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Elucidating heavy precipitation events

It is difficult to forecast heavy precipitation events accurately and reliably. The quality of these forecasts is affected by two processes whose relative importance has now been quantified by a team at the Laboratoire d'Aérologie (CNRS / Université Toulouse III–Paul Sabatier). The researchers have shown that these processes should be taken into account in low wind speed events. Their findings should help forecast these events, which repeatedly cause significant damage, especially in south-eastern France. They were first published online on November 28, 2013 in the *Quarterly Journal of the Royal Meteorological Society*.

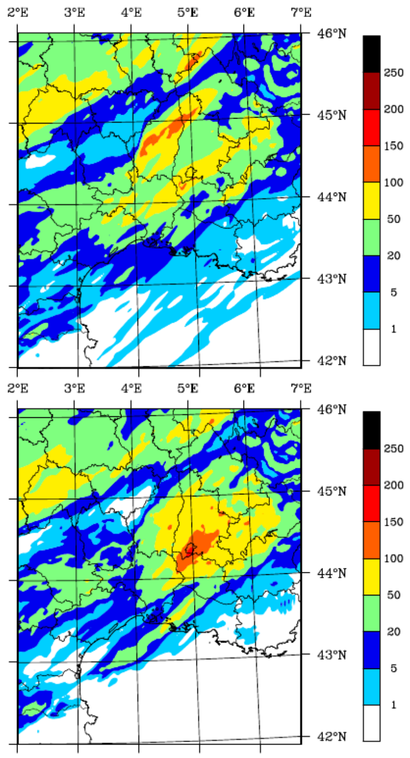
Nearly every autumn, the countries of the Mediterranean Basin are stricken by heavy rainfall and flash floods, which endanger populations and can cause significant property damage. South-eastern France is frequently affected by these events, caused by the interaction between topography and the still warm and moisture-laden air masses from the Mediterranean Sea. Weather forecasters are able to predict these events and issue weather warnings. However, simulating their evolution on different time scales remains difficult, just like forecasting the strength and location of precipitation, the two parameters that broadly determine the extent of flooding.

Researchers from CNRS and Université Toulouse III–Paul Sabatier at the Laboratoire d'Aérologie investigated two phenomena that play a key role in meteorology: the microphysics of hydrometeors (rain, snow and ice pellets)[1] and atmospheric turbulence. The aim was to determine the relative effect of these two processes on forecast sensitivity. To do this, the scientists looked at five heavy rainfall episodes that took place between September 2010 and November 2011 in south-eastern France and for which measured data was available. For each event, ensemble simulations were carried out using the Meso-NH[2] atmospheric research model, giving more or less importance to each of the two processes.

Two main results emerged. For high wind speed events, precipitation is scarcely affected by the perturbations introduced. It is therefore unnecessary to take account of these two processes to improve heavy precipitation forecasting. In this case, it is the interaction with the topography that determines the onset of precipitation. However, when wind speed is low, both the intensity of precipitation and its location (upstream of the topography) are far more sensitive to these two processes. In this case, the microphysics of hydrometeors and atmospheric turbulence need to be better represented so as to improve forecast sensitivity.

[1] This concerns phenomena such as the evaporation of raindrops, the autoconversion of cloud droplets into raindrops, and the accretion of raindrops by absorption of cloud droplets.
[2] Jointly developed by CNRM-GAME (CNRS/Météo-France) and the Laboratoire d'Aérologie, Meso-NH is a model that can deal with a wide range of scales, from the synoptic scale (10-100 km resolution) to Large Eddy Simulations (resolution of around ten meters).

These results suggest that in low wind speed situations, errors related to the representation of microphysical and turbulent processes make a significant contribution to the total error in the forecasting system. Taking greater account of these errors would improve heavy precipitation forecasting when wind speed is low. The study was also used to test a methodology that may be implemented as part of the HyMeX[3] international research program, launched in 2010 for a period of ten years and coordinated by Météo-France and CNRS.



Comparison of simulated precipitation (in mm) in two simulations carried out with the Meso-NH model for a heavy rainfall event on 6 September 2010. In the upper simulation, the value of the time tendency of raindrop evaporation was reduced by 50%; in the lower simulation, the value of the tendency was increased by 50%. © LA

Reference

Ensemble simulations with perturbed physical parameterisations: Pre-HyMEX case studies. Alan Hally, Evelyne Richard, Simon Fresnay and Dominique Lambert. *Quarterly Journal of the Royal Meteorological Society.* Article first published online: 28 NOV 2013. DOI: 10.1002/qj.2257

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[3] www.hymex.org/