Editorial of Special issue on Climate and Environment

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This special issue (SI) has its roots in the scientific discussion on climate and environment developed during and after the TIES-GRASPA 2017 Conference held in Bergamo, from 24th to 26th July 2017. The conference was jointly organised by The International Environmetrics Society (TIES) and the Italian Research Group for Statistical Applications to Environmental Problems (GRASPA) as a satellite meeting of the 61st World Statistics Congress of the International Statistical Institute.

As guest editors, we are really grateful to the Editor Laura Sangalli and the Managing editor Mara Bernardi for their continuous help and advice. We also want to express our appreciation for the timely and very high-quality job of the reviewers, which made this special issue possible.

The scientists contributing to this issue have been focused on various methodological and applied statistical problems related to climate and environment, which are reviewed in the sequel.

The methodological papers considered statistical models which are very important in climate and environmental applications, namely models for processes with index on Euclidean or spherical spaces and models for data with target space a cylinder or a sphere.

Statistical methods for large spatial and spatiotemporal datasets are an emerging issue in climate data science (Cressie, 2018, Fassò et al. 2018). When such a phenomenon is considered locally, models for Euclidean spaces are appropriate. In this field, the SI paper of Guhaniyogi and Banerjee (2018) considers multivariate meta kriging, which exploits parallelisation by dividing the entire dataset into a moderately large number of tractable subsets. Scalability of the well-known linear co-regionalization model and a simulation study reveals inferential and predictive accuracy offered by spatial meta kriging on multivariate observations. On the other side, global climate data are defined typically on a sphere (2D). In this frame, the SI paper of Emery et al. (2018) considers a new approach to simulate Gaussian random fields.

Environmental and climate data are often involved with directions, typical examples being wind direction and wave direction. In this frame, a directional variable observed concurrently with another variable is conveniently represented on a cylinder where the height in the cylinder is given by the concurrent variable value. In this frame, the SI paper of Lagona (2018) studies a hidden Markov model for segmenting cylindrical time series according to a finite number of latent classes. In particular, wave direction and height in the Adriatic Sea are analysed and clustered in three classes, which provide a parsimonious description of wave dynamics in terms of interpretable environmental regimes. Both SI papers of Di Marzio et al. (2018a,b) consider spherical data such as 3D wind direction, wave direction of bird flight direction. The former focuses on Kernel density classification with an exercise of temperature anomaly classification. The latter considers a binary response and a local polynomial regression for spherical predictors.

Population health effects due to air pollution typically manifest a certain time period after exposure and as such require analysis of the lagged association between health risk and environmental pollution. The SI article of Burr et al. (2018) introduces a new concept of synthetic lag and develop an associated synthetically lagged time series model that offers a flexible statistical framework both for selection of significant structural components within a pollutant series and for lagging these components.

Motivated by the fact that groundwater levels in urban areas are typically irregularly sampled, and their dynamics is not well understood, the SI paper of Manago et al. (2018) proposes to use a separable space-time Bayesian hierarchical model that allows to study spatial and temporal groundwater level fluctuations and to obtain multiple imputations of the missing values. The developed methodology is illustrated in an application to groundwater levels in Los Angeles, USA.

Lagoons are fragile ecosystems, highly sensitive to climate change. In this context, the appropriate definition of the spatial scale of microhabitats is of crucial importance from a conservational point of view. The objective of the SI article of Jona Lasinio et al. (2018) is to understand and describe the influence that different microhabitat spatial scales have on the variation of the biodiversity of lagoons. To do this, the deformed exponential transformations of the Tsallis entropy in the Po River Delta is modelled using mixed effect spatiotemporal models, where the fixed effects describe the habitat and seasonal variation while the random component accounts for the nested spatial effects of lagoons, areas and monitoring stations.

Understanding shapes and dynamics of epidemiological clusters is a critical step towards developing more efficient diseases surveillance and mitigation strategies. Smirnova et al. (2018) propose a new method based on functional data analysis and function-on-function regression to assess location, shape, and characteristics of environmental spatial clusters, with a primary application focus on the 1993 Jeffrey pine beetle (JPB) forest epidemic attack in the Lake Tahoe Basin.

An ever-increasing attention to biodiversity threats has led to interdisciplinary efforts - spearheaded by environmental sciences, statistics and machine learning - in developing and understanding ecological network models. Based on isotope characteristics and other attributes, the new data-driven approach of Lyubchich and Woodland (2018) allows to detect and describe complex species interactions. It shows how the complex ecological network models can be built based on limited information and, coupled with modern machine learning techniques, can be used to forecast interactions in marine ecosystems.

One of the most critical and challenging questions in modern climate sciences is to understand whether climate models provide an adequate representation of Earth's actual climate. Chatterjee (2018) proposes a new flexible bootstrap algorithm for systematic comparison of climate signals of observations and model outputs, in a hypothesis testing framework. The developed resampling scheme can be viewed as a variant of the wild bootstrap. The author derives the asymptotic consistency of the new bootstrap test and shows the utility of the proposed resampling methodology in application to precipitation data from the Indian subcontinent.

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