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Linking Attenuation To Weather Data – An Improved Algorithm

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Tens of thousands of very small aperture terminals (VSATs) are installed all over the world and a big percentage of VSATs are used for internet access. Their signal quality is dependent on orbital effects of the satellite, on the pointing accuracy of the antenna, on system effects, and on the meteorological situation along the slant path between terminal and satellite. Especially rain drops, but more generally, hydrometeors and gases attenuate electromagnetic waves and impact the link quality.

On the one hand, the use of attenuation data from VSAT networks to retrieve weather parameters is of great interest for numerical weather prediction (NWP) models. Especially in regions were radar data is scarce, this additional data source could positively impact weather forecasts. On the other hand, from the Rayleigh and Mie scattering theories it is clear that the level of attenuation depends on the ratio between the signal wavelength and the hydrometeor's diameter. The expected attenuation caused by water vapor, cloud droplets and precipitation are provided in the recommendations of the International Telecommunication Union (ITU). Consequently, NWP models can be used to forecast the expected attenuation [1]. To cover both cases, a conversion algorithm was developed within the European Space Agency (ESA) project "SatcomWeather".

When using the algorithm [2] to compute the expected atmospheric attenuation, the frequency, slant path elevation, vertical profiles of water vapor density, temperature and pressure, as well as the integrated water vapor (WV) and the integrated liquid water content in clouds or fog (LWC) are used as input data. The impact of the precipitation on the attenuation is computed as function of the rain rate and the affected path length. The total attenuation is then the sum of attenuation due to WV, LWC (if present) and precipitation (if present). In the case of retrieving meteorological parameters from a given attenuation, the computation follows a simple bucket model. The attenuation due to WV and LWC is computed based on vertical profiles. The resulting attenuation is compared to the given atmospheric attenuation. If the given attenuation is bigger than the computed one, precipitation must occur to account for the excess.

So far, we have evaluated the algorithm's skill to retrieve meteorological data from attenuation over three spring days where the calculated rain rates are compared to radar data. Our results show that the highest correlation between attenuation and meteorological parameters exists for precipitation, followed by WV and LWC. Especially precipitation can be retrieved with promising critical success index (CSI) scores, shown in Figure 1.

a)>=0.1 mm/h b)>=0.5 mm/h c)>=2.5 mm/h

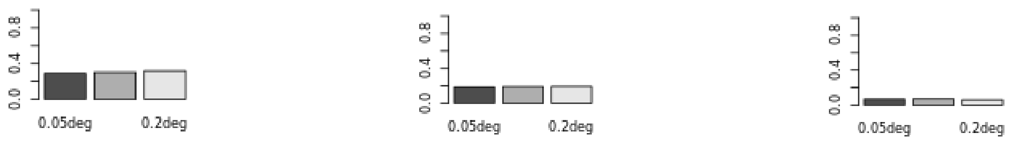

Figure 1. CSI values computed over all time steps (CSI of 1 is perfect, CSI of 0 displays no skill); a) CSI score for rain rates >= 0.1mm/h; b) CSI score for rain rates >= 0.5mm/h; c) CSI score for rain rates >= 2.5mm/h

References

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