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STUDY ON MEASURING AND WARNING OF FLOOD-CAUSING TORRENTIAL RAIN IN HUAIHE R. BASIN BASED ON CINRAD AND GMS

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1 INTRODUCTION

Locating between the southern temperate climate zone and northern subtropical climate zone, the basin of Huaihe River witnesses frequent occurrence of meteorological disasters, especially from May to August when heavy rains usually result in floods. There has been much research at home and abroad on the estimation of rainfall based on radar data and satellite imagery[1-7]. Experiments on heavy rains are mainly, however, based on Type 713 weather radar, which limits quantitative estimation of rainfall. With data from a Doppler weather radar on the S band (CINRAD/SA) co-manufactured by China and U.S.A. in 1999, this work makes quantitative estimation of rainfall over the Anhui region in the Huaihe River valley, supplemented with GMS satellite data, records from weather stations and automatic rain gauges. A localized model and set of indices have been set up to utilize the CINRAD/SA radar and GMS satellite, flood-causing heavy rains are pre-warned and forecast with interpretations of the NWP product HLAFS, and a software of pre-warning operation is finalized to watch this kind of rain over the valley.

2 METHODS

From the retrieval computation of radar and satellite data, quantitative estimation is made of the heavy rain at high spatial resolution between 1 and 100 km^2. Forecasts of rainfall are quantitatively updated over the future 48 h based on interpretations of HLAFS. With comprehensive and composite statistics of estimated radar and satellite values, rainfall is determined for the surface of the valley. Rainfall estimates and forecasts are used to diagnose whether the level of rainfall is high enough to cause floods so as to help in decision-making to issue pre-warnings of heavy rains that possibly cause floods in the valley of Huaihe River.

3 ESTIMATING RAINFALL WITH CINRAD/SA DATA

A localized *Z-I* relationship must be set up to respond to changes in season and geographic location. For this purpose, data from the Hefei CINRAD/SA for June and July in 2000 and 2001, scanning volume every 6 min., are used to set up new *Z-I* relationships for three parts of the valley, aided with automatic rain gauge records from 28 weather stations and methods of optimization and probability matching.

For the *Z-I* relation of CINRAD, Z=300$I^{1.4}$, currently used for rainfall estimation, the absolute error is small at short range and comparable to that of the optimizing approach but much larger at long range than *Z-I* relationships that take regional differences into account. It is then clear that rainfall can be better estimated with *Z-I* relations varying with elevation angle that are formulated with the method of optimization based on distance and climatic features than a unified *Z-I* relation.

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Using the climatological and optimized *Z-I* relations, three heavy rains are studied. It is known from the results of single-station estimates that the climatological *Z-I* relation has mean relative errors of 29% and 21%, respectively, and the optimized *Z-I* relation of 32% and 25%, respectively, relative to the life cycle observed at the site of observation. With the latter relation, the estimated rainfall is generally smaller than observation, especially for rainfall that is over 50 mm in 24 h, while the former relation has some advantage in estimating this level of rainfall. From the mean error of segmental estimations, it is known that the climatological *Z-I* relation is much better than the optimized *Z-I* relation in terms of estimated mean relative errors.

4 QUANTITATIVE ESTIMATION OF RAINFALL WITH GMS DATA

Based on cloud imageries of different GMS channels and the links between them, models are set up to estimate rainfall and cloud-top temperature for various kinds of cloud bodies[8] to apply in the valley of the Huaihe River. Here, three kinds of clouds (vigorously evolved convective cloud clusters, convective and stratiform clouds not in full strength and mixed clouds) are the objects for rainfall estimation.

5 PRE-WARNING OF FLOOD-CAUSING HEAVY RAINS

Floods are resulted when heavy rains are strong, widespread and long-lasting enough. Radar- and satellite- based rainfall estimates can be used to obtain rainfall for any previous periods. Total rainfall can be forecast and then pre-warnings can be issued for the river valley on the basis of these estimates in combination with rainfall output in comprehensive forecasting. The operational system issues pre-warnings every 6 h over the period from 0 to 48 h. Following the preset standard, pre-warnings are given for heavy rains that may cause floods if rainfall accumulates to be more than 100 mm in 72 h. Setting the time interval of validity at *X* h, composite estimated rainfall is used for the early period of 72 –*X* h and forecast rainfall is used for the late period of *X* h.

6 CONCLUSIONS

With the CINRAD/SA in Hefei and other interpretations of GMS satellite and NWP product of HLAFS, quantitative estimates and forecasts of floods-causing heavy rains were conducted, with very positive results in weather support during the floods of the Huaihe River valley in 2003 (details of which will be presented in separate papers). Our results are of high accuracy and applicability in routine operation.

(1) For rainfall estimation with the CINRAD/SA radar, both the optimized and climatological *Z-I* relations are better than generalized relations. It is known from the estimates that the climatological *Z-I* relation is better than the optimized one, with mean relative error for single-site rainfall smaller than 40% for the period of 24 h.

(2) Using the brightness temperature in the infrared window, an area rainfall estimation model is set up, on the basis of clouds classified with GMS imagery. The error is between 25% and 54% for the 24-h estimation and between 44% and 74% for the 1-h estimation.

(3) By integrating radar- and satellite- based estimates with data from rainfall gauging stations, the relative error will be decreased for the composite rainfall.

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