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Numerical study of a non-forecasted sea breeze thunderstorm in the Eastern Iberian Peninsula. Part I. HIRLAM and HARMONIE precipitation performance

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This study is a numerical investigation of a sea breeze thunderstorm that occurred in the eastern complex area of the Iberian Peninsula (Spain) on 7 August 2008, but was not forecasted by the operational numerical weather prediction (NWP). It is widely recognized that inadequate representation of cloud processes is the greatest source of uncertainty in the NWP. Two grid-spacing setups (5.0-km and 2.5-km) of the operational High Resolution Limited Area Model (HIRLAM) are used to simulate convection associated with sea breezes. In addition, this numerical study also employs the non-hydrostatic spectral HARMONIE model (2.5-km), which will be implemented shortly as the operational NWP in most of the European Weather Services. The overall aim is to improve local forecasting accuracy for dangerous sea breeze convective phenomena, and particularly to estimate the ability of NWP to correctly simulate convective precipitation associated with sea breezes. The study is focussed on an isolated sea breeze front case in which intense convective activity (heavy rainfall, hail and gusty winds) occurred over a preferential sea breeze convergence zone: the Iberian system mountains. The precipitation forecast performance of both HIRLAM and HARMONIE model setups is evaluated against high-density >500 raingauge measurements. The operational HIRLAM 6.1.2 version from the Spanish Meteorological Agency (AEMET) at 0.16 and 0.05 degrees missed the isolated sea breeze showers. In contrast, both the HIRLAM and the HARMONIE setups showed precipitation signals in the area where the most intense precipitation (Cati 45 mm) was observed. Preliminary results confirm that the HIRLAM 6.1.2 version (STRACO convection/condensation scheme) performed worse for this isolated sea breeze thunderstorm than more recent versions with updated versions of STRACO or the Kain-Fritsch/Rasch-Kristjansson (KF) convection/condensation scheme. Therefore, we found that the HIRLAM 2.5-km tended to slightly overestimate precipitation at the rain-gauge points for this single sea breeze storm event, whereas the HIRLAM 5-km tended to strongly underestimate rainfall at rain-gauge points. Despite the overprediction bias than the coarser model, the HIRLAM 2.5-km version performed better precipitation forecasts than the 5.5-km set up in terms of amount, because it correctly reproduced the heavy rainfall along the sea breeze boundary. In the case of the HARMONIE simulation at 0.025 degrees, the precipitation pattern showed much less widespread precipitation but much more focussed over the area where the isolated sea breeze convection occurred. Advances in short-term forecasts and increased understanding of isolated convection associated with sea breezes could have practical applications for dangerous convective phenomena.