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Aerosol optical depth over central north Asia based on MODIS-Aqua data

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Atmospheric aerosols, both natural and anthropogenic, can affect the regional and global climate through their direct, indirect, and semi-direct effects on the radiative energy budget of the Earth-atmosphere system. To quantify these effects it is important to determine the aerosol load, and an effective way to do that is by measuring the aerosol optical depth (AOD).

The central Asia region (mainly the Caspian and Aral sea basins), the arid and semi-arid regions of Western China as well as Siberia are of great interest due to the significant natural sources of mineral aerosols originating from local deserts and biomass burning from wildfires in boreal forests. What is of particular interest in the region is the phenomenal shrinking and desertification of the Aral Sea that drives an intense salt and dust transport from the exposed sea-bed to the surrounding regions with important implications in regional air quality. Anthropogenic particles are also observed due to fossil-fuel combustion occurring mainly at oil refineries in the Caspian Sea basin. Here we investigate the spatial and temporal variability of the AOD at 550 nm over central Asia, Siberia and western China, in the region located between 35º N - 65º N and 45º E - 110º E. For our analysis we use Level-3 daily MODIS - Aqua Dark Target - Deep Blue combined product, from the latest collection (006), available in a 1º×1º resolution (ca. 100 km × 100 km) over the period 2002-2014.

Our results indicate a significant spatial variability of the aerosol load over the study region. The highest AODs are observed over the Aral Sea year-round, with extreme values reaching 2.1 during July. In the rest of our study region a clear seasonal cycle with highest AOD values (up to 1.2 over the Taklamakan Desert) during spring and summer is observed. The arid parts of central north Asia are characterized by larger aerosol loads during spring, lower but still high AOD in summer and much lower values in autumn and spring. In the northern and northeastern parts of our study region (Siberia), the relatively high AOD observed during summer (reaching or exceeding 0.5) is most likely associated with biomass burning (wildfires).

Most parts of our study region exhibit an overall increasing AOD trend during the study period. The changes are more pronounced over and around the Aral Sea (relative change exceeding 50%), and are stronger during the warm period of the year (April to September). First comparisons with the trends of other possible aerosol sources in the region suggest that the observed overall trend is primarily associated with the increased dust transport from the exposed Aral Sea sea-bed under strong northerly and north-easterly winds.