Modelling Monsoons in India

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8th May 2022

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Note:

The ideas and concepts discussed in this presentation heavily draw insights, from the paper cited below:

 Devaraj Rajan, Srinivas Desamsetti. "Prediction of Indian summer monsoon onset with high resolution model: a case study."

Outline

Introduction

What is "Monsoon"?

- A monsoon is traditionally a seasonal reversing wind accompanied by corresponding changes in precipitation.
- Usually it refers to the rainy phase of a seasonally changing pattern.

Introduction

About Indian Summer Monsoons

- The **Indian Summer Monsoon**(ISM) typically lasts from June to September.
- India receives nearly **80%** of the annual rainfall during the summer monsoon season.

Introduction

Significance of Monsoons to the Indian Subcontinent

- India is an **agro-based** country. These make monsoons the most anticipated and **economically important** pattern.
- It has an important effect on **agriculture**, on **flora and fauna**, and on the climates of south asian countries.
- It has a significant effect on the overall well-being of residents and has even been dubbed the "real finance minister of India".

Introduction

- The start of the Indian rainy season is observed over the country's southern tip (Kerala) and is referred to as the monsoon onset.
- The ISM onset is one of the key aspects and unique for each year.
- Prediction of monsoon onset is crucial for agricultural planning which is connected to the food production for more than a billion people over India

Introduction

Some interesting information about the onset date

- The **earliest onset date** is 18 May 2004, 19 May 1990
- The **latest onset dates** are 13 June 1983(,1979), 18 June 1972.
- The Indian monsoon regularity is only in its annual recurrence, but its basic characteristics like onset, total seasonal rainfall, withdrawal, etc., have a large variability with the same gusto.

India Meteorological Department

What is the India Meteorological Department (IMD)?

- The IMD is the principal agency responsible for meteorological observations, weather forecasting and seismology.
- IMD predicts the ISM seasonal rainfall at a seasonal scale in April and being updated in June.
- For this it used statistical, empirical methods and has recently started using numerical models.

India Meteorological Department

IMD uses the following criteria for declaring monsoon onset over the country.

- **Widespread** and **persistent** rainfalls over Kerala and adjoining areas.
- Precisely , the rainfall must be **above 2.5 mm for two consecutive days** over **60%** of Kerala and adjoining regions.

Numerical Weather Prediction

- Used to predict the weather at the **short** (up to 3-days), **medium** (up to 10-days), and **extended range** time scales (up to a month).
- **NCMRWF**[1]generates weather forecasts daily using **deterministic** (**NCUM**) and dynamical **ensemble models** (**NEPS**) valid for the next 10 days.
- According to research by NCMRWF, these models show high predictive skills with a **5 to 7-day lead time**.

[1]National Centre for Medium Range Weather Forecasting

Numerical Weather Prediction

- NCUM is a high-resolution unifed global model analysis and forecasting system jointly implemented by the NCMRWF and the United Kingdom Met Office.
- Includes semi-implicit, semi-Lagrangian dynamical core.
- Has a temporal resolution of 7.5 min, which is the minimum time step while doing model integration.
- This high-resolution model has a prognostic cloud physics scheme for the formation of rainfall.
- NCUM is modular in nature and can be adjusted from regional to global scale
- NCUM is a global model with a horizontal resolution of $\tilde{1}7$ km, having 70 vertical levels, with a 4-dimensional variational (4D-Var) data assimilation system

Numerical Weather Prediction

1. the national agency IMD daily weather bulletins
2. press release from IMD
3. reliable/actual list of climatological onset dates from IMD
4. high-resolution daily rainfall data over the Indian region compiled by IMD
5. daily NCMRWF IMD rainfall analysis which is being carried out on routine basis and archived for the research study
6. the rain gauge observations reported for 15–31 May 2018
7. the weekly/daily press release issued by IMD, bulletins about the current weather status, and outlook for the next two weeks

Monsoon Onset Prediction

1. The study mainly focuses on the **dynamical operational numerical model forecasts** and their usage to predict the onset of the Indian summer monsoon.
2. Diferent monsoon onset criteria are addressed in the present study using the numerical model forecasts at medium-range time scales.
3. The models are evaluated on data from years 2018 (**early** onset), 2019 (**delayed** onset), 2020(**timely** onset).

Monsoon Onset Prediction

- The following methods briefy describe the relationship between the ISM onset and the meteorological parameters
- Different monsoon onset criteria are addressed in the present study using the numerical model forecasts at medium-range time scales.
- The models are evaluated on data from years 2018 (**early** onset), 2019 (**delayed** onset), 2020(**timely** onset).

Monsoon Onset Prediction

- IMD adopted a new methodology, and the criteria used mainly rainfall and large-scale circulation patterns
- Rainfall, wind, and long-wave radiation data have been traditionally used for identifying the monsoon onset
- The following methods briefy describe the relationship between the ISM onset and the meteorological parameters.

Monsoon Onset Prediction

The onset date may arrive only after 10 May. Minimum 8 out of 14 above referred stations should report 2.5 mm minimum rainfall for two consecutive days. On the second day, the onset may be declared, along with the following criteria are also satisfed in concurrence.

Monsoon Onset Prediction

For the period 15–31 May, the zonal component of winds at 600 hPa (U600) are extracted and averaged for the region of 0°–10° N and 55°–80° E. Similarly, the area average of zonal wind at 925 hPa (U925) is also computed for the region of 5°–10° N and 70°–80° E.

Monsoon Onset Prediction

The Outgoing Longwave Radiation (OLR) should be below 200 W/m2 in the box confned by 5°–10° N and 70°–75° E, then onset is declared.