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Tangible 3D printouts of scientific data volumes with FOSS - an emerging field for research

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Humans are very good in using both hands and eyes for tactile pattern recognition: The german verb for understanding, “begreifen” literally means “getting a (tactile) grip on a matter”. This proven and time honoured concept has been in use since prehistoric times.
While the amount of scientific data continues to grow, researchers still need all the support to help them visualize the data content before their inner eye. Immersive data-visualisations are helpful, yet fail to provide tactile feedback as provided from tangible objects. The need for tangible representations of geospatial information to solve real world problems eventually led to the advent of 3d-globes by M. Behaim in the 15th century and has continued since.
The production of a tangible representation of a scientific data set with some fidelity is just the final step of an arc, leading from the physical world into scientific reasoning and back: The process starts with a physical observation, or a model, by a sensor which produces a data stream which is turned into a geo-referenced data set. This data is turned into a volume representation which is converted into command sequences for the printing device, leading to the creation of a 3d-printout. Finally, the new specimen has to be linked to its metadata to ensure its scientific meaning and context.
On the technical side, the production of a tangible data-print has been realized as a pilot workflow based on the Free and Open Source Geoinformatics tools GRASS GIS and Paraview to convert scientific data volume into stereolithography datasets (stl) for printing on a RepRap printer.
The initial motivation to use tangible representations of complex data was the task of quality assessments on tsunami simulation data sets in the FP7 TRIDEC project (www.tridec-online.eu). For this, 3d-prints of space time cubes of tsunami wave spreading patterns were produced. This was followed by print-outs of volume data derived from radar sounders (MARSIS, SHARAD) imaging the north polar cap of Mars.
While these first pilot applications have demonstrated the feasibility of the approach, further research is required to explore both the methodology and application scenarios.