The Complex Refractive Index of the Earth's Atmosphere and Ionosphere

Ernest K. Smith
Professor Adjunct
University of Colorado
Boulder, CO 80309-0425

Abstract
The behavior of the complex refractive index of a propagation medium yields almost everything one needs to know for propagation purposes. This is because, with a little sophistication, one can even treat such topics as scattering, scintillations and antenna wetting via the complex refractive index. However it is not my intention to do so. In searching for a topic which would not intrude on the subject matters of the authoritative speakers who follow, but still allow me pretty free rein, I thought this title would do nicely.

ITS and NIST have had a long history of involvement in the atmospheric refractive index, dating from the work of Birnbaum, Kyder and Lyons (1951), Smith and Weintraub (1953), Bean and Dutton (1966) and more recently, and more generally, by Hans Liebe and co-workers (e.g. Liebe 1985, Liebe et al. 1993).In this talk I will review recent work on the constants and in atmospheric attenuation to 1000 Ghz.

For the ionosphere the Appleton equation for the refractive index of a cold plasma has stood the test of years [Davies 1989], but the applicability of the approximations, especially in regard to GPS frequencies, will be reviewed.

Bean, B.R. and E.J. Dutton [1966] **Radio Meteorology**, chapters 1 and 2, NBS 1966, Dover, 1968.

Birnbaum, G., S.J. Kryder and H. Lyons [1951] Microwave measurements of the dielectric properties of gases. ***J. Appl. Phys.*** **22**, 95.

Davies, K [1989] **Ionospheric Radio**, Peter Peregrinus Ltd. for the IEE Liebe, H.J. [1985] An updated model for millimeter wave propagation in moist air, ***Radio Science*** **20**, 1069.

Liebe, H.J., G.A. Hufford and M.G. Cotton [1993} Propagation modeling of moist air and suspended water/ice particles at frequencies below 1000 Ghz, ***AGARD 52nd Specialists Meeting of the Electromagnetic Wave Propagation Panel***, Palma De Mallorca, Spain, 17-21 May 1993.

Smith, E.K. and S. Weintraub [1953] The constants in the equation for the atmospheric refractive index at radio frequencies. ***Proc. IRE*** **41**, 1035.