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Aerosol surface levels, chemical composition and optical depth over Europe in the CALIOPE air quality modelling system

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In the frame of the CALIOPE project (Baldasano et al., 2008), the Barcelona Supercomputing Center (BSC-CNS) currently operates a high-resolution air quality forecasting system based on daily photochemical forecasts in Europe (12km x 12km resolution) with the WRF-ARW/HERMES/CMAQ modelling system (http://www.bsc.es/caliope) and desert dust forecasts over Southern Europe with BSC-DREAM8b (Pérez et al., 2006; http://www.bsc.es/projects/earthscience/DREAM). High resolution simulations and forecasts are possible through their implementation on MareNostrum supercomputer at BSC-CNS.
Recently, in Pay et al. (2010) a full year evaluation of the CALIOPE modelling system was presented. This work evaluated gas (O3, NO2 and SO2) and particulate phase (PM10 and PM2.5) simulations with EMEP ground-based measurements obtaining good scores within the range of most European models. This analysis highlights the fact that the dynamics of PM2.5 and PM10 are well reproduced, but mean concentrations remain systematically underestimated. In order to complement the previous results, in the present contribution, the aerosol chemical composition as well the AOD are evaluated in order to identify the origin of such discrepancies and to determine the sources of uncertainty. Chemical composition of EMEP/CREATE surface measurements and aerosol optical depth (AOD) from AERONET observations (Holben et al., 1998) are used. The performance of the modelled values has been quantitatively evaluated with discrete and categorical (skill scores) statistics by a comparison to surface observations.
The results of the evaluation with chemical composition of EMEP/CREATE surface measurements and AOD from AERONET observations highlight the fact that the most important underestimations are linked to total carbonaceous material (i.e. EC + OC) and secondary inorganic aerosols (SIA; i.e. nitrates, sulphates and ammonium) which are mainly found in the finer fractions.
In order to constrain these strongly underestimated species to provide a more realistic distribution of the different aerosol fractions over Europe, we have calculated correction factors for only SIA and organic carbon (i.e. EC + OC) species.
The results indicate a remarkable improvement in the discrete and skill-scores evaluation for PM2.5, PM10 and AOD when using correction factors for SIA and organic carbon species. The average underestimations are reduced from 53% to 18% for PM2.5 and from 58% to 35% for PM10 and correlations increase from 0.47 to 0.59 for PM2.5 and from 0.57 to 0.61 for PM10. Also, the average AOD underestimations are reduced from 41% to 13% and the correlations increase from 0.51 to 0.56 for AOD. Furthermore, if the correction factors are applied, the seasonal patterns of the modelled AOD are better reproduced when compared to the MODIS/Aqua satellite product.
An analysis of the relative contributions of anthropogenic and natural (i.e. desert dust and sea salt) aerosols over Europe and their seasonality will be also presented.

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