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Energy and mass balance observations on La Mare Glacier (Ortles-Cevedale, European Alps)

L. Carturan (1), F. Cazorzi (2), and G. Dalla Fontana (1)

(1) Department of Land and Agro-forest Environments, University of Padova (ITALY) (luca.carturan@unipd.it), (2) Department of Agriculture and Environmental Sciences, University of Udine (ITALY)

An experimental site was setup in 2005 on the ablation area of La Mare Glacier, at 2990 m a.s.l., to study the energy and mass balance exchanges between the glacier surface and the atmosphere and to investigate the climatic sensitivity of this particular glacier. An Automatic Weather Station was operated, in the framework of a monitoring network which has been implemented in the Upper Val de La Mare experimental watershed (Trentino, Italy). This basin was selected for a study of climate change effects on cryosphere and hydrology at high-altitude catchments. The 36.2 km2 wide basin has an average altitude of 2906 m a.s.l. and at present the 25% of its surface is glacierized; the annual runoff regime is dominated by snow and ice melt. Direct mass balance measurements have been performed since 1967 on Careser glacier (2.83 km2) and since 2003 on La Mare glacier (3.97 km2).
The AWS is mounted on a tripod which stands freely on the glacier surface and is solar-powered. The variables measured are: air temperature and relative humidity, wind speed and direction, shortwave and longwave incoming and outgoing radiation, precipitation and surface height. All the data are sampled at five-minute intervals as average values, with the exception of surface height which is sampled at hourly intervals, as instantaneous values.
The collected data were used to calculate the point energy and mass balance and to compare the results with similar investigations carried out on glaciers and available in literature. In particular, our attention has been focussed on some processes which regulate the response to climate changes.
The relative importance of the energy balance components was examined and a clear predominance of shortwave radiation inputs was found to exist during melt conditions. Given the relevance of the shortwave net balance, the ice albedo temporal variability (values ranging from 0.1 to 0.5) has been investigated and correlated with meteorological variables. Furthermore, a distinct diurnal cycle of cloud cover was found to control the actual radiation received by the surface, with a minimum coverage at morning and a maximum at late afternoon, due to thermal convection. In addition, the energy available for melt is affected by the glacier cooling effect, which produces a persistent katabatic wind and lead to a reduced climatic sensitivity with respect to the “free atmosphere”. The magnitude of the cooling effect has proved to be comparable with the findings of similar studies conducted in other European glaciers. Finally, the data of the first winter highlighted a very low accumulation on the AWS site, due to strong wind erosion of freshly fallen dry and cold snow. Accumulation became significant only in spring, with the deposition of snow in higher temperature conditions and absence of post-event strong northerly winds.