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A case study of heavy snowfall in North Rhine-Westphalia (25-27 Nov 2005): Observations, dynamics and forecast performance

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Numerical weather prediction (NWP) of intense snowfall events is particularly challenging. An accurate forecast requires the correct representation of dynamical and physical processes on various scales, ranging from the evolution of planetary-scale waves to the microphysics of ice particles. In this study, a specific event of heavy snowfall is examined that occurred in the north-western part of Germany in November 2005. Measured snow depth revealed an increase from 0 to 28 cm in less than 18 hours. In a first part, an overview on the synoptic evolution is presented, together with observations of precipitation type and vertical soundings, which reveal the existence of a layer above 0°C, a so-called melting layer, during the period of heavy snowfall. In the main part, the forecast performance of the operational NWP Model of the European Centre for Medium-Range Weather Forecasts is investigated. It is shown that only the latest short-term predictions captured the event, whereas earlier forecasts were significantly in error concerning the phase and/or amount of precipitation. These errors in the precipitation forecasts are associated with errors on various scales: A wrong representation of the upper-level wave evolution leads to a misplacement of the surface low-pressure system. The position of the latter is wrong by several hundreds of km in some of the 2-6 day forecasts. Also of great importance is the vertical structure of the atmosphere, since the profiles of temperature and humidity strongly influence the microphysical processes. Especially the existence and the depth of a melting layer is highly significant for the melting of snow and its parameterization in the model. The analysis shows that the relatively accurate short-term snowfall forecasts captured the large and the synoptic scale evolution well, but they underestimated the depth of the melting layer. This indicates that the melting rate of snow is overestimated in the model and that a correct snowfall forecast is only possible if the depth of the melting layer is underestimated. A more sophisticated representation of the melting of snow might therefore be crucial for a future improvement in the prediction of high-impact snowfall events.