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Intuitive Visualization of Transient Flow: Towards a Full 3D Tool

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Visualization of geoscientific data is a challenging task especially when targeting a non-professional audience. In particular, the graphical presentation of transient vector data can be a significant problem. With STRING Fraunhofer ITWM (Kaiserslautern, Germany) in collaboration with delta h Ingenieurgesellschaft mbH (Witten, Germany) developed a commercial software for intuitive 2D visualization of 3D flow problems. Through the intuitive character of the visualization experts can more easily transport their findings to non-professional audiences.

In STRING pathlets moving with the flow provide an intuition of velocity and direction of both steady-state and transient flow fields. The visualization concept is based on the Lagrangian view of the flow which means that the pathlets' movement is along the direction given by pathlines. In order to capture every detail of the flow an advanced method for intelligent, time-dependent seeding of the pathlets is implemented based on ideas of the Finite Pointset Method (FPM) originally conceived at and continuously developed by Fraunhofer ITWM. Furthermore, by the same method pathlets are removed during the visualization to avoid visual cluttering. Additional scalar flow attributes, for example concentration or potential, can either be mapped directly to the pathlets or displayed in the background of the pathlets on the 2D visualization plane.

The extensive capabilities of STRING are demonstrated with the help of different applications in groundwater modeling. We will discuss the strengths and current restrictions of STRING which have surfaced during daily use of the software, for example by delta h. Although the software focusses on the graphical presentation of flow data for non-professional audiences its intuitive visualization has also proven useful to experts when investigating details of flow fields.

Due to the popular reception of STRING and its limitation to 2D, the need arises for the extension to a full 3D tool. Currently STRING can generate animations of single 2D cuts, either planar or curved surfaces, through 3D simulation domains. To provide a general tool for experts enabling also direct exploration and analysis of large 3D flow fields the software needs to be extended to intuitive as well as interactive visualizations of entire 3D flow domains. The current research concerning this project, which is funded by the Federal Ministry for Economic Affairs and Energy (Germany), is presented.