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Mechanistic modeling of glaciated alpine basins: case studies

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A simple nonlinear differential model (see "Mechanistic modeling of glaciated alpine basins: model development", Perona & Burlando, this Session) is applied to a number of alpine basins with different topographic, morphologic and hydrologic characteristics. The studied catchments range in size from 4 to 3500 km^2 and are 2 to 32% glaciated. Glaciated areas are taken to represent an initial stored water volume (V). Observed streamflow (Q), precipitation (p), and temperature (T) are used in generating annual average daily time series for $Q, p,$ and T respectively. For each basin, model coefficients are obtained by applying the "Trajectory Method" for the reconstruction of differential equations from time series to the annual daily means of $p, T, Q,$ and V. It is shown that the model is adequately able to describe the link among the variables at the seasonal scale for all the basins. The coefficients with a clear physical meaning vary in a reasonable way and, as expected, are dependent on actual glacial conditions of the catchments. Model coefficients provide insight into the basin drainage time and the damping and elastic properties of the underlying dynamics of the system, which are dependent on input variables p and T. When precipitation is hypothetically set to zero, for instance, the model is dissipative thus showing that the drainage time is dependent on basin initial conditions. Through dissipation, all basins will end up with the same natural frequency function, albeit with different model coefficients. In summary, the mechanistic model provides a new approach to understanding the dynamics of glaciated alpine catchments. Case studies show that with very few input requirements, the model is able to reproduce the seasonal behaviour of observed streamflow regimes. Due to its simplicity and structure, the model can also be used in predicting glacial-nival behaviour under changing climatic scenarios.