Impact of Ionospheric Chemistry in the Martian Dynamo Region using Multifluid MHD Modeling

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Electromagnetic interactions between Mars remanent crustal magnetic fields and solar and planetary ions lead to time and space variations of the ionosphere. In this work, we continue the investigations started by Riousset et al. [JGR, 118, 2013; GRL, 41, 2014] and address the effect of chemistry on ion populations in the dynamo region, where ion dynamics are driven by collisions while electrons are still mostly magnetized. We adopt a mesoscale model to simulate dynamics of electrons and ions in the upper atmosphere (~100-400 km). Our approach focuses on numerical studies using the Martian Multifluid Magnetohydrodynamic (MF-MHD) Model (M4). The dynamo is a region which varies in time and space due to the lack of a global planetary intrinsic magnetic field, the location of the remanent crustal fields, and the planetary rotation responsible for day/night transition, and subsequent trans-terminator particle transfer. The time scales of atmospheric collision, gyromotions, and chemical processes will be discussed in detail to support the selection of relevant reactions for mesoscale studies of the dynamo regions. Several schemes are available in the referenced literature [e.g., Najib et al. JGR, 116, A05204, 2011], and will be used as a basis for the chemistry scheme. The improved model will more accurately reflect changes in the population of planetary ions, which can alter the dynamo current, thereby also causing perturbations in the magnetic topology. The MAVEN mission has shown the importance of ion escape in Martian atmospheric loss, and previous modeling studies [e.g., Riousset et al., 2014] have shown that electrodynamics in the dynamo region may impact upward transport of ions from the dynamo region, supporting the need for further studies of this region.