Lagrangian storm track

Documentation

Description:

This scripts is updated from the Crawford, et. al. storm track algorithm on their GitHub page…

Please refer to “Cyclone Tracking Description – Version 13.2.docx” for detailed output variables and notes descriptions. To verify your results or download the reference EASE2 nc files, please go to [Test Data for Cyclone Tracking Version 13\_2 - Google Drive](https://drive.google.com/drive/folders/1ejZ82e59XH2WmfLbztt_h0MwUpGphLF5)

Folder directory:

Server: azpana01

File path: E:\Simon\tracking\alexcrawford0927\final\_version

* Preprocess the nc file
* Preprocess and separate the NC file by month. Note: the file should be at least a year long
* You are free to set the dataset boundary within longitude -180 to 180 and latitude -90 to 90. However, detecting storms near the boundary will be noisy and highly inaccurate, so postprocess is needed from the final output.
* Put the separated nc files in {path}/{var}/{ra}\_yyyymm.nc

* Change the variables settings in program/settings.py
* Nc file and path
* ncvar\_p: pressure variable
* nctvar: time coordinate
* ncext: file format
* nx, ny: number of grid cells in the **EASE reference file** Projections/EASE2\_N0\_{res}km\_GenesisRegions.nc
* Default resolution (25km) is used
* For other resolutions available (e.g. 50km, 100km, 200km), please download them from [Test Data for Cyclone Tracking Version 13\_2 - Google Drive](https://drive.google.com/drive/folders/1ejZ82e59XH2WmfLbztt_h0MwUpGphLF5)
* *spres*: spatial resolution (in km)
* *ystart*, *yend*: first and last year of the NC file
* *mstart*, *mend*: first and last month of the NC file
* *dstart*, *dend*: first and last day of the NC file
* *path*: the base path of all outputs
* *ra*: dataset used, which will affect the naming of folders and files. *Please be reminded that the naming of the monthly-separated nc file in preprocessing should start with this variable*
* *var*: affect the naming of the folder. *Please be reminded that the monthly separated nc file in preprocessing should be stored in this file*
* Detection parameters
* *minfield*: minimum reasonable value in field array
* *maxfield*: maximum reasonable value in field array
* *kSizekm*: Size of kernel (km) used to determine if a grid cell is a local minimum. The equivalent of a 3 by 3 kernel with 100 km resolution would be 100, i.e., kSize = (2\**kSizekm*/*spres*)+1
* *nanThresh*: Maximum fraction of neighboring grid cells with no data (Not a Number) allowed for a grid cell to be considered during minimum detection
* minimum slp gradient for identifying (and eliminating) weak minima:
* *d\_slp*: slp difference in Pa (use 0 to turn off)
* *d\_dist*: distance in m (units that match units of cellsize)
* *maxelev*: maximum elevation for masking out high elevation minima, elevation in m (use 10000 to turn off)
* *minlat*: minimum latitude for masking out the Equator (default should be 5 for NH and -5 for SH)
* content: Contour interval (Pa; determines the interval needed to identify closed contours, and therefore cyclone area)
* *mcctol*: Multi-center cyclone (mcc) tolerance is the maximum ratio permitted between the number of unshared and total contours in a multi-centered cyclone. "Unshared" contours are only used by the primary center. "Shared" contours are used by both the primary and secondary centers.
* *mccdist*: Multi-center cyclone (mcc) distance is the maximum distance (in m) two minima can lie apart and still be considered part of the same cyclone system
* *maxspeed*: Maximum speed is the fastest that a cyclone center is allowed to travel; given in units of km/h. To be realistic, the number should be between 100 and 200 and probably over 125 (based on Rudeva et al. 2014). To turn off, set to np.inf. Also, note that instabilities occur at temporal resolution of 1-hr. Tracking at 6-hr and a maxspeed of 125 km/hr is more comprable to tracking at 1-hr and a maxspeed of 300 km/hr (assuming spatial resolution of 50 km). One example of scaling by temporal resolution = 150\*(3 x log(timestep, 6) + 2) / timestep
* *red*: The reduction parameter is a scaling of cyclone speed.  When tracking, the algorithm uses the cyclone speed and direction from the last interval to estimate a "best guess" position. This parameter modifies that speed, making it slower. This reflects how cyclones tend to slow down as they mature. To turn off, set to 1.
* *rg*: Regenesis Paramater; 0 = regenesis starts a new system track; 1 = regenesis continues previous system track with new ptid

* Run “run\_stormtrack.dat” file
* Use command run\_stormtrack.dat

The file has already been set to use “alex” environment for running the code. If you would like to create your one. Please use a conda environment and type

$ conda env create -f environment.yml

Or you can create by yourself step-by-step. In the Windows environment would be difficult in finding the “ESMF” module, so please follow the following steps in the command line to create

$ conda create -y -n {*env}* python=3.11 esmpy=8.4.0

$ conda activate {*env}*

$ python -c "import esmpy"

$ echo $ESMFMKFILE

$ {path\to\env}\Library\lib\esmf.mk *# run the esmf file*

Then you can install the remaining library required by each file.

* Roughly an hour is required to go through one year of global data with resolution 0.25-degree latitude and longitude.

Source

Research paper: [Sensitivity of Northern Hemisphere Cyclone Detection and Tracking Results to Fine Spatial and Temporal Resolution Using ERA5 in: Monthly Weather Review Volume 149 Issue 8 (2021) (ametsoc.org)](https://journals.ametsoc.org/view/journals/mwre/149/8/MWR-D-20-0417.1.xml?tab_body=pdf)

GitHub Page: [GitHub - alexcrawford0927/ HYPERLINK "https://github.com/alexcrawford0927/cyclonetracking?tab=readme-ov-file"cyclonetracking HYPERLINK "https://github.com/alexcrawford0927/cyclonetracking?tab=readme-ov-file": HYPERLINK "https://github.com/alexcrawford0927/cyclonetracking?tab=readme-ov-file"Lagrangian HYPERLINK "https://github.com/alexcrawford0927/cyclonetracking?tab=readme-ov-file" cyclone tracking algorithm originally developed while at the National Snow and Ice Data Center; modified while at the College of Wooster and University of Manitoba.](https://github.com/alexcrawford0927/cyclonetracking?tab=readme-ov-file)

Department webpage: [CEOS/NSIDC Extratropical Cyclone Tracking - Project - Canadian Watershed Information Network (umanitoba.ca)](https://canwin-datahub.ad.umanitoba.ca/data/project/cnect)

Test data: [Test Data for Cyclone Tracking Version 13\_2 - Google Drive](https://drive.google.com/drive/folders/1ejZ82e59XH2WmfLbztt_h0MwUpGphLF5)