Session: C39 Poster: TH146B

European assessment of regional (MM5/WRF) and global climate models (CMIP3/IPSL-CM5) : Are extreme cold waves characteristics well represented ?

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Despite their economical and health impacts, only a few recent studies concern extreme cold events. However, recent decade was punctuated by cold waves in Europe as during winter 2009-2010 and December 2010. Extreme cold days will probably narrow globally in frequency in a global warming future (e.g., 2046-2065) albeit still remain present in regions favored by cold waves such as Europe or United States. Thus, the present-day evaluation (i.e., 1961-2000 period) of climate variability modeled by GCM/RCM remains critical in order to model consistently extreme events characteristics in the future. In this study, an array of global (CMIP3/IPSL-CM5) and regional (MM5/WRF) climate models run on Europe domains compared with observations and ERA 40/ERA Interim reanalysis data is used to analyze different aspects of extreme cold waves. For each model, several statistical indices of frequency, intensity, temporal and spatial persistence (coherent in terms of health and energy impacts), for cold spells are calculated in order to assess the capacity of climate models to simulate these extreme events. Successful skill will be defined as a common criterion of good representation of each of the latter extreme temperature events characteristics. The purpose of this study is also to address the origins of biases obtained among the models. First, the impact of resolution is analyzed by comparing regional and global climate model output and studying a global climate model (IPSL-CM5) on different horizontal scales. Second, the temporal evolution of intensity (e.g., abrupt or slow departure) previewed in climate models is compared to reanalysis data. Third, low boundary layers processes are susceptible to mainly influence the intensity of extreme events. Here, they are studied comparing vertical potential temperature profiles showing whether better resolution of low troposphere ameliorate the simulated intensity of events. Finally, future projections (2045-2065 period; scenario A2) are carried out taking into account the above-mentioned capacity of climate models to represent the extreme cold waves characteristics on present-day period. A multi-model ensemble is chosen to provide future projections of extreme temperature events characteristics in Europe.