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'Environment to Climate' approach in synoptic climatology research: the example of a new synoptic classification based on climatic stress index

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Synoptic climatology deals with the relationships between atmospheric circulation and local climates, which, in turn affect the environment. Most synoptic classifications adopt the 'circulation (climate) to environment' approach. Others, perform atmospheric circulation classification for a particular environmental phenomenon, defined as 'environment to circulation (climate)' approach (Yarnal 1993). However, there is no unique classification method being the best (Huth et al. 2008).

The Levant region is characterized during the summer season by one dominating synoptic system, the Persian Trough, accompanied by persistent heat stress conditions. Accordingly, the current synoptic classifications, based on the 'circulation to environment' approach (Dayan et al. 2002, 2012; Alpert et al. 2004), lack the ability to reflect inter-diurnal variations in the local weather conditions. In order to overcome this weakness, an alternative synoptic classification, based on an index that reflects the climatic stress, was developed, demonstrating the 'environment to circulation' approach. The atmospheric variables from which the Climatic Stress Index (CSI) was constructed were found through derivation of two prediction equations, one for the national heat-stress (NHS) and the second for the height of the marine inversion (IB), which delineate the Planetary Boundary Layer (PBL) in the summer. The potential predictors were comprised of atmospheric variables found correlated with these weather attributes, together with indices representing synoptic to large-scale features, derived from composite maps extracted for days with extreme values of these weather attributes. The spectrum of the calculated daily CSI values was divided into three parts of equal size, used as the basis of the new synoptic types, defined as: 'comfort,' 'medium,' and 'discomfort.' The attribution of a certain day to one of these types is determined according to its calculated CSI. Our proposed classification was found to better delineate the NHS and the height of the IB in Israel.

Applying the CSI classification on local summer particulate matter (PM) concentrations revealed that an increase in daily PM, especially of PM2.5, is positively correlated with the CSI. Since an increased CSI is associated with weaker Etesian winds and thinner PBL, it suggests that the local mechanism of removal pollution dominates over the synoptic-scale mechanism of remote pollution transport from southeastern Europe by the Etesian winds.

This synoptic classification and the prediction equations, which are downscaling schemes, are applicable for both operative weather prediction and for climate prediction. The latter enables the assessment of future trends in the climatic stress, in general and in heat stress, in particular. This is due to its being compatible with the output of operative weather prediction models as well as the format of the disseminated output of climate models. Future predictions of the climatic stress, based on predicted future synoptic conditions, will enable better adaptation and planning strategies.