Comparison of aerosol extinction between lidar and SAGE II over Gadanki, a tropical station in India

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Abstract. An extensive comparison of aerosol extinction has been performed using lidar and Stratospheric Aerosol and Gas Experiment (SAGE) II data over Gadanki (13.5° N, 79.2° E), a tropical station in India, following coincident criteria during volcanically quiescent conditions from 1998 to 2005. The aerosol extinctions derived from lidar are higher than SAGE II during all seasons in the upper troposphere (UT), while in the lower-stratosphere (LS) values are closer. The seasonal mean percent differences between lidar and SAGE II aerosol extinctions are >100 % in the UT and <50 % above 25 km. Different techniques (point and limb observations) played the major role in producing the observed differences. SAGE II aerosol extinction in the UT increases as the longitudinal coverage is increased as the spatial aerosol extent increases, while similar extinction values in LS confirm the zonal homogeneity of LS aerosols. The study strongly emphasized that the best meteorological parameters close to the lidar measurement site in terms of space and time and \(B_a\) (sr\(^{-1}\)), the ratio between aerosol backscattering and extinction, are needed for the tropics for a more accurate derivation of aerosol extinction.

Keywords. Atmospheric composition and structure (aerosols and particles; instruments and techniques)

1 Introduction

The upper troposphere (UT) and lower stratosphere (LS) are regions of highly coupled dynamics and have created major scientific interest due to its particular role in radiative forcing and chemistry–climate coupling. Changes in UTLS aerosol characteristics play an important role in the global and regional climate system and the geochemical cycle (Hanson et al., 1994; Borrmann et al., 1997; Solomon et al., 1997). The tropical UT aerosols are important in establishing the characteristics of the stratospheric aerosols, as air enters the stratosphere in the tropics and carries tropospheric aerosol with it (Hamill et al., 1997). There have apparently been no major volcanic eruptions of the magnitude of El Chichón or Mount Pinatubo since 1991. Accordingly, the stratosphere has attained a relatively persistent volcanically quiescent period, in which variations and trends in the “background” stratospheric aerosol can be effectively investigated (Thomason et al., 2008). Recent studies using ground-based lidar and satellite instruments document an increase in stratospheric aerosols of 4–10 % per year from 2000 to 2010 (Vernier et al., 2011b; Hofmann et al., 2009; Nagai et al., 2010; Trickl, 2010). Solomon et al. (2011), using near-global satellite data, reported a negative radiative forcing of about \(-0.1\) W m\(^{-2}\) due to changes in the stratospheric aerosols over the last 10 years starting from 2000.

The vertically resolved measurements of physical and optical properties of aerosols are of great interest and can be obtained from ground-based lidar, but they are usually restricted both in time and space. Lidar observations of aerosols have been recognized as a valuable complementary source to the information obtained from satellites (Ramaswamy et al., 1995). For both an extensive period of observation and global coverage, satellite payloads are best suited. The Stratospheric Aerosol and Gas Experiment (SAGE) II provided multi-wavelength aerosol extinction coefficient profiles from the mid-troposphere through the stratosphere during October 1984–August 2005. SAGE II aerosol observations have been widely used for providing and studying cli-