The El Nino teleconnection to the isopycnal fluctuations in the southwestern East/Japan Sea

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Background of Study
Yun et al. (2004)

Fromation region
ESIW 26.9-27.2
Cold water intrusion

Summer (Aug. mean)
Winter (Feb. mean)
increasing
decreasing
15 year interval \(\rightarrow\) 1997-1982
(strong El Ninos)

A band of 17.2 year period
\(\rightarrow\) 13.7~22.9 years
Purpose

• To show some evidence of teleconnection between strong El Ninos and the isopycnal fluctuations in the southwestern East/Japan Sea at the 17.2 year period

• To determine the causal mechanism of the teleconnection
Data

- Isopycnal depth data from the bimonthly T, S data of the NFRDI of Korea from 1968 to 2002

- ECMWF reanalysis data
  - Data 1
    - Area: East Asian region
    - Period: Jan. 1968 – Aug. 2002
    - Spatial resolution: 1.125°
  - Data 2: ERA40
    - Area: entire globe
    - Period: same as above
    - Spatial resolution: 2.5°
• Significant level:
  Green: coh=0.52 at 80%
  Light blue: coh=0.62 at 90%
  Blue: coh=0.67 at 95%

• High coherency
  Teleconnection b/w Nino-3 and isopycnal fluctuations

(a) $27.0 \sigma_\theta$
(b) $27.1 \sigma_\theta$
(c) $27.2 \sigma_\theta$
Coherency:
- : 0.4
- : 0.52 → 80%
- : 0.62 → 90%
- : 0.67 → 95%
- : 0.80

Phase:
- no shading: 0°
- darkest: 180°
- yellow broken line: 90°

Coherence:
- Coh=0.47
- Ph=-139.9°
- (130.5°E, 42.0°N)

- T=17.2 yrs
- Coh=0.71
- Ph=-8°
- (133.9°E, 43.1°N)

- T=11.8 mos
- Coh=0.80
- Ph=154.8°
- (133.9°E, 43.1°N)

Isopycnal depth of 27.1 σθ at 103-7 vs. SST

Time series
- T at 130.5°E, 42.0°N
- T at 133.9°E, 43.1°N
- Isopycnal depth of 27.1 σθ at 103-7

Nino-3
To verify the teleconnection

(a) Coherency and phase
NINO-3 vs. SLHF

(b) Coherency and phase
Depth of 27.1 $\sigma$ vs. SLHF (surface latent heat flux)

coh=0.58
ph=43.5
(131.6°E, 43.1°N)

T=17.2 yrs
coh=0.80
ph=178.5°
(130.5°E, 40.9°N)

(c) Cross spectrum

T=17.2 yrs
coh=0.88
ph=176.1°
(131.6°E, 43.1°N)

(d) Time series

ECMWF
T at 130.0°E, 40.9°N

ECMWF
T at 131.6°E, 43.1°N

Observed
depth of 27.1 $\sigma$ at 103-7

Nino-3
To examine the teleconnection mechanism

(a) Coherencies and phases between NINO-3 and geopotential heights at 1000 hpa

(122.5°E, 50°N)
coh = 0.42
ph = 162°

(b) Coherencies and phases between NINO-3 and geopotential heights at 850 hpa

(87.5°E, 57.5°N)
coh = 0.70
ph = -12.2°
To see the atmospheric bridge effect

Coherency and phase of 1000 hpa geopotential heights between the western Indian Ocean (55E, 2.5S) and the Siberian high (117.5E, 52.5N)

Siberian high region
coh=0.84
ph=165°
at 117.5°E, 52.5°N

Western Indian Ocean
coh=1.0
ph=0.0°
at 55°E, 2.5°S
To examine further the atmospheric bridge effect

(a) Coherencies and phases between NINO-3 and geopotential height differences of 200 minus 1000 hpa

coh=0.86
ph=-11.3 (6 month time difference b/w Nino-3 and large thickness)
(45°E, 15°N)
Thickness time series of 200-1000 hpa along the high coherency path

- Thickness in summer after a strong El Nino
- Thickness in winter after a strong El Nino

- 100°E, 50°N
- 102.5°E, 30°N
- 100°E, 25°N
- 97.5°E, 22.5°N
- 82.5°E, 15°N
- 57.5°E, 10°N
- 50°E, 2.5°S

Nino-3
To see if the temperatures and specific humidities support the idea of the atmospheric bridging

(a) Cohrencies and phases between NINO-3 and air temperatures at 1000 hpa

- Coh = 0.23
- Ph = -30.8°N
  (87.5°E, 60°N)

(b) Cohrencies and phases between NINO-3 and specific humidities at 1000 hpa

- Coh = 0.25
- Ph = 37.7°
  (90.0°E, 50°N)

Specific humidity = mass of water vapor / a unit mass of air

Dark shading: opposite phasing to Nino-3
Cold core regions with winter (DJF) average temperatures of below -30°C in each year

Location of the Siberian high center with 1000 hpa geopotential heights above 260 m in each year

Higher humidity

More precipitation

Cloudier

Wetter ground

Less solar radiation

More evaporation

Plus the deep basin effect

In the region

Convergence of colder air into the basin
Conclusions

• There seems to be some teleconnection between a strong El Nino and the isopycnal fluctuations in the southwestern East Sea/Japan Sea.

• The teleconnection mechanism may be the atmospheric bridging between the Indian Ocean and the Siberian high region and the related cold surges toward the East Sea/Japan Sea.

• This leads to lower SSTs in the northwestern East Sea/Japan Sea and to shallower isopycnal depths in the ESIW, when a strong El Nino occurs.