RAIN GAUGE DATA MERGED WITH CMORPH YIELDS: RMORPH

John E. Janowiak[1], Pingping Xie[1], Jian-Yin Liang[2], and Robert. J. Joyce[1]

[1]Climate Prediction Center/NCEP/NWS/NOAA, Camp Springs, MD USA
[2]China Meteorological Agency, Guang Dong Province, China

ABSTRACT

A methodology to reduce the bias in high spatial and temporal satellite estimates of rainfall is presented in this paper. Furthermore, we describe a process in which the bias-adjusted satellite estimates are combined with rain gauge data. First, to reduce bias in the satellite estimates of precipitation, the estimates are adjusted by the ratio of the estimates and rain gauge data over the previous 30-day period. Then, an optimum interpolation procedure is employed to merge the rain gauge data with the bias-adjusted satellite estimates. Finally, over areas where rain gauge data are plentiful and available in a timely fashion such as over the United States, daily rain gauge data are disaggregated by hourly satellite analyses so that the rain gauge daily totals are preserved, yet partitioned into hourly amounts.

1. INTRODUCTION

CMORPH (Joyce et al. 2004) is a technique that merges pre-existing precipitation estimates that have been generated from passive microwave sensors aboard low earth orbit spacecraft to produce high spatial (0.07^o x 0.07^o latitude/longitude) and temporal (1/2 hourly) analyses of rainfall that are global in longitude and extend from 60^oN to 60^oS latitude. The method uses IR imagery from all available geosynchronous meteorological satellites, from which global coverage is available in the present-day constellation, to propagate the precipitating features that have been identified by passive microwave observations. The underlying premise is that the error when using the IR data to propagate these precipitating features is less than the error when using IR directly to estimate precipitation. In order to allow the precipitating systems to modify their shape and strength, the data are "morphed" as depicted in Figure 1.

Because the relationship is not perfect between precipitation and the parameters that the satellites retrieve (cloud-top temperature from infrared data and various information on hydrometeors via passive microwave), the satellite estimates are not as accurate as rain gauge measurements of precipitation. Therefore, by incorporating rain gauge information with the satellite estimates, the resulting analyses will be more accurate where rain gauge data are plentiful. And by using matchups of nearly co-located rain gauge data and satellite data, the bias in satellite estimates can be reduced over regions where rain gauge data are sparse.

A pilot study was conducted over the Guang-Dong province in southeastern China, where the authors had access to 394 stations that reported hourly precipitation. This data rich region was used to develop the merging method. This successful proof-of-concept provides encouragement that the merging technique can be applied to global data.

2. Merging Method

The merging of the rain gauge data with the CMORPH satellite-derived estimates of precipitation is done as a two-step process. The first step is a bias-reduction process. To begin this step, the gauge data and CMORPH data were interpolated to a common ½^{o} x ½^{o}. Then, at each grid location that contains rain gauge data, the ratio between the CMORPH and rain gauge data was computed over the previous 30-day period. These ratios were then multiplied by the CMORPH estimates so as to reduce the bias in the CMORPH estimates. The second step in the merging process integrates the hourly rain gauge observations directly with the CMORPH data via optimum interpolation (Gandin, 1965).

In Figure 2 we show the result of this two-step merging approach. Note that the influence of the CMORPH estimates is retained in the merged product (lower-right panel) in areas where rain gauge data are sparse. Cross-validation tests were conducted over data rich regions by withdrawing varying amounts of gauge data (10%, 20%, 30%, and 40%) and the results indicate that the optimum interpolation produces robust results.

We plan to inject a third step for areas, such as the U.S., where dense daily rain gauge data exist. For these areas, the daily rain gauge data will be partitioned into hourly amounts using CMORPH as the disaggregation medium, then the hourly rain gauge data will be inserted into the RMORPH analyses that were created by the first two steps in the merging process.

3. REFERENCES

Gandin, L. S., 1965: Objective analysis of meteorological fields. Israel Program for Scientific Translations, Jerusalem, 242 pp.

Joyce, R. J., J. E. Janowiak, P. A. Arkin, and P. Xie**,** 2004: CMORPH: A method that produces global precipitation estimates from passive microwave and infrared data at high spatial and temporal resolution.. *J. Hydromet.*, *5***,** 487-503.

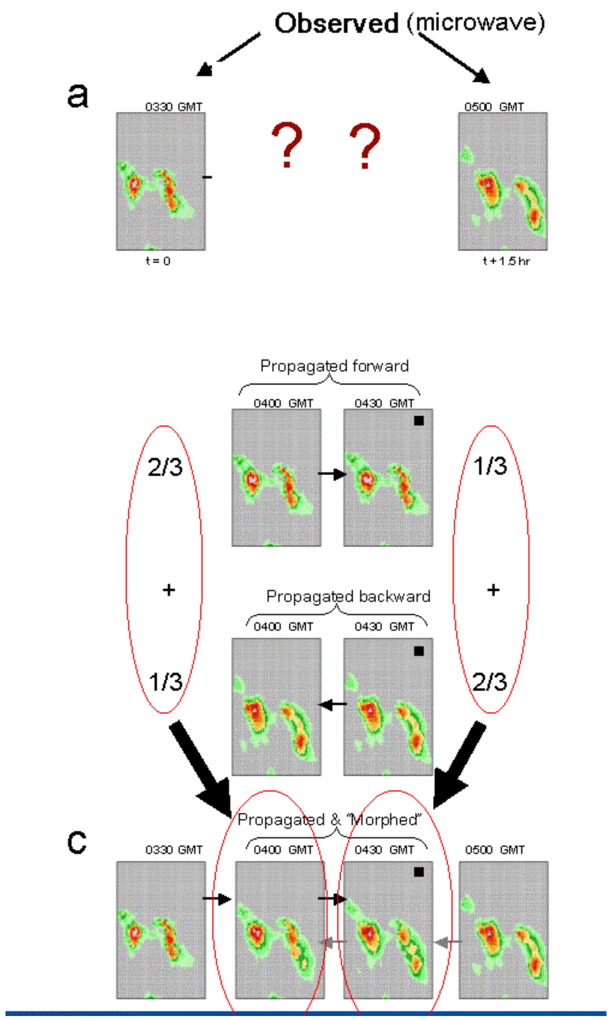

Figure 1. Depiction of morphing procedure. First, the initial passive microwave (PMW) data are propagated forward based on vector information determined from successive IR images. Then the succeeding PMW data are propagated backward. Finally, linear temporal weighting is used to morph the data so that shape and intensity changes are exhibited.

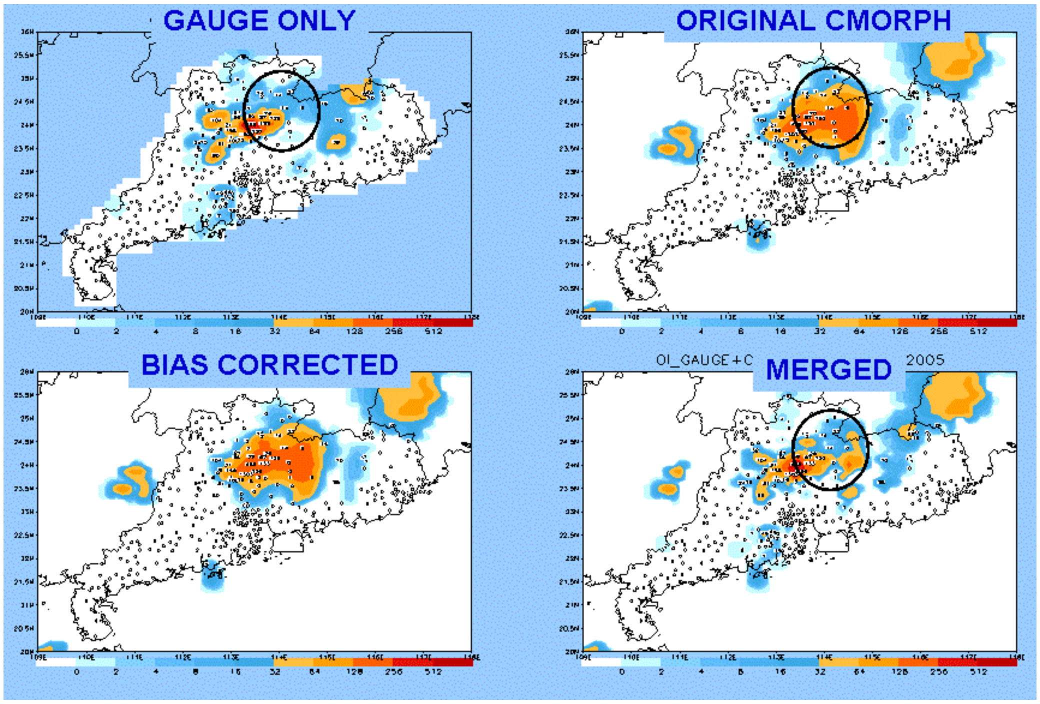

Figure 2. Plots of precipitation over the Guang-Dong province of China. Black dots show where gauge data are available. Lower-right panel ("Merged") shows the bias-adjusted CMORPH combined with the rain gauge data over. Over areas where gauge data are relatively sparse (circle region, for example), note the influence of the CMORPH estimates in the "Merged" product.