

Eulerian Storm Track

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Description

Synoptic variability in the atmosphere can be isolated by filtering atmospheric data temporally, in a manner that removes the diurnal and the greater than weekly variability (Blackmon et al. 1976). Then, the standard deviation of the filtered data at each latitude and longitude can be interpreted as the climatological baroclinic wave activity, which, for historical reasons, is termed the storm tracks (Wallace et al. 1988). Because these storm tracks are calculated for each latitude-longitude point using time-series data, rather than tracking individual storms, they are sometimes referred to as the Eulerian storm tracks – as opposed to the Lagrangian storm tracks. The storm tracks are a large-scale metric for the skill in the model representation of baroclinic wave behavior – which includes extratropical cyclones. Storm track location, seasonality and intensity correlate very strongly with transient poleward energy transport (Chang et al. 2002).

Storm tracks can be evaluated with atmospheric data such as meridional wind or geopotential height (see Chang et al. 2002 for a comparison of many different fields). Booth et al. (2017) show that storm track strength – defined as the area-average of the storm track over an ocean basin, using meridional winds at 850 hPa correlate very strongly with the storm track at 500 hPa. This is true for interannual variability and for a comparison across multiple models. Therefore, the metric in this diagnostic calculates the storm track using meridional winds at 850 hPa. The nomenclature and calculation follow that of Booth et al. (2017).

To isolate the synoptic timescale, this algorithm uses 24-hour differences of daily-averaged data. Using daily averages removes the diurnal cycle and the 24-hour differencing removes variability beyond 5 days (Wallace et al. 1988). After filtering the data to create anomalies, the variance of the anomalies is calculated across the four seasons for each year. Then the seasonal variances are averaged across all years. For the first year in the sequence, the variance for JF is calculated and treated as the first DJF instance. For the final December in the sequence is not used in the calculation.

The maximum strength of the Eulerian storm track can be sensitive to the data's spatial resolution. To exemplify this fact, we have included the map view of the storm track using ERA-Interim and ERA5 reanalysis data at two different resolutions (1.5° horizontal resolution for ERA-Interim data and 1° resolution for ERA5 data). For this reason, we do not include a difference plot of the lat/lon storm track maps. Instead, for a side-by-side comparison, we have generated a zonal mean of the storm tracks.

Version and Contact Information

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Functionality

The following are the codes in the POD.

Eulerian_storm_track.py is the main driver code.

Eulerian_storm_track util.py is the code that computes the statistics.

plotter.py is the code used to create the plots.

Eulerian_storm_track_obs.py is an internal code used to preprocess the observations and convert them to NetCDF files.

Required programming languages and libraries

This package is run using Python 3, and requires the following Python packages

- os
- numpy
- xarray
- netCDF4
- matplotlib
- cartopy
- basemap

Required model output variables

The following 3D (time, lat, lon) model fields are required:

- V850 (units: m/s, daily)

References

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