Temperature and CO_2 dependency of global carbonate weathering fluxes

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Weathering of carbonate minerals represents an important component in the carbon cycle at short time scales ($<10^5$ years), and it is believed to be mainly controlled by surface runoff, temperature and partial pressure of CO_2 (PCO_2). In this system much attention has been given to runoff relationship for global calculations. Nevertheless, recent studies have shown that carbonate weathering is a complex and dynamic system that depends on climate conditions and biospheric processes. Moreover, global assessments of carbonate weathering fluxes do not reveal processes happening in the soil or the river system which cause a non-linear dependency of carbonate weathering rate to runoff. In this work a new model framework for global carbonate weathering is presented considering equilibrium equations, bridging the gap between oversimplified global carbonate weathering models and integrated mechanistic models. Different approaches to derive soil- and river-CO_2 estimates were applied, and a new temperature-dependent parameterization of river PCO_2 was created. The controls on aquatic PCO_2 and thus river alkalinity were evaluated. Finally a global model for carbonate weathering was developed using equilibrium equations and information on the saturation state of water. This new approach allows to evaluate the sensitivity of carbonate weathering to climate changes (i.e., runoff and temperature variations). Results suggest a decrease in river alkalinity with increasing temperature, which is probably due to an increase in aqueous CO_2 evasion. Furthermore, our modeling results indicate that the temperature has also an indirect role in the control of carbonate weathering rates, impacting the water balance, biological activity and riverine CO_2 evasion.