Refractive Index Formulae for Radio Waves

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ABSTRACT

The radio refractive index formula adopted in 1963 by the International Union of Geodesy and Geophysics (IUGG) and the International Association of Geodesy (IAG) is being reviewed. Forty years ago, this formula was essential for the reduction of distances measured with microwave EDM instruments. Since then, long-range EDM has been replaced by the Global Positioning System (GPS). Today, the formulae are important for accurate measurements using radio waves, including GPS and VLBI (Very Long Baseline Interferometry). The new radio wave refractive index formulae of the last decades are discussed and the inherent problems of some of them are pointed out. State-of-the art formulae for routine and precise measurements in the radio wave spectrum are discussed as are computer programs that model the influences of resonance lines.

Two formulae for hand calculations of the radio refractive index N_r (in ppm, for infinite wavelengths) have been designed, one based on 'best available' coefficients and one based on 'best average' coefficients. For air with 0.0375% (375 ppm) content of CO_2, the latter is:

$$N_r = 77.6890 \frac{p_d}{T} + 71.2952 \frac{p_w}{T} + 375463 \frac{p_w}{T^2}$$

where p_d (= p_{tot} - p_w) is the partial dry air (including 375 ppm carbon dioxide) pressure (in hPa), p_w is the partial water vapour pressure (in hPa), and T is the temperature (in K). The accuracy of the dry air refractivity component N_d (first term on right hand side) is, conservatively, 0.02% of N_d. A conservative value for the accuracy of the water vapour component N_w (sum of second and third term on the right hand side) is 0.2% of N_w.

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