Potsdam Institute for Climate Impact Research

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Computer simulations in Potsdam explain the greening of the North

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Scientists at the Potsdam Institute for Climate Impact Research (PIK) have now explained for the first time why satellites have been observing a greening of northern vegetation since the beginning of the 1980s. Together with colleagues from Jena (Germany), Boston (USA), Paris (France) and Lund (Sweden), they used a sophisticated computer model to relate climate to the growth of plants, finding that only climate change can explain the change in vegetation. Despite some fluctuations from year to year, the onset of spring now occurs earlier in Canada, Northern Eurasia and Siberia than it did twenty years ago. The exact reasons for this had been unclear. The new study shows a convincing link between climate and vegetation growth for this large region. This link will now be used to predict future changes in the biosphere.

Wolfgang Lucht, scientist at PIK explains in his contribution to Science, to be published on May 31, how the relationship between climate and vegetation works. In the computer simulation, the growth of northern plants is directly controlled by climate. For this, many processes occurring in plants, such as photosynthesis, water fluxes, seasonal development, are all described individually, and in relation to each other. Climate change affects these processes, and even short-term fluctuations trigger the model to give just the response that was also observed from satellites. During the last 20 years, temperature has increased in the region, on average, by 0.8 degrees C. If the model is run with no

warming, or any other level of it, then observations do not match with the simulated vegetation trend. Clearly, leaves are forming earlier in the season there, and we now know why.

The calculations also show that the overall warming trend suffered a significant setback in 1992 and 1993, before continuing with similar speed. This was due to the massive eruption of Mount Pinatubo in the Philippines, which had ejected unprecedented amounts of fine particles into the upper atmosphere, producing a short global cooling episode. Vegetation growth was consequently reduced during these years. The storage of carbon dioxide in vegetation and soils, however, appears to have continued. The simulations show that this must be due to a slowed release of carbon dioxide from Northern soils.

The study sheds light on important processes of global change. Northern vegetation covers almost a quarter of the Earth's surface. Its forests are influenced by summer temperatures and can therefore be expected to react strongly on global warming. If fossil fuel emissions create the expected warming during the coming decades, then these Northern forests are likely to be most strongly affected. To assess the positive or negative outcomes of such changes we need computer simulations that reflect all major influencing processes. The present results and their agreement with observations from space show that predictions of future change in Northern forests have become more reliable than before.

Most of these results were achieved with support by the DEKLIM climate research programme of the German Federal Ministry for Education and Research, given to a team of five young scientists at PIK. The group, and its international partners, now plans to use the computer model to make further investigations of feedbacks between biosphere and climate, of consequences for global human use of the land, and of the global water cycle.

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