Satellite observations of mineral dust in the Sistan region

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Sistan (Figure 1): Is located in the Southeastern Iran, along the Afghanistan and Pakistan borders, and belongs to the "desert belt" that extends in the Northern Hemisphere from the west coast of North Africa, over the Middle East, Central and South Asia. Our analysis confirms the seasonal cycle and highlight high interannual variability of summer dust events. General objective: Investigate dust emission and transport in Sistan with special interest on the role of synoptic/local atmospheric dynamics.

Approach: Climatological analysis of desert dust satellite retrievals in the Sistan region, especially MODIS/Aqua Dark Target Deep blue combined AOD\textsubscript{550 nm} (Ervy et al., 2013)\textsuperscript{7}

Identification of specific dust events (case studies) that will be analysed by combining multiple ground-based/satellite obs, and numerical simulations of dust (RAMS regional meteorology and CHIMERE-CTM model).

MODIS data (Collection 6, 1° x 1° spatial resolution) are extracted from NASA/GIOVANNI web site (MYD08_D3 v6).

Analysis of MODIS Combined Dark Target and Deep Blue AOD derived from MODIS/Aqua


Figure 2. Left: Average seasonal cycle of MODIS DT-DB AOD\textsubscript{550 nm} (mean values and associated standard deviations) – Middle: Monthly means of MODIS DT-DB AOD\textsubscript{550 nm} and associated standard deviations. Right: Annual means of MODIS DT-DB AOD\textsubscript{550 nm} with associated standard deviations. The dashed line indicates the annual mean over the whole period (2003-2016).

Summer dust events over the Sistan region (30-31°N, 61-62°E) as detected by MODIS

Figure 3. Left: Monthly means of MODIS DT-DB AOD\textsubscript{550 nm} for the summer months – Right: Frequency of MODIS DT-DB AOD\textsubscript{550 nm} daily values above 0.5 for the summer months over the period 2003-2016.

- Summer monthly averages of MODIS AOD show high variability, from 0.09 (July 2003) to 0.17 (June & Aug., 2016).
- Monthly frequency of occurrence of MODIS AOD > 0.5 show pronounced differences between months and years, from 55% in (July 2003) to 0% (Aug., 2007, July 2015, June 2016).
- Such a high interannual variability of summer dust events is illustrated on MODIS AOD daily time series and averaged spatial distribution (Figure 4). Our results are consistent with the analysis of visibility records at Zabol reported by Rashki et al. [2015] over the period 2001-2012, that highlighted:
  - High frequency and severity of dust storms over the period 2001-2004 due to an extensive dry period that caused desiccation of the Hamoun lakes.
  - Low dust activity during the summer seasons of 2005 and 2007 due to water coverage in the Hamoun lakes and growth of vegetation in the basin.

MODIS AOD suggest moderate to low summer dust activity over the Sistan in the recent years (2015-2016)

June 3-5 2012

Figure 4. Top, Daily evolutions of MODIS DT-DB AOD\textsubscript{550 nm} for the summer months (June-July-August) 2003 to 2016, the blue line indicating the threshold AOD value of 0.5. Bottom, Associated averaged geographical distribution of MODIS DT-DB AOD\textsubscript{550 nm} for the summer months (June-July-August) 2003 to 2016. The black square indicates the Sistan source.

- MODIS DT-DB AOD\textsubscript{550 nm} reaches values up to 1.5 over Sistan.
- Zabol meteorological measurements highlight coincident low visibility and high wind speed.
- Dust is also observed by METEOSAT IDI and OMNI AI over the Sistan region.

June 13-14 2016

Figure 5. Left, MODIS DT-DB AOD\textsubscript{550 nm}, OMNI AI, and METEOSAT IDI dust retrievals for June 5 2012. Right, Meteorological measurements at Zabol in June 2012.

About the Sistan region

- MODIS DT-DB AOD\textsubscript{550 nm} reaches values up to 0.5 in Zabol.
- MODIS/Aqua combined AOD\textsubscript{550 nm} highlights high interannual variability of summer dust events and associated standard deviations.
- MODIS AOD\textsubscript{550 nm} suggests moderate to low summer dust activity over the Sistan in the recent years (2015-2016).

Case Studies

July 13-14 2016

Figure 6. Top, MODIS DT-DB AOD\textsubscript{550 nm} for 7 July 12, 13, 14, 15 2016. Bottom, OMNI AI for July 12, 13, 14, 15 2016.

- Dust is observed by METEOSAT IDI and OMNI AI over the Sistan region.

Conclusions

1. Dust temporal and spatial variability over the Sistan are investigated through analysis of 14 years of MODIS/Aqua aerosol retrievals (2003-2016).
2. Our analysis confirms the seasonal cycle and highlight high interannual variability of summer dust events.
3. Case studies (June 2012 – July 2016) will be further investigated by combining regional modeling and multiple observations.