

Aquifer Physics Modes for Hydrogeological Modeling – an Application of the COMSOL Physics Builder



GEORG-AUGUST-UNIVERSITÄT
GÖTTINGEN

Ekkehard Holzbecher

GZG Applied Geology, Goldschmidtstr. 3, 37077 Göttingen, GERMANY

Introduction: Although there are porous media and subsurface flow modes available in a toolbox of COMSOL Multiphysics, some common requirements in hydrogeological models can not be easily accessed in the graphical user interface. Most crucially, there is no distinction between confined and unconfined situations for permeable layers, i.e. aquifers.

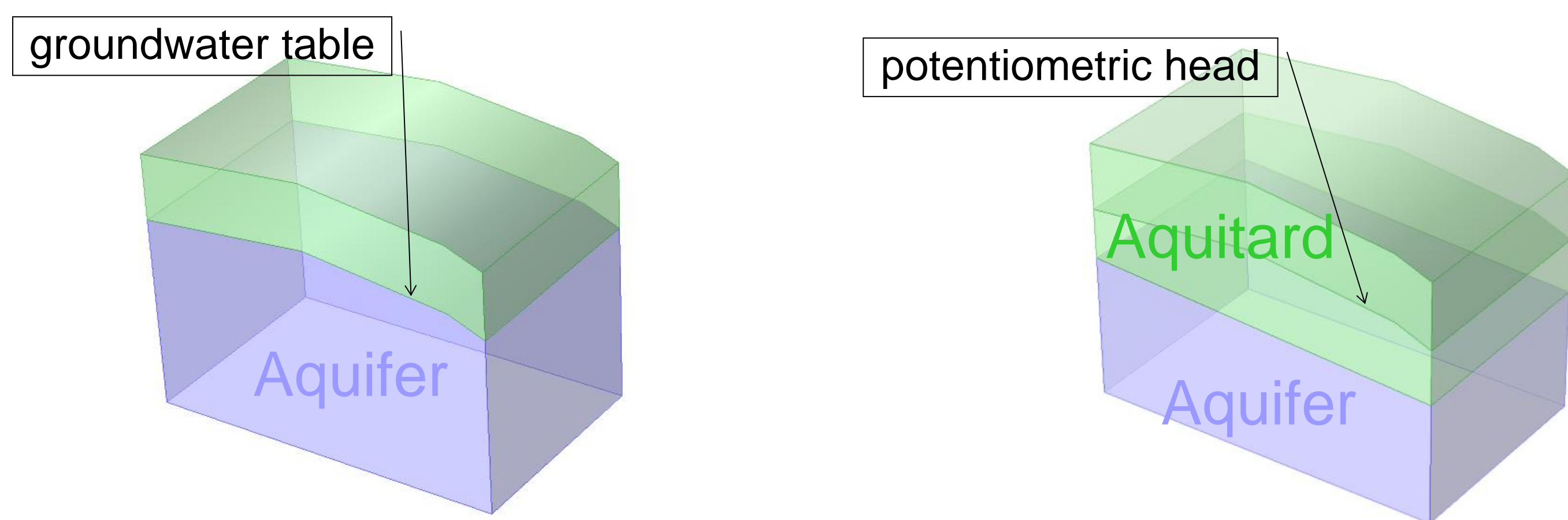


Figure 1. Sketch of unconfined and confined aquifers

Computational Methods: Using the Physics Builder for such distinctions *aquifer physics modes* are constructed that enable hydrogeologists to work with COMSOL Multiphysics as they are used to from other specialized software for hydrogeological modeling (Figure 2).

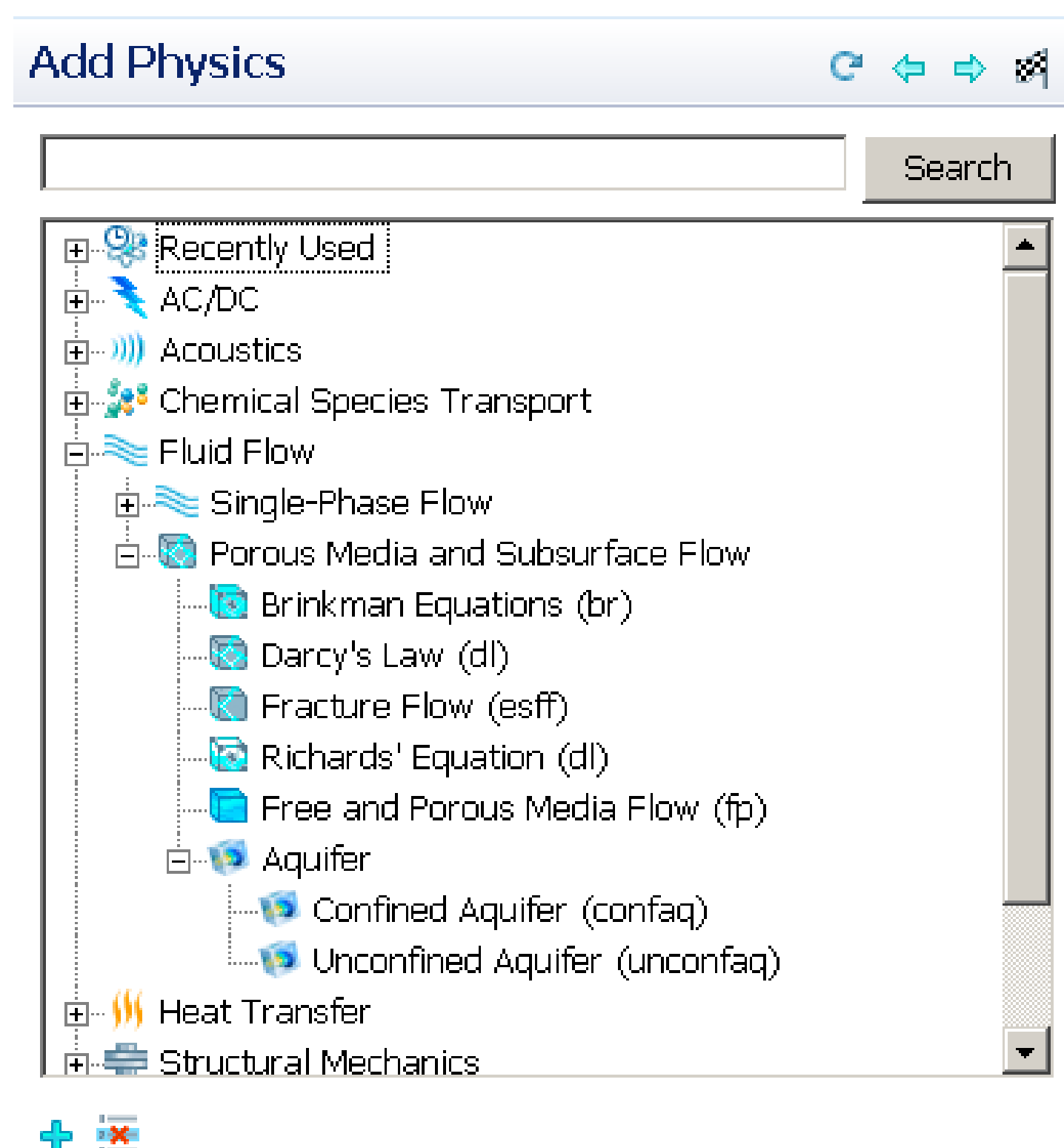


Figure 2. 'Add Physics' options: selection of aquifer modes

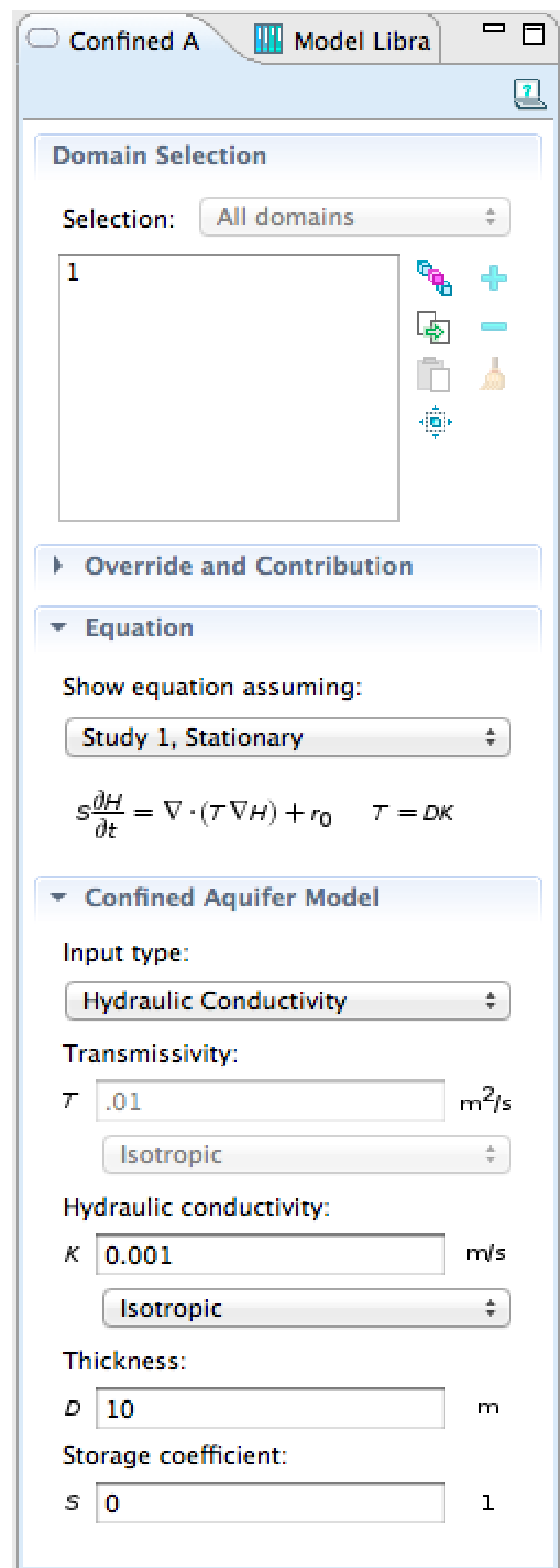


Figure 3. Domain selection input for the confined aquifer mode (*confaq*)

Allowed dimensions are: 2D, 2D axisymmetric, 1D, 1D axisymmetric. *confaq* and *unconfaq* modes can be steady state or transient, *aq* and *sf* are for steady state only. In Figure 3 the domain selection box for the confined mode is shown.

Results: We present results for the classical problems of a well in a regional groundwater flow field. The flow net calculated using the new aquifer mode is shown in Figure 4.

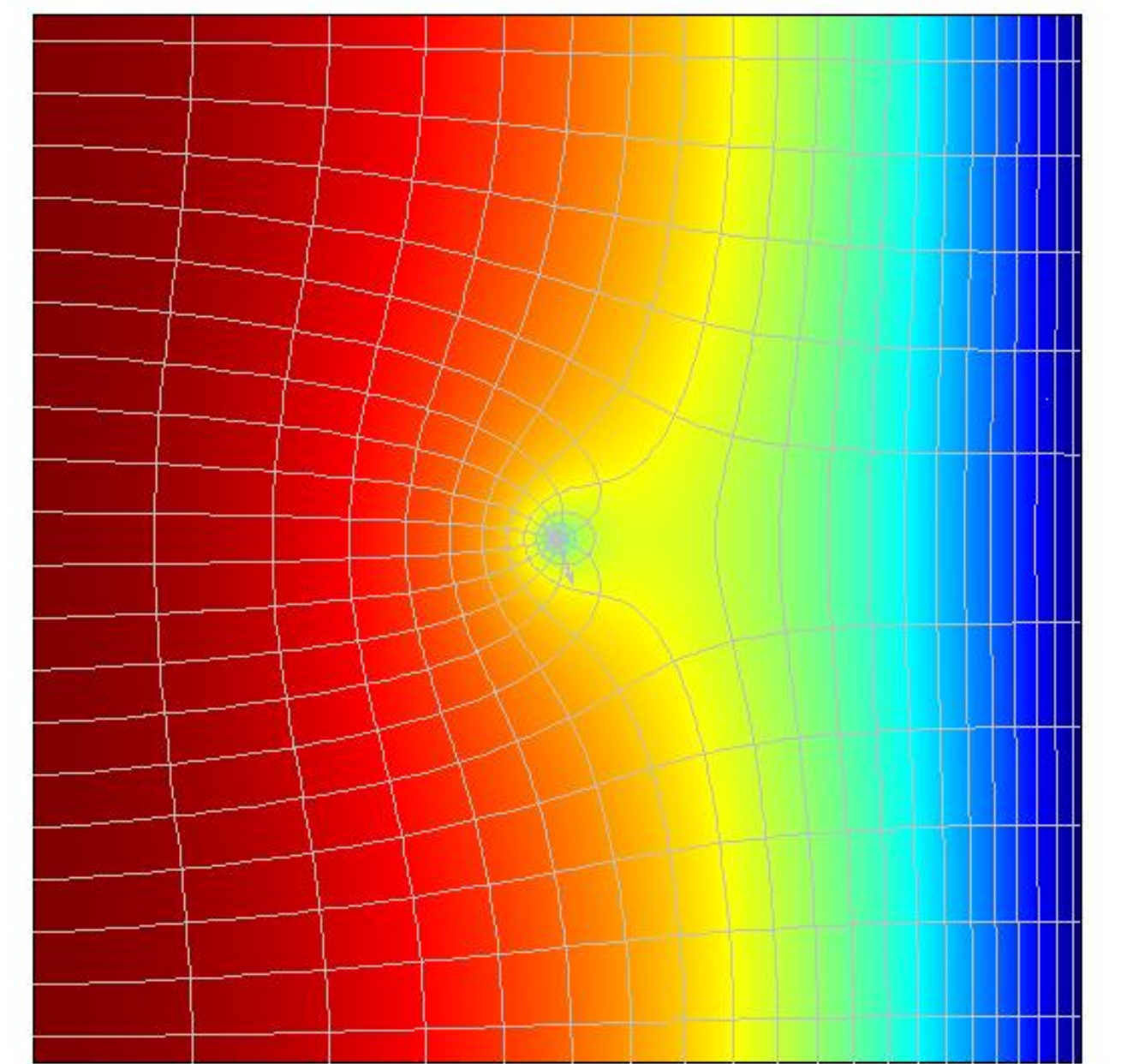


Figure 4. Flow towards a well in an unconfined aquifer; flownet consisting of streamlines and isopleths

The *aq* mode allows the modeling of aquifers, which are partially confined and partially unconfined. Figure 5 depicts results for the three situations along the symmetry line.

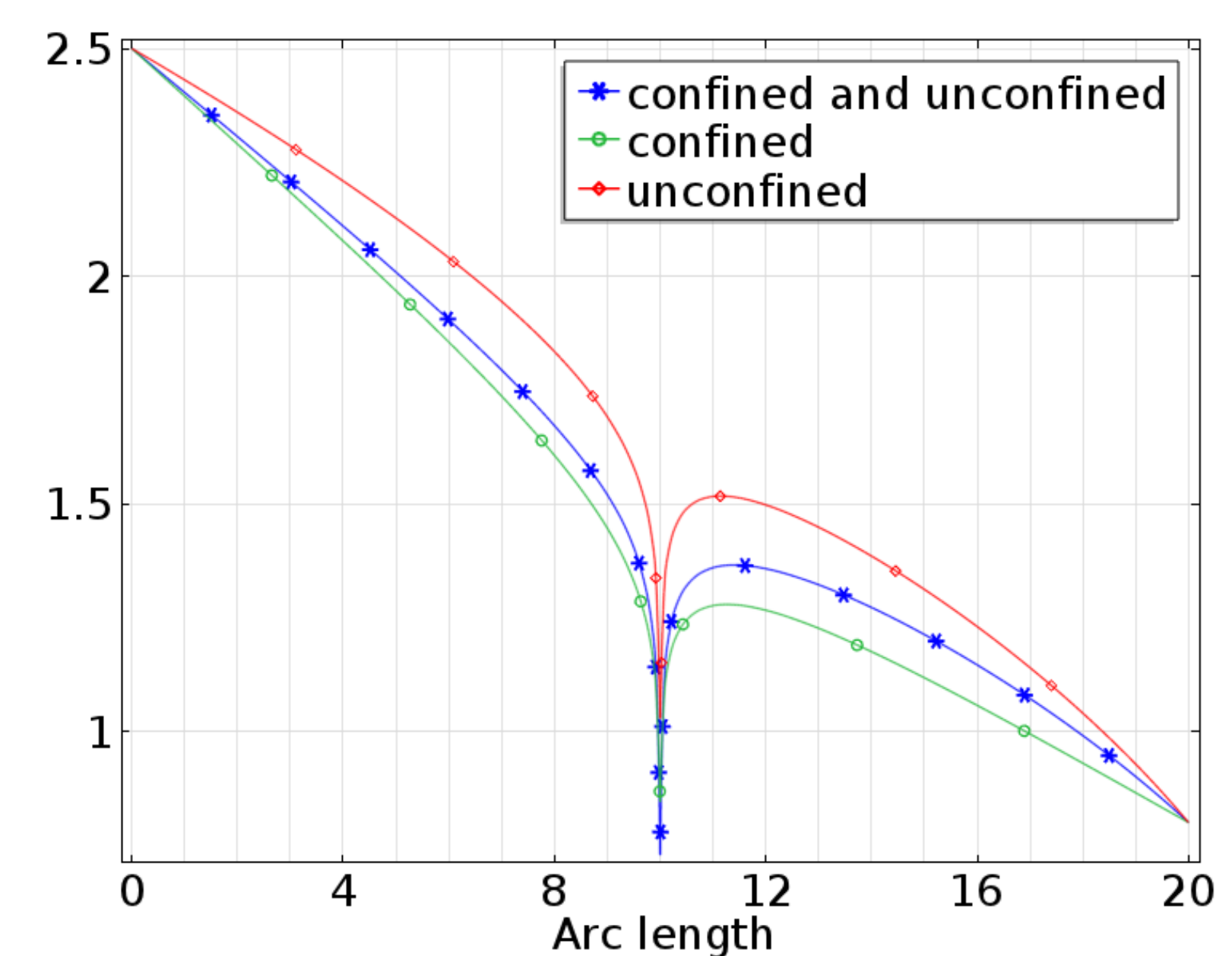


Figure 5. Hydraulic head around a pumping well for the confined, unconfined and partially confined/ unconfined cases; numerical solutions with *aq*-, *confaq*- and *unconfaq*-modes; all units in [m]

The *sf* mode allows the direct modelling of the streamfunction. Thus it is possible to compute exact flownets, i.e. Streamtubes with equal flow (gray lines in Figure 6).

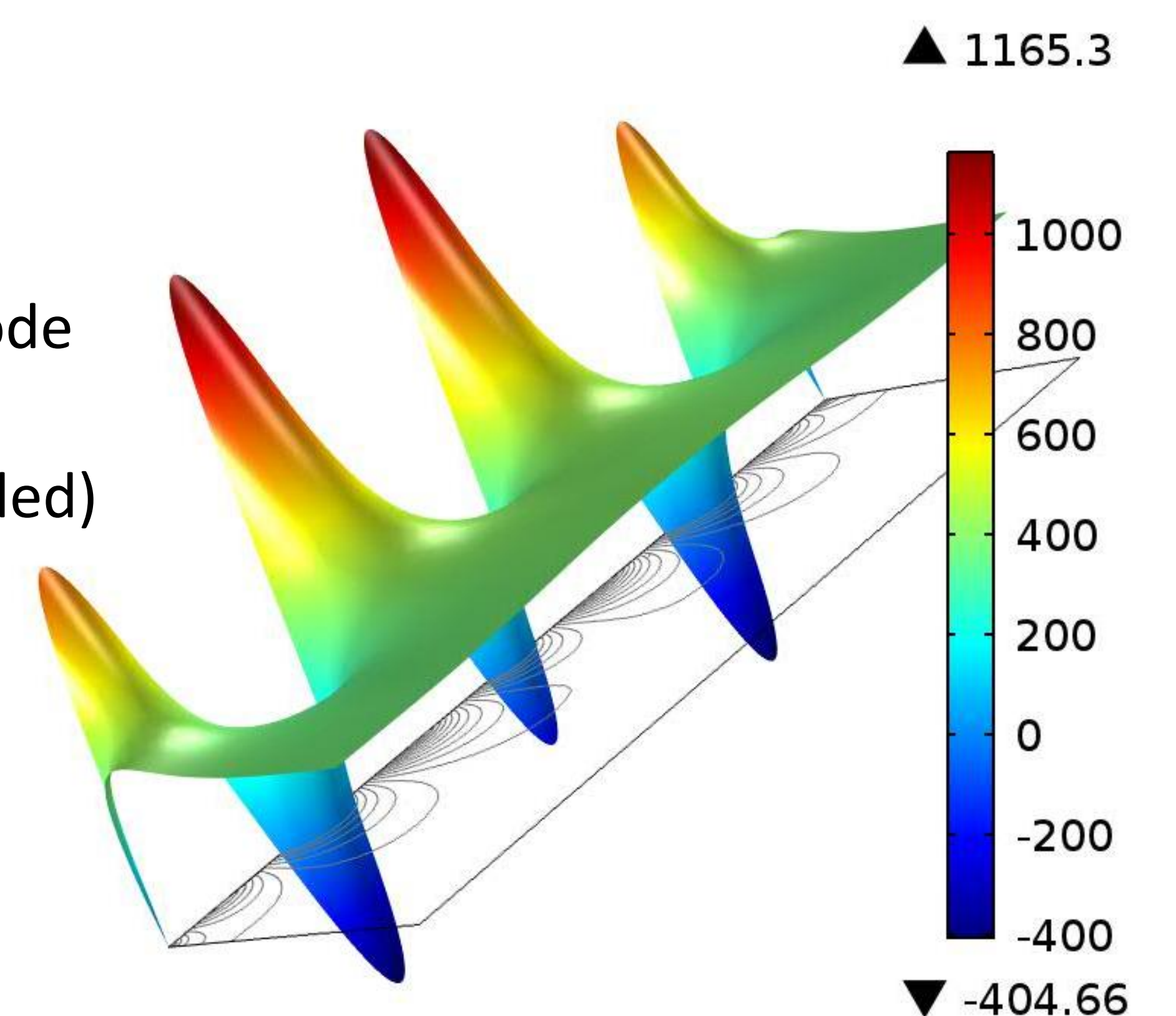


Figure 6. Streamfunction mode application (Toth model extended)

For availability of the aquifers modes, see website: www.geo-sol.de