Radio Wave Scintillation in the Neutral Atmosphere as Noise in Precision Spacecraft Tracking Observations

J. W. Armstrong (J]'].)

Tropospheric phase scintillation degrades the coherence of a radio link and thus introduces noise in interferometer observations and spacecraft Doppler tracking experiments. High-quality Doppler data were taken in March-April 1993 with the Mars Observer spacecraft when it was in interplanetary cruise (sun-earth-spacecraft angle $\approx$ 100 degrees; earth - spacecraft distance $\approx$500 light seconds). The radio wave phase residuals from these tracks can be used to study the statistics of the tropospheric scintillation and to assess its importance in precision tracking. Here I present temporal radio wave phase structure functions, $\langle|\phi(t) - \phi(t+\tau)$ [2), for X-band data taken at the three NASA/JPL Deep Space Network Tracking complexes. The observed structure functions are approximately powerlaw, $D(\tau)$ = const τ^{α}. I characterize the structure functions by their levels at τ = 100 seconds and their powerlaw indices, α. The powerlaw indices varied between 0.67 and 1.6, averaging 1.2. Substantial variation in the structure function level was observed, with a histogram of level showing many relative] y low values and fewer relatively large levels. There were small systematic variations in the levels between the tracking sites, with Australia having larger levels in this sample. 1 compare these observations with interferometric (i.e., spatial) measurements and discuss some implications for spacecraft tracking, particularly as these observations refine the noise model for low-frequency gravitational wave searches.

The work described in this paper was carried out at the Jet l'repulsion laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.

Abstract submitted for AAS [AAS] meeting

Date submitted: April 5, 1996 Electronic form version 1.6