Long-lead Prediction and Predictability of the Indian Summer Monsoon Rainfall

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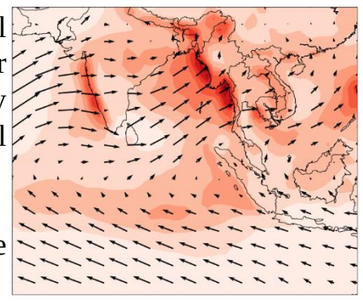
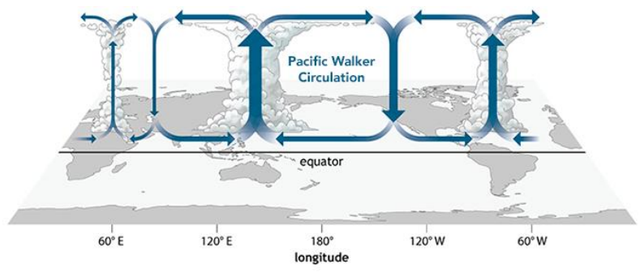
Introduction

ISMR, as measured by rainfall during June-September over continental India is the primary water resource for agricultural productivity in the region.



The lack of estimates of the potential limit of predictability of ISMR at long-lead has hampered progress in predicting ISMR one year or longer in advance.



The tropical SST distribution in all three ocean basins determines the intensity and locations of the three Walker cells and thereby influence ISMR of a given year.

Objectives

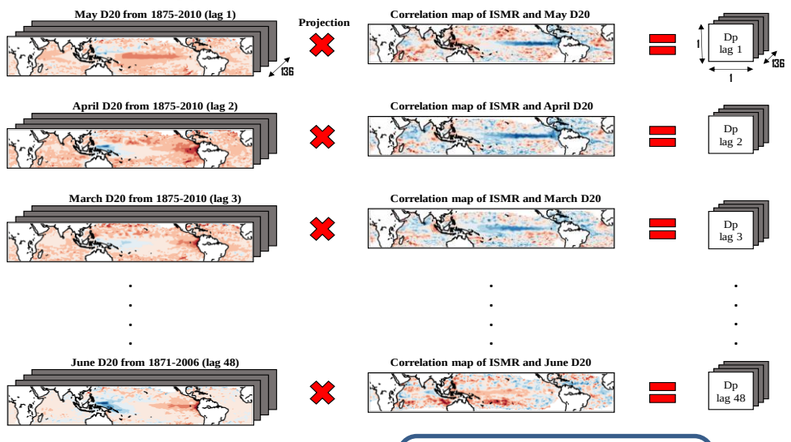
The objective of this study is to device a method for the true estimation of the long-lead predictability of ISMR by taking into account the simultaneous contribution from all the three tropical basins.

Data & Methodology

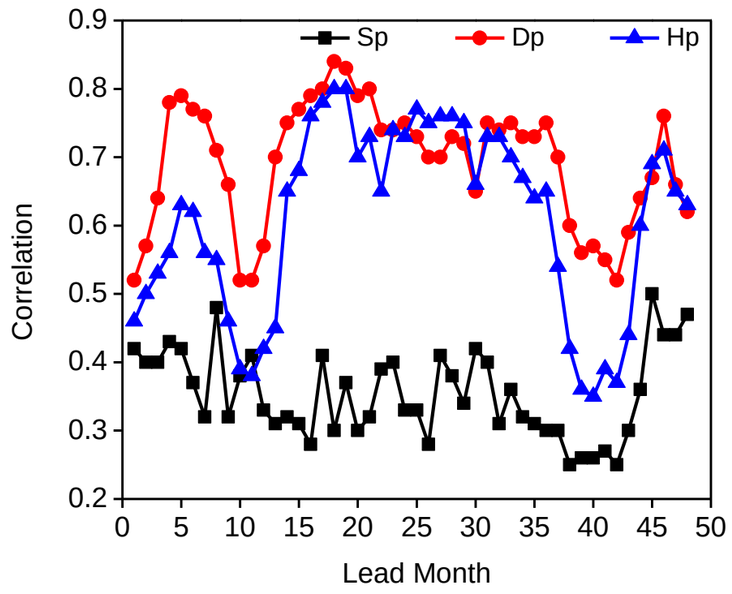
Data:

- **ISMR** is defines as the June-September accumulated rainfall over land points of India constructed from monthly mean rainfall data based on a fixed network of 306 stations and is available between 1871-2010.
- **Global gridded monthly mean sea surface temperature (SST)** are obtained from the Centennial in situ Observational-Based Estimate of SSTs (COBE SST2) for the period between 1871-2010.
- **Monthly heat content and D20** are obtained from Simple Ocean Analysis version 2.2.4 (SODA-2.2.4) for the period between 1871-2010.

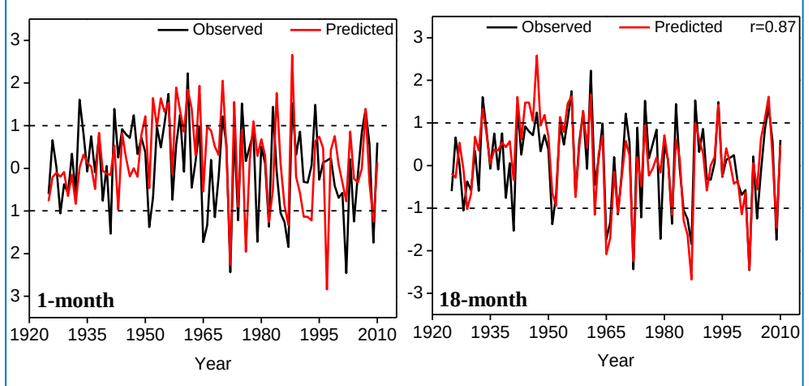
Methodology:



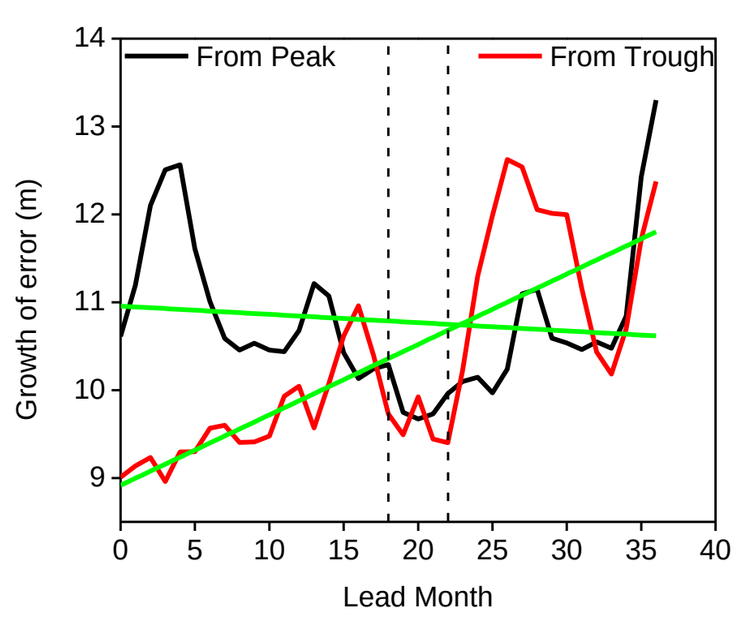
Results & Discussion



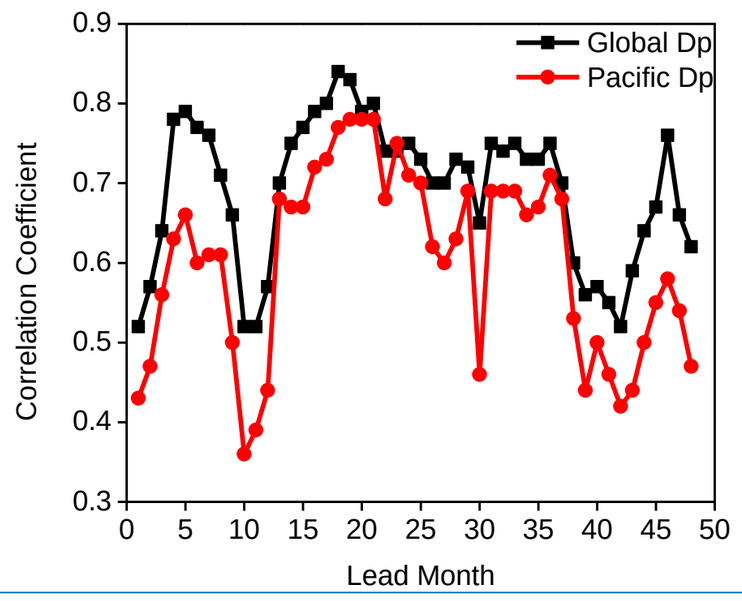
Simultaneous correlations between ISMR and Dp, Hp, Sp for all leads



Predicted and observed normalized ISMR anomaly for 1-month and 18-month lead hindcasts for 86 years. Correlation for 1-month lead = 0.52. Correlation for 18-month lead = 0.87



Zonal and latitudinal mean between 0^0E-360^0E, 7^0S-5^0N of estimated growth of errors for an initial condition corresponding to the peak of ENSO event (El Nino) and another initial condition corresponding to the trough of ENSO event (La Nina) with forecast lead months. Events are identified using D20.



- The correlation between Dp and ISMR up to 48-month leads indicate three minima at 1-month, 9-10 month and 41-42 month leads, while there are two maxima, one at 5-month lead another at 18-month lead.
- The 'potential skill' from the correlations between ISMR and Dp are tested with a simple linear regression model for predicting ISMR at 1-month and 18-month lead using Dp.
- The initial error, the growth rate of small errors and their saturation levels govern the predictability limit. The initial error and the error growth is phased locked with the annual cycle of ISMR driven by global ENSO.

Summary/Conclusion

- While recognizing the ENSO as a major driver of ISMR predictability, empirical estimates of potential predictability of ISMR from correlations with the conventional SST-based ENSO underestimate it.
- For the true estimation of the 'potential skill' or limit on predictability of ISMR, simultaneous contributions from all three tropical basins are essential.
- Predictor based on D20 associated with the global recharge-discharge oscillator is most suitable for estimating the potential predictability of ISMR. This is because D20 is least influenced by the atmospheric noises as compared to SST and HC.
- The initial errors, as well as the growth of errors with forecast-lead, are phase-locked with the annual cycle. The ISMR as well as the initial errors in D20 being phase-locked with the annual cycle, the 18-24 month lead forecasts tend to have a minimum forecast error.

Acknowledgements & References

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