PHYS.ORG

Trees invading warming Arctic will cause warming over entire region, study shows

January 12 2010, By Robert Sanders

Denali National Park is one area where once-treeless tundra will be invaded by trees as a result of global warming. A new study indicates that as trees move northward with increasing temperatures, they will enhance warming over the entire Arctic north of about 60 degrees north latitude, accelerating the melting of sea ice. (Abigail Swann/UC Berkeley)

(PhysOrg.com) -- Contrary to scientists' predictions that, as the Earth warms, the movement of trees into the Arctic will have only a local warming effect, University of California, Berkeley, scientists modeling this scenario have found that replacing tundra with trees will melt sea ice and greatly enhance warming over the entire Arctic region.

Because trees are darker than the bare tundra, scientists previously have suggested that the northward expansion of trees might result in more absorption of sunlight and a consequent local warming.

But UC Berkeley graduate student Abigail L. Swann, along with Inez Fung, professor of earth and planetary science and of environmental science, policy and management, doubted this local scenario because, while broad-leaved trees are dark, they also transpire a lot of water, and water vapor is a greenhouse gas that is well-mixed throughout the Arctic.

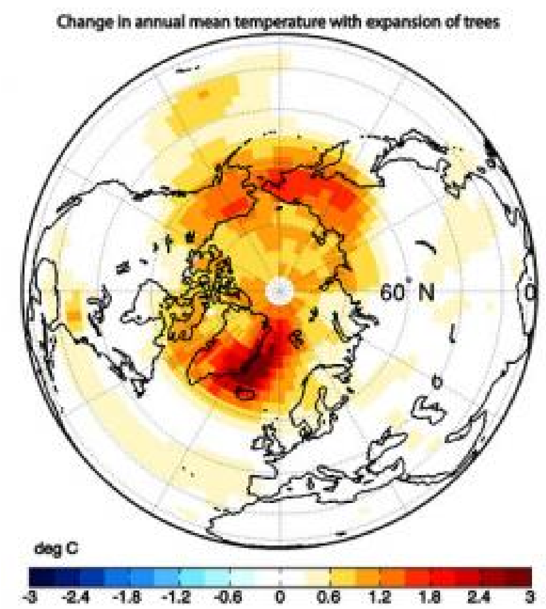
Taking account of this in a standard model of global warming, the researchers discovered that, while broad-leaved trees do absorb some additional sunlight, the water vapor they pump into the atmosphere causes a more widespread warming.

"Broad-leaved deciduous trees are not as dark as evergreen trees and so are generally assumed to be less important. But broad-leaved trees transpire a lot more water through their leaves and are actually able to change the water vapor content and increase the greenhouse effect. As the air warms, it can hold more water vapor, and the greenhouse effect increases further," Swann said. "So, broad-leaved trees end up warming the entire Arctic."

More importantly, the researchers' model predicts that the increased water vapor would melt more sea ice, resulting in more absorption of sunlight by the open ocean and dumping more water vapor into the atmosphere. This positive feedback will warm the land even more and encourage faster, more efficient tree growth and perhaps a faster expansion of trees into the Arctic.

All told, the model predicts an additional 1 degree Celsius increase in temperature over the Arctic as a result of this effect. Global warming already is predicted to increase temperatures in the Arctic between 5 and 7 degrees Celsius within the next 100 years.

The analysis was reported Jan. 7 in the online Early Edition of the journal *Proceedings of the National Academy of Sciences.*



Trees are darker than tundra, absorbing more light, but they also transpire more water, increasing water vapor, a potent greenhouse gas. As a result, when trees overrun Artic tundra, they will enhance warming, not merely over the land, but in a feedback loop, increase temperatures up to 3 degrees Celsius over parts of the north. (Abigail Swann and Inez Fung/UC Berkeley)

In judging the impact of vegetation on global warming, most scientists have focused on the albedo, or reflectivity, of vegetation, Swann said. The new study shows that water transpiration can have a large effect as well, especially in "closed" environments like the Arctic, where there is greater confinement of atmospheric gases. Swann suggests that the greenhouse consequences of transpiration will be much less in the mid-latitudes and tropics, or at least harder to pin down.

"We are trying to identify the physical processes that are going to be important with these changes, and this is an interaction that wasn't really looked at before," Swann said. "Counter to assumptions, it's not just a change in the color of the surface vegetation that affects warming."

Previous studies have shown that needle-leaved trees, because they are much darker than bare tundra, will absorb more light and increase warming. But needle-leaved trees transpire much less water than broad-leaved deciduous trees, so the UC Berkeley researchers expect transpiration to only slightly increase this warming effect.

If past episodes of warming are any indication, however, broad-leaved deciduous trees will expand their range more quickly into northern regions than will needle-leaved trees.

“Alaska is already getting shrubbier," Fung said. "We hypothesize that there are 'pioneers,' like shrubs and deciduous trees, that modify the climate until it is comfortable, and then the whole clan moves in."

Co-authors with Swann and Fung are Samuel Levis and Gordon B. Bonan of the National Center for Atmospheric Research in Boulder, Col., and Scott C. Doney of the Department of Marine Chemistry and Geochemistry at the Woods Hole Oceanographic Institution in Massachusetts.

Provided by University of California - Berkeley

Citation: Trees invading warming Arctic will cause warming over entire region, study shows (2010, January 12) retrieved 25 April 2024 from https://phys.org/news/2010-01-trees-invading-arctic-entire-region.html