Study advances science of carbon accounting

March 6 2012

Determining with precision the carbon balance of North America is complicated, but researchers at Oak Ridge National Laboratory have devised a method that considerably advances the science.

In developing their approach, a team led by Daniel Hayes of the Department of Energy's ORNL took advantage of inventory records from the United States, Canada and Mexico that track changes in the amount of carbon in various reservoirs such as plants, soils and wood. From these data, they made estimates of the current rate of atmospheric carbon dioxide sequestration over North America. This allowed researchers to calculate the state of the science in determining North America's carbon balance.

"Our results highlight both consistencies and mismatches among methods for quantifying sources and sinks of CO2 at sub-national scales and across different sectors such as forest, crop and other lands," Hayes said. "Depending on the approach, estimates suggest that the land-based sink offsets approximately 20 to 50 percent of total continental fossil fuel emissions."

The researchers noted that land and ocean sinks – which are sequestering carbon about equal amounts of carbon globally – are neither permanent nor fixed. Whether they continue to operate is a research question with critical implications. Hayes and colleagues found that much of the current carbon sequestration in North America is associated with the forest sector in the Northwest and Southeast.

"North American land ecosystems are thought to act as a relatively large sink for atmospheric CO2 , but both its current magnitude and response of this sink to future conditions are highly uncertain," Hayes said. The role played by North America is considerable as it may be responsible for up to a third of the combined global land and ocean sink of atmospheric CO2.

That ability to sequester carbon, however, may change given the influences of drought, wildfires and insect outbreaks that lead to carbon losses.

At odds in the carbon balance equation are the two most common assessment approaches – based on either top-down or bottom-up perspectives. From the top-down perspective, atmospheric models typically estimate much greater sink strength than bottom-up, or land ecosystem models. The inventory-based estimate is lower still than the average land model.

Each approach has strengths and weaknesses, and they all have substantial uncertainties. Modeling approaches are the primary tool available for making climate projections, but these rely on a large number of complicated and often poorly understood processes. Models are mainly based on physical, chemical and biological principles whereas inventories can track things like the movement of carbon in food and wood products that are influenced by social and economic factors.

Inventory methods like those used for this study have the benefit of extensive and repeated measurements yet there are many processes thought to be important that go unmeasured.

"You can't measure everything everywhere all of the time, especially in the future," Hayes said, "so we need models to fill in the gaps."

Scientists continue research to address knowledge gaps and uncertainties in each of these approaches.

"Ultimately, confidence in our ability to understand and predict the role of the North America carbon cycle in the global climate system will increase as new estimates from these different approaches begin to more closely converge and are combined in more fully integrated monitoring systems," Hayes said.

While there is still a huge range in estimates of CO2 sources and sinks, this paper, published today in the journal Global Change Biology, represents a major step toward reconciliation of the global carbon cycle. This could be especially relevant to policymakers.

"Efforts to establish atmospheric stabilization targets for CO2 emissions need accurate and reliable estimates of the global carbon budget," Hayes said.

More information: The paper, titled "Reconciling estimates of the contemporary North American carbon balance among terrestrial biosphere models, atmosphere inversions, and a new approach for estimating net ecosystem exchange from inventory-based data," is available here: onlinelibrary.wiley.com/doi/10 … 011.02627.x/abstract

Provided by Oak Ridge National Laboratory