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EDITORIAL

Latent variables and space-time models for environmental problems

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During the conference of the Italian Statistical Society on "Advances in Latent Variables" held in Brescia, Italy, June 19–21, 2013, the working group on environmental statistics, named GRASPA (http://www.graspa.org), organized the special track on "Space and space-time models: methods and environmental applications". This scientific activity was intended to celebrate the new condition as a permanent group of the Italian statistical society and renew GRASPA's long life, which dates back to 1989.

The idea of a special issue on the track main theme arose considering not only the number and scientific quality of the track contributions, but also the general interest of the topic, which exceeds the conference coverage. The result, raising from both track attendance and space-time statistical scientific community, is an interesting blend of various topics, which amounts at fourteen papers covering various environmental problems. To a large extent climate problems are considered, including upper atmosphere monitoring, rain simulation, air and water temperature and sea currents. Moreover, applications considered water body ecology, seismology and radon emissions.

From the methodological point of view, areas covered by the special issue are scalar and vector-valued stochastic processes with continuous index over space or over space-time. Moreover, functional data, point processes and time series methods are taken into account. Latent variables enter in a natural way in many of these papers either as spatial or temporal components. This methodological key is loosely used in the rest of this editorial to briefly review the special issue contributions.

As for spatial processes methods, the work by Ruiz-Medina and Porcu (2014) puts the theoretical basis for understanding the equivalence of Gaussian measures that index multivariate Gaussian fields. Their work will open the lines for research in estimation of Gaussian fields through tapering techniques as well as for assessing the properties of estimators of spatial dependence under infill asymptotics. For binary spatial data, which are built on the basis of a truncated latent Gaussian model, Bevilacqua et al. (2014) explore the possibility of building Euclidean likelihoods, obtaining high computational benefits and ensuring a reasonable level of statistical efficiency. In the same framework of spatial data, Verdin et al. (2014) introduce a stochastic weather generator for the variables of minimum and maximum temperature, as well as precipitation occurrence. In particular, temperature variables are modeled in a vector autoregressive framework, conditional on precipitation occurrence, whilst this last arises via a probit model. Both temperature and occurrence are spatially correlated using spatial Gaussian processes. Fontanella et al. (2014) consider a generalized latent-spatial-quantile regression (GLSQR) model for the understanding of indoor radon gas monitoring in central Italy.

Vallejo et al. (2014) consider a method for image landscape classification based on the assumption that the vector of image bands is a spatial multivariate process. They build such classification using the divergence of a modified Mahalanobis distance, given by the codispersion matrix.

Methods for space-time processes are faced with great detail in this issue. If spatial design represents a critical issue, the paper by Stehlik et al. (2014) gives a clear picture

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of the problems that need to be faced whenever working with a space-time model. The authors propose a class of integrated compound criteria for obtaining robust designs. In particular, they provide an insight into the relationship of a compound D-optimality criterion for both the trend and covariance parameters, and the integrated mean squared prediction error criterion. Working under the same framework of space-time processes, but in the multivariate setting, Lagona et al. (2014) note that the analysis of bivariate space-time series with linear and circular components is complicated by multiple correlations, across time, space and between variables. Also, they note that there might be different supports on which the variables are observed, the real line and the circle, and, finally, that periodic data are circular. The authors propose a multivariate hidden Markov model that includes these features of the data within a single framework. The model integrates a circular von Mises Markov field and a Gaussian Markov field, with parameters that evolve in time according to a latent (hidden) Markov chain. Sun et al. (2014) propose a Matérn spatial model for a space-time model conditioned at different time scales. They show that this model has clearly a better performance than the spatial exponential model, especially at short time scale.

Functional data are considered by Ignaccolo et al. (2014) for the understanding of collocation uncertainty in atmospheric vertical profiles related to high troposphere and low stratosphere. In particular, they propose a new model for heteroskedastic 3D functional regression, which is estimated thanks to splines representation as mixed effect models. The application to atmospheric pressure profiles clearly shows the capability to describe nonlinear dynamics.

In the area of point processes, the paper by Moller and Rasmussen (2014) discusses how to construct models for cluster point processes within territories modeled by d-dimensional Voronoi cells whose nuclei are generated by a latent Poisson process. Conditional on the Voronoi cells, the clusters are modeled as independent Poisson processes whose points may be aggregated around or away from the nuclei and along or away from the boundaries of the cells. In the same class of models, the paper by Adelfio and Chiodi (2014), faces the problem of estimation for the semi-parametric intensity function of a given class of space-time point processes. In particular, the authors try to account for the estimation of parametric and nonparametric components simultaneously, applying a forward predictive likelihood to semi-parametric models. For each event, the probability of being a background event or an offspring is therefore estimated.

Time series analysis covers an important part of this special issue. Allard and Bourotte (2014) describe how to disaggregate daily precipitations into vectors of hourly precipitations used as input values by crop and plant models. They build a stochastic model for rainfall data, on the basis of a censored latent Gaussian process. Finazzi et al. (2014), considering the water temperature variability of lakes at global level, propose a new approach for clustering of time series. In particular, after representing the temperature time series as a state space model, they obtain an efficient clustering algorithm by a modification of the EM algorithm and compare the results with more classical functional clustering.

Last but not least, considering the ecological status of various Mediterranean lagoons, Pollice et al. (2014) propose a Bayesian analysis based on a multivariate hierarchical model able to handle the variation of multiple ecological indexes according to space, time and logoon.

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