# TOOCAN data format
# Deep Convective Systems database

**Update**: 01/12/2023
**Version**: v2.08
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**[Reference]**

Fiolleau T. and Roca R. 2013 : An Algorithm for the Detection and Tracking of Tropical Mesoscale Convective Systems Using Infrared Images From Geostationary Satellite. IEEE Transactions on Geoscience and Remote Sensing, v. 99, p. 1-14

Fiolleau, T., R. Roca, S. Cloché, D. Bouniol, P. Raberanto, 2020: Homogenization of geostationary infrared imager channels for cold cloud studies using Megha-Tropiques/ScaRaB. IEEE Trans. Geosci. Remote Sens., vol 58, no. 9, pp. 6609-6622. **doi:** 10.1109/TGRS.2020.2978171

**[Objectives]**

A topical deep convective system (DCS) datatase combined with:

- the cyclones from the IBTrACS database
- Jirak classification

**[External datasets]**

**IBtRACS database**

*Knapp, K. R., M. C. Kruk, D. H. Levinson, H. J. Diamond, and C. J. Neumann, 2010: The International Best Track Archive for Climate Stewardship (IBTrACS): Unifying tropical cyclone best track data.* Bulletin of the American Meteorological Society, *91, 363-376. doi:10.1175/2009BAMS2755.1*

*Knapp, K. R., H. J. Diamond, J. P. Kossin, M. C. Kruk, C. J. Schreck, 2018: International Best Track Archive for Climate Stewardship (IBTrACS) Project, Version 4. NOAA National Centers for Environmental Information. doi:10.25921/82ty-9e16 [access date].*

**[Regions of interests]**

| | |
|---|---|
| EUROPE: | [55°W, 55°E] - [40°S, 40°N] |
| INDIA: | [30°E, 107°E] - [40°S, 40°N] |
| NorthWESTERNPACIFIC: | [85°E, 165°W] - [40°S, 40°N] |
| NorthEASTERNPACIFIC: | [190°W, 80°W] - [40°S, 40°N] |
| NorthAMERICA : | [130°W, 30°W] - [40°S, 40°N] |

**[TOOCAN output]**

- **Regional and monthly tracking files (in ASCII) documenting the DCS integrated morphological parameters and the DCS parameters at each 30minute-step of their life cycles.**

  TOOCAN-REGION-YYYY0MM0DD0-YYYY1MM1DD1.dat.gz

  YYYY0 : yearStart
  MM0 : monthStart
  DD0 : dayStart
  YYYY1 : yearEnd
  MM1 : monthEnd
  DD1 : dayEnd

  ex : TOOCAN-AFRICA-20140601-20140630.dat.gz

- **Regional segmented images at a 0.04° spatial resolution and a 30 minute temporal frequency (in NETCDF).**

# 1 Header

| Global Attributes | Data type |
|---|---|
| ############################################################ | a60 |
| ############################################################ | a60 |
| **TOOCAN Version** | 25x, a0 |
| **Institution** | 25x, a0 |
| **creator_name** | 25x, a0 |
| **contributor_name** | 25x, a0 |
| **Satellite** | 25x, a0 |
| **Region** | 25x, a0 |
| **time_coverage_start** | 25x, i0 |
| **time_coverage_end** | 25x, i0 |
| **Temporal resolution** | 25x, i0 |
| **Spatial resolution** | 25x, f0, a0 |
| **Lonmin - Lonmax** | 25x, i6, a3, i6 |
| **Latmin - Latmax** | 25x, i6, a3, i6 |
| **Nb columns** | 25x, i0 |
| **Nb lines** | 25x, i0 |
| **Population of DCS** | 25x, i0 |
| ############################################################ | a60 |
| ############################################################ | a60 |

Example :

```
############################################################
############################################################
# TOOCAN version       :            2.06
# institution          : CNRS/LEGOS/IPSL
# creator_name         : Thomas Fiolleau
# contributor_name     :       Remy Roca
# Satellite            :            MSG2
# Region               :          AFRICA
# time_coverage_start  :        20120401
# time_coverage_end    :        20120430
# temporal resolution  :          30 min
# Spatial resolution   :     0.04 degree
# Lonmin - Lonmax      :    -55 -     55
# Latmin - Latmax      :    -40 -     40
# Nb columns           :            2751
# Nb lines             :            2001
# Population of MCS    :           27483
############################################################
############################################################
```

# 2 Integrated DCS morphological parameters

| Parameters | Description | Units | Data type |
|---|---|---|---|
| **==>** | Indication for a new DCS | | 3x |
| **DCS_number** | Label of the DCS in the segmented images | | 15d |
| **INT_qltyDCS** | Quality flag indicating if the DCS initiates or dissipates due to missing images | | 22d |
| **INT_classif** | Classification of the DCS | 1➔ DCS with a duration < 5hr<br>2➔ DCS with a duration ≥ 5hr and described by a uniq maximum of their cold surfaces along their life cycles<br>3➔ DCS with a duration ≥ 5hr and described by several maximums of their cold surfaces along their life cycles | 22d |
| **INT_duration** | Life time duration | hr | 22.2lf |
| **INT_UTC_timeInit** | Universal Time of the DCS initiation | seconds since 1st January 1970 | 22.2lf |
| **INT_localtime_Init** | Local time of the DCS initiation initiation | seconds since 1st January 1970 | 22.4lf |
| **INT_lonInit** | Longitude of the DCS center of mass at its initiation | degrees | 22.2lf |
| **INT_latInit** | Latitude of the DCS center of mass at its initiation | degrees | 22.2lf |
| **INT_UTC_timeEnd** | Coordinated Universal Time of the DCS dissipation | Minutes since 1st January 1970 | 22.2lf |
| **INT_localtime_End** | Local time of the DCS dissipation | Minutes since 1st January 1970 | 22.4lf |
| **INT_lonEnd** | Longitude of the DCS center of mass at its dissipation | degrees | 22.2lf |
| **INT_latEnd** | Latitude of the DCS center of mass at its dissipation | degrees | 22.2lf |
| **INT_velocityAvg** | Average velocity of the DCS from its initiation to its dissipation | m/s | 22.2lf |
| **INT_distance** | Distance covered by the DCS | km | 22.2lf |
| **INT_lonmin** | Minimum longitude of the DCS along its life cycle | degrees | 22.2lf |
| **INT_latmin** | Minimum latitude of the DCS along its life cycle | degrees | 22.2lf |
| **INT_lonmax** | Maximum longitude of the DCS along its life cycle | degrees | 22.2lf |
| **INT_latmax** | Maximum latitude of the DCS along its life cycle | degrees | 22.2lf |
| **INT_TbMin** | Minimum brightness temperature of the DCS along its life cycle | K | 22d |

| | | | |
|---|---|---|---|
| **INT_surfmaxPix_235K** | Maximum cold cloud surface reached by the DCS along its life cycle at 235K | number of pixels | 22d |
| **INT_surfmaxkm2_235K** | Maximum cold cloud surface reached by the DCS along its life cycle at 235K | km² | 22.2lf |
| **INT_surfmaxkm2_220K** | Maximum cold cloud surface reached by the DCS along its life cycle at 220K | km² | 22.2lf |
| **INT_surfmaxkm2_210K** | Maximum cold cloud surface reached by the DCS along its life cycle at 210K | km² | 22.2lf |
| **INT_surfmaxkm2_200K** | Maximum cold cloud surface reached by the DCS along its life cycle at 200K | km² | 22.2lf |
| **INT_surfcumkm2_235K** | DCS Cold Cloudiness at 235K from its initiation to its dissipation | km² | 22.2lf |
| **INT_classif_JIRAK** | DCS classification according to the JIRAK definition | | 22d |
| **INT_classif_MADDOX** | DCS classification according to the MADDOX definition | | 22d |
| **INT_TSnumber_IBTRACS** | number of the Tropical Storm in the iBTRACS file associated with the DCS in a 1000km radius | | 28d |
| **INT_TSnature_IBTRACS** | nature of the Tropical Storm in the iBTRACS file | | 28d |
| **INT_TSmindistance_IBTRACS** | Distance of a DCS to a Tropical Storm (max: 1000km) | Km | 28.2lf |

## INT_qltyDCS :

**first digit** = DCS Initiation error

- 1: OK
- 2: DCS initiation explained by a recovery of the tracking due to a minimum of 5 successive missing GEO images
- 3: DCS initiation explained by the transition from a GEO global mode to a rapid scan mode.

**second digit** = DCS Dissipation error

- 1: OK
- 2: DCS dissipation explained by a recovery of the tracking due to a minimum of 5 successive missing GEO images
- 3: DCS dissipation explained by the transition from a GEO global mode to a rapid scan mode.

**third digit** = DCS Edge error

- 1: OK
- 2: DCS impacted by the GEO image boundaries along its life cycle
- 3: DCS impacted by the GEO image boundaries in a rapid scan mode along its life cycle.
- 4: DCS impacted by missing/bad pixels

**two last digits** = number of images interpolated along the DCS life cycle

Example:
**INT_qltyDCS = 11100**

First digit =1 ➔ DCS initiation OK
Second digit = 1 ➔ DCS dissipation OK
Third digit = 1 ➔ DCS not impacted by the image boundaries
Two last digit = 00 ➔ No interpolated GEO images during the DCS tracking

**INT_qltyDCS = 11108**
First digit =1 ➔ DCS initiation OK
Second digit = 1 ➔ DCS dissipation OK
Third digit = 1 ➔ DCS not impacted by the image boundaries
Two last digit = 08 ➔ 8 interpolated GEO images during the DCS tracking

**INT_qltyDCS = 11200**
First digit =1 ➔ DCS initiation OK
Second digit = 1 ➔ DCS dissipation OK
Third digit = 2 ➔ DCS impacted by the image boundaries
Two last digit = 00 ➔ No interpolated GEO images during the DCS tracking

**INT_qltyDCS = 11300**
First digit =1 ➔ DCS initiation OK
Second digit = 1 ➔ DCS dissipation OK
Third digit = 3 ➔ DCS impacted by the image boundaries in a rapid scan mode (GOES-13 and GOES-15)
Two last digit = 00 ➔ No interpolated GEO images during the DCS tracking

**INT_qltyDCS = 13100**
First digit =1 ➔ DCS initiation OK
Second digit = 3 ➔ DCS dissipation due to the transition from a GEO global mode to a rapid scan mode
Third digit = 1 ➔ DCS not impacted by the image boundaries
Two last digit = 00 ➔ No interpolated GEO images during the DCS tracking

**INT_qltyDCS = 21100**
First digit =2 ➔ DCS initiation explained by a recovery of the tracking due to a minimum of 5 successive missing GEO images.
Second digit = 1 ➔ DCS dissipation OK
Third digit = 1 ➔ DCS not impacted by the image boundaries
Two last digit = 00 ➔ No interpolated GEO images during the DCS tracking

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## INT_Classif:

Classification of the DCSs according to Roca etal (2017)

1➔ DCS with a duration < 5hr
2➔ DCS with a duration ≥ 5hr and described by a uniq maximum of their cold surfaces along their life cycles
3➔ DCS with a duration ≥ 5hr and described by several maximums of their cold surfaces along their life cycles

**INT_TSnature_IBTRACS:**

- the IBTrACS data are used to determine whether a Convective system is embedded into a tropical storm meteorological event. We can have access to the nature of the Tropical Storm in the iBTRACS file, associated with the DCS within a maximum distance of 1000km.
- The tropical cyclones are classified according to the Saffir-Simpson hurricane wind scale (SSHS).

| Nature of the tropical storm in the IBTrACS database | value |
|---|---|
| Mixture (contradicting nature reports from different agencies) | 1 |
| Not reported | 2 |
| Disturbance | 3 |
| subtropical | 4 |
| Extratropical | 5 |
| Tropical | 6 |
| SSHS category 1 | 11 |
| SSHS category 2 | 12 |
| SSHS category 3 | 13 |
| SSHS category 4 | 14 |
| SSHS category 5 | 15 |

https://www.ncdc.noaa.gov/ibtracs/pdf/IBTrACS_version4_Technical_Details.pdf
https://www.ncdc.noaa.gov/ibtracs/pdf/IBTrACS_v04_column_documentation.pdf

**INT_TSnumber_IBTRACS**

- The IBTRACS cardinal number of the Tropical Storm for a given season, associated with the DCS within a maximum distance of 1000km.

**INT_TSmindistance_IBTRACS**

- distance of the DCS to the center of the IBTRACS Tropical storm (max distance = 1000km)

**INT_classif_JIRAK**

Classification of the DCS according to the definitions given in Jirak etal(2003)

| DCS Category | Size / Duration / Shape | Value |
|---|---|---|
| MCC | - Cold cloud region ≤-52° with area ≥ 50 000 km²<br>- Size definition met for ≥ 6 h<br>- Eccentricity > 0.7 at time of maximum extent | 1 |
| PECS | - Cold cloud region ≤-52° with area ≥ 50 000 km²<br>- Size definition met for ≥ 6 h | 2 |

| | | |
|---|---|---|
| | - 0.2 ≤ Eccentricity < 0.7 at time of maximum extent | |
| MβCCS | - Cold cloud region ≤-52° with area ≥ 30 000 km²<br>- Maximum size ≥ 50000km²<br>- Size definition met for ≥ 3 h<br>- Eccentricity > 0.7 at time of maximum extent | 3 |
| MβECS | - Cold cloud region ≤-52° with area ≥ 30 000 km²<br>- Maximum size ≥ 50000km²<br>- Size definition met for ≥ 3 h<br>- 0.2 ≤ Eccentricity < 0.7 at time of maximum extent | 4 |

0 ➔ DCS does not display the physical characteristics defined by Jirak etal (2003)

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**INT_classif_MADDOX**

Classification of the DCS according to the definitions given in Maddox (1980)

0 ➔ DCS does not display the physical characteristics of MCC defined by Maddox (1980)
1➔ DCS displays the physical characteristics of MCC defined by Maddox (1980)

| Physical characteristics | |
|---|---|
| *Size:* | A—Cloud shield with continuously low IR temperature $\leq -32°C$ must have an area $\geq 100\,000$ km² |
| | B—Interior cold cloud region with temperature $\leq -52°C$ must have an area $\geq 50\,000$ km² |
| *Initiate:* | Size definitions A and B are first satisfied |
| *Duration:* | Size definitions A and B must be met for a period $\geq 6$ h |
| *Maximum extent:* | Contiguous cold cloud shield (IR temperature $\leq -32°C$) reaches maximum size |
| *Shape:* | Eccentricity (minor axis/major axis) $\geq 0.7$ at time of maximum extent |
| *Terminate:* | Size definitions A and B no longer satisfied |

# 3 DCS morphological parameters along their life cycles

| Parameters | Description | Units | Data type |
|---|---|---|---|
| **QCgeo_IRimage** | Flag Indicating the IR missing image | 0 ➔ missing of the IR image and interpolation of the TOOCAN segmented image<br>1 ➔ presence of the IR image | 20d |
| **LC_tbmin** | Minimum brightness temperature | K | 20.2lf |
| **LC_tbavg_235K** | Average brightness temperature at 235K | K | 20.2lf |
| **LC_tbavg_208K** | Average brightness temperature at 208K | K | 20.2lf |
| **LC_tbavg_200K** | Average brightness temperature at 200K | K | 20.2lf |
| **LC_tb_90th** | 90$^{th}$ percentile of brightness temperature | K | 20.2lf |
| **LC_UTC_time** | Coordinated Universal Time of the DCS | seconds since 1$^{st}$ January 1970 | 20.2lf |
| **LC_localtime** | Local time of the DCS | seconds since 1$^{st}$ January 1970 | 20.4lf |
| **LC_lon** | Longitude of the center of mass | degrees | 20.2lf |
| **LC_lat** | Latitude of the center of mass | degrees | 20.2lf |
| **LC_x** | Column of the center of mass in the image | Indices of the column | 20d |
| **LC_y** | Line of the center of mass in the image | Indices of the line | 20d |
| **LC_velocity** | Instantaneous velocity | m/s | 20.2lf |
| **LC_sminor_235K** | Semi-minor axis of the ellipse at a 235K threshold | km | 20.2lf |
| **LC_smajor_235K** | Semi-major axis of the ellipse at a 235K threshold | Km | 20.2lf |
| **LC_ecc_235K** | Eccentricity of the ellipse at a 235K threshold | $\frac{Sminor\_235K}{Smajor\_235K}$ | 20.2lf |
| **LC_orientation_235K** | Orientation of the ellipse at a 235K threshold | degrees | 20.2lf |
| **LC_sminor_220K** | Semi-minor axis of the ellipse at a 220K threshold | km | 20.2lf |
| **LC_smajor_220K** | Semi-major axis of the ellipse at a 220K threshold | Km | 20.2lf |
| **LC_ecc _220K** | Eccentricity of the ellipse for a 220K threshold | $\frac{Sminor\_220K}{Smajor\_220K}$ | 20.2lf |
| **LC_orientation _220K** | Orientation of the ellipse at a 220K threshold | degrees | 20.2lf |
| **LC_surfPix_235K** | Cold cloud surface of the convective cluster for a 235K threshold | number of pixels | 20d |
| **LC_surfPix_210K** | Cold cloud surface of the convective cluster for a 210K threshold | number of pixels | 20d |
| **LC_surfkm2_235K** | Cold cloud surface of the convective cluster for a 235k threshold | km² | 20.2lf |
| **LC_surfkm2_220K** | Cold cloud surface of the convective cluster for a 220k threshold | km² | 20.2lf |
| **LC_surfkm2_210K** | Cold cloud surface of the convective cluster for a 210k threshold | km² | 20.2lf |
| **LC_surfkm2_200K** | Cold cloud surface of the convective cluster for a 200k threshold | km² | 20.2lf |

**QCgeo_IRimage =** Flag Indicating the IR missing image

0 ➔ missing of the IR image at this time and interpolation of the TOOCAN segmented image
1 ➔ presence of the IR image