1. Introduction

- This study presents the concurrent effects of all important ecosystem processes and anthropogenic disturbances and management practices on North American net carbon budget for the 1990s.
- Patterns of change in plant and soil carbon stocks examined using the terrestrial carbon cycle component of the Integrated Science Assessment Model (ISAM).
- Since carbon sequestrations in terrestrial ecosystems and soils are accompanied by changes in CO₂ concentration, climate, land use, nitrogen deposition and soils management practices, and the interaction between them, which could augment or lessen carbon sequestration, we take a holistic approach to study carbon sequestration by incorporating major environmental changes.

2. Methods

- We use the terrestrial component of the Integrated Science Assessment Model (ISAM-2), which simulates carbon and nitrogen fluxes within the terrestrial biosphere at a 0.5° × 0.5° spatial resolution [Jain and Yang, 2005] (Figure 1).
- The modeled carbon cycle includes feedback processes such as CO₂ fertilization, climate effects on photosynthesis and respiration and increased carbon fixation by nitrogen deposition.
- Changes in land cover classifications are driven by clearing forest for cropland, reforestation and abandonment [Jain and Yang, 2005; Yang et al., 2005].
- Mineral nitrogen deposition rates are based on chemical transport model (Galloway et al., 2004).
- Changes in temperature and precipitation, and CO₂ are based on observation data.
- To estimate carbon sequestration in soils, following a change in cropland management from CT to NT, we use empirically-based sequestration estimates, or CMR curves, which are based on the mean annual change in soil carbon over the expected duration of active sequestration [Jain et al., 2005].

3. Results

- ISAM Estimated Biosphere Fluxes for the 1990s (gCm⁻² yr⁻¹)

   - CO₂ Fertilization
   - Nitrogen Deposition
   - Land Use
   - Forest Fire
   - Climate

- Figure 2: The ISAM estimated distribution of (a) net carbon exchange (gC m⁻² yr⁻¹) during the 1990s attributed to (b) cropland expansion and abandonment, (c) climate change, (d) increase in CO₂ concentrations, (e) nitrogen deposition, (f) forest fire, and carbon management due to no-tillage (Figure 3). Positive values represent net carbon release to the atmosphere and negative values represent net carbon storage in terrestrial biosphere.

- Estimated Soil Carbon Sequestration Potential, CT to NT Averaged Over the Period 1981-2000 (MgC/ha/yr)

- Figure 3: Soil carbon sequestration potential estimated by ISAM, with changes in climate CO₂ and nitrogen following a change from conventional tillage to no-till and averaged over the period 1981-2000. Units of sequestration (MgC/ha/yr) are for cropland areas within grid cells that adopted NT during this time period.

- Various Components of Terrestrial C Fluxes (TgC/deg/yr)

- Figure 4: The ISAM estimated latitudinal distribution of net terrestrial C flux (TgC/deg/yr) during the 1990s, which is sum of land use, climate, CO₂ fertilization, nitrogen deposition, forest fire, and carbon management fluxes. Positive values represent net carbon release to the atmosphere and negative values represent net carbon storage in terrestrial biosphere.

4. References

Yang, X., A. Jain, and W. Post, Modeling the combined effects of CO₂, nitrogen and climate on the carbon dynamics of plants and soils, Scientific Assembly of the International Association of Meteorology and Atmospheric Sciences of the International Union of Geodesy and Geophysics (IAG), Beijing, China, August 2-11, 2005.

5. Acknowledgments

This research was performed as part of the U.S. Department of Energy’s Integrated Assessment program, which is sponsored by the U.S. Department of Energy’s Office of Science, Biological and Environmental Research.