

An introduction to geostatistical analysis of spatio-temporal data with R



METMA IX

Montpellier, 13-15 June 2018

9th Workshop on Spatio-temporal modeling



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PROGRAM

The full program is available [here \(external link\)](#):

[Full program](#)

The scientific program will feature sessions with talks on the latest advancements in theory, methods and applications. It will include keynote presentations, invited presentations and contributed papers and posters.

The scientific program of Friday (June 15) will be co-organized with the [LEFE-Cerise project](#) and will focus on topics relevant to this project.

A satellite event will be held on June 12, 2018 (Tuesday): a workshop providing an introduction to geostatistical analysis of spatio-temporal data with R, given by members of INRA's [RESSTE network](#). The registration fee for this workshop is 50€. **Registration for the workshop is done through the registration form to the conference (soon available). Participating in the workshop requires being registered for the conference.**

Short course:

An introduction to geostatistical analysis of spatio-temporal data with R

Organizers: Denis Allard, BioSP, INRA; Liliane Bel, AgroParisTech; Edith Gabriel, Université d'Avignon; Thomas Opitz, BioSP, INRA; Eric Parent, AgroParisTech

The organizers

Eric Parent,
AgroParisTech, Paris



Liliane Bel,
AgroParisTech, Paris



Denis Allard,
BioSP, INRA (Avignon)



Edith Gabriel,
University of Avignon



Thomas Opitz,
BioSP, INRA (Avignon)

Why this workshop ?

- Space-time models and methods are essential in modern statistics with applications in:
- Wildfire occurrence, air quality, plant disease, climate data, sea surface temperature, disease mapping, unemployment data, flash floods,
- **But, space-time statistics is perhaps a bit intimidating at first**



Some particular points about Space-Time statistics

- ✓ Involves (very) large datasets: difficult to store, to read, to manipulate, to analyse
- ✓ We don't know how to explore the data for choosing a model/method
- ✓ Spatio-temporal or tempo-spatial?
- ✓ Likelihood (almost) impossible to compute
- ✓ Are there R packages? Which one should we use? Are there important features missing?
- ✓ Etc...

- ✓ We identified the need to illustrate the geostatistical analysis of spatio-temporal data
- ✓ On a realistic dataset the whole workflow
- ✓ From reading the data to do predictions and validate the model

Organization of the short course

- Session 1: Handling and importing large spatio-temporal data using structured objects; projection coordinate systems for geolocated data.
(Eric Parent)
- Session 2: Visualizing data according to their temporal, spatial or spatio-temporal structures.
(Edith Gabriel)

Lunch

- Session 3: Statistical inference for spatio-temporal models: method of moments; maximum likelihood, pairwise composite likelihoods.
(Thomas Opitz)
- Session 4: Prediction and validation.
(Liliane Bel)

Review paper in the « Journal de la Société Française de Statistique »



Journal de la Société Française de Statistique
Vol. 158 No. 3 (2017)

Analyzing spatio-temporal data with R: Everything you always wanted to know – but were afraid to ask

Titre: Données spatio-temporelles avec R :
tout ce que vous avez toujours voulu savoir sans jamais avoir osé le demander

RESSTE Network et al.^{1,2}

Abstract: We present an overview of (geo-)statistical models, methods and techniques for the analysis and prediction of continuous spatio-temporal processes residing in continuous space. Various approaches exist for building statistical models for such processes, estimating their parameters and performing predictions. We cover the Gaussian process approach, very common in spatial statistics and geostatistics, and we focus on R-based implementations of numerical procedures. To illustrate and compare the use of some of the most relevant packages, we treat a real-world application with high-dimensional data. The target variable is the daily mean PM_{10} concentration predicted thanks to a chemistry-transport model and observation series collected at monitoring stations across France in 2014. We give R code covering the full work-flow from importing data sets to the prediction of PM_{10} concentrations with a fitted parametric model, including the visualization of data, estimation of the parameters of the spatio-temporal covariance function and model selection. We conclude with some elements of comparison between the packages that are available today and some discussion for future developments.

Numéro spécial : Statistique pour les données spatiales et spatio-temporelles et réseau RESSTE

Editorial of the special issue: Statistics for spatial and spatio-temporal data and RESSTE Network

Delphine Blanke, Denis Allard

29-31



Éditorial du numéro spécial : Statistique pour les données spatiales et spatio-temporelles et réseau RESSTE

Delphine Blanke, Denis Allard

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Application of satellite image to the implementation of two stochastic models for modeling the transport of chlorophyll-a on Lake Valencia (Venezuela)

Maira Valera-López, Angie Pineda, José R. León

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Latent Gaussian modeling and INLA: A review with focus on space-time applications

Thomas Opitz

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Detecting and modeling multi-scale space-time structures: the case of wildfire occurrences

Edith Gabriel, Thomas Opitz, Florent Bonneu

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A tutorial on estimator averaging in spatial point process models

Frédéric Lavancier, Paul Rochet

106-123



Analyzing spatio-temporal data with R: Everything you always wanted to know – but were afraid to ask

RESSTE Network et al.

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<http://publications-sfds.math.cnrs.fr/index.php/J-SfS/issue/view/69>

RESSTE Network

<http://informatique-mia.inra.fr/resste>

RESSTE
Réseau MIA RESSTE

RESeau Statistiques pour données Spatio-Temporelles

Bienvenue

Lancement: Oct 2014

Estimation: Mai 2015

Estimation & Visualisation: Nov 2015

Atelier d'Avignon, Avril 2016

Modèles hiérarchiques - Mai 2017

JSFdS Paper - Lancaster Workshop

Processus de Points - 6 Déc 2017

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Bienvenue

Les progrès de l'instrumentation, des systèmes électroniques embarqués et de l'imagerie satellite génèrent de très grandes quantités de données, géolocalisées et répétées dans le temps. Un grand nombre de variables, parfois assez fortement dépendantes, sont disponibles. Les défis posés par ces données spatio-temporelles sont multiples : ils concernent à la fois la visualisation de ces données, la définition de modèles pertinents, les méthodes d'estimation pour ceux-ci et la mise en œuvre de ces méthodes pour des ensembles de données de (très) grande taille.

Le réseau RESSTE (**RE**Seau **S**tatistiques pour données **S**patio-**T**emporelles) propose une animation scientifique autour des modèles, méthodes et algorithmes pour les données spatio-temporelles, en fédérant statisticiens et scientifiques ayant à traiter ce type de données, et en confrontant les approches et les points de vue des différents domaines de la statistique. Il a pour ambition de contribuer à une plus large diffusion des méthodes statistiques spatio-temporelles auprès des statisticiens et des modélisateurs. A moyen terme, il s'agit d'initier de nouveaux fronts de recherche en statistiques spatio-temporelles répondant aux enjeux rencontrés par les scientifiques, et de favoriser les collaborations entre équipes de recherche.

RESSTE est financé depuis 2014 par le **département MIA de l'INRA**. Il compte à ce jour 70 membres dans 20 équipes ([voir la liste complète ici](#)) et est animé par un bureau de six personnes:

One of the outputs: review of R packages

TABLE 5. *Most important R packages for spatio-temporal analysis, along with their main features and limitations.*

Packages	Data.	Cov models	Estimation	Kriging	Big N
gstat	STDF, STSDF or STIDF data structure from spacetime .	4 classes: <i>Separable</i> , <i>Product-Sum</i> , <i>Metric</i> , <i>Sum Metric</i> . Geom. anisotropy	fit.StVariogram Weighted Least Sq. only.	krigeST Linear model for the trend. No NAs.	Moving Neigh only.
CompRandFld	Space \times Time data design. No NAs at all.	Many classes: <i>Separable</i> , <i>Product-Sum</i> , <i>Porcu</i> , <i>Gneiting</i> , ...	Weighted Least Sq. Comp. Lik. Hypothesis testing.	Kr1 No trend model. Tapering. Chordal and Geodesic dist.	Pairwise Comp. Lik., Tapering., Use of spam
RandomFields	RFsp : extension from sp package	Comprehensive: <i>Product-Sum</i> , <i>Gneiting</i> , <i>Porcu</i> , <i>mixtures</i> , ...	RFfit Weighted Least Sq., Max. Lik.	RFinterpolate incl. trend modeling	Use of spam Tapering

And now ?

We will make all material available

- Access to the full dataset & workshop presentations & J SFdS paper

<http://informatique-mia.inra.fr/resste>

- Send email to denis.allard@inra.fr to be added to the RESSTE mailing list for updates & news