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Seasonal Weather Forecast Biases Dependence on Static and Dynamic Environmental Variables in the Alpine Region

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Global seasonal weather forecasts have inherent biases compared to observational datasets over mountainous regions. This can be attributed to the model's inaccurate representation of local and global environmental processes on the Earth. In this context, the objective of this study is to assess the variation of seasonal weather forecast biases with respect to static and dynamic environmental variables over the Trentino-South Tyrol region (north-eastern Italian Alps), characterized by complex terrain.

The research employs the latest fifth-generation seasonal weather forecast system (SEAS5) dataset produced by the European Center for Medium-Range Weather Forecast (ECMWF), available at a horizontal grid resolution of 0.125° x 0.125° with 25 ensemble members in a re-forecast period from 1981 to 2016. The reference dataset is a high-resolution gridded observation (250 m x 250 m) over the region of interest. The spatiotemporal variation of monthly weather (i.e., precipitation and temperature) forecast biases over the region is inferred using several statistical indicators at observational dataset grid resolution. The static and dynamic environmental variables (i.e., respectively, terrain characteristics and large-scale atmospheric circulation indices) are used univariately to interpret their relationship with monthly weather forecast biases using the linear regression technique. A statistically significant linear relation between monthly weather forecast biases and terrain characteristics, as well as large-scale atmospheric circulation indices, has been found depending on seasonality and ensemble members.

Given significant univariate linear correlation, a simple linear bias reduction model is developed and assessed by implementing a random subsampling technique in which the regression parameters are simulated by splitting the data into calibration (70%) and validation (30%). The results reveal a reduction in the monthly weather forecast bias over the region.

This study demonstrates that the local and global environmental variables should be explicitly considered in the bias correction and downscaling of the seasonal weather forecasts over complex terrain.