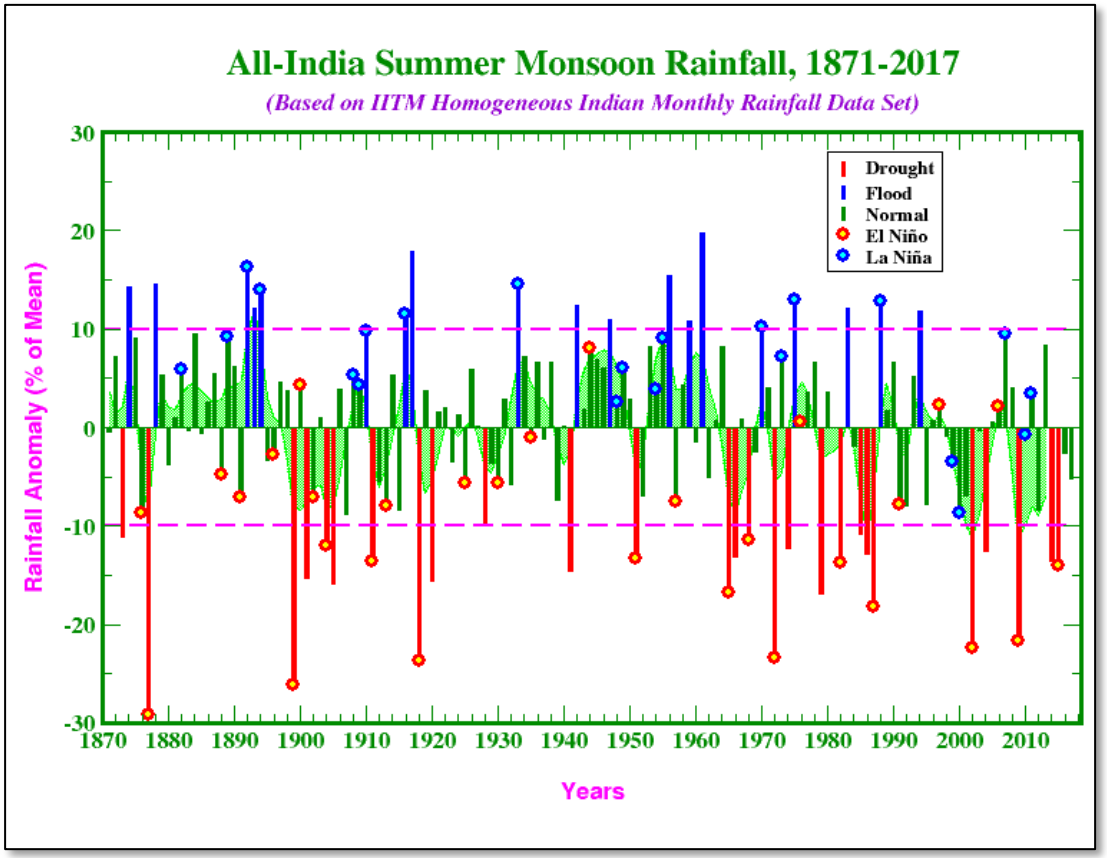
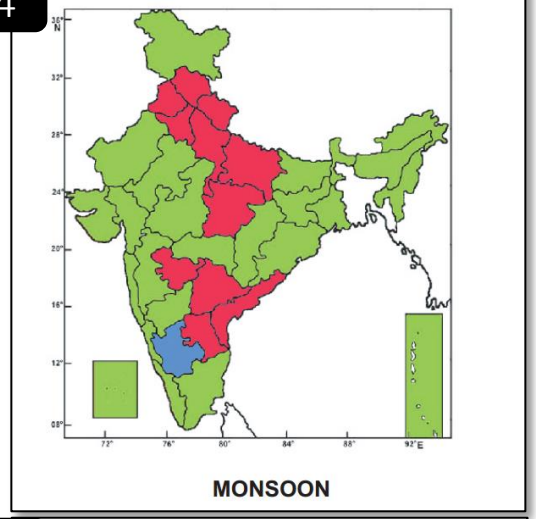
Estimating Long-Range Predictability: A brief overview

Arun Kumar
Climate Prediction Center, NOAA
Washington DC, USA
arun.kumar@noaa.gov

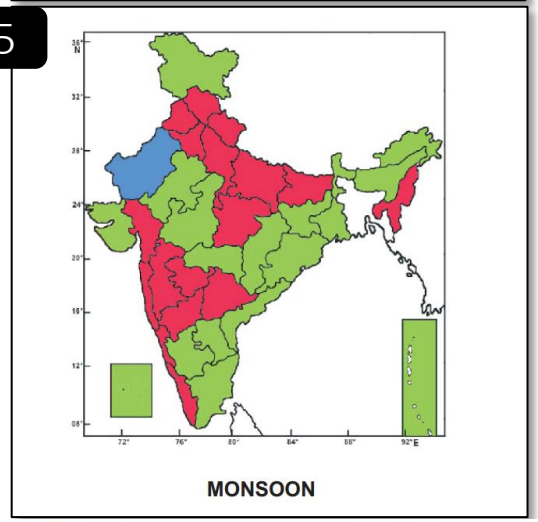
Indian Monsoon Rainfall Variability



2014

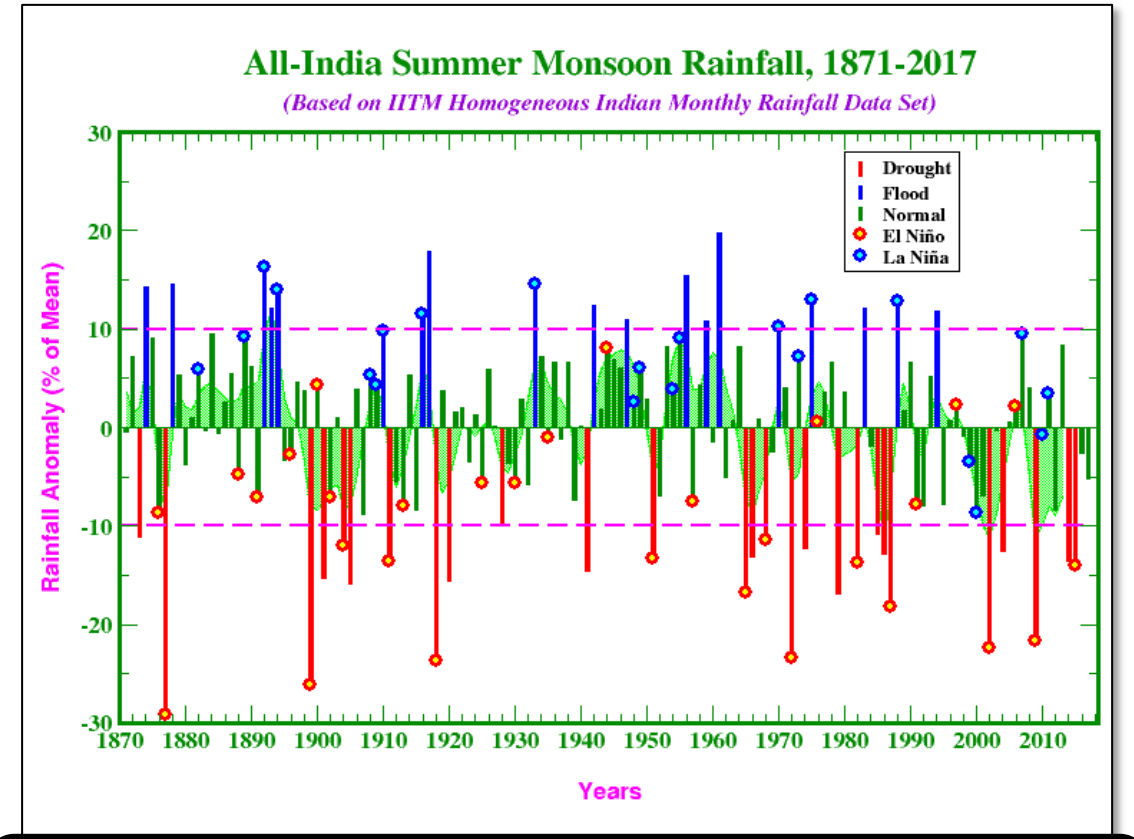


2015



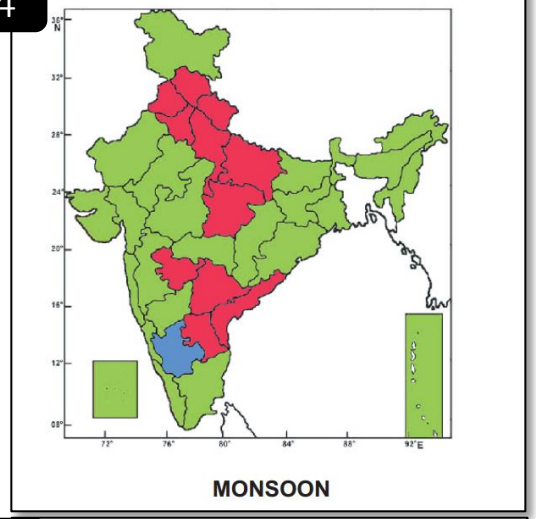
EXCESS +20% OR MORE | NORMAL +19% TO -19% | DEFICIENT - 20 % TO - 59 % | SCANTY - 60 % TO -99 % | NO RAIN -100 %

Indian Monsoon Rainfall Variability

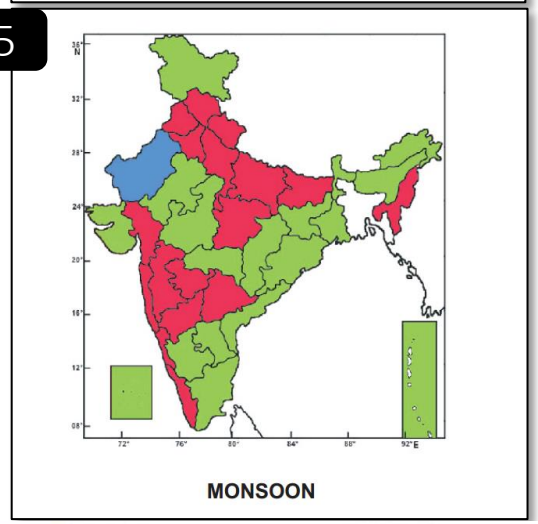


How much of the year-to-year variability could be predicted?

2014



2015



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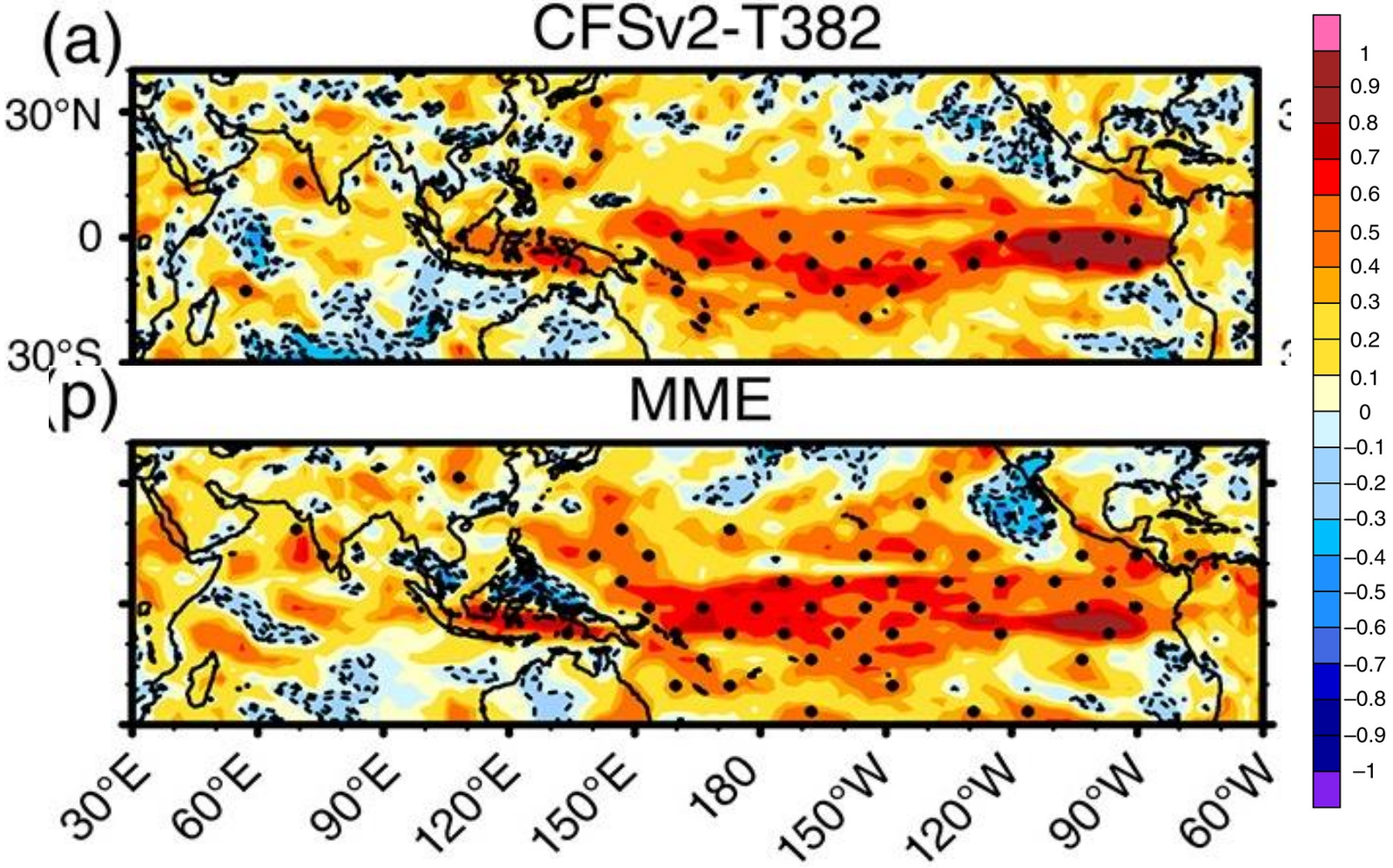
Prediction skill of JJAS seasonal mean rainfall



Pillai et al., 2018: Seasonal prediction skill of Indian summer monsoon rainfall in NMME models and monsoon mission CFSv2. DOI: 10.1002/joc.5413

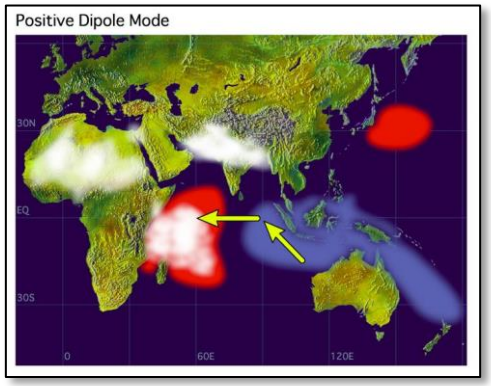
Why is the skill in predicting monsoon rainfall low?

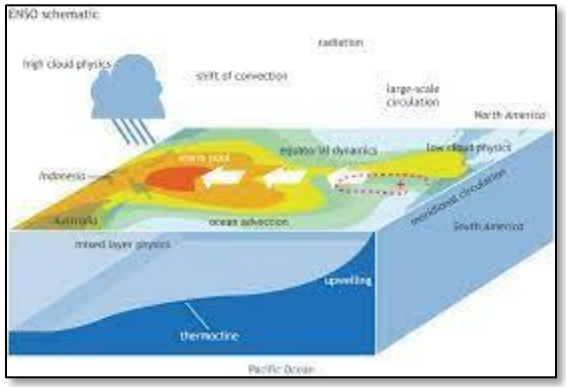
- Biases and errors in the prediction models compromise realization of prediction skill.
  - We know different seasonal prediction systems have different skill.
  - Specification of initial conditions (observational network) may be adequate.
  - Small ensemble size can also compromise skill.

- Low skill could be due to inherently unpredictable nature of monsoon variability.

Questions related to predictability

- What is the inherent level of predictability for monsoon variability?
- What are the sources of predictability?
  - MJO and BSISO
  - SSTs: ENSO, IOD
  - Stratosphere-troposphere connection
  - Land surface conditions
    - Snow cover; soil moisture
  - Low frequency variability
    - PDO
    - Climate trends
  - Other remote regions
    - Atlantic
  - …



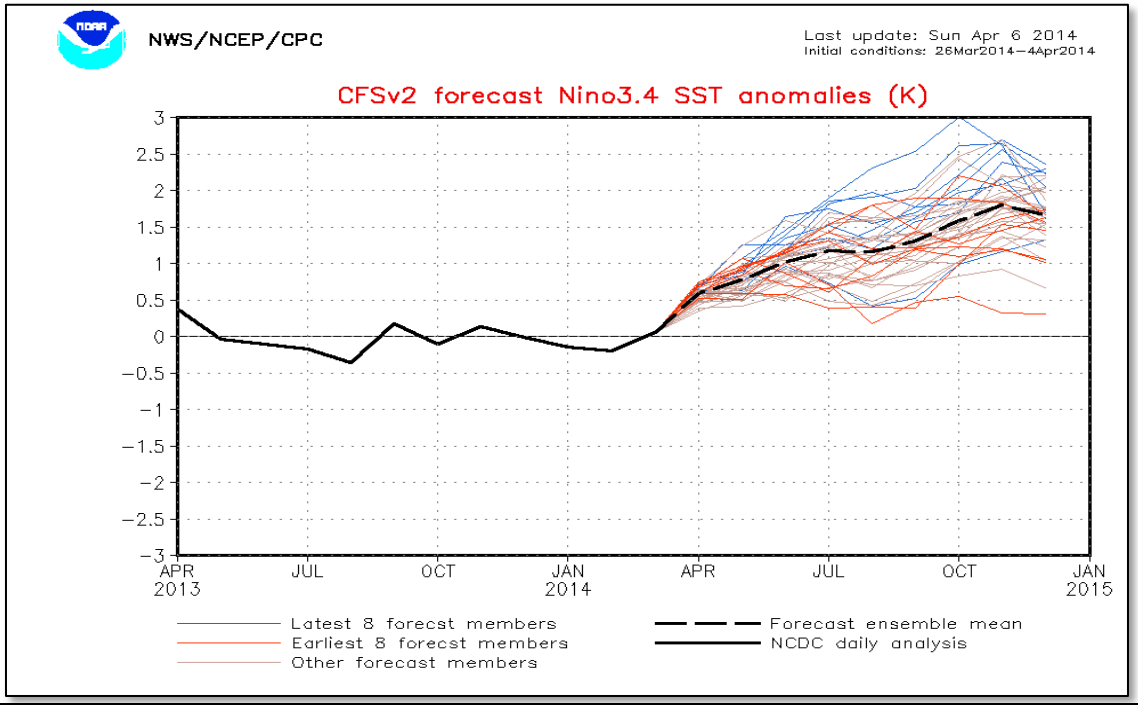


Why understanding limits to predictability is important?

- Understanding what can be achieved helps manage user expectations.
- Knowing what the important sources of predictability are helps provide a focus for model development efforts.
- It could also help in the design of operational prediction systems to realize predictability, and therefore, helps allocation of limited computing resources – ensemble size, model resolution, generation of initial perturbations, burst vs. lagged ensemble, …
- The question itself offers research challenges and opportunities for the utilization of extensive model data that is freely available.

How do we know there are limits to predictability?

- The purpose of ensemble prediction systems is to sample the space of future outcomes that can occur because of non-linear growth of initial perturbations.
- The very fact that we must run ensemble prediction systems points to the evidence that there are predictability limits.



Model based approaches for estimating predictability

- An ensemble of model simulations or initialized predictions can be used for estimating predictable components (common features among ensemble runs) from the unpredictable noise (spread among the ensemble members).
- Available data archives
  - S2S Project (http://s2sprediction.net/)
  - C3S seasonal forecasts (https://climate.copernicus.eu/seasonal-forecasts)
  - WMO Lead Center seasonal hindcasts (https://wmolc.org/)
  - NMME hindcasts (https://www.cpc.ncep.noaa.gov/products/NMME/)
  - CHFP seasonal hindcasts (http://chfps.cima.fcen.uba.ar/)

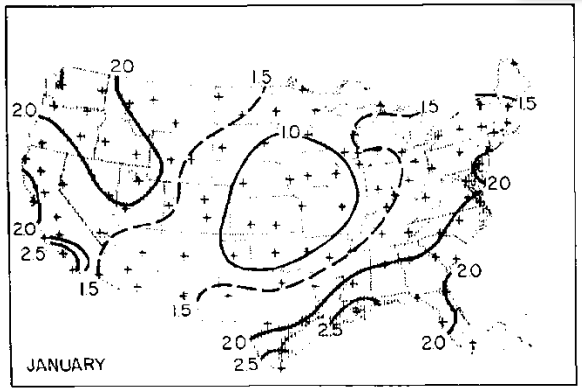
Some comments on the model-based estimates of predictability

- Model based estimates of predictability could be influenced by model errors. For example, a model that underestimates forecast spread (under-dispersive) can lead to an overestimation of predictability.
- It is best to use multi-model approaches for estimating predictability.
- A combination of analysis of model-based data and observational data is the best approach (although the observational data is limited, it could still be used to constrain certain aspects of model simulations).

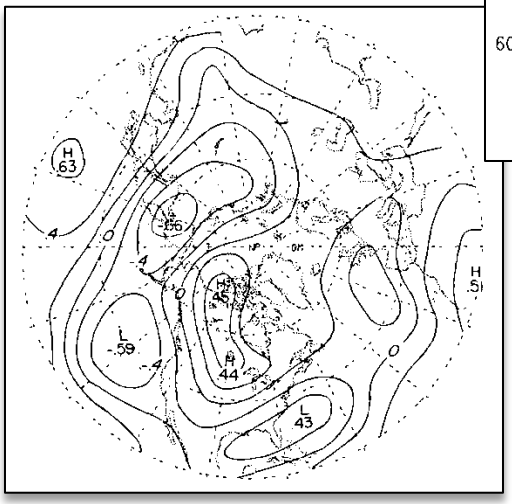
Some recommendations for future efforts in estimating monsoon predictability

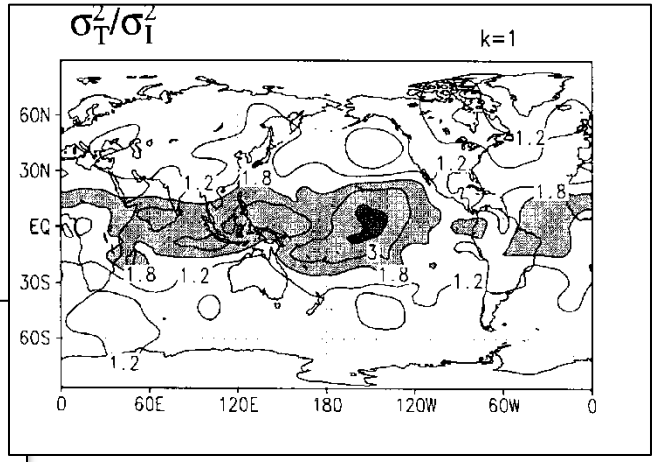
- Develop a time history for the estimates of predictability (and prediction skill) to chart progress. Repeat the exercise after every *n* years.
- Estimates should follow an open and agreed upon procedure.
- Explore different ways to estimate predictability from observational model data.
- Continue investments in research efforts to understand and explore sources of predictability.

1976



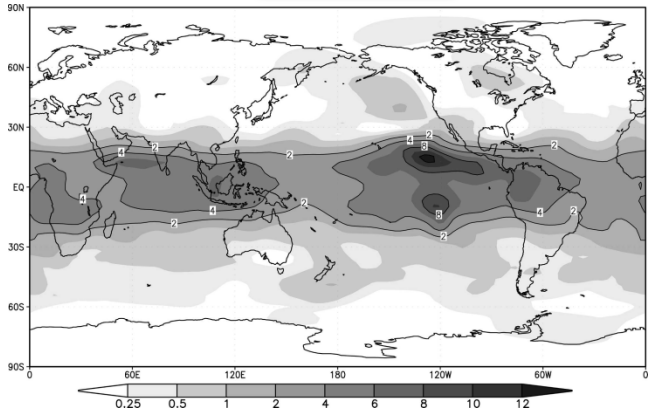
1981



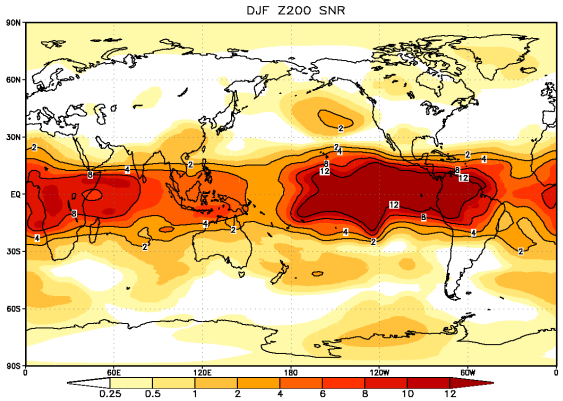


1995

2007



2015



Estimate of seasonal predictability over North America (1976-2015)

Thanks!

JGR Atmospheres

RESEARCH ARTICLE
10.1029/2018JD030082

Unraveling the Mystery of Indian Summer Monsoon Prediction: Improved Estimate of Predictability Limit

Subodh Kumar Saha[1], Anupam Hazra[1], Samir Pokhrel[1], Hemantkumar S. Chaudhari[1], K. Sujith[1], Archana Rai[1], Hasibur Rahaman[2], and B. N. Goswami[3]

[1]Indian Institute of Tropical Meteorology, Pune, India, [2]Indian National Centre for Ocean Information Services, Hyderabad, India, [3]Department of Physics, Cotton University, Guwahati, India

Key Points:

- The observed link between synoptic variability and predictable modes suggest a high predictability of the ISMR
- CFSv2 with improved physics shows ISMR prediction skill higher than current estimate of potential predictability
- Model shows ~70% of interannual variability of ISMR is predictable, which is much higher than earlier estimates (~45%)