Geophysical Research Abstracts
Vol. 18, EGU2016-1573, 2016
EGU General Assembly 2016
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Communicating spatial uncertainty to non-experts using R

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Effective visualisation methods are important for the efficient use of uncertainty information for various groups of users. Uncertainty propagation analysis is often used with spatial environmental models to quantify the uncertainty within the information. A challenge arises when trying to effectively communicate the uncertainty information to non-experts (not statisticians) in a wide range of cases. Due to the growing popularity and applicability of the open source programming language R, we undertook a project to develop an R package that facilitates uncertainty propagation analysis in spatial environmental modelling. The package has implemented Monte Carlo algorithms for uncertainty propagation, the output of which is represented by an ensemble of model outputs (i.e. a sample from a probability distribution). Numerous visualisation methods exist that aim to present such spatial uncertainty information both statically, dynamically and interactively. To provide the most universal visualisation tools for non-experts, we conducted a survey on a group of 20 university students and assessed the effectiveness of selected static and interactive methods for visualising uncertainty in spatial variables such as DEM and land cover. The static methods included adjacent maps and glyphs for continuous variables. Both allow for displaying maps with information about the ensemble mean, variance/standard deviation and prediction intervals. Adjacent maps were also used for categorical data, displaying maps of the most probable class, as well as its associated probability. The interactive methods included a graphical user interface, which in addition to displaying the previously mentioned variables also allowed for comparison of joint uncertainties at multiple locations. The survey indicated that users could understand the basics of the uncertainty information displayed in the static maps, with the interactive interface allowing for more in-depth information. Subsequently, the R package included a collation of the plotting functions that were evaluated in the survey. The implementation of static visualisations was done via calls to the 'ggplot2' package. This allowed the user to provide control over the content, legend, colours, axes and titles. The interactive methods were implemented using the 'shiny' package allowing users to activate the visualisation of statistical descriptions of uncertainty through interaction with a plotted map of means. This research brings uncertainty visualisation to a broader audience through the development of tools for visualising uncertainty using open source software.