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Using meteorological data for clear sky and cloud attenuation in Belgium and India

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Future High Throughput Satellite Communication Systems and Earth Observation Satellite Data Download foresee the use of frequencies in Ka band and above because those frequency bands offer advantages in terms of bandwidth and capacity. In that frequency range, the degradation due to the troposphere becomes important and the designers need a better estimate of the degradations and more specifically the attenuation due to gases and clouds. Even if the specific attenuation is small, except in the frequency band where resonance is present (such as 60 GHz for oxygen), it is always present. The meteorological data available worldwide are now currently used for the estimation of the attenuation due to oxygen, water vapour and clouds [1] [2]. Satellite propagation campaigns are ongoing for the accurate determination of attenuation models in Ka and Q band, using for example the Alphasat satellite from the European Space Agency [3], at 19.7 GHz and 39.4 GHz. The beacon receivers measure directly the power of the beacon received from the satellite but they suffer from various types of instabilities due to tracking inaccuracies, temperature effects, etc and cannot measure the total attenuation of the beacon, in the absence of an external reference (excess attenuation measurement). A concurrent radiometer measures the brightness temperature, enables the accurate estimation of the total attenuation along the path in the absence of scattering, and produce the Integrated Liquid Water (ILW) and Integrated Water Vapour (IWV) content. The cost of the equipment is however high and only a few experimenters use a radiometer [4].

Various types of meteorological data give the IWV and ILW, useful for the retrieval of the gaseous and cloud attenuation and the calculation of the total attenuation:

- GNSS network collects data from stations worldwide and produce the zenith IWV
- Radiosonde observations (RAOBS) give profiles of pressure, temperature and water vapour
- ECMWF (European Centre for Medium-Range Weather Forecasts) archives (ERA5, ERA-Interim, Operational model) give 3D datasets of pressure, temperature, humidity, wind speed and direction or directly the integrated values such as IWV.

Using those sources, it is possible to retrieve IWV and/or ILW. The methodology has been validated in Western Europe during the Alphasat campaign. In this paper, the various methods for the retrieval of IWV and ILW will be compared in the temperate region Louvain-la-Neuve (50.67° N, 4.62° E), Belgium, and also the data from Kolkata (22.34° N, 88.29° E), India located in tropical region, where a radiometer was available during the NSS 6 experiment, will be compared. The root mean square error on the retrieved IWV and its impact on the gaseous attenuation will be assessed.

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