Role of Indian Ocean in Biennial Monsoon Oscillation: A Regional-Coupling CGCM Study

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Regional-Coupling CGCM Experiments

Indo-Pacific Run

Indian-Ocean Run

Pacific Run
ENSO with/without Indian Ocean

Pacific Run

Nino3 index

Indo-Pacific Run
MJO with/without Indian Ocean

Observation (NCEP Reanalysis)

Pacific Run

Indian Ocean Run

variance of band-pass filtered $U_{850\text{mb}}$ regressed with OLR Index (Northern Winter)
Transition between Indian and Australian Monsoons (during Tropospheric Biennial Oscillation)

<table>
<thead>
<tr>
<th>JJA(0)</th>
<th>DJF(0)</th>
<th>JJA(+1)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>STRONG</strong> Indian Summer Monsoon</td>
<td></td>
<td><strong>WEAK</strong> Indian Summer Monsoon</td>
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</tbody>
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in-phase transition

out-of-phase transition

**STRONG** Australian Summer Monsoon
Simulated Indian Summer Monsoons

*Observations*  *Indo-Pacific Run*

(precipitation and 850mb wind)
Simulated Australian Summer Monsoons

Observations

Indo-Pacific Run

(precipitation and 850mb wind)
Interannual Anomalies of Monsoon Rainfall Indices
Time-Lag Correlation btw Monsoon Indices
Power Spectrum of Indian Summer Monsoon Rainfall
Indo-Pacific Run  |  Observations

SST Anomalies During Indian-to-Australian Monsoon Transition
SST Evolutions During TBO

In-Phase (autumn) Transition
- Strong Indian monsoon

Out-of-Phase (spring) Transition
- Strong Australian monsoon
- Weak Indian monsoon
Monsoon-Ocean Interaction During TBO

Indian Ocean SSTA

- **JJA(0)**: warm
- **SON(0)**: sign change
- **DJF(0)**: cold
- **MAM(+1)**: cold
- **JJA(+1)**: cold

**STRONG Indian Summer Monsoon**

- Transition from Indian Ocean to Pacific Ocean

Pacific Ocean SSTA

- **cold**
- **cold**
- **cold**
- **sign change**
- **warm**

**STRONG Australian Summer Monsoon**

- Transition from Pacific Ocean to Indian Ocean

**WEAK Indian Summer Monsoon**
SUMMARY

- The tropospheric biennial oscillation involves seasonally-dependent monsoon-ocean interactions in both the Indian and Pacific Oceans.

- The Indian Ocean is more crucial to the spring transition from Australian monsoon to Indian monsoon, and the Pacific Ocean is more crucial to the autumn transition from Indian Monsoon to Australian monsoon.
The Coupled Atmosphere-Ocean GCM

UCLA AGCM
- global
- 4°-lon. x 5°-lat.
- 15-layer

GFDL MOM
- basin
- 1°-lon. x 1/3°-3°-lat.
- 27-layer
Indo-Pacific Run  Observations  SST Anomalies During Australian-to-Indian Monsoon Transition