Orbit Opportunities for Innovative Cross-Sensor Validation: NPP* Over-flying the A-Train

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* NPP, the NPOESS Preparatory Project, was originally a risk reduction mission for the National Polar-orbiting Operational Environmental Satellite System (NPOESS). The NPOESS program was terminated in 2010. The civilian component continues on as the Joint Polar Satellite System (JPSS) and the military component continues on as the Defense Weather Satellite System (DWSS). NPP continues as a joint NOAA-NASA mission

The Orbits

NPP and the planned JPSS satellites fly at an altitude of approximately 824 km, allowing *full* global coverage in a single day for sensors with a large field of regard.

The A-Train missions operate at 705 km, which gives *near* daily global coverage in one day.

The Sensors

All NPP sensors have similar sensors on Aqua or Aura, & complementary sensors on other A-Train satellites

Type	Sensors	NPP Field of Regard	Aqua/ Aura FOR
Imager	VIIRS/MODIS	56	55
Ozone	OMPS/OMI	55	57
IR Sounder	CrIS/AIRS	48.3	49.5
Microwave Sounder	ATMS/AMSU-B	52.7	49.5
Earth Radiation Budget	CERES/CERES	56	55

The Opportunity

The difference in altitude (& therefore orbital period) means that the sensors can be compared over a wide range of differential viewing geometries as the satellites follow nearly identical ground tracks and having a common 16 day ground-track repeat cycle.

Approximately 30% of the time NPP & Aqua will be within ±15 minutes of each other and with relative scan angles between 0° & ±45°.

By comparing measurements of the same region at differing scan angles, we have the opportunity to assess:

- Response vs. scan angle variations
- Antenna beam patterns
- Algorithmic issues associated with atmospheric path length

NPP Orbit Chosen to Mimic Aqua Orbit Characteristics.

NPP

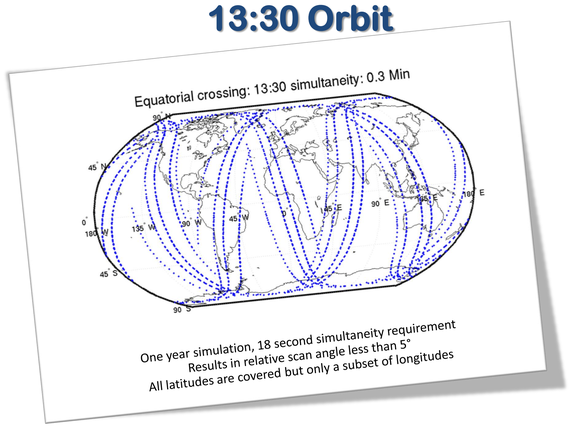
- Sun Synchronous
- 1330 Ascending Node
- 824 Km
  - 101.5 min orbit
- 16 day ground-track repeat
  - 227 revolutions

Aqua

- Sun Synchronous
- 1330 Ascending Node
- 705 Km
  - 98.9 min orbit
- 16 day ground-track repeat
  - 233 revolutions

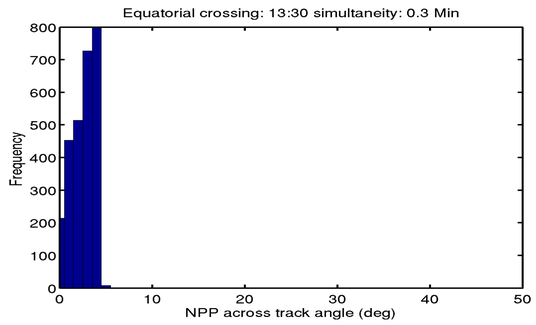
- Synodic Period (NPP directly over Aqua) = 2 days 16 hrs (2.667 days)
  - Synodic period is ~37.8 NPP orbits & ~38.8 Aqua orbits
  - Have a Simultaneous Nadir Overpass (SNO) every 2.667 days
  - SNO's occur at all latitudes & many longitudes over one year
  - Scan angle from Aqua to NPP nadir pixel ranges from 0 to ±5°

Location of SO's* with NPP & Aqua in 13:30 Orbit



* SO: Simultaneous Observation (one satellite viewing nadir)

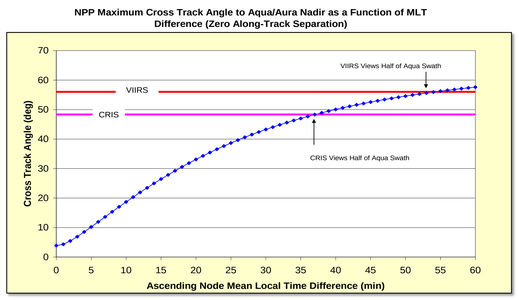
Variation of Relative Scan Angle with Identical Crossing Times



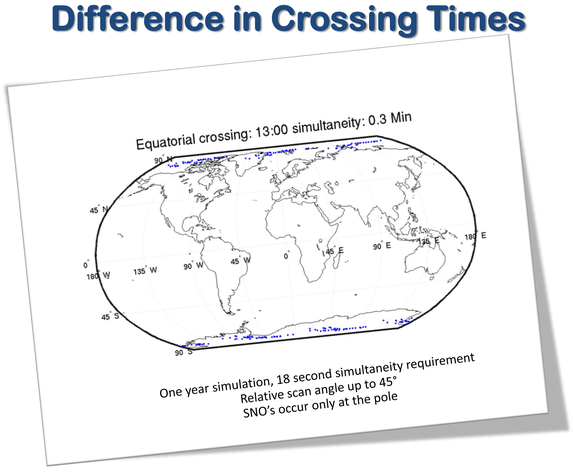
One year simulation, 18 second simultaneity requirement
Frequency count is based upon 1 data capture per minute

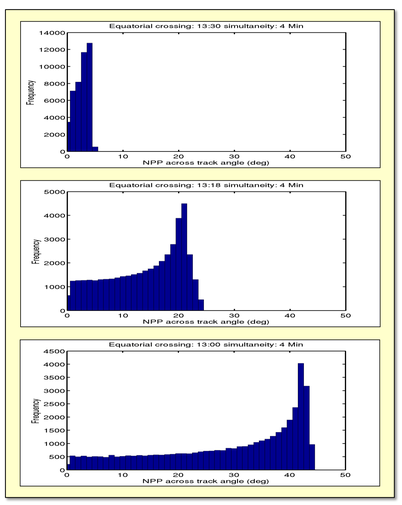
Tuning the Orbit

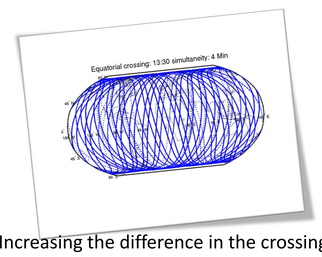
- Changing the ascending node time of NPP allows a wide range of interesting viewing geometries
- The greater the gap in crossing times, the larger the scan angle range
- At larger time differences, the true SNO's will occur only at higher latitudes



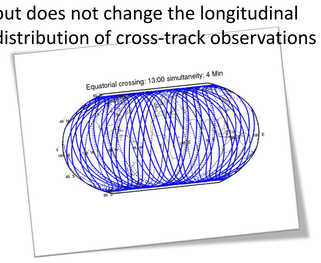
SNO's Move to the Poles with Larger Difference in Crossing Times



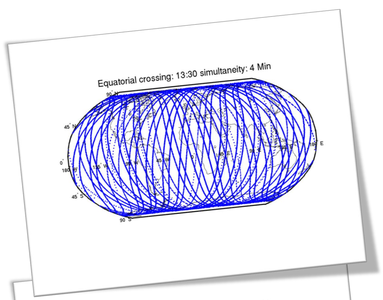


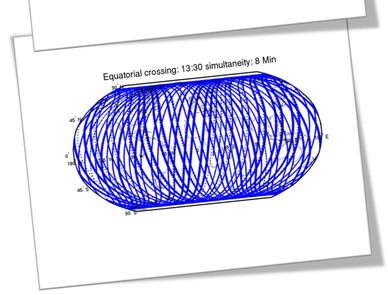


Increasing the difference in the crossing time yields a wider range in scan angles but does not change the longitudinal distribution of cross-track observations

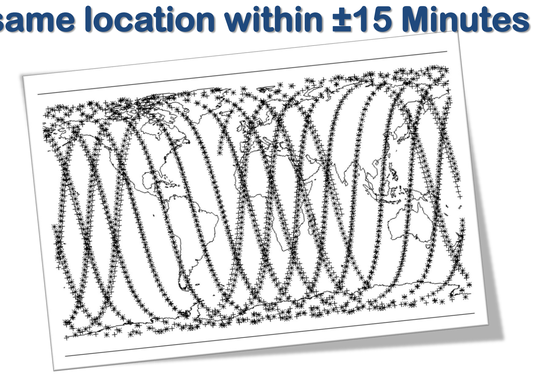


Relaxing the simultaneity requirement increases the number of "coincident" observations, but does not alter the longitudinal distribution



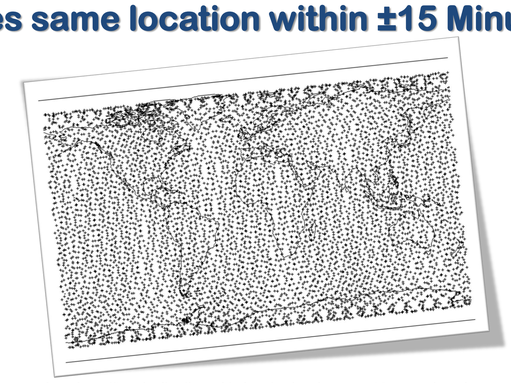


Location of NPP Nadir Pixel when Aqua sees same location within ±15 Minutes



These comparisons were made with slightly different orbital elements than previous charts, showing that the general patterns repeat, but they differ in the details.

Location of Aqua Nadir Pixel when NPP sees same location within ±15 Minutes



Aqua ground tracks uniformly distributed in longitude whereas NPP ground tracks are not. Results from resonances between synodic period & the orbital period of NPP.

Opportunities & Acknowledgements

- Details of the coincident observations are highly dependent on the orbital parameters
- Crossing times drift, requiring periodic orbital adjustments
  - Coordination among NPP, Aqua, Aura, operations is required
- More detailed orbit studies that explore the parameter space are needed
  - Trade off between strict simultaneity & scan angle differences
  - Optimize over ARM-CART or MOBY?
  - Cross-platform data products utilizing differing viewing geometry?
- We have benefited from discussions with Dr James Gleason (NASA/GSFC) who had the original orbit studies conducted by Richard McIntosh (a.i. Systems) & Dr Robert Wolfe (NASA/GSFC)