Probabilistic predictions using a groundwater model informed with airborne EM data
Some hydrological model predictions are particularly sensitive to the hydrostratigraphy of numerical groundwater models, which are used extensively in the management of groundwater resources. In this paper we present a method to estimate hydrological prediction uncertainty originating from uncertainty in subsurface structure. Densely sampled airborne electromagnetic (AEM) data, which captures the main geological features, along with borehole lithological information are used as input to the hydrostratigraphic models. Geophysical resistivity models obtained from spatially constrained 1-D inversion of the AEM data are translated into clay-fraction values with a spatially variable translator function. Hydrostratigraphic units are identified by k-means clustering on the 2-D space defined by estimated resistivity values and clay-fraction values. Areas with no data are represented stochastically using sequential indicator simulation (SIS) where the spatial model of each hydrostratigraphic unit is characterized by an indicator variogram. This results in an ensemble of equally likely hydrostratigraphic representations of the subsurface. A hydraulic conductivity value of each hydrostratigraphic unit of each realization is estimated in a groundwater model calibration constrained by observations of hydraulic head and stream base flow. Pumping well catchment areas are calculated for each realization. The result is a probabilistic well catchment area, which is checked for bias with a manually constructed geological model. There is a probability of 85% of the catchment extending beyond the manually constructed geology. The method is applied to the 45 km² large groundwater model of the Kasted site in Denmark. The method presented in the paper has the advantage of being data-driven, making the modeling process entirely reproducible.