Analysis of near-surface atmospheric variables on the NE of the Iberian Peninsula

P. Quintana-Seguí (1), J.J. Salas-Pérez (1), M. Turco (2)
1: Observatori de l'Ebre (Universitat Ramon Llull – CSIC), Spain.
2: GAMA Team, Dept. of Astronomy and Meteorology, Fac. of Physics, Universitat de Barcelona, Spain.

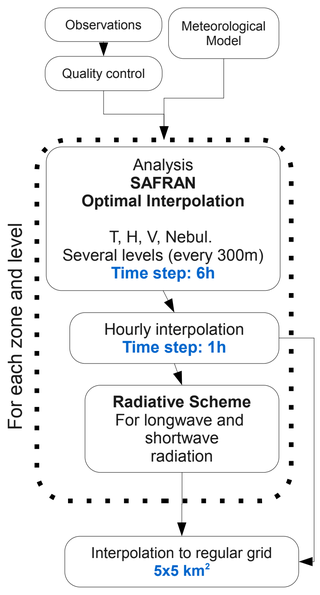
Introduction

SAFRAN (Durand et al., 1993; Quintana-Seguí et al. 2008) is a mesoscale atmospheric analysis system for screen-level variables. It produces a meteorological analysis at the hourly time step using all available ground data observations and the outputs of a meteorological model, by means of optimal interpolation. One of its main features is that it is based on climatically homogeneous zones (areas where spatial gradients of meteorological variables are not very relevant) and is able to reliably take vertical variations into account. Originally intended for mountainous areas, it was later extended to cover the whole of France (SAFRAN/F).

We have implemented SAFRAN on the NE of the Iberian Peninsula (SAFRAN/NEIP). SAFRAN/NEIP belongs to our effort to build a distributed hydrological model for this area, which is currently being developed within the context of HyMeX. This model is inspired by the French SIM (Habets et al., 2008).

Our objectives are to implement the analysis system, to validate it and to compare it to SPAN, which is a similar meteorological analysis system developed by AEMET (the Spanish meteorological office).

SAFRAN Meteorological Analysis



SAFRAN (Durand et al., 1993; Quintana-Seguí et al., 2008) provides the meteorological forcing to the system.

Inputs:
•All available observations
•First guess (meteorological model HIRLAM HNR)
Outputs:
• A gridded dataset of screen-level atmospheric observations:
  • all variables necessary to force a land-surface model.
  • high resolution: temporal (hourly) and spatial (5 km).

The analysis is done over irregular zones which are "climatically homogeneous".

Ideally, within each zone, the spatial gradients are only due to differences in topography (altitude). There must be observations within each zone.

There is one analysis for each zone and level (there is a level each 300 m.).

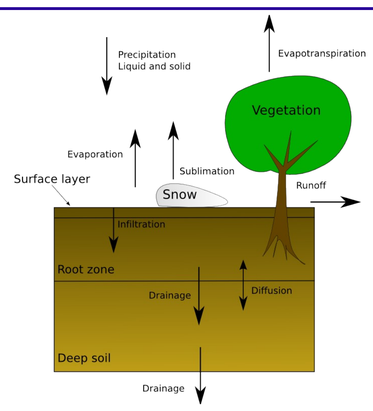
The method is well adapted to mountainous areas (common in the Iberian Peninsula), as it deals very well with vertical gradients.

Long and short wave radiation is calculated with a radiation scheme due to the lack of observations.

SPAN Meteorological Analysis

SPAN is part of the HIRLAM analysis and prediction system, but it can be used standalone to obtain an objective analysis of screen-level variables. Using optimal interpolation, at this very moment SPAN can analyze sea level pressure, wind speed, temperature and relative humidity. AEMET is currently extending it to also analyse precipitation.

SURFEX Land Surface Model



Our next step is to force the SURFEX land surface model with SAFRAN data.

SURFEX is a modular land-surface model. We will use the ISBA scheme (Noilhan and Planton, 1989) offline, forced by SAFRAN. ISBA calculates the water and energy balances.

We will use the simple force-restore method with three layers (as shown on the figure). In the future we might use a multi-layer diffusion version.

ISBA was first developed as a scheme for meteorological models, but it has been improved for hydrological contexts (Quintana-Seguí et al. 2009).

Summary and conclusions

• SAFRAN has been successfully implemented on the NE of the Iberian Peninsula.
•Our results are still preliminary:
  • more data of precipitation is needed.
  • the validation was not done using independent data.
• The choice of SAFRAN for this area of study is pertinent, as it performs similarly as it does in France, where it is operationally used in many contexts.
• The meteorological alert zones are generally homogeneous, nevertheless, our preliminary results show that the division in basins (eurocatchment) is better, mainly for precipitation, which is not a surprise from an hydrological perspective.
  • The meteorological alert zones were not defined using an objective methodology, they were defined using the experience of AEMET's forecasters. This study is an indirect validation of the homogeneity of the zones.
• We are at the beginning of the comparison between SPAN and SAFRAN. We already can see that there are differences in their respective spatial structures.
• We are in the right direction to build a model similar to the French SAFRAN-ISBA-MODCOU (Habets et al. 2008, Quintan Seguí et al., 2009).
  • The availability of a good data set is usually the major difficulty to overcome before using a land-surface model.
• The SAFRAN gridded database (which include many atmospheric variables of interest) and the simulations of the water balance (in the present and future climate) will be very useful for research on hydrology (water resources, drought, etc.), agronomy, risk of forest fires, etc.

References

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Acknowledgements

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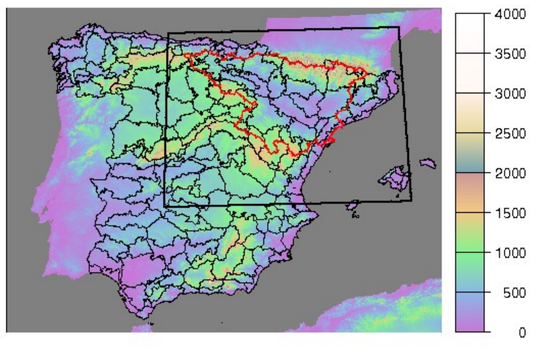


Study area
•NE of the Iberian Peninsula (black square)
•Focus on
  • the Ebro river basin (red line)
  • Internal basins of Catalonia (NE tip of the Peninsula)
• The black borders show the meteorological alert-zones of AEMET, the Spanish meteorological service.

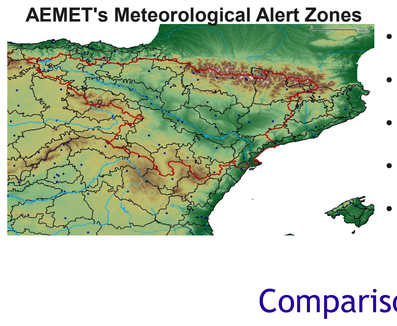
Time period:
Our first prototype of the system is applied to the hydrological year **2009/2010**.

Results

SAFRAN Zones

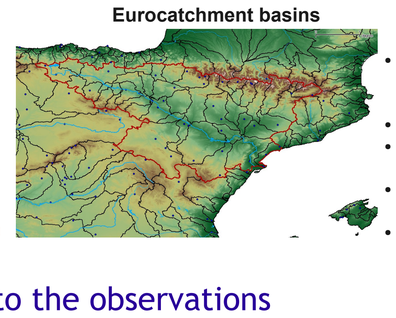
Two possible sets of "climatically homogeneous" zones are being tested:

AEMET's Meteorological Alert Zones



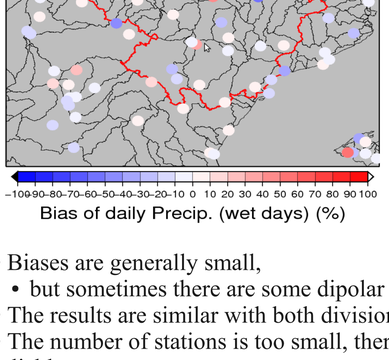
- Defined using the experience of AEMET
- They respect the climatology
- They respect the adminstrative borders
- This is the same method used in France
- The French zones are smaller than the Spanish ones.

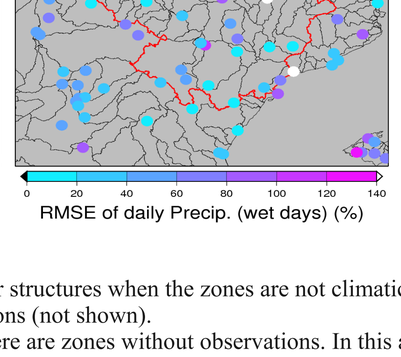
Eurocatchment basins



- The catchment is the natural space unit of hydrology
- Based on topography
- They respect water management borders
- *Eurocatchment*: It is official in the EU.
- Size is very variable

Comparison of SAFRAN to the observations





•The scores were calculated using the same data used to do the analysis, so it is not an independent validation.
•SAFRAN's vertical gradient was used to interpolate the analysis to the altitude of the station, to avoid errors due to the spatial interpolation.
•A day is wet if precipitation > 1 mm/d.

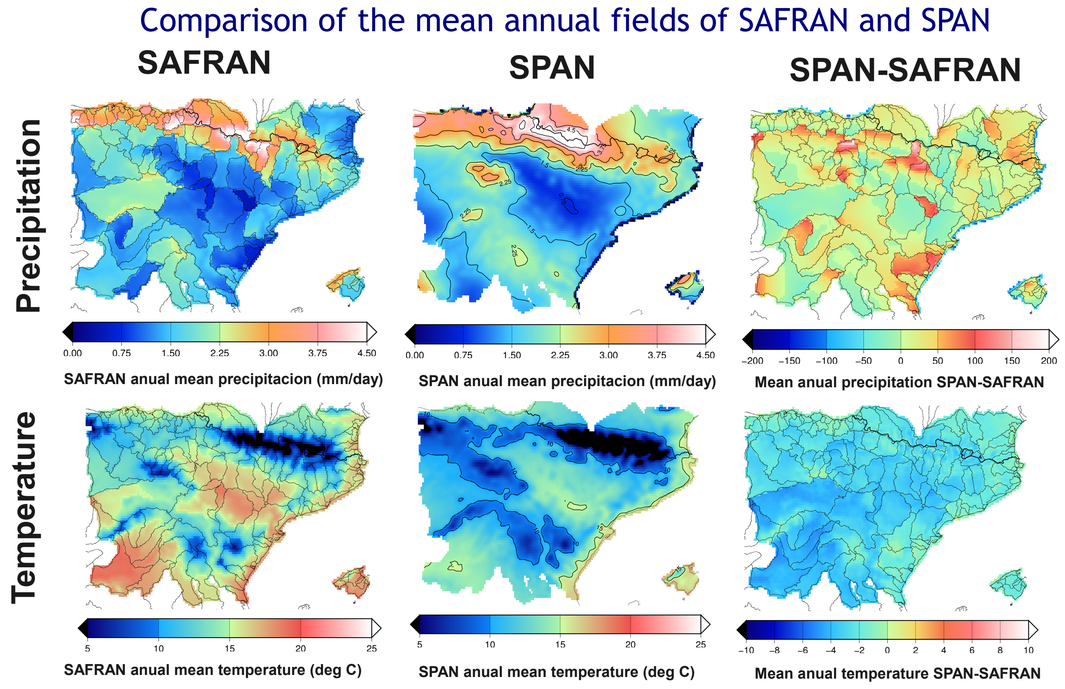
• Biases are generally small,
  • but sometimes there are some dipolar structures when the zones are not climatically homogeneous.
• The results are similar with both divisions (not shown).
• The number of stations is too small, there are zones without observations. In this areas, SAFRAN cannot do the analysis reliably.

In the following table we compare the general statistics using both sets of zones and we compare them to the scores in France (from Quintana-Seguí et al 2008).

	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

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

Comparison of the mean annual fields of SAFRAN and SPAN



This preliminary comparison shows the main differences between SAFRAN and SPAN: mainly the effect of the use of zones by SAFRAN which creates discontinuities in the borders.

Future work

Concerning the meteorological analysis, we will:
• dramatically increase the number of observations of temperature and precipitation.
• validate SAFRAN using independent data.
• choose the definitive set of zones (probably eurocatchment)
• compare it with the first guess
• continue the comparison with AEMET's SPAN analysis system, which also uses optimal interpolation.

Concerning the land surface model, we will:
• implement it (soon).
• force it with SAFRAN and SPAN (to compare the differences).
• validate the system with independent data (soil moisture, fluxes, etc.)

Within the HyMeX project we will:
• Compare the hydrological on the Ebro with other similar models taking part in HyMeX.
• Compare our model and the Mediterranean Land Data Assimilation System (MELDAS) on the Ebro river basin.

Impacts of climate change:
• The system described, once fully implemented, will also be used to study the impact of climate change.
•We are currently developing a statistical downscaling system especially suited to the Mediterranean region of the Iberian Peninsula (within the esTcena project). The downscaling system, will use the SAFRAN database as the observational database and will create forcing data suitable for use with SURFEX and any other distributed surface model (including hydrology, agronomy, etc.).

Hydrology:
• In 2012 we plan to couple SAFRAN-SURFEX to a routing scheme in order to simulate river discharge.