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On the characteristics of atmospheric circulation associated with snowfall in NW Greece

E. E. Houssos, C. J. Lolis, and A. Bartzokas

Laboratory of Meteorology, University of Ioannina, Ioannina, Greece (ehoussos@otenet.gr)

In this work the main atmospheric circulation types, associated with snowfall events in NW Greece, are examined. Also, a validation procedure is followed in order to investigate to what extent the circulation types revealed are related with snowfall in NW Greece.

For this purpose, two datasets are used. The first one consists of 6-hourly values of mean sea level pressure, temperature at 850hPa level and 500hPa height in 273 grid-points covering Europe and the Mediterranean, for the 45-year period 1/9/1957 to 31/8/2002. The second one comprises all the 6-hourly observations at the meteorological station of Ioannina (NW Greece).

From the first dataset and for each meteorological parameter a data matrix is constructed consisting of 65,744 rows and 273 columns. Each column represents the time series of the parameter at each grid point and each row represents the space series (map) of the parameter at the time of each observation (4 observations per day for the 45-year period). Then, a new matrix is created by merging the matrices of MSL pressure, T-850hPa and Z-500hPa in a united matrix of 65,744 rows x 819 columns. In this way, each row represents the 3-dimensional structure of the atmosphere (based on the 3 parameters used) at the time of each observation. Next, Factor Analysis is applied on this united matrix in order to reduce the dimensionality of the data set. The 819 columns are reduced to 8 (uncorrelated Factors), describing satisfactorily the 3-dimensional structure of the atmosphere, as they explain approximately 86% of the total variance.

From the second data set the observations reporting snowfall in Ioannina are found out and then a new data matrix is constructed consisting of the Factor scores rows corresponding to these observations only. In the new matrix (235 rows x 8 columns) each row describes the structure of the atmosphere over Europe and the Mediterranean in the cases of snowfall in Ioannina.

Cluster Analysis (K-Means) is applied in this final matrix in order to objectively classify the 235 atmospheric structures associated with snowfall in Ioannina (NW Greece) into 9 homogeneous and distinct clusters. The optimum number of clusters is decided by using the “Jump” method, first described by Sugar and James. For each cluster the mean maps of the initial 3 meteorological parameters (MSL pressure, T-850hPa and Z-500hPa) are constructed revealing the main characteristics of the atmospheric structure during snowfall events in NW Greece. According to the main results, snowfall in NW Greece is associated with a low pressure system around Greece combined with an anticyclone over W or NW Europe, causing cold northwesterly flow over NW Greece. In the upper atmosphere, a deep 500hPa trough usually extends from W Russia to Italy and the Ionian Sea. The main differences among the 9 atmospheric structures revealed are found in the exact location of the centres of the low pressure system and the anticyclone and the exact direction of the trough axis.

The final stage is an attempt to investigate whether a situation similar to one of the 9 atmospheric structures, causes snowfall in NW Greece. For this reason all the available meteorological maps were compared to the 9 created mean maps (in fact each case consists of a set of 3 maps, viz. MSL pressure, T-850, Z500). The comparisons were made by calculating the correlation coefficient between the space series of the anomalies of each case with the space series of the anomalies of the 9 mean maps. It was found that a considerable number of cases without snowfall in Ioannina are correlated well with the maps of snowfall. This can be explained by the fact that there are very many cases just before or just after snowfall in Ioannina which present an atmospheric structure very similar with the one during snowfall. Also, a couple of degrees of temperature difference may confine snowfall in higher altitudes and cause rainfall in Ioannina. Finally, it is obvious that the results would be more accurate if more meteorological parameters were used in the analysis.