Dust lidar ratios retrieved from the space-borne CALIOP measurements using the MODIS AOD as a constraint

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Dust lidar ratios are retrieved by a synergetic use of CALIOP and MODIS products for 5 years from 2007 to 2011. The CALIOP level 1 total attenuated backscatter data is used for the retrieval and the CALIOP level 2 aerosol profile product is used to determine dust layers. Quality assured (QA > 1 for dark target ocean, QA = 3 for deep blue land) aerosol optical depth (AOD) data from the MODIS level 2 aerosol product is used as constraint. MODIS AOD retrievals and CALIOP attenuated backscatter profiles closer than 10 km from the center of MODIS pixel are defined as collocated measurements. Clouds are screened out for both CALIOP and MODIS. The retrieval is performed for the whole column of the atmosphere from 30 km to the surface adopting a constant lidar ratio of 30 sr for aerosols of clear air above the detected layers. The retrieved dust lidar ratios show a log-normal distribution with mean (median) values of 39.5 ± 16.8 (38.1) sr and 46.6 ± 36.3 (39.2) sr for ocean and land, respectively. The mean values are comparable to the value of 44 sr currently used in the CALIOP level 2 aerosol algorithm but the median values are relatively lower. There is a distinct regional variation in the retrieved dust lidar ratios. Dust lidar ratio is larger for the Saharan Desert (49.5 ± 36.8 sr) than the Arabian Desert (42.5 ± 26.2 sr), which is consistent with many previous studies. Dust aerosols transported to the Mediterranean Sea (44.4 ± 15.9 sr), Mid Atlantic (40.3 ± 12.4 sr) and Arabian Sea (37.5 ± 12.1 sr) show lower values compared with their source regions. An aging process of the long-range transported dust to remote ocean may be responsible for low lidar ratios. Dust lidar ratio over ocean in East Asia is 41.8 ± 27.6 sr is comparable with previous studies. Over Taklamakan and Gobi Deserts region the retrieved dust lidar ratios (35.5 ± 31.1 sr) show low values but still comparable with previous studies. Dust lidar ratios for Australia (35.4 ± 34.4 sr) are also relatively low compared with other regions. Although the mean AOD difference between CALIOP and MODIS is small (close to zero), the distribution of the AOD difference shows that the CALIOP AOD is biased low. However, when including clear air AOD for CALIOP, AODs from the two sensors become more comparable. A conclusion that can be drawn from this is that retrieving only for the detected layers in the CALIOP algorithm is one of the major reasons for lower AODs for CALIOP than MODIS. Lidar ratios retrieved in this study are strongly affected by MODIS AOD, because it is used as a constraint for the retrieval.
