Improving Daily Satellite Rainfall Estimated over Africa by Merging With National Raingauge Observations

Tufa Dinku
International Research Institute for Climate and Society,
the Earth Institute at Columbia University

The availability of climate data, particularly throughout rural Africa, is very limited. The available weather stations are unevenly distributed, with most of the stations located in cities and towns along the main roads. Available data suffer from severe data gaps. Satellite proxies have been used as alternatives. However, satellite rainfall estimates also suffer from a number of critical shortcomings particularly at higher temporal and spatial resolutions. An attempt is made here to alleviate these problems by combining station measurements with the satellite rainfall estimates at daily time scale. Different methodologies are tested over the complex topography of East Africa (Ethiopia) and over the plains of West Africa.

1. The Challenge
   Interpolation of daily rainfall data is a challenging one. There are a number of problems that include:
   - Overestimation of rainfall occurrence or the spatial extent of rainfall; and
   - Underestimation of high rainfall values.

2. Approach
   i. Interpolate rainfall intensity using both gauge and satellite;
   ii. Determine rainfall occurrence from gauge and/or satellite data;
   iii. Multiply and (i) and (ii).

3. Implementation
   3.1. Ethiopia
   i. Interpolate station data using regression gridding (with IDW) using satellite estimate as auxiliary variable;
   ii. Interpolate gauge rainfall occurrence flags (0 and 1);
   iii. Combine station rain occurrence flags with that of the satellite;
   iv. Multiply (i) and (iii).

   3.2. West Africa
   i. Interpolate station data using regression Kriging with satellite estimate as auxiliary variable;
   ii. Convert satellite rainfall map to rainfall occurrence map (0 and 1);
   iii. Multiply (i) and (ii).

Regression Kriging is used for merging daily station data with corresponding satellite estimates over West Africa because the flat landscape and associated climatology allows the use of more sophisticated approach. Besides, only satellite rainfall is used for creating rain occurrence maps because satellite rainfall detection is good (about 80%) over this region. This is not the case over Ethiopia because of the complex topography.

4. Data
   4.1. Ethiopia
   Daily station data from 1991 to 2005 is used. The merging is done using about 450 stations for each day while 25 validation stations are used for the evaluation.

   4.2. West Africa
   Data from Jun-Sep 2001 is used for this evaluation. Then 100 stations are used in a cross validation scheme.

5. Results
   5.1 East Africa/Ethiopia
   Rain gauge, satellite and merge
   Skills of the products in estimating rainfall amounts
   Skills of the products in rainfall detection

   5.2. West Africa
   Rain gauge data (top left), satellite estimate (top right), gridded gauge (bottom left), and merged data
   Evaluating the skill of the products in estimating rainfall amounts.
   Evaluating the skill of the products in rainfall detection

Acknowledgment
This project has been funded by Climate Change Agriculture and Food Security (CCAFS)