UNIVERSIDAD DE GRANADA

Departamento de
Estadística e
Investigación Operativa

Seminario 3 (SPA Series): Velocity distributions and dynamics of spatial-temporal random fields

17/03/2025

Seminario del profesor **Krzysztof Podgórski** (Department of Statistics. Lund University) (https://portal.research.lu.se/en/persons/krzysztof-podgórski) en la **sala de conferencias del IMAG**. Dos sesiones, el **20 de marzo de 2025**, de **9:30-11:00 y de 11:30 a 13:00**.

Part I: Velocities of moving random surfaces

For a stationary two-dimensional random field evolving in time, one can derive statistical distributions of appropriately defined velocities utilizing a generalization of the Rice formula. The theory can be applied to practical problems where evolving random fields are considered to be adequate models. Examples include changes of atmospheric pressure, variation of air pollution, or dynamical models of the sea surface elevation. In particular, statistical properties of velocities can be obtained both for the sea surface and for the envelope field based on this surface. Additional extensions can be obtained by studying three-dimensional geometry of spatial waves. Their statistical distributions can be presented in explicit integral forms for the deep water seas modeled as Gaussian fields. The proposed approach allows for investigation of the effect that shape and directionality of the sea spectrum have on the joint distributions of the size characteristics.

Part II: Dynamics of spatial temporal random fields

General non-stationary spatial-temporal surfaces can have dynamics governed by velocity fields. By applying an extension of the standard moving average construction models which are stationary in time are obtained. The resulting surface changes with time is dynamically inactive since its velocities, when sampled across the field, have distributions centered at zero. A dynamical evolution can be added to such a field by composing it with a dynamical flow governed by a given velocity field. The models are extensions of the earlier discretized autoregressive models which account for a local velocity of traveling surface. For such a surface, its dynamics is a combination of dynamics introduced by the flow and the dynamics resulting from the covariance structure of the underlying stochastic field. An important connection between the resulting stochastic field and underlying deterministic dynamics is obtained by demonstrating that in the case of isotropic spatial dependencies, the observed random velocities are centered at the velocities of the underlying physical flow. Strategies for simulation of such fields are provided and foundation for statistical fitting and prediction procedures are obtained.

References

[1] Lindgren, G., Podgórski, K., Rychlik, I. (2022) Effective persistency evaluation via exact excursion distributions for random processes and fields. Journal of Physics Communications, 6, 035007.

[2] Podgórski, K., Rychlik, I. (2016) Spatial size of waves. Marine Structures, 50C, pp. 55-71.

[3] Podgórski, K., Wegener, J. (2012) Velocities of a spatial-temporal stochastic field with embedded dynamics. Environmetrics, 23, pp. 238-252.

[4] Baxevani, A., Podgórski, K., Rychlik, I. (2011) Dynamically evolving Gaussian spatial fields. Extremes, 14, pp. 223-251.

[5] Podgórski, K., Rychlik, I. (2008) Envelope crossing distributions for Gaussian fields. Probabilistic Engineering Mechanics, 23, pp. 364-377.

[6] Baxevani, A., Podgórski, K., Rychlik, I. (2003) Velocities for moving random surfaces. Probabilistic Engineering Mechanics, 18, pp. 251-271.

