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Scientists Say Soot Particles Can Lead to Flooding and Drought

New study collects data in China and India

A new climate study finds that large amounts of soot particles and other pollutants are causing changes in precipitation and temperatures that may be responsible for the tendency toward increased floods and droughts in China and other Asian regions over the last several decades.

A National Aeronautics and Space Administration (NASA) press release says the results of the study, published in the September 27 issue of the journal *Science*, indicate that black carbon or soot can affect regional climate by absorbing sunlight, heating the air and thereby altering large-scale atmospheric circulation and the hydrologic cycle.

Using a climate computer model at NASA's Goddard Institute of Space Studies and aerosol data from 46 ground stations in China, researchers found that the effect of increased amounts of soot over southern China created a "clear tendency" for flooding that has been occurring in southern China and the increasing drought over northern China that has persisted over the last several years. Research is currently being conducted to verify a similar pattern over India.

Black carbon or soot is generated from industrial pollution, traffic, outdoor fires and household burning of coal and biomass fuels. The black carbon aerosols soak up the sun's rays heating up the atmosphere. The heated air rises and creates rain clouds over polluted areas. The rising air is balanced by an increase in sinking air and drying in neighboring regions.

Scientists also believe that as soot heats the lower atmosphere over China, some of this warm air can get transported to other regions of the world, causing surface warming in distant locations. In a separate article in *Science*, researchers at the Georgia Institute of Technology say that the newly understood impacts of soot support arguments to shift more responsibility for curbing climate-changing pollution to developing nations such as China and India.

Following is the text of the NASA press release:

**National Aeronautics and Space Administration (NASA)
Goddard Institute of Space Studies
September 26, 2002**

Black Carbon Contributes To Droughts And Floods In China

A new NASA climate study has found that large amounts of black carbon (soot) particles and other pollutants are causing changes in precipitation and temperatures over China and may be at least partially responsible for the tendency toward increased floods and droughts in those regions over the last several decades.

In a paper appearing in the September 27 issue of *SCIENCE*, Surabi Menon of NASA and Columbia University, and her colleague, James Hansen of NASA's Goddard Institute for Space Studies, New York, indicate that black carbon can affect regional

climate by absorbing sunlight, heating the air and thereby altering large scale atmospheric circulation and the hydrologic cycle.

Using the NASA Goddard Institute for Space Studies climate computer model, and aerosol data from 46 ground stations in China, Menon and Hansen conducted four sets of computer simulations to monitor the effects of black carbon on the hydrologic cycle over China and India. The aerosol data from the Chinese ground stations were provided by Yunfeng Luo, a co-author on the study from the Institute of Atmospheric Physics, Chinese Academy of Sciences.

In the four numerical simulations, Menon and Hansen isolated specific factors such as sea surface temperature, other greenhouse gases, and aerosols and analyzed whether changes in those factors would be responsible for hydrologic cycle changes.

Out of the four scenarios, the effect of increased amounts of soot (over southern China) created a clear tendency toward the flooding scenario that has been occurring in southern China and the increasing drought over northern China that has persisted over the last several years.

"If our interpretation is correct, then reducing the amount of black carbon or soot may help diminish the intensity of floods in the south and droughts in the northern areas of China, in addition to having human health benefits," Hansen said. Currently research is being conducted to verify a similar pattern over India.

Black carbon or soot is generated from industrial pollution, traffic, outdoor fires, and household burning of coal and biomass fuels. Soot is a product of incomplete combustion especially of coal, diesel fuels, biofuels and outdoor biomass burning. Emissions are large in China and India because cooking and heating are done with wood, field residue, cow dung, and coal, at a low temperature that does not allow for complete combustion. These resulting soot particles absorb sunlight, just as dark pavement becomes hotter than light pavement in the summertime.

When soot absorbs sunlight it heats the air and reduces the amount of sunlight reaching the ground. The heated air makes the atmosphere more unstable, creating rising air (convection), which forms clouds and brings rainfall to regions that are heavily polluted.

The increase of rising air in southern China is balanced by an increase of sinking air (subsidence) and drying in northern China. When air sinks, clouds and thus, rain, cannot form, creating dry conditions. For example, deserts are places where subsidence occurs.

In recent years, northern China has suffered from an increased severity of dust storms, while southern China has had increased rainfall that is thought to be the largest change in precipitation trends since the year 1950. Menon and Hansen believe that human-made sunlight-absorbing aerosols may be responsible.

This research continues long-term observations of global climate change and was funded by NASA's Earth Science Enterprise and the National Science Foundation. NASA's Earth Science Enterprise is dedicated to helping us to better understand and protect our home planet.

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