Asymmetric Impact of Atlantic Multidecadal Oscillation on El Niño-La Niña Characteristics

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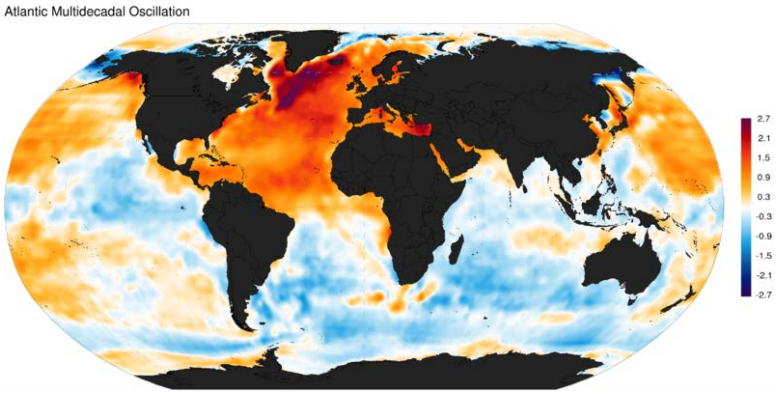
Introduction

AMO (Atlantic Multidecadal Oscillation)
~ AMOC (Atlantic Meridional Overturning Circulation)
~ THC (Atlantic Thermohaline Circulation)



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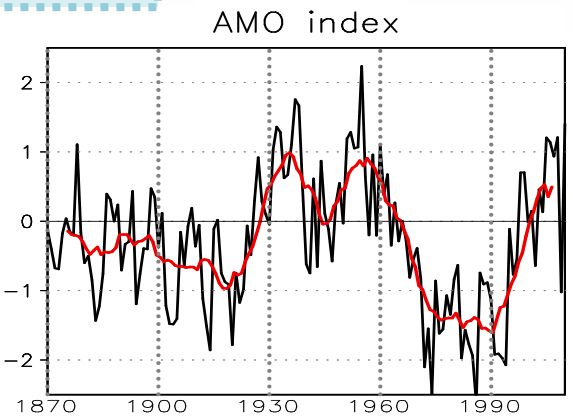
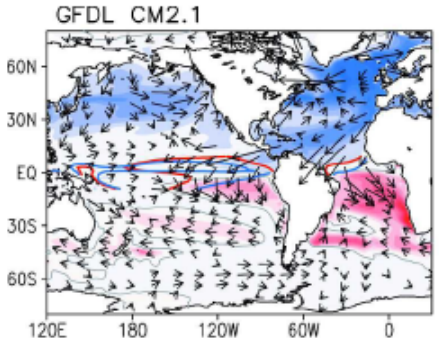


AMOC weakening
: cold North Atlantic
: -AMO (decadal)



ENSO? (interannual)

ENSO variability increase!!

Dong et al., 2006,
Timmermann et al., 2007
Zhang and Delworth, 2005

"thermocline change"
"frequency entrainment"

AMO & ENSO

–AMO ➡ ENSO variability 증가

Data

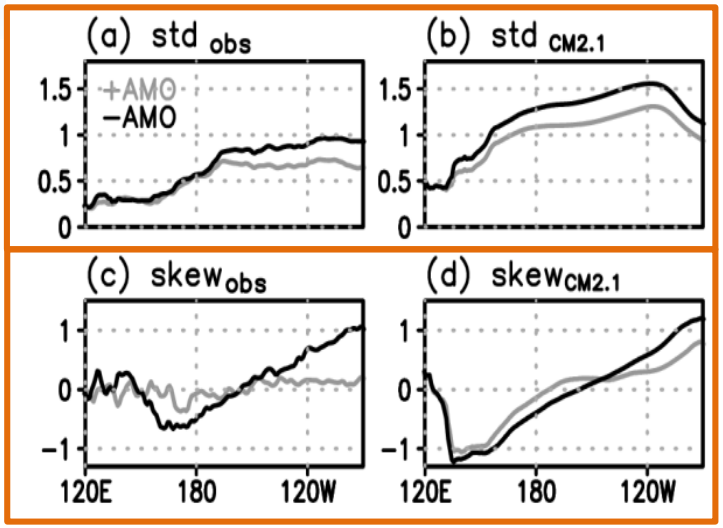
Observation : HadISST

NCEP/NCEAR Reanalysis

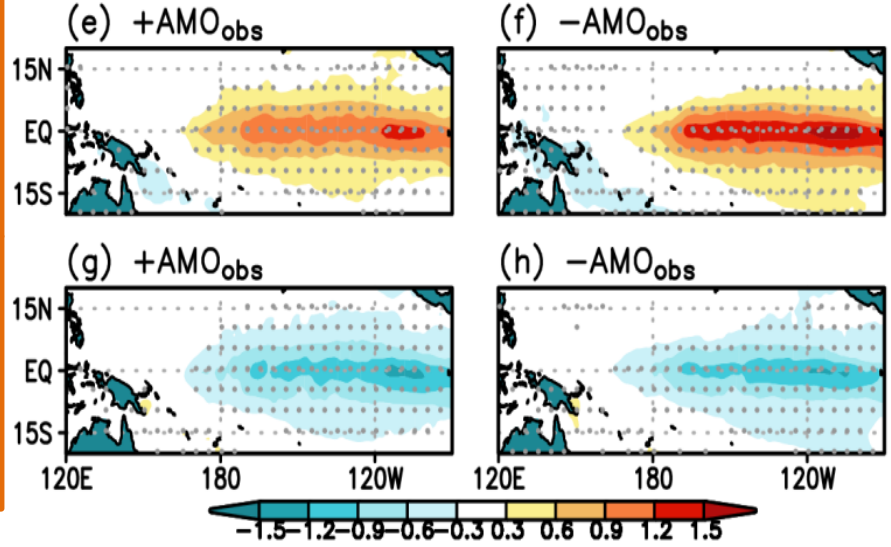
GPCP precipitation

GFDL CM2.1 pre-industrial control exp. (500 yrs)

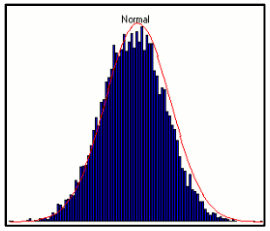
적도 태평양 SST



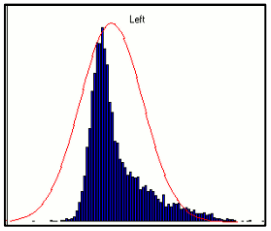
엘니뇨/라니냐 SST composite



skewness = 0



skewness > 0

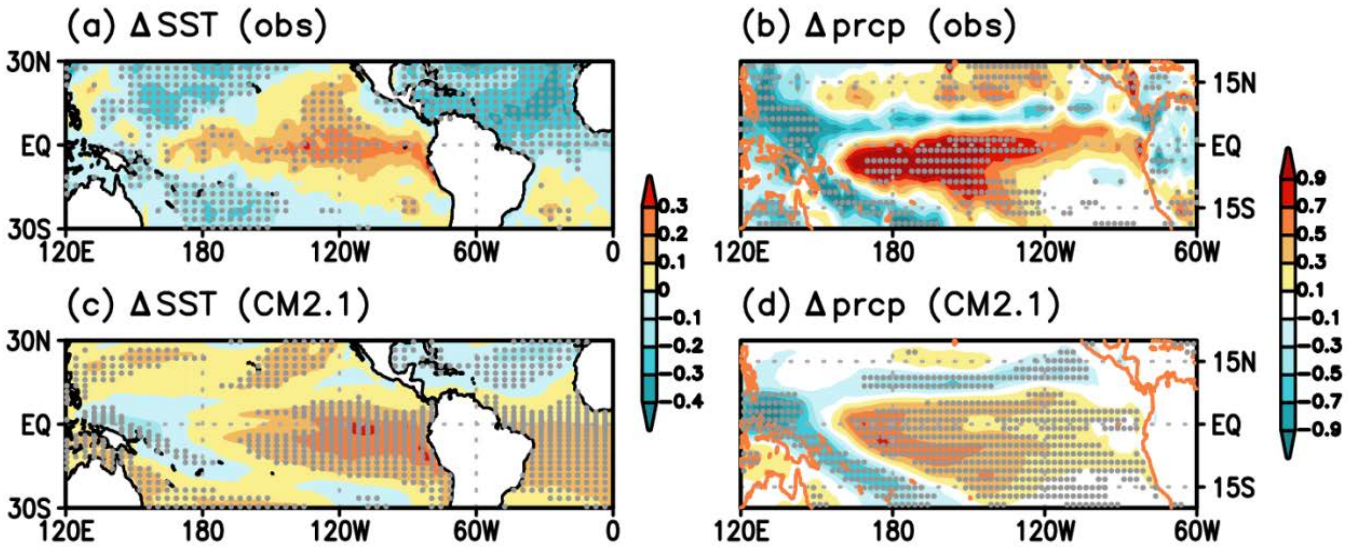


-AMO 시기에

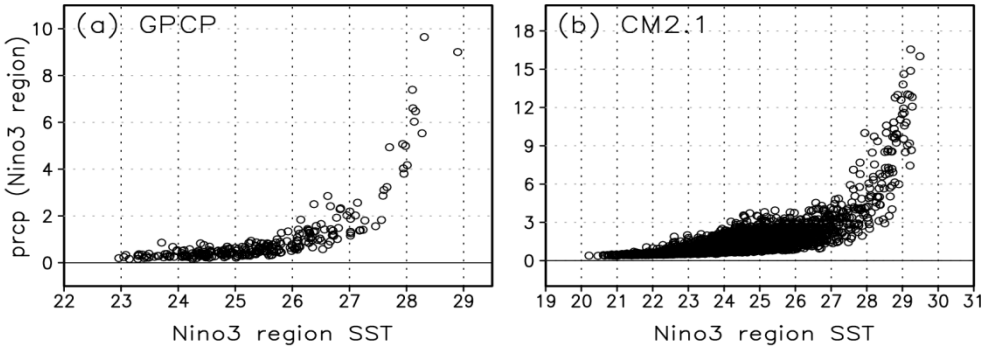
엘니뇨 강도 ⬆ 라니냐 강도 ⬆

AMO & Basic state over the tropical Pacific

Mean difference (-)AMO – (+)AMO



-AMO일 때, warmer mean SST
ITCZ 남하



ΔSST에 대한 Δprcp는 nonlinear!

⇒ mean SST가 높을수록 대기 반응이 강하다!

AMO & Atmospheric Sensitivity

ΔSST에 대한 Δprcp는 nonlinear!

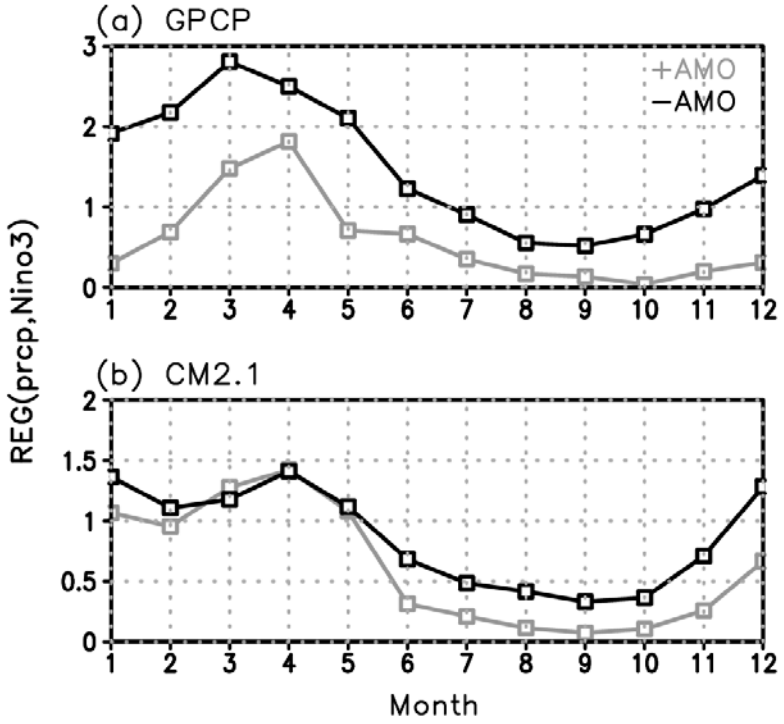
⇒ mean SST가 높을수록 대기 반응이 강하다!

-AMO일 때 warmer mean SST

⇒ -AMO일 때 ΔSST에 대한 대기 반응이 더 강하다!

(대기 민감도가 더 크다)

$$\frac{\Delta prcp_{Nino3}}{\Delta SST_{Nino3}}$$ ➡ Regression coefficient



AMO & Atmospheric Sensitivity

ΔSST에 대한 Δprcp는 nonlinear!

⇒ mean SST가 높을수록 대기 반응이 강하다!

-AMO일 때 warmer mean SST

⇒ -AMO일 때 ΔSST에 대한 대기 반응이 더 강하다?

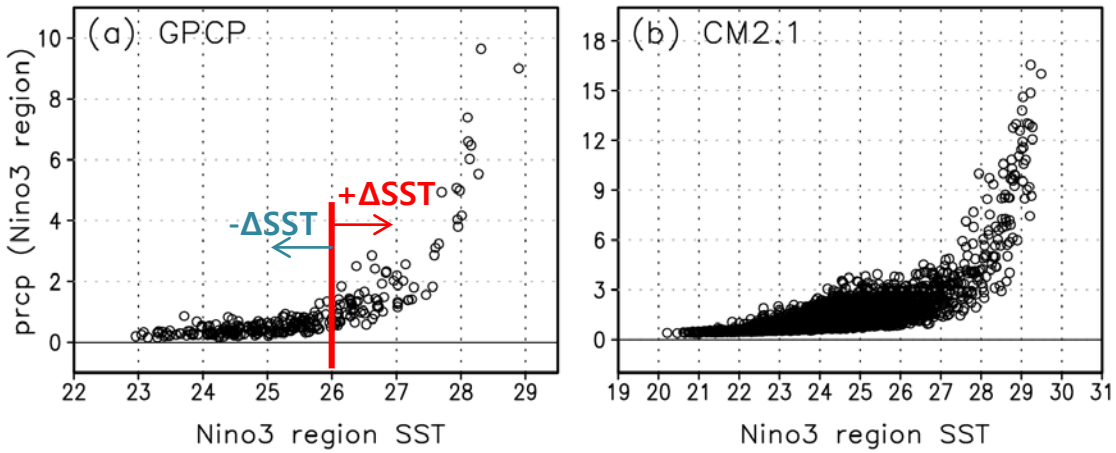
(대기 민감도가 더 크다)

-AMO 시기에

엘니뇨 강도 ↑ 라니냐 강도 ↑

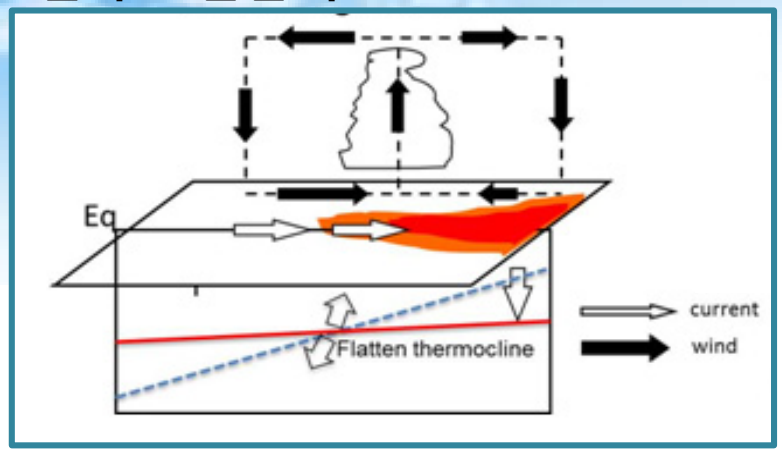
$$\frac{-\Delta prcp}{-\Delta SST} < \frac{+\Delta prcp}{+\Delta SST}$$

: 엘니뇨와 라니냐 발달이 비대칭적



AMO & Ocean–Atmosphere coupling strength

엘니뇨 발달 구조



Bjerknes feedback

Warm SST anomaly
⇒ Anomalous westerly
⇒ Deep thermocline
⇒ Warmer SST
⇒ …

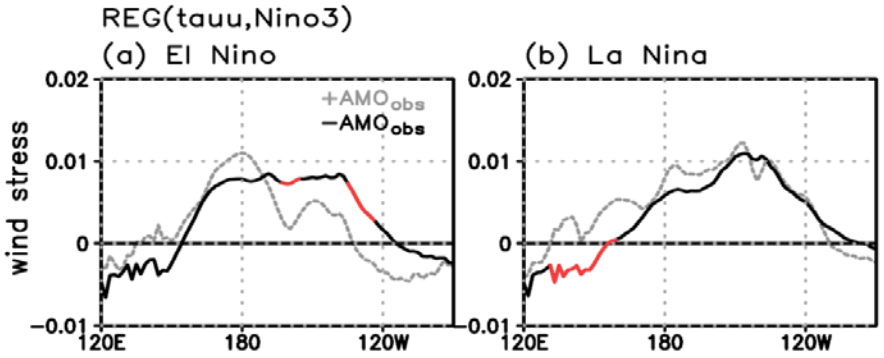
: 대기-해양 결합 과정

대기-해양 결합 강도의 차이
(El Nino vs. La Nina)

$$\frac{\Delta\tau_{Nino3}}{\Delta SST_{Nino3}}$$

➡ Partial regression Coefficient

관측



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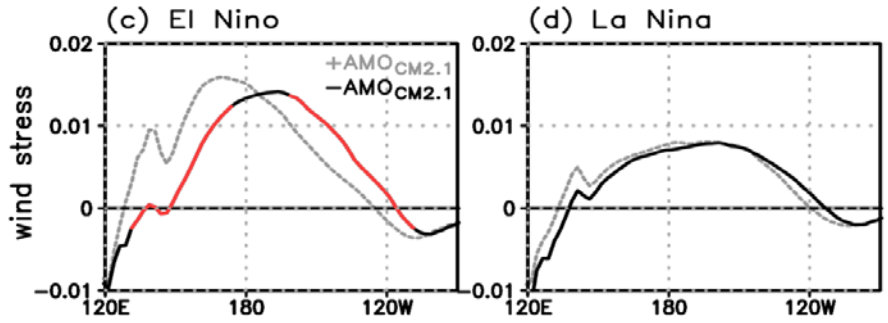

AMO & Ocean–Atmosphere coupling strength

✓ –AMO 시기의 엘니뇨 발달기에 대기 반응이 동쪽으로 shift
⇒ 더 강한 해양 반응 유도
⇒ -AMO 시기에 엘니뇨 강도 강화

✓ 라니냐 발달시에 대기-해양 결합 강도 차이는 AMO 위상에 따른 차이가 거의 없음

AMO 조건에 따른 ENSO의 비대칭적 발달

대기-해양 결합 강도의 차이
(El Nino vs. La Nina)

$$\frac{\Delta\tau_{Nino3}}{\Delta SST_{Nino3}}$$ ➡ Partial regression Coefficient

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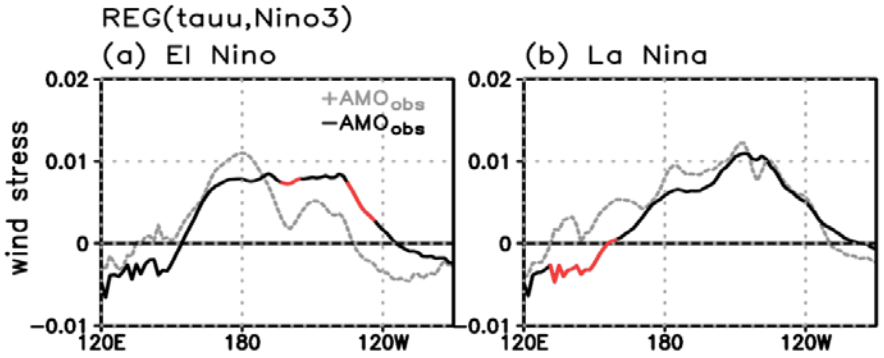

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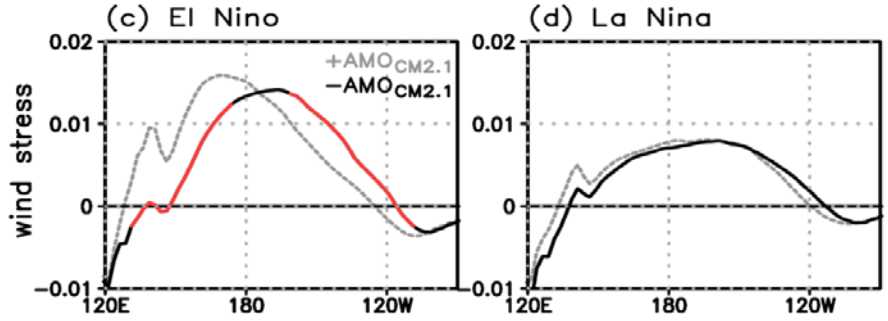

Summary