KEYNOTE: National Emissions Verification by Merging Earth System Measurements, Global Social Data and Earth System Models

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With the risks of climate change becoming increasingly evident, there is growing discussion regarding international treaties and national regulations to lower greenhouse gas (GHG) emissions. Enforcement of such agreements is likely to depend formally upon national and sectoral emission reporting procedures ("bottom-up" methods). However, for these procedures to be credible and effective, it is essential that these reports or claims be independently verified. In particular, any disagreements between these "bottom-up" emission estimates, and independent emission estimates inferred from global GHG measurements and related data ("top-down" methods) need to be resolved. Because emissions control legislation is national or regional in nature, not global, it is also essential that "top-down" emission estimates be determined at these same geographic scales. The current "top down" methods are reviewed, but these are not accurate enough at present for such verification purposes. A comprehensive strategy is described for quantifying and reducing uncertainties in GHG emissions, based on a synthesis of global observations of various types with models (and their adjoints) of the global cycles of carbon dioxide and other GHGs that include both the natural and human influences on these cycles. The overall goal is to establish a global observing and estimation system that incorporates all relevant available knowledge (chemical, physical, biogeochemical, technological and economic) in order to verify GHG emissions, as a key component of any global GHG treaty. Ref: R. G. Prinn, P. Heimbach, M. Rigby, S. Dutkiewicz, J. M. Melillo, J. M. Reilly, D. W. Kicklighter and C. J. Waugh, Report 200, MIT Joint Program on the Science and Policy of Global Change, http://globalchange.mit.edu/files/document/MITJPSPGC_Rpt200.pdf/.

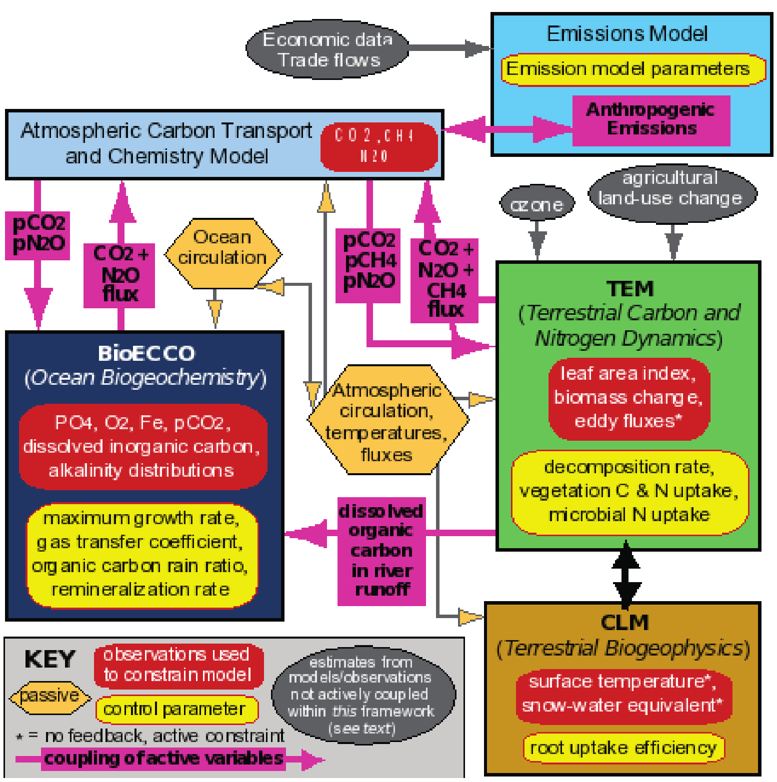

Figure 1. Coupled framework for estimating the rates of cycling of GHGs that have significant natural sources and sinks (e.g. CO_2, CH_4 and N_2O). There are four sub-models (names based on those used at MIT). The two linked terrestrial models form one sub-model in this framework. The four sub-models are linked by the fluxes of the GHGs (purple boxes and arrows). The best possible oceanic and atmospheric circulation data (orange hexagons) are treated as "passive" (not estimated) in the system along with other data (grey ovals). Red boxes give examples of the observations to be used for each sub-model (these are also "state variables" that each sub-model will estimate). The models have multiple uncertain parameters (examples in yellow boxes) treated as "control" parameters that are optimized so that the model system will be brought closer to the observed system.