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Use of Econometrics Models to Forecast Short Term Solar Irradiance

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OBJECTIVES

- Assess the applicability of econometrics models to forecast the global solar irradiance
- Provide point forecast with an information related to the volatility forecast
- Improving the accuracy of the forecast for grid integration and storage operations.

METHODS

Generality

Clear sky index kt^* :

- Remove seasonal variation of the global horizontal solar irradiance (GHI) by using a clear sky model (GHI_{clear})

$$kt^* = \frac{GHI}{GHI_{clear}}$$

Econometric time series:

AutoRegressive Moving Average(ARMA) :

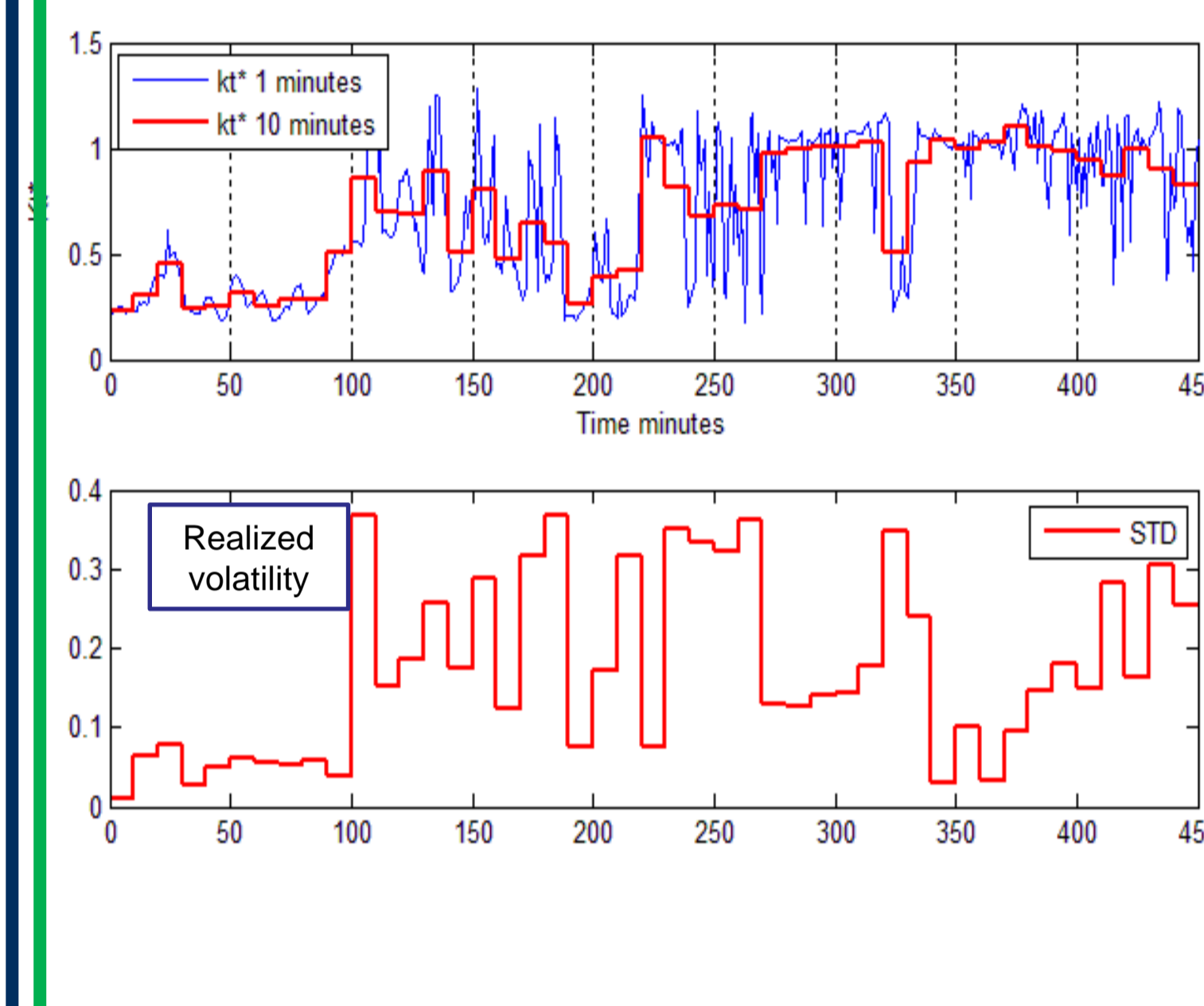
- $\widehat{kt}^*(t+h-1) = \alpha_0 + \sum_{i=1}^P \alpha_i kt^*(t-i) + \sum_{j=1}^Q \beta_j \varepsilon(t-j)$
With h forecasting time horizon

Generalized Autoregressive Conditional Heteroskedasticity (GARCH):

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^P \alpha_i \Delta kt_{t-i}^2 + \sum_{j=1}^Q \beta_j \sigma_{t-j}^2$$

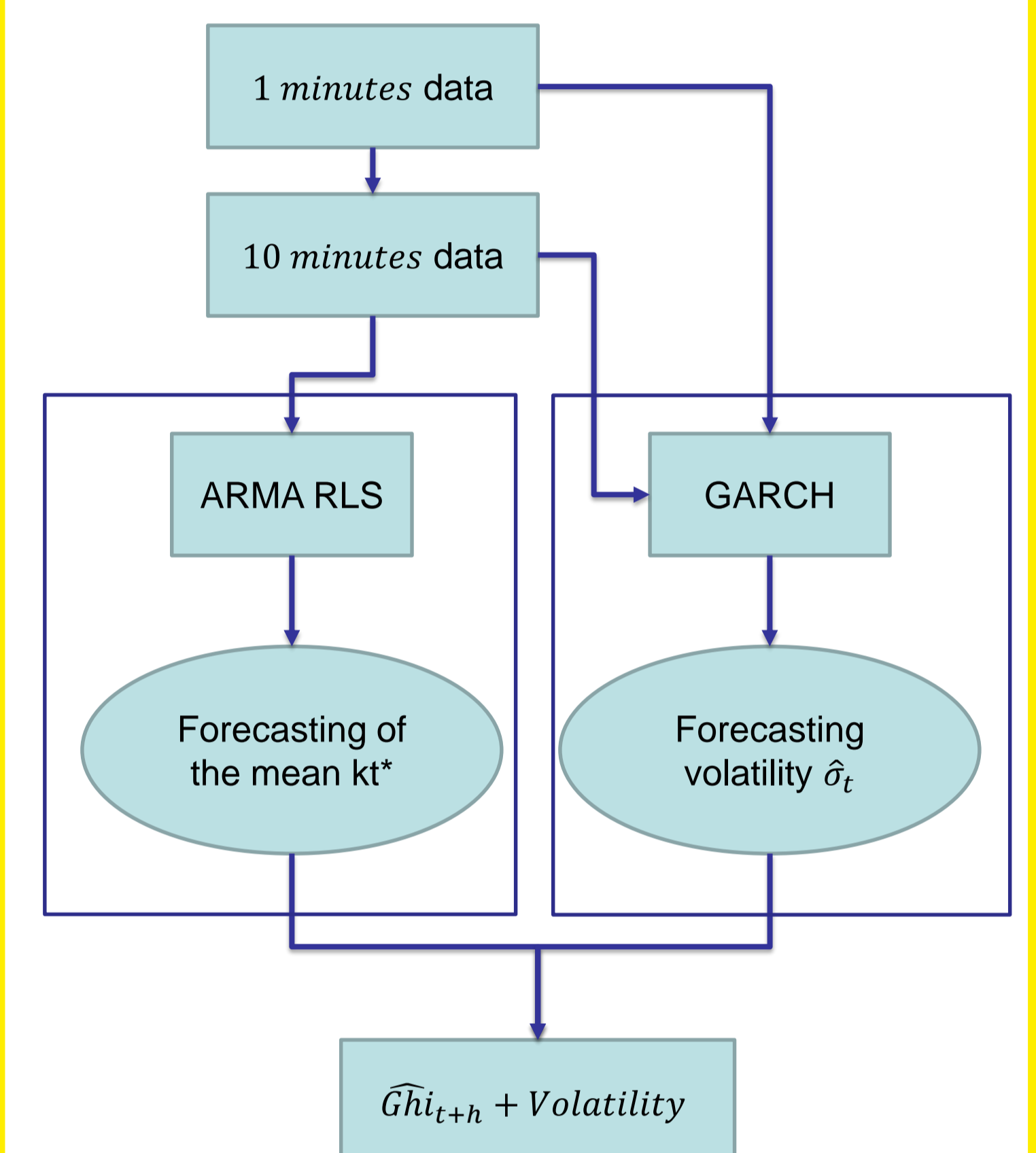
Volatility:

- Propensity to deviate from its average price over a given period
- Standard deviation



Methodology:

- Point forecast with recursive least square ARMA
- Volatility forecast with GARCH model



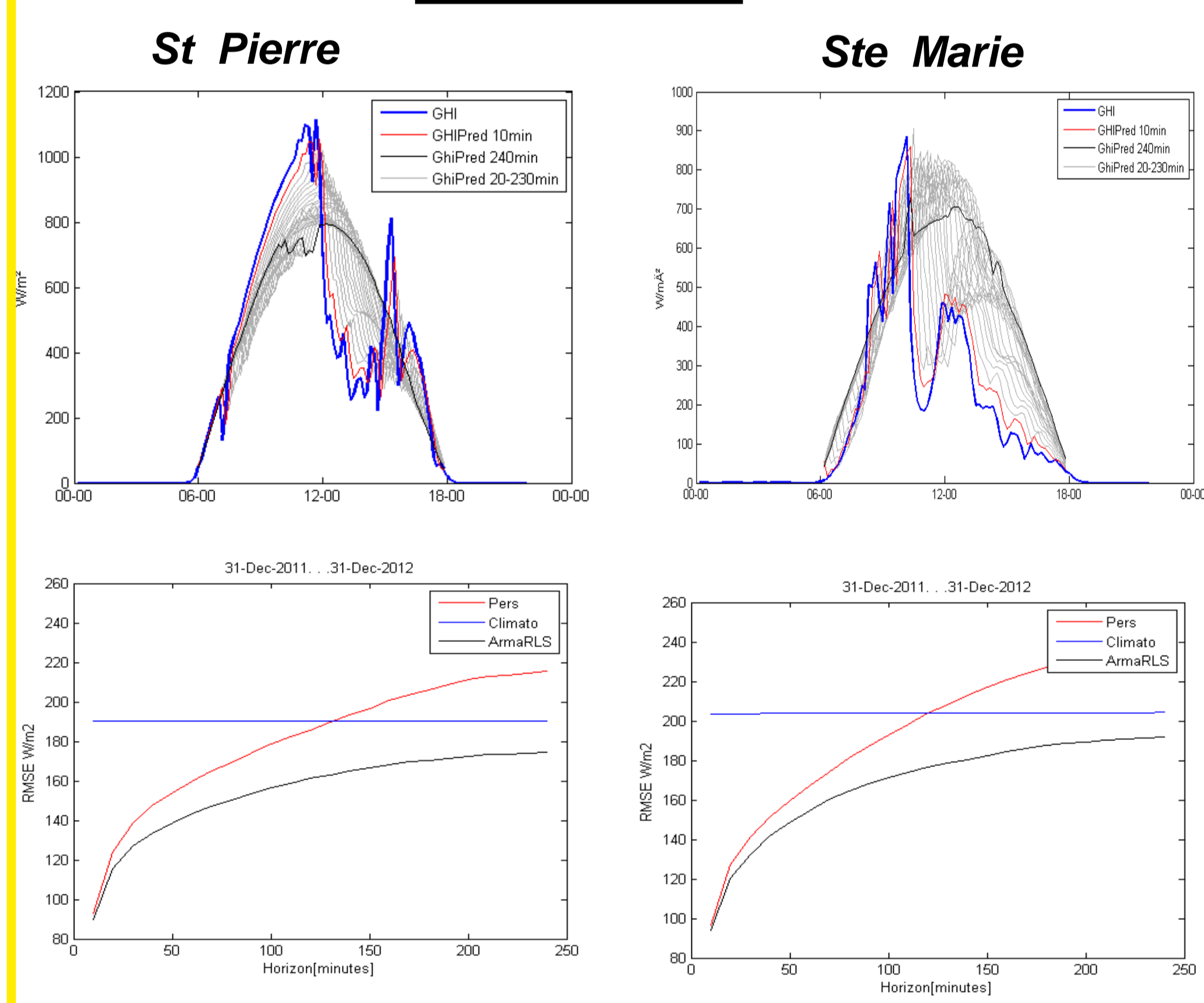
Data: 01 minutes records

- Piment Laboratory, University of la Reunion ,St Pierre
- Reuniwatt, Ste Marie

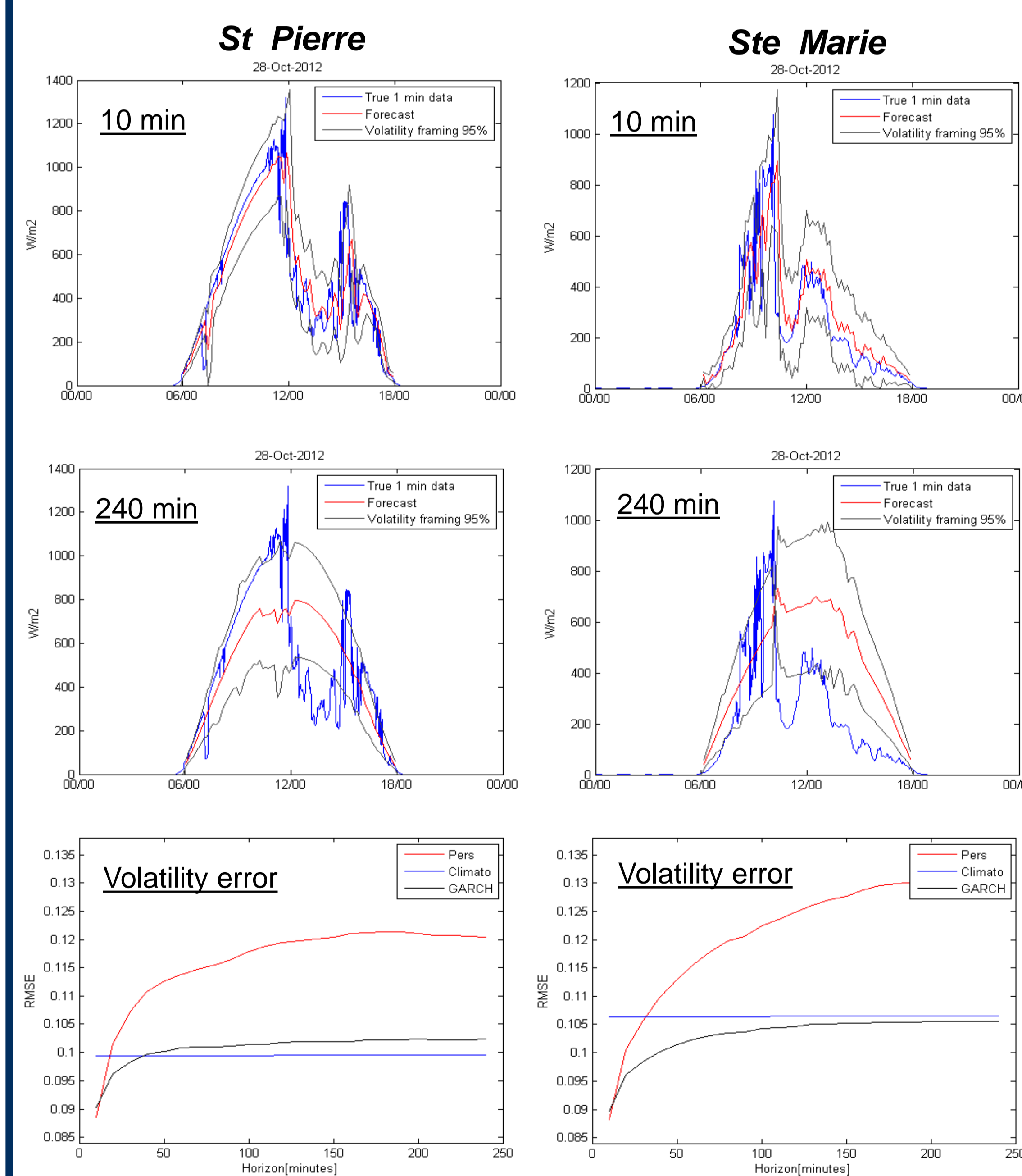
- Data collection period:
 - IUT St Pierre: 2012-2013
 - Ste Marie: 2010 – 2013
- Filtering with zenith angle > 85°

RESULTS

Point forecast



Point forecast with volatility framing



- The RMSE shows that volatility models work better if there are more fluctuations like in Ste Marie site.
- In St Pierre, climatology is better if the horizon forecast is greater than 40minutes.
- The GARCH model has tendency to return to the average value
- The forecast at 240 min, show clearly that the volatility tend to a climatologic model.

Model parameters:

- ARMA (3,3)
 - Forgetting factor $\lambda = 0.999$
 - GARCH(1,1), Sliding window, data sample = 400
- #### Forecast horizons and granularity
- 1 year data
 - Forecast horizons: 10 minutes to 4 hours
 - Granularity: 10 minutes

CONCLUSIONS

ADEME

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- The GARCH models fail to reproduce the behavior of the solar volatility
- Volatility could be an interesting factor for grid operations and for storage system management