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Modes of variability in Europe and Mediterranean region within LMDZ regional climate model with or without feedback to the global system

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Climate downscaling is generally conducted with a regional model nested into the outputs of a global model. The one-way nesting approach is widely used in the climate community, but it does not take into account any feedbacks from regional climate model (RCM) to general circulation model (GCM). Regional modes of variability are likely to be affected by this lack of interaction. The aim of the present study is to evaluate the behaviours of the one-way nesting methodology against those of a two-way nesting system which makes interactive coupling between RCM and GCM. Both models are based on LMDZ (the 'LMD' is for 'Laboratoire de Météorologie Dynamique', the 'Z' in LMDZ stands for 'zoom' ; it is the atmospheric component of the IPSL "Integrated Climate Model") configured as regional and global climate models, respectively. LMDZ-regional and LMDZ-global are run with identical boundary conditions, including sea surface temperature (SST) prescribed at their climatology values. LMDZ-regional has a resolution of about 100 km, which covers the region of Europe, the Mediterranean, North Africa and the Western North Atlantic. A regular resolution of 3.75° in longitude and 2.5° in latitude (about 300 km) is the configuration of LMDZ-global. The two models share an identical physical package and the same dynamical framework. The nesting of the models is performed by a relaxation procedure with a time scale of 90 minutes . The exchange between the two models in the case of two-way nesting is every two hours. All simulations last 150 years to ensure a good statistical significance of results. Regional modes of variability are evaluated with an empirical orthogonal functions (EOF) analysis. The investigated variables include the temperature at 2 meters (T2M) and the geopotential height (GEOP) at 500 hPa. Winter season is chosen due to the predominant role of the atmospheric dynamics in winter.