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Density waves in Titan's upper atmosphere

Jun Cui (1,2), Roger Yelle (3), Tao Li (4), Yuan Lian (5), Ingo Mueller-Wodarg (6), Darci Snowden (3,7)

(1) Nanjing University, Department of Space Sciences, Nanjing, China (jcui@nju.edu.cn), (2) Key Laboratory of Lunar and Deep Space Exploration, Chinese Academy of Sciences, Beijing, China, (3) Lunar and Planetary Laboratory, University of Arizona, AZ, Tucson, USA, (4) School of Earth and Space Sciences, University of Science and Technology of China, Hefei, China, (5) Ashima Research, Pasadena, CA, USA, (6) Department of Physics, Imperial College, London, UK, (7) Department of Physics, Central Washington University, Ellensburg, WA, USA

Analysis of the Cassini Ion Neutral Mass Spectrometer data reveals the omnipresence of density waves in various constituents of Titan's upper atmosphere, with quasi-periodical structures visible for N_2, CH_4, $^{29}N_2$ and some of the minor constituents. The N_2 amplitude lies in the range of $\approx 4\%$-16% with a mean of $\approx 8\%$. Compositional variation is clearly seen as a sequence of decreasing amplitude with increasing scale height. The observed vertical variation of amplitude implies significant wave dissipation in different constituents, possibly contributed by molecular viscosity for N_2 but by both molecular viscosity and binary diffusion for the others. A wave train with near horizontally propagating wave energy and characterized by a wavelength of ≈ 730 km and a wave period of ≈ 10 hr is found to best reproduce various aspects of the observations in a globally averaged sense. Some horizontal and seasonal trends in wave activity are identified, suggesting a connection between the mechanism driving the overall variability in the background atmosphere and the mechanism driving the waves. No clear association of wave activity with magnetospheric particle precipitation can be identified from the data.