

Using NASA's Giovanni Web Portal to Access and Visualize Satellite-Based Earth Science Data in the Classroom

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Data and Information Services Center
(GES DISC)

Teaching With New Geoscience Tools:
Visualizations, Models and Online Data

Amherst, MA
10-12 February 2008



GES-DISC Interactive Online Visualization and Analysis Infrastructure (Giovanni)

- With Giovanni and a few mouse clicks, one can easily obtain information on the atmosphere around the world.
- There is no need to learn data formats to retrieve and process data.
- You can try various combinations of parameters measured by different instruments.
- All the statistical analysis is done via a regular web browser.

<http://giovanni.gsfc.nasa.gov/>

Caution: Giovanni is a constantly evolving data exploration tool!



What is Giovanni?

Data Inputs

MLS Aura

OMI Aura

AIRS Aqua

MODIS Aqua

MODIS Terra

SeaWiFS

TRMM

HALOE UARS

TOMS EP, N7

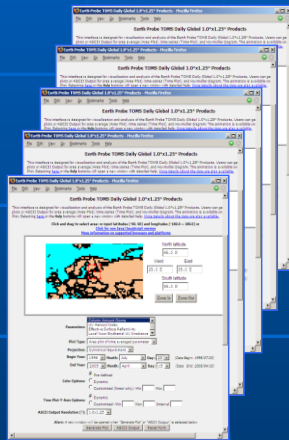
AMSR-E Aqua

MISR Terra

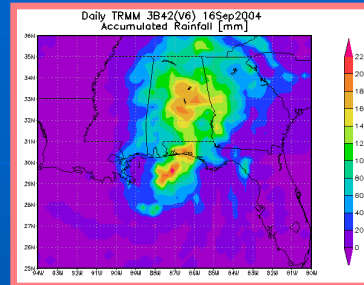
CloudSat

CALIOP CALIPSO

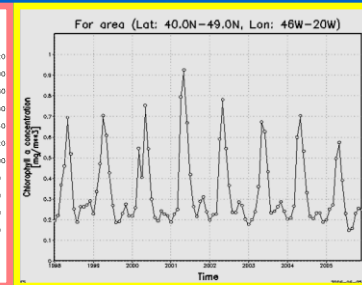
Giovanni Instances



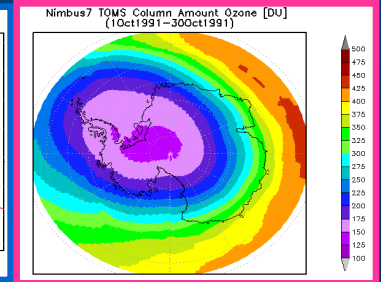
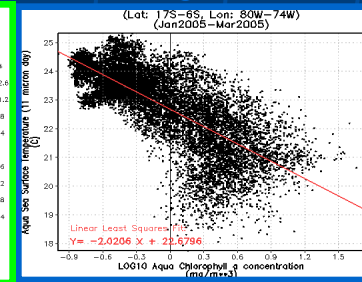
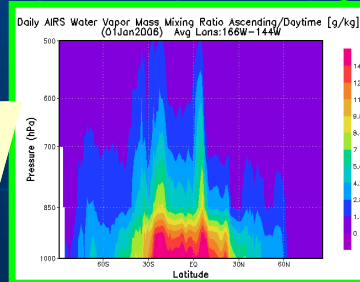
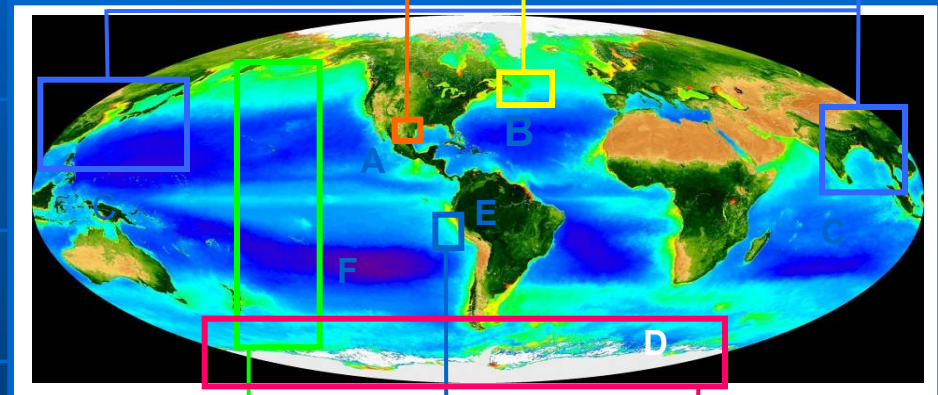
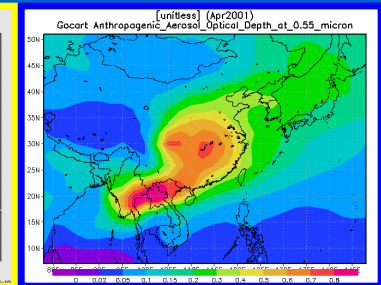
Area Plot



Time Series



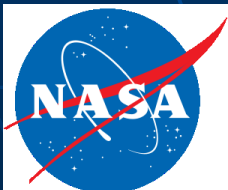
Model Output



Profile Cross-Section

Correlations

Column Densities



Giovanni capabilities

Basic (one-parameter):

- **Area plot** – averaged or accumulated over any data period for any rectangular area (various map projections)
- **Time plot** – time series averaged over any rectangular area
- **Hovmoller plots** –longitude-time or latitude-time cross sections
- **ASCII output** – for all plot types (can be used with GIS apps, spreadsheets, etc.)
- **Image animation** – for area plot
- **Vertical profiles**
- **Vertical cross-sections, zonal means**

Beyond basics:

- **Area plot** - geographical intercomparison between two parameters
- **Time plot** - an X-Y time series plot of several parameters
- **Scatter plot of parameters in selected area and time period**
- **Scatter plot of area averaged parameters** - regional (i.e., spatially averaged) relationship between two parameters
- **Temporal correlation map** - relationship between two parameters at each grid point in the selected spatial area
- **Temporal correlation of area averaged parameters** - a single value of the correlation coefficient of a pair of selected parameters
- **Difference plots**
- **Anomaly plots**
- **Acquiring parameter and spatial subsets** in a batch mode through Giovanni



Giovanni - Mozilla Firefox

File Edit View Go Bookmarks Tools Help

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

+ ABOUT NASA + NEWS & EVENTS + MULTIMEDIA + MISSIONS + POPULAR TOPICS + MyNASA

+ Tech Lab Home
+ GES DISC Home

Giovanni

+ OVERVIEW

SEARCH DISC
leptoukh] + GO
+ ADVANCED SEARCH

Giovanni
The Bridge Between Data and Science

GIOVANNI

Current Giovanni Interfaces

These Giovanni interfaces are operational:

Agricultural Online Visualization and Analysis System	View snapshot
AIRS Online Visualization and Analysis System	View snapshot
Aura MLS Online Visualization and Analysis System	View snapshot
MODIS Online Visualization and Analysis System (MOVAS)	View snapshot
Ocean Color Time-Series Project	View snapshot
OMI Online Visualization and Analysis System	View snapshot
TOMS Online Visualization and Analysis System	View snapshot
TRMM Online Visualization and Analysis System (TOVAS)	View snapshot
UARS HALOE Online Visualization and Analysis System	View snapshot

GIOVANNI NEWS

04.18.2006 OMI Level 2G now available in Giovanni
The OMI Level 2G total column ozone gridded product is now available in OMI Giovanni. This OMI Giovanni (now separated from TOMS Giovanni) allows users to interactively filter by quality flag and viewing zenith angle.
[+ Explore OMI Giovanni](#)

04.05.2006 GPCP Data now available in TOVAS Giovanni
Global Precipitation (GPCP, 1979 - 2005) data are available through TOVAS Giovanni. In addition, TRMM V5 data products have been replaced by TRMM V6. Also, new options have been made available on resultant image page, including "Unit options (mm or inch)" and "Nonlinear color scale".
[+ Explore TOVAS](#)

03.31.2006 New MODIS Aqua SST available in Giovanni
A new version of MODIS Aqua Sea Surface Temperature (SST) has been added to the Ocean Color Time-Series Project Giovanni subsequent to the full dataset reprocessing by the OBPB. The data product used in

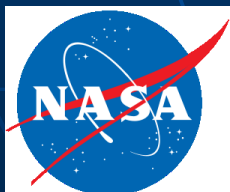
For full descriptions, features, and list of parameters available in each of our Giovanni interfaces, please check our [Giovanni Interface Description Web page](#).

What is Giovanni?

The GES-DISC Interactive Online Visualization and Analysis Infrastructure (Giovanni) is the underlying infrastructure for a growing family of Web interfaces that allows users to analyze gridded data interactively online without having to download any data. Through Giovanni, users are invited to discover and explore our data using sophisticated analyses and visualizations.

In the future, there will be more instances of Giovanni available and we

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



Science Questions



You will need to identify *which* specific data products can address your science question.

Data Products

Satellite

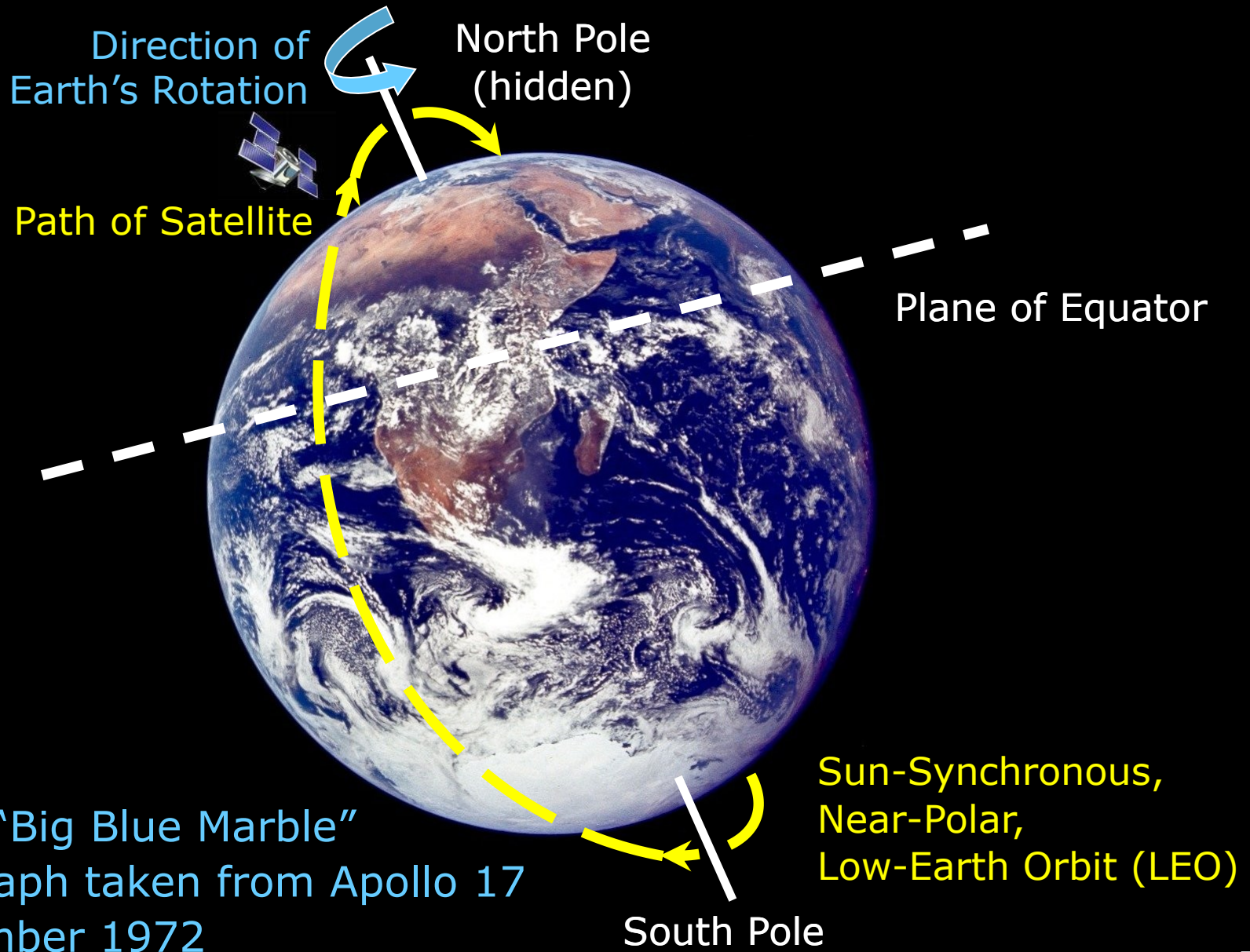
Data in Giovanni

Data within GES DISC (Archive)

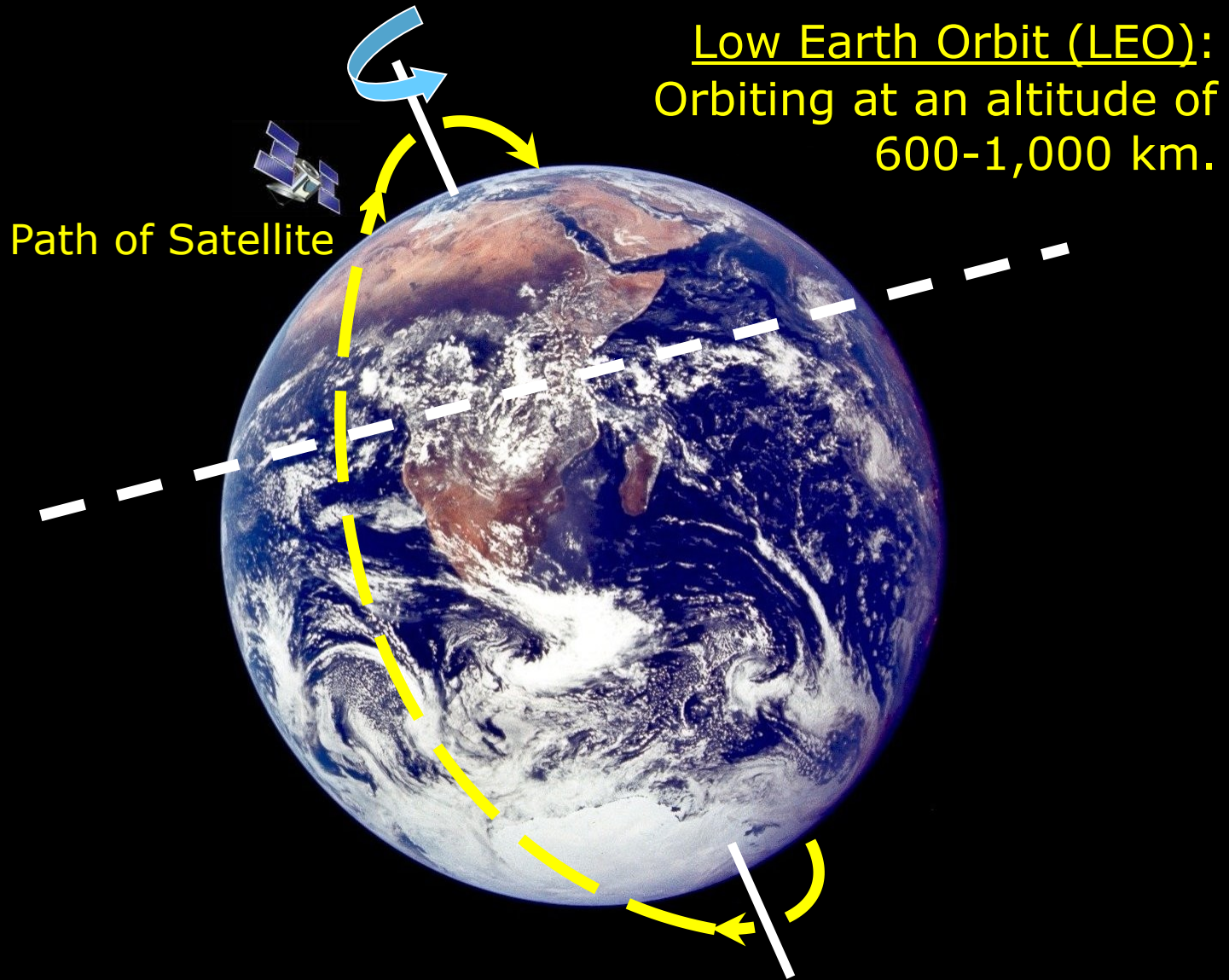
All Satellite Remote Sensing Data



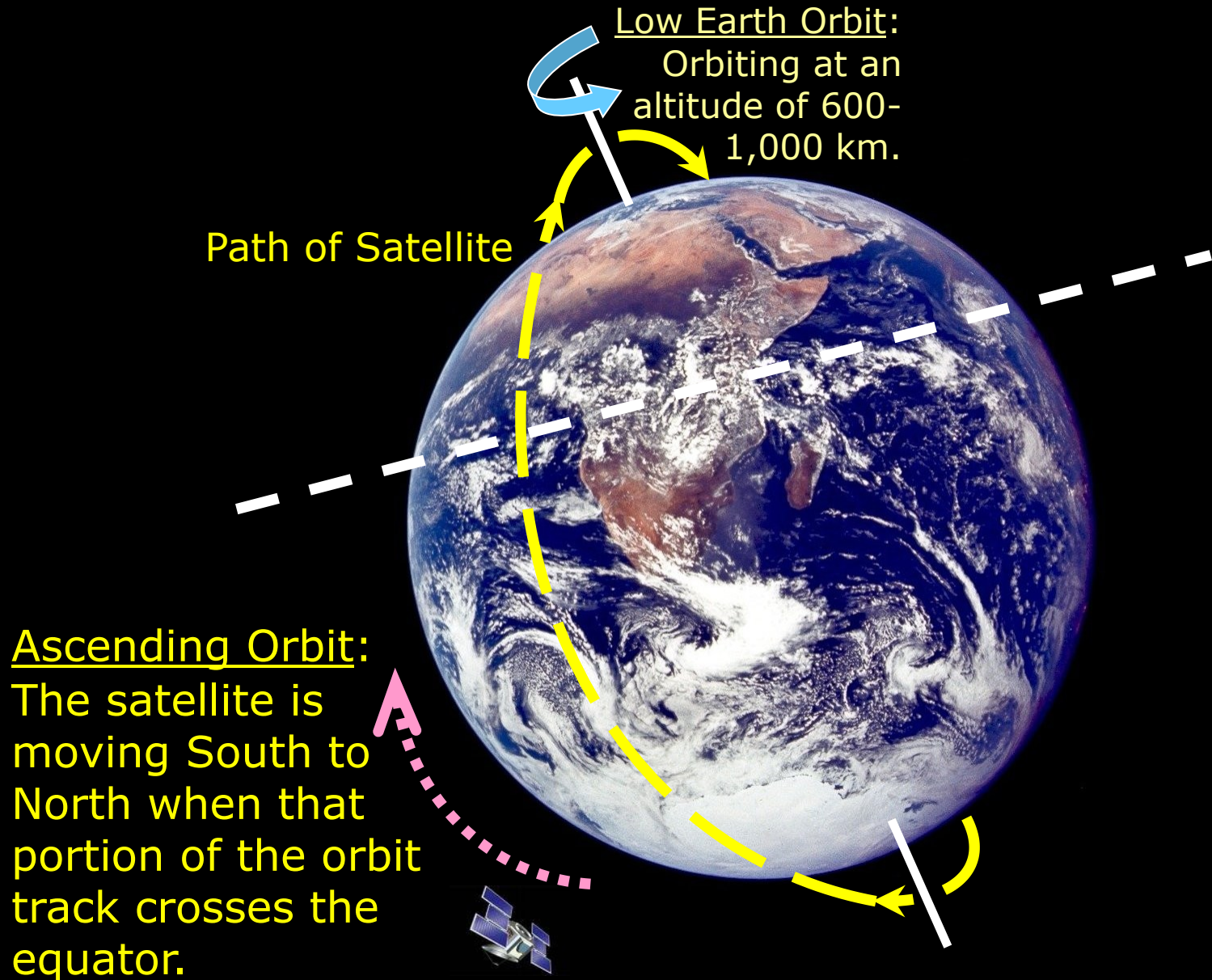
NASA Earth-Observing Satellites



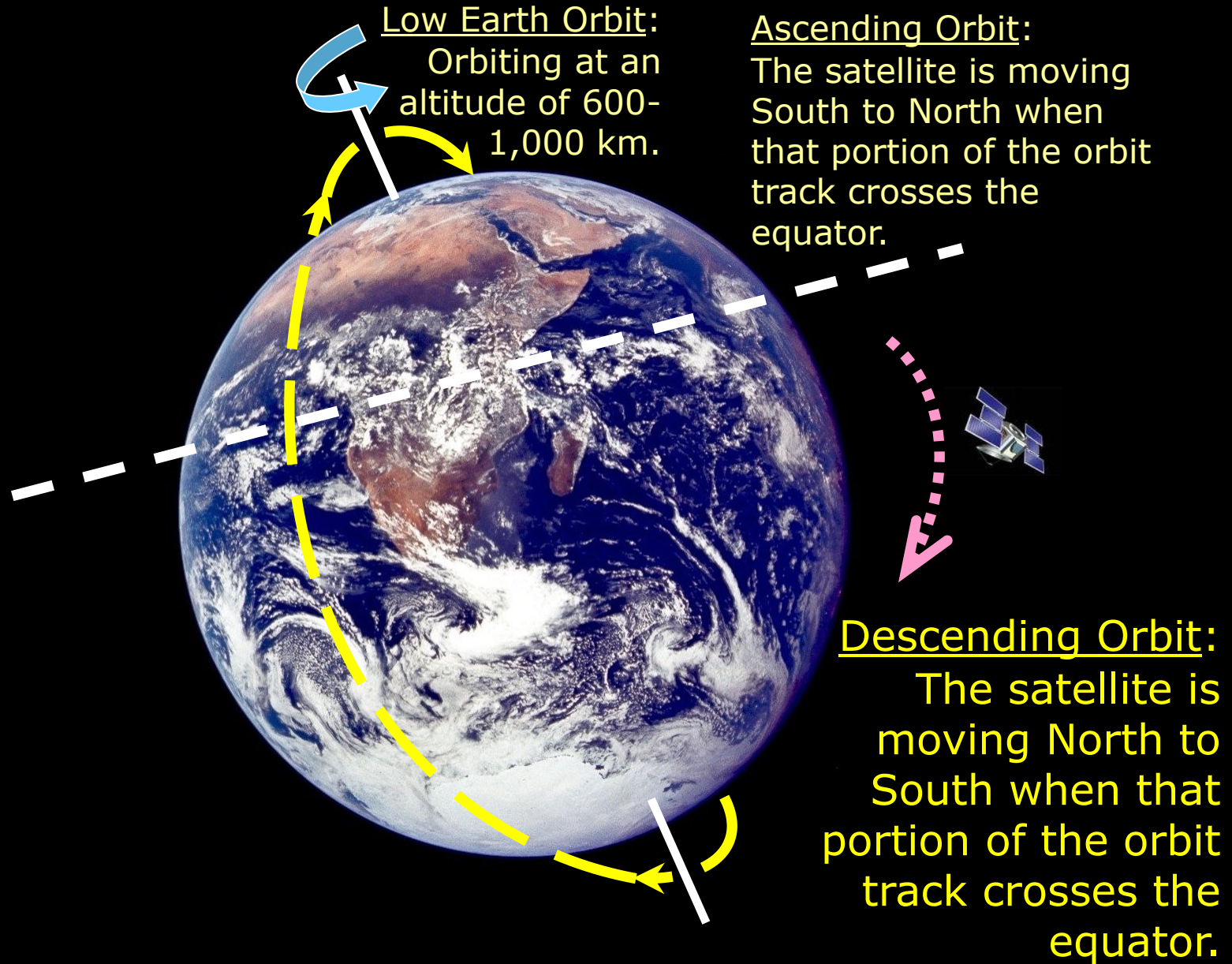
NASA Earth-Observing Satellites



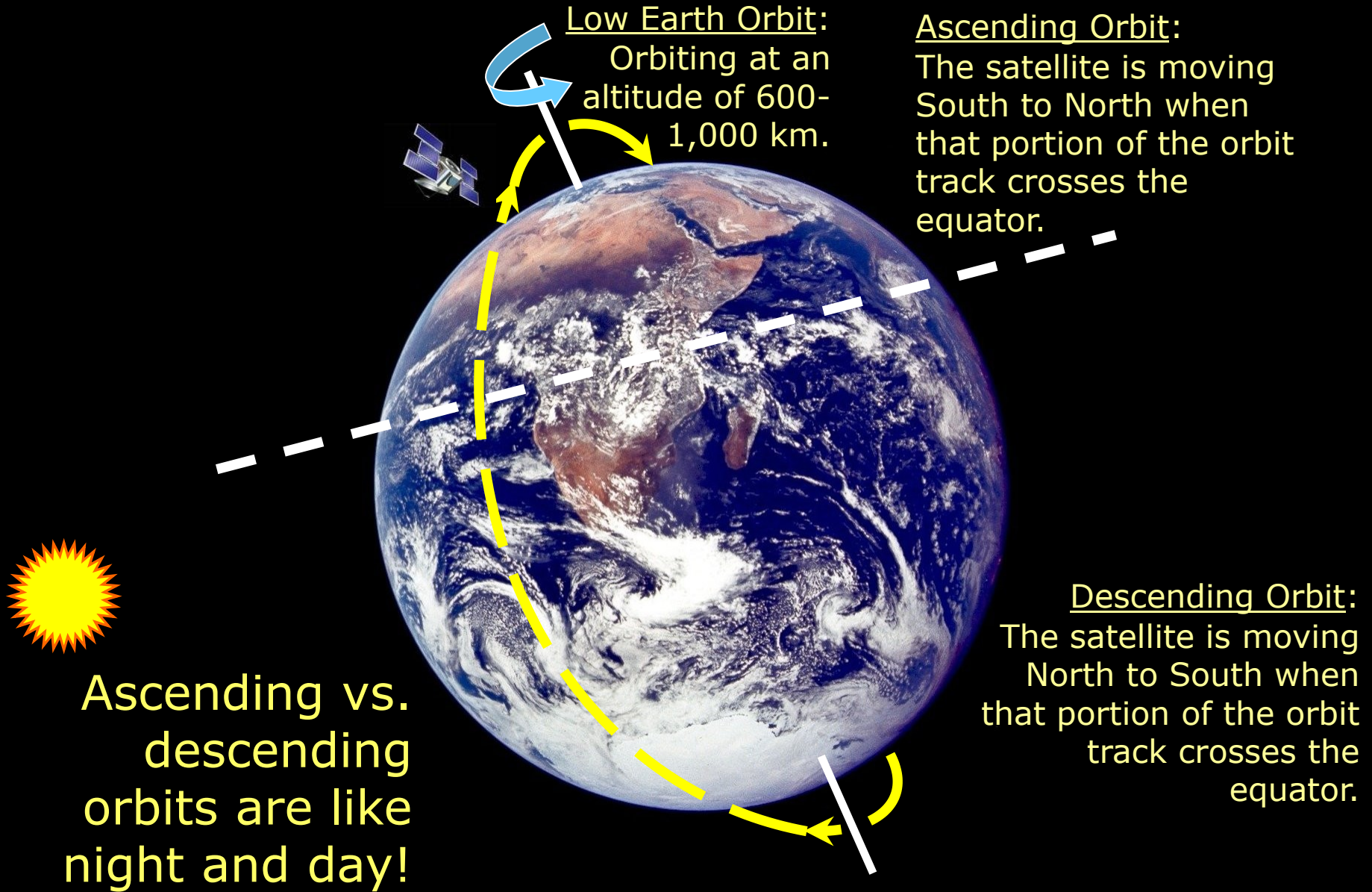
NASA Earth-Observing Satellites



NASA Earth-Observing Satellites



NASA Earth-Observing Satellites



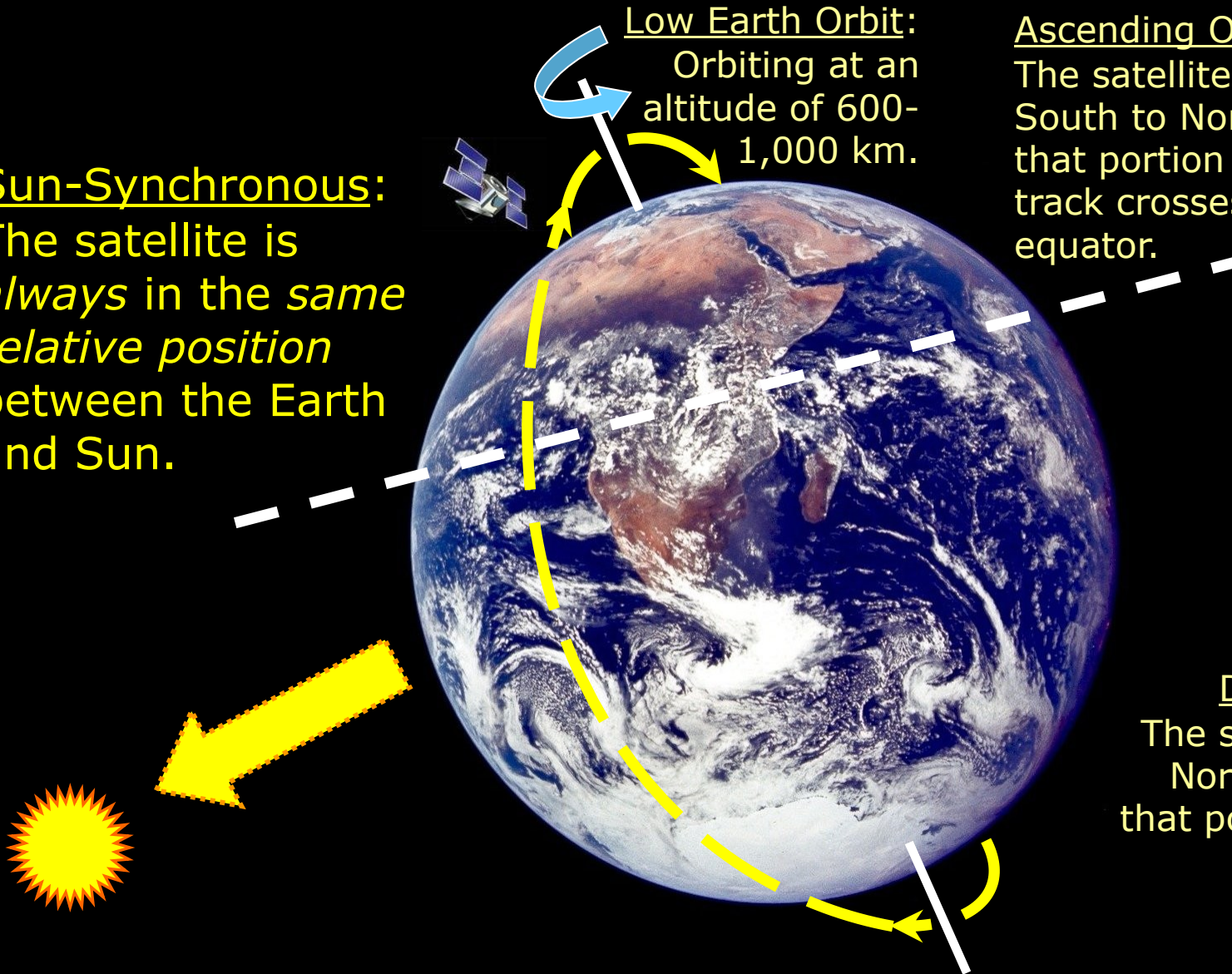
NASA Earth-Observing Satellites

Low Earth Orbit:
Orbiting at an
altitude of 600-
1,000 km.

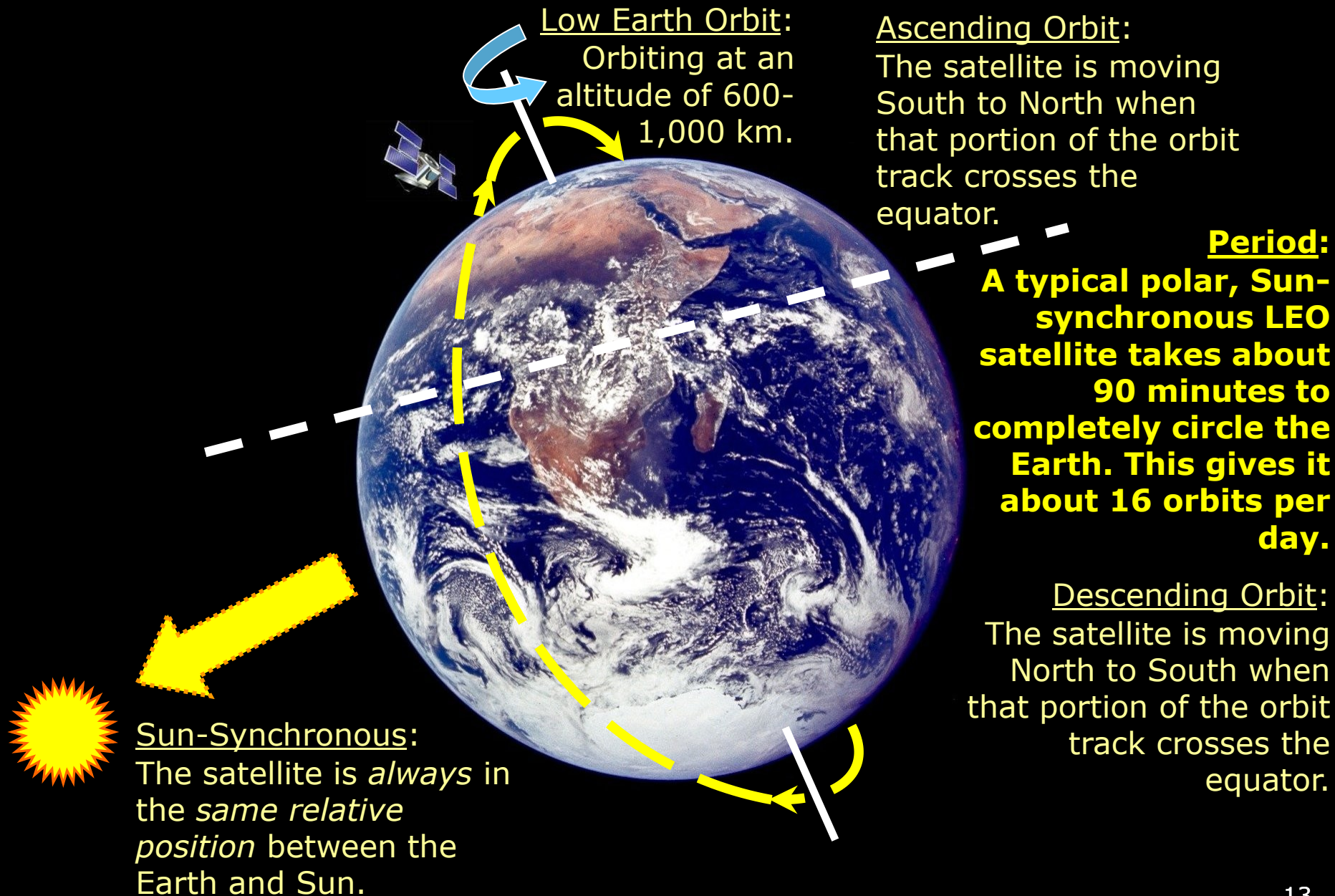
Ascending Orbit:
The satellite is moving
South to North when
that portion of the orbit
track crosses the
equator.

Sun-Synchronous:
The satellite is
always in the *same*
relative position
between the Earth
and Sun.

Descending Orbit:
The satellite is moving
North to South when
that portion of the orbit
track crosses the
equator.



NASA Earth-Observing Satellites



NASA Earth-Observing Satellites

Equator-Crossing Time:
The local apparent solar time when the satellite crosses the equator.

Example: Terra has an equator crossing time of 10:30 am, and is called an "AM" or morning satellite.

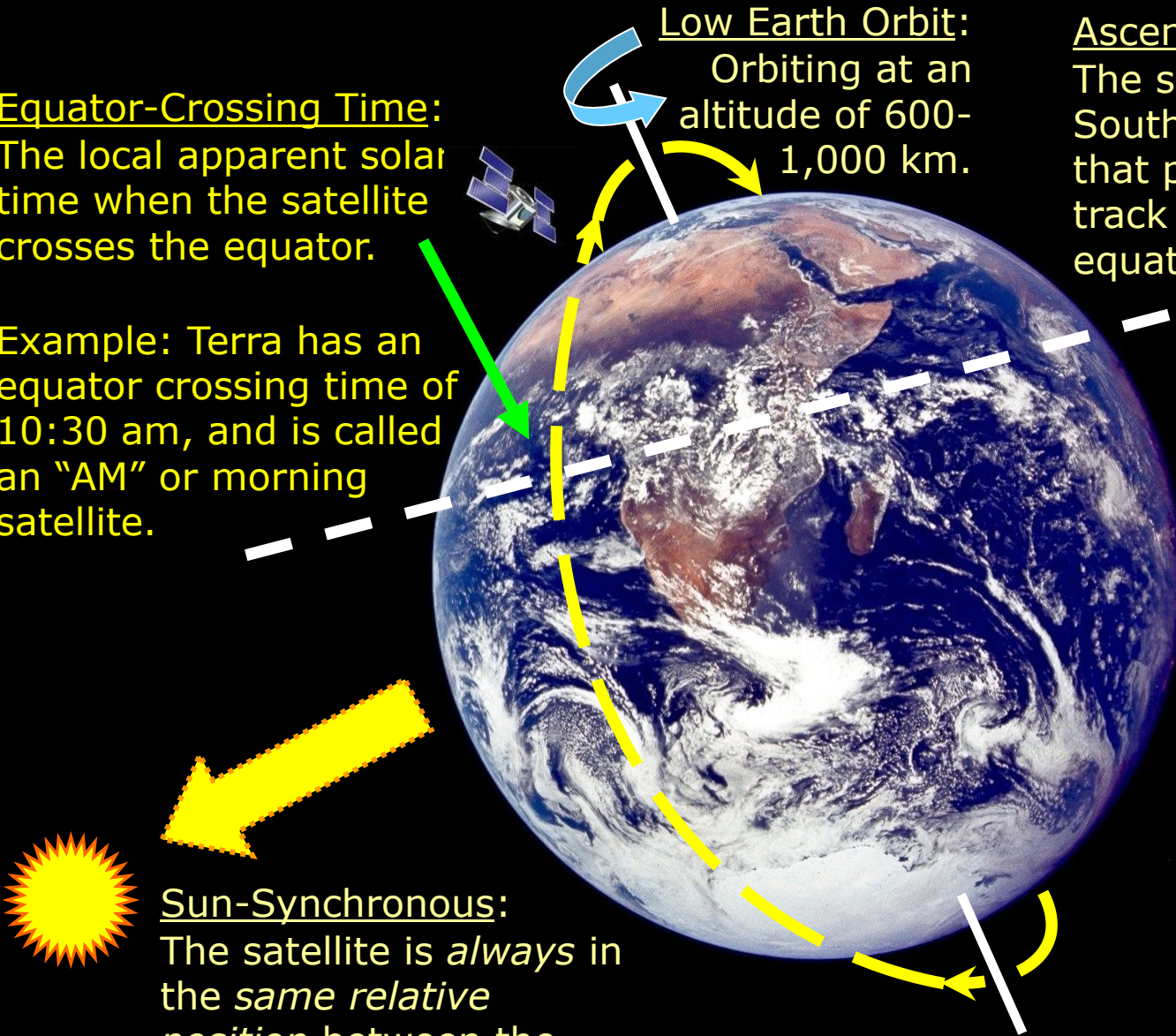
Sun-Synchronous:
The satellite is *always* in the *same relative position* between the Earth and Sun.

Low Earth Orbit:
Orbiting at an altitude of 600-1,000 km.

Ascending Orbit:
The satellite is moving South to North when that portion of the orbit track crosses the equator.

Period:
A typical polar, Sun-synchronous LEO satellite takes about 90 minutes to completely circle the Earth. This gives it about 16 orbits per day.

Descending Orbit:
The satellite is moving North to South when that portion of the orbit track crosses the equator.



NASA Earth-Observing Satellites

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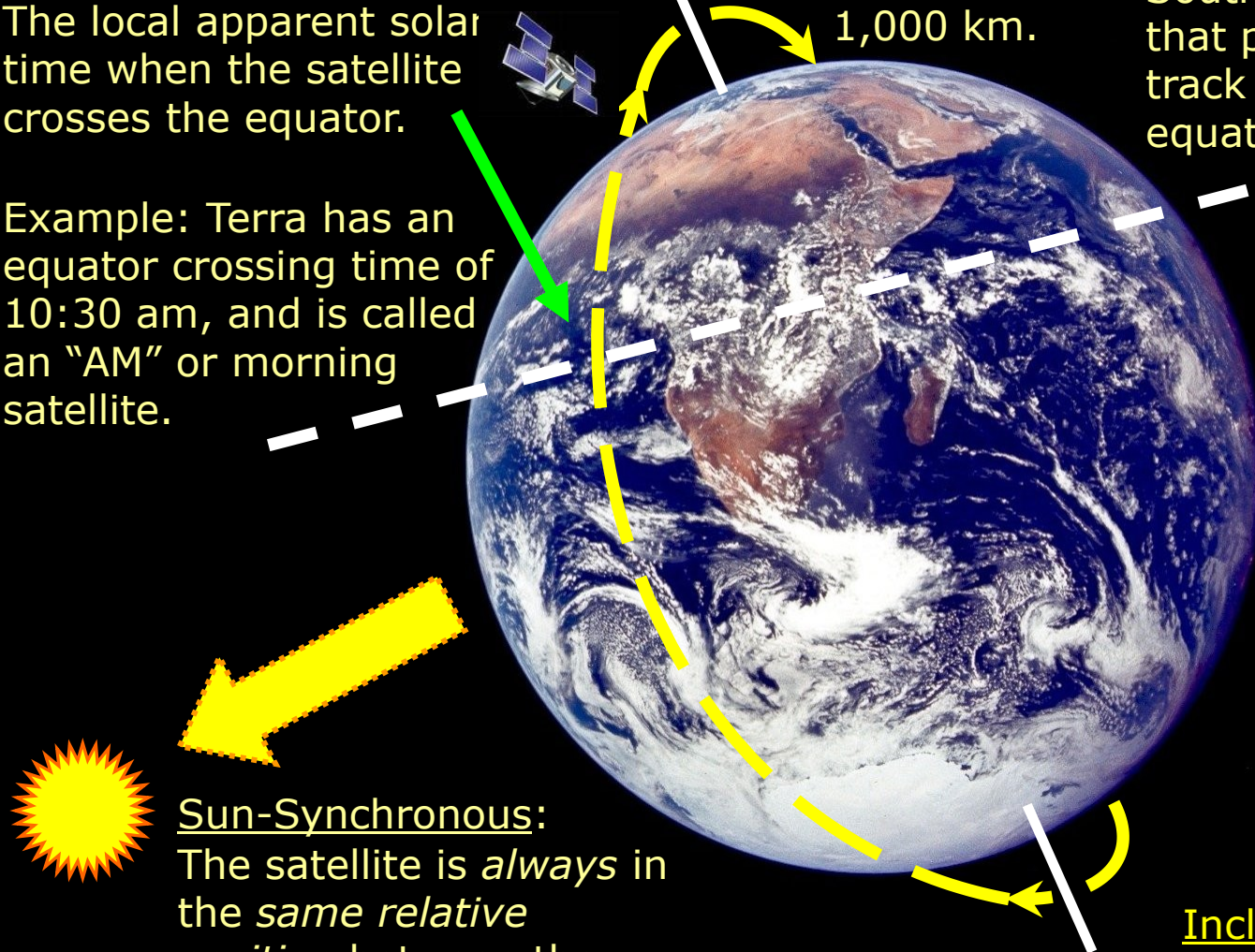
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Inclination:
The position of the orbital plane relative to the equator. For near-polar orbits, typically about 97° .



Satellite Inclination

Low Inclination
Orbit (often
near 57° --
Space Shuttle)

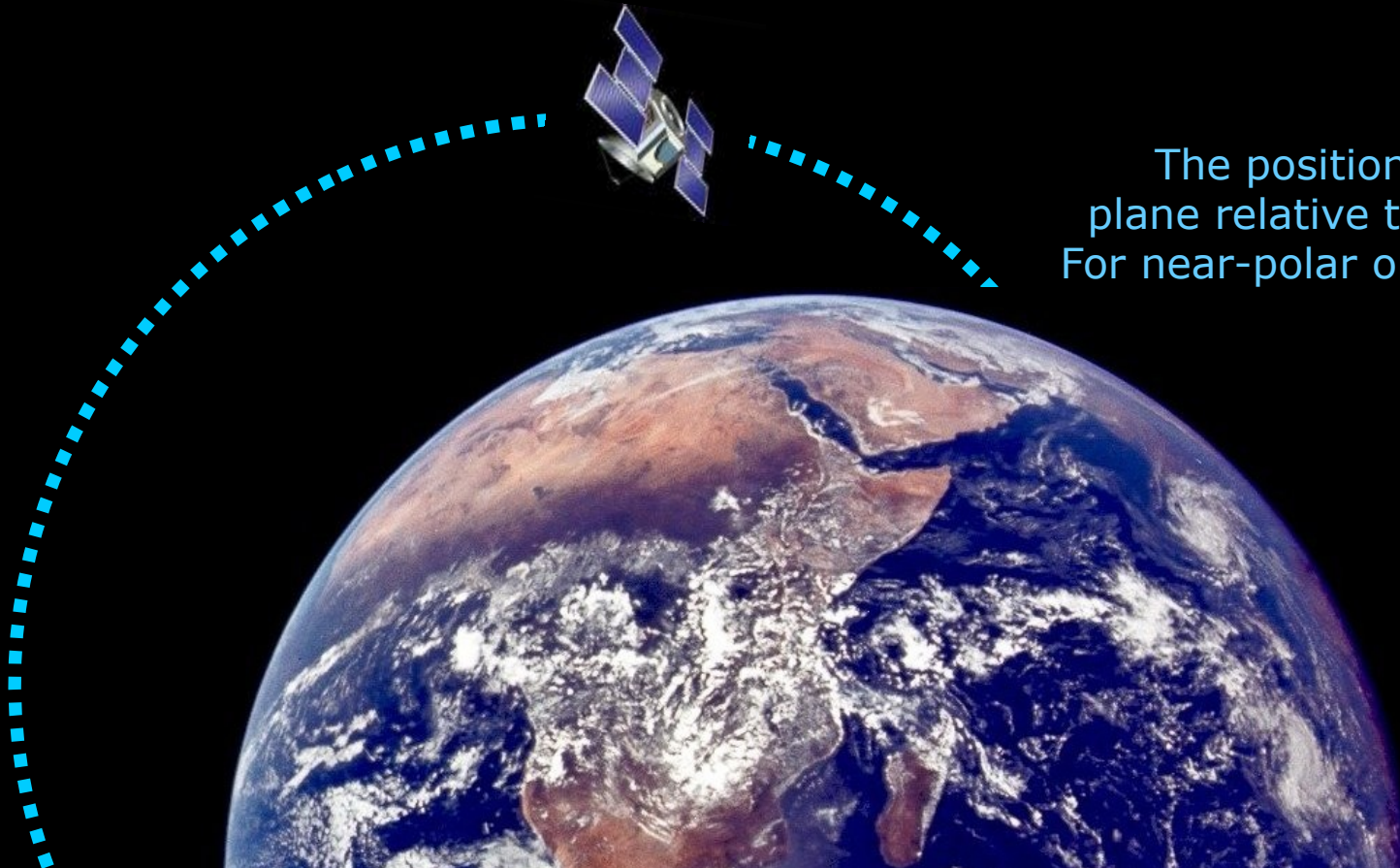
no polar
coverage



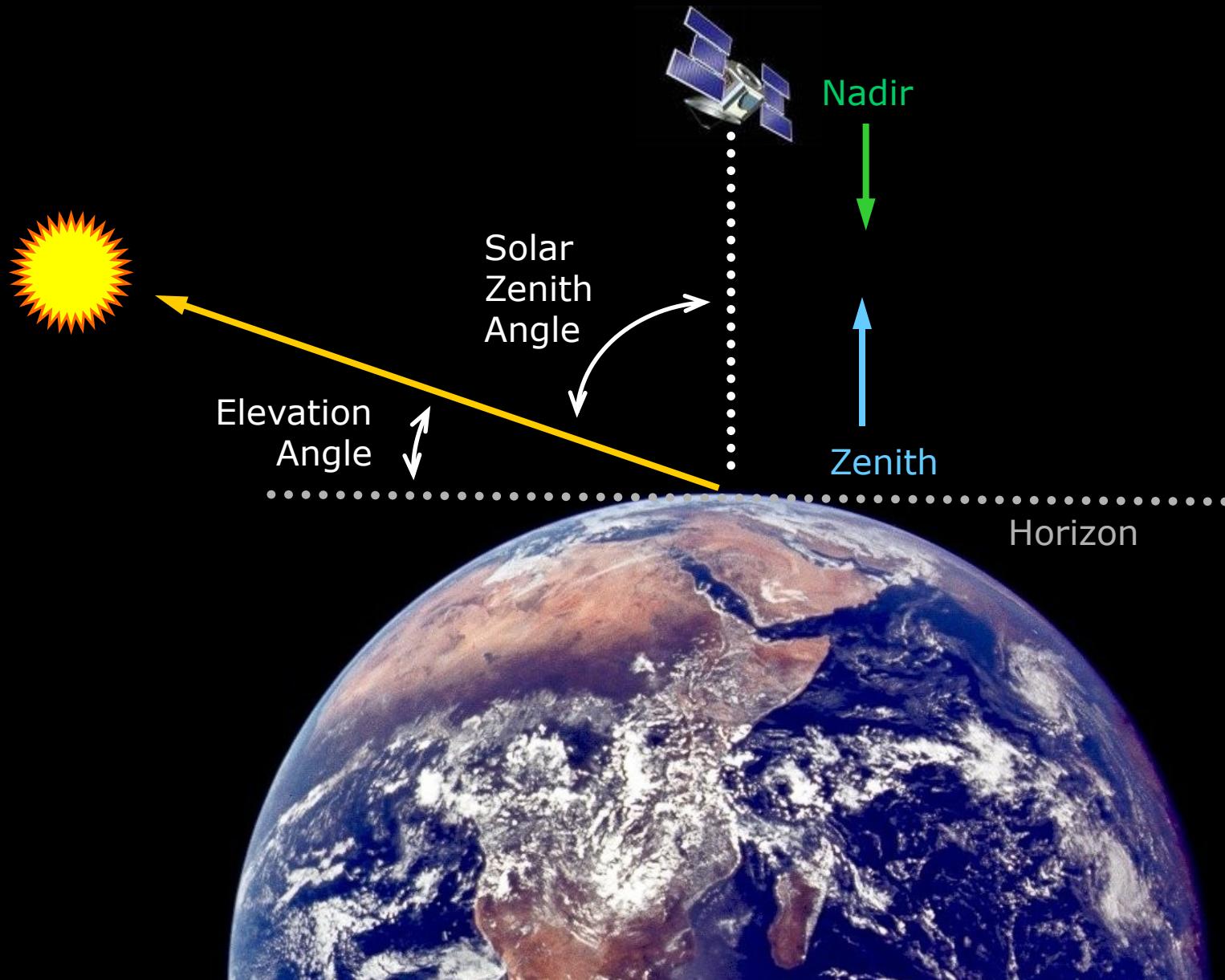
High Inclination
or Polar Orbit
(near 90°)

virtually
complete global
coverage

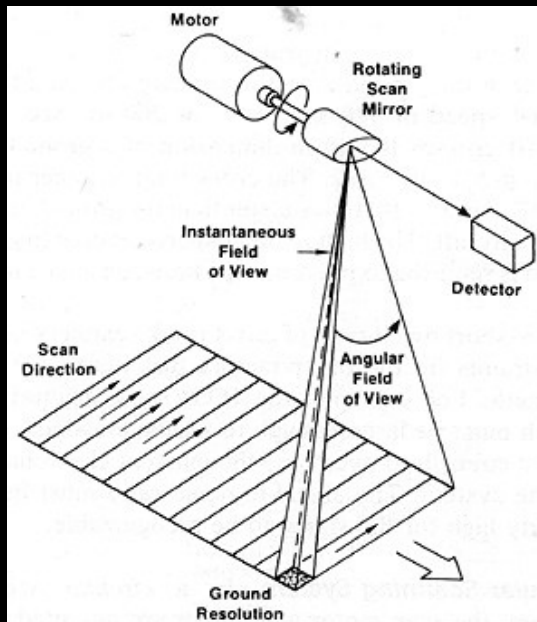
Inclination:
The position of the orbital
plane relative to the equator.
For near-polar orbits, typically
about 97° .



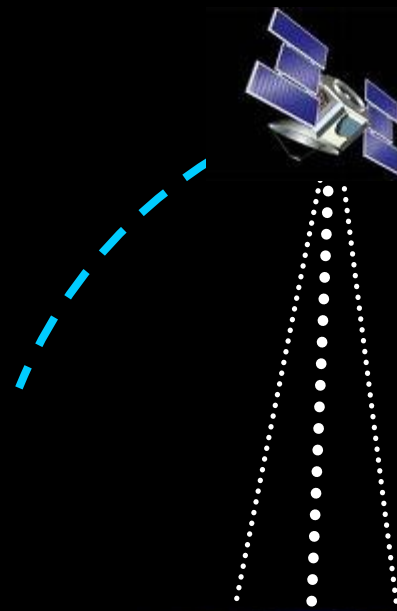
Satellite Viewing Geometry



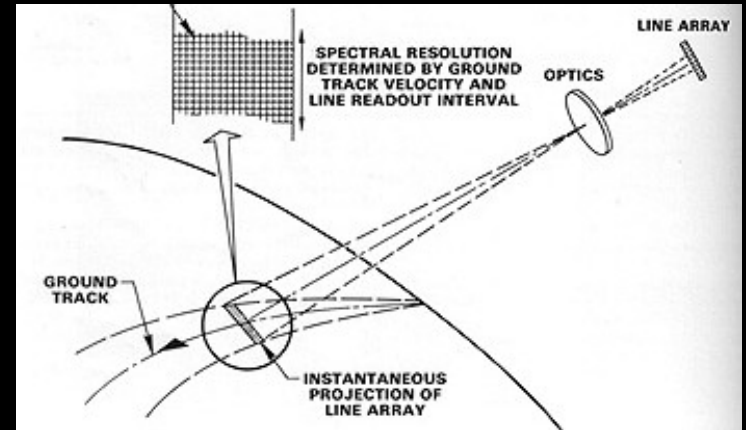
Satellite Viewing Geometry



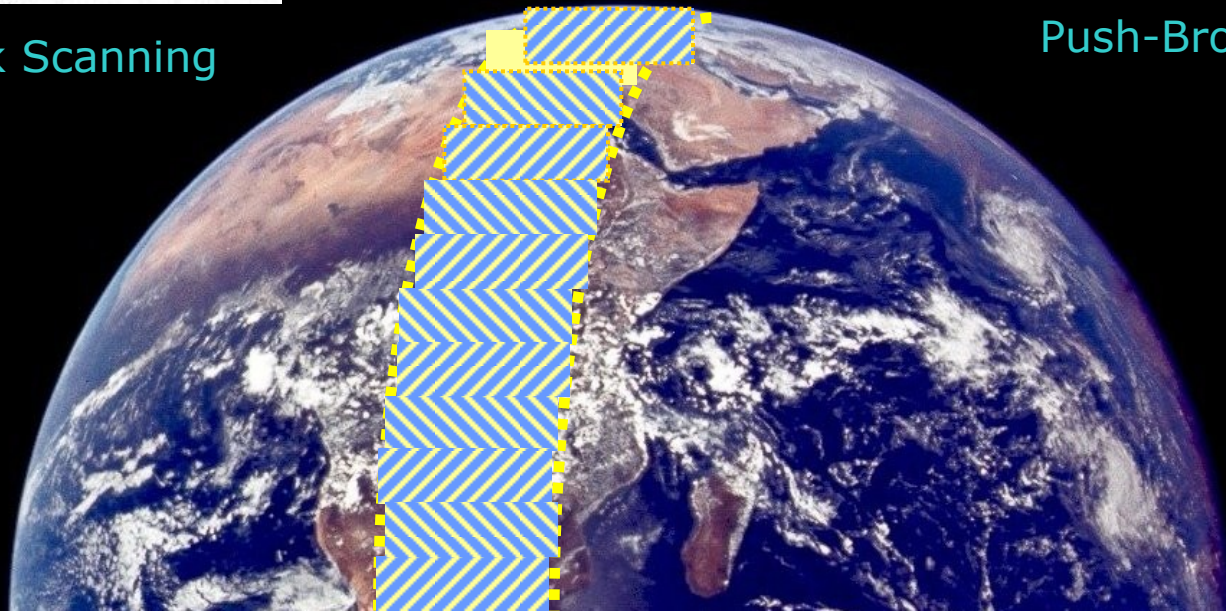
Cross-Track Scanning



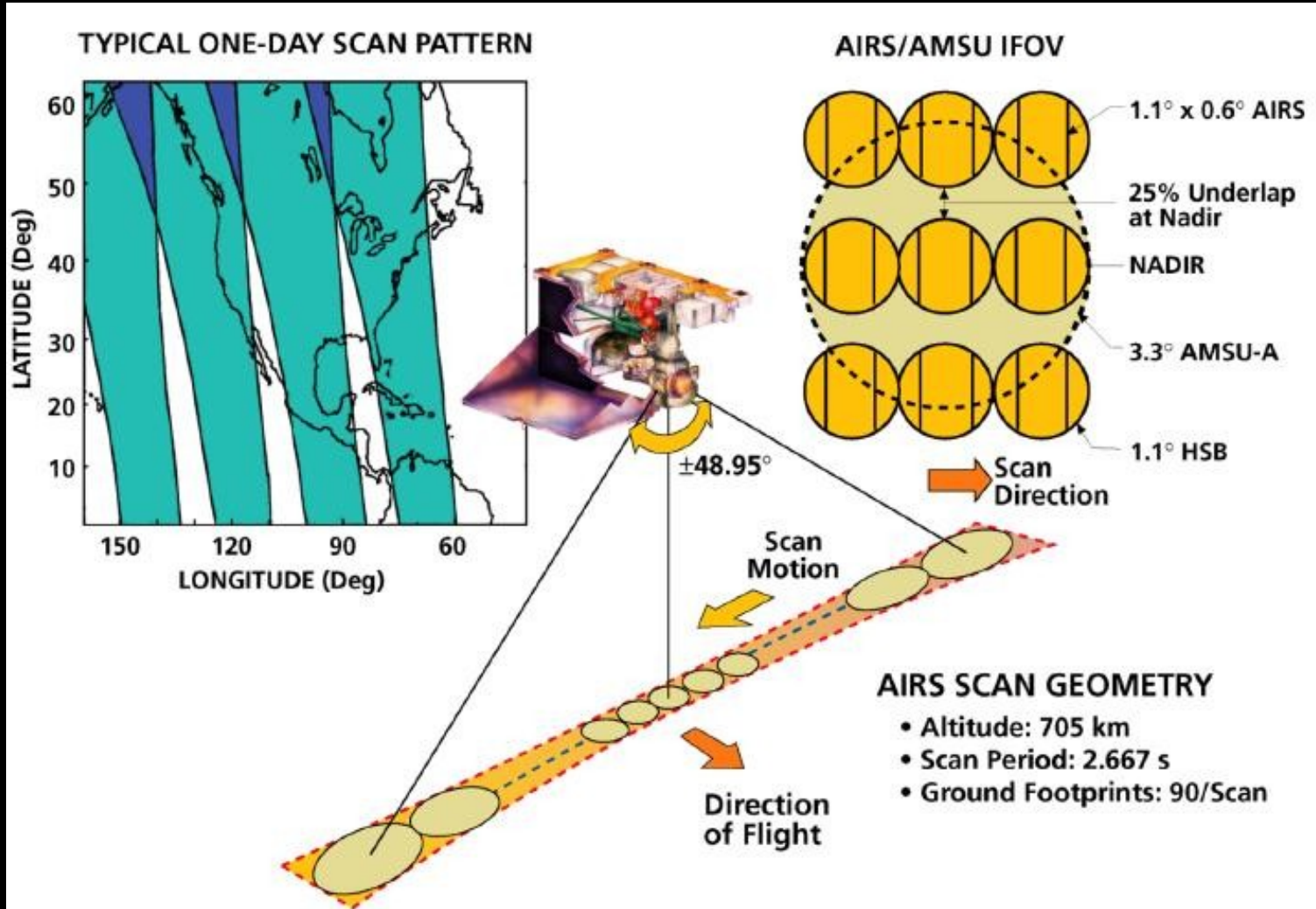
Direction of Satellite Motion



Push-Broom

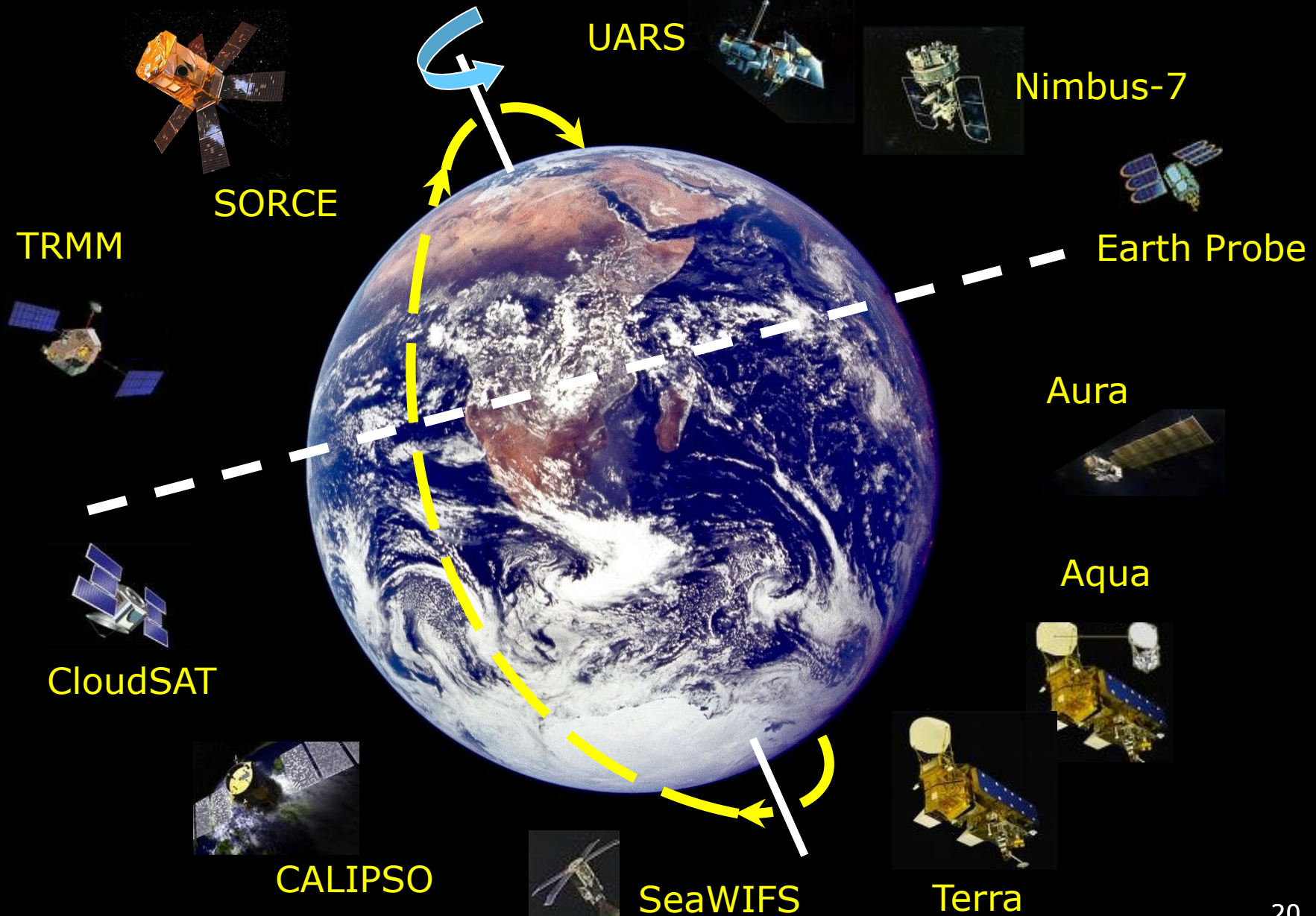


Satellite Viewing Geometry



Cross-track scanning results in individual observations (“pixels”) of varying size, and can leave gaps between successive orbits if the scan angle is not wide enough.

NASA Earth-Observing Satellites



NASA's A-Train:

A Constellation of Near-Simultaneous Afternoon-Viewing Satellites

Parasol
1:33
(ESA)

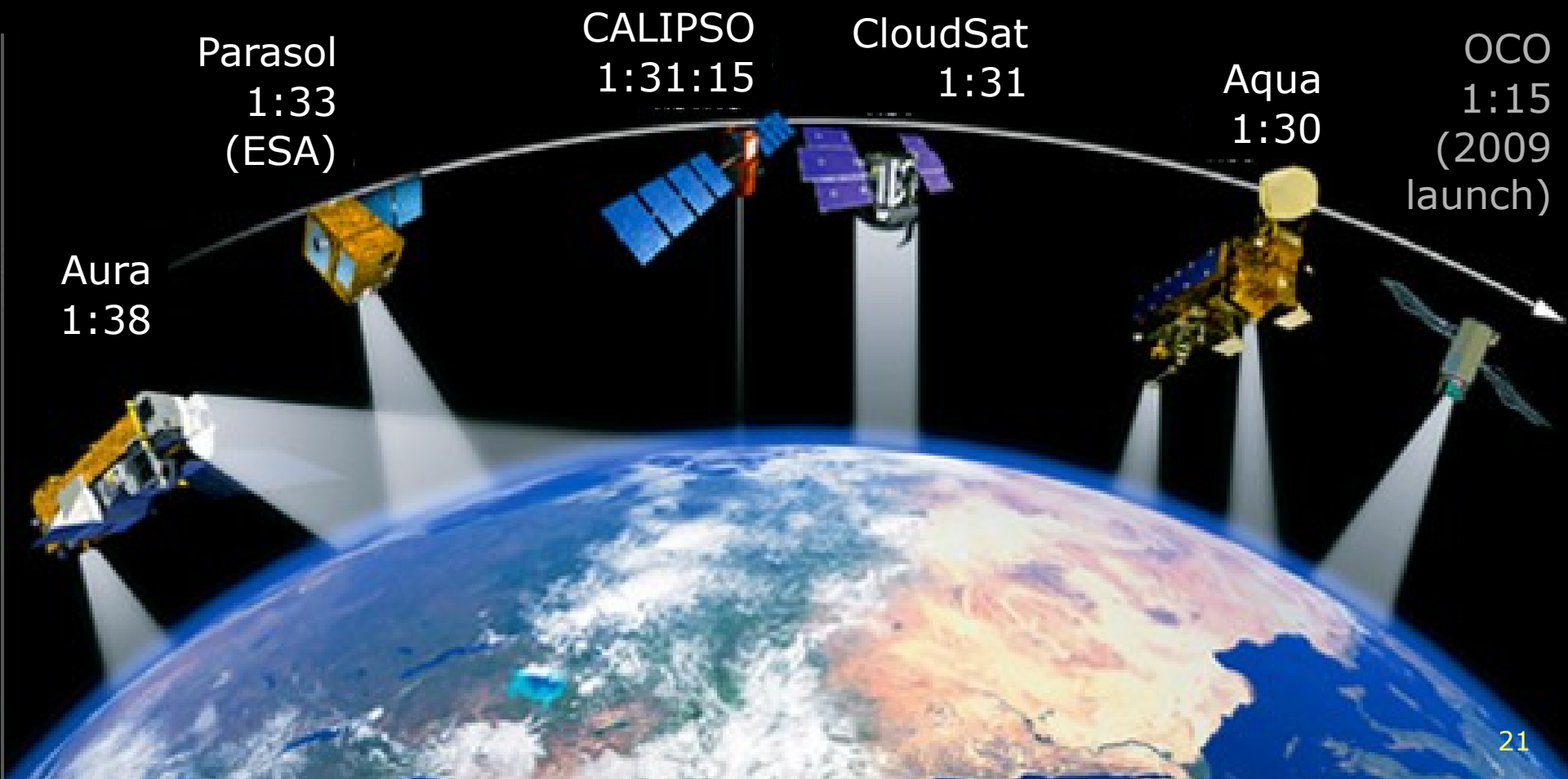
CALIPSO
1:31:15

CloudSat
1:31

Aqua
1:30

OCO
1:15
(2009
launch)

Aura
1:38

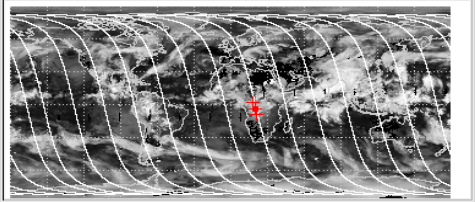


CloudSat, and coregistered MODIS/Aqua, AIRS/Aqua, CALIPSO lidar, and OMI/Aura Atmospheric Measurements

Plots of vertical profiles of clouds, temperature, humidity, cloud and aerosol classification; Horizontal swaths of cloud characteristics and total column aerosols, collocated with CloudSat track; Line over-plots of cloud pressures.

Select Constraints:

Spatial



Map View: Ascending Orbits Range (kilometers) | 1300

Temporal

Orbit Date Year | 2007 Month | Sep Day | 6 [Update Map](#) (Range: 02 Jun 2006 - 11 Sep 2007)

Parameters

Curtains

Temperature(2002/08/30 - 2007/09/19)

<input type="checkbox"/> Atmospheric Temperature Profile	AIRX2RET.003	AIRS Aqua	2002/08/30 - 2007/09/01
<input type="checkbox"/> Atmospheric Temperature Profile	AIRX2RET.005	AIRS Aqua	2002/08/31 - 2007/09/16
<input type="checkbox"/> Atmospheric Temperature Profile (Kelvins)	MAC07S0.002	MODIS Aqua	2006/06/02 - 2007/09/19

Water Vapor(2002/08/30 - 2007/09/19)

<input type="checkbox"/> H2O (Dew Point Temperature Profile in Kelvins)	MAC07S0.002	MODIS Aqua	2006/06/02 - 2007/09/19
<input type="checkbox"/> H2O Saturation Mass Mixing Ratio (gm/kg dry air)	AIRX2RET.005	AIRS Aqua	2002/08/31 - 2007/09/16
<input type="checkbox"/> H2O Saturation Mass Mixing Ratio (gm/kg dry air)	AIRX2RET.003	AIRS Aqua	2002/08/30 - 2007/09/01
<input type="checkbox"/> H2O Vapor Mass Mixing Ratio (gm/kg dry air)	AIRX2RET.003	AIRS Aqua	2002/08/30 - 2007/09/01
<input type="checkbox"/> H2O Vapor Mass Mixing Ratio (gm/kg dry air)	AIRX2RET.005	AIRS Aqua	2002/08/31 - 2007/09/16

Clouds(2006/06/02 - 2007/09/17)

<input checked="" type="checkbox"/> Cloud/Aerosol Classification (Vertical Feature Mask)	VFM.001	Calipso - Lidar	2006/06/13 - 2007/09/17
<input type="checkbox"/> ReceivedEchoPowers	1B_CPR.008	CloudSat	2006/06/02 - 2007/09/12
<input checked="" type="checkbox"/> Reflectivity dBZ	1B_CPR.008	CloudSat	2006/06/02 - 2007/09/12
<input type="checkbox"/> RO Ice Water Content	2B_CWC_RO.007	CloudSat	2007/01/07 - 2007/01/08
<input type="checkbox"/> RO Liquid Water Content	2B_CWC_RO.007	CloudSat	2007/01/07 - 2007/01/08

Strips

Surface(2002/08/30 - 2007/09/20)

<input checked="" type="checkbox"/> Cloud Top Pressure in hPa (Horizontal Strip)	MAC06S1.002	MODIS Aqua	2006/06/02 - 2007/09/16
<input checked="" type="checkbox"/> Aerosol Optical Depth 550nm	MAC04S1.002	MODIS Aqua	2006/06/02 - 2007/09/16
<input checked="" type="checkbox"/> Effective Cloud Pressure for O3 (Raman Ring)	OMCLRRS0.001	OMI Aura	2007/08/11 - 2007/08/12
<input checked="" type="checkbox"/> Effective Cloud Pressure (O2-O2)	OMCLO2S0.001	OMI Aura	2006/06/02 - 2007/09/18
<input checked="" type="checkbox"/> Final Aerosol Absorption Optical Depth	OMCLAERUVS0.002	OMI Aura	2006/06/02 - 2007/09/24
<input checked="" type="checkbox"/> UV Aerosol Index	OMCLTO3S0.002	OMI Aura	2006/06/02 - 2007/09/22

Select Visualization:

Subset Parameters Along Orbit Track - H2P [Services Help](#)

Generate Visualization **Reset** *Alert: A new window will be opened when "Generate Visualization" is selected.*

Near-Coincident A-Train Observations

- Modis (Aqua)
- AIRS (Aqua)
- CloudSat
- Calipso
- OMI (Aura)



Scientific Instruments on NASA Satellites



TRMM: Tropical Rainfall Measuring Mission

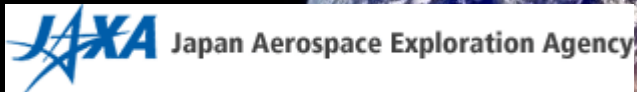
Instruments:

- Precipitation Radar (PR)
- TRMM Microwave Imager (TMI)
- Visible and InfraRed Scanner (VIRS)
- Cloud and Earth Radiant Energy Sensor (CERES)
- Lightning Imaging Sensor

Data Products at GES DISC:

- 3-hourly, daily and monthly rainfall
- Surface rainfall rate
- Accumulated rainfall
- Latent heating
- Cloud liquid water content
- Cloud ice content

in cooperation
with:



Scientific Instruments on NASA Satellites



SORCE: Solar Radiation and Climate Experiment

Instruments:

- Total Irradiance Monitor (TIM)
- Solar Stellar Irradiance Comparison Experiment (SOLSTICE)
- Spectral Irradiance Monitor (SIM)
- XUV Photometer System (XPS)

Data Products at GES DISC:

- Daily spectral solar irradiance
- 6-hr and daily total solar irradiance



Scientific Instruments on NASA Satellites

EOS Terra

Instruments:



- Adv. Spaceborne Thermal Emission and Reflection Radiometer (ASTER)
- Moderate Resolution Imaging Spectroradiometer (MODIS)
- Multi-angle Imaging SpectroRadiometer (MISR)
- Measurement of Pollution In The Troposphere (MOPITT)
- Cloud and Earth Radiant Energy Sensor (CERES)

Data Products at GES DISC:

- Aerosol optical depths
- Cloud fraction
- Cloud top pressure
- Aerosol parameters
- Water vapor
- Cirrus cloud reflectance
- etc.



Scientific Instruments on NASA Satellites

EOS Aqua

Instruments:

- Atmospheric Infrared Sounder (AIRS)
- Advanced Microwave Sounding Unit (AMSU-A)
- Humidity Sounder for Brazil (HSB)
- Advanced Microwave Scanning Radiometer for EOS (AMSR-E)
- Moderate-Resolution Imaging Spectroradiometer (MODIS)
- Clouds and the Earth's Radiant Energy System (CERES)



Data Products at GES DISC:

- Aerosol optical depths
- Cloud fraction
- Cloud top pressure
- Aerosol parameters
- Water vapor
- Cirrus cloud reflectance
- Surface pressure
- Temperature profiles
- H₂O and O₃ profiles



Scientific Instruments on NASA Satellites

EOS Aura



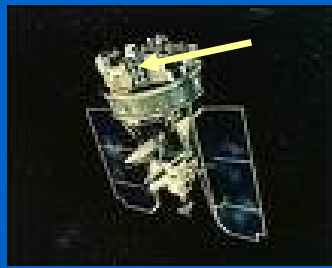
Instruments:

- High Resolution Dynamic Limb Sounder (HIRDLS)
- Microwave Limb Sounder (MLS)
- Ozone Monitoring Instrument (OMI)
- Tropospheric Emission Spectrometer (TES)

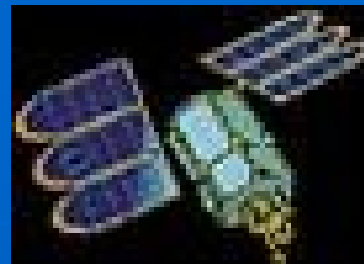
Data Products at GES DISC:

- Atmospheric profiles of H₂O, O₃, CO, ClO, HCl, HCN, OH and HNO₃
- Temperature profiles
- Geopotential height
- Total column O₃ and NO₂
- Aerosol index
- Cloud reflectivity
- Surface UV irradiance





Nimbus-7



Earth Probe



EOS Aura

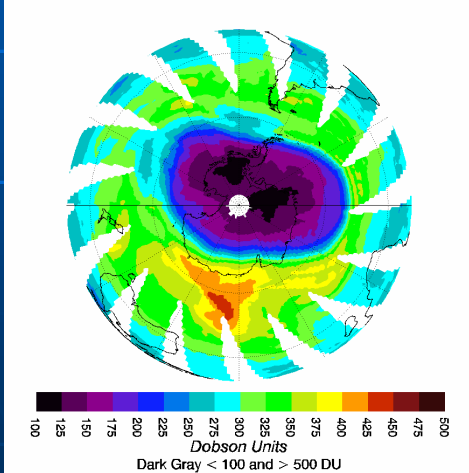
Nimbus-7 Total Ozone Mapping Spectrometer (TOMS)
 Earth Probe Total Ozone Mapping Spectrometer (TOMS)
 Aura Ozone Monitoring Instrument (OMI)

South Polar View

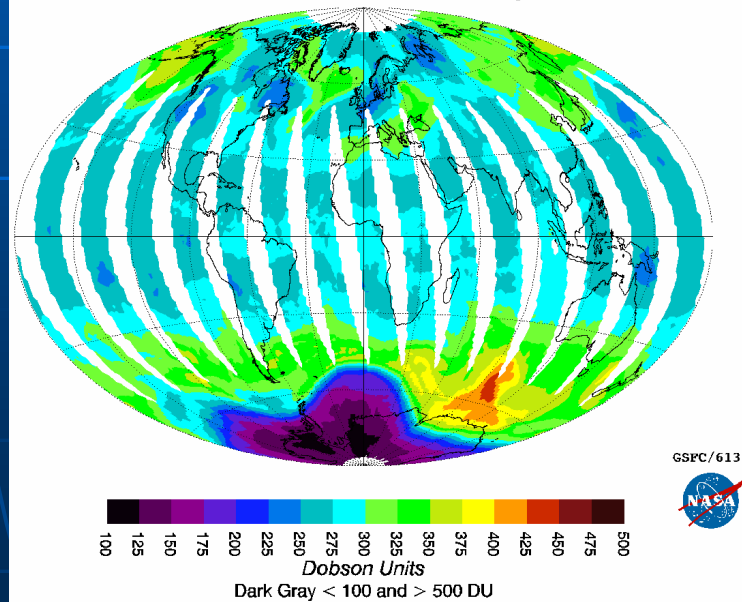
Global View

North Polar View

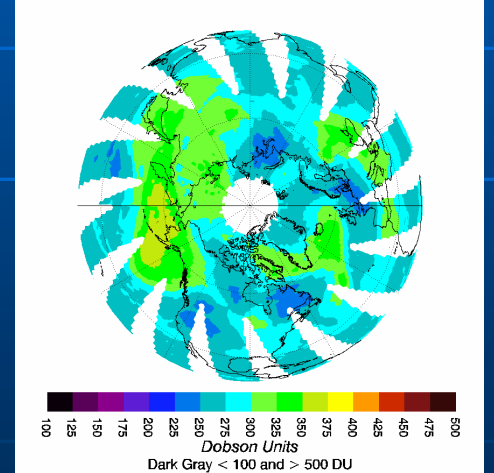
EP/TOMS Corrected Total Ozone for Sep 29, 1997



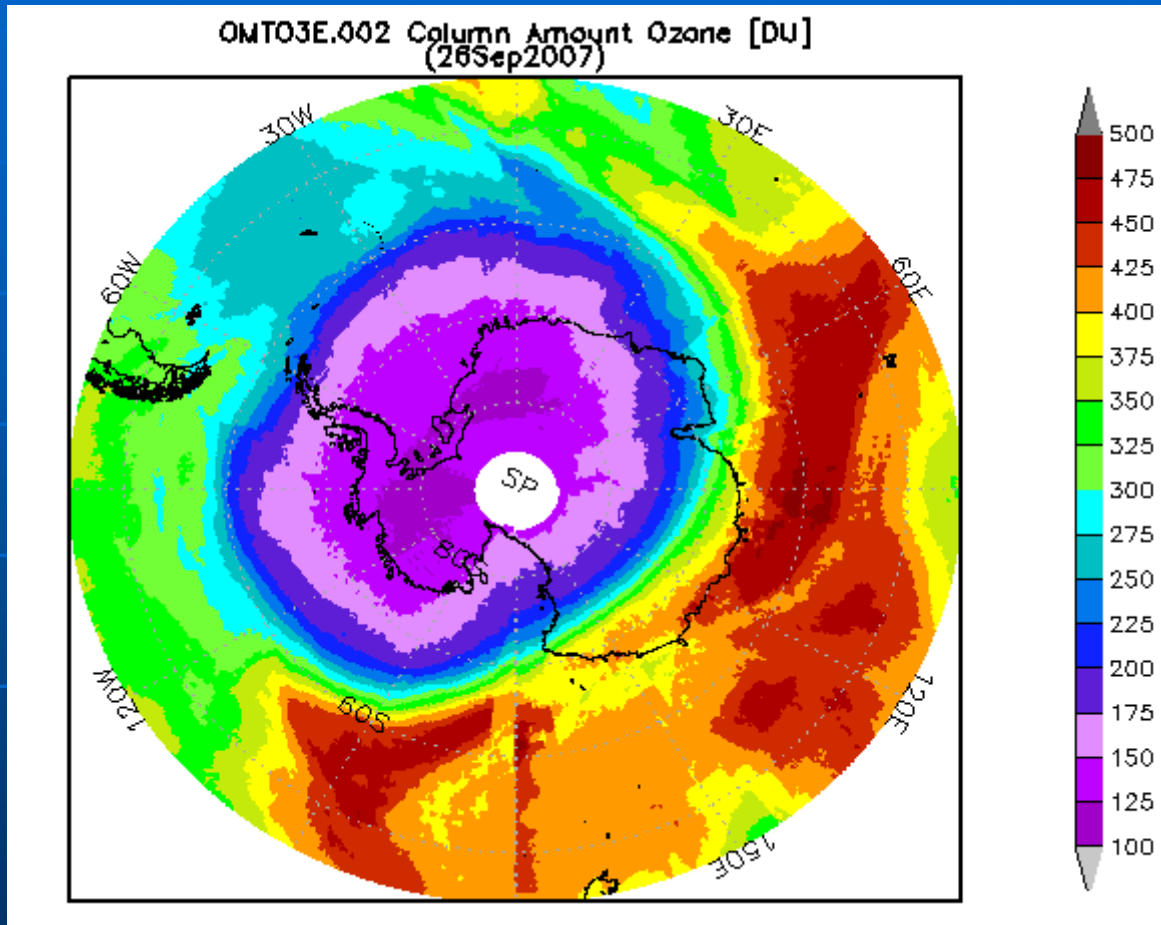
EP/TOMS Corrected Total Ozone Sep 29, 1997



EP/TOMS Corrected Total Ozone for Sep 29, 1997



2007 Antarctic Ozone Hole



- Orientation
- Size
- Shape
- Collar
- Polar Vortex
- Wind Speed
- Discontinuity
- “Polar Blank”

26 September 2007

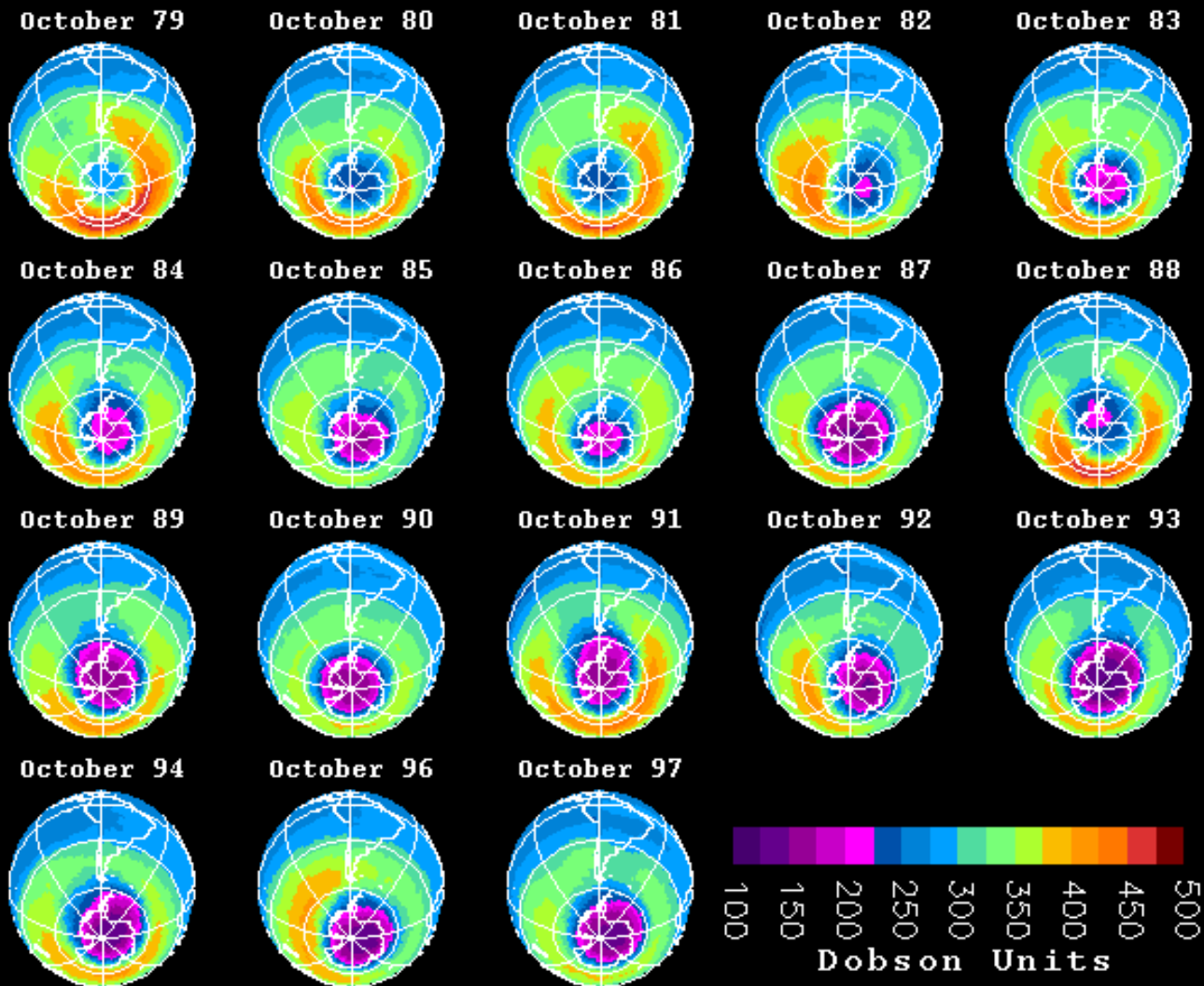


10-12 February 2008

Teaching With New Geoscience Tools Workshop

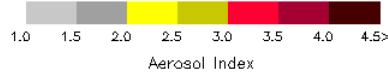
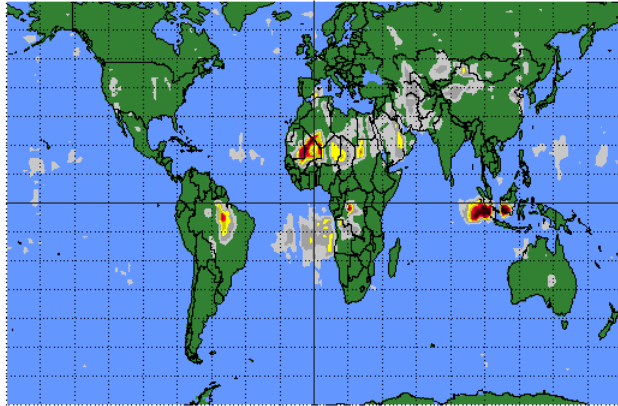
29

TOMS Total Ozone October Monthly Averages



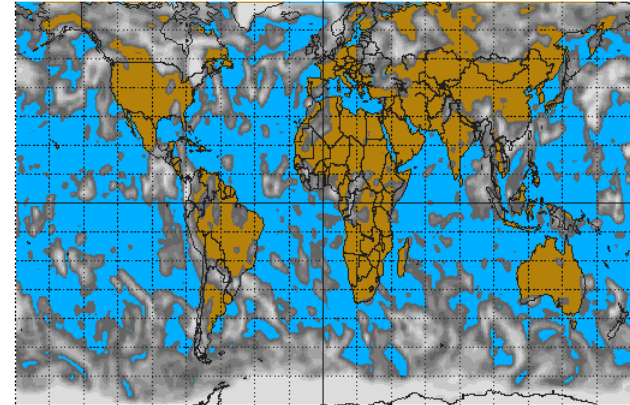
Other Useful TOMS/OMI Data Products

UV Aerosol Index



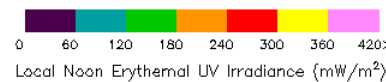
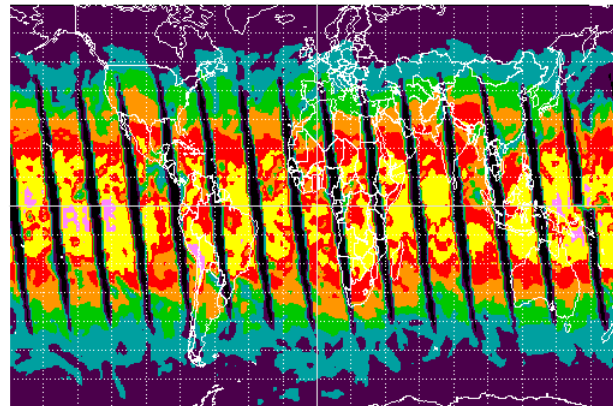
Goddard Space Flight Center

UV Effective Reflectivity



Goddard Space Flight Center

Noon-time Erythemal UV Irradiance



Goddard Space Flight Center

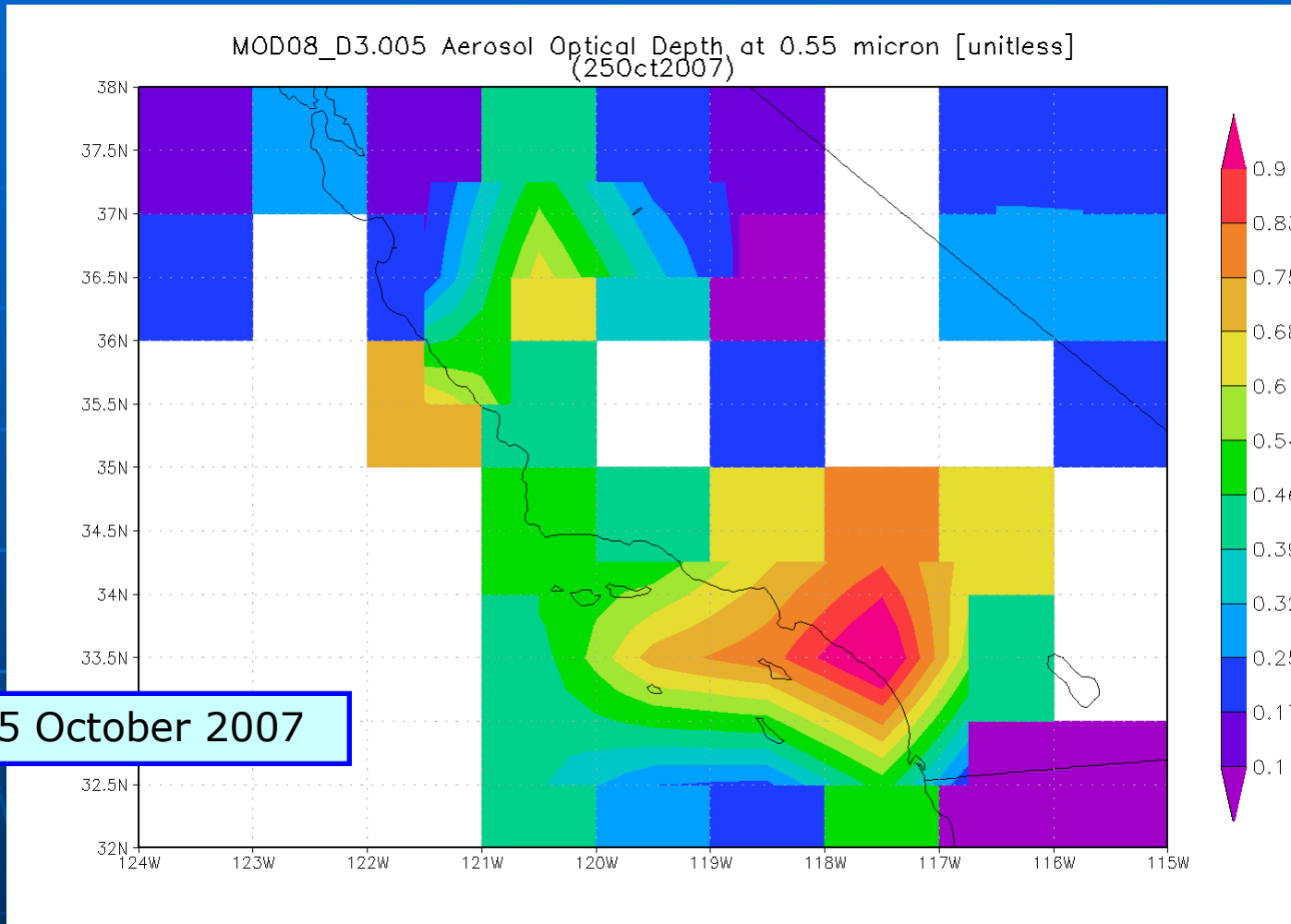
29 September 1997

10-12 February 2008

Teaching With New Geoscience Tools Workshop



Southern California Wildfires

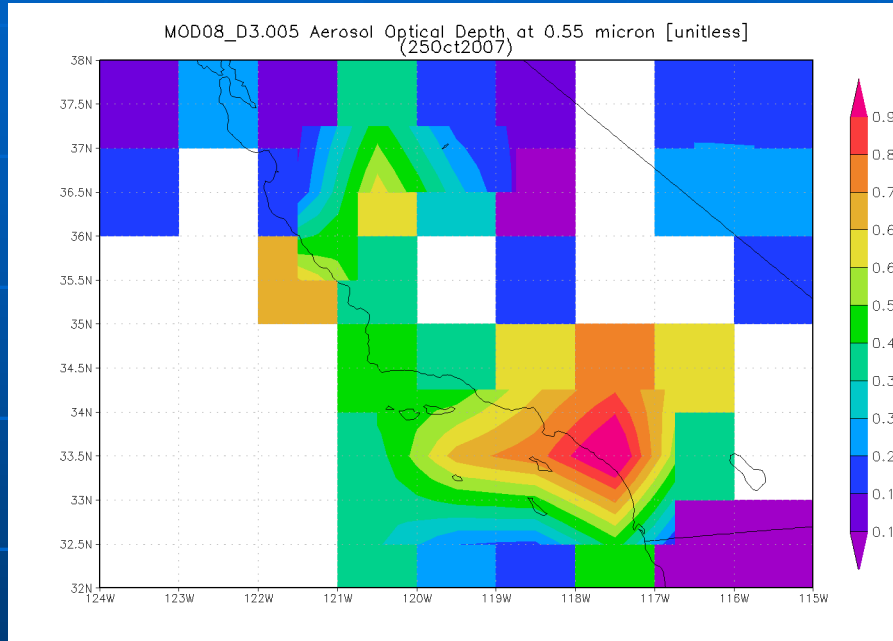


Aerosol Optical Depths at 0.55 μm (550 nm- red)
from the MODIS instrument on the Terra satellite

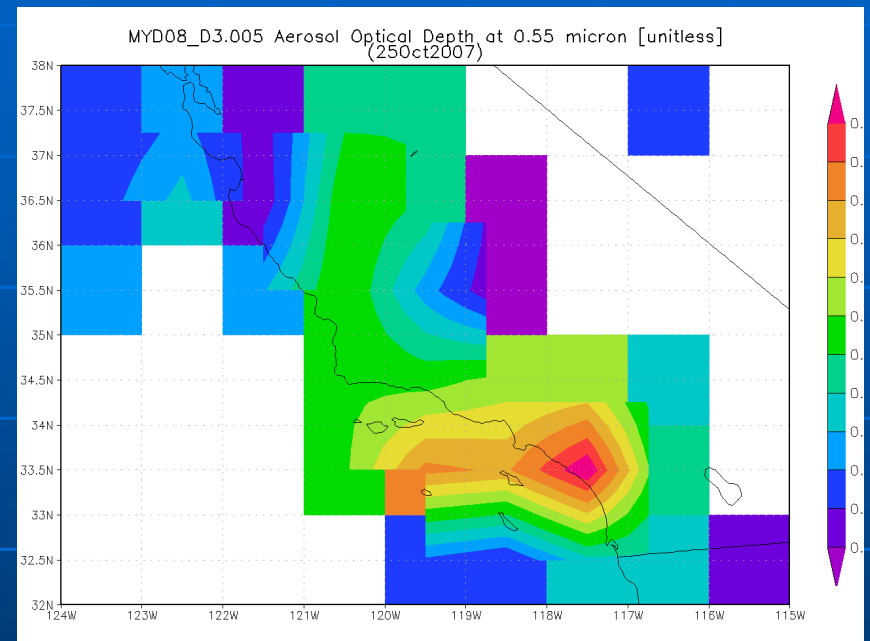


Southern California Wildfires

25 October 2007



MODIS on Terra
~10:30 am



MODIS on Aqua
~1:30 pm

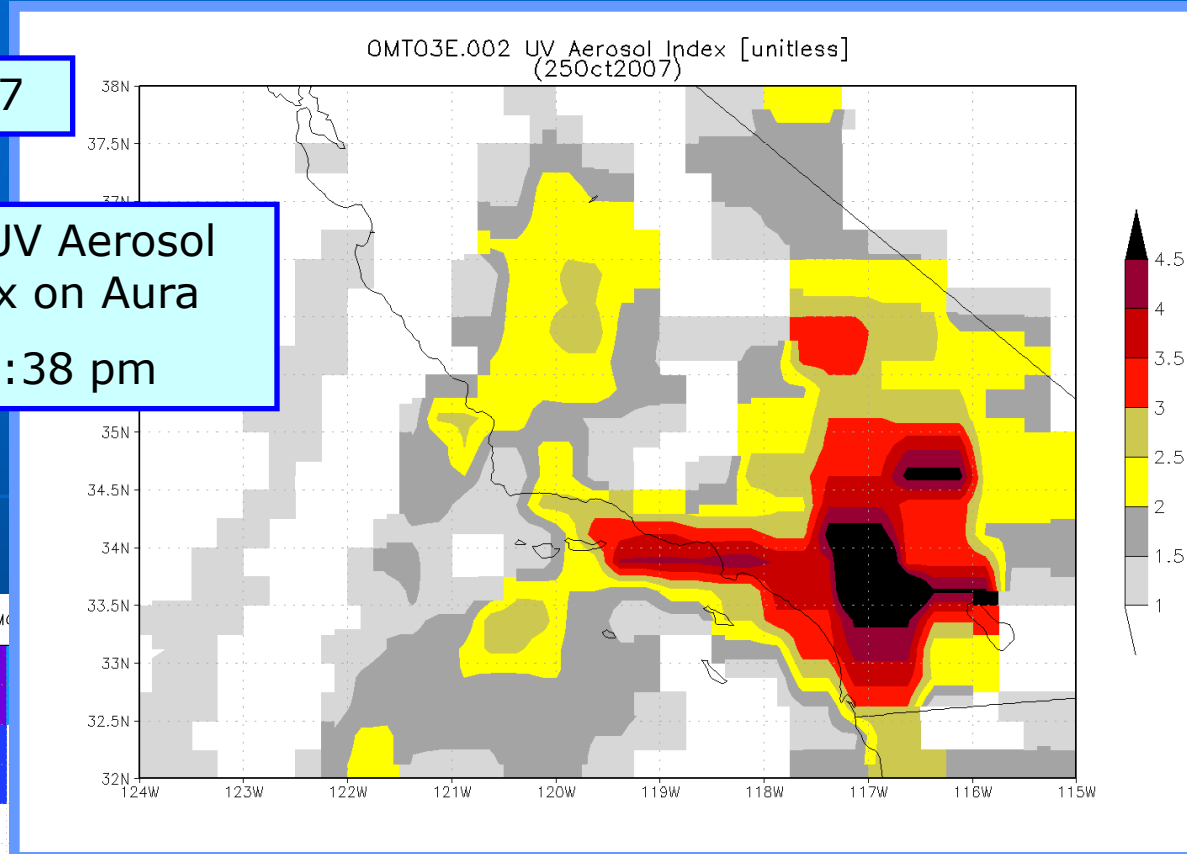
Aerosol Optical Depths at 0.55 μm (550 nm- red)



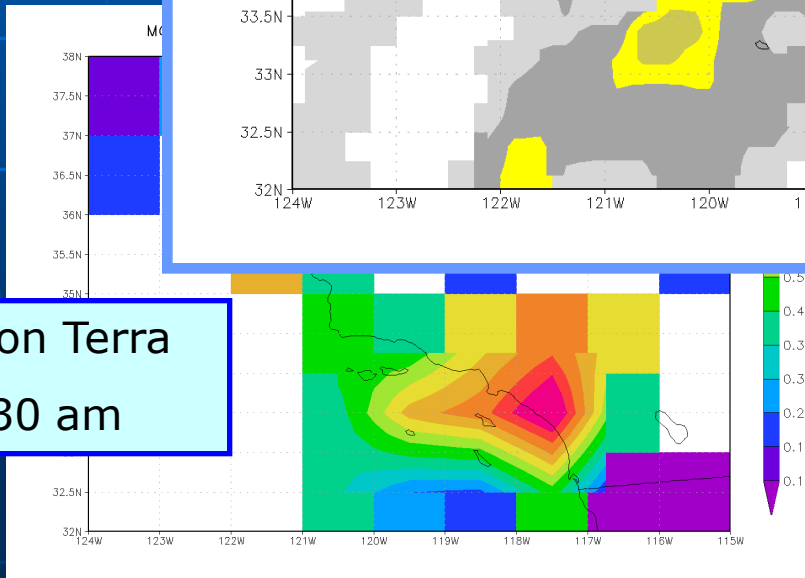
Southern California Wildfires

25 October 2007

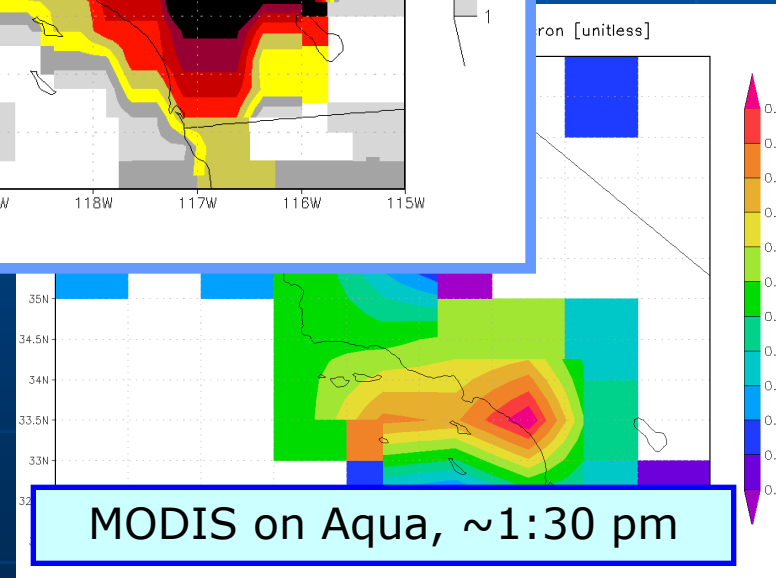
OMI UV Aerosol Index on Aura
~1:38 pm



MODIS on Terra
~10:30 am

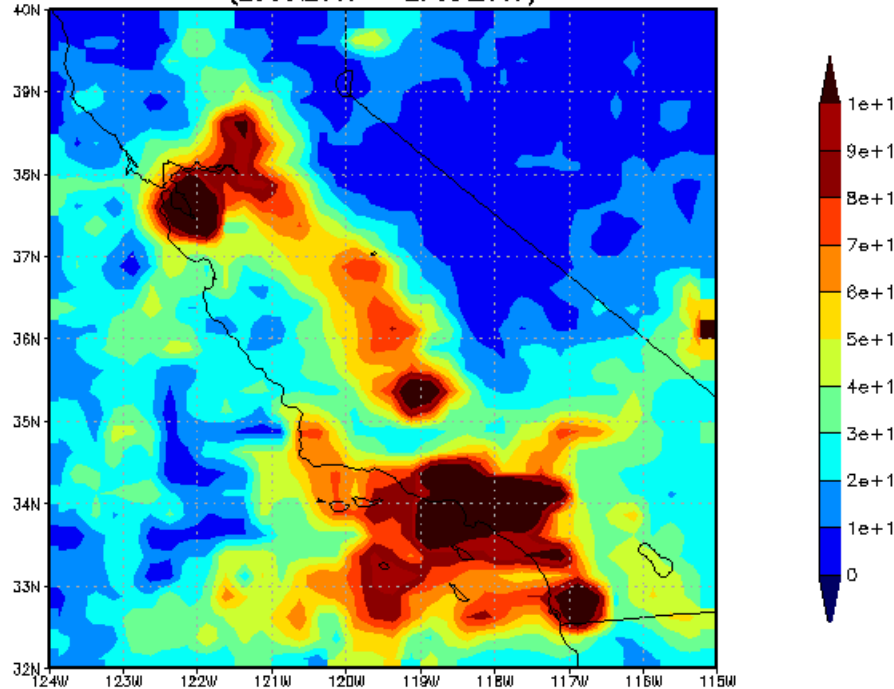


MODIS on Aqua, ~1:30 pm



Southern California Wildfires

OMNO2E.002 NO₂ Tropospheric Vertical Column Density [molec/cm²]
(23Oct2007 - 27Oct2007)

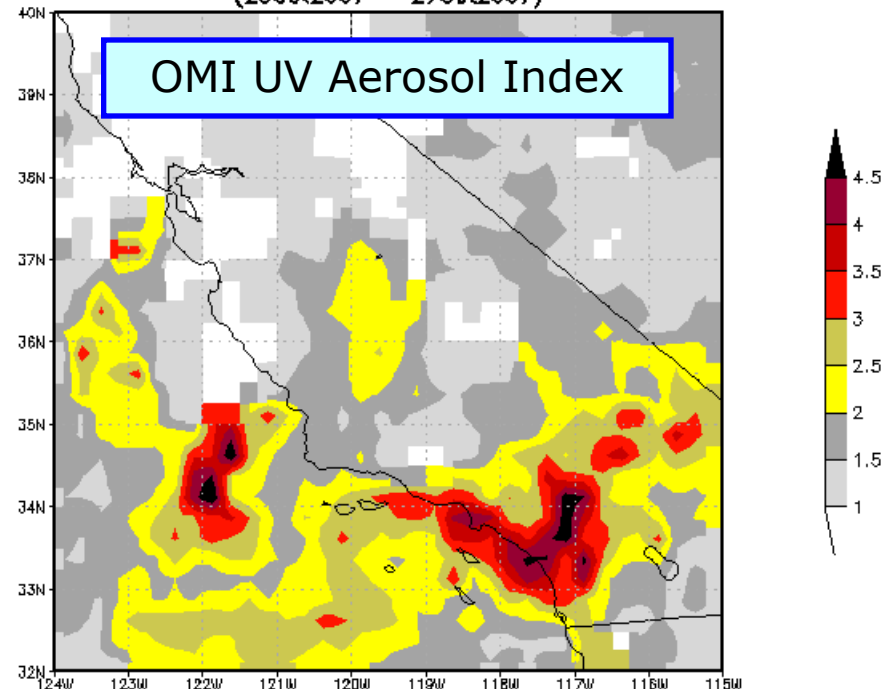


OMI Tropospheric NO₂

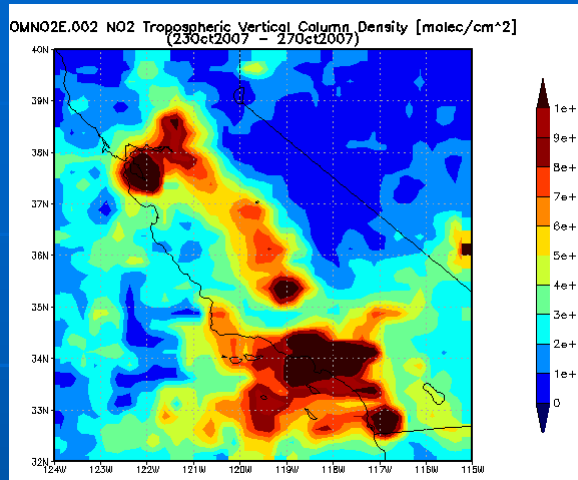
23-27 October 2007

Multi-day means "smear out" some spatial features, but allow for more complete coverage for data-sparse mapping

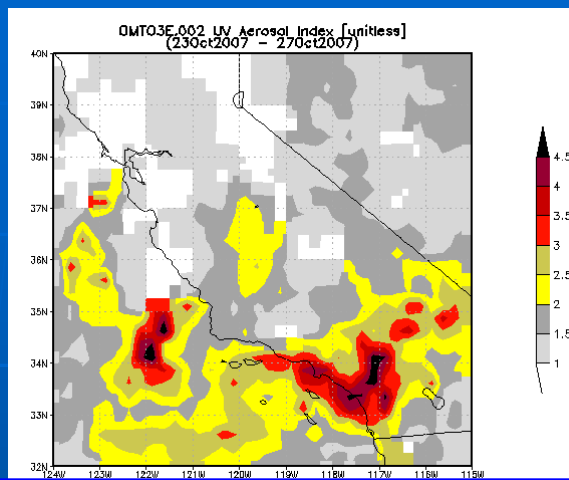
OMTO3E.002 UV Aerosol Index [unitless]
(23Oct2007 - 27Oct2007)



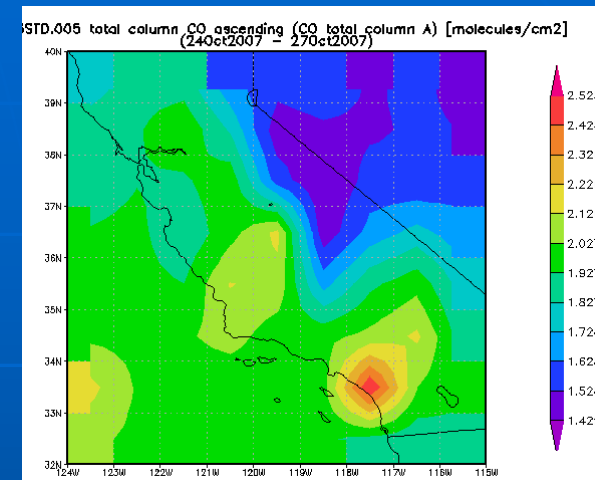
Southern California Wildfires



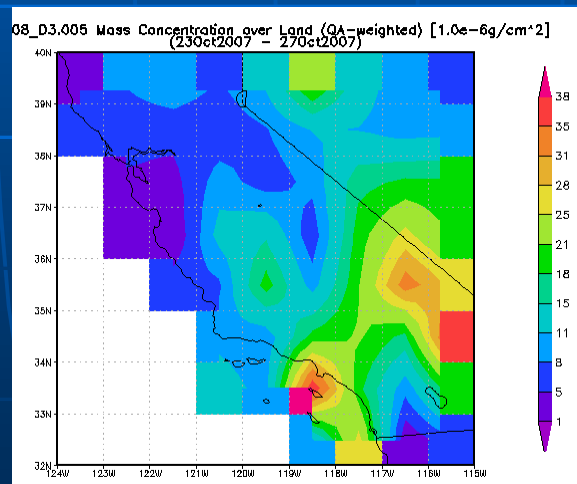
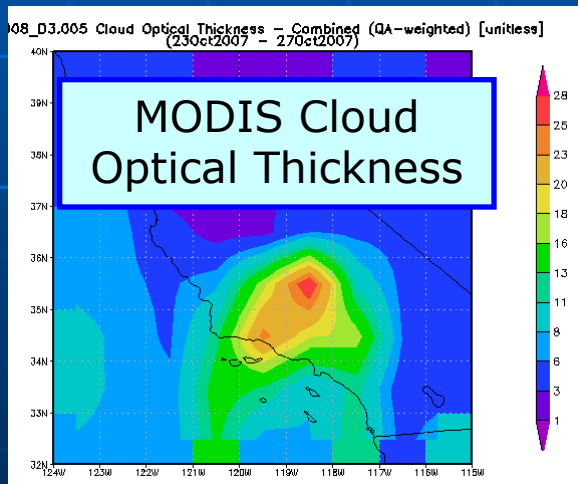
OMI Tropospheric NO₂



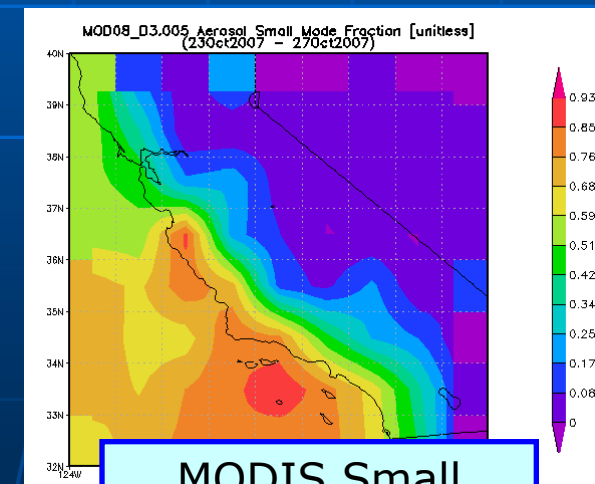
OMI UV Aerosol Index



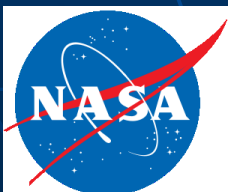
AIRS Carbon Monoxide (CO)



MODIS Aerosol Mass over Land



MODIS Small Aerosol Fraction



Access to current Giovanni interfaces:

<http://disc.gsfc.nasa.gov/techlab/giovanni>

TRMM rainfall products, near-real-time 3-hourly, Multi-Satellite Precipitation Analysis, and rainfall ground observation data

Aqua and Terra MODIS daily and monthly global aerosol data, GOCART model data, and MISR monthly global aerosol data

A-Train Along CloudSat Track featuring CloudSat cloud and MODIS Aqua temperature and humidity data

NEESPI (Northern Eurasia Earth Science Partnership Initiative) monthly products

Aura MLS version 2.2 daily near-global profile data

Aura MLS version 1.5 daily near-global profile data

Aura OMI Level 3 hi-res and TOMS-like daily global data

Aura OMI Level 2G derived data (BETA)

TOMS daily global from Earth Probe and Nimbus-7



Access to current Giovanni interfaces:

<http://disc.gsfc.nasa.gov/techlab/giovanni>

[Ocean Color](#) monthly global Aqua MODIS data and monthly and 8-day SeaWiFS data

[Agriculture-oriented TRMM](#) and other derived precipitation data

[Aqua AIRS version 5 and 4](#) daily global maps and profile data (BETA)

[Aqua AIRS version 5 and 4](#) monthly global maps and profile data (BETA)

[Aqua AIRS version 4](#) daily and monthly global maps and profile data

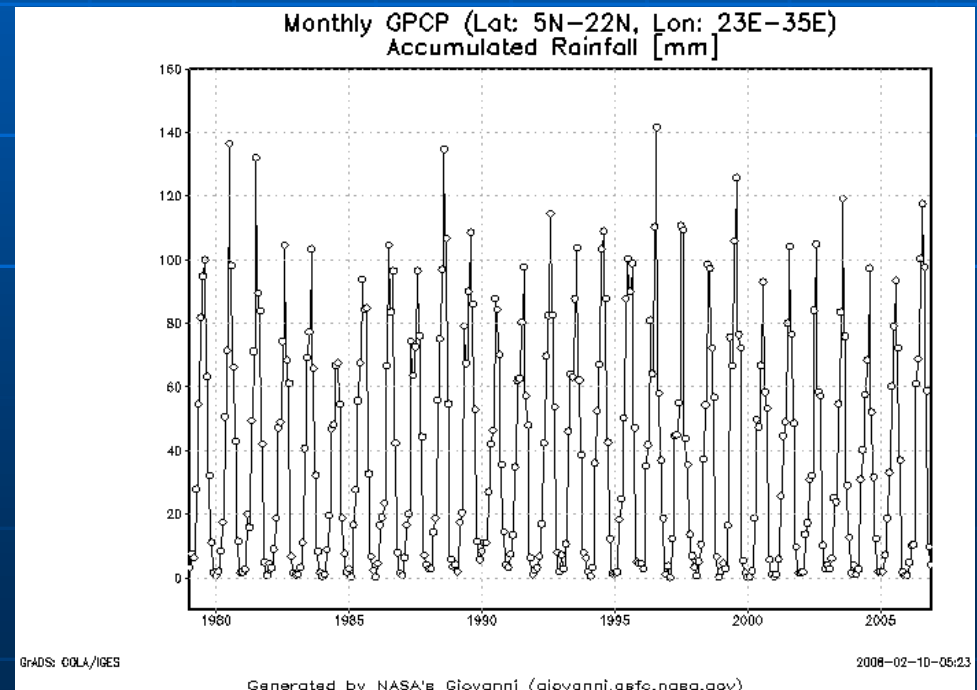
[UARS HALOE](#) atmospheric profiles



Sample Science Questions

1. How has rainfall changed in the Sudan?

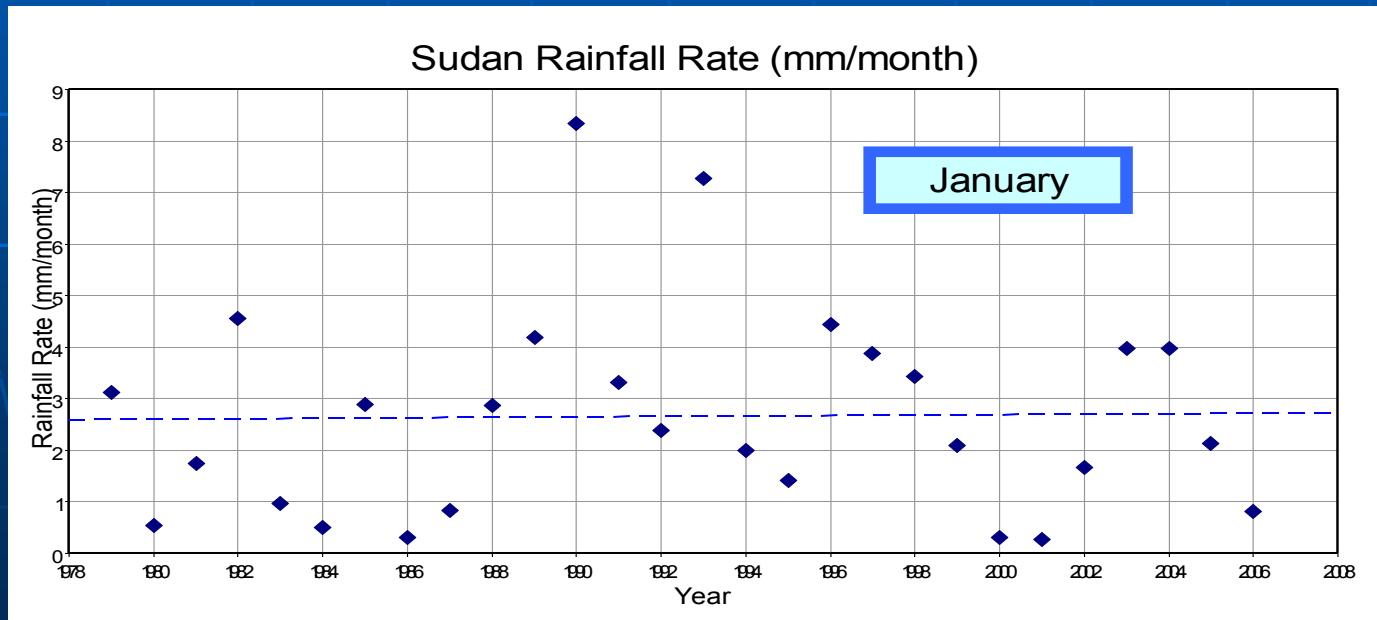
- <http://disc.gsfc.nasa.gov/techlab/giovanni>
- click on TRMM rainfall products (TOVAS)
- click on monthly global precipitation (GPCP), non-Java version
- 5-22 N Lat, 23-35 E Lon, Accumulated Rainfall, Time Series (area-averaged), Jan 1979-Dec 2006, Generate Plot
- A plot shows up in another browser window
- From the plot it is difficult to see a dramatic trend...



Sample Science Questions

1. How has rainfall changed in the Sudan?

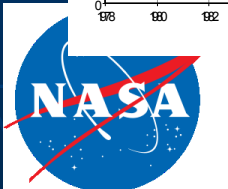
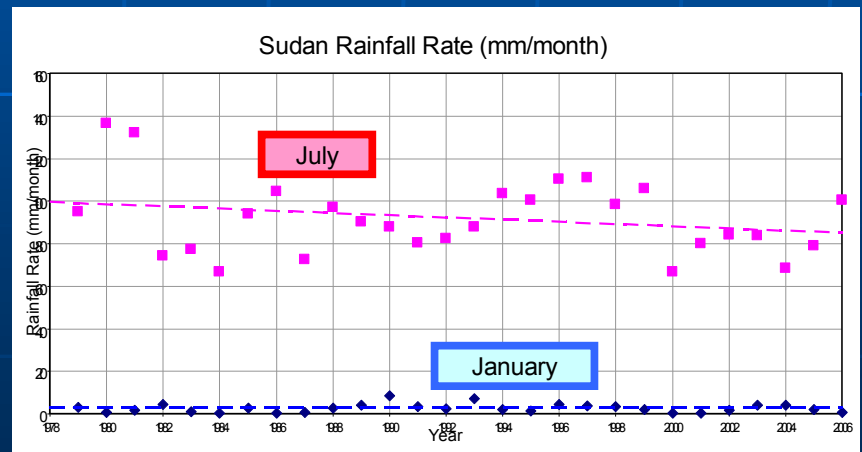
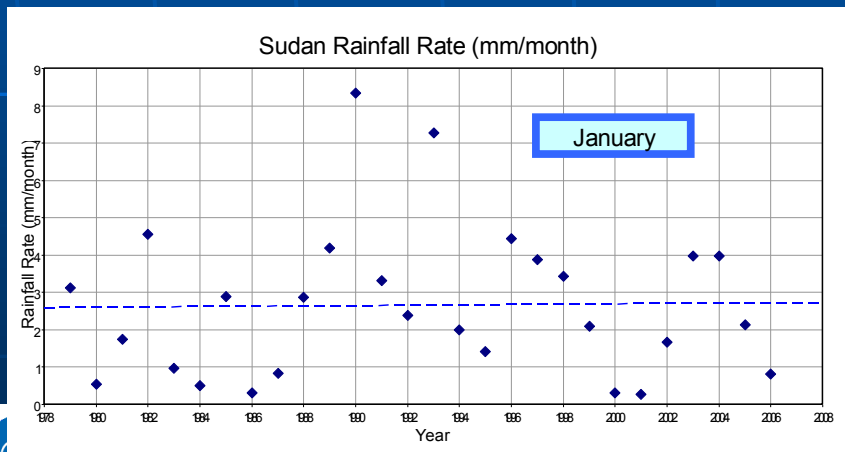
- Return to main window and click on ASCII Output button at bottom
- ASCII output pops up in separate browser window, save as text file
- Open text file in Excel, sort by month and plot up Jan. and July



Sample Science Questions

1. How has rainfall changed in the Sudan?

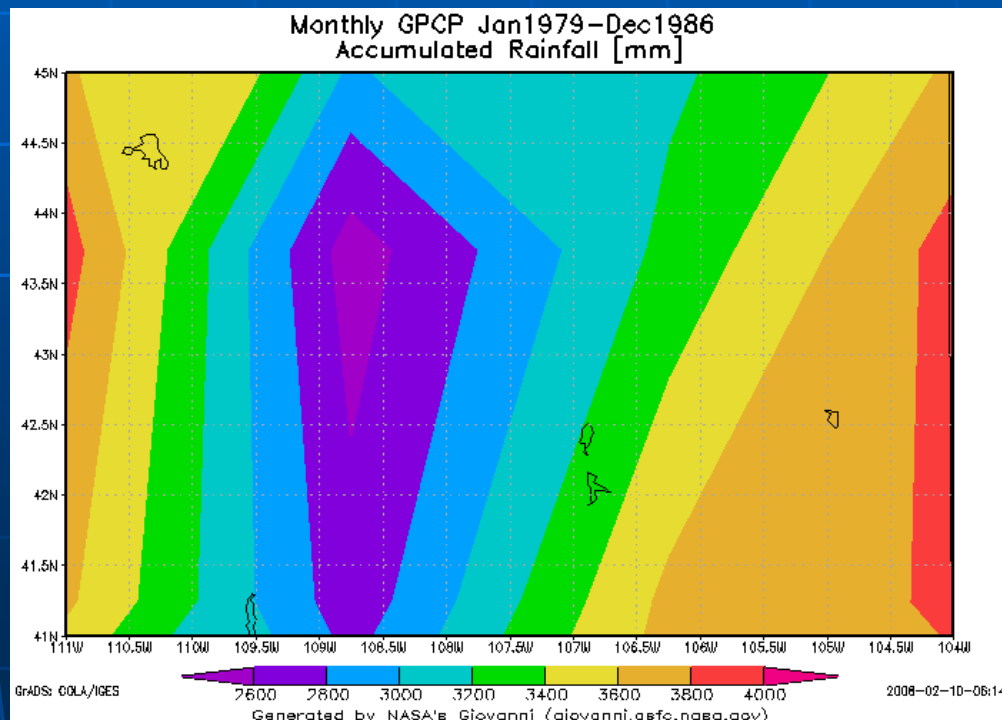
- While winter (January) rainfall rates are flat, summertime rates (July, the “rainy season”) have fallen 18% over the past three decades
- This is a contributing factor in the current crisis in Darfur.
- You can’t do everything in Giovanni alone, but sometimes a simple spreadsheet program can provide all the additional computational power to address complex issues.



Sample Science Questions

2. How has rainfall changed in Wyoming?

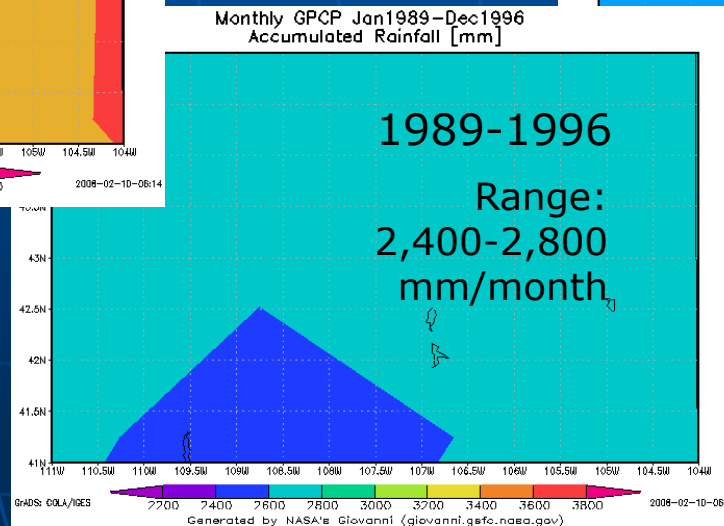
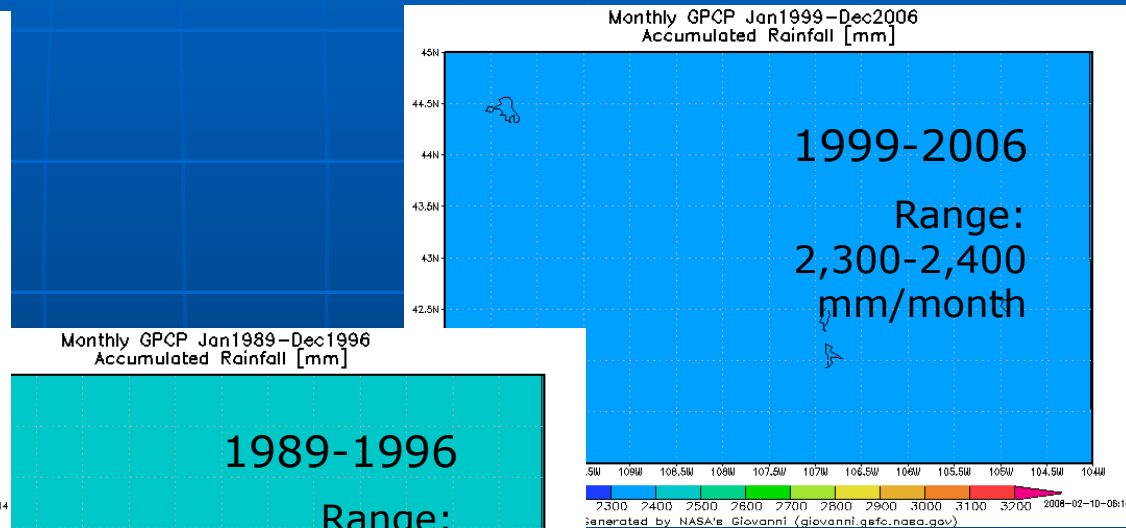
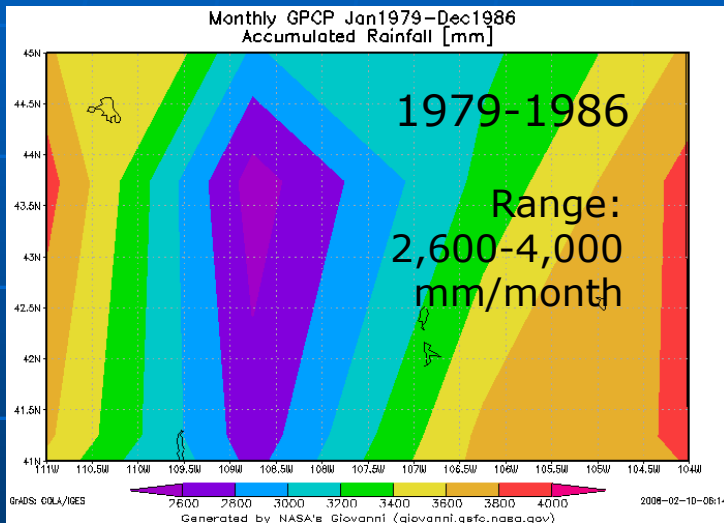
- <http://disc.gsfc.nasa.gov/techlab/giovanni>
- click on TRMM rainfall products (TOVAS)
- click on monthly global precipitation (GPCP), non-Java version
- 41-45 N Lat, 111-104 W Lon, Accumulated Rainfall, Lat-Lon Map, Jan 1979-Dec 1986, custom y-axis: min 2000, max 4000, interval 200, Generate Plot
- A plot shows up in another browser window
- Save plot as gif file



Sample Science Questions

2. How has rainfall changed in Wyoming?

- Do the same plots for 1989-1996 and 1999-2006



Large portions of the American plains, Rockies and West are becoming more uniformly dry.



Sample Science Questions

3. Is there an “ozone hole” in the Arctic? TOMS
4. What does the El Niño look like? AIRS
5. Is there a connection between central Atlantic sea temperatures and hurricanes? Hurricane Portal
6. Is the surface temperature changing differently in the two hemispheres? AIRS
7. Can one detect Canadian summertime boreal forest fires from space? MODIS
8. How do wildfires in the Western US differ from urban smog? OMI, MODIS, AIRS

