Python script for OWZ Tracker

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|  |  |
| --- | --- |
| Ver | Changes |
| 1.0 | Initial version |
| 1.1 | * Added command to run OWZ on existing pre-processed file for testing * Added list of python libraries |

# System Requirement:

Script is tested on following system

|  |
| --- |
| Ubuntu 18.04.4 LTS |
| Python 3.7.6 |
| **Libraries for pre-processing** |
| * Climate Data Operators version (CDO) 1.9.3 |
| * NCO version 4.7.2 |
| **Python Libs** |
| * netCDF4 |
| * numpy |

Table 1 System Requirement

# Package:

The package contains following python scripts and config files:

|  |  |
| --- | --- |
| owz.tracker.py | Main script to pre-process data and executes threshold and tracking operations |
| thrsh.py | Script for detecting tracks using threshold |
| tracker.py | Script for running tracker |
| Input\_thrsh\_SH | Configuration file containing threshold values for SH |
| Input\_thrsh\_NH | Configuration file containing threshold values for NH |
| data\_info\_file | Configuration file for tracker.py |
| topography | topog directory contains topography files for NH and SH i.e. topogNH.nc and topogSH.nc |

Table 2 Package contents

## owz\_tracker.py

This is the main entry point of script. It takes parameters from command line i.e. path of input and output directory and start & end year and performs following operations:

* + Pre-process Data
    - Extract individual variables (RH, SPFH etc) for each day 00H and 12H
    - Split NH and SH in separate files
    - Append topography
    - Generate owdata file (NH and SH)
  + Use owdata file as an input for thrsh.py file (Separate files for NH and SH )
  + Use generated OWZ2Tracker file as an input for tracker.py file
  + Save results in output directory
  + Continue process for each day of year

## thrsh.py

The script is for detecting tracks based on thresholds specified in Input\_thrsh\_SH and Input\_thrsh\_NH files

### Output

* This script will generate OWZ2tracker\_{year} for each year, which contains detected tracks based on thresholds
* It will also generate SubJ\_{year} file, which contains data for Sub Tropical Jets

## tracker.py

This script is for tracking TC on detected track. It takes OWZ2tracker\_{year} file for each year as an input (generated by thrsh.py file), read configuration from data\_info\_file and generates following files with TC counts:

### Output

* Clump\_out\_{year}\_NH/SH
* S\_CT\_out\_{year}
* S\_CT\_out2\_{year}
* S\_CT\_out3\_{year}

## input\_thrsh\_SH

This configuration file is used as an input by thrsh.py to detect TC in SH

|  |  |
| --- | --- |
| Min latitude for output window | -60.0 |
| Max latitude for output window | 5.0 |
| Min longitude for output window | 20.0 |
| Max longitude for output window | 350.0 |
| Number of smoothing operations for windshear | 3 |
| Write threshold array to NetCDF file if TRUE | False |
| Write lat/lon of thrsh=1.0 locations if TRUE | True |
| Number of threshld combinations | 1 |
| 850 OWZ | 50.0 |
| 500 OWZ | 40.0 |
| 950RH | 70.0 |
| 700 RH | 50.0 |
| 850-200 shear | 25.0 |
| SH 950 | 10.0 |

Table 3 Threshold Configuration for SH

## input\_thrsh\_NH

This configuration file is used as an input by thrsh.py to detect TC in NH

|  |  |
| --- | --- |
| Min latitude for output window | -5.0 |
| Max latitude for output window | 60.0 |
| Min longitude for output window | 20.0 |
| Max longitude for output window | 350.0 |
| Number of smoothing operations for windshear | 3 |
| Write threshold array to NetCDF file if TRUE | False |
| Write lat/lon of thrsh=1.0 locations if TRUE | True |
| Number of threshld combinations | 1 |
| 850 OWZ | 50.0 |
| 500 OWZ | 40.0 |
| 950RH | 70.0 |
| 700 RH | 50.0 |
| 850-200 shear | 25.0 |
| SH 950 | 10.0 |

Table 4 Threshold Configuration for NH

## data\_info\_file

This is the configuration file used as an input by tracker.py

|  |  |
| --- | --- |
| **Description** | **Value** |
| Longitude increment (degrees) | 1.0 |
| Latitude increment (degrees) | 1.0 |
| Time increment (hours) | 12.0 |
| Minimum number of neighbouring events for a clump to be considered | 2 |
| Minimum number of True links before TC declared | 5 |
| Minimum number of sea points to make a land influenced clump True | 2 |
| Topography value above which grid point is considered land (m) | 0.09 |
| Search factor to determine links in CT strings (km) | 550.0 |
| TH\_OWZ850 = Overriding thresholds | 60.0 |
| TH\_OWZ500 | 50.0 |
| TH\_rh950 | 85.0 |
| TH\_rh700 | 70.0 |
| TH\_wsh | 12.5 |
| TH\_sh950 | 14.0 |

Table 5 Tracking Configuration

# Usage

## Pre-process Data

The OWZ tracker expects the data to be of following format:

* Convert data into 1x1 Degree
* Script need 5 levels i.e. 950, 850, 700, 500 and 200
  + Set index of these levels in the owz\_tracker.py script. By default, it assumes that levels are in ascending order (ERA5 data is in ascending order) i.e. 200,500,700,850 and 950 and code will automatically rearrange them in descending order i.e. 950, 850, 700, 500 and 200
* Variable Names & File Name:

The script assumes that data has following file name format and variable names in NETCDF file.

|  |  |  |
| --- | --- | --- |
| Data | Variable name  (NETCDF) | File name |
| Relative Humidity | rh | RH\_{year} *e.g. RH\_1979* |
| Specific Humidity | mrsh | SPFH\_{year} *e.g. SPFH\_1979* |
| Temperature | temp | TEMP\_{year} *e.g. TEMP\_1979* |
| U Wind | uwnd | UWND\_{year} *e.g. UWND\_1979* |
| V WInd | vwnd | VWND\_{year} *e.g. VWND\_1979* |
| Level | lvl |  |
| Latitude | lat |  |
| Longitude | lon |  |

Table 6 Variable names and filenames

* In case of ERA5 and CERA, values of RH, SPFH etc. are in short/byte format, which need to be converted to float
* Latitude needs to be from -90 to 90 (By default it was in reverse order in ERA5 and CERA dataset i.e. 90 to -90)

## Run Tracker

To run the tracker, execute python script with following

**python owz\_tracker.py -i <input directory> -o <output directory> -f <year from> - t <year to>**

### Parameters

The script accepts following parameters:

|  |  |
| --- | --- |
| -i | Specify location of input data |
| -o | Specify location of output directory |
| -f | Starting Year |
| -t | Ending Year |

Table 7 Command line parameters for owz\_tracker.py

### Example:

To run tracker on NH and SH of ERA5 data execute following command:

**python owz\_tracker.py -i /var/climatenas/ERA5/OWZ\_Tracker/data -o output/ -f 1979 - t 1982**

Above script will process the input data from 1979 and 1982 and save results for NH and SH in the output directory

## Test Sample Data

To run tracker on sample pre-processed data use following data,

type --test followed by directory path of sample data “owdata”

for example:

**python owz\_tracker.py --test sample\_data/**

If data is in same directory write --test followed by dot “.”:

**python owz\_tracker.py --test .**

**Citation**

If using the code, or any part of it, please acknowledge the following papers:

* Tory, K. J., R. A. Dare, N. E. Davidson, J. L. McBride and S. S. Chand, 2013: The importance of low-deformation vorticity in tropical cyclone formation. Atmospheric Chemistry and Physics, 13, 2115-2132.
* Tory, K. J., S. S. Chand, R. A. Dare, and J. L. McBride, 2013: The development and assessment of a model-, grid- and basin-independent tropical cyclone detection scheme. Journal of Climate, 26, 5493-5507.
* Tory, K. J., S. S. Chand, R. A. Dare, and J. L. McBride, 2013: An Assessment of a model-, grid- and basin-independent tropical cyclone detection scheme in selected CMIP3 global climate models. Journal of Climate, 26, 5508-5522.
* Tory, K. J., S. S. Chand, J. L. McBride, R. Dare and H. Ye, 2013: Projected changes in late 21st century tropical cyclone frequency in 13 coupled climate models from the Coupled Climate Model Intercomparison Project. Journal of Climate, 26, 9946-9959.