



Press Briefing

IAU Centre for the Protection of the Dark and Quiet Sky from Satellite Constellation Interference

Thursday, February 3, 2022 at 18 UT

Introductory Remarks

Debra Elmegreen (*IAU President / Vassar College*)

The International Astronomical Union Centre

Piero Benvenuti (*University of Padova / IAU Centre Director*)

The IAU action lines

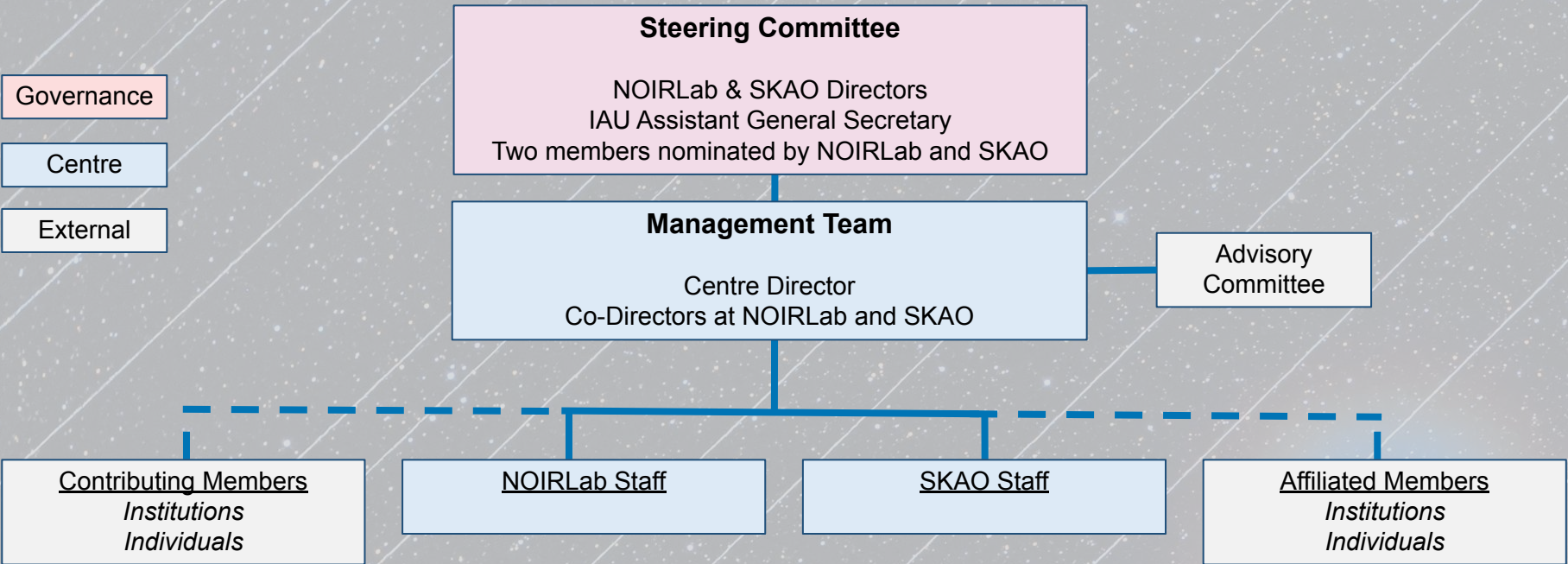
- The International Astronomical Union (IAU) represents more than **12,000 professional astronomers** from about 90 countries
- The IAU promotes and safeguards astronomy in all its aspects
- The IAU adopted **two lines of action** for the protection of the dark and quiet skies from satellite constellations interference:
 - Seeking consensus on regulatory guidelines by its Observer status in the UN COPUOS and other International entities (ITU, UNESCO, ICS,...)
 - Coordinating the community and stakeholders efforts in the development and implementation of mitigating measures
- The latter action led to the **Call for the IAU Centre**
- The proposal by NOIRLab and SKAO has been accepted by the IAU — **the Memorandum of Understanding** has just been signed.

A Pathway Forward: IAU Centre for the Protection of the Dark and Quiet Sky from Satellite Constellation Interference

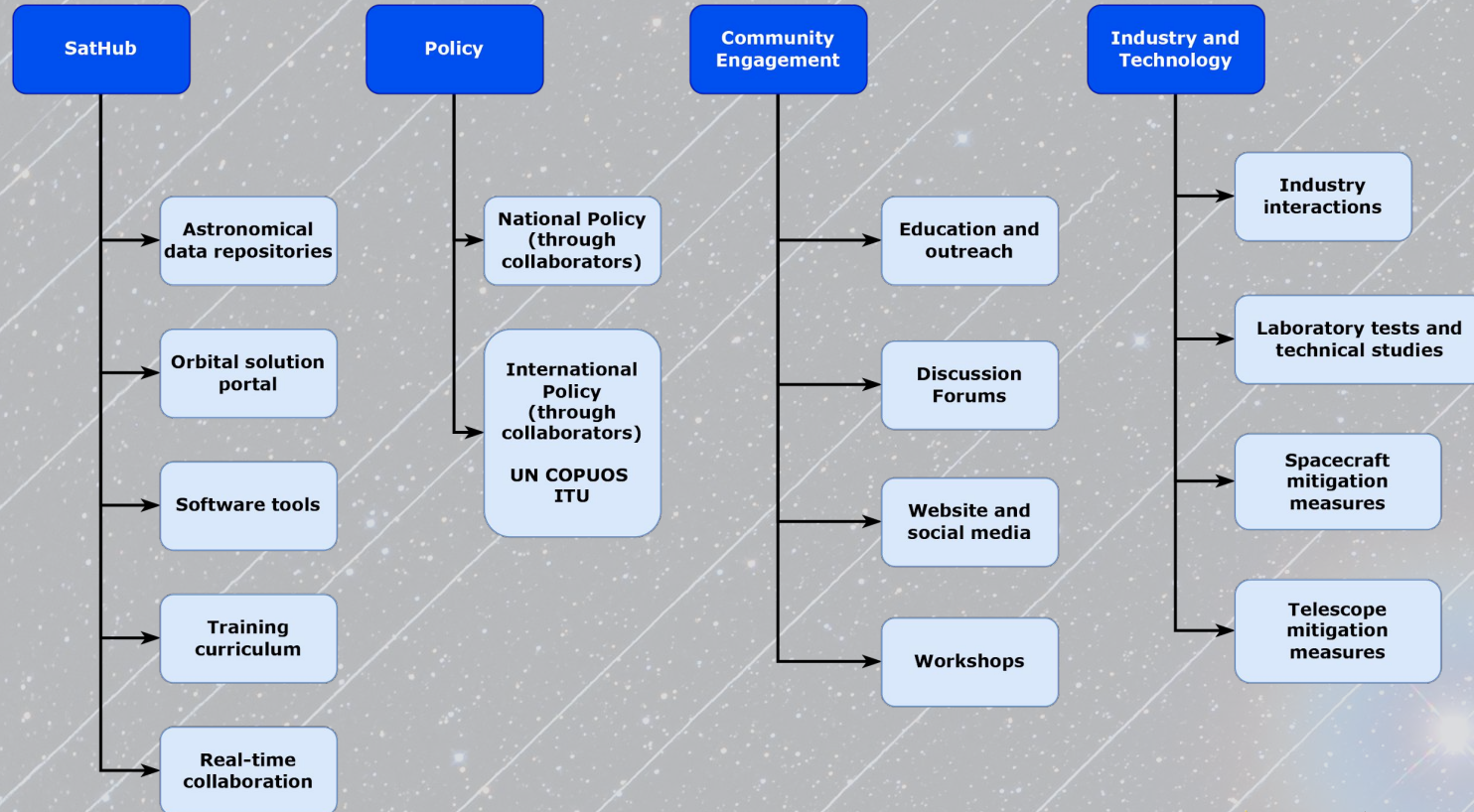
Mission

- The Centre will **coordinate efforts & unify voices** of the global astronomical community
- The Centre will bring together astronomers, industry, policy experts and the wider community and **act as a bridge between all stakeholders**
- The Centre will **produce and disseminate information and resources**
- The Centre will **continue research** on the satellite constellation issues to arrive at feasible and implementable solutions in the areas of:
 - A hub for observations, software, etc. (SatHub)
 - Policy
 - Industry and Technology
 - Community Engagement

Centre Organization

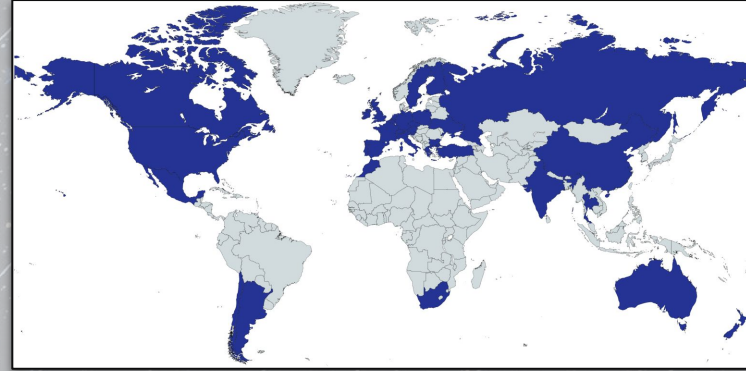


Organization Chart for the four Hubs



Planning ahead

- The Centre **starts operating** on April 1st, 2022
- The Centre will coordinate the involvement of **two groups of members**:
 - Contributing members (53 institutions, 31 with resources to offer)
 - Affiliated members



Nations with contributors or affiliated members

- From mid February to the end of March 2022, the Centre will hold a series of **“listening” sessions** online with potential contributing and affiliated members
- The first Centre **Working Plan** will be presented to the next IAU Executive Committee Meeting (April 2022)

Overview

Connie Walker (*NSF's NOIRLab/ IAU Centre Co-Director*)
and
Federico Di Vruno (*SKA Observatory/ IAU Centre Co-Director*)



Addressing the impact of satellite constellations on astronomy

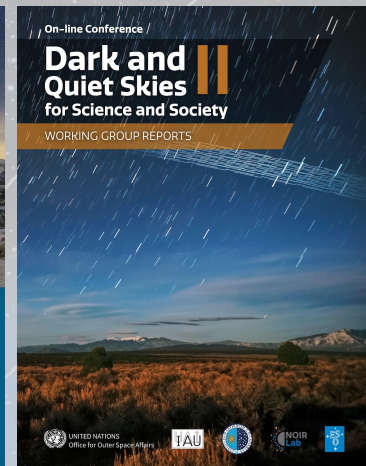
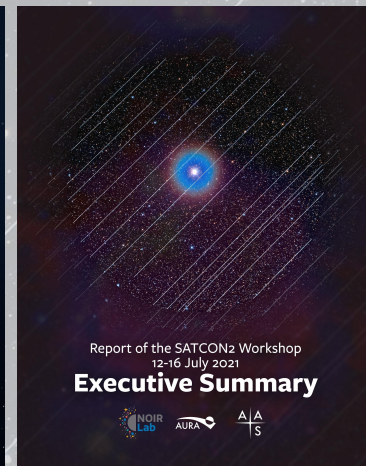
2019: A satellite constellation of 60 Starlinks launches in May

2020: Identify the issues; formulate recommendations for mitigation:
[SATCON1](#), [Dark & Quiet Skies I](#)

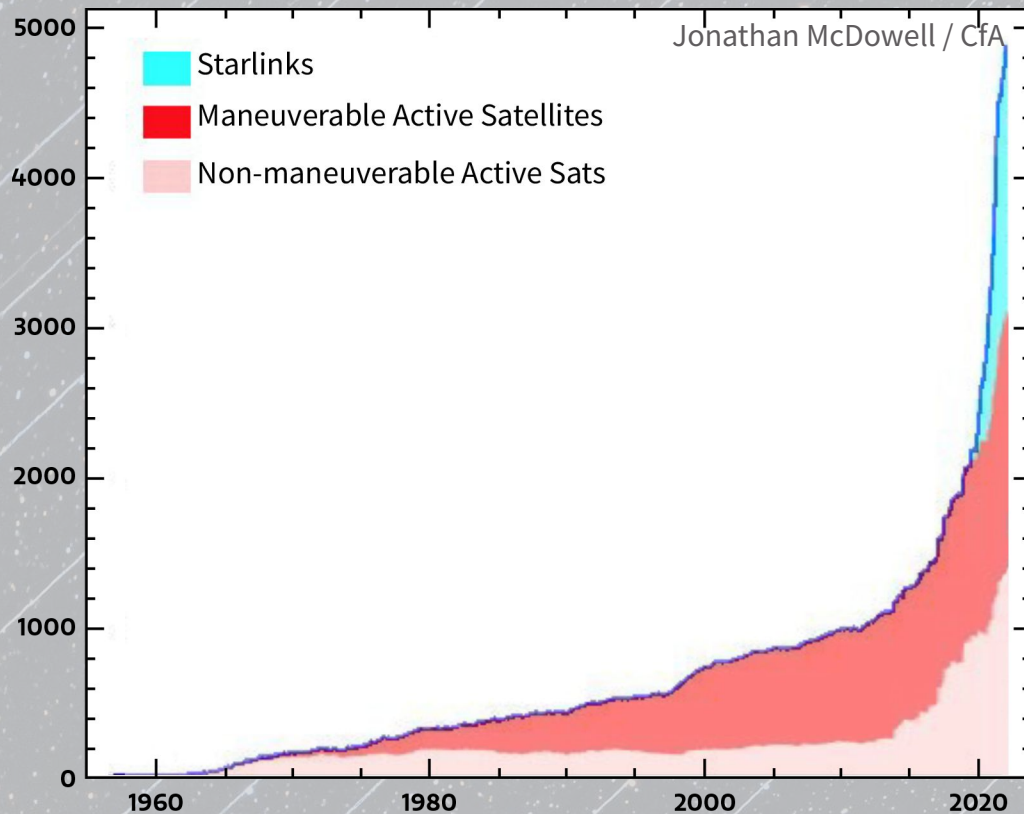
2021: Identify the pathways to implement Recommendations:
[SATCON2](#), [Dark & Quiet Skies II](#)

2022: Take the pathways to implement recommendations

IAU Centre on the Protection of the Dark & Quiet Sky from Satellite Constellation Interference



Number of Active Satellites (1957–2022)



Active satellites

2019 May 1: ~2,200

2022 Jan 1: ~5,000

Active + inactive satellites

~8,000

Trackable space junk

~~~38,000~~ (~41,000!)

## Small (1-10 cm) debris

~600,000



# Threats to optical/IR astronomy from satellite constellations

## Number

Hundreds of thousands proposed in FCC & ITU filings

## Brightness

V ~ +3 to +4 in parking orbits, +6.5 to +9 on station (smaller numbers = brighter)

## “Wild West” or “Far West”

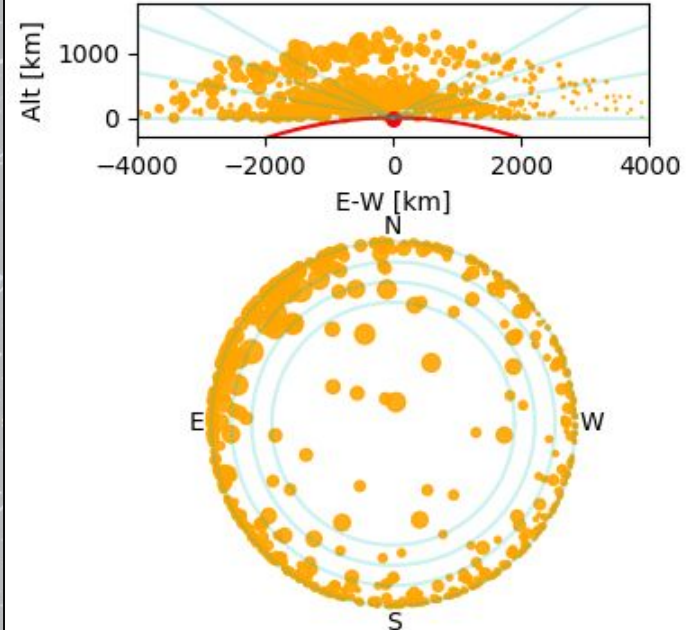
No protection for optical astronomy; limited protections for radio.

## Diffuse sky brightening

Scattering of reflected sunlight from satellite debris (<10cm)

### CHILE - SUMMER

Observatory latitude:  $-30.0^\circ$   
Constellation: Starlink Original 2019  
Sun: HA =  $51.0^\circ$   $\delta = -23.0^\circ$   
Sun elevation =  $44.2^\circ$   
Local Time: 15:24:00



# Threats to radio astronomy from satellite constellations

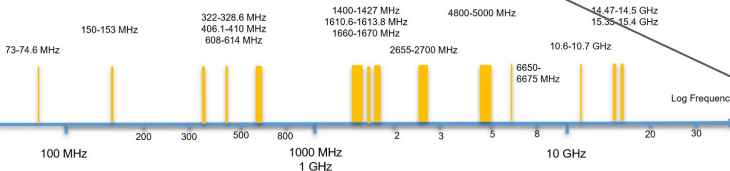
RQZ frequencies

South Africa: 100 MHz – 25.5 GHz  
Australia: 70 MHz – 25.25 GHz

SKA Frequencies

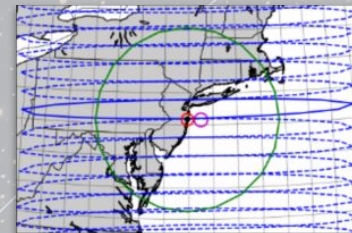


Current ITU-R  
RAS Allocations  
< 30 GHz



Radio Astronomy band  
10.6-10.7 GHz

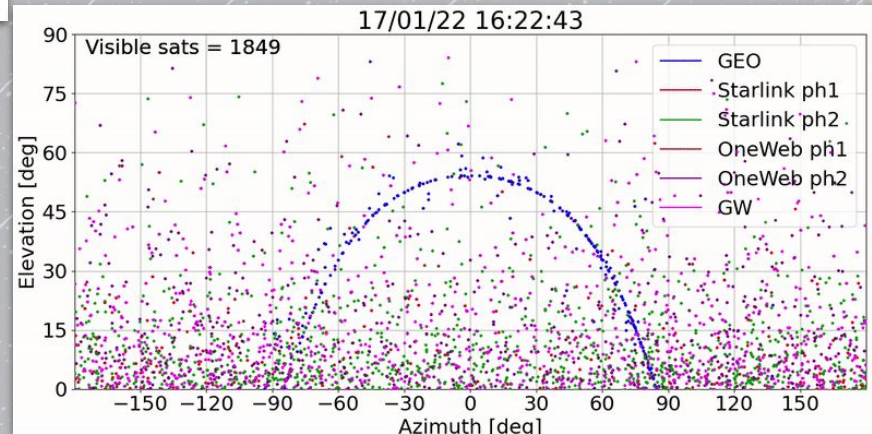
Satellite  
Downlink Band 5b  
10.7-12.7 GHz 8.3 - 15.4 GHz



SpaceX OneWeb Telesat (max) Telesat (min.) Satellite position

Satellite beam footprints. Credit: del Portillo et al.

- Need protected bands + wideband observations
- Radio Quiet Zones can't influence satellites
- Can see all satellites above the horizon
- Radio noise can also interfere
- Footprints of satellites can be very large





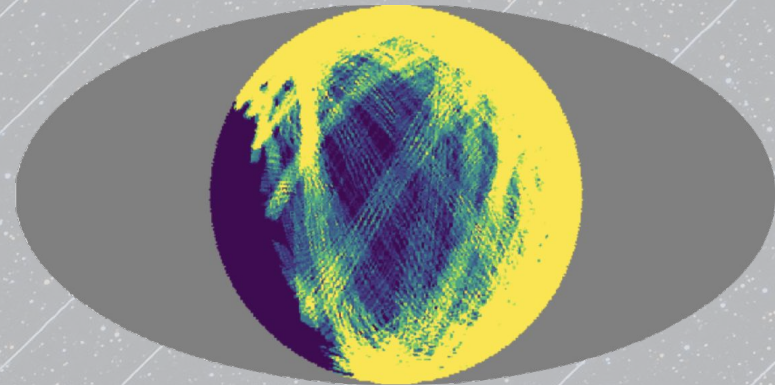
# Impact Assessment on the Science

## Radio Astronomy

- Cosmic Microwave Background experiments using single antennas / total power detectors
- Molecular gas emissions redshifted into satellite downlink frequencies
- High-Mass Star Formation regions (12.2 GHz maser)

## Optical/Infrared Astronomy

- **Low-elevation (twilight) studies:** Potentially Hazardous Asteroid missions will have fewer discoveries and orbit determinations
- Observatories with **wide fields of view** and **sensitive detectors** will be severely impacted



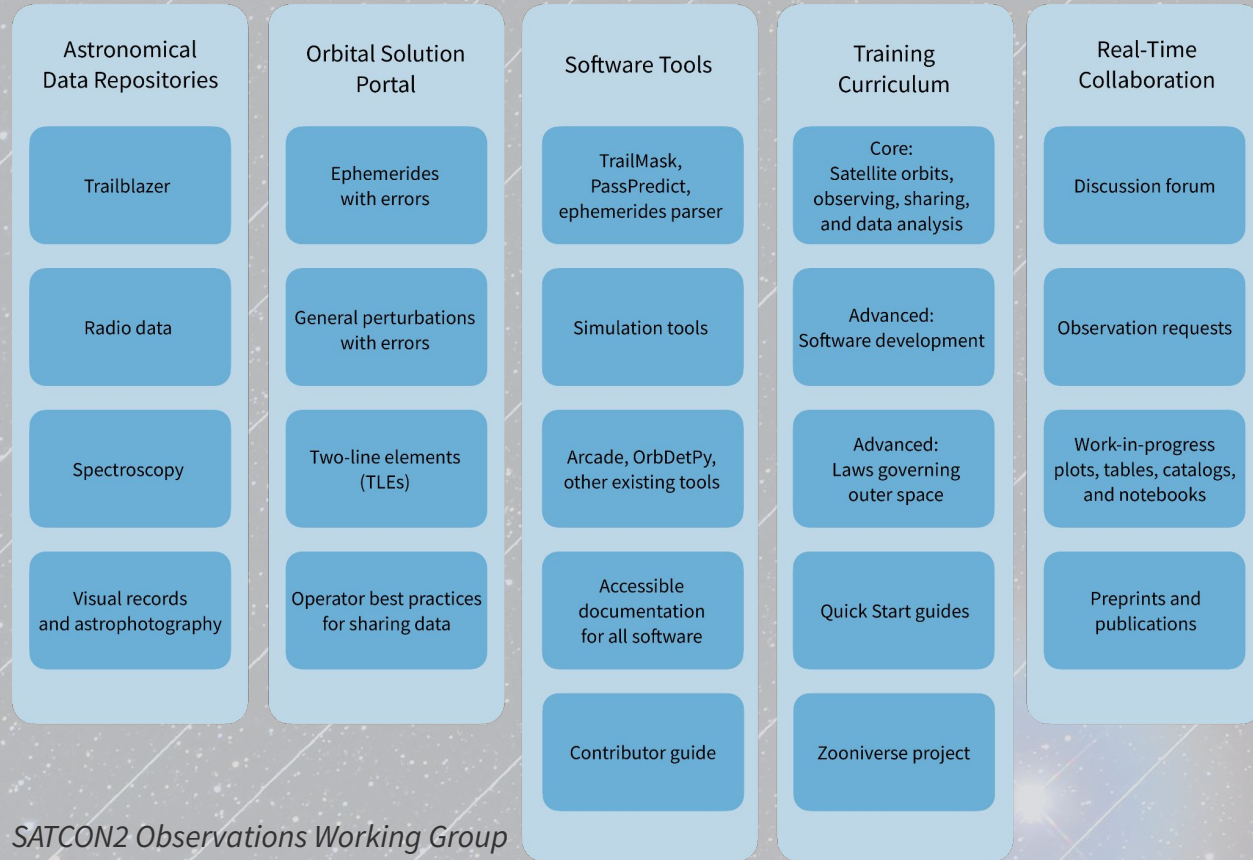
Satellite visibility from Rubin Observatory  
P. Yoachim (U. Washington)  
from Tyson et al. 2020

# SatHub: A Public, Coordinated Satellite Observation Hub

Meredith Rawls (*U. Washington / Vera C. Rubin Observatory*)



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

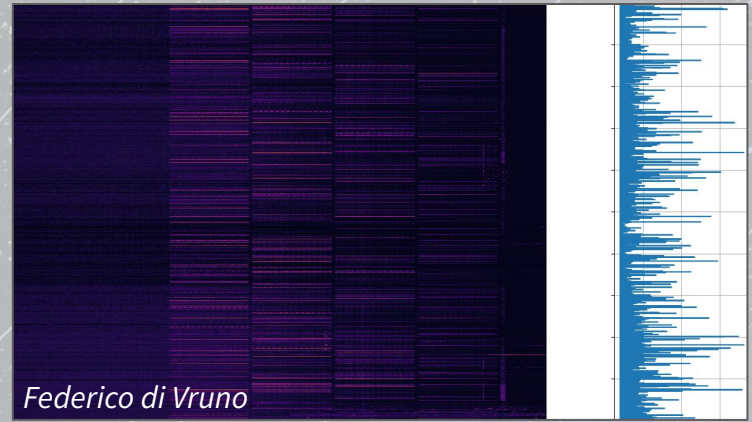
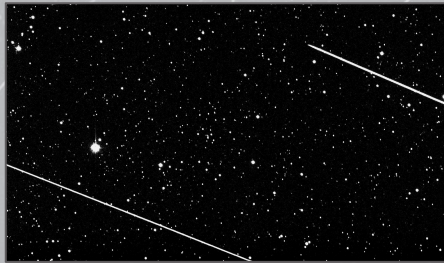


*SATCON2 Observations Working Group*

# Astronomical data repositories

Publicly available, easily accessible, user-friendly, documented

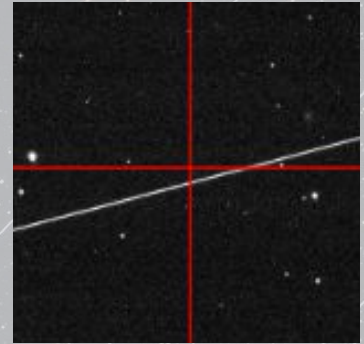
- Collection of optical/near-IR images with satellite streaks (e.g., **Trailblazer**)
- Spectra contaminated with reflected solar spectrum
- Space-based observations from low-Earth orbit (e.g., Hubble)
- Radio data affected by satellite interference
- DSLR images, visual sightings, other formats





# Orbital solution portal

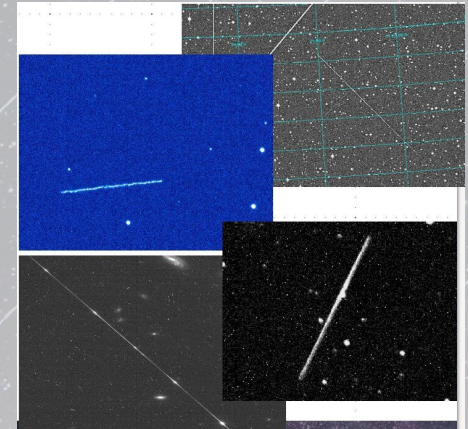
- Provide **public access to orbital solutions** every 8 hours or immediately following a maneuver, whichever is first, with **error bars**
- Ephemerides-style **and** general perturbation-style (“TLE”) solutions
- Automatic synchronization with complementary services



*Jeremy Tregloan-Reed*

# Software tools

- A home for PassPredict, TrailMask, Simulation & Modeling, etc.
- **User-friendly documentation**, support, and maintenance
- Standard **test suite** supporting a wide range of instrument and satellite signature properties to support software development



*Jonathan McDowell*



# Training curriculum for observers worldwide

- A crucial part of SatHub — a global LEO satellite monitoring campaign plus shared data and software are insufficient
- Outline of a training curriculum for observers of all kinds
  - **Core curriculum** (introduction, observing satellites, reporting observations, image and data analysis)
  - **Advanced modules** (software development, radio astro, space law)
  - **Quick start recipes** (for different observer hardware scenarios)

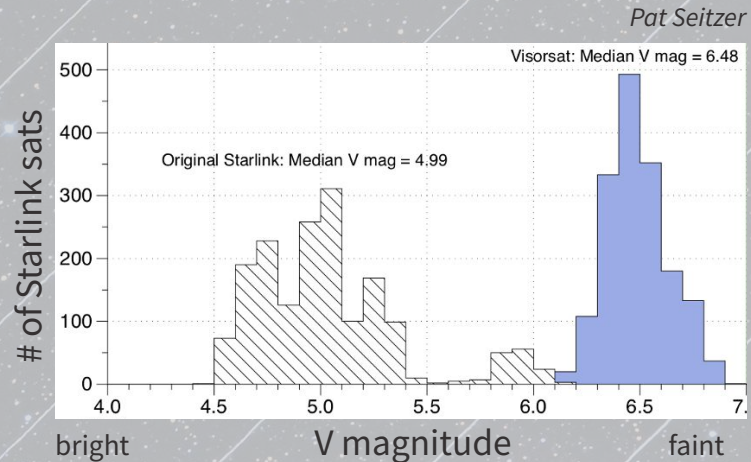




# We want everyone to interface with SatHub

Sky observers, data analysts, software developers, industry experts, students...

- As the satellite population changes, evolving impacts require **observer-operator dialogs**
- Information in SatHub will be **public**, open, and accessible to support real-time collaboration
- We aim to join innovation with existing solutions, prioritize **ease of use**, and enable **coordination among multiple stakeholders**



*There will be many opportunities for individuals and organizations to contribute to SatHub!*

# Policy Hub

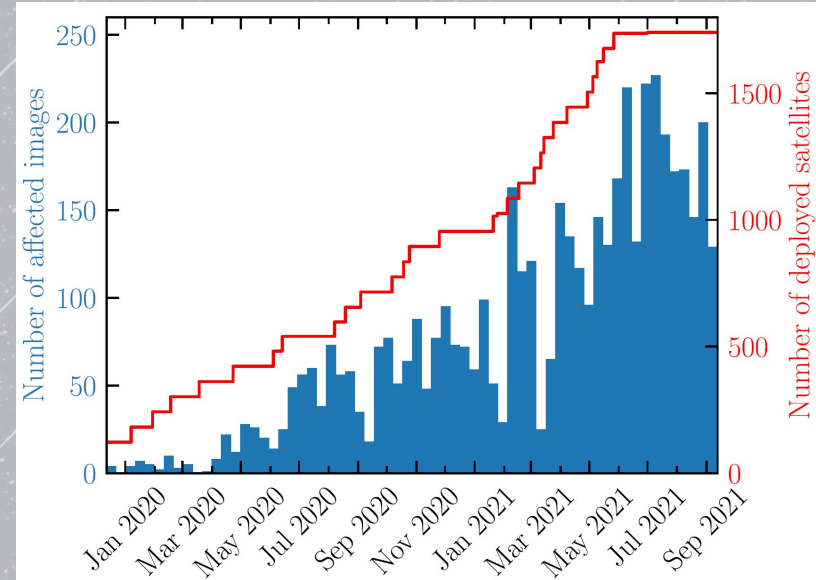
Richard Green (*University of Arizona*)



# Policy Hub

## Need and Purpose

- Urgent need for **coordinated policy action and scientific diplomacy** to protect astronomy
- Any space-active nation must adopt laws that protect interests of **all** space actors, including astronomers
  - E.g.: licensing obligation to mitigate adverse effects
- Such nations should provide proportional resources to **mitigate adverse effects** (i.e. damage to astronomical observational data) that can include SatHub support



*Actual observed number of satellite trails (in ZTF) over last 2 years vs. Starlink deployments.*

# Policy Hub Challenges

- **Obligations** to mitigate adverse effects on astronomy remain absent and are at best in the discussion phase in a few countries.
- Many space nations **invest significantly** in space commerce and wireless broadband access
- **No coherent voice** for balancing unfettered commercial access to LEO with long-term sustainability and mitigating impacts
- **Few countries have a comprehensive regulatory framework** from launch to de-orbit including in-orbit operations (e.g. in US, multiple agencies FAA, FCC, NASA, and NOAA)
- **Cohesion** needed between well-defined astronomy limits for reducing reflected sunlight, industry ability to technically reach such limits, and, a practical regulatory approach



# Policy Hub Functions

- The IAU Centre can **significantly contribute** to overcoming challenges and existing voids
- **Ongoing support** to organizations and lawmakers to accelerate legal protections
  - Information exchange and coordination among national advocacy groups
  - Education of national policy makers on the issues and advocacy for goals.
- **Support IAU efforts** to obtain UN COPUOS (and ultimately the General Assembly) endorsement of protections.
- **Central source of information** on closely related space policy issues
- **Coordination** with the radio spectrum management community



# Policy Hub Implementation

- As a foundation, **policy recommendations shall be advocated** based on the SATCON 1&2 and Dark & Quiet Skies 1&2 reports; dynamically adapt to new science and information; and, be accompanied by supporting resources
- **Activities at international forums** (e.g. COPUOS, ITU) coordinated through the IAU, SKAO, and key affiliates such as the European Southern Observatory (ESO).
- **National implementation** via the support and coordination of affiliates such as the American Astronomical Society (AAS), Royal Astronomical Society (RAS), European Astronomical Society (EAS), and others.
- Recognition that astronomy concerns about reflected sunlight and illumination pattern of radio transmissions align with much broader suite of issues that must be urgently addressed to produce **a sustainable balance in the use of space.**



# Policy Hub Progress

- UN+IAU-sponsored **Dark and Quiet Skies Workshops** obtained positive attention by UN-COPUOS Science and Technical Committee, and on path to COPUOS itself
- **Advocacy by international observatories and national societies** secured the attention of diverse space and regulatory agencies.
- Examples of national/regional progress:
  - In the US, AAS-originated briefings generated considerable interest in SATCON2 / D&QS2 results among staff of **Congressional committees, State Department, White House, Federal Communications Commission & Federal Aviation Administration.**
  - In Europe, EAS in contact with European Commission and conducting outreach to **Members of European Parliament**

# Community Engagement Hub

Jessica Heim (*University of Southern Queensland*)







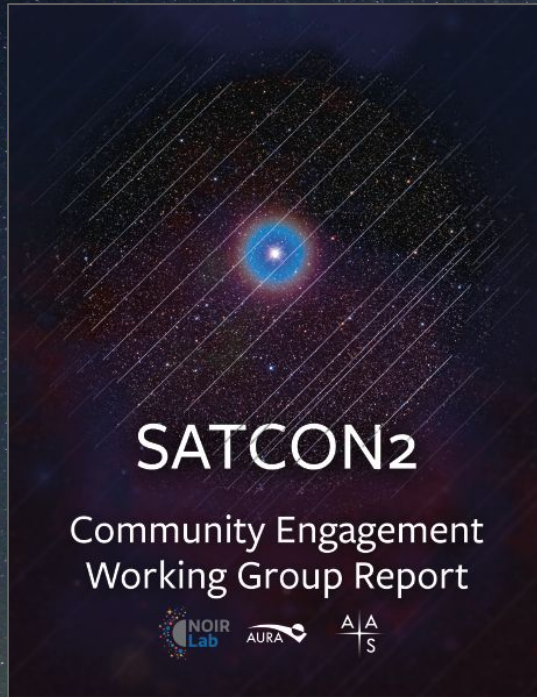








# Community Engagement Goals



**Engage** a wide set of constituents in our shared goals for dark skies and a sustainable presence in space.

Lay a foundation for ongoing **communication and collaboration** to preserve space as a scientific, environmental and cultural resource for humanity.



# Community Engagement — Constituencies (so far)

Amateur Astronomers

Astrophotographers

Astrotourism professionals

Planetarium Community

Indigenous communities

Environmental Issues

Social justice considerations



# Some Perspectives from Indigenous WG members

*“Satellites literally interrupt our relationship with the stars and ceremonial ways of connecting with them”*

*“If light pollution is erasing Indigenous stories, these satellites are rewriting them”*



# Equity and Broadband Access

Many rural and Indigenous communities are in need of improved Internet access.

However, these issues are multifaceted and complex.



# Working Collaboratively with Communities

It is essential to develop long-term, collaborative relationships rooted in respect, consideration, and consultation.



# Community Engagement - Findings & Recommendations

The sky belongs to everyone.  
All people are impacted by changes in the sky.

The sky is part of the environment.  
Earth's ecosystems can be affected by changes in the sky.

Industry, leadership, space actors  
and all constituencies must  
co-create a *shared, ethical,  
sustainable approach to space.*



# Community Engagement Hub of the IAU Centre

Facilitate opportunities for meaningful, productive collaboration between diverse constituencies

Work to build long-term relationships

Discussion Forums & Workshops

Social Media

Website “hub” of resources



# Community Engagement Hub's Vision

A truly just, equitable, and sustainable  
future on Earth and in space.



# Contact Information

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