Explaining the behavior of runoff and subsurface flow: The role of the precedent water and precipitation features on a tropical basin

Soraya Castillo, **Nicolás Velásquez**, Carlos David Hoyos, Janet Barco

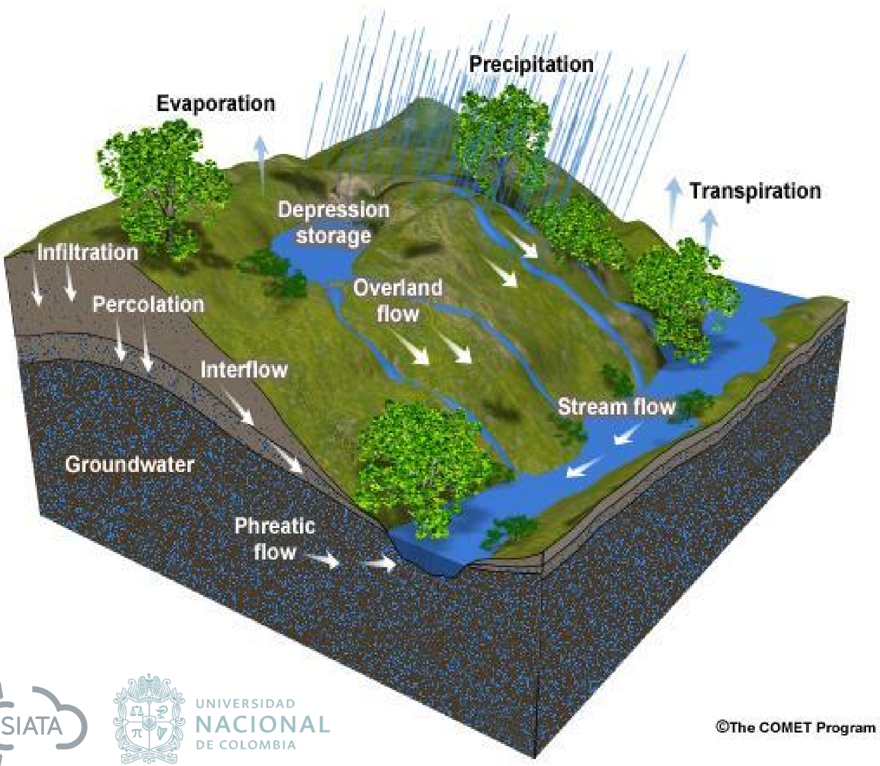
Con el apoyo de:

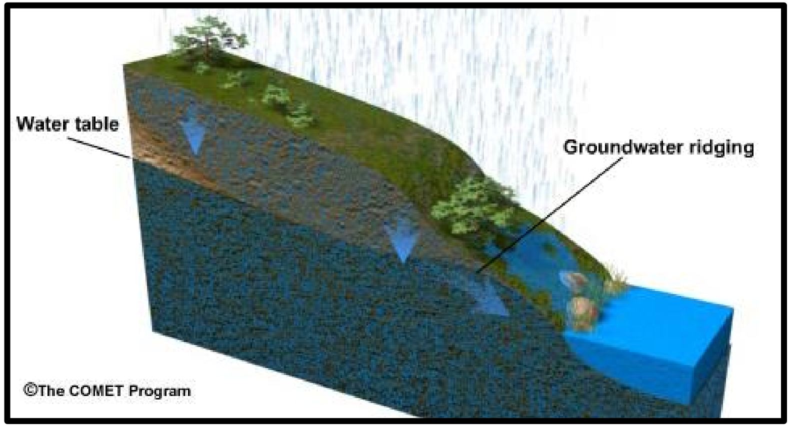
Un proyecto de:

Universidad Nacional de Colombia | SIATA | epm | ISAGEN | Medellín | Área Metropolitana Valle de Aburrá | Alcaldía de Medellín

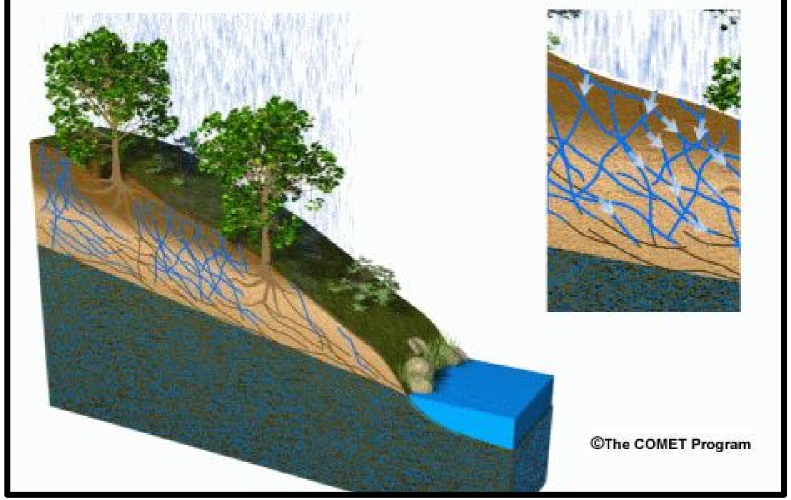
Hydrological processes

Components of Runoff and Groundwater





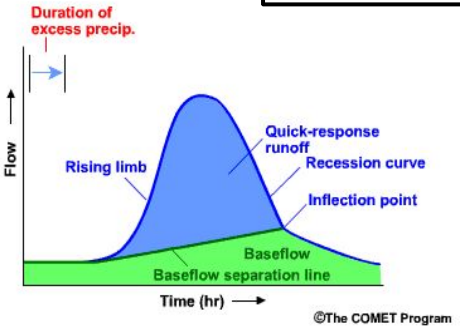
Interflow Through Macropores



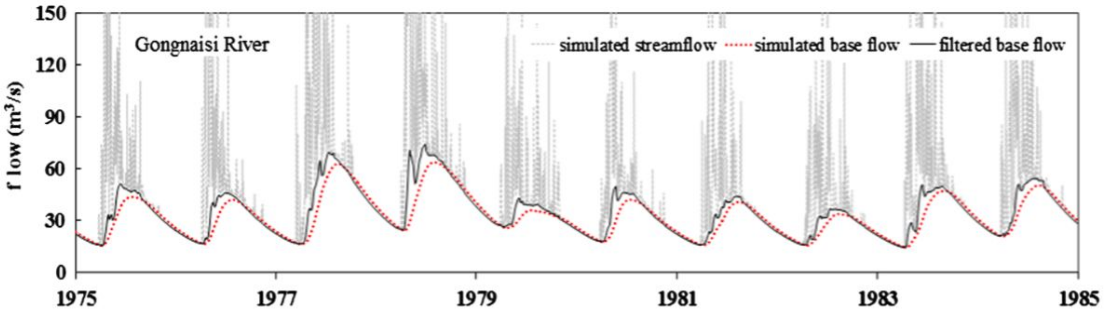
SIATA

UNIVERSIDAD NACIONAL DE COLOMBIA

Some methods for fluxes separation



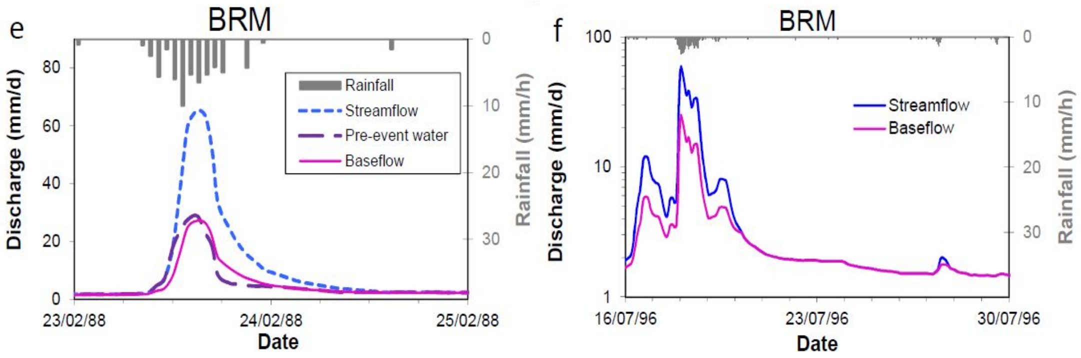
Hewlett and Hibbert (1966)



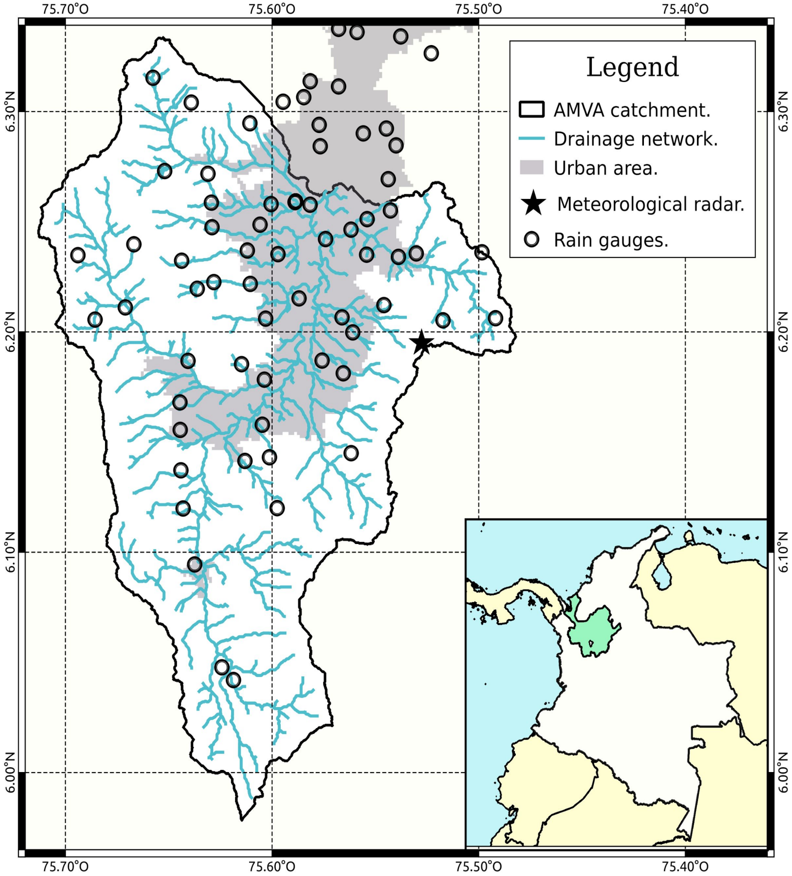
Hydrological models , such as SWAT (Gan et al., 2015)

$$Q_o = Q_T\left(\frac{\delta_T - \delta_S}{\delta_o - \delta_S}\right)$$

Chemical tracers (Pellerin, 2008; Rusjan 2015)



RDF, such as BRM (Stewart, 2015)



Study area - Data

Aburra Valley basin (470 km^2):

- Located in the Colombian Andean Region. Its terrain has steep **slopes** (25 - 75%).
- Well developed **soils**.
- **Urban area** coverage (24%).

Data:

- **C-Band** radar data.
- **84** storm events.
- **5min** level data.

SIATA

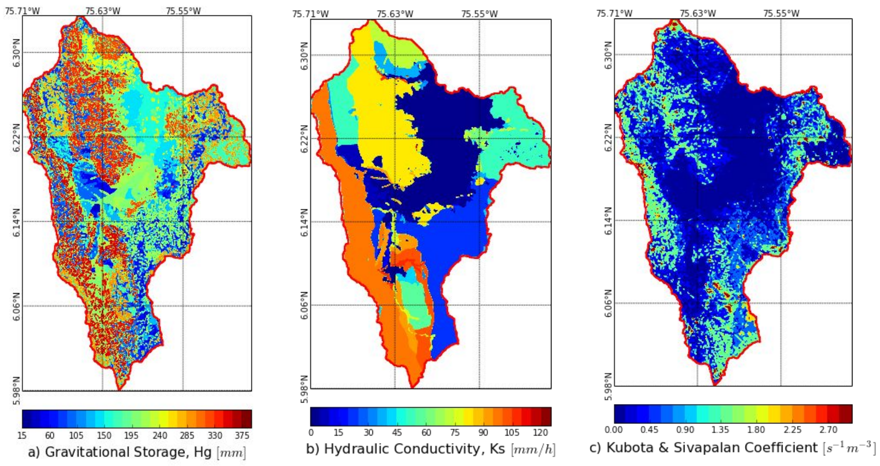
UNIVERSIDAD NACIONAL DE COLOMBIA

Methodology

Long term model parametrization at 1 hour scale.

- The model saves **states** every hour.
- We use this **states** as the initial **conditions** for events.

Maps of some relevant model parameters.



In the parametrization they are multiplied by an scalar

Model parametrization at 5min scale.

- It simulates **84** events.
- For each one it uses the state conditions of the 1hour scale model.
- Separates **runoff** and **subsurface**.

Rainfall comparison:

- Max intensity (I_{max}).
- Total rainfall.
- Structure at four selected events.

Soil moisture.

- Amount of stored water before the event.

SIATA

UNIVERSIDAD NACIONAL DE COLOMBIA

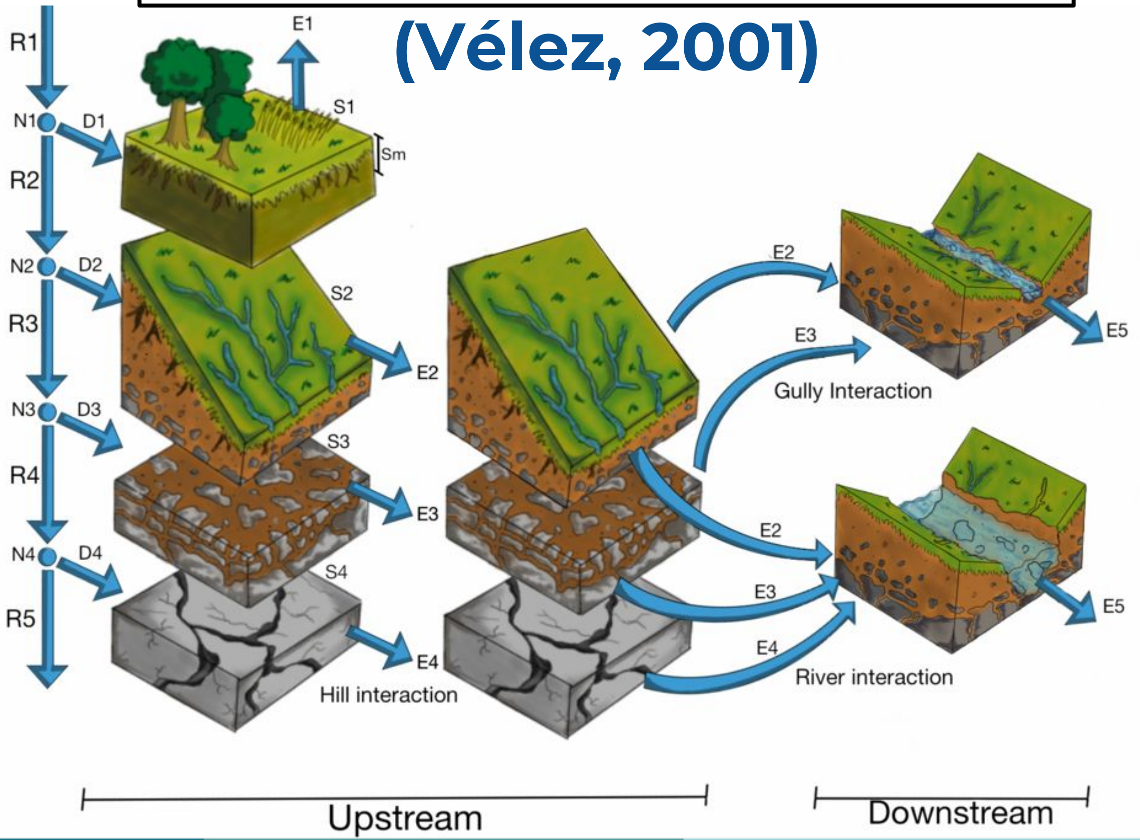
Model modifications:

- **Nonlinear** equation for horizontal hydraulic conductivity in function of storage (Kubota, 1995)
- **Virtual tracers** for surface, subsurface and baseflow.

code at: **https://github.com/nicolas998/WMF**

Hydrological distributed model

(Vélez, 2001)



SIATA UNIVERSIDAD NACIONAL DE COLOMBIA

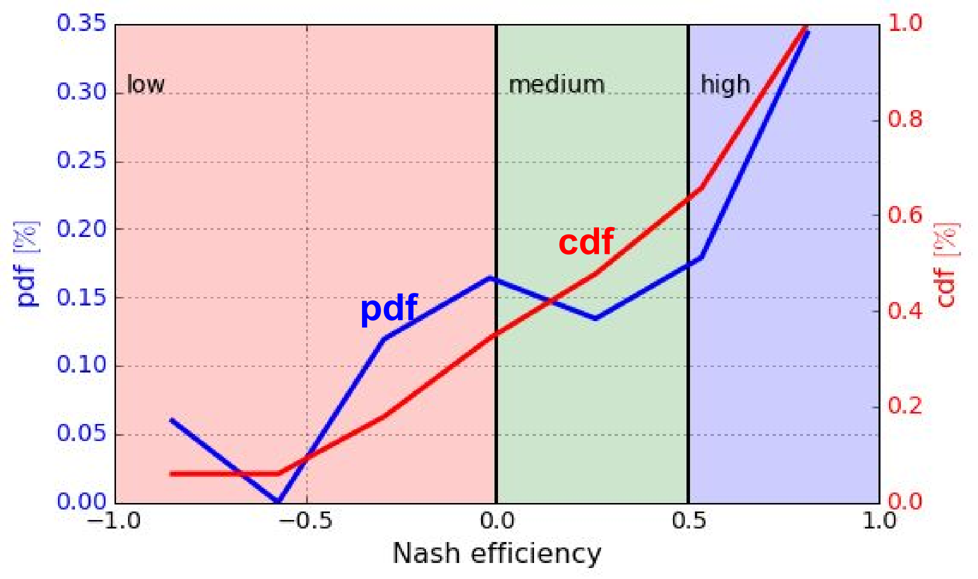
Hydrological simulation by events

Model parametrization:

- **Most sensitive scalar parameters:**
  - K_s, V_h, V_c, Evp

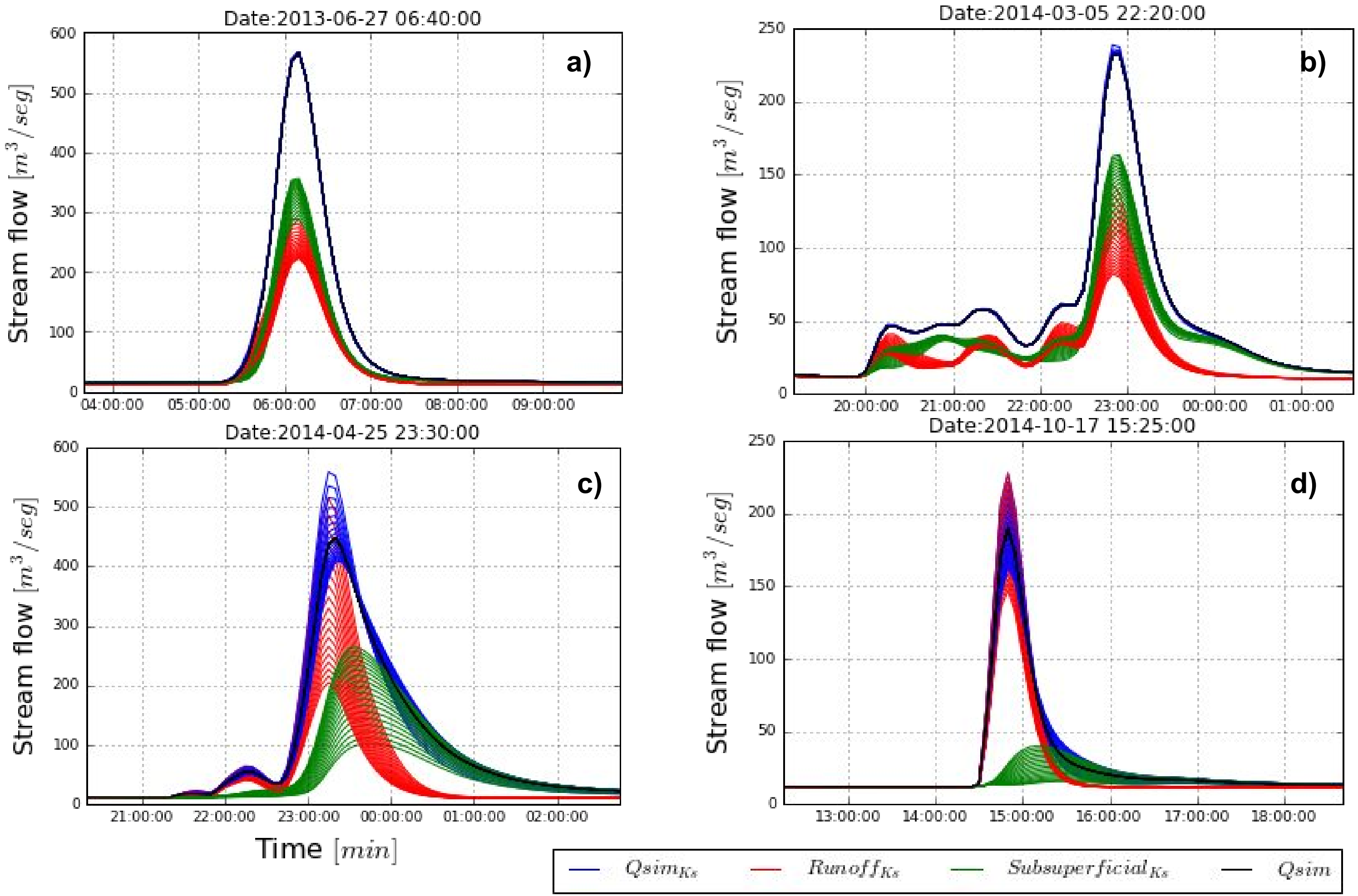
Model performance:

- **Nash > 0.0: 63%**
- **Nash > 0.5: 33%**



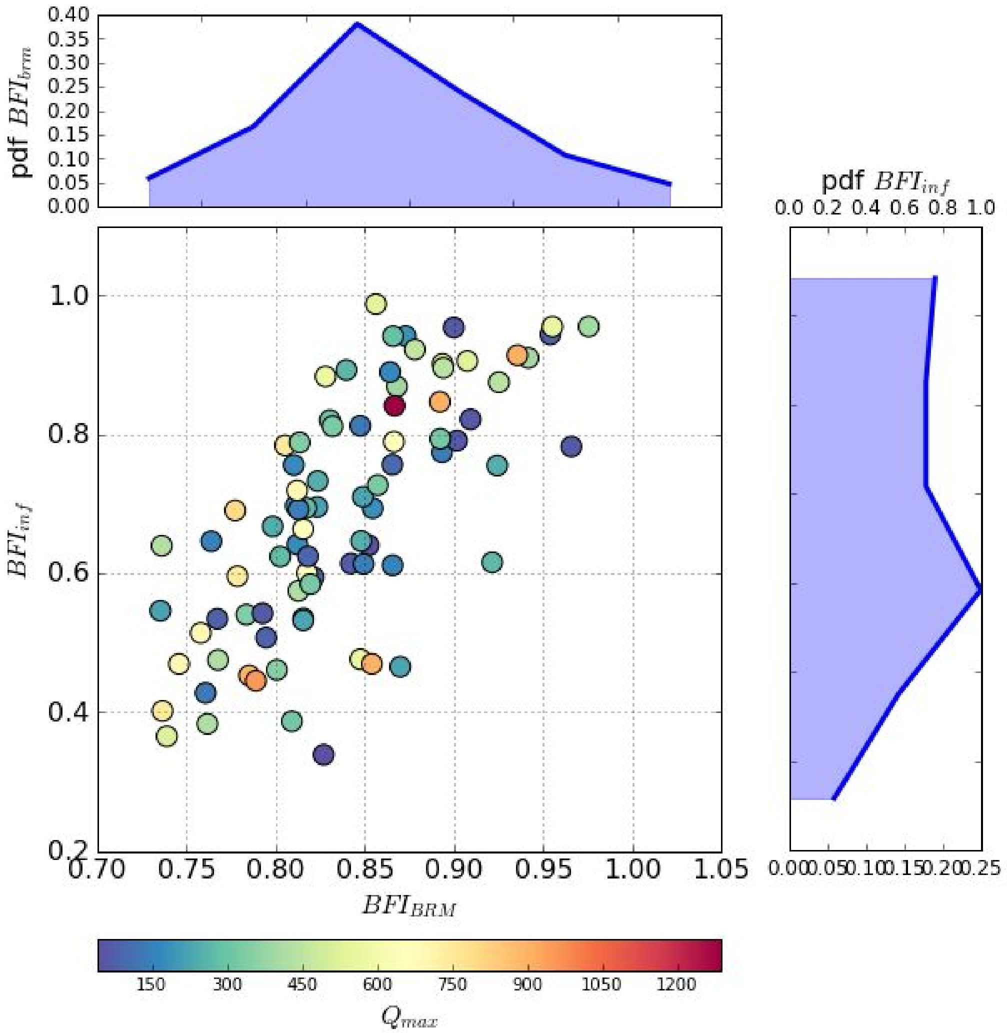
We use one set of scalar parameters. It achieves to reproduce the observed streamflow at the outlet of the basin.

Sensitivity analysis



We vary K_s coefficient between 0.1 and 100. The separation is robust for this variations

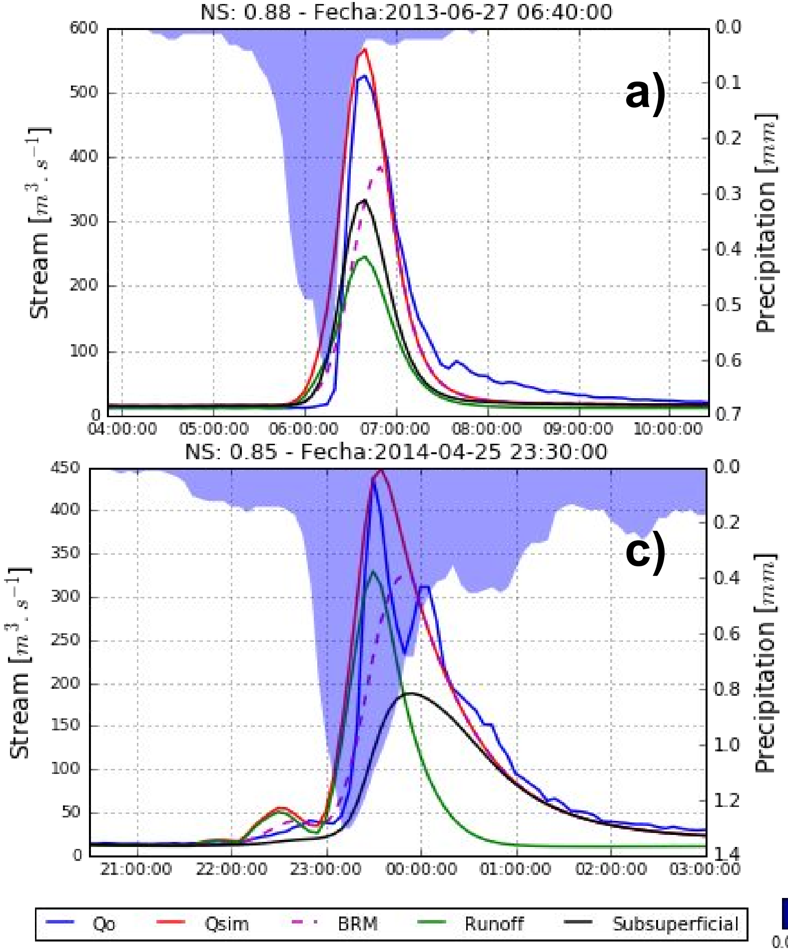
Virtual tracers and BRM separation.



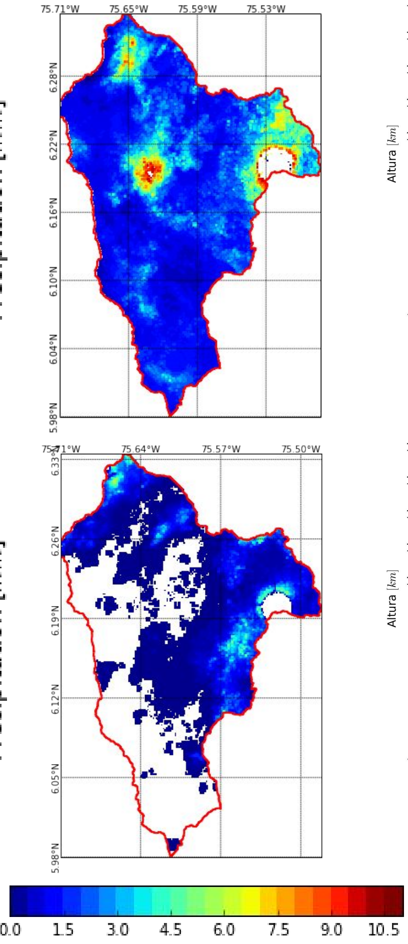
While BRM oscillates between 0.72 and 1.0, the model separation oscillates into 0.35 and 1.0

Results for four events.

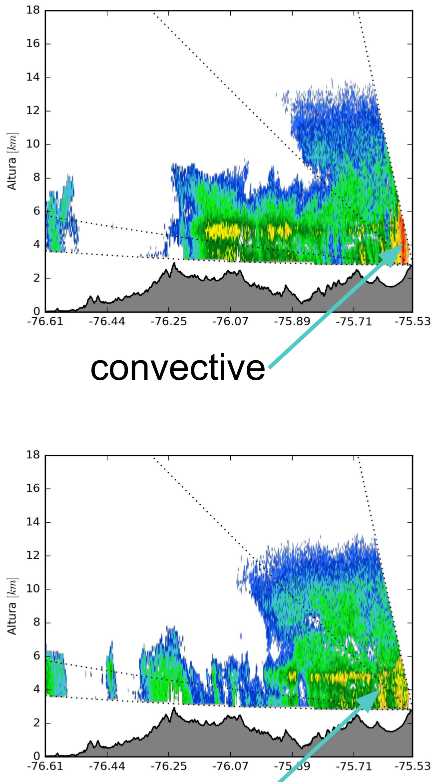
Streamflow simulations



Accumulated fields



Radar profiles

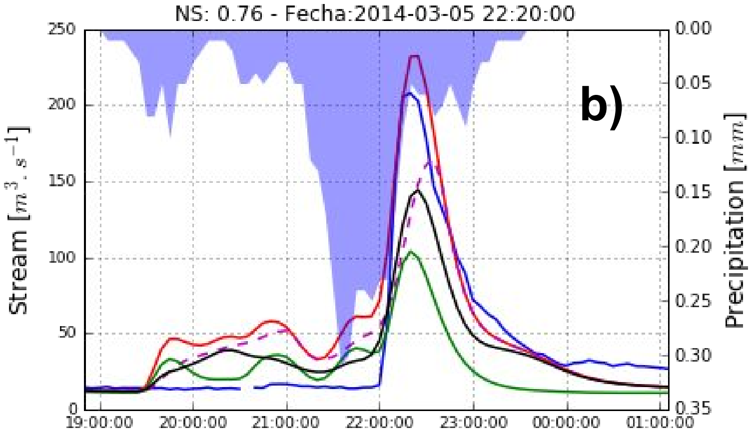


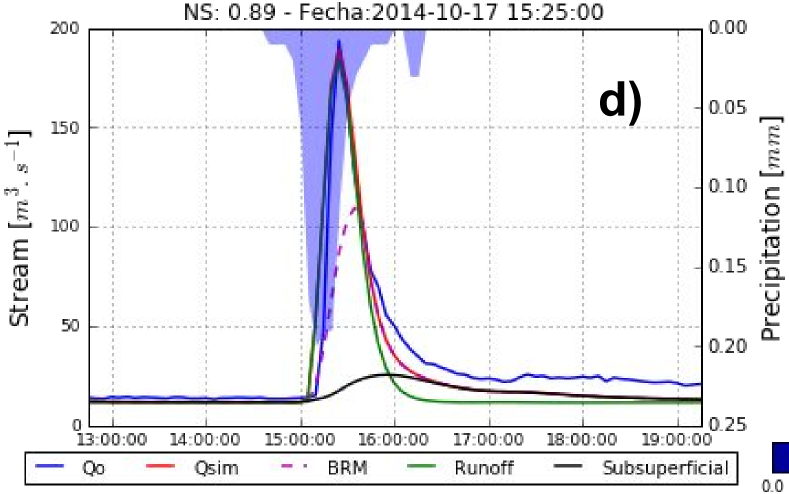
convective

stratiform

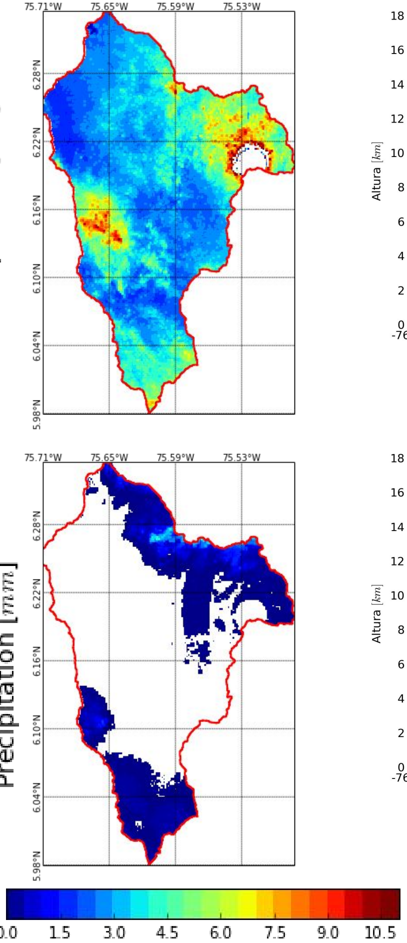
Results for four events.

Streamflow simulations

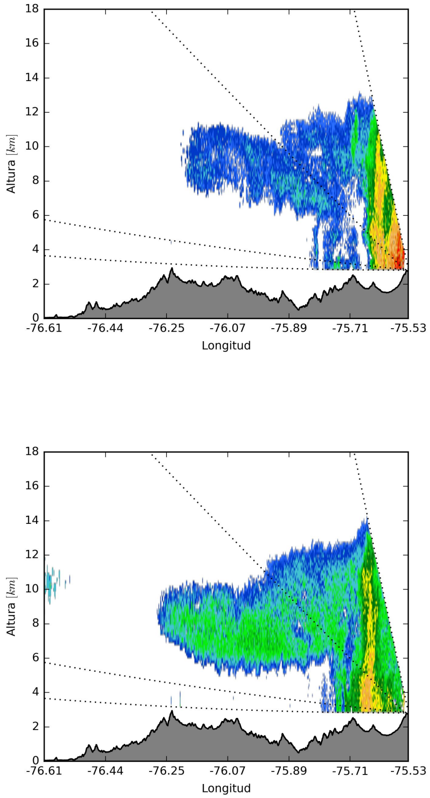




Accumulated fields

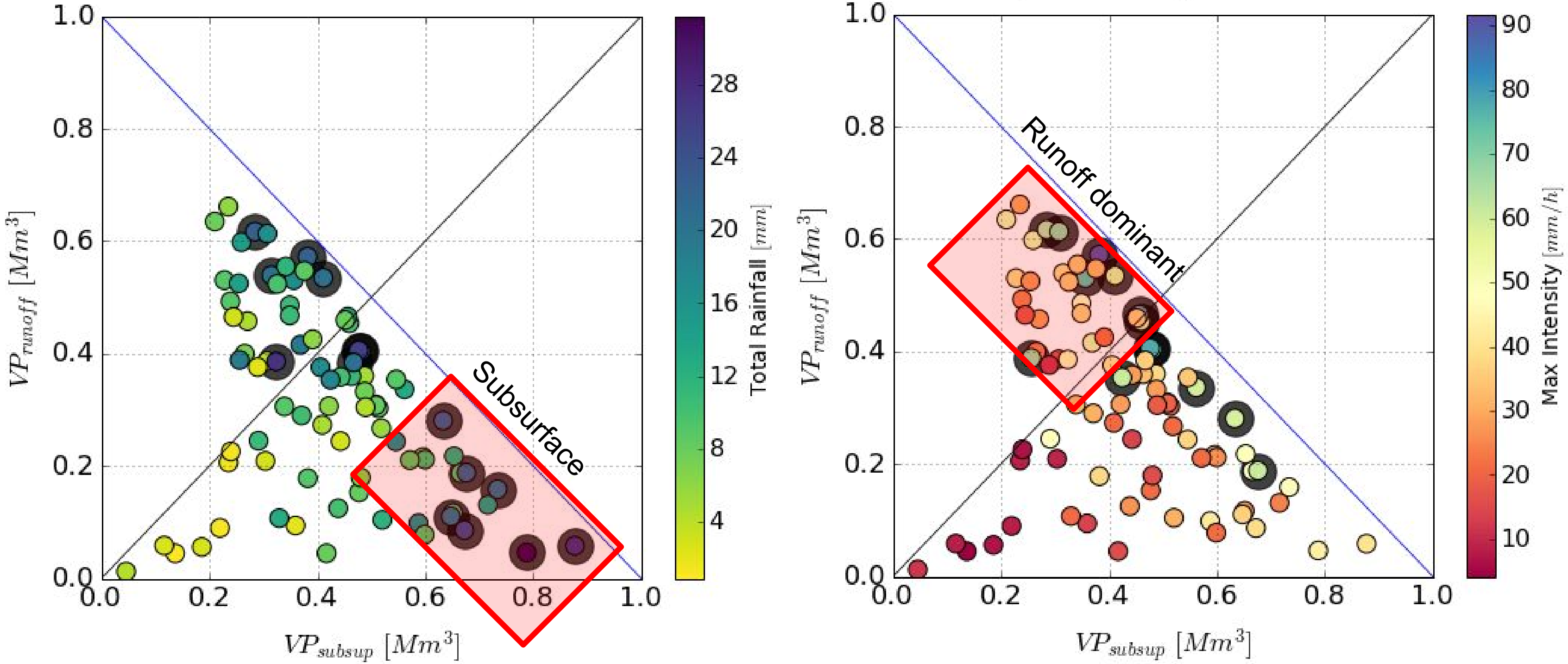


Radar profiles



Rainfall structure seems to be related to the flux separation.

Fluxes separation vs. rainfall

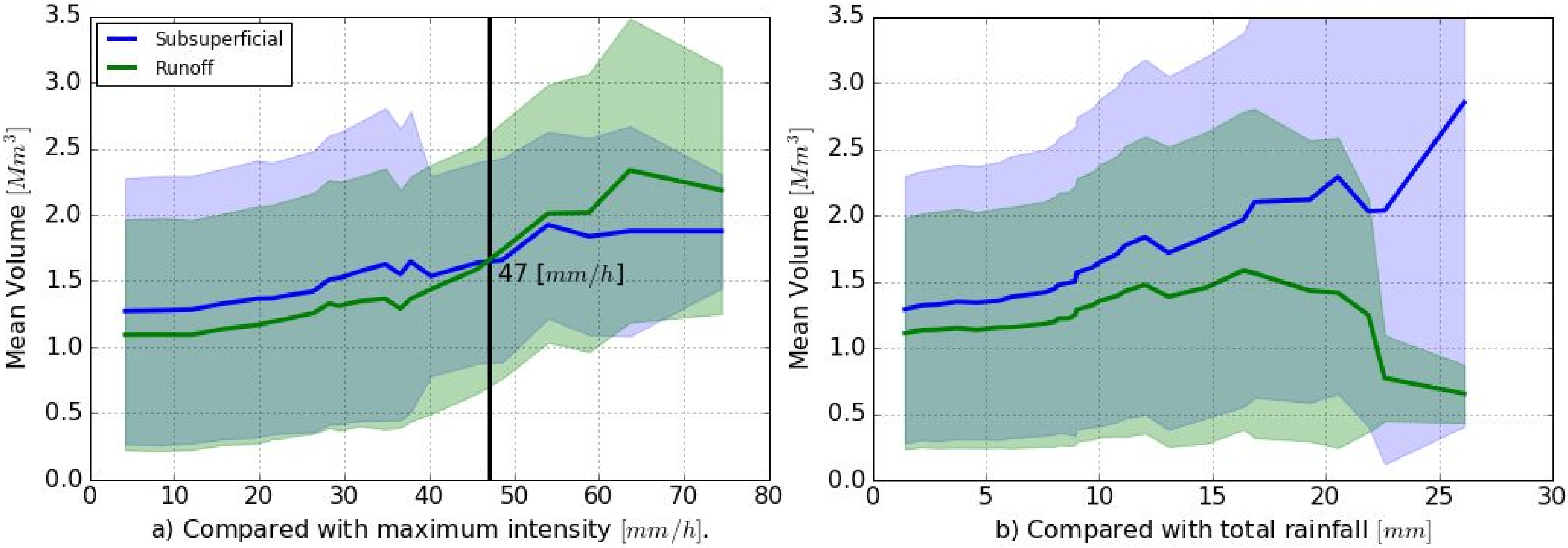


a) Coloured by total rain

b) Coloured by max intensity

Events with more total rainfall are likely to increase sub-surface. On the other hand, I_{max} is likely to increase runoff.

Fluxes separation vs. rainfall



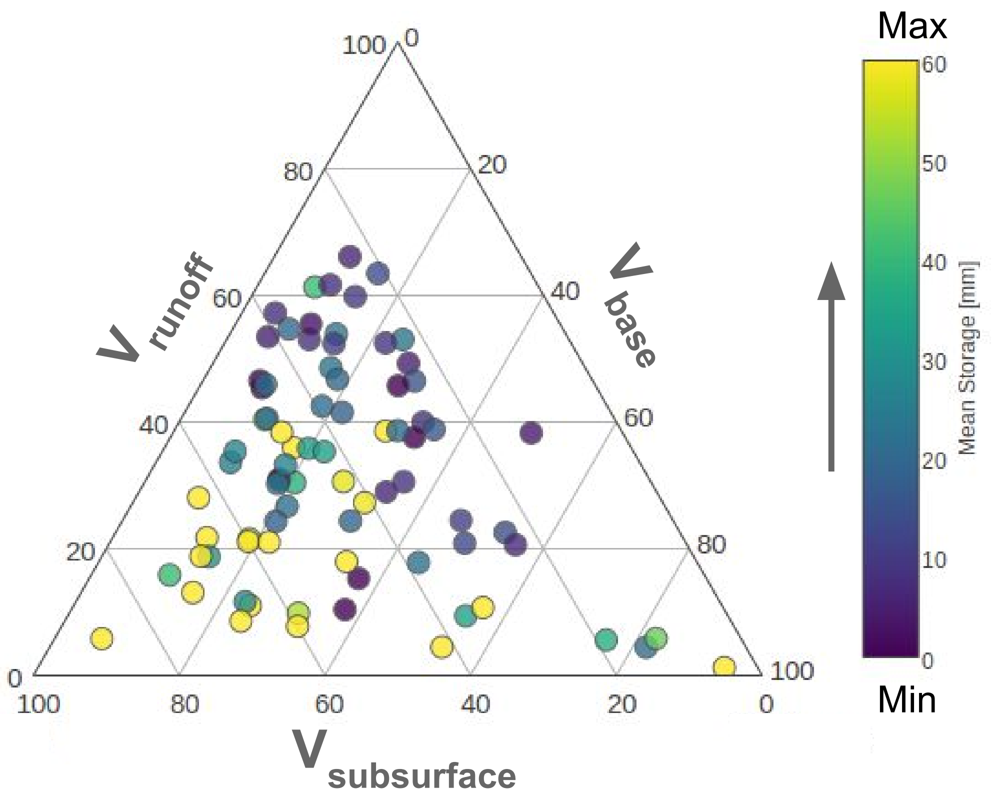
Sub-surface tends to overpass runoff, this change when I_{max} is greater than 47 mm/h. This value is related to the soil properties of the watershed. Total rainfall is likely to increase the sub-surface production.

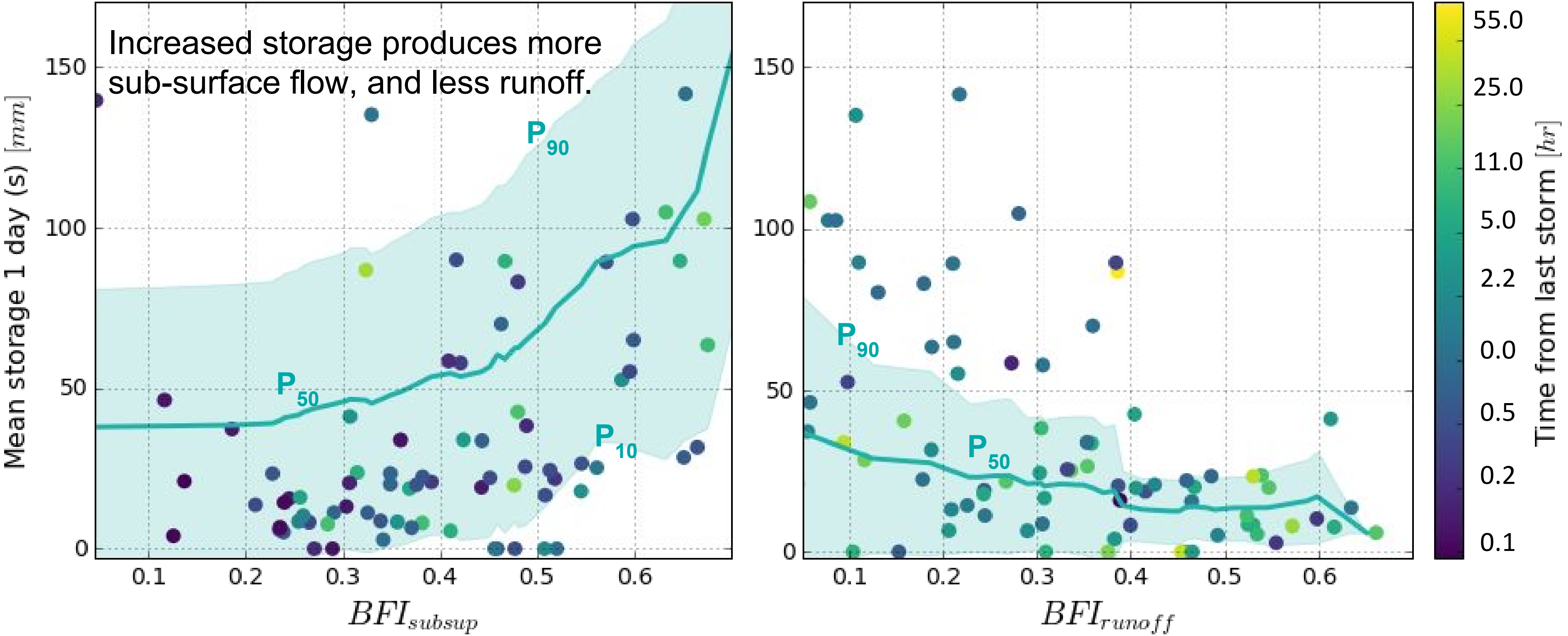
Antecedent Conditions

Comparisson of total runoff, base and sub-surface volume.

Sub-surface increase with the water storage. While, runoff decrease.

This could be associated to old water?.





Fluxes separation vs. mean storage

Conclusions

Conclusions:

- We separate **fluxes** with a hydrological model, results are consistent with BRM.
- **Subsurface** has a significant participation on the **hydrograph** formation.
- **Rainfall intensity** is related with **runoff** production. Total rainfall with subsurface.
- Antecedent storage increase **subsurface** portion.

Future work:

- Evaluate other features related to fluxes separation.
- **Explicitly** explore its relation with **convective** and **stratiform** systems.
- **Validate** results with **field measurements**.
- Explore fluxes separation at **multiple scales**.

Thanks !

Comments, questions, suggestions ?