Geophysical Research Abstracts
Vol. 17, EGU2015-709, 2015
EGU General Assembly 2015

Added value of regional climate modeling over areas characterized by complex terrain

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We present an analysis of the added value (AV) of downscaling via regional climate model (RCM) nesting with respect to the driving global climate models (GCMs) over regions characterized by complex terrain. Specifically, we analyse precipitation from ensembles of driving GCM and nested RCM (two resolutions, 0.44° and 0.11°) simulations for the late 20th (1976-2005) and late 21st century (2070-2099) over an area encompassing the European Alps. The GCM simulations are provided by the Coupled Model Intercomparison Project Phase 5 (CMIP5) and the RCM experiments used for this study are from two regional initiatives within Coordinated Regional Downscaling Experiment (CORDEX), namely: EURO-CORDEX (whole European domain) and MED-CORDEX (centered over the Mediterranean region). The 21st century projections are for the high-end representative concentration pathway RCP8.5. Different metrics of AV are investigated, measuring aspects of precipitation where substantial AV can be expected in mountainous terrains: spatial pattern of mean precipitation, daily precipitation intensity distribution and daily precipitation extremes (R95). The metrics are calculated by comparing model precipitation output with data from a high quality, fine scale (5 km) gridded observational dataset. Our analysis shows substantial AV of RCM downscaling for all metrics selected, and in fact results are improved compared to the driving GCMs not only at fine scales but also when the RCM fields are upscaled at the scale of the GCM resolution. We also find consistent improvements in the high resolution (0.11°) vs. the medium resolution (0.44°) RCM simulations. In terms of precipitation change projections, we find that the RCM downscaling substantially modulates the GCM-derived change signal, particularly in terms of fine scale spatial pattern associated with the complex topography of the region. Our results thus clearly demonstrate the AV of RCM nesting and point to the important role that high resolution nested RCMs can play in the study of climate change over areas characterized by complex topographical features.