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A regional air quality forecasting system over Europe: the MACC-II daily ensemble production

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Abstract. This paper describes the pre-operational analysis and forecasting system developed during MACC (Monitoring Atmospheric Composition and Climate) and continued in the MACC-II (Monitoring Atmospheric Composition and Climate: Interim Implementation) European projects to provide air quality services for the European continent. This system is based on seven state-of-the art models developed and run in Europe (CHIMERE, EMEP, EURAD-IM, LOTOS-EUROS, MATCH, MOCAGE and SILAM). These models are used to calculate multi-model ensemble products. The paper gives an overall picture of its status at the end of MACC-II (summer 2014) and analyses the performance of the multi-model ensemble. The MACC-II system provides daily 96 h forecasts with hourly outputs of 10 chemical species/aerosols (O_3, NO_2, SO_2, CO, PM_{10}, $PM_{2.5}$, NO, NH_3, total NMVOCs (non-methane volatile organic compounds) and PAN+PAN precursors) over eight vertical levels from the surface to 5 km height. The hourly analysis at the surface is done a posteriori for the past day using a selection of representative air quality data from European monitoring stations.

The performance of the system is assessed daily, weekly and every 3 months (seasonally) through statistical indicators calculated using the available representative air quality data from European monitoring stations. Results for a case study show the ability of the ensemble median to forecast regional ozone pollution events. The seasonal performances of the individual models and of the multi-model ensemble have been monitored since September 2009 for ozone, NO_2 and PM_{10}. The statistical indicators for ozone in summer 2014 show that the ensemble median gives on average the best performances compared to the seven models. There is very little degradation of the scores with the forecast day but there is a marked diurnal cycle, similarly to the individual models, that can be related partly to the prescribed diurnal variations of anthropogenic emissions in the models. During summer 2014, the diurnal ozone maximum is underestimated by the ensemble median by about 4 µg m^{-3} on average. Locally, during the studied ozone episodes, the maxima from the ensemble median are often lower than observations by 30–50 µg m^{-3}. Overall, ozone scores are generally good with average values for the normalised indicators of 0.14 for the modified normalised mean bias and of 0.30 for the fractional gross error. Tests have also shown that the ensemble median is robust to reduction of ensemble size by one, that is, if predictions are unavailable from one model. Scores are also discussed for PM_{10} for winter 2013–1014. There is an underestimation of most models leading the ensemble median to a mean bias of −4.5 µg m^{-3}. The ensemble median fractional gross error is larger for PM_{10} (~ 0.52) than for ozone and the correlation is lower (~ 0.35 for PM_{10} and ~ 0.54 for ozone). This is related to a larger spread of the seven model scores for PM_{10} than for ozone linked to different levels of complexity of aerosol representation in the individual models. In parallel, a scientific analysis of the results of the seven models and of the ensemble is also done over the Mediterranean area because of the specificity of its meteorology and emissions.

The system is robust in terms of the production availability. Major efforts have been done in MACC-II towards the operationalisation of all its components. Foreseen developments and research for improving its performances are discussed in the conclusion.

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Segers, A., Sofiev, M., Tarasson, L., Thomas, M., Timmermans, R., Valdebenito, Á., van Velthoven, P., van Versendaal, R., Vira, J., and Ung, A.: A regional air quality forecasting system over Europe: the MACC-II daily ensemble production, Geosci. Model Dev., 8, 2777-2813, https://doi.org/10.5194/gmd-8-2777-2015, 2015.