EGU24-3869, updated on 07 Dec 2024
https://doi.org/10.5194/egusphere-egu24-3869
EGU General Assembly 2024

Global sensitivity analysis of model parameters, heat transport processes and design parameters in ATES Systems

Luka Tas[1], Thomas Hermans[1], Martin Bloemendal[2,3], and Niels Hartog[2,4]
[1]Ghent University, Faculty of Sciences, Department of Geology (Laboratory for Applied Geology and Hydrogeology), Belgium (luka.tas@ugent.be)
[2]KWR, Water Research Institute, Nieuwegein, The Netherlands
[3]Department of Water Management, Delft University of Technology, Delft, The Netherlands
[4]Faculty of Geosciences, Utrecht University, Utrecht, The Netherlands

Shallow geothermal energy has not only great potential to mitigate CO_2 emissions associated with the heating and cooling of buildings but also offers wide applicability. Thick productive aquifer layers have been targeted first, as these are the most promising areas for aquifer thermal energy storage (ATES). Nevertheless, there is an increasing trend to target more complex aquifers such as low-transmissivity and alluvial aquifers or fractured rock formations. However, the uncertainty and thus the risk of failure in these contexts is significantly higher and it is therefore often not sufficient to rely on experience when designing the ATES system. In this context, a distance-based global sensitivity analysis was carried out for ATES. The analysis focused on one promising thick productive aquifer, used as a reference, as well as two more complex settings involving a low transmissivity and a shallow alluvial aquifer. Through this method, multiple random model realizations are generated by sampling each parameter from a predetermined range of uncertainty. A distance measure between the different model realizations can then be used to determine the relative importance of the uncertain parameters. Not only hydrogeological parameters but also operational and design parameters and boundary conditions were considered uncertain. The parameter distributions were also further analyzed to make a connection with the ATES efficiency. Finally, specific attention was paid to exploring the thermal energy exchange between the soil and the aquifer and its significance for ATES efficiency in shallow aquifers. The results of this study give insight into how the sensitive parameters change when the setting becomes more complex and if it is required to include heat transfer processes that are commonly ignored in traditional settings. This nuanced understanding contributes to the optimization of ATES systems, offering practical guidance for enhanced efficiency of feasibility studies, especially in challenging environments.