Pitch angle scattering of energetic electrons by whistler-mode hiss in the Jovian polar cap regions: Observations from the Juno spacecraft

S. S. Tetrick*[(1)], D. A. Gurnett[(1)], W. S. Kurth[(1)], G. Clark[(2)], B. H. Mauk[(2)], S. J. Bolton[(3)], J. E. P. Connerney[(4)], and S. M. Levin[(5)]

(1) University of Iowa, Iowa City, IA, 52242, USA;
(2) The Johns Hopkins University Applied Physics Laboratory, Laurel, MD 20723, USA;
(3) Southwest Research Institute, San Antonio, TX, 78238, USA;
(4) Goddard Space Flight Center, Greenbelt, MD, 20771, USA;
(5) Jet Propulsion Laboratory, Pasadena, CA, 91109, USA.

The Juno spacecraft arrived at Jupiter on July 5, 2016, taking both plasma wave and energetic particle measurements in the Jovian polar regions. During Juno's first and second pass over the northern and southern polar regions, highly field-aligned, uni-directional electron beams (up-going, with pitch angles from 0 to 15° and 165 to 180°, respectively, with energies of ~30 to 800 keV) were observed by the JEDI instrument [*Mauk et al.*, GRL, 2017]. The Juno Waves instrument, which measures the electric (50 Hz to 40 MHz) and magnetic (50 Hz to 20 kHz) field components of radio and plasma waves, detected intense up-going broadband whistler-mode emissions occurring within the same polar regions [*Tetrick et al.*, *GRL*, 2017]. This paper will investigate the interaction of whistler-mode hiss with energetic electrons in Jupiter's polar cap regions, contributing to the observed pitch angle scattering of the electron beams. From conservation of the first adiabatic invariant, the expected motion of the electron beams would cause the pitch angle to decrease with increasing radial distance. However, electron beams ranging from 2.53 to 7.22 Jovian radii (R_J) tend to increase in pitch angle, leading to the idea that the whistler-mode waves pitch-angle scatter the electrons. Whistler-mode waves have previously been shown to perturb the electron motions and diffuse them to higher pitch angles. This paper will also show results of incorporating the whistler-mode magnetic wave intensity into diffusion coefficients to then solve the diffusion equation for pitch angle scattering. We find that wave-particle interaction can explain at least some of the pitch angle diffusion that is observed in the electrons. For Perijove 1 in the north and Perijove 3 in the south, the modeled pitch angle scattering fits relatively well with the observed. However, for Perijove 3 in the north, the scattering caused by the waves was not significant enough to explain what was observed. Also, for Perijove 1 in the south there was no significant pitch angle scattering observed.