Geophysical Research Abstracts
Vol. 15, EGU2013-1994-1, 2013
EGU General Assembly 2013

Compositing radar reflectivity observations with an inverse method

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Quantitative Precipitation Estimation (QPE) has been one of the main applications of weather radars since its early stages. Nowadays, many advances have improved such estimates and radar networks have been deployed in many countries. In parallel, uncertainty in radar QPE has become a subject of interest by itself because of its significant role in the quality of estimates. When several radars cover the same area, some sources of uncertainty (e.g. path attenuation by intense precipitation, beam blockage or beam broadening), can be dealt using information from the least-affected radars instead of only reproducing a single radar approach in each one. So far, composites of radar observations are carried out through simple criteria (by picking the closest observation, the maximum value...) or quality indices –that need a priori definition of quality descriptors.

This study proposes an alternative methodology to retrieve the 3-dimensional reflectivity field most compatible with the measurements from the different radars of the network. With this aim, the methodology uses a model that simulates the radar sampling of the atmosphere. The model settings consider the specific features of each radar such as the location, hardware parameters (frequency, beam width, pulse length...) and scanning strategy. The methodology follows the concept of an inverse method based on the minimization of a cost function that penalizes discrepancies between the simulated and actual observations for each radar of the network. It is worth noting that for radar at attenuating wavelengths, the proposed methodology implicitly corrects the effect of attenuation due to intense rainfall.

The methodology has been applied on the network of C-band radars in the vicinity of Barcelona, Spain. The retrievals have been obtained for a 12 hours of rainfall with reflectivity observations of two radars; observations from a third independent radar have been used for verification at different heights. Conventional techniques have been also applied to compare its results with the ones of the proposed method. We analyzed some characteristics such as the vertical structure or the performance in attenuated regions. Different statistics have been computed to quantitatively assess the performance of the different methods; also, the spatial structure of the retrieved fields has been analyzed.