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Variations of surface albedo of glaciers in the semi-arid Andes of Chile

J. Abermann, C. Kinnard, and S. MacDonell
Centro de Estudios Avanzados en Zonas Aridas, La Serena, Chile (jakob.abermann@ceaza.cl)

The net short-wave radiation is a crucial factor of the surface energy balance of glaciers. It is governed by the quantity of incoming radiation, which is related to the latitude and the atmospheric turbidity, and by the surface albedo, which is a function of the surface properties and meteorological conditions. The high amount of incident solar radiation at the study site, together with the complicated snow accumulation patterns, make an understanding of temporal and spatial albedo variations essential for distributed energy balance studies.
The Guanaco Glacier (GUA) and the Toro 1 Glacieret (TOR1) (which we call a 'glacier' in the following for simplicity) in the dry Andes of Chile at 29.3°S and 70.0°W are studied. On each of them there is an on-glacier automated weather station (AWS) and three years of data are presented. Although less than 2 km apart, these two glaciers show different surface properties: whereas the AWS at GUA is standing on a smooth surface, the AWS at TOR1 is in a field of large penitents during summer. We apply a statistical model based on multivariate stepwise regression that takes independent AWS data as input in order to model temporal albedo variations. The model is calibrated over a one year period (Nov. 2008 – Nov. 2009) and validated over the remaining period (until Jan. 2011). The correlation coefficient (r) between the modeled and observed daily albedo was 0.77 for GUA and 0.87 for TOR1 over the validation period. The model results do not improve when taking more than eight predictor variables into account. Clouds have by far the most significant influence on the albedo at GUA (incoming long-wave radiation is correlated with albedo; r: 0.63), whereas at TOR1 snow height variations (r: 0.47) are important as well. We show a comparison with other albedo parameterizations suggested in the literature. To complement the point-wise results presented, we present time-lapse photographs to show spatial patterns of albedo and their temporal variations.