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GIM (Groundwater Integrated Modelling). The hydrogeological compiler.

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Complex problems in Earth Sciences demand the use of numerical models. To this end, a large number of codes have been developed during the last two decades. In spite of their power, as displayed in their many applications, these codes are sparse and, most often, used in the academic framework. To make things worse, they are aimed at solving a given set of physical phenomena (e.g. most codes solve groundwater flow and contaminant transport, but they do not take into account material deformation, others include deformation but not heat transfer, etc.) and most often they do not integrate stochastic techniques.

GIM (Groundwater Integrated Modelling) is aimed at providing a platform to fill this gap. The objective is to integrate the existing codes in an overall fully-parallel object oriented FORTRAN 95 structure. Thus, the capabilities of GIM are numerous (different solvers of direct and inverse problem, of groundwater flow, contaminant (conservative or not) or heat transport, etc.) as it takes profit of those of the codes embedded in its structure.

The use of GIM is illustrated with a simple example consisting of a Monte Carlo analysis of flow and transport problem:

1. Read data common to most of the existing “host” codes (finite elements or finite differences mesh, geostatistical model, state variable measurements, etc.) in an XML fashion. “Host” code particular variables (options, tolerances, convergence criteria, etc.) are supplied separately.
2. The data are used to pre-process the initial hydraulic conductivity fields on the basis of the geostatistical model. These fields will be calibrated in step 4.

3. Write data in the appropriate format for the “host” code.
4. Execute “host” code(s). In this example, an inversion code is used. However, many codes can be used at step 4 (e.g. for solving the inherent direct problem, modeller can use a flow simulator to calculate the velocity field driving the contaminant transport, which will be simulated using a “raw” transport simulator).
5. Collect results (the calibrated fields).
6. Post-process the output (e.g. histogram of hydraulic conductivity).

Including “host” codes in the overall structure of GIM is easy. One needs to add a routine for writing data at step 3 and a routine for reading the output at step 5. This confers versatility and an ample room for future developments.