THE CASSINI/HUYGENS DOPPLER WIND EXPERIMENT: RESULTS FROM THE TITAN DESCENT.

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The primary objective of the Doppler Wind Experiment (DWE), one of the six scientific investigations comprising the payload of the ESA Huygens Probe, is a determination of the wind velocity in Titan's atmosphere [1, 2]. Measurements of the Doppler shift of the S-band (2040 MHz) carrier signal to the Cassini Orbiter and to Earth were recorded during the Probe descent in order to deduce wind-induced motion of the Probe to an accuracy better than 1 m s^{-1}. An experiment with the same scientific goal was performed with the Galileo Probe at Jupiter [3, 4]. Analogous to the Galileo experience [5], it was anticipated that the frequency of the Huygens radio signal could be measured on Earth to obtain an additional component of the horizontal winds. Specific secondary science objectives of DWE include measurements of: (a) Doppler fluctuations to determine the turbulence spectrum and possible wave activity in the Titan atmosphere; (b) Doppler and signal level modulation to monitor Probe descent dynamics (e.g., spinrate/spinphase, parachute swing); (c) Probe coordinates and orientation during descent and after impact on Titan.

DWE complements the remote-sensing observations of temperatures and winds from the Cassini Orbiter, providing ``ground truth" for the zonal wind retrievals from the Composite Infrared Spectrometer (CIRS) experiment. It is anticipated that the Cassini Radio Science Subsystem (RSS) will provide additional clues about Titan's atmospheric dynamics from their series of radio occultation observations at a variety of latitudes. Doppler fluctuations indicate that the Probe descended through regions of turbulence or vertical wave propagation and may provide information on the associated eddy momentum mixing or planetary waves, respectively. In contrast to the strong radio attenuation in the Jupiter atmosphere inferred from the Galileo Probe signal level measurements, propagation effects at S-band for the Huygens DWE on Titan were confirmed to be negligible.

The largest uncertainties in the DWE wind measurement arise from trajectory errors. An important prerequisite for success was the stability of the oscillators used to generate the signal on the Probe and receive it on the Orbiter. The desired accuracy could be achieved only with a sufficiently stable radio signal over the duration of the descent. The specified frequency stability of $\delta f/f \cong 2 \times 10^{-10}$ ($\rightarrow \delta f/f \cong 0.4$ Hz at S-band) was met by using rubidium-based Ultra-Stable Oscillators in both the transmitter (TUSO) and receiver (RUSO), rather than the standard Temperature Compensated Crystal Oscillators (TCXO).

Initial impressions from the Titan atmospheric descent and a preliminary height profile of Titan's zonal wind will be presented.

[1] Bird et al. (1997) *ESA-SP 1177*, 321-335. [2] Bird et al. (2002) *Space Sci. Rev., 104*, 613-640. [3] Atkinson et al. (1996) *Science, 272*, 842-843. [4] Atkinson et al. (1998) *JGR, 103*, 22 911-22928. [5] Folkner et al. (1997) *Science, 275*, 644-646.