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Regional climate simulations with moisture tracers to investigate land-atmosphere interactions in the terrestrial water cycle over the Iberian Peninsula

Gonzalo Miguez-Macho (1), Alexandre Rios-Entenza (1), and Francina Dominguez (2)

(1) Fac. de Físicas, Universidade de Santiago de Compostela, Santiago de Compostela, Galicia, Spain (gonzalo.miguez@usc.es), (2) Dep. of Atmospheric Sciences, University of Arizona, Tucson, AZ, USA

In the semiarid interior of the Iberian Peninsula, the topographic insulation from the surrounding seas promotes the role of internal sources of moisture and water recycling in the rainfall regime. Within the inland portions of the Iberian Peninsula, the annual cycle of precipitation often has a distinctive peak in the springtime, when evapotranspiration is the highest, in contrast to the coastal areas, where it follows more external moisture availability and synoptic forcing, with a maximum in winter-autumn and a pronounced minimum in the summer. We present here regional climate simulations using the WRF model, with the new added capability of moisture tracers as a tool to explicitly investigate the sources and pathways of humidity in the terrestrial water cycle over the Iberian Peninsula and explicitly calculate the recycling ratio, as an indicator of land-atmosphere coupling. Six new prognostic variables were added in the WRF model corresponding to tracers for water vapor and other moisture species (cloud water, ice, snow, rain and graupel) originating from moisture evapotranspired in the selected region (the land mass of the Iberian Peninsula). The new moisture variables are advected, diffused, and convectively and turbulently mixed identically to the full moisture species including all humidity sources (terrestrial, maritime and lateral boundaries). In addition, the convective scheme (Kain-Fritsch) and the microphysics scheme (WSM6) are modified to account for generation and depletion among the different tracer species, assuming that within one model layer in a grid cell moisture of all origins is well mixed. With these modifications we are able to explicitly track the cycle of water of terrestrial origin and exactly measure its contribution to rainfall with high resolution within our region of interest. We contrast our results with diagnostic estimates of the recycling ratio following the method of Schär and of Eltahir and Bras.