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Radar rainfall estimation for a post-flash flood analysis: radome attenuation and the application of the mountain reference technique at C-band frequency

Francesco Marra (1), Marco Borga (1), Francesco Zanon (1), and Guy Delrieu (2)

(1) Department of Land and Agroforest Environment, University of Padova, Legnaro, Italy, (2) Laboratoire d'étude des Transferts en Hydrologie et Environnement, Grenoble, France

This work is dedicated to radar rainfall estimation for the post-event analysis of the flash flood event of 4 September 2009 which impacted the Upper Adige river system, in the Central Italian Alps with high rainfall amounts and causing damages to people and to the road system. The storm event was observed by means of a C-band weather radar system and a rain gauge network enabling the validation of radar rainfall amount estimates with fine time resolution. Results obtained by applying a number of corrections to radar reflectivity measures are described. Particular attention is paid on application of the mountain reference technique on (i) signal attenuation and (ii) wet radome attenuation. The two sources of error are treated in a similar way: reflectivity return from selected ground clutter are used to limit the path integrated attenuation for the former and to quantify the correction factor for the latter (when it rains only on the radar site). The large gradient of rainfall characterising the storm event enabled the isolation of the two sources of error.

During the event, large rainfall amounts over radar site caused serious underestimations in rainfall retrieval. A technique for radome attenuation estimation is presented and is integrated in the QPE procedure. Particular attention was paid to select time steps with significant rain intensities over the radar site but almost no rainfall over the path between the radar antenna and the selected clutter, to isolate the effects of radome attenuation. A two-way radome attenuation of 2.7 dB was found for this event.

The utility of the Mountain Reference Technique is demonstrated to quantify rain attenuation effects that affect C-band radar measurements in heavy rain. The proposed technique allowed estimation of an effective radar calibration correction factor, assuming the reflectivity-attenuation relationship to be known. Screening effects were quantified using a geometrical calculation based on a digitized terrain model of the region. The vertical structure of the reflectivity was modelled with a normalized apparent vertical profile of reflectivity. For this contrasted rainy system with convective and stratiform regions, the combination of the vertical (VPR) and radial (attenuation, screening) sources of heterogeneity yields a very challenging problem for radar quantitative precipitation estimation at C-band.