第Ⅱ部門

# Improving precipitation estimates using three dimensional weather radars

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## 1. Introduction

The use of weather radars in the field of hydrology has made a considerable progress over the last decade due to advantages associated with high temporal and spatial resolution observations and advances in distributed hydrological models. In addition, real time radar observations can be used to forecast short term rainfall. Combined use of forecasted rainfall and distributed hydrological models creates powerful a numerical tool for forecasting floods and related natural disasters. The objective of this paper is to discuss the methodology used in creating rainfall mosaics over South Korea using three dimensional gridded radar reflectivity.

## 2. Problems in using radar to estimate precipitation distributions

There are several problems associated with estimating precipitation distributions over large areas using weather radar measurements (Collier, 1996). The fundamental problem before radar derived rainfall distribution can be used for hydrological purposes is to make sure that they provide accurate and robust estimations. Ground clutters where the main radar beam encounter ground targets such as mountains, trees and man made structures are addressed in this study using digital elevation model (DEM) and dry ground clutter maps. Without appropriate precautions, these non-hydrometeor echoes can be erroneously attributed to estimated precipitation. Dry ground clutter maps are created from the radars observetions in non precipitation times and they are reasonably accurate to apply as ground clutter filters. Reflectivity near earth at ground clutter locations were filled with the help of vertical gridding and mosaics using other radars.

## 3. Use of three dimensional data

Most of the current weather radars are capable of scanning atmospheres three dimensionally with high spatial and temporal resolution, and therefore useful for monitoring and predicting the atmospheric conditions.

For a radar, observations made at native conical coordinates were transformed to longitude, latitude and altitude (x, y, z) coordinated system. And results were transformed in to 30" x 30" x 500 m resolution. Two methods were used to vertically interpolate the data. In nearest neighborhood method, for any given grid cell, if the center is in between the lowest and highest elevation angles, then it takes the value of the nearest radar bin. In the Vertical Adaptive Barnes method, if the center is in between the lowest and highest elevation angles, then it will take the weighted mean of the two nearest radar bin values, one at the tilt above and one at below. From the result, nearest neighborhood method produces

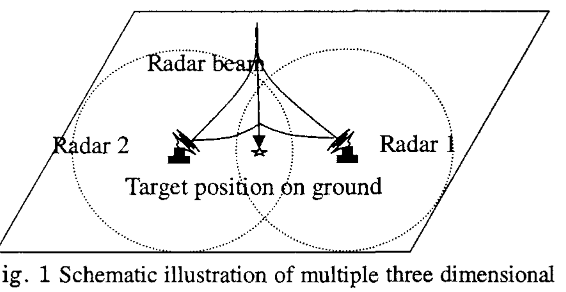


Fig. 1 Schematic illustration of multiple three dimensional radar observations to create reflectivity mosaic

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discontinuities in the resulting reflectivity image. Vertical Adaptive Barnes method produces smooth vertical profiles of reflectivity.

## 4. Reflectivity Mosaic over South Korea

Radar reflectivity data in Universal format acquired from Korean Meteorological Agency for Cheju, KMABRI, Dong-Hae, Jindo, Kunsan, Mt. Kwanak and Pusan ground stations were used in this study. TRMM Radar Software Library (RSL) was used to transform above data into radar data format in which two dimensional spatial resolutions at any point are based on the range and azimuth of different elevations. These data of different volumes was used to create the three dimensional reflectivity data bases.

While individual radars provide good local information, a utility often needs information over a wider area. The establishment of an overlapping network of radars provides this expanded coverage. Time synchronized multi radar coverage observations were used to avoid ground clutters for accurate rainfall estimations. If there are multiple radar values in clutter free radar values near to ground surface, maximum, average, weighted distance or nearest neighborhood schemes were used to merge data from multiple sensors. If there is no clutter free value near to ground, higher altitude values were used to avoid blunders (Fig. 1).

Radar reflectivity mosaics were created to estimate rainfall distribution for South Korean region for the Typhoon Rusa which hit the Korean peninsular on August 30th and September 1st 2002, causing 246 deaths and US$ 4.2 Billions of economic losses. A multiple radar reflectivity mosaic scheme has been developed in geographical coordinate system. Fig. 2 shows the reflectivity composite image created using maximum value algorithm at 15.00 hrs local time on August 31, 2002.

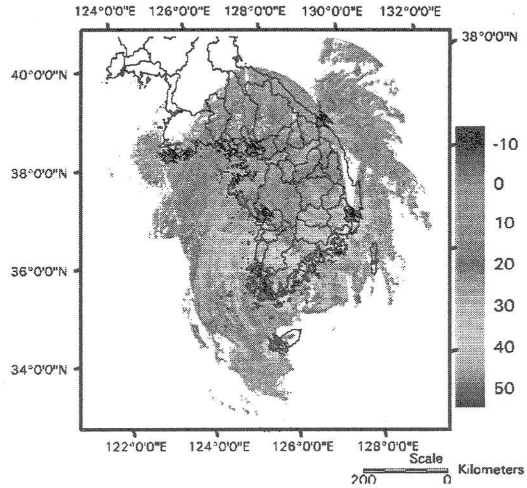


Fig 2 Composite QC reflectivity (dBZ) in the study region: August 31, 2002 15:00

Radar reflectivity (Z) mosaics are to determine rainfall rates (R) in every 10 minutes using Z-R relationship ($Z = A*R^b$). The coefficients A and b for each radar stations were determined by regression analysis using observed rainfall records.

Final target of this research is to develop software which enables the integration of high resolution three dimensional multiple radar into a single framework to depict and forecast the short term rainfall distribution over the Korean peninsular. Use of three dimensional radar reflectivity data reduces the uncertainties in the retrieved surface rainfall pattern.

## 5. Summary

Radar reflectivity mosaics over South Korea during typhoon Rusa were created using three dimensional measurements. Ground clutter maps created from the radar observed in non precipitation times and DEM were used to filter ground clutters. Near earth reflectivity at ground clutter locations were filled with the help of vertical gridding and mosaics from other radars.

**Reference:**

Collier, C.G. (1996). Application of weather radar systems, 2nd edition (Wiley, Chichester), Chapter 3, pp 41-92.