



Timescape: a simple space-time interpolation geostatistical Algorithm

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Environmental sciences include both time and space variability in their datasets. Some established tools exist for both spatial interpolation and time series analysis alone, but mixing space and time variability calls for compromise: Researchers are often forced to choose which is the main source of variation, neglecting the other.

We propose a simple algorithm, which can be used in many fields of Earth and environmental sciences when both time and space variability must be considered on equal grounds. The algorithm has already been implemented in Java language and the software is currently available at <https://sourceforge.net/projects/timescapedglobal/> (it is published under GNU-GPL v3.0 Free Software License). The published version of the software, Timescape Global, is focused on continent- to Earth-wide spatial domains, using global longitude-latitude coordinates for samples localization. The companion Timescape Local software is currently under development and will be published with an open license as well; it will use projected coordinates for a local to regional space scale.

The basic idea of the Timescape Algorithm consists in converting time into a sort of third spatial dimension, with the addition of some causal constraints, which drive the interpolation including or excluding observations according to some user-defined rules. The algorithm is applicable, as a matter of principle, to anything that can be represented with a continuous variable (a scalar field, technically speaking). The input dataset should contain position, time and observed value of all samples. Ancillary data can be included in the interpolation as well. After the time-space conversion, Timescape follows basically the old-fashioned IDW (Inverse Distance Weighted) interpolation Algorithm, although users have a wide choice of customization options that, at least partially, overcome some of the known issues of IDW.

The three-dimensional model produced by the Timescape Algorithm can be explored in many ways, including the extraction of time series at fixed locations and GIS layers at constant times, allowing for the inclusion of the model in the users' established workflow.

The software requirements are relatively modest since it has been purposely designed for potential users in various research field with a limited computing power at their disposal. Any respectful modern PC or laptop can run it. Users however need a separate database for sample data and models storage because these can be quite bulky in terms of data output: a single model can be composed of several billions of voxels (three-dimensional discrete cells, a sort of 3D pixels). Running times range from a few minutes for sketch models to some days of evaluation for a full-size model, depending on the users' hardware and model size.