The new H SAF FengYun MWHS/MWTS Machine Learning algorithm for rainfall and snowfall surface precipitation retrieval

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1 Introduction

Motivation → *Objective*

Satellite-based precipitation estimates are fundamental for monitoring the global water cycle and supporting applications such as hydrological forecasting and hazard assessment. Within the EUMETSAT H SAF (Satellite Application Facility for Operational Hydrology and Water Management) framework, passive microwave observations from low Earth orbit (LEO) satellites are exploited to generate global precipitation products. The combination of a distributed satellite constellation and advanced retrieval techniques enables improved monitoring of rainfall and snowfall at global scale (Sanò et al., 2022) .

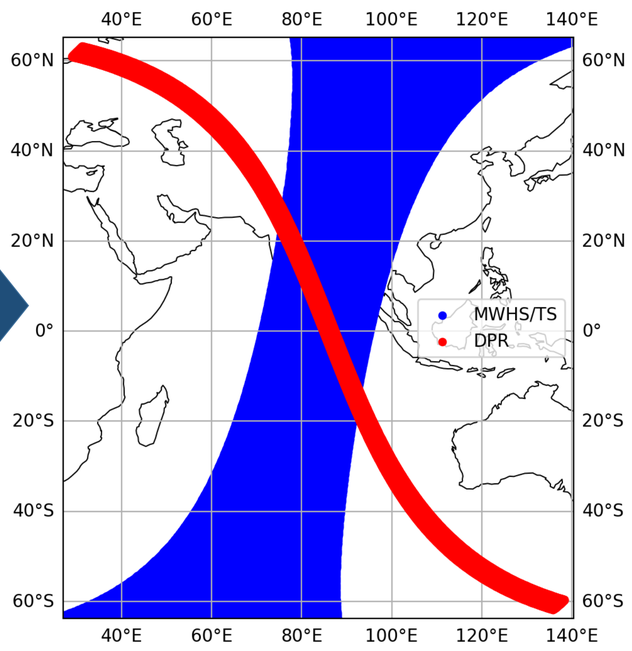
The FengYun-3 (FY-3) satellite series provides new opportunities for precipitation estimation through MWHS and MWTS observations, including underexploited channels around 118 GHz. This work aims to develop a machine learning-based precipitation retrieval algorithms for FY-3 MWHS/MWTS observations within the EUMETSAT H SAF framework, integrating satellite measurements, spaceborne radar-based reference, and ECMWF atmospheric information.

2 Data

Satellite	FY-3F
Microwave observations	MWHS and MWTS brightness temperatures (BT)
Precipitation reference	GPM DPR 2B-CMB V07C Ku-band (NS) product
ECMWF surface variables	T_{2m}, T_{skt} ,TPWV and $T_{H=0°C}$
ECMWF vertical variables	T, R and Q
Dataset size	8.93 M
Dataset size (rain rate ≥ 0.1 [mm h^{-1}])	693 k
Dataset period	2024

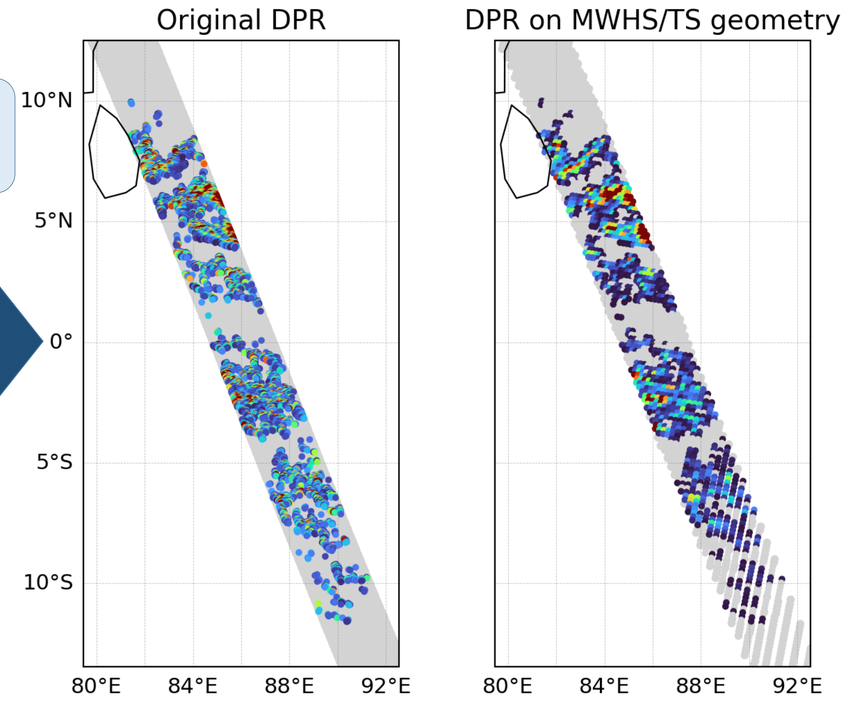
3 Training Dataset Generation

Temporal and spatial matching of MWHS/TS and DPR



Gaussian weighted averaging

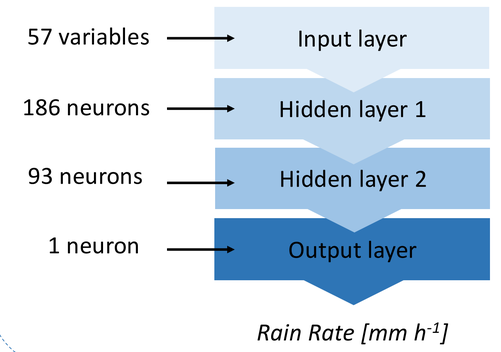
DPR data on MWHS/TS pixel grid



Additional Data:

ECMWF data and ancillary data: DEM, surface type and viewing angle

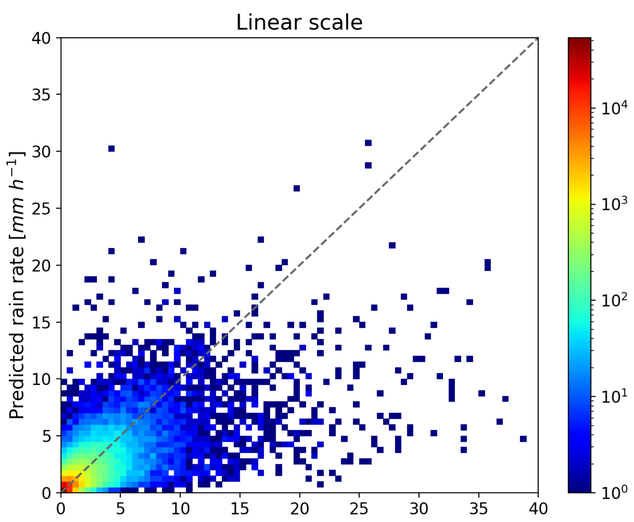
4 Shallow Neural Network (SNN)

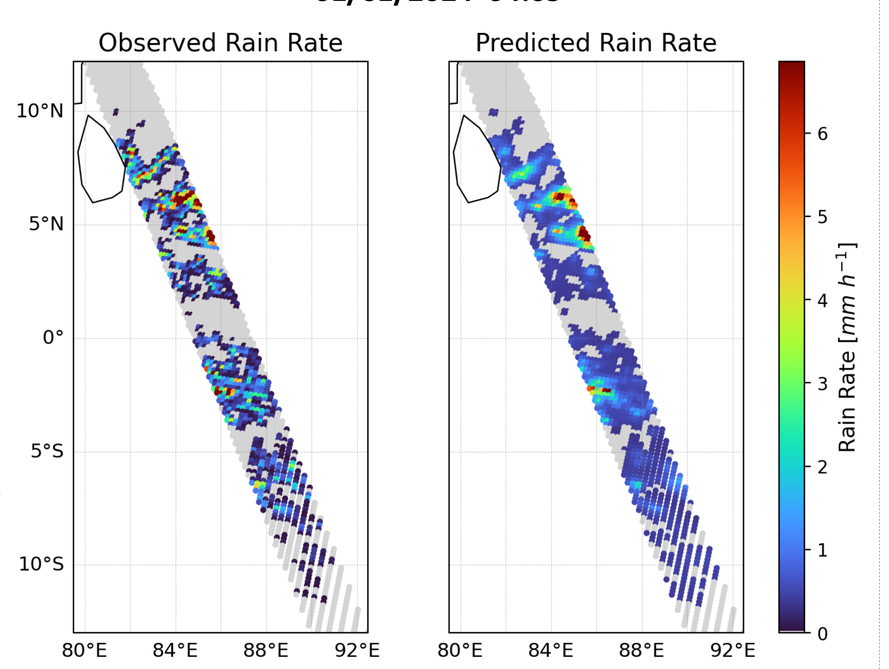


5 Results

The model performance was evaluated using an independent test dataset of 138,464 pixels, not used during the training phase

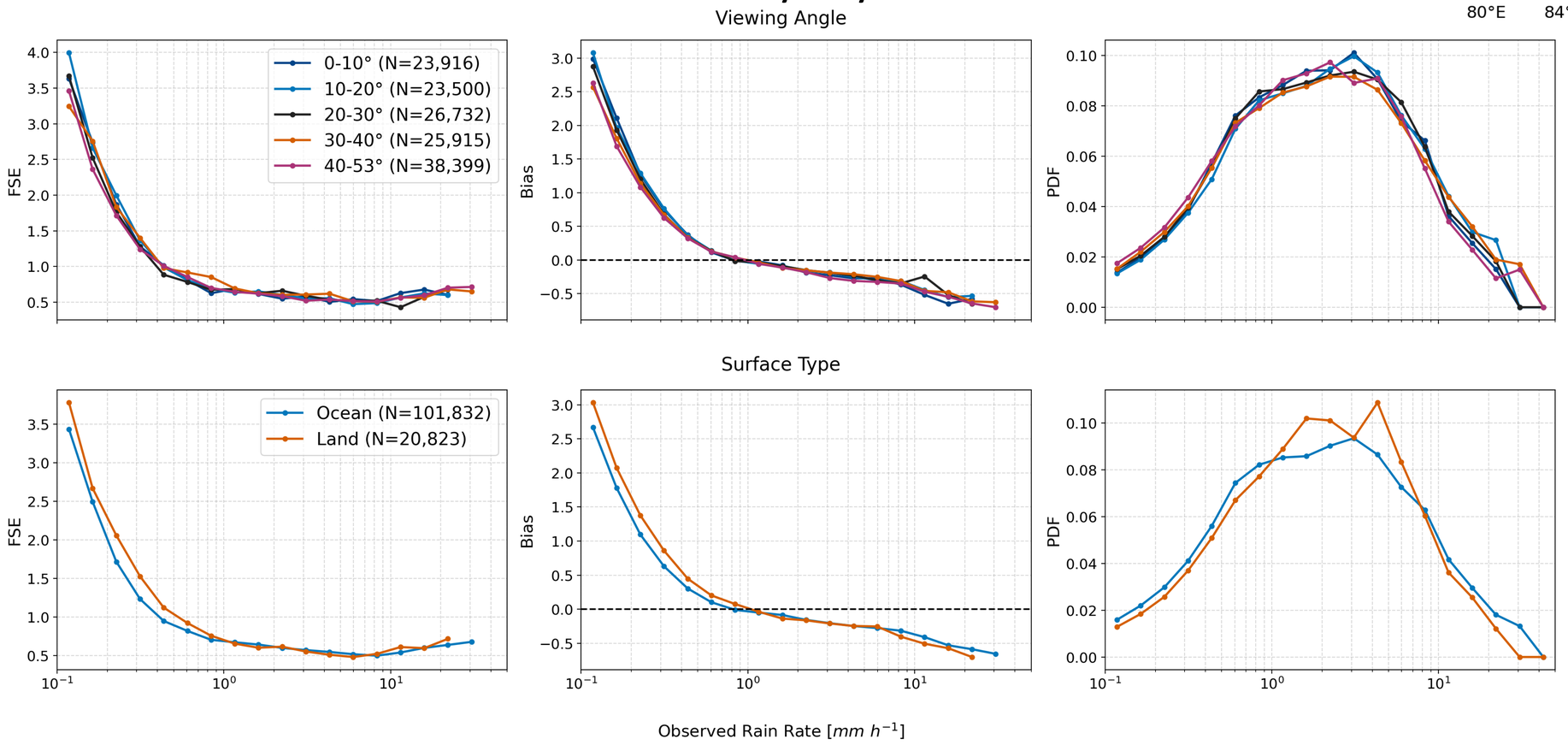
Metric	*Value*
Correlation	0.71
RMSE (mm h^{-1})	1.16
ME (mm h^{-1})	0.01
R^2	0.51





Sensitivity analysis

Viewing Angle



Surface Type

6 Future Perspectives

1. Precipitation phase classification: No precipitation / Rain / Snow / Mixed phase
2. Phase-dependent precipitation retrieval: Dedicated model for snowfall
3. Model improvement: Testing more complex architectures

References:

Sanò, Paolo, et al. "A machine learning snowfall retrieval algorithm for ATMS." Remote Sensing 14.6 (2022): 1467.

Acknwoledgements:

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