Localized heating of the Martian topside ionosphere through the combined effects of magnetic pumping by large scale magnetosonic waves and pitch angle diffusion by whistler waves

Christopher Fowler¹, Oleksiy Agapitov¹, Shaosui Xu¹, David Mitchell¹, Laila Andersson², Anton Artemyev³, Jared Espley⁴, Robert Ergun², and Christian Mazelle⁵

¹Space Sciences Laboratory, University of California, Berkeley, CA, USA (cmfowler@berkeley.edu)
²Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, CO, USA
³Institute of Geophysics and Planetary Physics, University of California, Los Angeles, CA, USA
⁴NASA Goddard Space Flight Center, Greenbelt, MD, USA
⁵IRAP, University of Toulouse-CNRS-UPS-CNES, Toulouse, France

We present Mars Atmosphere and Volatile EvolutioN (MAVEN) observations of periodic (~ 25 s) large scale (100s km) magnetosonic waves propagating into the Martian dayside upper ionosphere. These waves adiabatically modulate the superthermal electron distribution function, and the induced electron temperature anisotropies drive the generation of observed electromagnetic whistler waves. The localized (in altitude) minimum in the ratio $f_{pe} / f_{ce}$ provides conditions favorable for the local enhancement of efficient wave-particle interactions, so that the induced whistlers act back on the superthermal electron population to isotropize the plasma through pitch angle scattering. These wave-particle interactions break the adiabaticity of the large scale magnetosonic wave compressions, leading to local heating of the superthermal electrons during compressive wave ‘troughs’. Further evidence of this heating is observed as the subsequent phase shift between the observed perpendicular-to-parallel superthermal electron temperatures and compressive wave fronts. Such a heating mechanism may be important at other unmagnetized bodies such as Venus and comets.