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LANDCOVER CHANGES MAY RIVAL GREENHOUSE GASES AS CAUSE OF CLIMATE CHANGE

While many scientists and policy makers have focused only on how heat-trapping gases like carbon dioxide are altering our global climate, a new NASA-funded study points to the importance of also including human-caused land-use changes as a major factor contributing to climate change.

Land surface changes, like urban sprawl, deforestation and reforestation, and agricultural and irrigation practices strongly affect regional surface temperatures, precipitation and larger-scale atmospheric circulation. The study argues that human-caused land surface changes in places like North America, Europe, and southeast Asia, redistribute heat regionally and globally within the atmosphere and may actually have a greater impact on climate than that due to anthropogenic greenhouse gases combined.

The study also proposes a new method for comparing different human-influenced agents of climate change in terms of the redistribution of heat over land and in the atmosphere. Using a single unit of measurement may open the door to future work that more accurately represents human-caused climate change.

“Our work suggests that the impacts of human-caused landcover changes on climate are at least as important, and quite possibly more important than those of carbon dioxide,” said Roger Pielke, Sr., an atmospheric scientist at Colorado State University, Fort Collins, Colo., and lead author of the study. “Through landcover changes over the last 300 years, we may have already altered the climate more than would occur associated with the radiative effect

of a doubling of carbon dioxide." If carbon dioxide (CO_2) emissions continue at current rates, atmospheric CO_2 concentrations are expected to double by 2050. Land surface changes will also continue to occur.

Types of land surface strongly influence how the Sun's energy is distributed back to the atmosphere. For example, if a rainforest is removed and replaced with crops, there is less transpiration, or evaporation of water from leaves. Less transpiration leads to warmer temperatures in that area. On the other hand, if farmland is irrigated, more water is transpired and also evaporated from moist soils, which cools and moistens the atmosphere, and can affect precipitation and cloudiness.

Similarly, forests may influence the climate in more complicated ways than previously thought. For example, in regions with heavy snowfall, reforestation or afforestation would cause the land to reflect less sunlight, and more heat would be absorbed, resulting in a net warming effect despite the removal of CO_2 from the atmosphere through photosynthesis during the growing season. Further, reforestation could increase transpiration in an area, putting more water vapor in the air. Water vapor in the troposphere is the biggest contributor to greenhouse gas warming.

Local land surface changes can also influence the atmosphere in far-reaching ways, much like regional warming of tropical eastern and central Pacific Ocean waters known as El Niño. El Niño events create moist rising air, thunderstorms and cumulus clouds, which in turn alter atmospheric circulations that export heat, moisture, and energy to higher latitudes. Tropical land surface changes should be expected to play a greater role on global climate than El Niño, given that thunderstorms prefer to form over land, and the fact that the large area of tropical land-use changes far exceeds the relatively small area of water responsible for El Niño. Impacts of land use changes are harder to detect because they are permanent, as opposed to El Niño, which comes and goes.

Pielke Sr., and colleagues propose a new method for measuring the impacts of both greenhouse gases and landcover changes by using a formula that quantifies all the various anthropogenic climate change factors in terms of the amount of heat that is redistributed from one area to another. This heat redistribution is stated in terms of watts per meter squared, or the amount of heat associated with a square meter area. For example, if a flashlight generated heat of one watt that covers a square meter, then the heat energy emitted would be one watt per meter squared.

By using a measure based on the spatial redistribution of heat to quantify the different human influences on climate, including landcover changes and greenhouse gases, the researchers hope to achieve a more accurate portrayal of all of the anthropogenic influences on climate change in future research.

The paper was published in a recent issue of the Philosophical Transactions of the Royal Society of London. The research was funded by grants from NASA and the National Science Foundation.

For more information, see:
http://www.gsfc.nasa.gov/topstory/20020926landcover.html

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