

Differences in the hydrological behavior of two glacierized sub-catchments in the upper Arve watershed at Chamonix (French Alps): reality or measurement uncertainties?

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Hydrological changes in mountain areas are expected under future climate scenarios, with consequences for water availability and management at catchment and regional scales. Given the strong impact of highly glacierized mountainous regions on regional scale basins, our attention focused on the upper Arve watershed (202 km²), that is, in relation to its size, the most glaciated catchment in France (32% of total area, in 2012). It is located between the two massifs of Mont Blanc and Aiguilles Rouges and it is characterized by a high altitudinal gradient from 1025 to 4295 m a.s.l.. Within the study area we identified two glaciated sub-catchments, Arveyron d'Argentière (32.2 km²) and Arveyron de la Mer de Glace (79.4 km²).

The summer (JJAS) specific average daily discharge is higher of about 13.5% for the Arveyron d'Argentière catchment than for the Arveyron de la Mer de Glace catchment, whereas both are submitted to the same regional climate and have a comparable glacial cover. Our aim is to find explanations for the difference between the hydrological behavior of these two glacierized sub-catchments.

The different behaviors could be due to: (i) glaciological functioning, (ii) actual evapotranspiration, (iii) hydrogeological processes, (iv) spatial distribution of precipitation and/or (v) measurements uncertainty. We made a precise quantification of each component of the hydrological balance equation as well as of their uncertainties.

Looking at geodetic glacier mass balance over the 1979-2003 period, the two considered catchments are characterized by similar glaciological functioning (-0.40 ± 0.2 m a⁻¹ w.e. for Arveyron de la Mer de Glace and -0.31 ± 0.2 m a⁻¹ w.e. for Arveyron d'Argentière). The estimated evaporation rate of Arveyron de la Mer de Glace is greater than Arveyron d'Argentière but it is not sufficient to explain the different behavior. The contribution given by the summer precipitation to the summer discharge is similar in both catchments. Therefore, given measurement or estimations uncertainties we cannot raise any definite explanation for the behavior difference. Further investigations are needed particularly for quantifying the subterranean water fluxes.