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Does climate change affect intra-annual groundwater level fluctuations in Fennoscandia?

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For the period 1980-2016, the climate in Sweden and Finland is classified as subarctic climate, with some parts of Sweden classified as having humid continental climate (Kottek et al., 2006; Beck et al., 2018). These climate zones have a winter season which highly influences the regional hydrology, with large quantities of precipitation falling as snow in the cold months and a melting period in spring. This affects the groundwater level, which have maxima often occurring in spring and/or in autumn, when precipitation events coincide with low evapotranspiration (ET), and during snowmelt episodes. Water level minima coincide with high ET, i.e. in summer, and when precipitation events occur at negative temperatures, i.e. in winter. These processes are not uniform across the region; whilst process-influence and process timing vary spatially, some are more or less absent at different sites. Therefore, the timing of groundwater level fluctuations relate to the local water balance, which is highly influenced by the regional climate. Kottek et al. (2006) indicate the subarctic climate zone to have shifted northwards between the periods 1951-1975 and 2001-2025, being exchanged by humid continental climate, and subpolar oceanic climate in southern Sweden. Accordingly, as climate change progresses and mean temperatures increase, especially in the subarctic, the climate zones are predicted to shift more dramatically in space during the upcoming century, and the local winter season will thereby be altered furthermore (Beck et al., 2018). How this effects the regional hydrology is important for mitigation efforts and management, since high and low water tables occur in conjunction with water-related issues, such as water scarcity, floods, and hydrological droughts.
We aim to deduce how intra-annual groundwater level fluctuations were affected by snowmelt regimes and ET in the Swedish and Finnish parts of Fennoscandia, in the past and present. Groundwater in Fennoscandia is often shallow, with major water bodies being isolated from direct influence with each other. The groundwater observation wells we use are considered unaffected by direct anthropogenic influence, and are all in unconsolidated glacial sediment with a record of 30 years or more. We identify the mean month concurring with water table peaks and valleys for two pre-determined 5-year periods (past and present), correlated to meteorological data to verify driving mechanism (e.g. snowmelt, high ET). In addition, we calculate mean and standard deviations of annual water table fluctuations, and analyse differences between results from past and present time series to quantify any change. The results plotted in space and compared to concurrent climate zone classifications show how the climate zones directly impact local water table dynamics, and how the climate zone shift has affected change in intra-annual groundwater level fluctuations.

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Kottek, M., Grieser J., Beck C., Rudolf B., and Rubel F., 2006: World Map of the Köppen-Geiger climate classification updated. Meteorol. Z., 15, 259-263.