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# Quantification of modelling uncertainties: Parameter sensitivities of the coupled model ECHO-G with middle atmosphere

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One aim of the European ENSEMBLES project is to quantify modelling uncertainties in the projections of future climate change. In this context the sensitivity of the global climate model ECHO-G with middle atmosphere (ECHO-G MA) to parameter perturbations is studied. The results allow to make a reasonable selection of model parameters and appropriate ranges for the computation of larger perturbed physics ensembles.

The climate model ECHO-G with middle atmosphere consists of a 39 level atmosphere model version of ECHAM4 with highest pressure level at 0.01 hPa which is coupled to the HOPE-G ocean model. The model was intensively used for long-term transient climate simulations to project the GHG forced climate change. Although it is a fully coupled model, its efficiency allows us to simulate large size ensembles of climate experiments and longtime periods with a complex representation of the climate system.

To interpret the climate change signals in the SRES scenario runs with ECHO-G MA the range of model uncertainty is quantified. The sensitivity experiments concentrate on perturbing 5 relevant cloud parameters (sedimentation of ice crystals from cirrus clouds, conversion rate from cloud water to rain, entrainment rate for shallow convection, overshooting of convection, rain efficiency of middle high clouds). These parameters cannot be obtained by observations and have a large uncertainty range. Their sensitivities are analysed in studies of other modelling groups too, thus enabling a comparison of results.

We found significant non-linear effects in combining perturbations of different parameters.

The model is most sensitive to perturbations of the parameter controlling the sedimentation of ice crystals from high cirrus clouds. This is true not only for the temperature signal but particularly for radiation quantities (OLR, surface solar readiation). The model's response to perturbations of the other parameters is of opposite sign and less sensitive. Combined effects are dominated by the effect of sedimentation of ice crystals and are even enhanced by addition of variations in other parameters despite the opposite signs of the single effects.