QPE lessons learnt from the great Colorado Flood of September 2013

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The week of 9 to 15 September 2013 a heavy rainfall event, with local amounts exceeding 400 mm, fell over a broad region of the Colorado Front Range foothills and adjacent plains (Colorado, USA). During this week, point accumulations of about 300 mm (11.85 inches) fell within a 24-hour period of Sept. 12th – 13th. The 7-day rainfall, with a return period of over 500 years (NOAA Hydrometeorological Design Studies Center), triggered severe flooding over the region on 11 – 13 September, as well as localized flash flooding, landslides and debris flows which claimed 10 lives and caused damages estimated over $2 billion to private and public properties along the Colorado Front Range communities.

The rainfall generating this Colorado Flood event was atypical for this high-elevation, continental interior region. It was characterized by orographically-lifted, mixed-phase, stratiform precipitation mechanisms with a well-defined melting layer and appreciable collision-coalescence drop growth occurring between the melting layer and the surface, leading to a major challenge for operational QPE products, which resulted in significant uncertainty as to how much rain was falling and where.

The large uncertainties can be clearly shown through comparison of four different operational quantitative precipitation estimation (QPE) products that are derived from Stage II NWS-NEXRAD radar data. These products include 2 'radar-only' products (the 'default' QPE product from the regional NEXRAD Z–R relationship and the one using multi-parameter polarimetric radar information) as well as two rainfall gauge-corrected products that are produced by NOAA [the Multi-sensor Precipitation Estimate (MPE) and NCEP Stage-IV].

In order to further understand the nature of the discrepancies among these operational QPE estimates, the available level II radar data have been carefully analyzed through an advanced radar processing developed at CRAHI. Also, QPE products have been analyzed using a non-parametric raingauge–radar blending product used as reference to map their uncertainties, and to explore their origin. This analysis shows the extreme importance of including advanced QPE processing to deal with beam interception correction, and to provide QPE estimates at ground using adapted vertical profile reflectivity corrections and differentiated Z–R transformations depending on the type of rainfall associated to a given region (through the identification of the main rainfall generating processes).

The presentation will focus on lessons learnt from this analysis using the extraordinary case study of the Colorado Flood event of September 2013.