ELSEVIER

Atmospheric Research 77 (2005) 232–246

ATMOSPHERIC RESEARCH

www.elsevier.com/locate/atmos

Application of the hydrologic visibility concept to estimate rainfall measurement quality of two planned weather radars

D. Faure[a,*], G. Delrieu[b], P. Tabary[c], J. Parent Du Chatelet[c], M. Guimera[d]

[a]*ALICIME, 541 rue des Grillons, 69400 Gleizé, France*
[b]*LTHE, UMR 5564 (CNRS, UJF, INPG,IRD), B.P. 53, 38 041 Grenoble Cedex 9, France*
[c]*Météo-France, DSO/CMR/DEP, 7 rue Tesseirenc-de-Bort, B.P. 202, 78 195 Trappes Cedex, France*
[d]*Météo-France, DSO/CMR/PMO, 42 Avenue Gaspard Coriolis, 31 057 Toulouse Cedex, France*

Received 31 March 2004; received in revised form 17 September 2004; accepted 15 October 2004

Abstract

This paper presents a practical application of the "hydrologic visibility" concept to select the future site of two planned weather radars of the French national network ARAMIS. This selection was realised by simulating the errors in radar rainfall measurement due to interactions of the radar beam with relief, and to the vertical variation of the radar reflectivity with altitude. Results show the interest of these simulations to optimise the radar location according to the objectives of radar coverage. Beyond these results, this paper highlights aspects interesting for hydrology: this type of simulation can be used to assess the radar measurement quality before initiating a quantitative exploitation of radar data, and before making a comparison or a combination with rain gauge data.

Keywords: Weather radar; Hydrologic visibility; Rainfall; Measurement; Quality; Simulation

* Corresponding author.
E-mail address: dfaure.alicime@wanadoo.fr (D. Faure).

0169-8095/$ - see front matter © 2005 Elsevier B.V. All rights reserved.
doi:10.1016/j.atmosres.2004.10.021

1. Introduction

Weather radar measurement of rainfall is subject to a range of phenomena which affect the accuracy of the surface precipitation estimates, these difficulties increasing with relief and with the altitude of the radar site (Joss and Waldvogel, 1990). Since a few years, hydrologists have developed the concept of "hydrologic visibility" of a weather radar to describe the quality of the radar rainfall measurement over a region, a catchment area, or an agglomeration (Pellarin et al., 2002). From this concept, the LTHE (Laboratoire d'étude des Transferts en Hydrologie et Environnement, Grenoble, France) has developed a software called VISHYDRO to estimate this quality. This software, perfected in the framework of research actions, integrates in a very detailed way the effects of ground clutter and masks due to the interactions of the radar beam with relief, and the effects of vertical variations of radar reflectivity with altitude. Data required for these estimations are physical characteristics of the radar, a digitalised terrain model (DTM), and one (or a set of) vertical profile(s) of reflectivity (VPR) representative for the region.

In 2002, VISHYDRO was used in two studies with operational interest for the French Meteorological Office (Météo-France). The goal was to simulate the hydrologic visibility of two planned radars of the French national ARAMIS network: the future radar of the Tarn-Aveyron region (southern France) and the future radar of the Franche-Comté region (northeast France). The objective was to compare a priori the advantages and disadvantages of several sites pre-selected by Météo-France for establishing these new radars in order to extend and upgrade the ARAMIS network (Chèze and Guiméra, 2003). The determining criterion was the quality of the rainfall measurement over the region and particularly over several basins of priority interest for end users.

This paper synthesises the results obtained and highlights the aspects interesting for operational hydrology: the important and fast spatial variations of the radar rainfall measurement quality, and the interest to precisely estimate the effects of each source of error before a quantitative use of radar data.

2. Principle of the simulations

The VISHYDRO software uses algorithms described in detail in Delrieu et al. (1995) and Pellarin et al. (2002). The simulations are realised in two steps in order to estimate the errors on radar rainfall estimations induced by ground clutter, masks and non constant VPRs, for a given elevation angle of the radar beam.

2.1. Simulation of the "radar beam-relief" interactions

The first step is a numerical simulation of the interactions between radar beam and relief (Fig. 1). This simulation uses:

– a detailed description of the resolution volume of the radar measurement, taking into account the entire main lobe of the radar beam, an angular weighting function