Geophysical Research Abstracts
Vol. 13, EGU2011-5216, 2011
EGU General Assembly 2011

Titan's atmosphere reflected in its surface

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As a moon, Titan is unique in having a large atmosphere. It is also unique for having much of its atmospheric volatile and aerosol inventory eventually ending up in its surface. Models of photochemistry between its two main components, nitrogen (94% by volume) and methane (6%), below 800 km and ion chemistry above this altitude predict formation of a plethora of complex organics, including perhaps prebiotic molecules. Yet, the present inventory of chemical products even with highly sophisticated remote sensing and in situ devices on Cassini-Huygens has barely surpassed what was known from previous observations, especially Voyager flybys three decades ago. This confirms that the vast majority of the products must be in very low abundance in the atmosphere. On the other hand, the same products either condense or sediment out of the atmosphere on to Titan's surface, thus building up their concentration over time. Material evaporated from Titan's surface following the landing of Huygens probe and measured by the Gas Chromatograph Mass Spectrometer (GCMS) shows evidence of the presence of many complex species. The evaporation sequence of molecules identified so far is consistent with the predictions of hydrocarbon volatility. Work is underway to identify the large inventory of molecules recorded by the GCMS from surface evaporation. Finally, gardening by micrometeorites and radiolysis by energetic galactic cosmic rays could potentially modify the nature of surface material. However, such processes are slow so that the evaporation of top layers would still be representative of freshly deposited material and any volatiles removed from the interior by recent impacts or cryovolcanism. [www.umich.edu/∼atreya]