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Objective local weather types with applications on urban air pollution and on mortality with chronicle illnesses

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Synoptic climatology i.e. classification of the endless variability of the everyday weather states according to the pressure configuration and frontal systems relative to the point, or region of interest has long history in meteorology. Its logical alternative, i.e. classification of weather according to the observed local weather elements was less popular until the recent times when the numerical weather forecasts became able to outline not only the synoptic situation, but the near-surface meteorological variables, as well. Nowadays the computer-based statistical facilities are able to operate with matrices of multivariate diurnal samples, as well.

The paper presents an attempt to define a set of local weather types using point-wise series at five rural stations, Szombathely, Pécs, Budapest, Szeged és Debrecen in the 1961-1990 reference period. Ten local variables are used, i.e. the diurnal mean temperature, the diurnal temperature range; the cloudiness, the sunshine duration, the water vapour pressure, the precipitation in a logarithmic scale, also differing trace (below 0.1 mm) and no precipitation, the relative humidity and wind speed, including the more extremity indicators of the two latter parameters, i.e. number of hours with over 80 % relative humidity and over 15 m/s wind gusts. Factor analysis of these ten variables was performed leading to 5 fairly independent variables retained for cluster analysis to obtain the local weather types. Hierarchical cluster analysis was performed to classify the 840-930 days within each month of the 30 years period. Furthers neighbour approach was preferred based on Euclidean metrics to establish optimum number of types. The 12 months and the 5 stations exhibited slightly different results but the optimum number of the types was always between 4 and 12 which is a quite reasonable number from practical considerations. According to a further reasonable compromise, the common number of the types not too bad in either stations or months defines that the common optimum number of local weather types is nine.

This set of weather types, specified for each station, was used to “explain” the possible portion of local inter-diurnal variance of seven daily urban air quality measurements, i.e. CO, NO, NO2, NOx, O3, SO2 and PM10. Another set of data for testing the types are the mortalities with chronicle illnesses, i.e. cardio-vascular and respiratory illnesses. This set of 35 years data (1971-2005) is layered for capital city (Budapest, 2 million inhabitants) and rest of the countries (max. 200 000 inhab.).

The use of complex weather types is likely better than the common use of individual weather elements, e.g. diurnal mean temperature or a kind of bioclimatic index. The ability of the types to decrease the variability is also compared for both sets of target variables to the analogous ability of macrosynoptic classification by Peczely. The results are also discussed by grouping the investigated contaminants according to their origin.