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PROGRESSIVE REFINING OF SPATIAL AND TEMPORAL RESOLUTIONS IN A HYDROLOGICAL MODEL: HOW FAR SHOULD WE GO?

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We propose to analyse the potential synergy between spatial and temporal resolutions in a hydrological model. We aim to understand in which situations higher resolutions are needed for better simulation performances.

General methodology and input data

- **Rainfall:** Antilope dataset at 1h and 1km² resolutions (Météo-France)
- **PET:** daily SAFRAN database disintegrated at hourly time step
- **Discharge:** Hydro database at variable time step
- **Hydrological model:** GRSD semi-distributed model (Lobligeois et al., 2014) at 5 temporal resolutions (from 1h to 24h) and 5 spatial resolutions (from 50km² to catchment scale).
- **General methodology:**

- Calibrate GRSD at each resolution and for 240 catchments (2006-2014)
- Extract 10 most important rainfall-runoff events by catchment (Ficchi et al. 2016)
Describe the spatio-temporal variability of each event using different indexes
- Aggregate time series at 24h time steps (for comparison)
- Analysise performances according to rainfall and catchment characteristics

1) Rainfall-runoff events description

Different indexes performed to describe spatial variability, localisation and movement of the rainfall events:

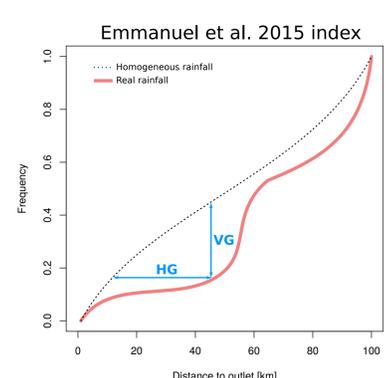
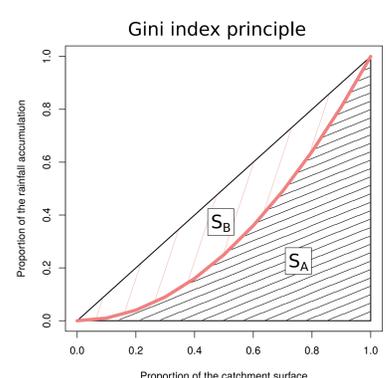
- Weighted standard deviation (Smith et al., 2004)
- Gini index applied to rainfall (Fig. below)
- Vertical gap (VG) and horizontal gap (HG) as proposed by Emmanuel et al. 2015 (Fig. below)
- Ratio of 90th and 10th quantiles of rainfall values
- Localization index (Smith et al., 2004) according to the distance to the outlet L_i

$$I_{\sigma} = \frac{\sum_{t=1}^T \sigma_t \cdot P_t}{\sum_{t=1}^T P_t}$$

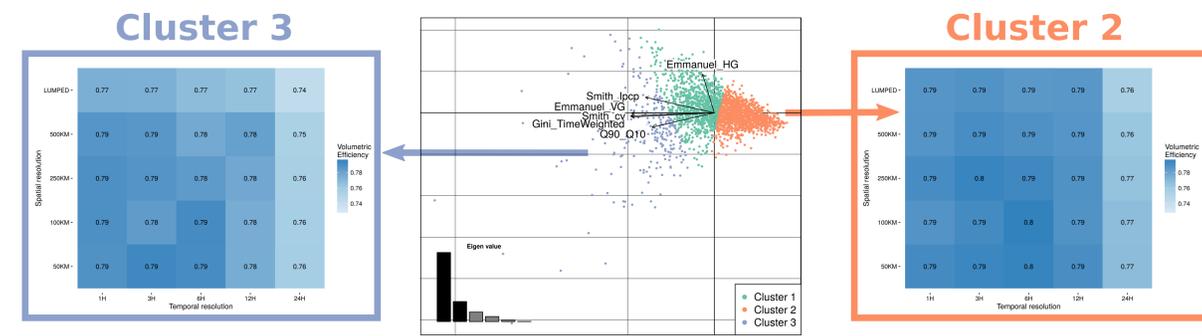
$$Gini(t) = \frac{S_B}{S_A + S_B}$$

$$I_{pcp} = \frac{C_{pcp}}{C_{bsn}}$$

$$C_{bsn} = \frac{\sum_{i=1}^N A_i \cdot L_i}{\sum_{i=1}^N A_i} \quad C_{pcp} = \frac{\sum_{i=1}^N P_i \cdot A_i \cdot L_i}{\sum_{i=1}^N P_i \cdot A_i}$$



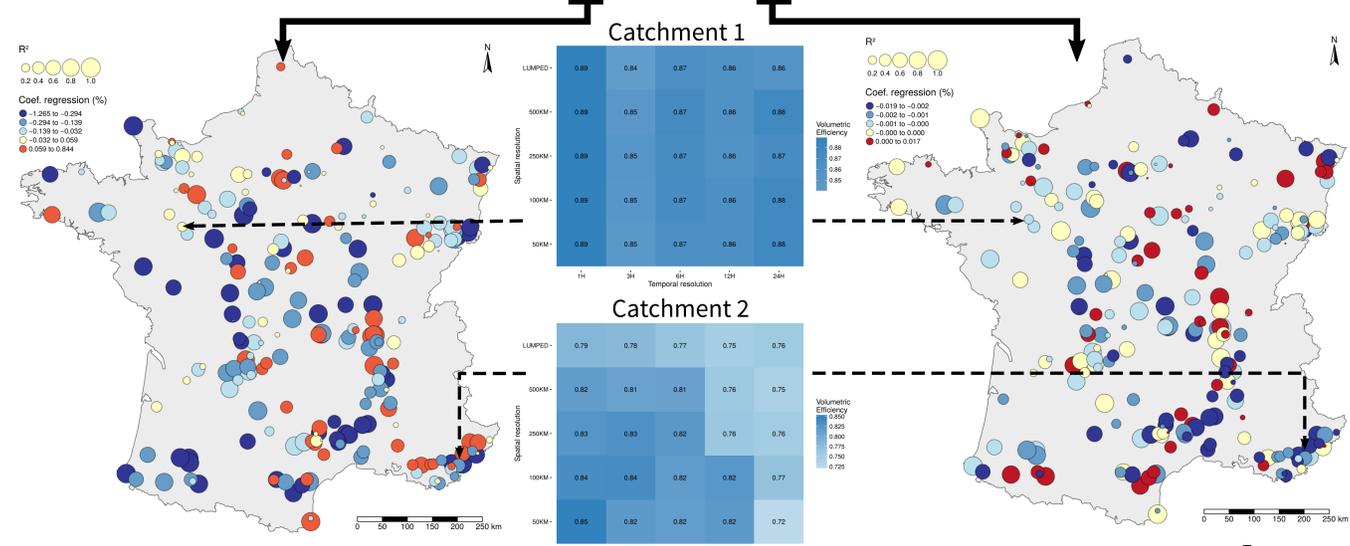
2) Higher resolutions for which rainfall-runoff events?



- Highlight highly correlated rainfall indexes
- Highly variable events benefit markedly more from higher resolutions than homogeneous events.

3) Higher resolutions for which catchments?

$$VE = a \cdot \delta T + b \cdot \delta S + c$$



Volumetric Efficiency VE
Temporal resolution δT
Spatial resolution δS
Regression coef. $a b c$

Example catchment 1: L'Argens at Roquebrune-sur-Argens (2530 km²)
Example catchment 2: La Sarthe at Saint-Denis-d'Anjou (7380 km²)

- **Catchment 1:** No synergy detected between spatio-temporal resolutions
- **Catchment 2:** Both spatial and temporal resolution lead to better performance
- No particular region seems to benefit from an increase of temporal resolution (coef. a)
- Whereas an increase of spatial resolution seems to be more beneficial in the South (coef. b)
- Catchments that benefit from simultaneous increase of both resolutions are few

4) Conclusion

- Higher resolutions do not always lead to better performance
- Increasing resolution should be thought both on time and space in order to overstep some thresholds in performance
- A semi-distributed model that can deal with different resolutions is useful to better catch hydrological responses
- Temporal and spatial resolutions do not affect performance similarly, a synergy is observed only for few catchments
- Further efforts will be placed in a better anticipation of the resolution that suits catchment and rainfall characteristics (eg. for modelling ungauged catchments).

References :

- Smith, M. B. et al. (2004). Runoff response to spatial variability in precipitation : An analysis of observed data. *Journal of Hydrology*, 298(1-4) :267-286.
 - Emmanuel, I. et al. (2015). Influence of rainfall spatial variability on rainfall-runoff modelling : Benefit of a simulation approach ? *Journal of Hydrology*, 531, Part 2 :337-348.
 - Ficchi, A. et al. (2016). Impact of temporal resolution of inputs on hydrological model performance : An analysis based on 2400 flood events. *Journal of Hydrology*, 538 :454 - 470.
 - Lobligeois, F. et al. (2014). When does higher spatial resolution rainfall information improve streamflow simulation ? an evaluation using 3620 flood events. *Hydrology and Earth System Sciences*, 18(2) :575-594.