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Analysis of a 4 year record of meteorological data and energy and mass balance of Forni Glacier, Ortles-Cevedale Group (Stelvio National Park, Italian Alps)

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Since 26^{th} September 2005 an Automatic Weather Station (AWS1 Forni) has been running on the ablation area of the largest Italian valley glacier, Forni, (ca. 12 km^2 of surface area in the Ortles-Cevedale group, Stelvio National Park, Lombardy Alps). The WGS84 coordinates of the AWS1 Forni are given by: 46˚ 23' 56.0" N (46.399˚ N), 10˚ 35' 25.2" E (10.590˚ E), ca. 2700 m, on the lower glacier sector, about 800 m far from the glacier front. From 2009 the AWS was inserted in the CEOP network in the frame of the GEWEX project. The AWS is managed by UNIMI and EvK2CNR Committee.

A four year record (from 1^{st}October 2005 to 30^{th} September 2009) of meteorological data is analyzed: air temperature, relative humidity, wind speed and direction, incoming and outgoing energy fluxes, air pressure, liquid precipitation and snow depth. This permitted to characterize the glacier surface conditions, the calculation of the energy balance and the evaluation of the ablation amount; moreover snow accumulation was considered thus permitting to estimate the glacier mass balance.

The mean value of 150.72 W m^{-2} of measured global radiation is obtained. A comparison with the annual mean extraterrestrial irradiance, 266.82 W m^{-2}, evidences the topography influence (N aspect) and cloud-effect which strongly decrease the amount of solar energy impinging on the glacier surface (with a reduction of ca. 44%). Albedo showed a strong inter annual variability with a mean annual value of 0.65; the lowest value of 0.63 was registered in 2006 and 2007 correlated to the fresh snow amount.

Considering only hours characterized by melting and condensation (i.e. melting occurs about 46.8% of the time and condensation 1.9% of the time), the parameter most influencing the surface energy balance is the net shortwave radiation (with an average during melting of 128.3 W m^{-2} and during condensation of 438 W m^{-2}). During melting the net energy resulted up to five-fold higher than during condensation and during melting the net longwave radiation revealed stronger negative values (-37.9 W m^{-2}, instead during condensation -23.4 W m^{-2}). Latent heat flux was characterized by opposite values: negative during melting (-1.09 W m^{-2}) and positive during condensation (23.3 W m^{-2}).

The cumulative ablation curve over the entire period was calculated through the complete energy balance considering only hours characterized by melting. The total melt value resulted -22.7 kg/m^2 or m w.e. Furthermore, for a period of ca. 30 days in summer 2009, an ablation stake was installed nearby AWS1 Forni to compare measured mass loss with calculated one; the comparison supports calculation of melting from measured energy fluxes.

Snowfall measurement represents a key element for evaluating glacier accumulation. The total value of solid precipitations (obtained from sonic ranger hourly measurements) resulted +7.21 m w.e., in particularly the yearly precipitation amount results quite constant over the four analyzed years with only one exception for year 2008 which was characterized by stronger snowfall (i.e.: 2.03 m w.e.).

Analyzing the calculated mass balance at a daily scale it results mass losses prevailing to gains: the latter do not exceed +0.05 m w.e. /day, instead losses are up to -0.08 m w.e./day.

The calculated melting was added to snow accumulation thus giving the specific annual mass balance (B) at the

location of the AWS1 Forni. B resulted equal to ca. -15.5 m w.e.

Moreover our data permitted further analysis to detect the factors mainly driving the glacier mass balance.