The impact of climate change on the water balance in the North-East of Spain: from downscaling of climate models to droughts.

Marco Turco[1,*], *Maria del Carmen Llasat*[1], *Pere Quintana Seguí*[2]

[1]GAMA (Meteorological Hazards Analysis Team) Department of Astronomy & Meteorology Faculty of Physics, University of Barcelona, Av. Diagonal 647, E-08028 BARCELONA (Spain)

[2]Observatori de l'Ebre (Universitat Ramon Llull - CSIC), Horta Alta 38, 43520 Roquetes, Spain.

The main objective of our project is to analyze the impact of climate change on the water balance of North-East of Spain, including on soil moisture. To fulfill this objective we need to generate regional climate scenarios using statistical downscaling, taking into account the uncertainty and on the robustness of these scenarios.

The main motivations of our dowsncaling work are the following. Firstly, the climate influences processes in natural and human system (e.g. Calmanti et al. 2007). Secondly, the Global Climate Models (GCM) are basic tools to study the climate, however due to heir coarse resolution (few hundred kilometres, Solomon et al. 2007), they are not useful to study the driving processes of many impacts at the regional scale (Giorgi et al. 2001). Thirdly, the climate projections are affected also by uncertainties due to deficiencies and approximations in the models used (McAvaney et al. 2001, Giorgi 2005).

We have structured our downscaling related work in two steps: First, we have analysed the past climatology of temperature and precipitation in Catalonia and we have implemented and evaluated an innovative statistical downscaling method in perfect conditions.

To better understand the climatology of past extremes and to set up a base to develop regional climate scenarios we have analyzed a subset of the precipitation and temperature indices defined by the Expert Team on Climate Change Detection and Indices (Turco and Llasat, 2010, submitted). Our analysis of the temperatures in the Northeast of Spain in the past (1950-2008) indicates a clear signal of increase, coherent to the observed global warming (IPCC, 2007). Instead no general (i.e. representative of the entire Catalonia) trends are found for the different precipitation indices in the period (1951-2003). Only two local trends have been found. Firstly, a significant local increase in the longest dry period index: around 30% of the area has an increase of around 2 day/decade. Secondly, the summer series of the precipitation intensity has a field significant dipolar trend pattern: slight negative trend in the inland part (around -0.5 mm/decade) and a positive trend pattern along the coast (around 1 mm/decade).

After analysing the climate of the region, we have implemented the downscaling methodology (Turco et al. 2010, in preparation). First, we have done some tests with a statistical downscaling procedure based on the Analog Method (AM; Lorenz, 1969) using the reanalysis fields as predictors in order to calibrate the model and quantifying its error. Using the air temperature at 850 hPa and the mean sea level pressure (ERA40) as predictors we downscaled the temperature obtaining good results.

To downscale the precipitation an extra effort is necessary, due to the heterogeneity of this field.

In our approach, the precipitation fields simulated by an ensemble of RCMs is statistically post-processed in order to downscale and to correct it using the analog method, according to the idea of the Model Output Statistics (MOS, Wilks, 2006), being the precipitation our predictor. The simulations are the ERA40-driven RCMs provided by the EU-funded project ENSEMBLES. The method improves the performance of the RCM in reproducing the mean as well as the extreme indices considered, at annual and seasonal scale.

The next stepts of our project are inspired by the methodology of Wilby et al. (2004). First, we will test this method under sub-optimal conditions (RCM driven by GCM) and then we will apply this method to RCM runs. Besides this, we will implement other downscaling methods since each method has different advantages and disadvantages and we will generate the scenarios using different emission scenarios (SRES, IPCC 2007) and different climate models (IPCC 2007). These steps permit us to evaluate some of the different sources of uncertainty: the emission scenarios uncertainty, the climate model error and the downscaling method error.

[1]* Corresponding author: Marco Turco, mturco@am.ub.es

Finally, to study the impact of climate change on the hydrology, a new gridded dataset will be build using the SAFRAN analysis system (Quintana Seguí et al., 2008). This dataset will contain precipitation, temperature and the other near-surface atmospheric variables necessary to force the SURFEX land-surface model, which contains the ISBA soil-vegetation-atmosphere transfer scheme (Noilhan and Planton 1989; Noilhan and Mahfouf 1996), using a methodology similar to Habets et al. (2008) and (Quintana Seguí et al 2009). The SAFRAN database will be used as observational database to apply the downscaling methods developed, to be able to force SURFEX in the future and obtain future scenarios evapotranspiration, soil wetness and runoff generation. This data will be very useful to study different drought indices and prepare future scenarios of drought conditions.