FORUM

Comment

In a news article in the February 27, 2001 issue [*Showstack*, 2001] Mike MacCracken, a scientist with the U.S. Global Change Research Program, was quoted as supporting the view that land-use change is an important issue with respect to climate change.

However, MacCracken is also quoted as stating that, "But for the 21st century, the kinds of changes that are projected for atmospheric composition are going to swamp anything due to land cover change."

Figure 1, reproduced here from the 2001 Intergovernmental Panel on Climate Change (IPCC) report, supports MacCracken's perspective, in that land-use change is shown as only a small perturbation of the Earth's radiation budget.

Our work strongly suggests a contrary perspective; namely, that the effects of land-cover change on climate may be comparable to, and, perhaps larger than, the effects on climate due to changes in atmospheric composition.

Global mean radiative forcing is not the only, or indeed likely, the most critical forcing of the Earth's climate system. Recent research [*Avissar*, 1995; *O'Brien*, 2000; *Zhao et al.*, 2001; and references therein] highlights the importance of land-use changes within the climate system. A recent global circulation modeling study, for example [*Chase et al.*, 2000], demonstrates that regional land-use change, particularly in deforested tropical regions, has an influence on the weather patterns worldwide. In Chase et al. [2000], the 10-year averaged, simulated January jet stream was displaced hundreds of kilometers worldwide as a result of replacing Earth's current landscape with natural vegetation.

The importance of regional land-use change on the global weather patterns should not be a surprise. We have seen global effects of regional perturbations in recent years whenever an El Niño or La Niña occurs. These ENSO events cause worldwide weather consequences, since they are of large magnitude, long persistence, and are spatially coherent. Thunderstorms, whose spatial patterns are altered by changes in Pacific sea surface temperatures, produce the changed weather patterns at remote locations—that is, teleconnections—as their heat, moisture, and wind energy are transferred over long distances. As shown in the classic study by Riehl and Malkus [1958], 1500–5000 cumulonimbus clouds are the conduits to transport this heat and wind energy. Since cumulonimbus clouds only occur over a relatively small percentage of the area of the tropics, a change in their spatial patterns, whether due to an El Niño or land-use change, would be expected to have global consequences. Moreover, since most thunderstorms occur over the land [*Lyons*, 1999], the role of land in the climate system is greater than inferred from their percentage coverage of the Earth's surface.

Future land-use change would similarly be expected to further alter the Earth's weather patterns.

This effect can occur even in the absence of a change in the global mean radiative forcing of the climate system. Land-use change, however, could also result in a significant net change of albedo and its feedback to cloud cover. Since land-surface changes have accelerated during the past century [*Leemans*, 1999], the potential for significant human-caused alterations in land-surface albedo exist.

It is evident in their summary that the IPCC report has not adequately considered the effect of land-use change on the climate system. Pielke [2001a] discusses this subject in more detail, while Pielke [2001b] overviews other issues that are only incompletely, if at all, discussed in the IPCC report. Our findings should be interpreted to suggest that humans have an even greater effect on climate than is suggested by the IPCC. The human influence on climate is significant and multi-faceted. These findings have implications for the inherent predictability of climate, as well as policy responses [*Sarewitz and Pielke*, 2000].

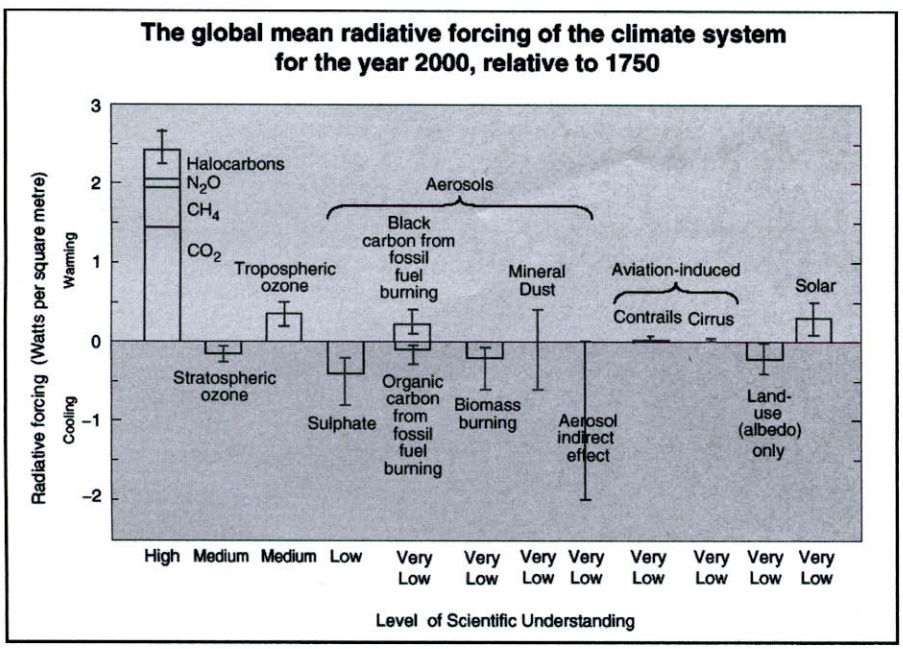

Fig. 1. Many external factors force climate change. (Reproduced from Working Group I of the Intergovernmental Panel on Climate Change [2001]). While this figure shows an estimated small effect of land use, the level of scientific understanding is admitted to be "very low." An obvious question is, how can such small uncertainty be conveyed in the figure in conjunction with a "very low" level of scientific understanding?

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