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Simulation of medicanes over the Mediterranean Sea in regional climate model ensembles: impact of ocean-atmosphere coupling and increased resolution

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Some cyclones over the Mediterranean Sea occasionally develop a tropical structure. These cyclones, also called medicanes, can produce significant damage due to the combination of intense winds and heavy precipitation. The small size of medicanes and the importance of air-sea interaction in their formation and intensification represents a challenge for RCMs. Large ensembles of high resolution and ocean-atmosphere coupled RCM simulations are now available from MedCORDEX and EURO-CORDEX. We use these ensembles to analyze the ability of RCMs to reproduce the observed characteristics of medicanes, and to assess the impact of increasing resolution and using air-sea coupling on its simulation.

As a reference for evaluating the simulations, we take the observational database of Miglietta et al. (2013), based on satellite images combined with very high resolution simulations. The simulated medicanes do not coincide in general on a case-by-case basis with the observed medicanes. This can be expected in climate mode simulations due to the small size of medicanes and the fact that they develop within the RCM domain. Therefore, the evaluation of medicanes in RCM simulations has to be done statistically.

The observed spatial distribution of medicanes is well simulated in general. Regarding the monthly distribution, RCMs have difficulties in simulating the first medicanes appearing in September after the summer minimum. The use of higher horizontal resolution clearly increases the simulated frequency of medicanes, resulting in generally better frequency values. But the intensity, which is underestimated in low resolution runs, is not improved by most increased resolution simulations. A few RCMs show a clear intensity increase in the higher resolution runs, suggesting that model formulation is more important in this respect than high resolution alone.

Air-sea interaction frequently produces a negative intensity feedback for tropical cyclones, which depends on the oceanic mixed layer depth. Here, the use of air-sea coupled RCMs has a limited impact on the simulated frequency and intensity of medicanes, but it causes an interesting seasonal shift from autumn to winter. Oceanic mixed layer depths are higher in winter in the Mediterranean Sea. An analysis of two contradictory simulated medicane cases suggests that the negative intensity feedback may depend on the mesoscale distribution of the oceanic mixed layer depth and the associated fine structure of SST. This increases the interest of applying air-sea coupled RCMs for climate change analysis of this type of cyclones.