Data assimilation of low-altitude magnetic perturbations into a global magnetosphere model

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The ionosphere is the only region of the terrestrial magnetosphere-ionosphere system where in situ observations with high temporal resolution and approaching global spatial scale are possible. Ionospheric measurements of magnetic fields with such spatio-temporal coverage have become available from the Active Magnetosphere and Planetary Electrodynamics Response Experiment (AMPERE), combining data from the Iridium satellites. Motivated by the emergence of this dataset, we report here on the first results of assimilation of low-altitude ionospheric magnetic perturbations into the Lyon-Fedder-Mobarry (LFM) global magnetospheric model coupled with the Rice Convection Model (RCM). Our assimilation approach relies on the assumption of a quasi-steady, linear approximate relation between equatorial magnetospheric pressure and ionospheric field-aligned currents. This approximation is implemented numerically by perturbing the coupled LFM-RCM model and considering only large-scale modes from the Fourier decomposition of the ionospheric magnetic field and equatorial magnetospheric pressure. This methodology was validated by using model-based assimilation tests of the so-called ”fraternal-twins” type. In this approach, the LFM-RCM model with one set of parameters is used to generate synthetic observations, while a model version with a different parameters is used to assimilate the ionospheric observations and calculate the magnetospheric pressure corrections which are then applied to reproduce the synthetic observations. The model with assimilated synthetic data responded correctly by modifying ionospheric currents and magnetic perturbations in the expected way. We thus found the approach proposed herein to be promising for future assimilation of real data.

