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Estimating the full CO_2 budget of the Earth surface denudation: constraints from the Amazon Basin

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The long-term atmospheric C budget is set by the relative magnitudes of volcanic and metamorphic degassing, rock weathering, oxidation of rock organic carbon, and organic carbon burial. Additionally, the influence of rock weathering on the geological C cycle depends on rock types (carbonate vs. silicates) and sources of acidity (atmospheric CO_2 vs. sulfuric acid produced by oxidative weathering of sulfides) [1,2]. Assessing the role of chemical denudation on climate evolution therefore requires a quantification of these different processes, at a scale that matters for the global Earth surface system, i.e. that of large rivers. Here we perform this quantification for the Madeira Basin, one of the main tributary of the largest world river, the Amazon. The headwaters of the Madeira drain regions of the Bolivian and Peruvian Andes almost solely underlain by sedimentary rocks [3], featuring high erosion rates and significant rock organic carbon content [4]. Using previous estimates of silicate and carbonate weathering [1,5,6] and rock organic carbon oxidation [4], along with new estimates for the apportionment of acidity sources, we derive a full CO_2 weathering budget for this catchment. This budget is highly dependent on the geomorphic context, with the Andean uplands rather acting as a CO_2 source whereas the foreland area is acting as a CO_2 sink. These observations bear important consequences on the role of mountain building on the long-term C cycle.

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