

EC WORKING GROUP

Dark and Quiet Sky Protection

CHAIR ADVISOR ORGANIZING COMMITTEE

Constance E. Walker
Richard Green
Piero Benvenuti (EC Liaison), Richard Green, John Hearnshaw (EC Liaison), Constance Walker

OTHER WG MEMBERS

Laura Ferrarese, David Galadí-Enriquez, Harvey Liszt, Ramotholo Sefako, R. Chris Smith, Diane Turnshek, Yongsheng Zhao

TRIENNIAL REPORT 2018-2021

1. Events

The term began with the very successful two-day, off-campus **focus meeting** held at Kuffner Observatory during the **2018 IAU General Assembly** in Vienna. The meeting was co-led by Connie Walker and Richard Green. Another EC WG member, Harvey Liszt, also presented. The first day of the meeting was a **joint CIE-IAU workshop and discussion** on technical issues, recommended standards for site protection for optical and radio observatories, measurement and modeling of artificial light at night, and heritage and dark sky sites and more. (CIE is the Commission Internationale de L'Eclairage.) The meeting opened with a talk from the CIE General Secretary, Kathryn Nield, on the CIE scope and activities, and was followed by technical talks by the Division 4 Director and the Division 2 President. The second day continued with presentations on **mitigating light pollution and radio interference through site protection and education**. The resulting discussion brought together members of the CIE, members of the Executive Working Group (EC WG) on Dark & Quiet Sky Protection and IAU Commission C.B7 to discuss next steps. Subsequently, CIE became involvement in Dark and Quiet Skies for Science and Society (D&QS) workshop in October 2020, as part of D&QS working groups and an MOU between CIE and IAU is under review by EC WG and C.B7 members.

For each AAS meeting during this trimester (January 2019, 2020 and 2021), Connie Walker with IAU and AAS members organized and executed 3 successful **AAS sessions on light pollution, radio interference and space debris**. The January 2020 session was on challenges to astronomy from satellites and had EC WG and C.B7 OC member, Harvey Liszt, as a speaker along with SpaceX and other astronomers. The most recent AAS [AAS special session on satellite constellations](#) in January 2021 had satellite operators from SpaceX, OneWeb and Amazon as speakers, and again included Dr. Liszt.

The EC WG Chair/C.B7 President co-chaired an online workshop (**SATCON1**) on satellite constellations impact and solutions. The workshop was sponsored by NOIRLab and AAS and funded by NSF and was held June 29-July 2, 2020. Richard Green, Harvey Liszt, David Galadí-Enriquez and members of the Commission C.B7 (like C.B7 VP James Lowenthal) were also engaged in the workshop SOC and the working groups; Richard Green was one of the WG chairs. Working groups were formed to research key issues in advance of the workshop. The workshop goal was to assemble solutions the satellite constellation companies and various observatories can implement to lessen the brightness of the satellites. The [report](#) and its [technical appendices](#) have been published along with [an article](#) for the public.

Commission C.B7 and the EC WG for Dark and Quiet Sky Protection supported the IAU commitment to the **Dark and Quiet Skies for Science and Society Workshop** (D&QS). That workshop was 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 the UN Committee on the Peaceful Uses of Outer Space (COPUOS), first through its Scientific and Technical Committee, then by the full UN General Assembly. The opportunity was originated by former IAU General Secretary, Piero Benvenuti, in collaboration with Simonetta Di Pippo, Director of UNOOSA.

The Workshop Scientific Organizing Committee (SOC) was chaired by the Commission President/EC WG Chair, Constance Walker, with support from Simonetta Di Pippo. Richard Green co-chaired a working group on optical astronomy. John Hearnshaw co-chaired a working group on dark skies oases. Harvey Liszt co-chaired a working group on radio astronomy. EC WG members, Piero Benvenuti and David Galadí-Enríquez were significantly involved in the SOC, Piero as part of the Steering Committee. The original intention was to hold the workshop in person in Santa Cruz de La Palma, Spain, in early October, 2020, but because of travel and other restrictions from COVID-19, the conference was held virtually, with some 900 global registrants. A follow-up workshop is now being planned for October, 2021 in the same venue.

The outcome of the process was a technical document, *Dark and Quiet Skies for Science and Society* (<https://www.iau.org/static/publications/dqskies-book-29-12-20.pdf>), and a 'Conference Room Paper' (<https://www.iau.org/static/publications/uncopuos-stsc-crp-8jan2021.pdf>), the summarized recommendations formatted for consideration by UN COPUOS.

The process was managed by the SOC that coordinated the efforts of five Working Groups: Dark Sky Oases, Bio-Environment, Optical Astronomy, Satellite Constellations, and Radio Astronomy. The Working Groups met several times over the course of the spring and summer of 2020 in order to prepare draft reports for presentation and discussion at the Workshop in October. The input from the workshop participants was then taken into account in producing the versions of the technical document and conference room paper referenced above.

The Working Group recommendations and documents represent a hard-won consensus, because membership included participants from lighting engineering and lighting manufacturing associations, as well as satellite constellation operators. EC WG on D&QS Protection and Commission C.B7 members played very active roles in the research and development of the reports. Strategically as well, EC WG and Commission C.B7 members involved in these workshops have had meetings on satellite constellations with EAS, RAS, CIE, SpaceX and COSPAR.

The EC WG, Commission C.B7 and Workshop SOC members have been active along with the Presidents of IAU National Committees in engaging national COPUOS delegates to familiarize them with the contents of the Conference Room Paper and to encourage their endorsement. The late April, 2021, meeting of the COPUOS Scientific and Technical Committee will be the first to be held in virtual format, so the IAU presentation of the Dark and Quiet Sky protection recommendations is particularly challenging. The prospect of UN endorsement makes the substantial effort well worthwhile.

In December 2020, ECWG Chair/B7 President and IAU and AAS members organized and hosted an **Astronomical Society of the Pacific 50-min. session on satellite constellations**: bringing awareness to science communicators

Also in December 2020, Margarita Metaxa (C.B7 WG Chair), Pedro Sanhueza (C.B7 Member), Constance Walker (ECWG Chair/B7 President) and Richard Green (ECWG Advisor) presented at the **IAUS367 the two-hour "Turn on the Night! Science & Education on Dark Skies Issues" associated event**.

2. Members

- **ECWG Advisor, Richard Green**, has
 - Served as Advisor to the Commission Organizing Committee.
 - Served on the SOC and as Co-Chair of the Optical Observatories Working Group for the D&QS Workshop.
 - On the completion of his rotation at the US National Science Foundation in 2019, resumed activity on national and regional site protection.
 - Participated on the Light Pollution, Radio Interference and Space Debris Committee of the American Astronomical Society.
 - Served on the SOC and chaired the Metrics Working Group for the US-sponsored SATCON1 conference.
 - Convenes the Arizona Astronomy Consortium of all the professional observatories in the State for joint action on site protection.
 - Engaged with staff and elected officials of local city and county governments on revisions to their outdoor lighting and sign codes.
 - Working with the Executive Director of the International Dark Sky Association to develop research projects on the environmental and policy issues associated with urban lightsheds.
- **ECWG OC Member, John Hearnshaw** has been active in
 - Gave an invited talk by videolink to the *2020 World Conference on Science Literacy (dark skies conservation session)* in Beijing in November on light pollution and dark skies protection. This was viewed by over 4000 conference participants, and subsequently over 18,000 people viewed the recording of the talk.
 - Continuing as a member of the board of the Aoraki Mackenzie International Dark Sky Reserve in New Zealand. He was chair until June 2020.
 - Writing a book entitled *The New Zealand Dark Skies Handbook* which should appear in print in July 2021.
- **ECWG Member Harvey Liszt** has been working as a
 - Member of the OC, IAU C.B7 Protection of Existing & Potential Observatory Sites
 - Member of and Chair, the IAU Scientific Committee on Frequency Allocations for Radio Astronomy and Space Science (IUCAF); www.iucaf.org. Organized the Fifth IUCAF International Spectrum Management School for Radio Astronomy, Stellenbosch, SA 2 – 6 March, 2020; <http://www.iucaf.org/sms2020/>
 - Member, Scientific Organizing Committee, and leader, Radio Astronomy Working Group, Dark Quiet Skies for Science and Society; <http://research.iac.es/congreso/quietdarksky2020/pages/home.php>
 - Vice-Chair, American Astronomical Society Executive Committee on Light Pollution, Radio Interference & Space Debris <https://aas.org/comms/committee-light-pollution-radio-interference-and-space-debris>
 - Spectrum manager of the (US) National Radio Astronomy Observatory; <https://www.cv.nrao.edu/~hlistz/RFI/>
- **ECWG Member, David Galadí-Enríquez**
2018
 - Publication of the *G*-index system to evaluate the content of blue light per lumen in artificial lighting installations, adopted by the regional Government of Andalusia as a metric to limit blue light in their future regulation: http://www.juntadeandalucia.es/medioambiente/portal_web/web/temas_ambientales/atmosfera/contaminacion_luminica/5_iluminacion/indice_espectral_G/indexG_descrip.pdf
 - Contributed to the blue light assessment and limitation criteria included in the European Union’s “Green paper” *Revision of the EU Green Public*

Procurement Criteria for Road Lighting & traffic signals (EUR 29631 EN, at http://ec.europa.eu/environment/gpp/pdf/tbr/190125_JRC115406_eugpp_road_lighting_technical_report.pdf).

- Presentation of the spectral index system (including G-index) at the biennial meeting of the Spanish branch of the Commission Internationale de l'Éclairage (CIE): Comité Español de Iluminación (Spanish Lighting Committee, CEI), Guadalajara (Spain), 25th May. This led to the publication of a report on possible risks related LED-based illumination (https://www.ceisp.com/fileadmin/user_upload/Riesgos-iluminacion-led.pdf).
- Four public talks (2 at Almeria city, one at Riba-roja, one at Granada city) on light pollution: general aspects, policies
- Publication of the book on popular astronomy *A ras de cielo* (“Grazing the sky”), by the Spanish publisher Ediciones Akal, including a chapter on light pollution: “Recuperar la noche” (“Recovering the night”). Official presentation at Madrid Planetarium (June 14th).
- Publication of the technical book *Fundamentos de fotometría astronómica* (“Foundations of astronomical photometry”), publisher Marcombo, including a chapter on photometry of extended objects applied to light pollution assessment.

2019

- Light Pollution Theory, Modelling and Measurement, Zselic Valley, Hungary, 25-28 June, presenting “Sky brightness empirical cartography: [the Andalusian QSkyMap](#)”
- Scientific advisor for the Spanish participation in the European citizen science project “[Star-Spotting Experiment](#)”, devoted to light pollution education and measurement.
- Coordinator of the new working group [ICOSAEDRO](#) (Impacto de las Constelaciones de Satélites En Detectores de Radio y Ópticos, “impact of satellite constellations on radio and optical detectors”) in the Sociedad Española de Astronomía (Spanish Astronomical Society, SEA).

2020

- Obtained the [Hoag/Robinson](#) award of the International Dark-sky Association (IDA) 2019 for his outstanding contribution in educating governmental organizations, businesses and the public about the merits of outdoor lighting control ordinances.
- Participant in the NOIRLab & AAS workshop [SATCON1](#) conference, mainly on simulation work
- Participant in the [First Trans-Frontier Meeting on Light Pollution Spain-Portugal](#) at Badajoz (September 24th).
- [Dark & Quiet Skies for Science and Society](#) conference, member of the satellite constellation working group, speaker on simulations
- Scientific advisor for the local Government of the Ibiza island for light pollution regulation
- Article [«Satellite mega-constellations pose a threat to ground-based astronomy»](#) in April’s issue of the international journal *Room Magazine*, a publication devoted to astronautics for the general public.

2021

- Scientific advisor for the local Government of the Ibiza island for light pollution regulation
- [XXX Biental Scientific Film Festival of Ronda](#) (Spain), meeting on light pollution and its impact on documentary films and photography, March 11th
- **ECWG Member, Diane Turnshek**
 - Founded and headed the International Dark-Sky Association Pittsburgh Chapter, [IDAPgh.org](#) (March 2017 - 2019) with the intention to bring together

members of the medical field, professional and amateur astronomers, lighting professionals, health and safety workers, and naturalists.

- Was on the Board of Directors for the Pennsylvania Chapter of the International Dark Sky Association (2019 – present)
- Received grant: 2018 Metro21, “Artificial Light Survey of Nighttime Pittsburgh,” with Stephen Quick, \$80K
- Is mapping the night skies of Pittsburgh, PA with drones and low-flying aircraft in advance of the city’s move to LEDs. She is measuring skyglow over the city with TESS-W photometers, SQM-Ls and the DarkSkyMeter app. Her astronomy students contribute to Globe at Night. The illuminance at ground level under a variety of current streetlights is being measured with a Sekonic C-7000 SpectroMaster Color Meter. This data will help city officials decide on the new LED streetlight revamp scheduled for 2021.
- Has met with David Mitchell of Lumican Lighting and is testing his LEDs (2700K, 2500K, 2200K) and those of three other manufacturers in public street-lights, prior to a decision being made by the City of Pittsburgh for their new 40K LED streetlights.
- Was guest lecturing in classes: “Lighting Architecture,” taught by Cindy Limauro, undergraduate, Spring 2018, 2019 and graduate course, Spring 2018, 2019
- Was editor, Triangulation: Speculative Fiction, Parsec Ink, Dark Skies (2019)
- Ran a one-day conference (Dark Skies, CMU, June 1, 2019), which included a medical professional and all the varied aspects of light pollution mitigation.
- Was quoted in Post-Gazette, Pittsburgh Tribune-Review, The Verge, The Washington Post, The Dispatch, CMU’s Piper, Tartan, and Home Page stories, University of Pittsburgh’s Pitt News and University Times, interviewed on local radio (including NPR’s WESA station), filmed for KDKA evening news, filmed for Heinz History Center, a Hotel Mars radio guest on The Space Show and the John Batchelor Show with 1M listeners.
- Supported numerous education and public outreach activities (invited by pre-K-12 schools, gifted education programs, church groups, homeschoolers, AAAP, school clubs, PTOs, gifted education groups).
- Taught CMU Courses: Skyglow Research 99-520 Summer 2020, 2021; Summer Academy for Math and Science (SAMS) class on Astronomy: Light Pollution, Summer 2018; OSHER Class "Stars" Summer 2020; Three basic astronomy classes
- **ECWG Member, Ramotholo Sefako**, has
 - Presented at the New Zealand Starlight Conference: “Sutherland Central Astronomy Advantage Area (SCAAA) Protection Regulations: Preserving Dark Skies at SAAO” in October 2019.
 - Helped set regulations protecting SAAO observing facilities in Sutherland against threats to astronomy research at the observatory, called “Regulations on Astronomy Protection Regarding certain activities within the Sutherland Central Astronomy Advantage Area” and “Declaration to Prohibit certain Mining Activities within the Sutherland Central Astronomy Advantage Area” in terms of the Astronomy Geographic Advantage Act, 2007 (Act Number 21 of 2007). These regulations delineate the acceptable levels of dust from mining.
 - Authored the SPIE paper R. Sefako, S. Taaibos, J. Bernado, N. Macebele, A. C. Mulaudzi, P. Vaisanen, "SAAO observing station protection regulations," Proc. SPIE 11450, Modeling, Systems Engineering, and Project Management for Astronomy IX, 1145012 (13 Dec. 2020); <https://doi.org/10.1117/12.2562521>.
- **ECWG Chair, Connie Walker**
 - Is president of IAU Commission C.B7
 - Co-chaired SATCON1 and the D&QS workshops
 - Is co-chairing SATCON2 workshop and the D&QS conference

- Is a member of the AAS Light Pollution, Radio Interference & Space Debris Committee and has organized the last 7 January AAS sessions on that topic (and on satellite constellations)
- Is a member of the Arizona Astronomy Consortium led by Richard Green in addressing light pollution issues and ordinances in the Arizona community.
- Is a member of the IDA Board of Directors and their Governance Committee.
- Successfully obtained 0.5 FTE position at NOIRLab on dark skies protection.
- Been involved with many education efforts on light pollution and dark skies awareness. (See the next section.) One example is leading the Globe at Night program, which is the longest-running citizen science campaign measuring light pollution worldwide (www.globeatnight.org).

3. Education

- The IAU100 Dark Skies for All initiative was co-created by the EC WG Chair along with Sze-Leung Cheung. The Turn on the Night kits and the Dark Skies Ambassadors were the main foci of the initiative. As a result, there were many world-encompassing educational/outreach events for the public through the IAU100 Dark Skies for All Global Project in 2019. The legacy of Dark Skies Ambassadors continues through the leadership of the OAO.
- A couple of our EC WG members (Diane Turnshek, Connie Walker) and many of our C.B7 members (including Margarita Metaxa) have led local, national and international events and programs. See the C.B7 triennial report for examples such as IAU's First e-Light Pollution Exhibition and a worldwide children's art campaign themed "Together Under One Sky".
- Richard Green (EC WG Advisor), Connie Walker (EC WG Chair), Pedro Sanhueza (C.B7 member) and Margarita Metaxa (WG Co-Chair, Achieving Sustainable Development within a Quality Lighting Framework) created and presented at the 2-hour "Turn on the Night" associated event which was part of the IAU Symposium No. 367 (2020) on "Education and Heritage in the era of Big Data in Astronomy". The event had presentations on the latest dark skies protection issues considered by the IAU's Dark and Quiet Skies working groups. Presentations were also made on dark skies education programs and cultural/scientific heritage. <https://www.youtube.com/watch?v=vevSIjcF-og>

4. Future plans

The future holds much work in prioritizing and implementing recommendations from the five main WGs of the Dark and Quiet Skies workshop (Dark Sky Oases, Bio-Environment, Optical Astronomy, Satellite Constellations, and Radio Astronomy). The Dark and Quiet Skies (D&QS) SOC (as well as that of SATCON₁) is considering the best means of continuing this effort and are working on the SATCON₂ workshop and D&QS conference as vehicles for the discussions in 2021. A recommendation for the future is to create a center to include the work of stakeholders worldwide. One main goal is to get UN approval of the D&QS recommendations which may take the next term to accomplish.

In addition to implementing the D&QS recommendations, in particular, concerning the mitigation strategies for satellite constellations, there is the challenge in general of changing the mindset of people worldwide in favor of responsible, quality lighting (especially with LED lighting). This will require more work on the part of our working group, as does the protection of observatory sites and the areas around them. To that end, the EC WG should work more closely with Commission C.B7 and the WG members of D&QS to encourage and enable one or more regional lighting plans to protect observatories and/or critical habitat areas, which could provide exemplars for actual reduction in artificial light at night on a decade timescale.

New membership to the EC WG is a vital consideration in this next term.

Recruitment from especially younger members is needed and being examined. Fatoumata Kébé has agreed to join the EC WG this next term. Meredith Rawls is another astronomer under consideration. She recently joined C.B7. They are excellent sources on who to recruit for younger members. There is the membership of the OYA, C.B7 and the D&QS WGs to consider as well. Fatoumata Kébé also co-chairs the EC WG on Junior Members.

Thank you for allowing our EC WG and its members to work on protecting dark and quiet skies.