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Visual quality control of high volume spatio-temporal data - A case study

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Preview formats of data are commonly used tools to achieve an overview over the content and quality of a given set of data. However, high volume spatio-temporal data preview formats have to be more sophisticated than merely reducing the resolution displayed. In addition, the processing power needed to produce preview objects might be considerable.

A preview format used in meteorology is the Contoured Frequency by Altitude Diagram (CFAD) that collapses a 3D weather situation into a 2D diagram of weather intensity vs. altitude. Isolines are used to contour the data and aid interpretation. The CFAD only shows a snapshot of the weather situation but requires image animation to show the temporal dynamics of the weather processes.

Adding the time-dimension as third dimension extends the CAFD to a Contoured Frequency by Altitude and Time Diagram (CFATD). Data can be contoured and show as "iso-tubes" instead of isolines. The CFATD gives an easy overview of the weather situation and its evolution over time, but also readily shows systematic errors in the data.

In a case study we applied this technique to soil erosion caused by heavy precipitation. Weather radar provides the only available spatially continuous input data for erosivity studies. Erosivity is calculated from a 2D rain rate map, which is derived from 3d volume data (reflectivity data). However, artefacts in the primary 3D data affect the derived 2D rain rate map, but can not be identified once incorporated into the 2D dataset. Analysis of the data quality based CFATD is required in addition to the rain rate to judge the reliability of the derived erosivity data sets.

The data for our study were radar reflectivity data of precipitation in the Freestate Province of South Africa. The data sets were transformed into 3D voxel volumes and imported into GRASS GIS and transformed into CFADs by a newly written GRASS software module. The CFADs were then stacked into a CFATD and exported to Paraview for 3D visualisation. The 3D visualisation was used to identify artefacts before calculating precipitation intensities from the radar reflectivity data. The precipitation intensity over time can then be intersected with a soil types map to estimate soil erosion caused by the precipitation events. Even better estimates of soil erosion by precipitation might be derived from models employing cellular automata.

CFATDs as preview formats could be routinely generated through a web processing service (WPS) and pyWPS, a Python-based WPS package, could be used in this instance. However, emerging Grid technology could be used to provide much more powerful processing services to handle much larger datasets or for comparing the results of ensemble simulations.