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Climate & Weather Systems

Group : 15

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Probabilistic Monsoon Prediction for Agricultural Planning

- Application domain: Monsoon rainfall forecasting

Real-world context

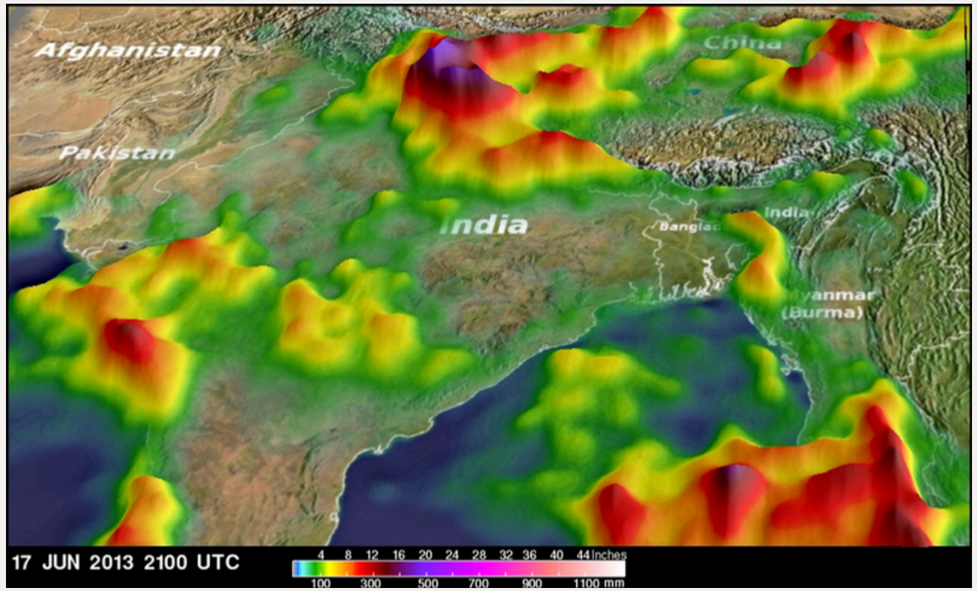
- Indian agriculture depends on monsoon rainfall
- Rainfall variability affects sowing and irrigation

Why uncertainty is intrinsic

- Chaotic atmospheric dynamics
- Measurement and forecast errors

Project Objective & Scope

- Probability distribution of daily monsoon rainfall
- Likelihood of rainfall exceeding critical thresholds
- Uncertainty in short-range rainfall forecasts



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Adapted from: NASA Global Precipitation Measurement (GPM) Mission, “Extreme India Monsoon Rainfall Analyzed”, NASA, 2013.
https://gpm.nasa.gov/mission-updates/trmm-news/extreme-india-monsoon-rainfall-analyzed

Project System Overview

NCMRWF forecast → Bayesian post-processing → Probabilistic prediction

Major Components:

- Raw deterministic forecast
- Bayesian Joint Probability model
- Calibrated ensemble output

Sources of Uncertainty

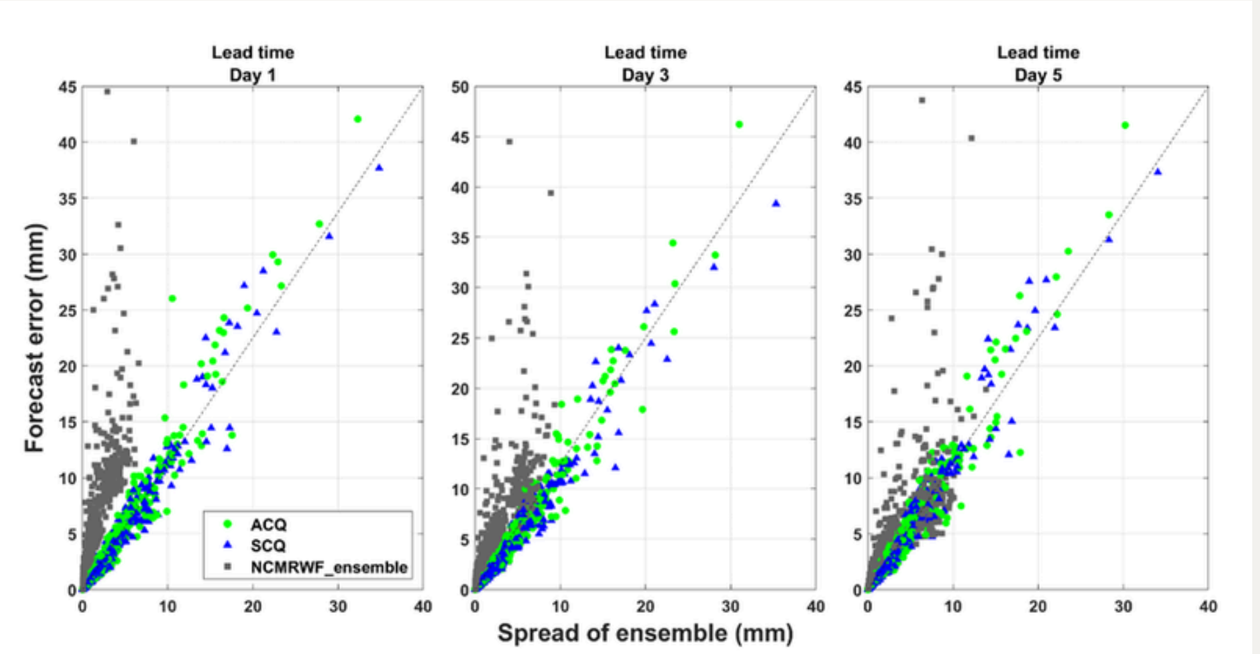
- Measurement noise (satellite & model errors)
- Atmospheric variability
- Model & parameter uncertainty
- Limited historical data

Key Random Variables

- Forecasted rainfall
- Observed rainfall

Conditioning variables:

- lead time
- spatial location



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Adapted from: Samal, N., Sahai, A. K., & Pattnaik, S., “Using a Bayesian Joint Probability Approach to Improve the Skill of Medium-Range Forecasts of the Indian Summer Monsoon Rainfall,” Journal of Hydrology, 2022. https://www.sciencedirect.com/science/article/pii/S221458182200297X

Probabilistic Models & Assumptions

Model:

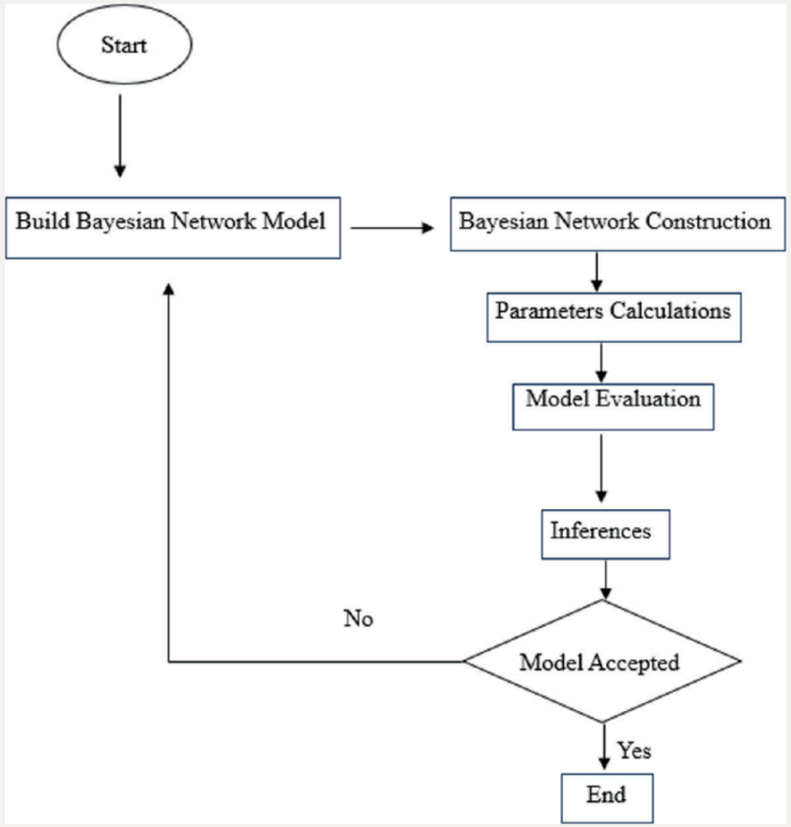
- Bayesian Joint Probability (BJP)

Assumptions:

- Joint distribution of forecast & observation
- Transformed rainfall ≈ normal
- Dependence captured via correlation

Probabilistic Reasoning & Inference Logic

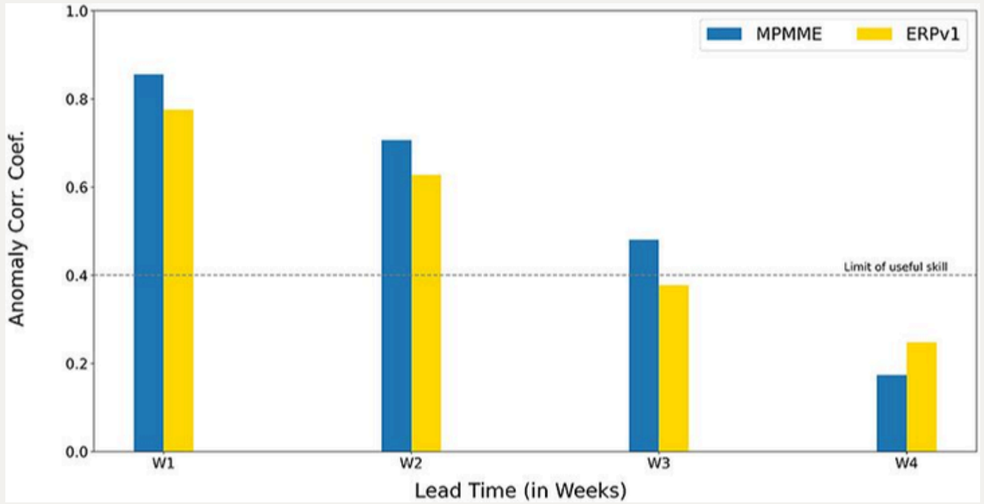
1. Transform Rainfall Data
2. Learn Joint Distribution
3. Condition on Forcast
4. Sample Ensembles



Operationalizing the Model

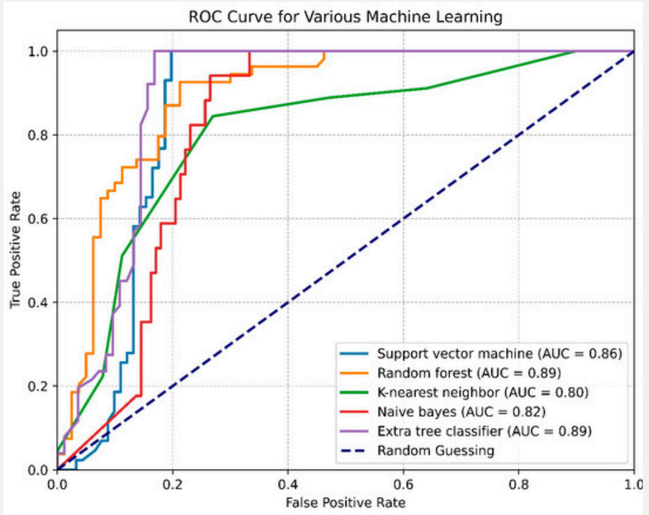
- **Implementation:**

  1. Ensemble generation
  2. Cross-validation
  3. Schaake Shuffle(spatial realism)



- **Evaluation metrics:**

  1. CRPS
  2. Bias
  3. ROC/ Spread-skill



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Current Limitations & Gaps

- Limited training data
- Assumes distributional form
- Underestimation of extremes
- No crop-level decision modeling

Planned Refinements and Role Coordination

• Next steps

1. Longer historical datasets
2. Extreme rainfall modeling
3. Crop-specific risk metrics

• Roles

1. Model refinement
2. Data validation
3. GitHub coordination

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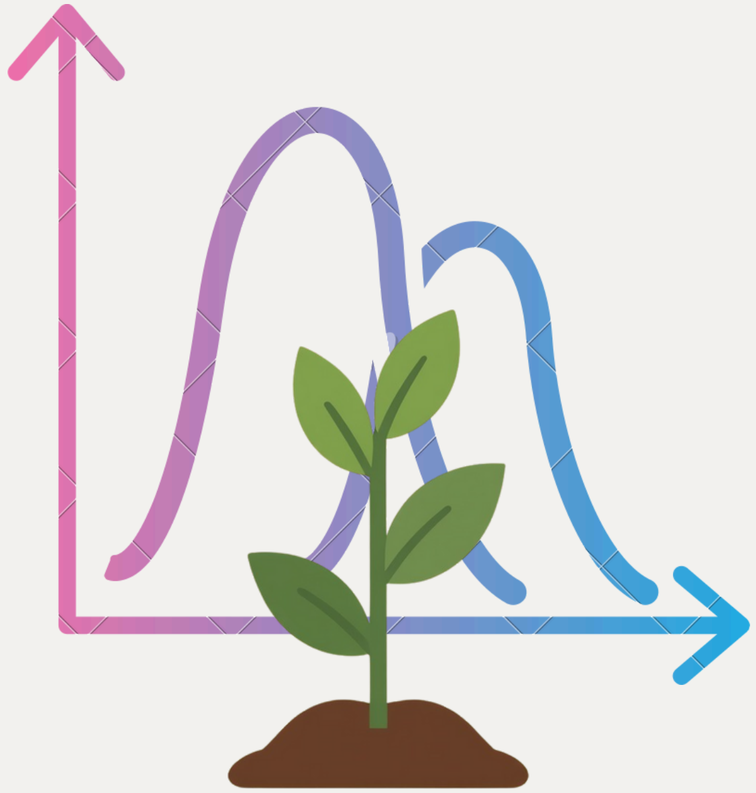
Summary of Group-Level Understanding

Probabilistic modeling enables risk-aware monsoon forecasts for agriculture.

- Uncertainty-aware forecasts
- Bayesian inference
- Decision support potential



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Thank You