Intraseasonal Variability and the Onset of Monsoon Rainfall

Kenneth R. Sperber
Program for Climate Model Diagnosis and Intercomparison
Lawrence Livermore National Laboratory, USA
(E-mail: sperber1@llnl.gov)

Goal: Multiscale analysis to evaluate the relationship between monsoon onset and intraseasonal variability

- Observations: The composite onset of Australian summer monsoon over Darwin is associated with the eastward propagation of the MJO (Hendon and Liebmann, 1990, JAE, 47, 2327-2340)
- CMIP5: Monsoon Onset (Sperber and Annamalai, 2014)
  - Periodic precipitation (Northern Australia and All-India Rainfall)
  - Onset defined for fractional accumulation of 0.2
- CMIP5: Evaluate the intraseasonal state at monsoon onset
  - Australian summer: MJO strong OLR patterns from Sperber (2003)
  - Stored summer: EEOF OLR patterns of Annamalai and Sperber (2005)

Data: Rainfall and OLR

- Pentad Averages: precipitation and 20-100 day bandpass filtered OLR analyzed
- Observations (1979-2004)
  - GPCP and AHVR OLR
- CMIP5 (27 models, historical runs, 1961-1999)

CMIP5 Climatological rainfall: Monsoon onset (Sperber and Annamalai, 2014)

- Onset occurs at a fractional accumulation of 0.2
- AUS: model onset equitably distributed over the observations
- India (half of Bismarck, FSM): model results have delayed onset (not shown)
- Sabet et al. 2019: most models early annual cycle (not shown)

a) MJS b) India

MJO AVHRR OLR EOF patterns: strong years (20-100 day filtered OLR, Jul-Aug)

- MJO EOF’s used in observed and model studies
  - Sperber (2003, 2004), Sperber et al. (2009), Sperber and Kim (2012)
  - Project model 20-100 day filtered OLR onto these observed patterns to obtain PC time series, that are used to construct the MJO biweekly phase plots (PC1 vs. PC2)

a) EOF-1 b) EOF-2

Australian monsoon onset: Observations

- MJO PC1 vs. PC2 for onset period for each year (1979-2004)
- Composite 20-100 day filtered OLR for the onset periods in Phase 4 (amplitude 0.1)
- Australian monsoon tends to occur during an active phase of the MJO, consistent with the study of Hendon and Liebmann (1990)

Boreal Summer Intraseasonal Variability (BSISV) Quadrature patterns (filtered OLR Wea*)

- These patterns correspond to Day 15 and Day 12 from the BSISV composite patterns from the OLR (Annamalai and Sperber, 2005) and ECMWF (Sperber et al., 2009)
- Project model 20-100 day filtered OLR onto these observed patterns to obtain PC time series, that are used to construct the BSISV biweekly phase plots (PC1 vs. PC2)

a) Day -15 b) Day -12

Indian monsoon onset: Observations

- BSISV PC1 vs. PC2 for onset period for each year (1979-2004)
- Composite 20-100 day filtered OLR for the onset periods in Phase 4 (amplitude 0.1)
- The BSISV results show that the MJO OLR pattern during the onset period of the Indian summer monsoon during an active phase of the BSISV, though the MJO results are not well established

Skill: Composite filtered OLR at onset vs. fraction of years that PC’s are in Phases 4-5 at onset

- In observations the MJO is active 45% of the time during Australian monsoon onset
- The pattern correlation is calculated over 45°E-120W, 20°S-20°N

CMIP5: MJO Skill vs. BSISV Skill

- Beal fit space-time pattern correlations relative to observed patterns -5, -15, 0, 15, 30, 45, 60, 75, 90, 105
- There is a statistically significant relationship between the BSISV skill and the MJO skill and the BSISV skill
- MJO skill is systematically greater than the BSISV skill

Preliminary Findings

- In observations there is a clear link between monsoon onset and the phase of the ISO (MJO and BSISV) during both Australian summer and Boreal summer
  - The ISO impacts monsoon onset -x 4% (5%) of the years during Australian summer
  - In Australian summer the majority of models do not have a strong link between the ISO and onset
- The composite intraseasonal spatial pattern at monsoon onset is poorly represented by the majority of models
- Variations other than the MJO and ISO are present in most models on intraseasonal time scales
- Overall, in CMIP5 the MJO space-time evolution is better represented than the BSISV space-time evolution