European Space Agency
International Conference on Comparative Planetology: Venus – Earth – Mars
ESTEC, Noordwijk, The Netherlands, 11- 15 May, 2009

OBSERVATIONS OF THE EFFECTS OF METEORS ON THE IONOSPHERES OF VENUS, EARTH AND MARS. Paul Withers[1], A. A. Christou[2], M. Mendillo[1], M. Paetzold[3], K. Peter[3], S. Tellmann[3], J. Vaubaillon[4], [1]Center for Space Physics, Boston University, 725 Commonwealth Avenue, Boston MA 02215, USA (withers@bu.edu), [2]Armagh Observatory, [3]Department for Planetary Research, Rhenish Institute for Environmental Research, Cologne, [4]IMCCE, Observatoire de Paris.

Introduction: Theoretical simulations have predicted that influx of meteoroids into the atmospheres of Venus, Earth and Mars produces a layer of metallic ions in each of these ionospheres [1]. These layers of metallic ions are predicted to occur below the peak altitudes of the ionospheric layers produced by the absorption of solar EUV and soft X-ray photons. Such meteoric ion layers are a well-known component of the terrestrial ionosphere, and recent ionospheric measurements by radio occultation experiments on the Venus Express (VEX), Mars Express (MEX), and Mars Global Surveyor (MGS) spacecraft have discovered ionospheric layers on Venus and Mars that probably contain metallic ions derived from meteoroids [3,4,5,6]. We have investigated the physical characteristics of meteoric layers on Venus and Mars and how the occurrence rate of these layers varies with time.

Physical Characteristics: On Venus, meteoric layers are only observed at solar zenith angles between 55 degrees and 90 degrees. The mean altitude of the meteoric layer is 113±4 km, the typical peak plasma density is 1E10 m^{-3}, and the typical layer width is 5-10 km [4]. On Earth, the typical altitude of the meteoric layer is 95-100 km, the typical peak plasma density is 1E9 m^{-3}, and the typical layer width is a few km [1,2]. On Mars, the mean altitude of the meteoric layer is 91.7±4.8 km, the mean peak plasma density is (1.33±0.25) x 1E10 m^{-3}, and the mean width is 10.3±5.2 km [5].

Occurrence Rates: The occurrence rate of meteoric layers varies with time on all three planets. On Earth, variations in properties of meteoric layers with time are generally attributed to temporal variations in atmospheric processes, such as tides and waves [1,2]. On Mars, the available evidence is more consistent with variations in occurrence rate being controlled by temporal variations in meteoroid flux [6]. If repeatable seasonal variations are observed on Venus, then meteoroid flux variations must be responsible because the state of the atmosphere of Venus does not change with season [4].

Conclusions: Observations of meteoric layers on Venus, Earth and Mars naturally lend themselves to analysis by the techniques of comparative planetology. Meteoric layers generally occur several scale heights below the ionospheric layer produced by solar EUV photons. This difference between the altitudes of these two layers is controlled by eddy diffusion rates and the vertical structure of the neutral atmosphere. Peak plasma densities in meteoric layers are typically 5-10% of plasma densities in the ionospheric layer produced by solar EUV photons. This ratio is affected by meteoroid flux and the chemical pathways by which metals and more common atmospheric species interact.

Figures:

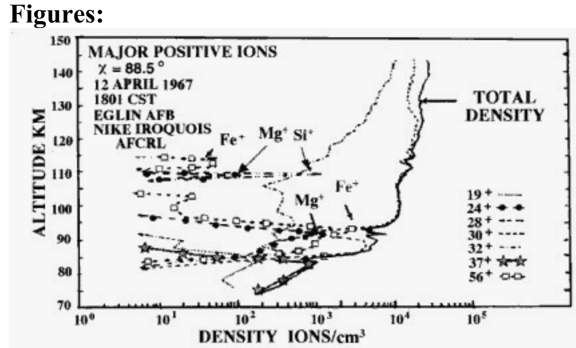

Fig. 1: Meteoric layer in the ionosphere of Earth (rocket flight). Reproduced from [2].

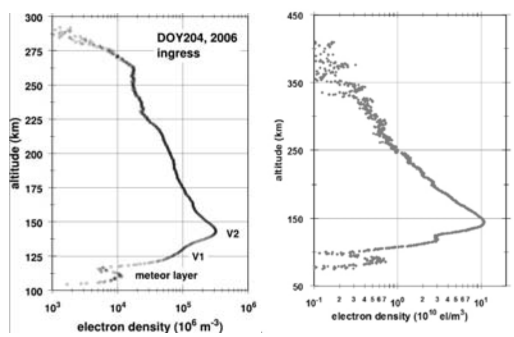

Fig. 2: Meteoric layer in the ionospheres of Venus (left) and Mars (right). Data from VEX [4] and MEX [6].

References:

[1] Grebowsky J. M. et al. (2002) in *Atmospheres in the Solar System*, pp. 235-244. [2] Grebowsky J. M. and Aikin A. C. (2002) in *Meteors in the Earth's Atmosphere*, pp. 189-214. [3] Paetzold M. et al. (2005) *Science, 310,* 837-839. [4] Paetzold M. et al. (2009) *GRL,* doi:10.1029/2008GL035875. [5] Withers P. et al. (2008) *JGR, 113*, doi:10.0129/2008JA013636. [6] Withers P. et al. (2009) Comparison of seasonal variations in the meteoric layer of the martian ionosphere and predicted meteor showers, *Icarus*, under review.