What's in a day?

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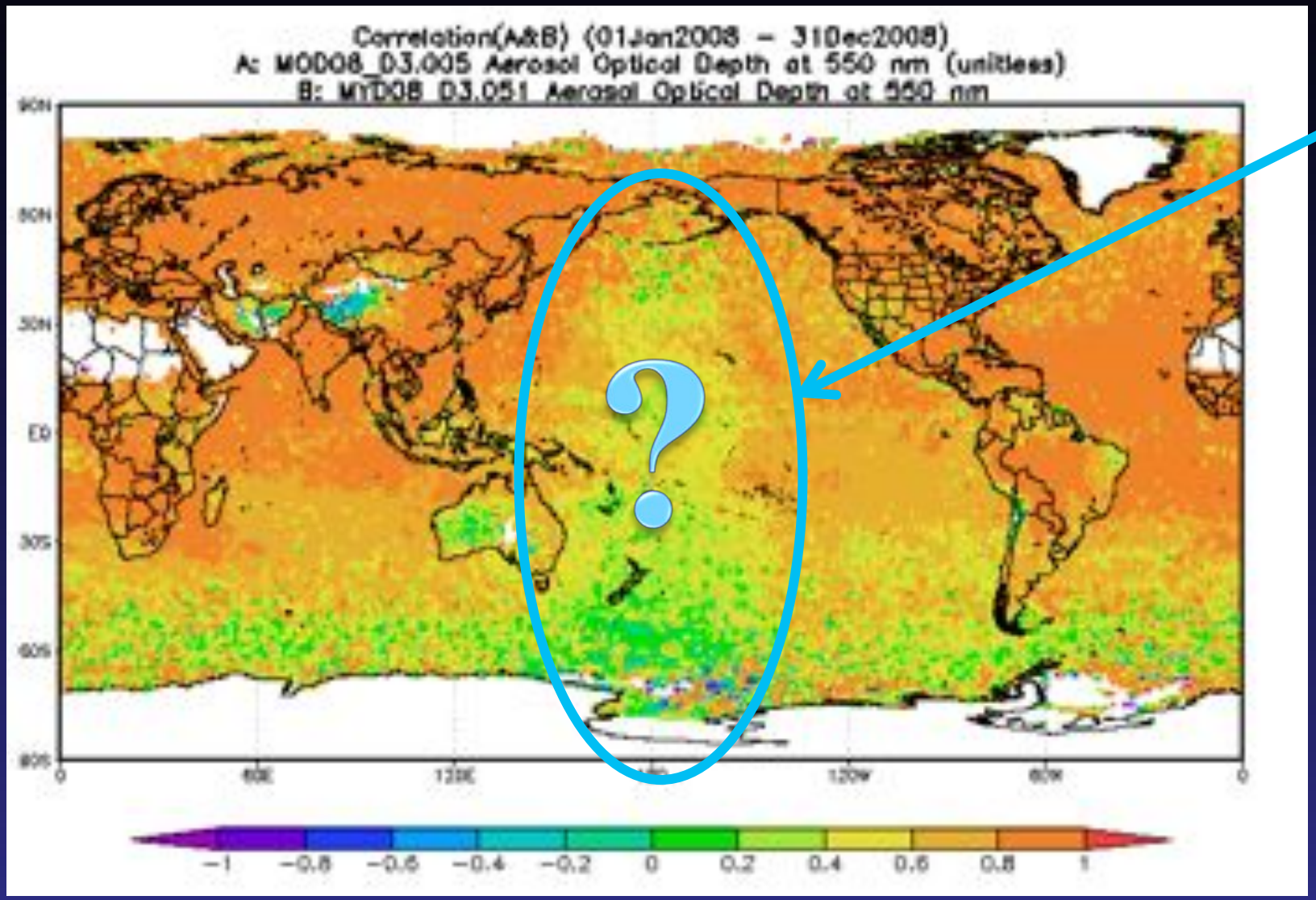
Why Level 3 products?

- Level 2 data is difficult to work with because of:
  - Formats
  - Volume
  - Number of files
- Level 3 data are easy to use … but might lead to wrong conclusions if not being careful
- Level 3 products are mostly used by modelers, application users, climate scientists

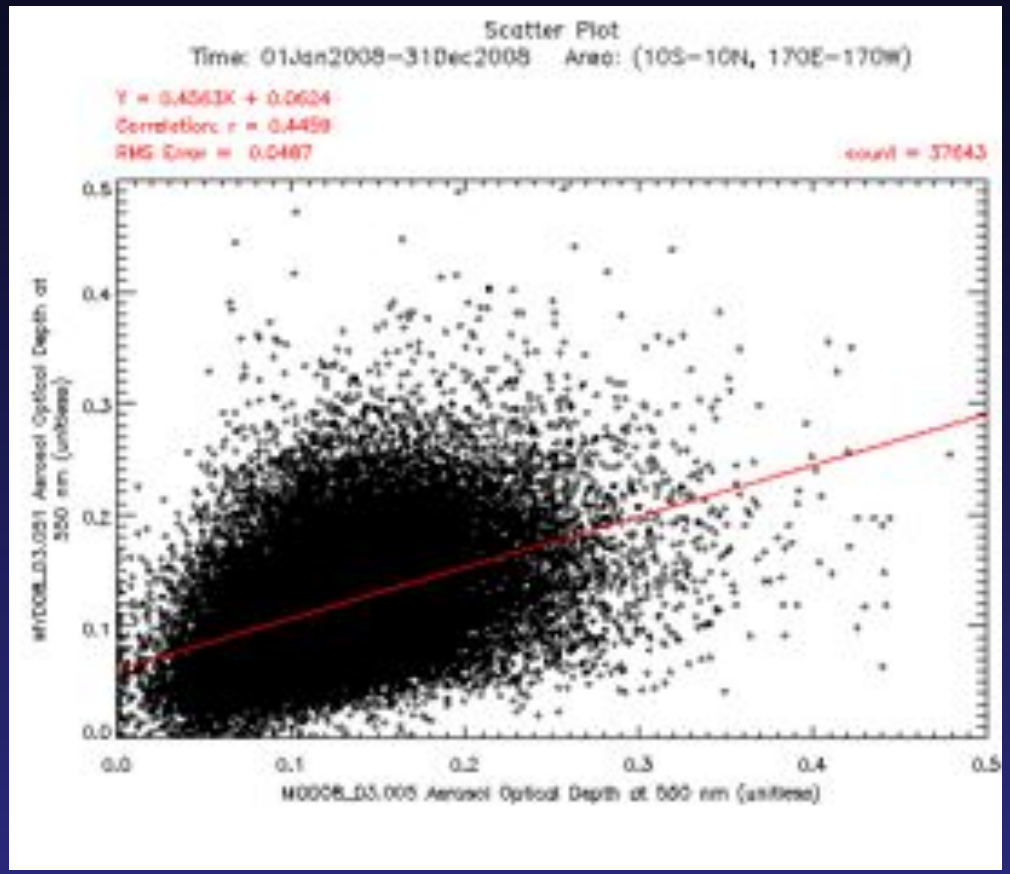
MODIS vs. MODIS



MODIS-Terra vs. MODIS-Aqua: Map of AOD temporal correlation, 2008

AOD MODIS Terra vs. Aqua in Pacific

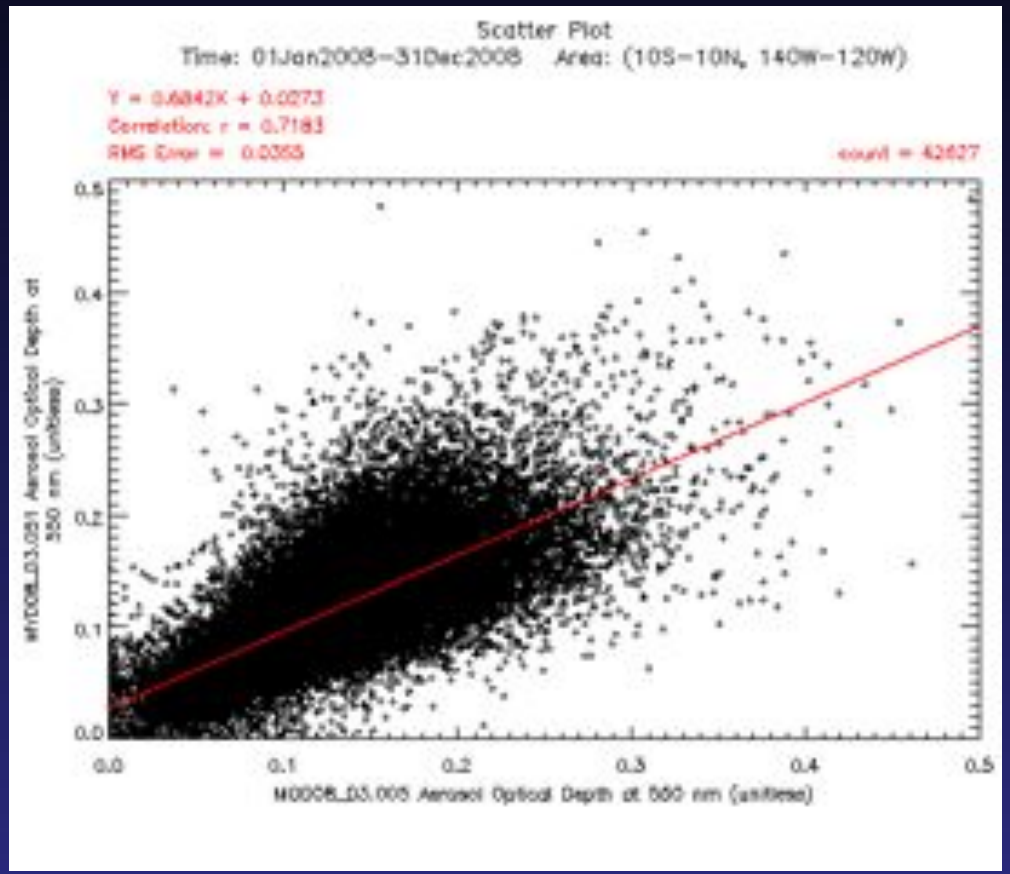
Over the dateline



$R^2 = 0.45$

$RMS = 0.05$

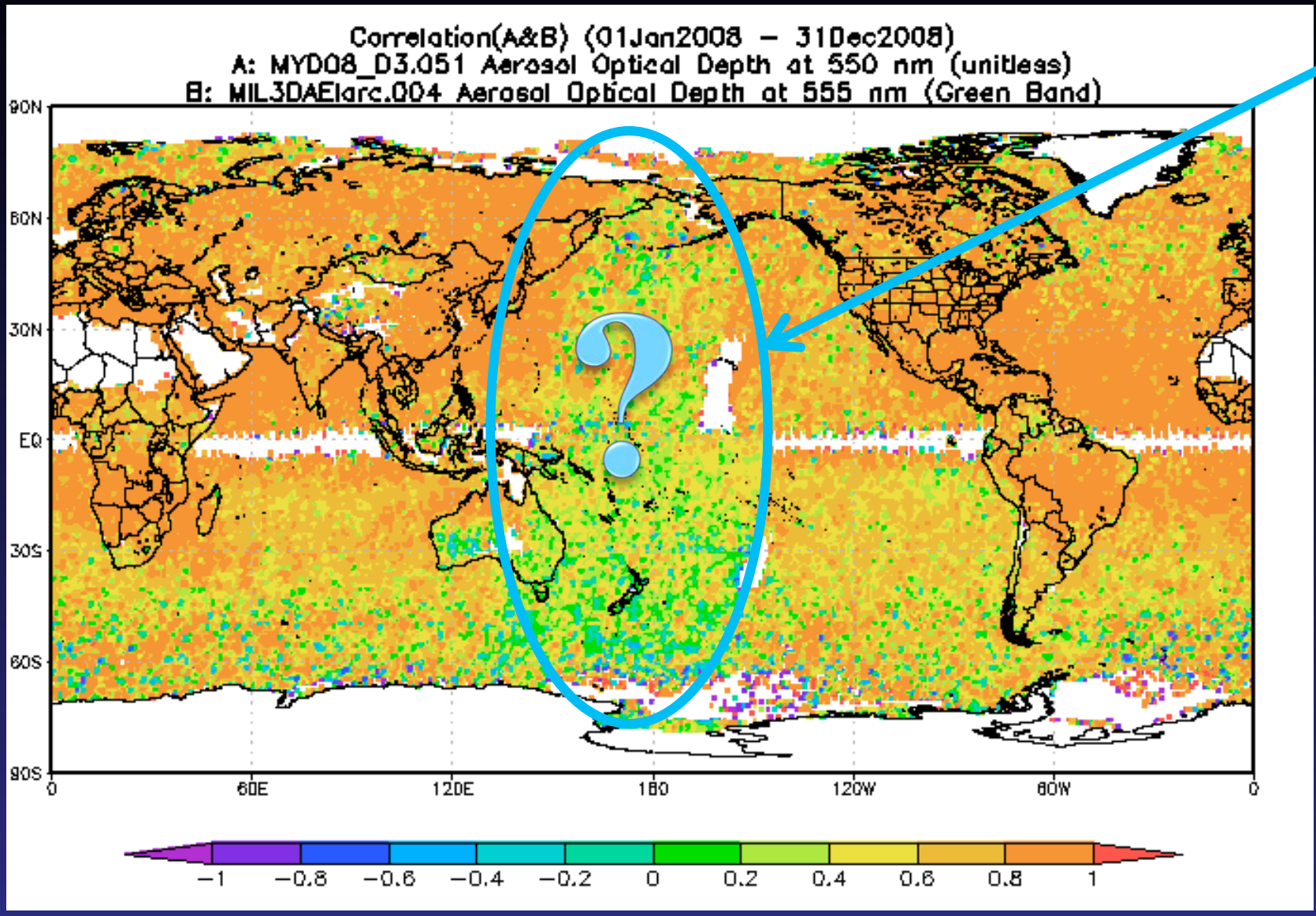
Away from the dateline



$R^2 = 0.72$

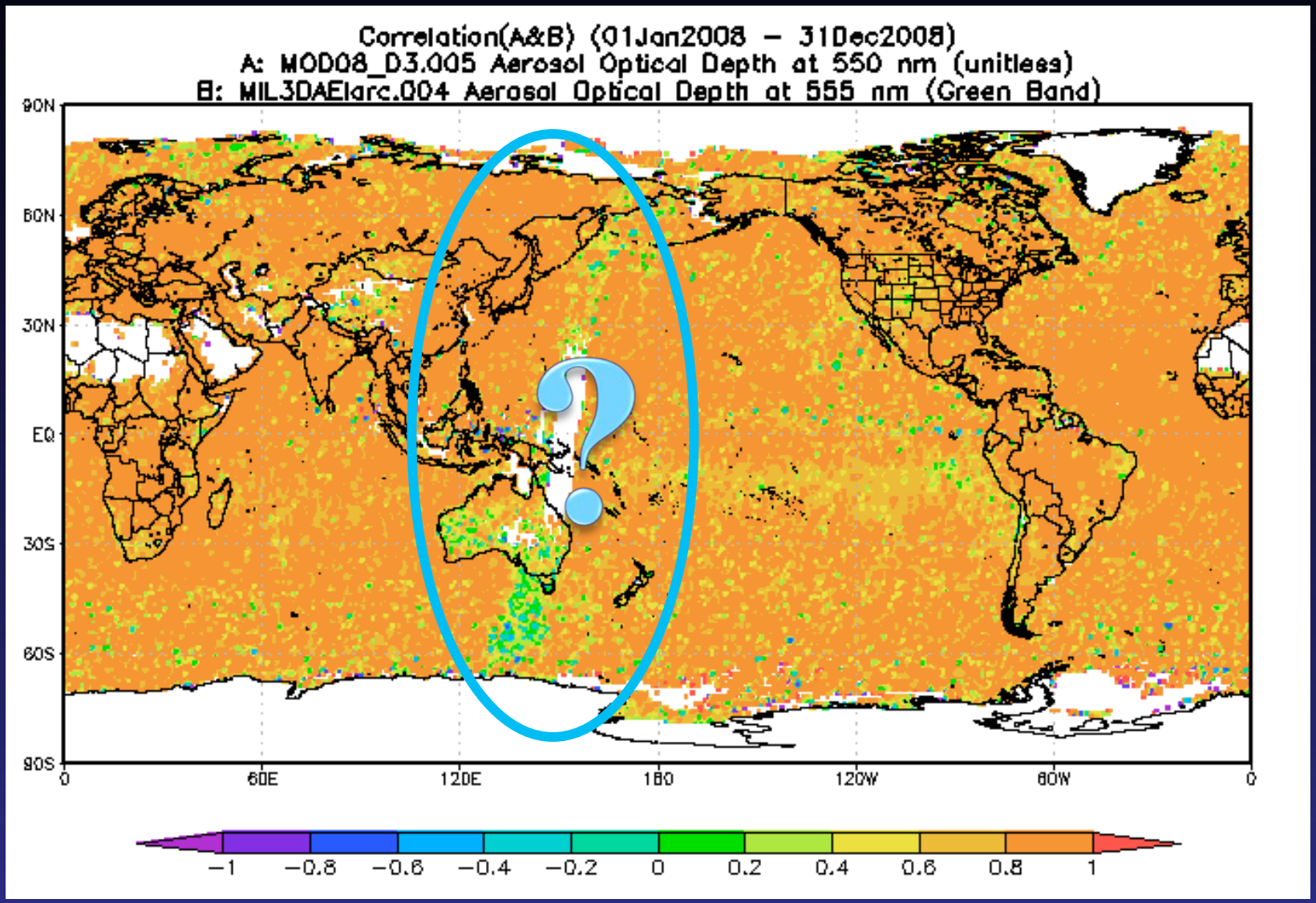
$RMS = 0.036$

AOD Aqua MODIS vs MISR correlation map



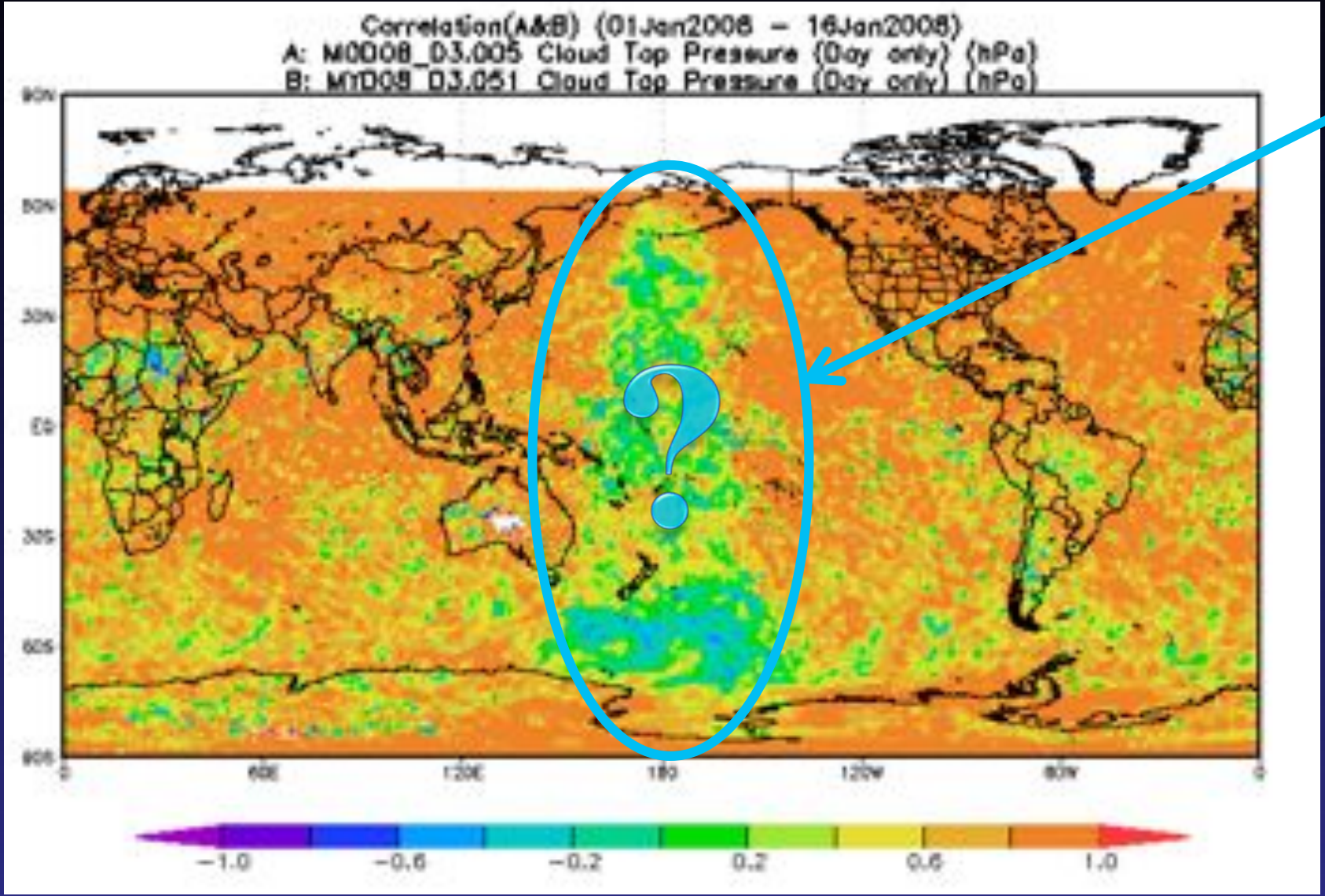
AOD Aqua MODIS vs MISR correlation map for 2008

MODIS vs. MISR on Terra



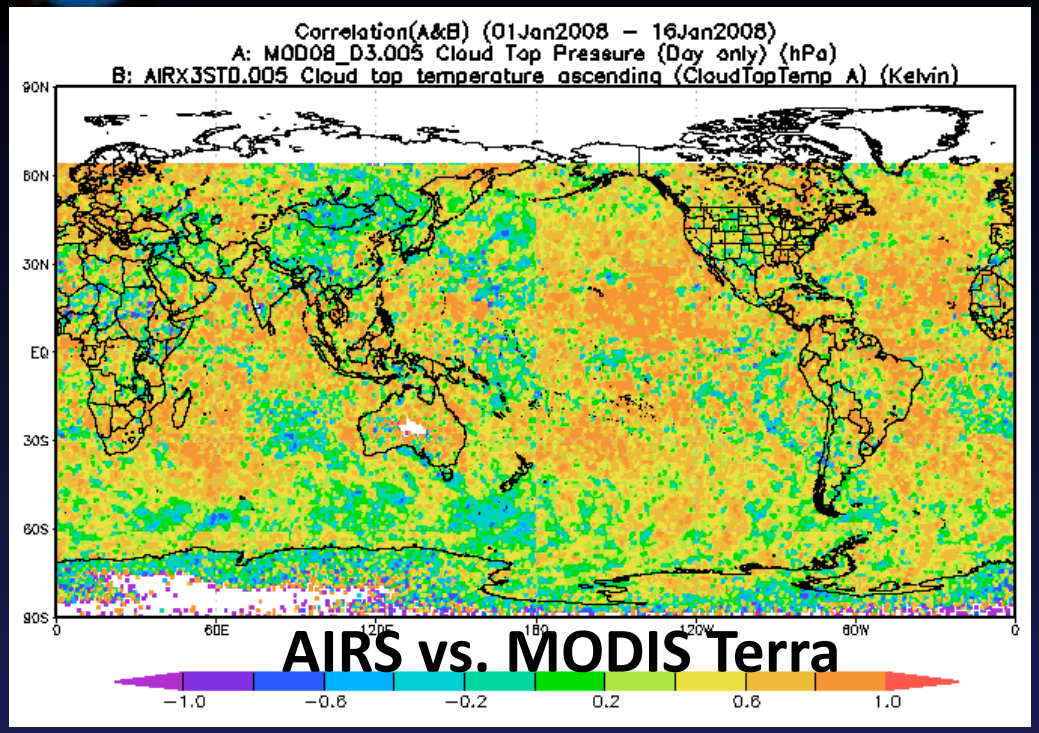
MODIS-Terra vs. MISR-Terra: Map of AOD temporal correlation

MODIS Cloud Top Pressure

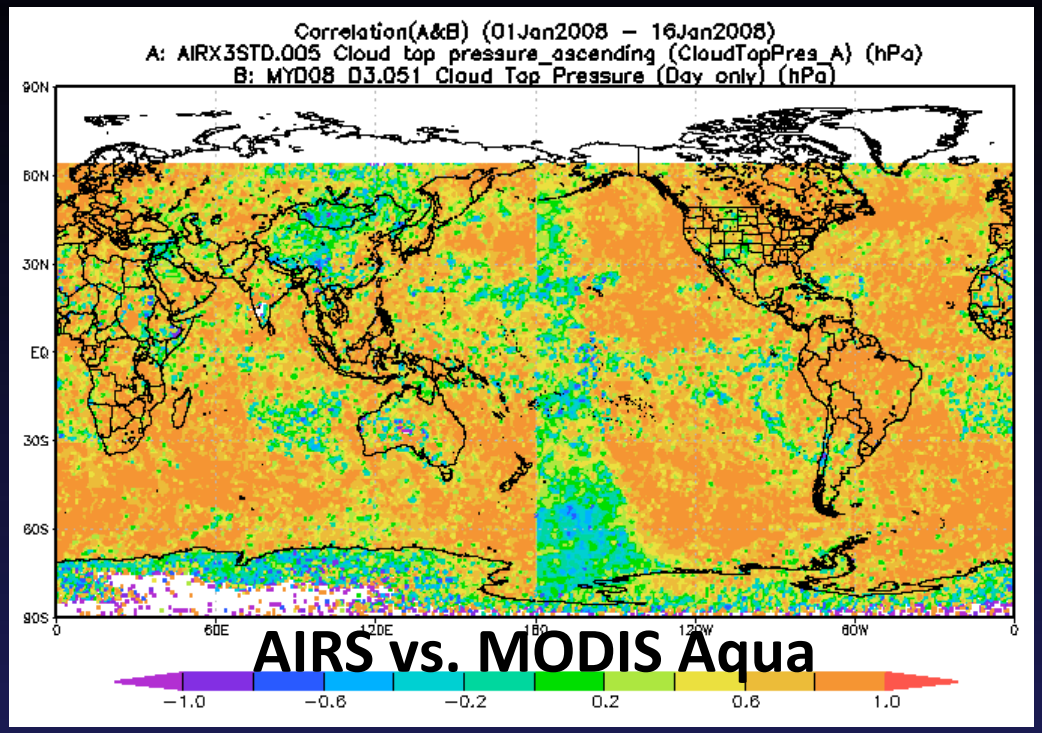


MODIS-Terra vs. MODIS-Aqua: Map of CTP temporal correlation, Jan 1–16, 2008

MODIS Terra & Aqua vs. AIRS Cloud Top Pressure

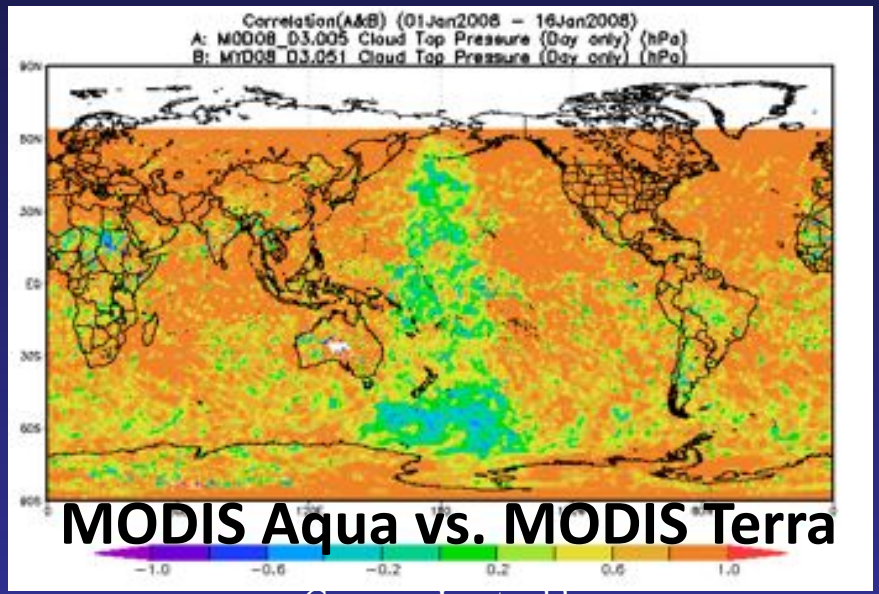


AIRS vs. MODIS Terra



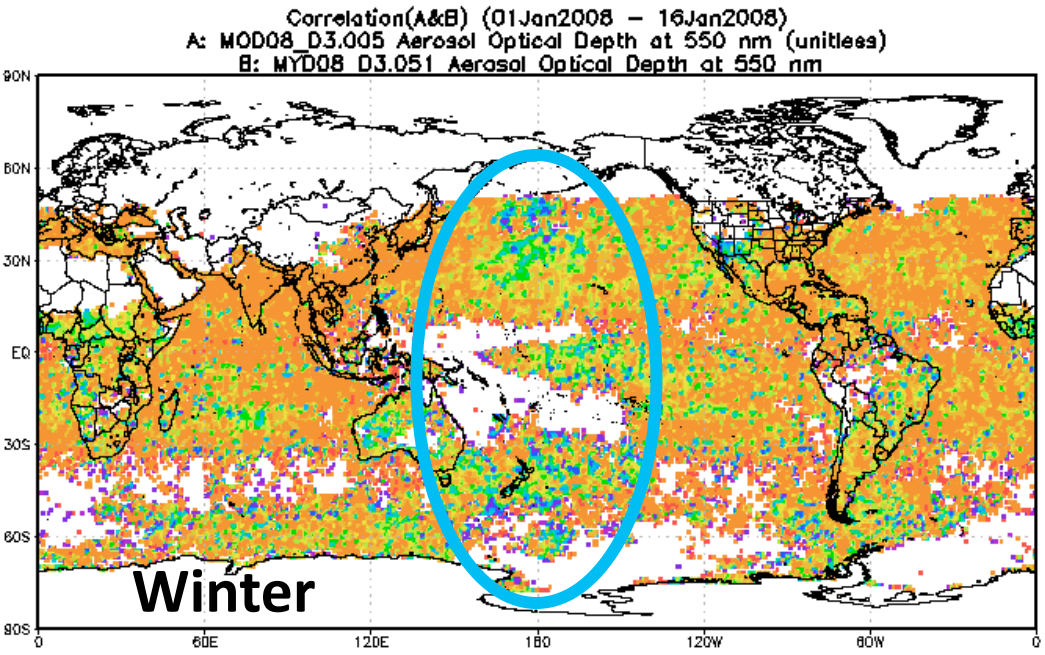
AIRS vs. MODIS Aqua

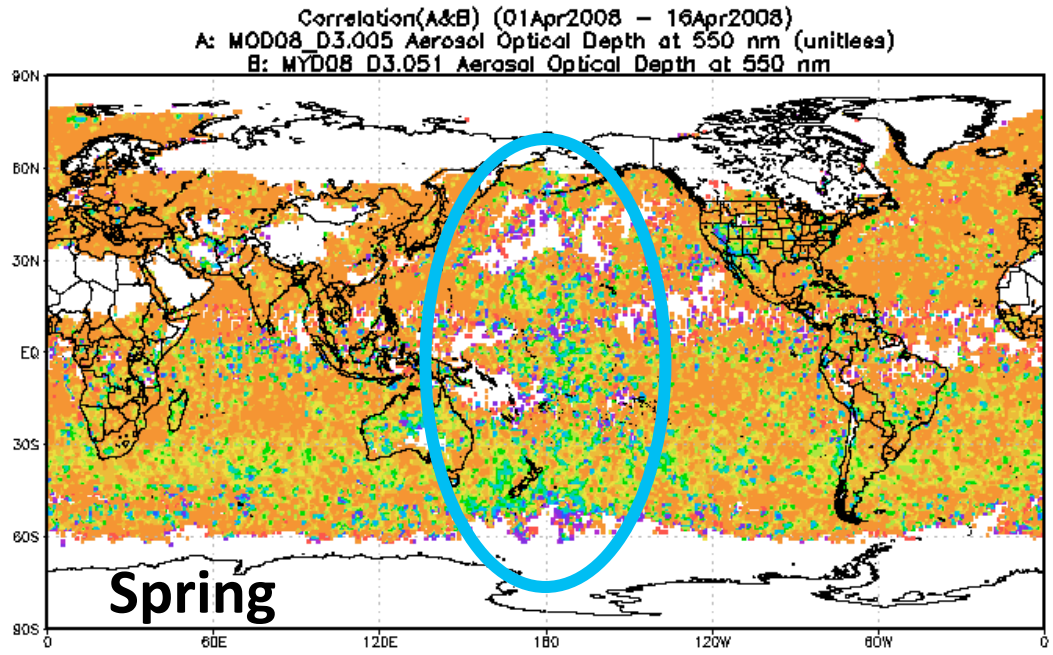
Correlation maps for Jan 1 – 16, 2008

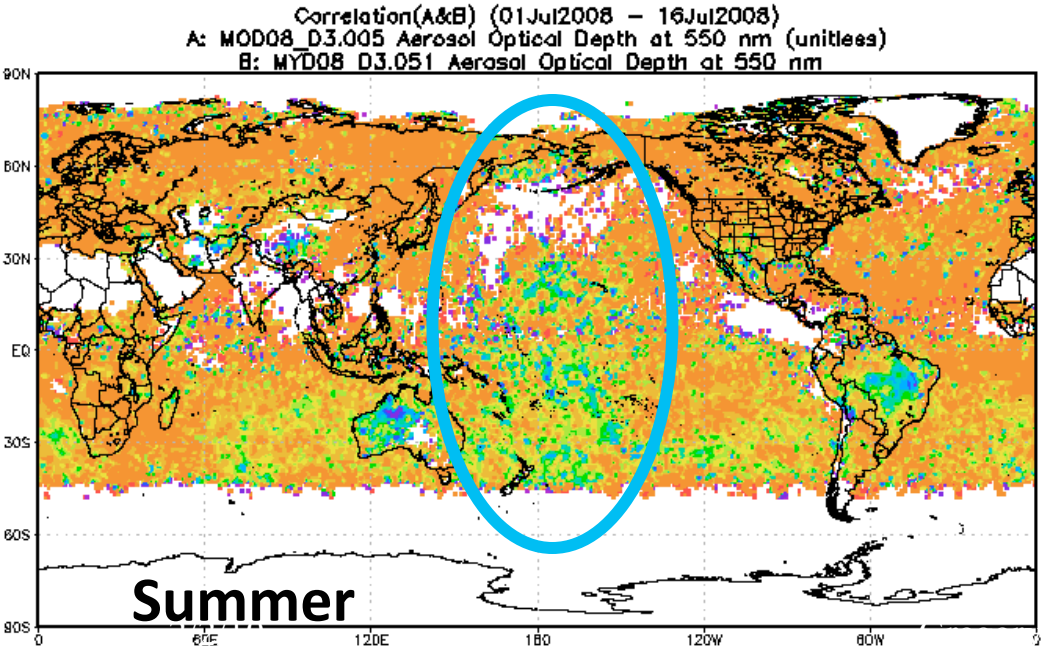


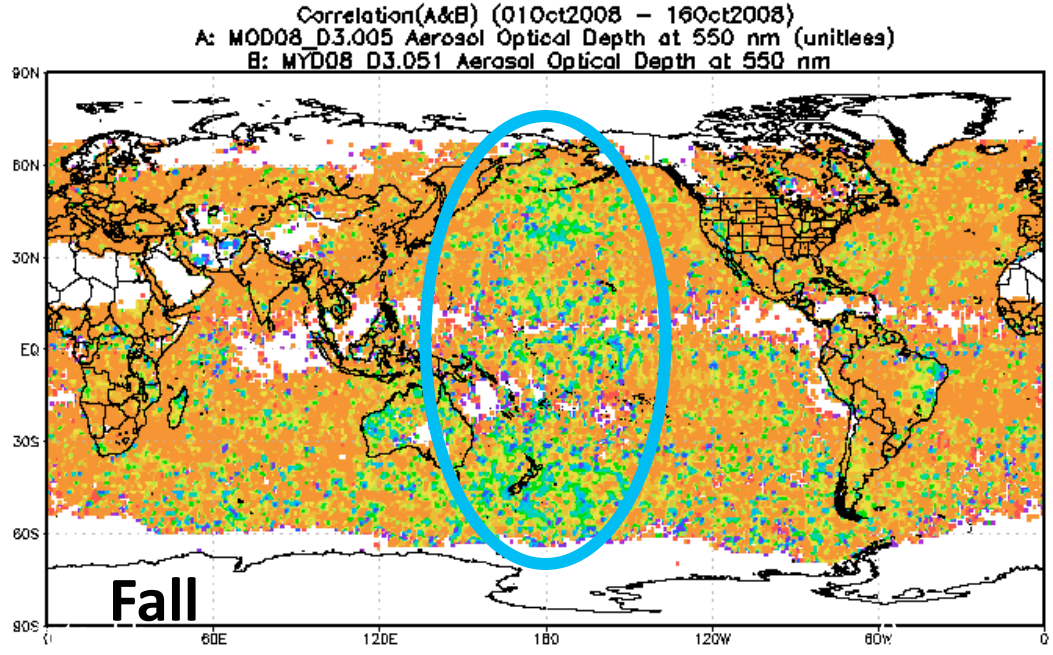
MODIS Aqua vs. MODIS Terra

Terra vs. Aqua MODIS AOD correlation: 16-day periods for 4 seasons









MODIS Atmos. Data day definition

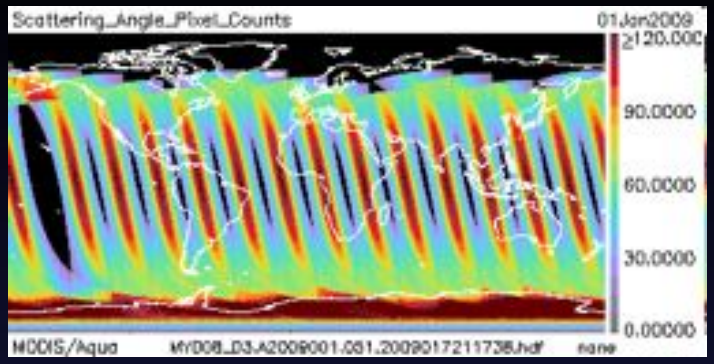
Level 3 daily products are generated by binning Level 2 data belonging to one day onto a certain spatial grid according to a dataday definition.

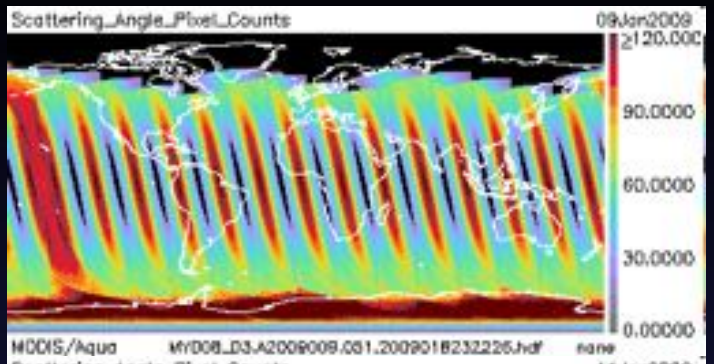
The latter is different for different sensors and even for the same sensor but by different groups.

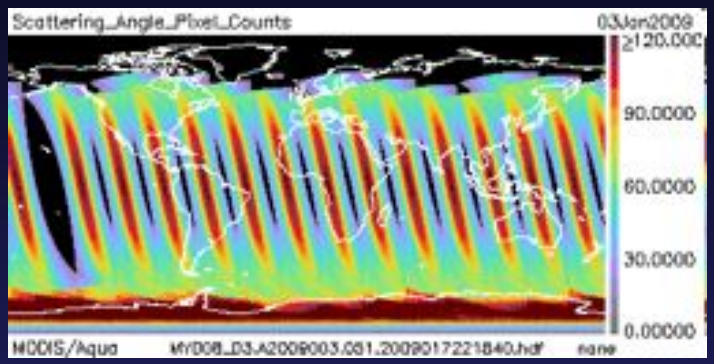
MODIS Atmospheric products (from MODIS L3 ATBD):

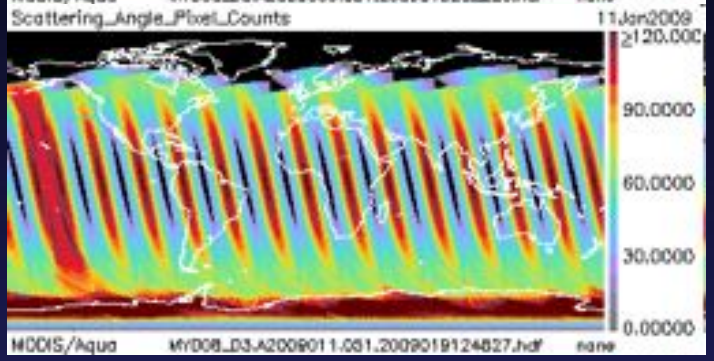
The Daily L3 product contains statistics computed from a set of L2 MODIS granules (HDF files) that span a 24-hour (00:00:00 to 23:59:59 UTC) interval. In the case where a L2 parameter is only computed during the daytime, then only daytime files are read to compute the L3 statistics.

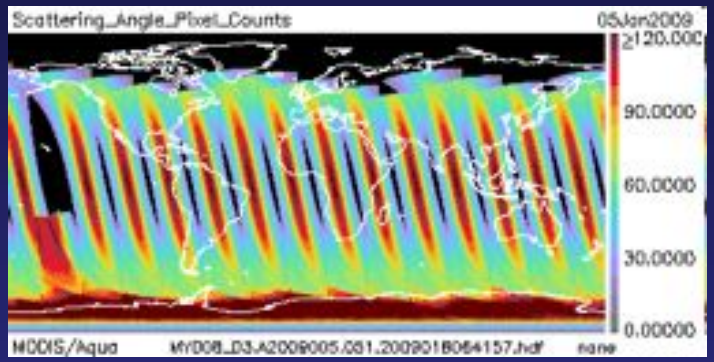
MODIS Aqua Level 3 coverage for diff. days in the 16-day cycle

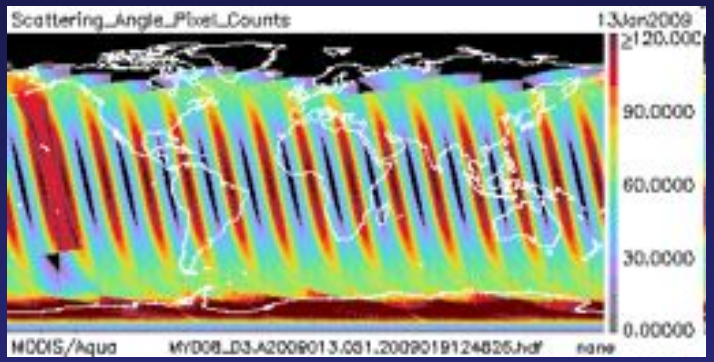


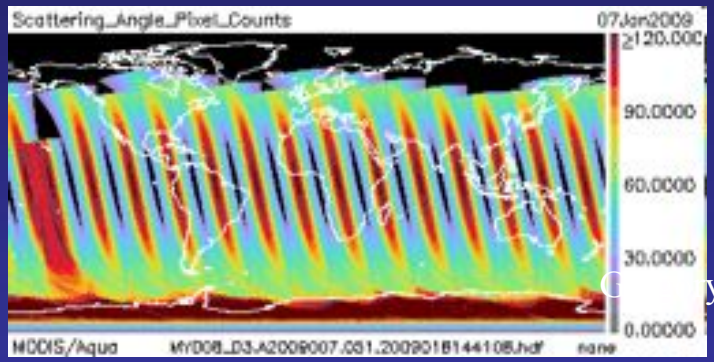


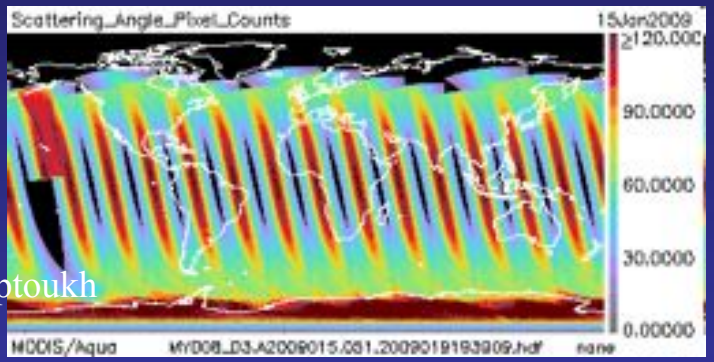






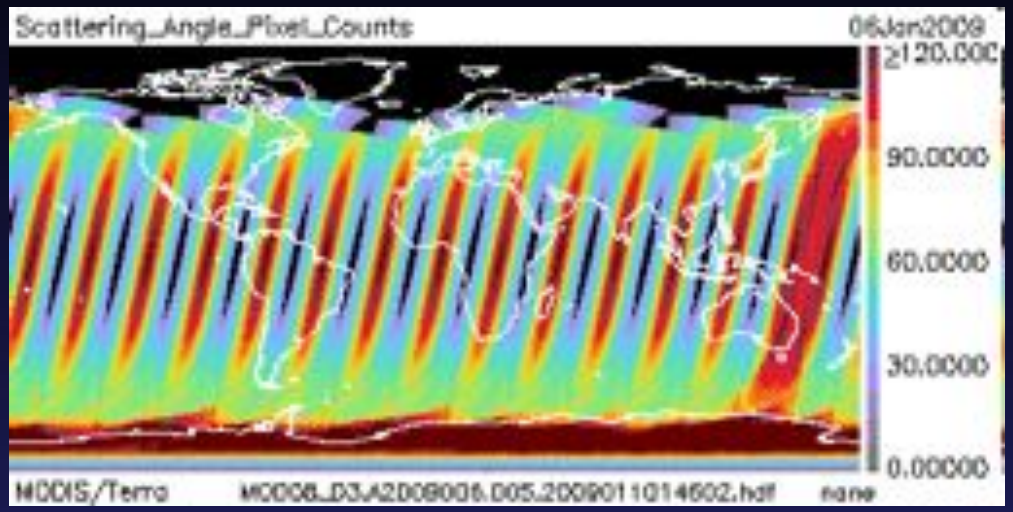






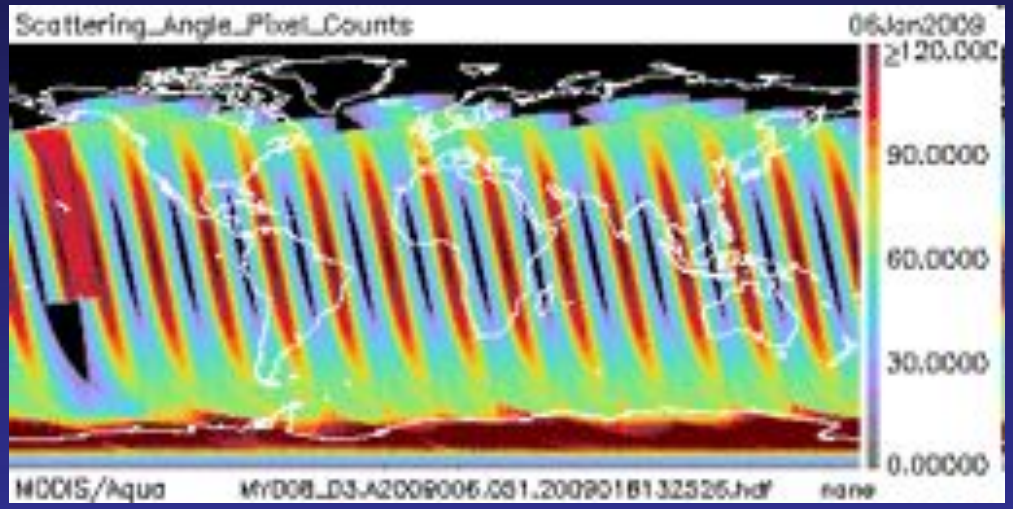
Orbit Time Difference for Terra and Aqua 2009-01-06

Terra



Terra

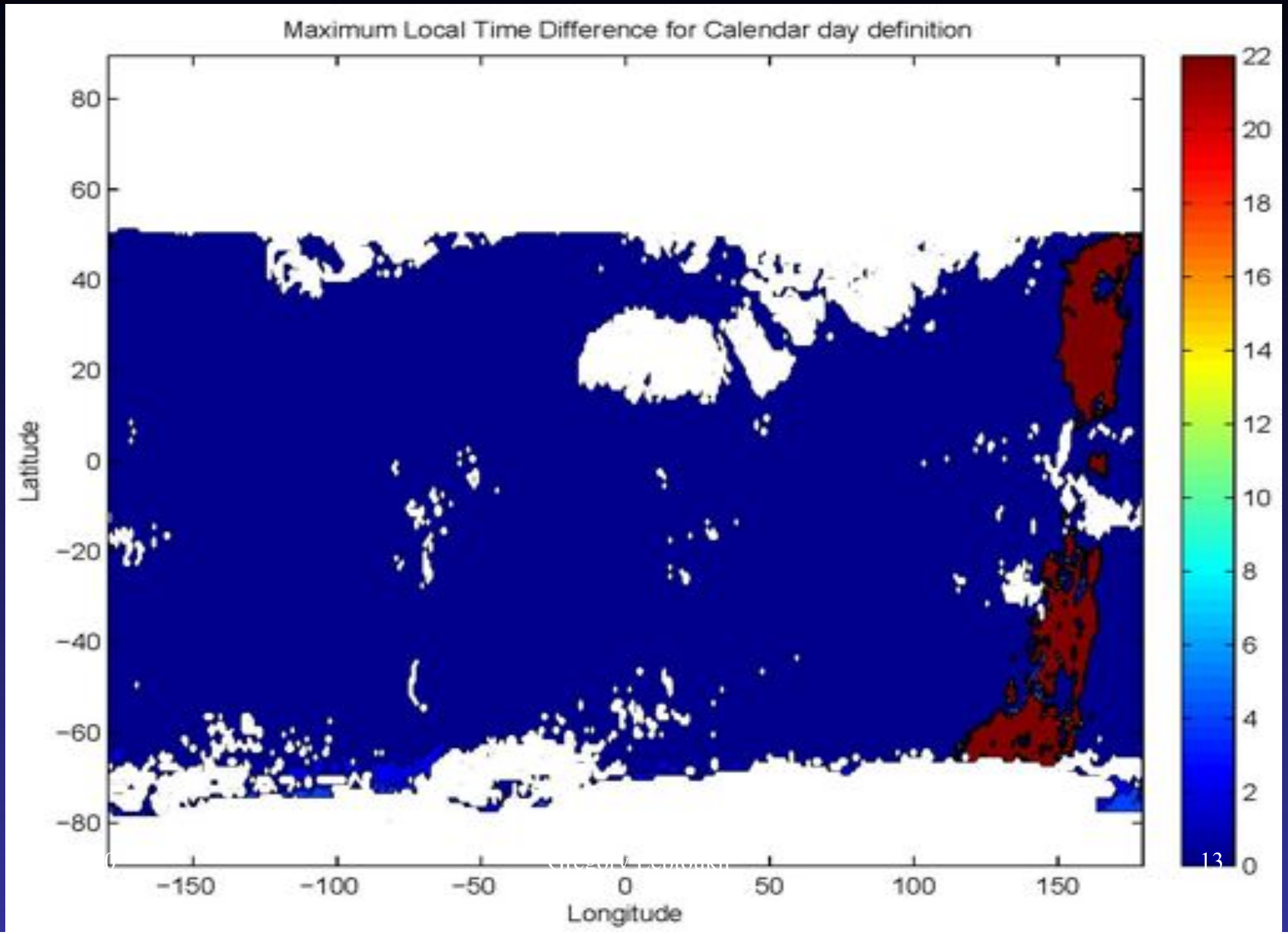
Aqua

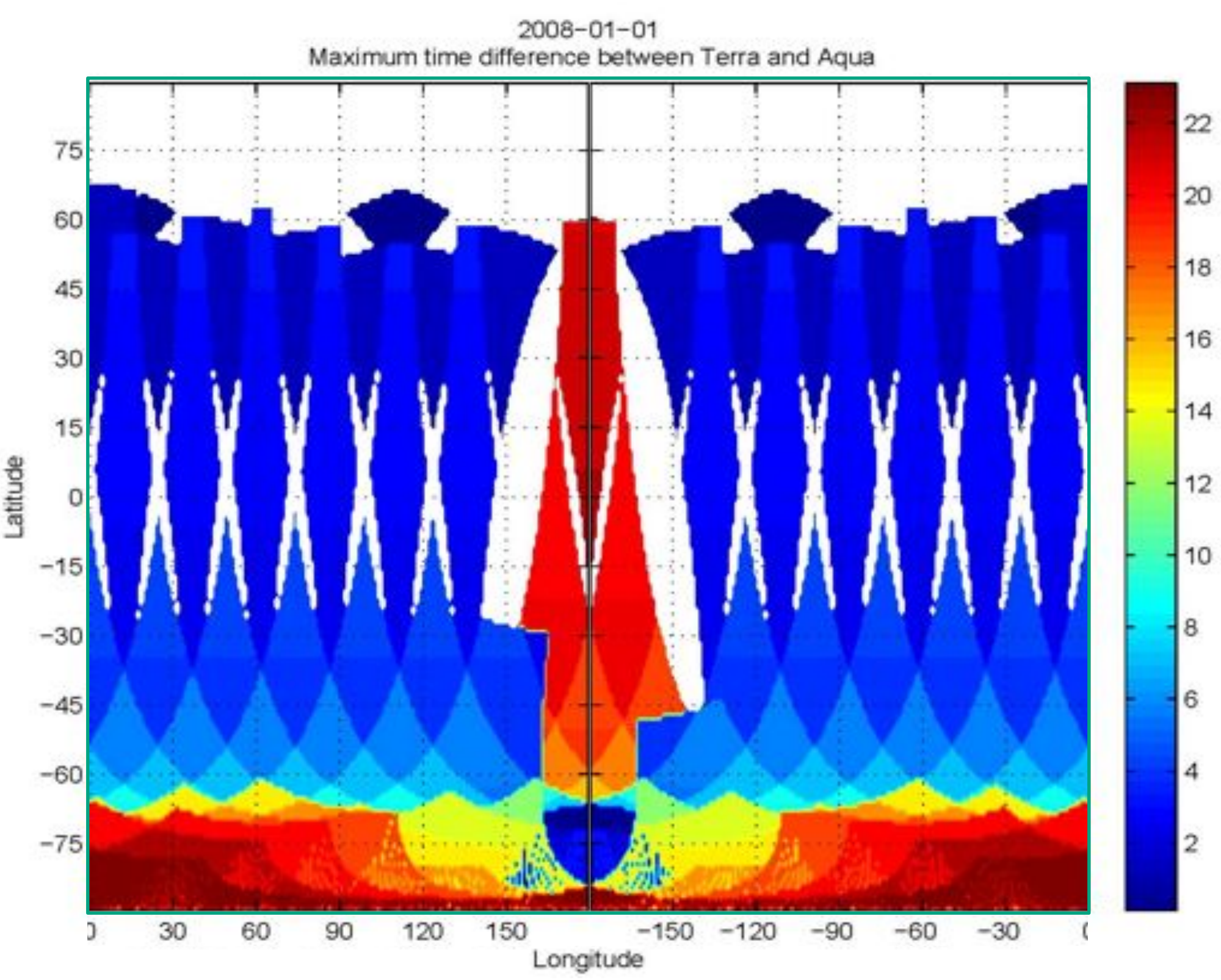


Aqua

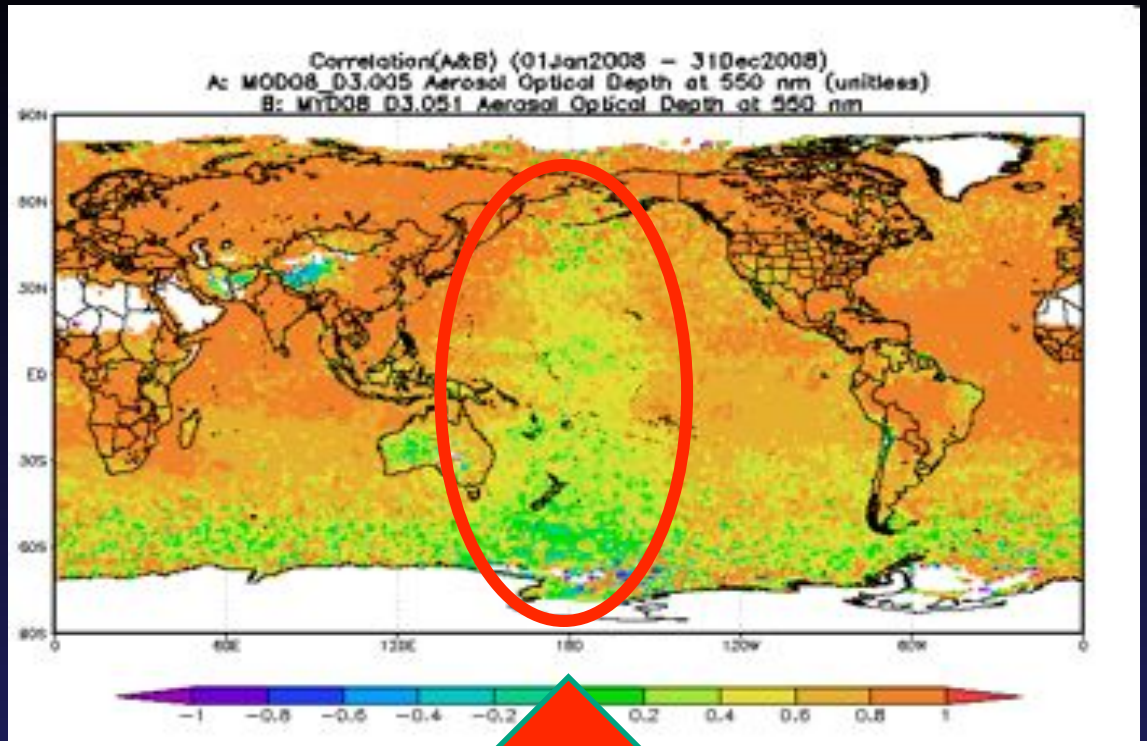
Orbit track from: http://www.ssec.wisc.edu/datacenter

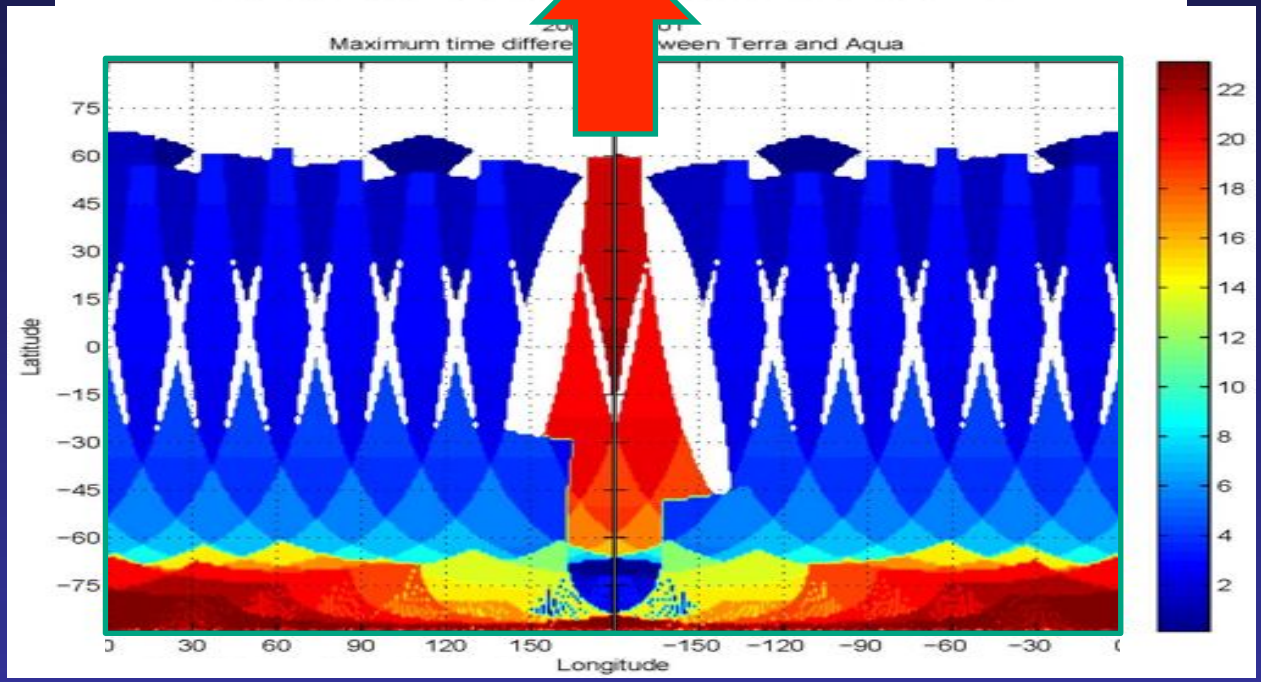
Max Time diff. for Terra (calendar day)




2008-01-01
Maximum time difference between Terra and Aqua
Latitude
75
60
45
30
15
0
-15
-30
-45
-60
-75
0
30
60
90
120
150
-150
-120
-90
-60
-30
Longitude
22
20
18
16
14
12
10
8
6
4
2

Artifact


Correlation(A&B) (01Jan2008 – 31Dec2008)
A: MODO8_D3.005 Aerosol Optical Depth at 550 nm (unitless)
B: MYDO8_D3.051 Aerosol Optical Depth at 550 nm
90N
60N
30N
EQ
30S
60S
90S
60E
120E
180
120W
60W
0
−1
−0.8
−0.6
−0.4
−0.2
0.2
0.4
0.6
0.8
1


Maximum time differe
ween Terra and Aqua
75
60
45
30
15
0
−15
−30
−45
−60
−75
Latitude
30
60
90
120
150
−150
−120
−90
−60
−30
Longitude
22
20
18
16
14
12
10
8
6
4
2

Data day definitions

Level 3 daily products are generated by binning Level 2 data belonging to one day onto a certain spatial grid according to a dataday definition. *The latter is different for different sensors, and even for the same sensor but as selected by different Science Teams.*

1. Calendar: all granules between 00:00 – 24:00 UTC: MODIS Atmospheric products, OMI L2G
2. Spatial (pixel-based): uses local date/time and ensures spatial continuity. TOMS, AVHRR, AIRS, OMI, MODIS Ocean, SeaWiFS

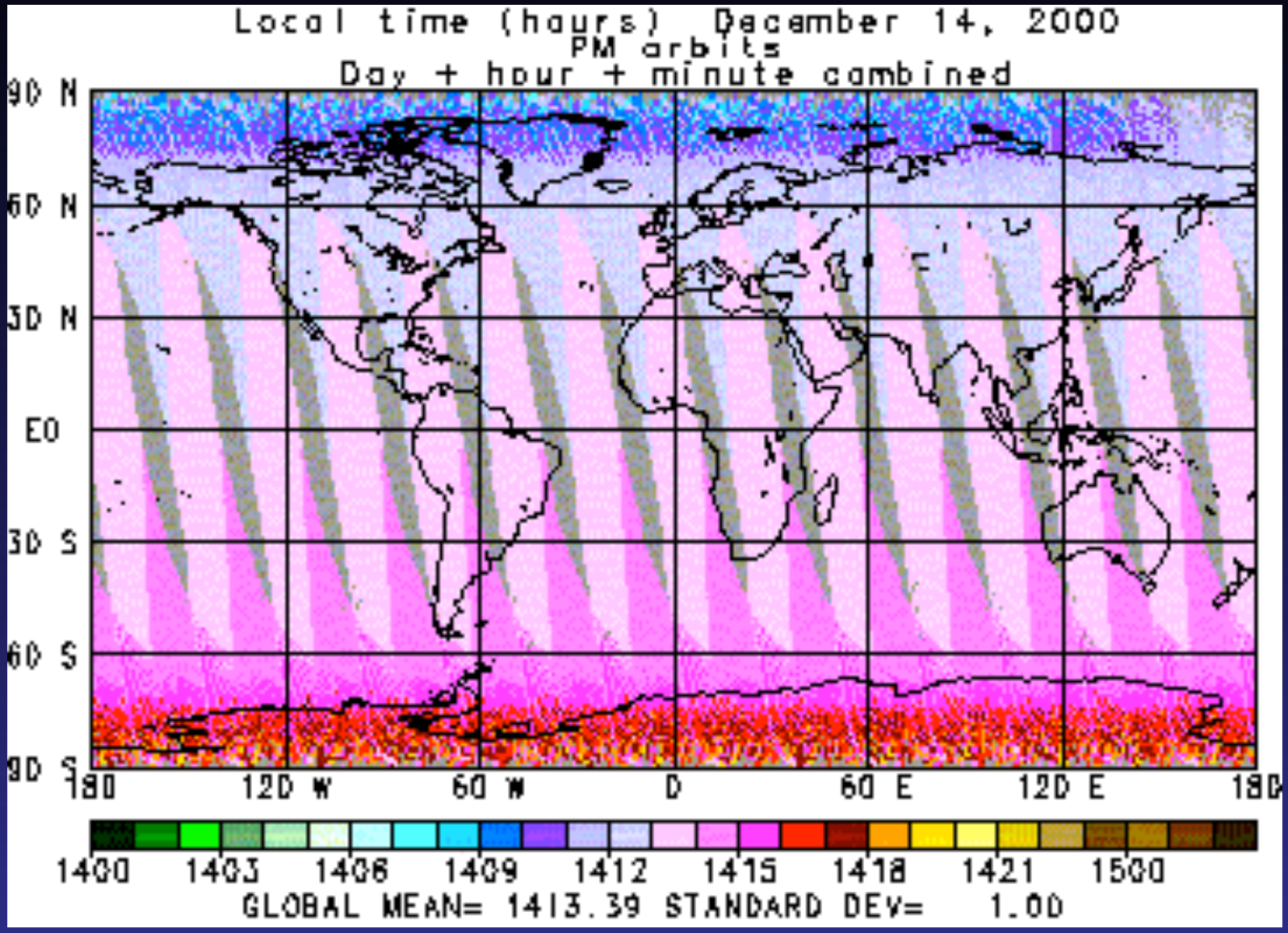
More flavors:

1. Calendar (EqCT): 24 hours centered at the Equatorial Crossing Time at 180 deg longitude, Intermediate case
2. Spatial (with Δt = 1.6 h to eliminate multiple overlaps at high lat.)
3. MISR: full 14 or 15 orbits depending on a day in the 16-day cycle

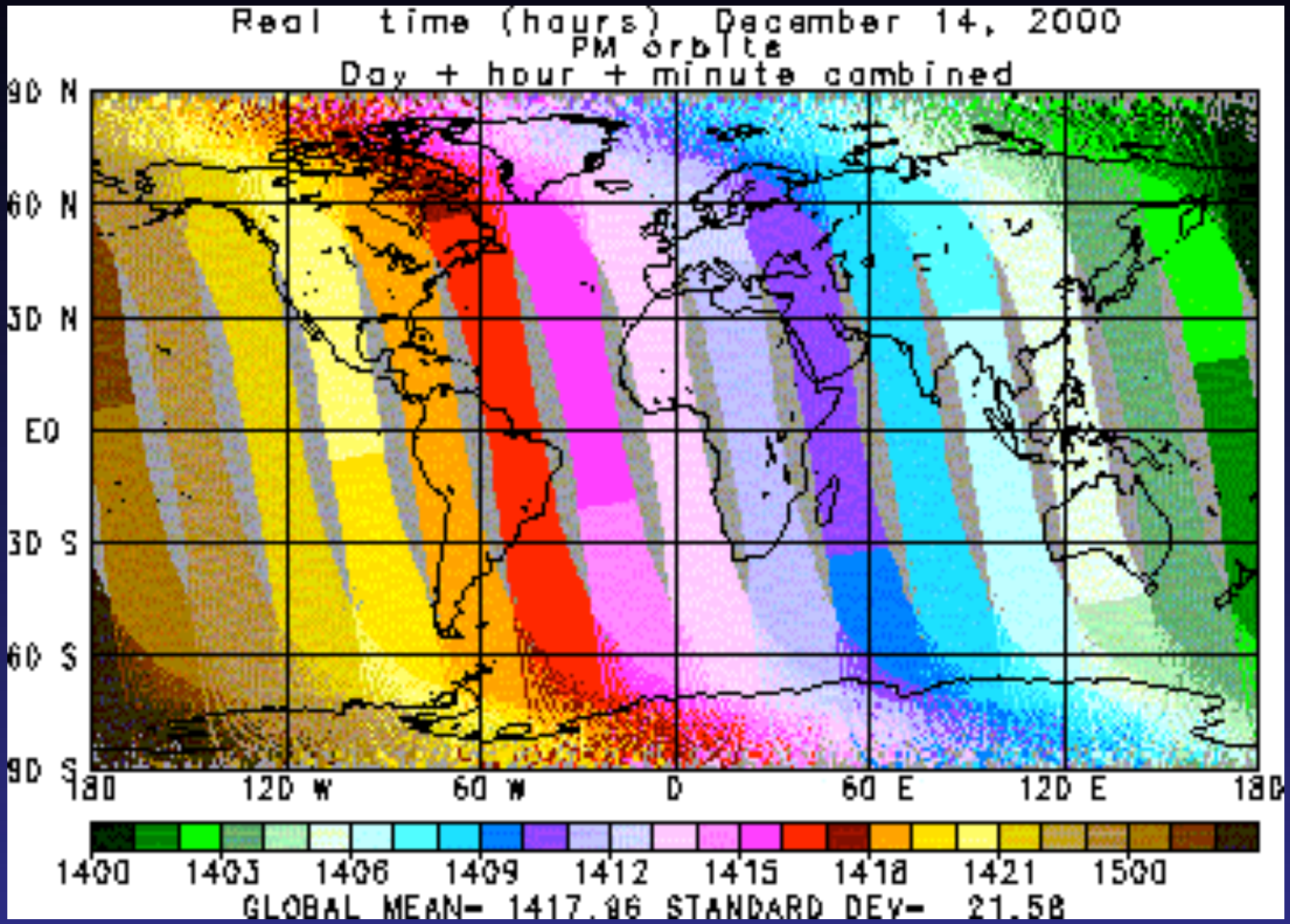
Spatial (local time) Data Day definition

- Each data set contains information for 24 hours of local time, e.g., 1:30 p.m.
- The gridding starts at the dateline and progresses westward, as does the satellite.
- Parts of scan lines that cross the dateline are included in the current date data set or the next, depending on which day is at the local time/day at that longitude.
- For Aqua, the p.m. orbit starts at roughly 1:30 Z on the day and ends on roughly 1:30 Z of the following day.

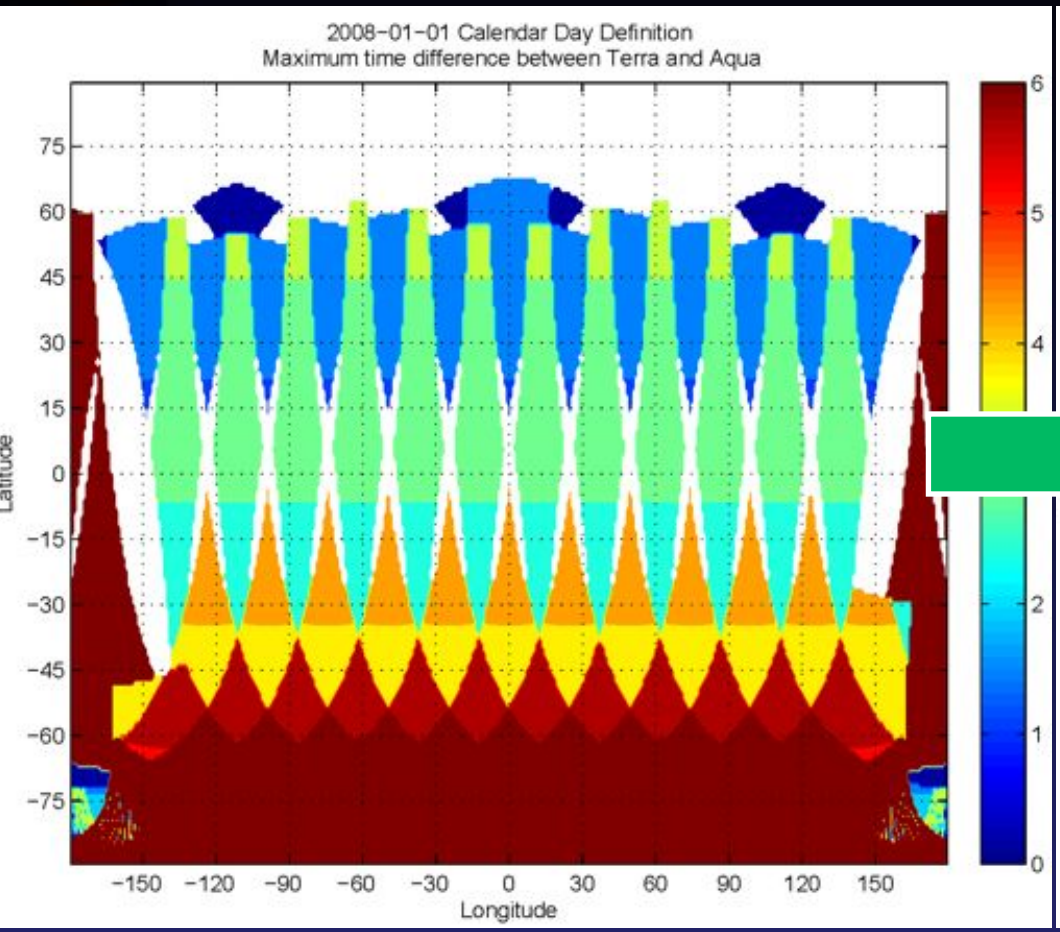
AIRS local time (from L. Iredell, GSFC)

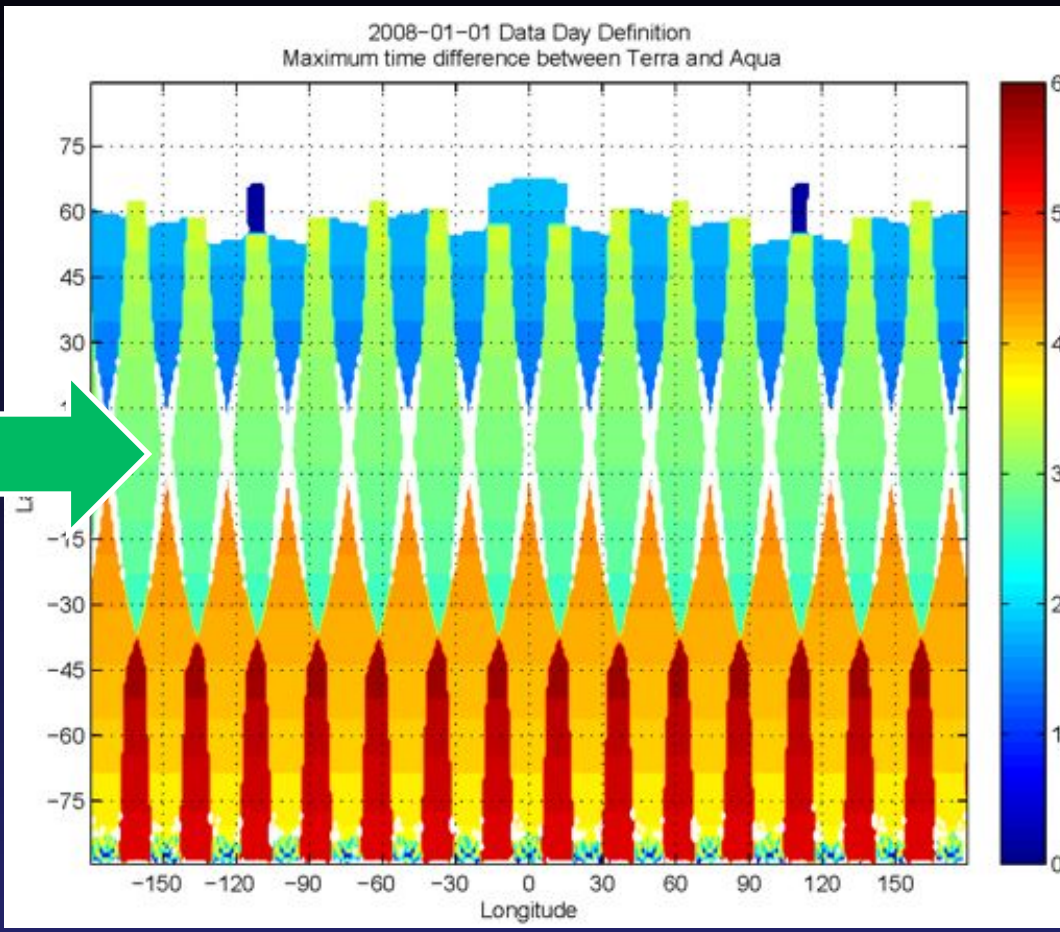


AIRS UTC time (from L. Iredell)



Max time diff. between Terra and Aqua





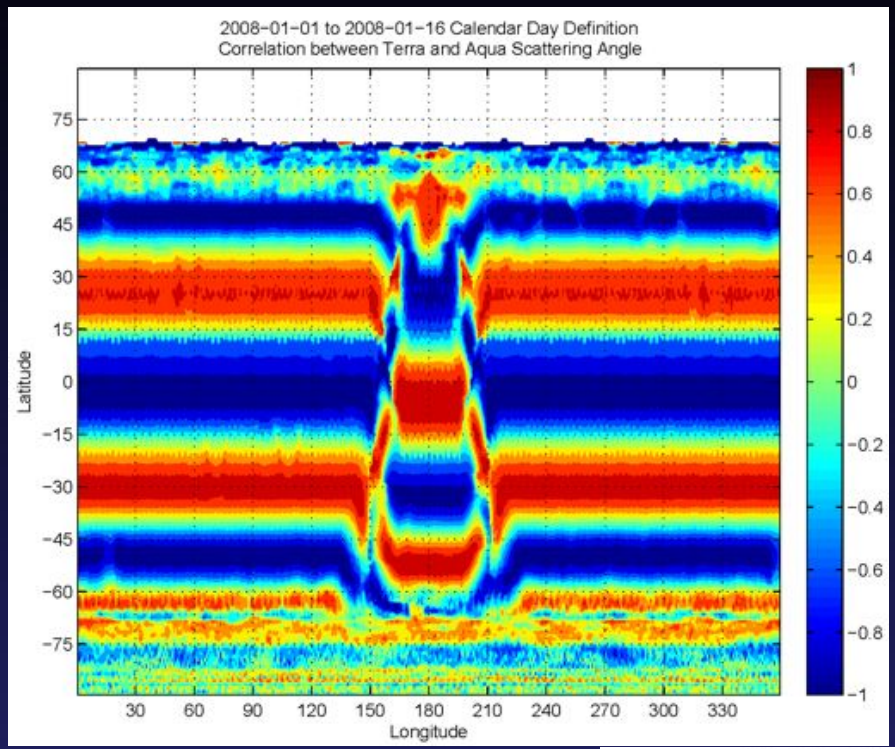
Calendar UTC (MODIS) dataday

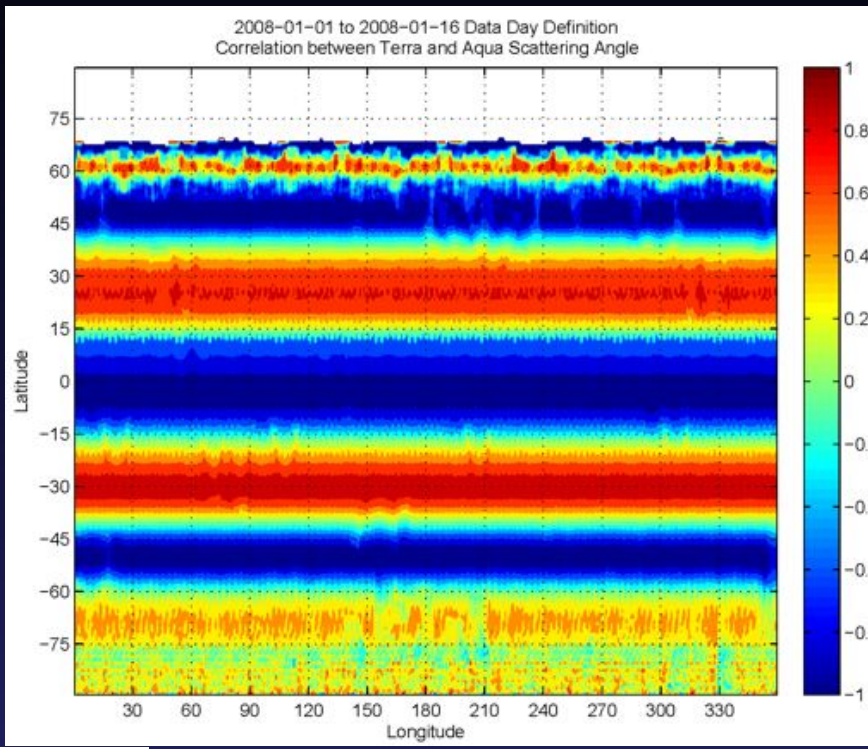
Spatial dataday

The artifact around the dateline disappears. In other areas, results are exactly the same for the (-7, 18) latitude belt.

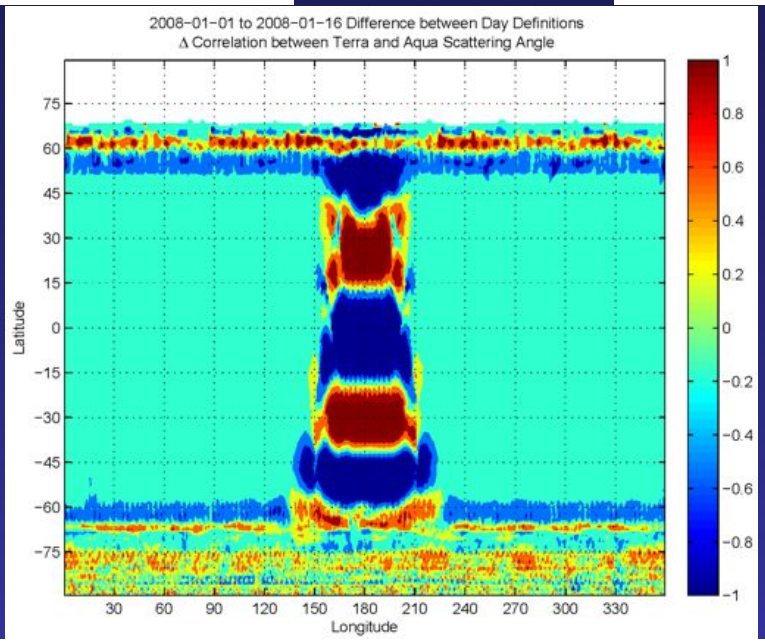
At higher latitudes, the additional restriction for one orbit time around the local time produces different results for two dataday definitions.

Removing the artifact in aerosol scattering angle correlation





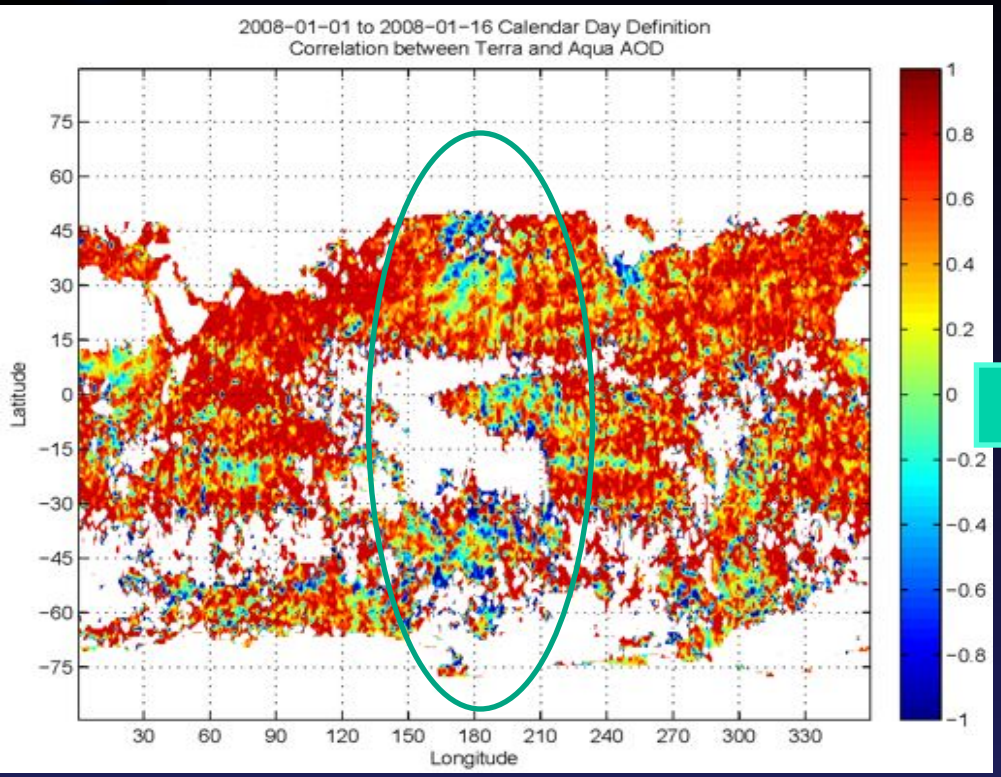
Calendar dataday

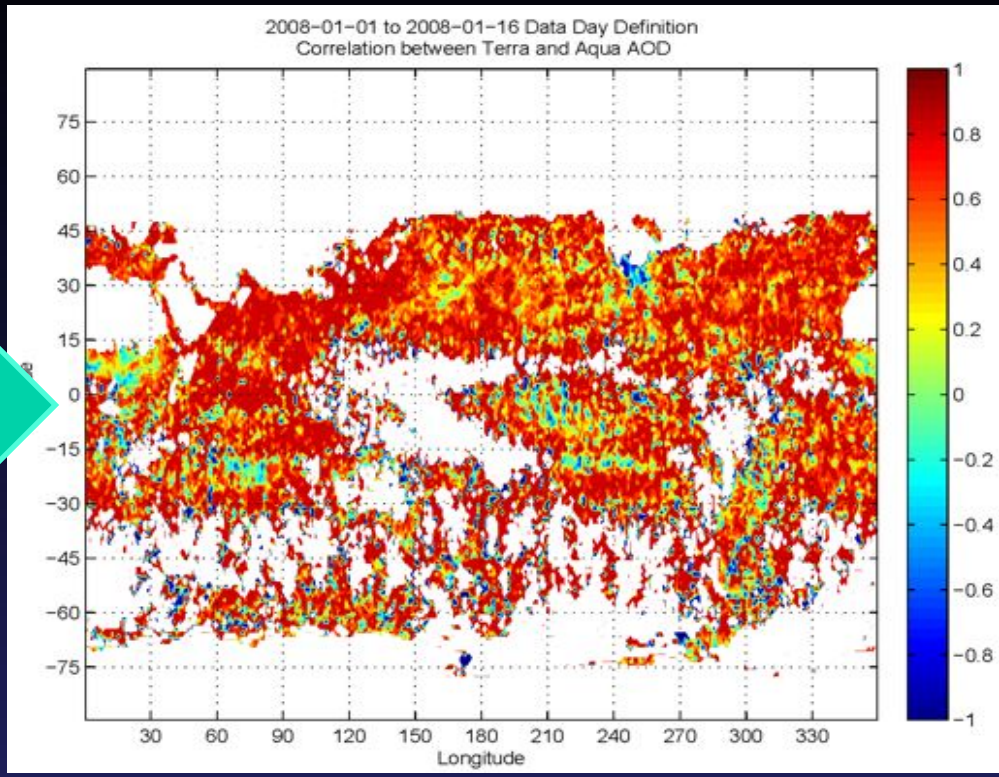


Spatial dataday

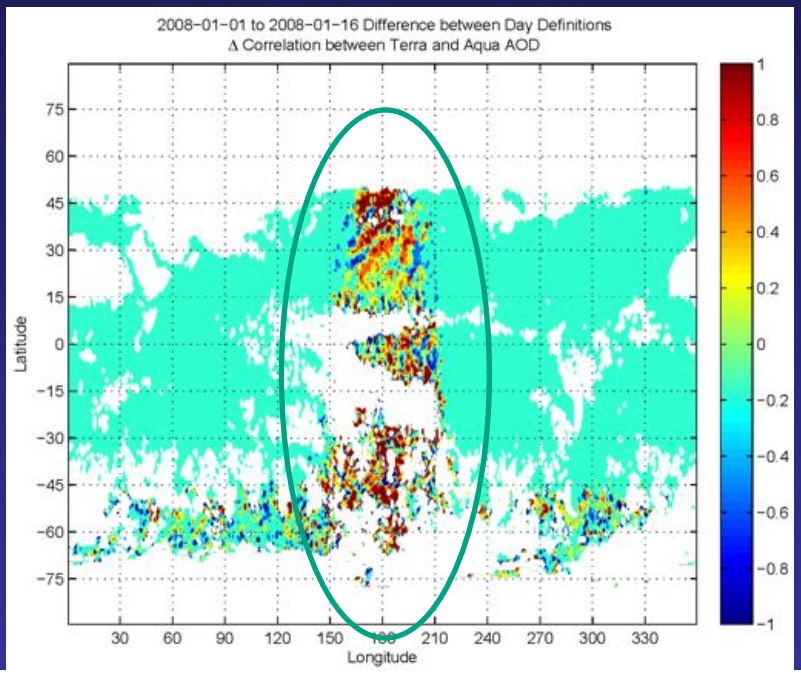
Artifact: difference between calendar and spatial dataday defs.

Removing the artifact in 16-day AOD correlation





Calendar dataday



Spatial dataday

Artifact: difference between calendar and spatial dataday defs.

Caveats and Options

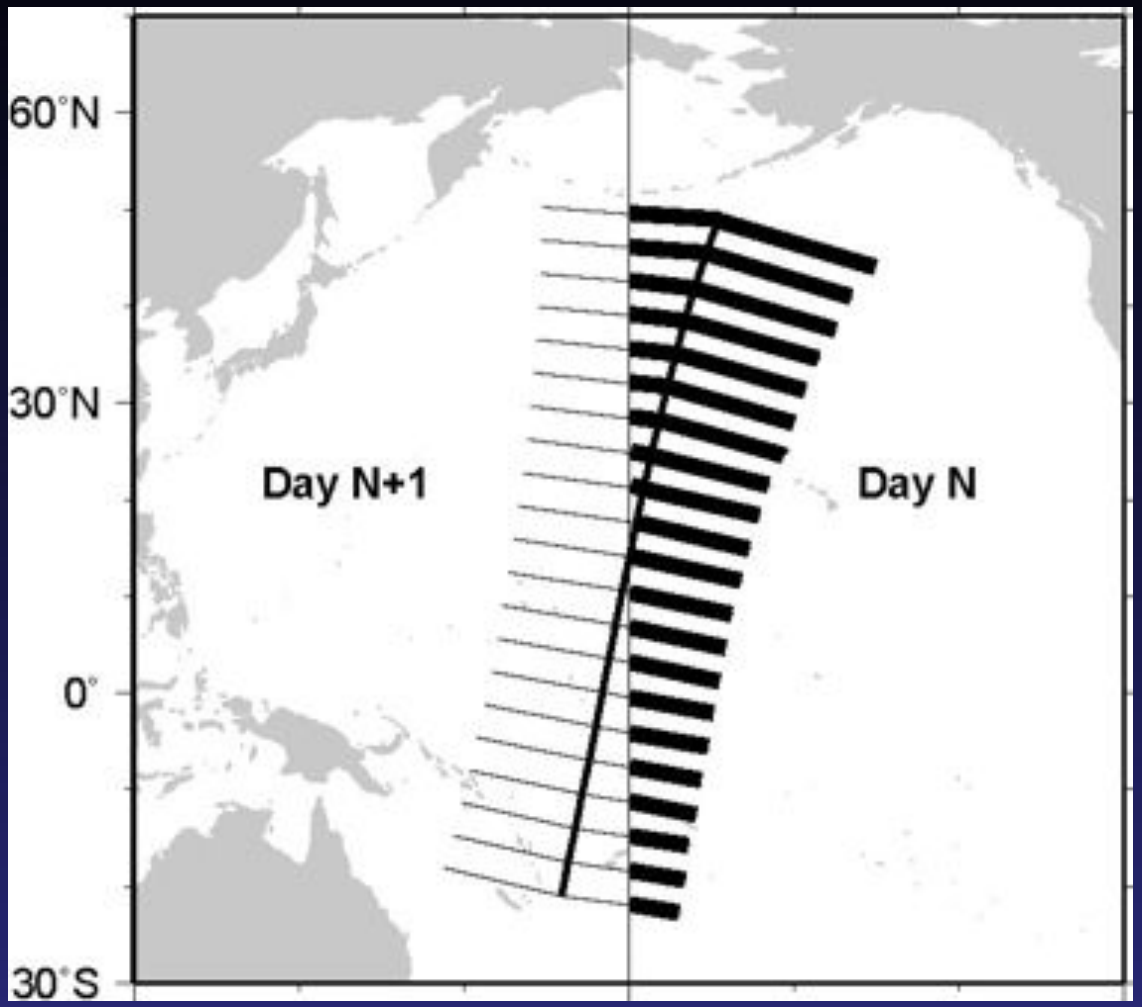
- Granule-based vs. L2 pixel-based:
  - Applying local-time approach to granules (not pixels) improves consistency between Terra and Aqua but
  - doesn't remove the artifact completely
- UTC begin and end time of a Level 3 day will be different for Terra and Aqua Level 3 products – it reflects the actual measurement local time
- Limiting orbit overlap to +- one around the local time:
  - where strong diurnal or other temporal changes occur, we know that all the observations averaged occurred with in a narrow and clearly defined local time window.

Conclusions and recommendations

- It's the sampling… and packaging of L2
- Ability to compare daily Level 3 products from different sensors depends on the dataday definition
- The calendar UTC 00-24 (MODIS) dataday definition leads to artifacts around the dateline due to Δt between measurements reaching up to 23 hours
- Spatial (local-time-pixel-based) dataday definition insures consistently small Δt between measurements from different satellites, thus removing artifacts

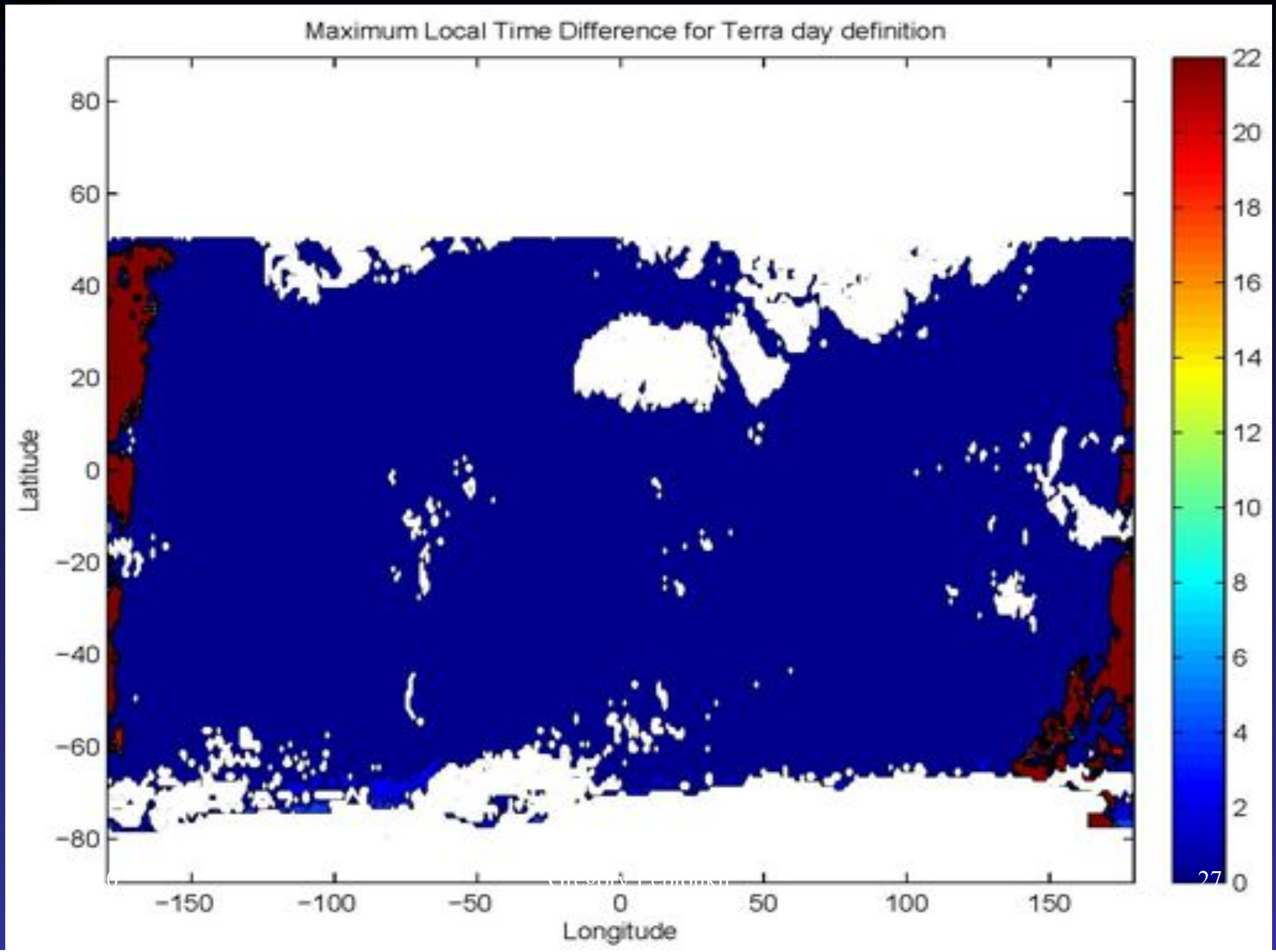
BACKUPS

A TOMS L3 day: the ensemble of all L2 ground pixels with pixel centers that have the same local calendar date on the ground.

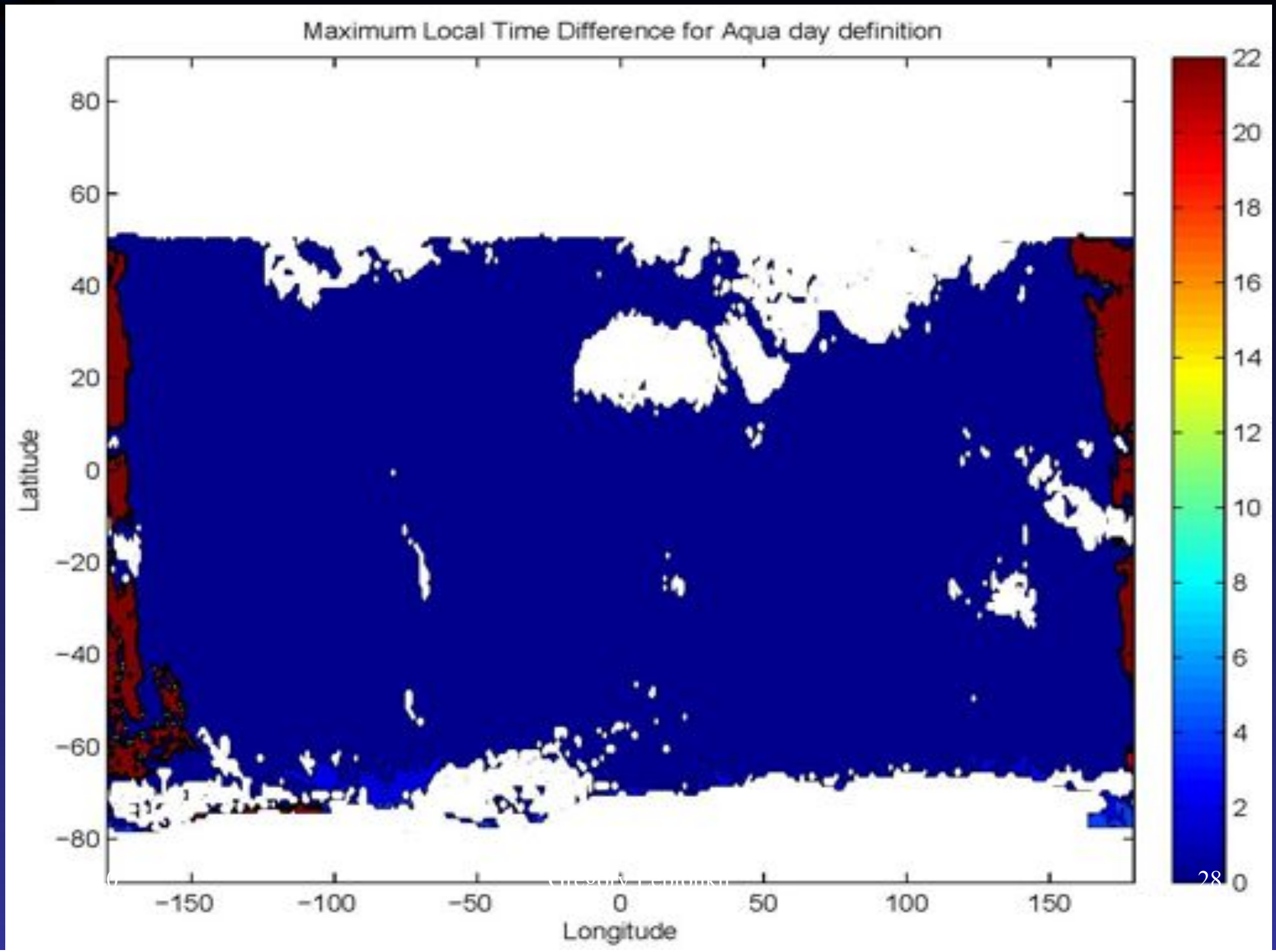


Pixels to the east of the 180° meridian get assigned to data-day N, whereas the pixels to the west of the meridian correspond to data-day N+1.

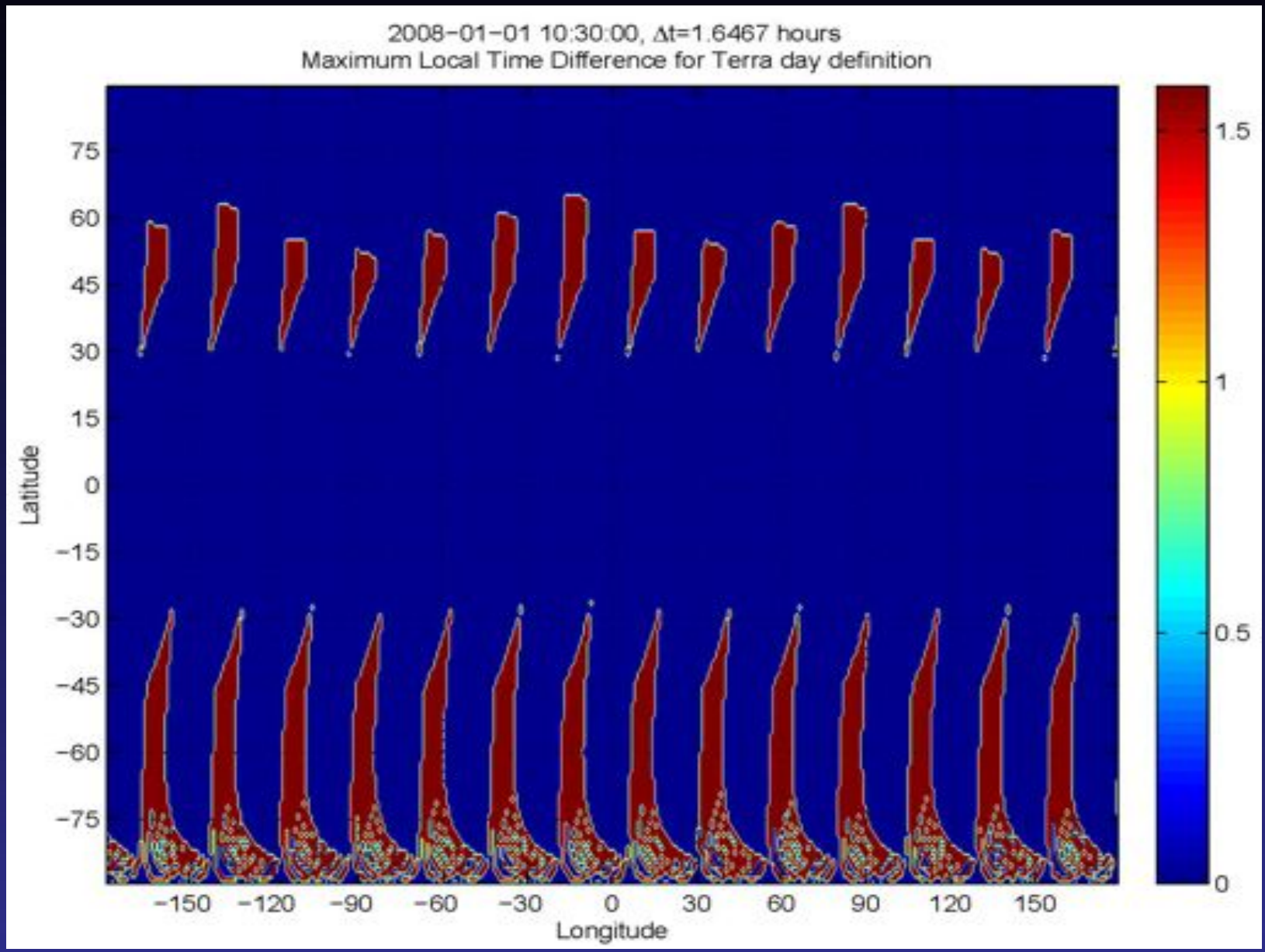
Max time diff. Terra: day starts at 10:30 pm



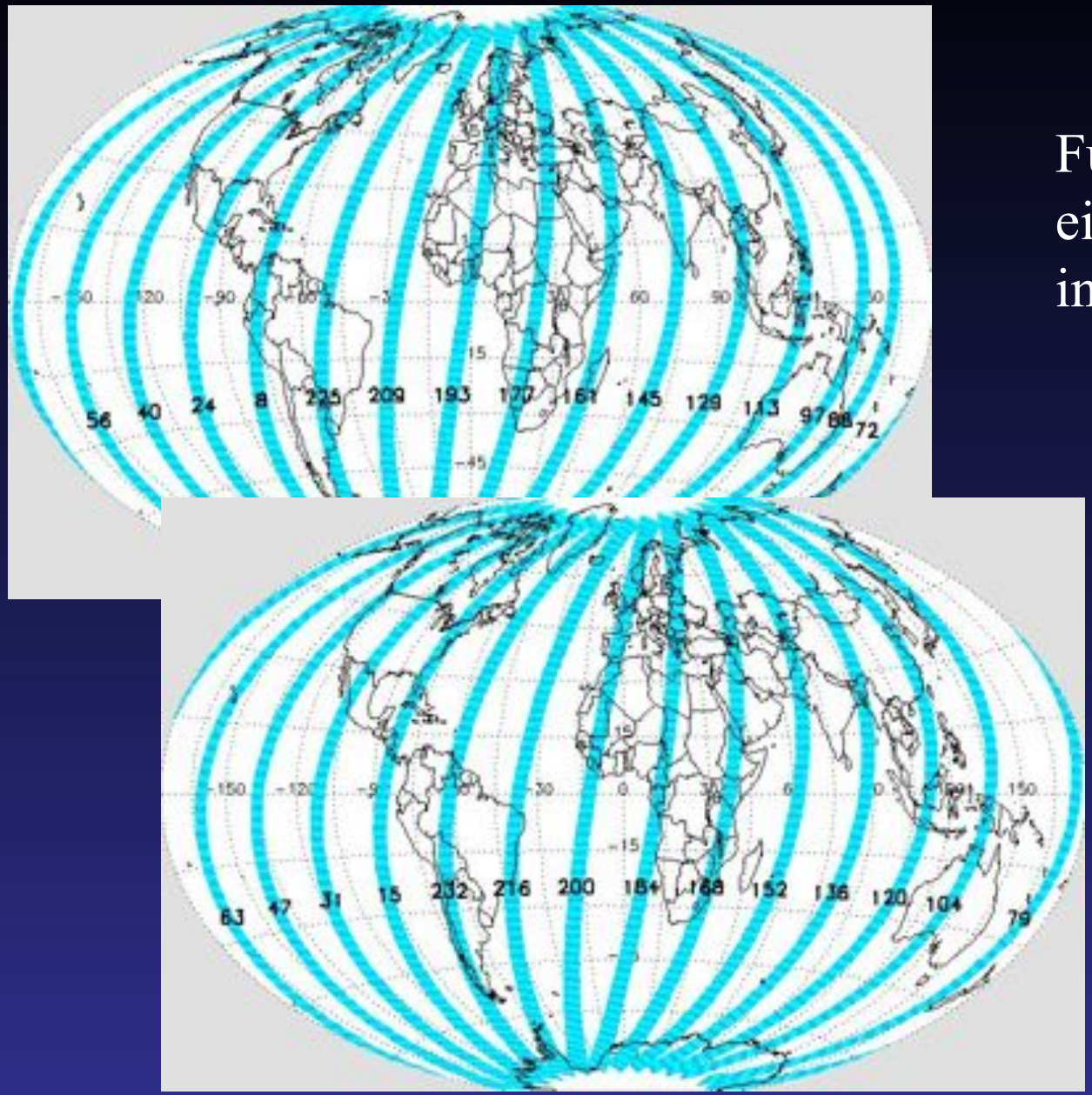
Max time diff. Aqua: day starts at 1:30 am



Max Local time diff. for spatial DD def. with additional orbit filtering



MISR data day: a day in a 16-day cycle



Full orbits:
either 14 or 15
in a dataday