LEO Orbital Deployment of Sounders (MW and IR): Temporal Refresh and Reliability

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SAT Discussion 4/11/2022

LEO Formulation Activities

- LEO Formulation team is developing candidate architectures for JPSS Follow-On (LEO) Program. Currently, we're focused on disaggregated Microwave and Infrared Sounder platforms.
- We would like to poll science and users regarding expected need for:
  - Temporal refresh
  - Orbit reliability
- Answers to these questions affect numbers of instruments/platforms needed to meet revisit and data availability objectives at a constellation level.

About this segment of LEO

- Targeted Observations
  - Temperature and Moisture Sounding
  - Atmospheric Composition Measurements that overlap with IR-Sounding channels
- Delegated to other platforms
  - Microwave Imagery, Precipitation requirements (akin to AMSR)
  - Near-IR imagery (akin to VIIRS)

Preliminary Inputs

- LEO Formulation team received preliminary requirements from OSAAP specifying target update rate for LEO Sounder constellation

Attribute	Minimum	Midpoint	Maximum
Update Rate	6 hr	4 hr	1 hr

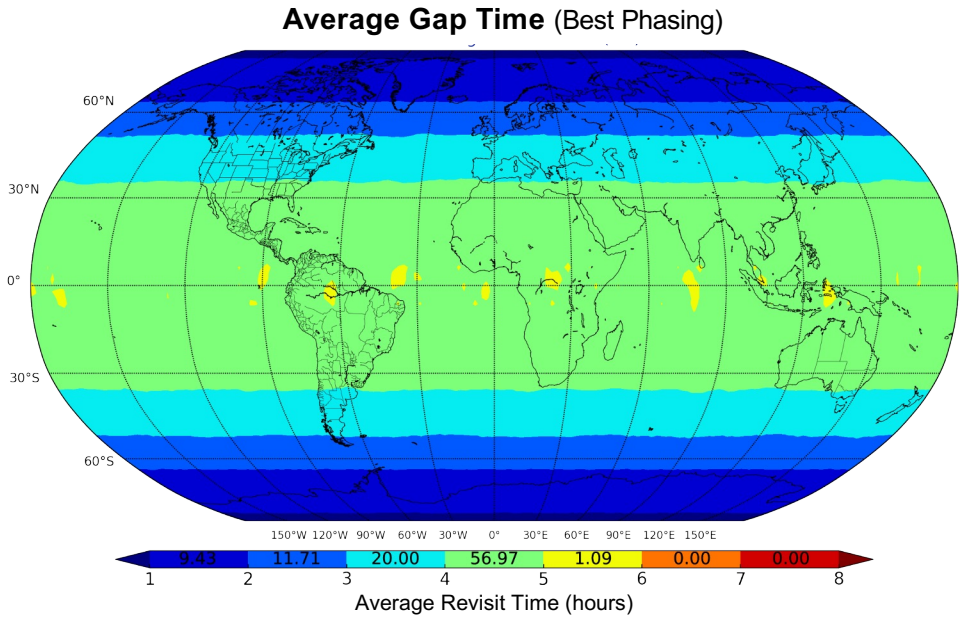
- Building on results of MW Workshop 2021, initial constellation is built on a 3-orbit backbone (0530, 0930, 1330 LTAN)
  - JPSS-like 833 km SSO orbits used for continuity
  - Backbone maintained for all other constellation analyses
- Orbital analyses conducted to determine expected quantity of platforms required to meet update rate goals for all candidate constellations

Initial Analyses

- Assessed 3-orbit backbone to establish a baseline for update rate
- Compared quantity of platforms vs. update rate.
  - Tested for variances is swath width (1500km – 3000km)
  - Compared sun-synchronous orbit (SSO) orbits to inclined orbits
- Metrics include:
  - Globally averaged average gap time
  - 95th Percentile average gap time
  - Maximum (worst case) gap time
- Notes:
  - In all cases, the 3-orbit backbone is maintained with platforms in SSO
  - Average gap time is the average taken across all latitude and longitude points

Globally-Averaged Average Gap Time

- Configuration
  - 3-Satellites with LTANS 0530, 0930, 1330, Swath 2200 km, Altitude 833km
  - Global Average = 3.9 hours (below the target update rate of 4 hours)
- Analysis
  - Sun-Synchronous orbits result in better coverage at poles
  - Tropical regions, 30ºN to 30ºS is consistently <u>above</u> the 4-hour mark



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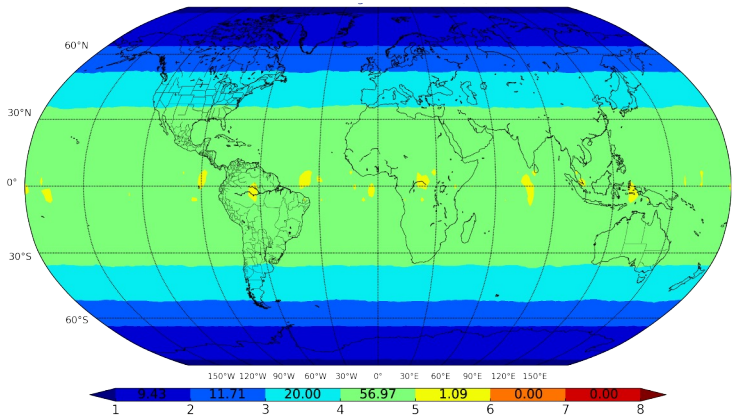
Baseline Constellation Performance

3 Satellites with LTANs of 1330, 0930, and 0530

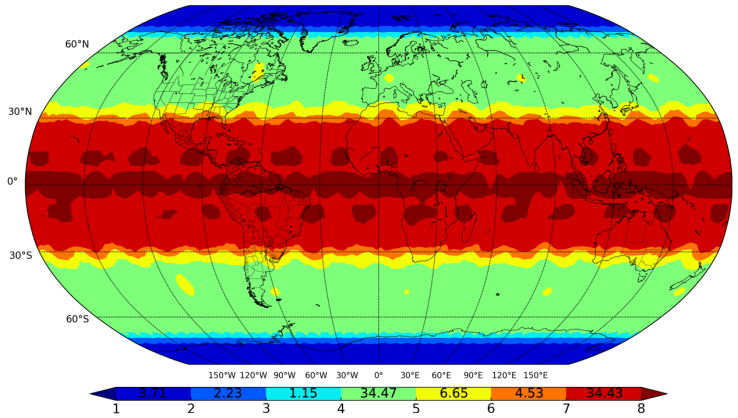
Metric	Global Average (hours)	Global Worst Case (hours)
Average gap time	3.9	5.1
95th percentile gap time	6.1	8.1
Maximum gap time	7.4	11.1

Average Gap Time (Best Phasing)



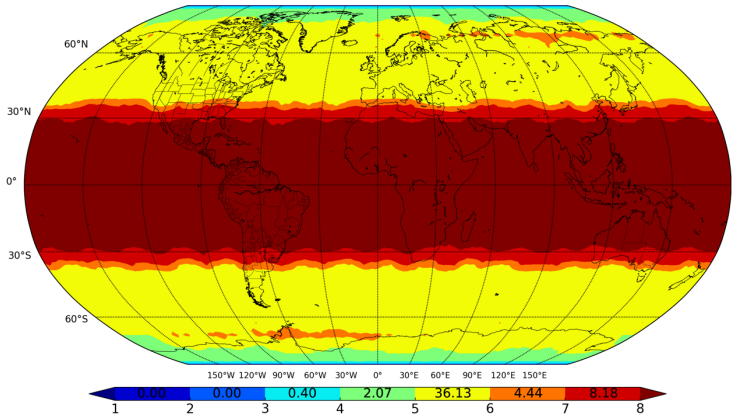
Average Revisit Time (hours)

95th Percentile Gap Time
(Best Phasing)



95th Percentile Revisit Time (hours)

Maximum Gap Time (Best Phasing)



Maximum Revisit Time (hours)

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Exploring Larger Constellations

Criteria	Minimum Platform Quantity
Average Gap Time Below 4 hours	3
95%-ile Gap Time Below 4 hours	5-6
Max Gap Time Below 4 hours	7-8
Average Gap Time Below 1 hour	11-12
95%-ile Gap Time Below 1 hour	15-16
Max Gap Time Below 1 hour	21-23

Assumes uniform swath

Beyond 3-backbone platforms, no restrictions on orbital solutions

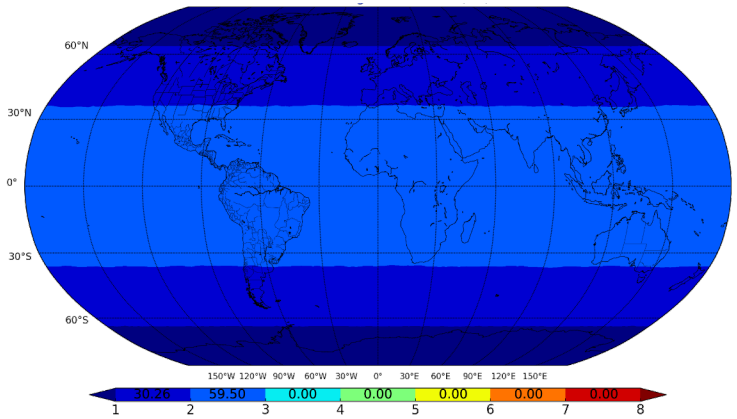
Note this platform quantity is for one type of platform. E.g., to achieve a 95%-ile gap time below 4 hours would require 6 Microwave Sounder platforms and 6 Infrared Sounder platforms.

Baseline +3 Constellation Performance

6 Satellites with LTANs of 1330, 0930, and 0530 (2 per orbit)

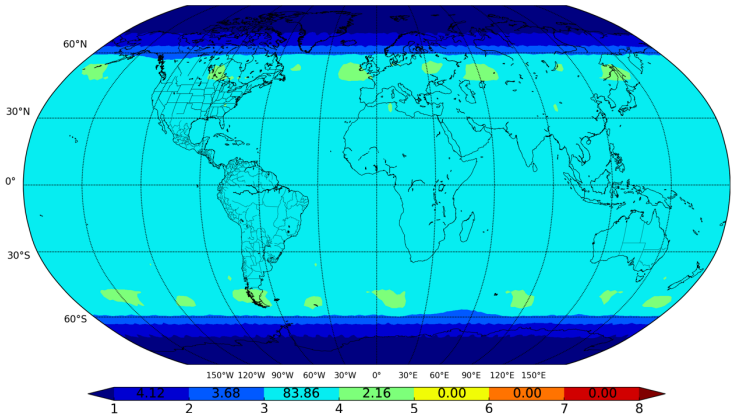
Metric	Global Average (hours)	Global Worst Case (hours)
Average gap time	1.9	2.5
95th percentile gap time	3.4	4.1
Maximum gap time	4.3	4.7

Average Gap Time (Best Phasing)



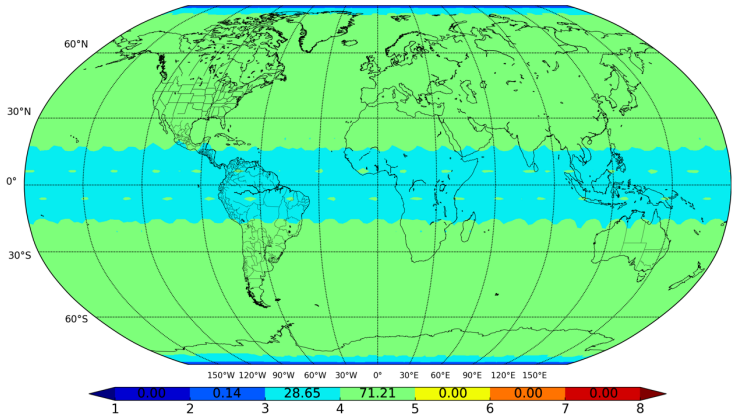
Average Revisit Time (hours)

95th Percentile Gap Time (Best Phasing)



95th Percentile Revisit Time (hours)

Maximum Gap Time (Best Phasing)



Maximum Revisit Time (hours)

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QUESTIONS REGARDING UPDATE RATE

- From a user perspective, what is the best definition of update rate?
  - Global Average Gap Time
  - 95%-ile Average Gap Time
  - Something else?
- Is the higher update rate at the equator acceptable to meet science/user needs?
- Is there a need to have some constraint on global/spatial uniformity of the data?
- What about the temporal distribution of the data during the day?