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Statistical downscaling of temperature over the Euro-Mediterranean region: the role of sea surface temperature and soil moisture as additional predictors

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Reliable regional climate simulations are important for devising appropriate mitigation and adaptation strategies at regional to local scales. General circulation models in conjunction with dynamical or statistical downscaling provide such fine-scale analytics. With respect to statistical downscaling the downscaled climatic output is mostly derived without considering important land-atmosphere and sea-atmosphere dynamics. However, the systematic representation of land and sea surface conditions within statistical downscaling can complement to narrow the uncertainties and can aid to better understand and simulate regional climate. In addition to commonly used atmospheric predictors, the additional variables sea surface temperature and soil moisture are systematically introduced in a statistical downscaling framework to infer additional insights and simulation gains. The study focusses on temperature over the Europe-Mediterranean region as predictand.
The daily E-OBS mean temperature data is subjected to S-mode principal component analysis (PCA) with Varimax rotation in order to achieve a temperature regionalization. The chosen predictors include large-scale pressure variables (geopotential heights), thermo-dynamical variables (specific and relative humidity) and slower-evolving sea surface temperature (SST) and soil moisture (SM) variables. Similarly, the predictor data is also subjected to PCA for dimension reduction.
As a first step, statistical models separately containing large-scale atmospheric circulation, thermo-dynamic variables, SST, and SM are developed. A robust model development process is ensured by minimizing root mean squared error (maximizing root mean squared error skill scores) within a cross validation framework with 1000 random iterations. Subsequently, statistical models with combinations of the different predictor variables are developed and compared. In this context, various lagged settings for SST and SM are also evaluated. Consequently, the overall and region specific additional influence of the two predictors SST and SM are assessed for each season over conventional atmospheric models.