Geophysical Research Abstracts,
Vol. 11, EGU2009-9810, 2009
EGU General Assembly 2009

CMORPH Improvements: A Kalman Filter Approach to Blend Various Satellite Rainfall Estimate Inputs and Rain Gauge Data Integration

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We present two major improvements to the CMORPH high-resolution precipitation analysis. The first is the adaptation of a Kalman filtering approach to merge the individual satellite-derived precipitation estimates that are ingested into CMORPH. The goal of CMORPH is to synergize the high-quality precipitation estimates derived from passive microwave (PMW) data aboard low earth orbit spacecraft with the outstanding sampling characteristics of IR data from geosynchronous satellites. However, in order to produce estimates of precipitation that have been merged from several sources in which the error (skill) is minimized (maximized) statistically, the accuracy of each input parameter must be estimated from "truth". Then, the individual estimates can be combined by weighting the contribution of each according to the relative accuracy of each estimate. This goal is accomplished by first estimating the error characteristics of each individual rainfall estimate that is ingested by CMORPH. The error of the individual inputs was determined by comparing them with hourly radar-derived precipitation ("truth") over the U.S. during June-September, 2007. Various statistical properties of the individual rainfall estimate inputs were stratified by sensor-type, temporal propagation direction, and temporal distance from scan time. Secondly, the CMORPH rainfall estimates were reconstructed using a Kalman filter in which the statistical parameters were used to derive weights to assign to each input such that the contribution to the final merged precipitation estimate of each individual estimate is a function its accuracy.

The other major improvement is the incorporation of daily rain gauge data in the CMORPH analyses to achieve better performance over the global land areas. First, bias correction is performed for the CMORPH estimates by matching the probability density function (PDF) of the satellite data with that of the gauge analysis. The bias corrected CMORPH satellite estimates are then combined with the gauge analysis through the optimal interpolation (OI) technique, in which the bias-corrected CMORPH is used as the first guess while the gauge data is used as the observations. Test results over China showed substantial improves of the gauge-CMORPH merged analysis in error statistics.

We will present details of the methodology and show the differences between the original CMORPH method and the Kalman filtered and gauge integration approaches.