Optimal Orbits for Inter-Calibration

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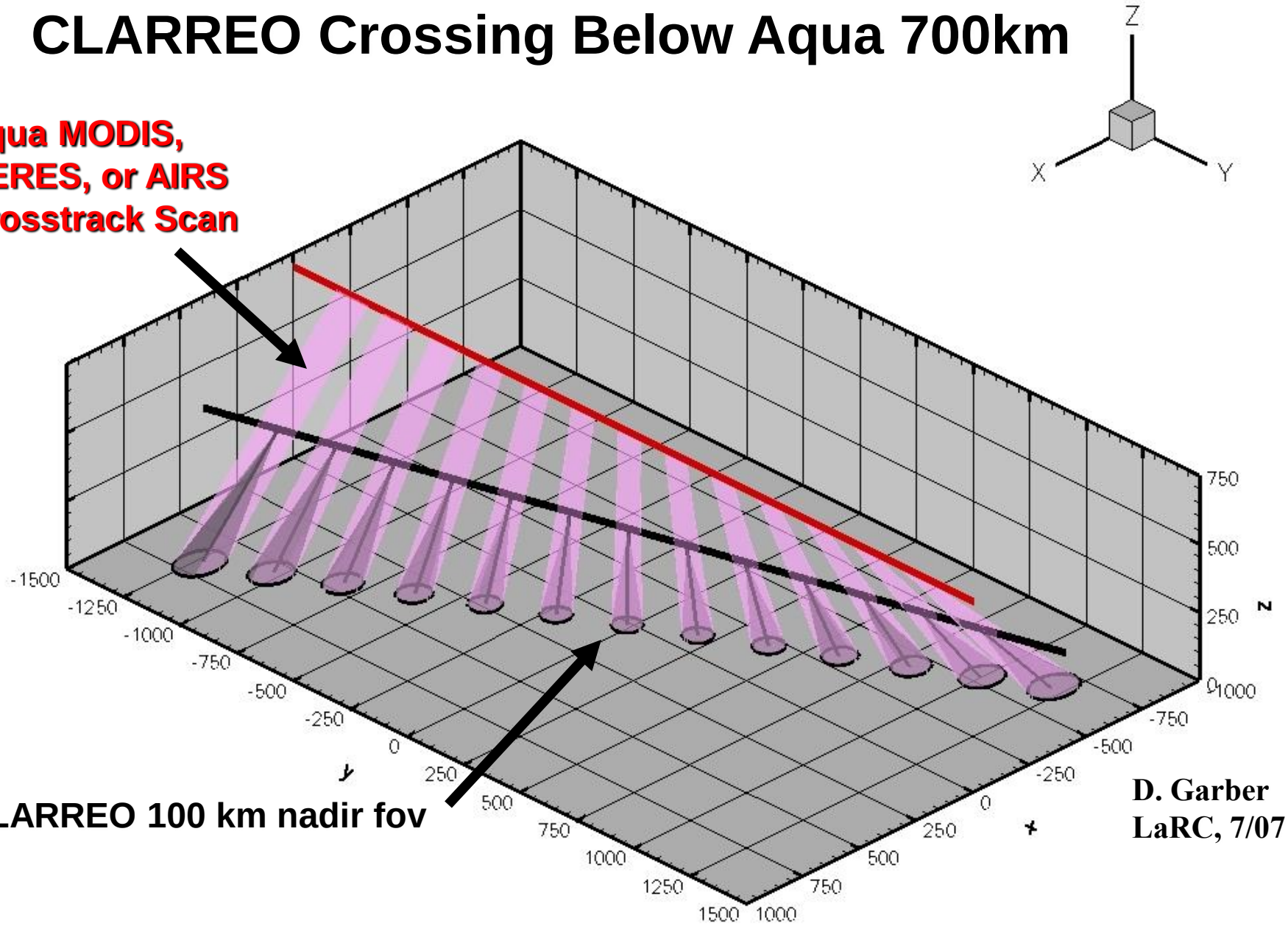
Radiation and Calibration are 8-dimensional Sampling Problems

- Latitude
- Longitude
- Altitude
- Time
- Solar Zenith Angle
- Viewing Zenith Angle
- Viewing Azimuth Angle
- Wavelength

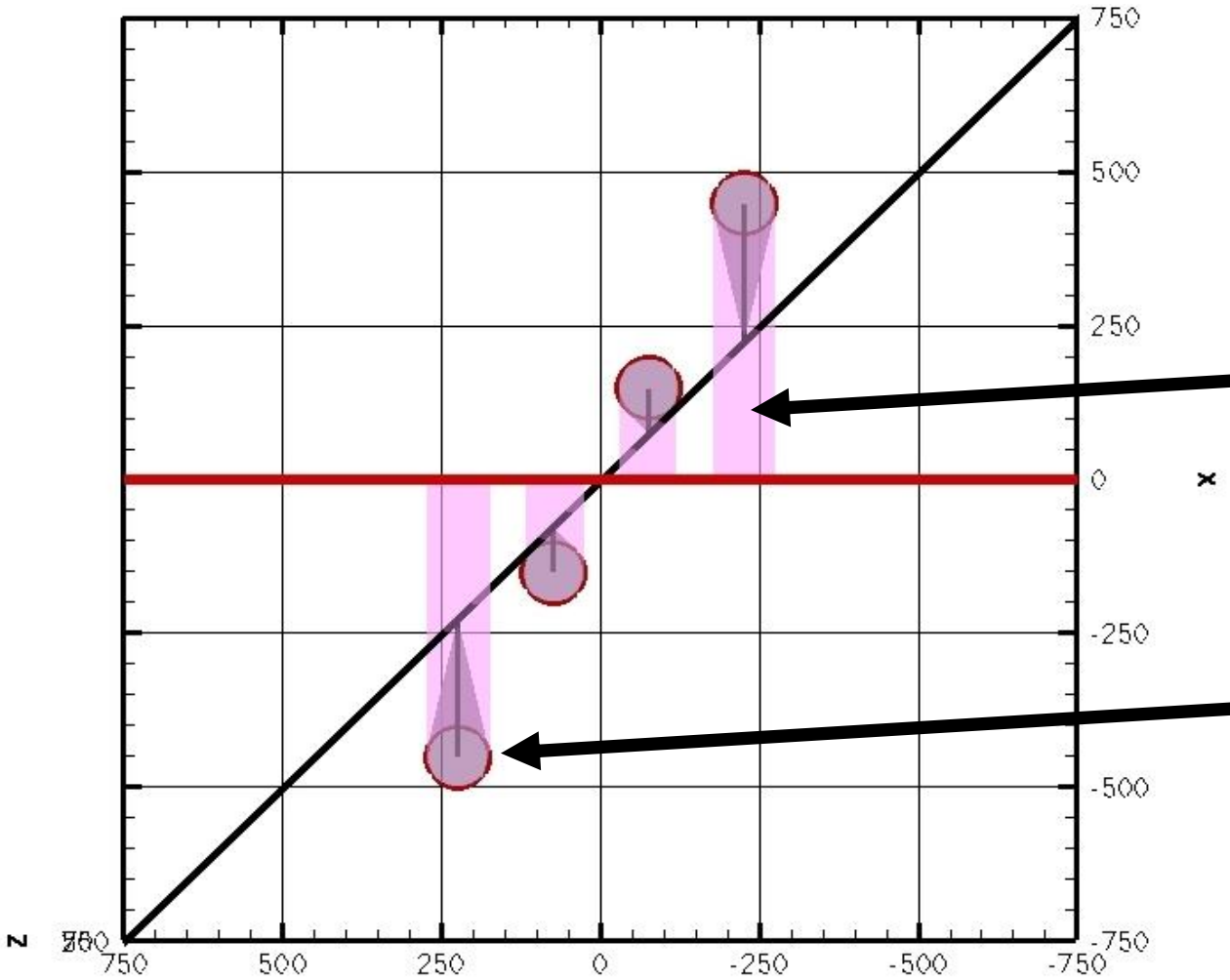
- Radiance signals vary a factor of 2 to 10 with all of these dimensions. Yet key climate change is a few tenths of a percent/decade.
- Climate Change adds a stealth "9th dimension": accuracy

CLARREO Crossing Below Aqua 700km



Time to Achieve Viewing Angle Matches:
40 seconds per 100km orbit altitude Difference: 140 seconds above

Top View: CLARREO under-flight of Aqua



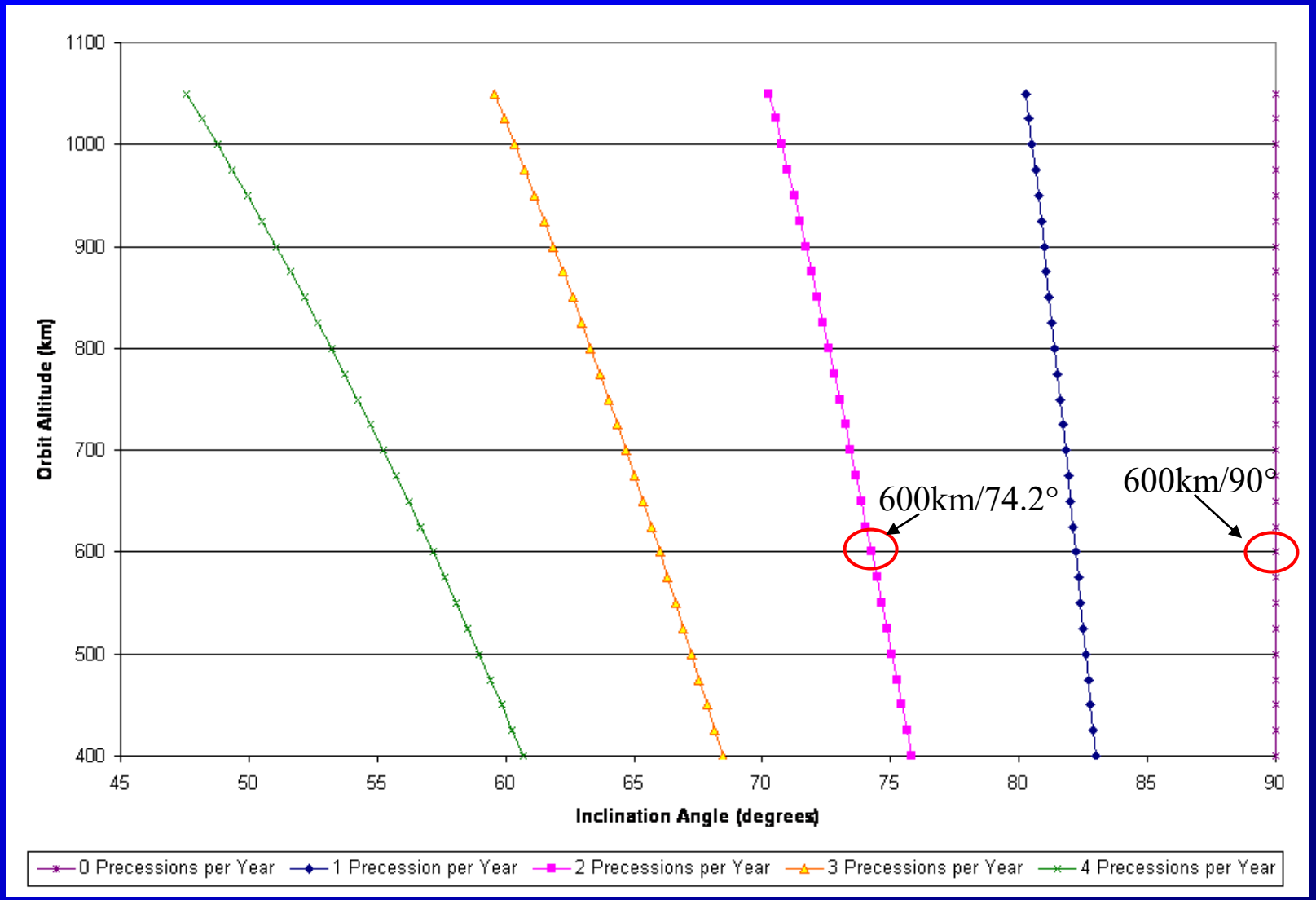
Aqua MODIS, CERES, or AIRS Crosstrack Scan

CLARREO 100 km nadir fov

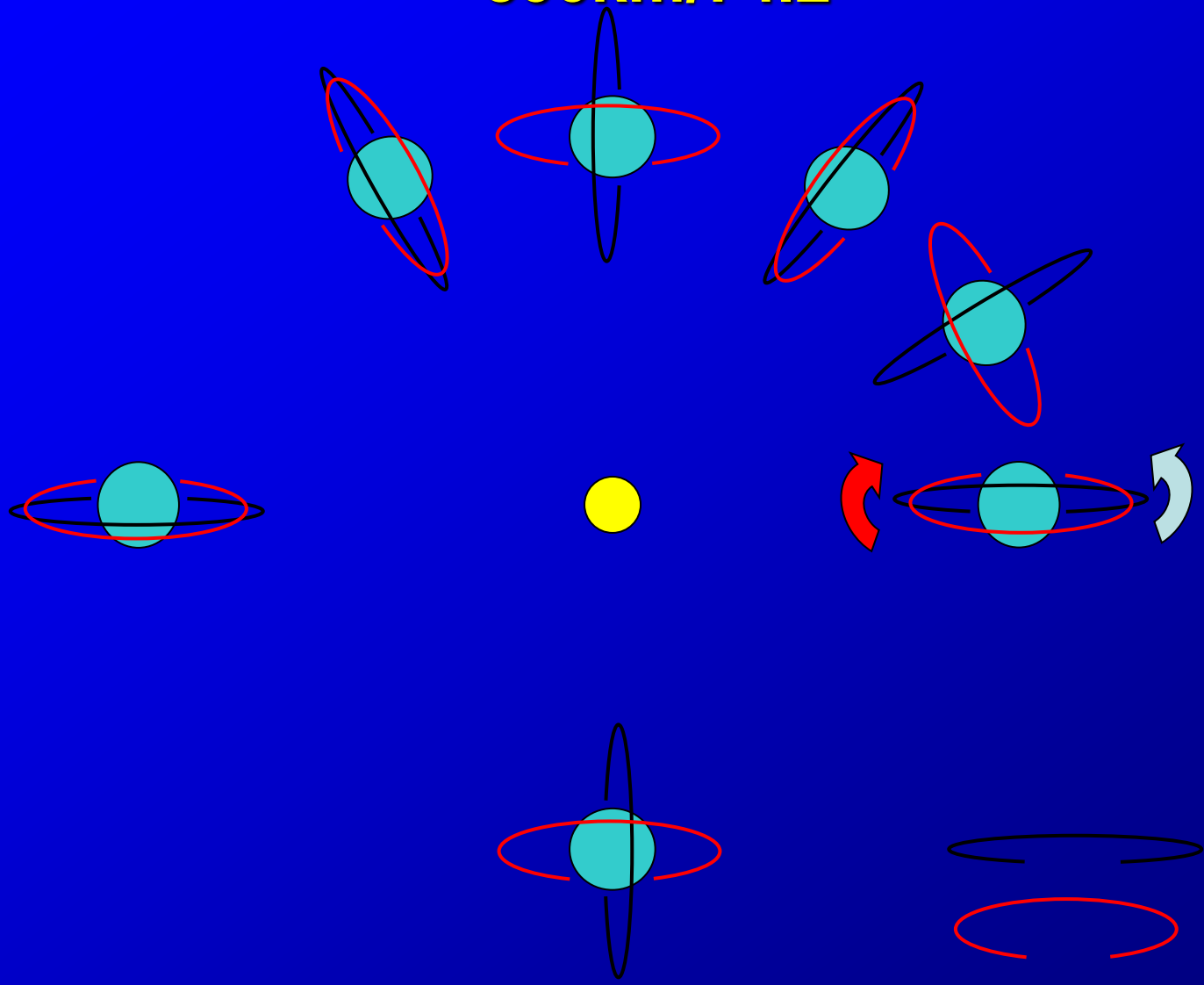
Angle Pointing (zenith, azimuth) is required to obtain any calibration matches beyond those at nadir. Options: pointable instrument, pointing table, or S/C reaction wheels

D. Garber LaRC, 7/07

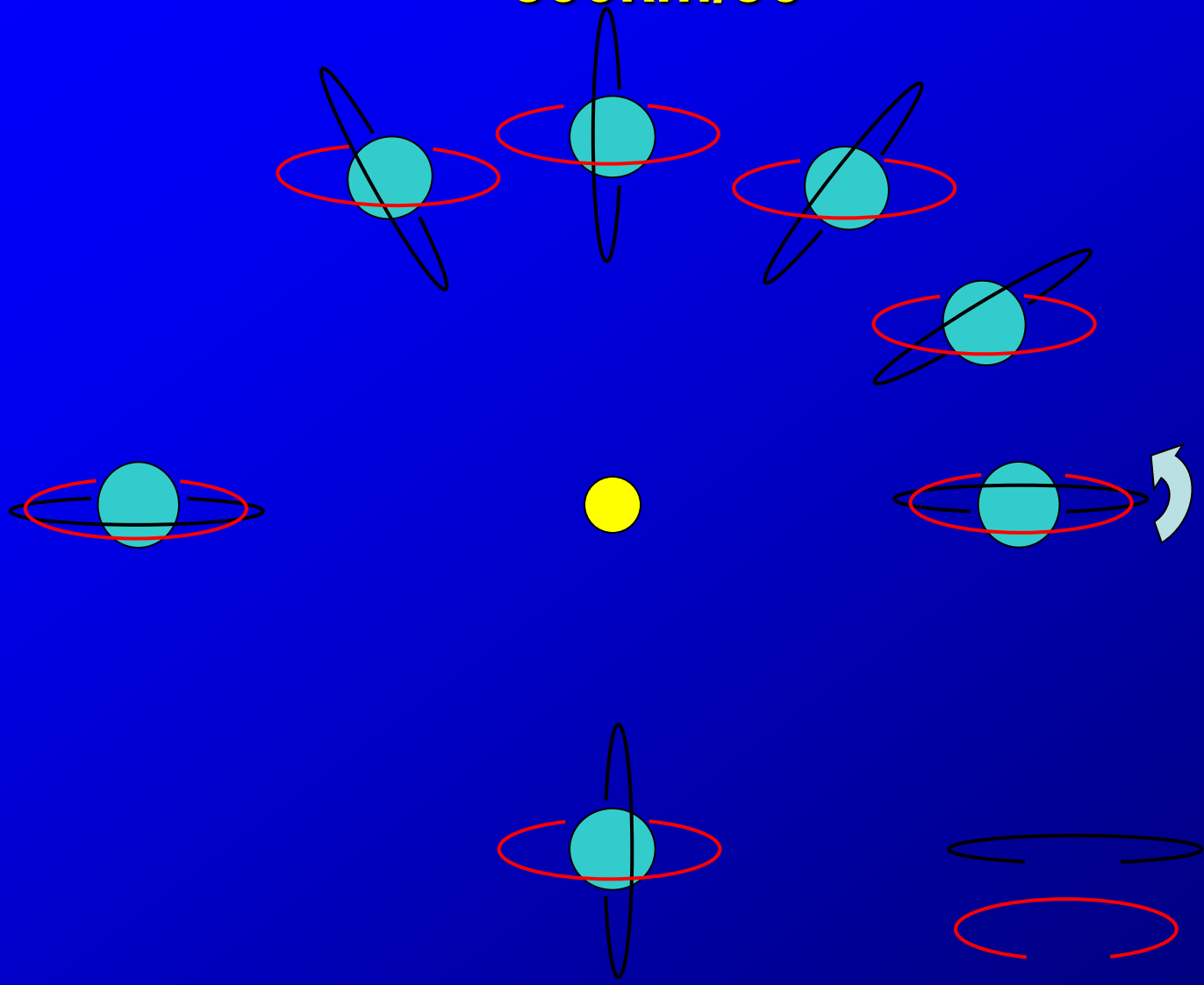
Precession Rate Trade Space



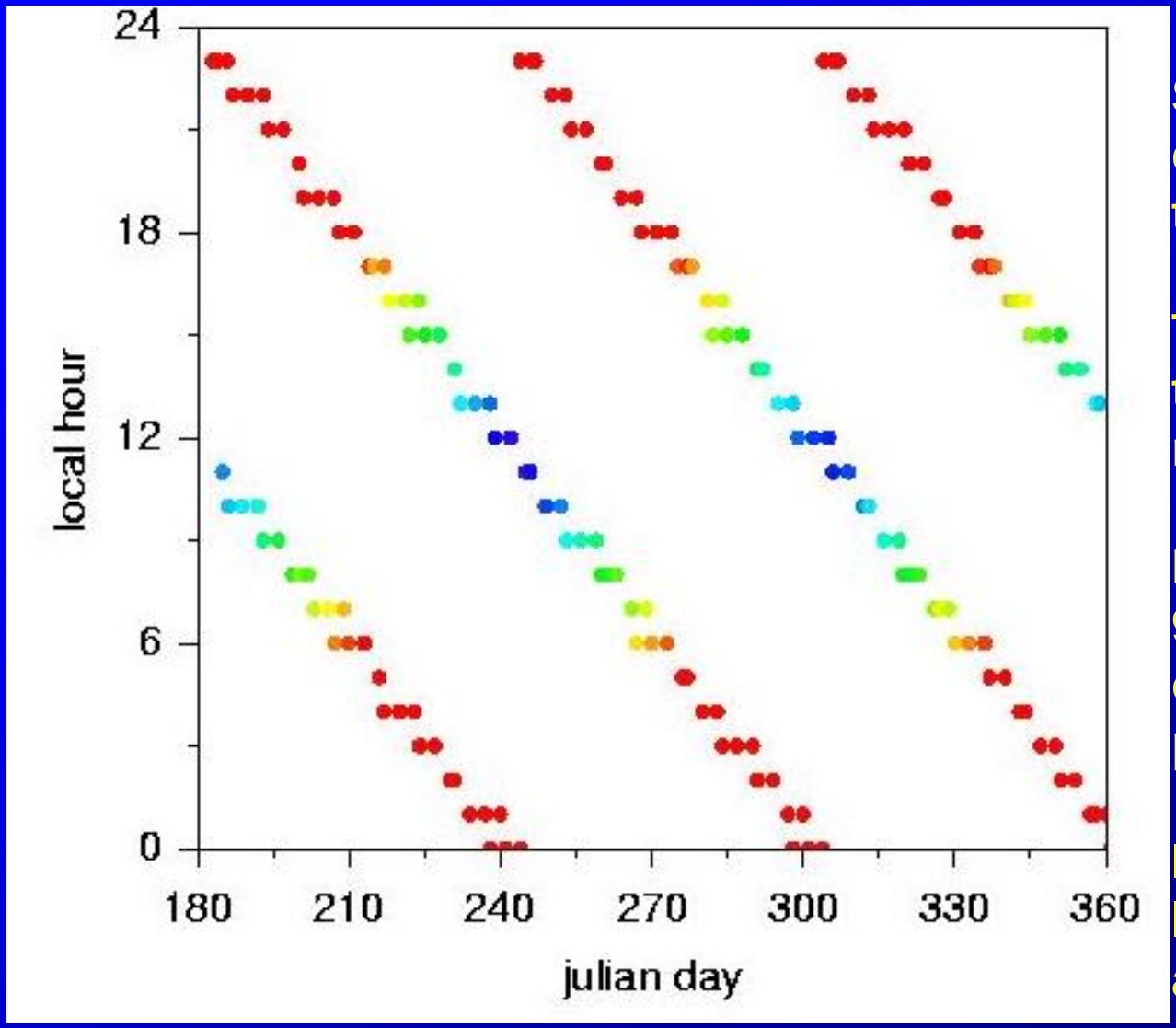
Sun-Synchronous with respect to CLARREO 600km/74.2°



Sun-Synchronous with respect to CLARREO 600km/90°



74 degree Inclination/600 km Orbit
6 months of Equator Crossing Times



Solar zenith angle in color (blue high sun to red low sun)

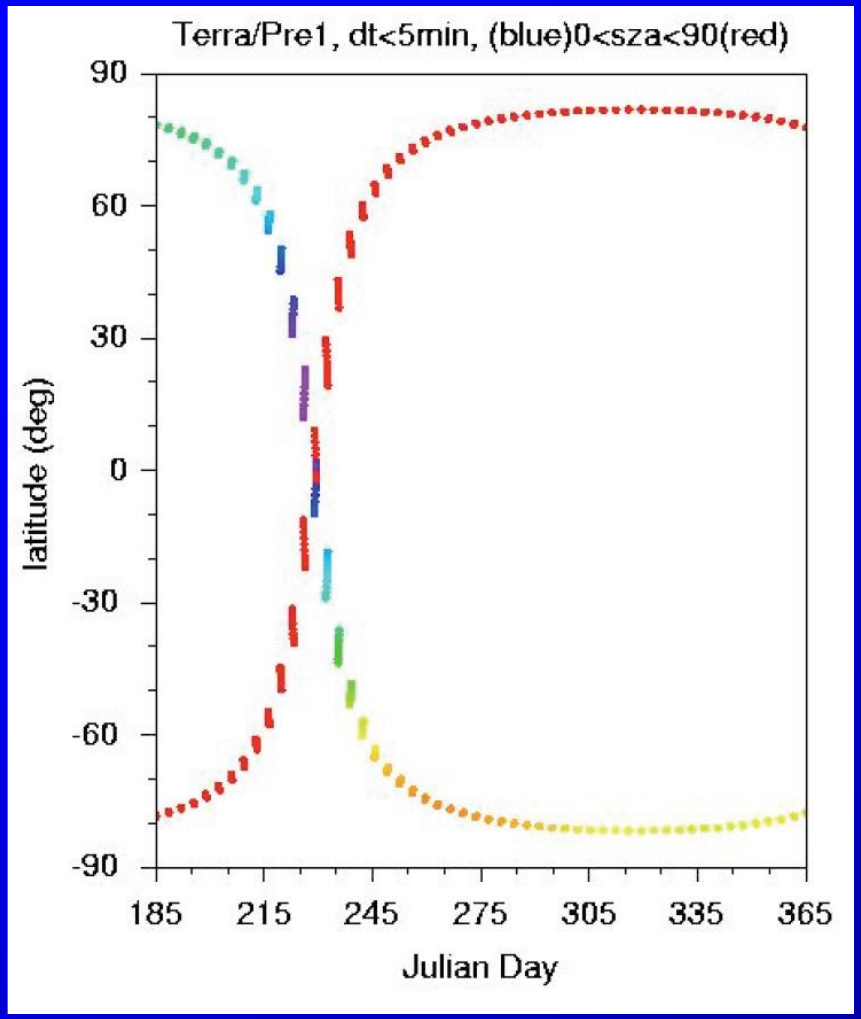
This orbit samples the equator at local noon 6 times per yr.

Nominal CLARREO 90 degree inclination orbit does this twice per year.

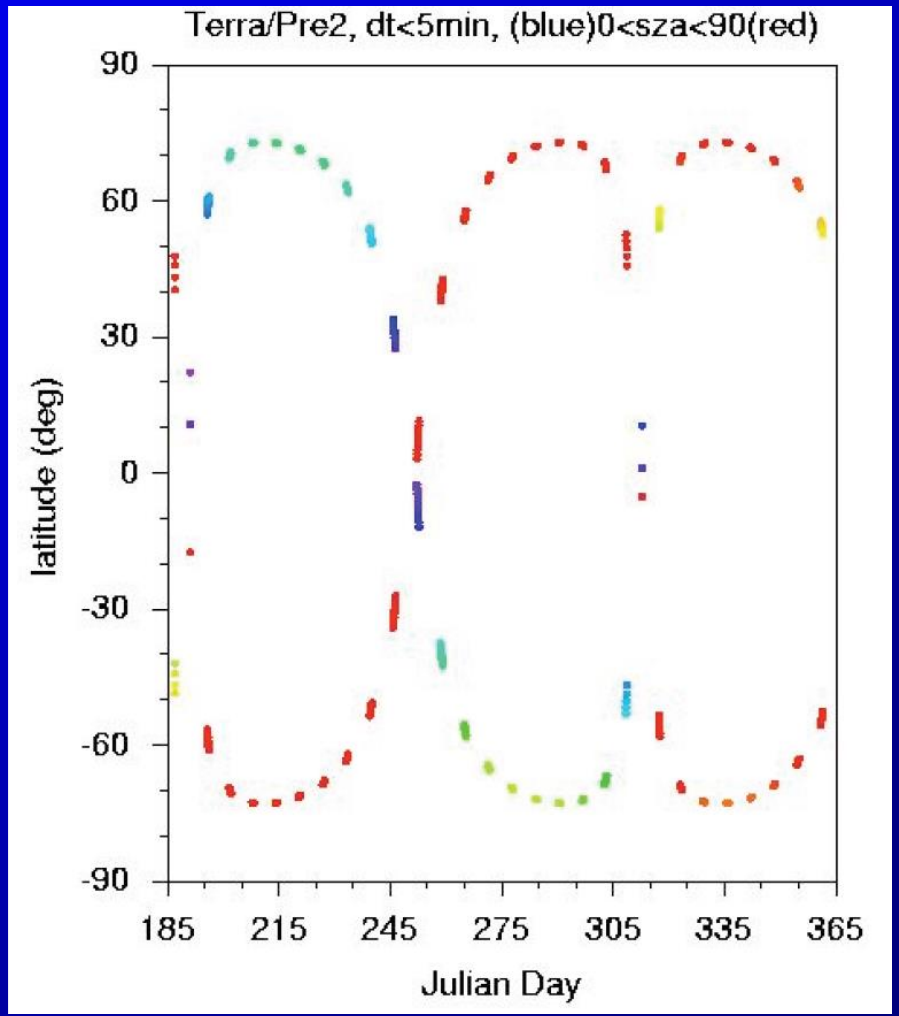
Inclination is max latitude seen at nadir, add 10 deg lat off nadir

How often and Where will Orbits Cross? June - Dec
CLARREO calibrating Terra/Aqua/NPOESS

90 degree Incl. 1 24-hr cycle/yr



74 degree Incl. 3 24-hr cycles/yr



Conclusion: intercalibration in polar regions is common for leo satellites, tropics less common: precession cycle limits.

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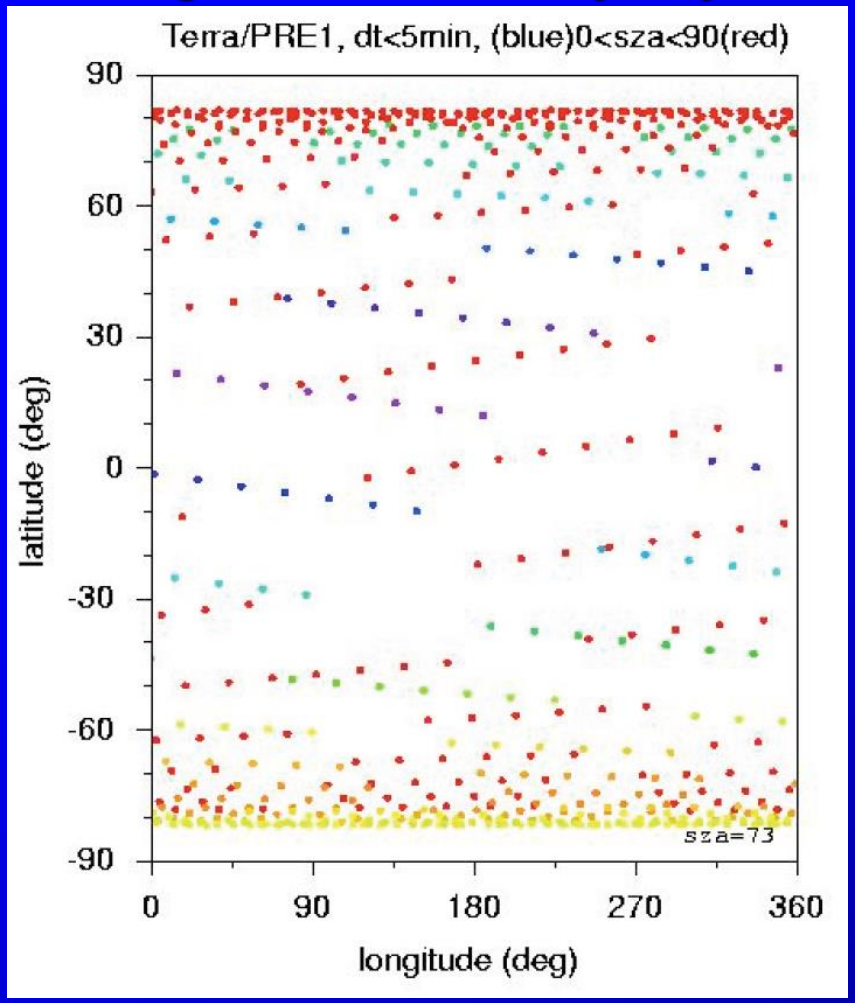

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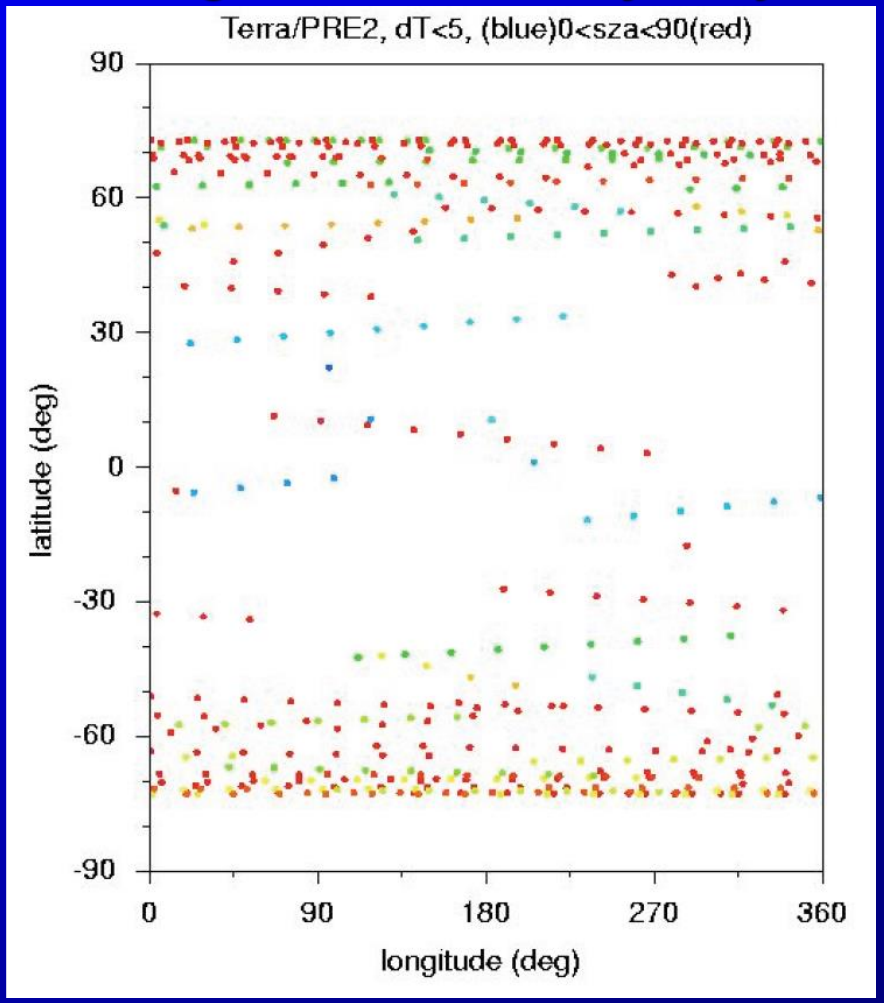
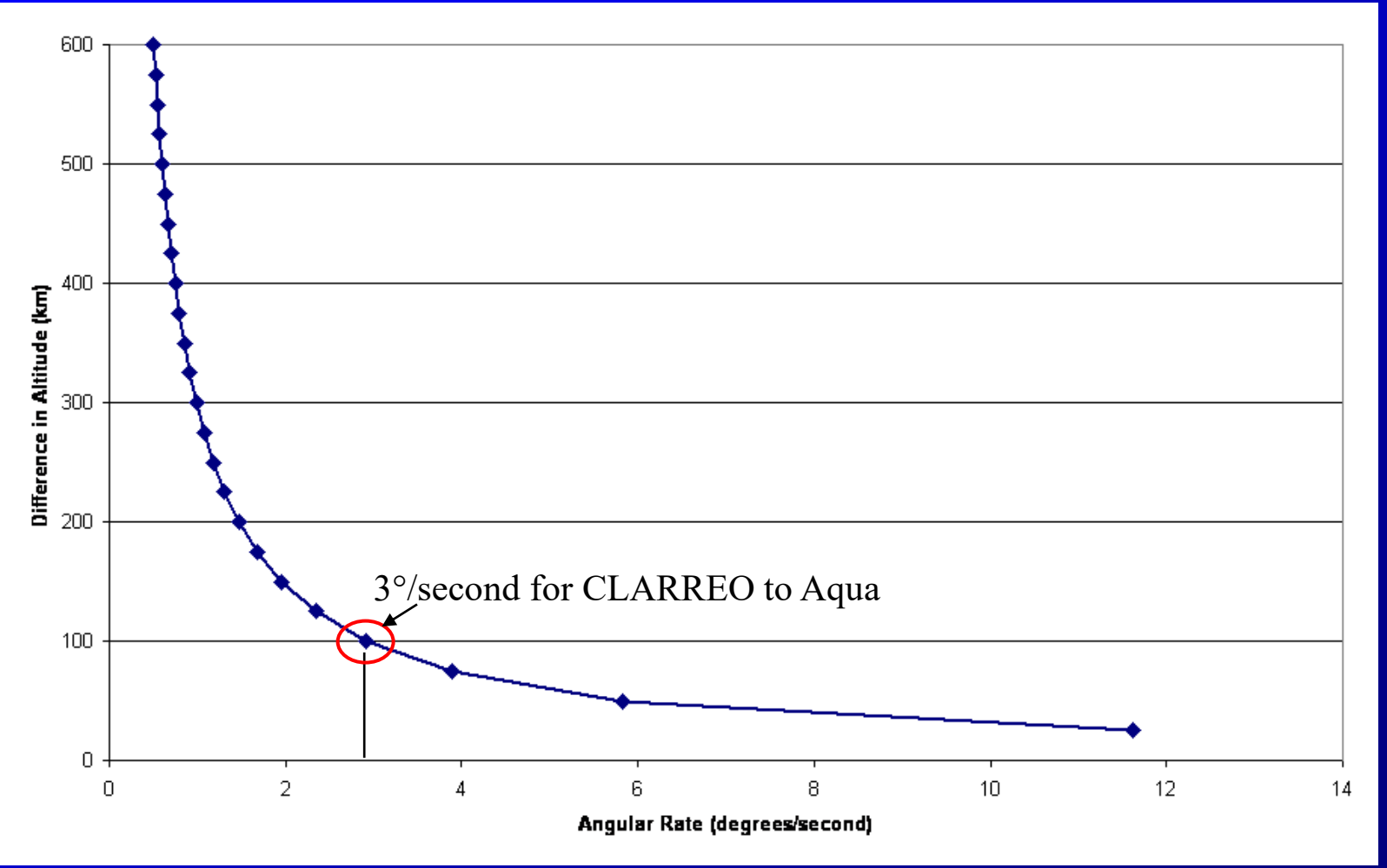
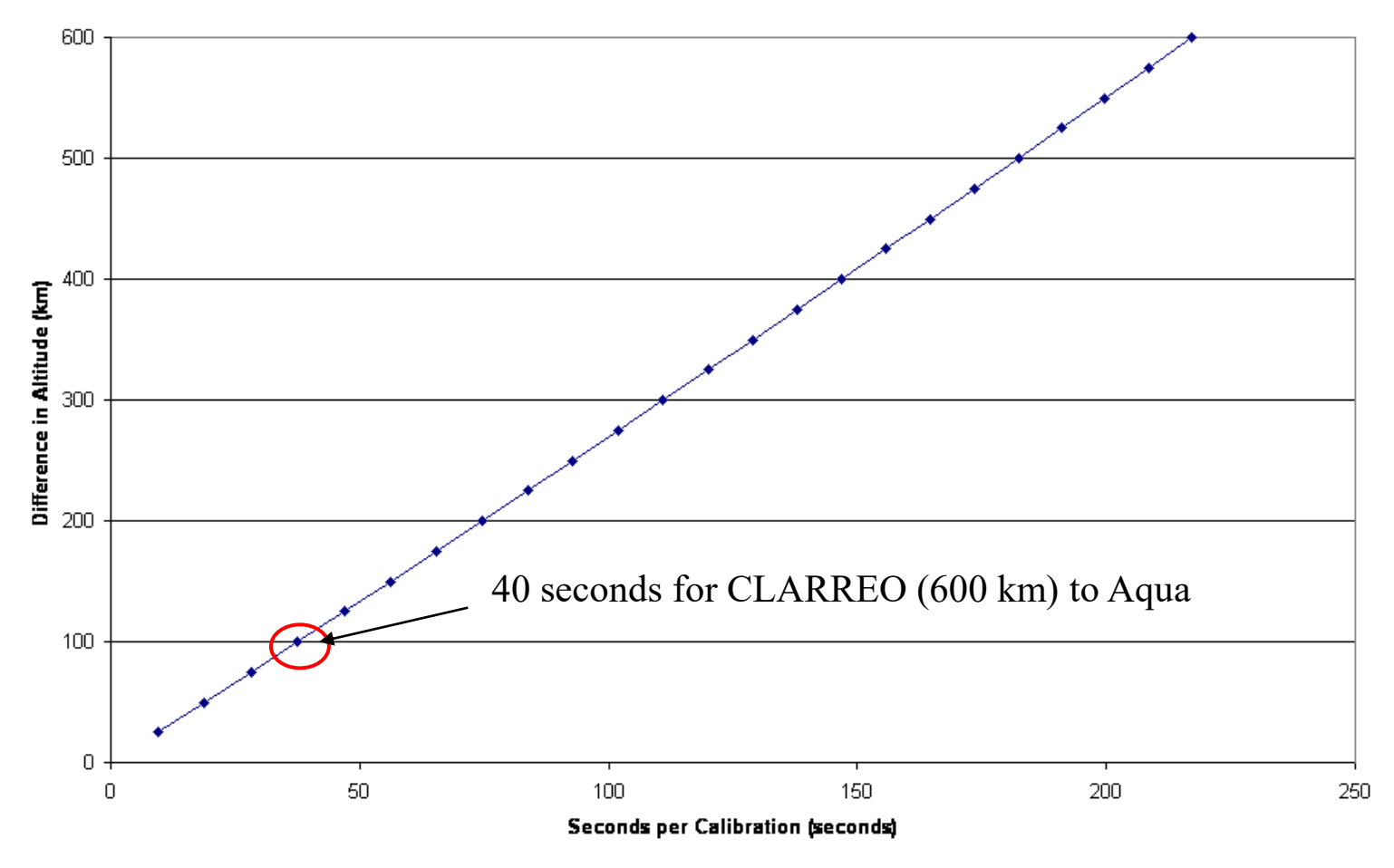


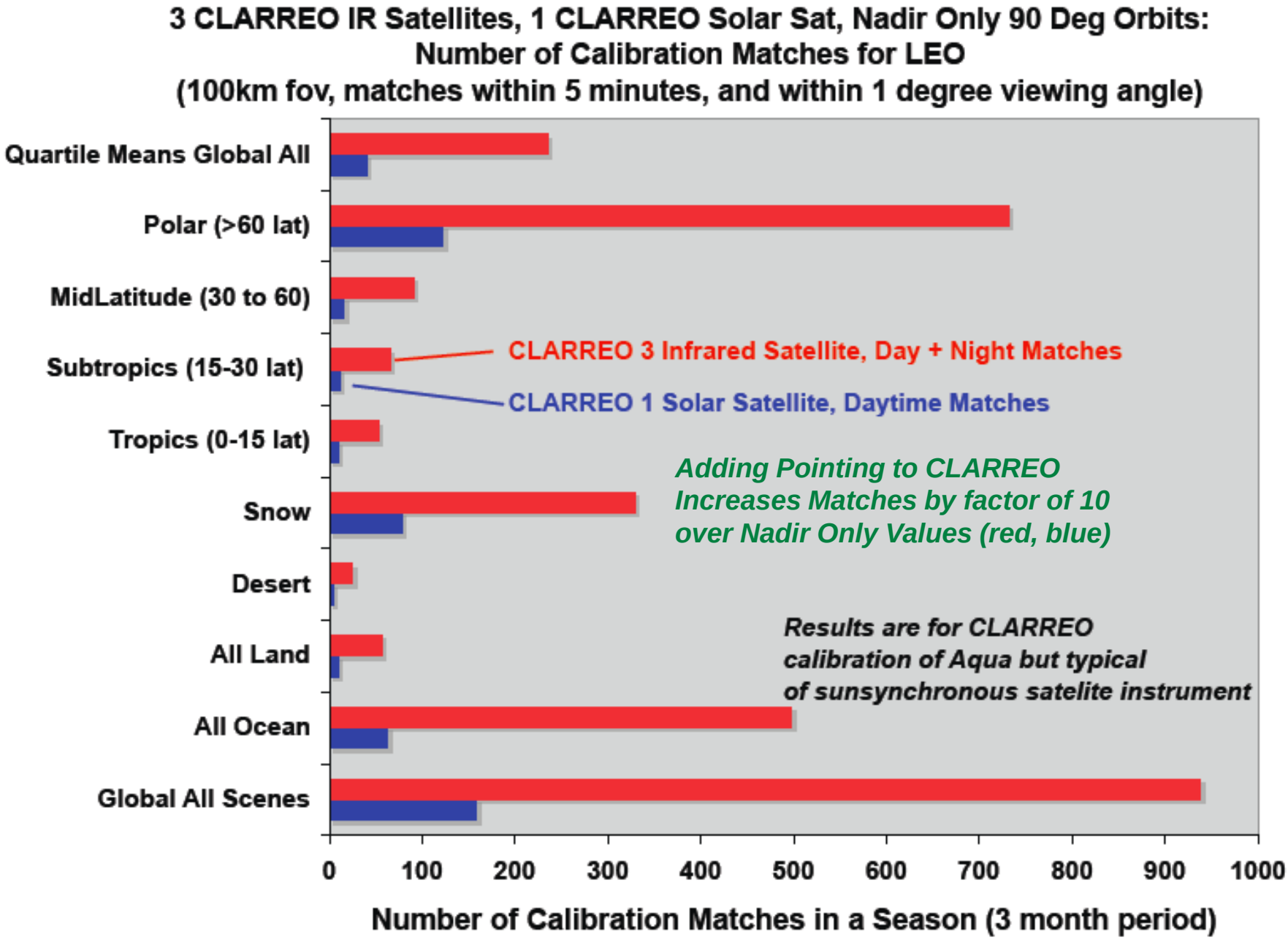
Conclusion: in 6 months can cross-calibrate across the entire Range of climate regimes: equator to pole, ocean to land. But is the sampling enough?

Maximum Slew Rate versus Altitude Difference



Minimum Calibration Duration versus Altitude Difference

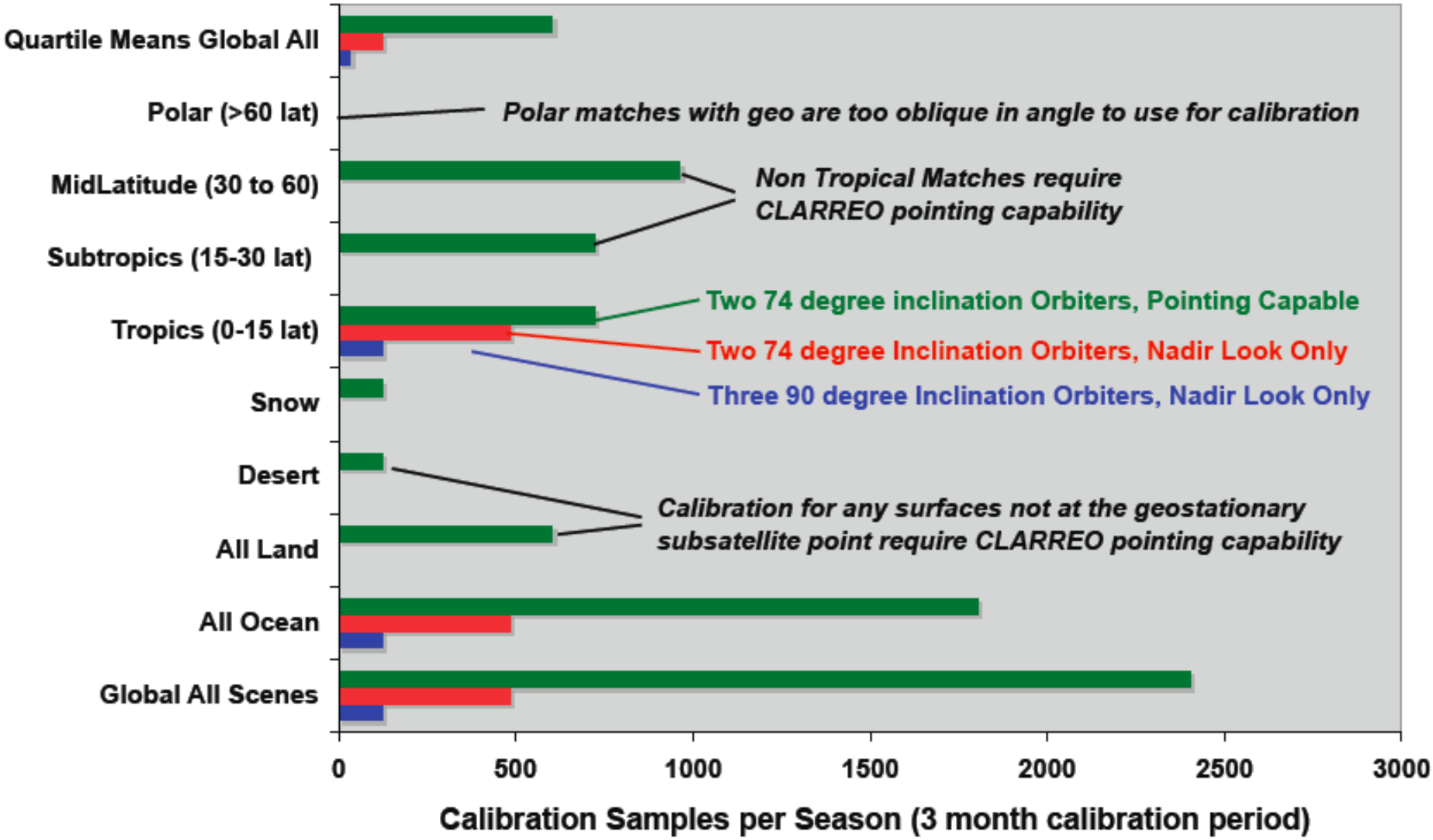




Conclusion: Solar Sampling Much Less: 1 satellite, day only

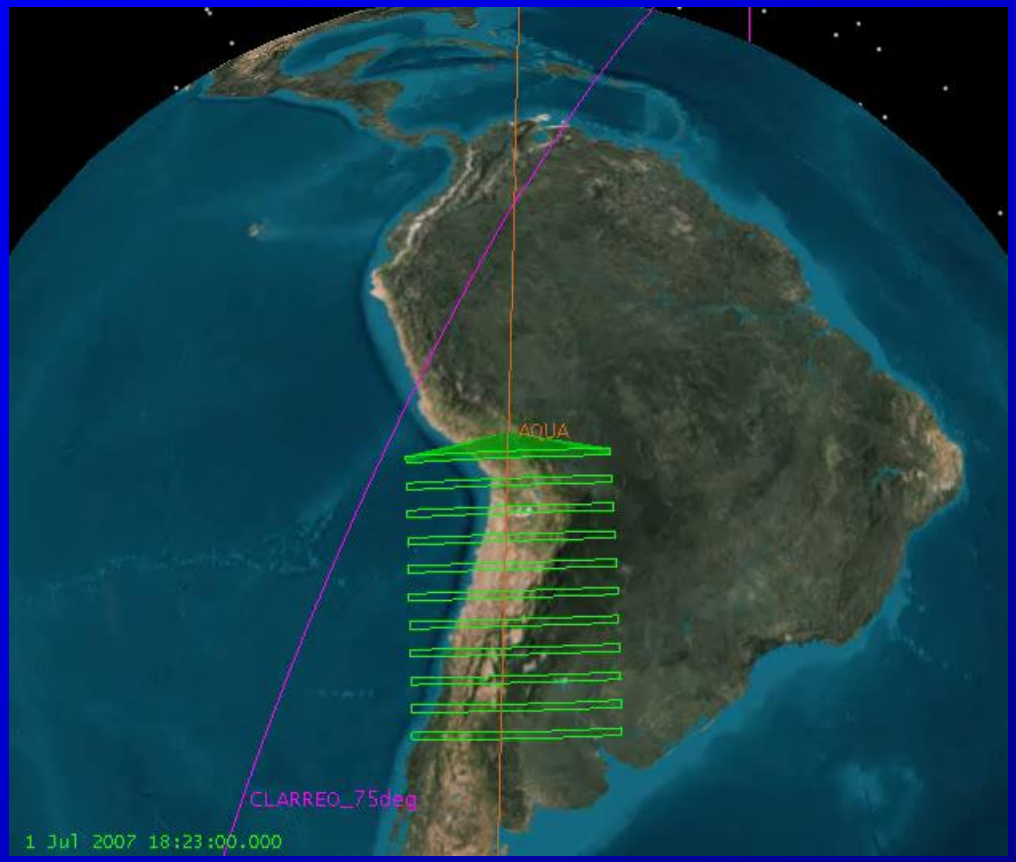
CLARREO Calibration of Geostationary Instruments: Samples Per Season

CLARREO 100km fov, geo match within 10 minutes and 4 degree viewing angle

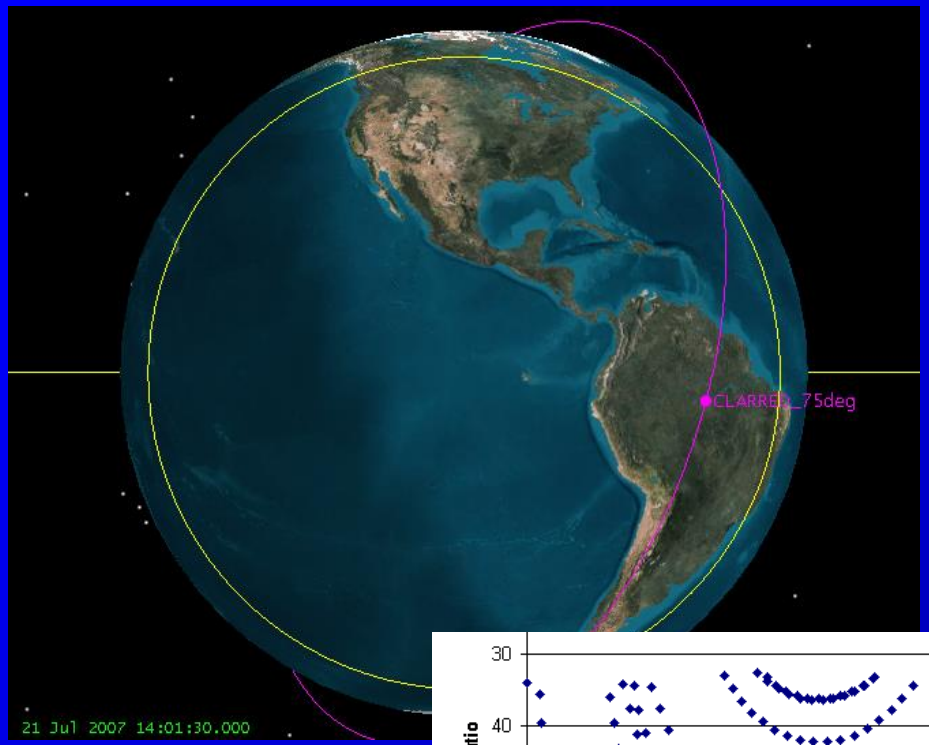


Conclusion: Pointing capability is critical to calibrate geostationary sensors at any position other than the sub-satellite equatorial point.

Orbit Plane Convergence Example



Geostationary Orbit Intercalibration



The maximum slew angular rate is less than 0.1 degree per second.

Precession rate is not a factor.

Pointing ability is required for