

Tracked IMERG Mesoscale Precipitation Systems (TIMPS)

Documentation: Version 1.1

James Russell, University of Utah

TIMPS Availability

The TIMPS homepage can be found at:

<https://jrussell.chpc.utah.edu/timps/>

The TIMPS data is currently available via an http server at:

<https://home.chpc.utah.edu/~u0816744/TIMPS/>

A python download script (that uses lftp) is available at:

https://home.chpc.utah.edu/~u0816744/TIMPS/download_TIMPS_andor_Track.txt

Input Data

The raw data is NASA's Integrated Multi-satellitE Retrievals for GPM (IMERG) V06B Final product. This data was downloaded from NASA GES DISC:

https://disc.gsfc.nasa.gov/datasets/GPM_3IMERGHH_06/summary?keywords=IMERG

Tracking

Tracking Algorithm

The Forward in Time (FiT) algorithm, developed and maintained by Gregor Skok at the University of Ljubljana is used to track precipitation systems in IMERG data for the TIMPS data set. The FiT algorithm was previously used to track precipitation systems in the IMERG predecessor TRMM 3B42. The FiT algorithm uses a process called cascading thresholds to separate systems in space and then uses a simple overlapping in time to connect systems in time. More information on the basic FiT algorithm can be found in the following publication and its predecessors:

<https://journals.ametsoc.org/view/journals/clim/26/8/jcli-d-12-00135.1.xml>).

For the TIMPS data set, a few modifications were made to the algorithm. These include the addition of a separation distance and a change to the algorithm that allows periodic tracking in the x-direction. The separation distance parameter allows the user to control when two systems that were previously one system become separate systems. This allows for splitting of two systems to occur and for them to maintain the same ID until their centers are greater than the separation distance apart.

Thresholding

Prior to tracking, the IMERG data must be processed using smoothing and thresholding. Smoothing is required to normalize the data between different satellite overpasses at different times and for a reduction in noise to allow the algorithm to process systems more accurately. For TIMPS a normalized threshold is used. In this process, a minimum threshold is set, and then contiguous areas of precipitation are thresholded based on a fraction of their maximum precipitation. This allows for the FiT algorithm to treat each contiguous area separately.

Tracking and Thresholding Parameters

- Smoothing: Uniform moving average with 5 grid cell (~50 km) window
- Minimum threshold: 1 mm/hr
- Normalized fractional thresholds: 0.11, 0.33
- Separation distance: 20 grid cells (~200km)

Domain

The domain is a global tropical strip, between 30.05 N and 30.05 S. Systems that spend any time on the edge of that domain are not processed since they may be incomplete systems. As a result, bulk statistics on systems at the edge of the domain may be somewhat incomplete and therefore should be used with caution.






Tracking period

The data set is currently available for the GPM period (2014-2020). Tracking is performed in 1 year intervals. For each year there is a 1 week buffer at the beginning to allow for spin up of the tracking algorithm and a 2 week buffer period at the end to allow for the FiT algorithm to complete tracking of any systems that began in the previous year.

Organization and Format

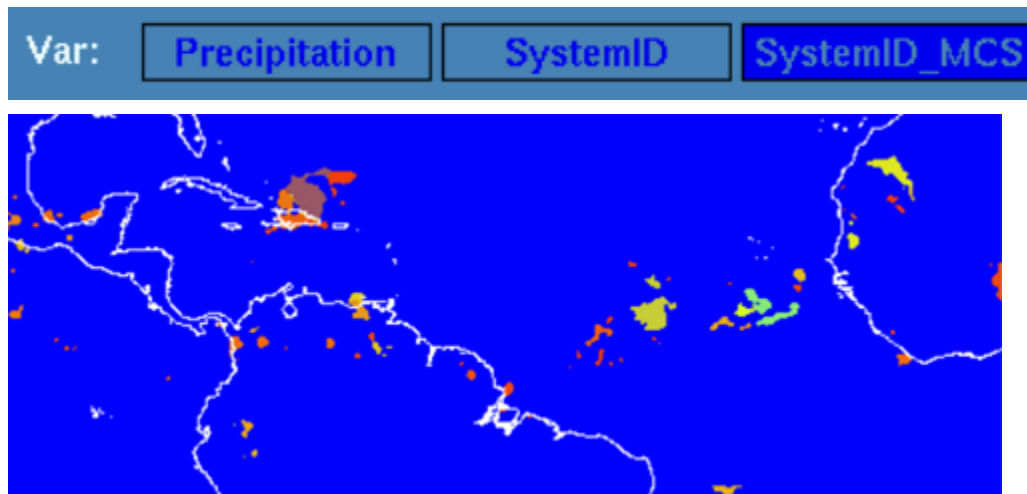
All output data is in netcdf format. The data is organized into two sets of files as in the figure below. The two sets of files are the geographical tracking files (Track) and the individual system files (TIMPS). The front page also has a python/lftp download script and this documentation.

Index of /~u0816744/TIMPS

Name	Last modified	Size	Description
 Parent Directory		-	
 TIMPS_Documentation ...>	2021-07-14 15:18	605K	
 TIMPS_files/	2021-07-14 15:11	-	
 Track_files/	2021-07-14 14:54	-	
 download_TIMPS_andor.>	2021-07-14 15:18	2.5K	





Each tracked system has its own netcdf file with various variables to quantify it. TIMPS files are available in year and month directories corresponding to the first time in each TIMPS file. Any of those systems may have times in the next year/month depending on how long the FiT algorithm tracked that system. By retaining only systems that began in the year the tracking was run for, we ensure the data set is continuous for the full period with no overlapping or twice tracked systems. Not all systems tracked by the FiT algorithm are retained as TIMPS files. Only those that reach at least 3000 km² in area and exhibit a maximum rain rate of at least 10mm/hr (an approximate convective cutoff for IMERG) are retained. The systems may still be smaller than 3000 km² at times or have times when the rain rate is not greater than 10mm/hr. This condition ensures that they reach this cutoff at some point during their lifetime. This is to ensure only systems that may be deemed mesoscale convective systems are processed.

Each Tracking file contains the precipitation data from IMERG and the tracked system ID as designated by the FiT algorithm. This data is best used for identifying IDs of systems within a given area or time period as desired. A subsection of the SystemID data will look as below with different colors indicating different system IDs:
















Each TIMPS file is provided in the TIMPS_files directory under a directory of the year and month for which it started. TIMPS files are only available for the System IDs in SystemID_MCS in the tracking files. An example of the directory structure is provided below:









Index of /~u0816744/TIMPS/TIMPS_files

Name	Last modified	Size	Description
 Parent Directory		-	
 2015/	2021-07-14 15:04	-	
 2016/	2021-07-14 15:12	-	
 2017/	2021-07-14 15:14	-	

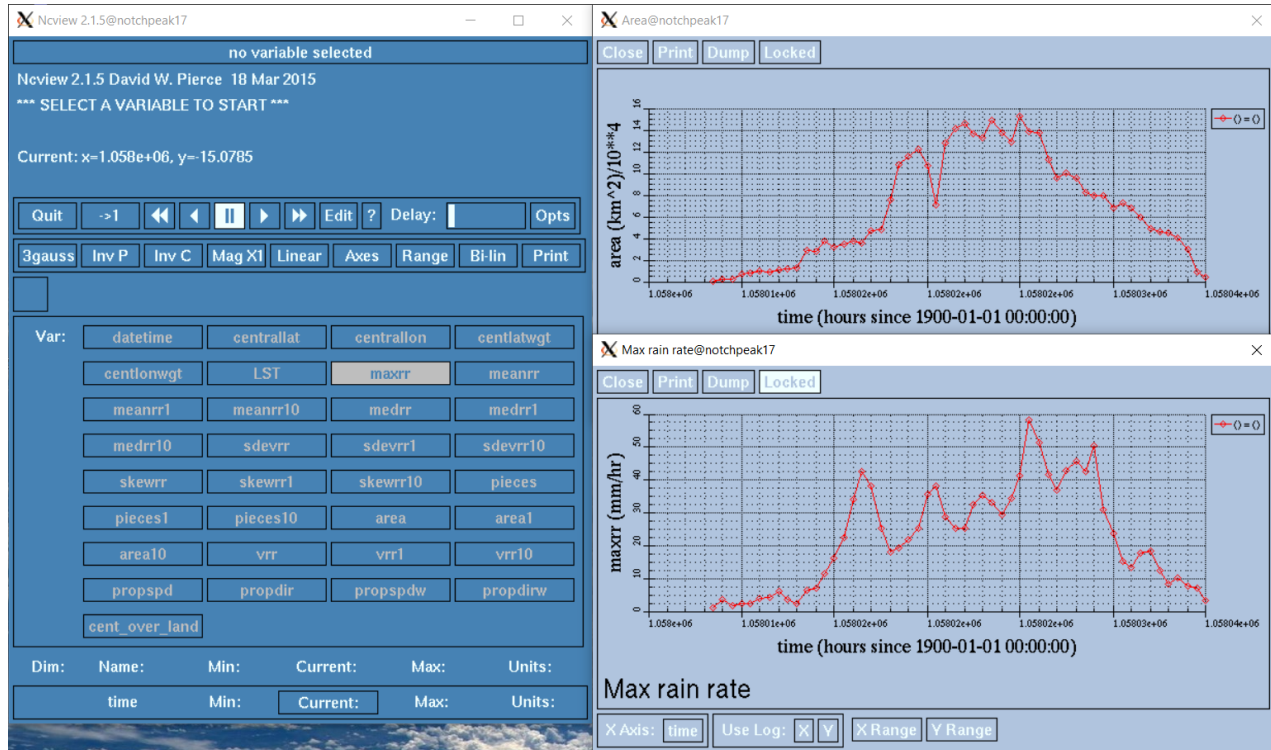
Index of /~u0816744/TIMPS/TIMPS_files/2015

Name	Last modified	Size	Description
 Parent Directory		-	
 01/	2021-07-14 14:13	-	
 02/	2021-07-14 14:15	-	
 03/	2021-07-14 14:19	-	
 04/	2021-07-14 14:22	-	
 05/	2021-07-14 14:25	-	
 06/	2021-07-14 14:32	-	
 07/	2021-07-14 14:40	-	
 08/	2021-07-14 14:48	-	
 09/	2021-07-14 14:54	-	
 10/	2021-07-14 15:01	-	
 11/	2021-07-14 15:04	-	
 12/	2021-07-14 15:10	-	

Index of /~u0816744/TIMPS/TIMPS_files/2015/01

Name	Last modified	Size	Description
 Parent Directory		-	
 TIMPS_0144826_201501.>	2021-07-14 14:10	61K	
 TIMPS_0144841_201501.>	2021-07-14 14:10	136K	
 TIMPS_0144842_201501.>	2021-07-14 14:10	65K	
 TIMPS_0144851_201501.>	2021-07-14 14:10	114K	
 TIMPS_0144860_201501.>	2021-07-14 14:10	122K	
 TIMPS_0144866_201501.>	2021-07-14 14:10	268K	
 TIMPS_0144871_201501.>	2021-07-14 14:10	271K	
 TIMPS_0144877_201501.>	2021-07-14 14:10	140K	

Each TIMPS file contains a variety of variables describing the system. Most variables are in a time-series format as in the below figure. Variables are available for all non-zero rain rate pixels within the system, >1mm/hr rain rate pixels, and >10mm/hr rain rate pixels. >10mm/hr is the proxy we use to represent convective rain rates within IMERG.



Variables

Netcdf variables:

- time - a date number in hours since 1900/01/01 00:00.
 - datetime - time in YYYYMMDDhhmm format expressed as an integer.
- Both time variables follow the IMERG convention of representing the first time of that half hour period thus each time actually represents the 30 mins following that time.
- centrallat - central latitude averaged over all grid cells (unit: degrees north)
 - centrallon - central longitude averaged over all grid cells (unit: degrees east)
 - centlatwgt - weighted (by rain rate) central latitude (unit: degrees north)
 - centlonwgt - weighted (by rain rate) central longitude (unit: degrees east)
 - lst - local solar time calculated as UTC time plus a correction factor ($\text{lon} \times 24/360$) in YYYYMMDDhhmmss expressed as an integer.
 - maxrr - the maximum rain rate (unit: mm/hr)
 - meanrr - mean of rain rates (unit: mm/hr)
 - meanrr1 - as above but only for rain rates >1mm/hr
 - meanrr10 - as above but only for rain rates >10mm/hr
 - medrr - median of rain rates (unit: mm/hr)
 - medrr1 - as above but only for rain rates >1mm/hr
 - medrr10 - as above but only for rain rates >10mm/hr
 - sdevrr - standard deviation of rain rates (unit: mm/hr)
 - sdevrr1 - as above but only for rain rates >1mm/hr
 - sdevrr10 - as above but only for rain rates >10mm/hr

- skewrr - skewness of rain rates (no units)
- skewrr1 - as above but only for rain rates >1mm/hr
- skewrr10 - as above but only for rain rates >10mm/hr
- pieces - number of contiguous areas making up the system (integer)
- pieces1 - as above but only for rain rates >1mm/hr
- pieces10 - as above but only for rain rates >10mm/hr
- area - spatial area of the system (units: km²)
- area1 - as above but only for rain rates >1mm/hr
- area10 - as above but only for rain rates >10mm/hr
- vrr - area of each grid cells multiplied by rain rate of each grid cells, summed over all grid cells (units: mm km² hr⁻¹)
- vrr1 - as above but only for rain rates >1mm/hr
- vrr10 - as above but only for rain rates >10mm/hr
- propspd - propagation speed of system centroid (units: ms⁻¹)
- propdir - propagation direction of centroid calculated as direction centroid is moving toward from north (clockwise) (units: degrees)
- propspdwr - propagation speed of system rain rate weighted centroid (units: ms⁻¹)
- propdirwr - propagation direction of rain rate weighted centroid calculated as direction centroid is moving toward from north (clockwise) (units: degrees)
- cent_over_land - binary indicating whether the center of the system is over land (1) or over water (0)

Netcdf groups:

Each TIMPS file also retains other variables as attribute (time) and value (variable: list of all values at each grid cell) pairs within a netcdf group (somewhat similar to a python dictionary with time as the keys and a variable as a list of values with each value representing a different grid cell).

- lat - latitude of each grid cell at each time
- lon - longitude of each grid cell at each time
- instrain - rain rate of each grid cell at each time
- loc_over_land - binary indicating which grid cell is over land (1) and over water (0) at each time

Tropical Cyclone (TC) related attributes/variables:

Each TIMPS is checked for its proximity to TCs by comparing its central location with the all TCs in the IBTrACS database. Any TIMPS within double the IBTrACS defined radius of the TC center is deemed a component of a TC. For those that are deemed TCs, the following attributes are present:

- within_TC = True
- TCname_cent (length time) - the name of the TC it is close to at that time.

If not:

- within_TC = False

If True, a number of other variables exist:

- cent_in_tc (length time) - binary indicating whether center is within TC.

- `dist_cent_cTC` (length time) - float indicating the distance in kms to the TC center.
- `TCrad_cent` (length time) - a float indicating the radius used for the TC.

Also, if True, a number of groups exist:

- `dist_loc_cTC` - float indicating the distance in kms from each TIMPS pixel to the TC center.
- `TCname_loc` - the name of the TC each pixel is close to at that time.
- `TCrad_loc` - the radius of the TC used for each pixel.