Data and methods for RSTs algorithm

The purpose of the developed algorithm is to find and classify RSTs at a given point in time, based on meteorological data supplied by any reanalysis or model output. To achieve this goal, the following steps are executed in order: input processing, SLP based troughs locating algorithm, RST conditions check and finally RST classification.

Input processing

To permit input data from different sources, data is first interpolated to a 0.5°X0.5°. This interpolation brings the different input resolutions to a common base. It also allows finding RSTs at a resolution which is best for further inspection, such as for the classification step of the algorithm.

However, before the data is interpolated, the geostrophic vorticity field is calculated and only then interpolated. The reason behind being keeping the original data for calculations and only interpolating the final results for the RSTs 0.5° grid. The geostrophic vorticity is calculated according to the following equation:

SLP based troughs locating algorithm

The algorithm seeks for initial local SLP minima, which can lead to a full RST, inside the following area: 27.5°N - 30°N (31°N?) and 30°E – 42.5°E. A grid point is considered such a local minimum if it has a lower SLP value than both its neighboring grid points. Neighboring grid points are examined in 3 axes: North-South, East-West and North-West to South-East, at a distance of ~1.5° from the tested grid point.

If a local minimum is found, the algorithm looks for a local minimum in its immediate neighborhood (which is not to the south of it and must have a higher SLP value) that may be the next point in the trough. As long as such minima are found, the algorithm keeps looking further for possible next points in the trough. When none is found, i.e., the trough ended, the grid points that were recorded along the way are considered a trough.

It is very common for many troughs to be found at different, yet close, starting points, which converge into one trough eventually. These are considered one trough and its path is considered as the longest trough found that shares at least one grid point with other found troughs. This way the algorithm clears each map from multiple converging troughs and leaves only 0-3 troughs most of the time (often only 0-1).

RST conditions check

Considering a trough as an RST requires certain conditions to be met. The first of which is a descending SLP gradient from North to South over the Levant region, and the second is a positive average geostrophic vorticity over another overlapping region. For the SLP gradient, the algorithm calculates the average SLP within two areas: 31°N - 35°N, 33°E – 37°E and 27°N - 31°N, 33°E – 37°E. If the first value is higher than the second, the SLP gradient condition is met. The geostrophic vorticity average is calculated over 29°N – 33.5°N, 32.5°E – 37.5°E. If it is positive, the condition is met.

RST classification

In this step each separate trough found earlier is classified as one of the following classes: No RST, RST with an Eastern axis, RST with a central axis or RST with a Western axis.

If one or both RST conditions are not met, all troughs at this point of time are classified as No RST. If the conditions are met, the algorithm focuses on the following region: 30°N – 33.5°N, 32.5°E – 37.5°E. A trough that does not pass through this region is classified as No RST. A trough that is found only in the Eastern (Western) half of the region is classified as an RST with an Eastern (Western) axis. A trough that crosses between the two halves of the region is classified as an RST with a central axis.

Data used

To test and tweak the algorithm, data was taken from the ERA-Interim reanalysis (Uppala et al., 2005; European Centre for Medium-Range Weather Forecasts, 2009; Dee et al., 2011) with 0.75°X0.75° and 2.5°X2.5° spatial resolutions, and from the NCEP/NCAR reanalysis archive at a 2.5°X2.5° spatial resolution (Kalnay et al., 1996; Kistler et al., 2001). The study period corresponds to the availability of the ERA-Interim data, i.e., 1979-2016. The data was taken for this region: 20°N - 50°N, 20°E – 50°E.