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Enhanced numerical simulation of high resolution wind field and pollutants dispersion

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The simulation of pollutants dispersion in atmospheric flows at different scales is one of the most important topics amongst the numerical applications. It ranges from the use of objective analysis tools, which interpolate observations of atmospheric variables and solve the gaussian equation of transport for inert pollutants, to the Computational Fluid Dynamics (CFD), which solves Reynolds-Averaged Navier-Stokes (RANS) or Large Eddy (LES) flow models coupled with chemical modules dealing with reactive pollutants. The model chain depends on the dynamic scale, on the main features of the phenomena to be simulated and on the availability of observations. The present study describes the possibility to exploit the ease and robustness of the CALMET code for the computation of Atmospheric Boundary Layer (ABL) flows at a sub-regional scale (10-50 km) together with the physical reliability of a RANS model of airborne pollutants dispersion. The CALMET flow field is coupled with the surface observations and the vertical profiles provided by the model coupling between the Land Surface Temperature assimilation framework ACHAB and the atmospheric Limited Area Model (LAM) RAMS. The rationale of the work relies on the necessity of accurate boundary conditions also for the cases where the domain extension is sub-regional. The merging of a hi-res low tropospheric (CALMET) with a low-res high tropospheric (RAMS) wind field allows to evaluating the combined effects of complex surface orography and the geostrophic wind. This approach prevents the limits of both models, namely the difficulty in the extension towards higher heights of hi-res atmospheric fields and the significant bias in reconstruction of the surface conditions by LAMs. A case study of a domain of 50 km x 50 km in the horizontal and up to 2 km aloft has been chosen to be modeled by CALMET using the observations of 3 surface stations and RAMS profiles of diagnostic wind speed, temperature and pressure. The analysis considers a simulation period in Summer 2008. The resulting flow field is then re-mapped onto a structured grid by a dedicated routine. On the same grid the Environmental Pollutants Advection-Diffusion (EPA-D) code solves the unsteady RANS dispersion model of inert gaseous and particulate pollutants. EPA-D is an in-house finite volume code that requires the wind and the turbulence field (either k-omega or k-epsilon variables) as an input for each time step. The code can also use the solution obtained by any CFD code run on the same structured grid. The results of the dispersion contours of a tracer pollutant computed by the CALMET-ACHAB/RAMS-EPA-D (CREPA) model are then compared with the same case computed with the well known and tested CALMET-CALPUFF chain to assess the reliability level of the application.