

Are Greenhouse Gases Changing ENSO Precursors in the Western North Pacific?

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18th Annual CESM Workshop

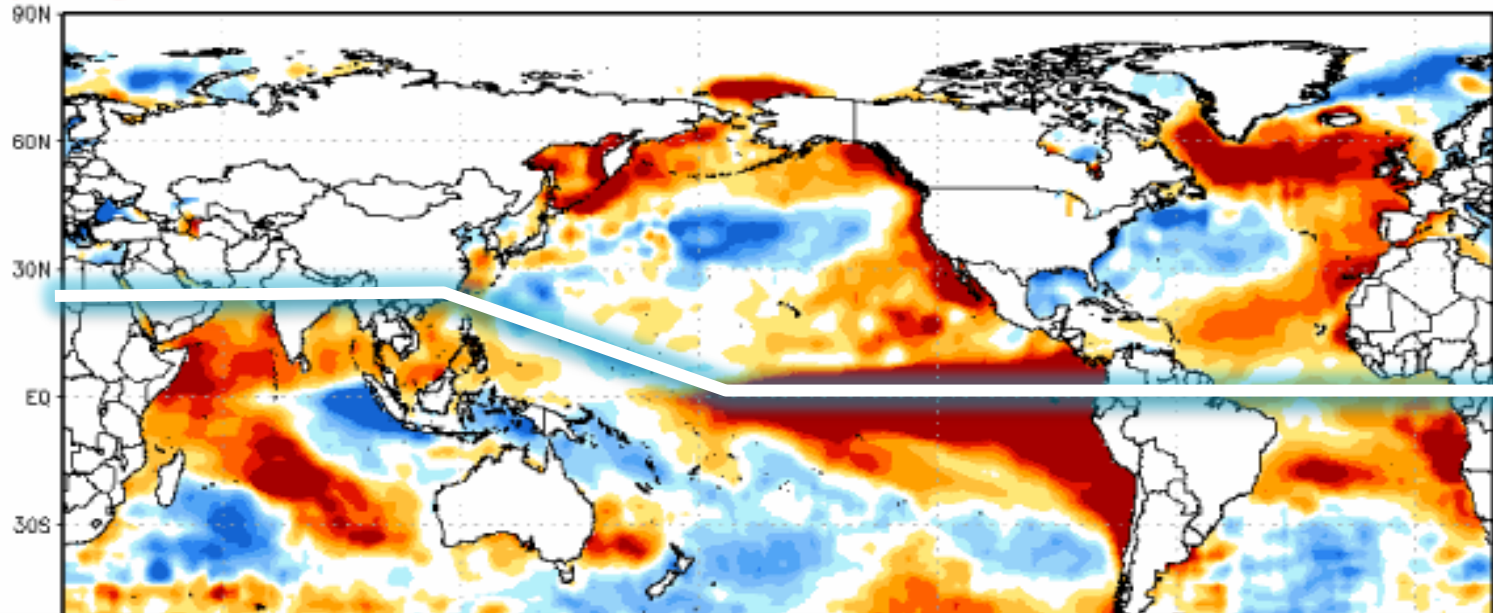


Are Greenhouse Gases Changing

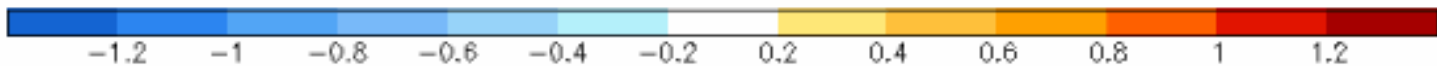
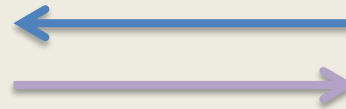
ENSO Precursors in the Western North Pacific?

Response Of East Indian And West Pacific Ocean SST Anomalies To ENSO Events Opposes The "Normal" Response

(During El Nino Events, SST Anomalies Of Portions Of East Indian and West Pacific Oceans Drop)



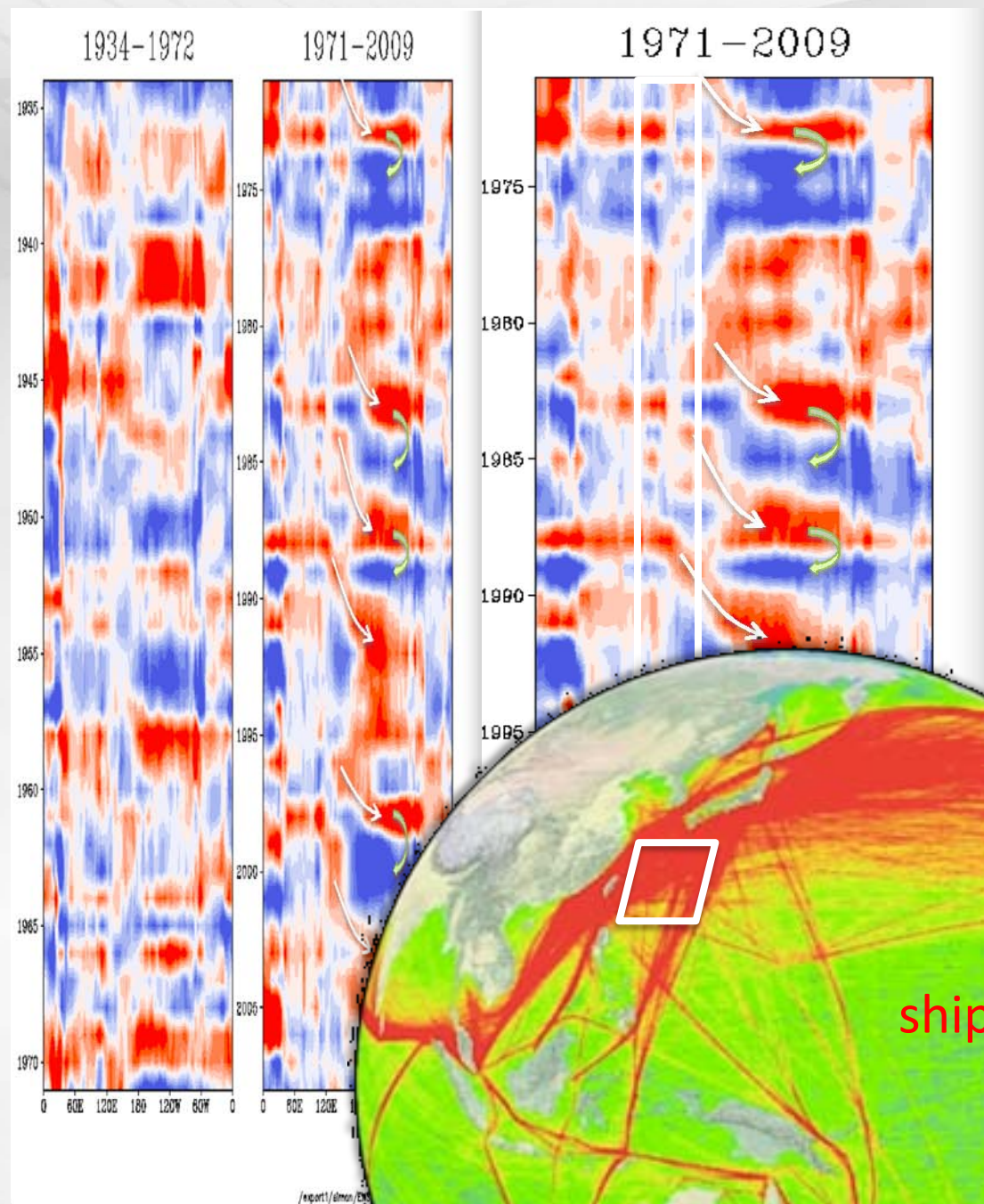
ENSO evolution:



(Wang and An 2002; Guan and Nigam 2008)

Longitude-time diagram

earlier



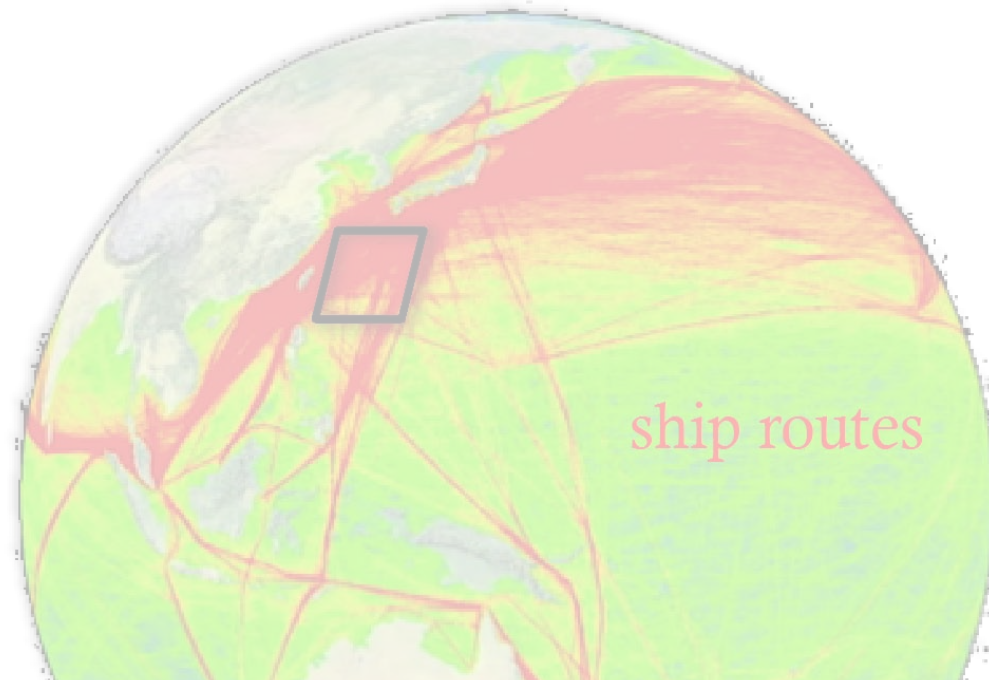
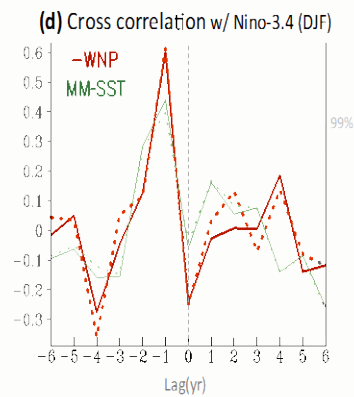
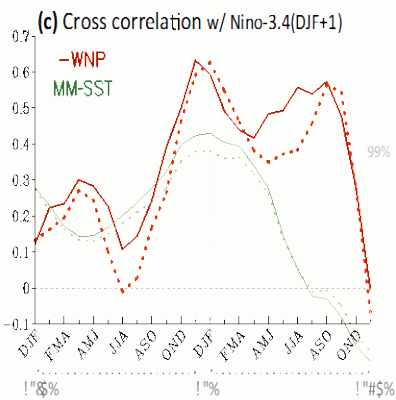
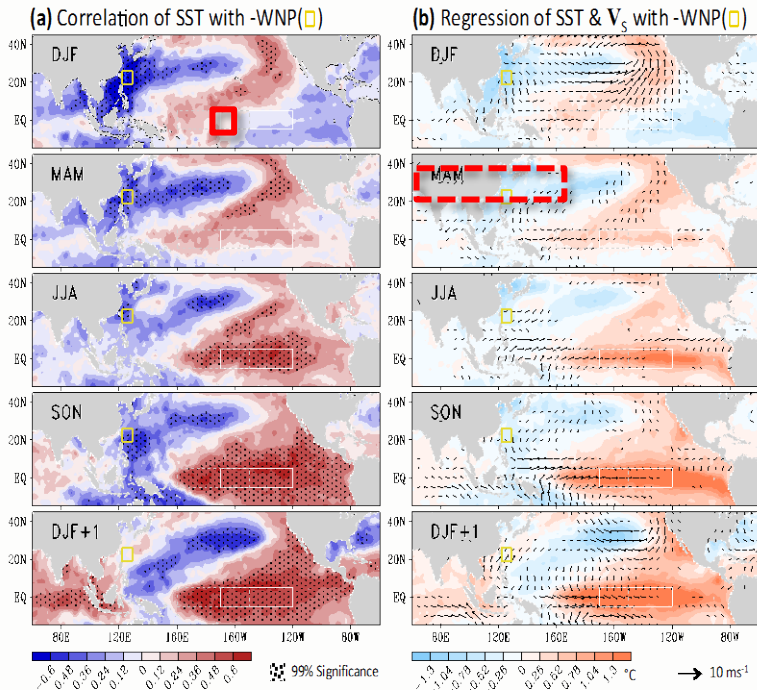
Pacific Northwest
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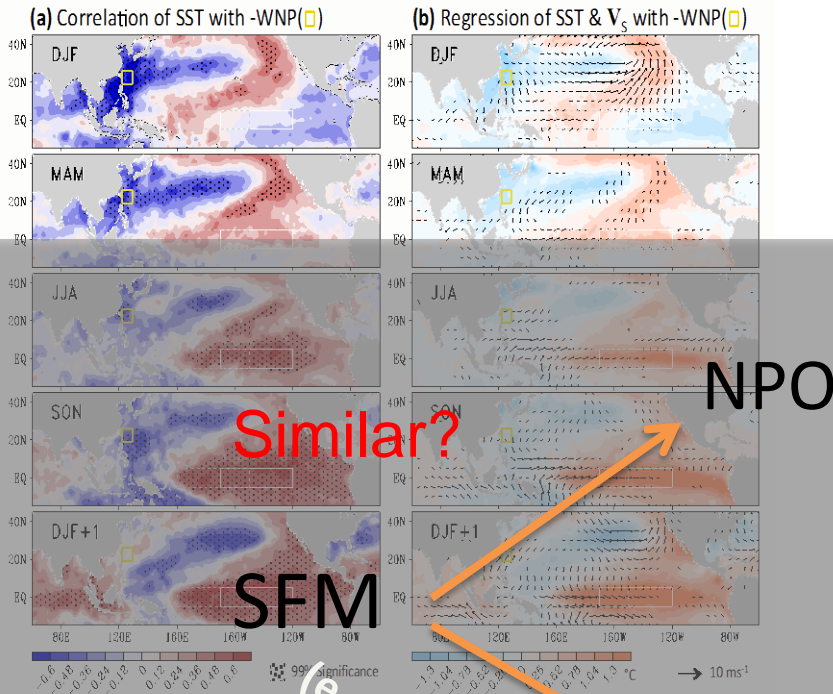
later

ENSO precursor: WNP

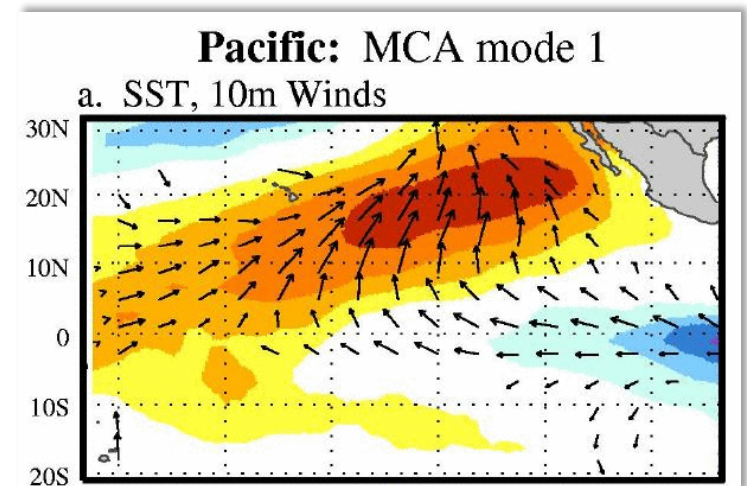
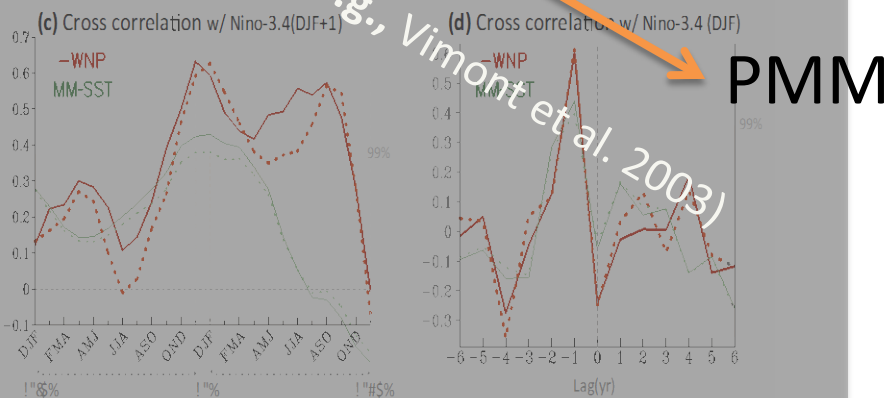
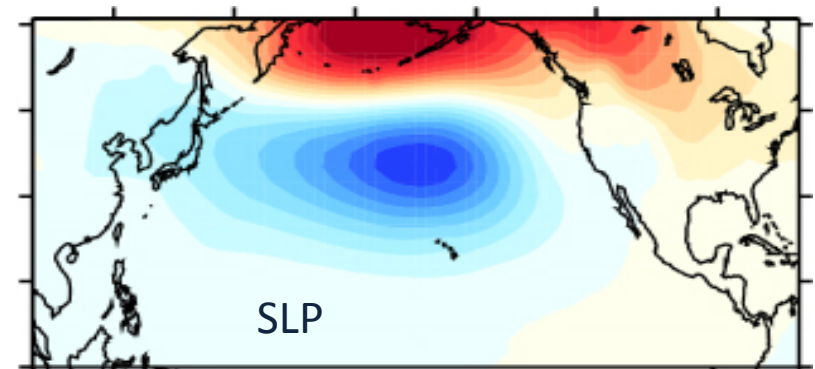
Western North Pacific



ENSO precursor: WNP

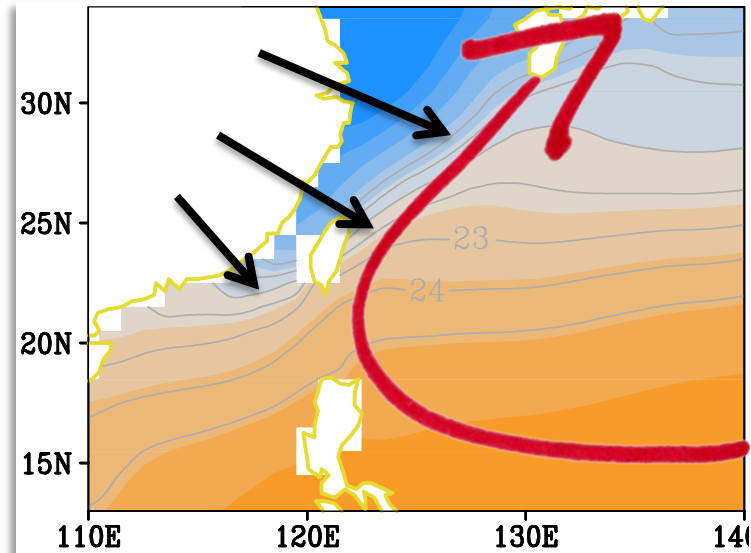


Western North Pacific



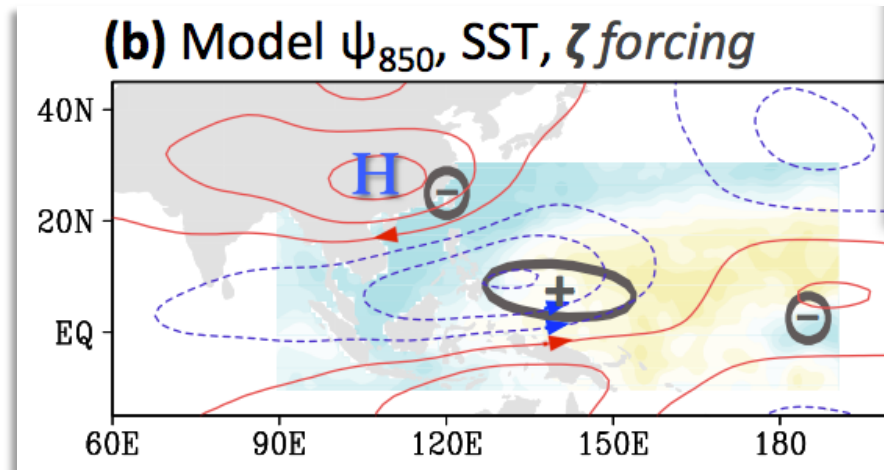
Why Western North Pacific (WNP)?

SST DJF Mean



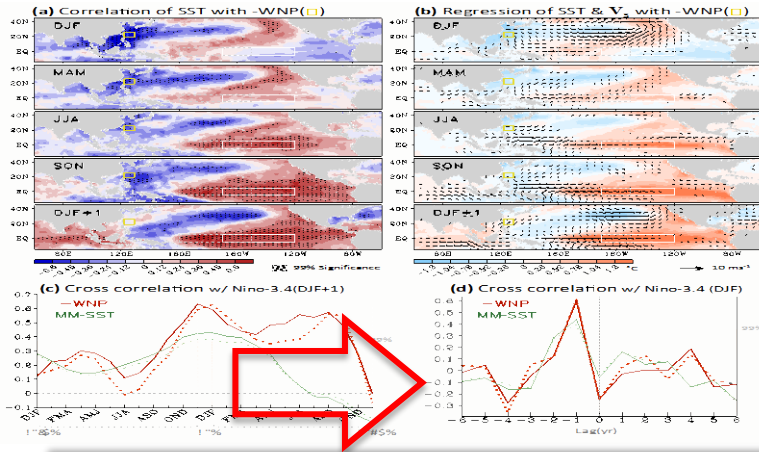
(1) East Asian Winter Monsoon impact

Kuroshio Current

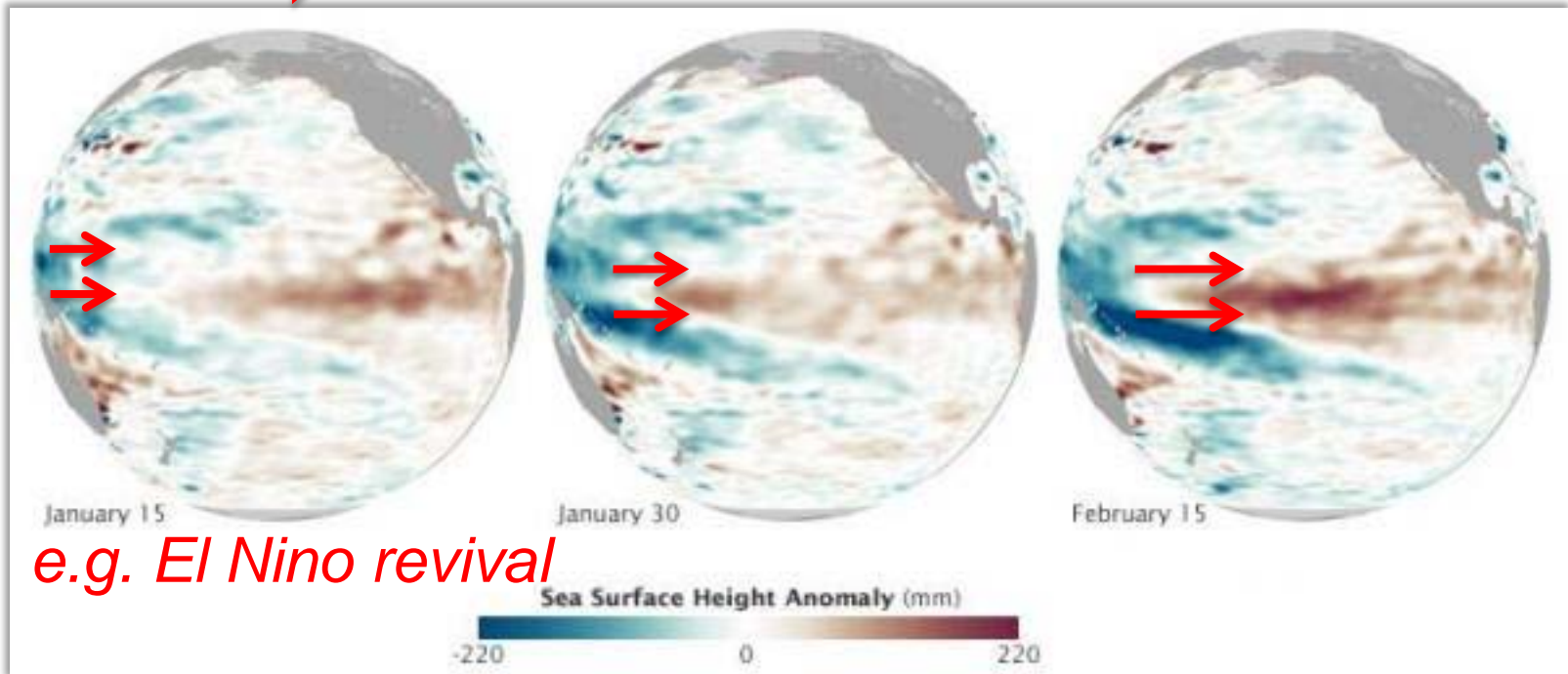


Barotropic model w/ composite WNP heat source/sink

Why Western North Pacific (WNP)?

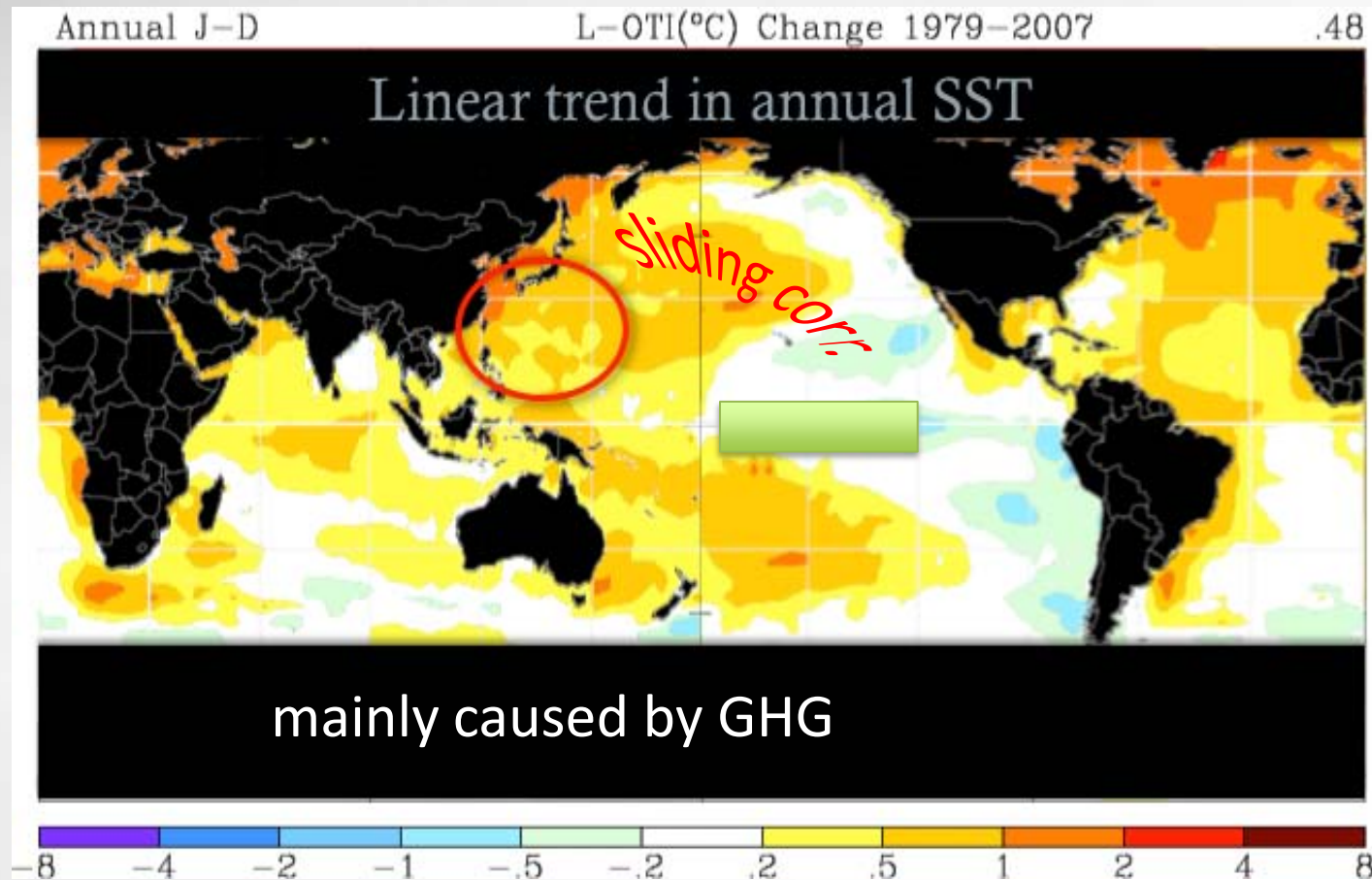


(2) Oceanic Kelvin wave - zonal wind triggered





Is **GHG forcing** enhancing ENSO precursors in the Western North Pacific?



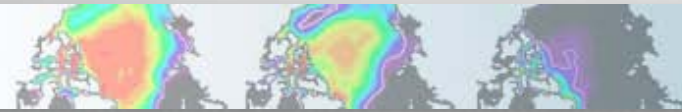
25-yr sliding correlation of SSTA

WNP vs. Nino-3.4

25-yr sliding correlation of SSTA

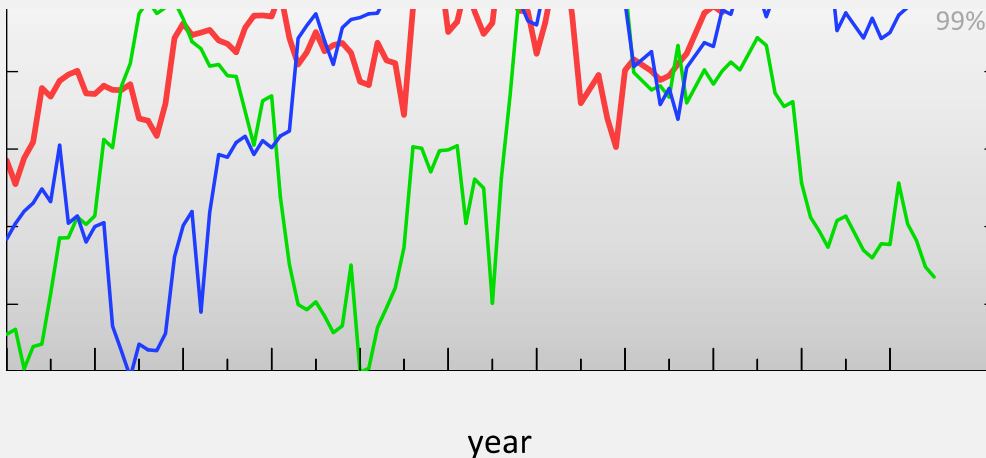
Community Earth System Model

CESM

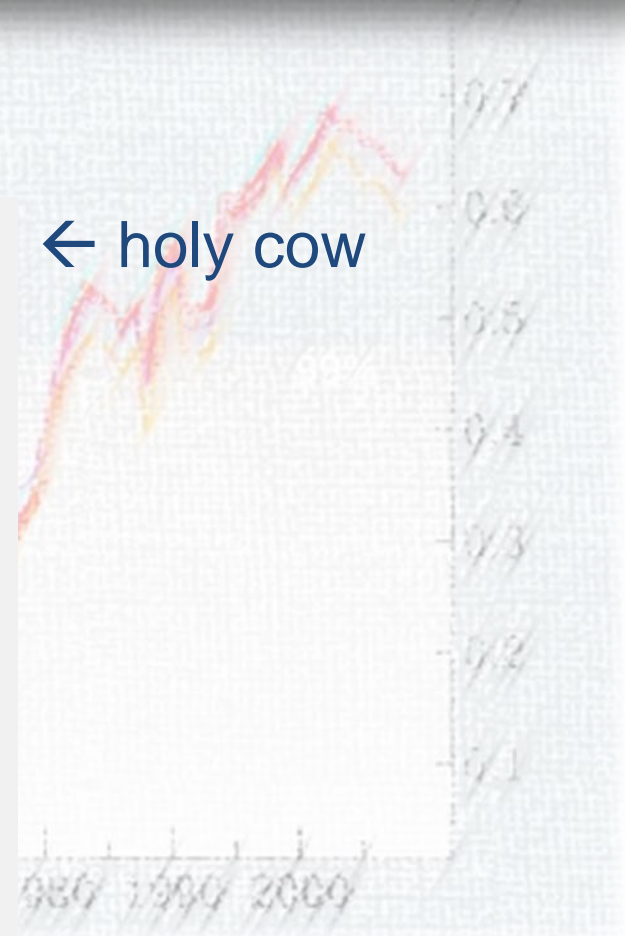


Historical forcing experiments (1850-2005):

) CESM simulations



← holy cow

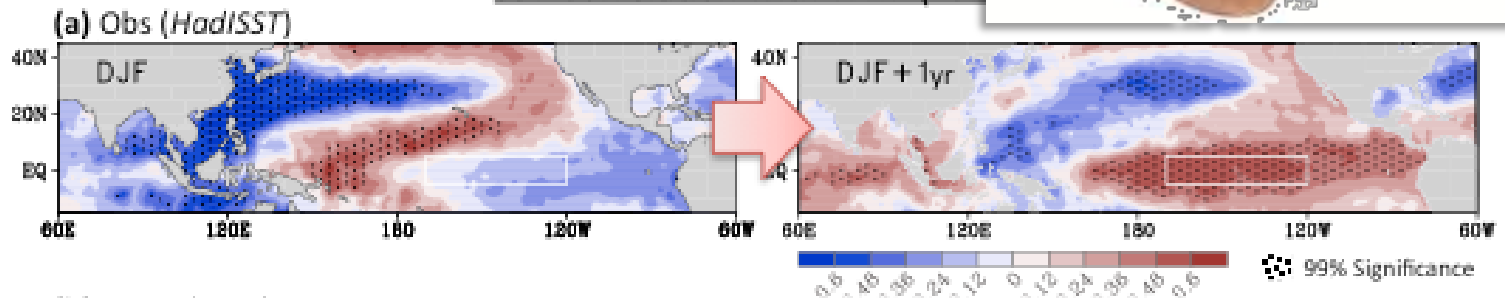


How good is CESM Realistic ENSO pre-conditions

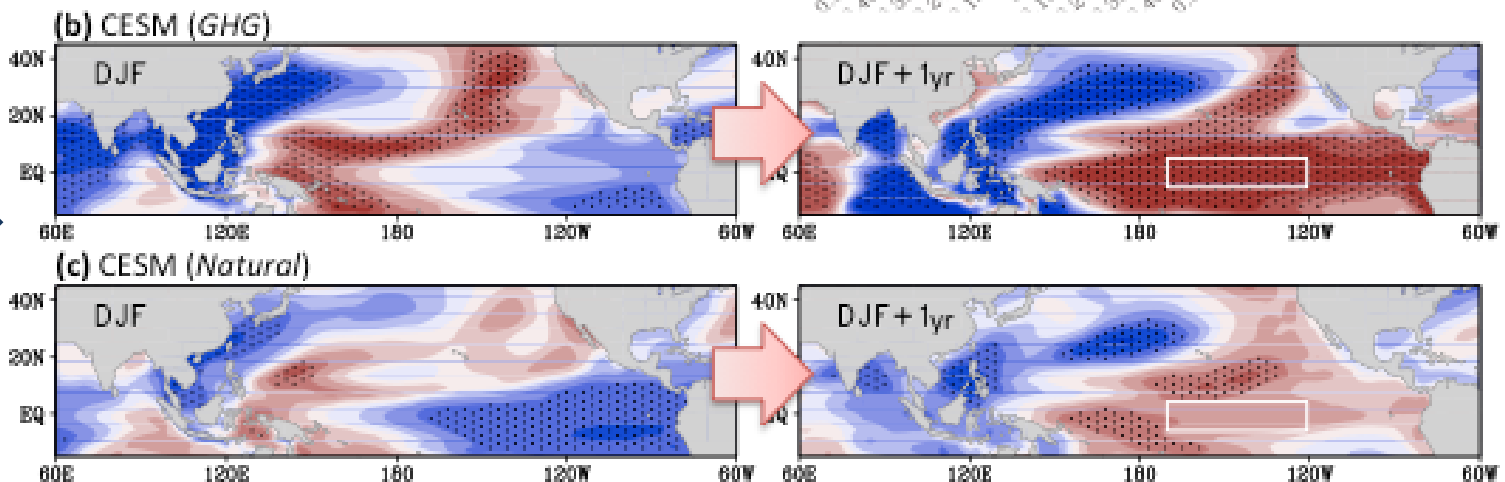


SST Correlation with WNP (DJF)

OBS →



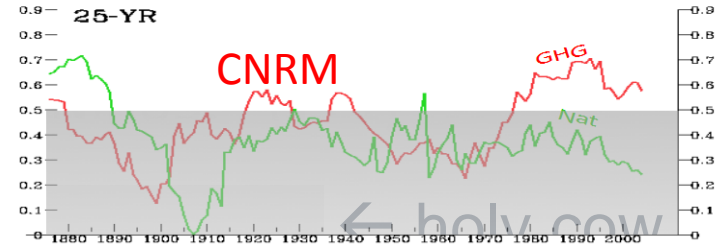
CESM1 →



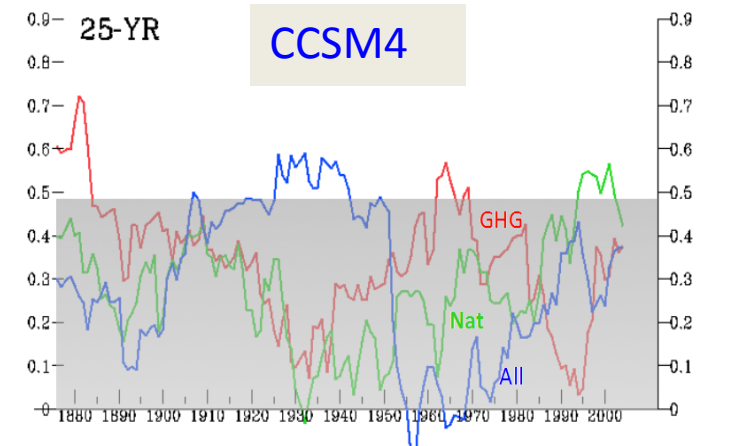
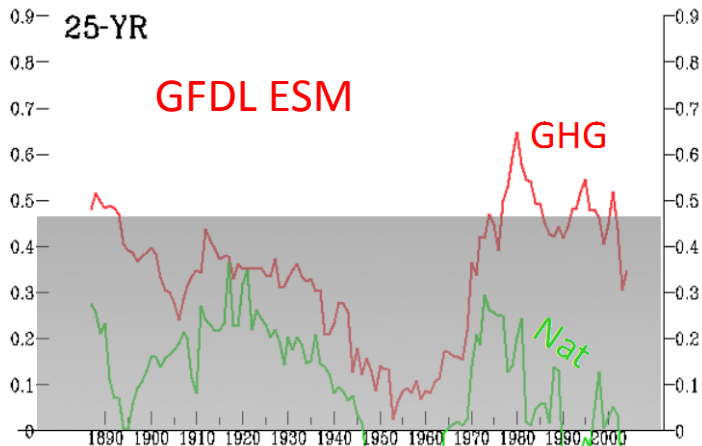
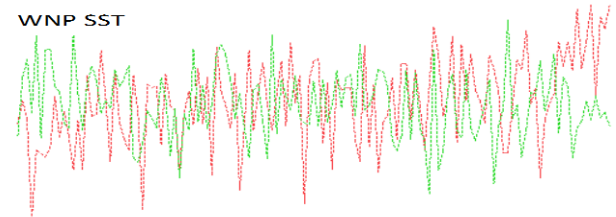
Other Models (from CMIP5)

GFDL CM3

) CESM simulations



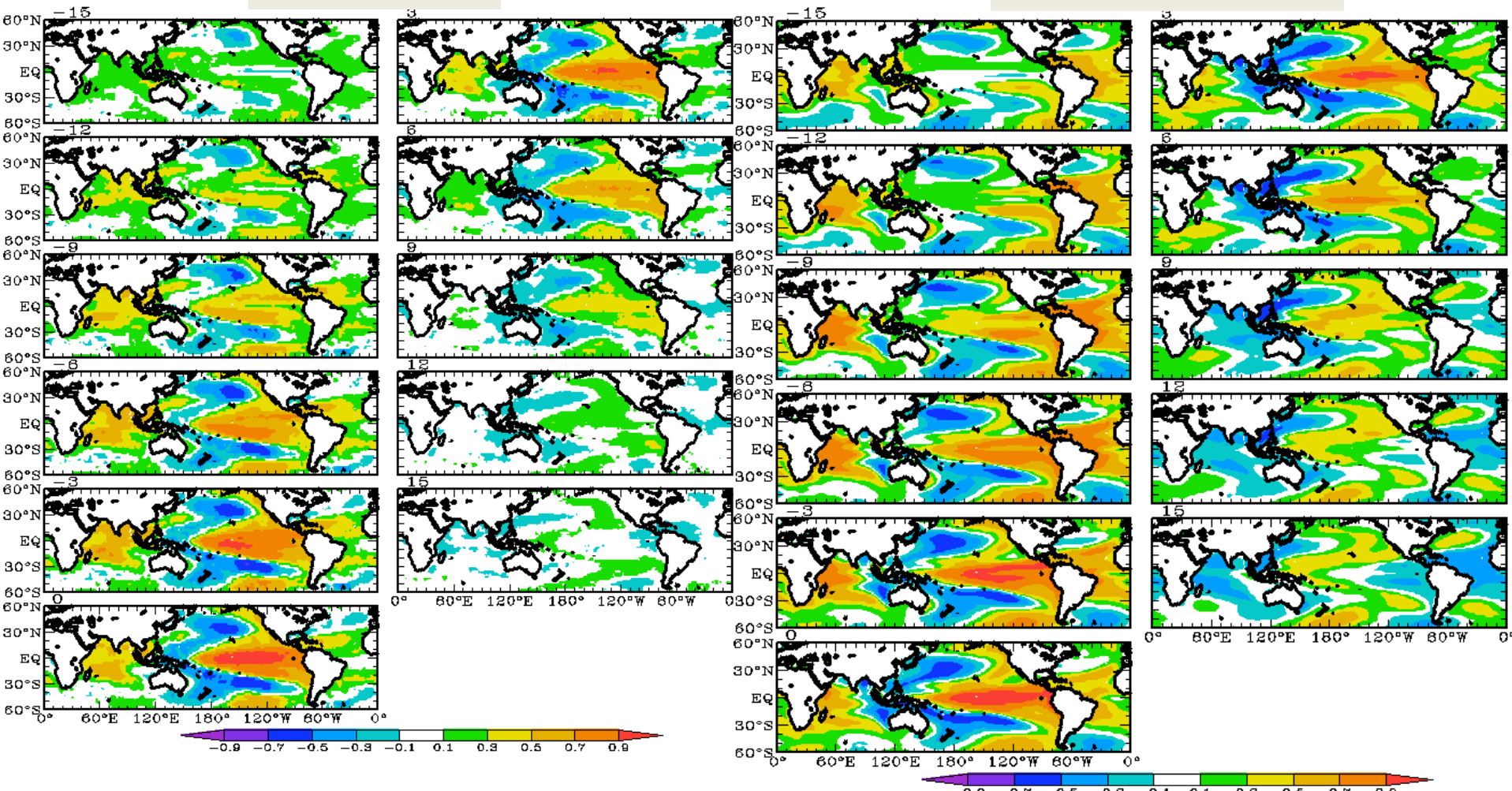
WNP SST



Lead-lag correlation of NINO3.4 with SST

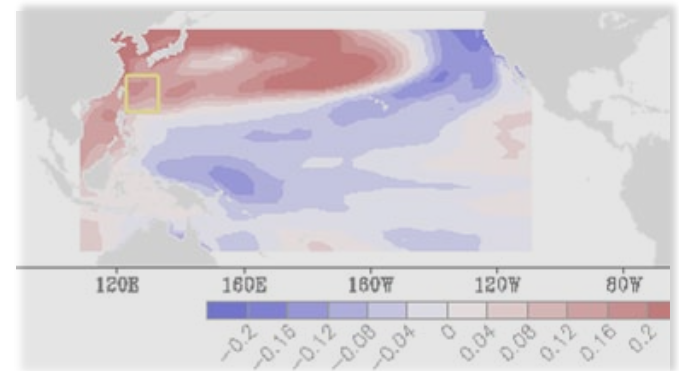
Observations

CESM1-CAM5.1-FV2

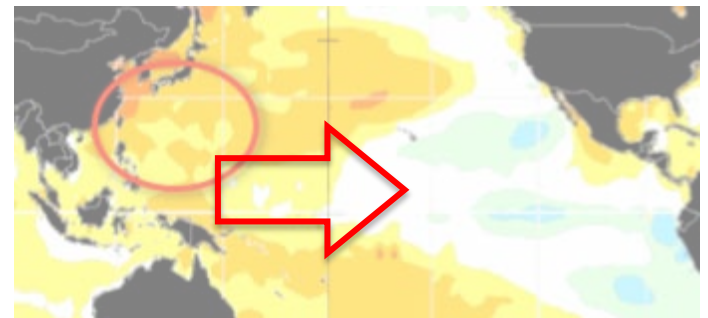


Summary

- NPO-*like* mode leads WNP to trigger ENSO



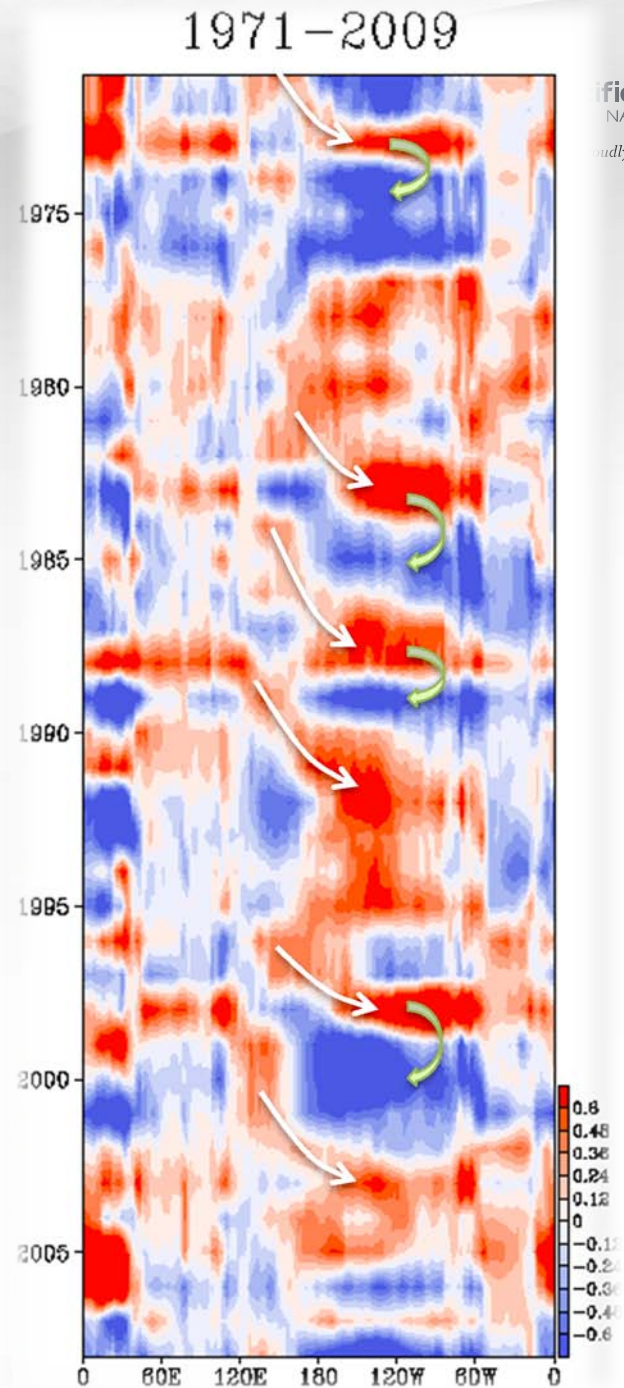
- GHG appears to enhance (accelerate) this process



Thanks to...

- ▶ S.-Y. (Simon) Wang (USU), Michelle L'Heureux (CPC/NOAA)
- ▶ Many discussions with B. Anderson (BU), K. Balaguru (PNNL), and more.
- ▶ Support from Earth System Modeling program/Office of Science/US DOE.
- ▶ S.-Y. Wang, M. L'Heureux, and J.-H. Yoon, 2013: Are Greenhouse Gases Changing ENSO Precursors in the Western North Pacific?, in print, J. Climate (CESM special issue), doi:10.1175/JCLI-D-12-00360.1

And it's only half the story!



Back-up slides



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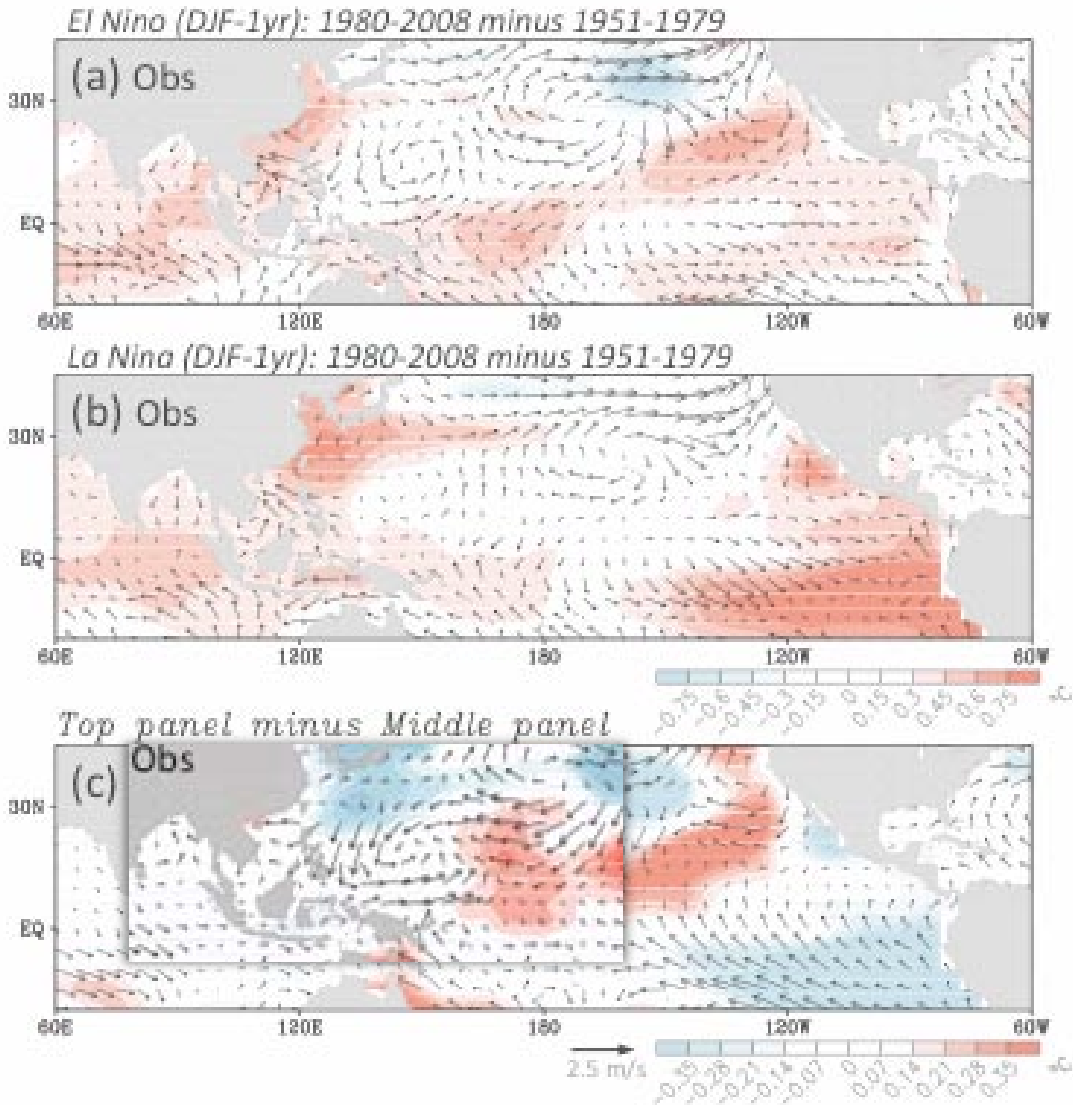
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WNP warming & dynamics



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Composite analysis:

NCEP + 20CR
& HadSST

WNP warming & dynamics

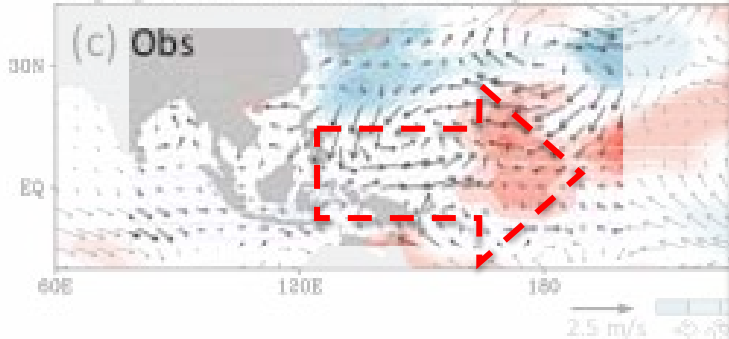
El Nino (DJF-1yr): 1980-2008 minus 1951-1979



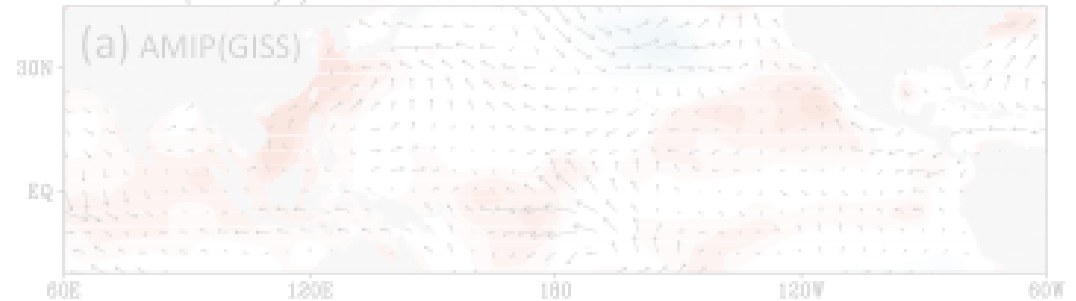
La Nina (DJF-1yr): 1980-2008 minus 1951-1979



Top panel minus Middle panel



El Nino (DJF-1yr): 1980-2008 minus 1951-1979

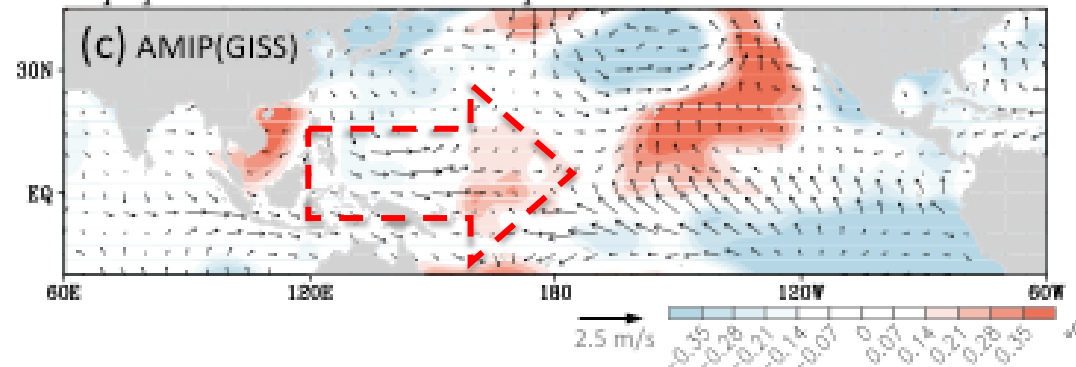


La Nina (DJF-1yr): 1980-2008 minus 1951-1979



AMIP run (GISS)

Top panel minus Middle panel



CAM - the Atmospheric Component of CCSM/CESM

Model	CCSM3 (2004)	CCSM3.5 (2007)	CCSM4 (Apr 2010)	CESM1 (Jun 2010)
Atmosphere	CAM3 (L26)	CAM3.5 (L26)	CAM4 (L26)	CAM5 (L30)
Boundary Layer Turbulence	Holtslag-Boville (93) Dry Turbulence	Holtslag-Boville	Holtslag-Boville	Bretherton-Park (09) Moist Turbulence
Shallow Convection	Hack (94)	Hack	Hack	Park-Bretherton (09) Shallow Convection
Deep Convection	Zhang-McFarlane (95)	Zhang-McFarlane Neale et al.(08) Richter-Rasch (08)	Zhang-McFarlane Neale et al.(08) Richter-Rasch (08)	Zhang-McFarlane Neale et al.(08) Richter-Rasch (08)
Cloud Macrophysics	Zhang et al. (03)	Zhang et al. with Park & Vavrus' mods.	Zhang et al. with Park & Vavrus' mods.	Park-Bretherton-Rasch (10) Cloud Macrophysics
Stratiform Microphysics	Rasch-Kristjansson (98) <i>Single Moment</i>	RK <i>Single Moment</i>	RK <i>Single Moment</i>	Morrison and Gettelman (08) <i>Double Moment</i>
Radiation / Optics	CAMRT (01)	CAMRT	CAMRT	RRTMG Iacono et al.(08) / Mitchell (08)
Aerosols	Bulk Aerosol Model (BAM)	BAM	BAM	Modal Aerosol Model (MAM) Liu & Ghan (2009)
Dynamics	Spectral	Finite Volume (96,04)	Finite Volume	Finite Volume
Ocean	POP2 (L40)	POP2.1 (L60)	POP2.2 - BGC	POP2.2
Land	CLM3	CLM3.5	CLM4 - CN	CLM4
Sea Ice	CSIM4	CSIM4	CICE	CICE

What is the SFM (Seasonal Footprinting Mechanism) or PMM (Pacific Meridional Mode)?

- Atmo-Ocean coupled climate variability
- MCA (Maximum Covariance Analysis, or SVD of Bretherton et al. 1992)
- similar to Multi-variate EOF

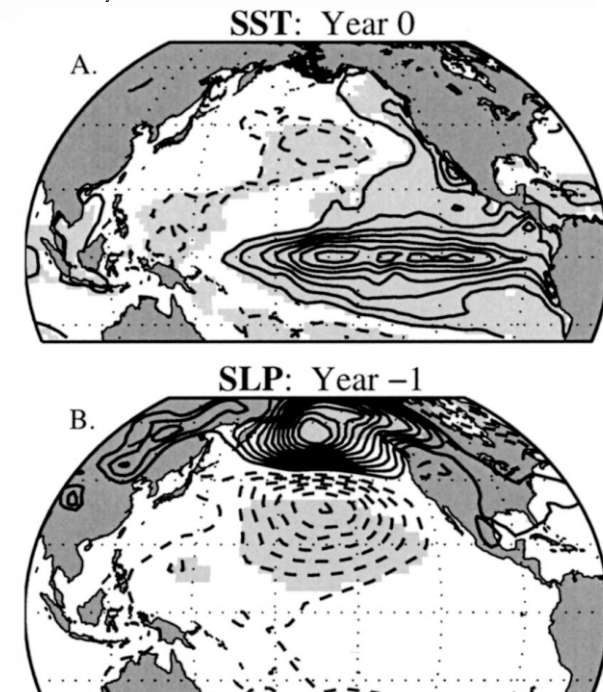
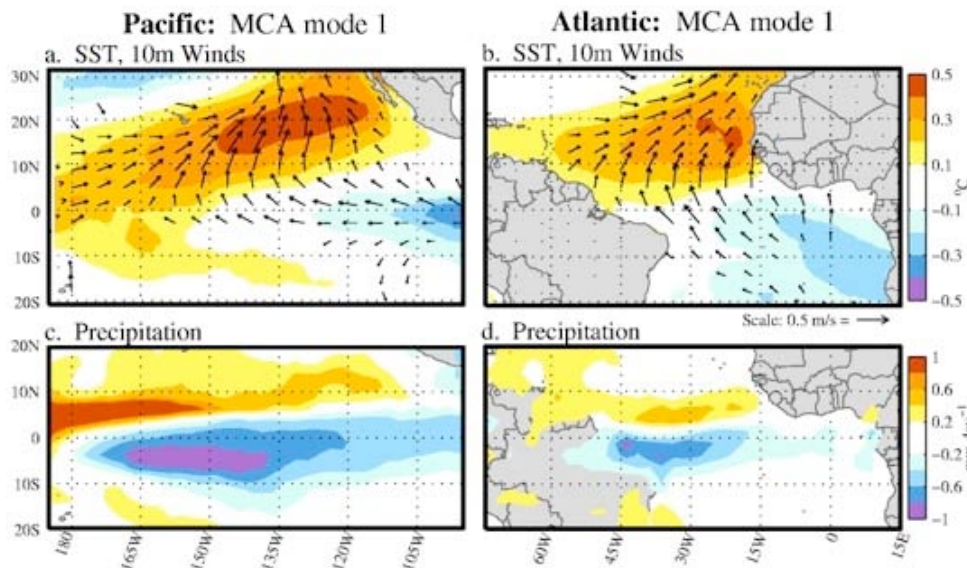
The Seasonal Footprinting Mechanism in the Pacific: Implications for ENSO*

DANIEL J. VIMONT, JOHN M. WALLACE, AND DAVID S. BATTISTI
Department of Atmospheric Sciences, University of Washington, Seattle, Washington

(Manuscript received 15 February 2002, in final form 23 July 2002)

ABSTRACT

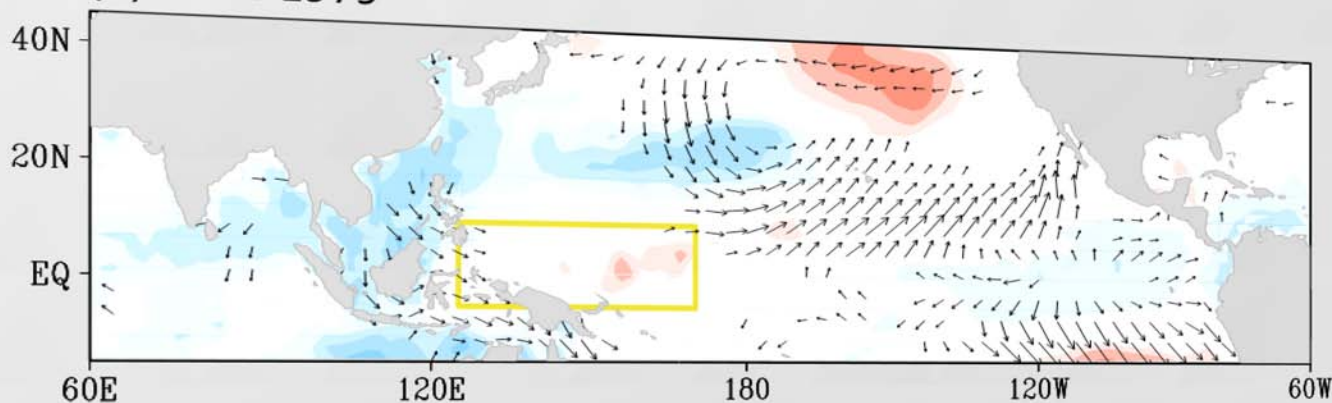
Midlatitude atmospheric variability is identified as a particularly effective component of the stochastic forcing of ENSO. This forcing is realized via a seasonal footprinting mechanism (SFM), in which the tropical atmosphere is forced during the spring and summer by SST anomalies generated by midlatitude atmospheric variability during the previous winter. The strong relationship between the SFM and ENSO may serve to enhance ENSO predictability and supports the view that ENSO is linearly stable in nature.



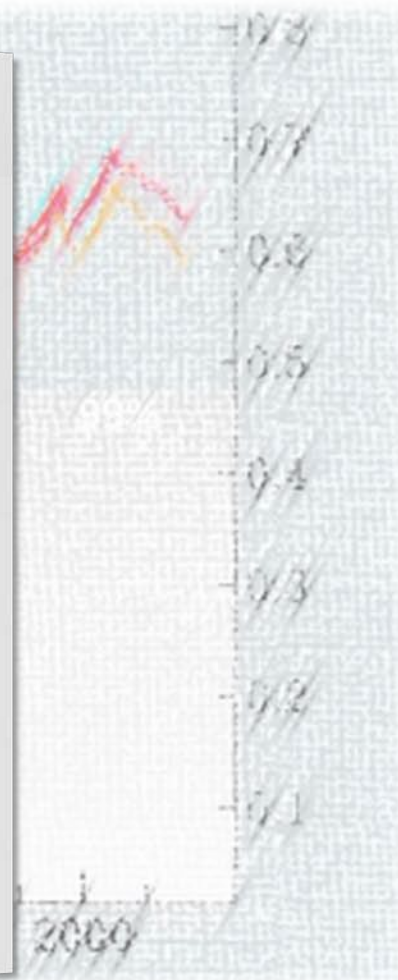
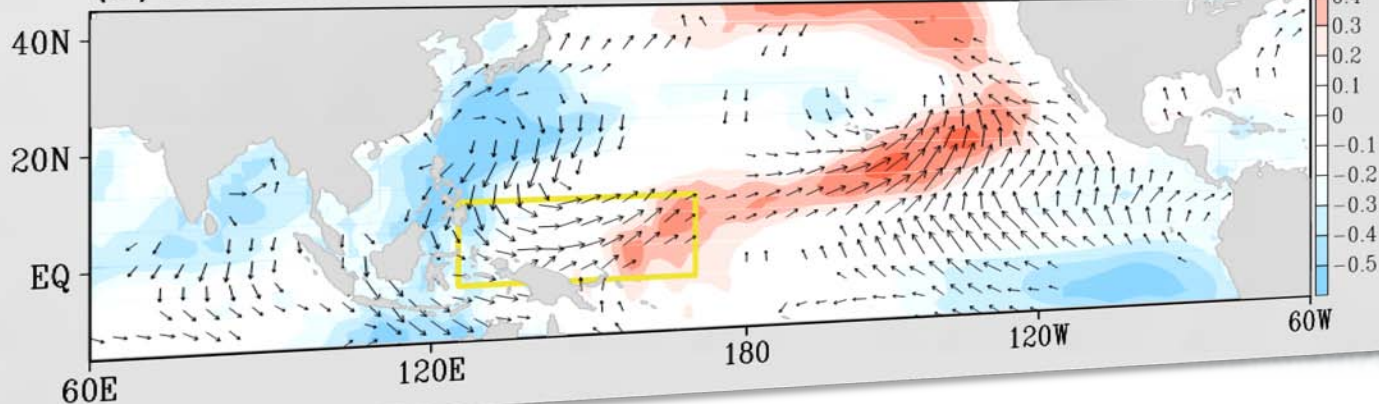
Correlation for ENSO precursors

[Observed] Correlation of SSTA, V_s (DJF) vs. Nino-3.4 (DJF+1yr)

(a) 1951-1979



(b) 1980-2008





WNP warming & dynamics

El Nino (DJF-1yr): 1980-2008 minus 1951-1979

(a) Obs

CESM free run

Community Earth System Model

CESM 350-year control run (natural variability)

CESM1

El Nino (DJF-1yr): PC1(warm) minus PC1(cool)

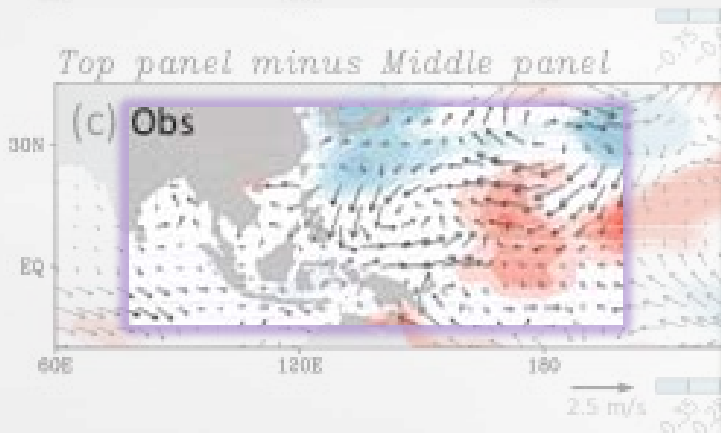
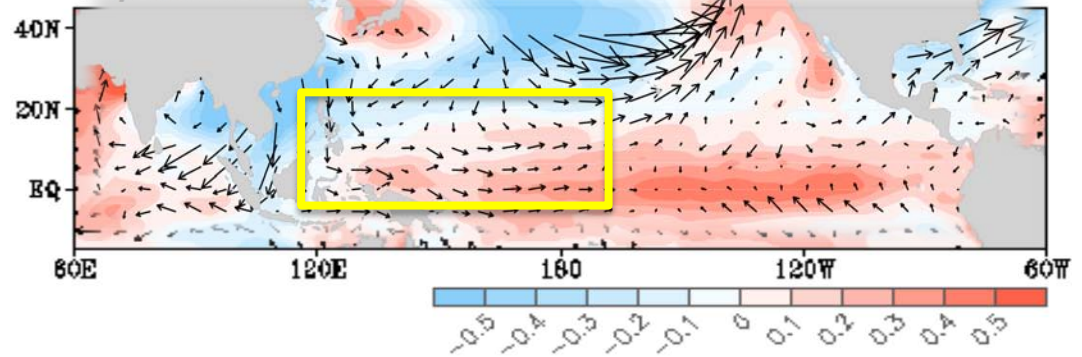
~300yr

CESM

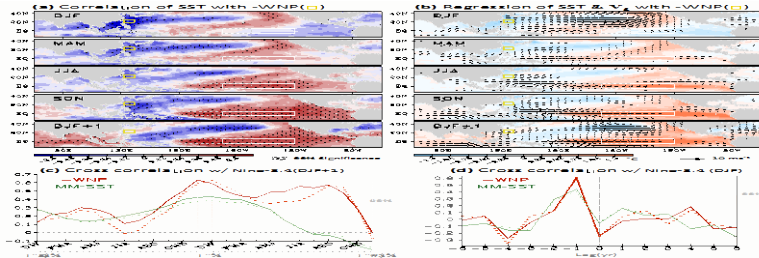
Top panel minus Middle panel

(c) Obs

Top minus Middle

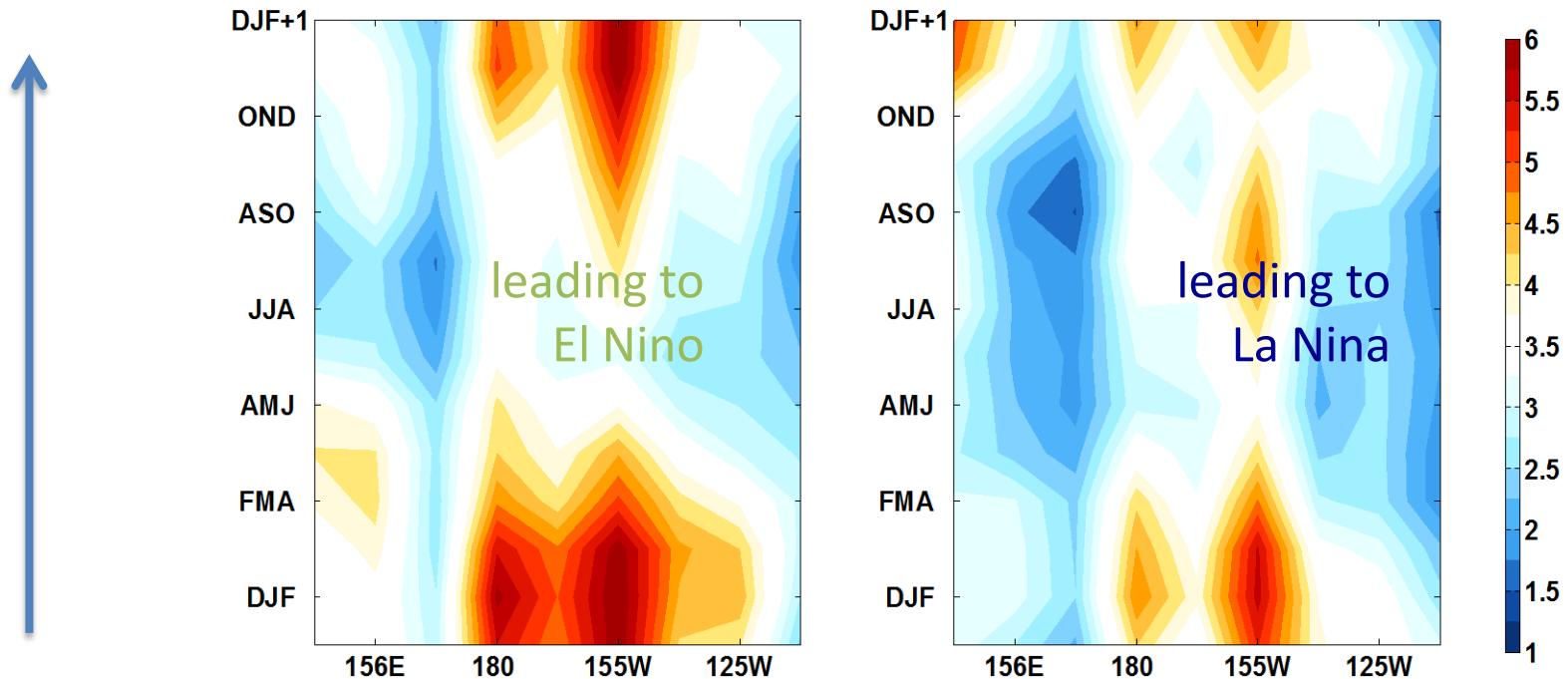


Why Western North Pacific (WNP)?



KW dynamic height composite

(2) Oceanic Kelvin wave - zonal wind triggered



ENSO precursor: WNP

Western North Pacific

