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Uncertainty Analysis using Aggregated Carbon Cycle, Atmospheric Chemistry, and Climate Model (ACC2)

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Aggregated Carbon Cycle, Atmospheric Chemistry & Climate Model (ACC2) is the most comprehensive global-mean model to date that calculates from the emissions of greenhouse gases the concentrations of the greenhouse gases, the radiative forcing, surface temperature change. It incorporated parameterization of the atmospheric chemistry of direct radiative forcing agents (CO_2, CH_4, N_2O, SF_6, 28 species of halocarbons, O_3, sulfate and carbonaceous aerosols, and stratospheric water vapor) and indirect radiative forcing agents (OH, NO_x, CO, and VOC). The overall model descriptions are consistent with the scientific findings reported in IPCC TAR (2001), Scientific Assessment of Ozone Depletion (WMO, 2003), and other recent literature. ACC2 is programmed in GAMS, which is advantageous for its implementation to Integrated Assessment frameworks and for the uncertainty analysis presented here. By employing the inverse problem theory, the model optimizes the maximum likelihood estimates of the uncertain parameters (e.g. beta factor and climate sensitivity) as well as updates observations (e.g. atmospheric CO_2 concentration, radiative forcing, and surface temperature change) by using corresponding prior information on the parameters as well as independent data on observations with associated uncertainty ranges. With sensible parameters values ACC2 can reproduce a realistic global-mean evolution of the carbon cycle and climate systems between 1750 and 2000. Furthermore, we analyze how such results are affected by the prior uncertainties in the CO_2 emission due to land use change.