

# Deep-Ocean Heat Uptake During Global Warming Hiatus Simulated in HadGEM2-AO

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발표 (전북대)

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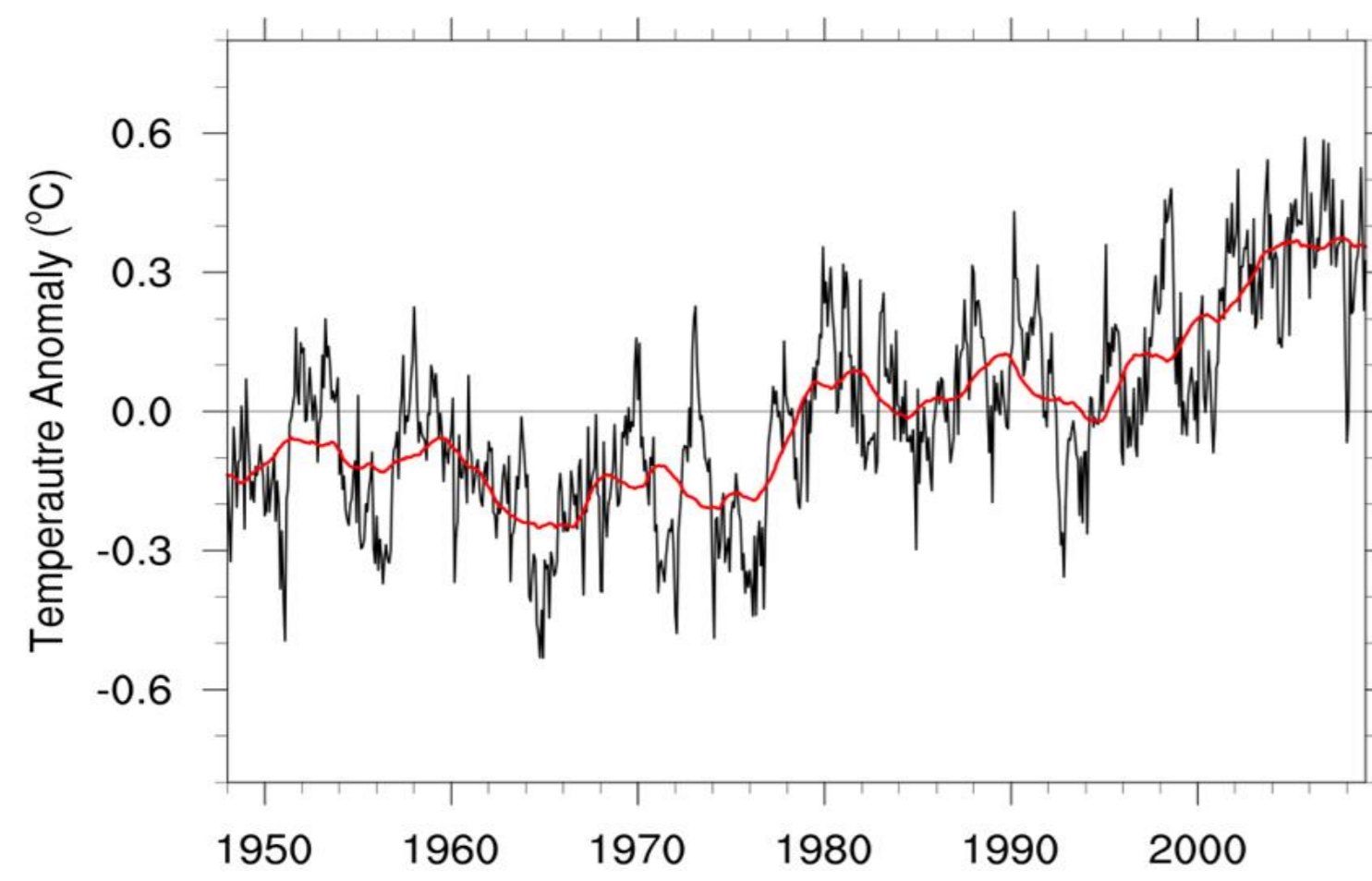
## Introduction

The increase rate of the observed global surface air temperature has reduced in recent decades, although the green house gases concentrations continuously increase. This phenomenon is called hiatus or warming pause(Held,2013). We investigated the characteristics of the warming pause in global warming scenario by HadGEM2-AO (Baek et al., 2013). The RCP8.5 experiment performed by the HadGEM2-AO was run for 95 years(2006-2100) and the radiative forcing of the experiment reached to 8.5W/m<sup>2</sup> by 2100 which means very high baseline emission scenario as a result of additional anthropogenic gases in atmosphere.

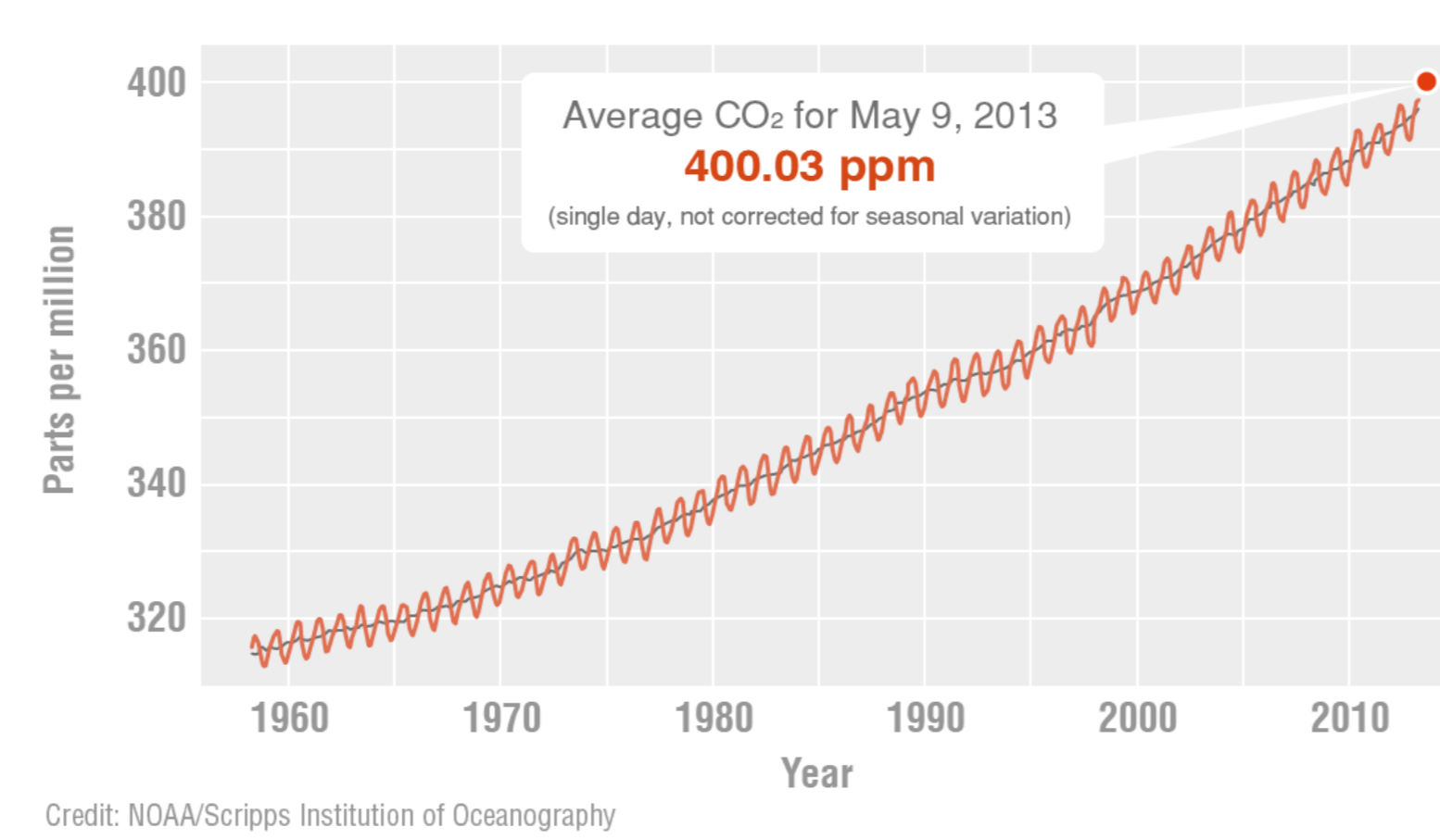
## Global Warming Pause

### Observed Rate Change of Global Warming

(a) Global Mean Temperature

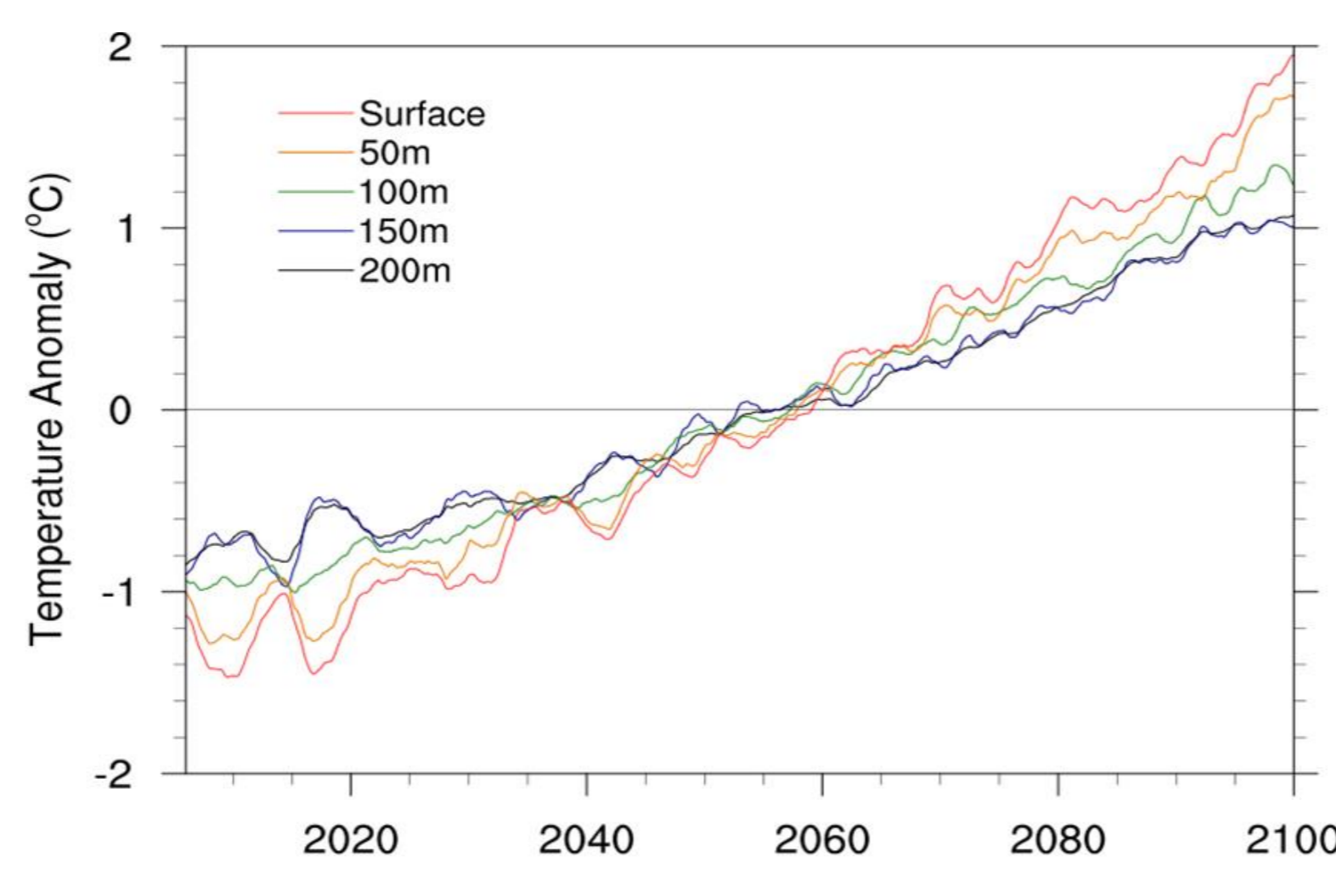
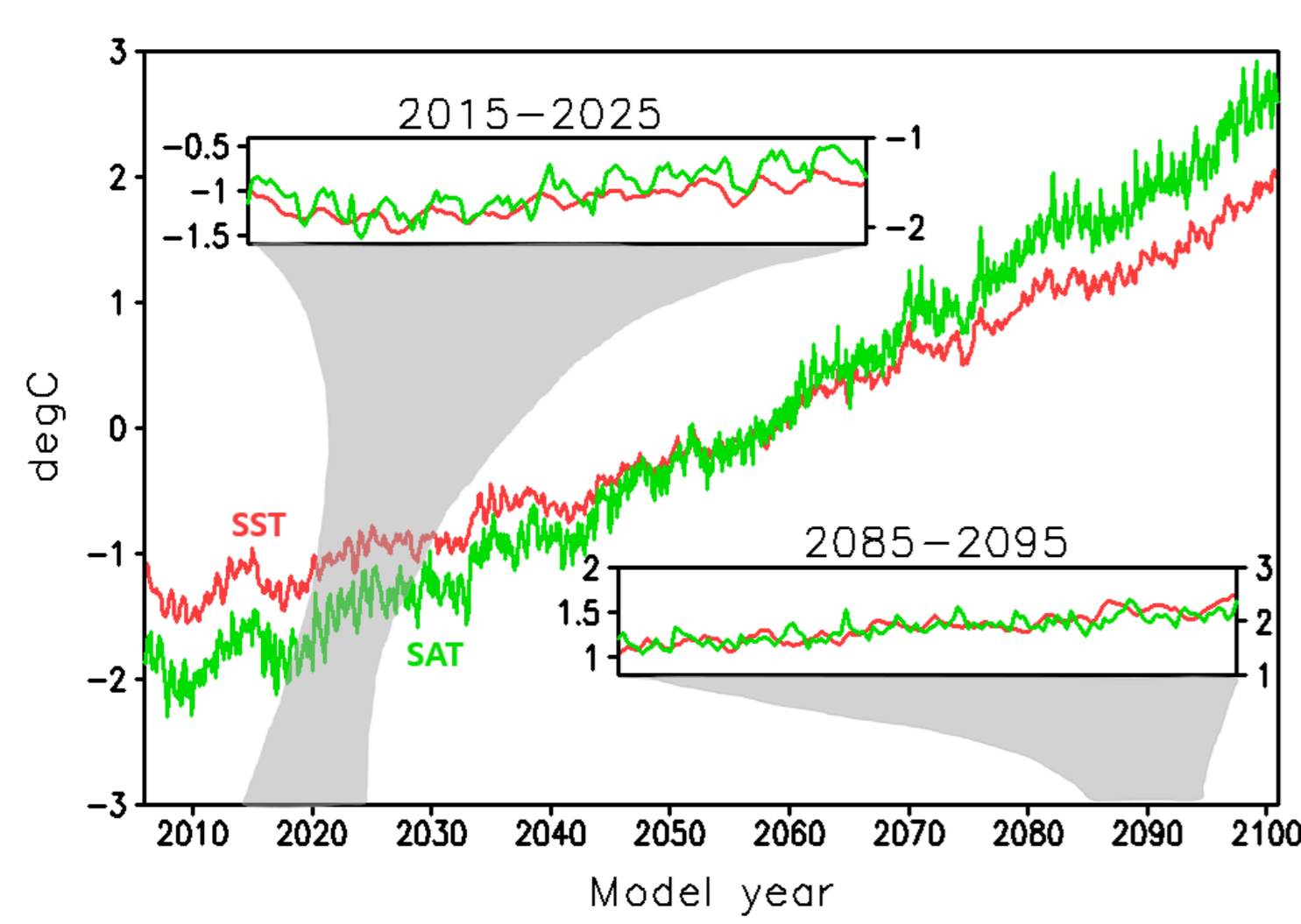


(b) Carbon Dioxide Concentration



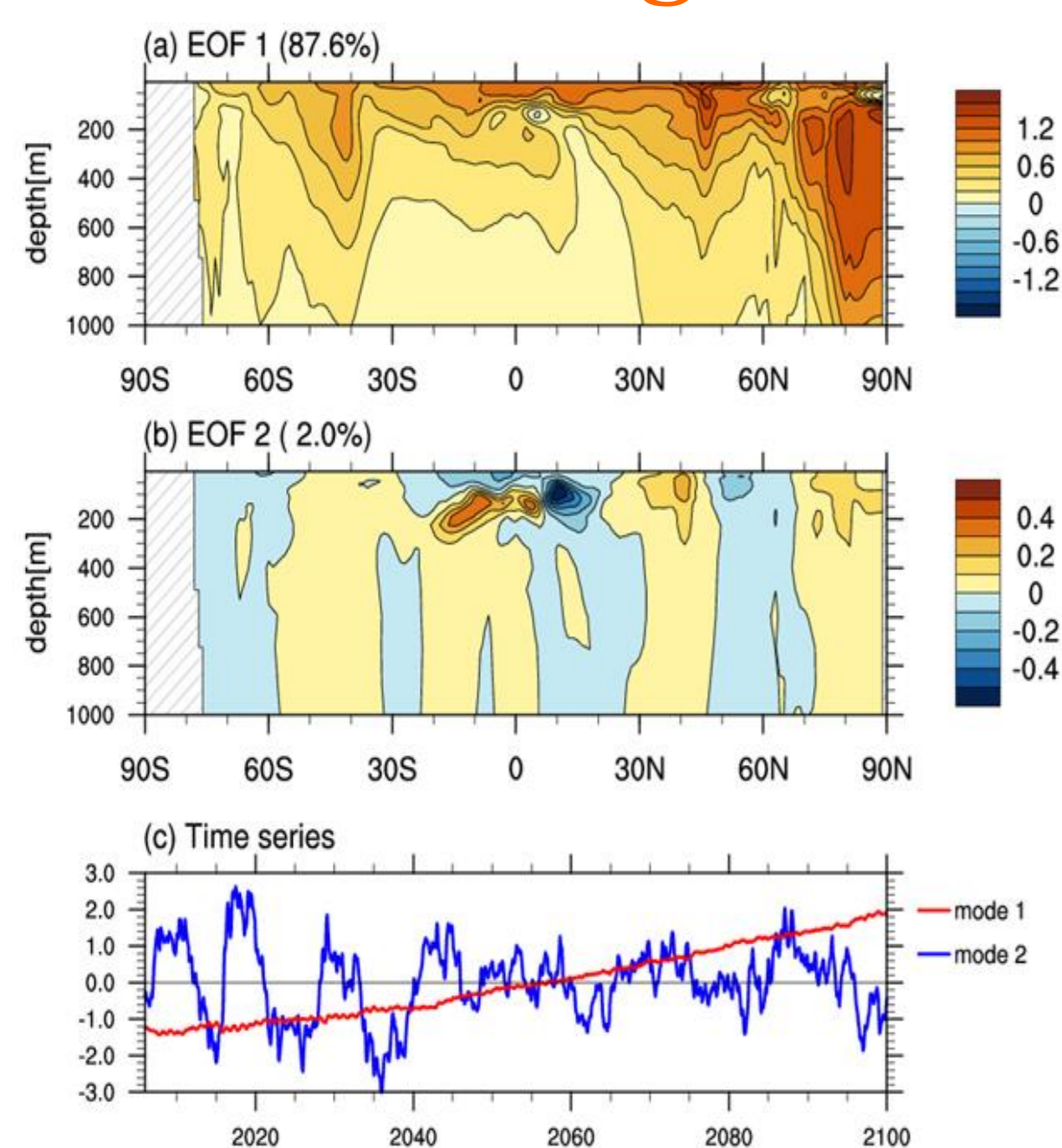
- ✓ Temperature slowed down for recent decade although continuously increasing in carbon dioxide concentration.

### Global Warming Pause in Future



- ✓ Global averaged sea surface temperature has several warming pause decades in global warming scenario in future.
- ✓ It means that the deeper layer gains heat from the upper layer during warming decades. (Meehl et al., 2011; Kosaka and Xie, 2013)

### Warming Pause under Global Warming

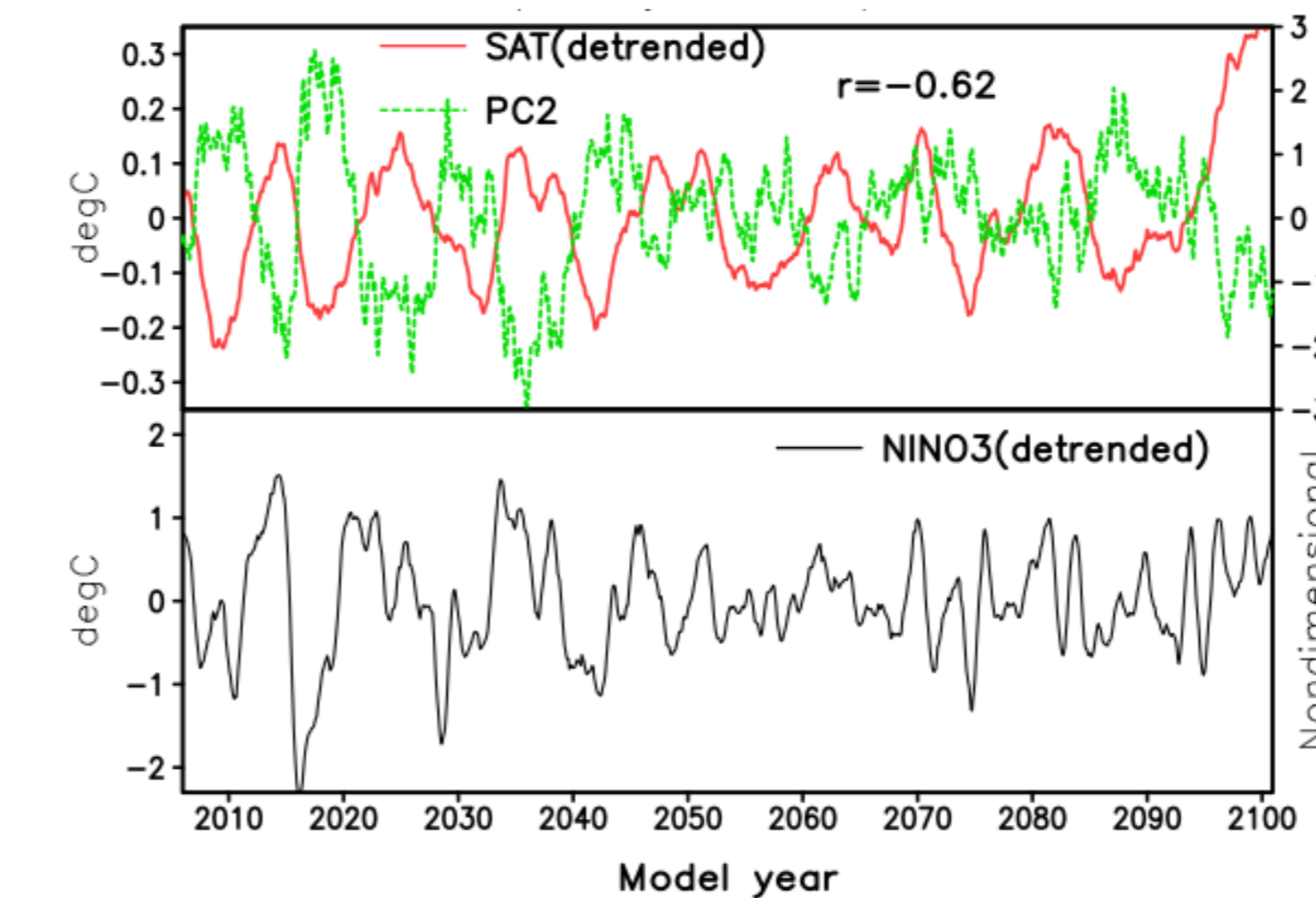


- ✓ The results of the empirical orthogonal function (EOF) analysis of zonal averaged ocean temperature show that the first mode indicates the global warming for whole period, and the second mode is decadal fluctuations which are related to global warming pause decades.
- ✓ Surface and subsurface layer and high-latitude layer in north hemisphere is more warming during global warming (first mode).
- ✓ Surface ocean temperature decreases against the deeper layer temperature under 100m increases for the hiatus decades (second mode).

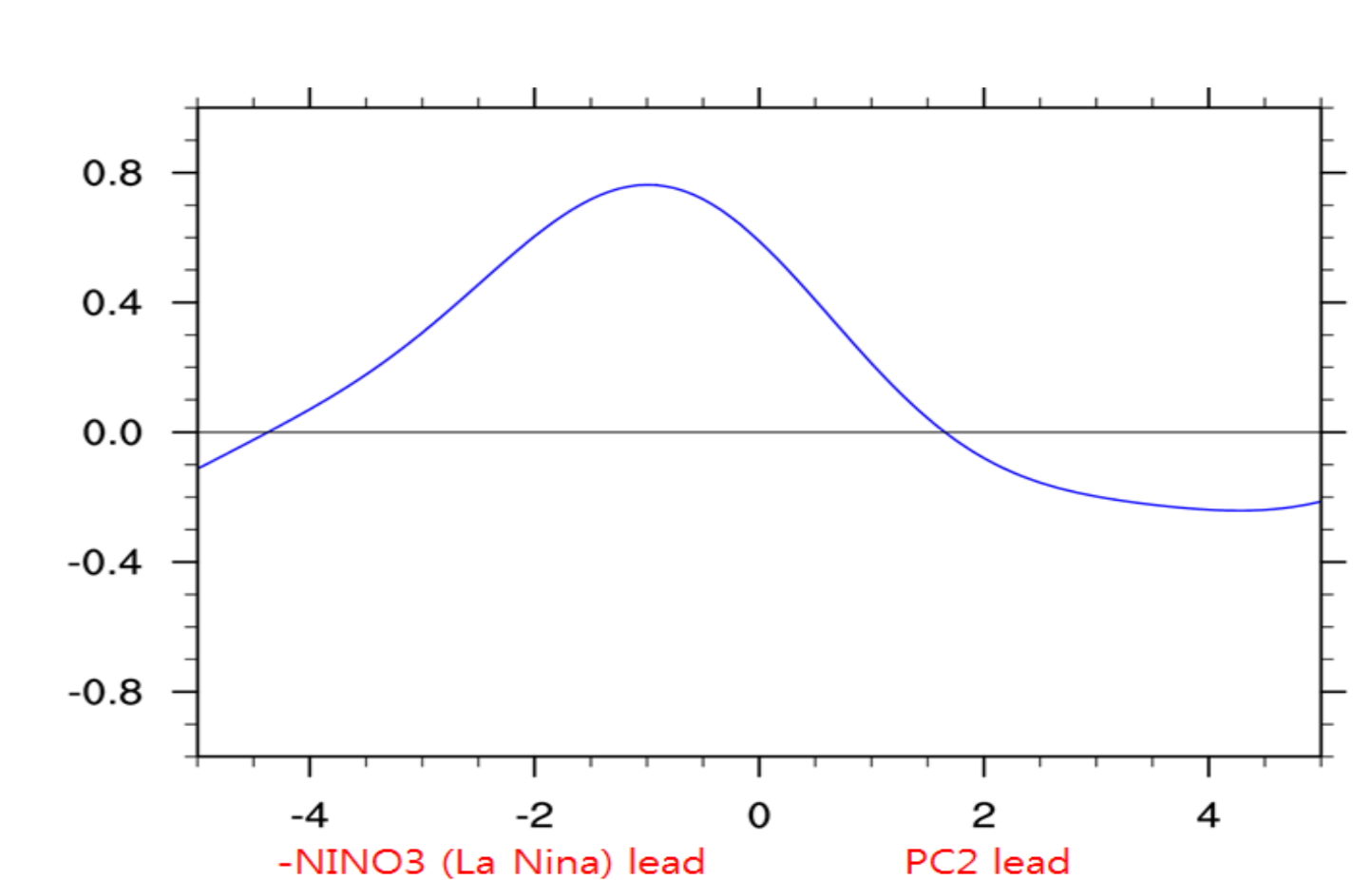
## La Nina leads Warming Pause

### Warming Pause and La Nina

(a) Time series



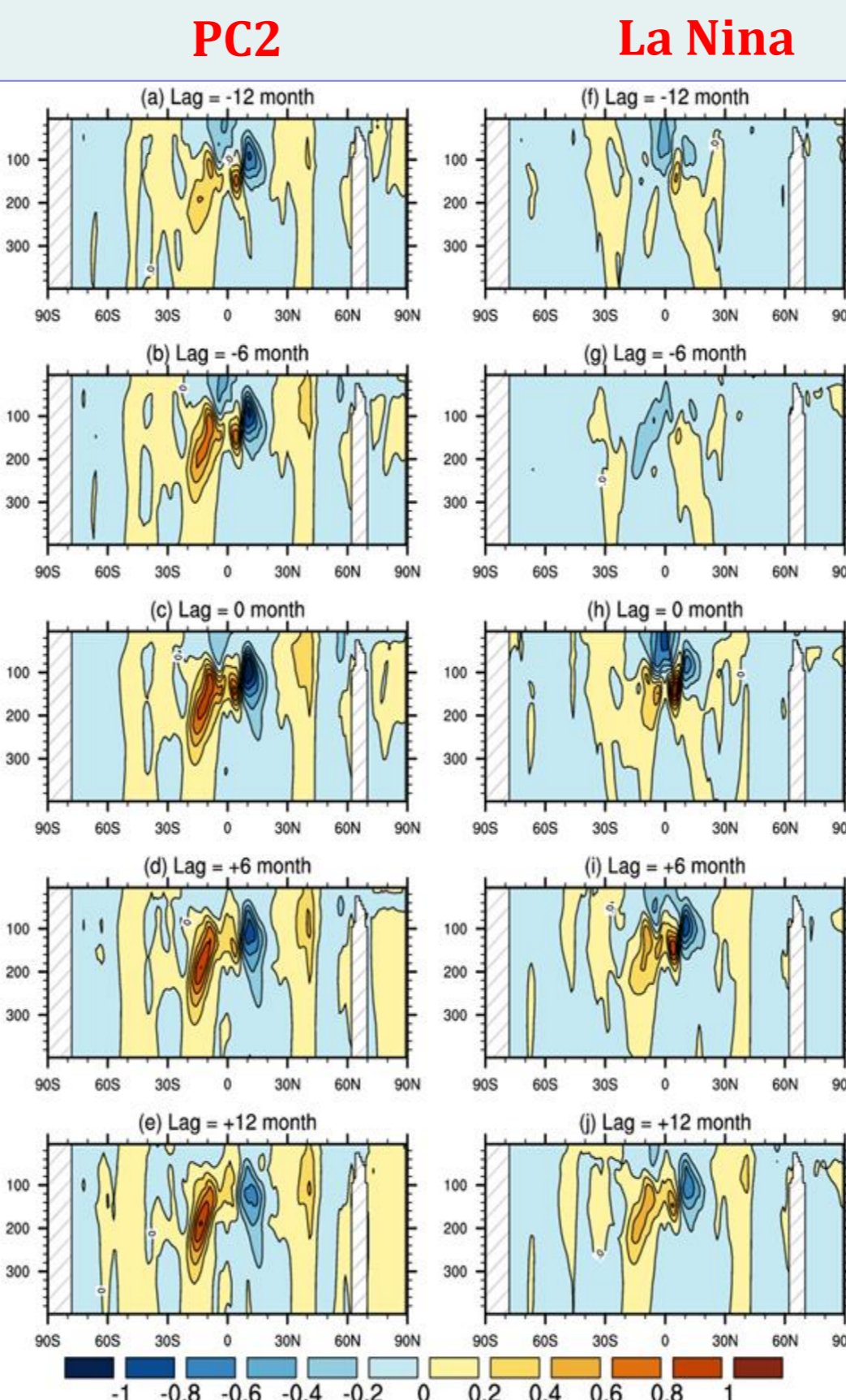
(b) Lead-lag correlation



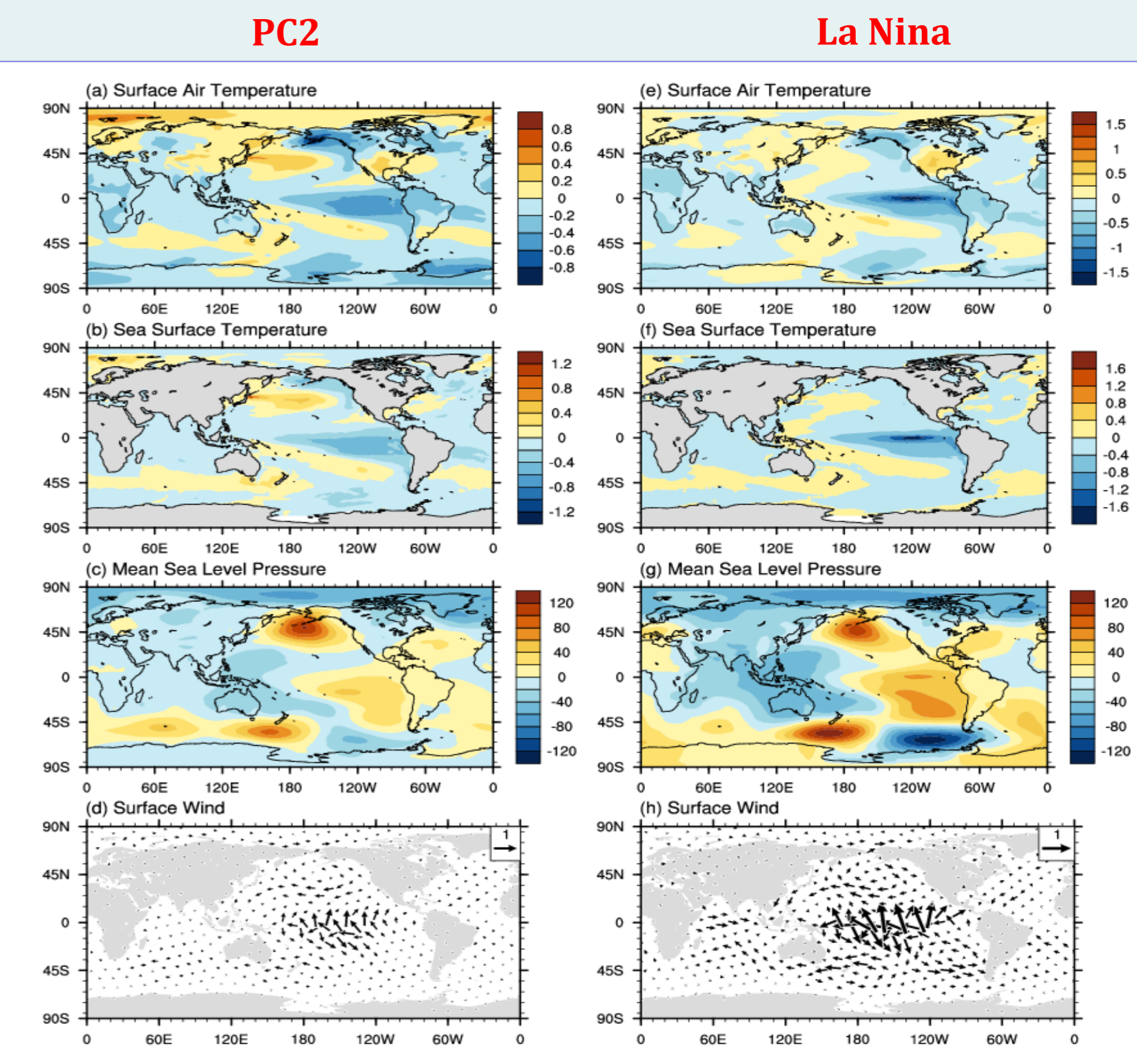
- ✓ PC2 Time series is the opposite phase with global averaged sea surface temperature anomalies (left, top), and in phase with La Nina index (Nino3 index multiplied by -1) (left, bottom).
- ✓ La Nina leads global warming hiatus about 11 months(right) which means that global warming hiatus is occurred by internal variability of climate system.

## Regression Coefficient

(a) Lead-lag regression coefficient



(b) Regression coefficient



- ✓ Heat of the layer from 100m to 200m in low-latitude transports southward and then into deeper ocean during around La Nina events and global warming pause periods.
- ✓ Polar region in North Hemisphere is warmer during global warming hiatus period than La Nina.

## Summary

We investigated the characteristics of the warming pause simulated in HadGEM2-AO. The EOF analysis of zonal averaged ocean temperature shows the cold anomalies appear in equatorial upper ocean during hiatus period. The results of La Nina events are related to the global warming hiatus. During hiatus period, heat transports subsurface layer into deeper ocean. The results of this study will be useful to understanding warming pause in recent decade.

## References

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- ✓ Kosaka, Y., and S.-P. Xie, 2013: Recent global-warming hiatus tied to equatorial Pacific surface cooling. *Nature*. doi:10.1038/nature12534.
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