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Modelling the impact of vegetation on carbonate weathering rates

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Carbonate rocks represent the major reservoir of carbon at the earth's surface. However, the contribution of carbonate weathering to the atmospheric CO_2 regulation is neglected at a scale of 100,000 years. The reason is that the atmospheric CO_2 involved in carbonate weathering returns to the atmosphere during carbonate precipitation in the ocean. In contrast, carbonate rocks exhibit high weathering rates with respect to silicates. Most of the rivers draining carbonate rocks are oversaturated with calcite, thus limiting weathering rates. Consequently, carbonate weathering rates could be strongly sensitive to climate and/or vegetation type. In addition, carbonate rocks could rapidly respond to brutal perturbations as the actual increase in atmospheric CO_2. Therefore, carbonate weathering could have an importance at shorter time scale.
In order to better understand this process, we report results from the Jura Mountains area (East France) exclusively composed of carbonate rocks. This region presents an altitude gradient increasing from 250 m to 1300 m. Over the basin, this gradient generates climatic contrasts of 5°C and a runoff three times higher in altitude. Contrary to calculations that predict the highest concentrations at low temperature, we notice that carbonate dissolution is twice higher in plains than in altitude. This observation may only be explained by a variation in soil pCO_2. Thus, in order to better constrain the observed variation in cation content (principally Ca and Mg) of rivers, we use the ASPECTS model (Rasse et al., 2001). Based on both hourly climatic data, vegetation type and soil type, ASPECTS may reconstruct pCO_2 in soil. Assuming equilibrium between rainwater entering the soil and soil pCO_2, it should be possible to estimate the amount of carbonate dissolved at equilibrium.
Our preliminary simulations show that the measured calcium and magnesium con-

centrations in rivers could be explained by a difference in CO_2 productivity in soil following elevation. We propose that the key parameter for carbonate weathering is the biological activity in soil, which is directly correlated to vegetation type and climate.