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Climatology and trends of aerosol optical depth on global scale using CALIOP vertically resolved data during 2007-2017

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Atmospheric aerosols, both natural and anthropogenic, affect the radiative energy budget of the Earth-atmosphere system and they can cause climate change through their direct, indirect, and semi-direct effects. The aerosol effects are largely determined by their optical properties. One of the most important optical properties is the aerosol optical depth (AOD). In the present work we present a global 3D climatology of AOD on a 2.5 deg x 2.5 deg horizontal and 500 m vertical resolution. The CALIOP Level 2 Version 4.10 profile product, during both daytime and nighttime for an 11-year long period (2007-2017), is utilized. The results reveal significant spatial variability, with larger AOD over the Northern Hemisphere than the Southern and over land than oceans. On a mean annual level, greater aerosol load (AOD up to 0.79) is observed above East Asia, the Arabian and Sahara Deserts and the Indian Subcontinent. Large AOD is also found over ocean areas where continental aerosols (mostly dust) are advected, such as in the tropical North Atlantic Ocean and the Arabian Sea. On the global scale the mean annual AOD is 0.13 of which 51 % is attributed to dust particles, according to the CALIOP classification scheme. In the Northern Hemisphere the annual average is 0.16 (63 % dust) and in the Southern Hemisphere it is 0.10 (32 % dust), indicating a strong inter-hemispherical asymmetry. We consider as “dust” the “dust”, “polluted dust” and “dusty marine” CALIOP aerosol subtypes. A significant seasonal variation is also evident with generally larger aerosol load during spring and summer compared to autumn and winter. Significant differences in the range and the patterns of the seasonal variability are observed depending on the area. The bulk of the aerosol load is mostly confined in the boundary layer. However, in regions with significant aerosol sources, such as the Sahara and Arabian Deserts, India and East Asia we observe a large vertical extent of the aerosol layer with relatively large AOD up to the height of 6 km. The interannual trends of the AOD are also investigated. Our results indicate a statistically significant increasing trend (up to 0.17 per decade) over India. Statistically significant decreasing trends (up to 0.38 per decade) are observed in East Asia and the Arabian Peninsula. Smaller, albeit mostly statistically significant, decreasing trends are also found over Europe, the eastern United States and parts of South America. Our results are compared against corresponding data from MODIS - Aqua Dark Target - Deep Blue combined product (collection 061, level 3). Preliminary results reveal that the interannual trends based on CALIOP and MODIS AOD are in generally good agreement.