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Clathrate hydrates as a trapping mechanism of noble gases in Titan's atmosphere

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In January 2005, Huygens probe landed on Saturn's largest Moon, Titan. The atmospheric measurements carried out during the descent of the probe showed that, except for some tiny amounts of 36 Ar, no other primordial noble gases were detected in Titan's atmosphere:(their mole fractions may be smaller than the GCMS instrument's sensibility [1]). It has been recently proposed that the formation of clathrate hydrates on the surface of Titan may act as a sink for atmospheric gases [2]. In the case of noble gases, their trapping in such hydrates can deeply modify their atmospheric concentration. To test this hypothesis, we have used the model of van der Waals and Platteeuw [3] to calculate the relative abundance of noble gases in clathrate hydrates on the surface of Titan. We show there is a strong correlation between the evolution of Titan's climate and the efficiency of the noble gases trapping in hydrates. Moreover, we find that, when the Titan's atmospheric temperature and pressure conditions decrease, the capture of Kr and Xe in hydrates becomes more efficient, whereas that of Ar diminishes.

[1] Niemann, H.B. et al. 2005, Nature 438, 779

[2] Osegovic, J.P. & Max, M.D. 2005, JGR 110, E08004

[3] van der Waals, J.H. & Platteeuw, J.C. 1959, Adv. Chem. Phys., 2, 1