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Sensitivity and path dependence in alpine permafrost systems

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With respect to the local and regional consequences of global climate change, the sensitivity of the system in question is often referred to. The same goes for alpine permafrost systems, where for example an increase in the depth of the active layer in rock permafrost walls can have consequences for rock stability, such as enhanced rockfall activity.
It is out of question that the process-related and systemic changes in such seemingly highly 'sensitive' and partly even 'transient' systems call for a detailed monitoring and analysis to (1) enhance the understanding of the processes and to (2) develop scenarios and risk analyses. But how can the sensitivity of a system be defined? Is an overall definition possible and reasonable? If so, what theoretical assumptions could be used and what would these mean regarding data acquisition and interpretation?
In keeping with this, a first attempt is made to transfer the 'sensitivity concept' by Brunsden & Thornes (1979) onto alpine permafrost systems. This concept calls for a holistic perspective and the consideration of different scales of time and space under consideration of internal/external impulses, thresholds and transience.
The central point is the relation between sensitivity and resistivity. These represent the system state at a given point of time and influence the system's reactions to internal and/or external impulses. A second factor of importance is the system's path dependence (or historicity). Past events and impulses determine the current system state as well as its development over time and can even affect its sensitivity towards future impulses.
The applicability of sensitivity and path dependence on mountain permafrost systems is tested at the 'Zugspitze' (2962 m a.s.l.) in the Northern Calcareous Alps at the border between Austria and Germany. Since 2007, a combination of several methods – i.a. electrical resistivity tomography, rock temperature measurements, geological surveys and cleft water measurements – has been applied. Additional data is provided by various earlier works at the study site. Therefore, the 'Zugspitze' seems to be suitable for a first application of the sensitivity concept in mountain permafrost systems.