Trajectories of Cyclones Bringing Precipitation to Turkey

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Abstract

Cyclones are systems that control weather conditions every day in many places of mid-latitudes. The purpose of this study is identifying the trajectories of cyclones that brings precipitation to Turkey. This study is carried out by using The University of Melbourne automatic cyclone tracking software [1] [2] and The National Centers for Environmental Prediction (NCEP) the Department of Energy (DOE) Reanalysis 2 mean sea level pressure (MSLP) field. The software searches minimum pressure in a certain region to locate the low centres. The cyclone positions are predicted and the algorithm looks for relation between original center and predicted ones. Linking is achieved by selecting the most likely candidate.

Introduction

Most of the precipitation are occured in cyclones and their associated fronts in the mid-latitudes. Once they arise it takes time for them to develop and it takes time to die away. When they become mature they cover large areas and affect people and the environment by creating risky events such as flash floods, large-scale floods or vigorous hail. Large-scale flood in Europe June 2013 can be given as an example of the risky events. Therefore, it is very important to know where the moisture source comes to Turkey. This project is achieved in two steps:

- Identifying the location of cyclones through the Laplacian of pressure.
- Linking cyclones based on identifying procedure.

Data and Methodology

Data

This study is conducting using 6-hourly (0000, 0600, 1200, 1800 UTC) NCEP/DOE Reanalysis 2 mean sea level pressure (MSLP) field at 2.5° x 2.5° spatial resolution for a region between 15W - 60E and 20N - 60N for 38 years (1979 - 2016).

Identification Procedure

The climatology of cyclones are described objectively by The University of Melbourne automatic cyclone tracking software [1] [2]. First step of this procedure is to interpolate the MSLP field to 101 x 101 polar stereographic (PS) array through bicubic spline interpolation. Also, field is smoothed since high resolution data causes a lot of spurious low center.

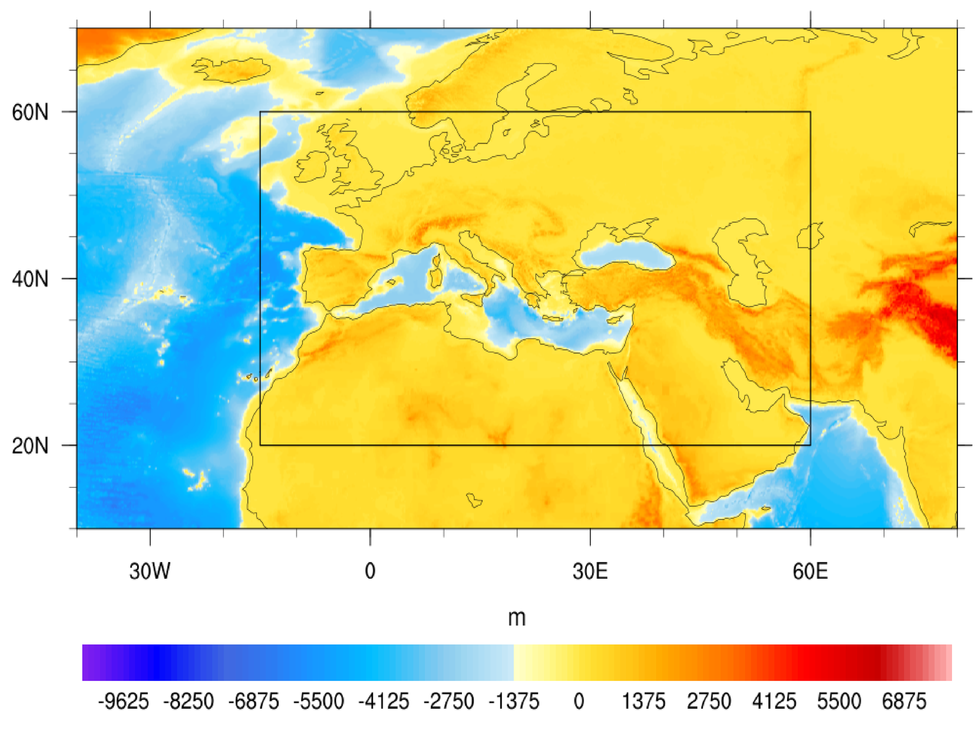

Figure 1: The search domain with the topographic elevations.

Several search control and strength criteria instruction parameters are set to consider the cyclones strong as second step. Finally, maximum values of the Laplacian of pressure are searched in 8 surrounding grid points over the whole domain. When a closed depression is not found, the search begins for open depressions.

Tracking Procedure

The software estimates the location of future low center for each defined low center based on identification results. Linking the cyclones depends on their velocities. Identified cyclones are around the estimated location in the next time step and an association is sought between predicted ones and defined centres and the best candidate is chosen for linking.

Parameter	NCEP 2	Description
nshell	8	number of surrounding gird points for searching
difti1	0	minimum distance between 2 systems (grid units)
cvarad	2	Radius around centre over which average the Laplacian of the pressure is found (deg.lat.)
cmnc1	0.1	minimum area averaged Laplacian for closed depressions ($hPa/deg.lat^2$)
zsmax	1000	maximum topographic height for finding cyclones (m)
rdpgrg	5	averaging radius for MSLP derived steering
rcprob	12.5	maximum pass radius for probability function (deg.lat.)

Table 1: Instruction parameter definitions and settings for cyclone identification and tracking procedures.

Results

Cyclone tracking is divided into seasons to see interseasonal variations. To see the strong cyclones that bring precipitation to Turkey, cyclones that survived 3 and more than 3 days are represented. As it is seen in Figure 2 - 5, cyclogenesis in Gulf of Genoa and northern Italy regions play major role for all seasons [3].

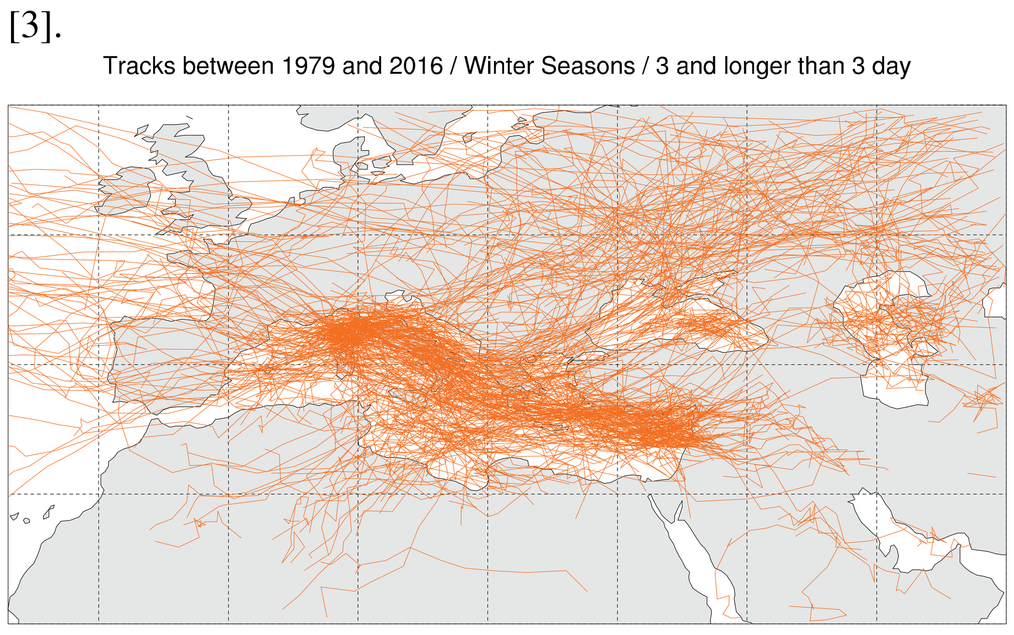

Figure 2: Winter seasons between 1979 and 2016.

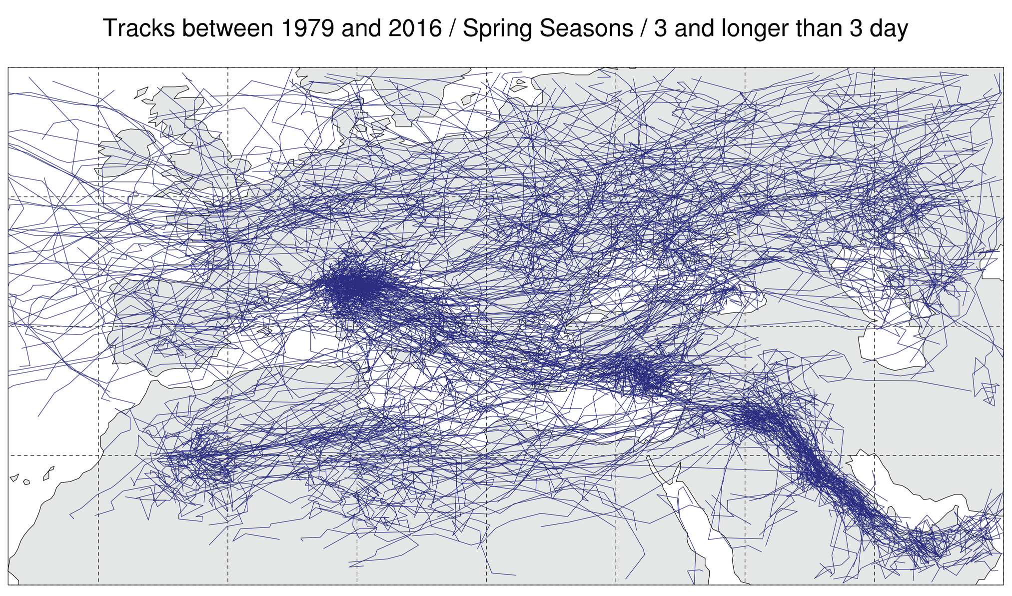

Figure 3: Spring seasons between 1979 and 2016.

In winter seasons, Turkey is also affected by southern Italy, the Aegean Sea and the Black Sea cyclones other than Gulf of Genoa and northern Italy cyclones. Sahara, Cyprus, the Aegean Sea, and the Black Sea are cyclogenesis regions in spring seasons. In addition to these, the Aegean Sea and Sahara cyclones have reduced impact on Turkey towards summer seasons.

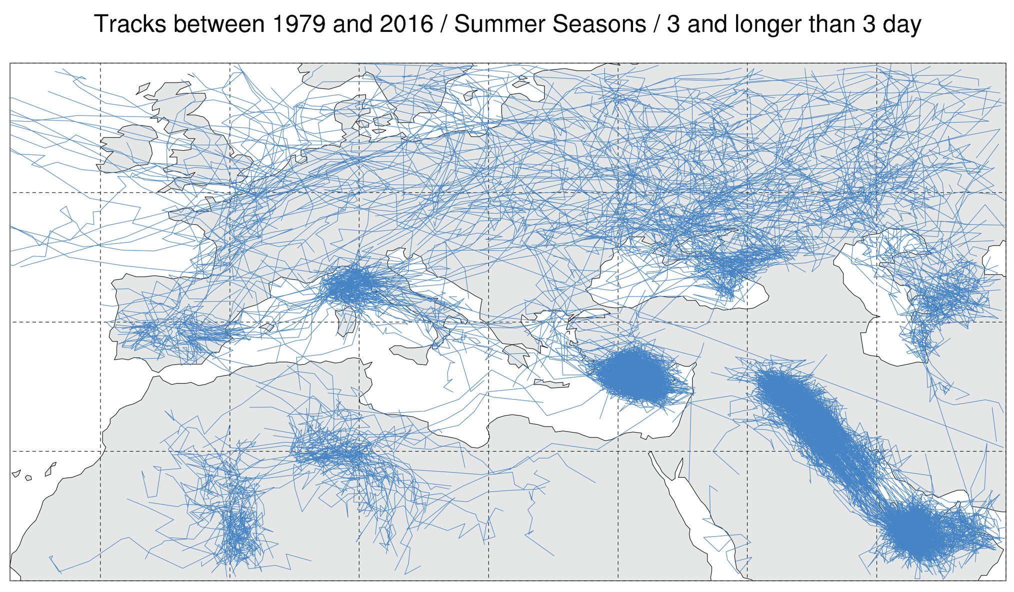

Figure 4: Summer seasons between 1979 and 2016.

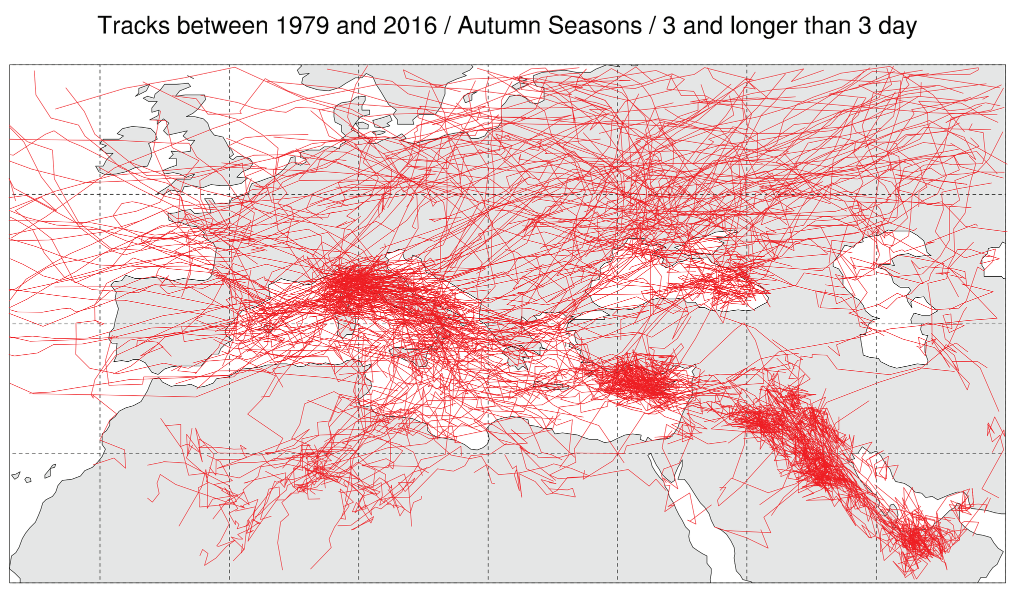

Figure 5: Autumn seasons between 1979 and 2016.

Cyclones of Cyprus and the Black Sea have high intensity in summer season. In autumn seasons, cyclones of Sahara, Cyprus, and the Black Sea become pronounced. These regions are the major cyclogenesis regions which bring precipitation to Turkey.

Conclusions

The climatology of the cyclones that come to Turkey from different regions. The results show that the cyclones affecting Turkey are primarily westerly and that they follow a more southerly trajectory in winter but their trajectory shifts northward towards summer.

Forthcoming Research

The use of the cyclone tracking software with other data sets with different spatial and tempral resolutions and determination of differences between them.

References

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