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Effects of climate variability and change on cyclones in the Mediterranean

Onno Doensen[1,2], Martina Messmer[1,2], Woon Mi Kim[1,2,3], and Christoph Raible[1,2]
[1]Climate and Environmental Physics, University of Bern, Switzerland (onno.doensen@unibe.ch)
[2]Oeschger Centre for Climate Change Research, University of Bern, Switzerland
[3]Now at National Center for Atmospheric Research, USA

The Mediterranean is characterized by a high extratropical cyclone activity. These cyclones are an important source for water availability in the region, but at the same time they have the potential to cause extreme weather in the form of precipitation and wind extremes. The Mediterranean is heavily affected by the ongoing anthropogenic climate change, which is expected to have a profound effect on cyclones in this area. In this study, we investigate the effects of internal climate variability and anthropogenic climate change on the characteristics of Mediterranean cyclones. The analysis is based on two simulations from the Community Earth System Model 1.2 (CESM): a seamless simulation spanning 3500 years from 1500 BCE to 2012 CE and a simulation of future RCP8.5 scenario from 2013 to 2300 CE. The simulations have a 1.9°x2.5° horizontal resolution, and cyclones are identified using an established detection and tracking algorithm. Comparison with the ERA5 reanalysis for the period 1981–2010 shows that CESM is able to realistically represent cyclone frequency on a global scale, though it slightly underestimates cyclone activity in the Mediterranean. Our results indicate that cyclone activity in the Mediterranean varies on interdecadal to centennial time scales before 1850 CE. These variations are linked to positive and negative climate anomalies and fluctuations in strength of several modes of circulation, such as the North Atlantic Oscillation. The variations caused by internal variability are, however, of smaller magnitude than the effects of future climate change on the Mediterranean cyclones. In the RCP8.5 scenario, Mediterranean cyclones will become less frequent based on our simulation, and cyclone related precipitation will decrease in addition to that, which is contrary to what is being observed in other important storm track regions, such as the North Atlantic. We hypothesize that the changes in cyclone characteristics are more pronounced in the Western Mediterranean than in the Eastern Mediterranean. Overall, the study suggests that cyclone activity in the Mediterranean is projected to leave the bandwidth of variability of the last 3500 years near the end of the century.