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Subpermafrost groundwater systems

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Groundwater basins in polar areas are probably among the least studied systems in the World. Foremost, this is because such systems are mainly situated in sparsely populated areas. Also, where the permafrost is thick and continuous over large areas, the recharge is very limited and terrestrial discharge takes place only in some few springs. A now completed study of polar groundwater was carried out in Svalbard, the arctic archipelago north of Norway. Based on field observations and simulation models it was concluded that major discharge conduits only formed during extensive global glacial phases, beneath the parts of the glaciers were the ice was temperate. During most of the interglacial periods, when the glaciers retreat, the number of discharge springs will decrease gradually as long as continuous permafrost covers the area. However, the amount of recharge and thereby discharge in each individual groundwater spring is today highly dependent on short-time fluctuations in precipitation and air temperature. This situation may also be applicable in other polar areas where glaciers are abundant and parts of them are temperate. Such conditions occur in e.g. Greenland and on islands north of the North American mainland, as well as in parts of Antarctica.

However, we cannot use the glacial-interglacial boundary conditions in all polar regions. Subpermafrost groundwater systems also exist in permafrost areas where few or no glaciers occur today and where the recharge has taken and takes place under e.g. larger lakes or snowfields. In many areas the groundwater systems may be much older than assumed in Svalbard. Their cycles may relate to several glaciations or to true non-glacial periods in the past. The development and melting of thick continuous permafrost are slow processes and the dynamic of the related groundwater systems will be dependent on cold/mild climate episodes lasting for many thousand years. The polar systems thereby have many of the same characteristics as the large groundwater basins in arid and semi-arid areas in warmer parts of the world.

We will present different conceptual models for polar groundwater and discuss how to approach large-scale numerical modelling of such data-poor systems. We want to examine how to use palaeoclimate information to understand the changes of the recharge- and discharge over long time spans.