Extending the SAFRAN meteorological analysis system to the Iberian Peninsula and the Balearic Islands. Analysis of its performance and applications.

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Introduction

- The physical simulation of the land surface is very important in many areas study such as climate, meteorology, hydrology.

- In Spain:
  - **land-surface – atmosphere coupling**: transition between wet and dry regimes.
  - **Water resources, droughts, floods**.

- A high quality gridded dataset of meteorological variables is necessary.

- A new gridded dataset of screen-level meteorological variables has been created.
Land-surface and underground water coupling

- **eartH2Observe (FP7) Spanish Case Study.**

- Drought risk is important in Spain.

- Non linearity between meteorological and hydrological droughts.
  - Underground water adds memory to the system.

- Coupling between underground water and the land surface processes.

**Objectives:**
- improve LSMs in order to better simulate the coupling between the land-surface and the water table.
- Understand the role of underground water during droughts in Spain.

- A good meteorological gridded forcing dataset is needed to perform these simulations.
Land-surface and coupled regional climate modeling

- MARCO project (Spain) is working on improving the next generation of RCMs.
  - Contribution to the international HyMeX program
- RCM models are evolving rapidly:
  - Regional Climate System Model (RCSM).
- Coupling: Each part of the system must be well represented, including the interactions with the other components.
- Land-Surface models must be improved.
- Offline high-resolution simulations are used in order to improve LSMs.
- A good gridded meteorological forcing dataset is needed to perform these simulations.
## Available meteorological forcing datasets for LSM simulation in Spain

<table>
<thead>
<tr>
<th>Product</th>
<th>Available in Spain</th>
<th>Sufficient Spatial resolution</th>
<th>Long period?</th>
<th>Enough variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERA-Interim, WFDEI, etc.</td>
<td>Yes. Global.</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>E-OBS</td>
<td>Yes. Europe</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Spain02</td>
<td>Yes. Spain.</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>MESAN</td>
<td>No. Sweden</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>SAFRAN</td>
<td>No. France</td>
<td>Yes</td>
<td>In France</td>
<td>Yes ++</td>
</tr>
<tr>
<td>MESCAN</td>
<td>Yes. Europe</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>SPAN (HIRLAM)</td>
<td>Yes. Spain</td>
<td>Yes</td>
<td>Maybe</td>
<td>Yes</td>
</tr>
</tbody>
</table>
SAFRAN meteorological analysis system

- CNRM-Météo France.
- Validated in France by Quintana-Seguí et al. (2008), Vidal et al. (2010).
- A 70 year analysis is available in France with many users and applications.

Observations → Meteorological Model (first guess) → Quality control

Climatically homogeneous zone

Optimal Interpolation
- T, RH, W, C.
- One value for each 6h time step
- Precipitation 1d time step
- 300 m. layers.

Radiation Scheme
- For visible and IR downward Radiation.

Spatial Interpolation
- Grid 5x5 km²
SAFRAN analysis in NE Spain.

- Pilot study.
- 1 year of data: 2009/10.
- First guess: AEMET HIRLAM HNR (5km).
- Observations: AEMET.
- Comparison with SPAN (precipitation) and HIRLAM.
- Zones: meteorological warning zones.
### SAFRAN analysis in NE Spain

#### Bias

<table>
<thead>
<tr>
<th></th>
<th>SAFRAN Analysis</th>
<th>HIRLAM Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>T (°C)</td>
<td>-0.2</td>
<td>-0.8</td>
</tr>
<tr>
<td>W (m · s⁻¹)</td>
<td>-0.2</td>
<td>0.5</td>
</tr>
<tr>
<td>HR (pp)</td>
<td>0.1</td>
<td>-0.4</td>
</tr>
<tr>
<td>C (oktas)</td>
<td>-1.4</td>
<td>-1.0</td>
</tr>
<tr>
<td>P (mm d⁻¹)</td>
<td>0.0</td>
<td>0.2</td>
</tr>
</tbody>
</table>

#### RMSD

<table>
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<tr>
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<th>SAFRAN Analysis</th>
<th>HIRLAM Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>T (°C)</td>
<td>1.4</td>
<td>2.2</td>
</tr>
<tr>
<td>W (m · s⁻¹)</td>
<td>1.3</td>
<td>2.0</td>
</tr>
<tr>
<td>HR (p.p.)</td>
<td>8.6</td>
<td>12.6</td>
</tr>
<tr>
<td>C (oktas)</td>
<td>3.0</td>
<td>3.2</td>
</tr>
<tr>
<td>P (mm d⁻¹)</td>
<td>3.2</td>
<td>6.8</td>
</tr>
</tbody>
</table>

- Good performance in general.
- Performance in Spain, close to the performance in France.
- Improvements needed for cloudiness.
Temperature and wind error maps

RMSD of mean annual temperature (°C) between SAFRAN and the dependent stations.

- Temperature errors are low and very homogeneous except on the mountain areas.

Relative bias of mean annual wind speed (%) between SAFRAN () and the dependent stations.

- Wind bias is negative in general, with exceptions. Strong contrasts in some close stations.
Validation of precipitation
SAFRAN, compared to SPAN and HIRLAM

- Validation of SAFRAN and SPAN with independent data.
- Both SAFRAN and SPAN are close and much better than HIRLAM HNR.

Extending SAFRAN to the Iberian Peninsula and the Balearic Islands

- First guess: ERA-Interim.
- Observations: AEMET.
- New zone set.
  - Smaller zones, closer in area to the French ones.
  - It would be possible to extend the analysis to Portugal.
- Period:
  - 12 year period already analyzed, it will be ready in a few months (eartH2Observe).
  - 30 year period to be performed in the MARCO project.
- Precipitation station network (AEMET).
- Climatically homogeneous zones.
Extending SAFRAN to the Iberian Peninsula and the Balearic Islands

- SAFRAN also analyzes wind speed, relative humidity and cloudiness.
- It also simulates downward IR and VIS radiation.
- 30 year period will be produced within the MARCO project.
Conclusions

- A high resolution (5 km) analysis has been produced.
- To date, it is the only high resolution product that provides all necessary variables to force a LSM in Spain.
- A 1 year pilot implementation has been validated.
- SAFRAN's scores in Spain are close to those of SAFRAN in France.
- SAFRAN and SPAN perform similarly (precipitation).
- SAFRAN has some known limitations (biased wind, errors at the zone borders).
- Mountain areas, which are critical for hydrological processes in Spain, are more difficult.
- The analysis is being extended to the Peninsula and the Balearics.
- The zone map has been redefined.
- A longer period will be produced.
- We plan to compare SAFRAN to other similar products such as Spain02 and SPAN on the longer period.
- The database will be shared to the scientific community.
- We want to thank Candelas Peral and Isabel Martínez Marco (AEMET) for their help with SPAN and Eric Martin (Météo-France) for his help with SAFRAN.
Thank You

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http://pere.quintanasegui.com
Validation of precipitation

Quintana Seguí et al.,
*Meteorological analysis systems in north-east Spain. Validation of SAFRAN and SPAN.*
Journal of Environmental Informatics. In Review.