

Annual Report for 2021

Commission C.B7: Inter-Division B-C Commission

Protection of Existing and Potential Observatory Sites

Organizing Committee Members: Richard Green (Advisor), James Lowenthal (Vice-President), Angel Otarola, Ramotholo Sefako, Diane Turnshek, Antonia Varela Perez, Constance Walker (President)

And 73 [Commission Members](#)

Various members of the IAU Commission C.B7 Organizing Committee and C.B7 members have been active in representing the interests of IAU in several major areas:

- The Dark and Quiet Skies (D&QS I) conference was held online from October 5-9, 2020, with more than 970 registered participants. Each daily session was followed by between 250 to 380 online attendees. A draft report, prepared during the preceding months by internationally recognized experts, was made available to the registered participants prior to the event. All participants were then invited to submit written comments within one week of the Workshop's conclusion. Their comments were then used to finalize the Workshop Report. (See <https://noirlab.edu/public/products/techdocs/techdoc021/>.) The Report represents the most up-to-date and authoritative analysis of the impact on astronomy by three classes of interference: artificial light at night (ALAN), the large number of low-Earth orbit (LEO) satellite trails, and radio-wavelength emission. <https://www.iau.org/static/publications/dqskies-book-29-12-20.pdf>.
- A special session on the impact of satellite constellations on astronomy was held online at the January 2021 AAS conference and half of an AAS town hall (online) was devoted to the continuation of the same topic at the June 2021 AAS conference. Talks were also given at the European Astronomical Society (EAS), Royal Astronomical Society (RAS), SGAF's Space Generation Fusion Forum and IAU Symposium 367 (on Dark Skies).
- Both a "Conference Room Paper" (CRP) and a Technical Presentation were presented to the online meeting of the UN Committee on the Peaceful Use of Outer Space's (COPUOS) Science and Technology SubCommittee (STSC) on April 21, 2021. Six countries joined the authorship of the CRP before the meeting and delegates from another dozen countries supported the recommendations made within the CRP during the meeting. The outcome of the Dark & Quiet Skies Conference was presented to the Scientific and Technical subcommittee, notably recommending measures to mitigate the impact of satellite constellations on astronomy. As a result, we were invited to report at the full COPUOS meeting in August. The CRP can be found here: <https://noirlab.edu/public/products/techdocs/techdoc022/>.
- The primary goal of the online SATCON2 workshop, held July 12-16, 2021, was to develop specific, implementable paths to carrying out the recommendations from SATCON1. (The SATCON1 workshop, held June 29-July 2, 2020, identified the issues and recommended mitigations for the impact of satellite constellations on astronomy. See <https://noirlab.edu/public/products/techdocs/techdoc003/>.) Over 550 people registered for the SATCON2 workshop. The workshop's two additional goals were to engage a considerably wider group of stakeholders in the conversations than had been presented SATCON1 and to explore existing policy frameworks and present ideas for development of policy capable of addressing an entirely new era in the exploration and use of space. In the couple of months before the workshop, four working groups (WGs) prepared draft reports relevant to the workshop's goals to present their findings at the workshop itself. Two of the working groups, Observations and Algorithms, explored some SATCON1 recommendations directly. The

Community Engagement working group brought many new voices and perspectives to the issue, and the Policy working group examined regulatory framework and mitigation approaches from national, international, and industry viewpoints. The final combined report of all the chapters is available as of the last week of October 2021. The Executive Report can be found here: <https://noirlab.edu/public/products/techdocs/techdoc031/>. The combined report can be found here: <https://noirlab.edu/public/products/techdocs/techdoc033/>.

- Several briefings were provided over the year to the NSF, the AURA Board, the NOIRLab Management Oversight Committee, the US Office of Science and Technology Policy, the US Board of Physics and Astronomy at the National Academy of Sciences (NAS), the US Committee on Astronomy and Astrophysics at the NAS, the US Space Studies Board at the NAS, the US National Committee for the IAU at the NAS, the US Astronomy and Astrophysics Advisory Committee, the IAU Executive Committee, the Committee on Space Research (COSPAR), the US FCC, the US FAA, the Satellite Industry Association, EAS, RAS, and the Commission Internationale de l'Éclairage (CIE) and many committees and staffers in Washington, DC, USA.
- A presentation was made to the delegates of the hybrid UN COPUOS in August to request a single agenda item dedicated to the topic of satellite constellations' impact on astronomy and society. Consensus was not reached and the request will be revisited at the in-person UN COPUOS Science and Technology Sub-Committee meeting in February 2022. We were also asked to present at the STSC symposium on Dark and Quiet Skies at that time.
- In September 2021, NOIRLab and SKAO in partnership submitted a proposal in response to the IAU call for a Center for the Protection of the Dark and Quiet Sky from Satellite Constellation Interference. The proposal was accepted and the IAU Center (abbreviated to IAU CPS) officially opened on April 1, 2022.
- The Dark and Quiet Skies II conference from October 3-7, 2021 focused on the technical and political actions needed to implement the recommendations from D&QS I, in particular identifying which stakeholders and partners would need to collaborate to implement a satisfactory solution for the preservation of dark and quiet skies. Specifically the topics concentrated on satellite constellations' impact on astronomy and society, artificial light at night and radio astronomy. The conference was to be hybrid, but an erupting volcano on the Canary Island of La Palma, caused the conference to be moved entirely online, to not use the resources needed on the island for its inhabitants. The conference program included invited talks as well as contributions selected through a call for abstracts. A total of 724 individuals, 32 percent of whom were women, registered to attend the conference; 77 countries were represented. On average 140 were attending at any one time. Results from the conference will be presented at the UN COPUOS STSC meeting in February 2022.
- From the IAU UN COPUOS Science and Technology SubCommittee (STSC) report, A/AC.105/C.1/L.394/Add.7: the Subcommittee, at its 955th meeting, on 7 February, agreed to include item 18, entitled "General exchange of views on dark and quiet skies for science and society", as a single issue/item for discussion on the agenda of the fifty-ninth session of the Subcommittee. The representatives of Algeria, Australia, Austria, Chile, Czechia, France, Germany, Indonesia, Italy, the Russian Federation, South Africa, Spain, Turkey, the United Kingdom and the United States made statements under agenda item 18. The observers for IAU and the Square Kilometer Array Observatory also made statements under the item. During the general exchange of views, statements relating to the item were made by representatives of other member States. The Subcommittee had before it the following: (a) Report on the United Nations/Spain/International Astronomical Union Conference on Dark and Quiet Skies for Science and Society (A/AC.105/1255); (b) Note by the Secretariat containing a

summary of discussions on dark and quiet skies for science and society (A/AC.105/1257); (c) Working paper entitled “Protection of dark and quiet skies”, prepared by Austria, Chile, the Dominican Republic, Slovakia, Spain, IAU, ESO and the Square Kilometer Array Observatory (A/AC.105/C.1/L.396). The Subcommittee noted that, as an ever-increasing number of stakeholders, including private entities, were launching spacecraft into orbit, concerns had been raised about spacecraft that reflected sunlight into astronomical telescopes or crossed their field of view, thereby degrading astronomical observations. Some delegations expressed the view that astronomical observations for both optical and radio astronomy were an essential aspect of space activities and should be protected from interference. Astronomical observations from space and Earth-based installations supported the ability to understand the universe, enabled deep space navigation and exploration and provided early warning detection of near-Earth objects. Some regions had already established practices to preserve the darkness of the sky. The delegations expressing that view encouraged States to follow the examples of those that had implemented regulatory actions to protect astronomy from A/AC.105/C.1/L.394/Add.7 4/5 V.22-00846 artificial light at night in defined areas. Mitigation measures against interference from satellite constellations had been implemented by industry in some cases, especially when it had been possible to engage with astronomers early in the project cycle. In addition, astronomers were devising other ways to reduce the impact of constellations. Some delegations welcomed the initiative taken by IAU in inviting delegations to engage with its recently opened Centre for the Protection of the Dark and Quiet Sky from Satellite Constellation Interference. The view was expressed that issues identified in relation to artificial light at night would be best discussed at the national level. Some delegations expressed the view that, owing to the rapid evolution in launches of satellite constellations, the ongoing exchange of views on dark and quiet skies should continue to take place in the Subcommittee, with an agenda item on dark and quiet skies for science and society to be included in future sessions of the Subcommittee.

- In addition, several C.B7 members (and D&QS Protection EC WG members and D&QS WG members) presented at the STSC Industry Symposium at the STSC meeting. The two-hour Industry Symposium focuses annually on one theme only and this year it was on satellite constellations’ impact on astronomy and the mitigations possible. The symposium was a major opportunity to inform the UN Delegates and to “go on the record”. Emphasis was placed on the growing partnership between the astronomy community and industry in achieving feasible solutions.
- Planning by EC WG and C.B7 OC members for the IAU GA2022 Focus Meeting on “Toward a World Standard on Dark & Quiet Sky Protection” is actively taking place.
- Note: future plans in last year’s C.B7 triennial report (the D&QS II Conference establishment of the IAU Centre & reporting back to the STSC) were accomplished.

Included here is the work accomplished by the one C.B7 Working Group, WG on Site Protection:

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Inter-Division B-C Commission WG Site Protection

Chair: Richard Green **Co-Chair:** Saeko Hayashi

Members: Elizabeth Alvarez, Zouhair Benkhaldoun, Yvan Dutil, Nalini Heeralall-Issur, Qing LIN, Harvey Liszt, Tushar Prabhu, Margarita Rosado, Ramotholo Sefako, R. Chris Smith, Jun TAO, Richard Wainscoat, Constance Walker, Haiyan ZHANG, Yongheng ZHAO

On the basis of their proposal, the Working Group on *Site Protection* and its parent Inter-Division B-C Commission of *Protection of Existing and Potential Observatory Sites* renewed for the current triennium (2021-2024) at the IAU business meeting held at the time originally scheduled for the General Assembly in 2021. These groups intend to provide a moderated forum for discussion of local issues and to encourage sharing of local experience as a general resource.

The emphasis of the Working Group and its members is on reduction of ground-based sources of artificial light at night (**ALAN**). Complementary effort on the critical issue of the impact of satellite constellations is the purview of the Executive Committee Working Group and the IAU Centre for the Protection of the Dark and Quiet Sky from Satellite Constellations. (See above.)

Major Objectives:

- Support the IAU effort to obtain United Nation's endorsement of dark/quiet sky protection through the UN Committee on the Peaceful Uses of Outer Space (**UNCOPUOS**).
- Support implementation of the framework of the Dark & Quiet Skies (**D&QS**) Conference Report for observatory site protection, including regional planning based on detailed modeling, dynamic usage zones, and active lighting control.
- Provide a forum for astronomer efforts to enhance local and national legal frameworks for dark/quiet sky protection in the near zones around observatories in the context of the D&QS recommendations.
- Coordinate efforts with Commission B4 Radio Astronomy to limit radio-frequency interference at radio telescopes from ground-based interference.
- Provide the technical interface to the International Commission on Illumination / Commission Internationale de l'éclairage (**CIE**) for development of outdoor lighting standards that protect the dark sky and implementation of the D&QS framework.
- Evaluate requests for IAU endorsement of proposals for special protection status to other entities, such as International Dark-Sky Association (**IDA**).
- Educate professional colleagues about the urgency of site protection issues; provide supporting materials for their public presentations.

Dark and Quiet Skies Conference

The Site Protection Working Group through its members expended its primary effort in support of the (second) Dark and Quiet Skies Conference, co-sponsored by the IAU, the Instituto de Astrofísica de Canarias (**IAC**), and the United Nations Office of Outer Space Affairs (**UNOOSA**). The purpose was to develop a set of policy recommendations for consideration and approval by UNCOPUOS through its Scientific and Technical Committee. The opportunity was originated by former IAU General Secretary, Piero Benvenuti, in collaboration with Simonetta Di Pippo, the former Director of UNOOSA.

The Conference Scientific Organizing Committee (SOC) was chaired by the Commission B7 President / Executive Committee WG [Dark and Quiet Sky Protection](#) Chair, Constance Walker, with support from UNOOSA staffer, Nathalie Ricard. The original intention was to hold the conference in person in Santa Cruz de La Palma, Spain in early October, 2021, but because of travel and other restrictions from the volcanic eruption, the conference was held virtually, with more than 900 global registrants.

The outcome of the process was

- a technical document, *Dark and Quiet Skies II for Science and Society* (https://www.iau.org/static/science/scientific_bodies/working_groups/286/dark-quiet-skies-2-working-groups-reports.pdf),
 - a 'Working Paper' (https://www.unoosa.org/res/oosadoc/data/documents/2022/aac_105c_1/aac_105c_1_396_0_html/AC105_C1_L396E.pdf),
- with summary recommendations formatted for consideration by UNCOPUOS.

The D&QS2 ALAN Working Group was one of three topic-focused working groups which met several times over the course of the spring and summer of 2021 in order to prepare draft reports for presentation and to plan the format of their topic at the Conference in October. (The other two were on satellite constellations and radio astronomy.) The input from the workshop participants was then taken into account in producing the versions of the technical document and Working Paper referenced above.

The D&QS2 ALAN Working Group recommendations and documents focused on implementation, based on the hard-won technical consensus of Dark and Quiet Skies I. The D&QS1 and 2 Working Group membership included participants from lighting engineering and lighting manufacturing associations, as well as experts in astro- and nature tourism, environment and human health. Three ALAN Working Group members disagreed with the consensus outcome from D&QS1 as containing too many compromises and could not support the final recommendations as presented in the D&QS2 Working Group report. However, the implementation plan was a strong consensus based on principles of good lighting, and including the forward-looking concepts of regional lighting management and active control enabling active lighting zone requirements.

Commission C.B7 and its Site Protection WG members played very active roles in the research and development of the report. IAU officers and members of other commissions are listed in parentheses.

Richard Green (co-chair), James Lowenthal (co-chair), (Antonia M. Varéla Perez (co-chair)), Zouhair Benkhaldoun, Andreas Haenel, Casiana Muñoz-Tuñón, Salvador Ribas, Connie Walker.

The April, 2022 meeting of the UNCOPUOS Scientific and Technical Subcommittee included a two-hour virtual symposium to present dark and quiet skies issues to the delegates. The Working Paper received support, so that the item will be on the agenda for further discussion and action next year, although the emphasis will be on satellite constellations, as discussed in the EC Working Group report.

Interaction with CIE

The Site Protection Working Group is the practical organizational interface for IAU to the international lighting engineering organization, CIE. There is a strong basis for joint advocacy for good outdoor lighting practices and practical research that further the aims of protecting the dark sky. Their CEO participated in the D&QS2 SOC. The fourth co-chair of the D&QS2 ALAN Working Group was from the CIE. Richard Green presented a summary of that WG report to CIE Division 4. Richard Wainscoat is IAU's official liaison to the CIE, and participates in some of their Technical Committees. An MOU is under development to formalize the shared goals and modes of interaction between the two professional societies.

Focus Meeting at the IAU General Assembly in 2022

A major means of implementing the goal of educating astronomers on the issues of dark and quiet skies is through Focus Meetings at the IAU General Assemblies. The Site Protection Working Group has played an active role in the proposal and organization of the Focus Meeting now planned for August in Busan. About half the meeting will be in the 'traditional' format of highlighting current issues with ALAN and hearing about protection plans for major world observatories. The other half will be devoted to the new and rapidly growing concern about satellite constellations.

Other Implementation Actions

The major area requiring attention is facilitating communication among observatories with telescopes of all scales about their efforts to secure public support and regulatory authority for light pollution control. The stated plan in the WG proposal was to activate that section of the Commission website, provide explicit support for any initial approaches to regional lighting plans, and organize regional hubs for coordination of efforts. All of those areas will require WG effort to make progress in the remaining two years of the triennium.