

# Deep learning based solar nowcasting system combining satellite observations and NWP data

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## Introduction

- ❖ Rapid growth of photovoltaic capacity in Hungary (>8 GW) requires accurate short-term forecasts
- ❖ Solar power production strongly depends on cloud variability
- ❖ Machine learning (ML) enables near-real time, high-resolution nowcasting

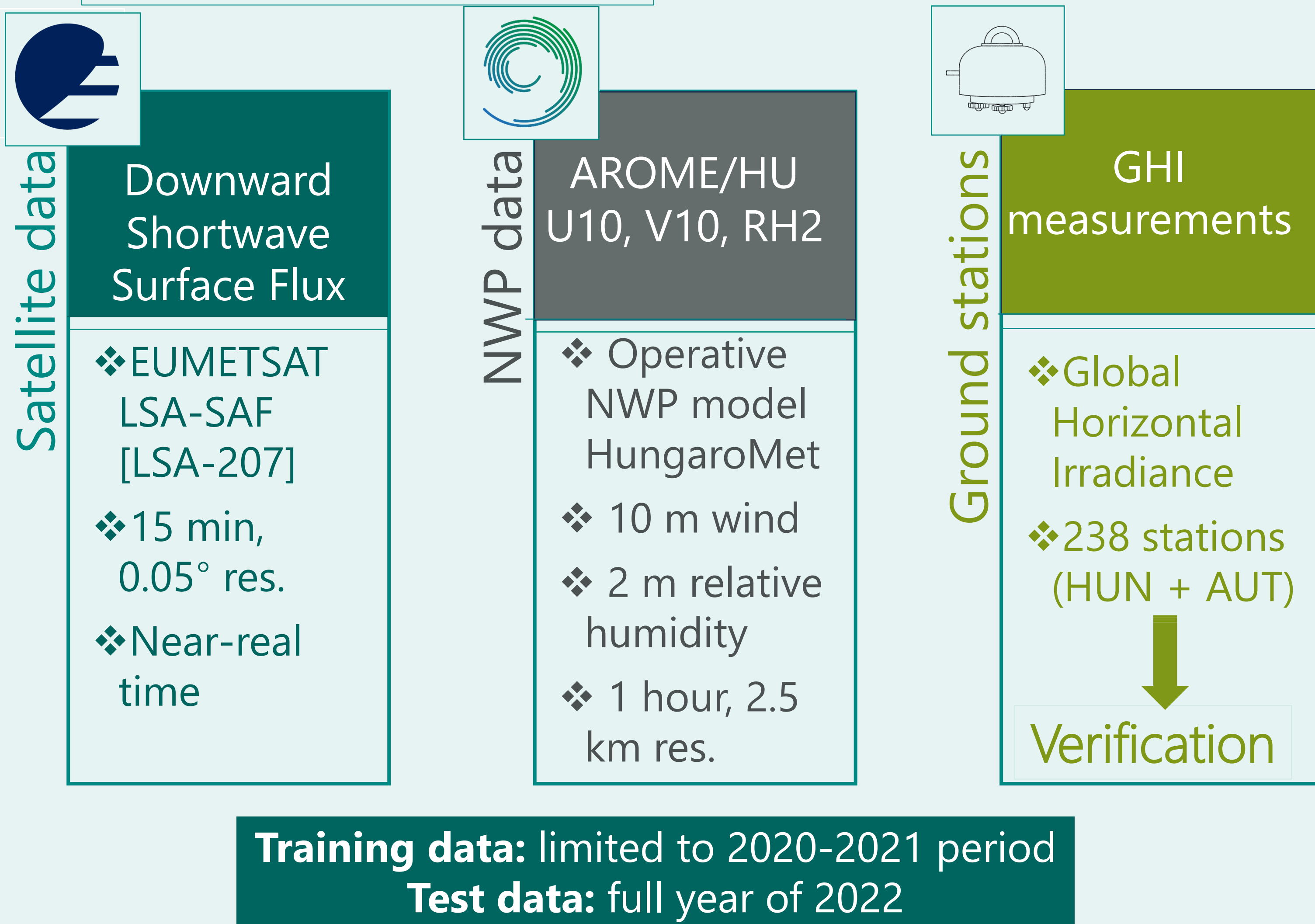
### Objective:

improve ML-based solar nowcasting by integrating NWP data in addition to satellite observations

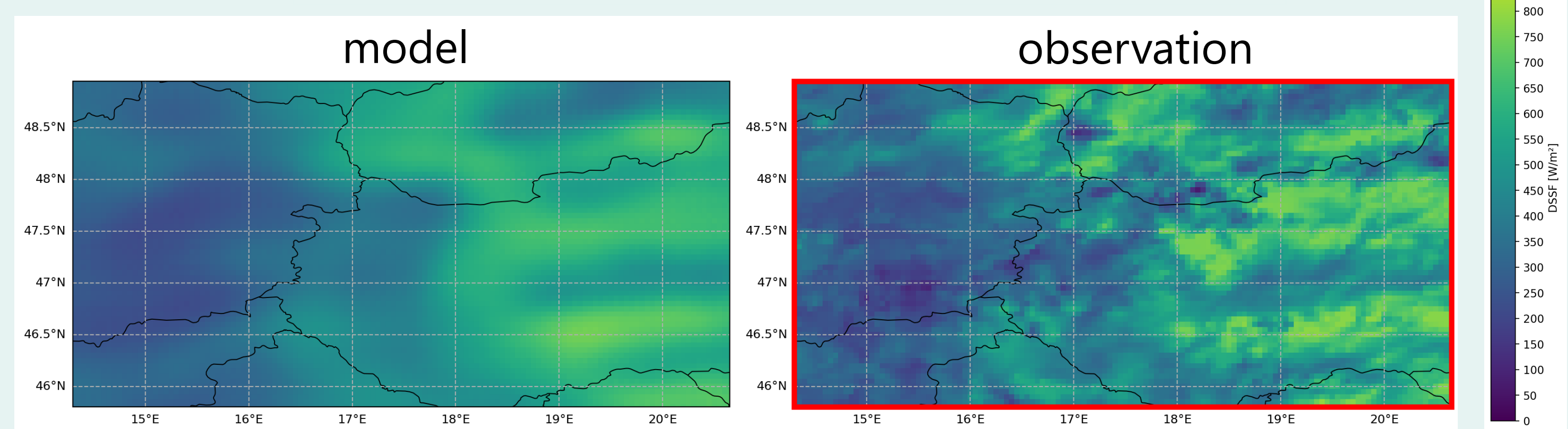
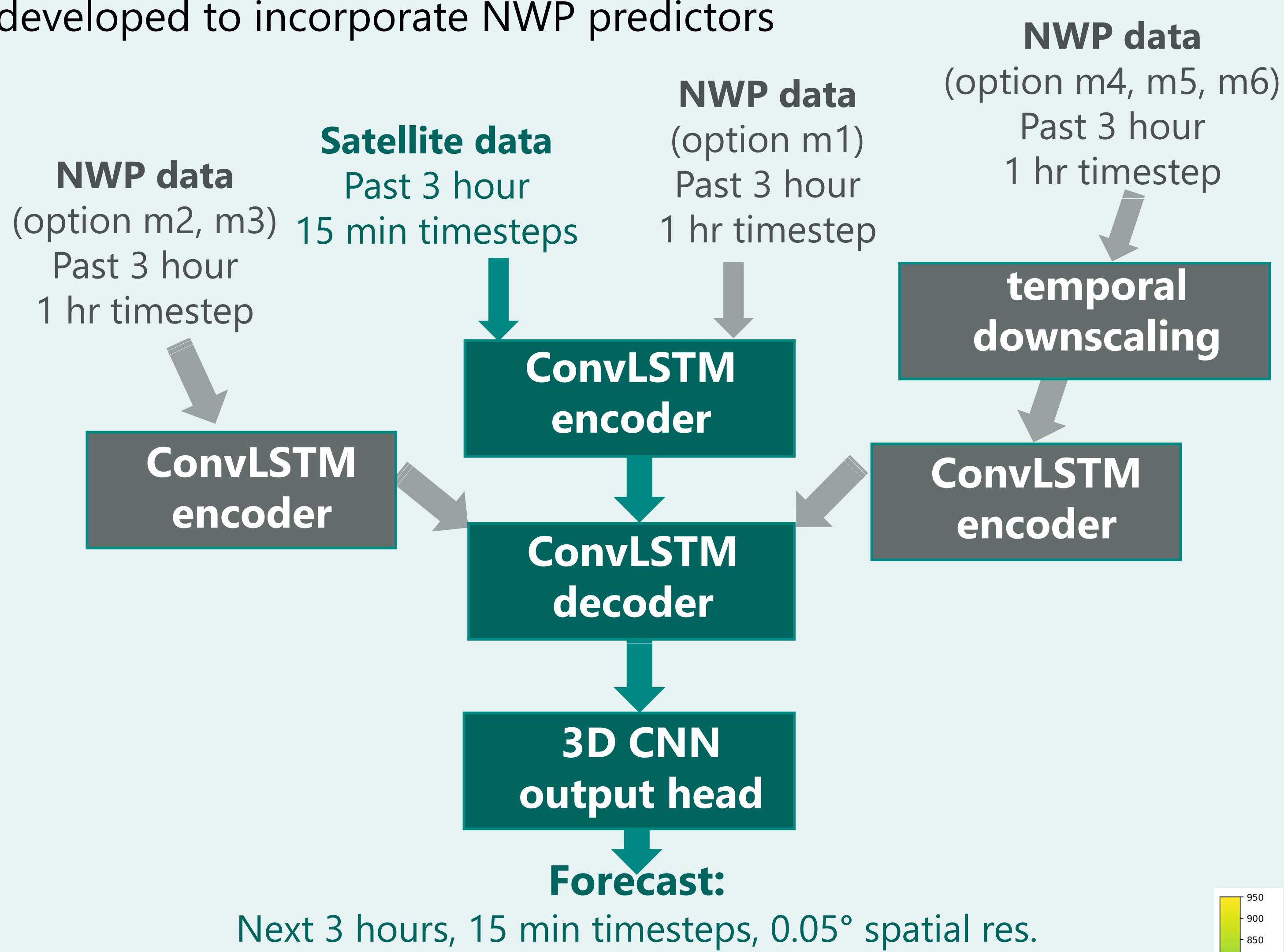
## Take-Home Points

- ❖ Integration of NWP data reduced RMSE of ML-based solar nowcasting compared to baseline model with satellite-only input
- ❖ the model captures both the diurnal and annual variability of solar irradiance
- ❖ The best performance was achieved by the neural network architecture using separate encoders for satellite and NWP inputs, without applying temporal downscaling to the NWP data
- ❖ extremely high irradiance values are not represented in the forecasts

## Data and Methods



**Neural network model:** Building upon the **baseline model** with satellite-only input, six **additional model variants** (m1-m6) were developed to incorporate NWP predictors



## Results

Verification was performed using the Harp software package

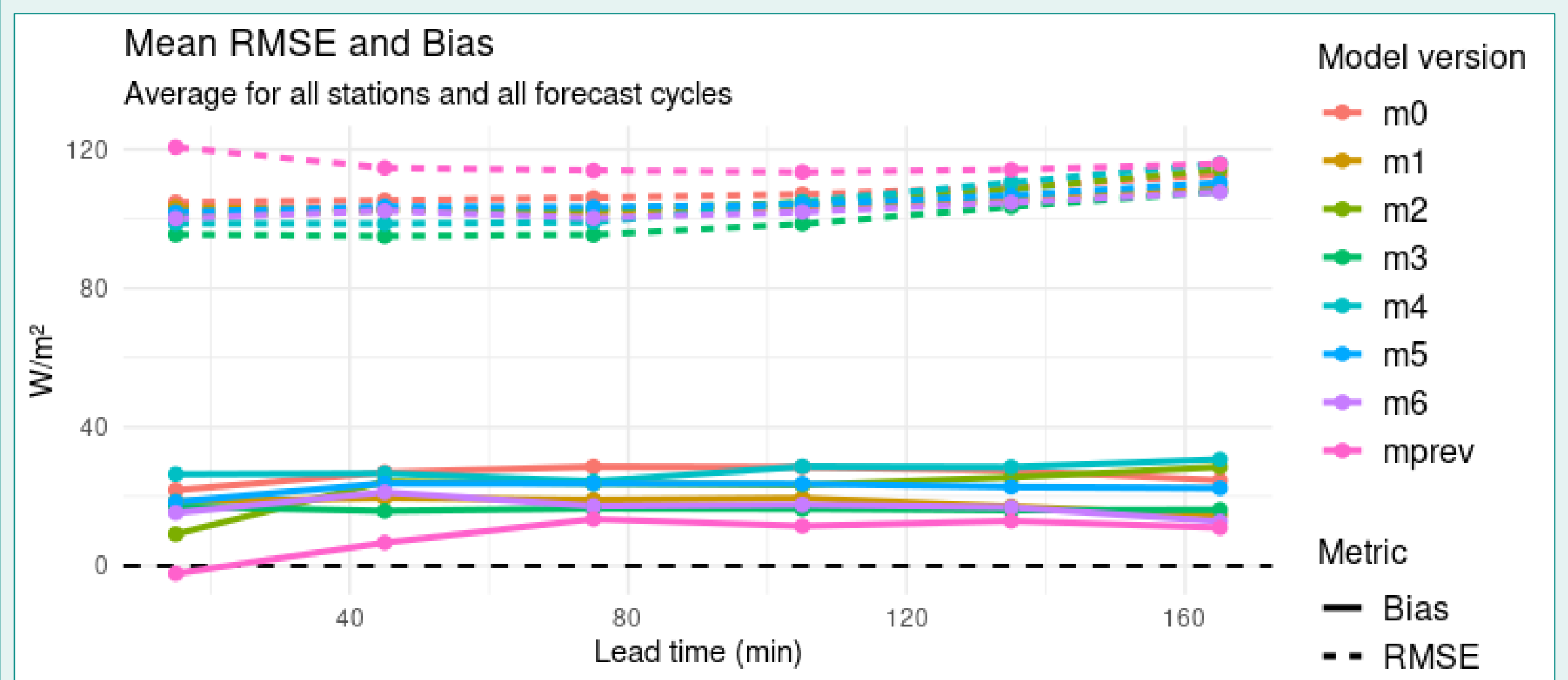


Fig.1: Mean RMSE & bias along lead time

- ❖ All model variants outperform baseline (mprev)
- ❖ NWP integration improves mainly at short lead times
- ❖ Bias is generally positive

- ❖ Overestimation in the morning and near daily maximum
- ❖ Underestimation in the afternoon

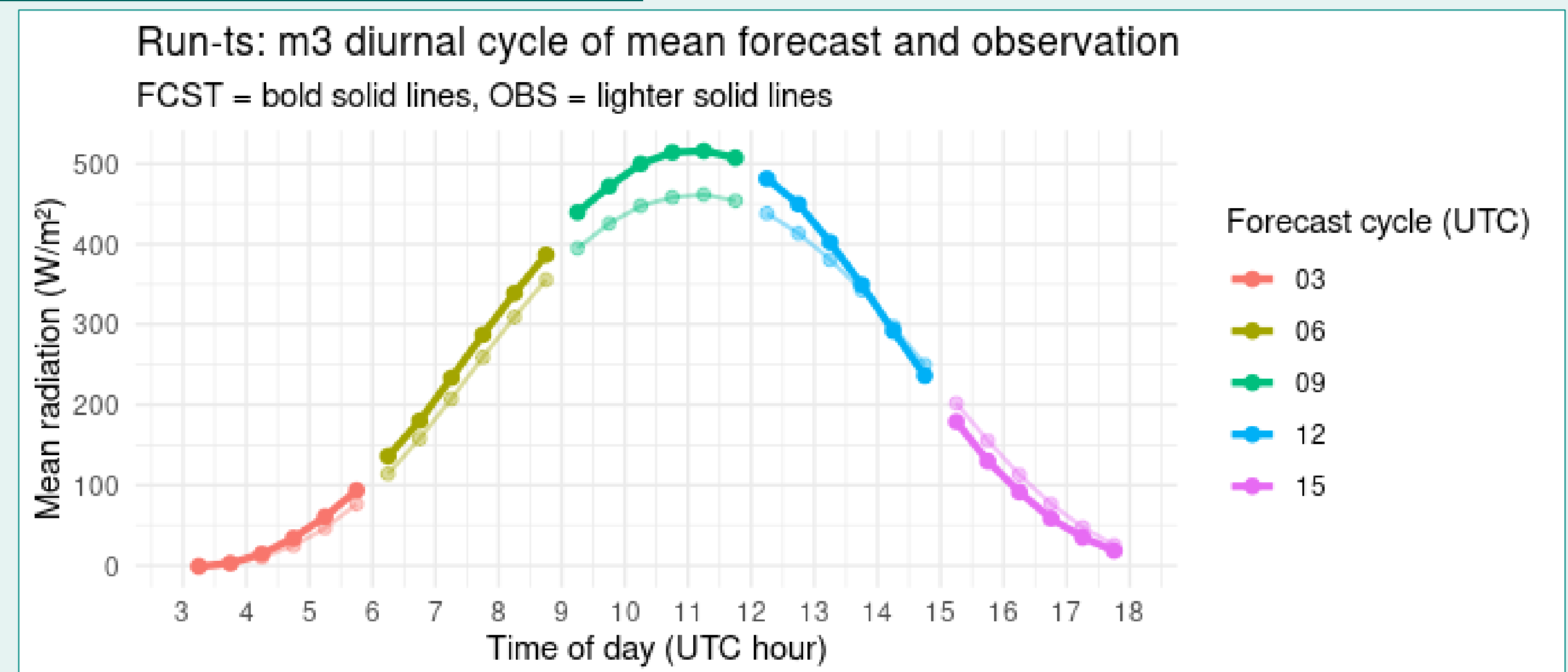


Fig.2: Mean diurnal cycle of forecast (m3) and mean observation

- ❖ Extreme values (<100 or 800 < Wm<sup>-2</sup>) are less accurately predicted
- ❖ Forecast do not exceed ~950 Wm<sup>-2</sup>
- ❖ Strong seasonal variability of RMSE, reflecting the annual cycle of solar irradiance
- ❖ Daily RMSE values between 16-145 Wm<sup>-2</sup>

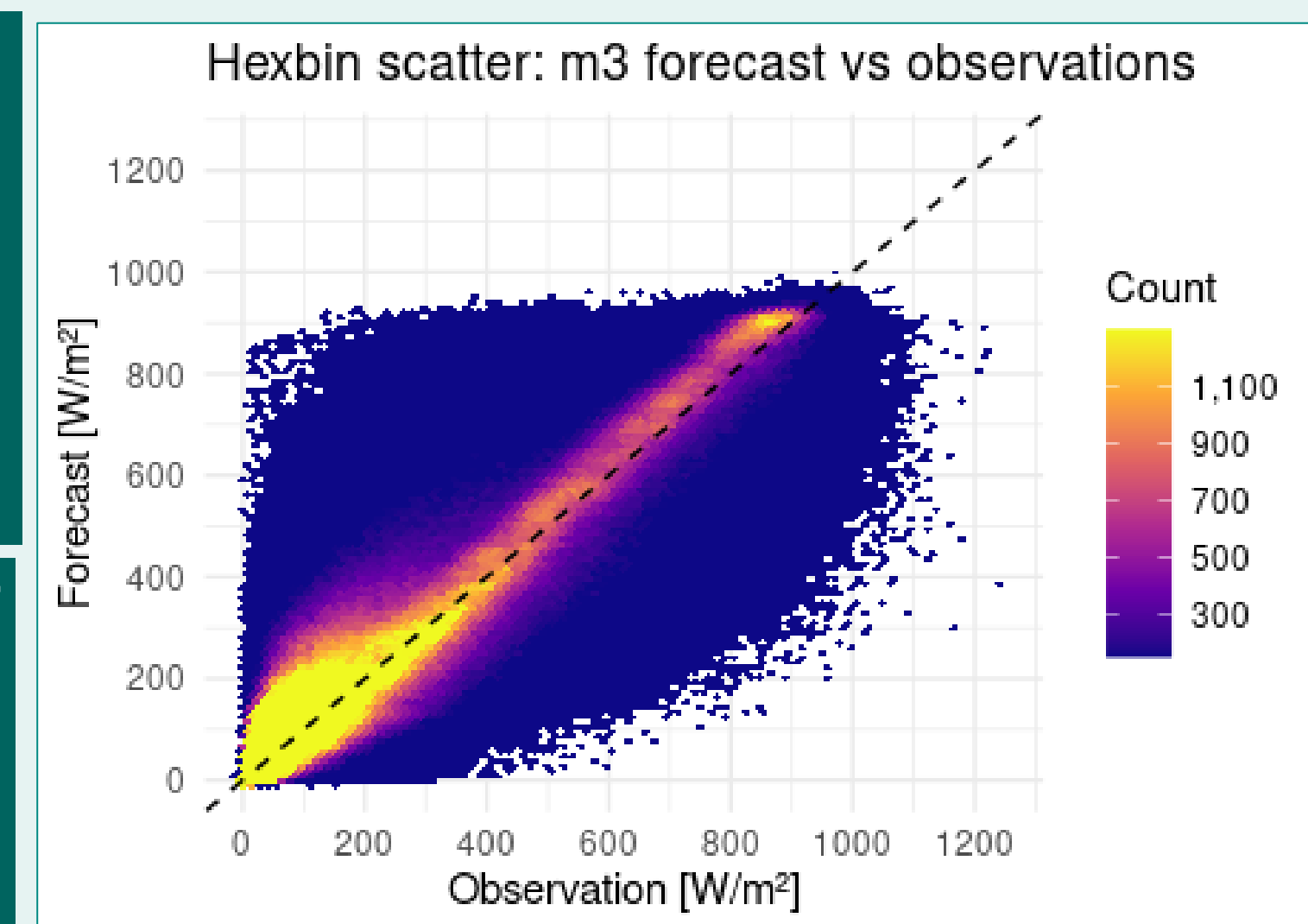


Fig.3: Scatter plot

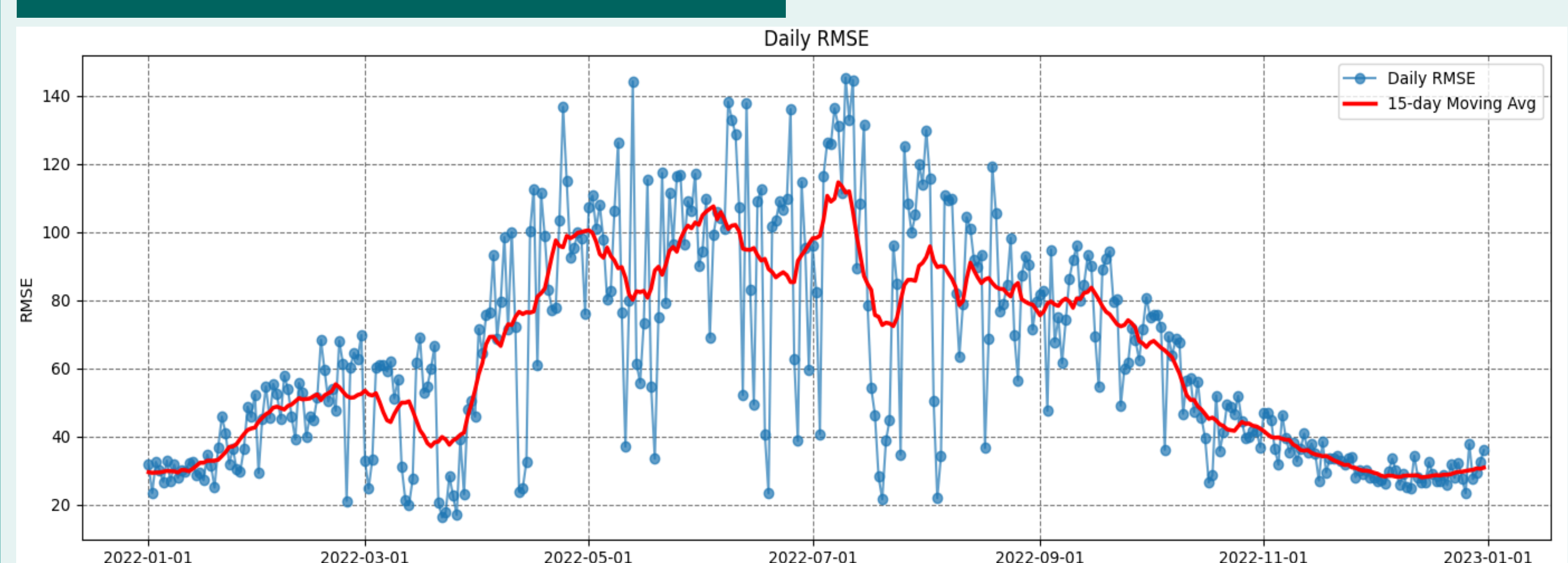


Fig.4: Daily mean RMSE of forecast (m3) relative to satellite data

## References

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