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Daily rainfall in Israel – statistical model based on synoptic scale predictors

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The geographical location of Israel with respect to the global climatic belts together with its topographical heterogeneity implies high spatio-temporal variability of the rainfall regime. However, this regime is dominated by the Cyprus low, contributing 90% of the annual rainfall. The daily rain totals and their spatial distribution are determined by a combination of several factors. These are the location and intensity of the pertinent cyclone, the wind speed and direction, the vertical temperature profile and the timing with respect to the rainy season. The final outcome is also influenced by the local topographical posting. The variance in the daily rainfall explained by synoptic-scale factors may be limited due to the convective nature of the rain in Israel.

This study examines the statistical relationship between atmospheric variables in the synoptic-scale and the daily rainfall in the rainiest months, i.e., December – February (DJF), in which 60-70% of the annual amount is obtained. The analysis is based on multi linear regression between the atmospheric variables at 12UTC, taken from NCEP/NCAR reanalysis, and the daily rainfall for four regions in Israel: the coast and mountains in the northern and central parts of the country. Prediction equations were derived for each region and month separately, based on 1,000 rain days.

The synoptic-scale variables were found highly correlated with the daily rainfall (R = 0.71-0.87) explaining 50%-76% of the inter-diurnal rainfall. The relatively lower correlations were found in the coastal regions, in which the rain is, indeed, more convective than in the inner-mountain regions. The atmospheric variables found most important are the 500-hPa geopotential height and the 1000-hPa vorticity. Since the 500-hPa geopotential height is a mixture of dynamic and thermodynamic factors, we excluded it from the regression. Then, the mid-troposphere temperature and the lower-levels zonal and meridional wind components, expressing moisture transport, were found also significant predictors. The composition of the predictors explaining the daily rainfall in various regions was most similar, but their importance hierarchy differed. For example, the temperature, indicating the dominance of the instability, was the most important in the coastal area, whereas in the mountain regions the wind components were the most important. The methodology developed can be used for rain prediction based on gridded data offered by forecasting models and climate models.