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The squall line of 4th October 2007 over the Western Mediterranean: attributing its predictability

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The prediction of mesoscale phenomena that initiates, organizes and evolves over the sea is an extremely demanding challenge of great importance for coastal regions. The afternoon of 4th October 2007, severe damaging winds and torrential rainfall affected the island of Mallorca. Reportedly, this storm produced F2-F3 tornadoes in the vicinity of Palma, with one person killed and estimated damages to property exceeding 10M€Ṡeveral studies have analyzed the meteorological context in which this episode unfolded, describing the formation of a train of multiple thunderstorms along a warm front and the evolution of a squall line organized after the convective initiation offshore Murcia at about 10UTC. Couhet et al. (2011 Atmos. Res; Heino Tooming award 2009) attributed the correct simulation of the convective system and its organization as a squall line to the adequate representation of a convergence line at low-levels over the Alboran Sea during the first hours of the day. In this study, we design a mesoscale ensemble data assimilation experiment to analyze the predictability of the 4th October 2007 episode and the potential of the assimilation cycle to advect critical observational information towards those decisive data-void areas over the sea. We quantify the impact of assimilating observations on the short-range probabilistic forecast of the squall line evolution, and carefully analyze the modifications the advection of information from land generate on the genesis environment of the event. We compare the skill of 3 ensemble configurations in representing both the convection initiation, and the later evolution of the squall line. On one hand, we test an Ensemble Kalman Filter which assimilates conventional (surface, radiosonde and AMDAR) data; and on the other, two downscaling configurations from the operational ECMWF global ensemble. Results show that the EnKF experiment successfully represents the area of convergences in which convective initiation occurred and thus the derived numerical predictions render improved evolutions of the squall line. Synthetic maps of severe convective risk reveal the improved predictability of the event using the EnKF as opposed to deterministic or downscaled configurations. Attribution experiments clearly point at surface observations as responsible for defining the low-level flows involved in the initiation of convection and its organization as a severe squall line.