# SAFARI 2000 Daily Rainfall Estimates, 0.1-Deg, Southern Africa, 1993-2001

## Abstract

There are numerous applications in climatology and hydrology where accurate information at scales smaller than the existing monthly/2.5 degree products would be invaluable. Here, the Microwave InfraRed Algorithm (MIRA) is used to produce an enhanced data product. MIRA combines satellite passive microwave (PMW) and infrared (IR) data to account for the limitations of both data types in estimating precipitation. Rainfall estimates are produced at the high spatial and temporal frequency of the IR data using rainfall information from the PMW data. An IR/rain rate relationship, variable in space and time, is derived from coincident observations of IR and PMW rain rate (accumulated over a calibration domain) using the probability matching method. The IR/rain rate relationship is then applied to IR imagery at full temporal resolution. The results presented here are the daily means of those derived rain rates at 0.1 degree spatial resolution.

## Background Information

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**Project:** SAFARI 2000

**Data Set Title:** SAFARI 2000 Daily Rainfall Estimates, 0.1-Deg, Southern Africa, 1993-2001

**Site:** Southern Africa
**Westernmost Longitude:** 10°
**Easternmost Longitude:** 50°
**Northernmost Latitude:** 0°
**Southernmost Latitude:** -34°

**Data Set Citation:**

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## Data File Information

The rainfall data sets are flat binary images with no headers. The compressed data files are named following the format "**mira_rainfall_YYYY.zip**". The data files are band sequential files that contain all of the daily images for the given year. The number of band sequential images in each annual file and the associated dates can be found in the file **mira_data_dates.csv**.

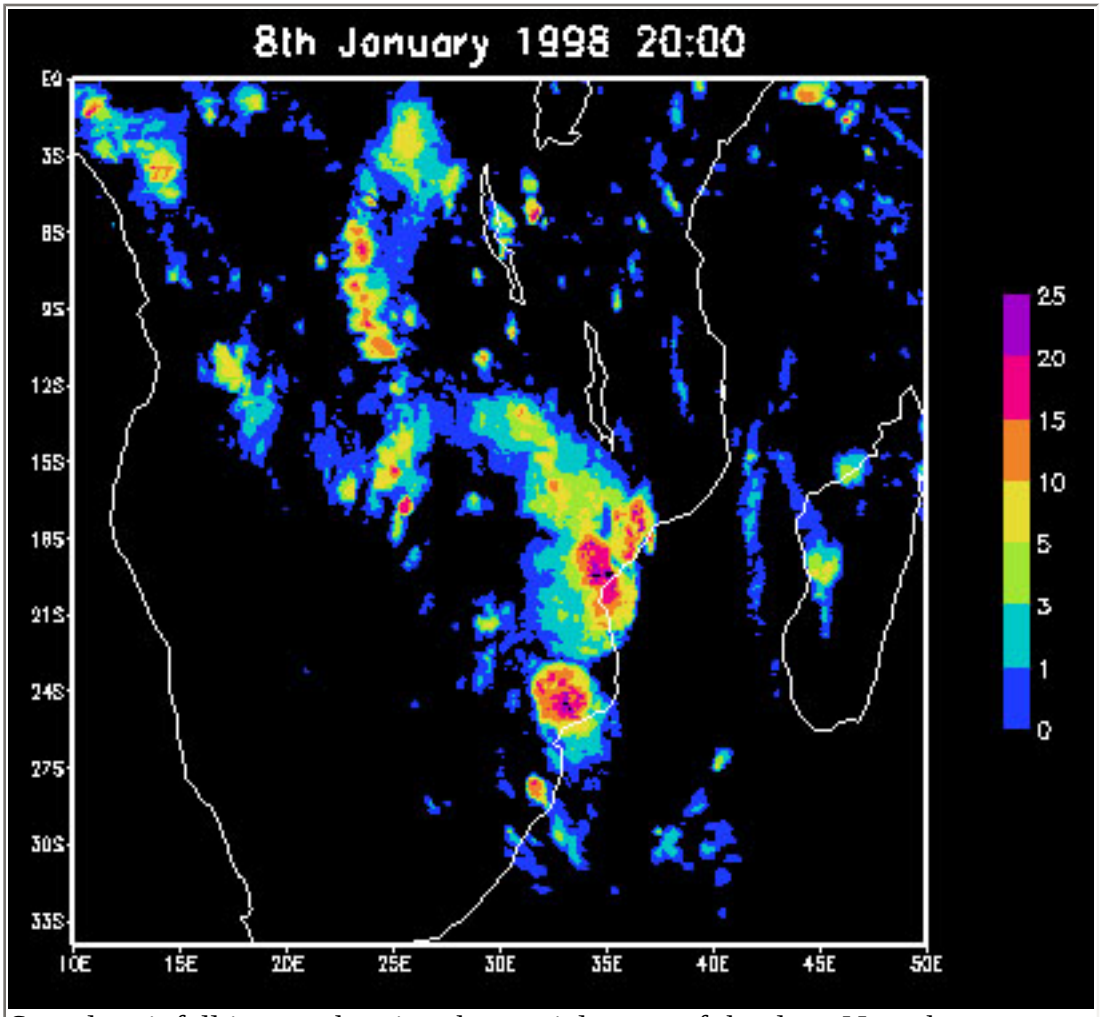
| Precipitation Image Files |
|---|
| mira_rainfall_1993.zip |
| mira_rainfall_1994.zip |
| mira_rainfall_1995.zip |
| mira_rainfall_1996.zip |
| mira_rainfall_1997.zip |
| mira_rainfall_1998.zip |
| mira_rainfall_1999.zip |
| mira_rainfall_2000.zip |
| mira_rainfall_2001.zip |

Below are the first few records of the **mira_data_dates.csv** file. The MIRA rainfall images are a concatenation of daily rainfall images listed in the information file **mira_data_dates.csv**. The information file is an ASCII file that has a two header records, the first of which is year, the second is the total number of days (bands) in each band sequential yearly file. Below this, the dates (bands) contained within each yearly file, are listed.

| band | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|---|
| | 362 | 354 | 283 | 332 | 351 | 353 | 341 | 364 | 353 |
| 1 | 1-Jan-1993 | 1-Jan-1994 | 1-Jan-1995 | 1-Jan-1996 | 1-Jan-1997 | 1-Jan-1998 | 1-Jan-1999 | 1-Jan-2000 | 11-Jan-2001 |
| 2 | 2-Jan-1993 | 2-Jan-1994 | 2-Jan-1995 | 2-Jan-1996 | 2-Jan-1997 | 2-Jan-1998 | 2-Jan-1999 | 2-Jan-2000 | 12-Jan-2001 |
| 3 | 3-Jan-1993 | 3-Jan-1994 | 3-Jan-1995 | 3-Jan-1996 | 4-Jan-1997 | 3-Jan-1998 | 3-Jan-1999 | 3-Jan-2000 | 13-Jan-2001 |
| 4 | 4-Jan-1993 | 4-Jan-1994 | 4-Jan-1995 | 4-Jan-1996 | 5-Jan-1997 | 4-Jan-1998 | 4-Jan-1999 | 4-Jan-2000 | 14-Jan-2001 |

**Image Parameters**

Each image is an array of 341 lines, each with 401 binary floating-point numbers, containing rainfall at 0.1 degree resolution for the area 10 to 50 degrees longitude and 0 to -34 degrees latitude. The array reads in the order: first point is centered on 10 degrees longitude and -34 degrees latitude, 2nd point is centered on 10.1 degrees longitude, -34 degrees latitude, etc.



Sample rainfall image showing the spatial exent of the data. Note, however, that this sample is an hourly image, not the daily data provided here.

| | |
|---|---|
| Number of lines | 341 |
| Number of samples | 401 |
| Number of bands (days) per file | variable, see dates file |
| Bytes per pixel | 4 (REAL*4 big-endian) |
| Fill Value (missing or not valid) | -99999 |
| Data Units | mean mm per hour |
| Pixel size | 0.1 degree |
| Projection | Geographic lat/long |

## Procedure

PMW data was obtained from the Special Sensor Microwave/Imager (SSM/I) on board the DMSP F10 and F14 satellites over Southern Africa for the time period 1993-2001 at a resolution of 0.5 degrees. Infrared (IR) data were obtained over the same time period from the Meteosat satellite in 2-hour slots at the satellite resolution of 5 km. The frequency distributions of PMW estimated rainrate (R) and IR brightness temperature (Tb) were derived from coincident satellite imagery, accumulated over a space and time domain large enough to ensure sufficient IR and PMW observations (the calibration domain). To derive an optimized Tb/R relationship for the calibration domain, the Probability Matching Method (PMM) of Atlas and Bell (1990) was used. In the PMM the histograms of coincident R and Tb observations are compared, such that the proportion of the R distribution above a given rain rate is equal to the proportion of the Tb distribution below the associated Tb threshold value. Working from the highest to the lowest rain rates, by calculating the proportion of the R distribution above rain rates at some interval (0.1 mm $hr^{-1}$) the appropriate Tb threshold values are obtained. In this way, an optimized Tb/R relationship is produced. In the case of this data set, the calibration domain was a temporal window of one month and spatially, a 2.5 by 2.5 degree (moving window). This resulted in 0.5 degree Tb/R images for each month from 1993 to 2001.

The spatially varying Tb/R relationship was then applied to the 2 hourly Meteosat IR data and the results interpolated to a 0.1 degree grid and averaged over a day, to give mean hourly rainfall for each day (1993-2001) where data were available. The results were normalized such that the integrated monthly rainfall totals from the MIRA algorithm were in agreement with the integrated monthly rainfall totals from the SSM/I.

## Additional Sources of Information

## References

Atlas, D. T. and L. Bell. 1990. Climatologically tuned reflectivity-rainrate relations and links to area-time integrals. J. Appl. Met., 29: 1120-1135.

Todd, M. C., C. Kidd, T. J. Bellerby, and D. R. Kniveton. 2001. A combined

satellite infrared and passive microwave technique for estimation of small-scale rainfall. Journal of Atmospheric and Oceanic Technology, 18(5): 742-755.

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