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Titan's Oxygen Chemistry: An Update

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Abstract

Prior to the arrival of Cassini in the Saturn system, photochemical models were unable to simultaneously reproduce the observed abundances of CO, CO_2, and H_2O. The observations were explained by invoking an internal source of CO in addition to an external source of H_2O or by assuming that the observed CO is the remnant of a larger primordial abundance. In 2008, we showed that the flux of O^+ detected by the Cassini Plasma Spectrometer (CAPS) coupled with the previously known flux of H_2O was sufficient to explain the oxygen bearing species in Titan's atmosphere [1]. This work demonstrated that it is no longer necessary to invoke outgassing from Titan's interior as a source for atmospheric CO or to assume that the observed CO is the remnant of a larger primordial abundance in Titan's atmosphere. Instead, it is most likely that the oxygen bearing species in Titan's atmosphere are the result of external input, most likely Enceladus. At the time, only one measurement of H_2O existed, from the Infrared Space Observation (ISO) [2], which was roughly consistent with our model, as shown in Figure 1. Two recent observations, from the Cassini Composite Infrared Spectrometer (CIRS) [3] and Herschel [4], indicate that our 2008 model over predicts the abundance of water in Titan's atmosphere by an order of magnitude and the model of Moreno *et al.* 2012 was unable to simultaneously reproduce the abundance of all 3 species. The new observations indicate that photochemical models may be missing chemical and/or physical processes. It is therefore time to revisit the photochemical model, now with stronger constraints on the stratospheric H_2O abundance, including the behavior as a function of altitude in the stratosphere, to ensure that the new observations do not point to a fundamental flaw in our understanding of Titan's atmosphere. We will present results from our recently updated model of Titan's oxygen chemistry

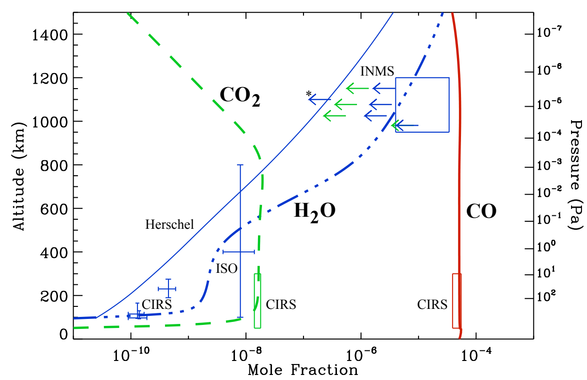

Figure 1- Model mixing ratios from Hörst *et al*. 2008 (thick lines) compared to observational constraints for CO (red, CIRS [5]) CO_2 (green, CIRS [6], INMS [7]), and H_2O (blue, ISO [2], INMS [7, 8], CIRS [3] Herschel [4]). The line plotted for Moreno *et al.* 2012 is their ``Semi-empirical profile A''. For the INMS measurements, the box indicates the range of values ***detected*** from individual flybys, while the arrows indicate globally averaged upper limits [7]. The arrow with an asterisk **(*)** is an upper limit inferred from OSI measurements from T5 [8].

References

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