### **Dark Skies Initiatives**

#### AAS Committee to Protect Astronomy and the Space Environment

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Picture: Stephen Hummel - McDonald Observatory

#### The Charge of COMPASSE

COMPASSE represents the interests of AAS relating to the protection of dark and radio-quiet skies, the safe and sustainable use of outer space, and related issues, and empowers AAS members to be effective advocates for the protection of U.S. astronomy.

**Primary Concerns:** Impacts on access to the night sky and impacts on astronomical science:

- 1. Commercialization of orbital space (Satcons)
- 2. Artificial light at night (ALAN)





Credit: J. McDowell/CFA

#### Satcon Issues

• Full cycle impact on observations

- o Streaks
- o Occultations
- Diffuse sky brightening
- Laser guide stars
- o Extinction
- Radio interference
- Impact on night sky accessibility
  - o Recruitment
  - Amateur astronomers
  - Cultural heritage

- Orbit overcrowding
  - Space debris
  - Space based observatories
  - EM spectrum traffic
  - o Kessler
- Environmental impacts
  - Launch and deorbit
  - Animal behavior
- The future of cis-lunar orbit

# Citizen scientists report global rapid reductions in the visibility of stars from 2011 to 2022 (Kyba et al. 2023)

The artificial glow of the night sky is a form of light pollution; its global change over time is not well known. Developments in lighting technology complicate any measurement because of changes in lighting practice and emission spectra. We investigated the change in global sky brightness from 2011 to 2022 using 51,351 citizen scientist observations of naked-eye stellar visibility. The number of visible stars decreased by an amount that can be explained by an increase in sky brightness of 7 to 10% per year in the human visible band. This increase is faster than emissions changes indicated by satellite observations. We ascribe this difference to spectral changes in light emission and to the average angle of light emissions.

# Light pollution indicators for all the major astronomical observatories (Falchi et al. 2023)

Light pollution at astronomical observatories is one of the main factors to be taken into account to preserve their scientific productivity and their useful lifetime. Using the Garstang–Cinzano model applied to the Visible Infrared Imaging Radiometer Suite (VIIRS) 2021 satellite radiance data, we have compared 28 sites, all hosting telescopes with apertures larger than 3 m, plus some additional selected sites. We computed and analysed five indicators of light pollution: radiance at zenith; averaged at 60° zenith distance; averaged over all the sky; averaged in the first 10° above the horizon; and horizontal irradiance. We found large variations of the values of the indicators, with a factor greater than 600 for the zenith artificial radiance between the least and most polluted major observatories. The results show that two-thirds of all large observatories have already surpassed the critical 10 per cent increase in radiance over the assumed natural levels. The results presented and the method described here can help to plan countermeasures in order to lower the impact of light pollution on observatories. These same methods can be also used to protect the night environment from the impact of artificial light (e.g. on biodiversity, on animal behaviour and physiology, on human health).

Average Radiance at 30° above horizon



#### The Issues

While satcons are the largest growing existential threat to ground-based optical astronomical observations ground based light pollution remains the largest current impact.

The two are additive - diffuse sky brightening from satellites increases the background upon which skyglow from ground based lighting acts.

Given estimates of how much diffuse brightening to expect all major astronomical sites will exceed the IAU recommended 10% for major facilities.

#### What is COMPASSE doing?

• Raising Awareness

Amongst our constituents (in AAS), with policymakers, with federal agencies, and in the broader community

• Coordinating Efforts

Maintain relationship with industry partners, federal agencies, policymakers, and other concerned/impacted groups

• Policy Solutions

Defining impacts to our science, defining threshold for harm, working with policymakers on oversight of mitigation of impact on astronomy

#### Some successes - Satcons

#### *FCC 22-91:*

"SpaceX must coordinate with NSF to achieve a mutually acceptable agreement to mitigate the impact of its satellites on optical ground-based astronomy. SpaceX must submit an annual report to the Commission, by January 1st each year covering the proceeding year containing the following information: (1) whether it has reached a coordination agreement with NSF addressing optical astronomy; and (2) any steps SpaceX has taken to reduce the impact of its satellites on optical astronomy, including but not limited to darkening, deflecting light away from the Earth, attitude maneuvering, and provision of orbital information to astronomers for scheduling observations around satellites' locations."

SpaceX and NSF reaches agreement late in January 2023

SpaceX asked FCC to consider this for all constellation operators

#### **Policy Desires - Satcons**

FCC rulemaking to require coordination with NSF as part of licensing

Environmental impact consideration for full life cycle

Consideration for aggregate impact rather than per individual payload

*Laser clearing house opt-in rather than opt-out* 

*Radio quiet zone protections, and stronger frequency enforcement* 

International coordination necessary

#### **Desires - ALAN**

Light pollution is easily limited/reversed Shielding, color, intensity, timing, location

Currently handled at a regional/local level (i.e., city ordinance)

Would like something to be considered at the federal level - still navigating our internal thoughts on what this might be.

### **Closing Thoughts**

Thought

• A dark and quiet skies regulatory (satcon and ALAN) framework is necessary to protect the future of astronomy

Questions

- How do we plan toward rapid expansion of international operators not subject to FCC regulations?
- What unknown affects need to be quantified?
- Can the NAS take a role in establishing a committee similar to CORF?
- Can the NAS take a role in establishing a group on Space Ethics?
- How can we navigate cis-lunar orbit regulation?