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Modelling derecho dynamics and the direct radiative effect of wildfire smoke upon it with NWP model HARMONIE

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Convection permitting numerical weather prediction model HARMONIE was used to simulate the dynamics of the derecho that swept over Eastern Europe on August 8, 2010. The storm moved over Belarus, Lithuania, Latvia, Estonia and Finland and the strongest wind gusts (up to 36.5 m/s) were measured in Estonia. The storm path is recorded on the radar images where characteristic bow echo was observed. The model setup was similar to near-future operational, nearly kilometre-scale environments in European national weather services.

Hindcast experiments show the ability of the HARMONIE model to predict the severe convective storm and forecast concurrent strong wind gusts. Wind gusts with very similar intensity to observed ones were simulated by the HARMONIE model and 2.5-km horizontal resolution appears sufficient for reliable forecast of the derecho event. The timing of the modelled storm was in good agreement with the observations. The simulated average storm propagation speed was 25 m/s, similar to the radar observations. Hindcast experiments suggest that more precise warning for the storm could have been issued if the HARMONIE model would have been utilised.

The derecho event was accompanied by the remarkable smoke aerosol concentrations (maximum total aerosol optical depth more than 4 at 550 nm) originating from the wildfires from Russia. Smoke plume travelled clockwise around Moscow from August 5 to 9. On August 8, 2010, smoke plume was situated on the Eastern border of Estonia. The derecho occurred on the western side of the smoke plume path.

HARMONIE experiments were performed to study the direct radiative effect of wildfire smoke on a severe convective storm. The impact of smoke aerosol on the derecho dynamics was investigated. Reduction in the shortwave radiation flux at the surface resulting from aerosol influence simulated by the HARMONIE model is up to 200 W/m2 in the area with the highest aerosol concentrations. This causes near surface cooling of up to 3 ºC. The direct radiative effect of aerosol increases the stability of the atmospheric boundary layer and this had influence on the simulated derecho dynamics.