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Use of Several Sources of Spatio-temporal Information to Improve Short-term Photovoltaic Power Forecasting

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Context

- **High penetration** rate of renewables characterized by a high variability:
 - **Jeopardize** the safe operating of the **grid system**
 - **Financial penalties** over production mismatches in a market-oriented context
- A **growing diversity of sources** that:
 - Represent **various phenomena** at different time & spatial scales
 - Can be **combined** to better seize weather dynamics [1]



Objectives

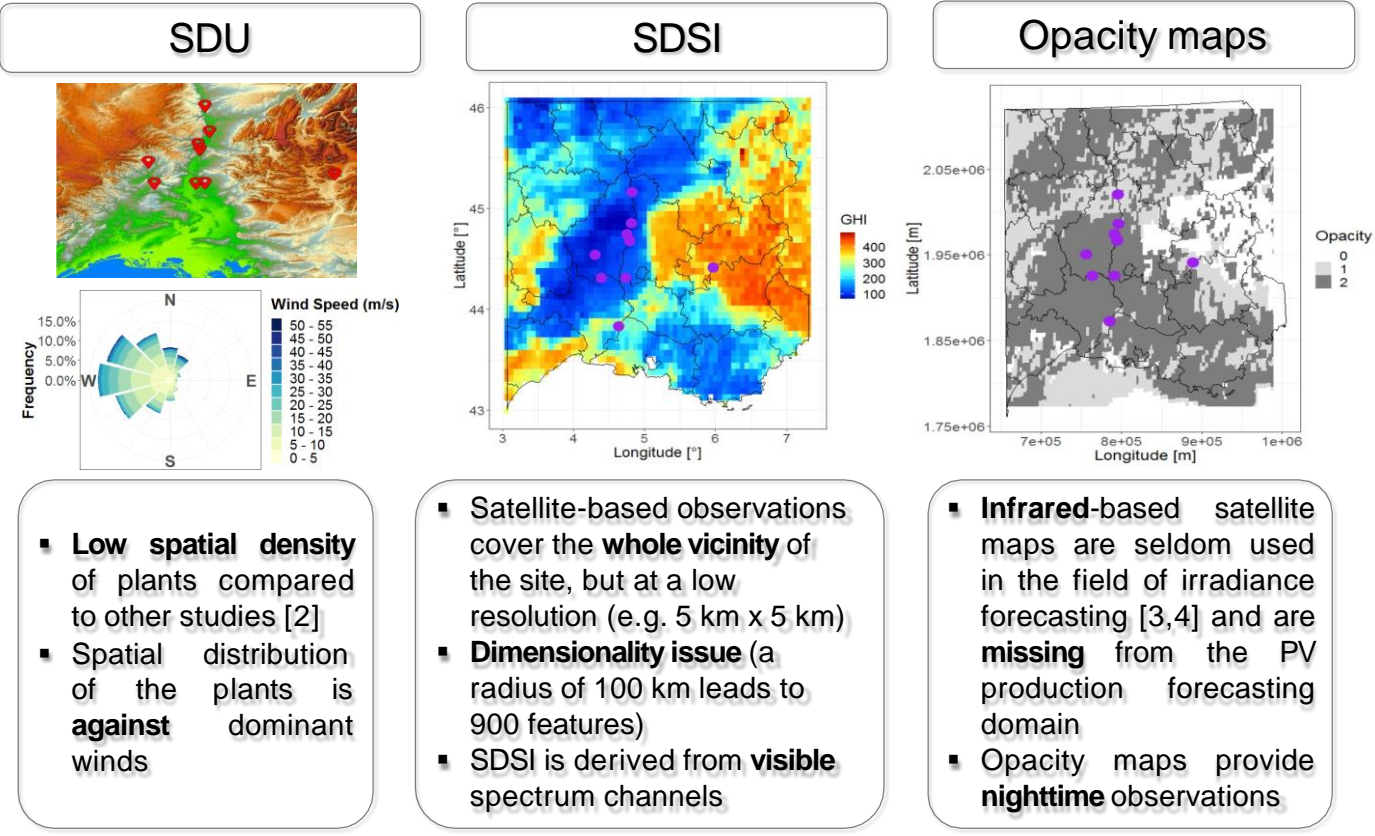
- Develop an **efficient** and **reliable** PV production forecasting model for short-term horizons (15' - 6h):
 - Combine several **spatio-temporal sources** of data
 - 9 **spatially distributed PV units (SDU)**
 - **Satellite-derived surface irradiance (SDSI)**
 - **Infrared-based satellite observations (Opacity maps)**
 - Select **relevant** information w.r.t. the forecasting horizon
 - **Reduction of the computational burden**



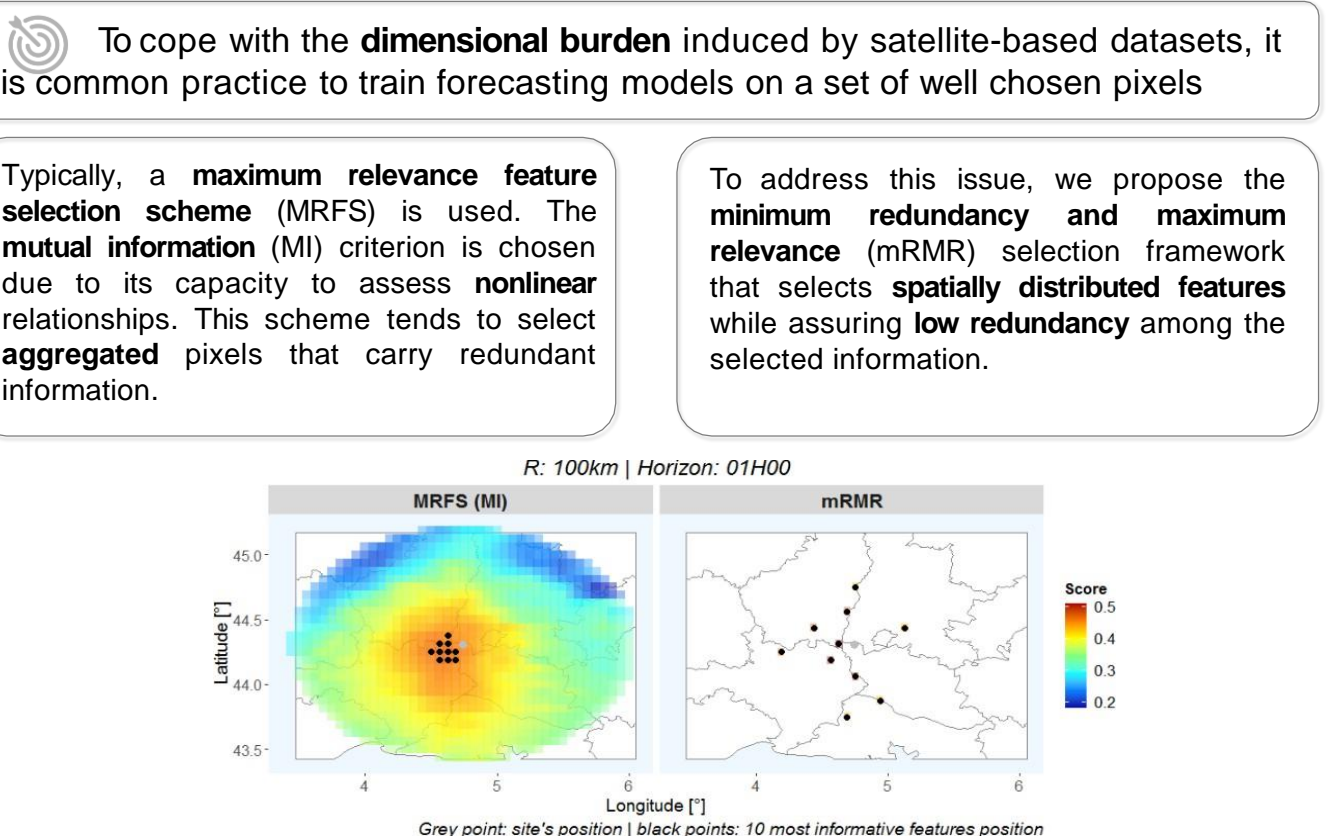
Methodology



Multi-inputs approach



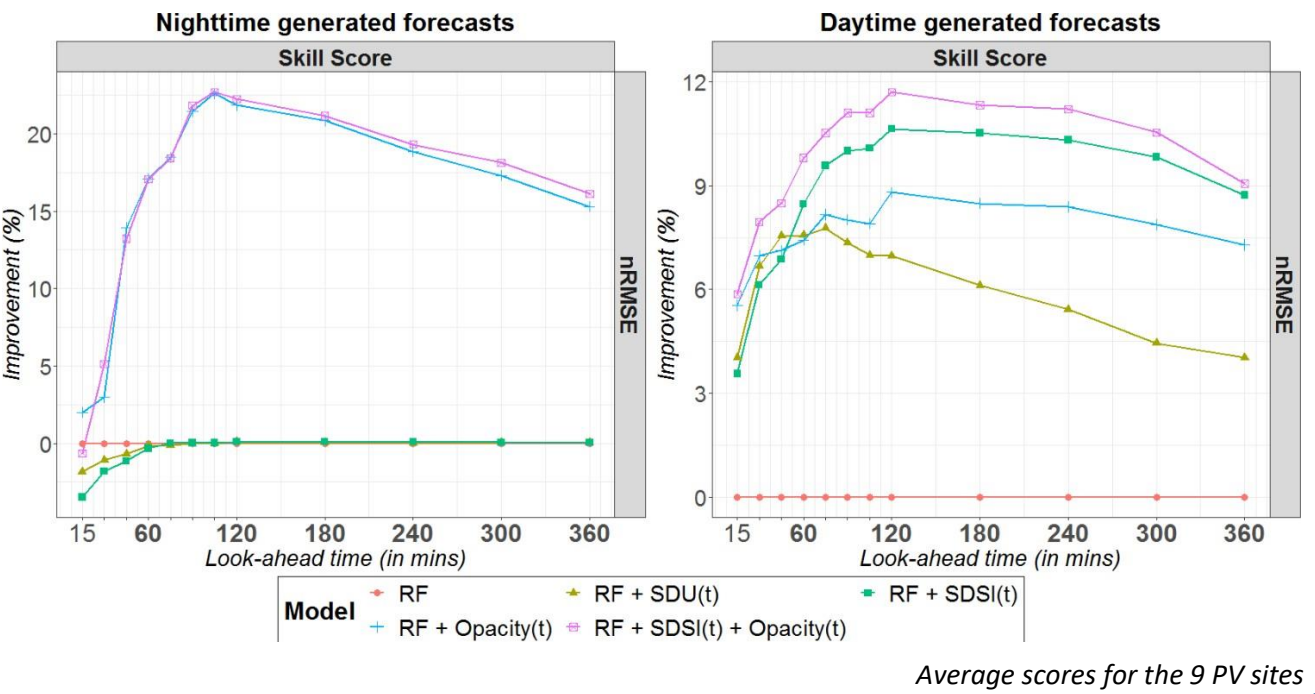
Feature selection



Results



- A **Random Forest (RF)** model is considered for its good performances
- Inputs are **clear-sky normalised** (this approach mitigates the deterministic component of the signal associated with sun's path and highlights the stochastic component due to cloud motion)
- Training set: 2015 / Tering set: 2016
- $nRMSE^x(h) = \frac{1}{N} \sum_{t=1}^N \left(\frac{|\hat{P}_{t+h}^x - P_{t+h}^x|}{P_{t+h}^x} \right)^2$ & $SS_{nRMSE^x}(h) = \frac{nRMSE_{Ref}^x(h) - nRMSE_{Mod}^x(h)}{nRMSE_{Ref}^x(h)}$



Conclusions & Perspectives



Conclusions

- The **mRMR** feature selection scheme enables the selection of **sparse features**, which **reduces the redundancy** among the retained information
- The integration of observations from **SDU** exhibits **accuracy improvements** up to 7,5% compared to a purely temporal approach
- For **this specific case study**, information contained in **satellite-derived datasets** is **richer** despite a coarser spatial resolution: we observe improvements of the nRMSE score up to 11% w.r.t. the temporal-based approach. This finding is supposed to result from the **poor spatial distribution** of the power plant network.
- **Opacity data** offer a clear **advantage** over SDSI observations for **nighttime-generated forecasts**
- The **ST nature** of **opacity maps** leads to **more accurate daytime** generated forecasts for the first leading times, but their **informative potential is slightly lower** than that of **SDSI** maps for horizons greater than 1 hour ahead
- **Opacity maps** appear as a variable able to **compete** with **SDSI**, but they cannot replace them. Quite the contrary, these sources of information are complementary and, when used **together**, they improve forecasting accuracy

Perspectives

- Extend the present investigations by assessing the influence of these sources of information over **probabilistic** forecasting
- Include observations from **all-sky imagers** to improve the accuracy for very short lead times
- The proposed contributions developed in this poster are detailed in a forthcoming **journal paper**

Bibliography



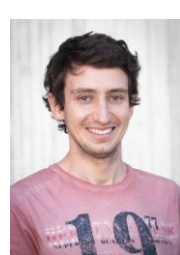
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About the author



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