

Daeyoung Kim¹, Jordi Badosa², Fausto Calderon², Maxime Grangereau³, and Emmanuel Gobet³
¹Ecole Polytechnique, ²LMD, ³CMAP, contact : daeyoung.kim@polytechnique.edu

INTRODUCTION AND OBJECTIVES

- Global Horizontal Irradiance (GHI) is the amount of solar radiation that reaches the surface of the Earth.
- The forecast of solar irradiance has an importance in predicting the amount of energy potentially generated in solar photovoltaic (PV) installations.
- The purposes of this research are to:
 - compare different forecast model performances,
 - understand the seasonal difference with regards to the forecast accuracy, and
 - acquire prerequisite knowledges to improve forecast models by observing the uncertainty quantities based on different types of days.

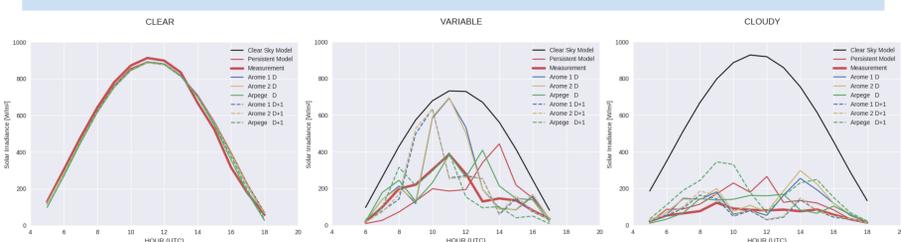
METHODOLOGY

- The ground-based GHI measurement is from SIRTA. (48.713°N and 2.208°E)
- Arome and Arpege of Météo France are the forecasts.
 - Arome 1 and Arome 2 stand for two different grid points next to each other.
 - Models named with 'D+1' are calculated at 12 UTC on the previous day, while the 'D's are computed at 0 UTC of the target forecast day.
- One-hour resolution data are acquired over the period of one year, from December 1st, 2015 to November 30th, 2016.
- Persistence model with one-day lagged values is used to fairly compare different methods of day-ahead forecasts. Regarding comparison, root mean square error (RMSE) and mean bias error (MBE) are considered in relative manner as following:

$$RMSE = \sqrt{\frac{1}{N} \sum_{t=1}^N (\hat{I}(t) - I(t))^2} \quad MBE = \frac{1}{N} \sum_{t=1}^N (\hat{I}(t) - I(t)) \quad \begin{matrix} \hat{I} = GHI \text{ Measurement} \\ I = GHI \text{ Forecast} \end{matrix}$$

$$Relative \ RMSE = \frac{RMSE_{Forecast}}{RMSE_{Persistence}} \quad Relative \ MBE = \frac{MBE_{Forecast}}{\frac{1}{N} \sum_{t=1}^N I(t)}$$

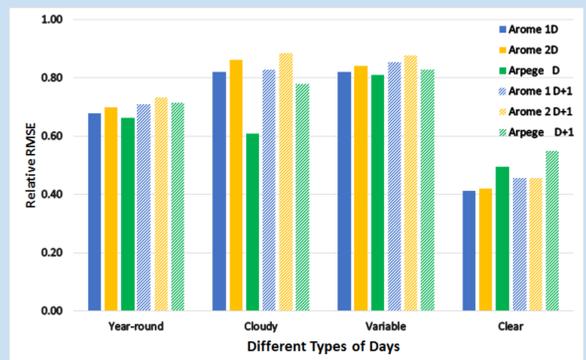
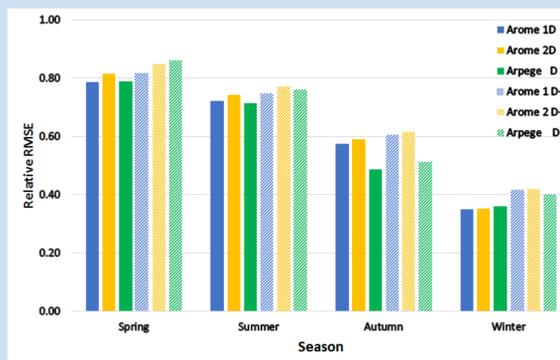
- For different types of days, days with clear sky index ($= \sum I / \sum I_{clr}$) of more than 0.7 are defined as clear days, more than 0.4 are variable and the others are cloudy. Examples of each type of the days are as following :



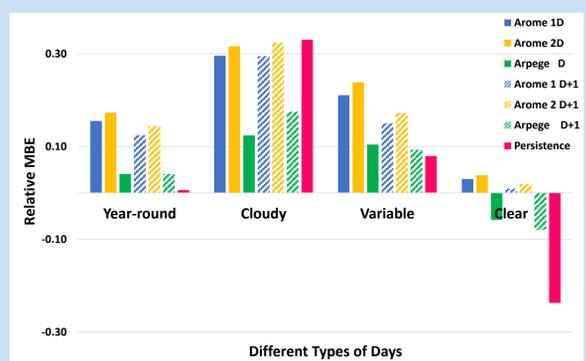
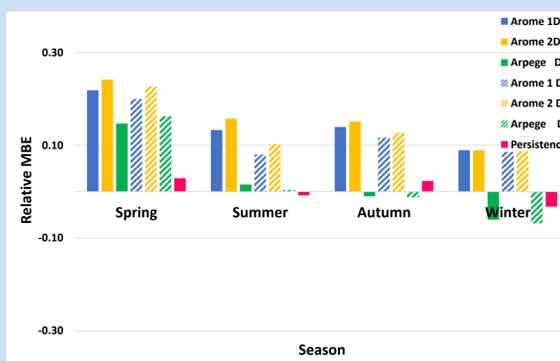
ACKNOWLEDGEMENT

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RESULTS



- Relative RMSE graphs (above) show that the forecasts of 'D's have tendency to have less error than that of 'D+1's, meaning that the day-ahead forecasts perform better with the up-to-date data. 'D+1's and 'D's differ by 12 hours.
- Seasonal graphs show that the relative errors are the highest in the spring. Considering the solar irradiance is the highest in the summer, it is inferable that the primary reason of errors is not the position of the sun.
- Arpege model shows better performance than Arome in general, except in the Winter and Clear days. The two day-ahead forecast models show that the ensemble model of them might result in the improvement of forecasts.



CONCLUSION

- Matching with the objectives of the research,
 - In day-ahead forecasts, up-to-date data are one of the core competencies in predicting with higher accuracy.
 - Arpege performs better than Arome not always, but in general. Especially in the winter and the clear days, Arome showed better performance.
 - The forecast uncertainty does not primarily rely on the position of the sun. It would rely on what is in between the Sun and the GHI instrument.

RESEARCH TRAJECTORY

- The evaluation metrics of RMSE and MBE do not convey a measure of the variability of the time-series for the solar irradiance data. Thus, the studies will further focus on:
 - First, evaluation of day-ahead time-series solar irradiance uncertainty.
 - Second, improvements of day-ahead forecast models using Statistics.