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Rapid 3D geological modeling to assess and visualize uncertainties in a web application

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Three dimensional modeling is a rapidly developing field in geological scientific and commercial applications. The combination of modeling and uncertainty analysis aides in understanding and quantitatively assessing complex subsurface structures. In recent years, many methods have been developed to facilitate this combined analysis, usually either through an extension of existing desktop applications or by making use of Jupyter notebooks as frontends. We evaluate here if modern web browser technology, linked to high-performance cloud services, can also be used for these types of analyses.

For this purpose, we developed a web application as proof-of-concept with the aim to visualize three dimensional geological models provided by a server. The implementation enables the modification of input parameters with assigned probability distributions. This step enables the generation of randomized realizations of models and the quantification and visualization of propagated uncertainties. The software is implemented using HTML Web Components on the client side and a Python server, providing a RESTful API to the open source geological modeling tool “GemPy”. Encapsulating the main components in custom elements, in combination with a minimalistic state management approach and a template parser, allows for high modularity. This enables rapid extendibility of the functionality of the components depending on the user’s needs and an easy integration into existing web platforms.

Our implementation shows that it is possible to extend and simplify modeling processes by creating an expandable web-based platform for probabilistic modeling, with the aim to increase the usability and to facilitate access to this functionality for a wide range of scientific analyses. The ability to compute models rapidly and with any given device in a web browser makes it flexible to use, and more accessible to a broader range of users.