The hierarchical clustering of eastern Mediterranean daily weather into mesoscale circulations

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The Synoptic Meteorology has long-time considered the weather succession as a random process, focusing the analysis merely on their daily maps pattern rather than on their dynamics. Long-term observations, suggest that the weather dynamics is not completely random. To proof this hypothesis, the daily weather was retrodicted (backward predicted) from the computerized climatological archives applying the Multivariate Statistical Analysis. Assuming the weather-states emerging, developments and decaying as similar processes of any birth, growth and death natural system, and their internal information, embedded into their history, than, these are determining also the climate evolution according to not yet known laws.

A weather type is a surface-upper atmosphere equilibrium state-variable related to the upper-scale circulation that integrates most of meso-δ (cloud, urban effects etc) and part of meso-α influences (Orlansky, 1975), modulated by meridional/zonal oscillations and controlled by the Solar cycles. According to the System Theory, the present states evolves from the former and evaluate to the future, being represented by daily sets of dots (or vertices) that connects the discrete states (WT_t, t= 1, 2,...N), as Graphs (in the sense of Koenig) and Marcov chains of different lags, l, ($M_t x M_{t+l}$; l=0,1,2,...NL). Their succession follows "preferences" expressed by the matrix symmetry, reflexivity and transitivity, leading toward a climatic “pre-order” state. The "pre-order" is determined by the three proprieties of the matrix: a) *Combinatorial* - i.e., combination of preferred successions, b) *Stochastic* - i.e., continuous dynamic discrete processes, represented by daily random variables families (ξ_t, $t \epsilon T$, where, t, is the time crossing the T interval with respect to the anterior events (Gabriel and Neumann, 1962), toward weather cycles, and, c), *Competitions* - i.e., mutual relations between cyclones and anticyclones. In this frame, the "Circulation types" represent complex pressure systems (Lows, Highs) of directional oriented location.

Cluster Analysis (CA) was applied as an exploratory tool to divide the statistical sample into homogenous-specific groups. The source of their informational input is unrelated to previous structures, except these imposed by the clustering model, Three algorithms were experimented, each providing specific information: (i) the K-MEANS CLUSTER PARTITIONING, that split-on the sample into a pre-established number of clusters, (ii), the NORMAL MIXTURE that adapts the K-means procedure to overlapped composed distributions, and, (iii), the HIERARCHICAL, applied in the present

study, split-on and combine the matrix rows in a decreased nested class number of a dynamic tree structure hierarchical sequence.

The analysis starts by transforming the daily vector of weather (WT_t, t=1,2,3....10724) into the matrix Wtj, (t=1,2...19724; of j=1,2, ...19) of binary states (0,1) and the building of specific dendogram by applying the Hierarchical Clustering. This uses the similarity/dissimilarity between the rows proximities (similar weather of zero dissimilarity), related to the Non-Parametric (Spearman Rho) correlation. The dissimilarity derived by Euclidian method, converts the correlations into inter-distances d (i,j), used to plot the edges of the daily weather into sub-branches, branches, sub-clusters and clusters. The gradual fusing integrates the weather states into branches, winter and summer seasonal circulations', creating coalitions of weather cycles. Noting by N, the weather states, number, than their monthly similarity/dissimilarity pairs ($[N\ (N-1)/2]$=171) concatenate into hierarchical levels, defined both as "ante" or "posterior" connexions, i.e., (positions) direction into the dendogram hierarchy.

To reduce the enormous volume of computations, the daily 18724 rows were summed-up into a monthly matrix (648, 12), representing 54 years (34 $\times$ 12 months = 648 rows). From the multitude of experiments, we will describe and interpret the dendogram connexions of the Eastern Mediterranean weather into branches, cycles and circulation obtained by a time ordered agglomerative hierarchical model.