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Glacier runoff under inner tropical conditions: Glacier 12 on Antizana volcano (0˚28'S), Ecuador

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Currently, there is a great scientific and socioeconomic interest in assessing the response of glaciers to climatic fluctuations to which they are exposed, particularly the Andean glaciers that have shown a high sensitivity to climate change. Glaciers in these regions act like water reservoirs that partly contribute to water supply mainly during dry season. In this work we present the application of a Distributed Surface Energy Balance (DSEB) over the Glacier 12 (4750-5700 m a.s.l, 1.68 km^2, 0º 29' S, 78º 9' W) located on the Antisana volcano in the Andes of Ecuador (inner tropics). Our purposes are identify the climatic factors that control seasonal and spatial variations in the mass balance and quantify the glacier melting and its transit to a discharge station.

A set of meteorological variables (short wave radiation, long wave radiation both incoming and outgoing , air temperature, relative humidity, wind speed and precipitation) were recorded (02 July 2011 to 16 May 2013) at half-hourly time step by an automatic weather station at 4750 m a.s.l. on the Glacier 12. These variables were used to characterize the meteorological conditions of the site: air temperature and relative humidity are relatively homogeneous throught the year and precipitation shows a slight seasonality that defines a dry period (June to September) and a wet period (October to May). During the months of June to September the wind speed showed high values (6.23 m/s in 2012) and is responsible of the intense turbulent flows that cause the reduction in melting.

The DSEB model was tested and validated in a neighboring glacier (15α) in the 2002-2008 period and allowed to identify that turbulent fluxes were the main ablation sources during the dry period, which implies a decrease in glacier runoff generation. In addition, in order to quantify the contribution of glacier melting to runoff downstream, a linear reservoir model was used to include the transit time of glacier runoff that reaches the discharge measurement station Los Crespos (4521 m a.s.l, 2.4 km^2 of drained area, 70.4% glacierized) where the storage constants for ice, firn and snow were calibrated according to observations. Although the model reproduce acceptably the hourly (r2=0.41) and daily (r2=0.29) glacier runoff recorded, the model shows that the glacier and snow melting is higher than the runoff recorded at Los Crespos station, this could be explained for these reasons: the upper limit of the glacier is difficult to be defined and the spatial variation for meteorological variables is highly uncertain, but mainly the complex geology could be the main cause for runoff losses.