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Development and validation of a global sediment dynamics model

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Sediment dynamics are an essential factor in earth system modelling, linked with many aspects such as nutrient transportation, ecosystems and flooding. While many studies are conducted in a local scale, understanding the behavior of sediment transport through rivers in a global scale is also necessary. In this study, we developed a global sediment dynamics model and assessed the reproducibility by using various observation data. The sediment dynamics model is developed within a framework called Integrated Land Simulator, which consists of a land surface model MATSIRO, river inundation model CaMa-Flood and a coupler Jcup. Sediment yield calculated from climate variables and land conditions are used as input. The physical processes considered are sediment transport and deposition for suspended sediments and bedload. Suspended sediments and bedload interact according to hydraulic conditions such as velocity. Simulations were conducted with a spatial resolution of 0.5 degrees and temporal resolution of around 15 minutes. Output analysis was conducted for daily, monthly and annual values.

The amount of global suspended sediment transported from land to oceans through rivers was estimated to be $2.9*10^9$ton/yr, whereas previous studies reported estimates of $13.5\sim22*10^9$ton/yr. This underestimation is partly caused by underestimation at river mouths that have catchment areas of less than 10,000km^2, which accounts for 89% of all river mouths in the model. This is due to poor accuracy of river discharge stemming from the coarse spatial resolution. It should also be noted that the newly developed model does not include human activities, and that our estimates were of similar magnitude of previous studies for pre-human conditions. For 42 validation points with relatively good river discharge simulations, seasonality was well represented but the peak values tend to be underestimated compared to observation values. Out of 28 validation points with data in each month, 17 points were able to simulate the same peak months as observations, with the rest within a 2-month difference.