REGIONALIZED CLIMATE CHANGE PROJECTIONS OVER SPAIN
BASED ON STATISTICAL ALGORITHMS

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1.- INTRODUCTION

The interest in estimating the potential socioeconomic costs of climate change has led to the increasing use of either dynamical or statistical downscaling modeling methods, to produce finer spatial-scale climate projections, useful for impacts assessments. Compared to dynamic downscaling, statistical downscaling has the advantages of being computationally cheap and easily adjusted to new areas. Statistical downscaling also requires very few parameters while a clear disadvantage is that it requires long and homogenous data series for establishment and validation of the statistical relationship (Heyen et al. 1996). In this vein, the Spanish State Agency (AEMET) has produced a new collection of regionalized climate change projections based on two statistical algorithms, which have been applied to a set of climate models from the Coupled Intercomparison Project Phase 5 (CMIP5). The underlying idea is to better estimate models uncertainty under three representative concentration pathways (RCP) emission scenarios (RCP4.5, RCP6.0 and RCP8.5).

2.- DATA

Three datasets are used:

- **Observational**:
  - 2324 rainfall stations from AEMET climate database (1951-2005)
  - 374 temperature stations from AEMET climate database (1951-2005)
- **Reanalyses**: Daily atmospheric fields from the National Centers for Environmental Protection Agency (NCEP)-National Center for Atmospheric Research (NCAR) are used (1951-2005).
- **Models:** Daily outputs from 20th century simulations and RCP4.5, RCP6.0 and RCP8.5 emission scenarios have been used. Number of models are labeled in the legend of the evolution plots.

Reference observational period: 1961-1990

3.- METHODOLOGY

Two statistical downscaling techniques, namely analogue (ANA) and Statistical Downscaling Model (SDSM) methods, have been applied to a large ensemble of new climate projections released through the World Climate Research Programme (WCRP) Coupled Model Intercomparison project Phase 5 (CMIP5). The downscaled projections shown here have been developed over mainland Spain and the Balearic Islands.

Briefly, the ANA method estimates high-resolution surface meteorological fields for a day "x" (the problem day), in two steps: the first step is based on a synoptic analogs selection whilst in the second step, an application of regression relationships to a set of selected predictors is performed. There are slight different modifications for precipitation and temperature (Petisco, 2008 a-b).

The SDSM (henceforth REG) is best described as a hybrid of the stochastic weather generator and regression-based in the family of transfer function methods. It permits the spatial downscaling through daily predictor-predictand relationships using multiple linear regression equations (Wilby et al. 2002).

4.- RESULTS

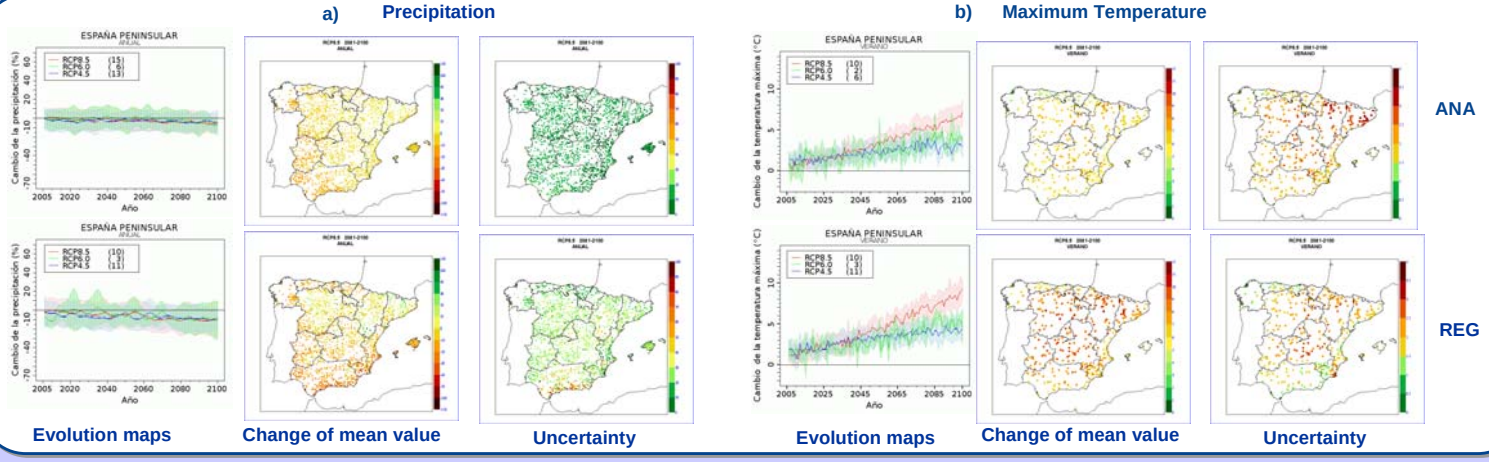
Upper (lower) maps refer to ANA (REG) methods. By way of summary, only precipitation (a) and maximum temperature (b) figures are shown.

Precipitation

- Left-hand side panel (evolution maps): Change in the annual accumulated precipitation (in %) in the period 2006-2100 for the three RCPs emission scenarios. A Gaussian filter has been applied.
- Central panel: Change of mean value (expressed in %) of annual accumulated precipitation for RCP8.5 scenario (2081-2100).
- Right-hand side panel: Uncertainty (2*σ over all global models used in RCP8.5 scenario) of annual accumulated precipitation for the period 2081-2100.

Maximum temperature

- Left-hand side panel (evolution maps): Change in the summer maximum temperature (in ºC) in the period 2006-2100 for the three RCPs emission scenarios.
- Central panel: Change of mean value (expressed in ºC) of summer maximum temperature for RCP8.5 scenario (2081-2100).
- Right-hand side panel: Uncertainty (2*σ over all global models used in RCP8.5) of summer maximum temperature for the period 2081-2100.



5.- CONCLUSIONS

The AEMET database of climate change projections has been recently upgraded with a new collection of regionalized climate change projections based on statistical algorithms. Two empirical algorithms based on analogue and lineal regression methods have been applied to a subset of available models from the Coupled Intercomparison Project Phase 5 (CMIP5) to better estimate models uncertainty under three representative concentration pathways (RCP) emission scenarios (RCP4.5, RCP6.0 and RCP4.5). Focus on the present study was put on annual precipitation and summer maximum temperature for mainland Spain.

Precipitation

- A slight decrease in the annual accumulated precipitation amount, more noticeable in REG method and in the last part of the century, is observed.
-- Higher tendency to decrease more pronounced in the eastern and southern fringes of Iberian Peninsula and Balearic Islands. Less uncertainty in the ANA method compared to the REG method.

-Maximum Temperature

--Increase in the summer maximum temperature, more evident in the RCP8.5 (the most emissive scenario) and in the REG method. Big similarities between RCP4.5 and RCP6.0 scenarios.
- Overall increase in mainland Spain, more noticeable in REG method. Different patterns in the uncertainty between both methods, more consistent in ANA method.

We have obtained different results for REG and ANA methods, which reveals the uncertainties due to the downscaling method. Attributing the differences between both downscaling methods remains a matter of further research.

The continuous update of regionalized climate change scenarios is an essential AEMET climate service for the community of within the deployment at national scale of the WMO Global Framework for Climate Services. Further enhancements will focus on adding new collections of regionalized climate change projections and on the development of user friendly tools for the manipulation and visualization of data.

References

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