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L-band Signal Propagation through Volcanic Plumes

Nicholas Rainville*(1), Scott E. Palo(1), Kristine M. Larson(1)
(1) Smead Department of Aerospace Engineering Sciences, University of Colorado, Boulder, CO, e-mail: nicholas.rainville@colorado.edu; palo@colorado.edu; KristineM.Larson@gmail.com

Decreases in the Signal to Noise Ratio (SNR) of Global Positioning System (GPS) signals at receivers close erupting volcanoes point to a reduction in signal strength when those signals intersect a volcanic plume [1]. The drop in SNR can be used to detect the presence of a plume from GPS receivers [2]. This study presents the results of a forward model for L-band signal attenuation due to absorption and scattering from particles within a volcanic plume to better understand which physical effects may cause the decrease in SNR observed in GPS data. This simulation includes total path length calculations based on the plume geometry, a charged particle model, a particle size distribution and density model, as well as a particle composition model for both for silica content as well as water and sulfuric acid surface films. The sensitivity of GPS plume detection to each of these parameters is investigated through a comparison of the simulated results with GPS data taken during the November 23rd, 2013 eruption at Etna volcano.

Results from this model when initialized with estimates of the model input parameters based on observations from optical imagers, radiometers, and radars [3], result in an underestimation of the signal attenuation. However uncertainties in those input parameters may account for this difference and this study presents an analysis of which parameters, and physical effects, have the greatest impact on signal attenuation. This includes increased particle permittivity due to surface coatings on ash particles, particle size distributions biased toward larger particle diameters, and plume density.

References

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