DAST

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Introduction

The study of precipitation regimes forms a cornerstone of modern climate science, offering crucial insights into climate evolution and environmental dynamics. Recent technological advances, particularly NASA's Global Precipitation Measurement (GPM) mission, have transformed our ability to study rainfall patterns.

Key Technological Developments:

- Advanced satellite remote sensing capabilities
- Multi-sensor data integration
- High-resolution temporal and spatial measurements

Introduction

- Precipitation data serve as a key input for climate models, helping to simulate atmospheric conditions and predict future climatic shifts.
- Hydrological assessments rely on precipitation patterns to model river discharge, groundwater recharge, and flood risks, essential for water resource management.
- Understanding extreme weather events, such as heavy rainfall and droughts, is crucial for improving early warning systems and mitigating natural disasters.

Dataset Overview

Key Highlights

- **Dataset Origin:** NASA's IMERG, based on GPM satellite constellation data.
- **Coverage:**
  - **Spatial:** Central Italy (10°E - 15°E, 41°N - 44°N).
  - **Temporal:** 2018–2023 (6 years).

Features

- High-resolution data: **0.1° x 0.1° spatial**, **30-min temporal**.
- **Applications:** Analyzing seasonal variability, extreme weather events, and trends.
- Quality assured through calibration and error control.

Data Characteristics and Access

Characteristic	Description
Temporal Coverage	2018-2023 (6 years)
Spatial Domain	10°E-15°E longitude, 41°N-44°N latitude
Spatial Resolution	0.1° × 0.1° grid spacing
Temporal Resolution	30-minute intervals
Number of Observations	9,000 (1,500 per year)
Data Format	GeoTIFF files
Variables Recorded	Precipitation (mm)

Data Access

- Via **NASA Giovanni Portal**:
  - Visualization, extraction, and analysis.
  - Combines geophysical parameters.
  - Advanced quality control tools.

Data Analysis And Interpretation

- Dataset composed of 9000 samples
- Location: Central Italy (10°E-15°E longitude, 41°N-44°N latitude)
- Temporal Information
- 6 Fields: geographic coordinates (longitude, latitude), rainfall observations (mm), timestamps (start_date, end_date)

Preprocessing

- Data was preprocessed before being analyzed
- Invalid or Null measurements removed
- Remaining points were sorted in increasing order (from oldest to newest)
- Organized in a grid (1500 samples per year)

Dataset (precipitation_timeseries.csv)

longitude	latitude	precipitation	start_date	end_date	source_file
14.949999911272805	41.050000168867896	3.0529177	20180101	20181231	GIOVANNI_g4_timeAvgMap_GPM_3IMERGDE_07_precipitation_20180101_20181231.tif
14.349999945618817	43.05000005438119	2.368493	20180101	20181231	GIOVANNI_g4_timeAvgMap_GPM_3IMERGDE_07_precipitation_20180101_20181231.tif
14.449999939894482	43.05000005438119	2.3093014	20180101	20181231	GIOVANNI_g4_timeAvgMap_GPM_3IMERGDE_07_precipitation_20180101_20181231.tif
14.549999934170145	43.05000005438119	2.1268356	20180101	20181231	GIOVANNI_g4_timeAvgMap_GPM_3IMERGDE_07_precipitation_20180101_20181231.tif
14.649999928445812	43.05000005438119	2.0838766	20180101	20181231	GIOVANNI_g4_timeAvgMap_GPM_3IMERGDE_07_precipitation_20180101_20181231.tif
14.749999922721475	43.05000005438119	2.0870137	20180101	20181231	GIOVANNI_g4_timeAvgMap_GPM_3IMERGDE_07_precipitation_20180101_20181231.tif
14.84999991699714	43.05000005438119	2.0867124	20180101	20181231	GIOVANNI_g4_timeAvgMap_GPM_3IMERGDE_07_precipitation_20180101_20181231.tif
14.949999911272805	43.05000005438119	2.0556574	20180101	20181231	GIOVANNI_g4_timeAvgMap_GPM_3IMERGDE_07_precipitation_20180101_20181231.tif
10.050000191765243	42.95000006010552	2.4261644	20180101	20181231	GIOVANNI_g4_timeAvgMap_GPM_3IMERGDE_07_precipitation_20180101_20181231.tif
10.150000186040907	42.95000006010552	2.5993836	20180101	20181231	GIOVANNI_g4_timeAvgMap_GPM_3IMERGDE_07_precipitation_20180101_20181231.tif
10.250000180316572	42.95000006010552	2.6975205	20180101	20181231	GIOVANNI_g4_timeAvgMap_GPM_3IMERGDE_07_precipitation_20180101_20181231.tif
10.350000174592237	42.95000006010552	2.981411	20180101	20181231	GIOVANNI_g4_timeAvgMap_GPM_3IMERGDE_07_precipitation_20180101_20181231.tif
10.450000168867902	42.95000006010552	2.5517945	20180101	20181231	GIOVANNI_g4_timeAvgMap_GPM_3IMERGDE_07_precipitation_20180101_20181231.tif
10.550000163143565	42.95000006010552	2.5613286	20180101	20181231	GIOVANNI_g4_timeAvgMap_GPM_3IMERGDE_07_precipitation_20180101_20181231.tif
10.65000015741923	42.95000006010552	2.542534	20180101	20181231	GIOVANNI_g4_timeAvgMap_GPM_3IMERGDE_07_precipitation_20180101_20181231.tif
10.750000151694895	42.95000006010552	2.5336437	20180101	20181231	GIOVANNI_g4_timeAvgMap_GPM_3IMERGDE_07_precipitation_20180101_20181231.tif
10.85000014597056	42.95000006010552	2.517274	20180101	20181231	GIOVANNI_g4_timeAvgMap_GPM_3IMERGDE_07_precipitation_20180101_20181231.tif
10.950000140246225	42.95000006010552	2.5885615	20180101	20181231	GIOVANNI_g4_timeAvgMap_GPM_3IMERGDE_07_precipitation_20180101_20181231.tif
11.050000134521888	42.95000006010552	2.5796576	20180101	20181231	GIOVANNI_g4_timeAvgMap_GPM_3IMERGDE_07_precipitation_20180101_20181231.tif
11.150000128797553	42.95000006010552	2.6985068	20180101	20181231	GIOVANNI_g4_timeAvgMap_GPM_3IMERGDE_07_precipitation_20180101_20181231.tif
14.249999951343153	43.05000005438119	2.354589	20180101	20181231	GIOVANNI_g4_timeAvgMap_GPM_3IMERGDE_07_precipitation_20180101_20181231.tif
11.250000123073217	42.95000006010552	2.676178	20180101	20181231	GIOVANNI_g4_timeAvgMap_GPM_3IMERGDE_07_precipitation_20180101_20181231.tif
14.14999995706749	43.05000005438119	2.4027534	20180101	20181231	GIOVANNI_g4_timeAvgMap_GPM_3IMERGDE_07_precipitation_20180101_20181231.tif

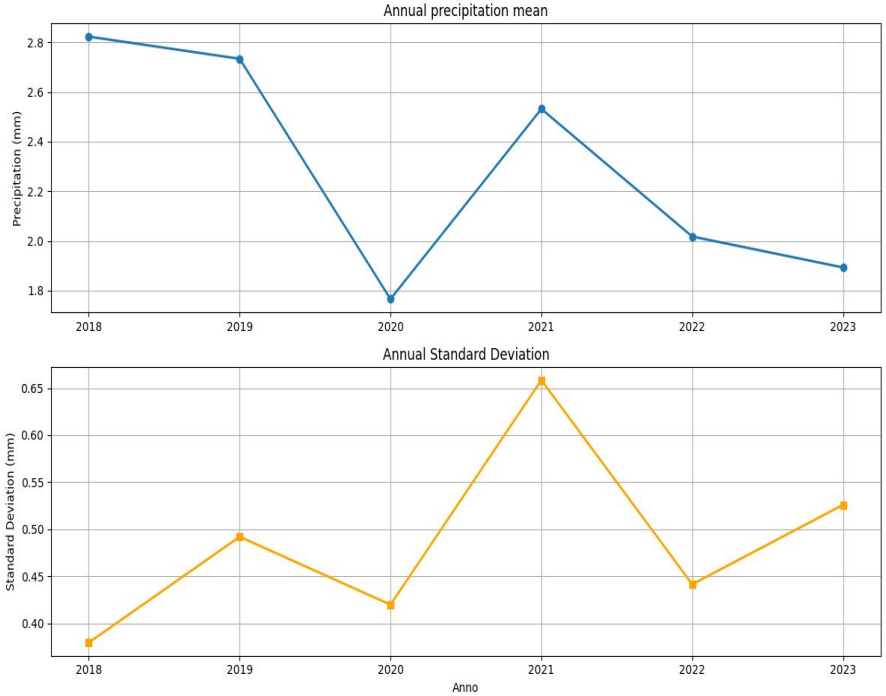
Temporal Evolution Analysis

- Annual Patterns:
  - Highest mean registered in 2018, (2.8mm)
  - Lowest in 2020 (1.8mm)

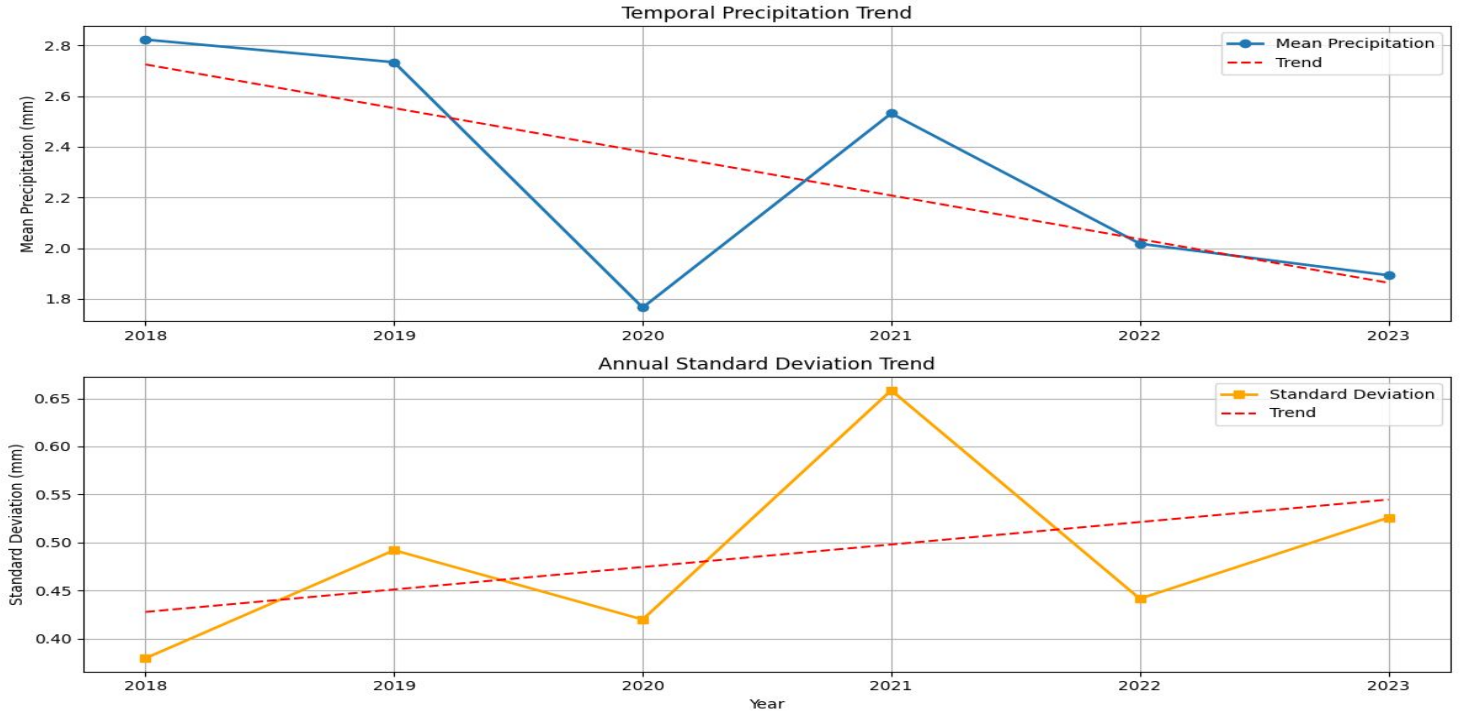
$$\bar{x}_y = \frac{1}{n}\sum_{i=1}^{n} x_i$$

- Standard Deviation:
  - Describe how much the precipitation samples vary from one to another
  - Increasing Trend shows increased variability in precipitation in later years.

$$\sigma_y = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(x_i - \bar{x}_y)^2}$$



Temporal Trends



Spatial Analysis

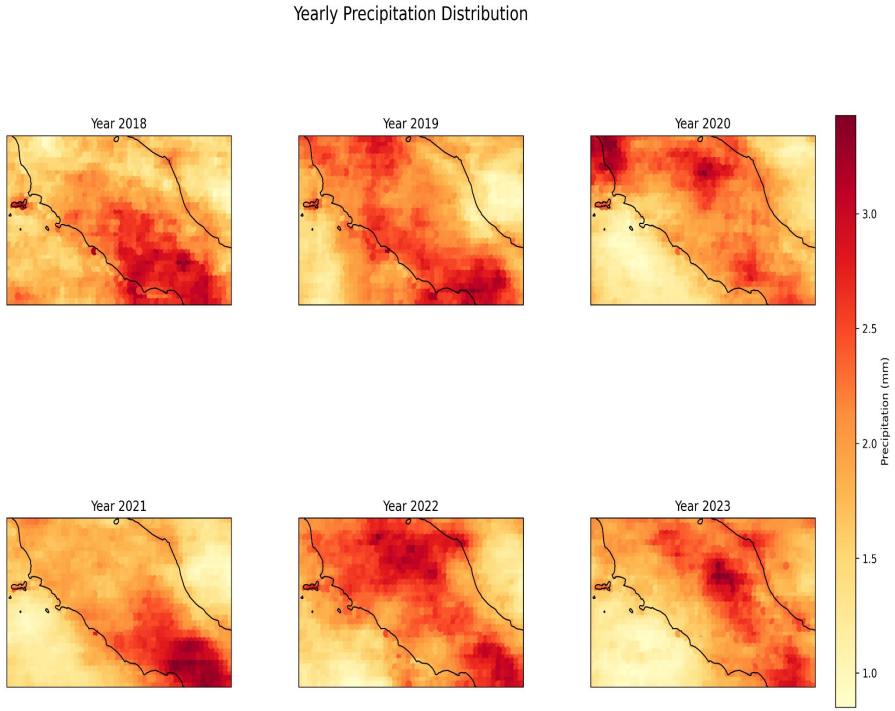
- The study domain of the spatial analysis is described by

$$D = \{(lon, lat) \in R^2 : 10E \leq lon \leq 15E, 41N \leq lat \leq 44N\}$$

- The annual precipitation distribution analysis ranges from 0.75mm to 3mm

Spatial Analysis

- Spatial Consistency:
  - Persistent patterns in all of the region
  - Central-Eastern portion of the area of study shows higher precipitations
- Temporal Evolution:
  - distribution was fairly uniform in 2018, it increased in heterogeneity in the following years
- Geographic Features:
  - the precipitation patterns seem to follow the geographic features of the region



Topographic Influence

- 3d model emphasizes the interaction between the topography and the precipitation patterns.
- Diagonal trend with higher values residing in areas with increasing latitude and east longitude.