

## **The Forest as an Integral Component of the Climate System**

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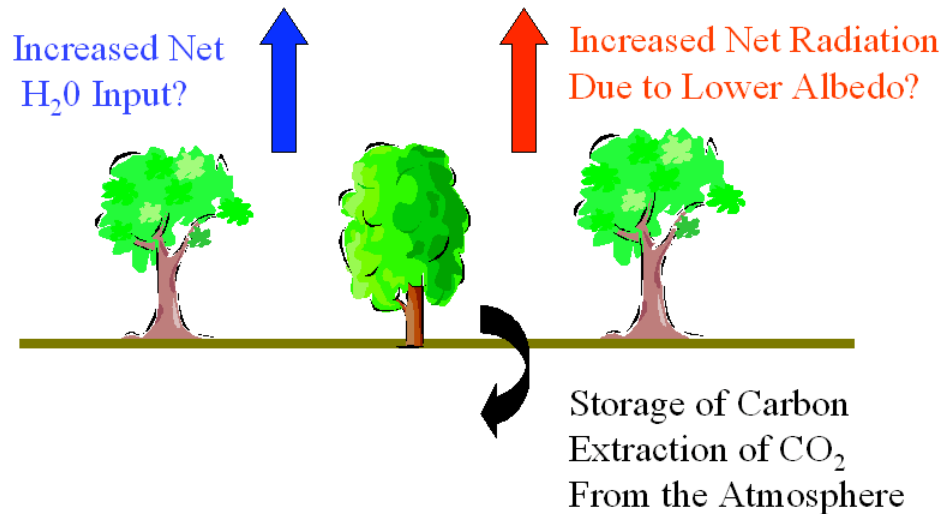
The prevailing perspective that the climate system evolves independently of forest (and other ecosystem) dynamics is flawed. Rather than the prescribed surface boundary that appears in atmospheric-ocean general circulation models, the Earth's surface involves complex, nonlinear physical, chemical and biological fluxes.

Landscape processes directly and indirectly influence the Earth's energy budget. Changes in the atmosphere occur in response to land use changes and there are complex interactions between the two. Carbon dioxide concentrations in the atmosphere significantly influence the transpiration of water and the growth of transpiring leaf area. Storage of carbon in the soils and release of carbon dioxide from soils and vegetation are affected as a result. If carbon storage in trees is increased, for example, this could alter albedo and water balance, with climatic effects.

The complex interactions associated with carbon dynamics thus make the issue of carbon sequestration a multi-faceted problem. If the goal is to reduce carbon dioxide in the atmosphere, in order to reduce the greenhouse gas warming potential of this gas, an associated darkening of the surface, as carbon is stored in the upper soil layers could actually result in a net radiative warming (see Figure 1). It is thus problematic to treat carbon sequestration as independent of these other issues, and such treatment may cause unintended and unexpected outcomes.

Human-caused land use change already has a greater effect on climate regionally than do greenhouse gases. In some areas, the observed warming and drying trend might have been caused by changes from the original landscape to agriculture or other development, as in Belle Glade, South Florida.

There is a need to focus on regional climate changes, which may be caused by regional land use changes, more than global ones. It is possible to have large changes regionally (with associated impacts) that sum to no net global change. For example, on global average, albedo may not have changed much, but locally, albedo has changed a great deal.



## Carbon sequestration as an integrated Earth system issue.

The alteration of the landscape in order to sequester carbon could have other climate consequences. Tropical deforestation not only results in the input of CO<sub>2</sub> to the atmosphere, but also can alter the regional and global hydrological cycle as tropical thunderstorm patterns change. Reforestation and afforestation would also have a regional and global effect on the hydrological cycle.

Since carbon dynamics interact with water, energy, and other trace gas dynamics within the Earth's climate system, an integrated assessment is required to determine the costs and benefits to the environment of deliberate carbon sequestration.

### References

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