Geophysical Research Abstracts
Vol. 12, EGU2010-10730, 2010
EGU General Assembly 2010

Chemistry in Titan's Hydrocarbon Seas

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Multiple lines of evidence from the Cassini-Huygens mission demonstrate that Titan's large lakes and seas are composed of liquid ethane and methane. In addition to the aforementioned constituents, recent work on solubility indicates that propane, dissolved acetylene and nitriles will be significant components (Cordier, D. et al., ApJ v. 707, 128, 2009). Here we make a preliminary examination of the kinds of chemistry that might occur in such a multicomponent organic solution at temperatures of 90 K subject to various energy sources including modulations of solar heating on seasonal and longer timescales (Aharonson et al., Nature Geoscience v. 2 851, 2009), cosmic rays, and (more speculatively) regional cryovolcanism. It is known that carbon cations (C+) can form in methane, and thus these cations might be found in the liquid methane and ethane comprising the polar seas of Titan. As a result, the methane would become a weak protic solvent, which opens the possibility of methane and its sister alkanes participating in more vigorous organic reactions and erosional processes with the surrounding bedrock than previously thought. We apply these considerations to several problems: (a) We calculate rates of chemical erosion of geological features surrounding the large seas, assuming the surrounding country rock to be (i) water, (ii) water-ammonia, (iii) solid organics. (b) We recompute the solubility of minor polar constituents in the seas, which should be enhanced thanks to the protic behavior of the methane. (c) Non-aqueous biochemistries in hydrocarbon liquids such as those proposed by Benner et al. (Current Opinions in Chem. Bio. v. 8, 672-689) will be aided by the potential for enhanced polarity of the liquid. This work was supported by the NASA Astrobiology Institute, and the program "Incentivazione alla mobilita' di studiosi straineri e italiani residenti all'estero."