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Decadal Trends in the Background Stratospheric Aerosol

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Stratospheric aerosol measurements are made with Nd(YAG) lidars at Boulder, Colorado and at Mauna Loa Observatory, Hawaii. Since the eruption of the volcano Pinatubo in June 1991, minor eruptions having brief, local stratospheric effects have been observed, but there have been no major eruptions capable of perturbing the global stratosphere above 20 km. This has provided an unusual opportunity to study the background aerosol, free of volcanic effects. The period following the decay of the Pinatubo aerosol, from about 1996 to the present, is the longest period without a major volcanic stratospheric aerosol perturbation since the sulfate layer was discovered by Junge in 1959. Both Boulder and Mauna Loa show a well-defined annual variation in the background aerosol with a maximum in winter believed to be associated with transport from the tropical source region. There appears to be a clear biennial variation in the amplitude of the aerosol backscatter growth rate during these annual cycles at both sites. At Boulder, where aerosol lidar measurements began about 2000, an increasing decadal trend of about 8-10% per year in the integrated stratospheric lidar backscatter has been observed above 20 km. At Mauna Loa, where the lidar record extends back to the 1970's, a similar increase in aerosol backscatter, beginning in about 2000, has been observed. Under non-volcanic conditions, the background sulfate aerosol is sustained mainly by sulfur dioxide (predominantly from the burning of coal) and carbonyl sulfide emissions at the surface which enter the stratosphere in the tropics. Increased emissions and/or enhanced tropical upwelling circulation in the lower stratosphere, possibly related to climate change, could thus affect the decadal trend of the background stratospheric aerosol. It is shown that recent (since 2000) increases in coal burning may account for a portion of the aerosol increase.