Geophysical Research Abstracts
Vol. 12, EGU2010-12251, 2010
EGU General Assembly 2010

Erosion of organic carbon from mountain forest by landslides

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Erosion of particulate organic carbon (POC) from mountains is known to occur at very high rates. This is true of both POC from the terrestrial biosphere (vegetation and soil) and that contained in sedimentary rocks of variable geological age. To understand the controls on the carbon transfer from these different reservoirs, and how they might change under evolving tectonic and climatic forcing, it is necessary to examine the mechanisms responsible for erosion of POC in mountains. Here we quantify the role of landslides in the transfer of POC in natural, forested catchments of the western Southern Alps, New Zealand, using remote sensing and measurements of standing biomass density. First, we derive a model to account for variations in biomass density and carbon stock with altitude based on forest plot measurements. This is combined with the probability distribution of landslide area as a function of elevation, derived over the last four decades, to quantify the rate of landslide-driven erosion of biogenic POC. We also quantify the erosion of fossil POC from bedrock using area-volume scaling laws and the organic carbon content of bedrock. Our findings suggest that high fossil and non-fossil POC erosion rates can be sustained by landslides and highlight the importance of landslides for the input of fossil POC to river networks. We also seek to quantify the proportion of the mobilized POC that is delivered directly to the channel thalweg. We find an important fraction of the mobilized carbon remains on hillslopes. The precise role of this transient carbon store within the landscape remains to be assessed, as does the specific nature of the coupling between hillslopes and river channels and its implications for the fate of landslide-mobilized POC.