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Towards a globally nested EMEP4UK model

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Abstract: EMEP4UK is a regional high-resolution atmospheric chemistry transport model capable of simulating current and potential future air pollution in the UK with a high degree of spatio-temporal detail. The model is based on the Europe-wide EMEP MSC-W model with chemical and physical processes driven by the WRF meteorological model. The standard configuration of EMEP4UK comprises an outer European domain and a nested inner UK domain at higher spatial resolution (3 km $\times$ 3 km); the outer European domain is constrained by a set of prescribed boundary conditions which, for most chemical species, do not account for interannual variability or episodic events of transboundary pollution. However, long-range transboundary air pollution is becoming increasingly relevant as the UK, and Europe as a whole, reduce anthropogenic emissions, shifting emphasis towards better understanding the extent of long-range, transboundary contributions to UK air quality. EMEP4UK in its standard configuration is not built to account for this. Hence we test a globally nested version of the EMEP4UK model, with which we endeavour to better represent transboundary pollution and natural episodic events occurring outside the model's European domain. We are particularly interested in the extent to which the UK is impacted by far distant biomass burning emissions, as the frequency and intensity of wildfires is expected to increase with climate change in many regions of the northern hemisphere. Here, we evaluate model output through comparison with measurements from UK supersites. We focus on fine particulate matter ($PM_{2.5}$) due to its impacts on human health, and in light of the recently revised World Health Organisation $PM_{2.5}$ annual-mean guideline value of 5 µg m^{-3}, which presents an ambitious target value for further air pollution control policies. We find that the standard configuration of EMEP4UK underestimates $PM_{2.5}$ compared to measurements (9-26%), while the globally nested configuration overestimates (10-35%). A major reason for the overestimation of the globally nested configuration is an overestimation in seasalt. Other reasons include factors related to model resolution, emissions and atmospheric convection. Ultimately, this work aims to provide a methodology for understanding long-range, transboundary pollution and its interaction with local emissions, to help inform related policies and decision-making.

Keywords: *Regional atmospheric chemistry transport model, open biomass burning, air quality, particulate matter, long-range transport*