Geophysical Research Abstracts
Vol. 17, EGU2015-13428, 2015
EGU General Assembly 2015

The regime of aerosol optical depth over Central Asia based on MODIS Aqua Deep Blue 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 therefore important to determine the aerosol load, and an effective way to do that is by measuring the aerosol optical depth (AOD).

In this study we investigate the spatial and temporal variability of the AOD over the climatically sensitive region of Central Asia (36° N - 50° N, 46° E - 75° E), which has significant sources of both natural and anthropogenic particles. The primary source of anthropogenic particles is fossil fuel combustion occurring mainly at oil refineries in the Caspian Sea basin. Natural particles originate mostly from the two deserts in the region (namely Kara-Kum and Kyzyl-Kum), where persistent dust activity is observed. Another source is the Aral Sea region, which due to its phenomenal desertification also drives an intense salt and dust transport from the exposed sea-bed to the surrounding regions. This transport is of particular interest because of health-hazardous materials contained in the Aral Sea sea-bed.

For our analysis we use Level-3 daily MODIS - Aqua Dark Target – Deep Blue combined product, from the latest MODIS collection (006), available in 1° x 1° resolution (about 100 km x 100 km) over the period 2002-2014.Our first results indicate a significant spatial variability of the aerosol load over the study region. The data also show a clear seasonal cycle, with large aerosol load being associated with strong dust activity during spring and summer (AOD up to 0.5), and low during autumn and winter (AOD up to 0.4). In spring and summer significant aerosol load is observed in the Garabogazköl basin, Northeast and South-southeast Caspian Sea (offshore North Iran and Azerbaijan), as well as southwest of the Aral Sea. In the later region, the high AOD values can be explained by export of dust from the exposed sea-bed under strong northerly and north-easterly winds, and was found to be slightly larger during summer. From this analysis we have excluded the Aral Sea, over which the AOD values were extreme (up to 2.1 and 1.3 during July and January, respectively).

The AOD exhibits statistically-significant increasing trend, with an $\sim$40% mean regional relative change. The changes over are more pronounced over and around the Aral Sea, and are stronger during the warm period of the year (April to September). Our results suggest that these trends are associated with increased dust transport from the exposed Aral Sea sea-bed during the study period, which will be examined with the trends of the frequency and strength of aerosol events over central Asia, as well as their association with the Aral Sea desertification.