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New Development of the Online Integrated Climate-Chemistry model framwork (RegCM-CHEM4)

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The RegCM-CHEM4 is a new online integrated climate-chemistry model based on the regional climate model (RegCM4). The RegCM4 developed at the Abdus Salam International Centre for Theoretical Physics (ICTP), is a hydrostatic, sigma coordinate model. Tropospheric gas-phase chemistry is integrated into the climate model using the condensed version of the Carbon Bond Mechanism CBM-Z with lumped species that represent broad categories of organics based on carbon bond structure. The computationally rapid radical balance method RBM is coupled as a chemical solver to the gas-phase mechanism. Photolysis rates are determined as a function of meteorological and chemical inputs and interpolated from an array of pre-determined values based on the Tropospheric Ultraviolet-Visible Model (TUV) with cloud cover corrections. Cloud optical depths and cloud altitudes from RegCM-CHEM4 are used in the photolysis calculations, thereby directly coupling the photolysis rates and chemical reactions to meteorological conditions at each model time step. In this study, we evaluate the model over Europe for two different time scales: (1) an event-based analysis of the ozone episode associated with the heat wave of August 2003 and (2) a climatological analysis of a six-year simulation (2000-2005). For the episode analysis, model simulations show a good agreement with the European Monitoring and Evaluation Program (EMEP) observations of hourly ozone over different regions in Europe and capture ozone concentrations during and after the summer 2003 heat wave event. Analysis of the full six years of simulation indicates that the coupled chemistry-climate model can reproduce the seasonal cycle of ozone, with an overestimation of ozone in the non-event years of 5-15 ppb depending on the geographic region. Overall, the ozone and ozone precursor evaluation shows the feasibility of using RegCM-CHEM4 for decadal-length simulations of chemistry-climate interactions.