Lidar Observations of Volcanic Emissions to the Stratosphere

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Following development of high-power lasers, the technique of detecting monochromatic light backscattered by a target (light detection and ranging - lidar), found primitive application to volcanic studies after the Agung eruption of 1963. In this application, laser light is backscattering off of stratospheric aerosol particles which form in the stratosphere from volcanic gaseous sulfur injections, and is detected with a telescope and sensitive light detectors. However, lasers with adequate power and repetition rate for scientifically useful studies were generally not available to the scientific community until the 1970's. Thus, major eruptions such as that of El Chichón in 1982 and Pinatubo in 1991were studied by lidars at numerous locations. Initially, red light (693 nm) from a low repetition rate ruby laser was the only adequately powerful light source available; however, by 1990 the green light (532 nm) of the Nd:YAG laser, with its higher repetition rate, became the standard of volcanic lidar studies and remains so today.

Although a lidar gives only a single geographic representation of volcanic effects on the stratosphere, the vertical resolution of the technique and its continuous operational character have made it an invaluable tool for scientific studies of the processes involved in stratospheric aerosol particle formation. In this discussion of volcanic lidar measurements, data from several lidars with long-term records will be presented and compared to other long-term point measurements of the vertical profile of the stratospheric aerosol, such as balloonborne particle counters.

With the recent absence of major volcanic eruptions, the stratosphere has been in a relatively quiescent state for the past six years. In fact, in terms of aerosol particles, the stratosphere is probably in its cleanest state since the discovery of the sulfate layer by Junge in the late 1950's. This unusual situation allows the question of the existence and nature of a "background" stratospheric aerosol to be pursued, asking the important scientific question: "Do stratospheric aerosol particle formation processes related to non-volcanic or anthropogenically influenced tropospheric sulfur gas injections, which are generally totally masked by the effects of major volcanic eruptions, exist?"