Long-Term Model Assimilated Aerosols from MERRA-2 : Data and Services at NASA GES DISC

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Suhung Shen[1,2], Dana Ostrenga[1,3], Paul Huwe[1,3], Bruce Vollmer[1], Steve Kempler[1]
suhung.shen@nasa.gov [1]NASA Goddard Space Flight Center, [2]George Mason University, [3]ADNET

The Modern-Era Retrospective analysis for Research and Applications, Version 2 (MERRA-2) is the atmospheric reanalyses conducted with NASA assimilation system GEOS-5. Alongside the meteorological data assimilation, MERRA-2 includes an interactive analysis of aerosols, land, ocean, and ice that feed back into the circulation.

About MERRA-2 Aerosol Products

http://gmao.gsfc.nasa.gov/pubs/docs/Bosilovich785.pdf

- **Aerosol Components:** Dust, Black Carbon (BC), Organic Carbon(OC), Sea-salt, Sulfate (SO_4)
- **Aerosol Property:** mixing ratio, column mass density, emission, surface mass concentration, optical depth, dust PM 2.5, deposition, sedimentation, etc.
- **Model: MERRA-2** (based on MERRAero, aerosol components are fully coupled with meteorological fields)
- **Assimilation Inputs:** MODIS, MISR, AERONET, and AVHRR (pre-EOS period)
- **Temporal Coverage:** 1980-present
- **Temporal Resolution:** hourly, 3-hourly, monthly, and monthly diurnal
- **Spatial Coverage:** Global
- **Spatial Resolution:** 0.5°x0.625°
- **Data Format:** NetCDF-4

Searching Data

http://disc.sci.gsfc.nasa.gov/uui/#/search/?MERRA+aerosol

Other Data Services:

- ✓ **HTTP** (for direct download)
- ✓ **OPeNDAP** (for access via applications)
- ✓ **GDS** (for access via applications)
- ✓ **Data Recipes** (step-by-step instruction on accessing and reading data with varies data tools)

Getting Subsetted Data

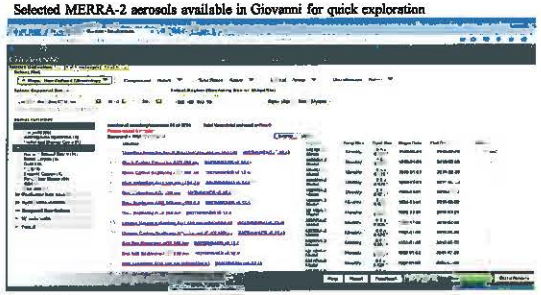
http://disc.sci.gsfc.nasa.gov/daac-bin/FTPSubset2.pl

- ✓ Parameter, spatial, temporal subsetting
- ✓ Regridding (bilinear interpolation, nearest neighbor, distance-weighted average, ...)
- ✓ Resolution (gpcp2.5, cfsr1.0, ERA40, ...)
- ✓ Data Format (HDF-EOS2, netCDF4, NetCDF-classic)

Visualization Data: Giovanni

http://disc.gsfc.nasa.gov/giovanni/

Selected MERRA-2 aerosols available in Giovanni for quick exploration



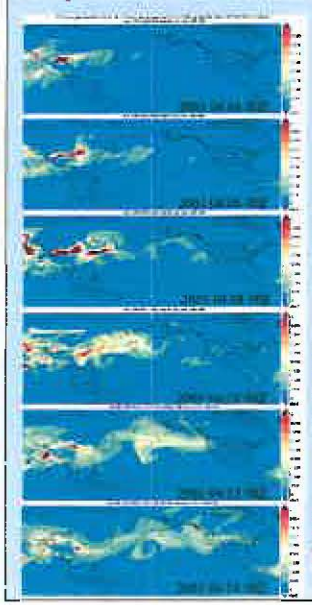
Visualization Functions:

- ✓ Single time or time averaged Lon-Lat Map
- ✓ Single point or area averaged time series
- ✓ Animation
- ✓ Interannual variation analysis
- ✓ User defined climatology
- ✓ Histogram
- ✓ Vertical profile, or crossmap
- ✓ Scatter Plot
- ✓ Correlation Map
- ✓ Difference between two variables

Download Features:

- ✓ Image map (png, geotiff, KMZ)
- ✓ Image map data (netCDF)
- ✓ Time series plot (png)
- ✓ Time series data (CVS, netCDF)
- ✓ Image map or time series within a shapefile, such as country, watershed
- ✓ Lineage for getting intermediate data

Example Dust Storm from Asia to North America



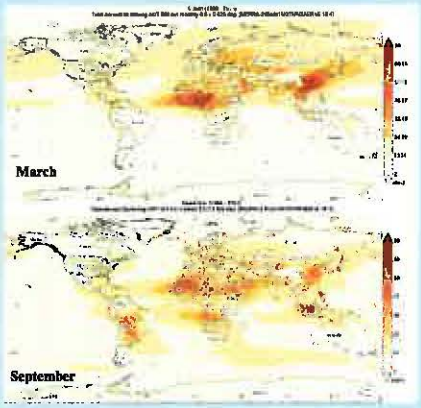
Above: True color image from MODIS, the famous "**Perfect Dust Storm**" on **April 7 2001** over Northeast China. Courtesy http://earthobservatory.nasa.gov/IOTD/view.php?id=5341)

Left: MERRA-2 assimilated hourly **column dust mass density**, the dust travels east and from Asia across the Pacific reaching California and even Maryland in about 6-10 days

(Images are generated with Giovanni plot function "Maps: Time Averaged Map". This function is able to plot time averaged map over an interested region.)

Monthly Climatology of Total Aerosols AOT 550nm

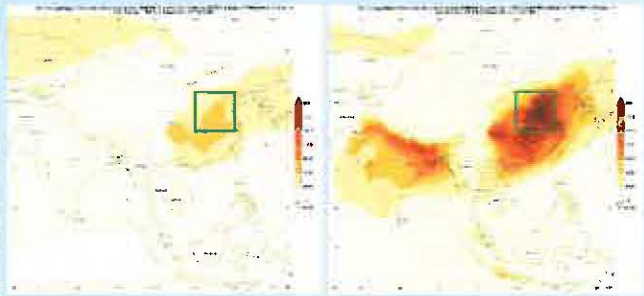
(Base period 1980-2014)



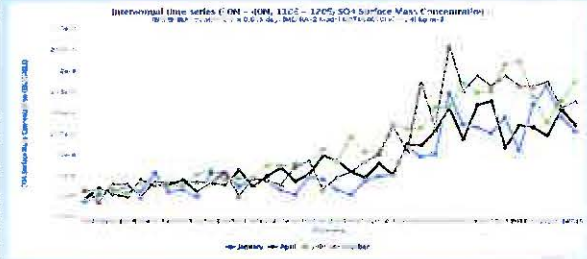
Above: Example global monthly climatology **Total aerosol scattering AOT at 550 nm** for Mar and Sep, respectively. The average was calculated for 35 years period from 1980-2014

(Images are generated with Giovanni plot function "Maps: User Defined Climatology". This function enables monthly climatology calculation of user selected base periods.)

Interannual Variations of Aerosols



Left Images SO4 Surface Mass Concentration over Asia, showing that the value in 2015 is much larger than in 1980



Time series show that SO4 Surface Mass Concentration over East Central China (green box area) has increased continuously from 1980 to 2015. The increases are more significant during the periods of 1990's and 2000's

(Generated with Giovanni plot function "Time Series: Scattered")

Acknowledgements:
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References:

Bosilovich, M. G., R. Lucchesi, and M. Suarez, 2015. **MERRA-2: File Specification**. *GMAO Office Note No. 9*, http://gmao.gsfc.nasa.gov/pubs/docs/Bosilovich785.pdf
Colarco, P., A. Da Silva, M. Chin, and T. Diehl (2010), Online simulations of global aerosol distributions in the NASA GEOS-4 model and comparisons to satellite and ground-based aerosol optical depth, J. Geophys. Res., 115, D14207, doi: 10.1029/2009JD012820
da Silva, A. M., C. A. Randles, V. Buchard, A. Darmenov, P. R. Colarco, and R. Govindaraju, 2015. File Specification for the MERRA Aerosol Reanalysis (MERRAero). GMAO Office Note No. 7