

Title: Dataset associated with "A Tale of Two Dust Storms: Analysis of a Complex Dust Event in the Middle East"

Abstract:

Lofted mineral dust over data-sparse regions presents considerable challenges to satellite-based remote sensing methods and numerical weather prediction alike. The Southwest Asia domain is replete with such examples, with its diverse array of dust sources, dust mineralogy, and meteorologically-driven lofting mechanisms on multiple spatial and temporal scales. A microcosm of these challenges occurred over 3-4 August 2016 when two dust plumes, one lofted within an inland dry air mass and another embedded within a moist air mass, met over the Southern Arabian Peninsula. Whereas conventional infrared-based techniques readily detected the dry air mass dust plume, they experienced marked difficulties in detecting the moist air mass dust plume, which only became apparent when visible reflectance revealed it crossing over an adjacent dark water background. In combining information from numerical modelling, multi-satellite/multi-sensor observations of lofted dust and moisture profiles, and idealized radiative transfer simulations, we develop a better understanding of the environmental controls of this event, characterizing the sensitivity of infrared-based dust detection to column water vapor, dust vertical extent, and dust optical properties. Differences in assumptions of dust complex refractive index translate to variations in the sign and magnitude of the split-window brightness temperature difference commonly used for detecting mineral dust. A multi-sensor technique for mitigating the radiative masking effects of water vapor via modulation of the split-window dust-detection threshold, predicated on idealized simulations tied to these driving factors, is proposed and demonstrated. The new technique, indexed to an independent description of the surface-to-500 hPa atmospheric column moisture, reveals parts of the missing dust plume embedded in the moist air mass, with best performance over land surfaces.

Contact: Steven Miller (Steven.Miller@colostate.edu; 970-491-8037)

License information or restrictions placed on the data: None

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Associated Publication: Miller, S. D., L. D. Grasso, Q. Bian, S. M. Kreidenweis, J. F. Dostalek, J. E. Solbrig, J. Bukowski, S. C. van den Heever, Y. Wang, X. Xu, J. Wang, A. L. Walker, T.-C. Wu, M. Zupanski, C. Chiu, and J. S. Reid, 2019: *A Tale of Two Dust Storms: Analysis of a Complex Dust Event in the Middle East. Atmospheric Measurement Techniques*, In press. <https://doi.org/10.5194/amt-2019-82>.

Format of data files : .gif

Software:

Image Magick used to convert PNG to animated GIF

Quality assurance and quality control that have been applied:

Individual frame fidelity quality-checked prior to inclusion

Limitations to reuse: None

Date dataset was last modified:

12 August 2019

Are there multiple versions of the dataset? no

Related materials: None

Data source: WRF-Chem model (<https://www2.acom.ucar.edu/wrf-chem>)

Related Files: None

File Information:

SUPP_MOVIE_1_WRFCHEM_INTDUST.gif

Animated gif image displaying Weather Research and Forecasting Chemistry (WRF-Chem) model simulation of column-integrated dust in units of grams per square-meter, scaled over values 0.1 to 3.4, over the Arabian Peninsula of Southwest Asia. A 97-frame animated sequence rendered at 30 min temporal resolution over the period 2016-08-03 0000 UTC to 2016-08-05 0000 UTC.

Definitions:

WRF-Chem = Weather Research and Forecasting Chemistry

Variable information:

Atmospheric column-integrated dust, in units of grams per square-meter

Uncertainty, precision, and accuracy of measurements:

Numerical model output

Environmental or experimental conditions:

Numerical simulation

Method(s):

Column-integrated dust output from the WRF-Chem model for the analysis period 3 Aug 2016 0000 UTC to 5 August 2016 0000 rendered as individual portable network graphics (PNG) images and combined to form animated Graphic Interchange Format (GIF).

Standards or calibrations that were used:

Data scaled over the range of 0.1 to 3.4 grams per square-meter, mapped to a rainbow color palette

SUPP_MOVIE_2_DEBRA_msg_s20160804_0000_e20160804_1000.gif

Animated gif image displaying Meteosat Second Generation-3 (Meteosat-8) satellite imagery of lofted dust over the Arabian Peninsula of Southwest Asia. A 39-frame animated sequence rendered at 15 min temporal resolution over the time period 2016-08-04 0000 UTC to 2016-08-04 1000 UTC. Lofted dust shown in yellow, using the Dynamic Enhancement Background Reduction Algorithm (DEBRA) of Miller et al., 2017:

Miller, S. D., R. L. Bankert, J. E. Solbrig, J. M. Forsythe, and Y.-J. Noh, 2017: A Dynamic Enhancement with Background Reduction Algorithm: Overview and Application to Satellite-Based Dust Storm Detection. *JGR-Atmospheres*, 122(23), 12,938–12,959, doi.org/10.1002/2017JD027365.

Definitions of acronyms, site abbreviations, or other project-specific designations used in the data file names or documentation files:

MSG-3 = Meteosat Second Generation-3 (Meteosat-8); a geostationary satellite operated by the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT; www.eumetsat.int)

DEBRA = Dynamic Enhancement Background Reduction Algorithm

Variable information:

Lofted dust imagery confidence factor, shown in this imagery as yellow with brightness indexed to higher confidence.

Uncertainty, precision, and accuracy of measurements:

Satellite image enhancement

Environmental or experimental conditions:

Lofted dust storm over the Arabian Peninsula

Method(s):

DEBRA dust enhanced imager rendered from MSG-3 (Meteosat-8) observations as individual portable network graphics (PNG) images and combined to form animated Graphic Interchange Format (GIF).

Standards or calibrations that were used:

DEBRA algorithm as described by Miller et al. (2017)

SUPP_MOVIE_3_WRFCHEM_TPW.gif

Animated gif image displaying Weather Research and Forecasting Chemistry (WRF-Chem) model simulation of Total Precipitable Water (TPW) over the Arabian Peninsula of Southwest Asia. A 97-frame animated sequence rendered at 30 min temporal resolution over the time period 2016-08-03 0000 UTC to 2016-08-5 0000 UTC.

Definitions of acronyms, site abbreviations, or other project-specific designations used in the data file names or documentation files:

WRF-Chem = Weather Research and Forecasting Chemistry

TPW = Total Precipitable Water

Variable information:

Total Precipitable Water, the atmospheric column-integrated amount of condensed water vapor, provided in units of mm

Uncertainty, precision, and accuracy of measurements:

Numerical model output

Environmental or experimental conditions:

Numerical simulation

Method(s):

TPW output from the WRF-Chem model for the analysis period 3 Aug 2016 0000 UTC to 5 August 2016 0000 rendered as individual portable network graphics (PNG) images and combined to form animated Graphic Interchange Format (GIF).

Standards or calibrations that were used:

Data scaled over the range of 10-65 mm, mapped to a white-green-blue graduated color palette