Simulation of the water balance of the NE Iberian Peninsula with a distributed hydrological model

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Observatori de l'Ebre

HyMeX
HYdrological cycle in Mediterranean EXperiment

Simulation of the continental hydrological cycle within HyMeX

- The HyMeX project is promoting the study of the continental hydrological cycle in the Mediterranean.
- Several scales: from the plot scale to the whole Mediterranean basin.

→ WG2: Hydrological continental cycle

→ TTM2: Multiscale modeling of the continental surfaces

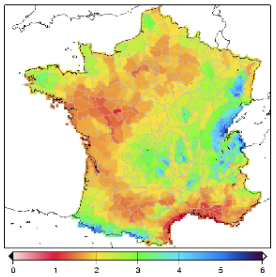
- → TTM2a: Whole Mediterranean basin hydro-meteorological modeling
- → TTM2b: Distributed hydrological modeling over medium to large river basins

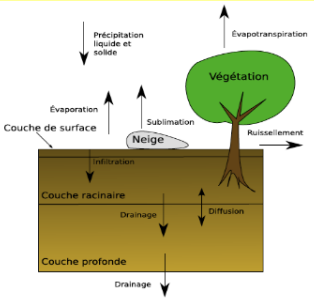
Motivation

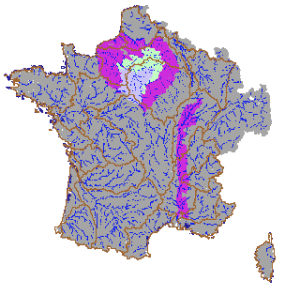
- We want to understand the water budget on the continental surface.
- Meteorological analysis systems and land surface models provide a complete picture of this budget.
    - Droughts (meteorological, agricultural, hydrological).
    - Role of the vegetation, land use and cover.
    - Impacts of climate change.
- But these are complex and data hungry models.

SIM France

SAFRAN Atmosphere 8 km	**SURFEX** **(ISBA 3-L)** Land surface 8 km	**MODCOU** Encaminament Aigües subterrànies

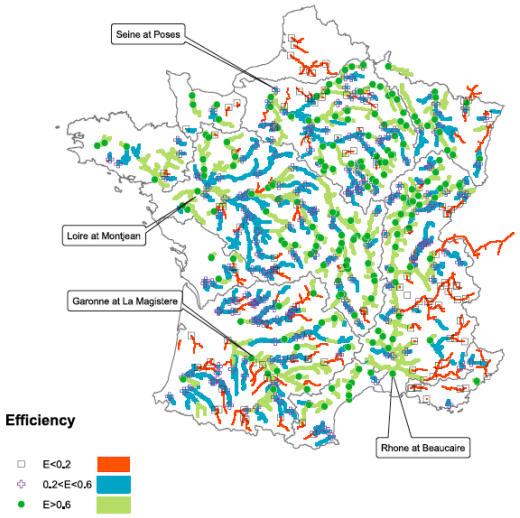






Météo-France

École de Mines de Paris

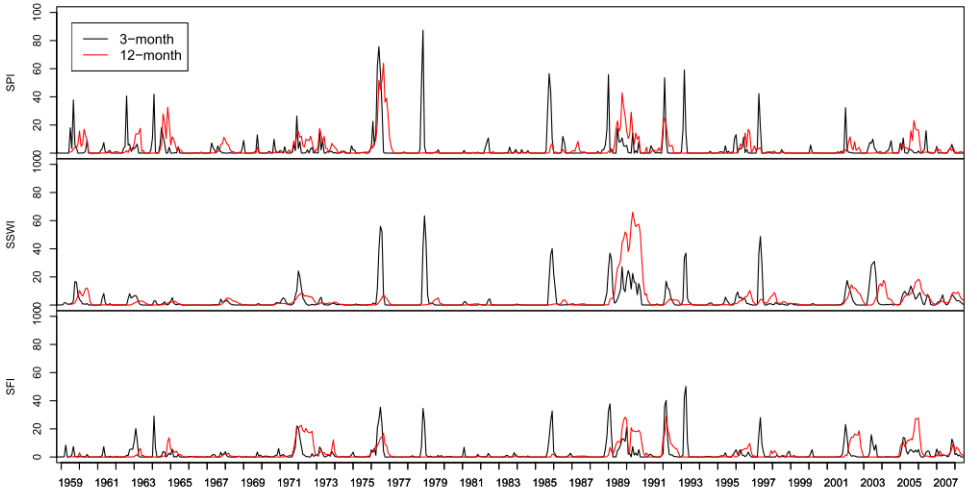


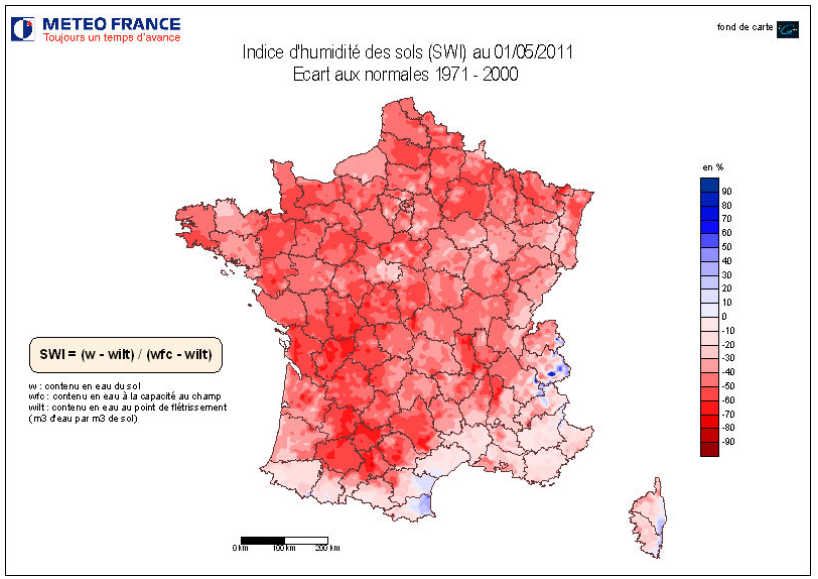
Habets et al. 2008

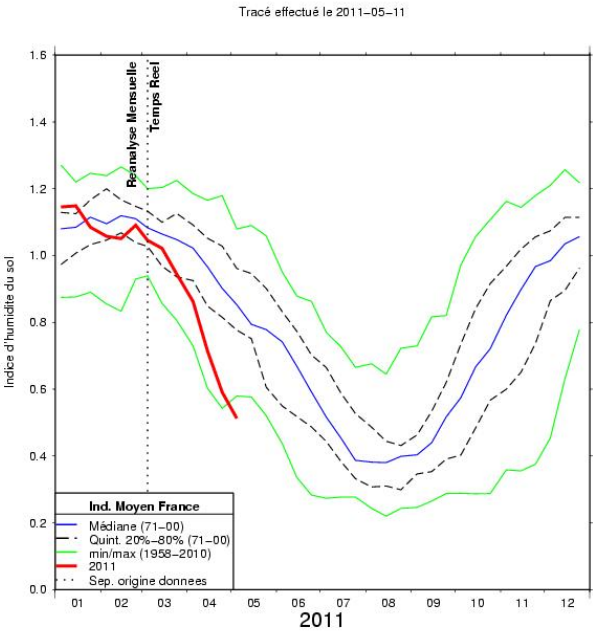
- Is the father of the SURFEX-based hydrological models to be used in HyMeX.
- Developed at Météo-France
- **It is operational**
- Forecasting of river flows all over France
- Monitoring of the water budget.
- Monitoring of the snow.
- 50 year reanalysis: 1970-2008
- **It is used in research**
- Improvement of land-surface modeling.
- Impacts of climate change
- Data assimilation.

Climatology and monitoring of droughts

- Climatology of droughts in France
- Vidal et al (2010), HESS
- 50-year drought reanalysis in France
- SPI (atmosphere)
- SSWI (soil moisture)
- SFI (flow)
- Multi-scale





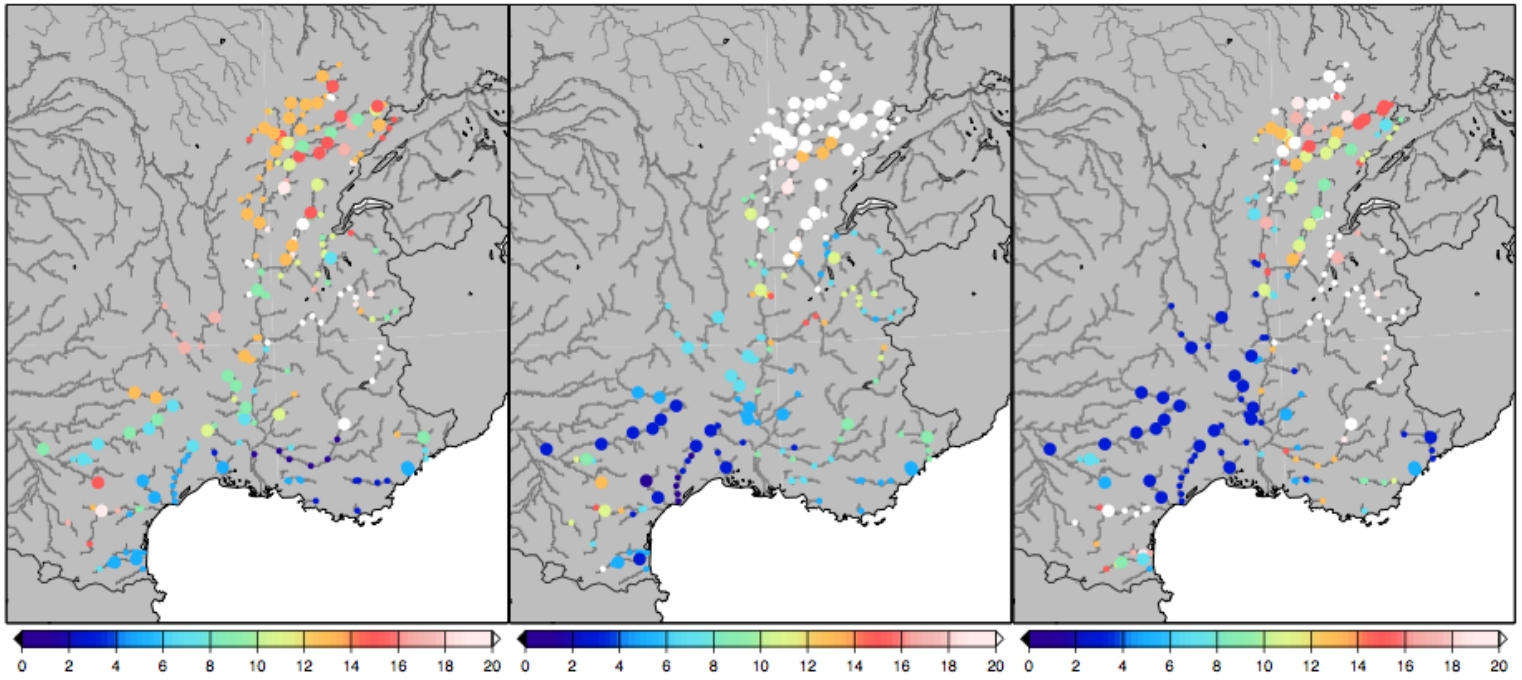


- Monitoring of droughts.
- Maps of SWI anomalies
- Comparison to the climatology.

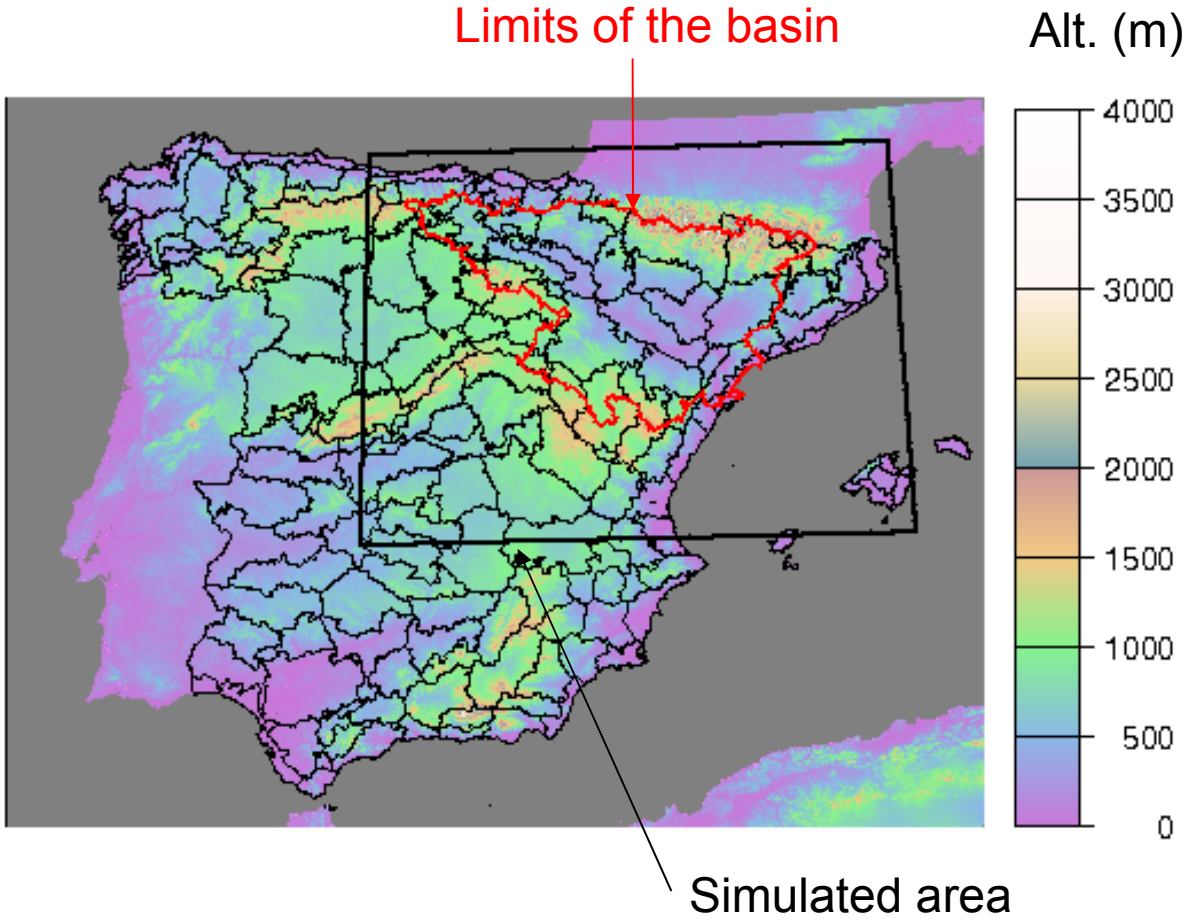
Impacts of Climate Change

- SIM is very well adapted to study the impact of climate change on the water cycle.
- There have been studies on many basins (Rhône, Adour, Garonne, Seine, etc.)
- Here we show the last study on the Mediterranean basins of France (Quintana-Seguí et al. 2011, NHESS): Comparison of three downscaling methods.

Return period (y) in 2035-2064 of the 10 year return flow in 1970-1999



The Ebro river basin



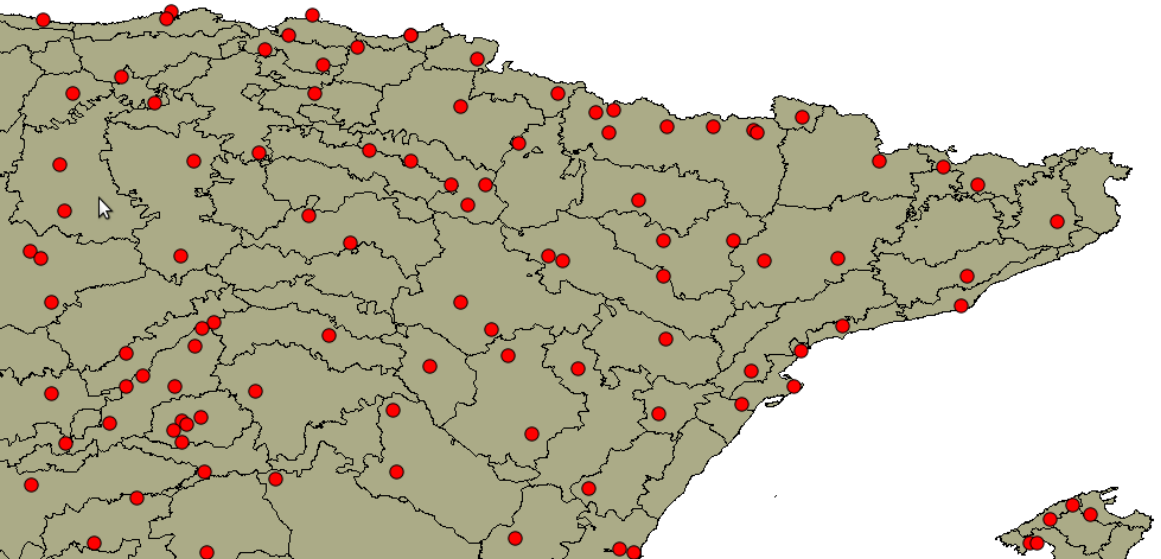
- Basin surface: 86,000 km^2
- High spatial and temporal variability of precipitation.
  - The Pyrenees play an important role.
  - Mediterranean and Atlantic influence.
- 187 reservoirs impounding 57% of annual runoff (Batalla et al. 2004).
- **The Ebro river basin presents many challenges for modellers.**

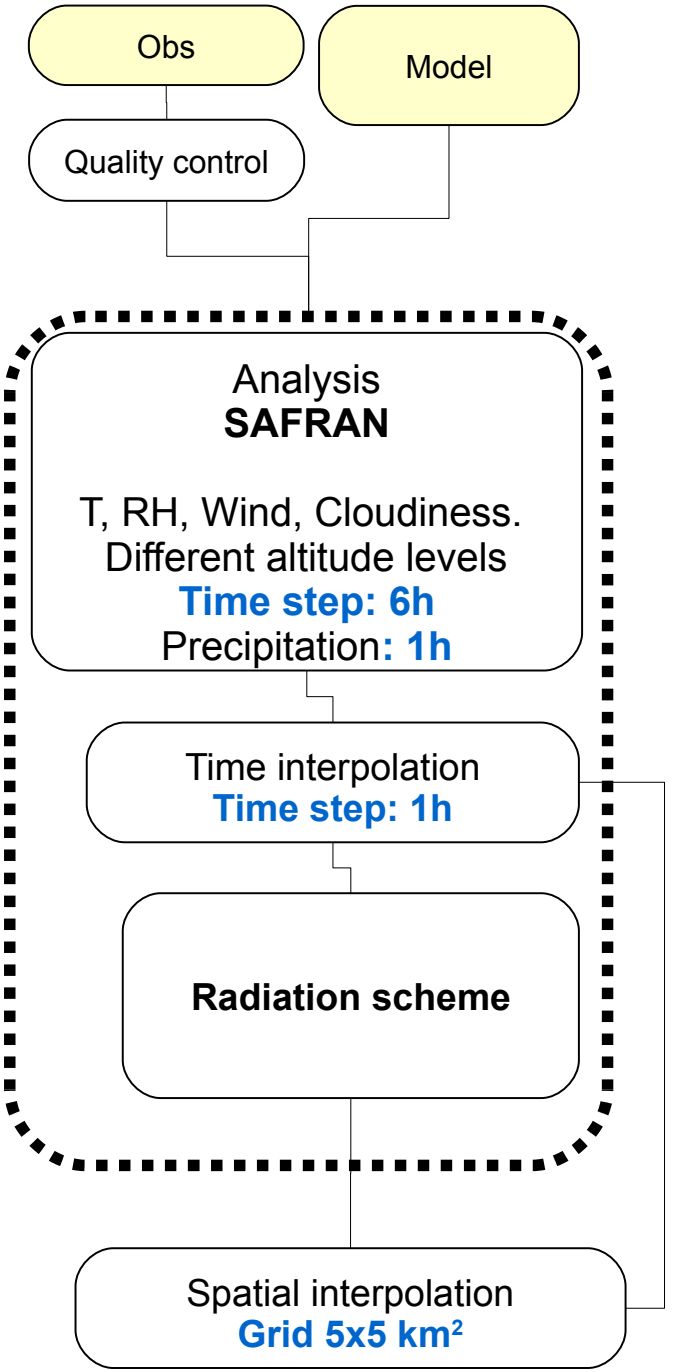
Meteorological analysis

- In order to force SURFEX **we need a high quality gridded dataset of observations**.
  - It must analyse all relevant variables to force the land surface model.
  - With high spatial and temporal resolution (~5 km, 1h)
- **SAFRAN** is our natural choice, because it is used in SIM France.
- In order to apply SAFRAN **we need all available meteorological data at screen level**: this must be done in collaboration with the national meteorological agency (AEMET).
- AEMET is also developing its own analysis system (SPAN), based on the HIRLAM analysis code.
- Our first task is to apply SAFRAN to the study area and compare it to SPAN, in collaboration with AEMET.

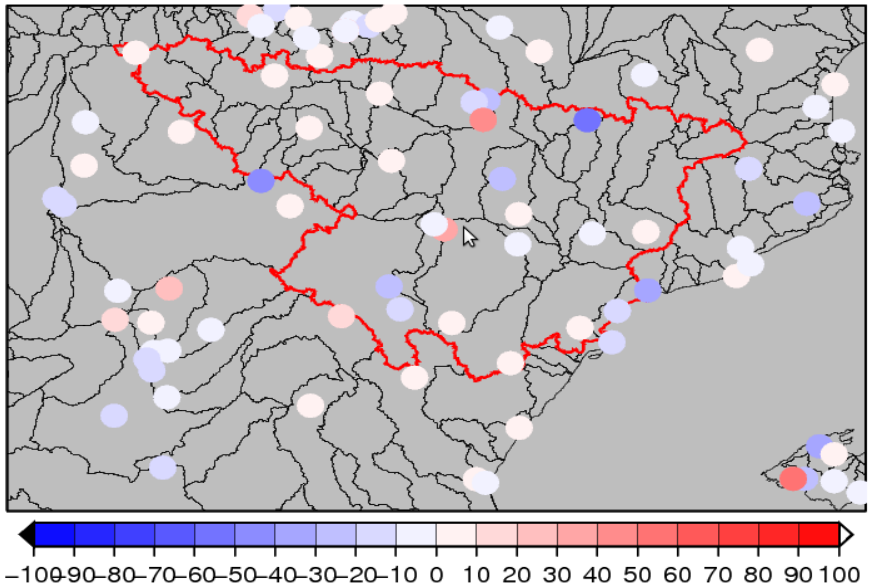
SAFRAN

- “Climatically homogeneous” zones
- Analysis at several altitude levels.
- The analysis is interpolated to a regular grid according to the altitude of the cells.
- The system assimilates observations every 6 hours (every 24 for precipitation), but it produces hourly data.

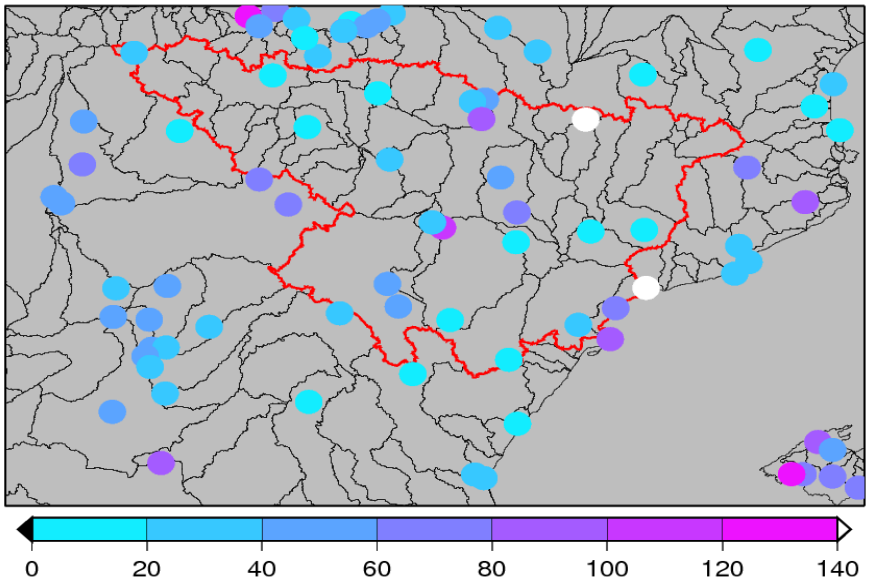




SAFRAN: preliminary results



Bias of daily Precip. (wet days) (%)



RMSE of daily Precip. (wet days) (%)

	Temperature (C)		Wind Speed (m/s)		Precipitation (mm/d)	
	<Bias>	<RMSE>	<Bias>	<RMSE>	<Bias>	<RMSE>
meteoalerta	0,0	0,9	−0,2	1,1	0,0	3,2
eurocatchment	0,0	0,8	−0,3	1,1	0,0	2,5
SAFRAN/F 0102	0,0	1,5	−0,3	1,4	0,0	2,4
SAFRAN/F 0405	0,0	1,4	−0,2	1,4	0,0	2,4

Stats in France from Quintana-Seguí et al. (2008)

The scores of SAFRAN in Spain are comparable to the scores in France.

Check our poster for more results.

Statistical downscaling for climate studies

The analog method as a MOS-like downscaling for ENSEMBLES RCM-precipitation

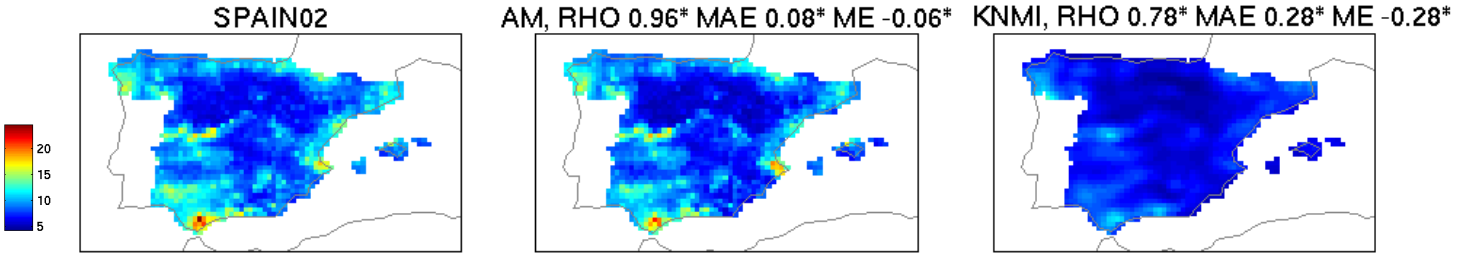
METHOD:

- Dynamical AND Statistical downscaling
- Analog method as a MOS, using the RCM simulated precipitation as predictor

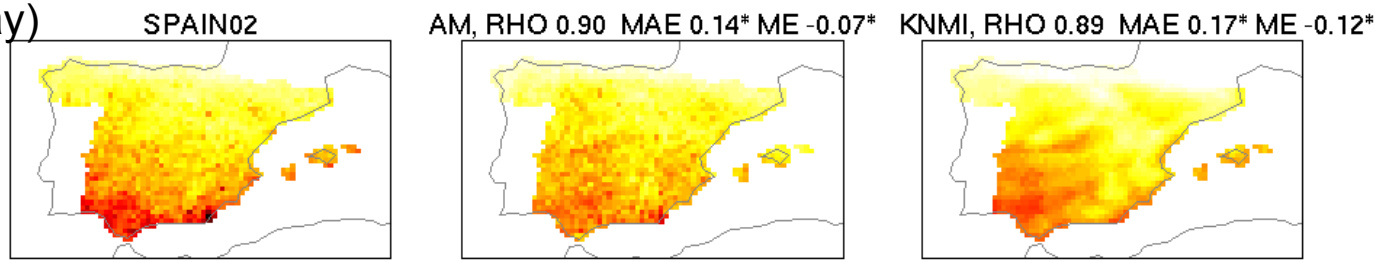
VERIFICATION:

- Overall, the MOS analog method is able to improve the reliability scores for all RCMs (10)
- It maintains the spatial coherence of the precipitation fields (which is very important for hydrology),
- it is parsimonious (so that one can assume that it is also robust) and transferable (since it performs well in the different climates of Spain).

SDII (mm/d)



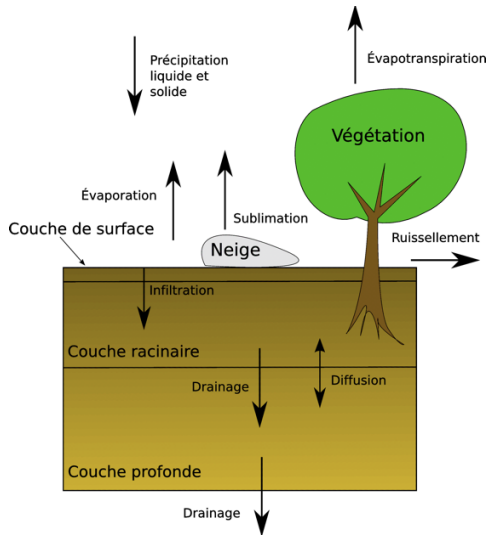
CDD (day)



MORE DETAILS --> Turco M., Quintana Seguí P., Llasat M. C., Herrera S., Gutiérrez J. M. Testing MOS-like Analog Precipitation Downscaling for ENSEMBLES Regional Climate Models over Spain. Submitted to JGR

Next steps for the Ebro application

- We are now finishing the implementation of SAFRAN.
    - With one year of data.
    - Next year we will probably be able to extend the period of the analysis.
- We will start implementing SURFEX in the next months, which will allow us to start studying the water budget of the basin.
- After implementing SURFEX, we will work on the simulation of river flow.
    - In order to achieve this objective, it will be necessary to collaborate with the relevant water and basin agencies. This is specially true in an influenced basin as the Ebro.
- Developing such a model requires the collaboration with many different kins of agencies in order to obtain data and knowledge. This requires time and a multidisciplinary approach.



Similar approaches in other basins

- SIM has been an inspiration for other research teams which are developing a similar approach in other basins.
  - Ebro (Spain)
  - Maritsa (Bulgaria)
  - Sebou and Tensift (Morroco)

Maritsa (Bulgaria)

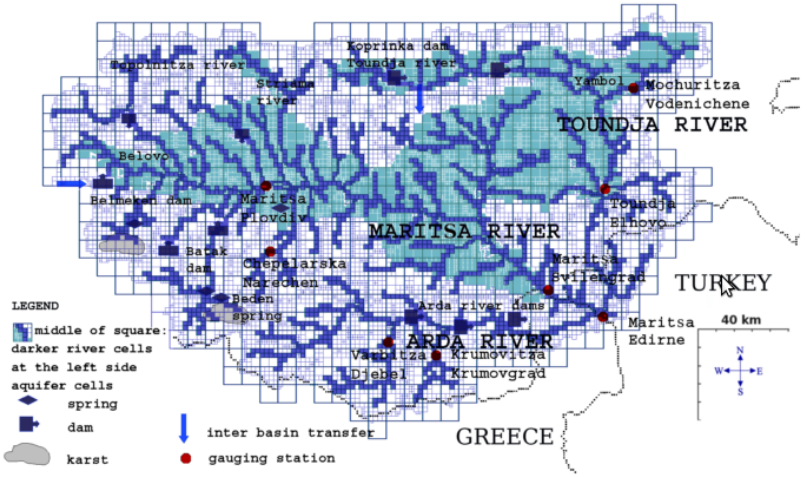


Fig. 1. Surface hydrological network of the Maritsa river system: the river meshes are in dark colour, grey colour represents the aquifer area; dams are shown with dark boxes; the larger springs with diamonds and river gauges with red circles; karstic areas in Maritsa river basin are shown too.

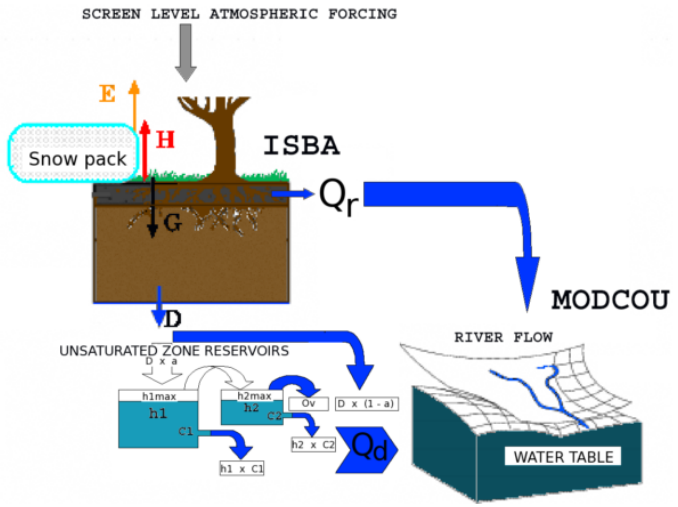
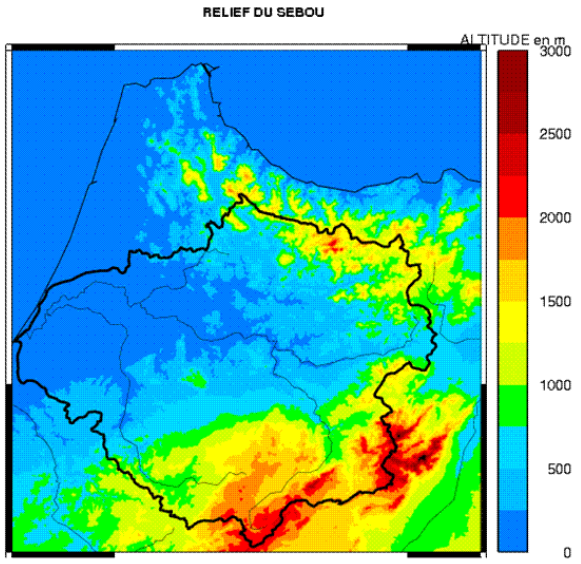
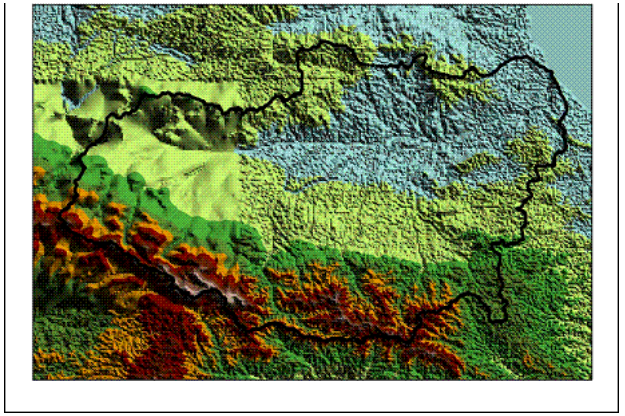


Fig. 3. Scheme of the ISBA – MODCOU coupled model with the 2 additional reservoirs for the drainage, representing the unsaturated layer: H – sensible heat flux, LE – evaporation (latent heat) flux, G – ground heat flux, D – ISBA drainage, Qr – ISBA surface runoff, Qd – final drainage.

- Hydrometeorological service of Bulgaria.
- Real-time monitoring and forecasting of the water budget and flows.
- Forced by a meteorological model (Aladin), not by a meteorological analysis.
- Snow is important: ISBA is well adapted
- Additional reservoirs were added to improve the slow component of the runoff.
- It shares common problems with other mediterranean basins: karstic systems, human influence.

Sebou and Tensift (Morroco)





- Météo-Maroc, IRD, Météo-France and Sisyphe.
- Semi-arid area with a snow component.
- Flash floods
- Agriculture is important on the Tensift basin.
- SAFRAN meteorological analysis.
- SURFEX land surface model.
- Hydrological model to be developped.

Conclusions

- Land surface models (SURFEX) are very interesting tools to study processes at the interface between the soil, the vegetation and the atmosphere.
- HyMeX is promoting the use of such tools in different basins and scales.
- The use of SURFEX in several basins will allow interesting intercomparisons.
- In order to use them, it is necessary to have good meteorological data. At such scales it is necessary to work together with national weather services.
- In order to get meaningful results in terms of discharge it is necessary to collaborate with water and basin agencies.
- On the Ebro river basins we are finishing the implementation of SAFRAN and we are validating it. In the next months, we will start working on SURFEX.

The Ebro river seen from Rasquera (Catalonia).

Main points to discuss in the PW7 working group

- Update the list of on-going or future modelling activity
- Data requirements for model input and evaluation: SOP, EOP, LOP.
- Data availability
- HyMeX data base
- Links with other TTM
    - TTM1: High-resolution (coupled, ensemble) modellling platforms for intense events.
    - TTM3: Regiona Climate modelling (Atmosphere-Ocean-Land)