



lava Sea

Studying Wildfires and Aerosol-Cloud-Precipitation Interactions with Advanced Remote Sensing from Space

Smults

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Sumatra

Image Credit: NASA Earth Observatory





Outline



- Tools for analyzing large satellite data
- NASA Giovanni
 - <u>http://giovanni.gsfc.nasa.gov</u>
 - 2006 and 2015 events: long-dry periods and wildfires
 - El Nino influences
- MISR INteractive eXplorer (MINX)
 - <u>http://misr.jpl.nasa.gov/</u>
 - Plume injection heights
 - Ship tracks
- New sensors for studying cloud-precipitation processes



Data Analysis with Giovanni

0.9



Time Series, Area-Averaged of Combined Dark Target and Deep Blue AOD at 0.55 micron for land and ocean monthly 1 deg. [MODIS-Terra MOD08_M3 v6] over 2000-Mar - 2016-Aug, Region 90E, 10S, 130E, 10N

MODIS AOD



0.8 - 0.7 - 0.6 - 0.5 - 0.4 - 0.3 - 0.2 - 0.1

Time Series, Area-Averaged of Aerosol Optical Depth 555 nm monthly 0.5 deg. [MISR MIL3MAE v4] over 2000-Mar - 2016-May, Region 90E, 10S, 130E, 10N



MISR AOD



Credit: NASA GIOVANNI giovanni.gsfc.nasa.gov





- Strong relationship between drought and AOD extremes
- 2015 is strongest in the past decade



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National Centers for Environmental Information / NESDIS / NOAA



GMI Model CO Perturbation





Time Series, Area-Averaged of Combined Dark Target and Deep Blue AOD at 0.55 micron for land and ocean: Mean daily 1 deg. [MODIS-Aqua MYD08_D3 v6] over 2015-06-01 - 2015-11-30, Region 90E, 10S, 130E, 10N



- Selected date range was 2015-06-01 - 2015-11-30. Title reflects the date range of the granules that went into making this result.



- Selected date range was 2006-06-01 - 2006-11-30. Title reflects the date range of the granules that went into making this result.



- Selected date range was 2009-06-01 - 2009-11-30. Title reflects the date range of the granules that went into making this result.



June 1 – Oct 31, 2009





- Selected data range was 2009-06-01 - 2009-10-31. The data date range for Combined Dark Target and Deep Blue AOD at 0.55 micron for land and ocean: Mean daily 1 deg. [MODIS-Terra MOD08_D3 v6] is 2009-06-01 - 2009-11-01 01:29Z. The data date range for Precipitation Rate daily 0.25 deg. [TRMM TRMM_3B42_Daily v7] mm/day is 2009-06-01 - 2009-11-01 01:29Z.

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MISR INteractive eXplorer (**MINX**)







Analysis using MINX





Histograms of zero-wind heights, wind-corrected heights, cross-track and along-track wind speeds retrieved using MINX. Cross-sectional plot of heights as a function of distance from the source (red: zero-wind heights; blue: wind-corrected heights). The green is the terrain height.





Smoke plumes cool surface, warm atmosphere, reduce precipitation in southeast Asia (Tosca et al., 2010, 2011)
Plumes are sub-gridscale until/unless merge into clouds
How to parameterize plume size, shape, lifecycle, foreing to improve air quality and climate predictions?
Need geometry, age PDFs. MISR/MINX to the rescue!



Paugam et al. (2016)

Our implementation (km, AGL)

2.

0.0

Parameterization and validation of plume injection in mesoscale and global models

Trentmann et al., (2006) - Delayed forcing?

Kahn et al. (2007) and Paugam et al. (2015) - MODIS fire channel saturation

Val Martin et al. (2012) - Screening for a subset

Sofiev et al. (2012) - Representation of random case?





Study of Ship Tracks with MINX

Albedo

1.2

1.0

0.6

0.2

Units=NA









The strength of the MISR cloud albedo response to aerosol plumes depends mainly on cloud cellular structure, dryness of the free troposphere, and the boundary layer depth.

About 7% of segments revealed a reduced cloud albedo (A) in the ship-polluted region.













Future Work



Remote Sensing of Cloud and Precipitation Microphysical Properties





Use of VIS-NIR (0.5-2µm), LWIR (8-12µm), submm-wave (240-680 GHz), and microwave (10-37 GHz) channels to make simultaneous side-profiles of clouds and precipitation.







Key Questions on Cloud-Precipitation Processes

Skofronick-Jackson et al. (Whitepaper, 2016)

To what extent is *the character of precipitation* and variability of precipitation determined by the large-scale dynamics versus the cloud-scale processes?

- Which cloud processes lead to the onset of precipitation?
- Which cloud processes lead to extremes in precipitation?