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Biogeochemical Consequences to Hydrologic Change in an Integrated Global System Model

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In this study, the impact of hydrologic (i.e. precipitation) change on the global physical and ecologic systems is investigated. The MIT Integrated Global System Model (IGSM) is designed for simulating the global environmental changes that may arise as a result of anthropogenic causes, the uncertainties associated with the projected changes, and the effect of proposed policies on such changes. The current IGSM formulation includes an economic model for analysis of greenhouse and aerosol precursor gas emissions and mitigation proposals, models of atmospheric chemistry, climate, ocean as well as of the terrestrial biogeophysical and ecologic systems. All of these models are global and coupled but with intermediate levels of regional detail.

Through the use of the IGSM, the sensitivity of these globally linked systems to imposed changes in the frequency, duration and strength of precipitation is explored. A range of probability distribution functions which determine the arrival rates and duration/intensity of precipitation events at the surface is considered. This range is constructed in such a way as to statistically reproduce the increased probability of hydrologic extremes (i.e. droughts and floods), and span a range of plausible precipitation regime changes of the global system. Analysis will be presented that characterizes the sensitivity of these imposed stochastic precipitation changes on the major components of the globally integrated model. In particular, emphasis will be placed on the impacts of these hydrologic changes to the global biogeochemical fluxes, and their subsequent feedbacks to the modeled climate system. The analysis presented will indicate that a substantial sensitivity exists of global N2O fluxes to not only a change in mean precipitation but changes in the event-based statistics of precipitation (i.e. probably density functions of storm duration/intensity and inter-storm arrival rates). A similar sensitivity is seen for global carbon and methane fluxes, but to a lesser degree for storm

statistics. Overall, the results underscore that potential impacts (and feedbacks) between the global biogeochemical and hydrologic systems are limited not only to mean state changes, but the frequency and intensity of hydrologic events and extremes.