

HAIMOS Ensemble Forecasts for Intra-day and Day-Ahead GHI, DNI and Ramps

University of California San Diego

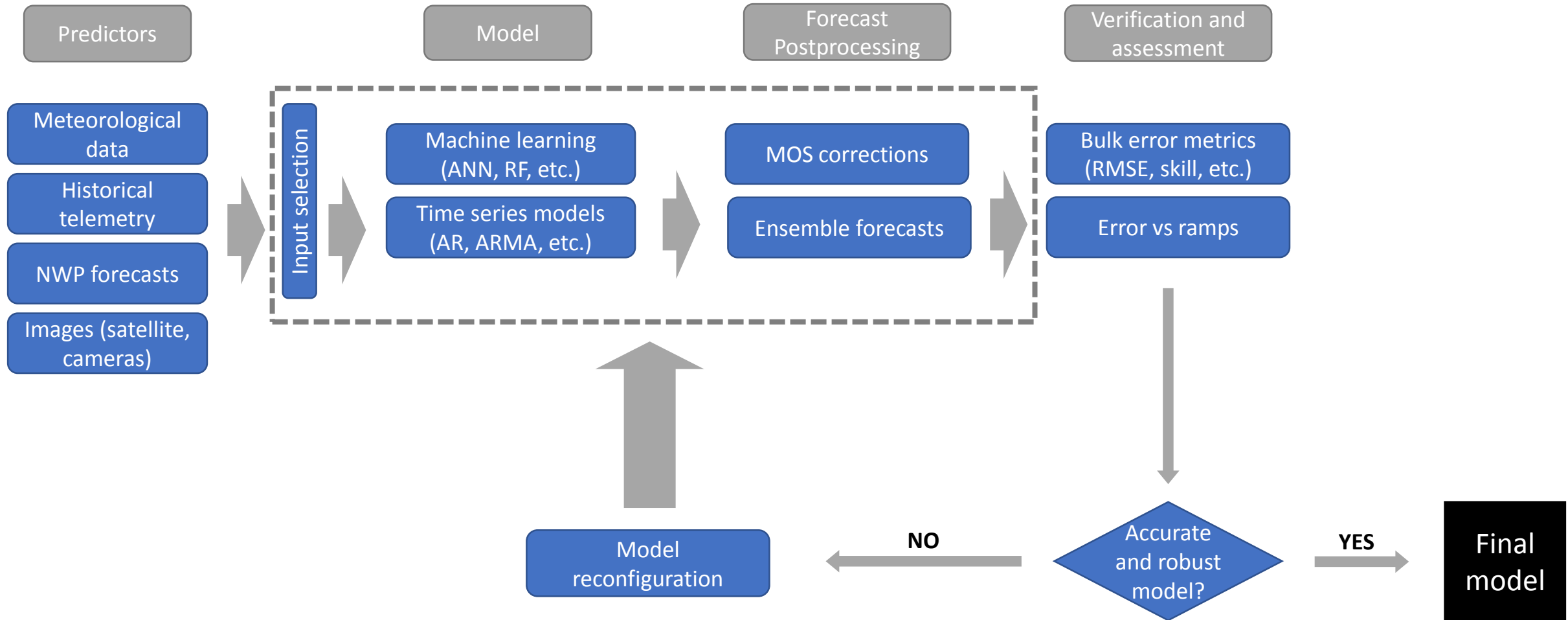
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Project Team: UCSD and Clean Power Research (CPR)

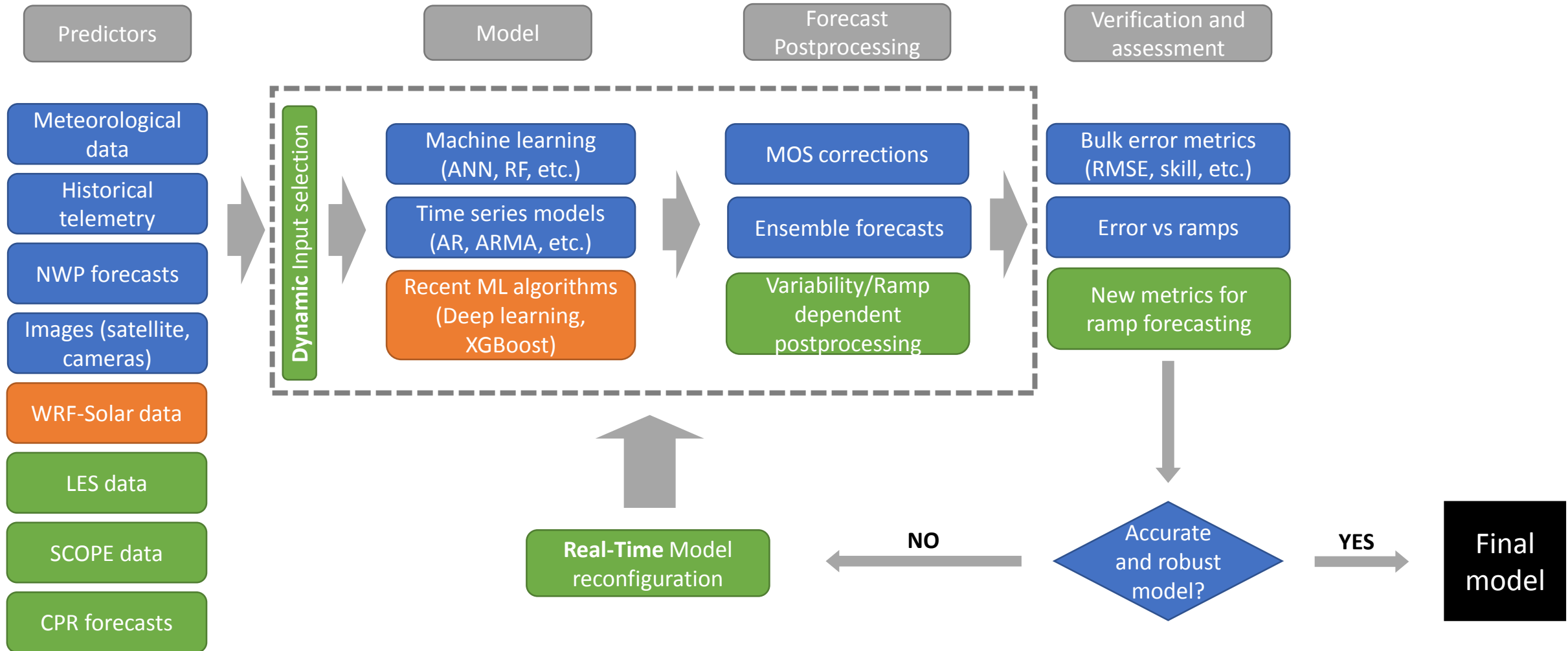
Technical Approach

- Typical approach to irradiance forecasts



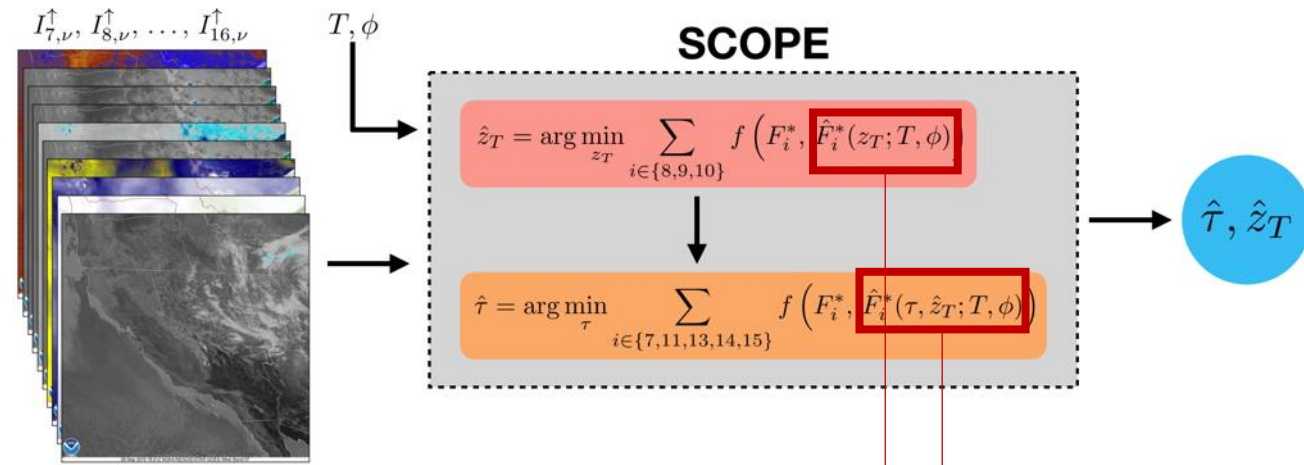
Technical Approach

- HAIMOS approach

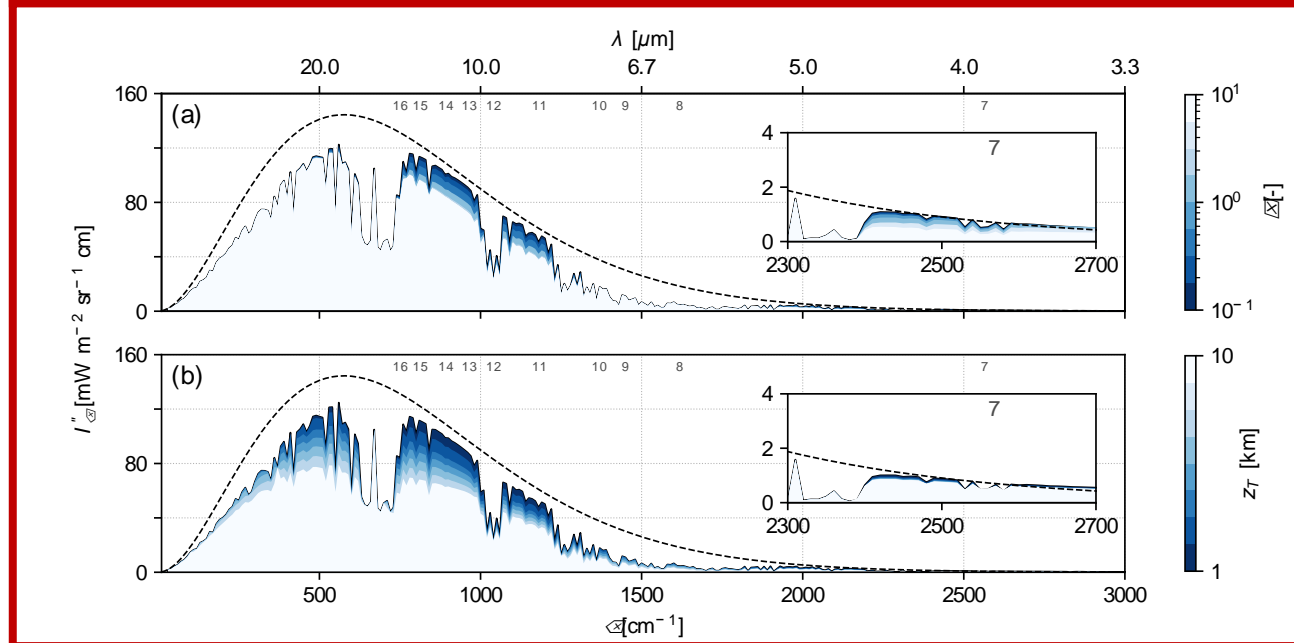


Technical Approach: SCOPE

- Spectral Cloud Optical Property Estimation (SCOPE)
 - couple radiative modeling with high-resolution spectral satellite imagery
 - real-time, accurate estimation of cloud optical properties
- Approach: compare outgoing longwave radiation (OLR) at the top of the atmosphere (TOA) from remote sensing and radiative modeling.
- Radiative model (Li et al. (2018)*)
 - spectrally-resolved and computationally efficient radiative model



RTM model variation with cloud optical depth (Top) and cloud top height (Bottom)

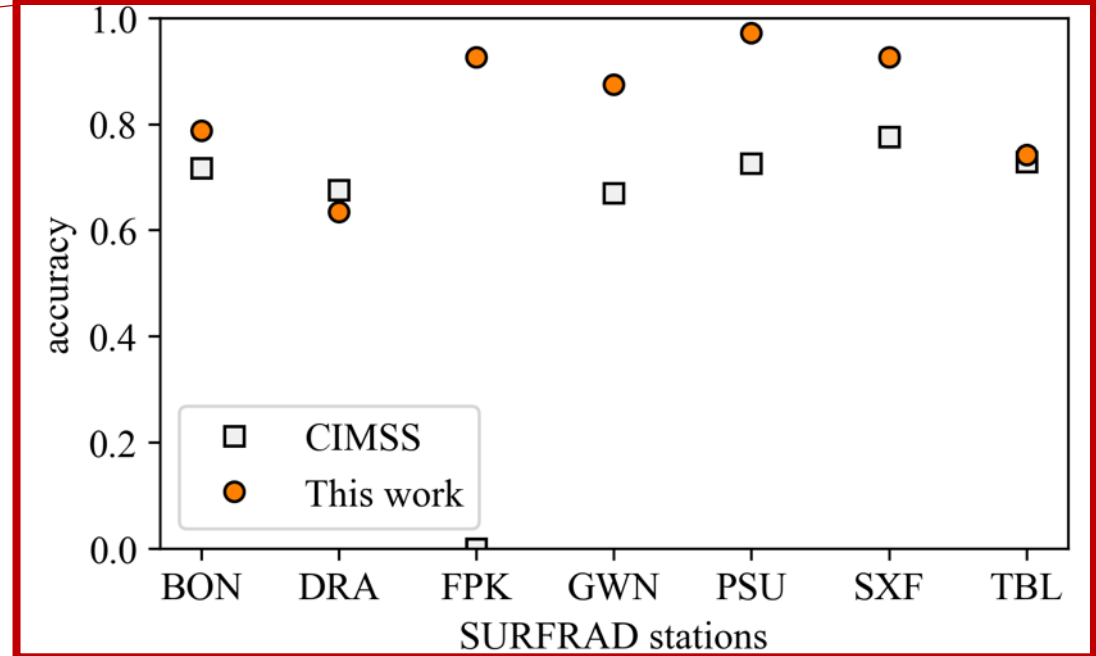


*Li, Liao and Coimbra (2018) "Spectral model for clear sky atmospheric longwave radiation"

Preliminary Results: SCOPE

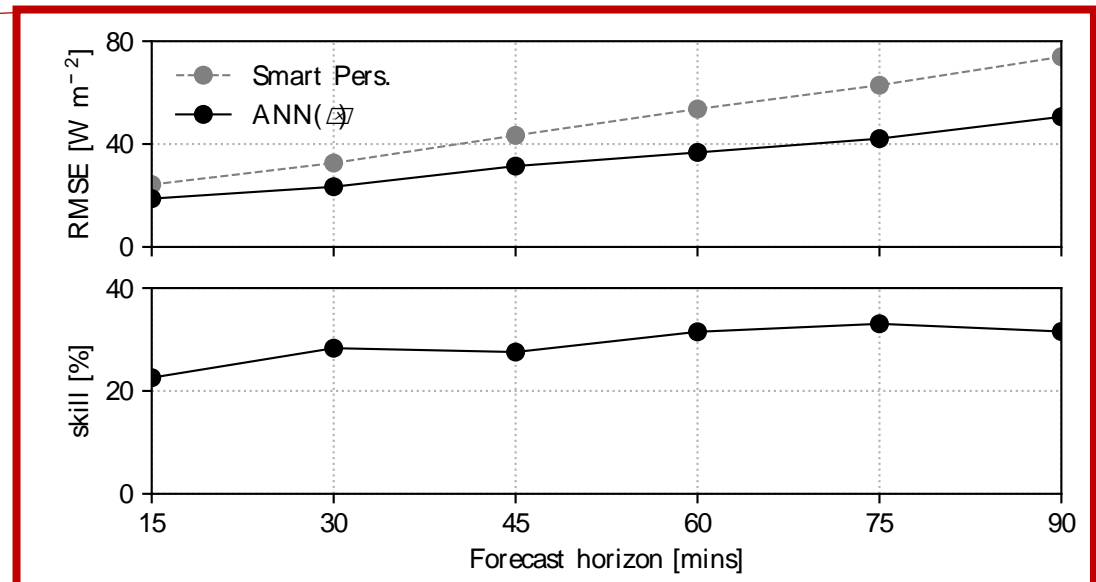
SCOPE's validation

1. Data: 1 complete year (2018) at 5-minute resolution for seven stations (SURFRAD).
Validate against DLW measured at each site.
2. Clear-sky identification for SURFRAD sites.
Compared against CIMSS data



SCOPE's data in forecasting

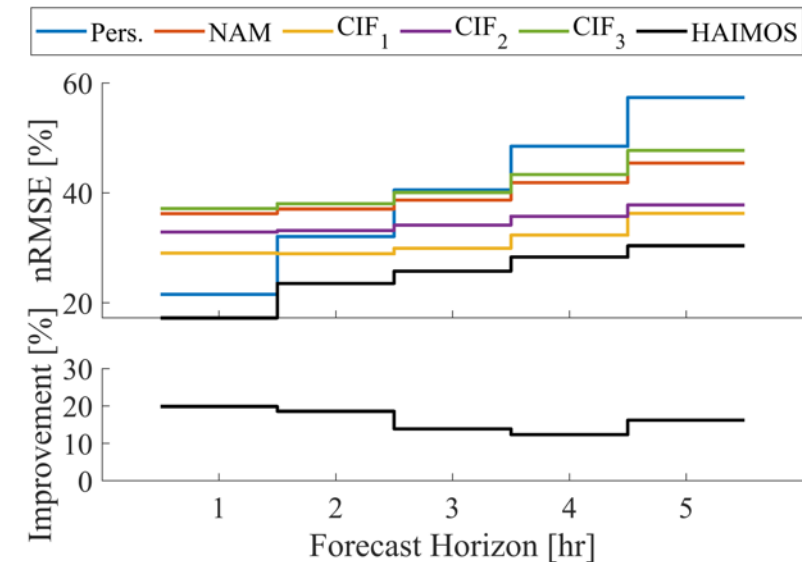
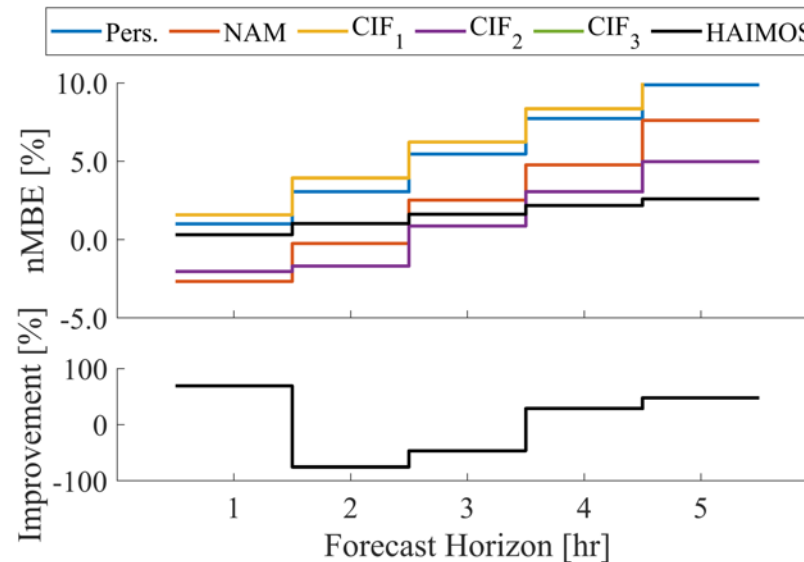
- GHI forecasting with estimated cloud optical properties from SCOPE
- GHI forecast performance for BON (testing set) for the early-morning hours
- Forecasts produced before sunrise.



Preliminary Results: HAIMOS optimization

- Motivation: Improving the forecast skill during large variability periods
- Input selection depending on the current (measured data) and future (NAM forecasts) irradiance variability.
- Optimization algorithm
 - Test inputs in terms of bias-variance metrics
 - Selects input that ranks highest
 - Iterates over unselected inputs until no improvements are observed.

Data	Description
Measured data	Irradiance data measured
Modeled irradiance	Satellite-derived irradiance data (CPR) for the target locations and neighboring nodes (49 in total)
CPR_i	Forecasted irradiance from CPR. Several forecasts are available, denoted by the subscript i .
NAM	GHI from the NAM model NAM
NAMcc	Total Cloud cover from NWP model NAM

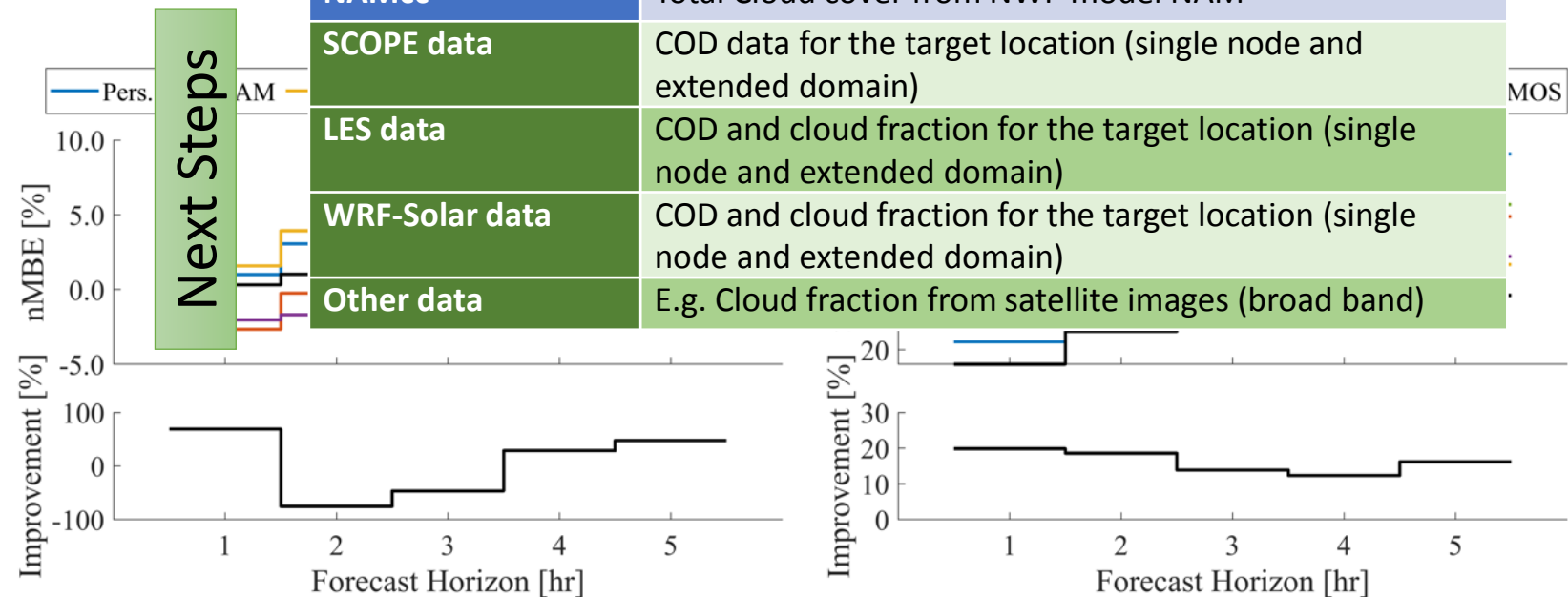


Normalized MBE (left), and RMSE (right) for the validation testing set for BON as a function of the forecasting horizon. HAIMOS forecast is in black and competing forecasts are in color.

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SCOPE data	COD data for the target location (single node and extended domain)
LES data	COD and cloud fraction for the target location (single node and extended domain)
WRF-Solar data	COD and cloud fraction for the target location (single node and extended domain)
Other data	E.g. Cloud fraction from satellite images (broad band)



Normalized MBE (left), and RMSE (right) for the validation testing set for BON as a function of the forecasting horizon. HAIMOS forecast is in black and competing forecasts are in color.