Population and climate change: fully coupled Earth and Human Systems

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Earth System Models (ESM) designed to study climate change should be fully coupled to a Human model that includes variables such as Population, Energy, Agriculture and Fisheries, Water, as well as environmental sources and sinks. Fully coupling (or two-way coupling) is essential in order to have positive, negative, and delayed feedbacks. For example, the phenomenon of El Niño is the result of such feedbacks, and as a result one-way coupled ocean-atmosphere models (widely used until the mid-1990's) were not able to forecast El Niño. Current ESMs include fully coupled land-oceanatmosphere and vegetation. However, the Human System, which in reality is not only strongly coupled but dominates the Earth biosphere and its changes, is not included or coupled in ESMs. A different type of models, known as Integrated Assessment Models (IAMs), have been designed to include the impact of the human component, including economics, agriculture and energy, on climate change. However, they are still not fully coupled, and typically have one-way coupled components, such as population (obtained, e.g., from UN projections), and simple climate models to reflect the impact of emissions. We are developing a regional prototype human model, including policy knobs or levers, i.e., opportunities to interact with the model through choice of alternative policy instruments, fully coupling it with a realistic ESM that will keep track of carbon pools, land cover types, etc. for each of the ~10 regions. We will show preliminary results including model calibration using Ensemble Kalman Filtering.