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The effect of 3DVAR data assimilation and Noah LSM over the Iberian summer temperature and energy balance

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The use of the Noah Land Surface Model (LSM) in regional modeling has increased during the last decades, while data assimilation is not so commonly used. Thus, this study focuses on the impact of both options on WRF simulations, and how they affect the summer surface temperature bias and energy balance over the Iberian Peninsula (IP).

For that purpose, a numerical downscaling exercise over the IP was run nesting the WRF model inside ERA-Interim. Four different configurations of the model were run during 2010-2014 after a one-year spin-up (2009). In the first experiment (N), including the Noah LSM for the calculation of the soil temperature and moisture, the boundary conditions drive the model after the initialization. The second experiment (D) includes also the LSM, but the 3DVAR data assimilation step is run every six hours (00Z, 06Z, 12Z and 18Z). The third and fourth experiments (S and C respectively) present the same configurations as the previous experiments, but without the Noah LSM. The domain covers the IP with a 15x15 km2 grid and 51 vertical levels. The sea surface temperature is updated daily and observations from the PREPBUFR dataset (NCEP ADP Global Upper Air and Surface Weather Observations) are assimilated inside a 120-minute window centered at the analysis times in the 3DVAR assimilated runs (C and D).

Results show that the experiment including the data assimilation and the Noah LSM (D) produces the best correlations and the smallest RMSE. Both experiments including the Noah LSM (D and N) showed similar biases, but the RMSE obtained by N is not as good as that from D. A larger bias is obtained by the C experiment (with data assimilation but without the LSM), but not as remarkable as that from the experiment without both options (S). However, the correlations obtained by C are comparable to those from D. According to these results, the effect of the Noah LSM in temperature is similar to that derived from the data assimilation scheme for temperature bias. Conversely, for day-to-day variations (correlation coefficient), data assimilation performs much better. Thus, in terms of mean square error, the combination of land surface model and data assimilation yields the optimum combination.

The spatial distribution of the Bowen ratio was also calculated for each experiment. Those experiments including the Noah LSM are the ones obtaining the most similar results to those obtained by previous studies, particularly the N experiment. The mean Bowen Ratio value for the experiments without the Noah LSM is around 0.5, while for D is 1.48 and for N 3.78. If we focus on the energy balance, the experiments including Noah LSM are those able to better close the balance (residual below 25 W/m2 – mean value for the entire IP). The residual of the experiments without Noah LSM can reach values of 200 W/m2 because the estimation of Ground Flux is severely affected by the use of a diffusive soil scheme.