Geophysical Research Abstracts
Vol. 13, EGU2011-7955, 2011
EGU General Assembly 2011

Discovery and characterization of an ozone layer in Venus' atmosphere

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The SPICAV instrument onboard the Venus Express spacecraft is a multi-channel suite covering the far ultraviolet to the mid-infrared. In this presentation, we will focus on the results obtained by the UV channel during stellar occultations observations. Stellar occultation technique possesses well-known advantages: self-calibration, low sensitivity to instrument aging, simple laws of radiative transfer. In addition, occultation with stars permit to cover a broad range of latitudes at any given season and they provide optimal geometrical registration. Since Venus Express orbit insertion, several hundreds of occultations have been performed by SPICAV, yielding profiles of atmospheric constituents between 80 and 140 km. In the SPICAV UV range, CO_2 possesses a broad signature shortward of 200 nm which allows one to retrieve CO2 concentration and subsequently to deduce atmospheric pressure and temperature profiles in the upper mesosphere and in the thermosphere. The Venusian thermosphere shows excessive variability, with the equivalent of more than three scale heights change in density in less than a few days. No other spectral signature besides that of CO_2 and haze particles was expected to appear in SPICAV ultraviolet spectra at this altitude range but a consistent search was undertaken, revealing the presence of ozone at 100 km ($<10^8$ cm^{-3}) and of sulfur dioxide above 90 km at a concentration of 0.1 to 1 ppm. Venusian ozone accounts for a vertically confined and horizontally patchy layer lying in the thermosphere at a mean altitude of 100 km, with local concentrations of the order of 10^7-10^8molecules.cm^{-3}. O_3 production mechanism appears intimately related to the presence of oxygen atoms carried from the dayside by the subsolar-to-antisolar thermospheric circulation. While this mechanism is known to produce the extended zone of O_2 near-infrared emission in the downwelling zone about the antisolar point, we obtain no firm indication of ozone accumulation in the same region. Ozone destruction may occur via several preferred pathways, including reactions with chlorine or with hydroxyl radicals. Our observed ozone concentrations are consistent with values expected for a chlorine catalytic scheme, thus supporting the standard model of photochemistry above the clouds. Ozone concentrations are also consistent with values required to explain the recent observations of hydroxyl radical airglows in the nightside.