3.15 A REAL-TIME DAILY PRECIPITATION ANALYSIS OVER SOUTH ASIA

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1. Introduction

In support of weather and flood monitoring activities at USAID and USGS, a new system has been developed and put into operation at the Climate Prediction Center (CPC) of NOAA to produce real-time analyses of daily precipitation on a 0.1° latitude/longitude grid over South Asia (70°E-110°E; 5°N-35°N). The automatic system defines analysis of daily precipitation by merging 4 kinds of observation-based individual data sets using the algorithm of Xie and Arkin (1996). This paper gives a brief description of the input data sets, the merging algorithm, and the operational system used to create the real-time analysis.

2. INPUT DATA SETS

Four kinds of observation-based data sets are used as inputs to construct the merged analysis of daily precipitation. These are 1) analysis derived from GTS gauge observations of daily precipitation; 2) the GOES Precipitation Index (GPI, Arkin and Meisner 1987) inferred from full resolution IR data from geostationary satellites (Janowiak et al. 2001); 3) estimates derived from microwave observations of SSM/I (Ferraro and Marks 1995); and 4) those from AMSU-B (Zhao et al. 2001). Fig.1 shows an example of the input daily precipitation fields for July 20, 2001.

The gauge-based analysis of daily precipitation is derived by interpolating reports from ~280 GTS stations over the target domain. In general, it is reliable in both spatial distribution patterns and in precipitation quantity over areas with dense gauge network, while it may present unreasonable distribution patterns over regions with no gauge available nearby. The GPI estimates are based on up to 48 times of half-hourly IR observations but they are indirect in nature and exhibit significant bias over land. The SSM/I and the AMSU-B estimates are more physically based but they have incomplete spatial coverage and large random error due to the limited sampling. In general, all of the individual data sources show similar large-scale distribution patterns but present differences in smaller scale features and in magnitude (fig.1). Three major deficiencies exist in these individual data sources, i.e., incomplete spatial coverage; significant random error; and non-negligible bias.

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3. MERGING ALGORITHM

The analysis of daily precipitation is defined by merging the four kinds of individual input data sources. The merging algorithm is originally developed by Xie and Arkin (1996) to construct analysis of monthly precipitation on a 2.5° latitude/longitude grid over the globe and is modified by Xie et al. (1999) to produce real-time daily precipitation analysis on a finer grid of 0.1° latitude/longitude over the African continent (20°E-55°W; 40°S-40°N).

The merging algorithm defines the analysis of daily precipitation in two steps. First, to reduce the random error inherent in the individual data sources, the 3 kinds of satellite estimates (GPI, SSM/I and AMSU-B) are combined linearly through the Maximum Likelihood Estimation method, in which the weighting coefficients are inversely proportional to the individual error variance. Since the output of the first step contains bias passed through from the original inputs, a second step is introduced to remove the bias by blending the first-step-output with the gauge data through the method of Reynolds (1988). In this blending process, the first-step-output and the gauge data are used to define the 'shape' and the magnitude of the precipitation field, respectively. This blending process is first performed on a grid of 5.0° latitude/longitude and then repeated on grids of finer scales for regions where gauge data are available. As a result, the magnitude of the precipitation is corrected on fine scale over areas with dense gauge network while only large-scale bias is removed over regions with poor gauge coverage.

Fig.1 shows an example of the merged analysis of daily precipitation for July 20, 2001. The merged analysis presents similar spatial distribution patterns with those of satellite estimates while its magnitude is close to the gauge-based analysis over areas with gauge data. Cross validation tests were conducted using daily data over the Africa continent and the results showed that the merging algorithm is able to produce daily precipitation analyses with improved quality (reduced random error and bias) compared to the individual inputs.

4. OPERATIONAL SYSTEM AND PRODUCTS

An operational system has been developed to automatically produce the daily precipitation analysis over South Asia on a quasi real-time basis. The system acquires and quality controls the individual input data sets, creates analyzed fields of daily precipitation on a 0.1° latitude/longitude grid using the merging algorithm

described above, and then outputs the results in both binary data files and in GIF graphics.

Starting from June 15, 2001, the system has been put into operation at the Climate Prediction Center of NOAA and its products are available on a quasi real-time basis through ftp at ftp.ncep.noaa.gov /pub/cpc/fews/A.Asia.

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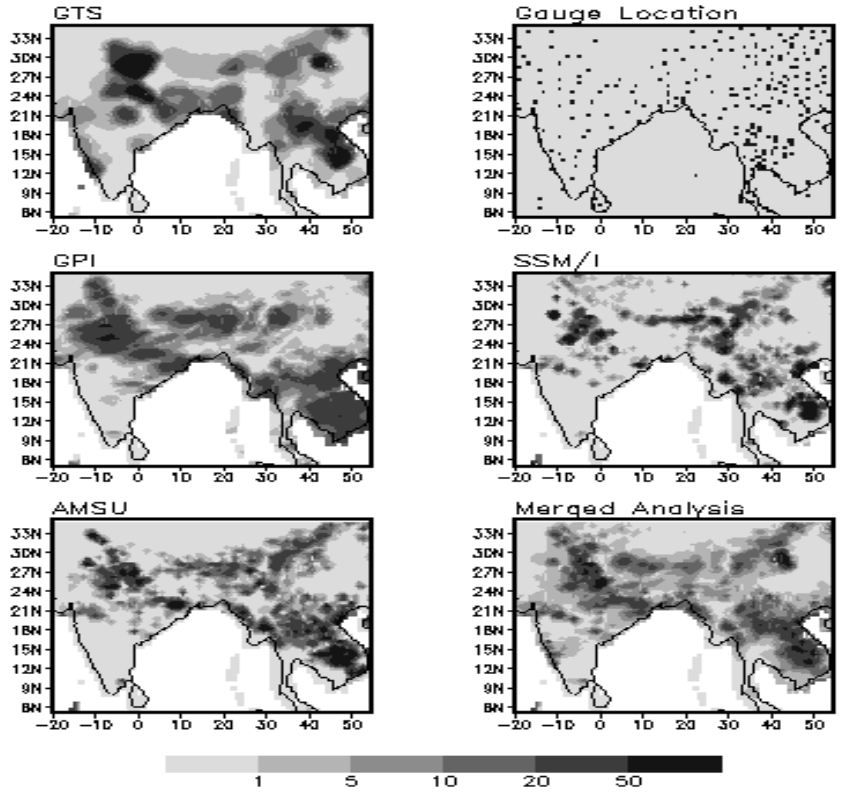

Fig.1 Daily Precipitation (mm/day) for July 20, 2001, obtained from GTS gauge-based analysis, satellite estimates of GPI, SSM/I and AMSU-B, and the merged analysis. Also displayed is the distribution of GTS gauge stations over the target domain.