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A role of turbulence transfer in predicting radiation fog using the regional Eta model

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Understanding mechanisms for fog formation, evolution, and dissipation is fairly difficult due to complexity of physical processes and their interplay. Consequently, fog predictions represent a great challenge which is generally further amplified by a lack of detailed measurements. Accurate fog predictions require high-resolution models and detailed physical parameterizations. One of the essential parameterizations is treatment of turbulence transfer and its interplay with microphysics and general structure and stability of the PBL. Regional Eta model driven by the control and the first four of the ECMWF ensemble members has been used to investigate the formation, evolution, and dissipation of radiation fog over plain terrain in France. A series of sensitivity tests conducted to investigate the role of turbulence closure schemes on prediction accuracy was completed using liquid water content, temperature and wind speed data. The results of the two Eta ensembles which differ only in turbulence scheme (Mellor-Yamada-Janjić boundary layer scheme, used in the original Eta model, and Nakanishi-Nino scheme (NN2009)) are compared. Preliminary results show that the improved parameterization of turbulence transfer that is calibrated by results from large-eddy simulations (NN2009) can significantly improve prediction accuracy. One of the main causes for the improvement appears to be formulation of the turbulent length scale that realistically increases for decreasing stability. The NN2009 scheme also allows for increased level of the turbulent kinetic energy which is important for complex interaction of radiation, microphysics, and turbulence for fog formation, evolution and dissipation. In particular that becomes essential in balancing the effect of subsidence vs. fog vertical growth. Since saturation conditions leading to fog formation are sensitive to initial thermodynamic conditions, results from the ensemble predictions justified the use of probabilistic fog forecasting.