
MONT-MÉGANTIC INTERNATIONAL DARK SKY RESERVE

2021 ANNUAL REPORT



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General Information

After the pandemic made the year 2020 radically different from the usual context, the year 2021 did not bring a full return to normalcy yet. Nonetheless, our night-sky preservation efforts remained at full intensity despite the circumstances.

At the heart of the International Dark-Sky Reserve, Mont-Mégantic National Park and the ASTROLab were able to reopen for more public activities. In addition to the daytime visits, astronomy evenings were held at the summit and the base of the mountain, all-week in summer and weekends in autumn.

Many municipalities in the Reserve completed their streetlight replacement work in the follow-up to our preceding interventions with them. These new conversions are a significant step forward in the use of Amber LED fixtures in the buffer zone of our protected territory. The large-scale use of Amber LED lighting helps sustain the leadership of the mount Mégantic's region in dark-sky-friendly outdoor lighting.

Our influence is also felt throughout the national park system of Québec. The preservation of the nocturnal environment will be increasingly integrated in the overall conservation goals of all parks and the attractiveness of night-time activities to the public will also be developed and enhanced.

Contacts

The nomination in recent years of Mélina Dubois-Verret and Dany Gareau having brought a great impulse to our efforts, the year 2021 also saw a new addition to our team. Earlier this summer, Séverine Clause was hired by the MMIDSR as Dark Sky Protection Officer. Her presence on the field will enable us to work ever more closely with citizens and promptly answer the demands of our partners. As a reminder, the Reserve's team is an integral part of the staff of Mont-Mégantic National Park.



The Mont-Mégantic International Dark Sky Reserve Team :

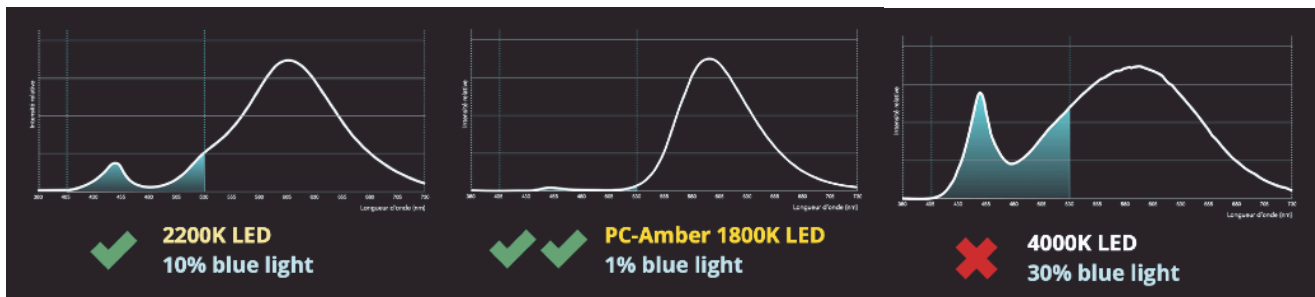
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Lighting

PUBLIC LIGHTING

In one of the most important street lighting conversion steps since the creation of the Reserve in 2007, at least 7 municipalities completed the transformation of their public lighting with Amber LED fixtures. In total, nearly a thousand Amber LED fixtures were installed in replacement of the previous non-cutoff HPS luminaires.

Not only do the new luminaires have 0% uplight, but they also emit almost no blue light. PC-Amber LED emit approximately 1% of their output in the blue spectral band (between 405 and 530 nm), compared to 10% for HPS, 20% for 3000K LED and 30% for 4000K LED.



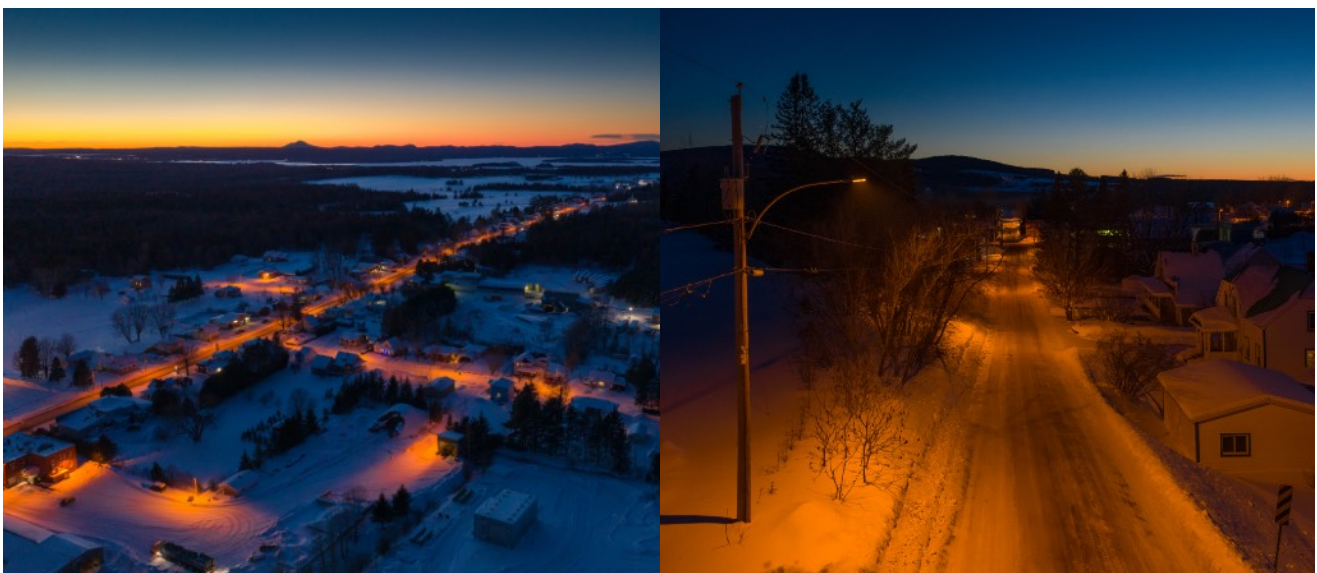
Based on the amount of fixtures, the most significant change happened in East Angus in late 2020, where 525 PC-Amber 1800K LED fixtures are now in service. After Sherbrooke, which is by far the largest city in area and population, the towns of Lac-Mégantic and East Angus constitute the next largest municipalities in the Dark-Sky Reserve. The retrofit work in East Angus is in itself an important achievement in reducing the number of non-compliant fixtures in the territory of the Reserve, especially in zone 2 (or "buffer area"), since most conversion projects were done in the core area in the early years of the Mont-Mégantic IDSR. Out of seven municipalities having completed their migration to Amber LED lighting in the last year, six belong the buffer area.



Just east of East Angus, the town of Bury also proceeded to convert its entire streetlight array to Amber LED devices. Located 27km from the Mont-Mégantic Observatory, it was the only municipality inside the zone 1 that was still didn't have fully compliant streetlights (either Amber LED or HPS). The new luminaires offer better illumination, including greater uniformity, less glare and no uplight, with a reduction in lumen output.



In addition to East Angus and Bury, the municipalities of St-Romain, Lac-Drolet and St-Sébastien also recently converted their public lights. These actions are directly linked to the energy savings and light pollution studies the Reserve team conducted in collaboration with those municipalities in 2019 and 2020. These field studies proved especially effective in demonstrating the potential energy savings and reduced maintenance costs of LEDs, while simultaneously helping the local administrations to choose truly dark-sky-friendly solutions.



Stratford and St-Isidore-de-Clifton deserve a special mention. While their conversion work was finished during the year, both of these municipalities had already started the retrofitting of legacy fixtures on their own over the last few years. We wish to congratulate their initiative in regard to the protection of the night sky and nocturnal environment and we hope that others will follow their path.



Green hooks: municipalities that recently completed their public light fixtures conversion to PC-Amber LED.
Yellow hooks: municipalities that already had 100% compliant public light fixtures (PC-Amber LED and/or HPS).

	PC-Amber LED light fixtures	Distance from Mont-Mégantic Observatory	Regional County Municipality	Dark Sky Reserve Zone
East Angus	525	39 km	Haut-Saint-François	Zone 2
Bury	92	27 km	Haut-Saint-François	Zone 1
Stratford	90	37 km	Granit	Zone 2
Lac-Drolet	85	38 km	Granit	Zone 2
St-Sébastien	74	39 km	Granit	Zone 2
St-Romain	48	37 km	Granit	Zone 2
St-Isidore-de-Clifton	37	35 km	Haut-Saint-François	Zone 2

The city of Sherbrooke has continued its streetlights conversion process. Just in the last three years, more than 3300 Amber LED streetlights (1800K or 2200K) have either replaced obsolete models or been installed in new developments of Sherbrooke's urban area. However, in recent months, the current semi-conductor shortage has forced Hydro-Sherbrooke, the responsible agency, to slow the pace of conversion while waiting for the delivery of already ordered devices. This slowdown can be illustrated by comparing the yearly numbers: roughly 600 new luminaires have been activated in 2021 up to September, while more than 1700 were installed in the whole of 2020. Nevertheless, major works are still scheduled for late 2021, such as the conversion to 2200K LED fixtures of a 3 km section of Boulevard Bourque, one of Sherbrooke's main commercial arteries.

With only a handful of municipalities in the Reserve's outer territory not fully compliant with the street lighting goals, we hope to be able to include them in one of our future annual reports. We already know that some of those administrations are currently assessing the available options.

PRIVATE LIGHTING

The Mont-Mégantic IDSR is currently engaged in an awareness campaign targeted at specific areas of the city of Sherbrooke. In order to reduce light pollution where it is most acute, we approached about 40 businesses on Boulevard Bourque. These businesses are car dealerships, hotels, retailers, grocery stores, restaurants and many more. Most of these have extensive exterior lighting. This business area is however surrounded by several residential neighbourhoods.

The goal of project « Objectif Ciel Étoilé » (Objective Starry Sky) is to establish Boulevard Bourque as the first commercial street in Quebec to conciliate businesses' needs and night sky protection. The core of the pilot project is a personalized process, free of charge for participating enterprises, that includes: eco-lighting consulting services, inventory of existing exterior lighting, regulation conformity assessment, proposal of replacement solutions and promotion of collaborating corporate citizens.



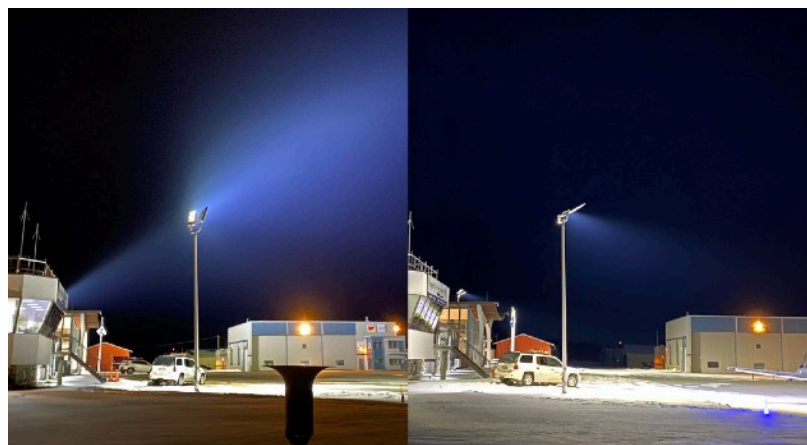
Since the majority of enterprises and their lighting are covered under vested rights, this project aims to appeal to and inform business owners, so as to induce them to modify their lighting fixtures in order to reduce light pollution and enhance the quality of life of the neighbourhood. This project is realized in collaboration with the city of Sherbrooke and "Commerce Sherbrooke", a non-profit organization whose mission is to support, encourage and advise local businesses. We have had as of yet a generally positive reception from business owners and hope to have several results to present to the city council next spring.



CCT of lighting from different car dealerships along Boulevard Bourque.

Even beyond our interventions and targeted projects, an increasing number of private and public institutions of the region are choosing proper lighting in conformity with city regulations, such as 1800K/2200K LED full-cutoff fixtures. While we are always pleased to see any new dark-sky-respecting installation, it has become more difficult to keep track of all new interesting setups in the Reserve, which is a nice problem to have.

We have had to intervene in some cases where inappropriate lighting was regrettably installed. One example this year was the Sherbrooke Airport, located between East Angus and Cookshire. New LED lamps had been mounted to light the tarmac between the runway and the hangars. The illumination was both very high and very badly directed, with most of the light launched skywards. Thankfully, the



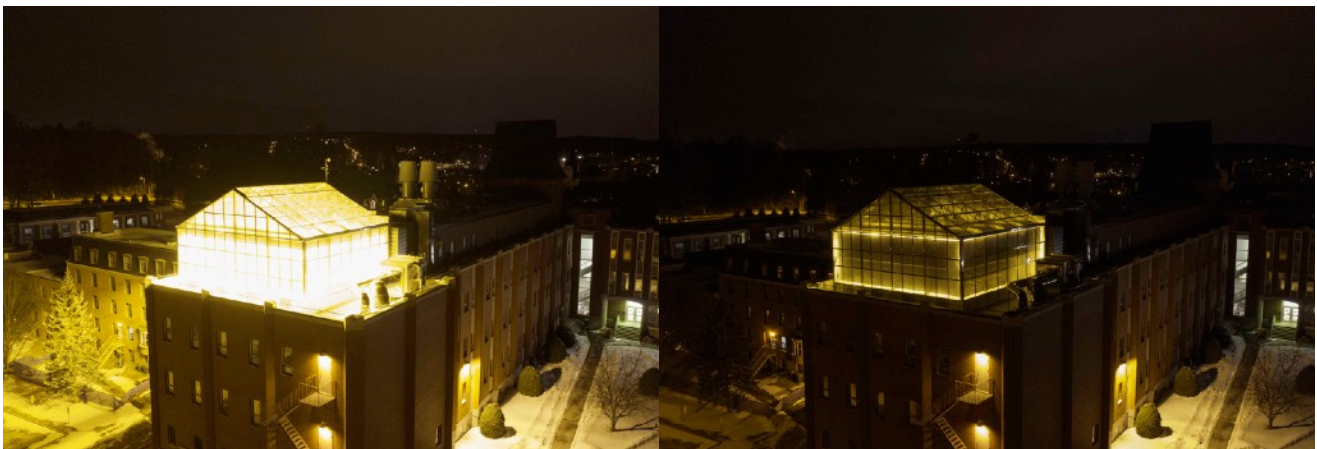
The badly aimed lighting of the airport sent a large amount of light towards the sky. Re-orienting the devices reduced wasted light and even illuminated the taxiways in a more effective way.

airport staff was cordial and collaborative when contacted, and solutions meeting their peculiar needs were discussed and developed. Modifying the fixtures' orientation proved quite illuminating in showing how the equipment could be employed more efficiently, while significantly reducing light pollution and, crucially, the blinding glare affecting pilots on final approach. Luckily, the majority of these lights are shut off most of the time and manually activated when necessary. As the airport is also in the process of replacing its security and building lighting, we are currently collaborating with them to guide their choice towards full-cutoff 1800K/2200K fixtures, eliminating the previous non-cutoff HPS wall packs.

REGULATIONS

The Regional County Municipality of Granit (RCM Granit) finally ratified its new light pollution ordinance after a multi-year revision process. This modified ordinance, very similar to the one adopted by RCM Haut-Saint-François in 2019, is a welcome update, being a notably better framework to manage allowed lighting types, especially by introducing colour temperature as a central criteria instead of using the lighting technologies.

One crucial addition to RCM Granit's regulation is new standards on greenhouse lightning. Previously, the ordinance applied mostly to exterior lighting. Considering the phenomenal amount of light produced by this growing industry and the increasing threat to the integrity of the Reserve's night sky, the interior lighting of greenhouses and the light pollution abatement methods of the producers are now regulated under this new county-wide framework. The challenge of constructing the dispositions of this new regulation has been to balance the efficient, effective and available



The research greenhouse of Bishop's University in the Lennoxville borough of Sherbrooke is already equipped with blackout curtains and represents an example of available solutions for greenhouses.

means of reducing light pollution and the specific needs and constraints of greenhouse agriculture. Those dispositions were significantly inspired by the national standards adopted in the Netherlands and we also consulted experts in the field. The RCM of Haut-Saint-François has also added these new elements to its existing ordinance.

This new part of the regulation is translated below:

"Greenhouse lighting

In addition to the provisions for exterior lighting, greenhouses using interior photosynthesis lighting must use vertical and horizontal blackout curtains to limit light leakage to the exterior. Buildings for greenhouse cultivation must comply with all of the following provisions:

- a) Vertical facades must have curtains obscuring 95% of the surface between sunset and sunrise or during lighting operations. No lamp installed inside should be directly visible from outside the building;
- b) The roofs must have curtains obscuring a minimum of 98% of the surface between sunset and sunrise or during lighting operations;
- c) The opacity of the blackout curtains must be a minimum of 99%, as certified in the product data sheet;
- d) Interior lighting devices must be designed and installed to not send any light upward (0% upright)."

NEW LARGE SCALE OFFERING OF 2200K LED FOR QUEBEC'S MUNICIPALITIES

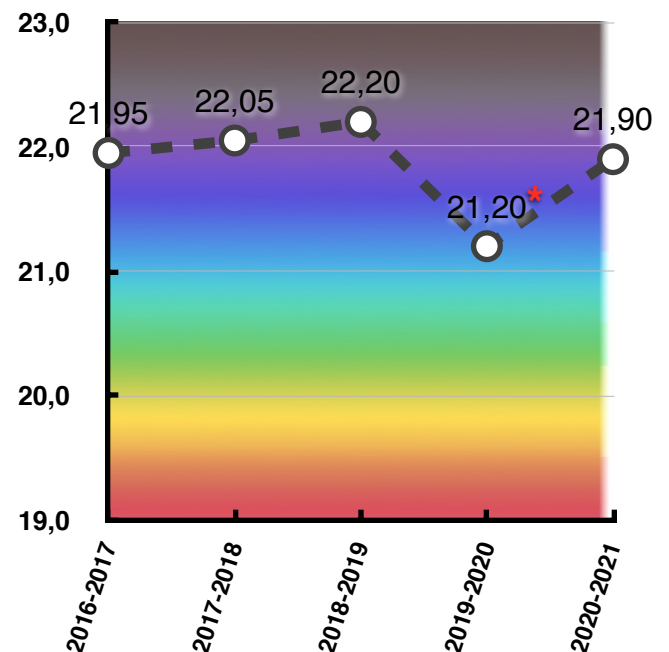
We are glad to report that the call for tenders made by the Fédération Québécoise des Municipalités (FQM, Quebec Federation of Municipalities), aiming to give municipalities easier and simpler options for 2200K or lower street lighting solutions, was won by the Energere bid. This company was already a major partner of the FQM and has previously converted the urban lighting of multiple dozen municipalities in Quebec. This 2200K LED standard is one more possibility for the townships of the MMIDSR, of course, but it marks a major step forward for the installation of truly "dark sky" fixtures in other regions of Québec interested in going beyond the ordinary 3000K and 4000K that are usually offered by Energere. We are looking forward to see more cities and municipalities go ahead with the installation of low-blue light LED fixtures thanks to this new turnkey solution.

Sky Quality

ZENITHAL SKY BRIGHTNESS

We've been monitoring zenithal sky brightness since 2016 with a SQM-LE installed at the summit of mount Mégantic and a TESS-W photometer since 2019 at the same location. Under these very dark conditions, we found in previous years that the best way to characterize the year over year sky brightness was to filter the SQM or TESS data to eliminate readings influenced by the Sun, the Moon, the Milky Way and, ideally, the clouds. SQM readings between February and October 2020 were not good because the IR filter of the unit was knocked off the lens assembly during a de-icing maintenance. This resulted in much brighter readings during that period. The SQM has now been repaired and so, while it's now back to normal, it's possible that readings from that point might be slightly different from the original state due to difference in calibration or materials. We'll see with more data from the SQM in the future years, but it looks quite possible since the TESS-W data (see next paragraph) doesn't show any brightening for 2021.

Most frequent SQM readings (in bins of 0,05 mag _{SQM} /arcsec ²)	
	Sun below -18° Moon below -5° Galactic latitude >40°
June 2016 to May 2017	21,95
June 2017 to May 2018	22,05
June 2018 to May 2019	22,20
June 2019 to May 2020	21,20* <i>*(most readings taken with defective SQM)</i>
June 2020 to May 2021	21,90 (SQM repaired in October 2020)

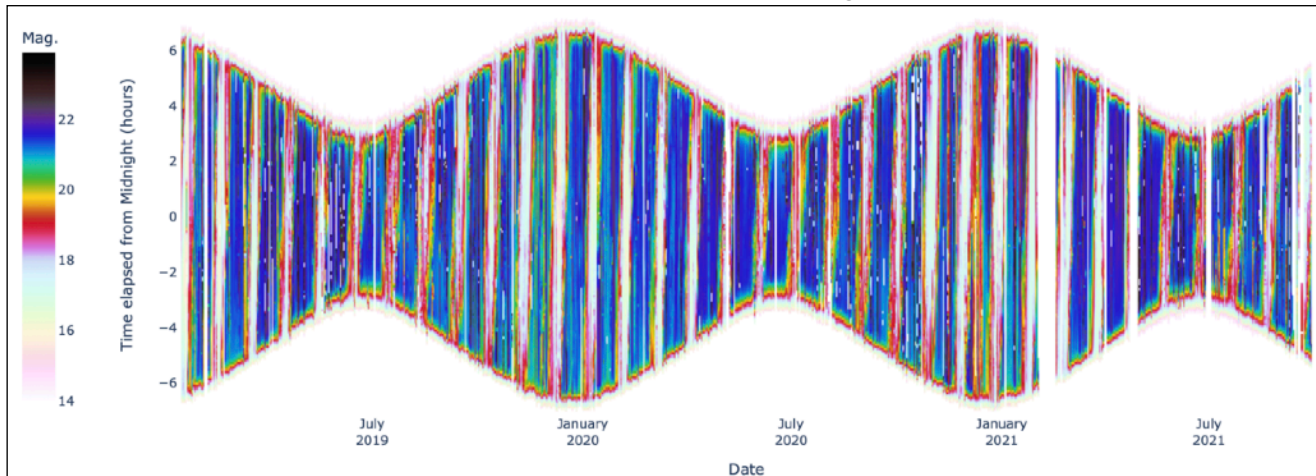


As mentioned, we also have a TESS-W photometer installed alongside the SQM since 2019. A newly available [online tool](#) has proved very useful in the analysis of the TESS-W data. Developed from the publication [Natural Night Sky Brightness during Solar Minimum](#) (Alacron et al., 2021), this

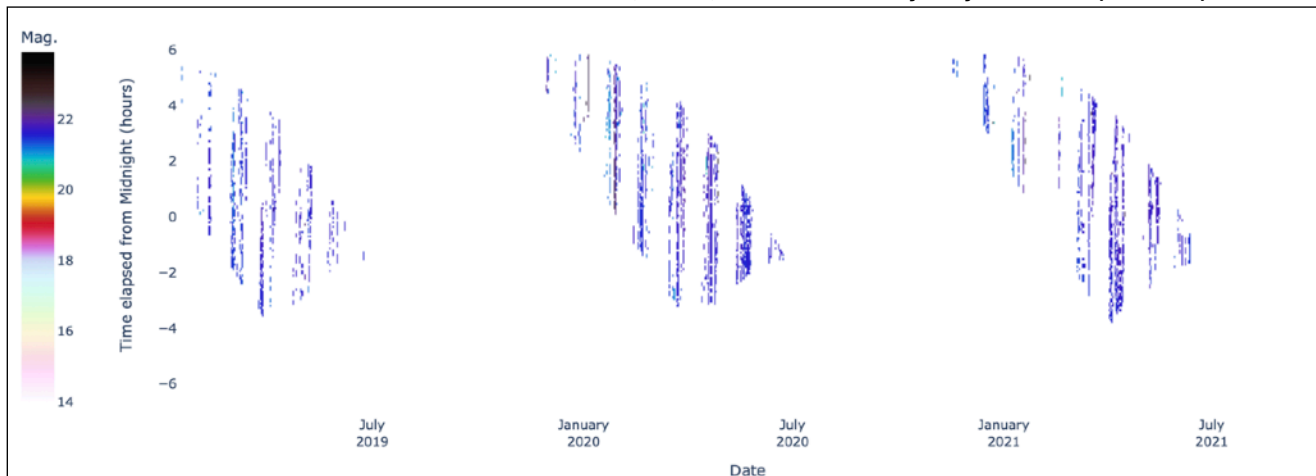
technique is highly similar to our previous method for filtering the SQM and TESS-W data. The Internet of Things EELab is an interactive website that allows the user to control and analyse data of all connected TESS photometers. With this tool, we can quickly dispose of data taken when the Sun and Moon are too close to the horizon, when the Milky Way is close to the zenith, when cloud cover is important or even when zodiacal light becomes a factor.

Filtering thresholds for the Sun and Moon remain the same as previously, and the Milky Way has been only slightly corrected ($>40^\circ$ galactic latitude against $>45^\circ$ in our previous reports). Cloud cover is filtered using a different method, but the results are similar. Zodiacal light is a possible new addition, but it was found non-significant in the data, with a difference on the median values measured at only 0,01 to 0,03 mag/arcsec² darker.

All recorded TESS-W measurements at Mont-Mégantic (stars237)

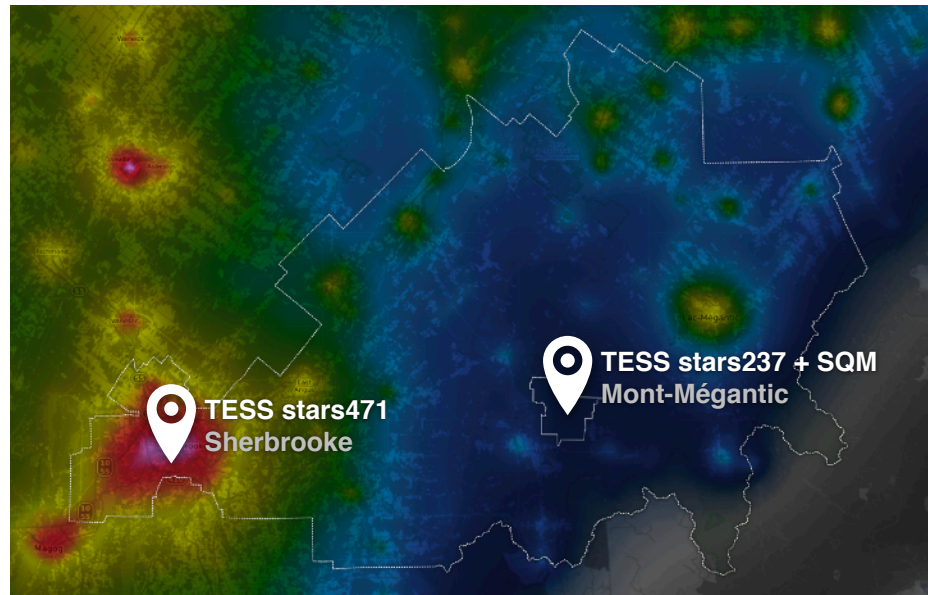


TESS-W measurement filtered to remove Sun, Moon, Clouds and Milky Way influence (stars237)



TESS measurements can easily be filtered and analyzed thanks to the new IOT-EELab online tool.

In order to study the evolution of light pollution in a brighter location, we have recently installed a TESS-W photometer in Sherbrooke, at the Mont-Bellevue city park. Not only will this unit enable the monitoring of light pollution in the Reserve's largest urban area, it will also benefit the Urban Night Sky Place project currently applying for an IDA certification.

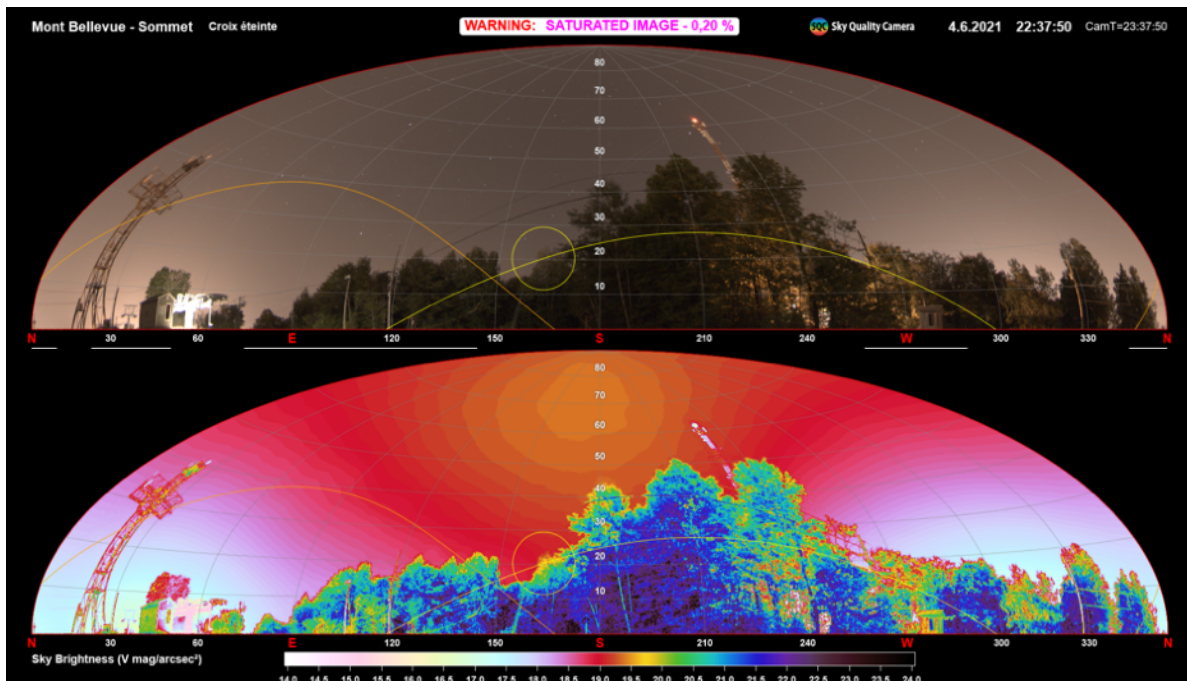
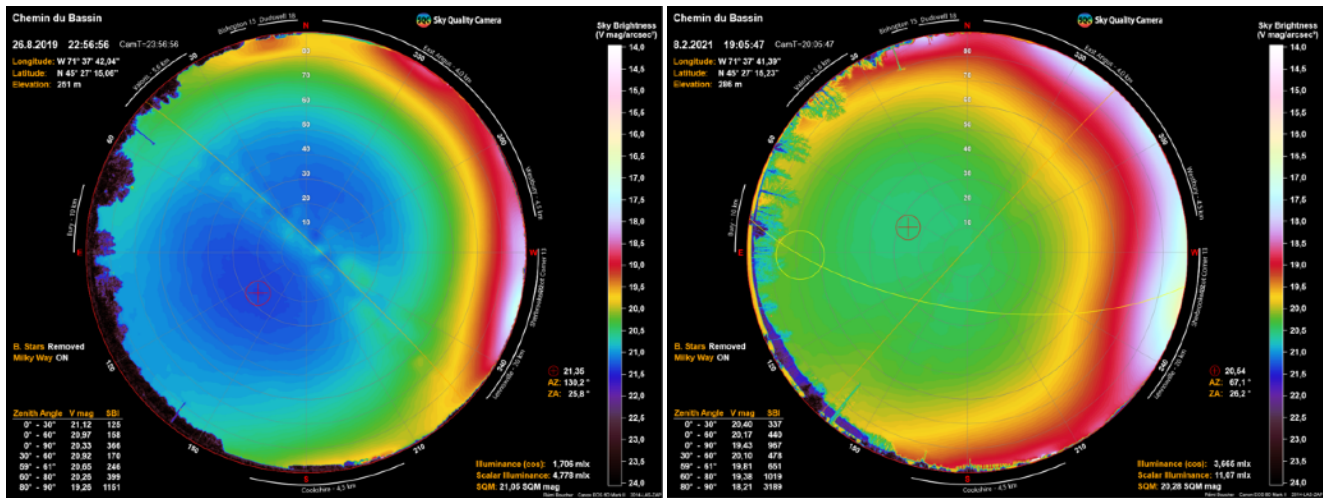


As the instrument has only been active for four months, the available data is still limited. Nonetheless, the device has already given a baseline for night brilliance in Sherbrooke, under clear skies, close to 19,6 mag_{TESS}/arcsec². It should be remembered that the spectral sensitivity of the TESS is different from the SQM and thus the reported magnitudes between the devices should not be directly compared. One of our goal is to follow the evolution of light pollution in Sherbrooke, considering the continuing public and private lighting conversion process as opposed to the demographic and building growth of the urban agglomeration.

Mont-Mégantic : TESS readings (mag _{TESS} /arcsec ²)			Sherbrooke : TESS readings (mag _{TESS} /arcsec ²)		
	Sun below -18° Moon below -5° Galactic latitude >40° No clouds			Sun below -18° Moon below -5° Galactic latitude >40° No clouds	
	Mean	Median		Mean	Median
2019	21,57	21,59			
2020	21,64	21,62			
2021	21,66	21,68	2021 *(May 12th to September)	19,58	19,57

ALL-SKY BRIGHTNESS

Few measurements were made in the last year with the Sky Quality Camera (SQC). Most of them were made mostly during winter time, in order to compare the amount of skyglow when snow is present on the ground and reflects light upward. Preliminary results were shown at the [ACFAS conference](#) in May, but we plan to acquire more of them in the future to have a larger dataset. Other measurements were also made to assist the project of Urban Night Sky Place in Mont-Bellevue.



All sky brightness measurements from the summit of the Mont Bellevue in Sherbrooke in June 2021.

Outreach

At the heart of the Dark-Sky Reserve, Mont-Mégantic National Park saw an increase of 30% in daytime visitors at the ASTROLab relative to 2020, for a total of 15 000 people. While astronomy evenings returned, public health regulations limited the permitted number of places to a fraction of the physical capacity. Nevertheless, 3800 guests were able to see the evening activities at the ASTROLab and the Popular Observatory. Full (limited) house all summer long, in fact.

Due to the pandemic, it was impossible to present the usual special summer events: the Popular Astronomy Festival in July and the Perseids Festival in August. It is dearly hoped that 2022 will see the return of these usually highly well-attended outreach events.

Online, the ASTROLab team has continued to offer occasional Facebook Live events, though the pace of those slowed. The educational efforts of the ASTROLab went mostly to online classroom events with schools all over Quebec and even beyond. Unable to come to the mountain, the mountain came to the schools, with interactive personalized videoconferences with an experienced astronomy guide. In total, 960 meetups were conducted, with 23 300 starry-eyed students!



In reconnaissance of its leadership and capacity to adapt in the difficult context of the pandemic, the ASTROLab's education team was awarded two important awards. In November 2020, the team won the "Award of Excellence in Heritage Interpretation" by the Quebec Association of Heritage Interpreters (AQIP). This award recognizes the exceptional quality of an achievement used for the dissemination and enhancement of a heritage resource.

Also, in 2021, the team won the Qilak Award for Astronomy Outreach and Communication. The award is sponsored by the Canadian Astronomical Society (CASCA), the Federation des Astronomes Amateurs du Québec (FAAQ) and the Royal Astronomical Society of Canada (RASC). It is intended to recognize Canadians who have made an outstanding contribution, during a particular time period, either to the public understanding and appreciation of astronomy in Canada, or to informal astronomy education in Canada, and to promote such activities among the members of the sponsoring organizations.

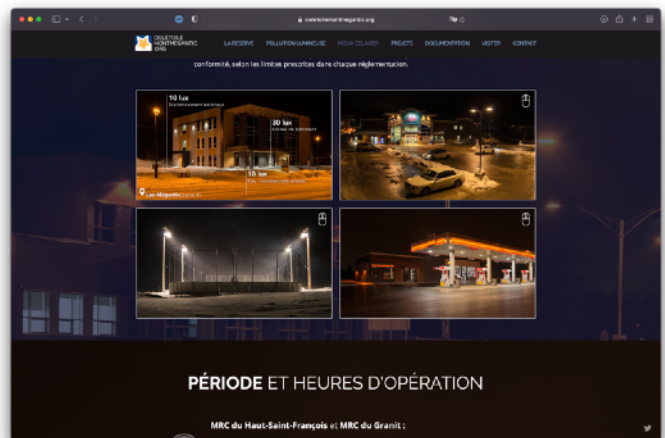
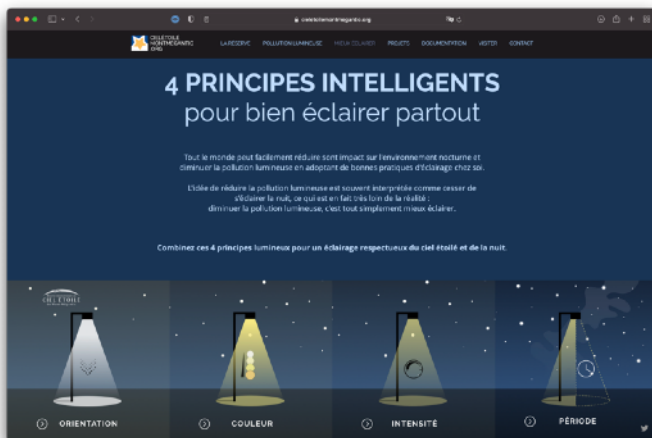
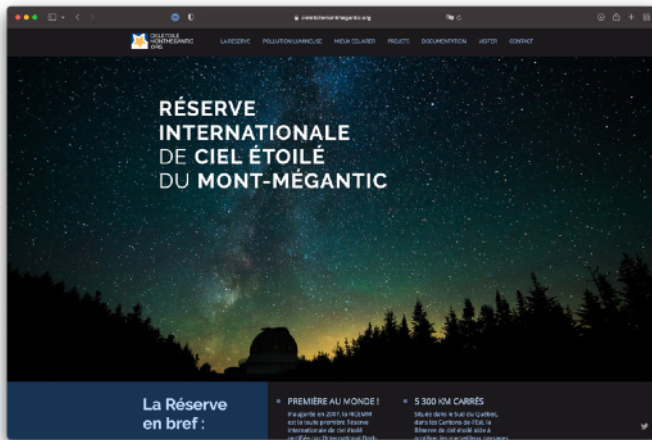


On the presentations and conferences side, Rémi Boucher and Mélina Dubois-Verret each gave a keynote during the ACFAS annual conference, where a seminar on Nocturnal Studies was part of the program. ACFAS is a non-profit organization contributing to the advancement of science in Quebec, Canada and international Francophone scenes. Rémi's presentation showed how the presence of snow can strongly increase light pollution in winter, while Mélina's showed our means of supporting the municipalities and bringing our expertise for Mont Tremblant National Park.

Remi Boucher also gave a conference during the Ontario Good Roads Association (OGRA) 2021 conference. The conference explained the impacts of light at night and how the Mont-Mégantic region was successful in limiting light pollution while achieving good public lighting.

In March 2021, Mélina Dubois-Verret presented during the Canadian Parks Collective for Innovation and Leadership (CPCIL) conference. She showed our work on Characterization of light pollution for Québec's national parks and their potential application for International Dark Sky Parks.

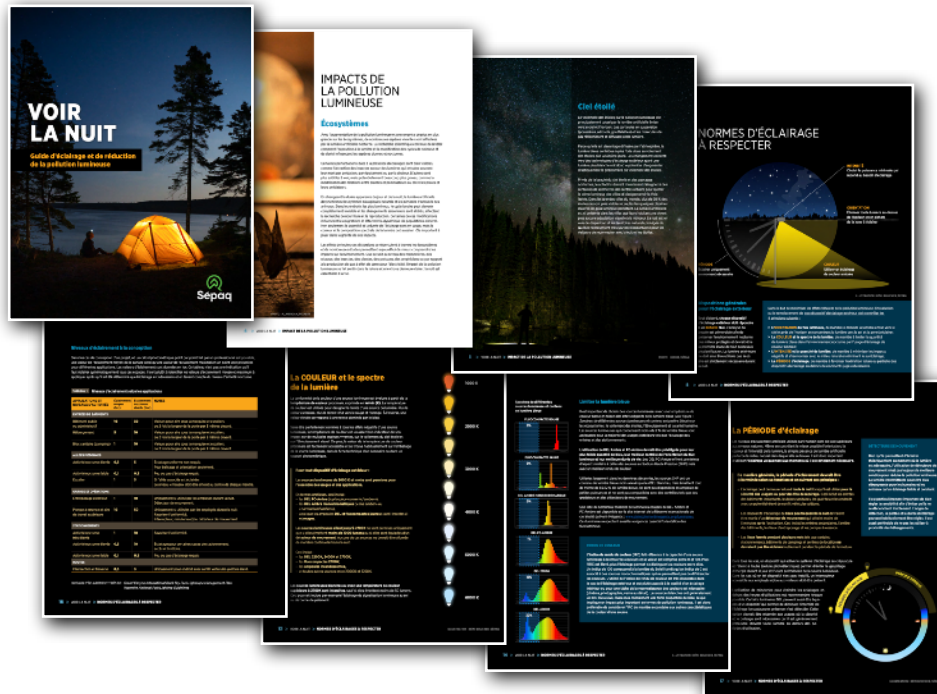
We also have a brand new website for the Dark Sky Reserve: meganticdarksky.org! The website, which is currently only in french (and also accessible at cietoilemontmegantic.org), will very soon be available in english. Not only is there a lot of information about the Reserve itself, but it also serves as a hub for informations about good lighting practices, links to the regions regulations, dark sky luminaires available in 2200K or less, ongoing projects, scientific studies, and much more.



Conservation and Research

On the Québec's national parks side, we are working on the "SÉPAQ étoilée" project. The project aims to give more presence to the night conservation inside the parks network. Not only does the protected territories should show the example in reducing light pollution, but the quality of the night time environment and the night sky experience go hand in hand with a great visitor experience.

Part of this year's efforts were focused on creating a completely new lighting guide for Quebec's national parks. The lighting specifications of the 30 pages guide were inspired by the recommendations and standards of the IDA, the International Union for the Conservation of Nature (IUCN), the Mont-Mégantic IDSR, Parks Canada, the Royal Astronomical Society of Canada (RASC), the US National Park Service (NPS), as well as the Bureau de Normalisation du Québec (BNQ). Guidelines from those multiples sources were combined in a way that any park following the guide will be using some of the best techniques to limit light pollution. A lot of attention was put in educating the reader to the negative impacts of light at night and making technical lighting information as easy to understand as possible.



Moreover, a dozen of TESS-W photometers are in the process of being calibrated and installed in many parks of the network. With a lot of potential for dark areas spread across Quebec and ongoing work in retrofitting light fixtures, several parks should attempt to obtain Dark Sky Place certification in the coming years.

Community and Media Relations

Some media appearances since the last annual report :

- Sébastien Giguère was interviewed about the dark skies in the television show "Y'a du monde à messe", Télé-Québec, September 2020.
- Featured in Fodor's Travel "9 of the Best Dark Sky Parks in North America to See the Night Skies", December 2020.
- In the journal La Tribune, about our pilot-project on Boulevard Bourque, February 2021.
- Another similar article on Boulevard Bourque, from Radio-Canada, February 2021.
- In the Haut-Saint-François local journal, an article looking at last year's efforts from the Mont-Mégantic IDSR team, February 2021.
- In the same journal, an article about St-Isidore-de-Clifton that completed their lighting retrofit to amber LED, March 2021.
- Mentioned in a story about the work on creating an Urban Night Sky Place in Sherbrooke, La Tribune, March 2021.
- Mentioned in SkyNews story about an art collaboration with the Mont-Mégantic Observatory, March 2021.
- An article in Bury's local journal, about the recent retrofit of the town's streetlights to Amber LED, June 2021.
- Interviewed for IDA's Nightscape magazine, in "Playing the long game", Summer 2021.
- Part of an article about Quebec's best astronomy locations, in Le Bel Âge magazine, October 2021.
- Mentioned in the national journal, Le Devoir, about Sherbrooke's plan for a future Urban Night Sky Place, September 2021.

We are very happy to participate in the upcoming IDA's annual conference in November, where we will be able to present some of our most recent projects and achievements. We hope this will give new ideas to other dark sky advocates and invite more people to join the movement about the conservation of nocturnal environment.

We hope IDA is satisfied with this year's annual report and that our actions show how deeply we care about reducing light pollution. Even with this many pages, this report could not include everything we've worked on and accomplished since last year.

**- RÉMI BOUCHER, SCIENTIFIC COORDINATOR AND SPOKESMAN, ON BEHALF OF
THE MONT-MÉGANTIC INTERNATIONAL DARK SKY RESERVE TEAM**