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Erosion and sedimentation in the Var aerial catchment and submarine basin (Southern French Alps - Mediterranean) using Badlands

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The Var catchment in southern France covers ∼2800 km2 from the Mercantour external crystalline Alpine massif down to the Mediterranean Sea.The 120 km-long Var river starts at an altitude of 2352 m and experiences violent flash floods every year, during fall and spring times. During such events water discharge can increase 10-fold, and suspended sediment concentration reaches tens of kilograms per cubic meter, generating recurrent hyperpycnal currents. Onshore, a compilation of Late Quaternary river incision rates obtained from Cosmic Ray Exposure (CRE) dating of river polished surfaces in the Var catchment systematically point out relatively fast incision rates (1-2 mm/yr) since ∼15-20 ka (i.e. posterior to the LGM). Large incision rates seem correlated with interglacials and may be due to a wetter climate and to the abrupt release of glacier meltwaters. Offshore, the Var river is connected to a deep submarine canyon characterised by abundant hyperpycnal turbidite flows, so that the largest part of river sediment load is directly deposited in a deep submarine basin (> 2000 m depth).

We use the code Badlands to model the incision rate, the topographic evolution and the deep marine sedimentation of the Var catchment over the last 200 ka. Onshore incision is modeled using a Stream Power Law, with variable precipitation rate and erodibility. The original version of the code was adapted to take into account hyperpycnal flows. When the flow density at the river mouth exceeds a threshold (1040 kg/m3), sediments continue their route down the submarine slope similarly to aerial river systems, but with two key differences:
- drainage area does not increase downstream;
- Archimedes force due to underwater flow conditions is accounted for by multiplying S by a factor < 1, which simulates a lower shear stress on the submarine channel floor.
Deposition is forced in the deep basin below a fixed depth.
We use a smoothed present-day topographic and bathymetric grid of the onshore and offshore Var catchment area as initial condition. Sea level fluctuations in the Mediterranean Sea are considered in the model. The model runs for 200 ka and flexural isostasy is computed with a variable effective elastic thickness (EET). Thanks to these rich datasets and the modified numerical model implementation, now accounting for submarine erosion and sedimentation, we are able to investigate the control of climatic, lithological and isostatic parameters on onshore erosion and offshore sedimentation rates in the Var aerial catchment and submarine basin.