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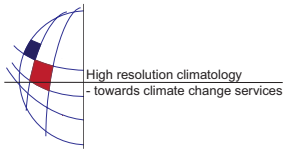

Local predictions of frost, fog, and low clouds

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An operational chain of nested numerical weather prediction models has been extended with a two-dimensional boundary layer model in order to produce short-term and local predictions of frost and low visibility. For an experimental period of six months the topographical boundary layer model TBM has been coupled to the operational COSMO-2 model of MeteoSwiss for the hydrological catchment of the Glatt river (ZH, Switzerland). Eight daily COSMO-2 runs covering 24 hours each have been completed by hourly runs of the boundary layer model TBM which assimilates local observations.

Verifications of the COSMO-2/TBM runs document a remarkable quality and level of sophistication in the simulation of nocturnal boundary layers for a substantial range of low visibility conditions caused by radiative mist developing into fog and low stratus. In the topographical boundary layer model TBM the subscale processes governing the nocturnal cooling (long wave radiative transfer, condensation, deposition, sedimentation, vertical mixing, and wind) have been tuned for a five day period with a variety of weather and visibility conditions. Simulations of numerous other nights with reduced visibility have successfully been verified with visibility, radiation, and temperature observed at Zurich airport. Apparently the subscale processes relevant for nocturnal cooling are represented in the topographical boundary layer model TBM and have been tuned for practical application.

Calm nights after days with well mixed convective boundary layers have been simulated most precisely and consistently. With TBM the development of initially stable near ground layers into mist, fog, and finally mixed low stratus is obtained with remarkable temporal and spatial precision. Cases of marked low-level inversions with stratus, either persisting or hardly dissipating during the day, have been simulated less consistently. A sensitivity of the simulations to the external forcings from the COSMO-2 and the assimilated local observations has been demonstrated and shows a need for refining both the coupling to the external model and the assimilation procedure in order to obtain more stable sequences of model runs in particular cases. The transmission of short wave radiation through low stratus, fog, and mist needs to be implemented directly in the topographical boundary layer model TBM, as the dissipation of mist, fog, and low stratus occurred systematically too rapidly when using the transmission of the COSMO-2 model which underestimates the formation of radiation fog.

The quality of the nocturnal boundary layer simulations obtained by COSMO-2/TGM is remarkable. With the mentioned refinements the topographical boundary layer model TGM is suggested for operational predictions of frost and low visibility for airports and roads.