Studying Diurnal Variations of Aerosols with NASA MERRA-2 Reanalysis Data

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https://disc.gsfc.nasa.gov

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Introduction

- Studies have suggested much of the feedback between dust aerosols and atmospheric dynamics is associated with diurnal and synoptic scale variability. However, lack of sub-daily resolution of aerosols from satellite observations makes it difficult to study diurnal characteristics, especially over tropical and subtropical regions.
- The NASA atmospheric reanalysis (MERRA-2) data set, distributed from NASA Goddard Earth Science Data and Information Services Center (GES DISC), provides meteorology, atmospheric chemistry, and aerosols at hourly time resolution, making study of diurnal characteristics possible.
- MERRA-2 scientists have generated monthly diurnal products, which may be used to study climate diurnal characters without much data preprocessing. This presentation, using dust and SO4 as examples, illustrates diurnal characteristics.

MERRA-2 Reanalysis Data Overview

https://gmao.gsfc.nasa.gov/reanalysis/MERRA-2/docs/

MERRA-2 (the second Modern-Era Retrospective analysis for Research and Applications) is a NASA reanalysis data set for the satellite era, focused on historical analyses of meteorology, atmospheric chemistry, land, ocean, and aerosol data with temporal scales ranging from weather to climate context.

- **Temporal Coverage:** 1980-present
- **Temporal Resolution:** Hourly, 3-Hourly, Monthly, **Monthly diurnal**
- **Spatial Coverage:** Global
- **Spatial Resolution:** 0.5° x 0.625° (361x576, L1, L42, L72, L73)
- **Number of Product Groups:** 95
- **Data Format:** NetCDF-4

Getting MERRA-2 Data

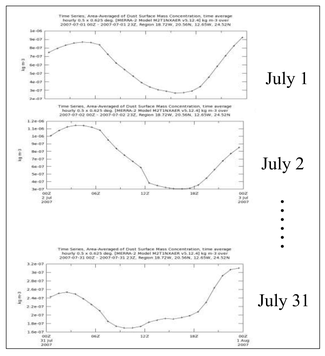
http://disc.gsfc.nasa.gov/datasets?keywords="MERRA-2"

The product landing page contains:

- **Product Summary**
- **Documentation**
  - ✓ User's guide
  - ✓ File specific
  - ✓ Key references
  - ✓ Tools
- **Data Citation:**

Cite the dataset in publications e.g: Global Modeling and Assimilation Office (GMAO)(2015), MERRA-2 tavgM_2d_aer_Nx: 2d, Monthly mean,Time-averaged, Single-Level, Assimilation, Aerosol Diagnostics V5.12.4, Greenbelt, MD, USA, Goddard Earth Sciences Data and Information Services Center (GES DISC), Accessed [***Data Access Date***] 10.5067/FH9A0MLJPC7N

The names of monthly diurnal data products start with 'M2TU'; for example *M2TUNXAER*. The data are composed by averaging each hour from all days of a month. For example, July 2007:

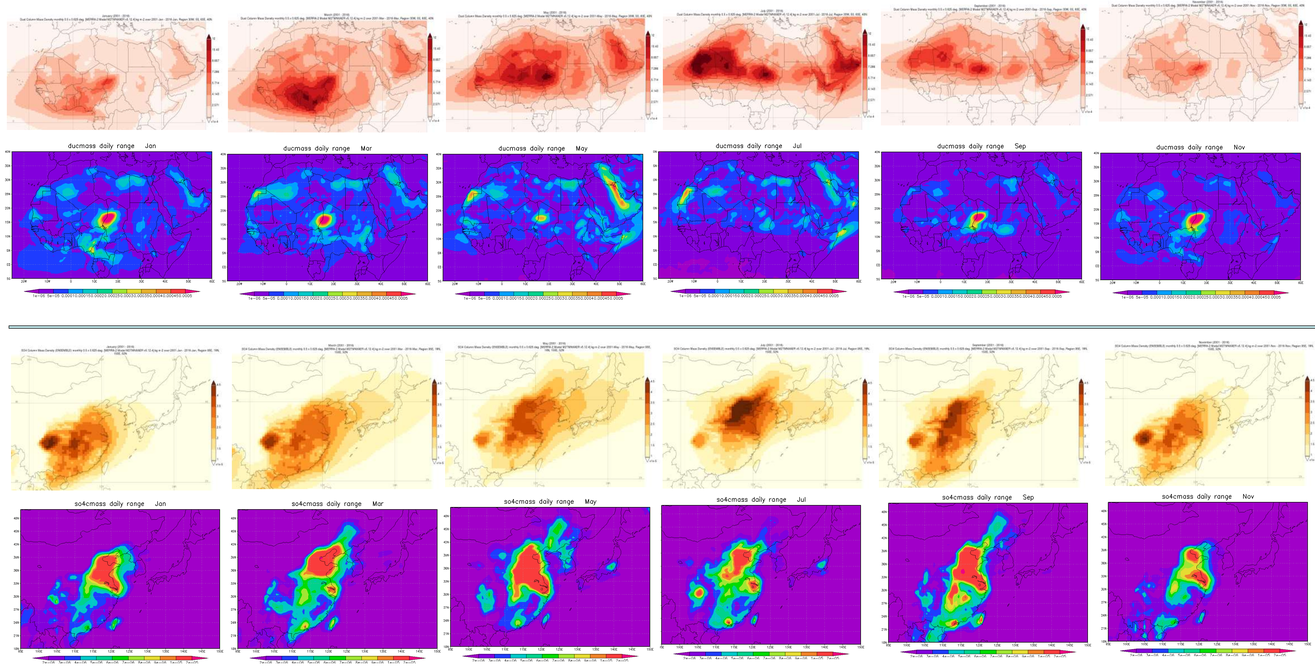


Data Access Methods:

- ✓ MERRA-2 subsetter
- ✓ Direct download (HTTPS)
- ✓ OPeNDAP
- ✓ GDS
- ✓ Giovanni: **visualization**

Online **Data How-to** are available with step-by-step instructions on accessing, reading and viewing data with various data tools.

Multi-year Means of Monthly and Monthly Diurnals



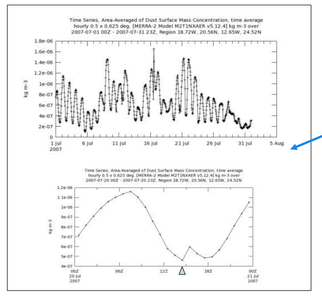
The images at left are multi-year (2001-2016) averages of monthly **means** (upper) of column dust mass concentration and its **diurnals** (lower) over Africa, from left to right, for January, March, May, July, September, and November, indicating their climatological seasonal variations.

The images at left are multi-year (2001-2016) averages of monthly sulfates (SO4) **means** (upper) and its **diurnals** (lower) over East China, from left to right, for January, March, May, July, September, and November, showing their seasonal variations.

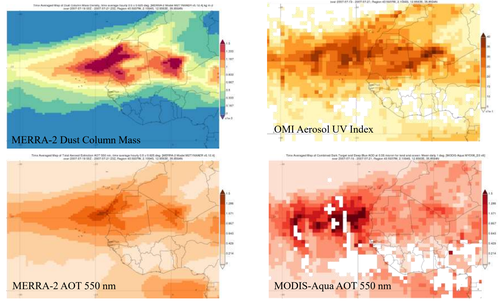
Sulfate particles may increase the acidity of the atmosphere and form acid rain.

A Case of Diurnal Variations of Dust over West Africa, July 20, 2007

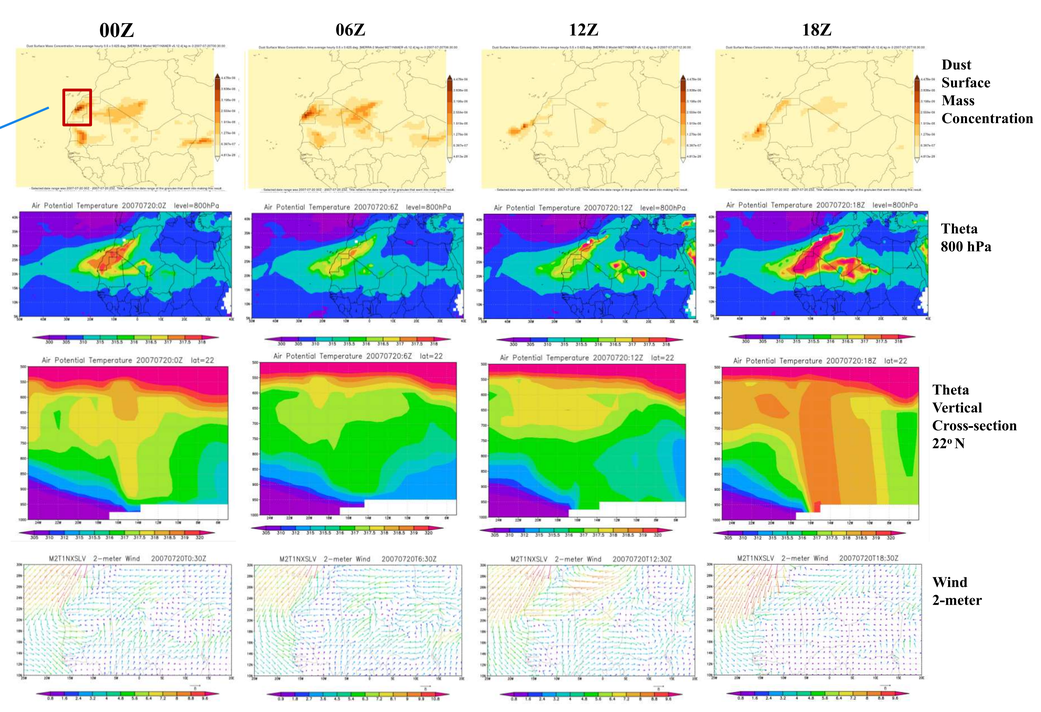
True color image from MODIS-Aqua (July 20, 2007, 14:05 UTC), courtesy MODIS Rapid Response Team.



Example of hourly time series for a month (July 2007) and a day (July 20, 2007) from MERRA-2, clearly showing diurnal cycles of surface dust mass concentration over west Africa (18.7° W, 20.6° N, 12.7° W, 24.5° N).



The images above are three-day (July 19-21 2007) averaged column dust mass and aerosol optical thickness (AOT) at 550nm from MERRA-2, aerosol UV index from OMI/Aura, and AOT at 550nm from MODIS/Aqua. The MERRA-2 aerosols show similar features to the satellite observations at large scale. OMI-Aura and MODIS-Aqua acquire data around 1:30 pm local time.



The images above are examples for July 20, 2007 at 00Z, 06Z, 12Z, and 18Z for surface dust mass concentration (DUSMASS), potential temperature (theta, derived from temperature and pressure), and wind at 2 meters, clearly indicating the dust diurnals associated with meteorological dynamics. Potential temperature measures the static stability of the atmosphere.