Mixing weather types and daily precipitation modelling as an approach to obtain climatic precipitation regions in mountain areas

Marc Lemus-Canovas\(^1\), Joan A. Lopez-Bustins\(^1\), Laura Trapro\(^2\) & Javier Martin-Vide\(^1\)

\(^1\)Climatology Group, Department of Geography, University of Barcelona, c/ Montalegre, 6, Barcelona, PO: E08001
\(^2\)Snow and Mountain Research Center of Andorra (CENMA-IEA), Institut d’Estudis Andorrans, Av. Rocafort, 21-23, Sant Julià de Lòria, PO: AD600

Objectives

The present study addresses three main objectives:

1. to perform an objective synoptic classification centred on Western Europe, and therefore valid for the Pyrenees;
2. to interpolate the mean daily precipitation (MDP) values for each weather type;
3. to present an improved-proposal for objective regionalization of precipitation regimes in the Pyrenees by means of a non-supervised clustering method;
4. generating a synthetic annual precipitation series for each region derived from the previous clustering.

Study area and database

- Daily mean sea level pressure (mslp) was provided by the ERA-20C reanalysis at 18 UT, enveloping the area 30°N-55°N and 12°W-15°E at a spatial resolution of 1° for the 1961-2010 period.
- The precipitation database used was provided thanks to the international cooperative effort of 4 meteorological institutions within the framework of the Interreg Project POCTEFA CLIM’PY: AEMET (Spain), MeteoFrance (France), SMC (Catalonia, Spain) and CENMA-IEA (Andorra).
- We used 349 daily precipitation series distributed throughout the study area.
- All the covariates used in the regression models were developed from a 90 x 90 m DEM extracted from the Shuttle Radar Topography Mission (SRTM).

Methods

- To derive the atmospheric circulation catalogue, we applied a S-mode PCA and a K-means clustering to the mean sea level pressure data.
- Then, mean daily precipitation maps were computed by each weather type and for 3 different regression models: Generalized Linear Models (GLM), Generalized Additive Models (GAM) and Regression Kriging (RK).
- Finally, we used the mean daily precipitation models based on the weather types to derive precipitation regions and their annual trends, following the scheme showed in Fig. 2.

Synoptic classification: deriving the main weather types (WT)

![Synoptic classification: deriving the main weather types (WT)](image)

Options for the objective clustering

- PCA in precipitation maps
- Standardize each precipitation series and calculate a regional mean series for stations included inside each region
- Rescaling to fall in an interval established for PCA
- Transform to the standardized series to get a mean precipitation series
- Pick the mission method (C = U, L,...) and select the best clustering map

Precipitation regions and their annual trends

![Precipitation regions and their annual trends](image)

The results obtained from the annual trend of the daily frequencies of the WT (Fig.3) indicated a statistically significant decrease in WT dominated by low pressures, i.e. weather types that denote high MDP records. 4 WT with a predominance of high pressures and low MDP values tended to show an statistically increase.

Conclusions

- A robust method to obtain precipitation regions in mountain areas mixing weather types and spatial daily precipitation amounts was presented.
- This regionalization allowed us to study the behaviour of precipitation by regions with the same pluviometric characteristics.

Replicability

The present study was funded by CONACYT-IESB 2009/1 and by the MINECO project CGL2014-57979-P (Spanish Ministry of Economy and Competitiveness to MRI and JALB). The authors thank the CENMA-IEA for the financial support. This work was developed within the European project POCTEFA CLIM’PY which was supported and funded by the European Union (POCTEFA-2008-2009). It has been granted with a predoctoral FPI grant (Spanish Ministry of Education, Culture and Sports).

Acknowledgements

The authors thank the CENMA-IEA for the financial support. This work was developed within the European project POCTEFA CLIM’PY which was supported and funded by the European Union (POCTEFA-2008-2009). It has been granted with a predoctoral FPI grant (Spanish Ministry of Education, Culture and Sports).