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Assessing the impact of aerosol-atmosphere interactions in convection-permitting regional climate simulations: the Rolf medicane in 2011

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A critical challenge for assessing regional climate change projections relies on improving the estimate of atmospheric aerosol impact on clouds and reducing the uncertainty associated with the use of parameterizations. In this sense, the horizontal grid spacing implemented in state-of-the-art regional climate simulations is typically 10-25 kilometers, meaning that very important processes such as convective precipitation are smaller than a grid box, and therefore need to be parameterized. This causes large uncertainties, as closure assumptions and a number of parameters have to be established by model tuning. Convection is a physical process that may be strongly conditioned by atmospheric aerosols, although the solution of aerosol-cloud interactions in warm convective clouds remains nowadays a very important scientific challenge, rendering parametrization of these complex processes an important bottleneck that is responsible from a great part of the uncertainty in current climate change projections. Therefore, the explicit simulation of convective processes might improve the quality and reliability of the simulations of the aerosol-cloud interactions in a wide range of atmospheric phenomena. Particularly over the Mediterranean, the role of aerosol particles is very important, being this a crossroad that fuels the mixing of particles from different sources (sea-salt, biomass burning, anthropogenic, Saharan dust, etc). Still, the role of aerosols in extreme events in this area such as medicanes has been barely addressed.

This work aims at assessing the role of aerosol-atmosphere interaction in medicanes with the help of the regional chemistry/climate on-line coupled model WRF-CHEM run at a convection-permitting resolution. The analysis is exemplary based on the “Rolf" medicane (6-8 November 2011). Using this case study as reference, four sets of simulations are run with two spatial resolutions: one at a convection-permitting configuration of 4 km, and other at the lower resolution of 12 km, in whose case the convection has to be parameterized. Each configuration is used to produce two simulations, including and not including aerosol-radiation-cloud interactions. The comparison of the simulated output at different scales allows to evaluate the impact of sub-grid scale mixing of precursors on aerosol production. By focusing on these processes at different resolutions, the differences between convection-permitting models running at resolutions of 4 km to 12 km can be explored. Preliminary results indicate that the inclusion of aerosol effects may indeed impact the severity of this simulated medicane, especially sea salt aerosols, and leads to important spatial shifts and differences in intensity of surface precipitation.