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Short term solar irradiance forecasting with multiscale approach

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OBJECTIVES

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

METHODS

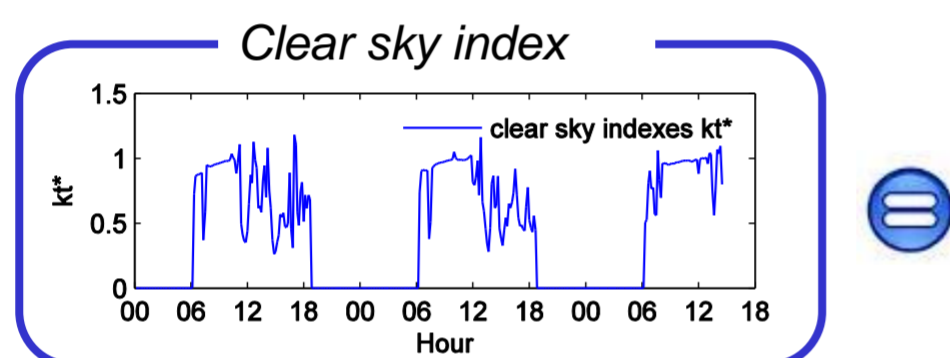
Clear sky index:

- Remove seasonal variation of the solar radiation
- Ratio of observed global irradiance GHI by clear sky irradiance GHI_{clear}

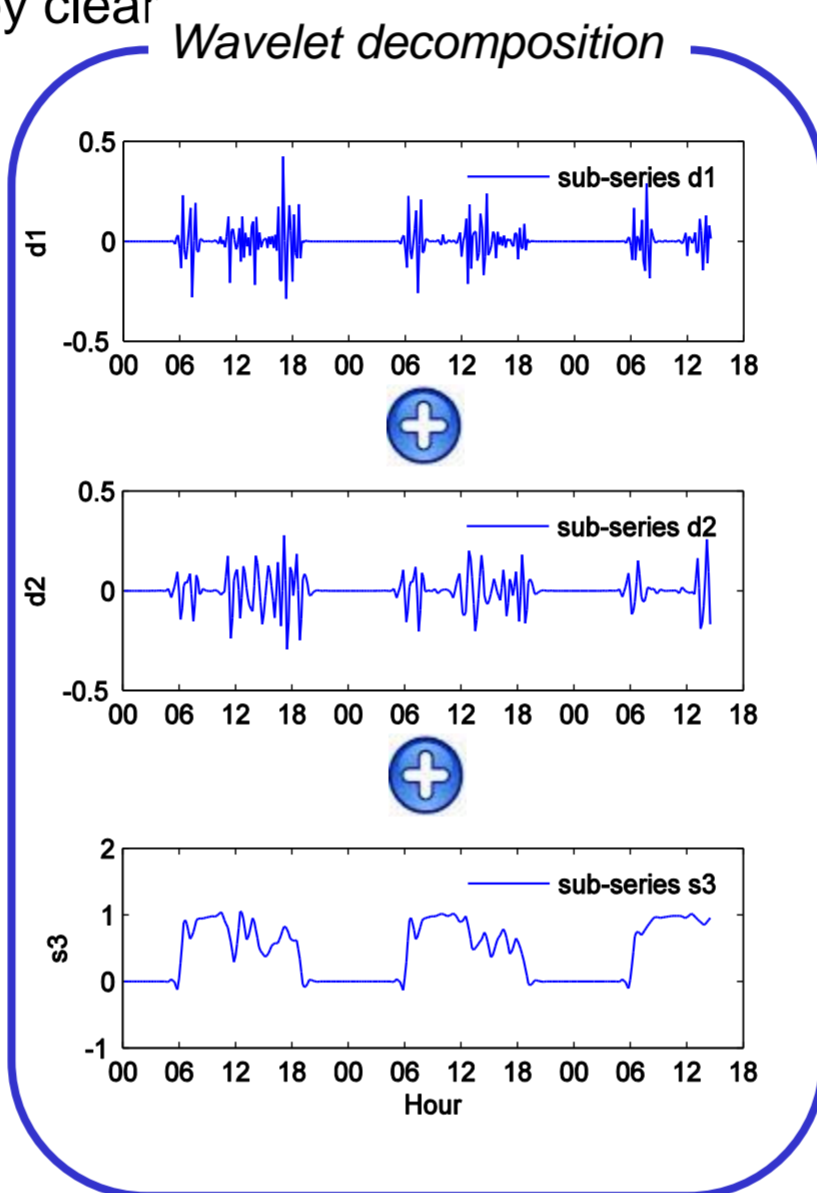
$$kt^* = \frac{GHI}{GHI_{clear}}$$

Discrete wavelet transform:

$$DWT(m, k) = \frac{1}{\sqrt{a_0^m}} \sum_n \psi \left(\frac{k - nb_0 a_0^m}{a_0^m} \right)$$



Wavelet decomposition



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:

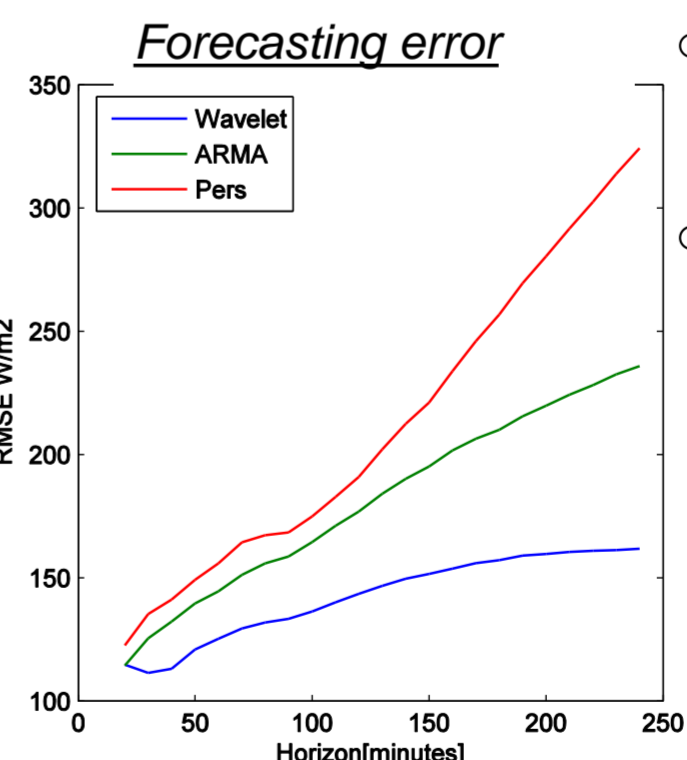
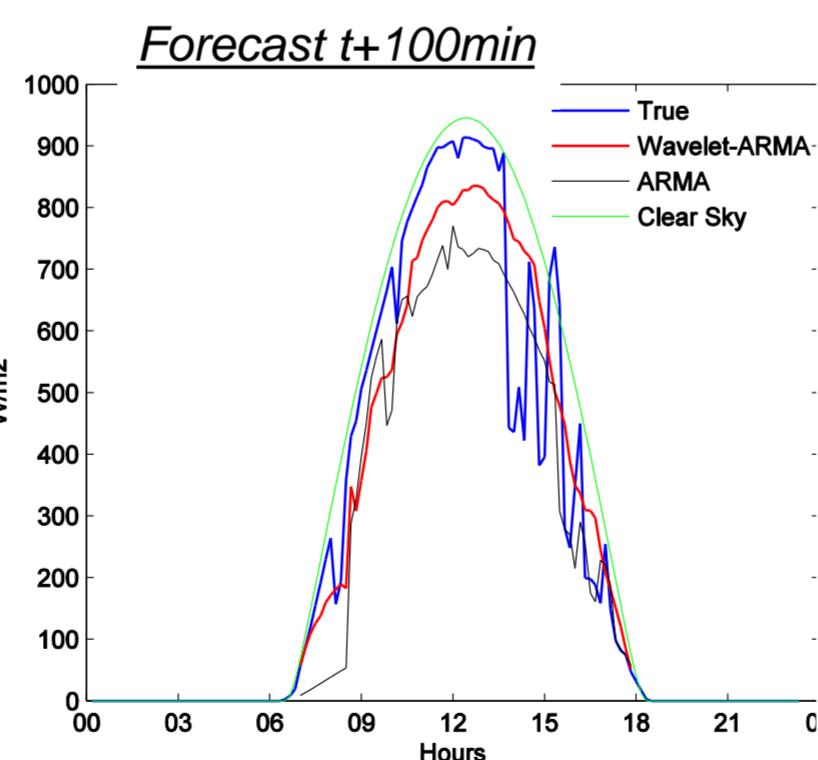
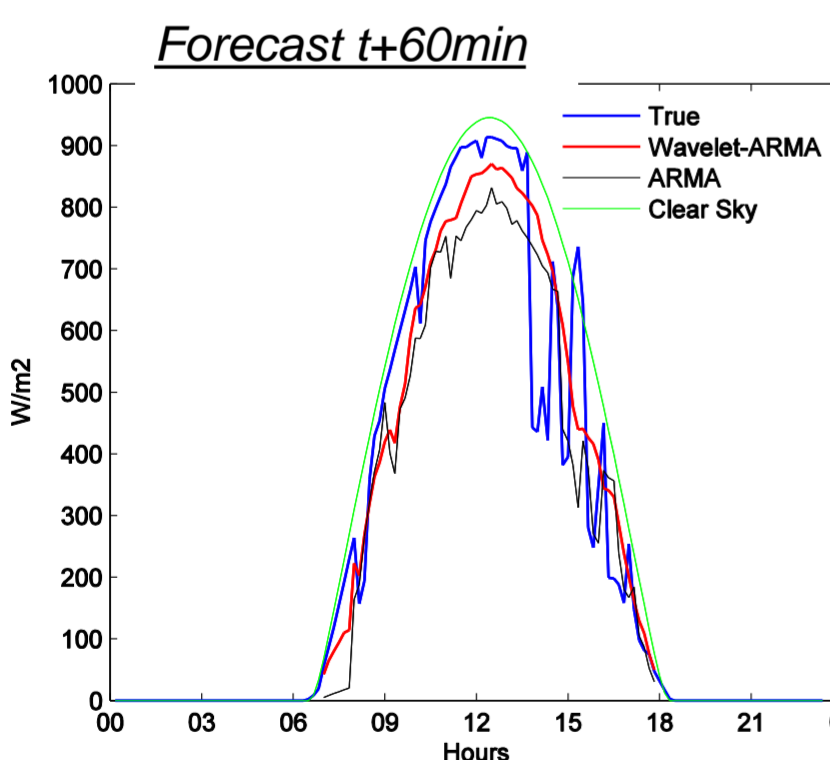
$$\hat{kt}_{t+p}^* = \frac{1}{p} \sum_i^p kt_{t-i+1}^*$$

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

Data:

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

FIRST RESULTS (20 DAYS)



- 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

