SLAPIS
Système Local d'Alerte Précoce pour les Inondations au Sahel
SAHEL

# WRF verification in Niger and Burkina Faso

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AGENZIA ITALIANA PER LA COOPERAZIONE ALLO SVILUPPO

# Contents

# Context: General

- Intensification of precipitation in the Sahel (Panthou et al., 2018; Massazza et al., 2021; Chagnaud et al., 2022)
- Flood risk has increased exponentially in the Sahel (Wilcox et al., 2018; Elagib et al., 2021; Fiorillo et al., 2018).
- Early warning systems (EWS) constitute a key tool for risk reduction and adaptation (Sendai Framework, 2015–2030)
- Regional NWP play a key role, although their deployment remains limited due to lack of financial and computational resources
  (Parker et al., 2021; Lamptey et al., 2024; Vogel et al., 2020)

# Context: objectives

## General Objective

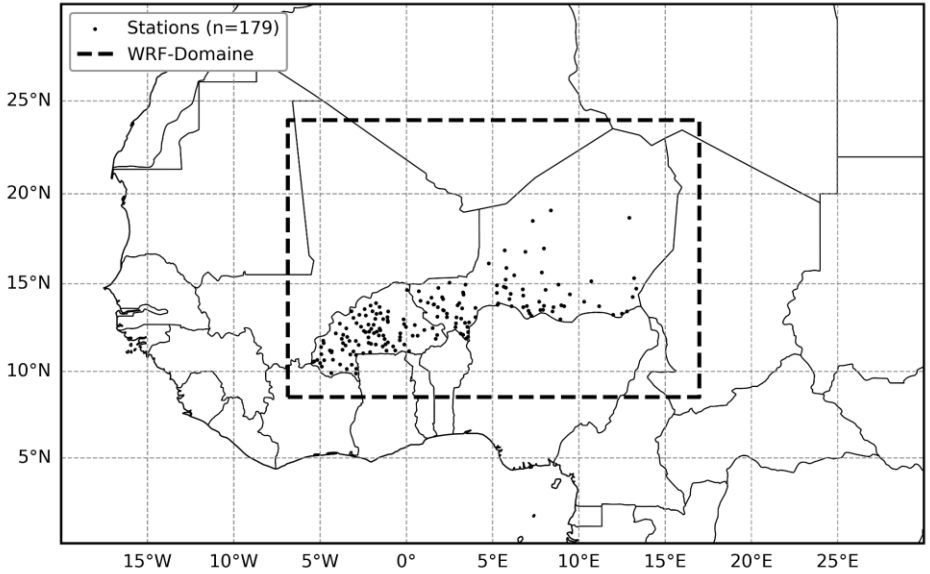
To **evaluate the performance of three numerical weather prediction systems** (GFS, WRF-BF, and WRF-NI) in simulating daily rainfall during the monsoon season (JAS 2023–2024) over the Sahelian region

## Specific Objectives

- ⚙️ **Compare** the ability of the three models to reproduce observed daily rainfall distributions.
- 📊 **Assess** their systematic biases, especially the drizzle bias and the underestimation of intense rainfall events.
- 🗺️ **Evaluate** their spatial skill

# Methods: WRF Model setup

- Initial data: operational GFS (Global Forecasting System from NCEP) at 0.25 deg;
- 36 hr simulation starting at 18:00 UTC;
- Period:
  - hindcast: JAS 2023 and JAS 2024;




| Parameterizations | BURKINA | NIGER |
|---|---|---|
| Microphysics | Thompson | WSM6 |
| Cumuls | 0 | New Tiedtke Scheme |
| Boundary layer | MYJ | YSU |
| Radiation | RRTMG | RRTMG |

# Methods: Model Evaluation Framework

## 1. Point-Based Evaluation

- **Data**: Ground observations from Burkina Faso and Niger(JAS 2023 & 2024)
- **Methods**:
  - Probability Density Function (PDF)
  - Taylor Diagram
  - Performance Diagram

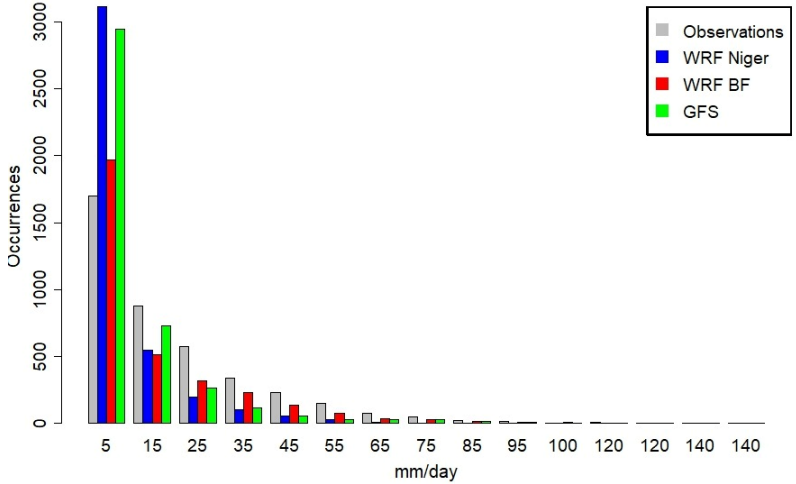
*Complementary approaches*

## 2. Spatial Evaluation

- **Data:** CHIRPS satellite rainfall fields
- **Methods:**
  - Frequency Bias
  - Fraction skill scores *(absolute and percentile thresholds)*

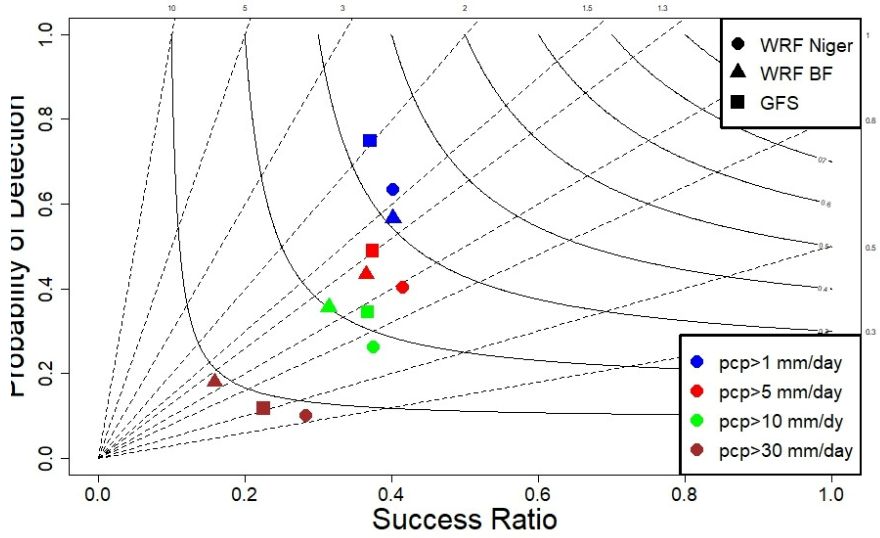
# Results: (a) Model vs Rain Gauges

probability density of observed daily precipitation compared to forecasts



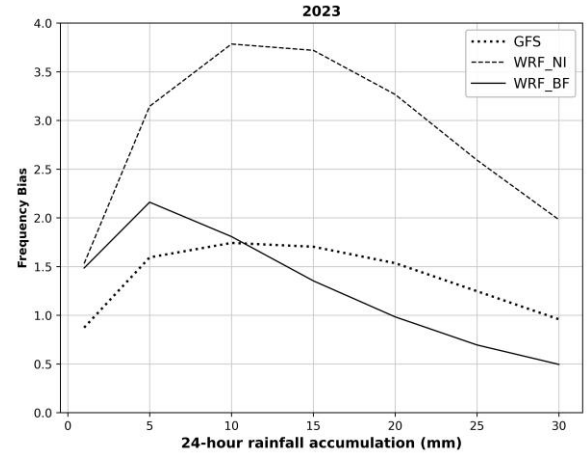

drizzle bias (Gutowski et al. 2003; Lazoglou et al., n.d.)

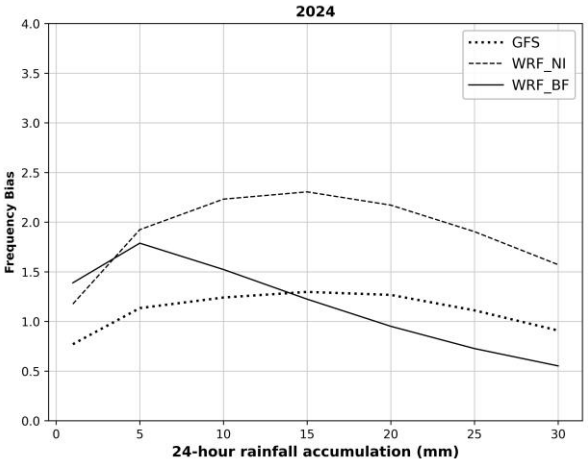
significant underestimation of moderate precipitation events (10–30 mm) and heavy events (> 30 mm)

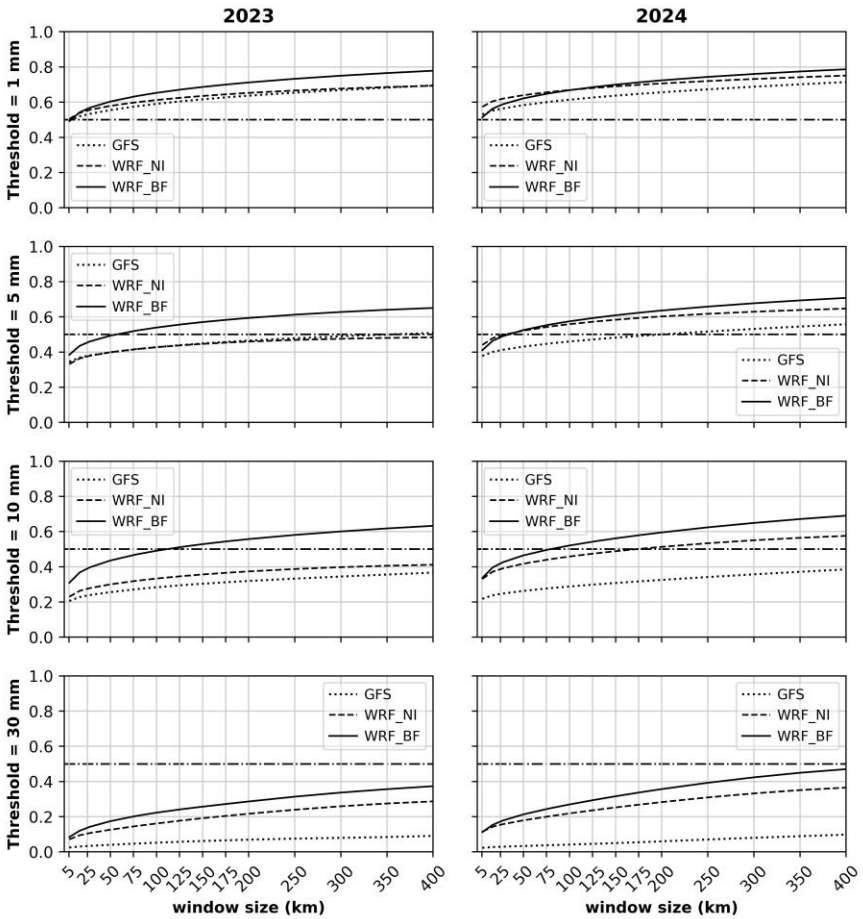



skill decreases rapidly when the precipitation threshold increases.
The WRF models (both Niger and Burkina-Faso versions) are better than GFS for most thresholds, however all model data display common biases: an overestimation of low to moderate precipitation and a marked underestimation of intense events.

# Results: (b) Model vs Gridded obs



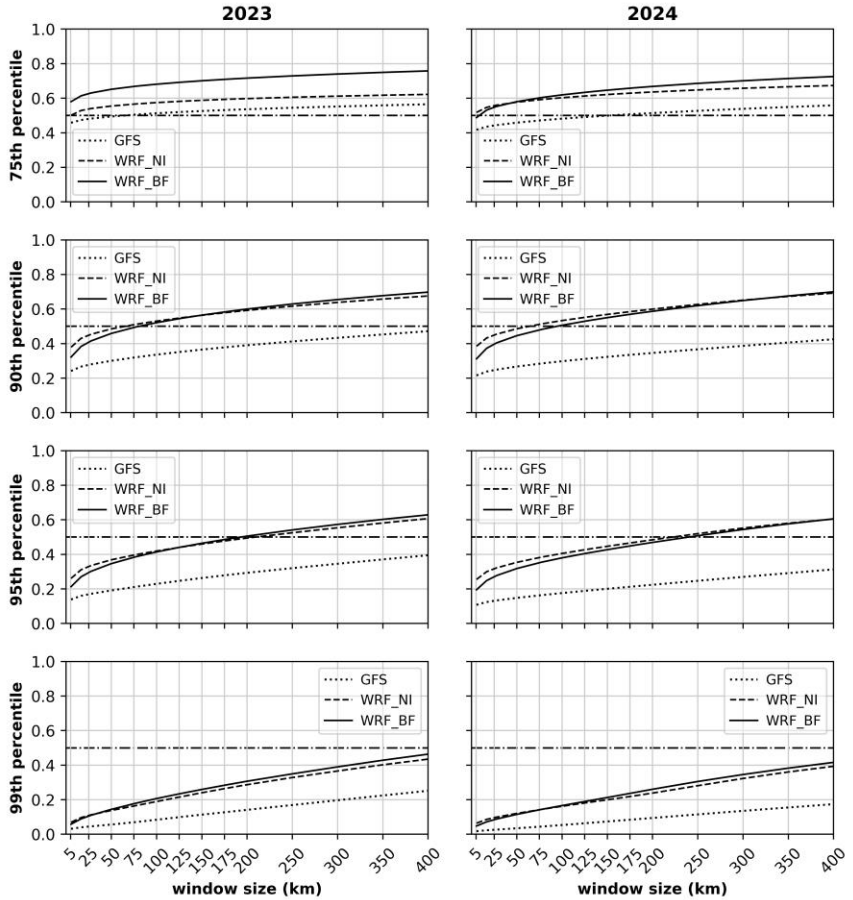



# Results: (c) Model vs Gridded obs

FSS ↗ with window size

FSS ↘ with threshold

WRF_BF ≈ WRF_NI



# Conclusion and Perspectives

## 🧩 Key Findings

- WRF models (**WRF-BF** and **WRF-NI**) **outperform GFS** for most rainfall thresholds
- All models exhibit a **drizzle bias** – overestimation of light rainfall and underestimation of heavy events.
- **WRF-BF** shows the **best agreement** with observations in both temporal and spatial analyses.

## ⚙️ Implications

- Confirms the **added value of regional downscaling** for Sahelian rainfall forecasts.
- Provides scientific evidence supporting the **operational use of WRF** within the **SLAPIS early-warning system**
- Offers guidance for improving **model configuration** and **forecast calibration** in future operations.

## 🚀 Next Steps

- 🔧 Refine physical parameterizations (microphysics, convection).
- 📈 Apply **bias correction** and **machine learning post-processing**.
- 🌍 Strengthen **collaboration between ANAM-BF, DMN Niger, and CNR–LaMMA**.

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# Thank You

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