



Dynamical Downscaling of NCUM Global Forecast of ISMR using Regional Coupled Model



Suraj Ravindran, Akhilesh Mishra, Ankur Gupta

suraj@ncmrwf.gov.in

National Centre for Medium Range Weather Forecasting, Noida
Ministry of Earth Sciences, Government of India

Introduction

- **Dynamical downscaling** of the Indian Summer Monsoon Rainfall from **NCUM-Global** model using a high resolution regional coupled model for forecasting has got wider applications.
- The **NCMRWF Regional coupled modeling system** integrates various components (Unified Model, NEMO, JULES, and Wavewatch) to simulate the atmosphere, ocean, land, and wave dynamics.

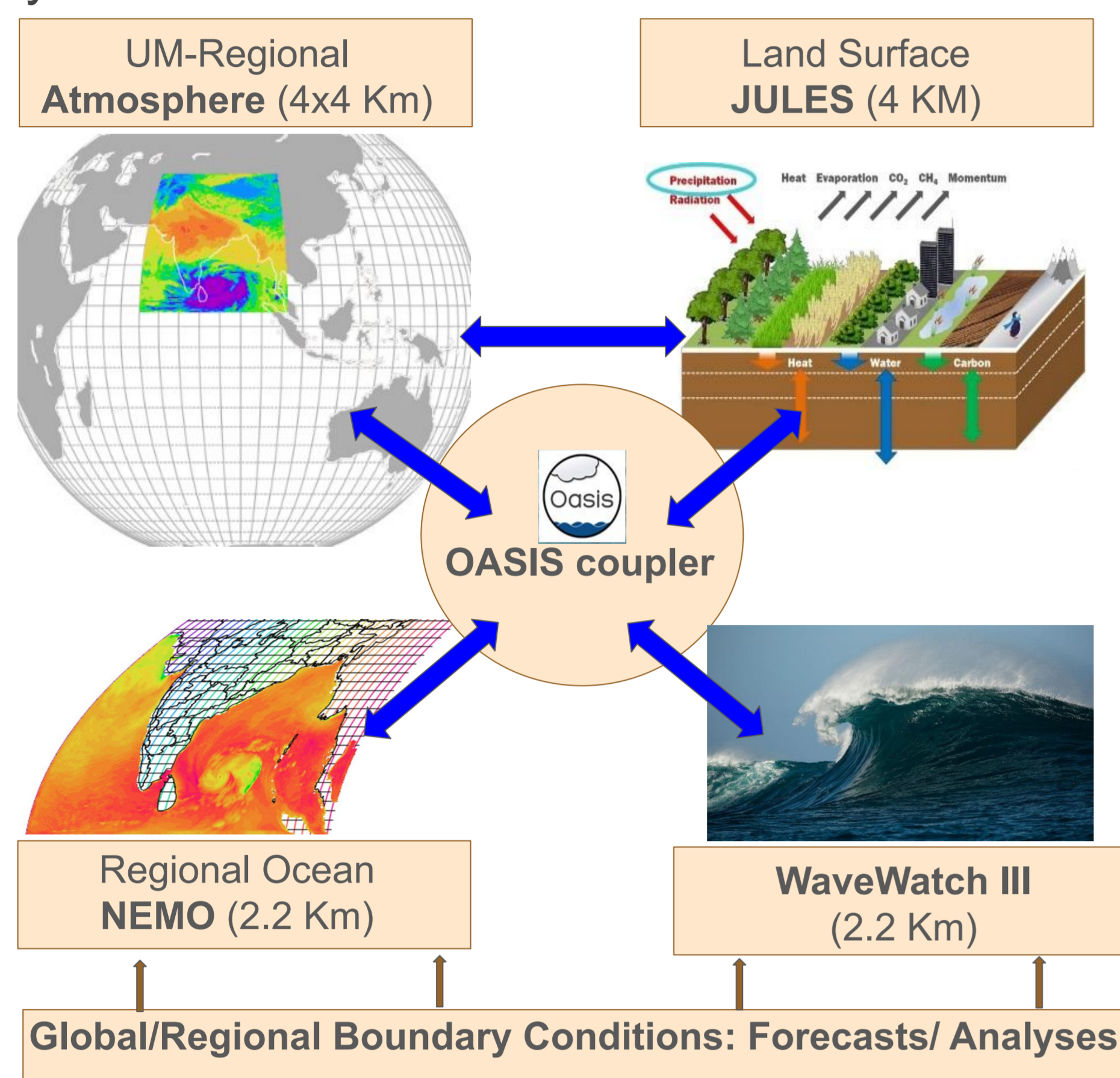


Figure 1: Schematic diagram of components in the NCMRWF Regional coupled environmental model.

- Identifying the **skills and challenges** of such regional coupled products are vital for enhancing the reliability.

Data & Methodology

- **ATM** : Regional Atmosphere (UM)
- **ATM-KPP** (Partially-Coupled): Regional Atmosphere (UM) is coupled with multicolumn ocean mixed layer model (KPP).

Components	Resolution (Km)	Grid Points
Atmosphere & Land Surface	4.05 x 4.05	900x904x80
Ocean & Wavewatch III	2.2 x 2.2	1100x1760x75

- ATM and ATM-Kpp experiments were initialized daily using NCMRWF Global Data Analysis.
- KPP model is initialized with NEMO Analysis produced daily at NCMRWF at ORCA025 grid.
- 6-hourly lateral boundary forcings are taken from realtime Global Model Forecast NCUM-G operational at NCMRWF.
- Both experimental forecasts (ATM and ATM-Kpp) of ~4 Km resolution are of 10- days length for the entire monsoon (**JJAS 2023 and 2024**) season.
- Daily accumulated rainfall is compared with NCMRWF merged satellite-gauge rainfall dataset of ~0.25 degree horizontal resolution (**OBS**).

Results

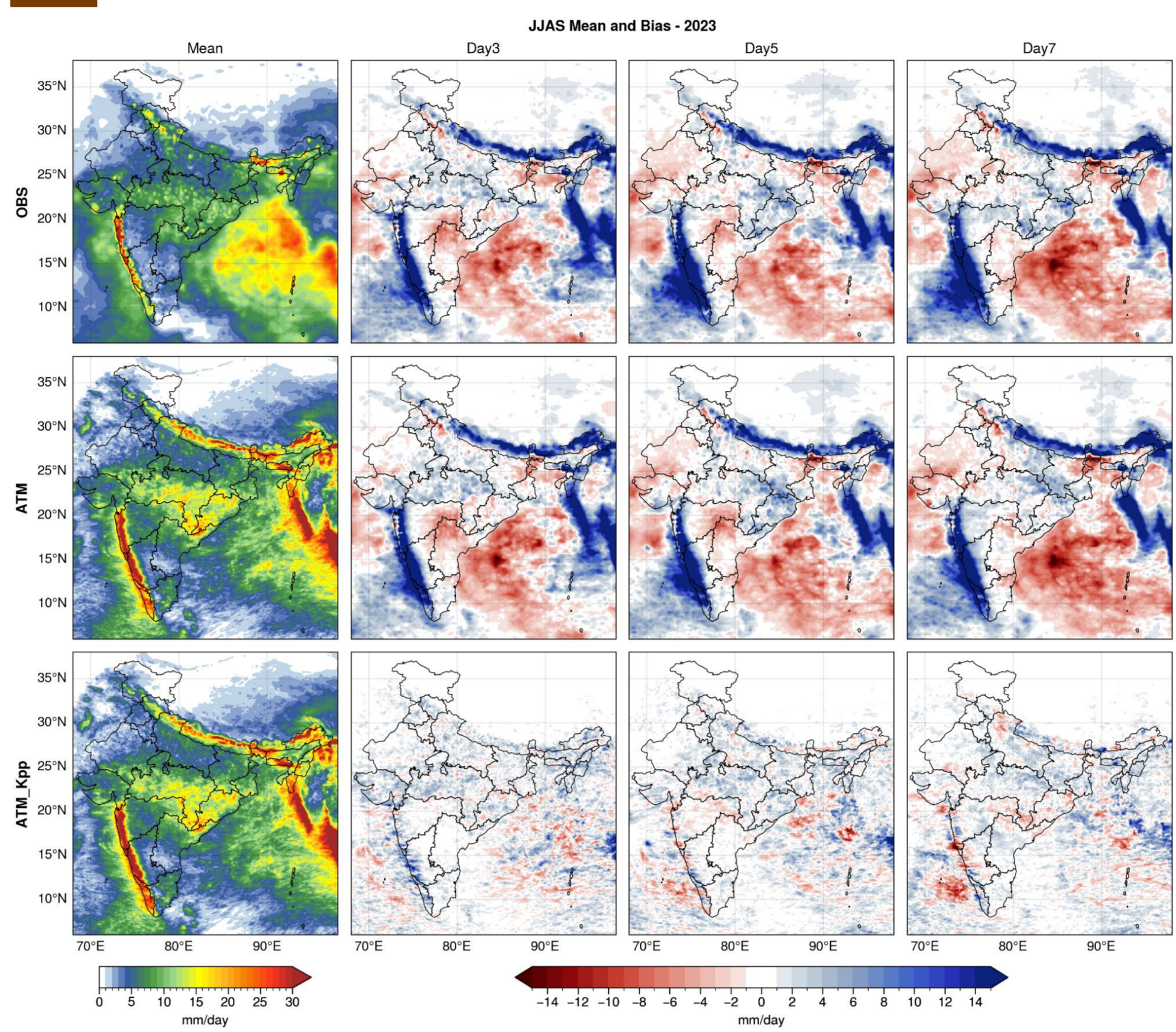


Figure 2: Mean (column 1, Day1) and mean-error (column 2 to 4) for Day 3, Day 5 and Day 7 of the seasonal temporal average of JJAS 2023.

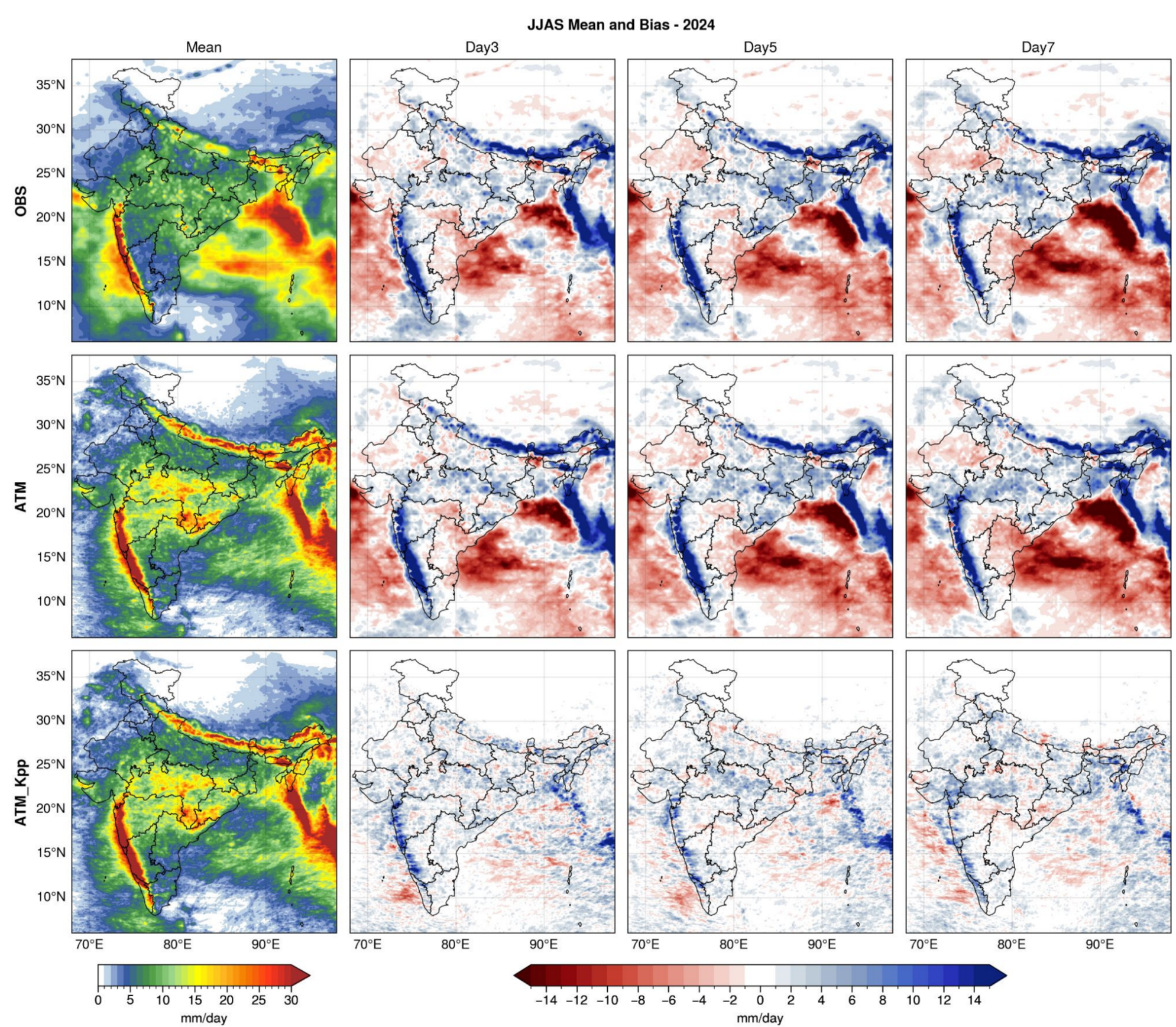


Figure 3: Same as Figure 2 but for JJAS 2024.

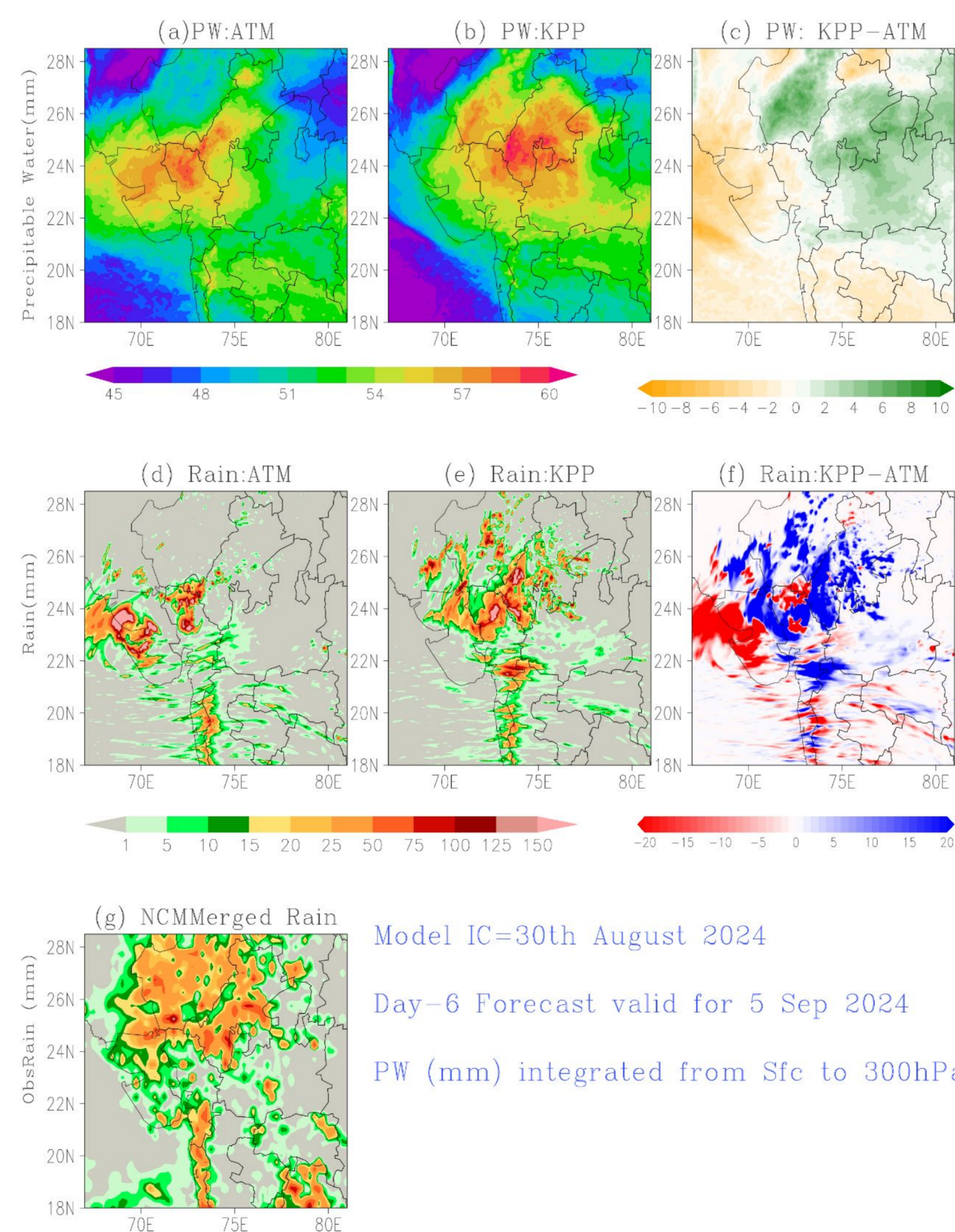


Figure 4: Case study of a heavy rainfall event over Northwest India, 5 Sep 2024.

Support Figures

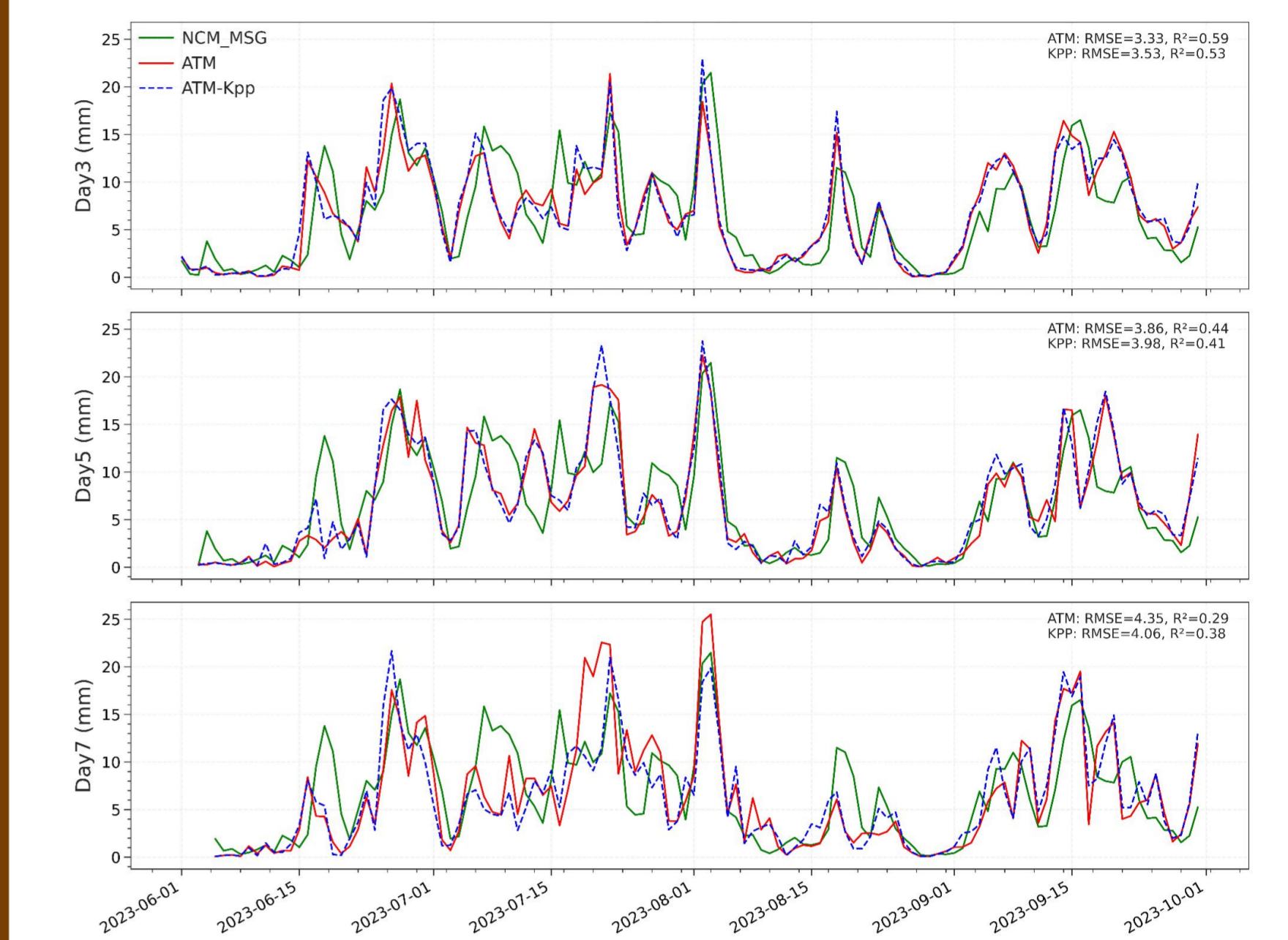


Figure 5: Spatially averaged daily rainfall over Central India for JJAS 2023.

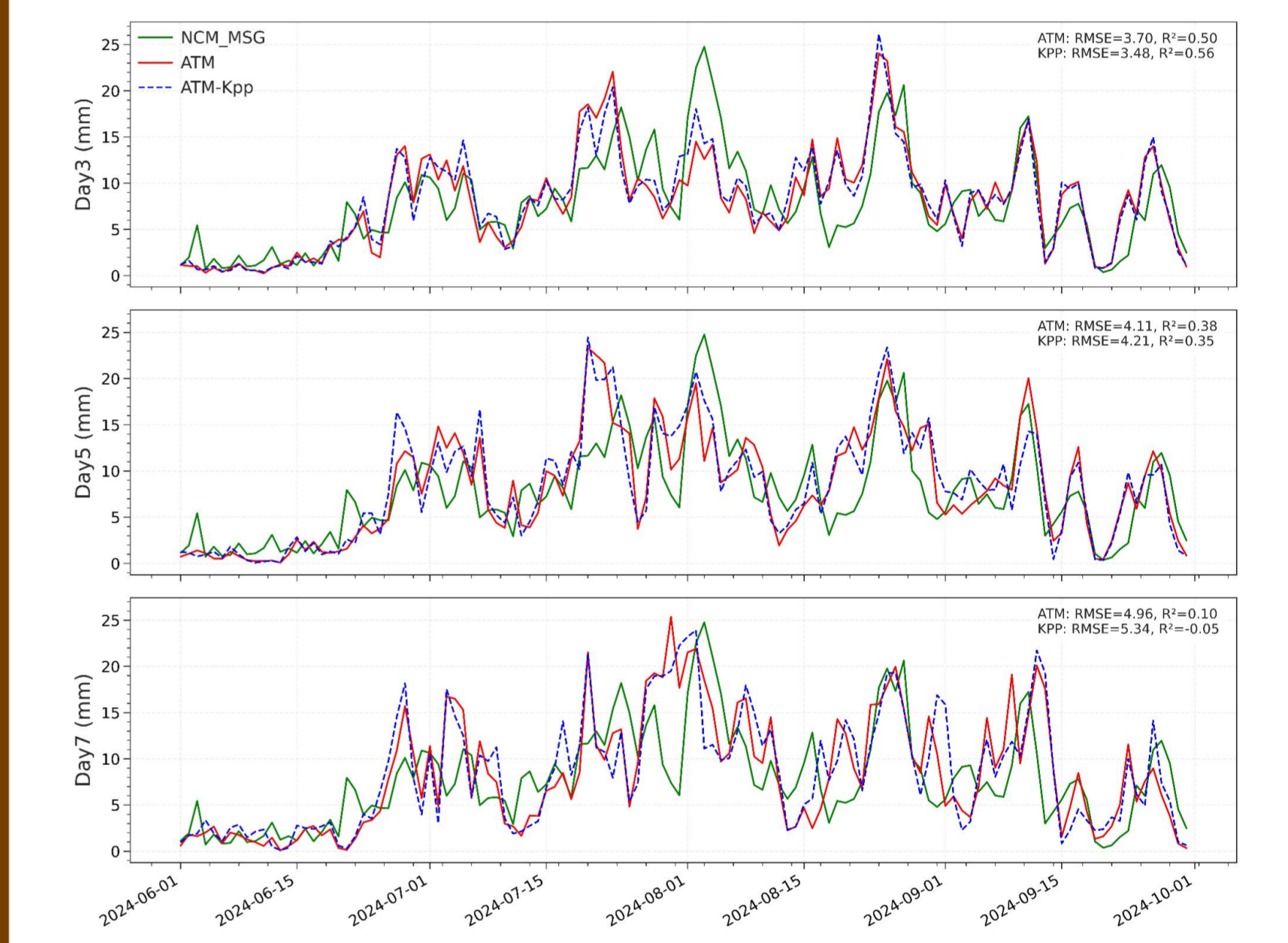


Figure 6: Same as Figure 5 but for 2024.

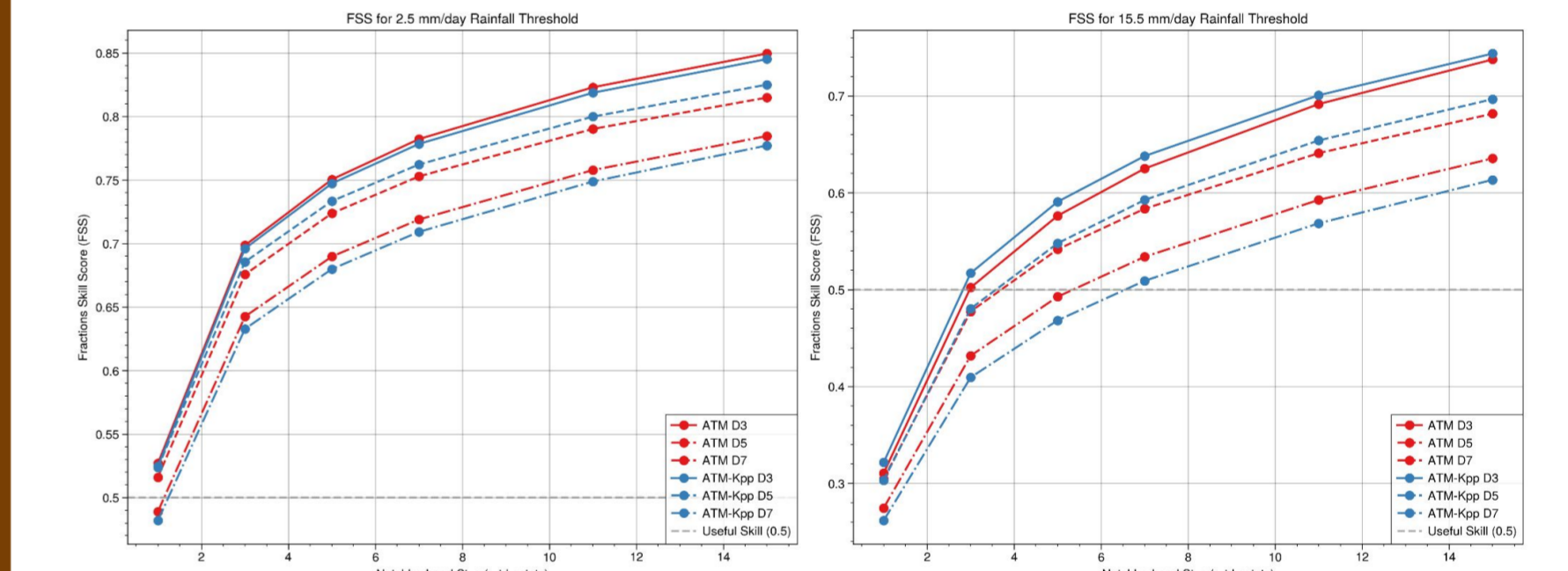


Figure 8: Fractional Skill Score by rainfall threshold averaged over Central India.

Summary

- Experiments show the **ability of coupled model in capturing the monsoon features**. However, seasonal mean rainfall in **both coupled and uncoupled models significantly overestimate rainfall** over the orographic regions, especially **western ghats**.
- **Event specific case studies** indicate that Partially coupled model (ATM-Kpp) has slightly better skills in rainfall prediction at **longer time leads**.
- **KPP model is a multicolumn model without horizontal advection**, this could limit the realistic mixed layer/ocean state prediction skills.
- A **fully coupled ocean-atmospheric model** is necessary for the coupled process studies and better understanding of the **air-sea interactions** over Indian monsoon region, which may further improve rainfall prediction skills.