Timescale of Oceanic Response to ENSO Estimated from Simulations with the NCEP Climate Forecast System

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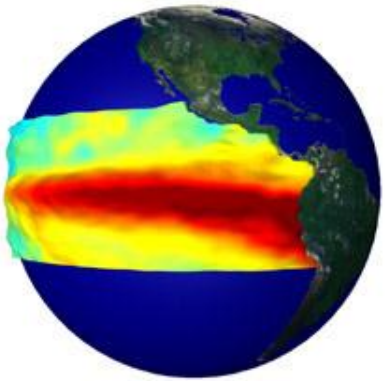


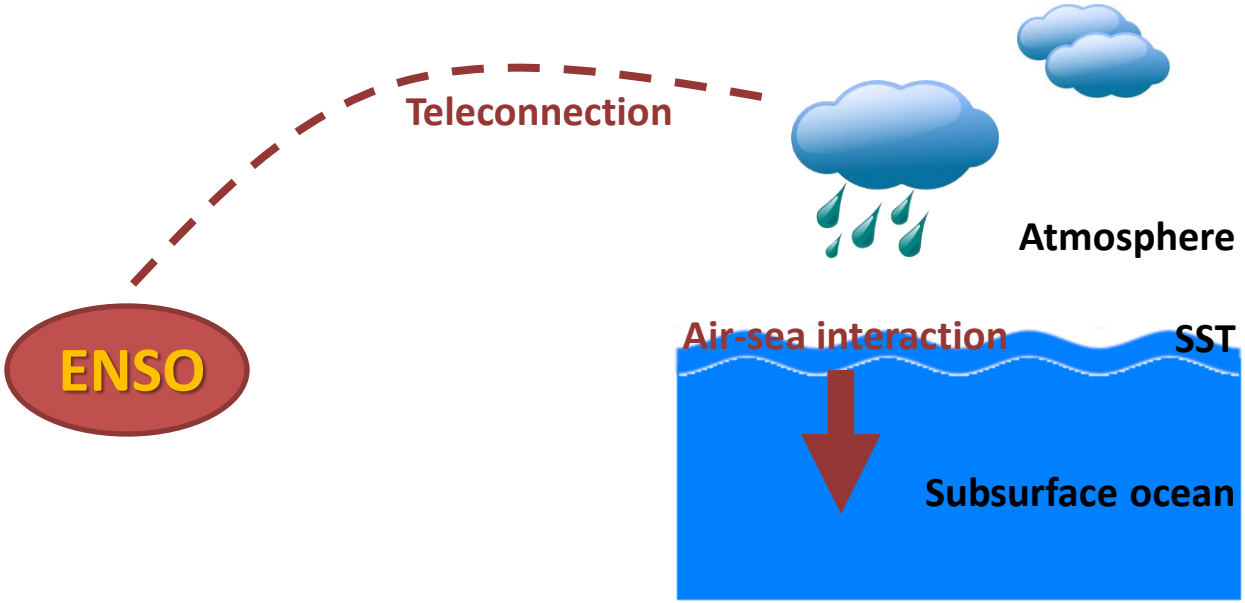
NOAA's 37th Climate Diagnostics and Prediction Workshop

Fort Collins, Colorado, 22–25 October 2012

Outline

1. Experimental setup
2. Oceanic response to ENSO
   - ♦ Spatial characteristics
   - ♦ Temporal evolution
3. Conclusions

Background Information



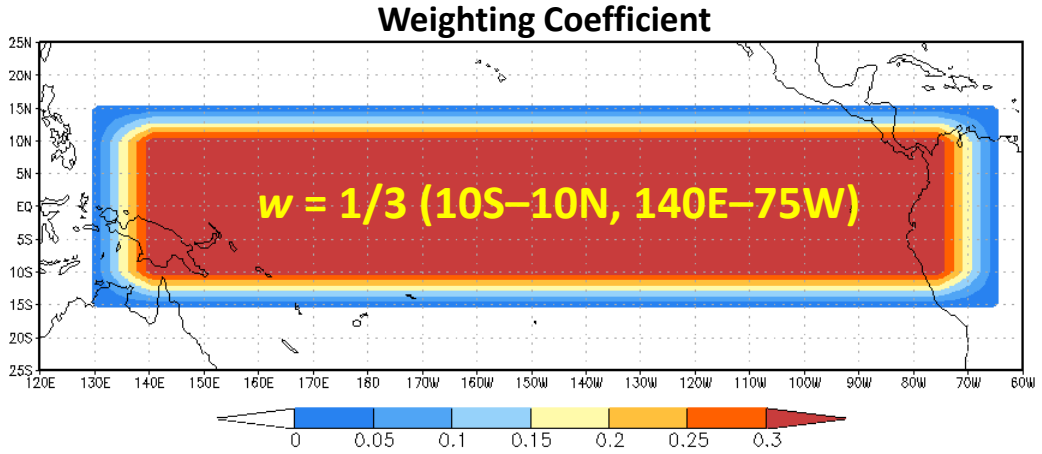
Modeling studies

- **AMIP: prescribed observed SST → realistic ENSO variability**
- **CMIP: bias in simulating ENSO variability**

Experimental Setup (CFSv1)

Tropical Pacific SST in the CFS is relaxed to the observed SST.

$$SST_{NEW} = (1 - w)\, SST_{MODEL} + w\, SST_{OBS}$$



- Daily SST_{OBS}: interpolated from the weekly OISST
- Simulations: 9 ensemble members, 1981–2011 (31 years)
- NCEP Global Ocean Data Assimilation System (GODAS)

Questions to be addressed

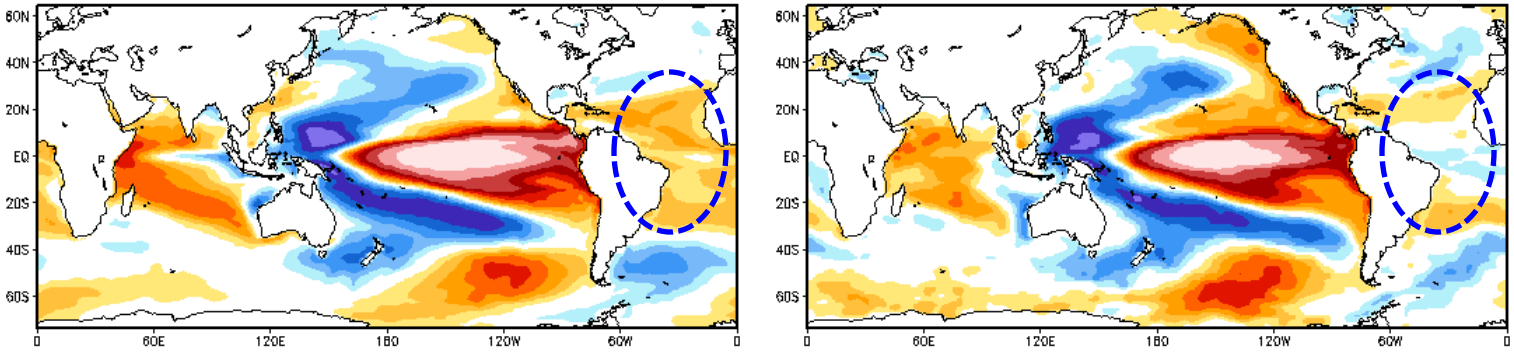
- What are the spatial characteristics of ocean temperature response to ENSO?
- What is the timescale of ocean temperature response to ENSO in different ocean basins?
- How does the response timescale change with depth?
- What are the mechanisms responsible for the different timescales in different ocean basins?

Spatial Characteristics: *Horizontal*

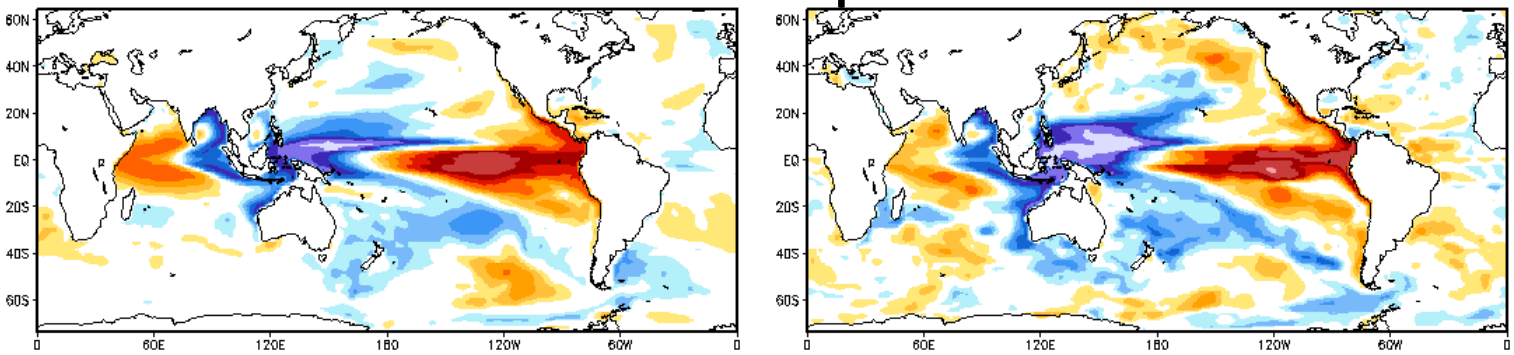
All months of 31 years

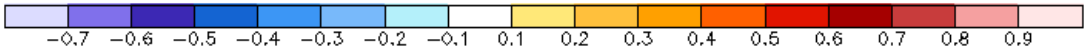
Correlation (Ocean temperature, Nino 3.4 SST)

CFS **SST (5-m depth)** **GODAS**



CFS **105-m depth** **GODAS**

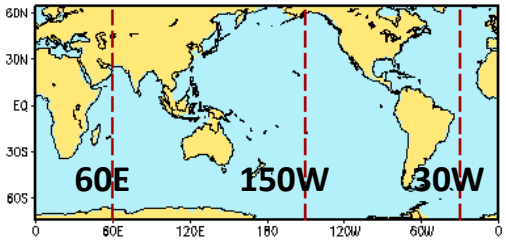




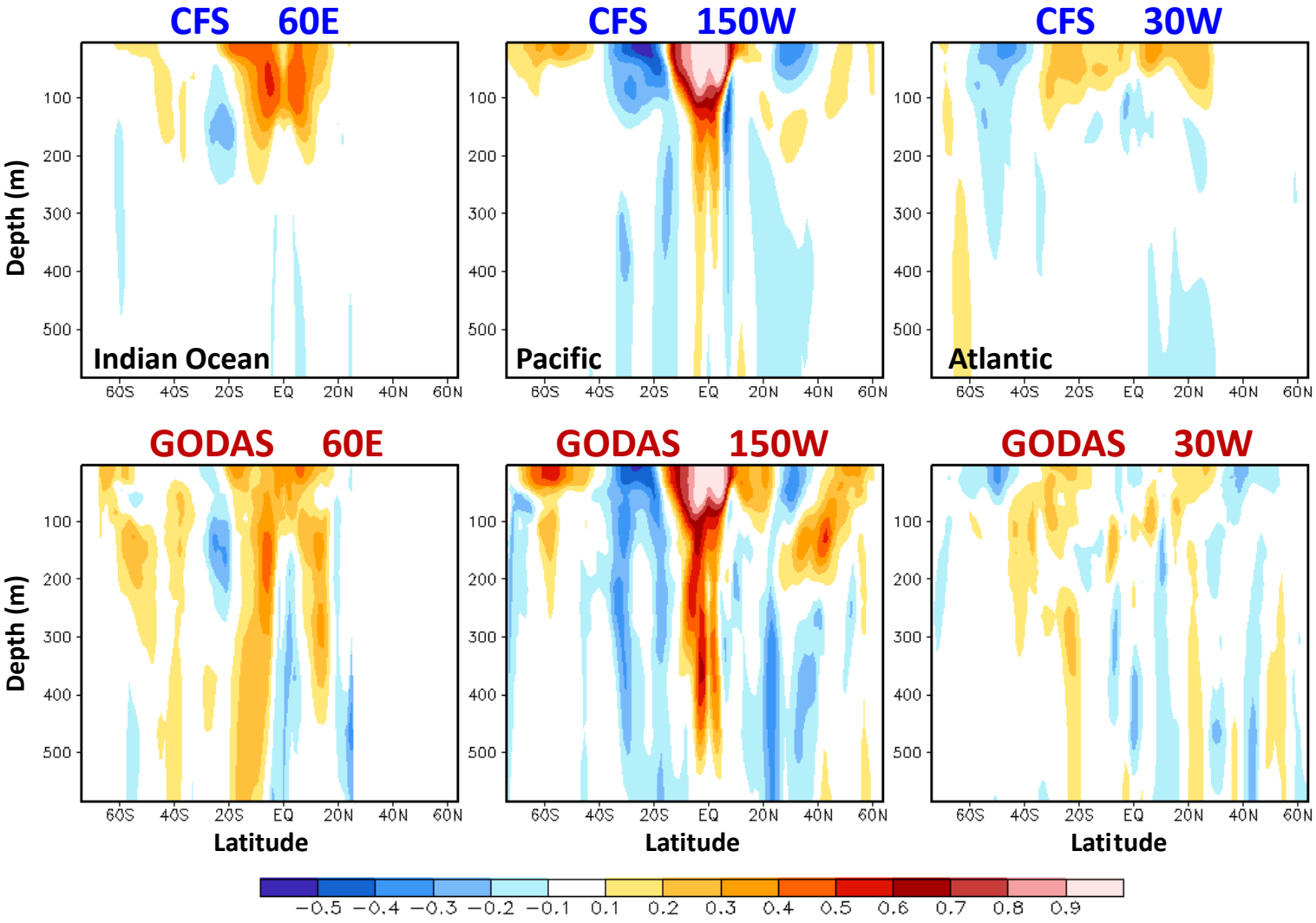
Nino 3.4 SST: base time series to represent the ENSO variability

CFS: correlation for individual members, then averaged over 9 members

Spatial Characteristics: *Vertical-Meridional*

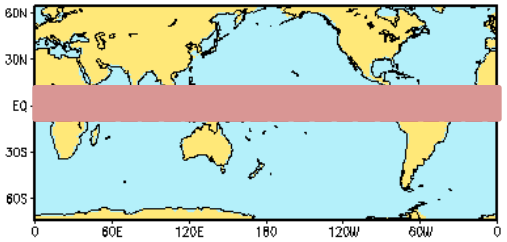


Correlation (Ocean temperature, Nino 3.4 SST)



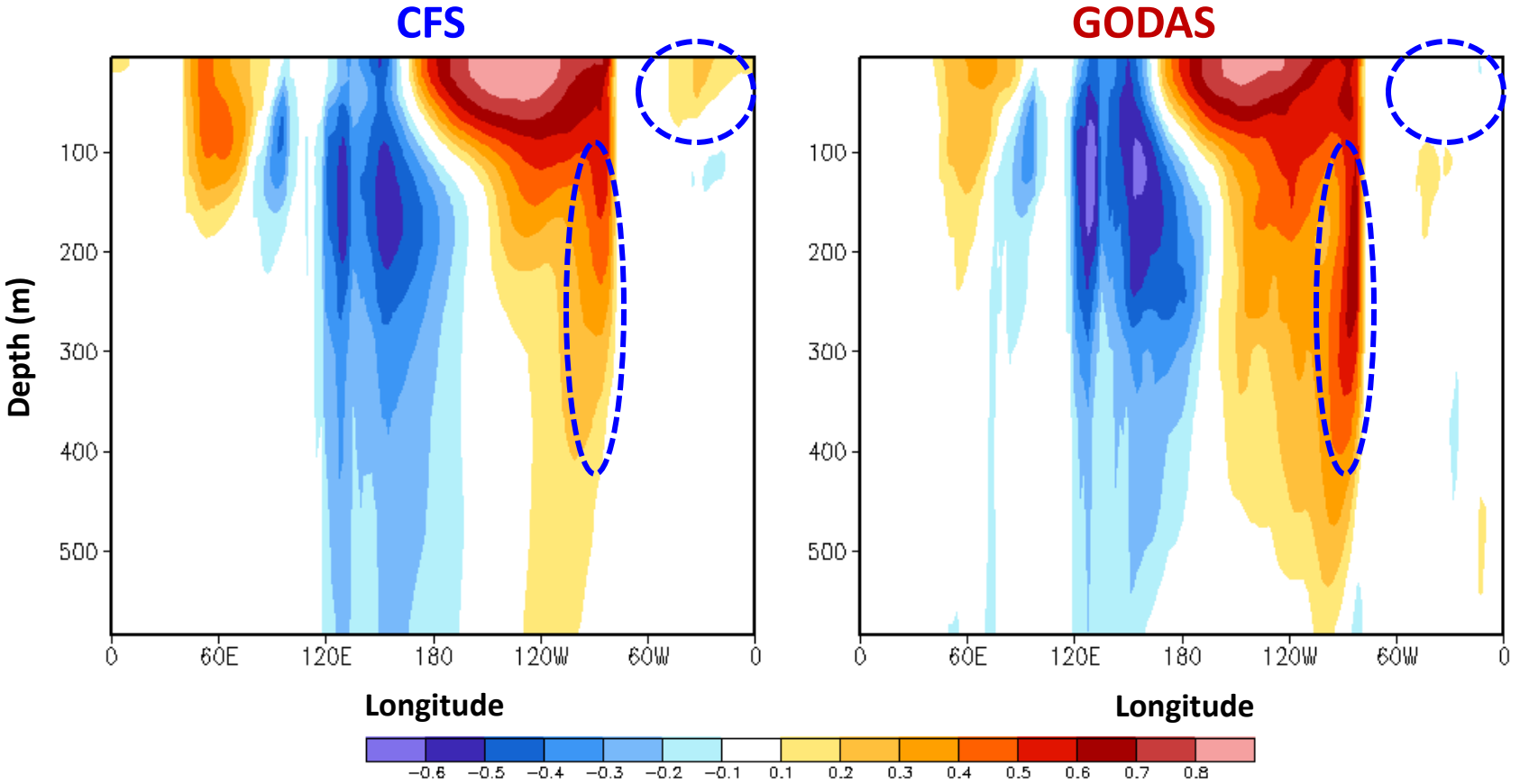
In the upper oceans, CFS agrees reasonable well with GODAS.

Spatial Characteristics: *Vertical - Zonal*

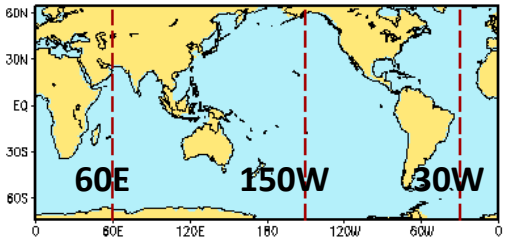


Correlation (Ocean temperature, Nino 3.4 SST)

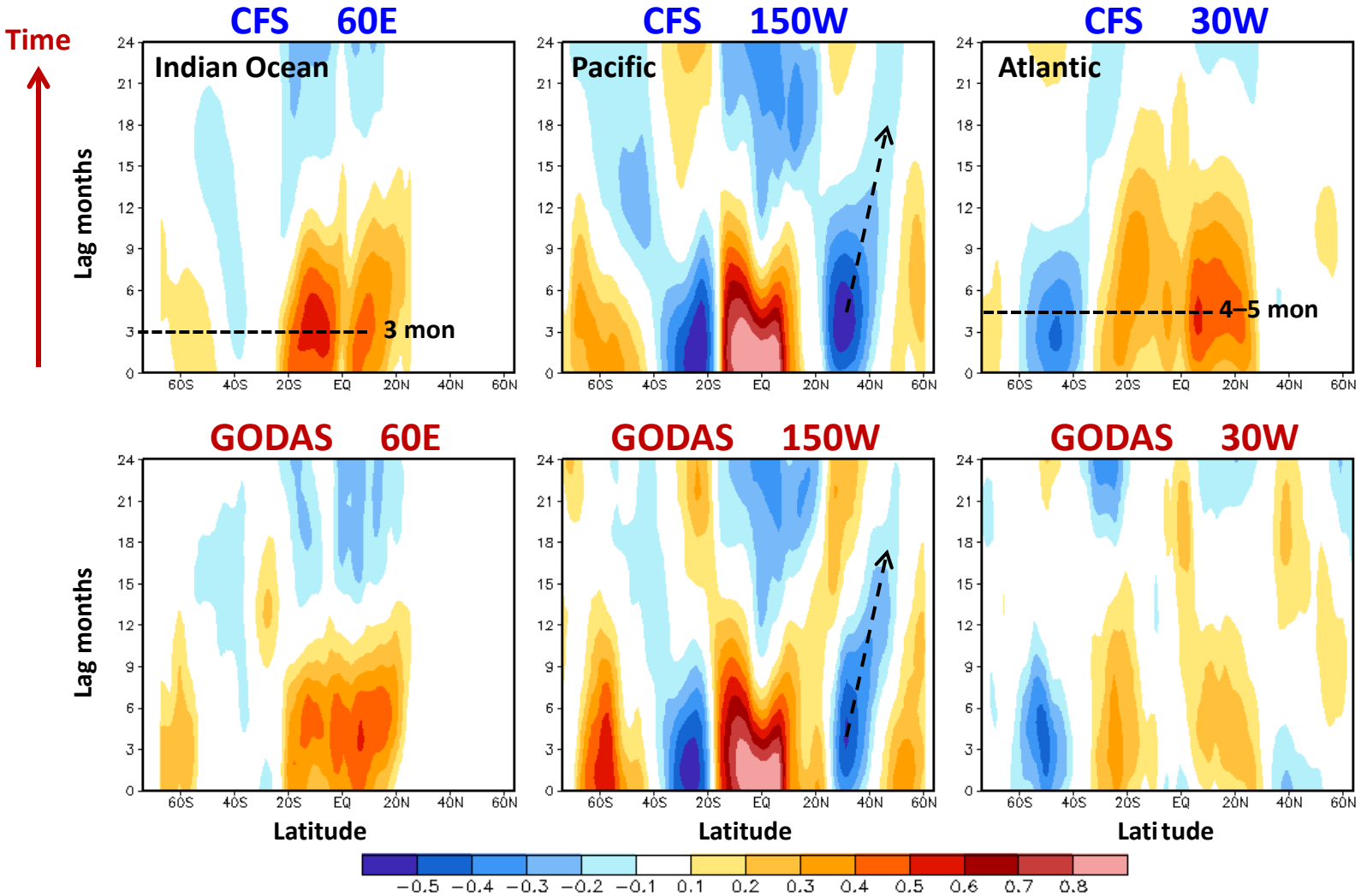
Averaged over 10S – 10N



Time Evolution: *Meridional*

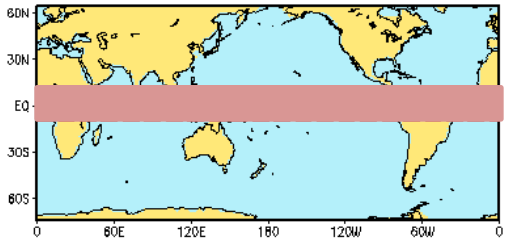


Lag-correlation (SST, Nino 3.4 SST)



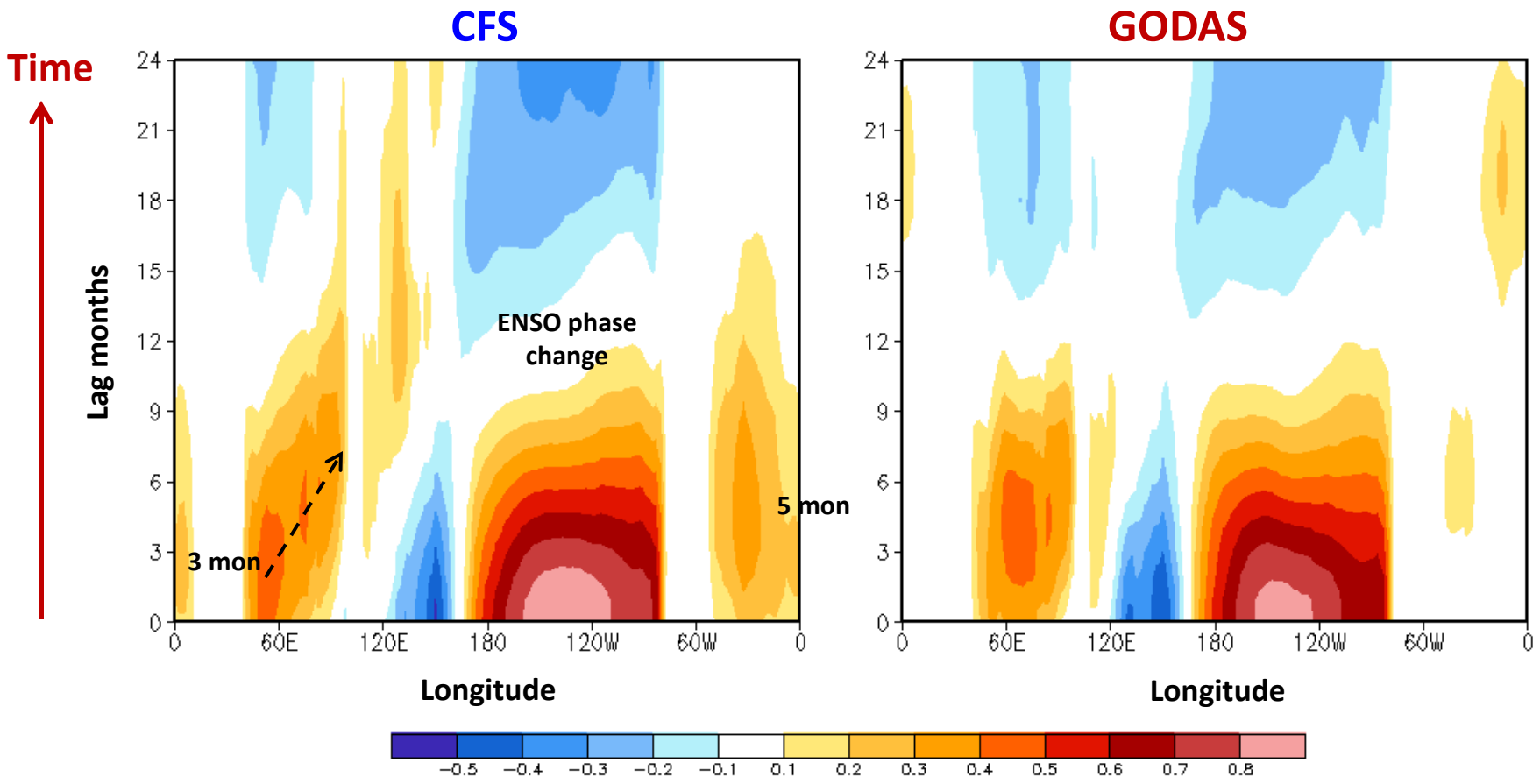
Response timescale: lagged months when lag-correlation reaches a maximum.

Time Evolution: *Zonal*

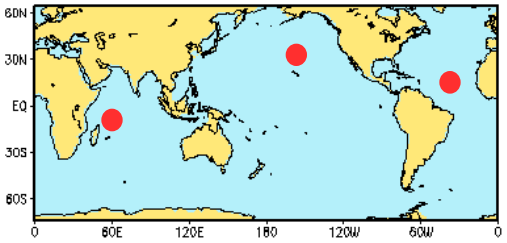


Lag-correlation (SST, Nino 3.4 SST)

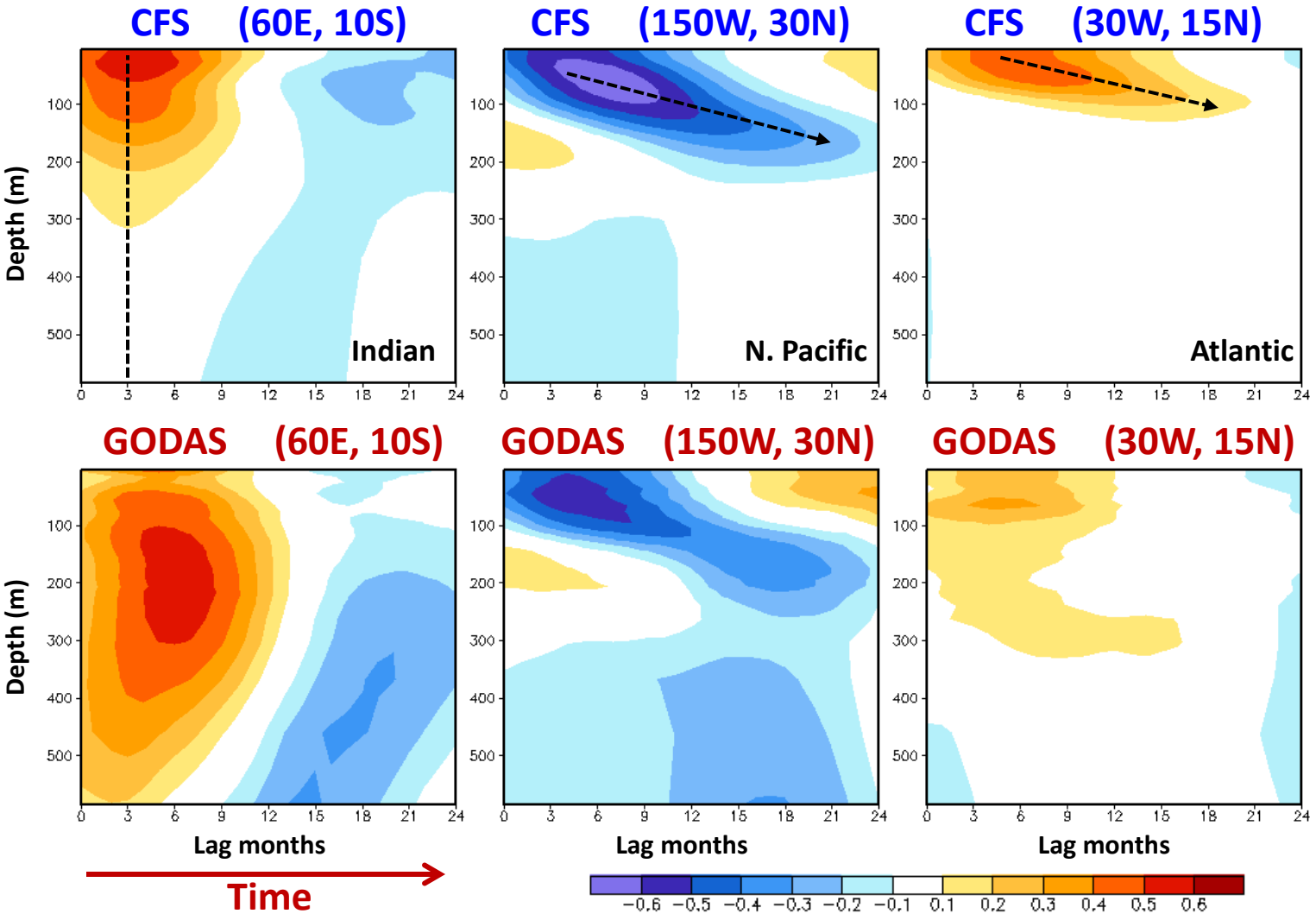
Averaged over 10S – 10N



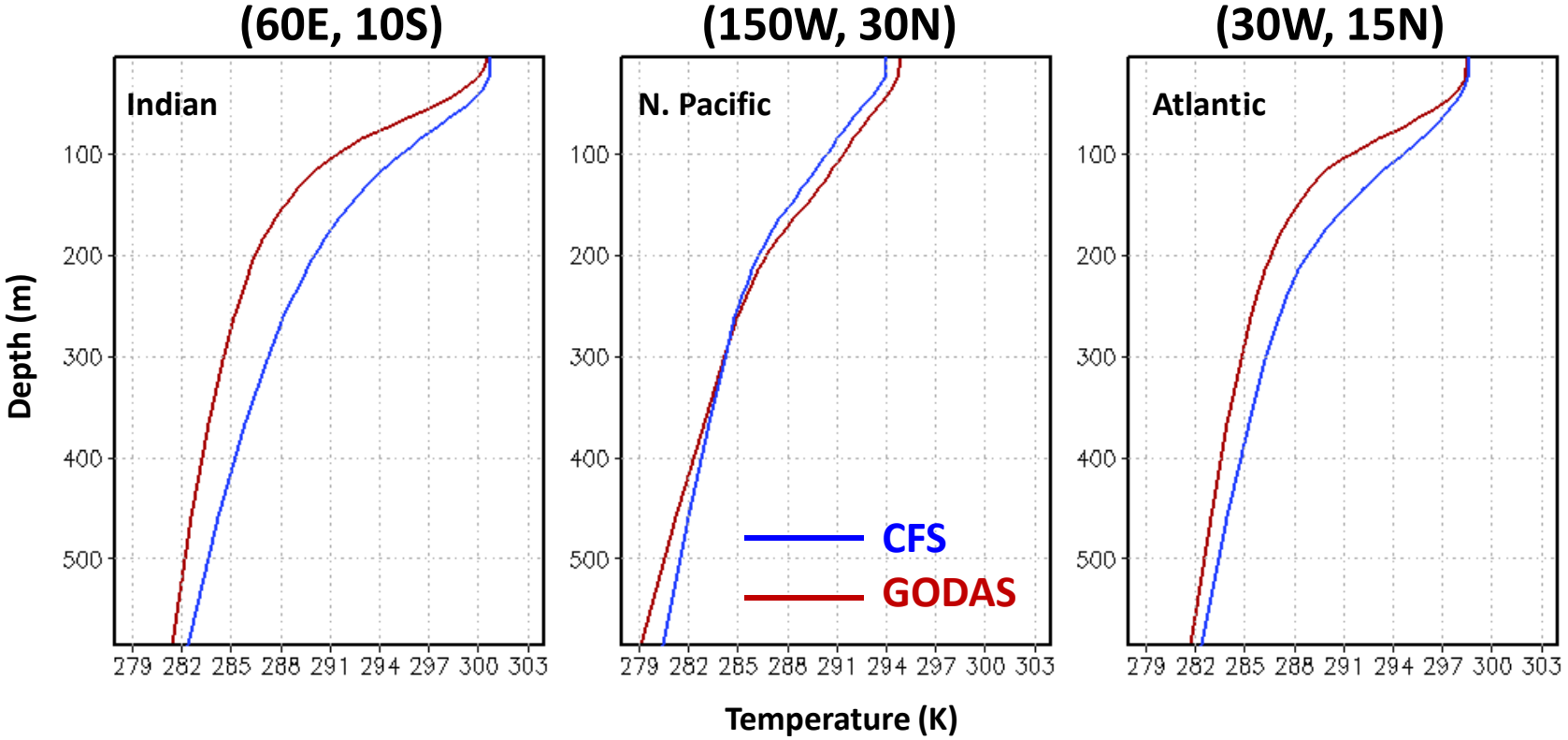
Changes with depth: *Selected Locations*



Lag-correlation (Ocean temperature, Nino 3.4 SST)



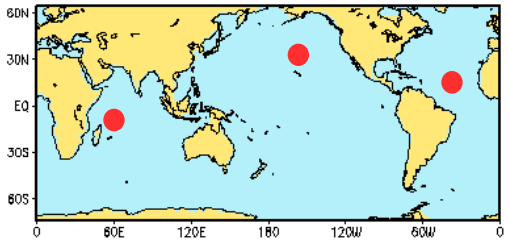
Temperature Profile

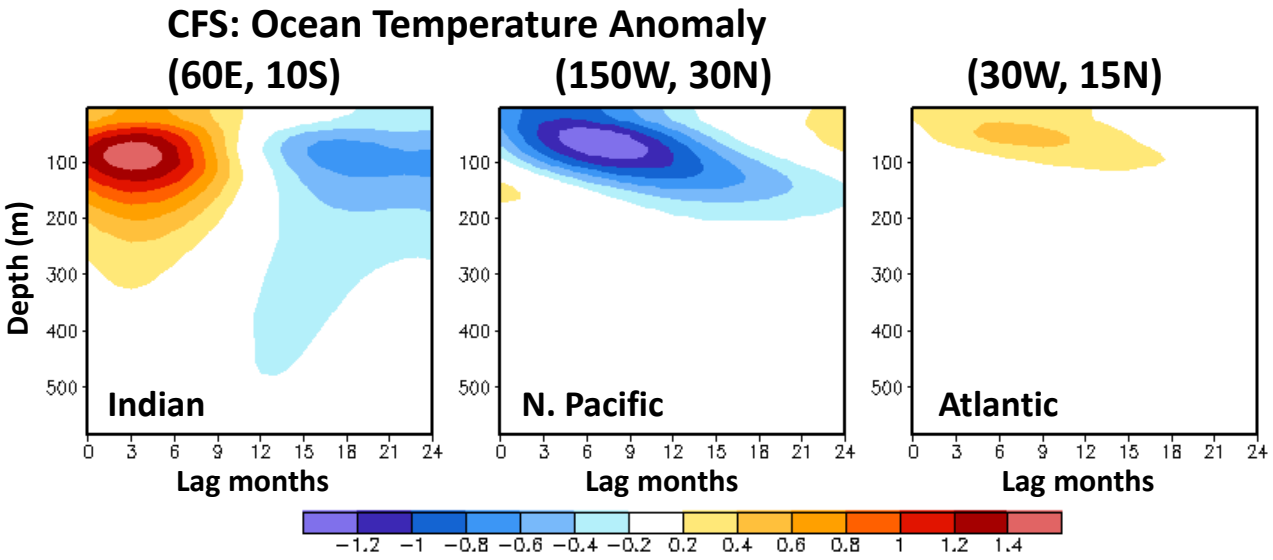


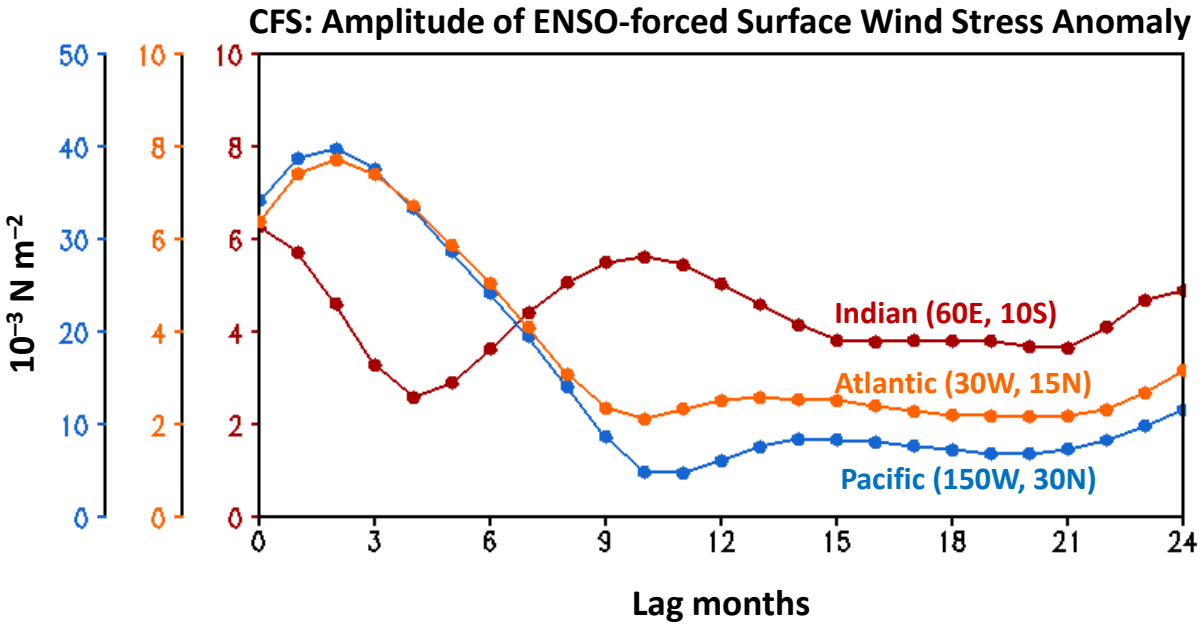
Mixed Layer Depth (m)

Location	(60E, 10S)	(150W, 30N)	(30W, 15N)
CFS	57	57	54
GODAS	39	56	46

Surface Wind Stress



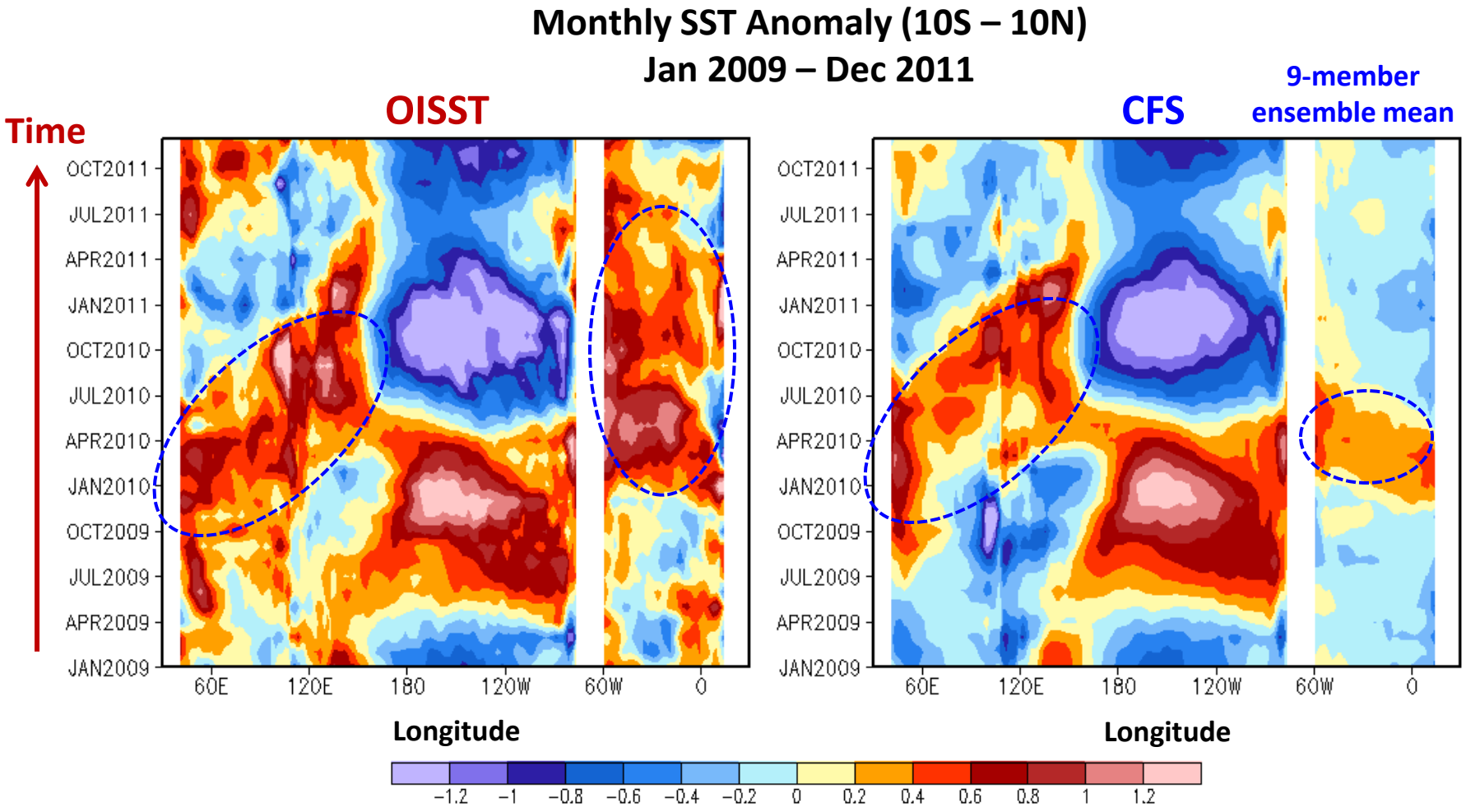




Location	e-folding time
Indian	2 mon
N. Pacific	6 mon
Atlantic	5 mon

The timescale depends on how persistent the surface wind response to ENSO is.

Attribution of SST Anomalies



Conclusions

1. Based on the CFS simulations with the relaxation of tropical Pacific SST to the observations, we documented the characteristics of oceanic response to ENSO.
2. The relationships between ocean temperature and the Nino 3.4 SST in the CFS are in good agreement with those in GODAS.
3. The oceanic response to ENSO has different timescales in different ocean basins. The ENSO-forced local surface wind stress may play an important role.