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An analytical model of the effects of catchment hypsography on the flood frequency distribution

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The role of the temperature regime on the flood frequency distribution in alpine basins is examined through a minimalistic analytical model of the flood formation mechanisms. We represent rainfall as a marked Poisson process of storm arrivals in time with rate λ each storm having a depth h, where h is modelled as an exponentially distributed random variable with mean α. Each rain event occurs in a liquid form over a fraction of the basin area, the contributing area A_c, while in the rest of the basin the precipitations are in a solid form and do not contribute to the discharge at the outlet. The contributing area depends upon the temperature at the date when the event occurs and, as a consequence, on the watershed elevation characteristics, which are represented through a one-parameter non linear hypsographic curve. Under these assumptions the probability distribution of the annual maxima of discharge is analytically derived, considering also the effect of the seasonal variability of the parameters α and λ. The first results demonstrate that the flood frequency curve in high elevation basins is determined by the superimposition of the precipitation and temperature regimes; the deviations from the undisturbed flood frequency curve (no snow accumulation effect) are particularly relevant when the two regimes are in phase and low return periods are considered. Thanks to its general character, the method can be useful to assess basin similarity through the study of the effects of basin hypsography on flood events.