EPSC Abstracts
Vol. 11, EPSC2017-557, 2017
European Planetary Science Congress 2017

Characterising gravity waves in the Martian thermosphere using MAVEN accelerometer data

A. Siddle, I. C. F. Mueller-Wodarg

Blackett Laboratory, Imperial College London, Prince Consort Road, London SW7 2AZ, UK

Abstract

Gravity waves (GW's) are ubiquitous in the Martian atmosphere and sources of such waves include topography disturbing wind flow near the surface and shear flow in the atmosphere. GW's can have profound effects on the atmosphere as they carry momentum from their source in the lower atmosphere into the upper atmosphere (mesosphere/thermosphere) [1]. More accurate theoretical descriptions of the atmosphere are possible only when the effects of GW's are included in models, so studying their properties and characteristics is vital for gaining a full understanding of the Martian atmosphere [2][3]. GW's in Mars' upper atmosphere (140-160 km) have been studied using accelerometer data from MAVEN. Waves have been extracted from density profiles by deriving an unperturbed background density model. The relative density perturbations (amplitudes) and wavelengths of the GW's have been characterised with extensive Fourier analysis. Wave amplitudes of atmospheric mass densities are found to be mostly below 10%. Apparent horizontal wavelengths are found to range from 10's to 100's of km. Temperature profiles have been derived from density measurements and temperature waves have been extracted. Temperature perturbations are found to be mainly below 10 K and wavelengths are comparable to those of density waves. Improvements to temperature extraction techniques will be discussed.

The relationship between GW properties and conditions within the atmosphere has been studied and a clear trend is seen with temperature. Both wave amplitude and wavelength increase with decreasing temperature; which is consistent with recent findings from MAVEN's Neutral Gas and Ion Mass Spectrometer (NGIMS) data [4]. Our study shows that both density amplitudes and wavelengths can vary by nearly a factor 2 over a 200 K temperature range. A positive correlation between solar zenith angle and both amplitude and wavelength has also been found, however this correlation is weakened by the removal of the temperature dependence. Waves extracted from MAVEN accelerometer data are compared to those determined from MAVEN's NGIMS dataset as well as Mars Global Surveyor accelerometer data [5]. We find consistency between the results obtained using the three datasets.

Using data from MAVEN's accelerometer and NGIMS instrument, global background temperature structures will be determined. Improved temperature extraction techniques developed using models will also be implemented

References

[1] Forbes, J. M. (2002) Wave Coupling in Terrestrial Planetary Atmospheres, in Atmospheres in the Solar System: Comparative Aeronomy (eds M. Mendillo, A. Nagy and J.H. Waite), American Geophysical Union, Washington, D. C..

[2] Barnes, J. R. (1990), Possible effects of breaking gravity waves on the circulation of the middle atmosphere of Mars, J. Geophys. Res., 95(B2), 1401–1421

[3] Angelats i Coll, M., F. Forget, M. A. López-Valverde, P. L. Read, and S. R. Lewis (2004), Upper atmosphere of Mars up to 120 km: Mars Global Surveyor accelerometer data analysis with the LMD general circulation model, J. Geophys. Res., 109, E01011

[4] Terada, N., et al. (2017), Global distribution and parameter dependences of gravity wave activity in the Martian upper thermosphere derived from MAVEN/NGIMS observations, J. Geophys. Res. Space Physics, 122, 2374–2397

[5] Withers, P. (2006), Mars Global Surveyor and Mars Odyssey Accelerometer observations of the Martian upper atmosphere during aerobraking, Geophys. Res. Lett., 33, L02201