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Model ensembles for the simulation of atmospheric compounds over Europe

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The simulation of atmospheric compounds at regional scale has undergone many progresses during the last decade. However it has been recognized that models still are uncertain. The use of an ensemble of models may help quantify uncertainty in several respects. An ensemble of models predicting atmospheric compounds under emission scenarios actually gives two new informations relative to using a single model:

(i) The average (or the median) over this ensemble of responses is a new response by itself, which smoothes the errors of individual models, and should therefore be more accurate.

(ii) The spread of the ensemble should represent the uncertainty in model predictions.

Unfortunately it is not possible to verify responses of future several emission scenarios and their associated uncertainties directly. But a first evaluation of whether these new possibilities, offered by model ensembles, are realistic can be achieved by simulating past periods. In this presentation, we provide a spatially detailed analysis of the general features of air quality ensemble modelling for Europe, using the EURODELTA results for several pollutants: ozone, nitrogen dioxide and secondary inorganic aerosols. We link the spread of the ensemble and the uncertainty using statistical tools borrowed from ensemble weather forecast verification techniques.

For ozone daily maxima the ensemble spread origin differs from one region to another. In the neighbourhood of cities or in mountainous areas the spread of values does not span the range of variations, due to poorly resolved emissions or complex-terrain me-

teorology. By contrast in Atlantic and North-Sea coastal areas the excessive spread is due to differences between model boundary conditions. For NO_2 daily averages the ensemble spread is generally too weak because models miss highest values due to stagnant meteorology in stable boundary layers near cities. For secondary particulate matter compounds the simulated concentration spread is more balanced, observations falling nearly equiprobably within the ensemble, and the spread originates both from meteorology and aerosol chemistry and thermodynamics. Further, we discuss how these concepts can be extended to other atmospheric compounds.