Comparing High-Resolution Radar Reflectivity and Tipping-Bucket Gage Rainfall to estimate Post-Fire Debris-Flow Susceptibility

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Wildfires increase the occurrence of post-fire hazardous flash floods and debris flows from steeplands during intense, but spatially variable, rainfall. To limit loss of life from these hazards, we are collaborating on refining a real-time early warning system. To estimate rainfall intensities over entire burned areas, we deployed a mobile radar truck (SMART-R, C-band Doppler) to three southern California fires over two winter seasons (2006-2008) to provide high-resolution atmospheric reflectivity data. Within these fire perimeters we also installed tipping-bucket rain gages on topography susceptible to debris flows, to provide point measurements of assumed precipitation “truth”.

Results illustrate the difficulty involved in comparing spatially continuous atmospheric radar measurements with terrestrial point measurements. During the 2006-2007 winter with record-low rainfall, both data sets record similar spatial patterns of rainfall intensity, although rainfall magnitudes differed slightly. In contrast, for the wetter 2007-2008 winter, SMART-R and gage data exhibit different spatial patterns, with rain gages often recording significantly greater rainfall than inferred by the SMART-R. For the largest storm event of the 2007-2008 winter, the SMART-R underestimated the total rainfall at one gage location by 129mm (73%).

Such rainfall underestimates provide inaccurate information, leading to potential false-negative warnings issued to the public. At all burned areas the SMART-R detected regional topographic influences, in addition to illustrating time-varying storm characteristics – attributes difficult to deduce from rain gage point measurements alone.

Two important locational factors influence the SMART-R to gage precipitation correlations – distance from the SMART-R, and beam height above topography. For example, echoes reflecting off atmospheric ice at high beam heights may account for the significant underestimation of rainfall during the 2007-2008 winter. These, and other complicating factors, must be refined in order to increase confidence in using radar precipitation estimates for a real-time warning system.