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Impact of the Indian and the North Pacific ocean on ENSO variability in a hybrid coupled model,

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Impact of the Indian and North Pacific Ocean on ENSO Variability in a Hybrid Coupled Model

Korea Ocean Research & Development Institute
Sang-Wook Yeh
- Indian Ocean & North Pacific Ocean and ENSO
• Indian Ocean & North Pacific Ocean and ENSO

Tropics -> North Pacific

North Pacific -> Tropics

Alexander et al. (2002)

Vimont et al. (2001)
• Indian Ocean & North Pacific Ocean and ENSO

• The Indian and North Pacific Ocean could influence to ENSO via atmosphere and ocean
• Indian Ocean & North Pacific Ocean and ENSO

• How the Indian and North Pacific Ocean differently acts to ENSO?
• Methodology

- Control run and two Idealized runs
• HCM [Hybrid Coupled Model] : Control run
- Two idealized runs

**Indian Ocean coupled run**
- Coupled with a modified ZC ocean model
- Coupled with a slab ocean model

**North Pacific Ocean coupled run**
- Coupled with a modified ZC ocean model
- Coupled with a slab ocean model
Methodology

Simulation period:

Control run (200 years),

Indian Ocean coupled run (120 years),

North Pacific Ocean coupled run (150 years)
• Results: Changes in ENSO properties

(a) Obs. [ERSST, 1950–2006]

(b) Control run

Red noise spectrum

NINO3 SST index [control run]
• Results: Changes in ENSO properties

- Maintaining the air-sea coupled feedbacks in the Indian Ocean
- enhances the biennial tendency of ENSO variability
- reduces the ENSO amplitude.
• Results: Changes in ENSO properties

- Maintaining the coupled feedbacks in the North Pacific Ocean
- enhances the ENSO amplitude.
• **Results: Changes in ENSO properties**

The Indian Ocean and the North Pacific Ocean differently acts to change in ENSO properties in terms of frequency and amplitude.
- The ENSO frequency is related to the zonal structure of zonal wind stress anomalies along the equatorial Pacific (An and Wang, 2000).

Fig. 2. First SVD mode between the tropical zonal wind stress anomaly (heavy line) and SST anomaly (thin line) calculated for the two periods Jan 1962–Dec 1973, and Jan 1981–Dec 1992, which are associated with different oscillation frequency regimes. The SVD modes for the former and latter periods are indicated by solid and dotted lines, respectively.
Understanding the change in ENSO frequency

- Control run: Black
- Indian Ocean coupled run: Red
- North Pacific Ocean coupled run: Green
• Understanding the change in ENSO frequency

• Hypothesis

- The change in the ENSO period toward an enhanced biennial component is related to the shift of equatorial Pacific zonal wind stress anomalies due to the impacts of Indian monsoon.

Via Atmosphere
(i.e., Anomalous Walker circulation)

Indian monsoon variability

The zonal structure of wind stress anomalies
- Understanding the change in ENSO frequency

-Power spectral of Indian monsoon rainfall index (65E-100E, 10N-30N)
• Understanding the change in ENSO frequency

The linear regression coefficients between the Indian monsoon rainfall index and zonal wind stress anomalies

- Control run
- Indian Ocean coupled run
- North Pacific Ocean coupled run

Control run: Black
Indian Ocean coupled run: Red
North Pacific Ocean coupled run: Green
• Conclusion

- The Indian Ocean and the North Pacific Ocean acts differently to the ENSO statistics (i.e., amplitude and frequency) when air-sea interactions are included.

- While the Indian Ocean enhance the ENSO biennial frequency, the North Pacific Ocean acts to enhance the ENSO amplitude.

- The center of zonal wind stress is shifted to the west in the Indian Ocean coupled run compared to the control run and the North Pacific Ocean coupled run, which is associated with the Indian monsoon variability. This results in an enhancement of the quasi-biennial frequency of ENSO period.