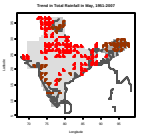
Understanding the Indian Monsoon for Enhanced Agricultural Decision Making



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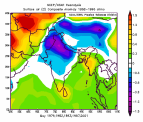


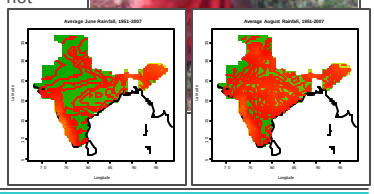
Motivation

Agriculture depends heavily on summer monsoon

Accounts for nearly all yearly rainfall

Current forecasts do not account for variation
- Intra-seasonally
- Spatially

Current forecasts becoming less accurate with **climate change**



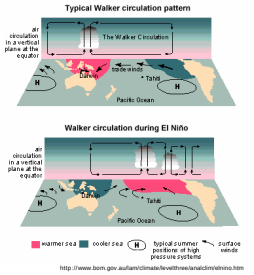
Background

Indian Summer Monsoon = Yearly season of rainfall (JJAS)
Caused by LAND-SEA temperature gradient

Current forecasts use **ENSO**
- El Niño → drought
- La Niña → normal

Seasonal Changes
- Eurasian Warming
- New "flavor" of El Niño

Sub-seasonal Changes
- Increase May and June Rainfall
- Decrease July Rainfall

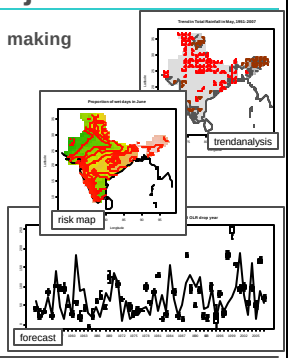


Project Objectives

Improve agricultural decision making capabilities by:

Understanding **changes** occurring in Indian monsoon
- trend analysis

Developing enhanced forecasting techniques that account for changes and operate on **sub-seasonal** and **sub-national** levels
- risk mapping
- forecast and skill assessment



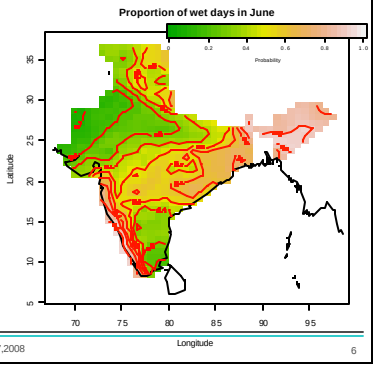
Risk Analysis

Risk Maps and Characterization

- Probability of experiencing a **wet day**
- Probability of experiencing at least **7 wet days**
- Average **wet spell length**

Historical behavior of rainfall variables

Sub-seasonally and **spatially specific** for decision

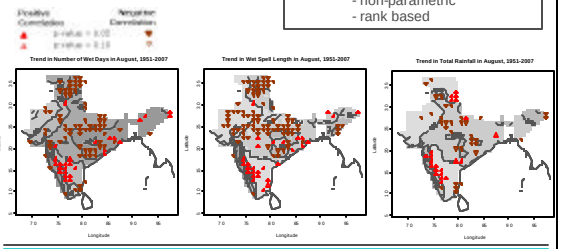


Trend Analysis

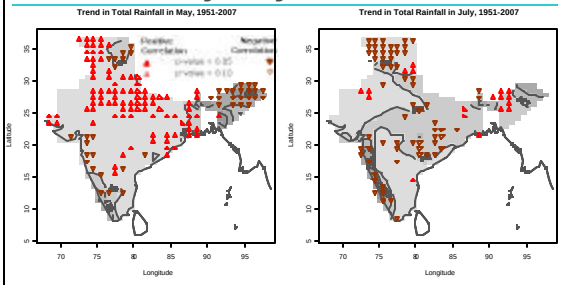
Trend Maps

Trends for:
- Total rainfall
- Number of wet days
- Wet spell length

Two-sided significance test on Kendall's tau statistic:
- non-parametric
- rank based



May/July Trends

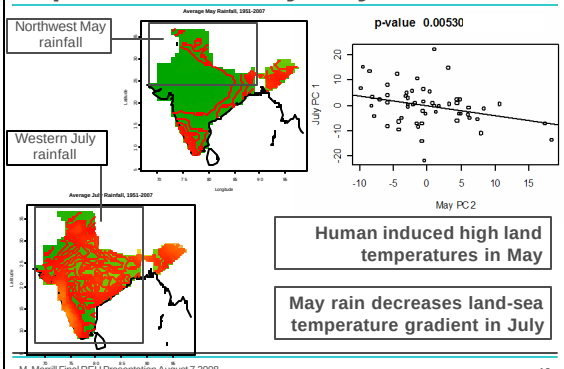


- PCA on west India stations to reduce number of variables
- Correlate first few PCs for May, June and July

Implications of May/July Correlation

Northwest May rainfall

Western July rainfall



Human induced high land temperatures in May

May rain decreases land-sea temperature gradient in July

Forecast

Forecast Technique

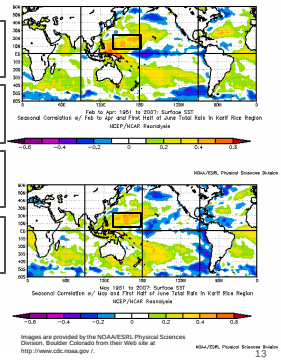
K. Krishna Kumar, The Climatic Impacts on Indian Agriculture, PROMISE-ICTP, 2003

Forecast steps:
- Determine **predictors** from global climate features
- Use **GCV** to choose best combination
- Fit locally weighted polynomial
- Test forecasts
- Determine forecast skill with **RPSS**

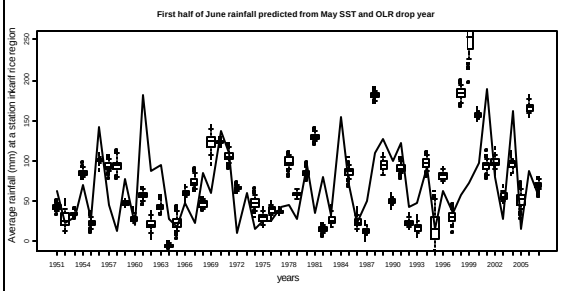
Forecast rainfall for:
- Orrisa and surrounding region
- First half of June
- Delivered: May 1st and June 1st

Predictors

- Sea Surface Temperature (SST)
- Outgoing Long-wave Radiation (OLR)
- 500mb Geopotential Height (Z500)
- Surface Air Temperature

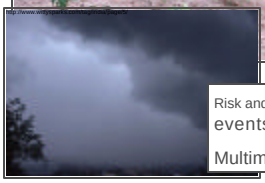


Forecast



Indicates potential for skill with spatially and temporally specific forecasts, particularly for dry years.

Conclusions & Forward Plan



- Risk Maps can be used with forecasts for agricultural decision making.
- The observed increase in May rainfall in northwest India is correlated with the decrease in July rainfall in the west.
- There is potential for skillful forecasts on the sub-seasonal and local levels.

Risk and Trend analysis for extreme rainfall events

Multimodal ensemble and logistic forecasts

Acknowledgements

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Questions?