

Titan's Methane Cycle

SUSHIL K. ATREYA¹, HASSO B. NIEMANN², TOBIAS C. OWEN³ and THE
HUYGENS GCMS TEAM

¹University of Michigan, Ann Arbor, MI 48109-2143 USA

²Goddard Space Flight Center, Greenbelt, Md, USA²

³University of Hawaii, Honolulu, HI USA Greenbelt, Md, USA

The GCMS measurements provide a strong evidence that the Huygens Probe descended through what appears to be a thick cloud or haze composed of methane in Titan's middle troposphere. Moreover, the GCMS measurements at the surface indicate the presence of a reservoir of methane, presumably liquid. Supporting evidence for these findings comes from the Probe's DISR and the SSP data. Thus methane on Titan appears to be like water on earth with its liquid reservoir in the oceans and lakes and a meteorological cycle of evaporation, condensation, followed by precipitation. However, the cycle of methane on Titan, is far more complex, as photochemical processes in the upper stratosphere play a key role, by *irreversibly* destroying methane, and converting it to heavier forms of hydrocarbons (1, 2). Many of the latter would condense out of the atmosphere on to the surface of Titan. In the absence of recycling, Titan's methane would be destroyed in approximately ten million years. Lacking the greenhouse warming provided by methane, the nitrogen atmosphere of Titan too would gradually collapse. Although not entirely impossible, it is difficult to imagine that Titan somehow goes through episodic build-up and collapse of its atmosphere, and that the present earthlings are lucky to be observing Titan in its full glory. Instead, we favor a permanent atmosphere on Titan. Because of the critical role methane plays in maintaining an atmosphere on Titan, we have investigated many recycling possibilities, including water-rock reactions (serpentinization) as on Mars, as well as the thermal breakdown of heavy hydrocarbons in Titan's interior. We will discuss these and other possibilities in order to understand the full hydrogeological-meteorological-photochemical cycle of methane on Titan.

References

- [1] E. H. Wilson and S. K. Atreya, *J. Geophys. Res.*, 109, E06002, doi: 10.1029/2003JE002181 (2004).
- [2] E. H. Wilson and S. K. Atreya, *Planet. Space Sci.*, 51, 1017 (2003).