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Entire Atmosphere Global model (EAGLE): development, first version and preliminary results

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Historically, numerical models of the upper atmosphere layers (>80 km) and the lower atmosphere layers (<80 km) progressed almost independently just prescribing the lower/upper boundary conditions, which is usually a very rough approximation of all the physics happening below/above. With a rising knowledge about atmospheric sciences related to progress, both, in measurements and models, it became clear that interrelation between atmospheric layers is important and needs to be addressed explicitly. Here, we present a step in this direction with a focus on the ionosphere by showing our first results of the Entire Atmosphere Global Model (EAGLE) that combines Chemistry-Climate model (CCM) HAMMONIA and Global Self-Consistent Model of the Thermosphere, Ionosphere and Protonosphere (GSM TIP). The model allows calculating the atmospheric state from the ground to 15 radii of the Earth including ionosphere and plasmasphere interactively simulating the main physical, radiative, chemical, and dynamical processes in the lower, middle and upper atmosphere. The model treats thermodynamic interaction of charged and neutral components of photochemical ionospheric processes and excitation of the dynamo-electric field under the influence of the tidal winds. It also includes production of nitric oxides from energetic electron precipitation in the thermosphere, and is able to realistically describe the electric field distribution and other parameters of the ionosphere close to the geomagnetic equator. The vertical model domain starts from the ground, which allows studying the lower atmosphere influence on the thermosphere/ionosphere system. We apply EAGLE in assimilation mode using nudging to meteorological data below 60 km for January 2009. We compare the output from short-term (from several days to a month) model ensemble runs against observations to evaluate the model and to estimate the sensitivity of the ionosphere to the introduced lower atmospheric perturbations. EAGLE can be used in the future for nowcasting and short-term prediction of the thermosphere/ionosphere system with implication for planning satellite missions, forecasting space weather/climate, estimation of the risks generated by explosive solar events, and functioning of the global positioning systems.

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