Short term solar irradiance forecasting with multiscale approach

Faly H. Ramahatana Andriamasomanana, Pierre-Julien Trombe, Philippe Lauret, Mathieu David

Short term solar irradiance forecasting with multiscale approach

Faly H. Ramahatana[a], Pierre-Julien Trombe[b], Philippe Lauret[a],Mathieu David[a]

[a]PIMENT, University of La Réunion, 117 rue du Général Ailleret, 97430 Tampon, Reunion Island, France

[b]DTU Compute, Technical University of Denmark, 2800kgs Lyngby, Denmark

OBJECTIVES

- Multiresolution decomposition (MRD) of solar radiation time series
- Wavelet decomposition and standard ARMA forecasting

METHODS

Clear sky index:

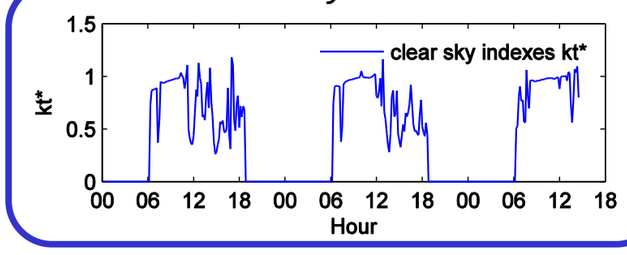
- Remove seasonal variation of the solar radiation
- Ratio of observed global irradiance *GHI* by clear sky irradiance *GHIclear*

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

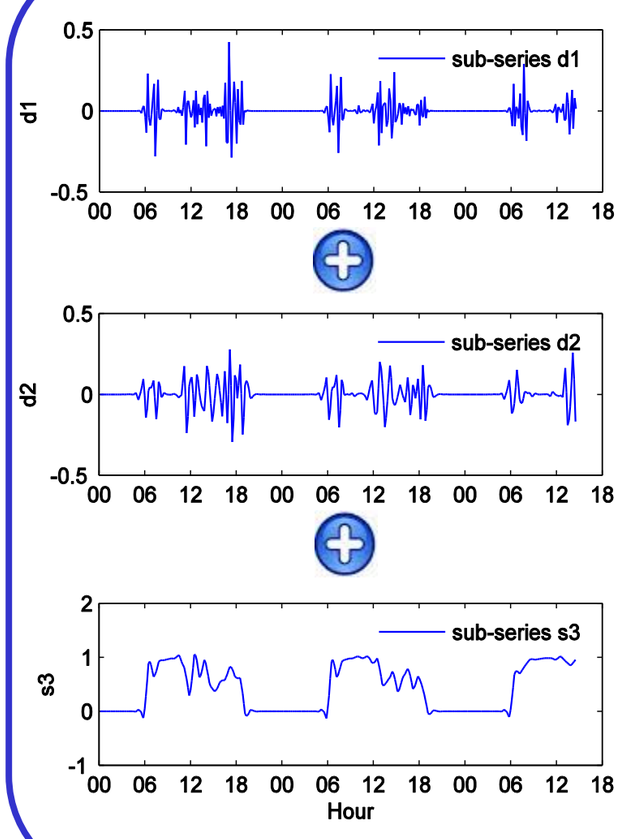
Discrete wavelet transform:

$$DWT(m,k) = \frac{1}{\sqrt{a_0^m}} \sum_n \psi\left(\frac{k - nb_0a_0^m}{a_0^m}\right)$$

Clear sky index



Wavelet decomposition



Data:

- St Pierre 10 minutes ground measurements of the GHI 2012 - 2013
- Clear sky filtering with zenith angle < 85°

Process:

Decomposition in subseries of the initial time series of kt* with a wavelet transform. Forecasting of each sub-series with an ARMA process. The final forecast of kt* are obtained by summing up the forecasted sub-series.

Model characteristics:

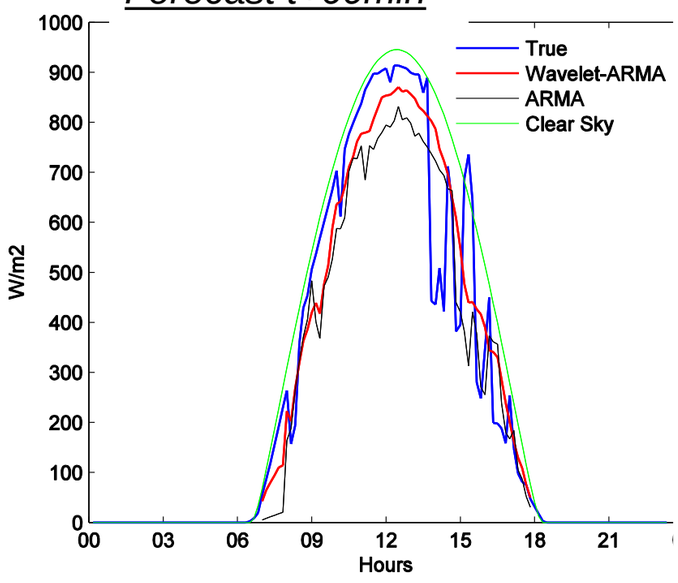
- To avoid Border distortion in decomposition: padding of the end of the kt* time series with the smart persistence model:

$$\widehat{kt}^*_{t+p} = \frac{1}{p}\sum_{i}^{p} kt^*_{t-i+1}$$

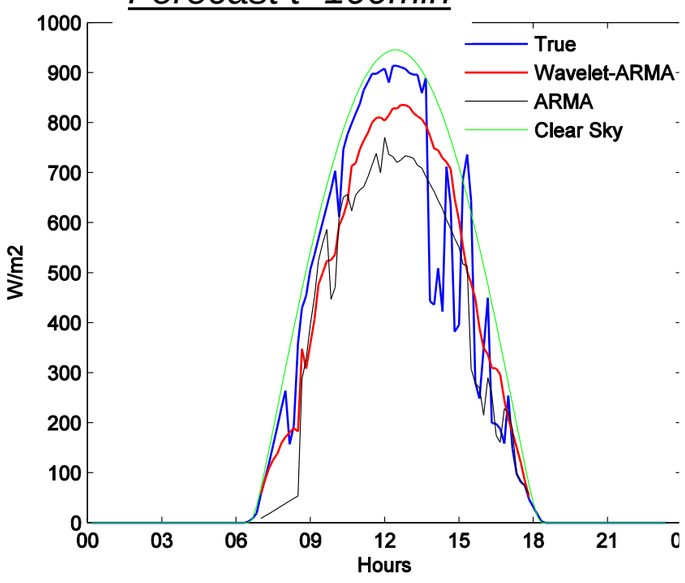
- 3 months sliding window training
- Wavelet type : Symmetrical Daubechies - Sym 4
- Filter order: 2
- ARMA orders: 5,3

FIRST RESULTS (20 DAYS)

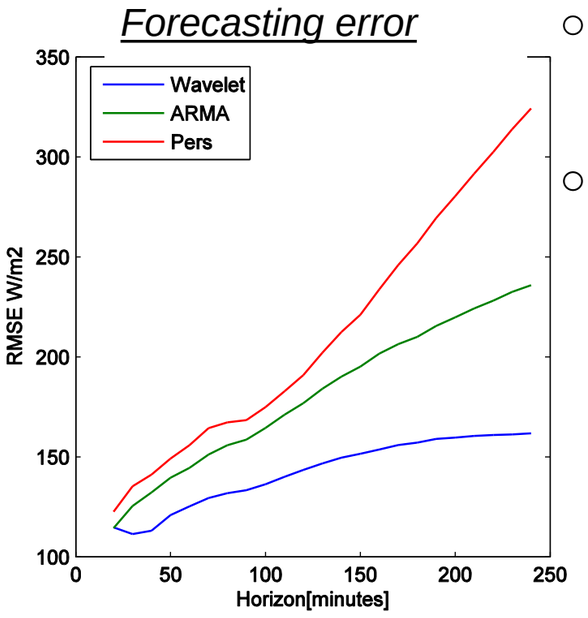
Forecast t+60min



Forecast t+100min



Forecasting error



- Wavelet trend to smooth the forecasts.
- Partially avoid time delays of the forecasts commonly observed using an ARMA model without a wavelet decomposition.

CONCLUSIONS

- Forecast of Wavelet-ARMA model are more accurate than the standard ARMA models.
- Wavelet decomposition can be used efficiently in radiation solar forecasting.
- Multiscale capture both local and global information about irradiance fluctuations

UNIVERSITÉ DE LA RÉUNION — S'ouvrir aux mondes

piment — Physique et Ingénierie Mathématique pour l'Energie et l'environnemeNT

DTU

ADEME — Agence de l'Environnement et de la Maîtrise de l'Energie