Association between tropical variability and Indian summer monsoon (ISM) through moisture budget

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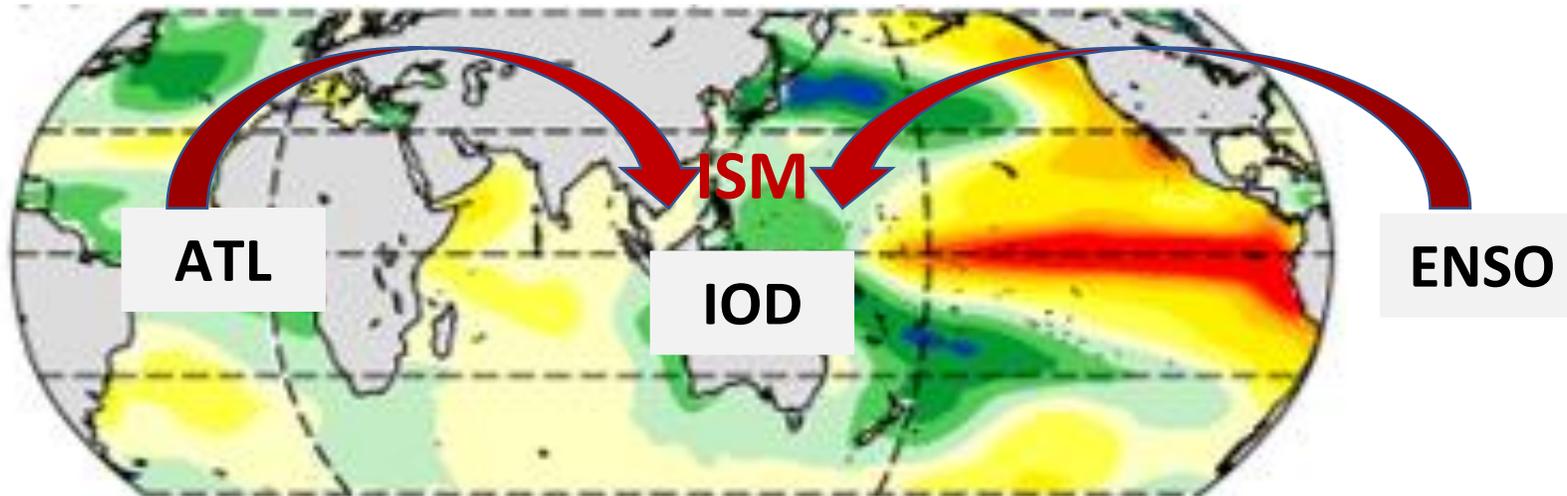
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ISM Teleconnection…

- Different hypothesis proposed for various SST variability like:
  - El Nino Southern Oscillation (ENSO)
  - Indian Ocean Dipole (IOD)
  - Atlantic Tropical Variability (ATL)
  - Preceding Winter ENSO (WENSO)

ISM Teleconnection...

- Different hypothesis proposed for various SST variability like:
  - ENSO: Sikka 1980, Webster et al., 1998, Goswami 1998, Seager et al., 2003
  - IOD: Ashok et al 2001, Behera et al., 1999, Annamalai 2010
  - ATL: Kucharski et al., 2007, Yadav et al., 2018
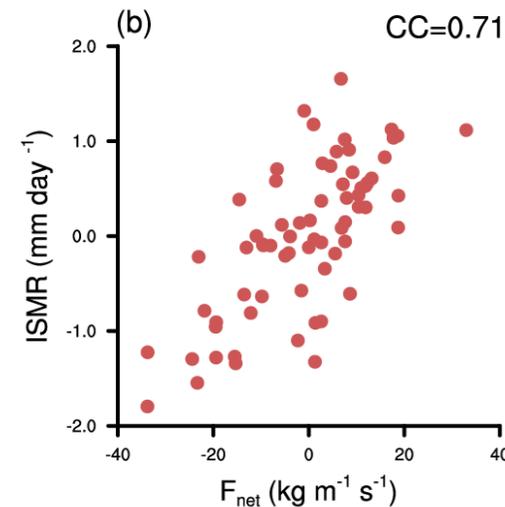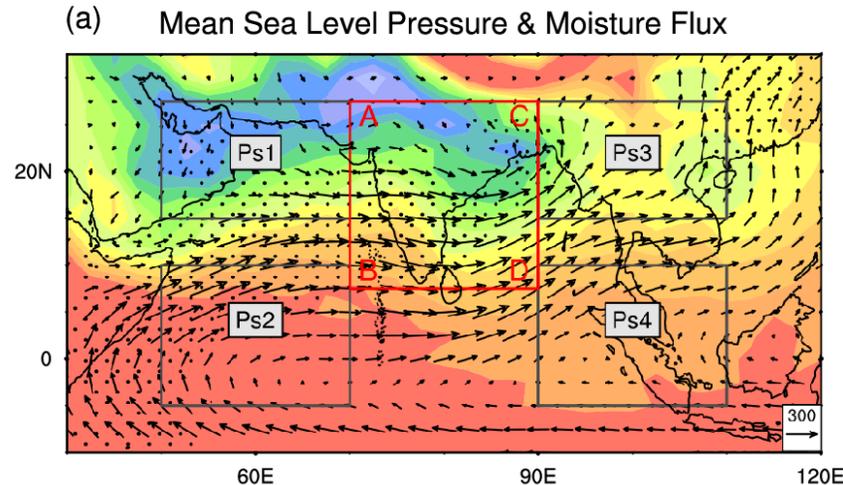 - WENSO: Chakraborty 2018

Problem:
- Quantification of the ISMR through a common mechanism
- Direct linkage of dynamic forcing with precipitation.
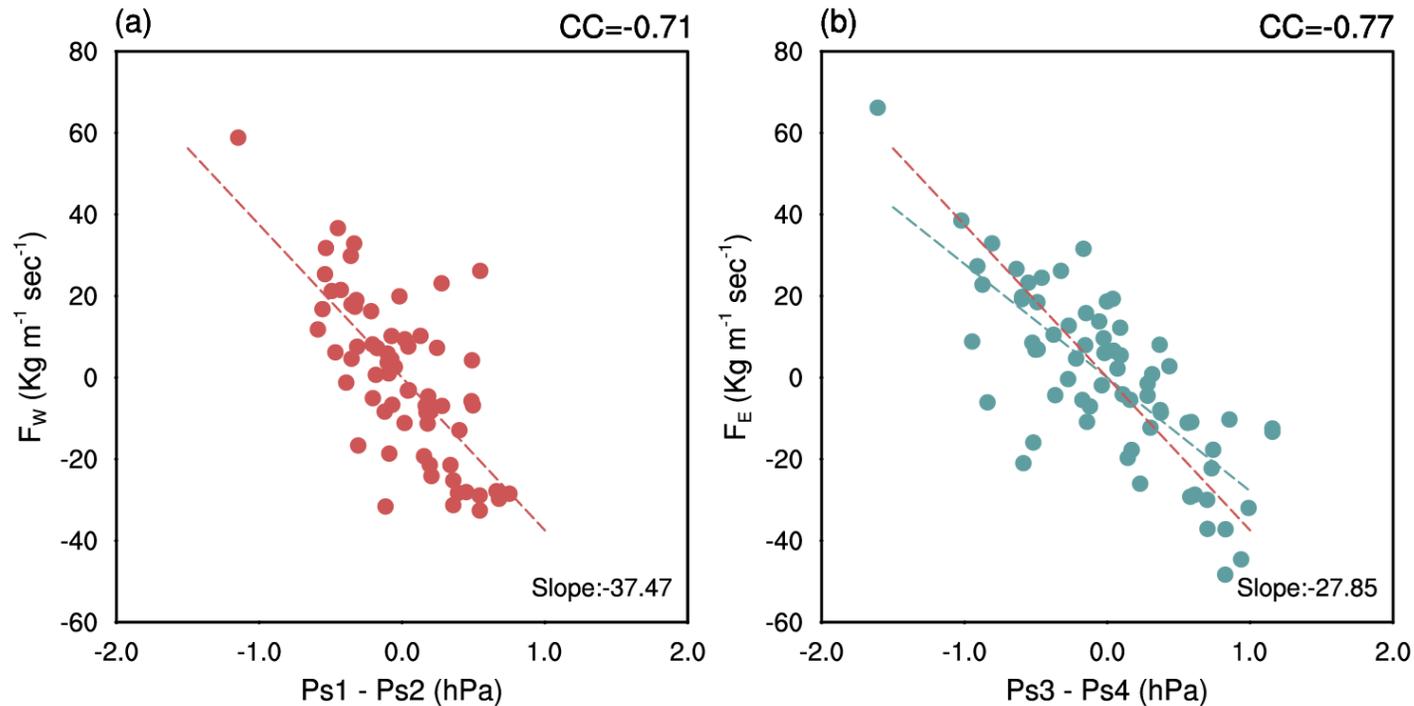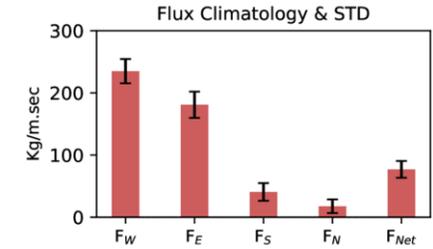
Moisture budget theory
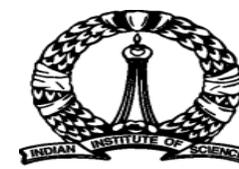
$$\frac{1}{A}(F_w - F_e + F_s - F_n) = \bar{P} - \bar{E} + \frac{\partial P_{wat}}{\partial t},$$

$$\frac{1}{A}(F_{net}) = \bar{P} - \bar{E} + \frac{\partial P_{wat}}{\partial t}$$

ISMR ∝ Fnet

(a) JJAS climatological mean sea level pressure along with vertically integrated moisture flux. (b) Scatter plot between net moisture convergence & ISMR.

Geostrophic Assumptions:

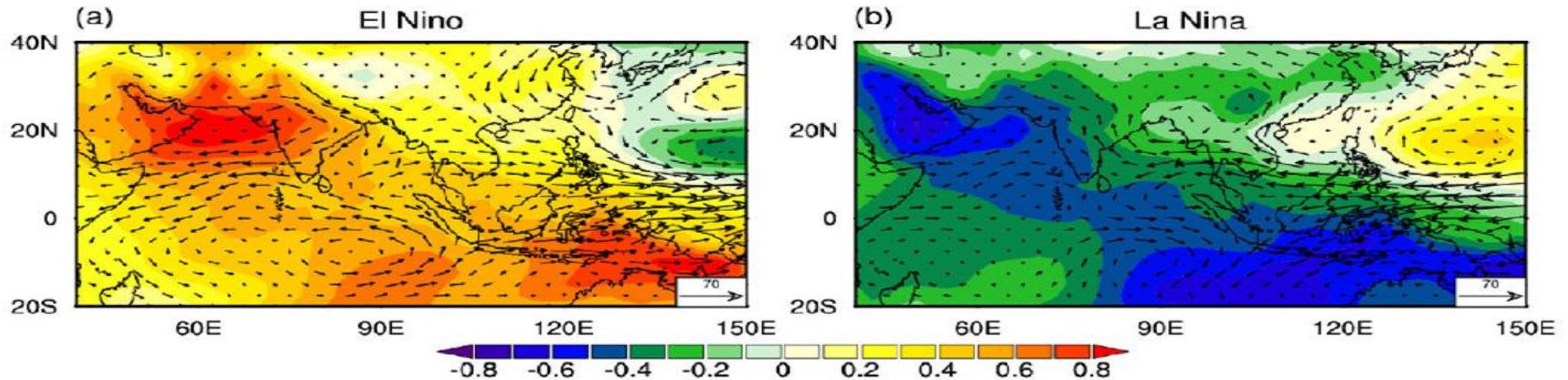$$fu = -\frac{1}{\rho}\frac{\partial p}{\partial y}$$

Relation between vertically integrated zonal moisture flux and meridional pressure gradient along the (a) western and (b) eastern boundary.
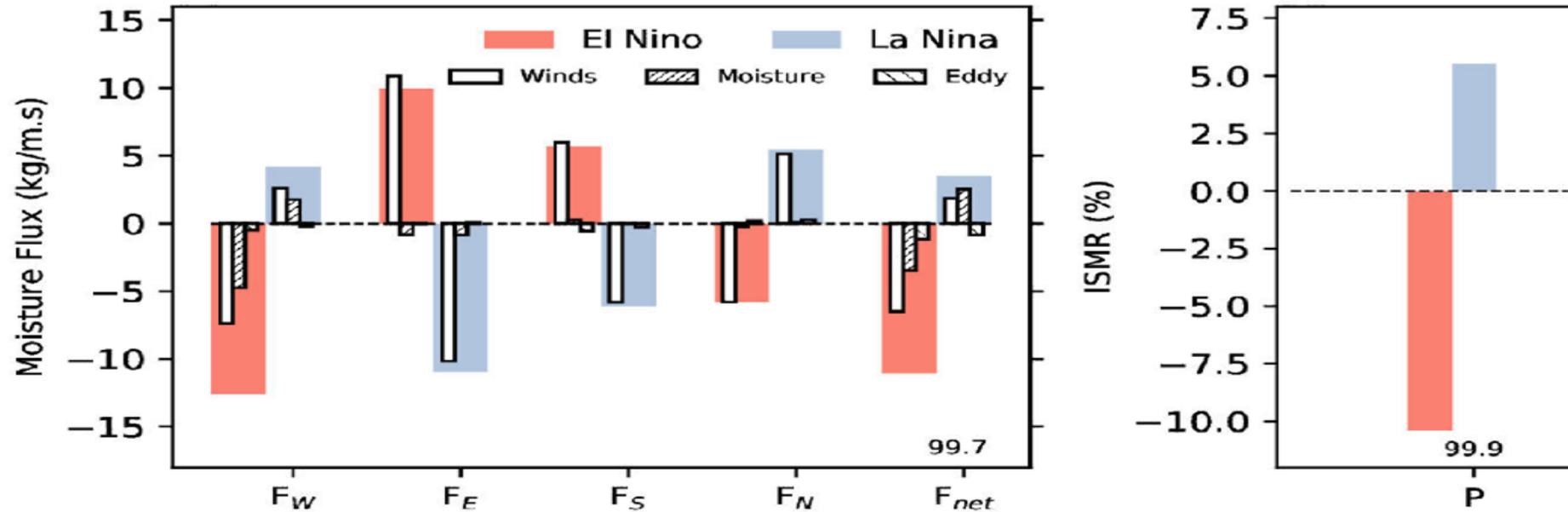
ENSO:

Composite change in the surface pressure anomalies during (a) El Nino (b) and La Nina.

El Nino: Weakening (strengthening) of dPs on the western (eastern) side

La Nina: Strengthening (weakening) of dPs on the western (eastern) side

ENSO:

The corresponding change in moisture flux and its components and precipitation during ENSO years over the Indian land region.

$$\vec{F}' = \langle \vec{V} q \rangle' = \langle \vec{V}' \bar{q} \rangle + \langle \bar{\vec{V}} q' \rangle + \langle \vec{V}' q' \rangle$$

Wind component   Moisture component   Eddy flux component

Summary:

We proposed a common mechanism for major tropical events that physically links surface pressure with moisture budget of the atmosphere.

(a) ENSO : Drought *minus* Flood

(b) Non-ENSO : Drought *minus* Flood

Low P_s High P_s

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