The South African rainfall enhancement programme: 1997-2001

Deon E Terblanche*, Marion P Mittermaier#, Roelof P Burger, Karel JP de Waal and Xolile G Ncipha
South African Weather Service, Private Bag X15, Bethlehem 9700, South Africa

Abstract

This paper provides a summary of the South African Rainfall Enhancement Programme (SAREP) that was conducted in the Limpopo Province of South Africa. SAREP included an operational cloud-seeding campaign based on the South African developed hygroscopic flare-seeding technology which ran from December 1997 to the end of December 2000. In addition, a radar-based storm climatology was compiled using data collected during the period October 2000 to April 2001. During the cloud-seeding campaign 95 storms were seeded of which 37 were selected for treatment early in their lifetimes. This subset allowed a 'time of origin' analysis to quantify the seeding effect on radar-estimated rainfall. The Thunderstorm Identification Tracking Analyses and Nowcasting (TITAN) software was upgraded as part of SAREP for such an analysis. It was found that seeded storms on average produced twice the radar-determined rainfall that their controls produced. The cost for the additional rainfall was determined to be about R0.04/m^3.

The radar-based storm climatology for the 10 000km^2 target area was compiled using storm lifetime of 15 min and 30 dBZ radar reflectivity as the TITAN storm-tracking thresholds. It was found that more than 2 000 of these radar storm tracks affected the target area during the 7 months from October 2000 to April 2001. By comparing these radar storm tracks with those that were seeded, it was possible to identify the 290 radar storm tracks that could have been regarded as legitimate candidates for seeding. Based on the preliminary findings of this study, it is suggested that if 75 of the legitimate candidate storms in the specific target area are seeded, a marked (~10%) increase in area rainfall over the target area could be realised. This would have considerable socio-economic benefits. It is recommended that further development of this technology should remain a high priority in an integrated water resource management plan for South Africa.

Keywords: rainfall enhancement, cloud seeding, storm climatology

Introduction

The development of the hygroscopic flare-seeding technology

The South African Rainfall Enhancement Programme (SAREP) was a semi-operational cloud-seeding project that was conducted in the Limpopo Province between 1997 and 2001. It was based on the hygroscopic flare-seeding technology that was developed in South Africa by the National Precipitation Research Programme (NPRP) during the period 1990 to 1997.

The NPRP came about when the previously separate projects at Bethlehem (the Bethlehem Precipitation Research Project) and at Nelspruit/Carolina (the Programme for the Augmentation of Atmospheric Water Supply) amalgamated in 1990. This national programme was jointly funded by the South African Weather Bureau (now the South African Weather Service – SAWS) and the Water Research Commission (WRC). Co-operation under the banner of the NPRP led to significant progress in rainfall enhancement techniques in South Africa as well as in the development of the technologies to support such experiments. An internationally recognised highlight of the NPRP was the development of the hygroscopic seeding flare and its application to convective clouds. This flare is used for seeding growing convective clouds in the updraft areas below cloud base. Small (~0.5 μ) hygroscopic particles that act as efficient cloud condensation nuclei (CCN) are released when the flare burns. These particles alter the initial cloud droplet size distribution towards a broader spectrum with a lower droplet concentration. The modified distribution is conducive to inter-droplet collisions and the eventual growth of cloud droplets to rainfall through a process known as coalescence. Coalescence is a very efficient precipitation formation process that is generally not active in the continental convective clouds over the interior of South Africa.

The initial tests conducted under the NPRP focused on characterising the physical and chemical properties of the burning flare and on conducting some seeding trials. Mather and Terblanche (1993a; b) reported the results of the initial tests to the WRC and in the local scientific literature. They presented arguments why this new approach to cloud seeding could be more appropriate to improve the rainfall production efficiency of local convective storms. In the following year, with a randomised seeding experiment well underway, Mather and Terblanche (1994) reported progress and some preliminary results to the international scientific community at a conference arranged by the World Meteorological Organisation (WMO), an agency of the United Nations. The findings were well received and the WMO declared that the South African work represented a significant step forward in the quest to develop viable methods to enhance rainfall. With the randomised experiment completed, Mather et al. (1997a; b) concluded their detailed reporting on the programme to the WRC and the international scientific community. In total 127 storms were selected as part of the randomised seeding experiment of which 62 were seeded and 65 were studied as controls. It was found that the seeded group provided statistically significant more rainfall than the control group.

For a short period after 1995 the NPRP was tasked to conduct semi-operational seeding around Tzaneen in the Limpopo Province. This project was carried out on request of the Limpopo Province government who also provided additional financial support. The NPRP used this opportunity to develop methods for the evaluation of non-randomised cloud seeding and intro-

Present affiliation: Met Office, FitzRoy Road, Exeter, EX1 3PB, UK
* To whom all correspondence should be addressed.
☎ +2758 303-5571; fax: +2758 303-2352;
e-mail: deon@weathersa.co.za
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