Airborne Sunphotometry Of Smokes And Hazes

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The particles suspended in clouds, smokes, and hazes scatter and absorb sunlight. In this way they change the balance of incoming and outgoing solar energy. Widespread, persistent changes in clouds, smokes, or hazes can change the Earth's energy balance and thereby global and regional climates. National and international research programs are now being conducted to better understand these particle-induced climate changes and how they relate to changes caused by greenhouse gases.

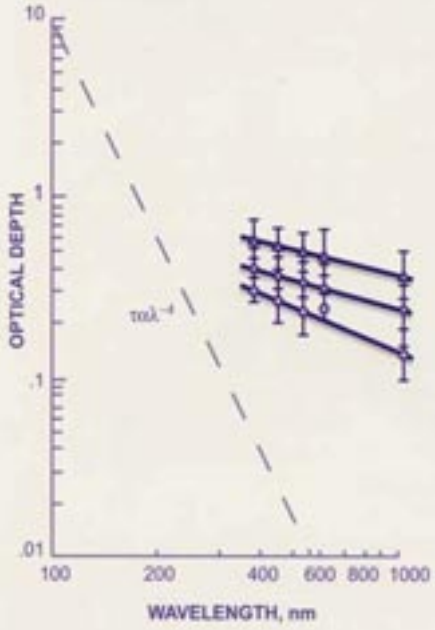
The Ames Airborne Tracking Sunphotometers measure the transmission of sunlight through hazes, smokes and clouds. They fly on a variety of aircraft, including the NASA DC-8 and C-130, the University of Washington CV-131A and CV-580, and the Center for Interdisciplinary Remotely Piloted Aircraft Studies (CIRPAS) Pelican (modified Cessna). Because different wavelengths of sunlight (ultraviolet, visible and infrared) are attenuated differently, the sunphotometers make measurements in different wavelength bands of the sun's spectrum. Results are described by a quantity called optical depth, which measures how strongly light is attenuated.

The 6-channel Ames Airborne Tracking Sunphotometer (AATS-6) has been used in several studies of different types of smoke. These studies revealed an important difference between jet-fuel smokes and forest-fire smokes. As the plots on the reverse show, forest-fire smoke optical depths (right) depend on wavelength more strongly than do those ofjet-fuel smoke (leJ2). (The forest-fire curves slope downward more than the jet-fuel curves.) The sun colors in the photographs above the plots agree with the sunphotometer data in the plots. Note that the sun, when observed through forest fire smoke (photo on reverse, right), appears redder than when viewed through jet-fuel smoke (photo on reverse, left).This occurs because the forest-fire smoke attenuates red (700 nanometer [nm]) wavelengths much less than blue (400 nm) wavelengths, and hence, transmits more red light. The jet-fuel smoke, having nearly equal attenuation in the visible region (400 to 700 nm), transmits all colors nearly equally, preserving the sun's white color (photo on reverse, left).

These results have implications for the potential climatic impact of smoke from large scale fires, and on the detectability of smoke from satellites. In particular, they explain previous remote-imaging measurements that showed greater transparency of forest-fire smoke at longer wavelength.

The Ames Airborne Tracking Sunphotometers also measure water vapor, which can have a strong impact on the growth of smoke and haze particles. In addition, the 14-channel Ames Airborne Tracking Sunphotometer (AATS-14) can measure ozone, an important atmospheric oxidant that can be produced by biomass burning.

JET FUEL FIRE FLIGHT 13
13 MARCH 1987



FOREST FIRE BURN FLIGHT 12
DECEMBER 1985