TARCAT - TAMSAT African Rainfall Climatology And Time Series

Ross Maidment, ElenaTarnavsky, David Grimes, Richard Allan

TAMSAT, Department of Meteorology, University of Reading, Reading, UK.

*Tropical Applications of Meteorology using SATellite data

1. Background

The majority of the African population is dependent on rainfed agriculture. Thus changes in future rainfall climate can have serious consequences - both from humanitarian and economic viewpoints.

Good predictions depend on a secure knowledge of present climate - but this is poorly understood due to the inadequacy of ground based observations (Figure 1). Satellite-based estimates can be used to fill the gap.

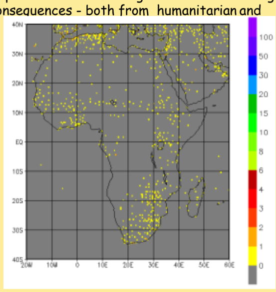

Figure 1. GPCC gauge locations March - May 2007 Colours show no. of gauges per square degree

2. Algorithm

Existing global rainfall time series using satellite data are either too short (<10 years) or temporally inhomogeneous (different sensors and different proportions of gauge data included at different times).

Because most African rainfall is convective, the TAMSAT algorithm (Figure 2), based on locally calibrated Cold Cloud Duration derived entirely from Meteosat Thermal Infra-Red imagery gives good results across most of Africa (see Panel 3). The one-off calibration and single channel input ensure temporal homogeneity.

Figure 2. The TAMSAT algorithm Comparison with local gauge data is used to derive threshold temperature T_t which identifies rainy cloud.

Local calibration is used to derive a relationship between rainfall amount and number of hours colder than threshold temperature (CCD).

The standard TAMSAT product is dekadal totals at 0.0375⁰ resolution.

3. Validation

A validation study has been carried out in Uganda with the collaboration of the European Commission Joint Research Council and the Ugandan Met Service.
Comparison is between TAMSAT, NOAA-RFE 2.0, GPCP (satellite estimates) and ERA-40, ERA-Interim (ECMWF model re-analysis products) with kriged gauge data. Rainfall amounts were compared at dekadal time scale and 0.5^0 resolution. Only grid squares containing at least one gauge were used (Figure 3f). Validation covers the long rainy season (Feb - Jun) 2001 - 2005.

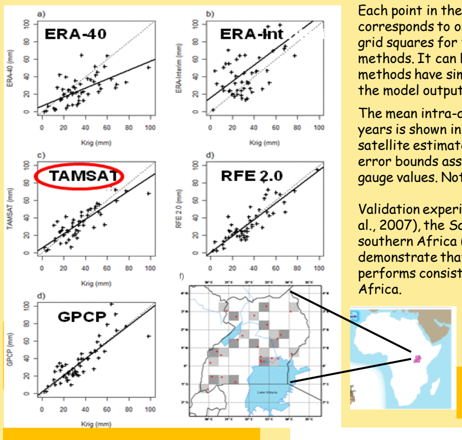

Figure 3a-e. scatterplots of mean dekadal rainfall estimate v. gauge data.
Figure 3f . Location of gauges. Grey squares contain at least 1 gauge.

Each point in the scatter plots in Figure 3 corresponds to one dekad averaged over all grid squares for the various estimation methods. It can be seen that all satellite methods have similar quality and outperform the model outputs.

The mean intra-annual pattern over the 4 years is shown in Figure 4. Once again satellite estimates are largely within the error bounds associated with the kriged gauge values. Not so for the model outputs.

Validation experiments in Ethiopia (Dinku et al., 2007), the Sahel (Jobard et al., 2007) and southern Africa (Thorne et al., 2001) demonstrate that the TAMSAT algorithm performs consistently in different parts of Africa.

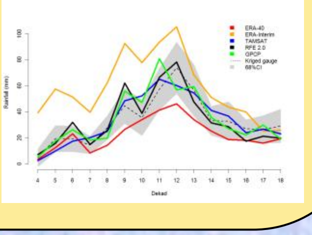

Figure 4. Intra-annual variation for Uganda

4. TARCAT - data availability

The first step in the TARCAT project has been to assemble all TIR data from the Eumetsat archive. Figure 5 gives an overview of data availability. There are sufficient data available to generate the time series from 1982 to the present.

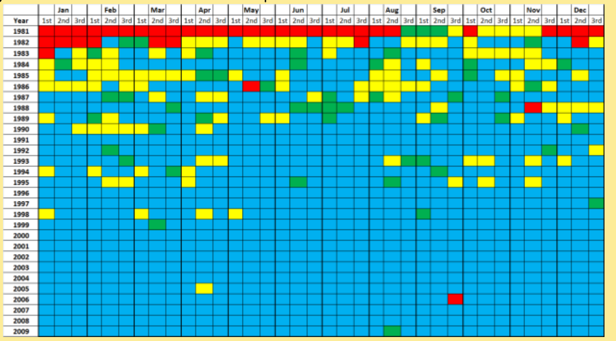

Figure 5. Each cell is one dekad. Colour indicates number of missing hours in the dekad: blue < 3; 3 < green < 5; 5 < yellow <30; red > 30

5. Progress so far

As a pilot project, a 15 year rainfall time series has been generated for Ethiopia in collaboration with Columbia University IRI (USA) and the Ethiopian National Met Agency. The time series at dekadal time step averaged over all Ethiopia is shown in Figure 6 compared with ERA Interim. The two time series show broad agreement. The higher values of ERA Interim are consistent with the Ugandan validation in Panel 3. It appears that ERA-Interim strongly overestimates dry season rainfall.

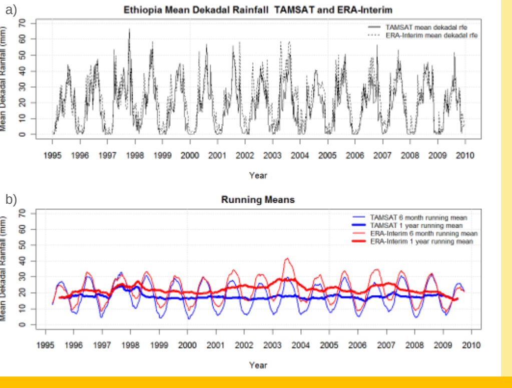

Figure 6a. Dekadal time series averaged over all Ethiopia for TAMSAT and ERA Interim.
Figure 6b. 6 month and 12 month running mean for TAMSAT and ERA-Interim

6. Next steps

We expect to produce a preliminary version of the rainfall data set for the whole of Africa from 1982 to the present by the end of 2010.

Tests on the long term stability of the rainfall calibration will be carried out using currently available gauge data from the TAMSAT archive.

We intend to carry out further detailed calibration and validation experiments in collaboration with African NMAs. One such workshop was held in Ethiopia in December 2010, a second for East Africa will be held in Uganda 2011.

We are currently seeking funding for other workshops.

Acknowledgements

The authors are grateful to the National Meteorological Services of Ethiopia and Uganda and the International Research Institute at Columbia University for their collaboration and provision of raingauge data for this study.
The European Commission JRC funded the Ugandan validation. The Ethiopian calibration workshop was funded by Google. The 2011 Ugandan workshop will be funded by the UK Natural Environmental Research Council

References

Dinku, T, Ceccato, P, Grover-Kopec, E.; Lemma, M., Connor. S.J.; Ropelewsk C.F., 2007; Validation of satellite rainfall products over East Africa's complex topography. *Int. J. Rem. Sensing*, **28(7)**, 1503-1526.

Jobard, I.M., Chopin, F., Berges, J.C., Ali, A., Lebel, T., Desbois, M., 2007: Presentation of the EPSAT-SG method and comparison with other satellite precipitation estimations in the frame of Precip-AMMA *EGU Vienna 15-20 April 2007.*

Thorne, V., Coakley, P., Grimes, D.I.F. & Dugdale, G., 2001: Comparison of TAMSAT and CPC rainfall estimates with rainfall, for southern Africa. *Int. J.Remote Sensing, 2001, Vol 22, No.10, pp1951-1974.*