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Altitudinal spread of area and area changes: a case study for deriving new parameters for monitoring Alpine glaciers

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A time series of four glacier inventories for the Austrian Alps between the little ice age maximum and today reveals shifts in the altitudinal range of the maximum glacier-covered area and in the altitudes where the greatest changes in size of the area took place. These shifts are the result of the specific mass balance, the ice thickness distribution, but also of changes in ice dynamics and have already been subject to studies within the last two centuries. The time series of inventories now allows i) a derivation of these parameters for all glaciers in the Austrian Alps and ii) a comparison of these topographic parameters with records of directly measured ELAs and ice flow velocities.
For the Austrian Alps, the altitudinal zone with the maximum ice cover shifted from 2950 m in 1969 to 2925 m in 1998 and 3025 m in 2006. The maximum area changes took place at elevations of 2675 m (2006 to 1998) and 2850 m (1998 to 1969).
Thorough empirical investigation and theoretical foundation are needed to show if these area shifts can be related to shifts of the ELA and responses of the ice flow velocity or not. As a first step, the suggested potential parameters are investigated for the glaciers and periods where direct mass balance data are available.
The mean ELAs for the above named periods for the seven mass balance glaciers shifted by 112 m from 2945 m (1971-1980) to 3057 m (1981-2000), and by 23 m to 3079 m (2001-2010). From the comparison of geodetic and direct mass balance, the elevation of zero altitudinal change can be derived and compared to the ELA.
Like the ELA, all topographically derived parameters are governed not only by climate, but also by the individual topographic properties of specific glaciers. Thus further investigations of a larger sample of mass balance glaciers are needed to find out if these parameters are suitable for automatic glacier monitoring.