Dynamic Time-Variable Boundary Conditions

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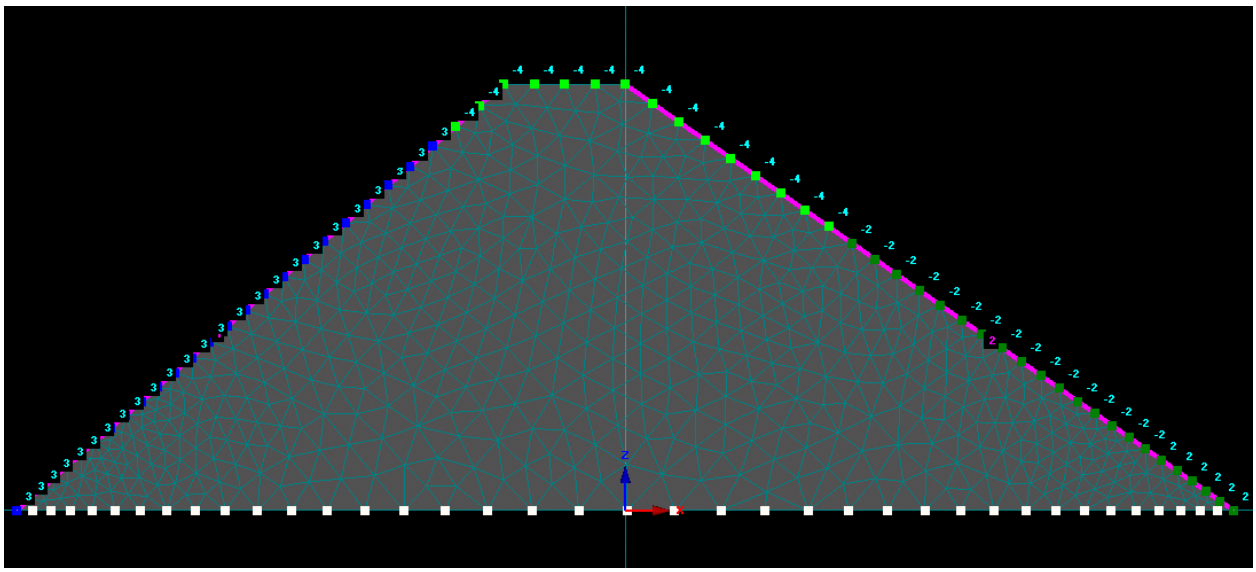
This series of examples demonstrate the use of Dynamic Time-Variable Boundary Conditions.

Dike1:

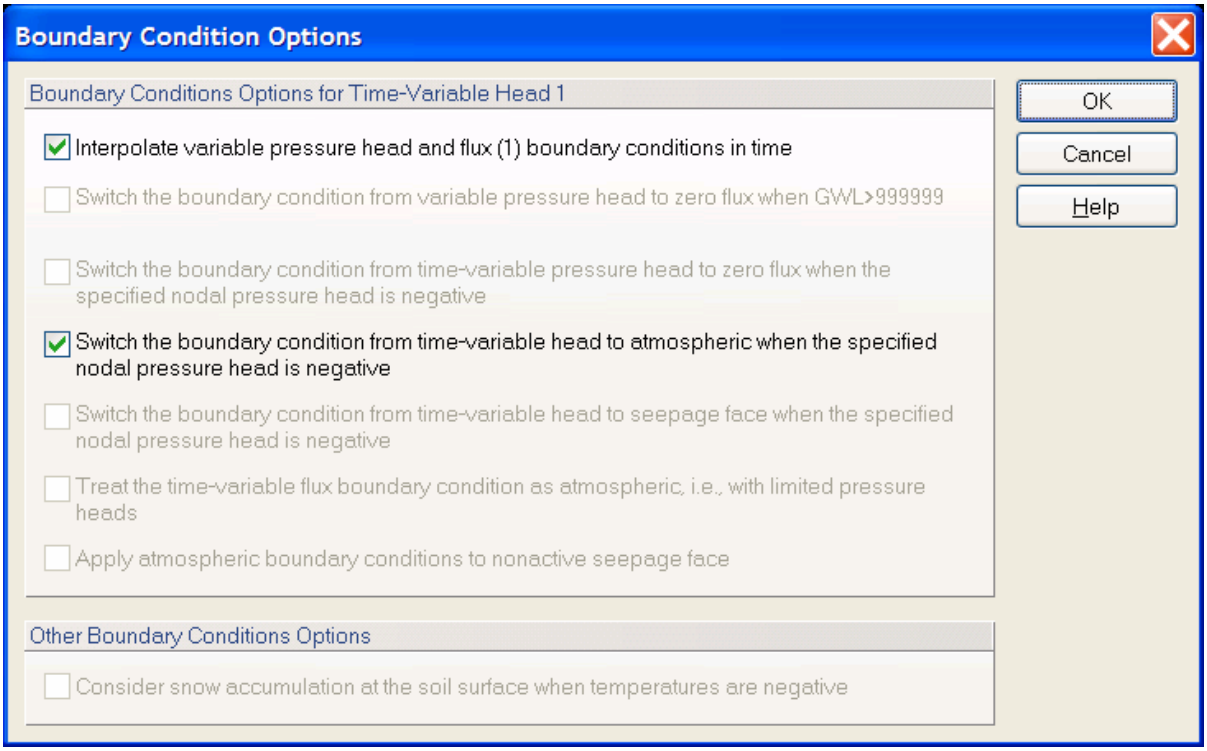
Flow through a dike with a time-variable pressure head boundary condition on the left side (Kode = 3; blue color), seepage face (Kode=-2, dark green) on the right side, and atmospheric boundary condition (Kode=-4; light green) on the top. The dike is 70 cm high and 200 cm wide at the bottom. The time-variable pressure head BC on the right represents the fluctuating water level in the upstream reservoir.



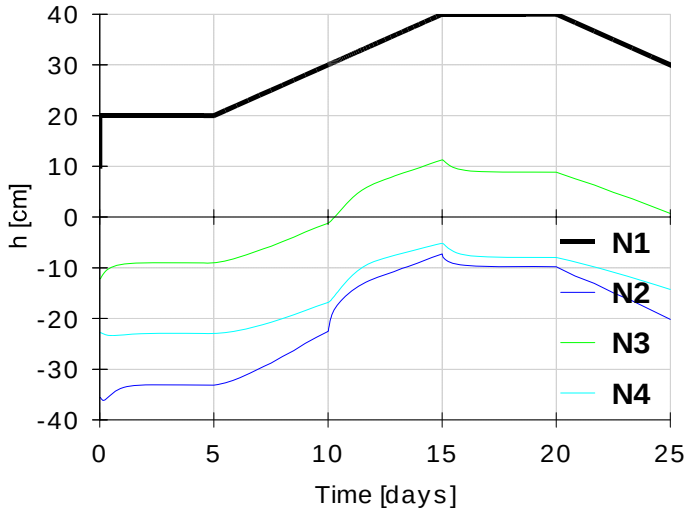
Specified pressure heads are linearly interpolated in time, so that there are no sudden changes in water levels. The specified pressure head (hBnd) is applied to the lowest located node (i.e., the node with the lowest z-coordinate, zBot) with the applied time-variable boundary condition. The applied pressure head in other nodes is recalculated, taking into account the vertical location of a particular node (i.e., h=hBnd-(z-zBot)). Therefore the node located at the water level in the reservoir will have zero applied pressure head. Calculated pressure heads for nodes above the water level are negative, which is not realistic. HYDRUS offers several ways how to deal with these nodes. User can select that instead of the time-variable boundary condition, these nodes (i.e., above the water level) will have either a) zero flux, b) atmospheric BC, or c) seepage face. In this example, we use option (b) with the atmospheric BC. This means that applied atmospheric fluxes (precipitation and evaporation) will be applied to nodes that are above the water level.

Note that the length of the potential seepage face (specified by a user) should reflect as closely as possible the length of the actual seepage face (calculated by the program), since one can not use the option “Apply atmospheric boundary conditions to nonactive seepage face”. This is because

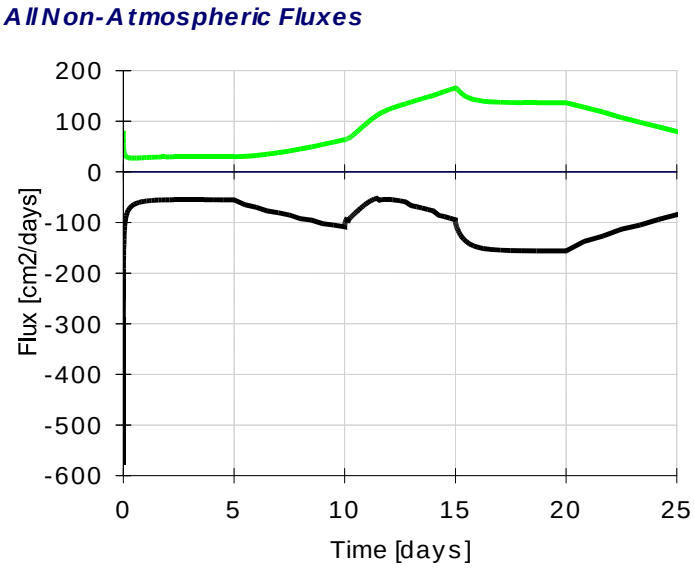
only one (other than interpolation) “Boundary Conditions Options for Time-Variable Head” can be used. The nonactive part of the seepage face will thus have a no flow boundary condition applied.



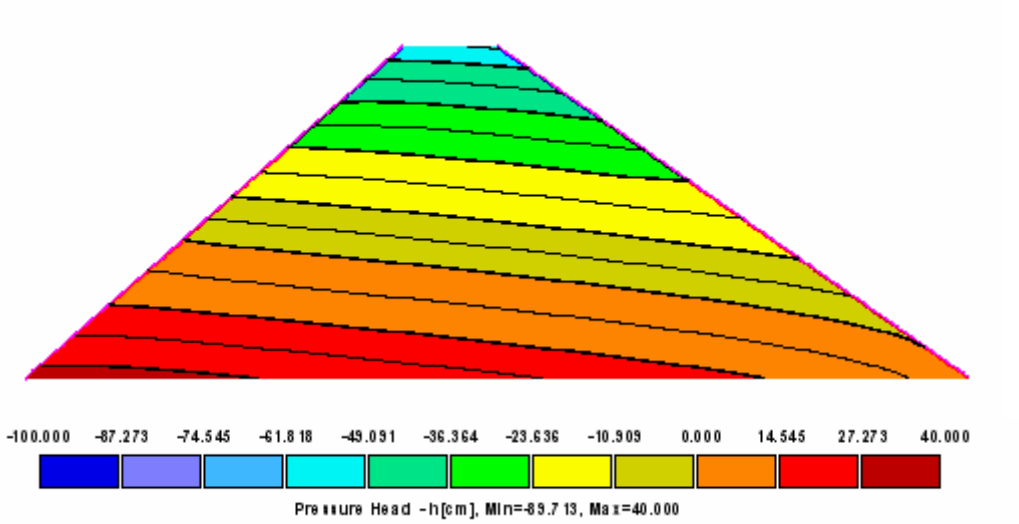
Observation Nodes: Pressure Heads



This figure shows pressure heads at four observation nodes. The N1 node is the left-most node, which shows the applied time-variable pressure head specified at this node. Notice the linear interpolation of pressure head values.



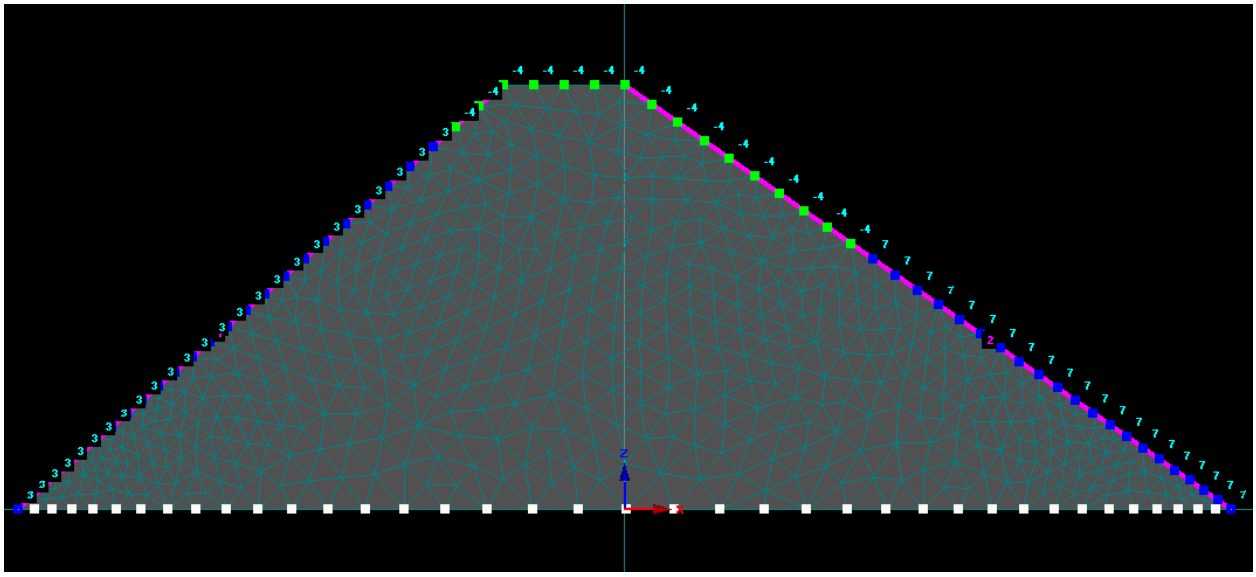
This figure shows non-atmospheric boundary fluxes. While the black line represents the inflow across the time-variable pressure head boundary, the green line represents the outflow across the seepage face. Notice smooth changes in fluxes at both boundaries as a result of smooth changes of applied pressures. There is rainfall between 10 and 15 d, which leads to more abrupt changes in fluxes at these times.

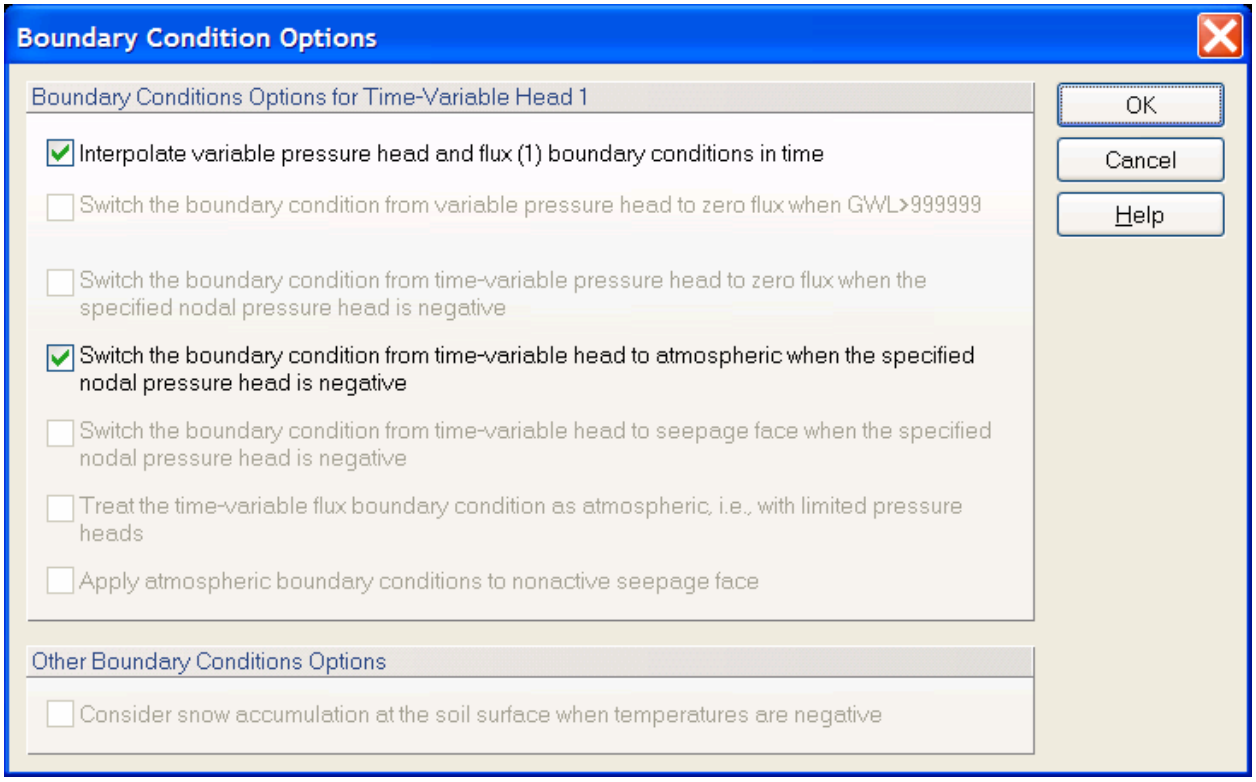


This figure shows the pressure head profile at the end of the simulation. Notice that the line between yellow and orange colors represents the ground water level. The cross-section of this line with the seepage face boundary defines the active and nonactive parts of the seepage face.

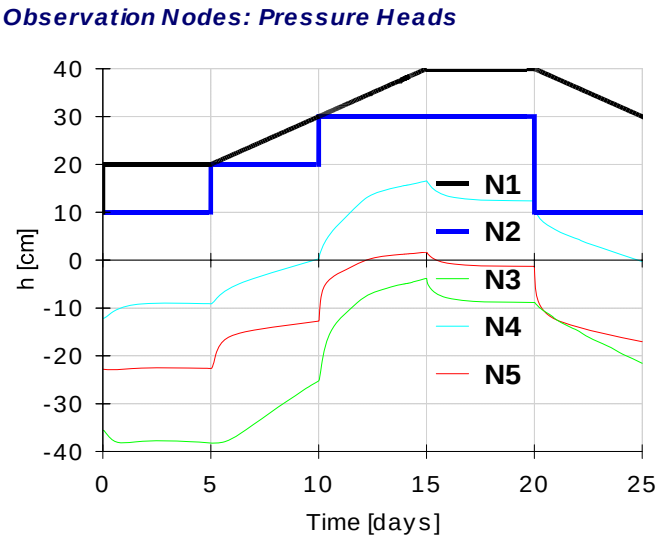
Dike2:

Flow through a dike with two time-variable pressure head boundary conditions (on both sides, Kode=3 on the left and Kode=7 on the right; blue color) and the atmospheric boundary condition (Kode=4; light blue) on the top.

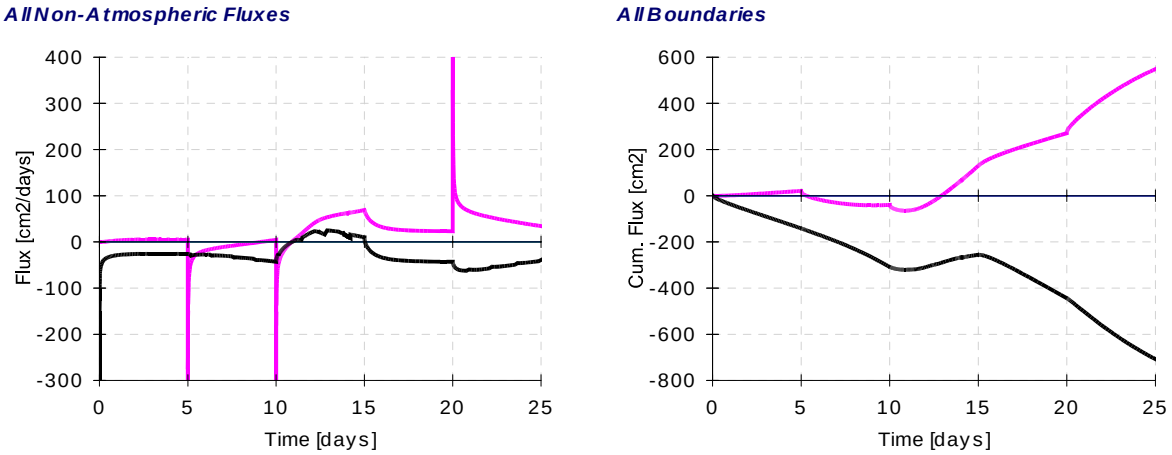




Notice that interpolation in time can be applied to only one time-variable pressure head boundary (Kode=3).



This figure shows pressure heads at five observation nodes. The N1 node (black line) is the left-most node, which shows the applied time-variable pressure head specified at this node. Notice the linear interpolation of pressure head values. The N2 node (blue line) is the right-most node, which also shows the applied time-variable pressure head specified at this node. However, notice that here pressure heads were not interpolated with time. This has quite significant effects on boundary fluxes.



This figure shows non-atmospheric boundary fluxes (actual on the left and cumulative on the right). While the black line represents the inflow (outflow, when values are positive) during rainfall between 10 and 15 days) across the time-variable pressure head boundary (Kode=3), the pink line represents the outflow across the seepage face. Notice smooth changes in black line, reflecting gradual changes in pressure heads at this boundary (Kode=3), and large peaks in pink line, reflecting sudden changes in pressure heads at this boundary (Kode=7). However, notice that since these peaks are relatively short, they do not have a large effect on the cumulative fluxes. Both fluxes (actual and cumulative) are in cm2, which is in fact cm3 per 1 cm in the perpendicular (y) direction.