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The high-latitude ionospheres of the Earth and Venus

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The presence of a planetary magnetic field at Earth and the absence of such a field at Venus results in substantial differences in the dynamics and morphology of the high-latitude ionospheres. In both cases photoionisation is the primary mechanism by which the dayside ionosphere is created while particle precipitation and transport processes act to maintain the plasma densities at night. However the mechanisms driving plasma transport at Earth and Venus are fundamentally different and so the planetary ionospheres respond differently to solar activity. The transport of plasma has implications for aeronomy and atmospheric chemistry in the night sector.

In the terrestrial case plasma is frozen in to the magnetic field. Transport in the polar regions is largely due to the high-latitude convection pattern which results from interaction of the terrestrial magnetic field with the interplanetary magnetic field (IMF) carried by the solar wind [1]. The convection varies with the orientation of the IMF and, under appropriate conditions, dayside plasma can be transported antisunward [2].

At Venus plasma transport is primarily driven by the day-to-night pressure gradient [3]. Lowering of the dayside ionopause under conditions of low solar flux inhibits this process [4] but it has been observed to have a significant effect in the pre-dawn sector at low-latitudes under conditions of moderate solar activity [5].

Aberystwyth University's ionospheric radiotomography experiment routinely observes the plasma distribution in the high-latitude terrestrial ionosphere in a latitude versus altitude plane. The polar orbit of Venus Express is ideal for investigating the Venusian high-latitude ionosphere close to the solar terminator with periapsis located close to 86o N. The ASPERA-4 instrument records the first extended in situ data set of the plasma environment under conditions of low solar activity. These two experiments provide a database covering all solar wind conditions and local time sectors. When Earth and Venus are aligned along the Parker spiral the two planets experience similar solar wind conditions. Observations conducted under these conditions close to solar minimum are presented at both planets and comparisons are drawn. The role of plasma transport is of particular interest and is discussed with reference to the driving processes.

References: [1] Dungey, J. W. (1961) Phys. Rev. Let., 6, 47-49. [2] Foster, J. C. (1984) JGR, 89, 855-865. [3] Knudsen et al. (1981) GRL, 8, 241-244. [4] Knudsen et al. (1987) JGR, 92, 13391-13398. [5] Brannon et al. (1993) GRL, 20, 2739-2742.