The ICTP Regional System Model (RegESM) to simulate the monsoon in the South Asia CORDEX domain

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Eighth ICTP Workshop on the Theory and Use of Regional Climate Models

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2) Experiment design

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Motivation

To correcting simulate the intra-seasonal oscillation (ISO) of the Indian monsoon it is necessary to use a coupled atmosphere-ocean model as supported by different studies. (Fu et. al 2002 ; Fu et al. 2007; Ratnam et al. 2008; Seo et al. 2009; Samala et al. 2013)

Precipitation and river discharge well exceed the evaporation making the Bay of Bengal the freshest region in the Indian Ocean.

↓

¾ of riverine discharge during mjjas season

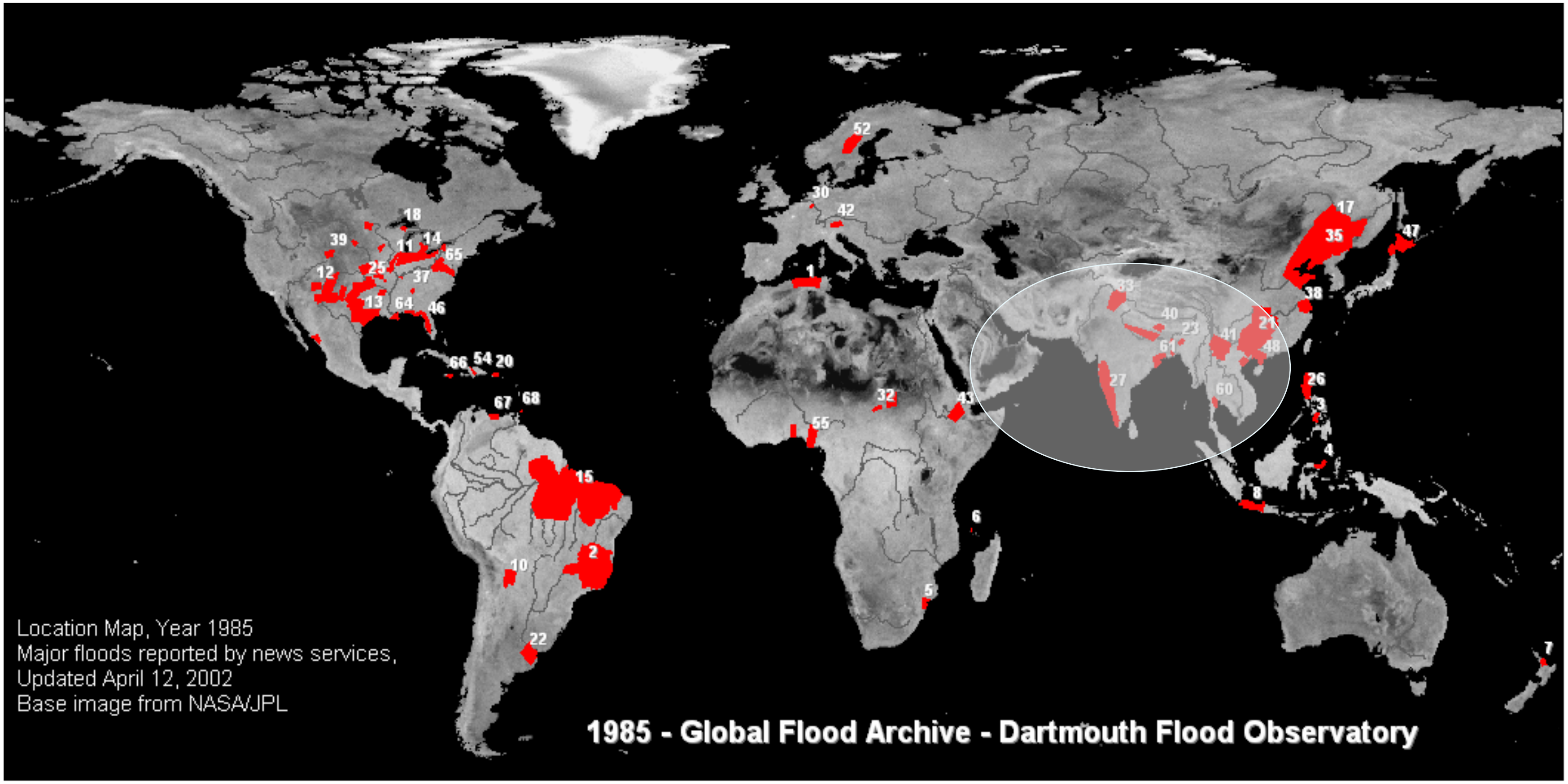
↓

Possible effects in the NE monsoon

Socio-economic motivations

Motivation

- 75% of Bangladesh is less than 10m above sea level and 80% is flood plain



http://www.dartmouth.edu/~floods/Archives/GlobalFloods1985-2007.gif

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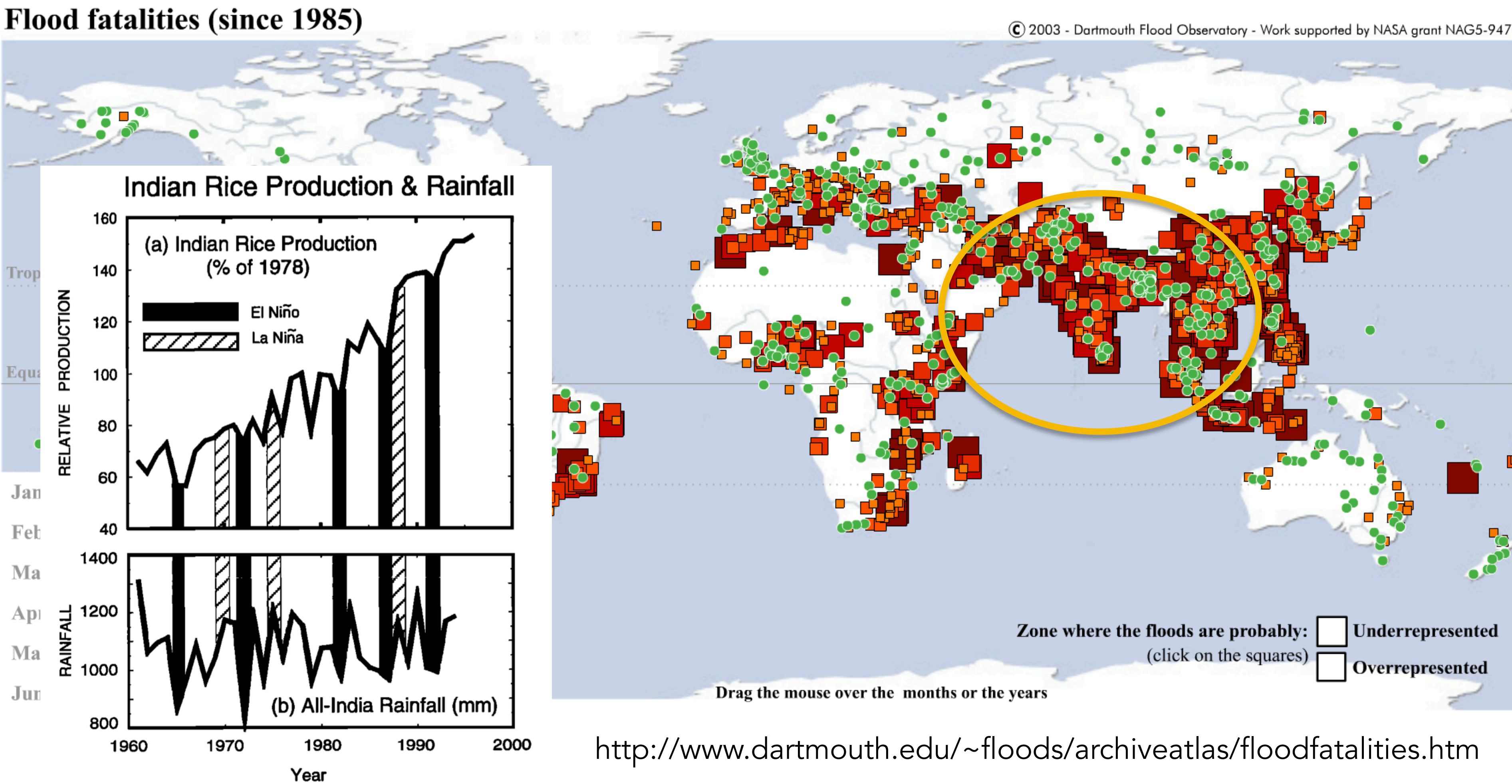
Motivation



Webster et Al 1999

http://www.dartmouth.edu/~floods/archiveatlas/floodfatalities.htm

Experiment design

ATMOSPHERIC MODEL:

RegCM4.4

Grid points: Y direction-170; X direction-216

Horizontal Resolution: 50 km

Vertical levels: 18

Boundary conditions: ERA-Interim

Cumulus convection: MIT (Emanuel 1991)

Land surface: CLM4.5 (Olson et al. 2014)

OCEAN MODEL:

MitGCM c63s

Grid points: Y direction-276; X direction-408

Horizontal Resolution: 18 km

Vertical levels: 45

Initial and Boundary conditions: MOM Simulation at 0.25°

Vertical mixing: Nonlocal K-Profile Parameterization KPP (Large et al. 1994)

COUPLER:

RegESM

Coupling intervals: 3hr ATM-OCN 1day ATM-RIV-OCN

Exchange fields: winds, surface air pressure, water and heat fluxes ATM-OCN; SST OCN-ATM; runoff ATM-RIV; fresh water discharge RIV-OCN

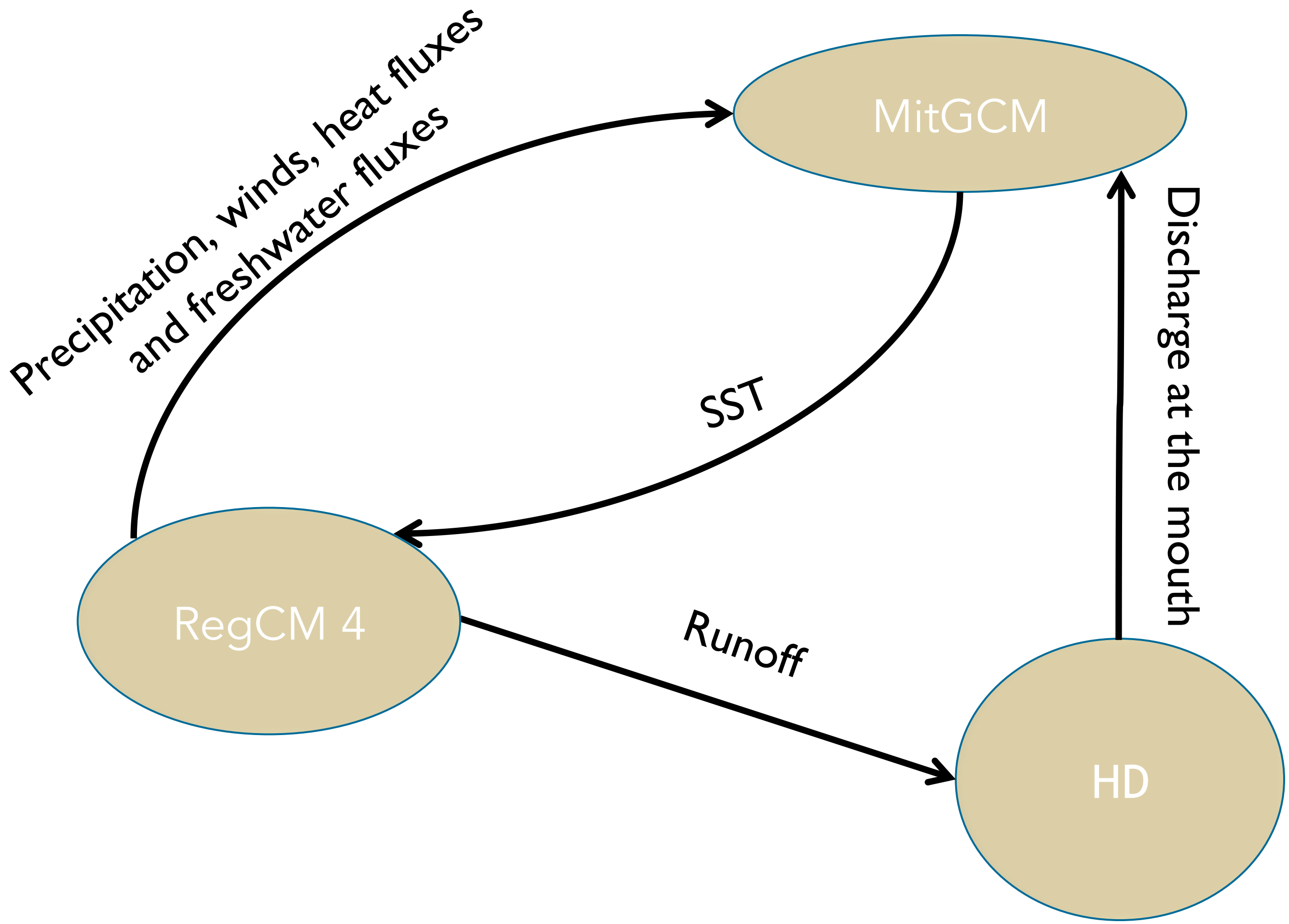
RIVER ROUTING:

HD

Grid: Global grid

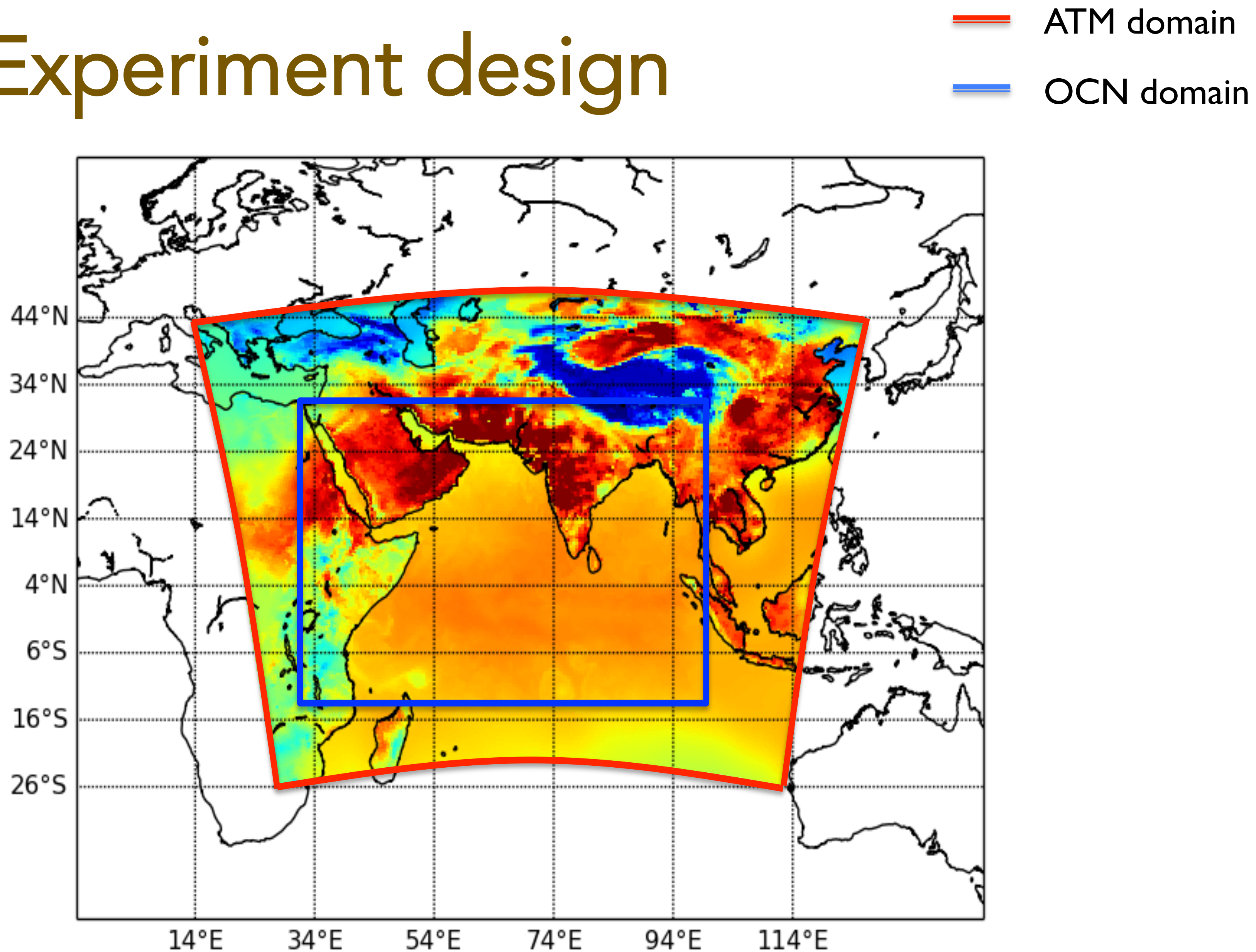
Rivers: all the rivers with a mean annual discharge > 500 m^3/s

Experiment design



29 years simulated (1979 – 2007) coupled and uncoupled simulations

Experiment design



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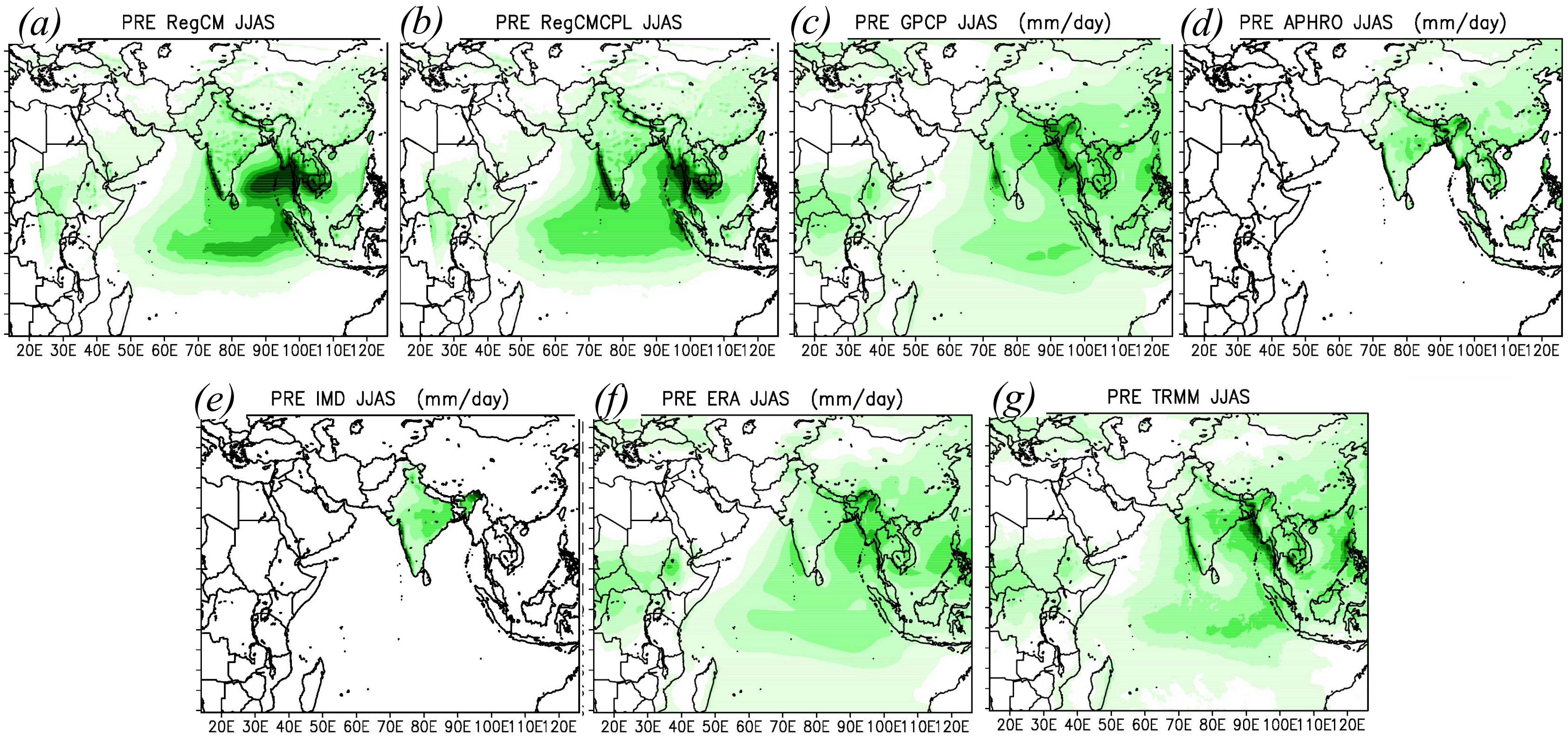
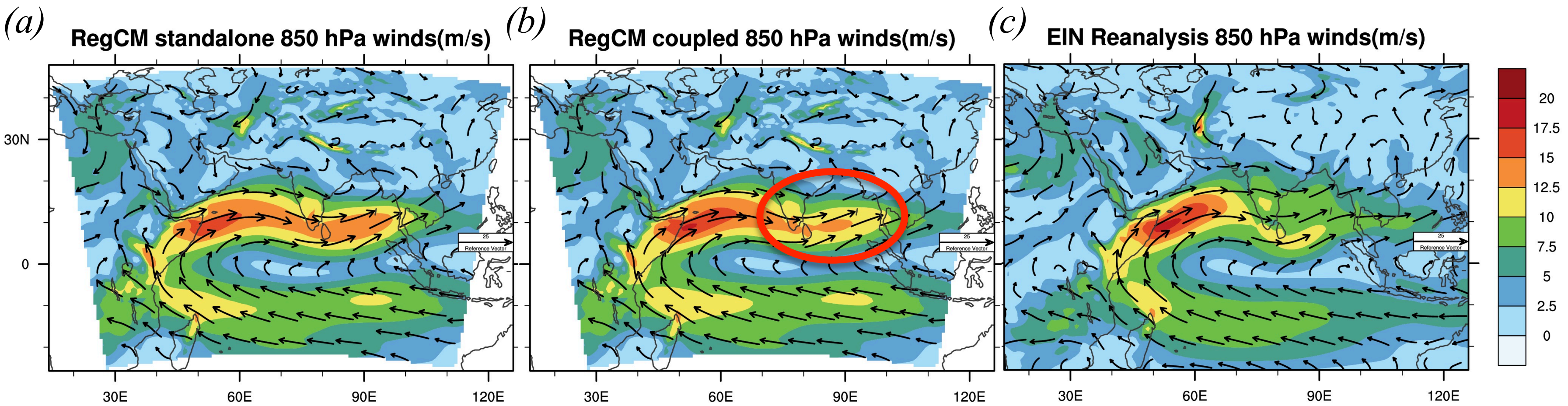
Climatology

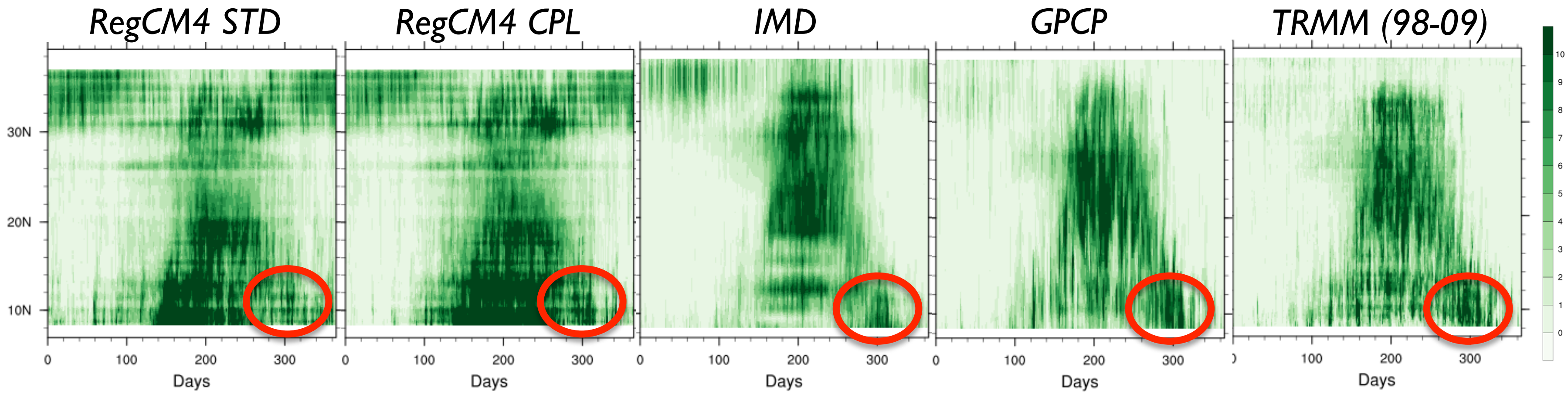


Dynamics

The resulting summer land-sea temperature gradient promotes the development of a low-level cross-equatorial jet that transports moisture from the ocean toward the Asian continent, giving rise to the strongest monsoon on Earth. [Findlater, 1970]

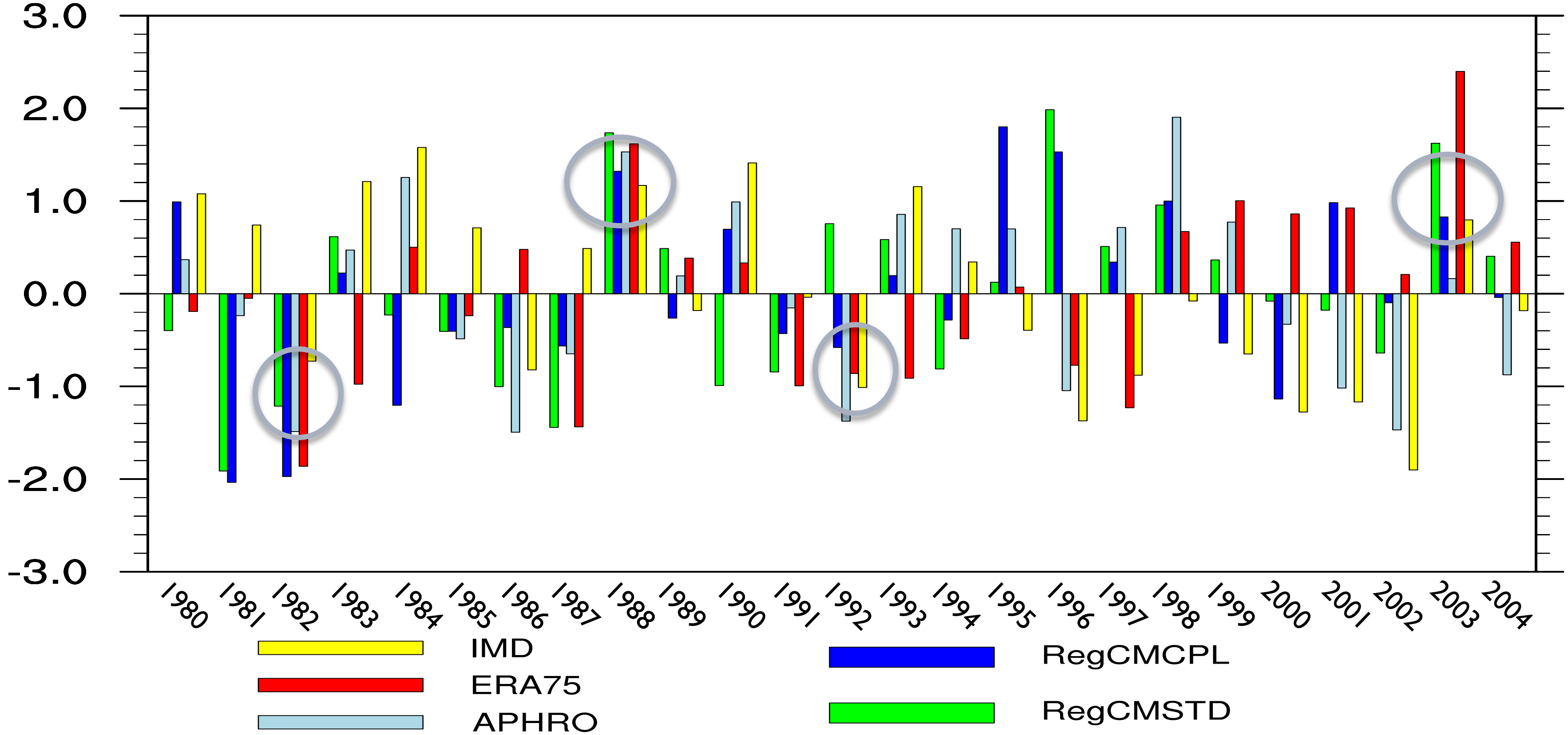


Hovmüller diagrams of Precipitation



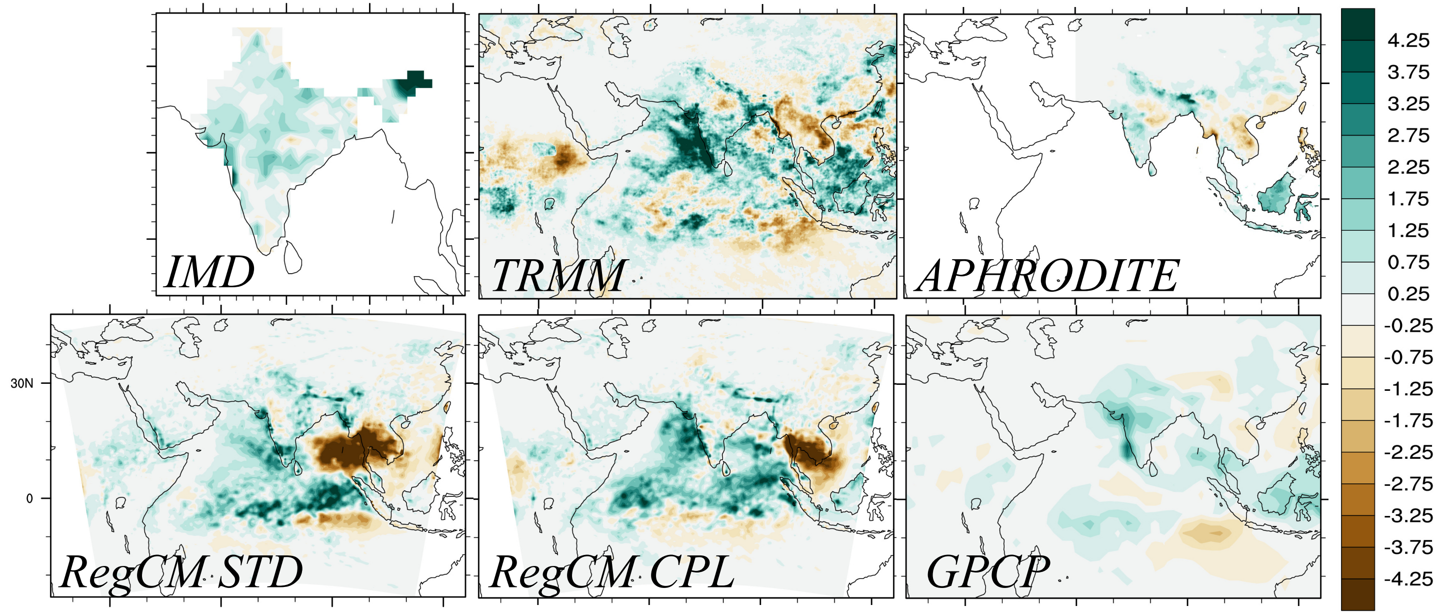
The coupled model shows improvements in correctly simulating the intensity of the North-East monsoon probably due to the freshwater forcing from the river discharge on the SST over the Bay of Bengal as suggested by Seo et Al (2009).

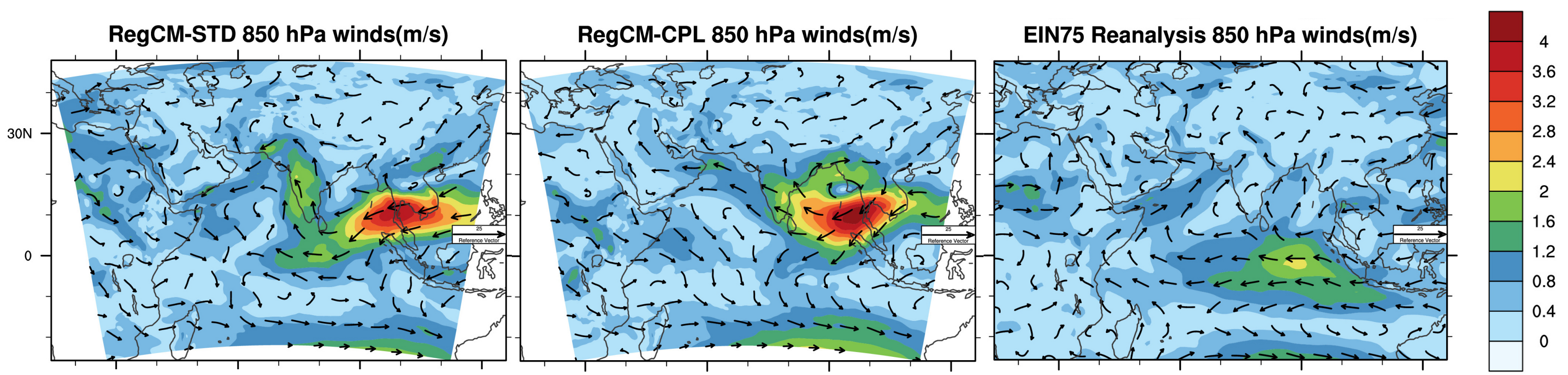
Inter-annual variations in rainfall



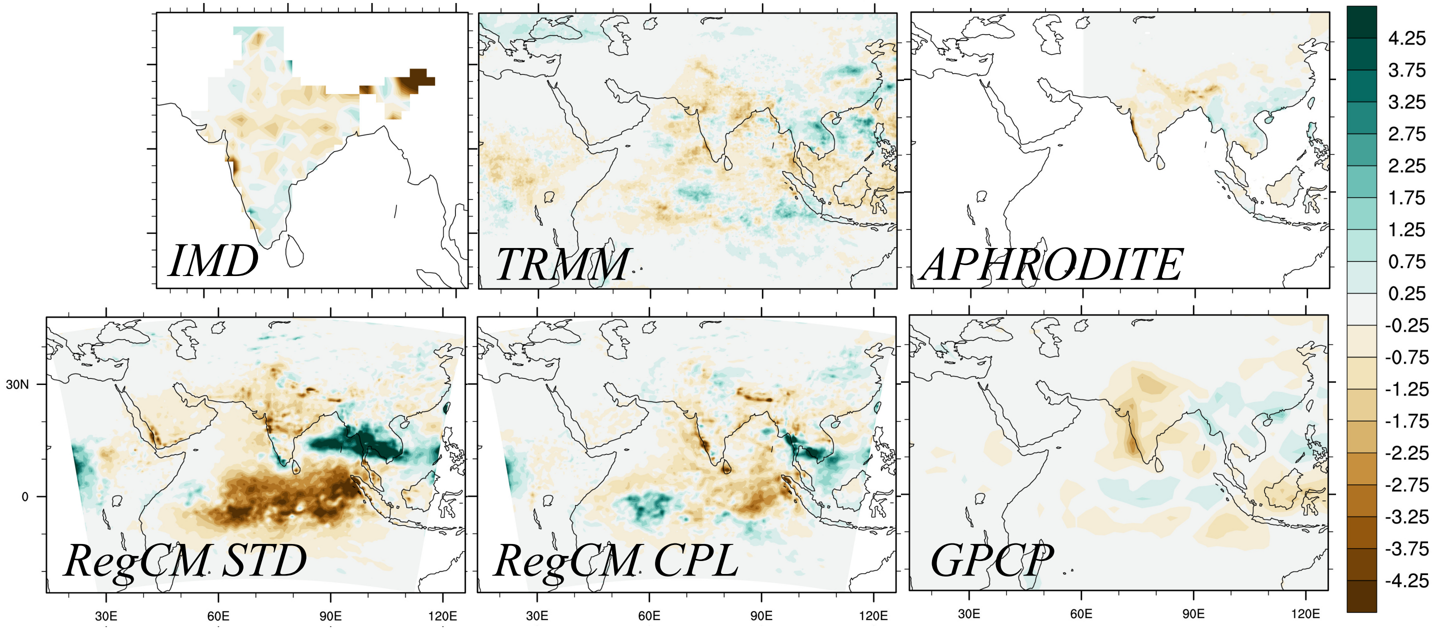
RegCM coupled simulation capture the sign of inter-annual variations in 68% of the years if we consider IMD (40% in the uncoupled simulation; 36% in the Era Interim reanalysis).

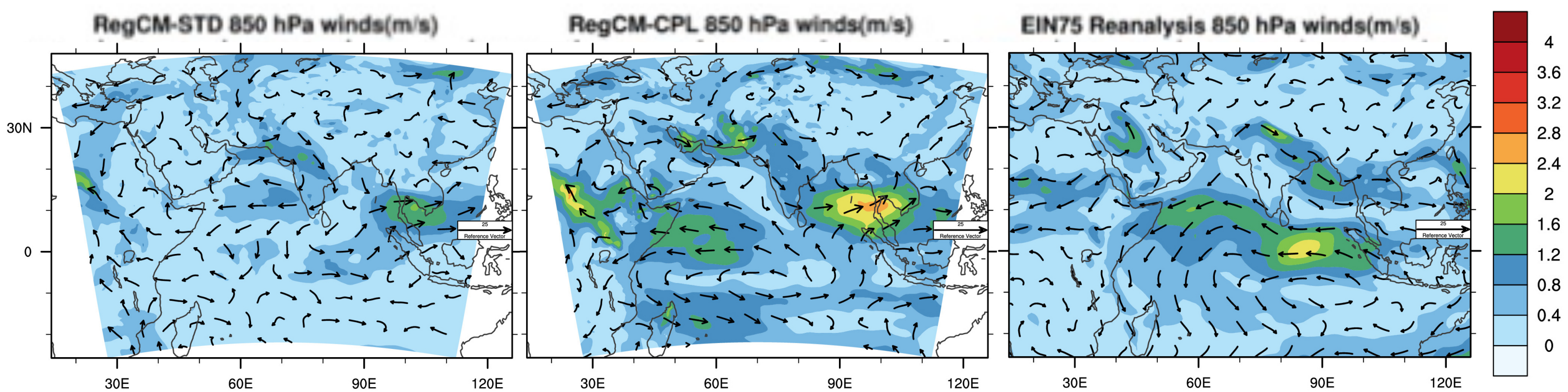
Inter-annual variations in rainfall (WET)





Inter-annual variations in rainfall (DRY)





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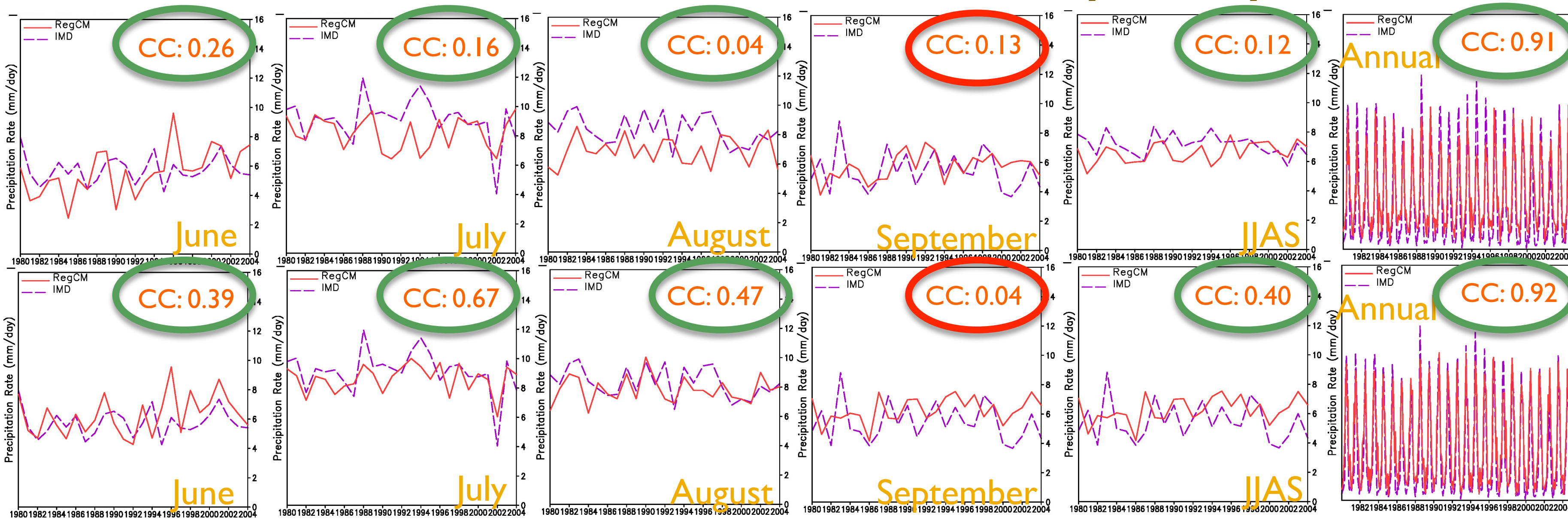
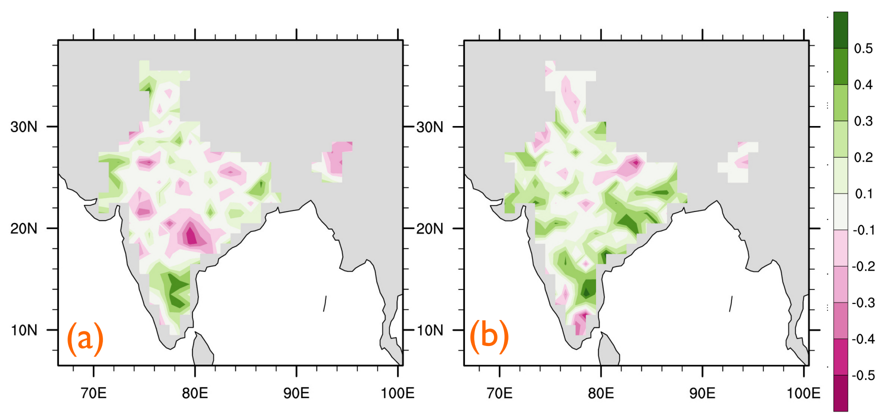
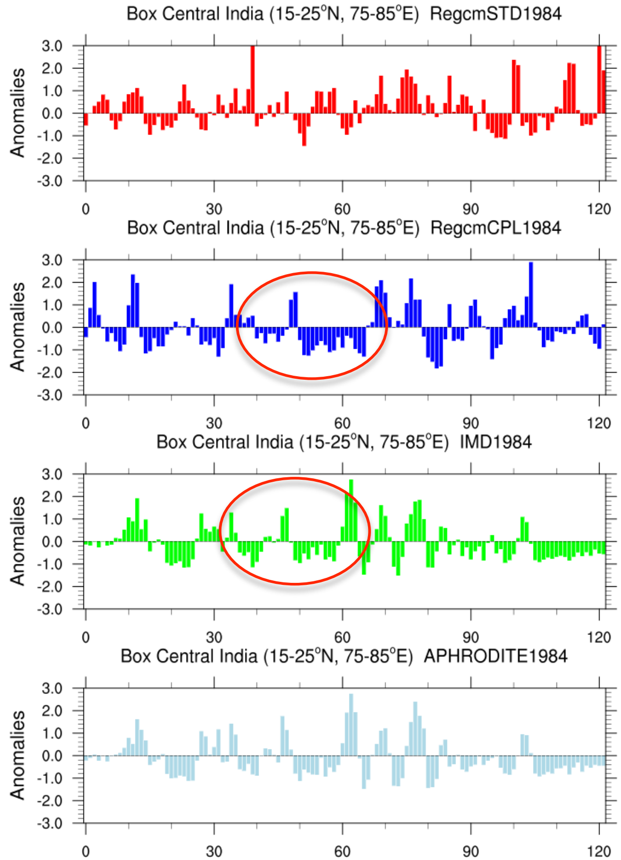
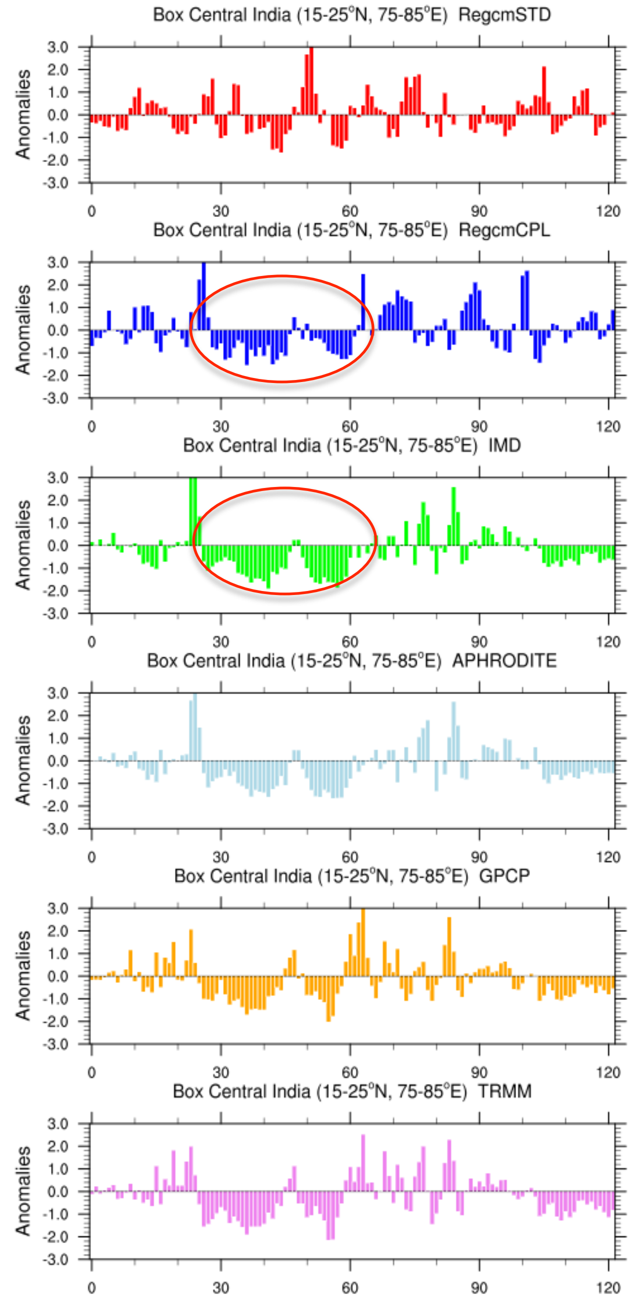
Inter-annual variations of daily precipitation





Intra-seasonal oscillations

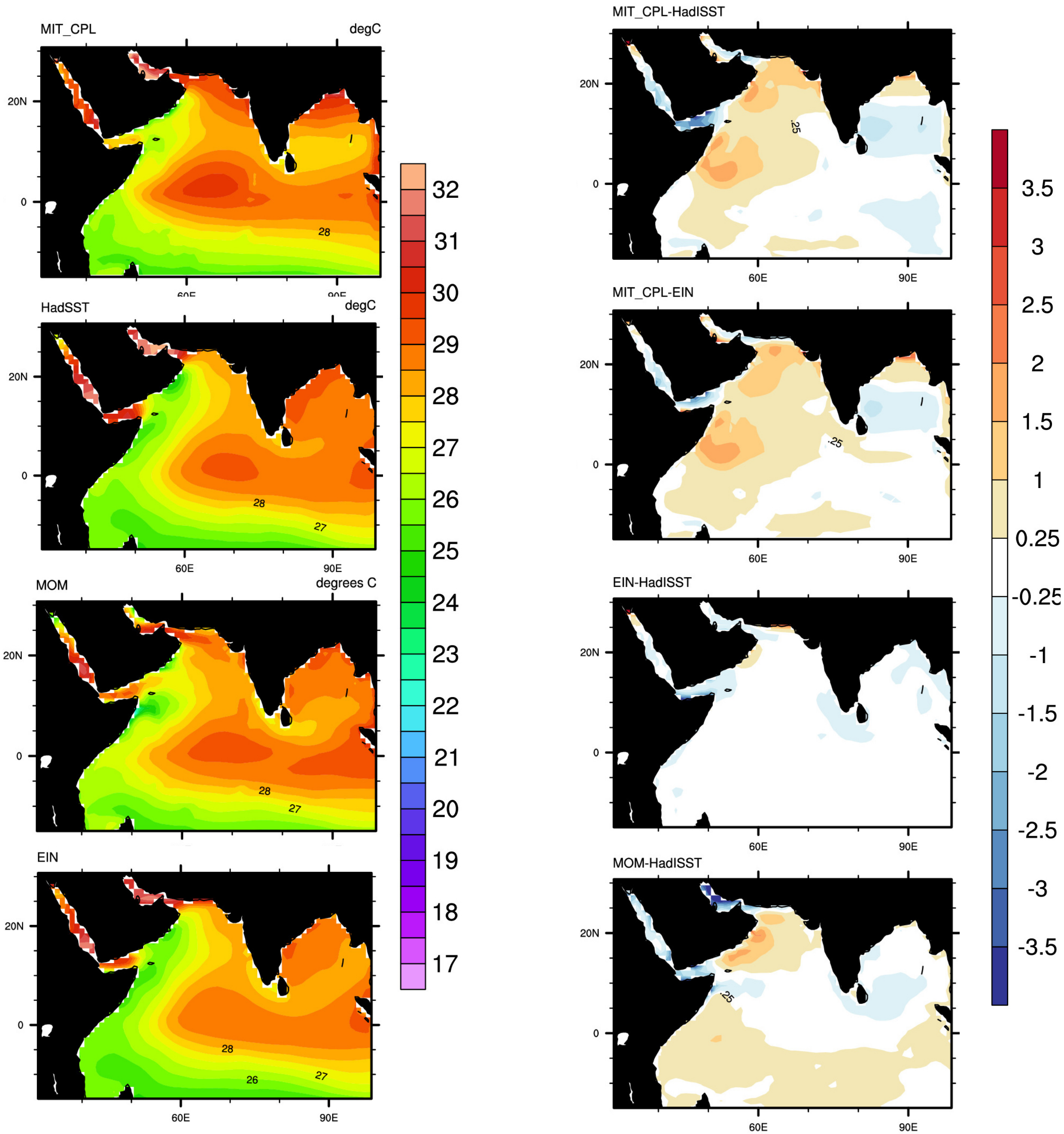




Anomalies of area weighted daily accumulated rainfall over Central India domain (15-25°N, 75-85°E) during June to September in 1984 (left column) and 2002 (right column) for RegCM standalone (red), RegCM coupled (blue), IMD(green), APHRODITE (light blue), GPCP (orange) and TRMM (pink)

The intra-seasonal analysis has been carried out over the core monsoon zone of Central India (15°N to 25°N and 75°E to 85°E) as suggested by Rajeevan et al. (2010)

JJAS SST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EIN-HadISST
MOM-HadISST
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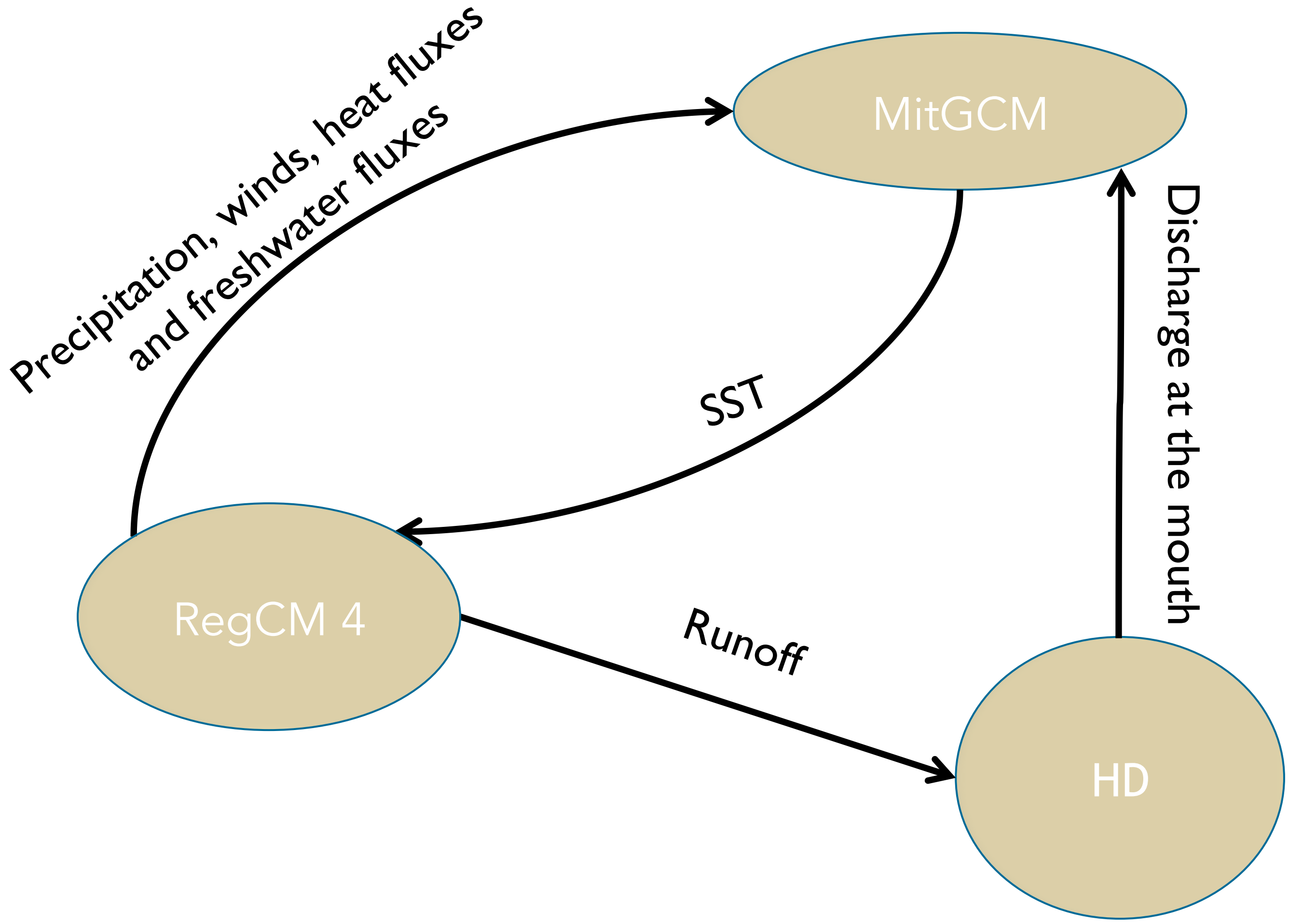
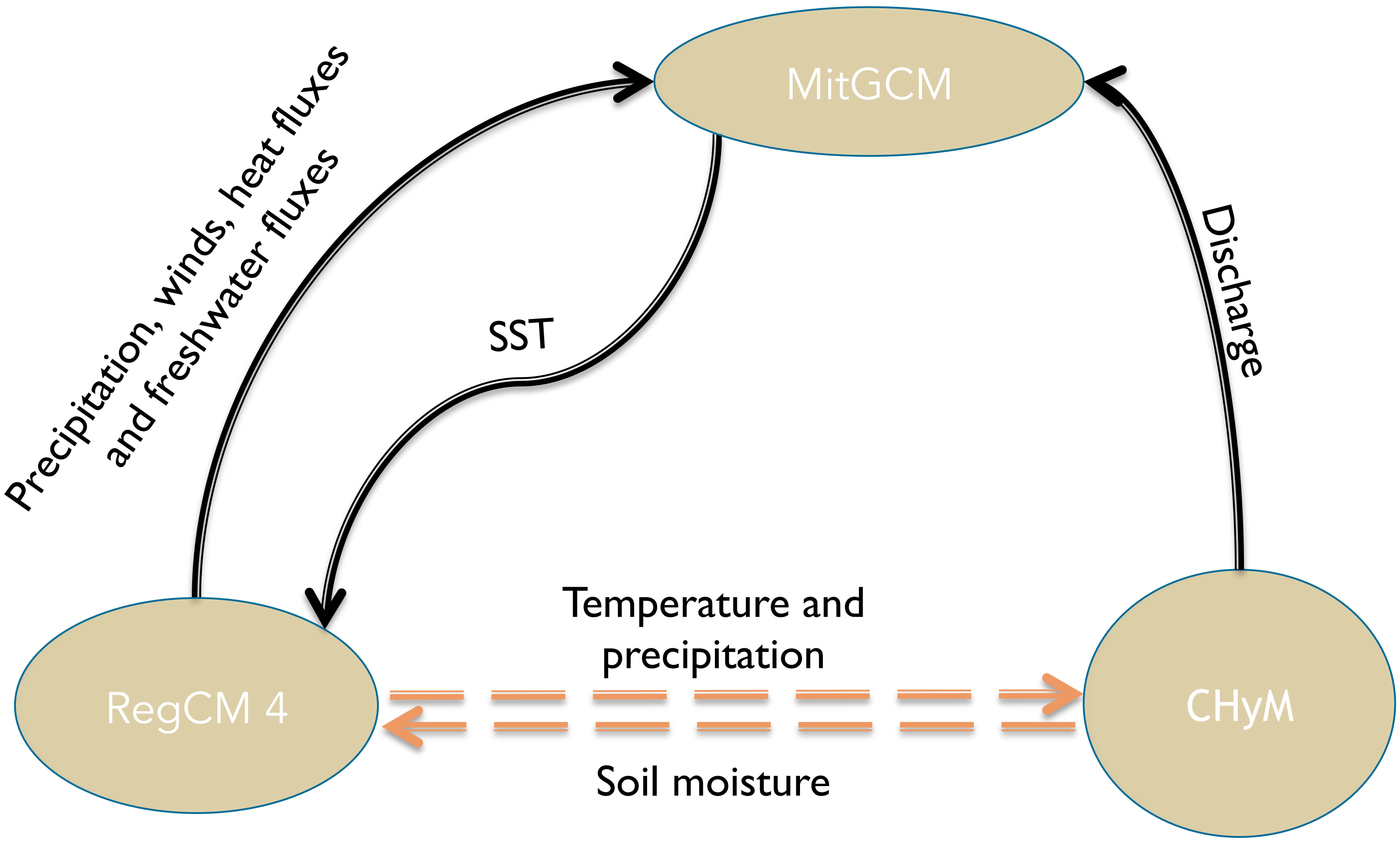
Actual design



Future design



Preliminary Conclusions

- Decrease of the precipitation positive bias over the Bay of Bengal of the coupled run.
- Better low-level jet simulated by the coupled model, particularly over Bay of Bengal.
- Higher CCs for the coupled simulated inter-annual variations of daily precipitation.
- More realistic sequences of active and break phases of the Indian monsoon.

Thank you!

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