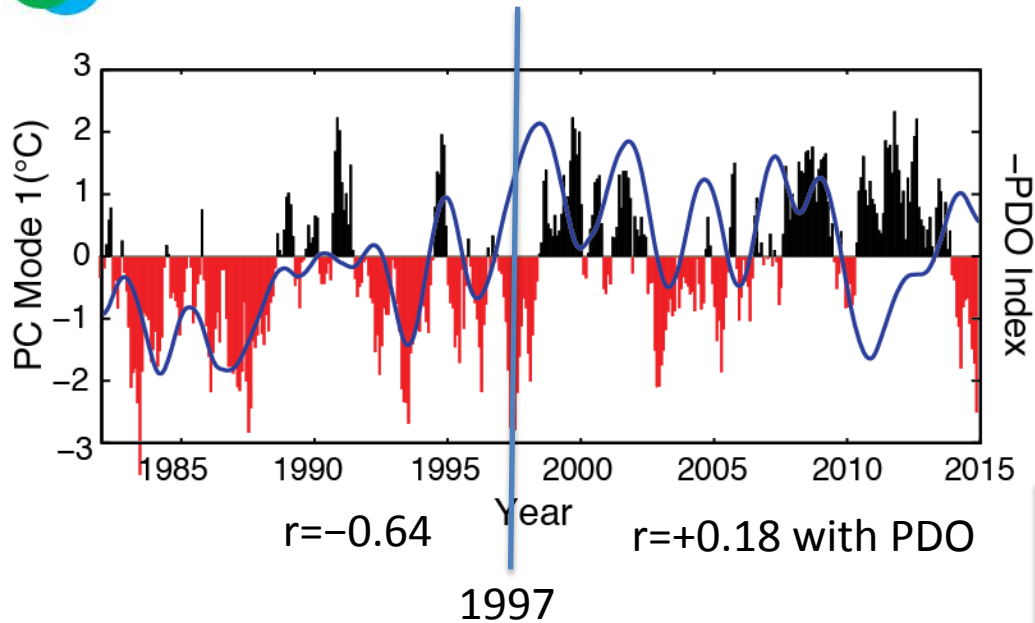
CSEOF Mode1: 25.0%



- Variance of the winter/spring months determine the 1<sup>st</sup> mode.
- Southerly wind anomalies accompany the warming in the YECS as suggested by pervious studies (i.e., Yeh and Kim 2010; Oey et al. 2013; Lee et al. 2014).

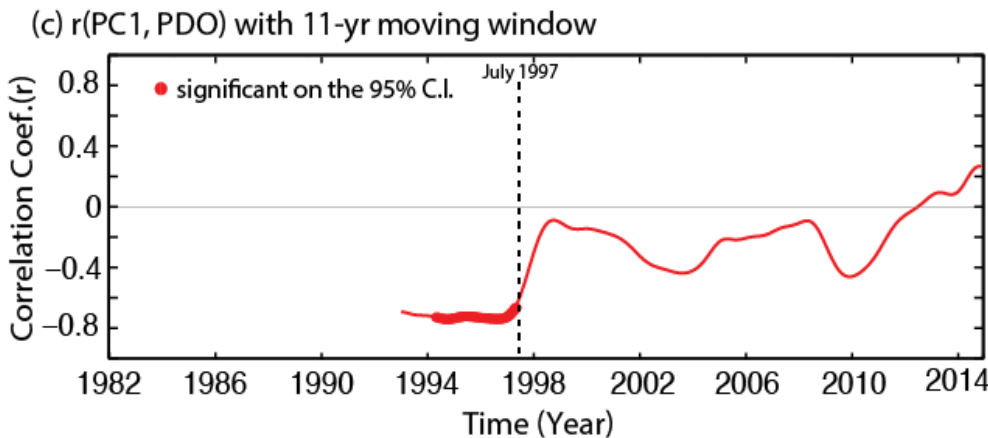


# Relation of PC1 with Climate Indices



$$PC1 = -0.70PDO + 0.03AO \quad (r = 0.64)$$

$r = -0.51$  (1982-1996)  
due to common physical processes (ENSO)



PC1	PDO	NPGO	AO	N34
1982-1996	<b>-0.64</b>	-0.16	<b>+0.48</b>	+0.13
1998-2014	+0.18	-0.06	+0.24	+0.23
Whole Period	-0.32	+0.22	+0.18	-0.15

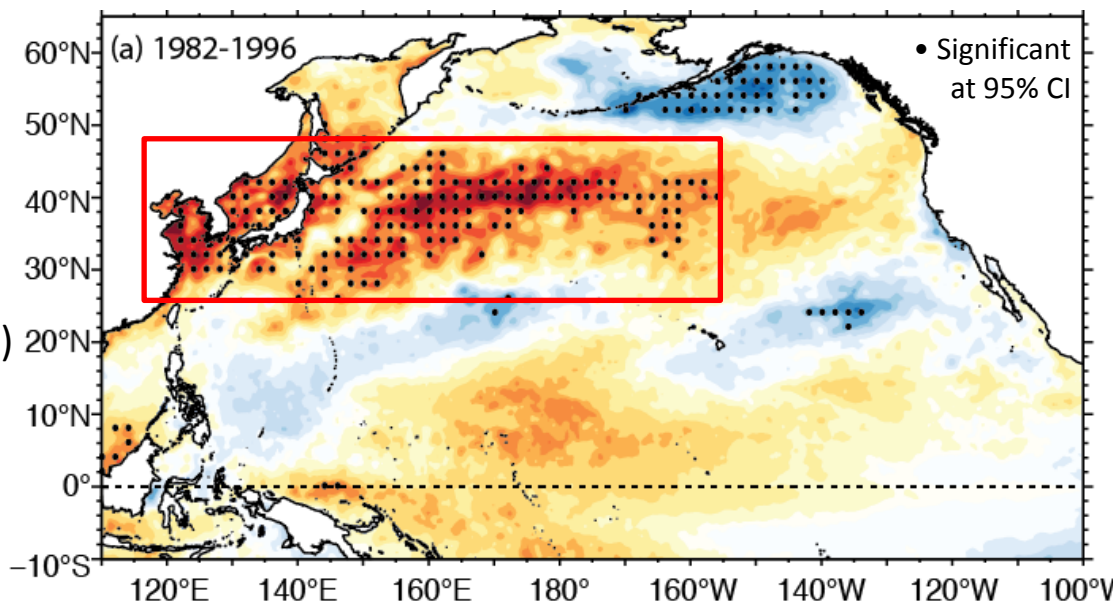
- The significant correlation of up to  $-0.70$  drops to insignificant level across 1997.
- Is the relationship change between the PDO and YECS SST related with the 1997 /1998 North Pacific climate regime shift?



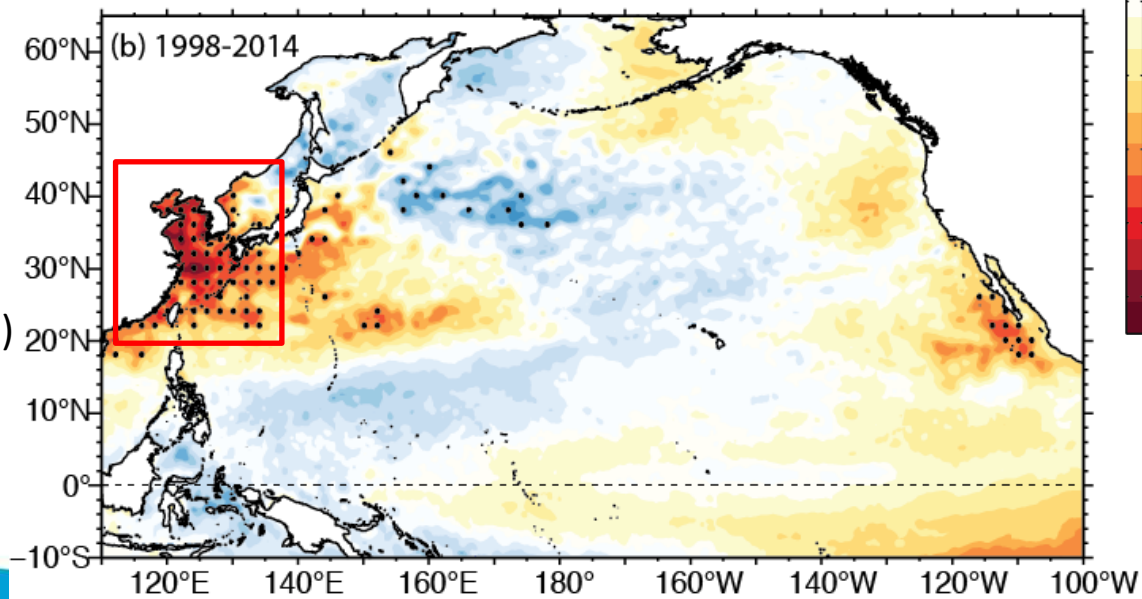


# Correlation(YECS PC1, North Pacific SSTa)

Before  
Regime shift  
(BRS;1982-1996)



After  
Regime shift  
(ARS;1998-2014)



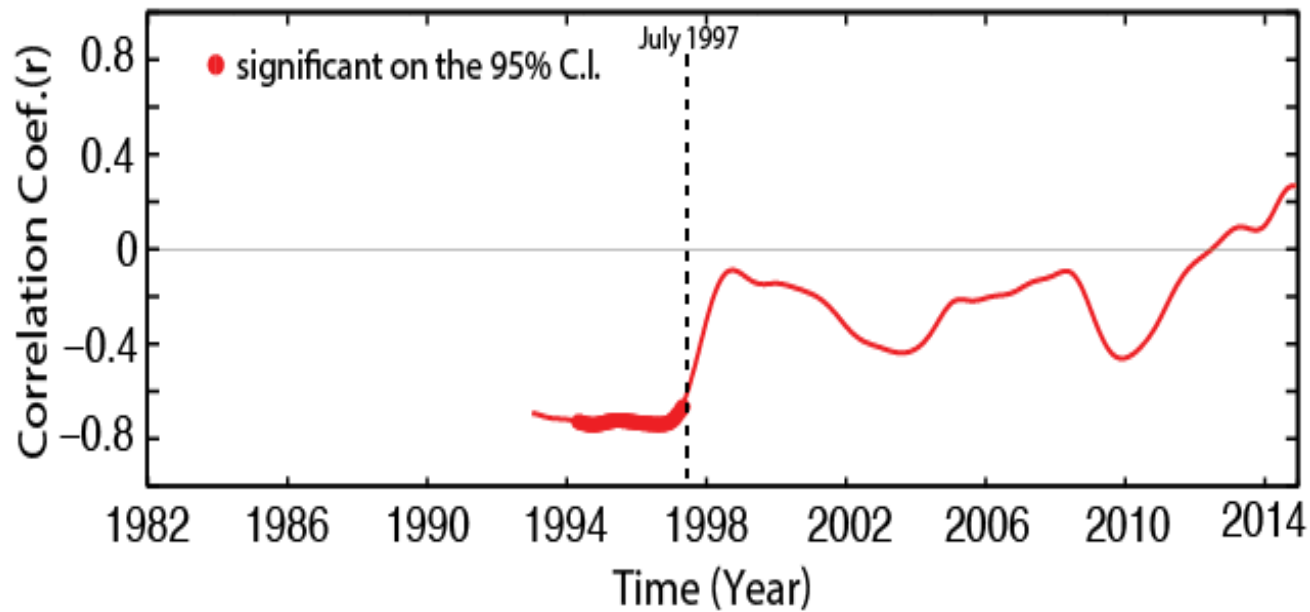
- SST PC1 in the YECS varies coherently with SST in broad regions over the North Pacific before the regime shift.

- The coherent regions shrank dramatically to the seas around China in the recent period.



# What could control SST after 97/98?

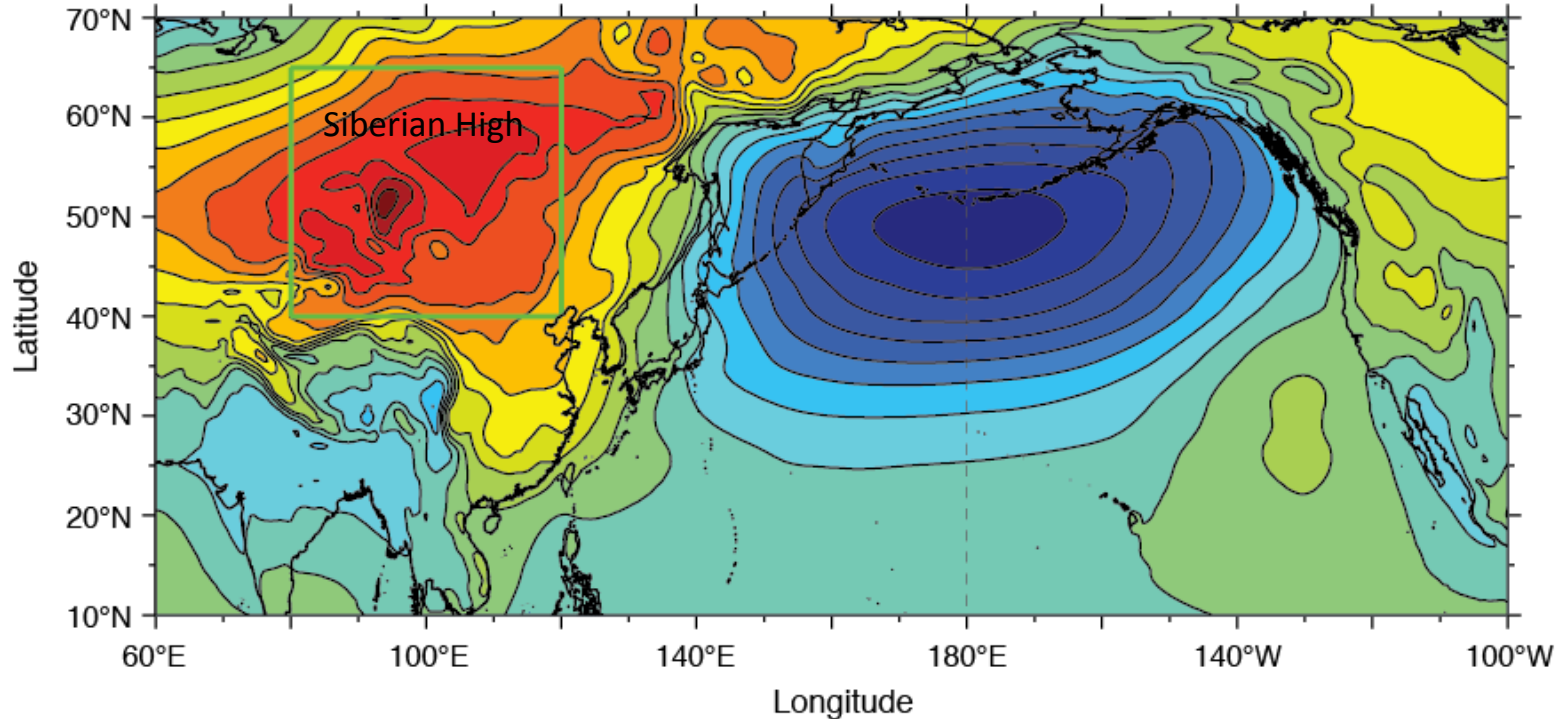
(c)  $r(\text{PC1}, \text{PDO})$  with 11-yr moving window





# Siberian High Index

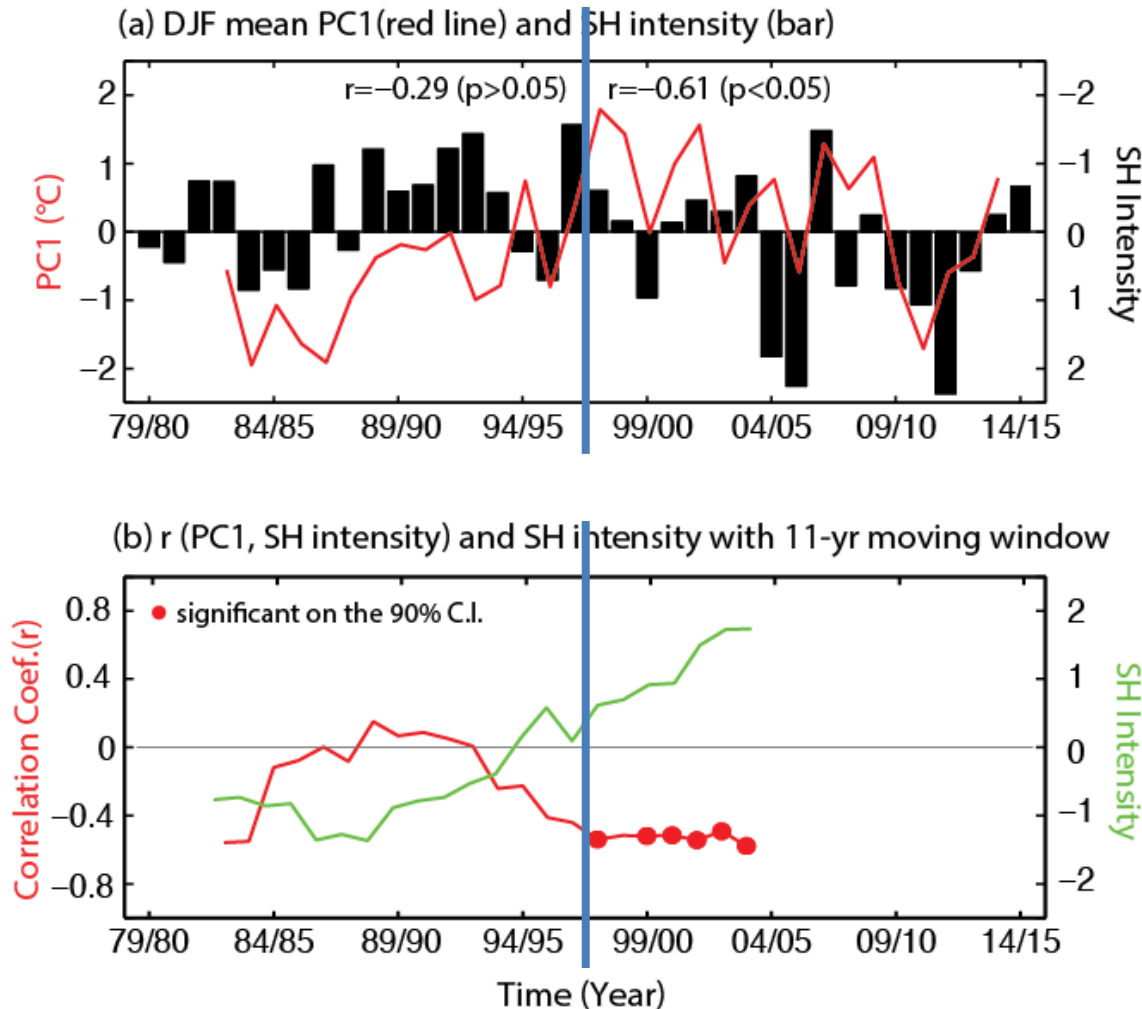
DJF mean SLP (1979-2015) ECMWF interim



- **SHI** is defined as a normalized SLP anomalies area-averaged over the northwestern Mongolian region (the green box).

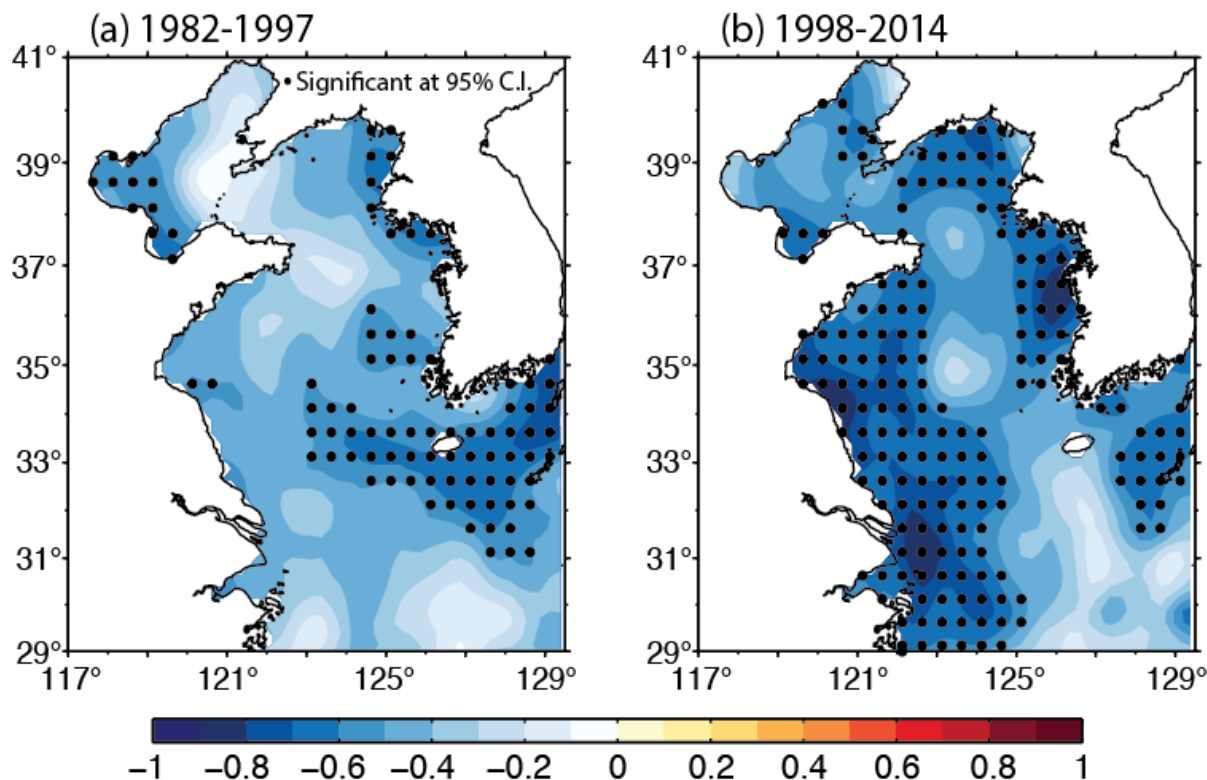


# Correlation of PC1 with Siberian High Index



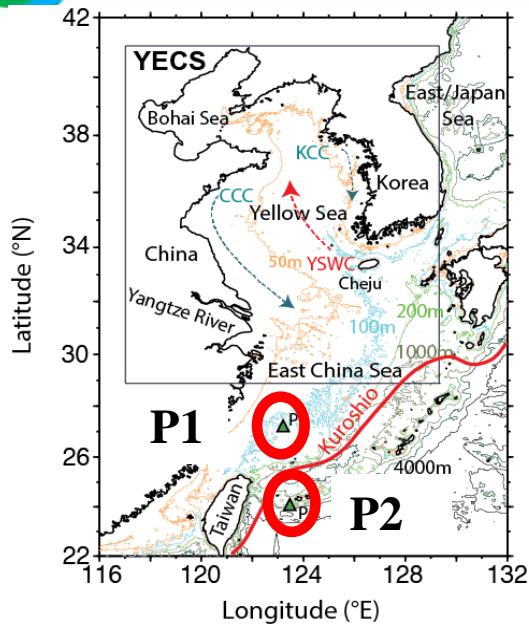
- The SST PC1 timeseries were **weakly correlated** ( $r=-0.3$ ) with the SH index before the late 1990s (1982–1997), while their correlation **increased to  $-0.6$**  in after the late 1990s (1998–2014).
- A moving correlation with an 11-year window demonstrates that the **correlation increased** to a significant level after the 1997/98, along **with SH intensification**.

# Correlation (SH intensity, SSTa)



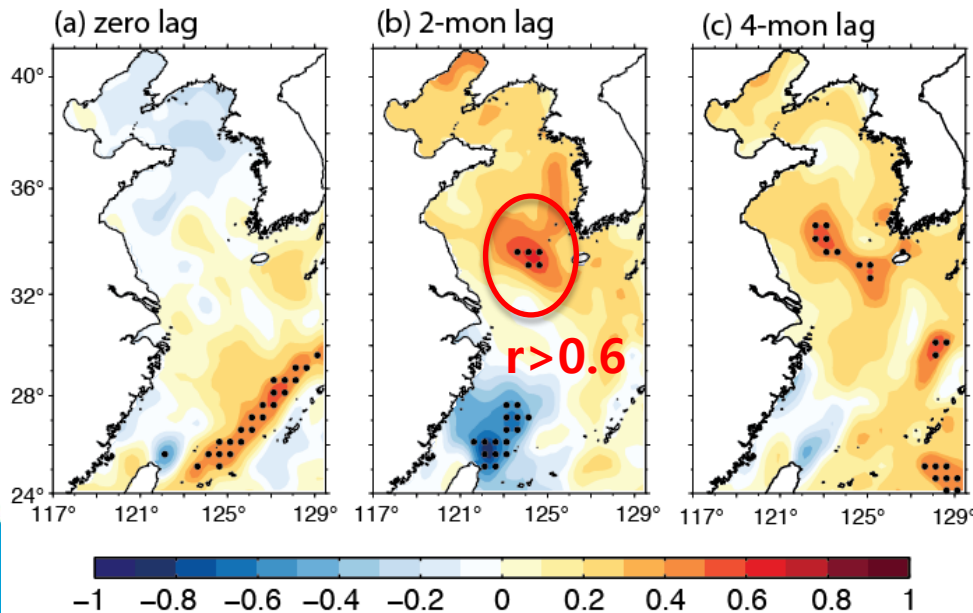
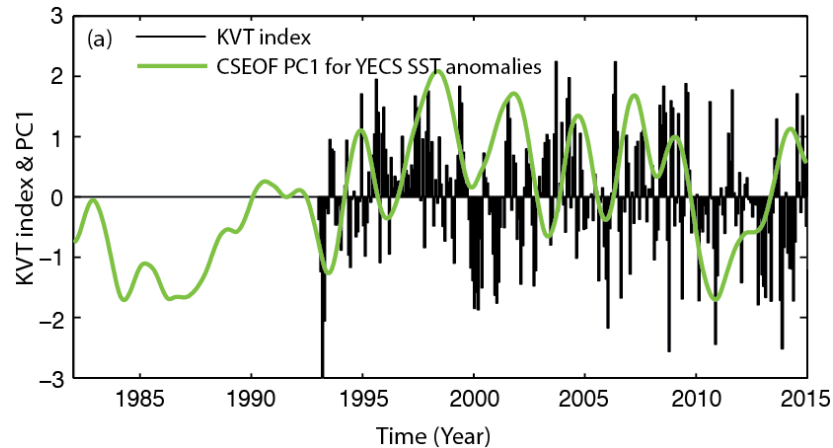
- Recently observed cooling trend in the YECS can be attributed, at least in part, to the **intensified SH pressure system**.
- However, there are weak correlations especially along the trough.

# Effects of the Kuroshio



$$\text{Kuroshio Volume Transport (KVT)} = 0.31 \times \text{SLD}_{P1-P2} + 6.55$$

Yan and Sun (2015)



## KVT precedes SSTa

High correlations ( $r > 0.6$ ) appear along the central trough in 2 to 4-month lagged maps, suggesting **the influence of the Kuroshio on the local SST of the YECS** (Wei et al. 2013).



# Conclusions

1. The SST long-term variation in the Yellow and East China Seas (YECS) shows **a recent basin-wide cooling trend** after 97/98 before which a warming trend persists.
2. This recent cooling can be explained by two factors:
  - A **weakening of the North Pacific** (PDO) influence on YECS SST variability
  - More importantly, the **SH intensification** by wind strengthening
3. Future study: **Ecosystem responses** to the cooling, & **possible mechanisms** for North Pacific regime shift



Спасибо  
**Thank you**