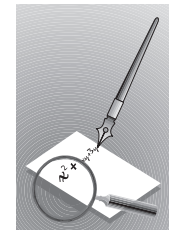
commentary and analysis



Carbon Sequestration—The Need for an Integrated Climate System Approach
C.-G. Rossby's Experience and Interest in Weather Forecasting

Carbon Sequestration—The Need for an Integrated Climate System Approach

The concern with respect to the anthropogenic input of carbon dioxide into the atmosphere (Houghton et al. 1995) has resulted in proposals for long-term removal programs of this gas based on forestation and agricultural procedures. Referred to as "carbon sequestration," the value of this effort is defined by the amount of CO_2 removal and the length of time before it would be reemitted into the atmosphere. The extraction of the CO_2 from the atmosphere reduces its contribution as a radiatively active greenhouse gas. Landscapes that would be modified for this purpose have been referred to as "biomass farms."

However, the alteration of the land surface is likely to result in other effects on the heat energy of the atmosphere. Any additional water vapor evaporated or transpired into the atmosphere, for instance, would increase the greenhouse gas warming effect and at least partially offset the benefit of carbon sequestration. Alternatively, a net reduction in water vapor input might enhance the benefit of carbon sequestration with respect to a reduction in greenhouse gas concentrations.

Since, in the atmosphere, however, a water vapor molecule has a much shorter lifetime than a carbon dioxide molecule, the evaluation of changes in transpiration or evaporation would have to consider its net effect over multiyear timescales. Changes in water vapor flux into the atmosphere can also alter cloud and precipitation, so that its net effect on the radiation budget is quite complex.

It is, therefore, somewhat more straightforward to evaluate the change in the long-term surface energy budget due to the landscape change associated with carbon sequestration. A darkening of the land surface, for example, would result in a lower albedo, which would contribute to atmospheric heating (Cotton and Pielke 1995)—an effort contrary to the goals of carbon sequestration. Elevating the albedo would add to the goal of carbon sequestration. Just changing the surface albedo from 0.2 to 0.15, for example, can reduce the annual averaged insolation reflected back into space by 5 W m^{-2} or more!

There has, unfortunately, been no attempt to evaluate the benefit of carbon sequestration as a means of reducing the concentrations of the radiatively active gas CO_2 in the atmosphere, while at the same time, assessing the influence of this sequestration on the radiatively active gas H_2O, and on the surface heat energy budget. Until these effects are factored in as part of an integrated climate assessment, a policy based on carbon sequestration as a means to reduce the radiative warming effect of increased atmospheric concentrations of CO_2 could actually enhance this warming.

References

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