Reconstructing mechanistic models of alpine basins hydro-climatic behaviour using observed data

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Abstract. Time series of mean daily values of precipitation p, temperature T and river runoff Q for a glacio-nival basin are analyzed with the purpose of obtaining a 2-D differential model describing the hydro-climatic basin behaviour at a seasonal scale. This is done without claiming any classic empirical link between the volume V of water that is stored on the basin and the corresponding river runoff Q. Such a relationship is directly obtained from observed basin data in two steps. We first propose a differential input-output model of the state variables (V, Q) having considered both the physics of the system and the link among the observed quantities (p, T, Q). Second, we extract the numerical value of the unknown model coefficients by analyzing the trajectory in the state space (V, Q) using the "Trajectory Method" for the reconstruction of differential equations from time series. The nonlinear model that is obtained mimics well the original data, and seems to catch some essential properties of the underlying system dynamics. Moreover, it appears to be enough robust against forcing, and is thus able to describe the basin dynamics at daily and weekly time scales reasonably well. Results show the benefit of this approach not only to study the linear vs non-linear role played by the different terms of the model, but also to investigate the long-term system behavior under different forcing scenarios.

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