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Estimation of Trends in Distributions of One-Minute Rain Rates Over the UK to Assess Impacts on Telecommunications

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It is known that the rain rate exceeded 0.01% of the time has experienced an increasing trend, in the UK, over the last twenty years. It is very likely that rain fade and outage experience a similar trend. This paper presents a method, applicably globally, to estimate these trends. The input data are parameters easily extracted from numerical weather prediction reanalysis data. The method is verified using rain gauge data from the UK.

Dynamic fading due to rain and wet snow tends to be larger than that due to other mechanisms on terrestrial and Earth-space links at frequencies above approximately 5 GHz. The International Telecommunication Union (ITU-R) maintains a set of models for predicting average annual distributions of rain fade, with a one-minute integration time, on individual links. An important parameter in these models of rain fade is the one-minute rain rate exceeded for 0.01% of an average year (R0.01%). Several recent reports have suggested that trends in climate parameters could be having significant effect on telecommunications systems over their lifetime. A satellite communications system has a typical life-cycle of 30 years, from initial conception to decommissioning.

The objective of this work is to develop a method to estimate trends in the R0.01% rain rate, globally, using readily accessible data. A relationship is postulated between very low resolution rain parameters from Numerical Weather Prediction (NWP) reanalysis data and the one-minute averaged, point rain rates required for radio regulation, and the optimization of network spectral efficiency and performance. Trends in these parameters can then be linked to trends in one-minute rain rates. The transformation of reanalysis parameters to one-minute rain rate CCDF parameters has been optimized to provide the best fit to the 743 experimental CCDF statistics, acquired from over the 139 locations, archived in the database of the ITU-R Study Group 3: DBSG3. Inherent in this process is the assumption that the climate is stationary. The three reanalysis parameters MT (mean annual total rain height), MC (mean annual convective rain height) and Pr6 (probability of rainy 6-hours periods) are calculated by averaging over 44 years of ERA40 and the data collection period of DBSG3 data was ignored. In this project we use NOAA NCEP/NCAR Reanalysis 1 data spanning 1958 to 2011. The motivation for the NOAA NCEP/NCAR Reanalysis project was to remove the apparent climate change artefacts introduced by the occasional changes made to numerical weather models. The MT and MC data are calibrated using rain gauge measurements from the VASClimO (Variability Analysis of Surface Climate Observations) dataset version 1.1. This dataset provides daily precipitation accumulation derived from rain gauge measurements, integrated over regions of diameter 1o, over land, derived from 9,300 gauge stations.