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Six Cassini radio occultation experiments over the four years period 2006-2009 profiled Titan's neutral atmosphere on both the ingress and egress sides. One additional ingress only occultation brings the total number of observed profiles to eleven, covering a broad range of observation latitudes. Each occultation is carried out using three monochromatic and phase coherent radio signals of wavelength = 0.9, 3.6, and 13 cm (Ka-, X-, and S-bands, respectively).

The three radio signals were transmitted simultaneously by Cassini through the neutral atmosphere of Titan, and the refracted signals were observed on the Earth. Changes in the observed signal frequency are used to recover the refractivity profile of the atmosphere, hence estimate the expected loss in signal strength due to defocusing of the radio signal by differential refraction. The refractive defocusing component (wavelength independent, in principle) is then removed from the actual measured extinction profiles of the radio signals, yielding the "true" signal extinction profiles due to absorption and scattering along the propagation path.

The initial Cassini observations are diffraction-limited. We extend diffraction reconstruction procedures developed for radio occultation observations of planetary rings to attempt to remove diffraction effects first. The procedures are tested using idealized models of simple isothermal atmospheric profile extending above a hard- limb (knife-edge) model. Reconstruction of the "observed" (simulated) diffraction-limited data shows good agreement with the assumed atmospheric profile and the location of the hard-limb for a range of model parameters.

We then apply a similar approach to the actual measured data. Strong wavelength-dependent extinction profiles behavior is observed. Its large-scale structure appears well modeled by predictions based on N2-N2 collision-induced gaseous absorption. Interesting localized features of yet unexplained origin are also observed.

Because the spatial scales of the extinction profile features are relatively large compared with the Fresnel scale of diffraction, the recovered profiles are close to the diffraction-limited ones. The exception is in the vicinity of Titan's limb were the physical location of the hard-limb is more accurately determined when diffraction effects are removed. Accurate recovery of Titan's radius at multiple observation latitudes is valuable for constraining Titan's figure. In addition, removal of diffraction effects is an important first step for reliable characterization of atmospheric small-scale structure caused by turbulence and possibly gravity waves.