CLIMATIC TRENDS IN SNOW OBSERVATIONS IN ANDORRA

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ABSTRACT: Andorra has three historical climate series of temperature, precipitation and snow thickness recorded by FEDA (Forces Elèctriques d'Andorra, in his moment FHASA), since September of 1934 in three different sites: Central Encamp (1,145 m), Engolasters (1,640 m) and Ransol (1,640 m). These observations record series of continuous 83 years, one of the longest in the Pyrenees and covering the last three international climatic periods. Within the framework of the CLIM'PY project (Interreg V - POCTEFA), whose objective is the analysis of climate change in the whole of the Pyrenean massif, an exhaustive work of quality control and analysis of the databases daily scale as well as the homogenization of the series on a monthly and daily scale. This work describes the behavior and the evolution of the principal snow variables in Andorra: snow thickness and snow duration. On one hand, based on the daily-accumulated snow thickness series, the analysis focuses on the seasonal and annual values obtained from the total thickness and the number of days with snow on the ground. On the other hand, the analysis of the series also aim to detect the existence of a statistically significant climate trend, both in the snow precipitation and the duration of the snowpack and deepen in the possible effects of Climate Change on nivological variables.

KEYWORDS: Snowpack, daily-accumulated snow, Climate Change.

1. INTRODUCTION

Andorra has a mountain climate very influenced by the geographical environment and topography, with a high local variability. In this case, it has a mountain climate with Mediterranean influence and a subcontinental tendency (Esteban et al., 2012).

The northernmost parts of the territory, receive a greater Atlantic influence with more advections of north and northwest, however in the south of the country, the influence of a Mediterranean character is remarkable, with south advections.

This work focuses on the series of snow observations of the Ransol weather station, located in Canillo, at a valley bottom at 1,645 m. Previously, a second detailed review and quality control of the daily data of maximum and minimum temperature and the daily precipitation of the series was performed by Esteban et al. (2017, in publication).

The study focuses on the analysis of snow precipitation and snow accumulation. In the preparation of the series to continue working with “Engolasters”, at a similar altitude but not at the bottom of the valley, and “Central”, at a lower altitude and more in the center of Andorra but also in the bottom of the valley as Ransol.

These three weather stations have records since 1934 with maximum and minimum temperatures, precipitation and heavy snow daily. Subsequently, the National Meteorological Service (SMA) installed a network of stations to cover the territory at different altitudes. Later, the snow and Mountain Research Center of Andorra (CENMA) also deployed a network of high-mountain automatic weather stations. Figure 1 shows the stations used for the search and the other stations to cover whole territory.

2. DATA AND METHODS

Due to the long record available for the FEDA station, these series were used for climate change studies. There is a first homogenization on an annual and monthly scale. Work is currently being done on daily homogenization. Based on the verification of the meteorological data used by the CLIM'PY European project. It is a project of the POCTEFA program within the EU that studies climate change in the Pyrenees from the daily meteorological series that existed from 1950 to 2015. From the Andorran series together with the series

provided by the Meteorological Service of Catalonia (SMC) and the Météo France (MF) service will be done a characterization of the climate present in the Pyrenees and the different future projections, in temperature, snow precipitation and the snowpack and his evolution.

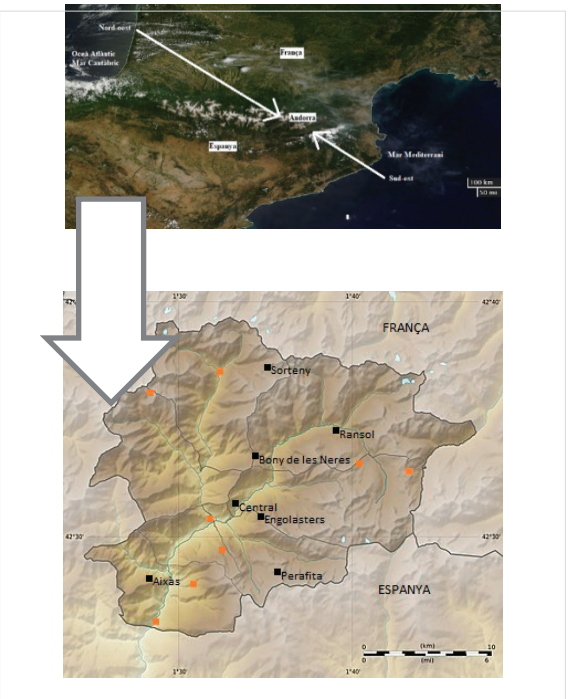

Figure 1: Map of Andorra with CENMA-IEA (Snow and Mountain Research Center of Andorra, Andorran Research Institute) and FEDA weather stations. In orange, there are other stations.

The quality control was devoted to identify the errors of observation, recording or transmission of the data in a daily basis. On one hand, the values of precipitation were exhaustively contrasted during the winter period considering the 3 stations. Identical quality control was performed with high precipitation values, including decimals, between 3 stations. For exemple the repetitions of precipitation values for three days in a row, including decimals, in 1 or several stations. On the other hand, recent snow thickness in days without significant precipitation and high temperature were identified. Notorious variation of the thickness of snow, compared to the previous day-later, without precipitation was another criteria used to identify an clean erroneous values together with the days of melting and maintenance of the snow thickness during several days of minimum thicknesses of snow (1-2 cm), without low temperatures, the new snow from one day to the other surpassing the 95th percentile (10 cm), the days were new snow exceeds the 80th percentile (50 cm), or the consistency of the collected precipitation and the new snow is 5 mm by 5 cm. Finally, the coherence between the minimum temperature and the new snowfalls was checked. These filters have been used to control the whole snow database.

3. RESULTS

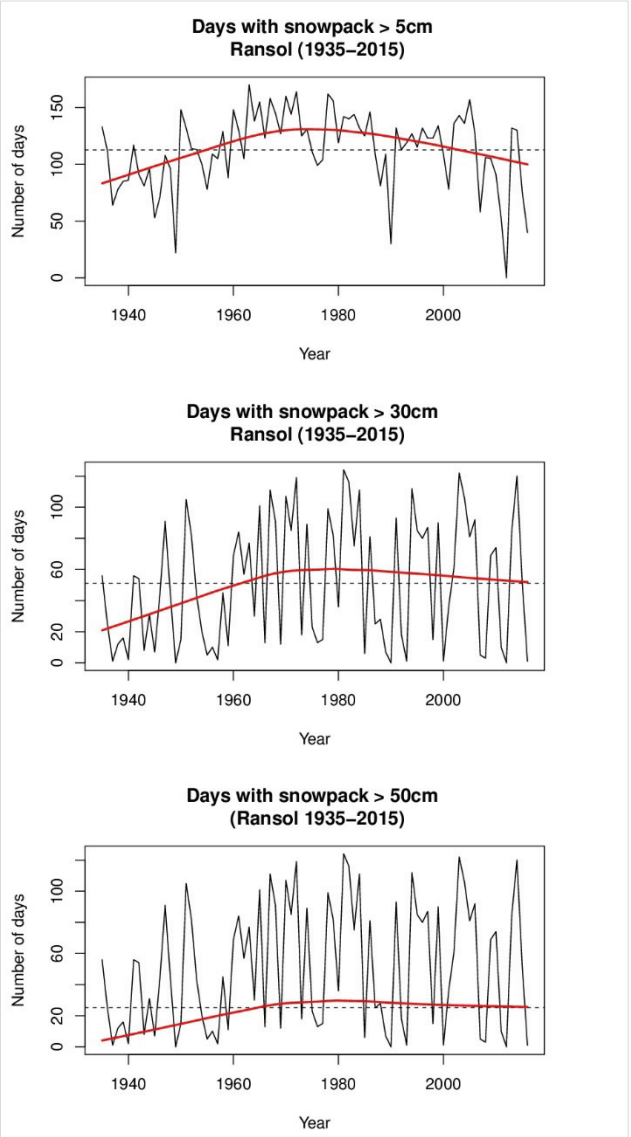

Figure 2: Number of days with snowfall above thresholds 5cm, 30cm and 50cm

After the process of quality control, a negative climatic signal was detected in the number of days with more than 5cm snowpack and more slightly in the number of days with more than 30 cm and 60 cm since 1970's. Until the 70's a slightly positive trend is detected. However no of these trends

were statistically significant due to the high inter-annual variability.

4. CONLUSIONS

Ransol is the best placed weather station with a long historical record to work the potential climatic trend of snow variables. The quality control permitted to increase the quality and the reliability of the series to perform climatic trend analysis. After the quality control process, the analysis showed no statistical significant climatic trend of all the snow variables studied in this research. Currently, we are working on a national database of snow obervations with all the snow measurement points available in the Country were the same process of quality control and climatic analysis will be performed. Quality control allowed an improvement of the series highly required to study and analyze snow precipitation, the cover of the snowy mantle and his potential future evolution in a context of climate change.

ACKNOWLEDGEMENT

CENMA acknowledges the 2015 grant from the Andorran Government of the complementary call for European aid POCTEFA 2014-2020, Ref. AUEP002-AND / 2015.

Autors also thank to Forces Hidroelèctriques Andorra (FEDA).

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