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Modelling of atmospheric hazards and severe weather phenomena to Western Mediterranean basin coastal floods since 1960

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The main goal of this study is to present a methodological approach to improve synoptic classifications associated to basin coastal floods. A further step is done towards an objective reclassification of new events to improve and facilitate the task of flooding weather forecast.

In a recent study, we identified more than 3,600 cases of flood in the municipalities of the Spanish Mediterranean coast from 1960 to 2013, and analyzed synoptic patterns associated to them. A Principal Sequence Pattern Analysis was applied to sea level pressure, temperature at 850 hPa, geopotential at 700 hPa and 500 hPa (data provided by the 20th Century V2 Reanalysis Project). The methodology used is based on three steps: (1) Principal Sequence Component Analysis in S-mode, the scree-test to determine the number of components involved and Orthogonal Varimax rotation to minimise the number of variables with high factorial loadings; (2) Cluster Analysis to determine the main synoptic patterns associated with flooding activity in the study area using the non-hierarchical K-means and the hierarchical Ward clusters; and (3) Discriminant Analysis for validating the model. The results showed twelve Principal Sequence Patterns related to atmospheric convection associated with a trough in the middle levels of the troposphere, and to thermal forcing. Regional differences are modulated by a triggering effect due to local convergences.

Once the synoptic patterns were identified, the new flood time-series recollected for 2014 and 2015 have been reclassified from the component score coefficients matrix and Discriminant Fisher Functions of the reference period (1960-2013). The component scores were calculated from the following equation:

$A_{ij} = \Sigma B_{ik} C_{kj}$

Where A_{ij} is the score value at time i for the PCA component (j); B_{ik} is the variable at time (i) at the grid point (k); and C_{kj} is the component score coefficient at the grid point (k) and PCA component (j).

2) To classify new events, we used the Fisher discriminant functions:

$SP = max_t\{Z_t + \Sigma A_{jt} X_{jt}\}$

Where SP is the predicted synoptic pattern; Z_t is the constant coefficient of the Fisher discriminant function for the synoptic pattern (t); A_{jt} is the score value of the PCA component (j) for the synoptic pattern (t); and X_{jt} is the Fisher function coefficient for the PCA component (j) and the synoptic pattern (t).

In comparison to other techniques, the method applied in this study obtains the discriminant functions that can be applied to reclassify a classification, as we did in this study, or to classify flood events in the future. Consequently, in a Meteorological Service, this tool could be an operational system for classifying any flood synoptic pattern for a period of 6-hours and delimiting the more likely flooding areas for the studied region.