A Hierarchical Multivariate Spatio-Temporal Model for Clustered Climate data with Annual Cycles

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Abstract

We introduce a Bayesian multivariate hierarchical framework to estimate a space-time process model for a joint series of monthly extreme temperatures and amounts of rainfall. Data are available for 360 monitoring stations over 60 years, with missing data affecting almost all series. Model components account for spatio-temporal correlation and annual cycles, dependence on covariates and between responses.

Spatio-temporal dependence is modeled by the nearest neighbor Gaussian process, response multivariate dependencies are represented by the linear model of coregionalization and effects of annual cycles are included by a circular representation of time. The proposed approach allows imputation of missing values and interpolation of climate surfaces at the national level. It also provides a characterization of the so called Italian ecoregions, namely broad and discrete ecologically homogeneous areas of similar potential as regards the climate, physiography, hydrography, vegetation and wildlife. To now, Italian ecoregions are hierarchically classified into 4 tiers that go from 2 Divisions to 35 Subsections and are defined by informed expert judgments. The current climatic characterization of Italian ecoregions is based on bioclimatic indices for the period 1955-2000.