Regional Coupled Ocean-Atmosphere Simulation of the Indian Monsoon

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Outline

Results from 15km grid spacing:

1. Coupled regional downscaling of reanalysis (R2 & SODA v2.2.4) (1985-) 1990-2007 (RCOAMS)


**Coupled regional model: RSM-ROMS**

### RSM Physics

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1. No flux coupler; identical grids for RSM and ROMS so fluxes and SST exchanged directly
2. Coupling interval: 24 hours
3. Atmospheric lateral boundary conditions interval: 6 hours
4. Ocean lateral boundary conditions: Monthly mean interpolated to daily values
1. Observational uncertainty in SST climatology over northern Indian Ocean climatology explains nearly 50% of model error.

2. Similarly observational uncertainty between IMD and TRMM3B42 over land is large.
SST and Ocean Currents

Pre-onset period: May

JJAS period

Post demise period: October
Surface ocean eddy kinetic energy

Pre-onset period: May

JJAS period

Post demise period: October
Coupled downscaling of reanalysis: Intraseasonal variability

Precipitation variance of 20-90 day filtered anomalies

(a) Observation (TRMM)

(b) RCOAMS

Wet and dry spell composite of precipitation and 850hPa winds

(a) Wet composite (TRMM/MERRA2)

(b) Wet composite (RCOAMS)

(c) Dry composite (TRMM/MERRA2)

(d) Dry composite (RCOAMS)
Onset and Demise

Objective definition of onset and demise

- $C'_m(n) = \sum_{i=1}^{n} [D_m(i) - \bar{C}]$

Cumulative daily anomaly (CDA)  
Daily  
Annual mean climatology

- **Onset**: day after CDA reaches **absolute minimum**
- **Demise**: day after CDA reaches **absolute maximum**
- Posed in general terms that are applicable to any variable which exhibits **strong seasonal cycle**

Noska and Misra, 2016
Correlations of seasonal rainfall anomalies

With length of the season

With onset date of the season

With demise date of the season
Evolution around onset from coupled downscaling of reanalysis

Precipitation

K.E. at 850hPa

RMS
CC
Evolution around demise from coupled downscaling of reanalysis

Precipitation

K.E. at 850hPa
Coupled downscaling of reanalysis: SST at onset and demise

Evolution around onset

Devolution around demise
Coupled downscaling of reanalysis: 20C depth (heat content) and surface ocean currents at onset and demise
Correlation of onset/demise date with global SST

(a) DJF (IMD ONSET)

(b) DJF (RCOAM ONSET)

(c) SON (IMD DEMISE)

(d) SON (RCOAM DEMISE)
CCSM4 Downscaled integrations
CMIP5 historical simulation of JJAS Monsoon Rainfall
Coupled and Uncoupled Downscaling of CCSM4

SST Climatology and systematic errors

Rainrate Climatology and systematic errors
Standard deviation of Model and observed Rainrate
Latent and Sensible heat flux climatology from both models (top four panels) and their difference (bottom two).
Surface Ocean Eddy Kinetic Energy

Pre onset: May

JJAS period

Post onset: October
Conclusions

• Coupled regional systems are offering new insight to downscaling:
  • It is conceivable to rationalize large-scale rectification from coupled downscaling in the monsoon systems

• RSM-ROMS provides a viable tool for understanding Asian Monsoon:
  • Indian monsoon is truly a coupled process, with as much seasonal transformation happening underneath the ocean surface as over it-unraveled in our coupled simulation

• Impact on variability from high resolution coupled downscaling:
  • Seems to damp atmospheric variance over warm tropical Indian ocean while raising over the subcontinent

• (Tropical/Subtropical) oceans have much to offer to regional continental climate........