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Earth climate history, and weathering at the watershed and continental scale

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The link between climate and weathering of continental surfaces has been established from watershed scale studies. The consumption of CO_2 through weathering of silicate rocks is linked to temperature (through an exponential law including an activation energy) and runoff (through a linear dependency), as evidenced from many watershed studies. Such kind of dependencies defined the negative feedback mechanisms that stabilizes the Earth climate. Since the early 80's, all biogeochemical-climatic models calculating the evolution of atmospheric CO_2 and climate at the geological timescale rely on such laws, and use them to calculate the balance between CO_2 degassing and CO_2 consumption through weathering from mean annual global climatic parameters (0D models). We will show how a 2D numerical model of new generation (GEOCLIM), coupling the modeling of weathering processes with GCM type climate model leads to a re-interpretation of the Earth climate drivers and to a new climate history for the Mesozoic (characterized by the Pangea break-up), simply through the spatialization of weathering laws and the explicit calculation of the water cycle. We calculate that the increase in continental runoff, forcing weathering to increase during the break-up of Pangea (from 270 to 65 Ma) is responsible for the decrease in atmospheric CO_2 by about 1800 ppmv, corresponding to a continental cooling of 9˚C, despite a source of CO_2 (solid Earth CO_2 degassing) maintained at a constant value.

Apart from improving the link between climate and weathering through spatialization, parametric weathering laws include more than it seems. Even if only runoff and temperature is mathematically visible, the proportionality constant and activation energies also implicitly account for the role of relief, slope, vegetation, uplift rate, but for the

present day general configuration of the global environment. This makes questionable the direct use of these parametric laws in the geological past, where relief or vegetation might be extremely different. A more explicit account for the weathering processes is thus highly required, as far as it can be done. Particularly, the role of vegetation on weathering rates at the catchment scale is explored through the use of a mechanistic model of weathering processes (WITCH).