The Abdus Salam International Centre for Theoretical Physics

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Epochal changes in the teleconnections between subtropical and tropical Indian Ocean

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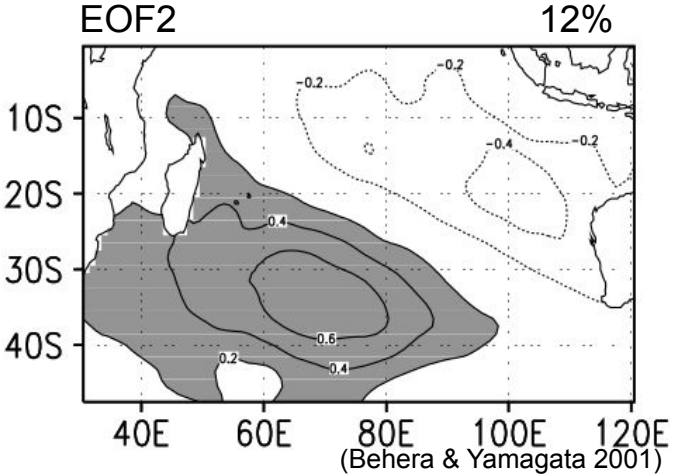
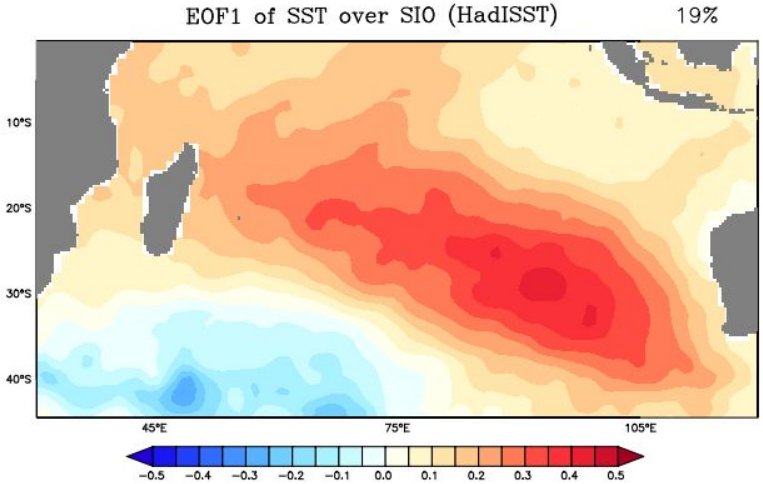
Subtropical Indian Ocean Dipole (SIOD):

Second dominant mode of SST variability over Subtropical Indian Ocean (Behera & Yamagata 2001).

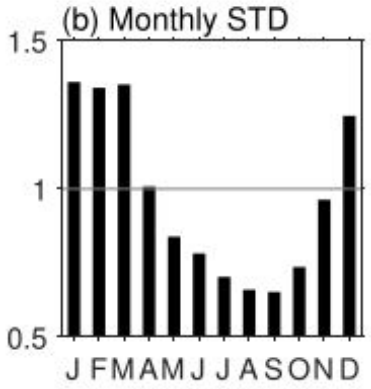
➢ **Developed by the wind-evaporation-SST feedback mechanism and peaks during the austral summer (Behera & Yamagata 2001; Suzuki et al., 2004).**



(Behera & Yamagata 2001)



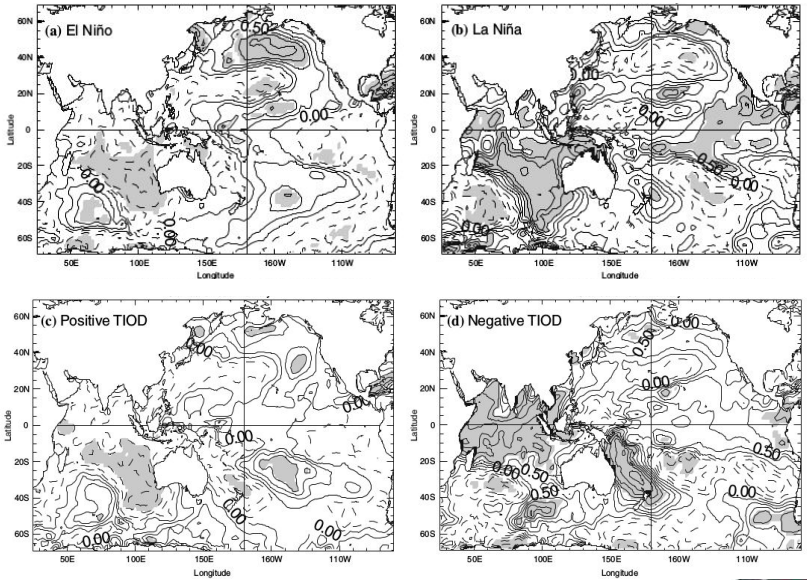
EOF1 significantly related to ENSO (Venzke et al., 2000)



(Zhang et al., 2019)

Impacts of SIOD on Global climate:

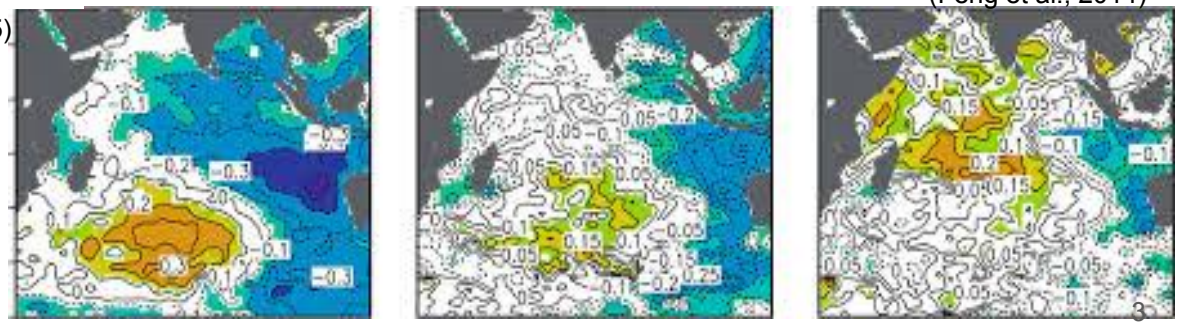
Composite analysis of SST anomaly prior to ENSO and IOD(FM)



(Terray et al., 2005)

- Terray et al., 2005; Terray 2011; Yan et al., 2013: After the climate regime shift (1976/77), SIOD significantly **correlated (positive) with ENSO** in 9 months lead.
- Terray et al., 2007; Feng et al., 2014; Zhang et al., 2020: Positive **SIOD lead to the development of positive tropical IOD**.

(Feng et al., 2014)



Lag +3 Lag +6 Lag +9

Data and Methodology

Dataset Used

- ➔ Hadley Centre Global Sea Ice and Sea Surface Temperature (HadISST1.1)
- ➔ Ocean Reanalysis System 4 (ORAS4, Balmaseda et al. 2013)
- ➔ ECMWF's ERA20CM (1900-2010) and ERA5 (1979-present) surface wind data

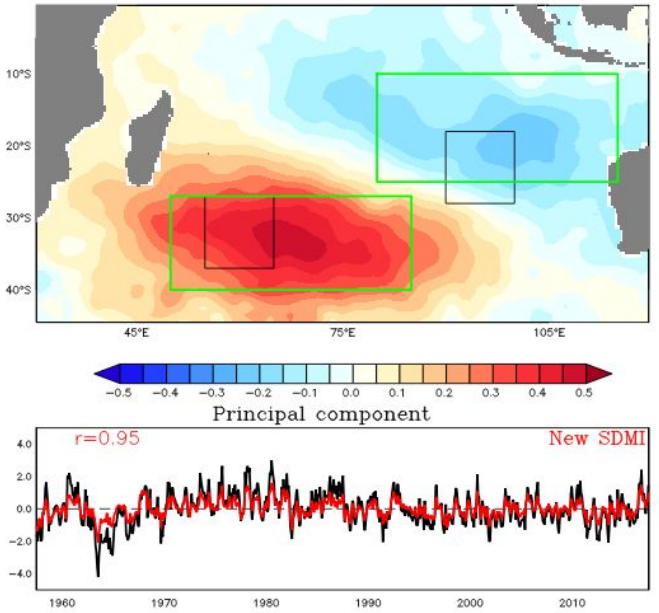
Techniques

- ➔ EOF analysis - To find the dominant modes of variability
- ➔ Regression, Correlation and composite analysis

Study period is 1958 - 2017

New SIOD index = Difference between average SSTA over 50°-85°E, 40°-27°S and 80°-115°E, 25°-10°S

EOF2 (HadISST) 16%

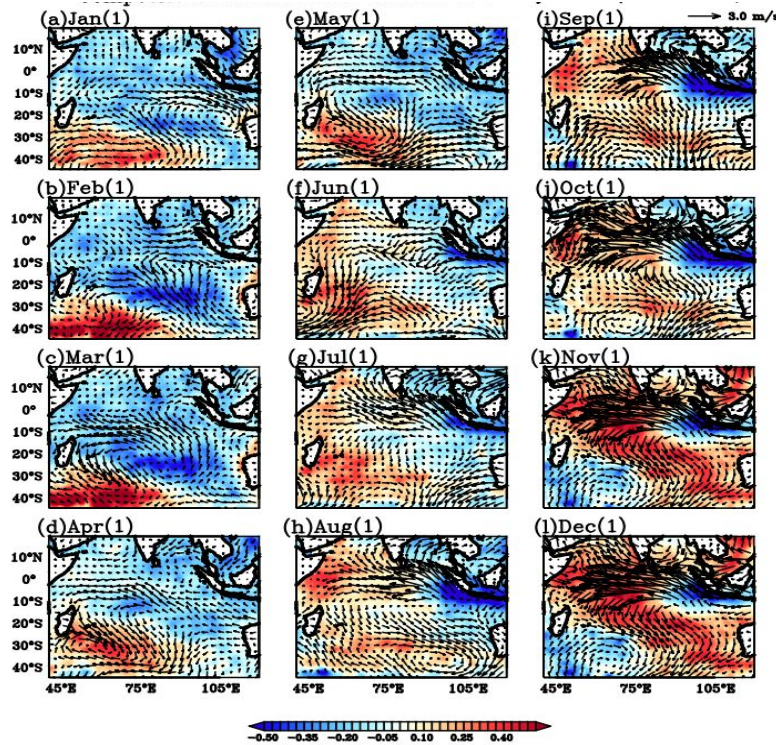


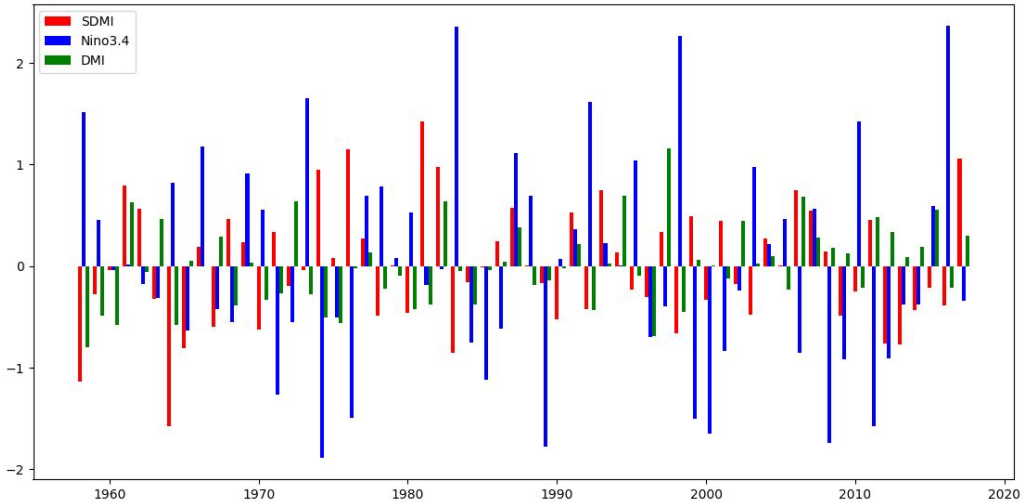
Correlation between Behera & Yamagata (BY) SDMI and PC = 0.85

Standard deviation of new SDMI = 0.53
Standard deviation of BY SDMI = 0.66

SIOD and tropical Indian Ocean

Composite of SST and surface wind during PIOD years



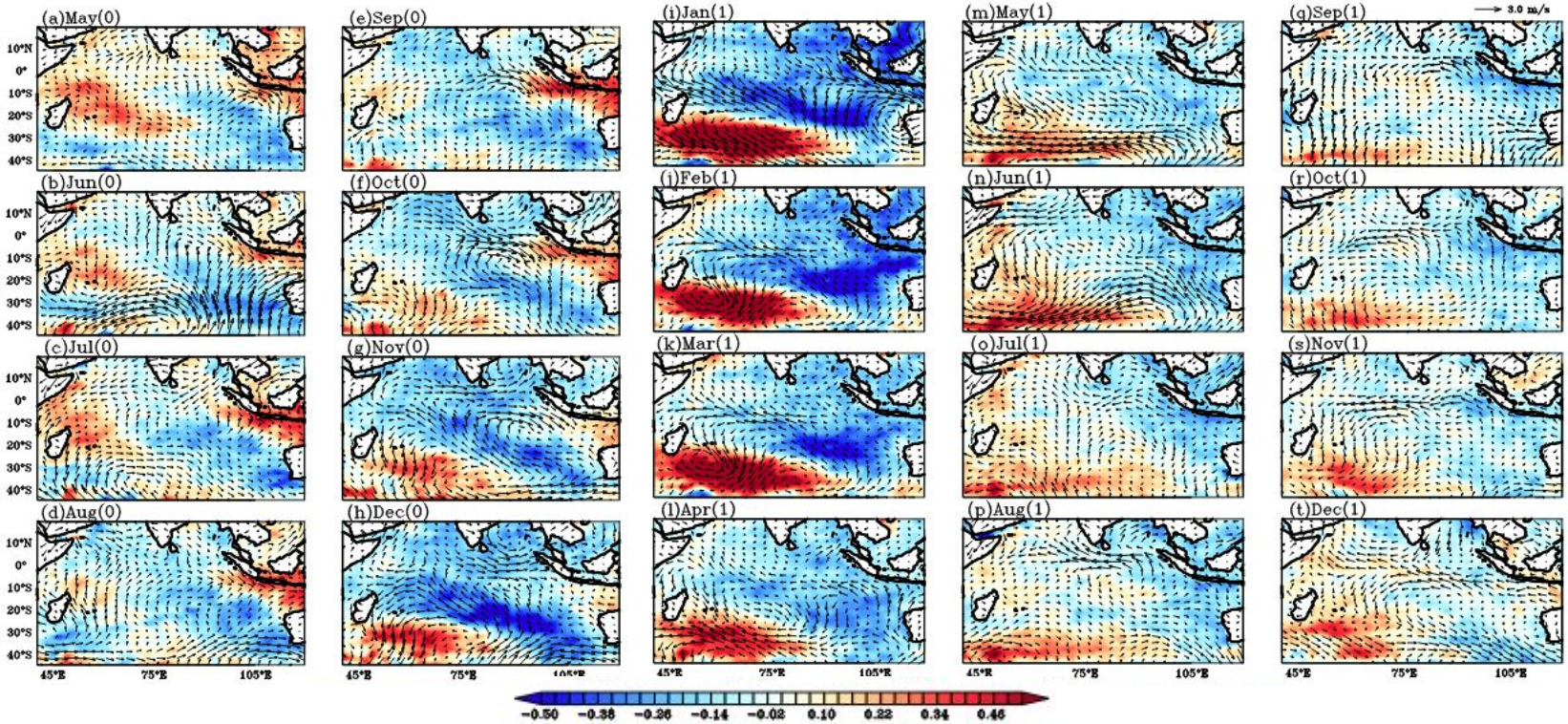


Correlation b/w JFM SIOD and following SON tropical IOD (1958-2017) = **0.26**
1958-1977 = **0.16**, 1978-2017 = **0.34**

Correlation b/w JFM SIOD and SON tropical IOD prior to it(1958-2017) = **-0.45**
1958-1977 = **-0.27**, 1978-2017 = **-0.57**
The correlations has increased after 1977.

Whether SIOD causes the development of tropical IOD or tropical IOD triggering SIOD?

Composite analysis: positive SIOD events



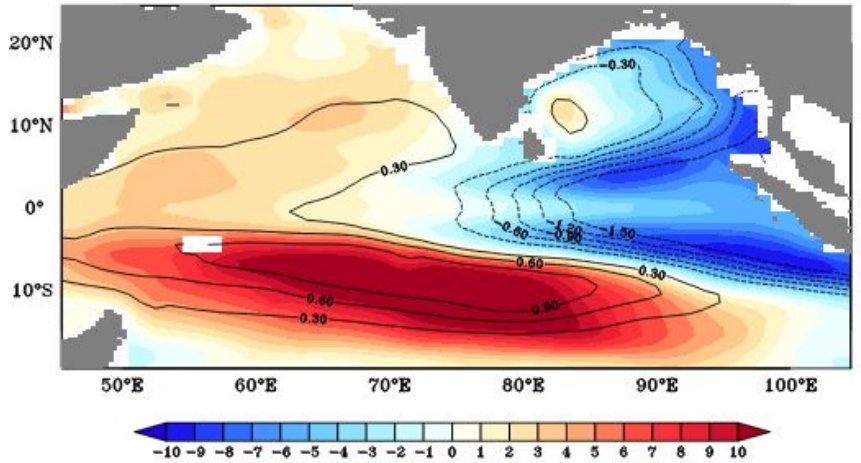
(Here '(0)' represents previous year and '(1)' represents peak year of SIOD.)

The (negative) correlation between SIOD and tropical IOD prior to SIOD is stronger than the (positive) correlation between SIOD and the following tropical IOD.

The easterly wind anomalies are prevailing over tropical Indian Ocean from August of the peak year.

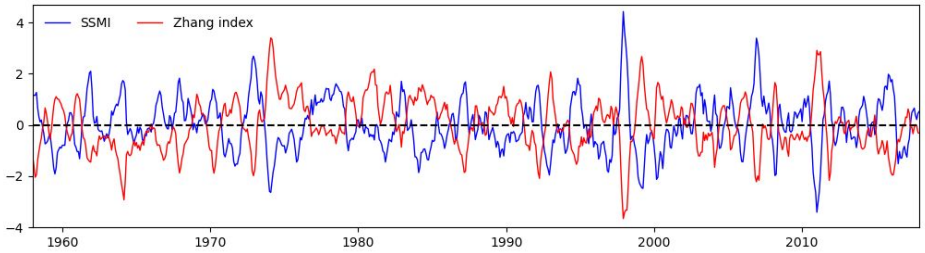
SIOD and Tropical Subsurface mode:

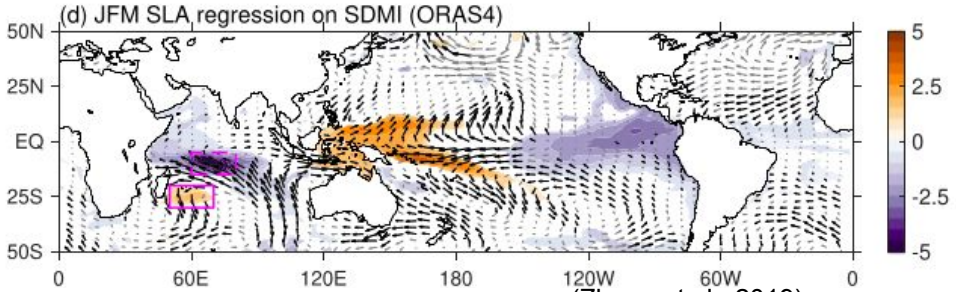
EOF1 of d20 (shaded) and 100m temp (contour) variability



The northern pole (60°–80°E, 15°–5°S) of the SLA dipole by Zhang et al., 2019, is the region of southern pole of the tropical subsurface mode (SSM) (60°-90°E, 15°-5°S) (Sayantani & Gnanaseelan 2015, Kakatkar et al., 2020).

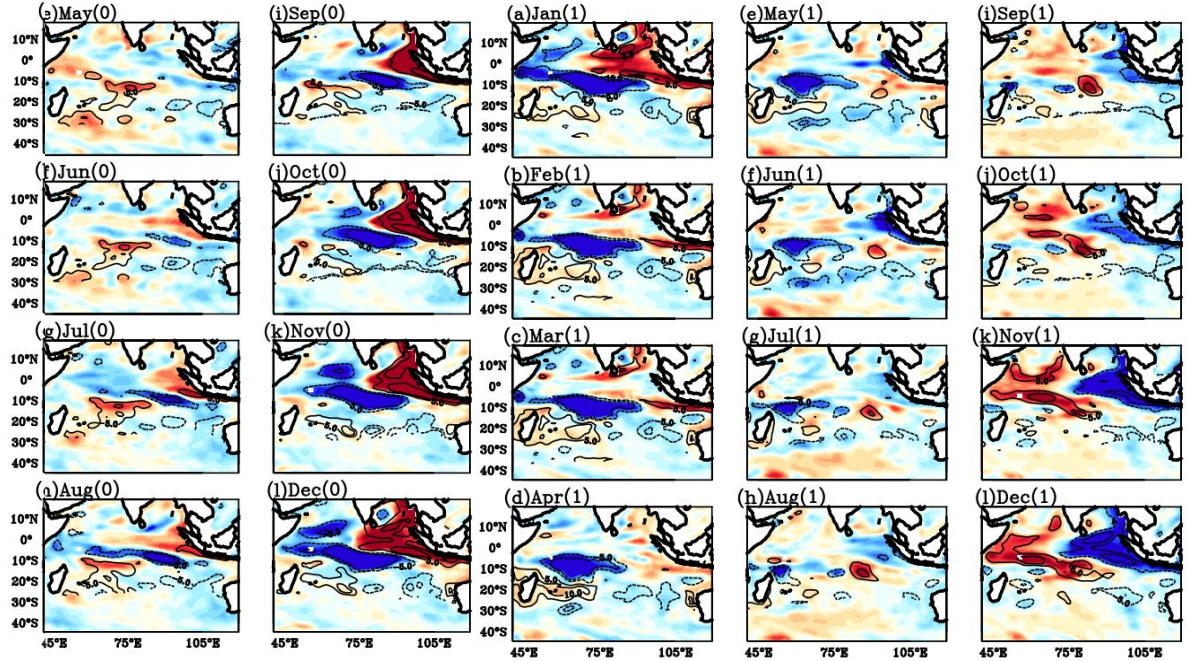
Correlation between SSMI and SLA dipole index (Zhang index)= -0.76



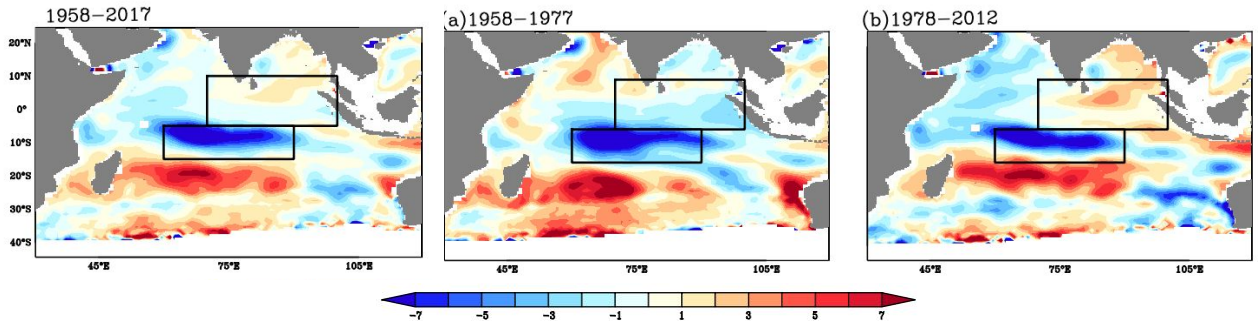


(Zhang et al., 2019)

Composite of d20 (contour) and 100m temp (shaded) anomalies in positive SIOD events



Regression of d20 anomaly on SDMI



- A negative SSM is developing from June-July months before the peak of positive SIOD(JFM) and begins to decay in the following February.
- The positive SIOD leads to the development of positive SSM in the following months.

SUMMARY

- SIOD in positively linked with the following tropical IOD, whereas negatively correlated with the preceding tropical IOD. They display a seesaw pattern of co-variability.

- These relationship between SIOD and tropical IOD strengthen after the climate regime shift of 1976/77.

- The opposite relationship between SIOD and tropical subsurface mode (SSM) also strengthened after the climate regime shift.