Jet Propulsion Laboratory
California Institute of Technology

Exploring and Using MISR Aerosol, Cloud, and Plume Data

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AGU Fall Meeting, December 10, 2019

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Schedule

1:00: Introduction to the MISR instrument and data products Abigail Nastan, JPL

1:45: Obtaining MISR data from the ASDC DAAC using the MISR Order Tool, ASDC Datapool, NASA Worldview, and NASA Earthdata Search Makhan Virdi and Walt Baskin, ASDC

2:30: Visualizing and analyzing MISR L2 Cloud products Michael Garay, JPL

3:15: Break

3:30: Visualizing and analyzing MISR Plume Height Project data Mika Tosca, School of the Art Institute of Chicago and JPL

4:15: Visualizing and analyzing MISR L2 Aerosol products Ralph Kahn, NASA Goddard, and Michael Garay, JPL

5:00: Discussion and questions

Logistics

Wifi

Network:

Password:

Food/Drink

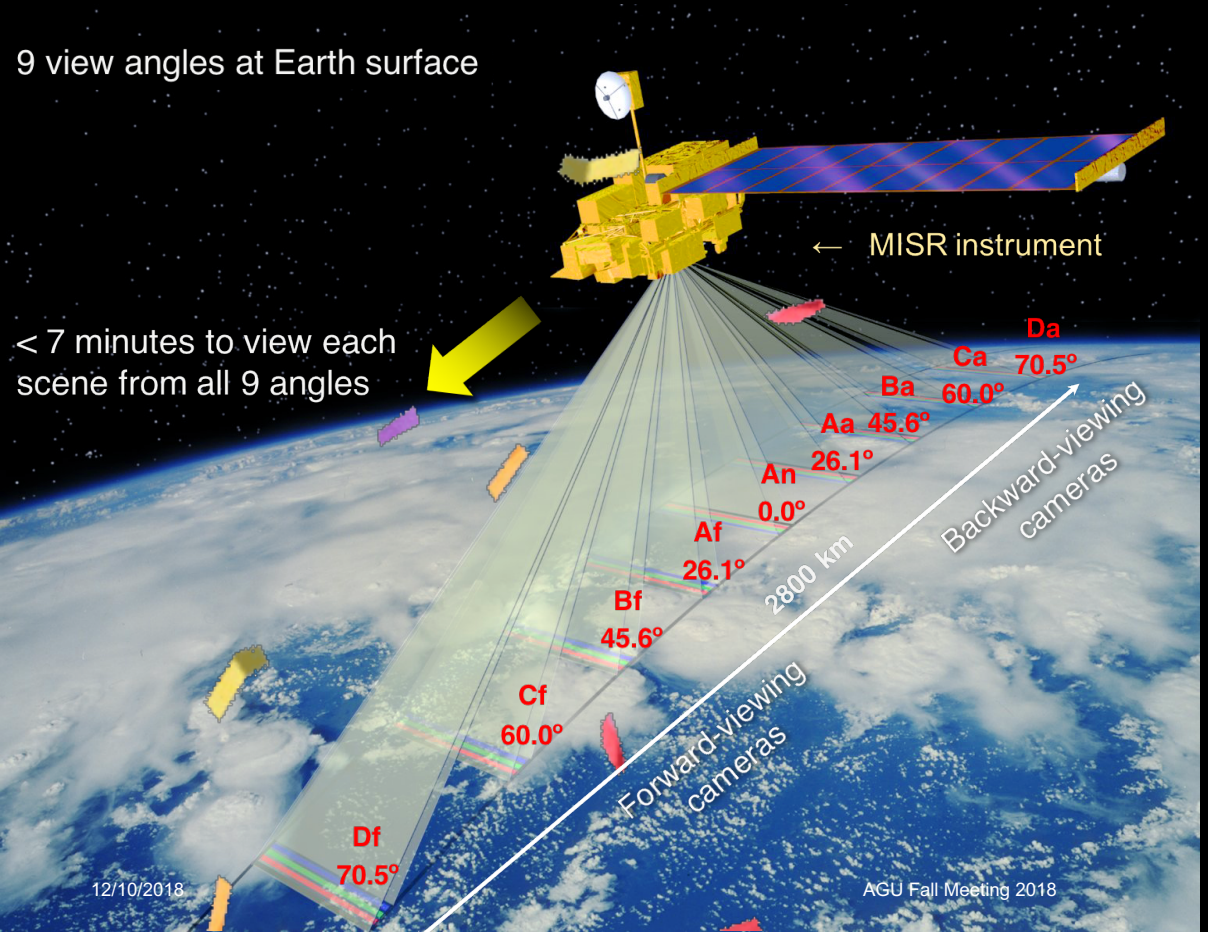
Coffe/tea break: 3:15

Slides will be distributed after the workshop

Introduction to the MISR instrument and data products

Abigail Nastan

MISR fast facts



Happy (almost) 20th birthday, Terra!

Platform: Terra

Launch: 12/10/1999

Data record: 2/2000 – present

9 cameras

446, 558, 672, and 867 nm

9-day global coverage

Daytime imagery only

MISR instrument photos

"Family portrait"

V-9 Optical bench

Undergoing tests

In JPL space simulator

On Terra

Launch

Why 9 cameras?

1. Change in reflectance with angle distinguishes different types of aerosols, and surface structure

2. Oblique slant paths through the atmosphere enhance sensitivity to aerosols and thin cirrus

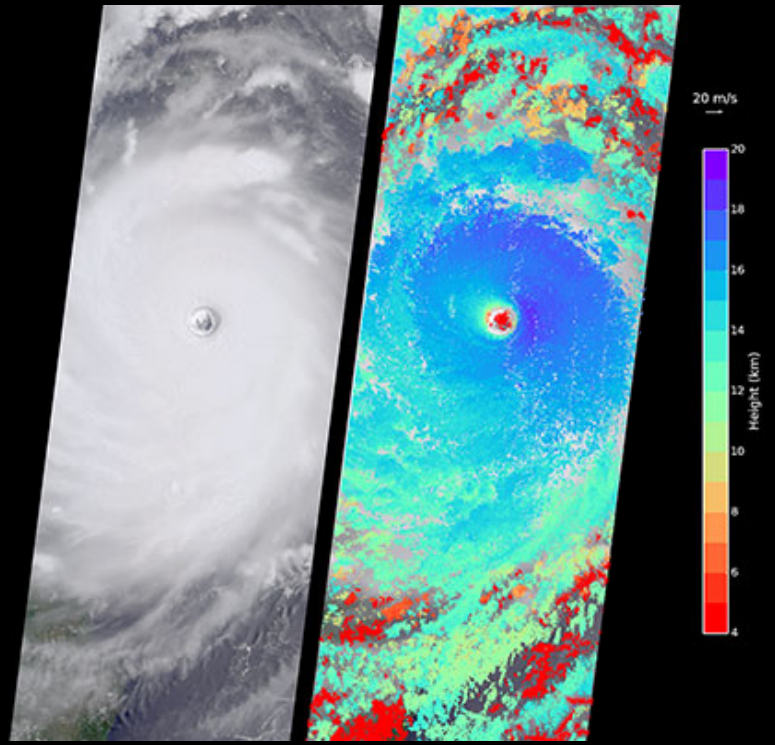
3. Stereo imaging provides geometric heights of clouds and aerosol plumes

4. Cloud motion, derived from time lapse (< 7 min) between cameras (forward to backward views), permits determination of winds aloft

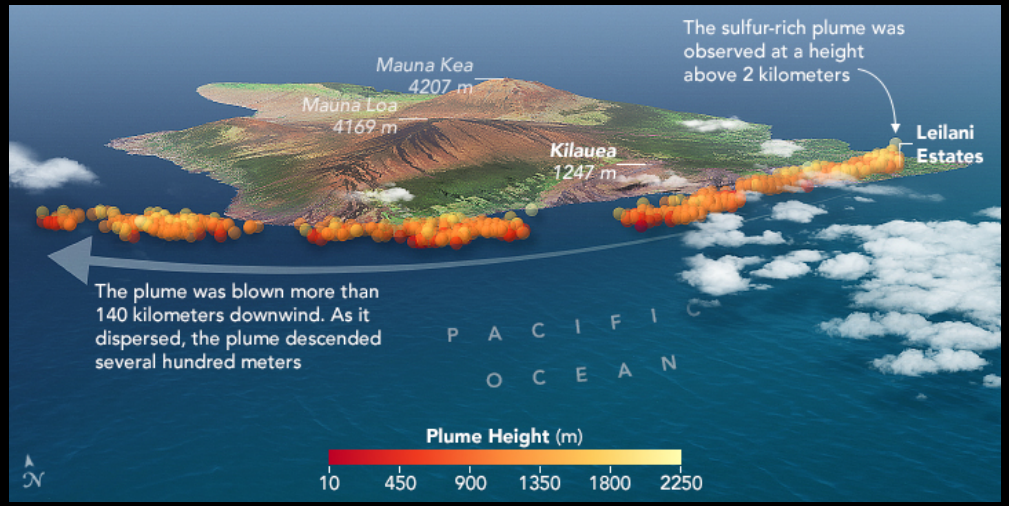
5. Different observation angles enable sun glint avoidance or accentuation

6. Integration over angle is required to accurately estimate hemispherical reflectance (albedo)

Why MISR? Height of objects in the atmosphere

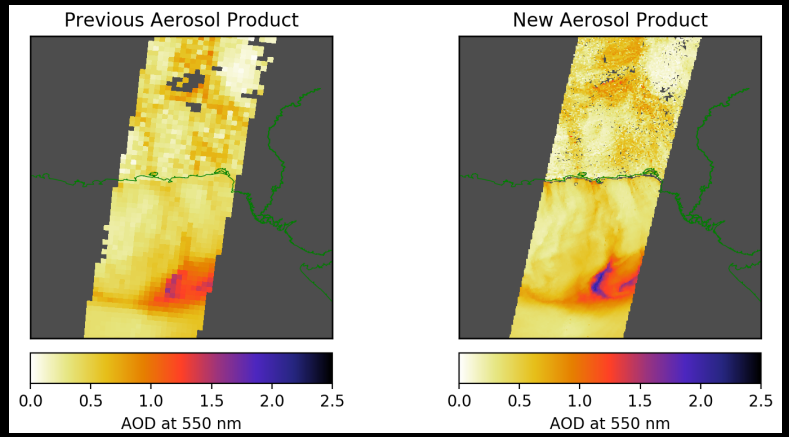


Typhoon Nepartak, July 7, 2016
Standard cloud product

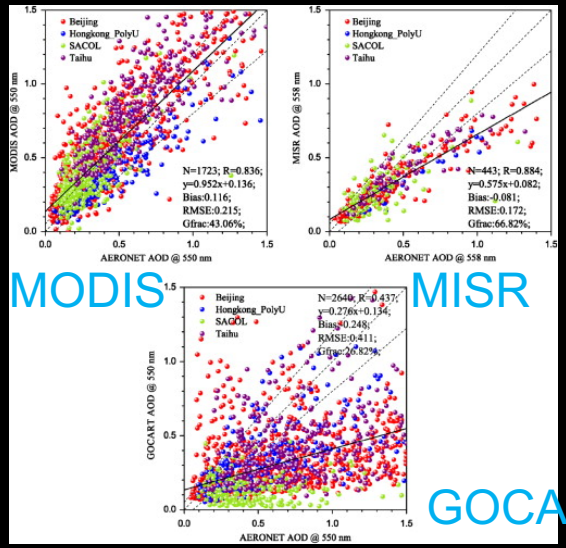


Kilauea eruption, May 6, 2018
MINX software

Why MISR? Aerosol performance and particle properties

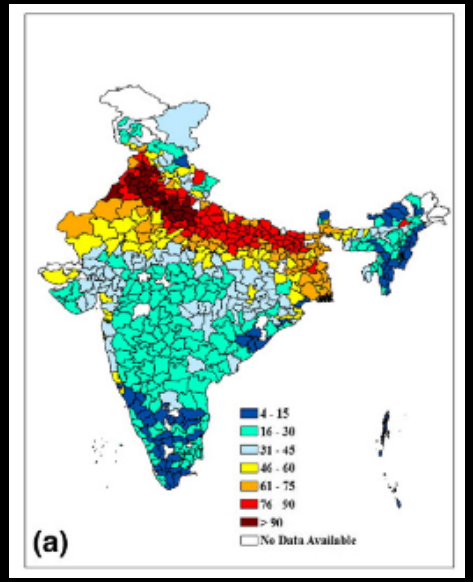


Dust storm off Pakistan
Old vs. new MISR aerosol

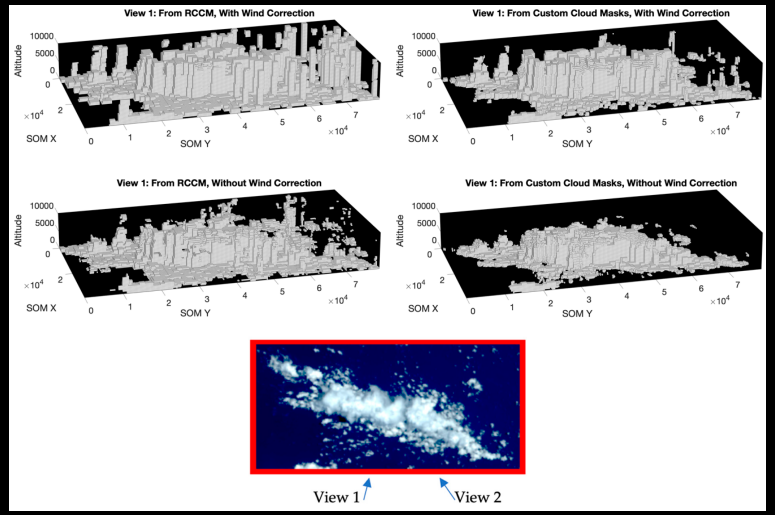


Comparison of MODIS, MISR, and GOCART AOD
Cheng et al. (2012)

Why MISR? PM and tomography

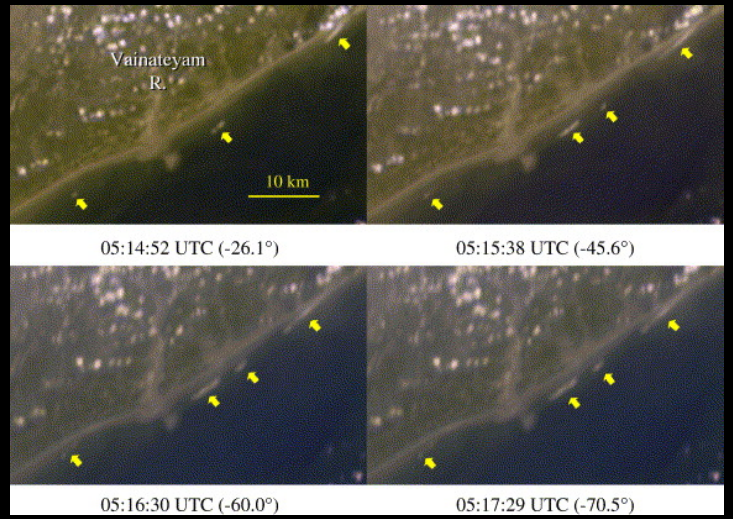


Total PM concentrations in India, 2000-2010 (Chowdhury et al. 2016)

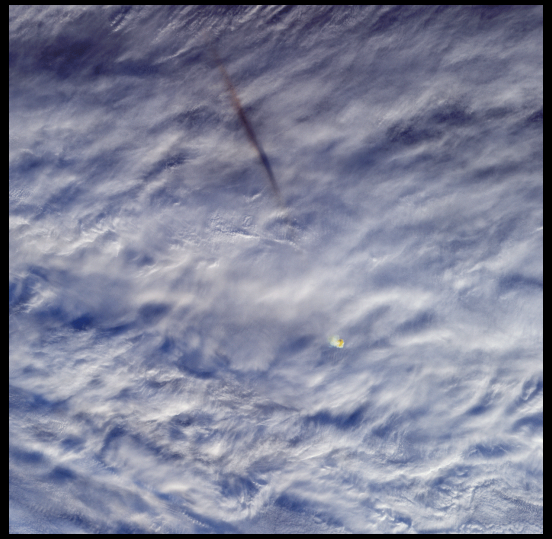


Cloud volume reconstruction by ray casting, (Lee et al. 2018)

Why MISR? The weird and unusual

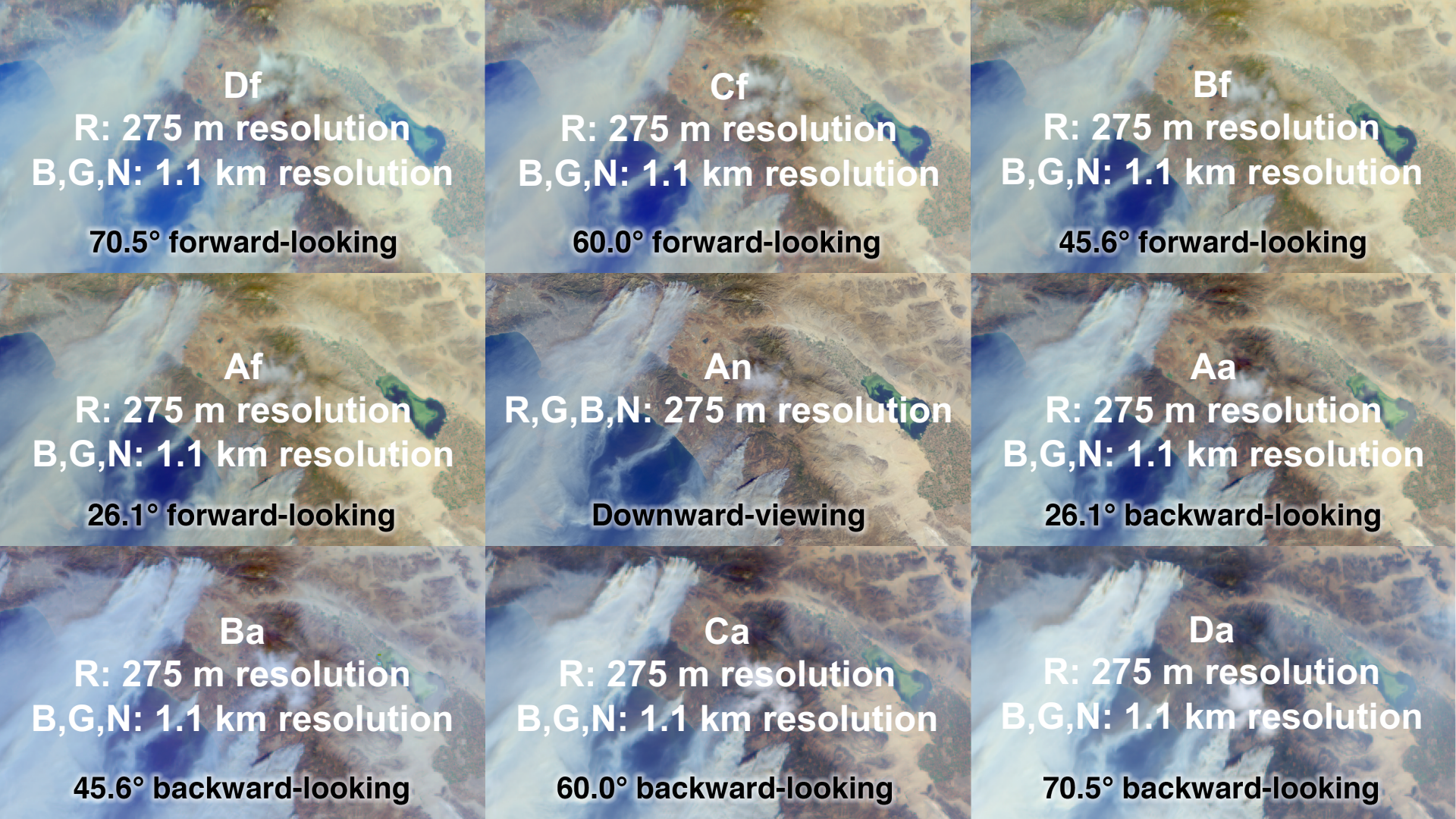


Waves of the Boxing Day tsunami breaking in India (Garay et al. 2007)

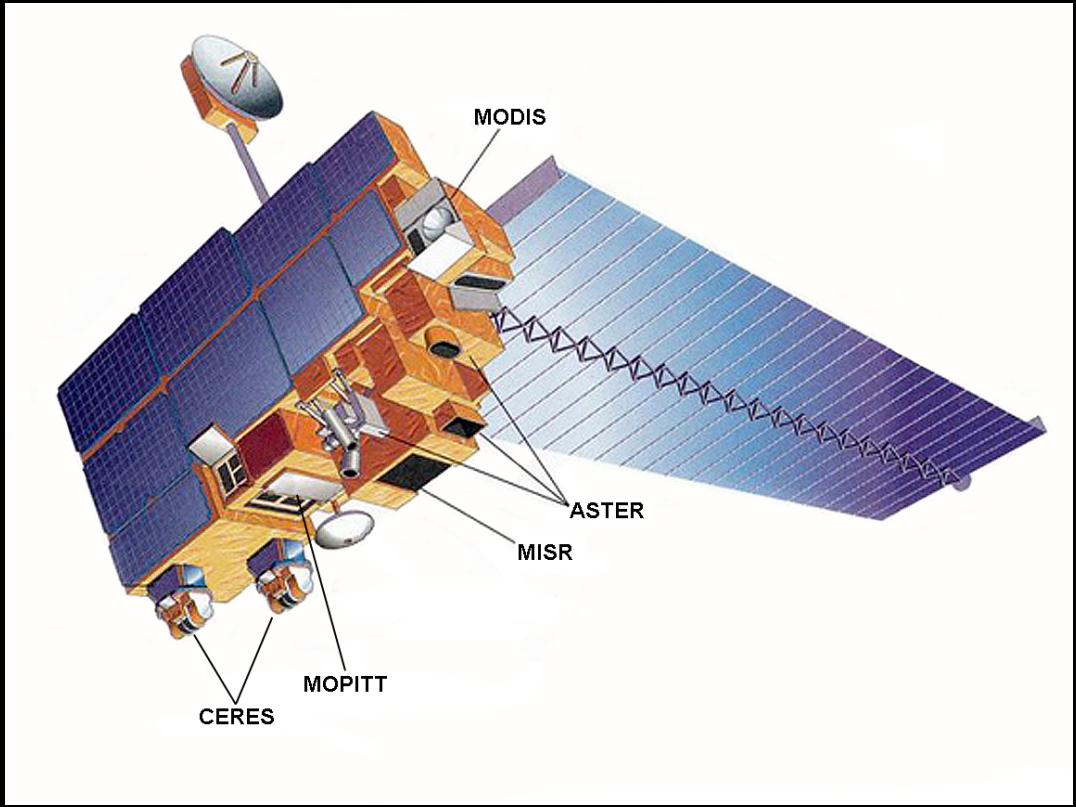


Bering Sea bolide debris cloud, December 18, 2018

The details


Df
R: 275 m resolution
B,G,N: 1.1 km resolution
70.5° forward-looking
Cf
R: 275 m resolution
B,G,N: 1.1 km resolution
60.0° forward-looking
Bf
R: 275 m resolution
B,G,N: 1.1 km resolution
45.6° forward-looking
Af
R: 275 m resolution
B,G,N: 1.1 km resolution
26.1° forward-looking
An
R,G,B,N: 275 m resolution
Downward-viewing
Aa
R: 275 m resolution
B,G,N: 1.1 km resolution
26.1° backward-looking
Ba
R: 275 m resolution
B,G,N: 1.1 km resolution
45.6° backward-looking
Ca
R: 275 m resolution
B,G,N: 1.1 km resolution
60.0° backward-looking
Da
R: 275 m resolution
B,G,N: 1.1 km resolution
70.5° backward-looking

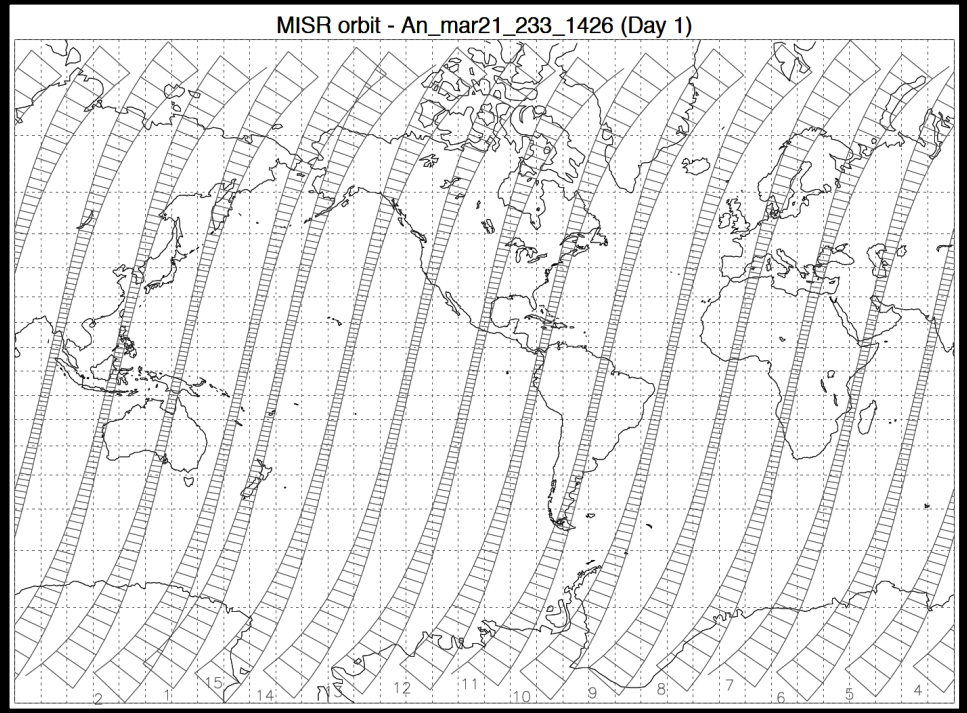
Terra fast facts



Terra carries 5 instruments:

- **ASTER** (Advanced Spaceborne Thermal Emission and Reflection Radiometer)
- **CERES** (Clouds and the Earth's Radiant Energy System)
- **MISR** (Multi-angle Imaging SpectroRadiometer)
- **MODIS** (Moderate-resolution Imaging Spectro-radiometer)
- **MOPITT** (Measurement of Pollution in the Troposphere)

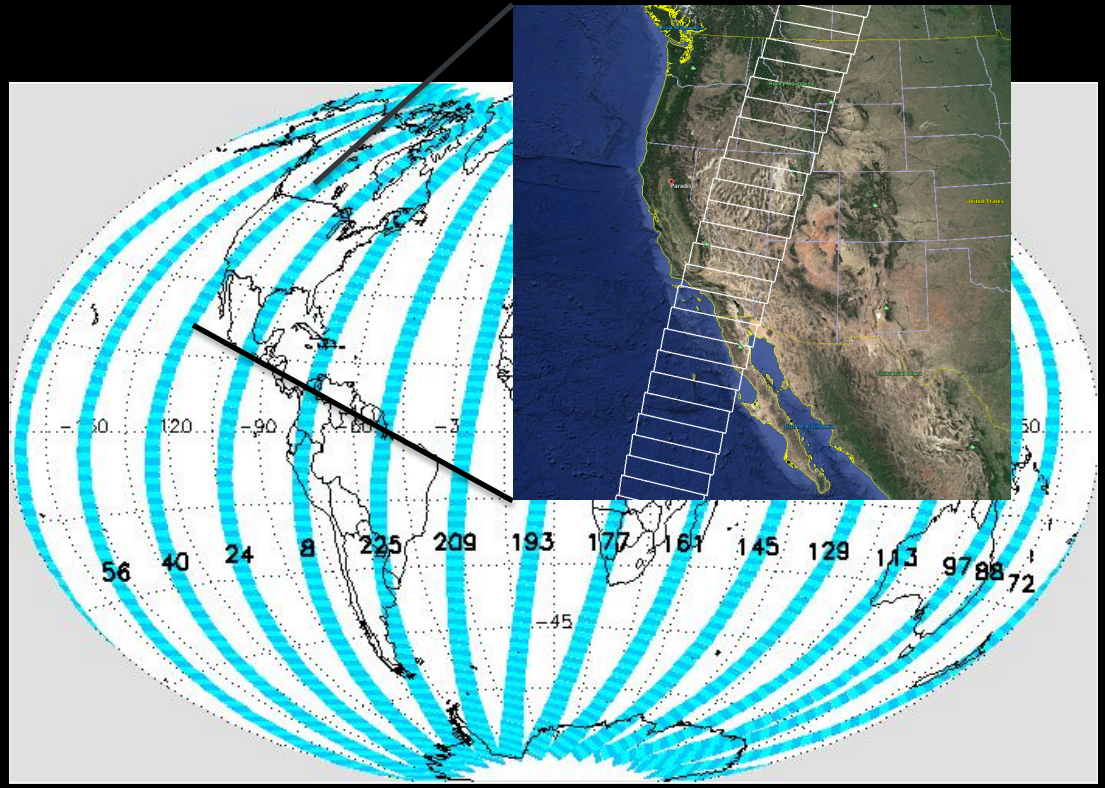
Terra orbit



Terra orbit characteristics:

- **Altitude:** 705 km (low-Earth)
- **Period:** 99 minutes
- **Sun-synchronous:** orbital plane precesses with the same period as the earth's solar orbit period
- **Descending:** travels from N to S on earth's day side (ascends on night side)
- **10:30 am crossing time:** Crosses equator at 10:30 am local time on the day side for every orbit
- **Repeating:** Orbital pattern repeats every 16 days

MISR orbit/path convention



Terra **orbits** the earth 15 times/day.

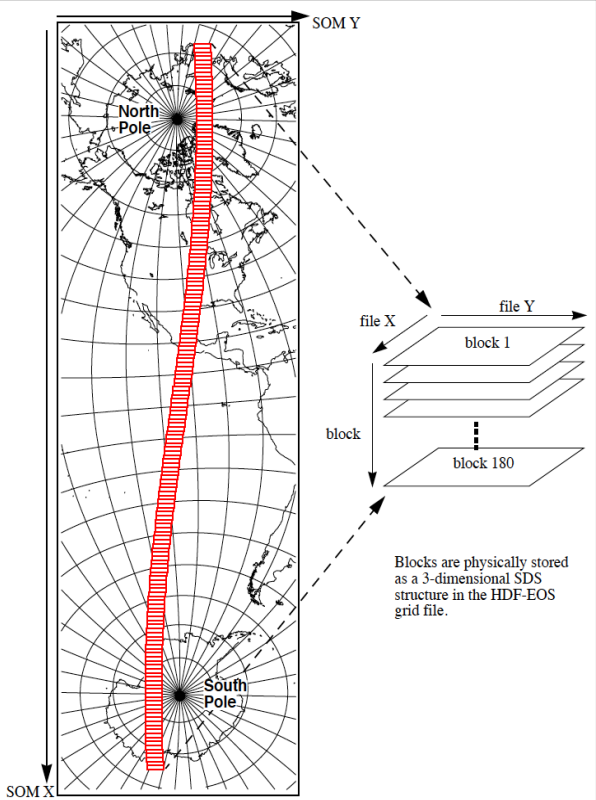
Orbit numbers indicate the number of revolutions since launch.

233 distinct orbit **paths** repeat every 16 days.

Each **path** is divided into 180 **blocks**.

Paths overlap, allowing near global coverage in 9 days.

MISR Space Oblique Mercator projection



SOM projected data stored in HDF-EOS grid file using stacked-block format.

A separate **SOM projection** is defined for each of MISR's 233 paths.

SOM minimizes re-sampling distortions

The **origin** of each path is where the satellite crosses the ascending node – the equator on the night side

Satellite **ground track** defines a curved line on earth's surface that becomes the center of a modified oblique Mercator projection called Space Oblique Mercator (SOM)

The MISR data products

The MISR filename convention

MISR_AM1_GRP_TERRAIN_GM_P028_O002510_AN_F03_0024_b058-062.hdf

MISR	- instrument name - constant for all MISR products
AM1	- satellite name - constant for all MISR products
GRP_TERRAIN	- MISR product type
GM	- acquisition mode (if pertinent: **GM** = **G**lobal **M**ode, **LM** = **L**ocal **M**ode)
P028	- TERRA **P**ath **number (1 - 233)**
O002510	- TERRA **O**rbit number (995 – 100971+)
AN	- camera name (if pertinent: DF, CF, BF, AF, AN, AA, BA, CA, DA)
F03	- format version number (format of product file)
0024	- product version number (algorithm that created product)
b058-062	- block range (if file was subsetted during the data ordering process)
hdf	- **h**ierarchical **d**ata **f**ormat (standard HDF-EOS file structure)

The MISR data products

Level	Name	Example uses
1	Radiance data	Images
2	**Cloud/stereo data**	**Cloud-top heights, cloud motion vectors**
2	**Aerosol data**	**Aerosol climatologies, PM studies**
2	Land surface data	Vegetation health
2	TOA/albedo data	Climate studies
2.5	**Plume height project**	**Global wildfire plume heights**
3	Radiance, aerosol, aerosol, and surface	Global-scale, long-term studies
3	Aerosol joint	Global-scale, coarse-resolution particle properties
3	Cloud motion vector	Wind climatologies

The role of Distributed Active Archive Centers

The MISR project	Our DAAC (ASDC)
• Developed instrument • Develop and test algorithms • Deliver working code to ASDC to produce data products • Deliver special data products (plume project)	• Receives raw instrument data • Processes data through the algorithms • Stores completed data products • **Provides public access to data products**

misr.jpl.nasa.gov

eosweb.larc.nasa.gov