Geophysical Research Abstracts
Vol. 13, EGU2011-13126, 2011
EGU General Assembly 2011

Realising the Uncertainty Enabled Model Web

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The FP7 funded UncertWeb project (http://www.uncertweb.org/) aims to create the "uncertainty enabled model web". The central concept here is that geospatial models and data resources are exposed via standard web service interfaces, such as the Open Geospatial Consortium (OGC) suite of encodings and interface standards, allowing the creation of complex workflows combining both data and models. The focus of UncertWeb is on the issue of managing uncertainty in such workflows, and providing the standards, architecture, tools and software support necessary to realise the "uncertainty enabled model web". In this paper we summarise the developments in the first year of UncertWeb, illustrating several key points with examples taken from the use case requirements that motivate the project.

Firstly we address the issue of encoding specifications. We introduce and explain the usage of UncertML 2.0, a flexible encoding for representing uncertainty based on a probabilistic approach. This is designed to be used within existing standards such as Observations and Measurements (O&M) and data quality elements of ISO19115 / 19139 (geographic information metadata and encoding specifications) as well as more broadly outside the OGC domain. We show the profiles of O&M that have been developed within UncertWeb and how UncertML 2.0 is used within these. We also show encodings based on NetCDF and discuss possible future directions for encodings in JSON.

We then discuss the issues of workflow construction, considering discovery of resources (both data and models). We describe a brokering based approach to service composition. We discuss why such brokering approaches might be necessary in a world where the web service interfaces remain relatively heterogeneous, including many non-OGC approaches, in particular the more mainstream SOAP and WSDL approaches. We discuss the trade-offs between functionality to manage uncertainty being delegated to the service interfaces themselves and the functionality being integrated in the workflow management system. We describe two utility services to address conversion between uncertainty types, and between the spatial / temporal support of service inputs / outputs.

Finally we describe the tools being generated within the UncertWeb project. We consider three main aspects:
i) Elicitation of uncertainties on model inputs. We are developing tools to enable domain experts to provide judgements about input uncertainties from UncertWeb model components (for example parameters in meteorological models) which allow panels of experts to engage in the process and reach a consensus view on the current knowledge / beliefs about that parameter or variable. We are developing systems for continuous and categorical variables as well as stationary spatial fields.
ii) Visualisation of the resulting uncertain outputs from the end of the workflow, but also at intermediate steps. At this point we do not have complete implementations but rather define the support we envisage providing, which is driven by the requirements from the use cases that motivate UncertWeb.
iii) Sensitivity and uncertainty analysis on model outputs. Here we show the design of the overall system we are developing, including the deployment of an emulator framework to allow computationally efficient approaches.

We conclude with a summary of the open issues and remaining challenges we are facing in UncertWeb, and provide a brief overview of how we plan to tackle these.