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Recent surface cooling in the Yellow and East China Seas and its possible causes

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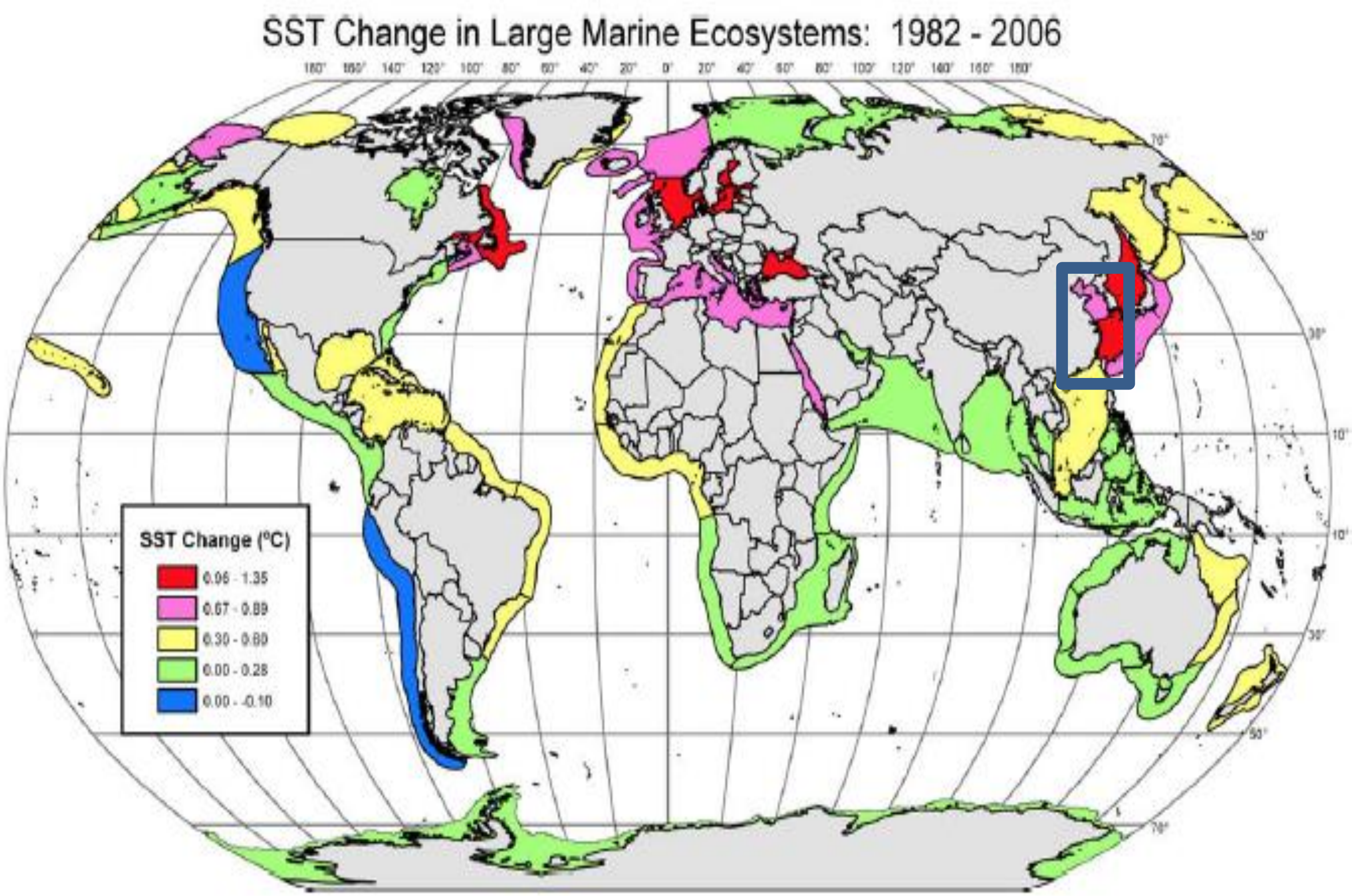
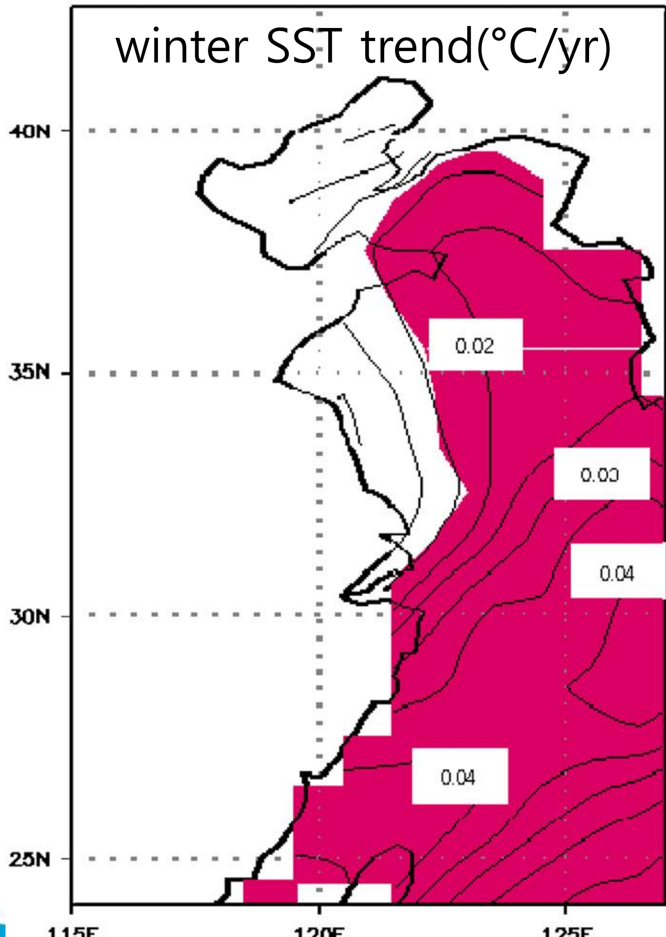
SST Changes in LMEs

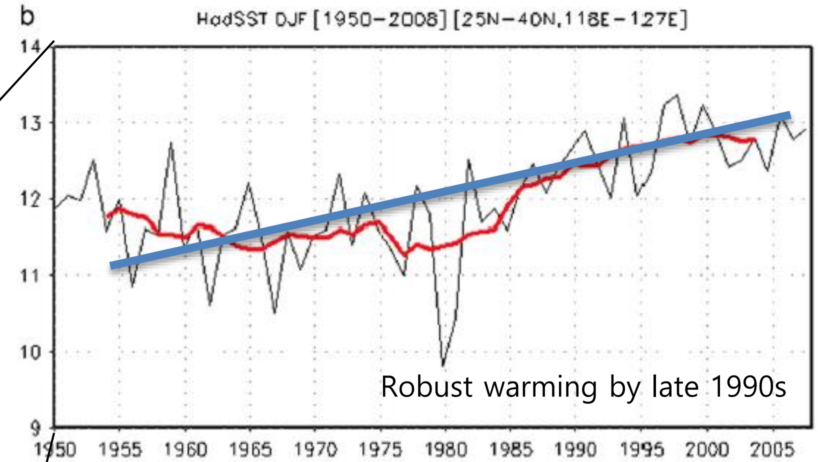
Belkin (2009)



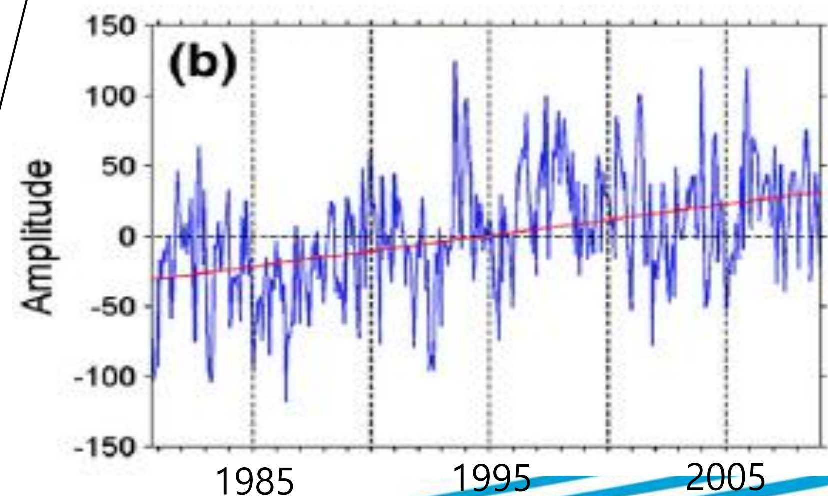
YECS SST change

Yeh and Kim (2010)
Trends in winter SST(°C/yr)
Based on HadISST (1950–2008)



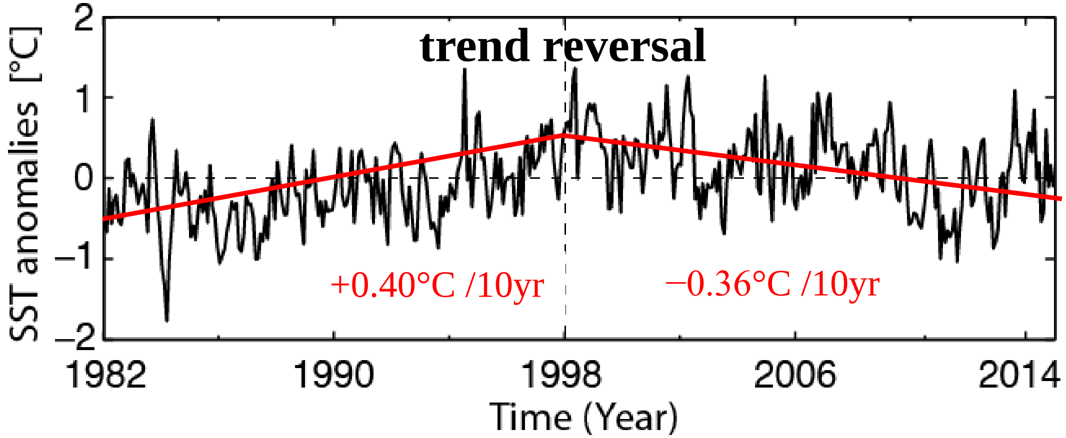


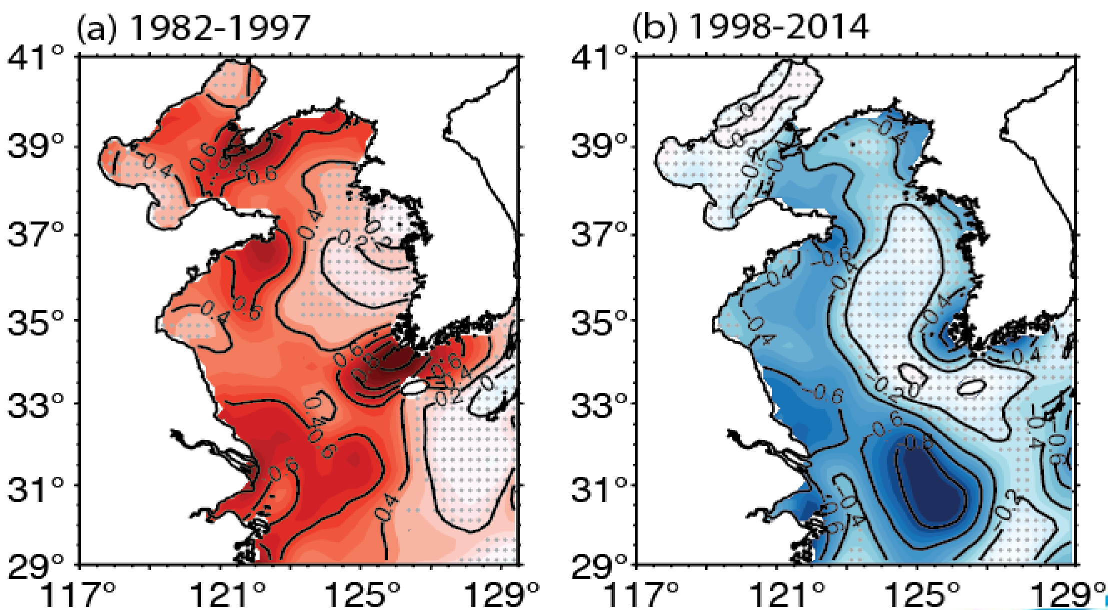
Park et al. (2015)
AVHRR SST anomaly (1981–2009):1st EOF amplitude



SST Trend Shift: Warming to Cooling

YECS averaged monthly SSTa (OISST)





Basin-scale cooling

- Dynamics?

CSEOF Analysis

Kim KY et al. (2015, ESR)

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

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

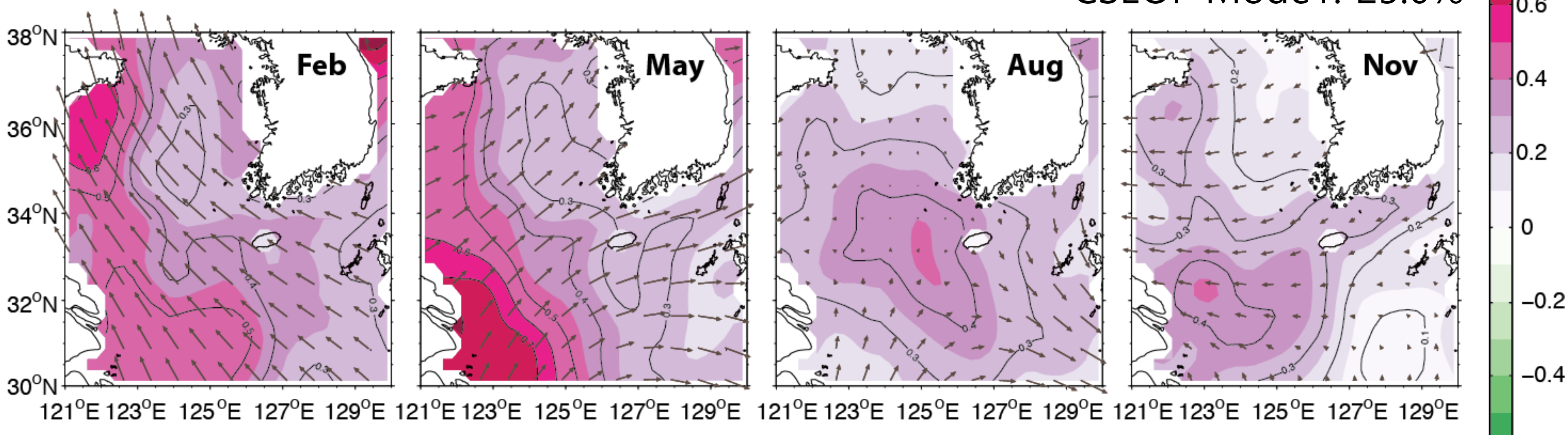
cf) EOF : $P(r,t) = \sum_n B_n(r)T_n(t)$

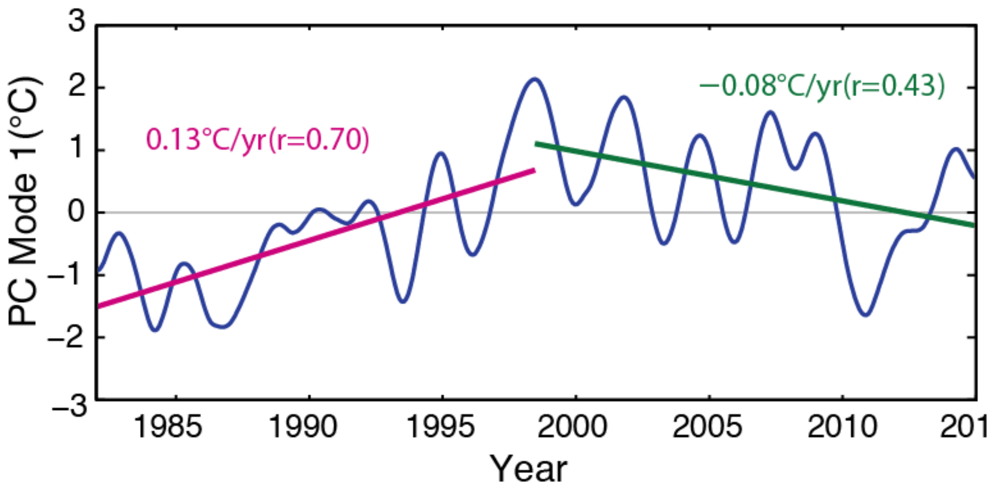
- Periodic time series
- d: nested period (or seasonal period = 12)

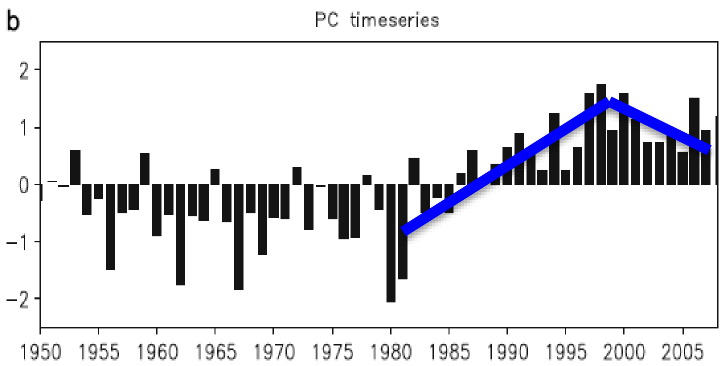
- Target variable: monthly averaged SSTa (OISSTv2)
- Predict variable: surface winds (ECMWF Interim)

CSEOF mode1 for YECS SSTa

CSEOF Mode1: 25.0%

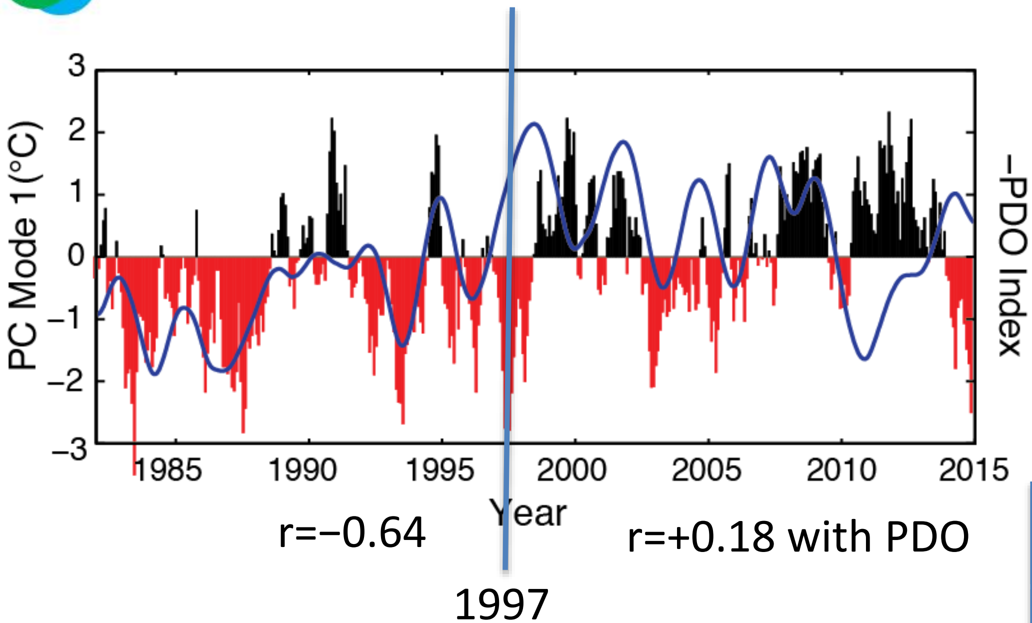


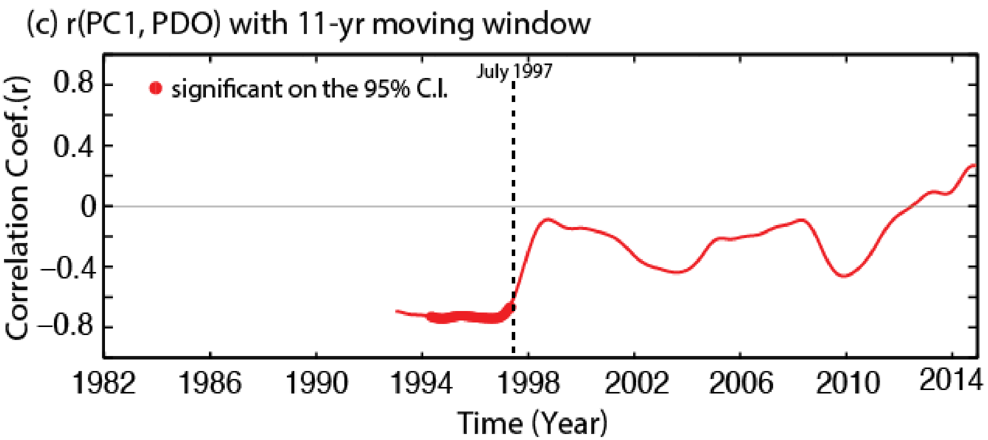




Yeh and Kim (2010,CSR)

Relation of PC1 with Climate Indices





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

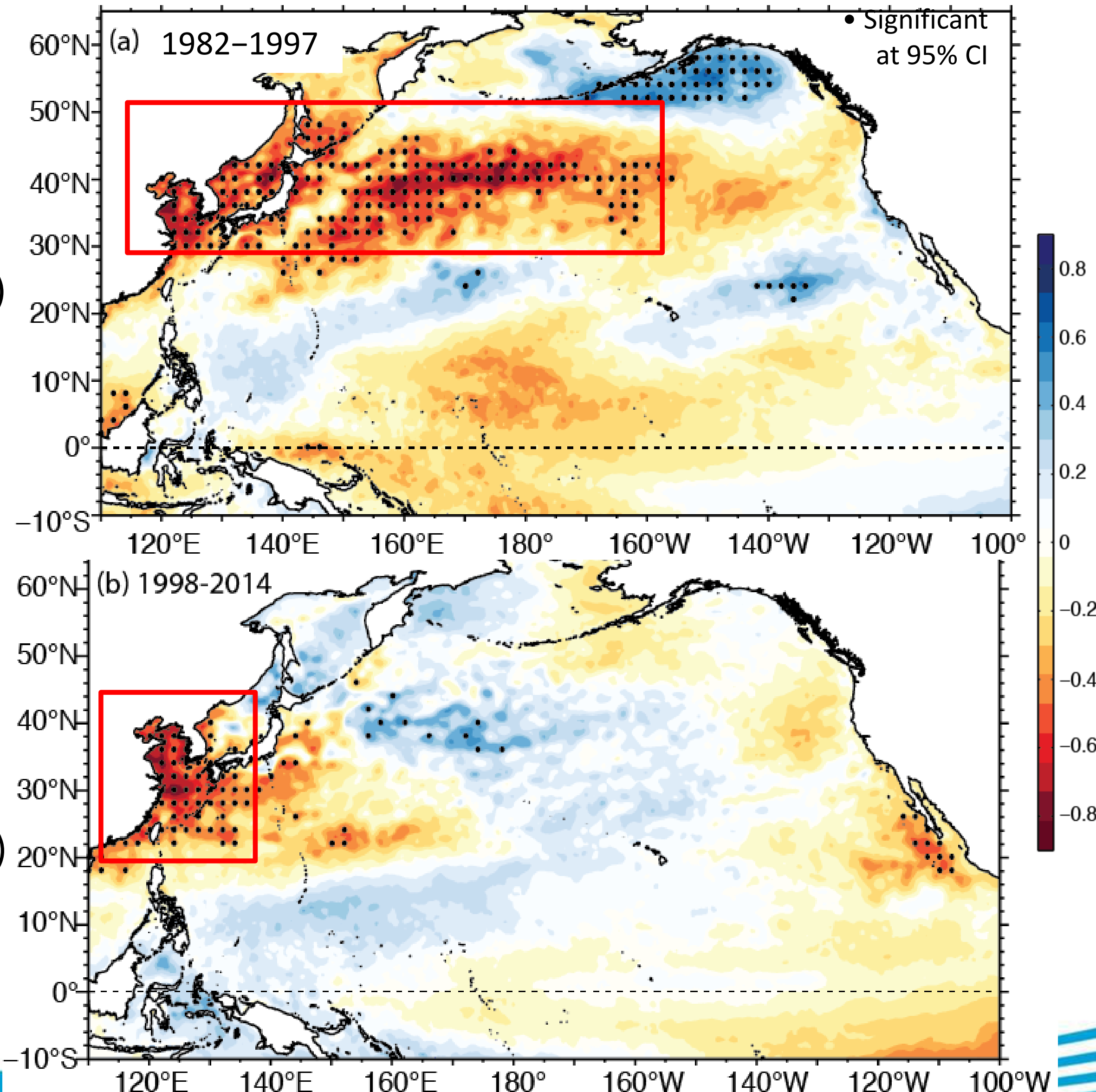
PC1	PDO	NPGO	AO	N34
1982−1996	**−0.64**	−0.16	**+0.48**	+0.13
1998−2014	+0.18	−0.06	+0.24	+0.23
Whole Period	−0.32	+0.22	+0.18	−0.15

- 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;1982–1997)

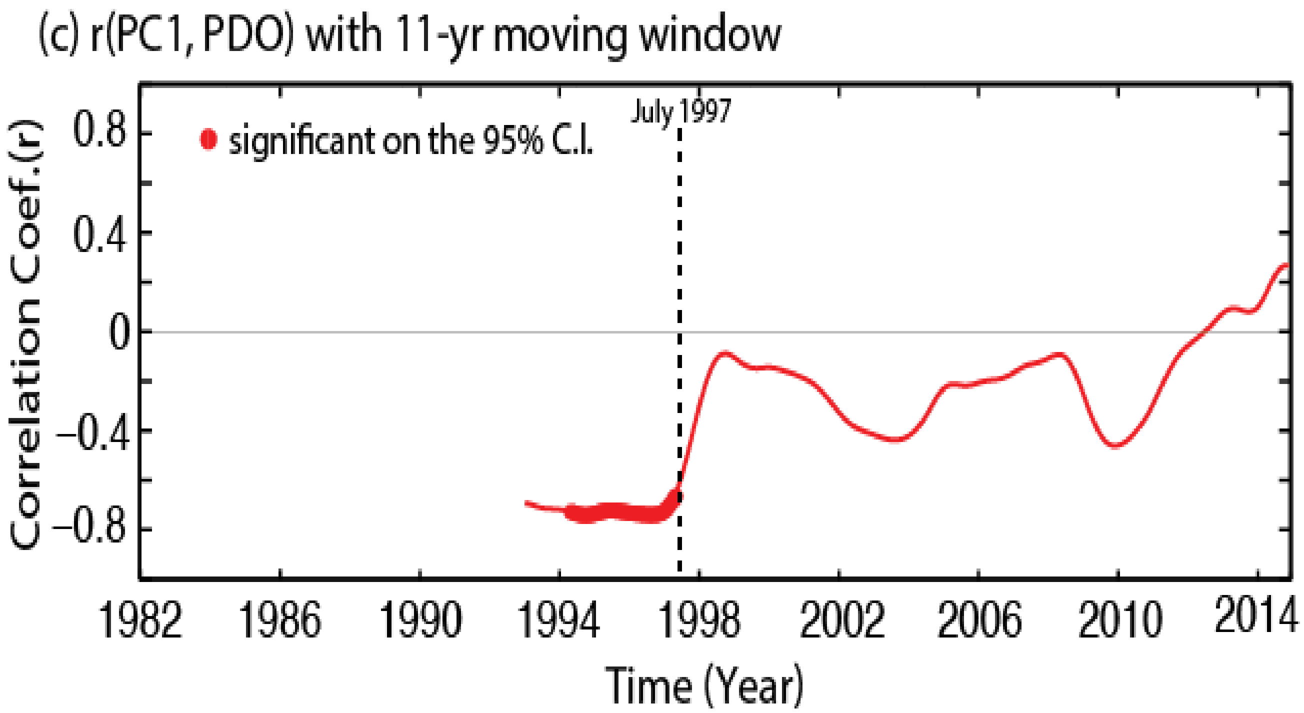
After
Regime shift
(ARS;1998–2014)



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

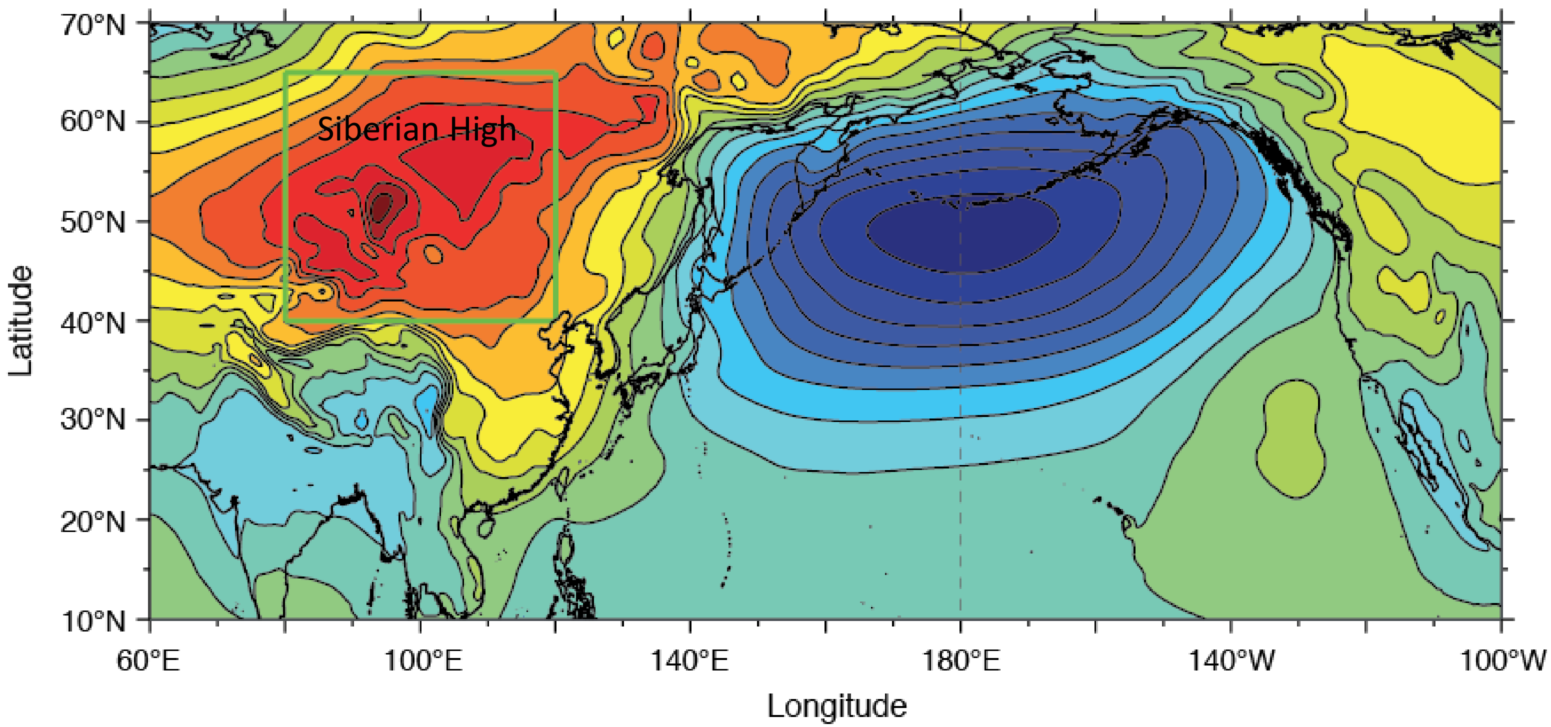
- The coherent regions shrank dramatically to the seas around China in the recent period.

What contributes to the cooling after 97/98?



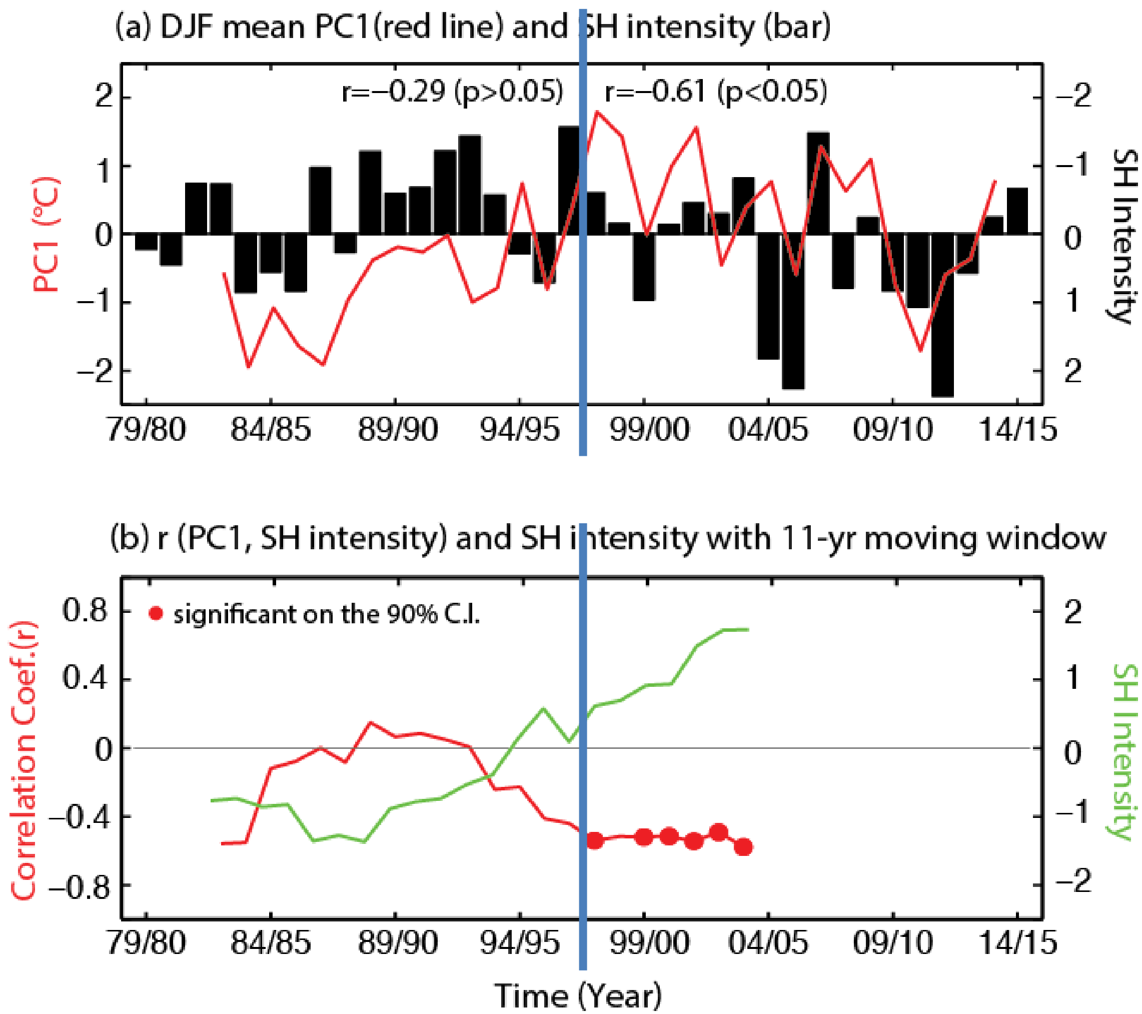
Siberian High Index

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).

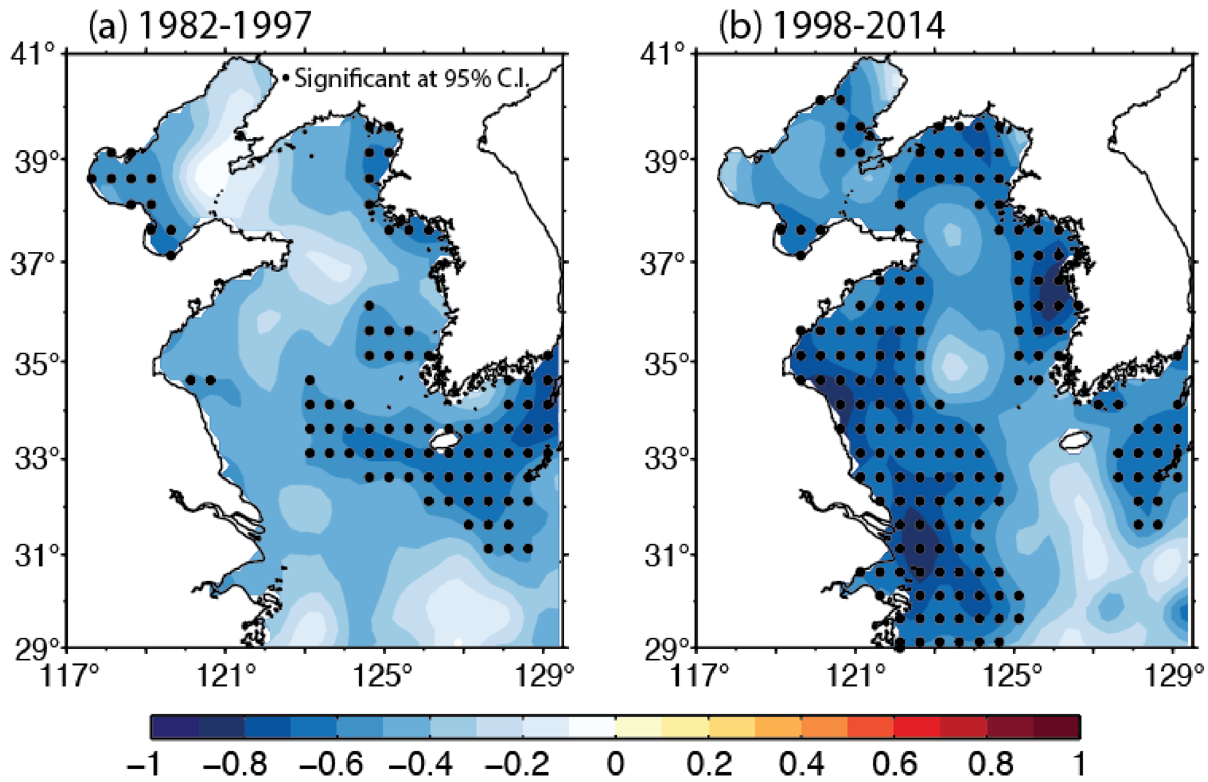
Correlation of PC1 with Siberian High Index



- 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).

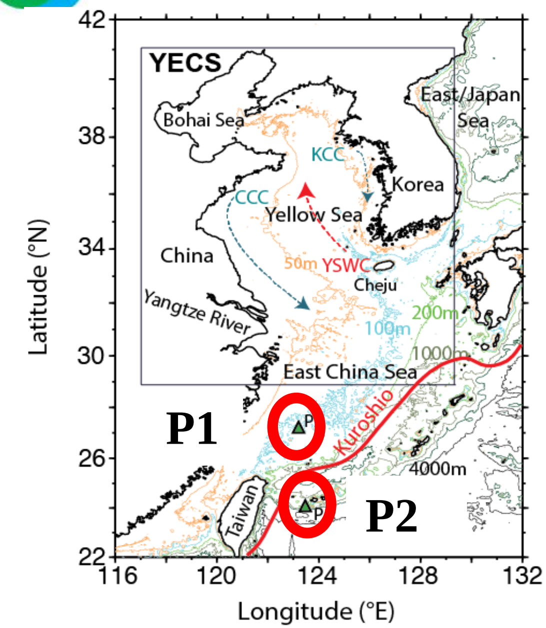
- A moving correlation with an 11-year window demonstrates that the **correlation increased** to a significant level after the 1997/98, along **with SH intensification**.

Correlation (SH intensity, SSTa)



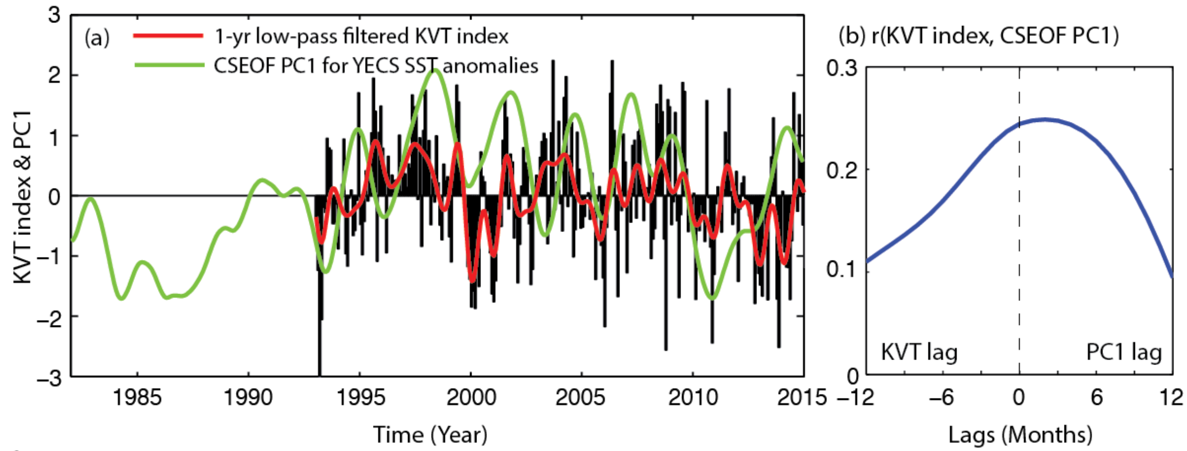
- Recently observed cooling trend in the YECS can be attributed, at least in part, to the intensified SH pressure system.
- However, there are weak correlations especially along the trough.

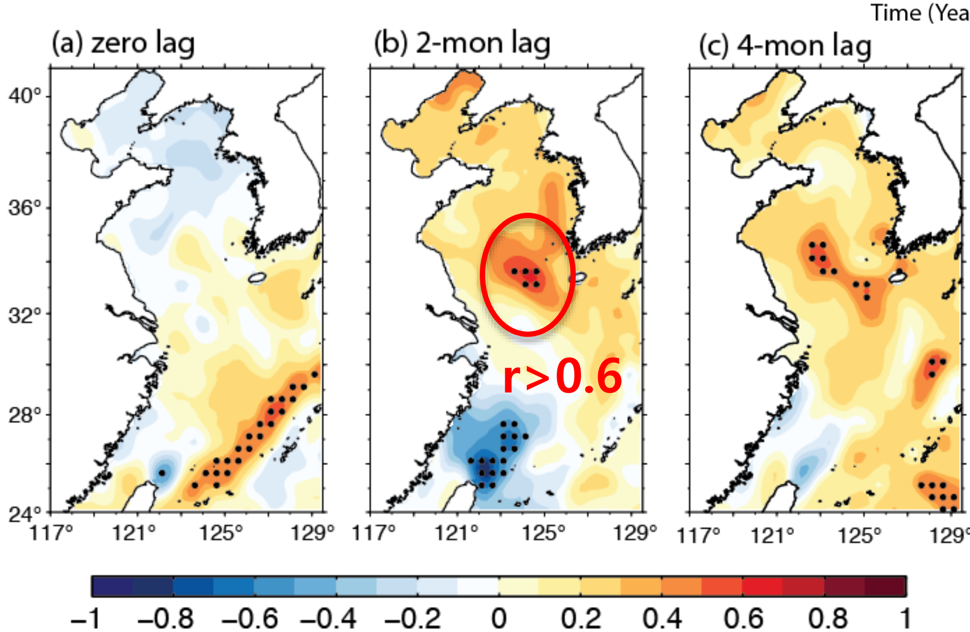
Effects of the Kuroshio



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

Yan and Sun (2015)





KVT precedes SSTa

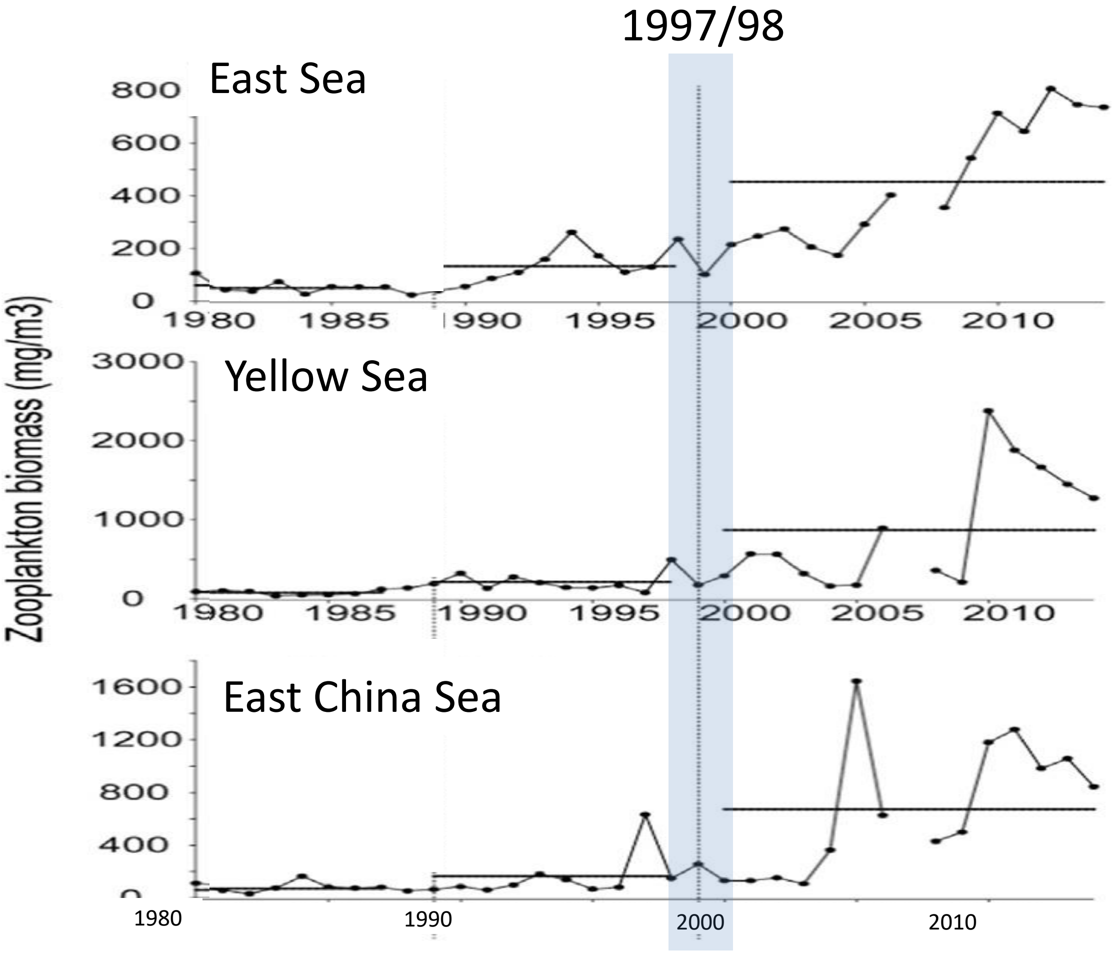
High correlations (r>0.6) appear along the central trough in 2 to 4-month lagged maps, suggesting **the influence of the Kuroshio on the local SST of the YECS** (Wei et al. 2013).

Conclusions

1. The SST long-term variation in the Yellow and East China Seas (YECS) shows **a recent basin-wide cooling trend in winter** after 97/98 before which a warming trend persists.
2. This recent cooling can be explained by two factors:
   - The **weakening of the North Pacific** (PDO) influence on YECS SST variability
   - The **SH intensification** by wind strengthening
3. Future study
   - Effects of the recent cooling on **ecosystem** in YECS

Regime Shift in 97/98

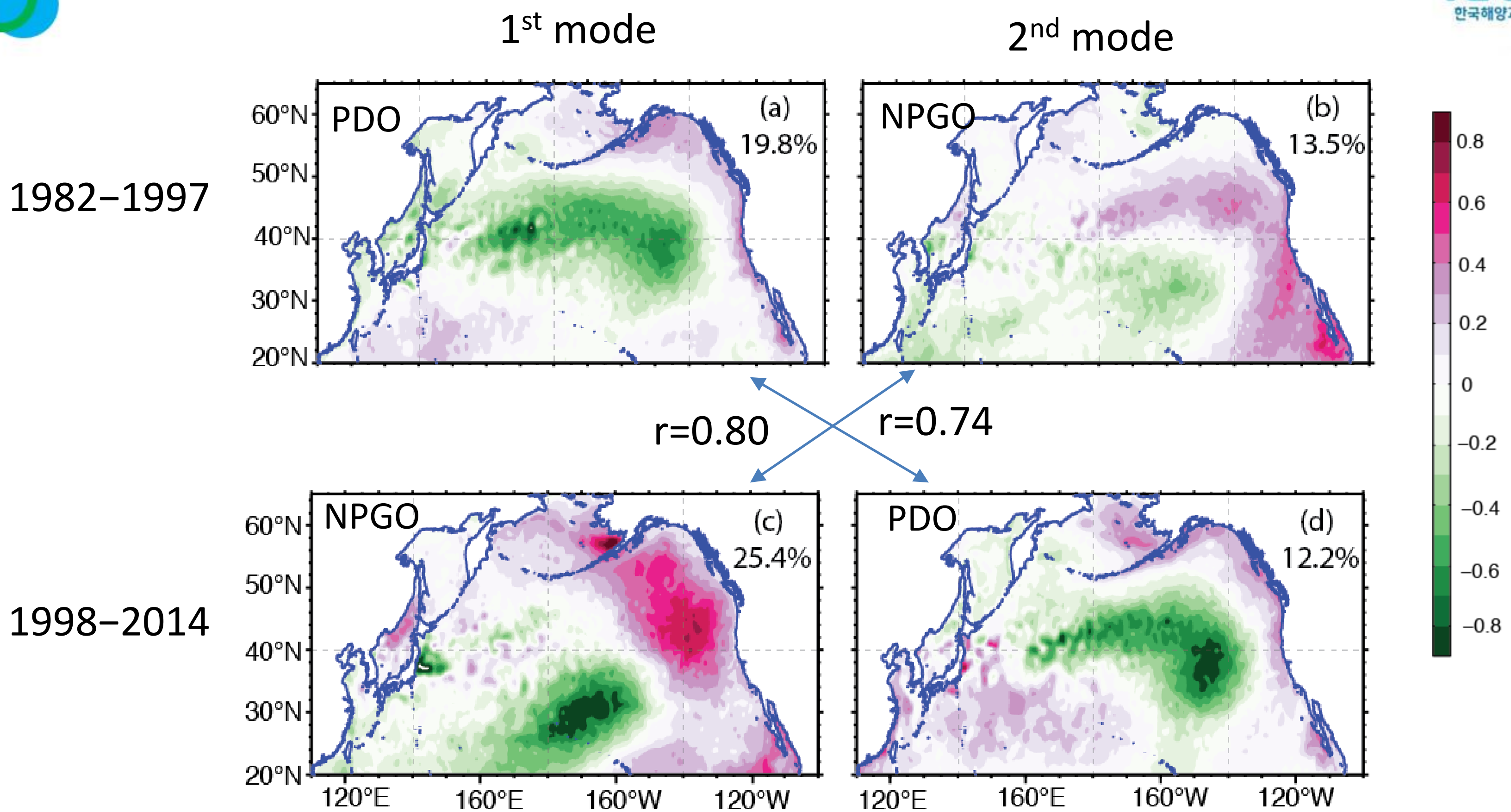
Jung et al (2017)



谢谢

Thank you

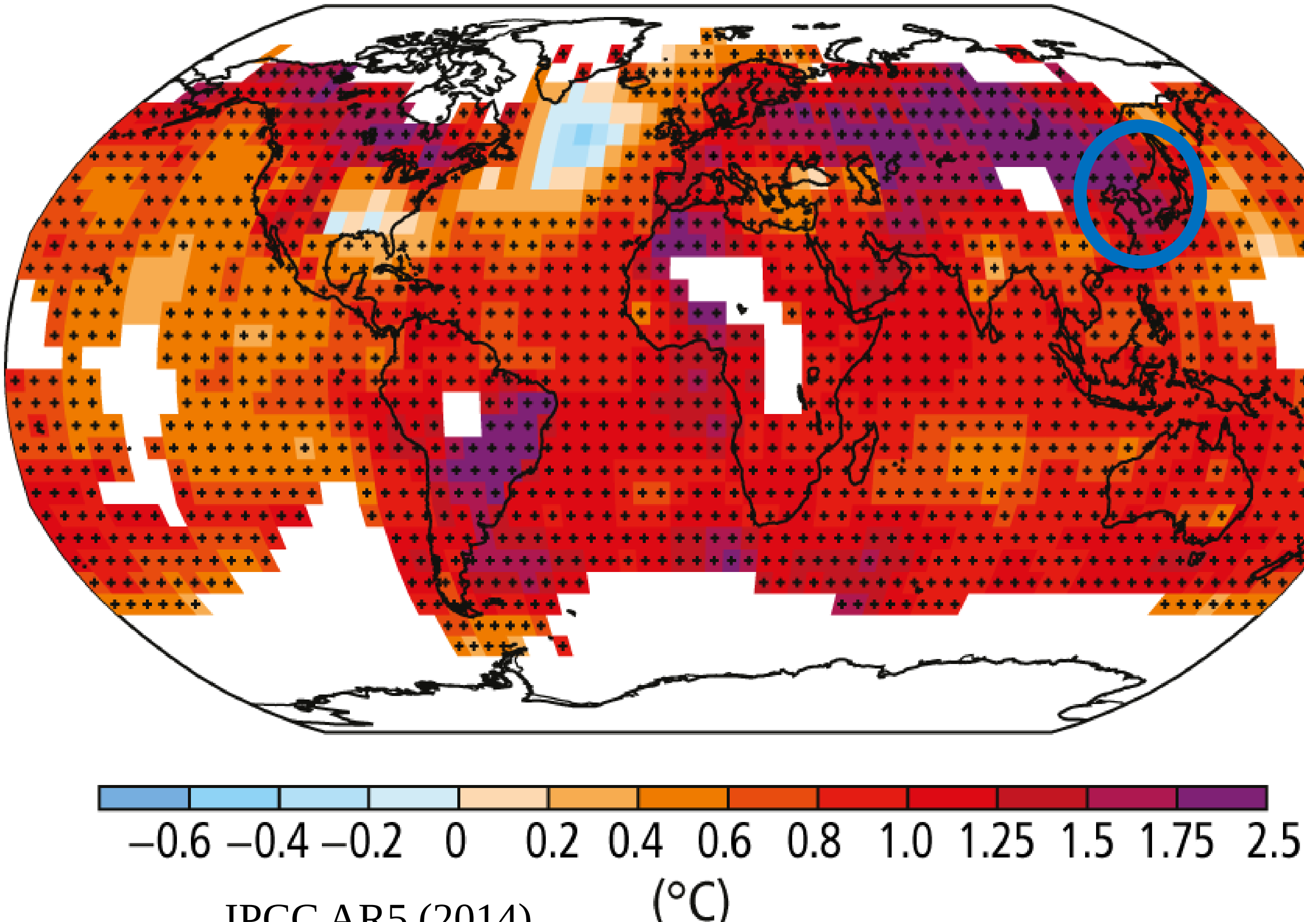
North Pacific SST Mode Shift



- The NPGO signal becomes the 1st mode after the regime shift (Bond et al. 2003; Di Lorenzo et al. 2010).

Surface Temperature Changes

1901 to 2012



IPCC AR5 (2014)

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

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

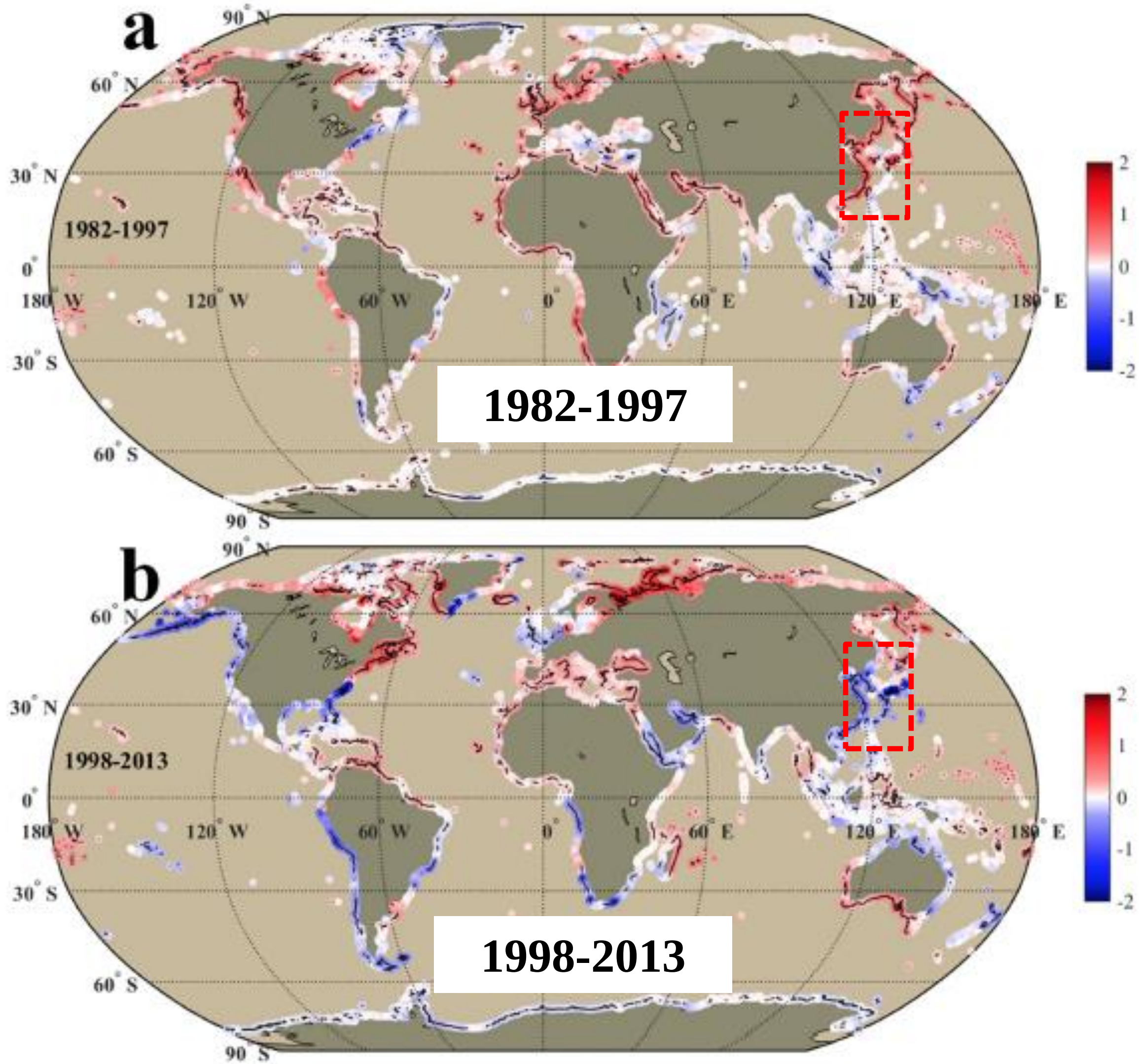


Figure 2. The linear SST trends (unit: °C/decade) along the world's coastlines in the warming (1982–1997, **a**) and hiatus periods (1998–2013, **b**). Black points/lines in the shading color indicate the trends in those locations are significant in statistics (P< 0.05). We generated the two sub-panels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