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Propagation Induced Distortion of Wideband Waveform Radar Signals in Dependence of Polarisation and Frequency

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Wideband Waveform radar signals of Bandwidths in excess of 300 MHz are anticipated to play an important role in the emerging systems in radar remote sensing. In telecommunication and remote sensing applications, large-bandwidth signals are required for generating high channel capacity and data-transfer rates. In radar-imaging applications, large bandwidths are required for obtaining higher spatial resolution, for instance. The well-known benefits of wideband signals, however, are available only under the premise that the free-space propagation effects do not distort or impair the amplitude and phase composition of the different frequency components contained in such signals. Indeed, the so-called free-space is, however, often filled with precipitation media, such as rain. Contrary to popular belief, such media are capable of generating dispersion by causing unequal attenuation and phase-shift of the different frequency components present in the wideband signal. In this contribution, we shall report investigations in this regard.

More precisely, using an appropriate scattering model of rain media, we shall, in the first step, quantify, along vertical and horizontal polarisations, the amplitude extinction and phase-shift in rain media for different frequencies in the range of 5-60 GHz. In the second step, we shall use this information to quantify the distortion of wideband signals with different centre carrier frequencies and different modulation depths. Also, the results will be used to construct the 'channel impulse response' appropriate for different rain media that are likely to occur in reality. In this contribution, for brevity, accuracy and reliability of scattering calculations, we shall rely as much as possible on ITU-recommendations for computing attenuation and phase-shifts. The results should enable the radar engineer and the telecommunication engineer to estimate the degree of tropospheric-propagation-induced distortion of wideband signals both in the frequency domain and the time domain. Estimates of maximum bit-transfer rates in rain media will also be given.