TAMSAT

What is TAMSAT?

TAMSAT is a research group based at the University of Reading, UK. TAMSAT stands for ‘Tropical Applications of Meteorology using SATellite and ground-based observations’. Our main aim is to provide reliable and timely rainfall estimates for sub-Saharan Africa using satellite imagery.

Why use satellite imagery?

The standard way to measure rainfall is using a raingauge; this provides a reliable pin-point measurement of how much rain has fallen. However, across most of Africa the raingauge network is extremely sparse and it often takes many months before raingauge records are accessible to the wider community. This is not very useful when you need to know the current state of the rainy season. Satellite imagery can help to overcome such problems as they provide full spatial coverage, capture images on a frequent basis (currently every 15 minutes) and the data are available in near real-time.

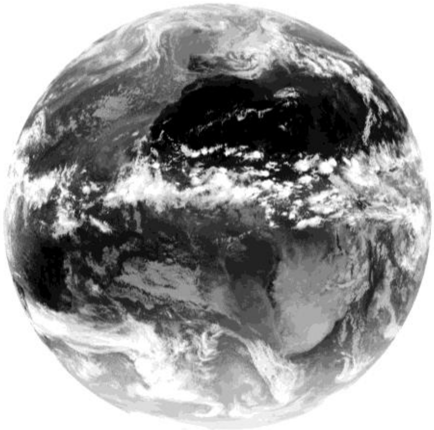

Figure 1. Meteosat TIR image at 18:00, June 20th, 2010

TAMSAT uses thermal infra-red (TIR) imagery in the 10.8 μm band from the Meteosat satellite. At this wavelength, the satellite is essentially measuring the temperature of the surface in view. An example is given in Figure 1; the darker the surface the warmer it is. Since temperature decreases with height, we can use temperature as a proxy for height when looking at clouds. We know that rainfall in Africa typically comes from tall, convective systems characterised by cold cloud tops. Using TIR imagery therefore allows us to identify and monitor such cold cloud tops which in turn allow us to estimate rainfall.

The rainfall estimation process

The TAMSAT approach to rainfall estimation is very simple and the only real-time requirement is TIR satellite imagery. The process is explained below.

1. For a particular region, we identify the optimum cloud top temperature (T_t) to distinguish between rain and no-rain. This assumes that if the cloud top temperature is equal to or colder than the threshold, there is rain at the surface. If the cloud top temperature is warmer than the threshold, the cloud is deemed too shallow to precipitate and there is no rain at the surface. This is illustrated in Figure 2.
2. Once the optimum threshold has been chosen, the cold cloud duration or CCD is calculated on a pixel basis over 1 day. The result is a gridded map of counts where for each time step, a count has been recorded if the cloud top temperature was equal to or colder than the prescribed temperature threshold. Areas of high counts or CCD correspond to more occasions when the cold cloud top exceeded the temperature threshold indicating the likelihood of greater rainfall amounts at the surface.
3. Daily CCD totals are summed over a 10-day period known as a dekad.

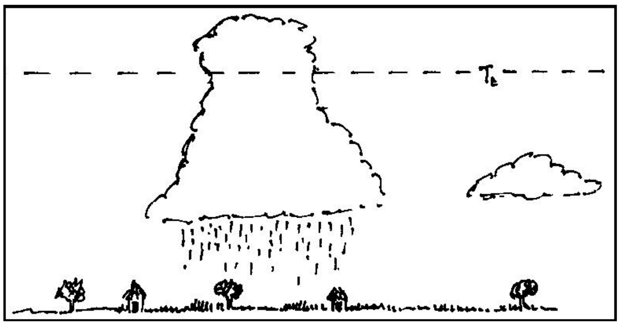

Figure 2. Schematic indicating the optimum temperature threshold. Clouds with tops colder than the given temperature threshold *Tt* are assumed to be raining. Clouds with tops warmer than *Tt* are assumed not to be raining.

4. Rainfall is estimated assuming a linear relationship between rainfall and CCD:

$$rain = a_0 + a_1 CCD$$

where a_0 and a_1 are the calibration parameters. These are determined, along with T_t, during the calibration process which uses historic raingauge records to produce a one-off calibration. This calibration process is very important as it tries to determine the best linear relationship between rainfall and CCD.

5. For near real-time rainfall estimates, the calibration parameters (a_0 and a_1) that are already determined are applied to the latest CCD.
6. It is well known that the African rainfall climate varies regionally and seasonally. To reflect such variations, all the calibration parameters (T_t, a_0 *and* a_1) vary on a regional and monthly basis, hence it is *local calibration*. An example is given in Figure 3.
7. The end product is a gridded rainfall map of 10-day totals at 0.0375° (approx. 4km) resolution for all of Africa including Madagascar. An example is given in Figure 4.

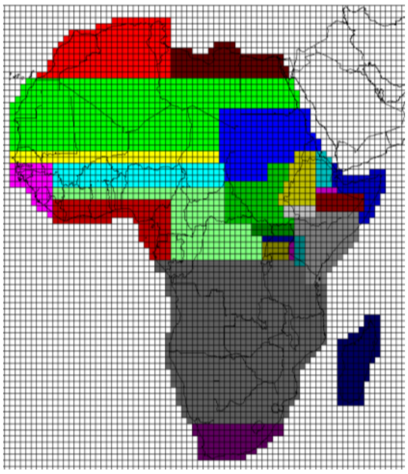

Figure 3. Calibration zones for August. Each zone represents a different relationship between rainfall and CCD reflecting the spatial variation in rainfall climate.

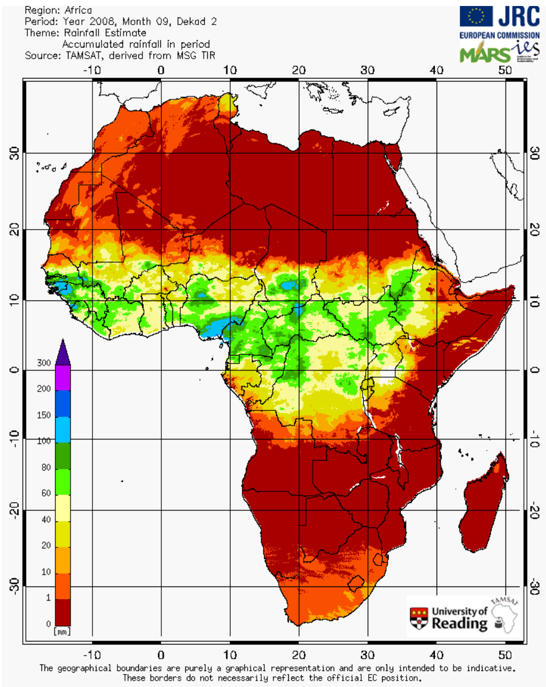

Figure 4. 10-day TAMSAT rainfall estimates for 2nd dekad (11th-20th) September 2008.

Limitations of the TAMSAT rainfall estimates

The TAMSAT rainfall estimation algorithm provides rainfall estimates using cloud top temperature; it does not directly measure the rainfall. Therefore care must be taken when using the TAMSAT rainfall estimates. Here are some words of warning.

- The TAMSAT algorithm is only suitable if the rainfall is convective in nature. It is not suitable if the rainfall is from frontal systems (eg Southern Africa during boreal summer) or from warm rain processes (eg Guinea Coast during the monsoon).
- Whilst estimates are at a fine spatial resolution, spatial averaging and/or temporal aggregation are required before the estimates become reliable. Typically, for 10-day totals, 0.5° resolution would be a suitable scale. Finer scales are permissible, but only if the temporal resolution is increased.
- Where few raingauge records exist, the calibration is likely to be less reliable.
- Whilst many studies have shown TAMSAT rainfall estimates to perform well, they are only estimates and are not meant as a substitute for raingauges.

TAMSAT products

TAMSAT currently have various products available.

- Our main product which all other products are derived from is the 10-day rainfall estimate. These are available at the end of each 10-day period.
- Monthly and seasonal totals.
- Climatologies and anomalies with respect to the 2000 - 2009 period.
- TARCAT v2.0 is a new product that uses archived satellite imagery to generate a consistent dataset of 10-day rainfall estimates going back to 1983.
- Daily rainfall estimates (part of TARCAT v2.0). This is currently a research product, but there are encouraging signs that this is a viable product for certain applications.

Further information

For more information about TAMSAT, its products and research projects, please visit www.met.reading.ac.uk/~tamsat

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