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Spatial and seasonal characteristics of cold-air pools in the upper Zêzere valley (Serra da Estrela, Portugal)

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Occurrence, formation, spatial patterns and intensity of cold air pools/lakes were studied in the Serra da Estrela (40º 20'N 7º 35'W, 1993m, Central Portugal) from January to December 2000. Data was collected using a network of air temperature dataloggers installed at different topographic positions (interfluves, valley floors and slopes) recording at 2-h intervals. A k-means classification was applied to the dataset of instantaneous air temperatures, and 3 types of thermal patterns were identified. Type 1 (66% cases) shows events with decreasing air temperatures with altitude. Type 2 (27% cases) shows accumulation of cold air in the valleys with higher valley floors showing the lowest temperatures. Type 3 (7% cases) show accumulation of cold air, but with lowest air temperatures in the valleys at lower altitudes. Causal factors for the occurrence of the patterns were studied by applying discriminant analysis on meteorological and topographical variables. Type 1 occurs under atmospheric instability conditions, while types 2 and 3 relate to atmospheric stability. Types 2 and 3 are controlled by seasonality and local insolation/shadowing effects.
For the detailed study of cold air accumulations, two approaches were followed: the analysis of temperature differences between a station in a crest and a station in a glacial cirque floor; and, the analysis of 5-min interval temperature data along a transect in the Zêzere valley.The differences in air temperature between the glacier cirque floor (Covão Cimeiro, 1620m) and the crest (Cântaro Gordo, 1870m) were classified into 9 types of regime. Thermal inversions in the cirque were found in 6 types (48%). These are characterized in detail and the geographical and meteorological controlling factors are analyzed using one-way ANOVA and discriminant analysis. The 6 types show different daily regimes and inversion intensities, as well as a seasonal trend. The maximum inversion intensity was 9 ºC, and the minimum temperature -17 ºC at the cirque floor. Simultaneoulsy, the ridge showed -9 °C. Thermal inversions show atmospheric stability with low wind speed and low cloudiness. The sequence of patterns throughout the year is controlled by topographic factors and insolation at the cirque floor. The formation of thermal inversions in a NNE-SSW direction valley (Zêzere valley), their durationand dissipation were studied in detail during 5 days of atmospheric stability using air temperature recorded at 5-min intervals. During the day, air temperature decreased with altitude (-0.7 ºC/100m to -1 ºC/100m), and during the night, the valley floor showed lower temperatures than the mountain summit. During the night a thermal belt formed and the valley floor was 3 ºC colder than the top of the inversion layer. During the day there was an asymmetry in the distribution of temperatures along the valley controlled by solar radiation. Air temperatures ranged from -5 °C to 16 ºC.
The results show the effect of topography on air temperatures in situations of atmospheric stability and can be extrapolated to the mountains with similar climatic and topographic conditions. The identification of the shadowing effect induced by valleys and its impact on the maintenance of cold air lakes during the morning in the valleys of North-South orientation can be of special interest for planning and environmental impact studies.