Hydrology and Earth System Sciences
An Interactive Open Access Journal of the European Geosciences Union

Hydrol. Earth Syst. Sci., 4, 555-563, 2000
www.hydrol-earth-syst-sci.net/4/555/2000/

Improved rainfall estimates in convective storms using polarisation diversity radar

A. J. Illingworth[1], T. M. Blackman[2], and J. W. F. Goddard[3]
[1]JCMM, Dept of Meteorology, University of Reading, Reading RG6 6BB, UK
[2]Dircon Ltd, UK
[3]RAL, Chilton, Didcot OX11 0QX, UK
e-mail for corresponding author: a.j.illingworth@reading.ac.uk

Abstract. Errors arise when using conventional radar reflectivity, Z, to estimate rainfall rate, R, and these can be particularly severe during severe convective storms; the very events when accurate estimates are needed so that action can be taken to mitigate the effects of flooding. Concentration is on three problems associated with heavy rainfall: hail, attenuation and absolute calibration of the radar, and consider how polarisation radar parameters, differential reflectivity, Z_{DR}, and specific differential phase shift K_{DP}, might lead to their alleviation. It is essential to consider the fundamental limits to the accuracy with which these parameters can be estimated. If Z_{DR} can be measured to an accuracy of 0.2 dB, then it provides a measure of mean raindrop shape which is sufficiently precise to improve rainrate estimates. This can be achieved at S-band (10 cm), but seems very difficult for operational C-band (5 cm) radars; differential attenuation by the heavy rain introduces a negative bias into Z_{DR} which increases with range. However, the magnitude of this bias at C-band can then be used to correct for the total attenuation of Z. Differential phase, K_{DP} has the advantage that it is a phase measurement and so is unaffected by attenuation. It only responds to the rainfall and is unaffected by the hail, but K_{DP} is a noisy parameter and is only useful for heavy rainfall above 30 – 60 mm hr^{-1}. Fortuitously, K_{DP} and Z_{DR} are not independent and one use of K_{DP} and Z_{DR} may well be to exploit this redundancy to identify rain areas as opposed to hail, and in rainfall to use the redundancy to provide an automatic calibration of the absolute reflectivity, Z, to 0.5 dB (12%). Finally, the noisy character of both Z_{DR} and K_{DP} together with the low level of the co-polar correlation coefficient provide the first reliable means of detecting and removing anomalous propagation which is a major operational problem for all weather radars.

Keywords: polarisation radar, rainfall calibration, attenuation, hail, anomalous propagation

Final Revised Paper (PDF, 1502 KB)

Citation: Illingworth, A. J., Blackman, T. M., and Goddard, J. W. F.: Improved rainfall estimates in convective storms using polarisation diversity radar, Hydrol. Earth Syst. Sci., 4, 555-563, 2000. Bibtex EndNote Reference Manager