Ensemble of geological models of a complex coastal aquifer for uncertainty estimation and groundwater modelling in the framework of the DEM'EAUX ROUSSILLON project

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The creation of geological and sedimentological models is a non-unique process due to the many choices that must be made during their conception. The choice of the geological and sedimentological depositional concepts, the decision regarding the modeling strategy (stochastic or deterministic), the type of algorithm used for the simulations (MPS, SGS, Kriging, TGS…) are all factors that influence the final models and the corresponding uncertainty quantification.

Regarding the coastal sedimentary Roussillon aquifer (south of France), different sets of geological models have been created and are used for the hydrogeological simulations; homogeneous permeability model, depth relative permeability model, and stochastic models.

The homogeneous and depth relative models are created based on the large structural envelopes delimiting the main aquifers. The stochastic models are also based on these envelopes but simulate inside complex sedimentary facies and permeability fields using the multiple-point statistics algorithm DeeSse. Different geological concepts were tested depending on the different representations and interpretations of the possible spatial distribution of the sediments. Each model has its own strengths and weaknesses. It is by combining these different approaches that we created an ensemble of geological models deemed to cover some conceptual uncertainty range.

These models are then used to feed hydrogeological simulations to create an ensemble of hydrogeological models and outputs that are used to characterize the hydrogeological uncertainty and help increase the robustness of the prevision. To do so, we developed an integrated process to convert the geological model to physical model and directly used them in hydrogeological simulations. The models run on MODFLOW, using the flopy python interface which helps the automation of the process. These models can then be calibrated in a semi-automatic manner using various inversion methods such as PEST, POPEX, or using ensemble Kalman filters.