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Process-based modeling of chemical weathering: A step to reduce model complexity

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Riverine export of major and minor elements to the oceans plays an important role in global biogeochemical cycles. Understanding the response of riverine export to environmental changes over various time- and spatial-scales is therefore essential for prediction of future changes in riverine chemistry including nutrients and pollutants.

Although quantification of chemical weathering rates has been recognized as one of the most important challenges to understanding the Earth system, there remain two scientific and technical problems to be resolved: a significant discrepancy between field- and laboratory-scale weathering rates and computational load for integration of process-based weathering models to large scale climate models such as general circulation models.

A new process-based chemical weathering model was developed to examine possibilities of a reduction of the computational load without losing its ability to reproduce riverine major ion concentrations. We applied the model with full complexity (i.e. vertically one-dimensional heat, moisture, gas, and solute transport and dissolution/precipitation of all minerals) to three different small watersheds to verify the model to reproduce major ion concentrations of modern streams. Then, we reduced model complexity by removing its vertical dimension and/or reducing the number of minerals to be considered. We will present sensitivity of the model results to the reductions of model complexity, and discuss how such process-based weathering models can be applied to environmental studies.

Keywords: chemical weathering, process-based modeling, stream chemistry