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3D numerical fog prediction with parameterized microphysics

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In complex terrain advection plays a dominant role. Fog formation is favoured in regions where cold air accumulates. These processes cannot be resolved with a 1D approach and have to be treated explicitly using a 3D model. Numerical simulation requires high horizontal and vertical resolutions combined with sophisticated cloud physics. The detailed parameterization of fog microphysics from the PAFOG 1D model was implemented into the non-hydrostatic mesoscale model (NMM) of NOAA/NCEP. Prognostic equations for total liquid water content as well as for the total droplet number concentration (Nc) are solved. Droplet growth is simulated using a parameterization of the Köhler theory. Advection and turbulent diffusion of Nc is solved by the dynamical framework of NMM, making the microphysics fully coupled in 3D.

Simulations were done on a domain of 100 km by 100 km with a horizontal resolution of 1 km. The vertical discretization uses 45 levels of which 30 are within the lowest 1500 m above ground. The very high vertical resolution requires a modification of the turbulence scheme to prevent excessive cooling in the thin layers above the surface. Initial and boundary conditions are derived from the 4 km resolution NMM weather forecasts of the University of Basel. Case studies in Switzerland for Zürich-Unique airport are presented and also compared with 1D ensemble forecasts and observations. Spatial patterns of fog were validated with a cloud product derived from Meteosat Second Generation satellite data and show a generally good agreement.