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Numerical modeling of the circulation of ionospheric particles in the magnetosphere: Gyrokinetic approach

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Recent satellite observations have revealed that the ionosphere is an important source of the magnetospheric plasma. O+ ions of ionospheric origin have been reported to sometimes dominate the ring current during an intense magnetic storm, and other ionospheric ions such as N+ contribute to the ring current with a ratio as high as N+/O+ ˜0.5. Despite the importance of their contributions to the ring current hence to the development of geomagnetic storms, global simulation models of the Earth's magnetosphere have not included them in a self-consistent manner. This is simply because it is quite computer intensive to resolve cyclotron motions of particles in the presence of strong intrinsic magnetic field of the Earth, and requires elaborate techniques to accommodate kinetic effects in a global model. We have recently developed a particle tracing model based on the gyrokinetic theory in which ion motions are averaged over one or more cyclotron periods but still retain non-local physics of ion gyration in the strong field region. In this study ions originating from the topside ionosphere are followed in a magnetospheric field obtained by a global TVD MHD model. We will present results of the numerical model and compare them with satellite observations with a particular emphasis placed on the formation of the ring current during a geomagnetic storm.