

Press Conference: Conclusions from Satellite Constellations 2 (SATCON2) Workshop

NSF's NOIRLab and American Astronomical Society

Friday, 16 July 2021, at 4:00 pm US EDT

Rick Fienberg, AAS

Introduction



Welcome & Overview of SATCON2

Connie Walker (NSF's NOIRLab)

Jeff Hall (Lowell Observatory)

Co-chairs, SATCON2 Scientific Organizing Committee

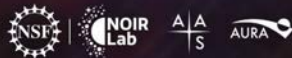
SATCON₂

Toward the Implementation
of Mitigations to Minimize
the Impact of Satellite
Constellations on Astronomy

noirlab.edu/satcon2

Co-chairs:

Jeffrey Hall (Lowell Observatory)
Constance Walker (NSF's NOIRLab)



SATCON₂ is funded by the NSF and hosted
by the NSF's NOIRLab and the AAS

The SATCON2 Workshop

- Why SATCON2?
- The objectives
- Thank yous



At the heart of the SATCON2 workshop

- Four working groups
- Six working group chairs and 90 working group members
- Worked ~2 months before the workshop
- Over 550 registrants
- 8.5 hrs of presentations (w/ Q&A); 6 hrs of discussion/questions
- Q&A, discussion and feedback from attendees → report
- Final report in ~2 months + a final press briefing
- Future: SatHub + plans for a center

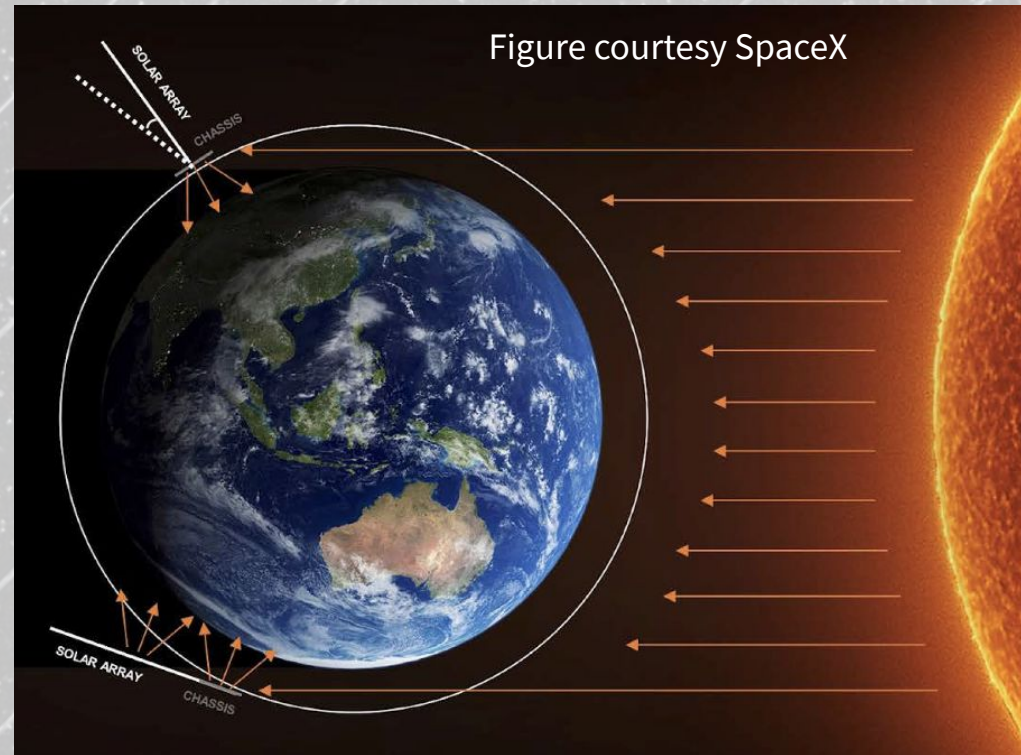
Observations Working Group

Meredith Rawls (University of Washington)



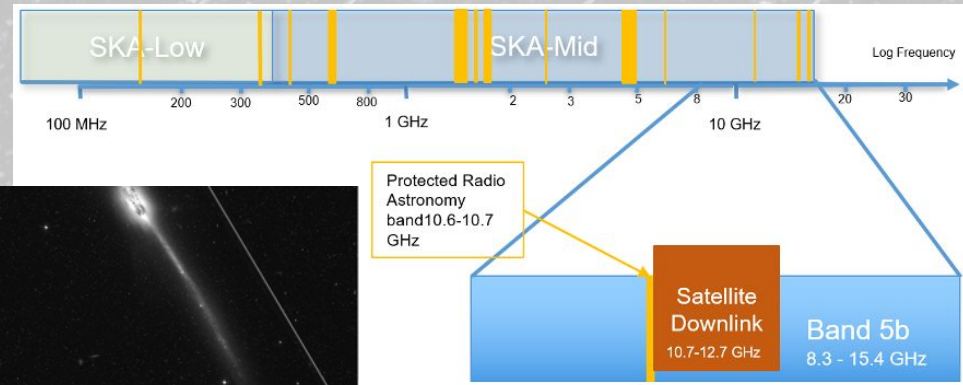
Low-Earth Orbit (LEO) satellites reflect sunlight and beam information to Earth in radio waves, affecting observers

- SATCON1 (mid-2020) gave ten recommendations to mitigate impacts on optical/NIR astronomy
- SATCON1 concluded no combination of mitigations can fully avoid all impacts
- SATCON2 Observations WG is addressing how to best implement three of the SATCON1 recommendations



The charge of the Observations WG is to make a plan to implement SATCON1 Recommendations 8–10

- **Rec 8:** Coordinating observations of satellite constellations
- **Recs 9 & 10:** Requirements for operators sharing data
- Our WG is international and includes satellite operators, educators, astronomers who use ground- & space-based observations, entrepreneurs, and experts at many wavelengths including radio



Figures: Tyson et al. 2020; Kruk et al. submitted; courtesy Mike Peel



SatHub: a one-stop shop for training, outreach, and collection & analysis of LEO satellite observations

- Coordinated observation-focused hub enabling astronomers, community members, and operators to work together
- Primary goal: inform and enable timely LEO satellite observing
- Secondary goal: host software, tutorials, ephemerides, images+
 - Software (see Algorithms WG!) with documentation and tutorials
 - Instructions for specific observer setups, including unaided eye
 - Lesson plans and citizen science projects for educators
 - Connections to queryable affected data products (e.g., Trailblazer)
- Funding model TBD



Standard requirements for present and future LEO satellite operators to aid all night sky observers

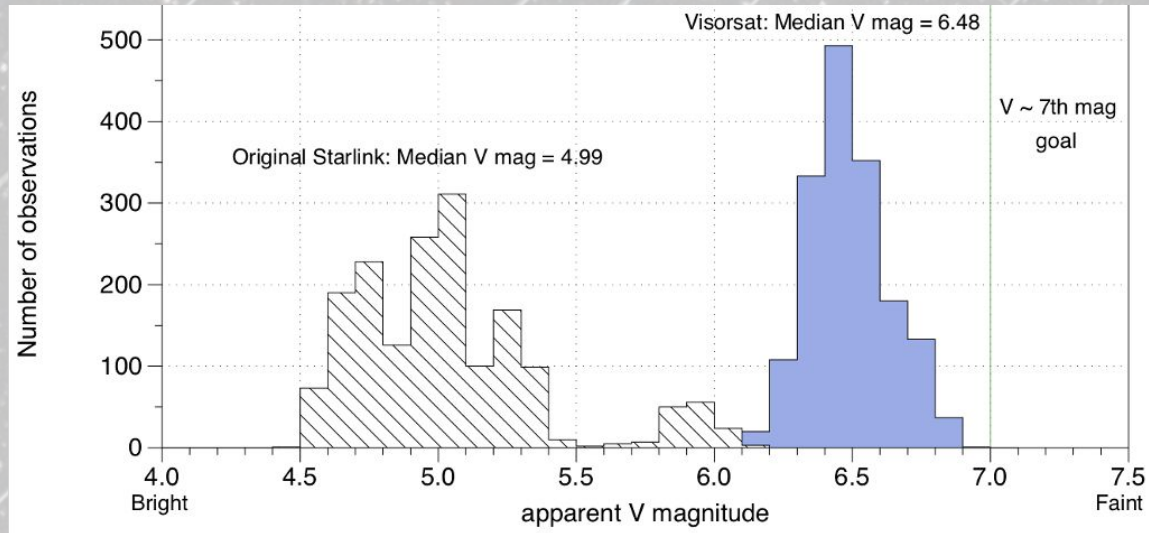
1. Provide error bars on two-line elements (TLEs), or adopt the Celestrak-proposed format with covariances (**error bars**)
2. Provide ephemerides — including error bars — so all observers can learn when satellites will pass through a viewing window
3. Provide updates **at least every 8 hours or immediately following maneuvers**, whichever comes first
4. Contribute to funding a publicly accessible third-party website (SatHub) to serve these data
5. Share beaming strategy information to aid **radio astronomy**



Figure: Jeremy Tregloan-Reed

Fast pace requires observer–operator dialogs

- Key design needs remain low orbits (< 600 km) and darkening (> 7th V mag), but as we study broader impacts, **these may evolve**
- Many aspects of SatHub will be useful for industry, and we hope these will **attract funding from satellite operators**



MMT-9 observations:
VisorSat 4x fainter than
original Starlink

Figure courtesy Pat Seitzer
(U. Michigan)



Algorithms Working Group

Jonathan McDowell (Center for Astrophysics | Harvard & Smithsonian)

Rob Seaman (Lunar and Planetary Laboratory)

Draft findings and recommendations:

1. We re-emphasize SATCON1 recommendations 1 to 3

New tools are critical to *partially* mitigate impacts on astronomy:

- **Will my observation be affected?** *PassPredict*
- *PassPredict* and simulation software will also enable quantification of the predicted degradation of science data in a particular situation
- **Can I salvage useful science from affected data?** *TrailFix*
- Astronomers also need a large **simulation and modeling effort** to assess impacts of current and future constellations on both ground-based and space-based observations

2. The working group has carried out a study of the **algorithms and interfaces needed** for these software tasks; this will be included in the report .

Draft findings and recommendations:

3. **Some software already exists** to help with parts of these tasks. Much is specialized to particular instruments, **needing to be generalized.**
4. There are gaps where software does not exist and we will need a significant software development effort. Project management, documentation, user support, and maintenance are needed, requiring **substantial resources and funding.** Educational materials (e.g., lesson plans) are also desirable.
5. To support the diverse community of night sky users, **software must be provided in several forms:** libraries (integrated with core astronomy interfaces like *AstroPy*), applications for data pipelines, and web services.

Draft findings and recommendations:

6. It is urgent to develop a set of example datasets covering a wide range of instrument and satellite-trail properties which can serve as a **standard test suite** for the development of the software and as benchmark comparisons for archival and new sources of data.
7. We endorse the **SatHub concept** developed by the Observations WG. SatHub can provide a natural home for curated software, satellite catalogs and ephemeris access, and test data including their documentation and distribution. This will need continuing professional development, support and maintenance.
8. Constellations are being launched now, but software takes time to develop. **Resources should be made available as soon as possible.**

Draft findings and recommendations:

9. If the satellite constellations are deployed as planned, we find that **no software solution** can fully mitigate the impact on astronomical observations and on spectroscopic observations in particular. It is likely that the community will be **forced to make a massive investment in hardware** such as auxiliary spotting cameras or other solutions at all ground-based observatories.

Community Engagement Working Group

Aparna Venkatesan (University of San Francisco)

James Lowenthal (Smith College)

Community Engagement WG (21 members): amateur astronomers, members of sovereign / Indigenous / First Nations groups, dark-sky advocates, planetarium professionals, environmental/ecological non-governmental organizations.

Scores of interviews, surveys, conversations, outreach, meetings.

The sky belongs to everyone.
Space is a global commons.
All people are impacted by changes in the sky.
The sky is part of the environment.
Ecosystems depend on the night sky and on each other.

We invite industry, leadership, space actors and all present here today to co-create a *shared, ethical, sustainable approach to space*.

Duty to consult: ask impacted groups, including sovereign nations of AI/AN and global Indigenous communities; fully consider their concerns; sovereignty, transparency, written agreements; jurisdiction of treaties in space.

Connect with existing groups and networks to engage, listen, share, act: affected constituencies; government agencies; cultural, grassroots, and political leaders.
“Raise all voices.”

Engage with satellite industry to build relationships and find common ground.

Recognize the economic, legal, political structures that affect tech choices.

Learn from the past: telephones, trains/planes/cars, fossil fuels, internet, ozone hole, climate change...

“Science vs. Internet” is a **false choice**. Broadband is crucial, but don’t assume unmitigated satcons are the only way.

Policy Working Group

Richard Green (University of Arizona)

Policy Working Group Approach

- Explore and assess paths to implementation of SATCON1 recommendations, particularly those relevant to industry.
- The Policy Working Group consists of 30 participants with expertise in astronomy, law and policy, engineering and satellite industry operations.
- We divided the effort into three subgroups:
 - Industry Public Policy
 - Domestic US Policy and Law
 - International Policy
- The Industry Core subgroup consists of participants from SpaceX, OneWeb & Airbus-OneWeb, Amazon/Kuiper, Telesat, AST&Science, and the Satellite Industry Association.
- Their report today of these positive discussions does not imply any corporate endorsement (yet!).
- Optimism of starting a long-term engagement between industry and the dark skies community for satellite companies wanting to be good stewards and responsible actors in space.

INDUSTRY PUBLIC POLICY SUB-WORKING GROUP SUMMARY

- Encourage operators to consider effects on astronomy early in constellation development
 - Preferable to test/model prior to production vs observing/mitigating after launch
- Pre-launch:
 - Build accurate, cost effective and readily available testing and modeling during early stages of constellation design
 - Share mitigation approaches and lessons learned
- Post-launch:
 - Routinize observational data and expand transparency from satellite location data
- Best practices, guidelines should focus on clear outcomes and performance based metrics, not proscriptive approaches
 - Foster ongoing innovation in mitigation and voluntary measures

US Domestic Sub-Working Group Conclusions

1. The reality: there currently exists no national or international regulation of on-orbit activities of any kind beyond the Outer Space Treaty restrictions on weapons and the general concepts of due regard, harmful contamination and harmful interference.
2. In considering effect of satellite constellations, need to aggregate impact and apply such aggregation in an equitable manner.

US Domestic Sub-Working Group Conclusions

Nevertheless, considering:

- The growing understanding of the need to regulate light pollution whether for aesthetic, scientific or cultural reasons at all levels of government;
- Importance of astronomy to planetary defense;
- The model of space traffic management and radio quiet zones; and
- The responsibilities imposed by international law,

The obligation to reduce detrimental effects of satellite constellations on astronomy should be a condition of licensing. But the actual implementation of such a condition must capture well-defined standards and requirements, be driven by practice and research, not be overly-prescriptive and should, to the extent possible, go hand-in-hand with international efforts.

International Policy Considerations for Addressing Pollution from Orbital Infrastructure: Impacts on Astronomy and the Environment

WG Focus:

Identify how international obligations are implemented by the US regulatory and policy mechanisms, with specific regard to international space law and international environmental law, identify gaps, and suggest where the implementations could be strengthened.

Conclusions and emerging policy gaps

- Lack of clear protections for the orbital environment and gaps exist for on-orbit impact assessments, with direct impacts on astronomical observations
- The effects of satellites on the human and outer space environment cannot be considered in isolation. A cumulative analysis of satellite influence needs to be performed.
- Critical need for discussion in multilateral fora to increase actions at the international and national levels for the reduction of environmental impacts and interference with astronomy.

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And now... Q&A