HUYGENS GAS CHROMATOGRAPH MASS SPECTROMETER (GCMS) RESULTS FROM TITAN. H.B. Niemann[1], W.T. Kasprzak[1], S. Atreya[2], J. Demick-Montelara[1], T. Owen[3], E. Raaen[1], J. Haberman[1], E. Patrick[1]. [1]NASA/GSFC, Code 699, Greenbelt, MD, 20771 (Hasso.B.Niemann@nasa.gov, Wayne.T.Kasprzak@nasa.gov). [2]University of Mich., Ann Arbor, MI48109-2143. [3]University of Hawaii, Honolulu, HW 96822.

Introduction: The GCMS instrument was opened to the lower atmosphere of Titan at 147 km altitude and obtained gas composition data during the 2 hour and 27 minute descent of the probe to the surface [1] on Jan. 14, 2004. Another 70 minutes of data were obtained on the surface before loss of communications with the orbiter. Data from the direct atmospheric sample inlet have yielded mixing ratios for the most predominant species as well as isotopic ratios for N, C, and H. Gas chromatographic data are still being analyzed and data from the Aerosol Collector and Pyrolyzer instrument have been reported separately [2].

Titan Atmosphere: The GCMS instrument confirmed that the main constituents of Titan's lower atmosphere are N_2 (~95%) and CH_4 (~5%). Heavier mass molecules are not present in the lower atmosphere and the organic chemistry seems concentrated in aerosols. The altitude profile of the CH_4 mole fraction near and at the surface is evidence of a "humid" atmosphere with methane precipitation and liquid methane in/near the subsurface at the landing site [3].

The most abundant noble gas is ^{40}Ar due to radioactive decay of ^{40}K in the rocky core of Titan. There is a small amount of primordial ^{36}Ar as well while Kr and Xe are virtually absent (<10 ppb).

The chemical lifetime of CH_4 in the atmosphere is only 10–100Myr. Because the carbon in CH_4 does not show the same kind of isotopic fractionation as the nitrogen and oxygen isotopes do, it must be continually or periodically replenished. The absence of Kr and Xe, small amount of ^{36}Ar and the substantial amount of ^{40}Ar imply that CH_4 is likely produced by hydrothermal activity in the interior with only a small portion having arrived as a hydrate clathrate. The isotope ratio for $^{12}C/^{13}C$ is less than the value of Earth organic or inorganic samples implying that the CH_4 is not of a biologic origin and its slight depletion on Titan must await another explanation.

The $^{14}N/^{15}N$ ratio is less than that of the Earth which implies escape of N_2 over the eons. The source of the N_2 is most likely NH_3 delivered to Titan trapped in ices. Thermal dissociation of NH_3 in the moon's interior or photochemical processes acting on the arrived NH_3 converts it to N_2. The $^{14}N/^{15}N$ values suggest that Titan once had an atmosphere that was 2-10 times higher in pressure than the current atmosphere.

Some clues as to the surface composition have been obtained from the vapors of organic molecules emitted while the probe was on the surface.

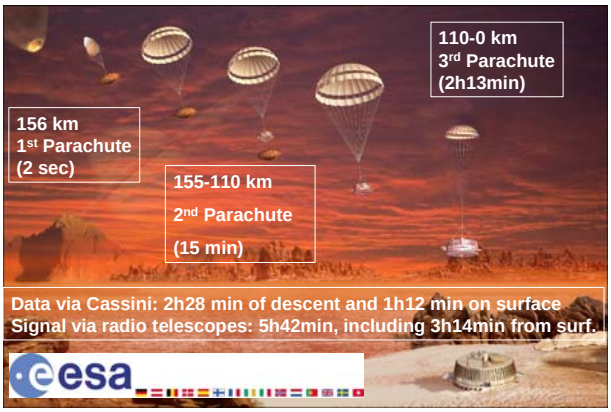

Figure 1. Huygens Probe descent and landing overview.

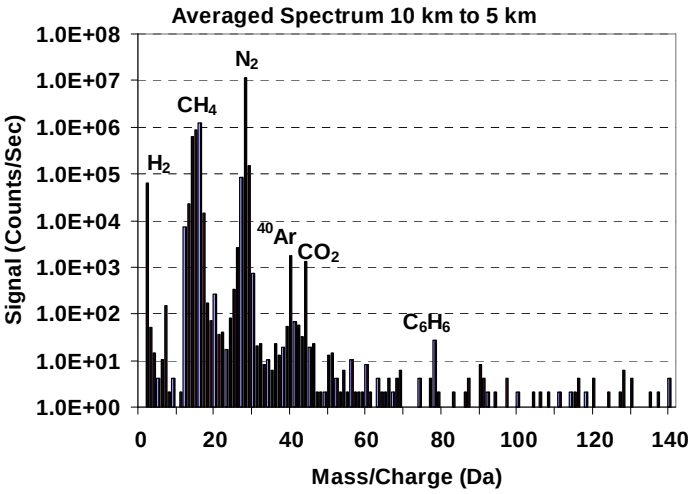

Figure 2. The direct inlet averaged mass spectrum from 10 km to 5 km showing the major atmospheric constituents of H_2, CH_4, N_2, and ^{40}Ar. CO_2 may be due to background gas in the sensor.

References:

[1] Niemann, H.B., et al. (2005), *Nature*, 438 (8), 779-784. [2] Israel, et al. (2005), *Nature*, 438 (8), 796-799. [3] Atreya et al. (2006), *Planetary Space Sciences*, 54 (12), 1177-1187.