



## On the uncertainty of altitudinal precipitation gradients connecting glaciers to meteorological stations.

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Estimating the response of the current continental cryosphere to ongoing climate changes depends to a large extent on the assumptions made on the precipitation gradients linking observations from outside the cryosphere to the glaciers concerned. The change of precipitation with altitude in Alpine valleys (PG) is seasonally and locally variable and is difficult to measure or to determine indirectly, which implies that precipitation on glaciers and basin precipitation in the Alps are uncertain quantities. This paper addresses the uncertainty first from errors of measurements at individual stations, then presents examples of the simultaneous effect of screening (rain shadowing) and altitude on PG in the Eastern Alps. Basin precipitation (P) is then treated as the residual in the balance of runoff, evaporation and storage in snow and ice, and PG results from assuming a linear increase of precipitation with altitude. The uncertainty of the annual basin precipitation is determined by that of the other terms of the balance. The uncertainty of the mean annual PG depends further on the representativity of the low altitude reference station. Seasonal or monthly values of PG are less constrained, they are subject to possible equifinality of uncertainties in vertical temperature gradients and degree day factors in the storage term. These may temporarily compensate one another and may give the right annual PG at the cost of wrong monthly values. This uncertainty is, however, reduced by the expected different seasonal course of PG, temperature gradient and degree day factor, respectively. The balance has been solved for 80 basins in the Eastern Alps, yielding seasonal values of PG in a range from 5 to 10 % per 100m with lower values in summer.