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Implementation of geostatistical models for large spatiotemporal datasets using multi-resolution approximations

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The multi-resolution approximation approach (MRA) [1] provides an efficient representation of Gaussian processes that scales beyond millions of observations. MRA leaves flexibility in the selection of covariance functions and allows to trade off computation time against prediction performance, depending on the selection of parameters. Recent work [2] has shown how MRA can be used for global spatiotemporal processes by integrating nonstationary covariance functions, where parameters vary over space and/or time following a kernel convolution approach. As such, MRA turns out to be a promising approach for geostatistical modelling of global spatiotemporal datasets, such as those coming from Earth observation satellites.

In this work, we show how MRA can be used for spatiotemporal analysis from a practical perspective. In the first part, we will discuss the influence of parameters (spatiotemporal shape of partitioning regions, the number of basis functions, and the number of partitioning levels) by analyzing a real world dataset. In the second part, we will present and discuss our implementation as an R package stmra[3]. We will demonstrate how traditional models as from the gstat package can be implemented efficiently with MRA, and how non-stationary models can be defined by users in a relatively simple way.

[1] Katzfuss, M. (2017). A multi-resolution approximation for massive spatial datasets. Journal of the American Statistical Association, 112(517), 201-214

[2] Appel, M., & Pebesma, E. (2020). Spatiotemporal multi-resolution approximations for analyzing global environmental data. Spatial Statistics, 38, 100465.

[3] https://github.com/appelmar/stmra