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When are Mediterranean heavy rain events sensitive to atmosphere-ocean coupled processes? A case study in southern France.

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In Autumn, the Mediterranean coasts are prone to heavy rain events, as is the Cévennes region, in southern France. Even though these events have been extensively studied, the extent to which they are sensitive to the coupled effects between atmosphere and ocean is still an open question. Such coupled effects include the effect of the Mistral and Tramontane, two cold orographic winds which are able to cool the surface of the sea rapidly in autumn, which can in turn have an impact on subsequent heavy rain events up to 10 days later.

To quantify such coupled effects, two different 20km-resolution regional climate simulations have been performed for the 1989-2009 period:

- An atmosphere-only simulation forced by ERA-interim SST
- A coupled atmosphere-ocean simulation, which generates a high-resolution coupled SST

However it is not possible to directly assess the impact of air-sea coupling on Mediterranean rain event by comparing these two simulations. In fact, the difference between the ERA-interim SST used to force the first simulation and the high-resolution SST is not only due to air-sea coupling, but also to different biases. In order to be able to isolate the impact of coupled processes on the rain event, a third simulation has been performed by forcing the atmospheric model by a SST field obtained from the high-resolution coupled SST field but from which the quick (submonthly) variations of SST (that reflects the rapid feedbacks between atmosphere and ocean) were removed.

While comparing the first two simulations makes it possible to quantify the impact of different SST fields on heavy precipitation events, comparing the latter simulations makes it possible to isolate the rapid retroactions. First, two case studies chosen among the 22 heaviest simulated rain events during the 20 years in question are studied in order to characterize the impact of atmosphere-ocean retroactions on precipitation. Results show that important parameters to characterize the impact of SST differences and atmosphere-ocean coupling on heavy precipitation are the presence of convergence zones and SST differences upstream of the precipitation area. Then, these two factors are used in order to build an index of rain sensitivity to SST differences, which is tested qualitatively and statistically for the 22 heaviest precipitation cases in the Cévennes area during the 1989-2009 decades. Using this index, it should be possible to predict in which situations submonthly air-sea interactions can have an impact on heavy rain events.