Comparison and validation of two meteorological analysis systems in the Northeast of Spain

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General context

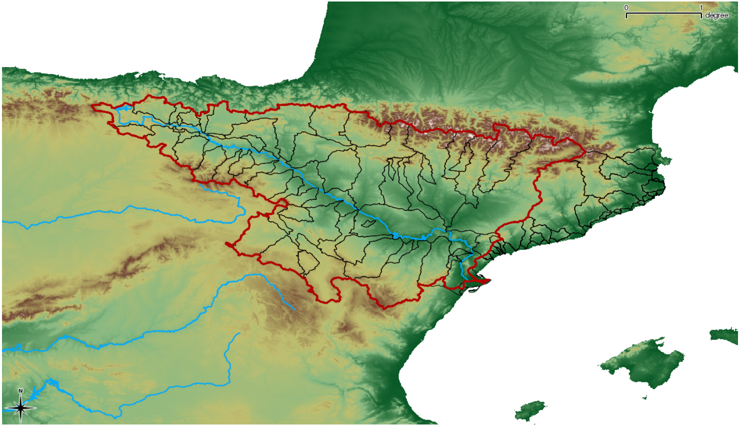
HyMeX

1. WG2
2. TTM2b: Distributed hydrological modelling over medium to large river basins

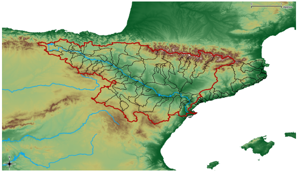
Current project of collaboration between the **Ebro Observatory** and **AEMET**.

1. Implementation and validation of a system to calculate the land-surface water balance.
2. Prototype on the NE of Spain.

Area of study



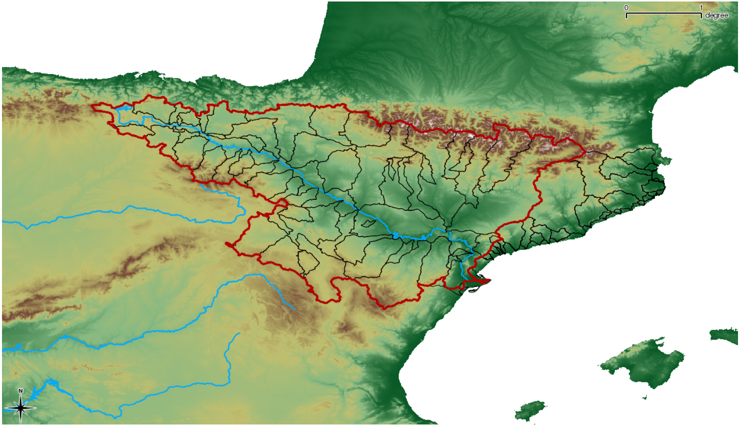
Area of study



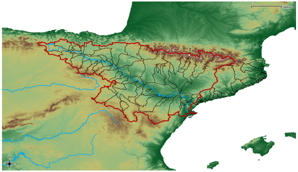
Ebro River Basin

- Basin surface: 86,000 km2
- High spatial and temporal variability of relief, precipitation, etc.
- Severely influenced by water management: 187 reservoirs impounding 57% of annual runoff (Batalla et al. 2004).

Area of study



Area of study



Catalan basins

- A total of: 16.600 km2
- Typically Mediterranean.
- Relief.
- Flash floods.
- Severely influenced by water management.

Area of study

These basins are

- vulnerable to drought and floods,
- sensitive to the impacts of climate change.
- water scarcity is a major problem
- severely influenced:
  - the society is changing how these basins work
  - the changes in the water cycle at these basins severely affects the society.

This is a very interesting challenge!

Objectives

General objectives

To develop and validate a distributed hydrological model for the NE of Spain.

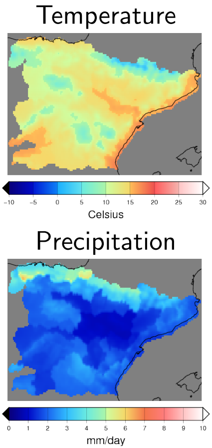
- Based on SAFRAN and SURFEX, following the steps of SIM France.

Specific objectives

1. Validation of the SAFRAN meteorological analysis system in NE Spain.
2. Comparison of SAFRAN to SPAN, an alternative system developed at AEMET.

Meteorological Analysis

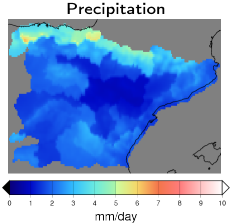
- In order to force the land-surface model we need high quality distributed meteorological data.
- A meteorological analysis system combines observed data with the output of a meteorological model to build the best estimate possible of the state of the atmosphere at a given moment.



Meteorological Analysis systems

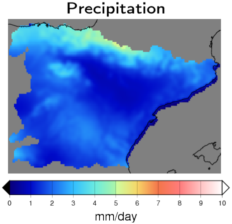
SAFRAN

- Optimal interpolation.
- Climatically homogeneous zones.
- Operational at Météo-France.



SPAN

- Optimal interpolation.
- Operational at AEMET and the rest of HIRLAM countries.



Data

First Guess

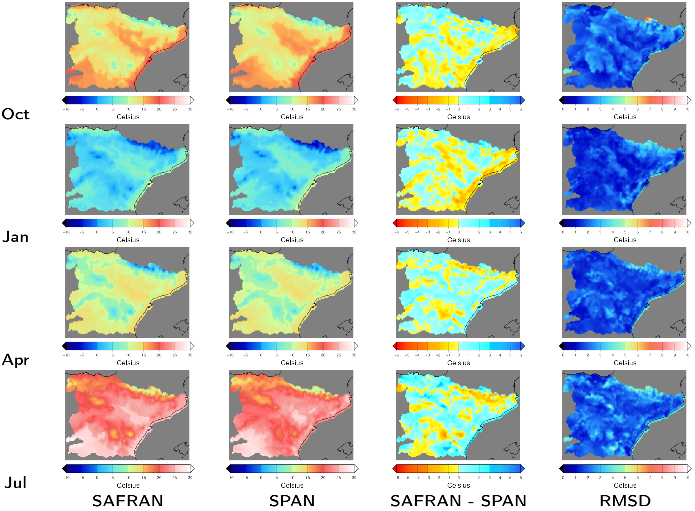
In both cases, the outputs of the operational 5 km HIRLAM model were used as first guess.

Observations

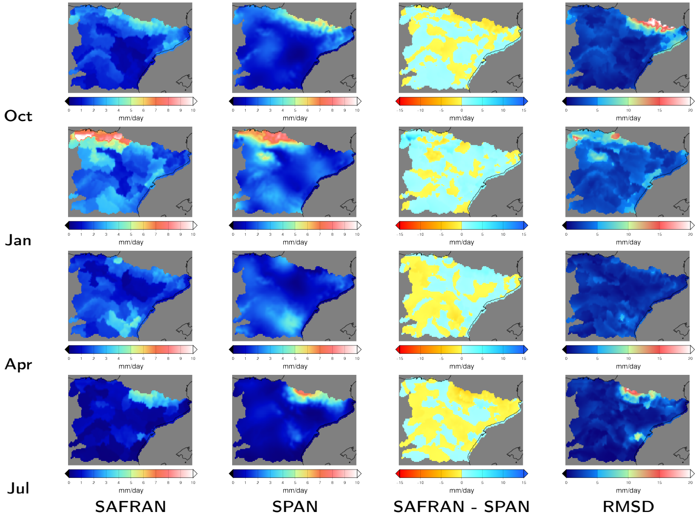
1 year: 2009/2010

Variable	Stations	Freq.
P	3509	Daily
T	128	Every 6 hours
RH	128	Every 6 hours
WS	128	Every 6 hours

SAFRAN vs SPAN: Temperature



SAFRAN vs SPAN: Precipitation



Comparison to the observations

Data sets

SF-M	SAFRAN interpolated to the same altitude as the observations.
SFR-M	**SAFRAN interpolated to the 5km grid**
SP	**SPAN**
HIR	HIRLAM operational meteorological model (5 km).

Dependent data

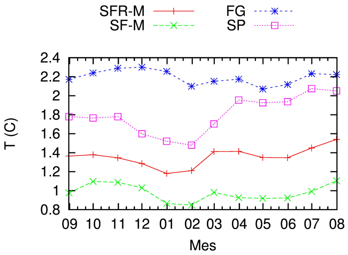
	< *Bias* >				< *RMSE* >			
Variable	SF-M	SFR-M	SP	HIR	SF-M	SFR-M	SP	HIR
T (℃)	-0.0	-0.3	-0.6	-0.8	1.0	1.4	1.9	2.2
WS (m/s)	-0.3	-0.4	-0.2	0.5	1.1	1.1	1.5	2.0
RH (p.p.)	0	0	-1	-1	7	8	10	13
P (mm/d)	-1.3	-1.1	-1.8	-4.0	6.4	6.4	7.4	11.7

Independent Data

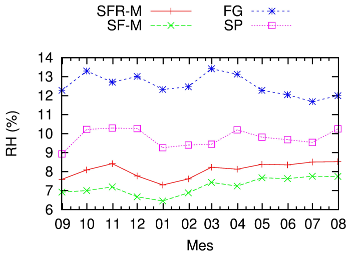
	Bias			RMSE		
	SF-M	SFR-M	SP	SF-M	SFR-M	SP
P. (mm/d)	-1.6	-1.4	-1.9	7.6	7.6	7.8

RMSE

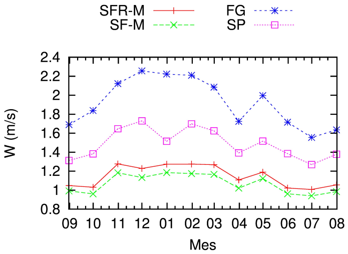
Temperature



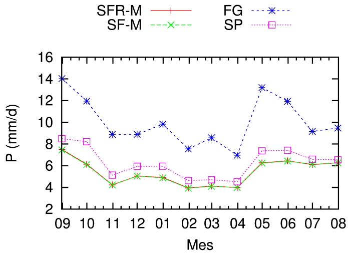
Relative Humidity



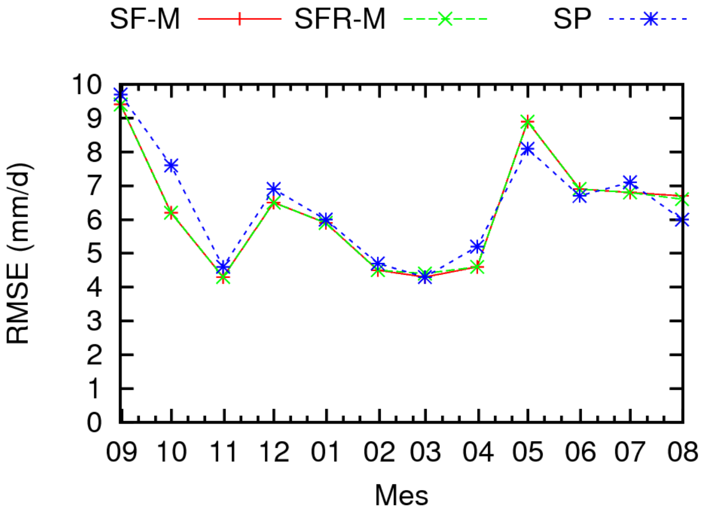
Wind Speed



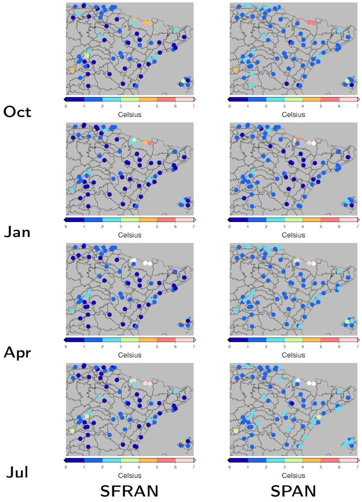
Precipitation



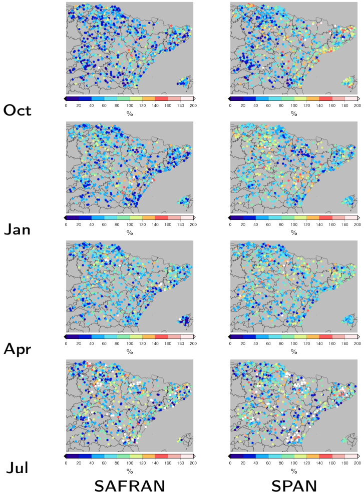
RMSE of Precipitation (independent stations)



RMSE of Temperature



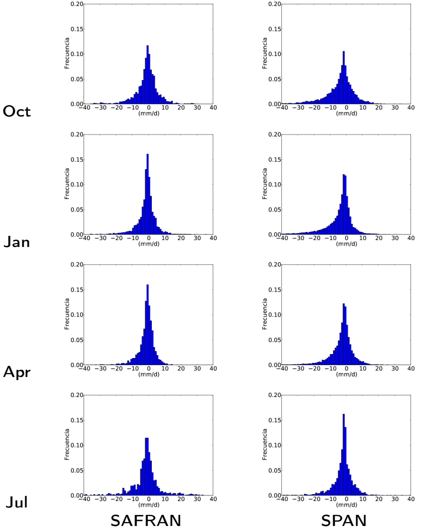
RMSE of Precipitation



Distribution of Errors of Precipitation (independent data)

Distribution of errors:

- Differences at each station and at each analysis time.



Conclusions on the validation

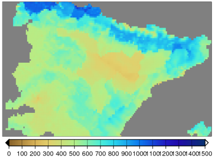
1. According to their performance, both systems can be used to force a land-surface model.
   - SAFRAN is slightly better than SPAN for most variables.
   - Results similar to those of SAFRAN/F.
2. SAFRAN's maps show the borders of the zones, which is an artefact. It doesn't affect the results.
3. Both SAFRAN and SPAN have more problems on the mountainous areas.
4. Our implementation of SAFRAN has been done in a way that it is easy to apply it in different areas.
5. Few results were shown, a technical report and an article are being written.

Current status and future work

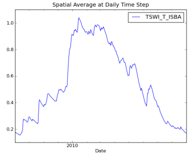
Task list

- ⊟ Meteorological analysis (SAFRAN)
  - ☒ Implementation
  - ☒ Validation
  - ☐ Extension of the period
- ⊟ Land Surface Model (SURFEX)
  - ☒ Implementation
  - ☐ Validation
- ☐ River routing
  - ☐ Implementation
  - ☐ Validation

Mean evapotranspiration (2009/10)



Aggregated evolution of the SWI (2009/10)



Main challenges

- The validation of a distributed hydrological model is far from trivial.
- Lots of data need to be gathered and evaluated.
- The human influence makes it more difficult, but more interesting.
- This will imply an enhancement of the collaborations with other research teams and agencies.

General Conclusions

- **SAFRAN is already implemented and validated**
- **We are approaching our objective to build a useful tool to study the continental water cycle in Spain.**
  - The tool is transferable and distributed.
  - The use of SURFEX facilitates the comparison of the results with other implementations in France, Bulgaria (Maritsa) and Morocco (Sebou, Tensift)
  - Having a tool as complete as SIM (France) will take some years,
  - but with SAFRAN+SURFEX we can already perform studies relevant to HyMeX.