AUTOMATIC IDENTIFICATION AND CLASSIFICATION OF RED SEA TROUGHS

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Introduction

The Red Sea Trough (RST) is a low-pressure system extending from south toward the Eastern Mediterranean (EM) and further to the Levant. RSTs are most frequent in the fall and the winter, fading out by mid-spring. This system is the most frequent among all easterly troughs, which extend from the east African Monsoon toward the EM, and is attributed to the lee effect of mountain ridges east of the Red Sea.

Our algorithm aims at explicitly identifying RST days and classifying them as one of three types, according to the location of the trough axis; to the west, east or over Israel.

The fully automated system is not tailored to a predetermined spatial resolution, so it is applicable to a variety of reanalysis datasets, operational forecast model results and climate model outputs.

Methodology

The following steps are executed in order: input processing, SLP based troughs axis locating algorithm, required RST necessary conditions check and, finally, RST classification.

Input and pre-processing

To permit input data from different sources with various resolutions, data is first interpolated to a common basis, i.e., grid of 0.5°X0.5° resolution. Such an interpolation of the SLP data was found optimal for identifying and locating the trough axis.

Locating the trough axis

The algorithm seeks for an initial local SLP minima, which can be regarded as the core of an RST, extending northward.

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). As long as such minima are found, the algorithm keeps looking further for the next points in the trough.

Conditions for RSTs over the Levant

A few conditions were specified to be met, if the day is identified as an RST day:

The 'SLP gradient' condition, i.e., the SLP decreases from north to south across the Levant region.

The 'vorticity condition', i.e., the geostrophic vorticity over the region of interest is positive.

The third condition is that no Sharav Low or an Eastern Low exists in the area.

The last condition is obviously finding at least one RST trough axis.

Final RST classification

If the conditions above are met, the algorithm focuses on classifying the RST according to its relative location to the region of interest.

If more than one axes exist for a given day, all axes receive a Geostrpohic Vorticity score (GV score) and the one with the highest GV score is selected as the RST axis for that day.

A GV score is the total of GV values in each grid point along the axis.

The classification of the selected RST axis is the final classification for the input map.

Results

An evaluation of the automatic classification, done for randomly selected 200 days, showed that in 96% of them the subjective classification is similar. For 100 days, identified subjectively as RSTs, the automatic classification agreed on 85%.

Climatological aspects of the RST

The distribution of RST days along the year is presented below:

A distinct shift in the RST axis was noticed between day and night. The day time axes were tilted towards the east, while night time axes were centered over Israel.

Conclusions

The identification methodology proposed here is an 'explicit' one. It is not intended for a general synoptic classification but rather focuses on one important class.

The algorithm was shown to identify and classify RSTs at a high rate of success and is intended to use with multiple input sources.

This methodology will be important in future researches as exemplified by the results shown above.