Evolution of observed daily temperature and precipitation extremes in the Balearic Islands

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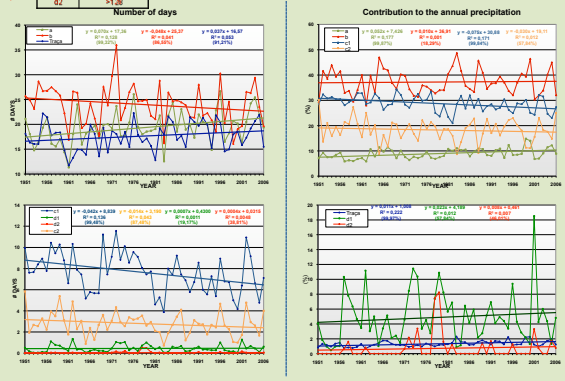
Framework and objectives

- Climate is characterized by the statistical distributions of atmospheric parameters.
- Typically, climate evolution is analyzed by means of temporal changes in the basic attributes of the distributions, such as the mean or the standard deviation.
- In this study, we extend previous analysis of climate change in the Balearic Islands during the last decades, focusing on the distribution of extremes.
- The main objective of this research is to detect tendencies in the frequency of occurrence of extreme episodes of 24h precipitation as well as daily max and min temperatures in various locations of the archipelago.
- As a first step, we quantify the changes in the annual frequency of extremes by means of linear trends derived using least squares fit.

Daily precipitation

Category	Precipitation (mm)
Traça	<1
a	1-4
b	4-16
c1	16-32
c2	32-64
d1	64-128
d2	>128

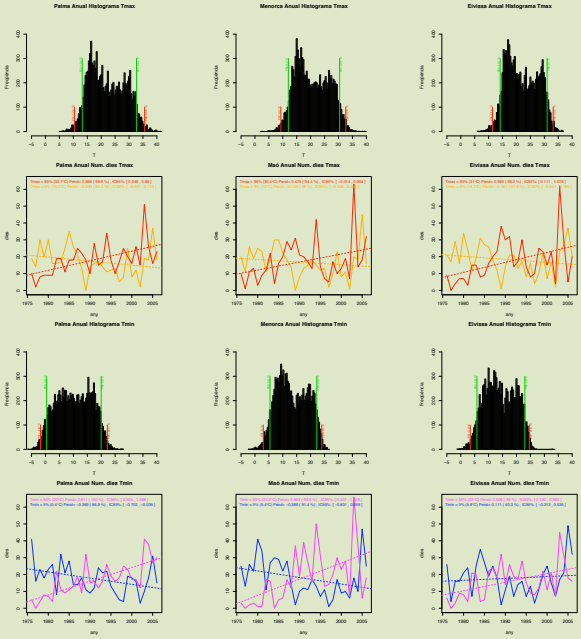
- The AEMET (prev. INM) archives quasi-continuous series of 24h precipitation records (PA24h) over the period **1951-2006** for 18 stations.
- We compute the histogram of PA24h using categories based on powers of 2.
- For each category, the yearly frequency and the relative contribution to the annual total is analyzed and a linear trend for each one is computed.



The series show a tendency of the precipitation regimes towards the extremes, being currently more frequent those days with weak precipitations (Trace and a) and more determinant on the annual precipitation the torrential days (d1 and d2) than in the mid XX century.

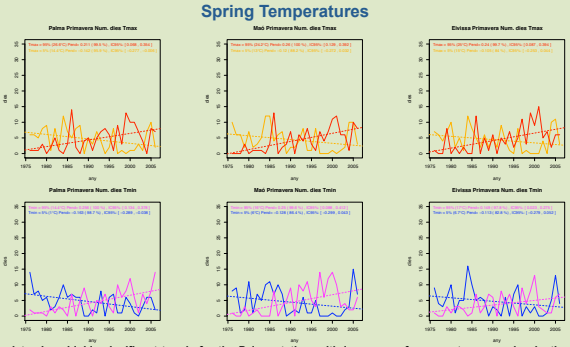
Max/min daily temperatures

- The AEMET (prev. INM) archives quasi-continuous series of daily maximum an minimum temperatures for the period **1976-2007** for the stations at the 3 main airports of the Balearic Islands (**Palma, Maó i Eivissa**).
- We plot the distributions for each station and parameter to define extremes as those registers beyond **percentiles 5 and 95** of the corresponding distribution.
- For each thereshold, parameter and station, the annual frequency of occurrence is derived and time-trends are computed
- The analysis focuses on the annual distributions as well as on the seasonal components of the trends.



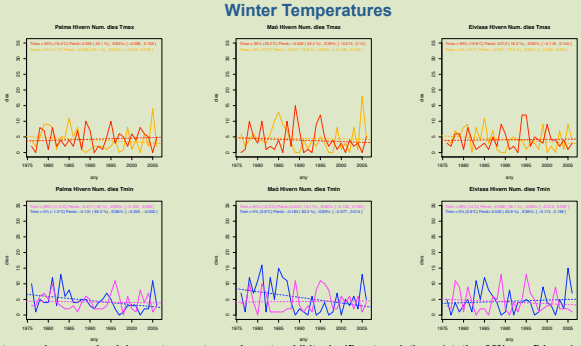
- **Maximum and minimum temperatures show bimodal distributions, revealing the existence of two thermal stations (warm and cold) clearly differentiated and a rapid transition between them.**
- **All 3 thermometric stations evince an increase in the frequency of warm maximum and minimum temperatures and a reduction in the number of cold maximum and minimum days (except for cold minima in Eivissa).**
- **It's noteworthy the significant increase of +81 and +96 days per century of extremely warm minimum temperatures.**

Spring Temperatures



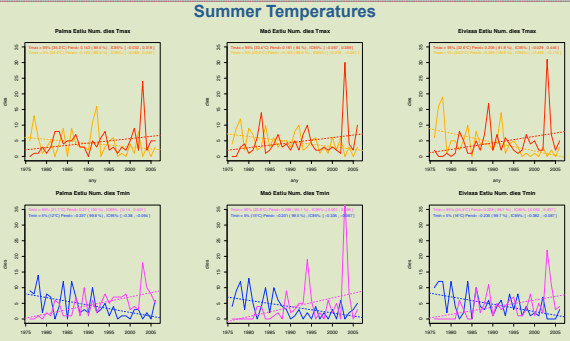
Spring data show highly significant trends for the Palma station, with increases of warm extremes and reductions in the frequency of coldest extremes more pronounced than the annual series. Observed trends up to +26 days per century for spring in the frequencies of extreme maximum and minimum temperatures are a clear indication of substantial changes in the distribution of observed temperatures in the Balearic Islands.

Winter Temperatures



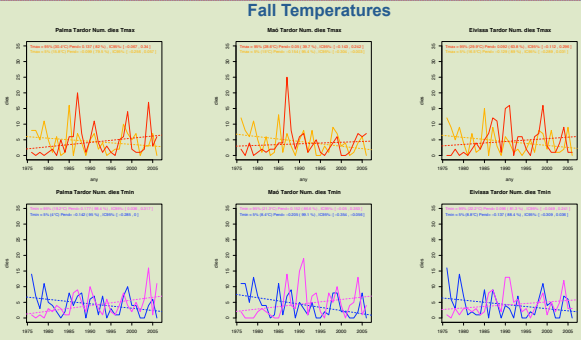
Winter maximum and minimum temperatures do not exhibit significant variations (at the 95% confidence) throughout the period 1976-2007 in any of the 3 monitoring stations. The only exception are the extremely cold temperatures that show a significant trend of -13 days per century in the Palma Airport station.

Summer Temperatures



Beyond the confirmation of the trends detected in the annual data, summer series highlight the strong increase in the frequency of minimum temperatures, both warm and cold. The increased frequency of minimum temperatures above 20ºC ("tropical nights" definition of AEMET) with a trend of nearly +30 days per century in all 3 Islands is very remarkable.

Fall Temperatures



Fall series show a significant trend towards a reduction in the number of days with extremely cold temperatures along with an increase in warm records, revealing the tendency towards a longer warm season extending well into the fall.

Conclusions and outlooks

- The analysis of the longest complete pluviometric and thermometric series available from AEMET (prev. INM) for the Balearic Islands has previously shown significant changes in mean attributes such as the increase of the mean annual temperature and the decrease of precipitations during the second half of the XX century.
- Focusing on the extremes of precipitation and temperatures (max and min) distributions provide new evidences of changes in the climate of the Balearic Islands.
- In general, extremely warm maximum and minimum temperatures (above percentile 95) increased the frequency of occurrence over the study period (1976-2007), whereas the extremely cold (below percentile 5) days were significantly reduced.
- Future reviews of this study will explore more robust methods to compute trends than the least squares, which show excessive sensitivity to outliers and heterosquedasticity.
- Further research will attempt the analytical description of the precipitation and temperature distributions and analyze parametric changes during the study period.

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