INTEGRATED GLOBAL SYSTEM MODEL FOR CLIMATE POLICY ANALYSIS: I. MODEL FRAMEWORK AND SENSITIVITY STUDIES

by

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SUMMARY

Alternative policies to address global climate change are being debated in many nations and within the United Nations Framework Convention on Climate Change. To help provide objective and comprehensive analyses in support of this process, we have developed a model of the global climate system consisting of coupled sub-models of economic growth and associated emissions, natural fluxes, atmospheric chemistry, climate, and natural terrestrial ecosystems. The framework of the global system model is described and the results of sample first runs and a sensitivity analysis are presented. This multi-dimensional model addresses most of the major anthropogenic and natural processes involved in climate change and is also computationally efficient. As such, it can be used effectively to study parametric and structural uncertainty and to analyze the costs and impacts of many policy alternatives. The initial runs of the model have helped to define and quantify a number of feedbacks among the sub-models, and elucidate the geographical variations in many variables that are relevant to climate science and policy. The effect of changes in climate and atmospheric carbon dioxide levels on the uptake of carbon and emission of methane and nitrous oxide by land ecosystems, is a potentially important feedback which has been identified. The sensitivity analysis has enabled preliminary assessment of the effects of uncertainty in the economic, atmospheric chemistry, and climate sub-models as they influence critical model outputs like temperature, sea level, rainfall, and ecosystem productivity. We conclude that uncertainty regarding labor productivity, technological change, deep oceanic circulation, aerosol radiative forcing, and cloud processes are all important influences on these outputs. Subsequent papers will apply this global system model to assessment of policies currently under discussion in the Framework Convention on Climate Change and other issues such as impact-based methods for ranking greenhouse gases.