Modelling transfer of elements from the continent to the ocean at the large watershed scale in a tropical environment

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Continental weathering of silicate rocks has been recognized as a major driver of climatic changes at the geological timescale. New evidences and preliminary modelling works [1] show that the impact of continental weathering on the geochemical cycles and climate might be non negligible at shorter time scales, from 10^2 to 10^4 years, with for instance an increase in total continental weathering by 12% from the LGM towards the present day [2].

Continental weathering at large scale (10^6 km^2) is generally described through parametric laws (see for instance [3]), linking weathering rates to mean annual air temperature and continental runoff. These laws are masking numerous other parameters, implicitly included, such as the role of vegetation and physical erosion. These laws generally overestimate weathering rates in tropical area, because of high local temperature and runoff. It was indeed stressed by Edmond et al. and others [4] that chemical weathering in tropical environment might be extremely low due to the development of thick soils undergoing weak physical erosion.

Here we present the results obtained with a coupled model of biospheric and weathering processes used to estimate the transfer of elements to the ocean originating from the Guyana shield. The biospheric LPJ model [5] is coupled to the WITCH model [6] that estimates dissolution/ precipitation of minerals in the soil environment from kinetic laboratory laws. The BERNI interface estimates partial pressure of CO_2 in soils, hydrological profiles and uptake/release of elements by plants on a 0.5°long×0.5°lat grid, all these input being required by the weathering model. LPJ is coupled to the WITCH model [6] that estimates dissolution/precipitation of minerals in the soil environment from kinetic laboratory laws.

Output of the coupled model includes major ion concentrations in main stream (Rio Negro and Orinoco) that are compared to available data, and CO_2 consumption through weathering for a tropical environment. We emphasize the need for the development of mechanistic numerical models of weathering processes working at the continental scale.

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