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Frequency and Polarization Diversity for Optimal Information-Sensing in Severe Weather Conditions

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The performance of microwave remote sensing sensors such as weather radars, synthetic aperture radars and communications systems deployed in disaster risk monitoring, assessment and management depend crucially on the frequency and polarization used by these systems. In this contribution, we shall analyze how the frequency and polarization used in such remote sensing systems affects their operational capability, particularly under severe weather conditions due to heavy rain events.

In keeping with this objective, we shall investigate and report the attenuation and phase-shift suffered by electromagnetic signals in dependence of frequency, polarization and rain-rate. A key quantity to be worked out is the dependence of signal degradation and loss as a function of the effective 'link length' of the sensors. In the same vein, we shall put forward scaling factors to transform attenuation and phase shifts between different frequencies and polarizations. Another key aspect to be addressed will be to assess the magnitude of backscattering (the radar signal providing feature) against its loss due to the propagation-induced attenuation of this signal. The computational approach of the analysis to be reported will be based on the solution of the electromagnetic scattering by raindrops. In this regard, a point-matching algorithm for solving Maxwell's equations will be developed and translated into a Matlab program.

In summary, the contribution will reveal optimal frequencies for radar remote sensing under the variations of precipitation rate, polarization, effective link-length, backscattering and propagation loss. Appropriate examples of sensor signal degradation will be used to illustrate the topics covered in this paper.

1. Sogo Okamurat and Tomohiro. Oguchi, "Electromagnetic wave propagation in rain and polarization effects," Proc. Jpn. Acad., Ser. B 86 (2010), doi: 10. 2183/pjab.86.539