
MONT-MÉGANTIC INTERNATIONAL DARK-SKY RESERVE

2019 ANNUAL REPORT



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General Information

Twelve years ago, in September 2007, a region of 5300 km² around the Mont-Mégantic National Park in the province of Québec, Canada, became IDA's first International Dark-Sky Reserve. The Reserve currently encompasses 34 municipalities, including the city of Sherbrooke, that work to reduce light pollution and preserve the quality of the night sky and the nocturnal environment. With such a large territory and more than 211 000 people actually living inside the Reserve, the challenges to reduce light pollution are great but the benefits for all those people and for the one visiting the region are even greater.

Mont Mégantic was already known for its astronomy related activities for a long time with the presence of the Mont-Mégantic Observatory (OMM) since the late 70's and the ASTROLab in the 90's, but the creation of the IDSR really helped to consolidate and built partnerships between the national park, municipalities and local organizations. Mont-Mégantic is now internationally known for its efforts in preserving and experiencing the night sky and we can feel it with more and more with tourists coming from everywhere in the world.

The number of visitors for the ASTROLab grew substantially last summer, especially for our daytime activities where it went from 7000 to 9500 daily visits, thanks to a brand new 4K movie and VR experience introduced in 2019. Nighttime activities at the ASTROLab and the observatories did not increase as much during the same period, but they didn't have much room to grow as they were already almost filled to maximum capacity. The Mont-Mégantic National Park is currently working on new projects and installations to increase the capacity and the opportunities to watch the sky in the future. 19 500 people also follow us on Facebook, increasing last year's number by approximately 8,5%.

Contacts

The Mont-Mégantic IDRS team and activities are tightly woven between the Mont-Mégantic National Park (SÉPAQ) and the ASTROLab corporation. This year, we are happy to welcome Mélina Dubois-Verret in our team. Mélina's role is to reinforce our partnerships and relations with the municipalities, Regional Municipalities Councils (RCM) and other organisations. By being a strong link between the IDSR team and outside entities, Mélina is increasing our ability to do even more in outreach, lighting policies, research and conversion of lights. Many projects done during the last year could not have been achieved without her and many more are to come.

Mont-Mégantic International Dark-Sky Reserve Team :

- | | |
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Lighting

No major program to convert light fixtures was underway during the last year. However, municipalities inside the IDSR continue to follow the dark-sky regulations of the region and progressively install or change lights in accordance to its high standards. As a reminder, for most applications such as roadway and parking lots, light fixtures inside the IDSR are required to have a maximum CCT of 2200K with no uplight. Light levels and schedules are also regulated, each depending on on the type of use.

Following the work of the last years, the city of Sherbrooke converted hundreds of luminaires to PC-Amber LED across its territory, while adding new models for certain neighbourhood or streets. Being by far the largest city in the Reserve, Sherbrooke is where the largest number of new lights are being installed. Benefiting from the similarity of the visual colour of PC-Amber LED compared to HPS lamps, Hydro-Sherbrooke, the electricity provider and the entity responsible for the installation and maintenance of streetlights, has been doing HPS to LED replacements since 2015 for fixtures nearing their end-of-life or when other project of road work give them an opportunity. Prior to using LED, thousands of luminaires were already converted to full-cutoff HPS.



New PC-Amber LED luminaires installed inside the city of Sherbrooke. Multiple models of fixtures can be identified, from decorative to more regular streetlights.

Amber LED can also be found on many new commercial, institutional and industrial buildings. This shows that Sherbrooke's municipal inspectors are applying the regulation on exterior lighting when permits for new constructions are emitted. Monochromatic Amber LED are also used inside some luminaire models, mostly for wall packs or parking luminaires, but they are visually very difficult to differentiate from PC-Amber.



PC-Amber LED parking lights and wall packs on a new outdoor gear store.



Monochromatic Amber LED and 2700K wall packs.



Recently built school using PC-Amber and monochromatic Amber LED.



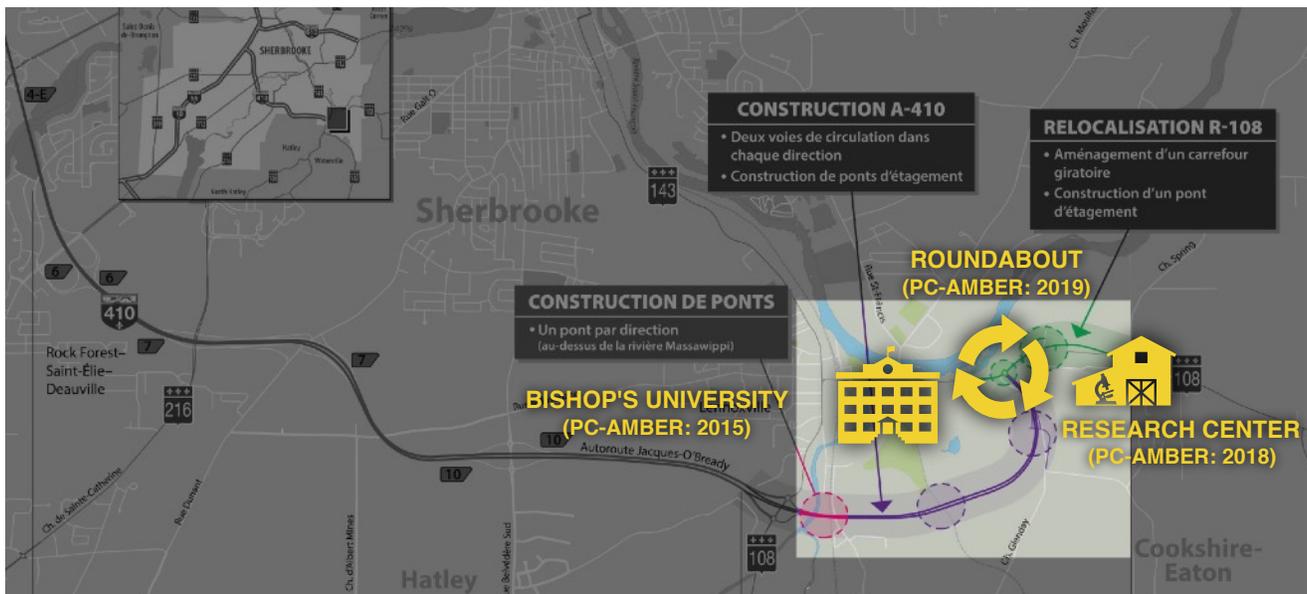
New gas station using PC-amber and warm light fixtures.



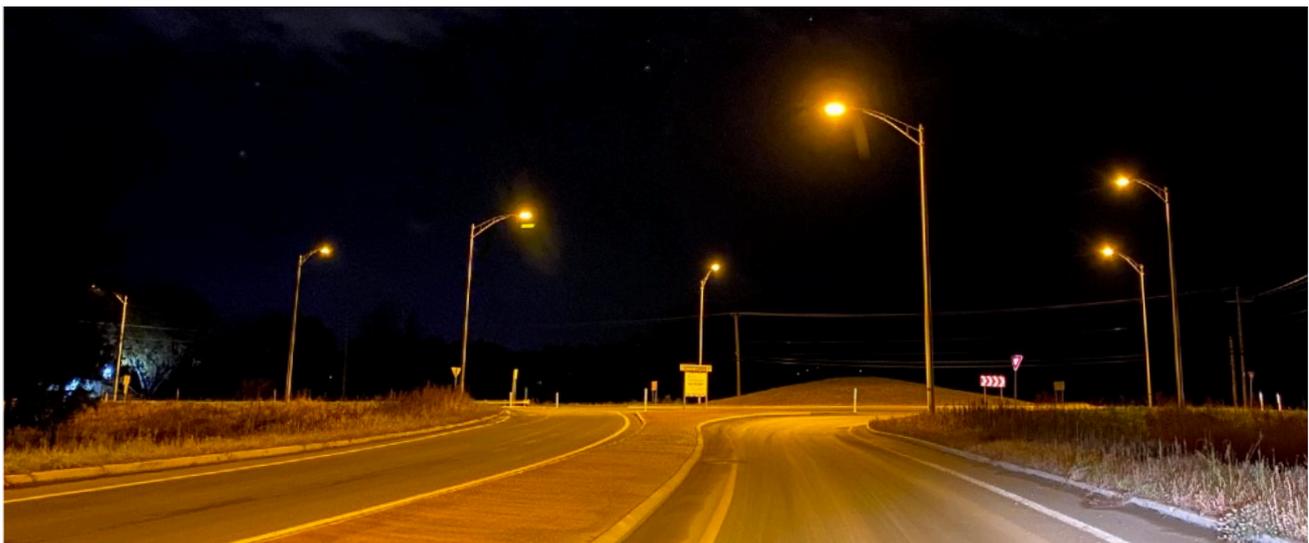
A pleasant surprise : a car dealership using Amber LED lighting! The front row of cars is lit with white LED for colour rendering while amber is used for the rest of the lot and the building entrances.



An important project to extend the Highway 410 by "Transports Québec" (Québec's Ministry of Transportation) is currently underway in the southern part of Sherbrooke. HPS luminaires were installed during the first phase of the project, between 2010 and 2015. This year, PC-Amber LED were installed for the roundabout that will end the new part of the highway, providing very good visibility with low glare. The roundabout is also very close to the Agriculture Canada's Research and Development Center and the Bishop's University that have both installed PC-Amber LED light in recent years (see [2015 and 2018 annual reports](#)). We are happy to see this good collaboration from Transport Québec doing major infrastructure work while respecting the efforts of the IDSR.



Final phase of the highway 410 extension.



PC-Amber LED illuminating the roundabout of Highway 410 and Route 108, in the District of Lennoxville, Sherbrooke.

In Lac-Mégantic, we also offered our expertise and support for the municipality inspector in resolving cases where complaints from citizens were made. For one site in particular, cool-white LED floodlights had been installed and were shining inside neighbour's houses. The headquarter of the company, being well outside the territory of the IDSR, didn't realized that special guidelines for exterior lighting were enforced in Lac-Mégantic and so proceeded with the same white LED installation that they did in other cities where they operate. Following our on-site visit and the inspector's report, the company was very receptive and agreed to change its lights according to the regulation. The good news is that not only did they change the cool-white LED projectors to full cutoff PC-Amber LED fixtures in Lac-Mégantic, but they also made a similar conversion for their site in Sherbrooke, where they also operate.



Before and after pictures of a transport company in Lac-Mégantic where cool-white LED were replaced with PC-Amber.

Another small but interesting conversion took place thanks to the volunteer work of a citizen from Lac-Mégantic, Bernard Boulet. He convinced the owner of a motel to change the lights outside his building to lower intensity and warmer lights, going from 5000K to 2700K. Lac-Mégantic has also been recently certified Cittaslow, an international network of "cities where living is good".

We also see changes in smaller municipalities, like Notre-Dame-des-Bois and Val-Racine, where some HPS streetlights have been replaced with new PC-Amber or 2000K LED during the last year, also trying new models from different manufacturers. Amber lights are also installed on private or institutional buildings, thanks to the good collaboration with some electricians in the region.



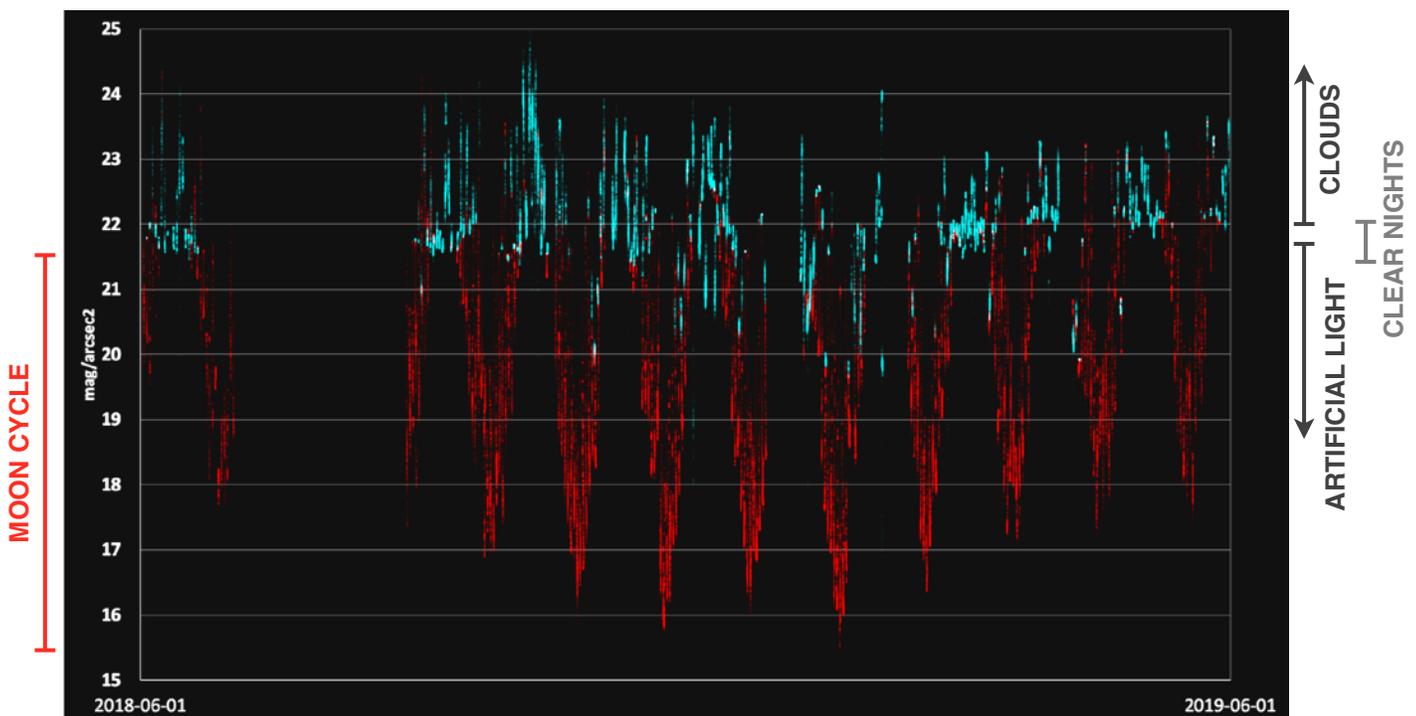
The Haut-Saint-François RCM, which encompass nearly half of the IDSR territory, officially updated its light pollution regulation in April. Multiple changes in lighting technologies made this update necessary. Of particular importance, colour temperature (CCT) is used in the new regulation, instead of the types of lighting technologies, to control for the blue light content. Also, the installation of electronic signs is prohibited for municipalities near the center of the IDSR, while also being restricted in number and type of use where permitted. A lot of effort were made to give more explanations when necessary and simplify when possible to make sure the regulation is more accessible to non-experts. A large summarizing table also helps in making the regulation easier to understand and apply.

Sky Quality

We are continuing and making good progress in our efforts to have much better monitoring and measurement of the light pollution and sky brightness inside the Mont-Mégantic IDSR :

ZENITHAL SKY BRIGHTNESS

We now have more than three years of continuous recording of the zenithal sky brightness with our SQM-LE installed on the summit of Mont Mégantic, at the center of the Reserve. With more than a million individual readings, many interesting facts were learned from this monitoring. The first year of measurements (2016-2017) showed us that the amount of light pollution at zenith is so low over Mont Mégantic that the SQM is recording mostly natural values of sky brightness. When taking only the data points during the astronomical night (i.e. when the Sun is lower than 18° below the horizon), the Moon cycle causes the biggest changes in sky brightness, reaching around 16 mag/arcsec^2 during full moons (see red points in graph). After filtering out the data when the Moon is present (resulting in the cyan points), cloudy nights can be recognized by darker measurements than the natural value of $\sim 22 \text{ mag/arcsec}^2$. Clouds amplify light pollution near a city, but they make the sky darker when far away from artificial light sources by blocking the light from the stars and the Milky way. There is also some occasional bright peaks caused by the use of artificial lights near the Observatories. Both the clouds and artificial lights will produce more variable and less frequent data points, while the natural sky will be more stable, allowing it to stand out in this large amount of data.



Reporting the most frequent value is often done but it can also be misleading because the Milky Way will have a strong impact on the recorded values for the greatest part of the year. A very dark site with no light pollution at zenith could be reported as brighter than reality because of this. Indeed, when looking at our measurements between June and January, when the plane of the galaxy is high in the sky, the values will typically be around 21,6 or 21,7 mag/arcsec², while the most frequent values between February and May is 22,0 mag/arcsec². For this reason, we proposed to only use values when the SQM is aiming at a galactic latitude of 45° or more, when the Sun is below 18° and the Moon is below 5°. We presented our methods and results last year during the Artificial Light At Night Conference (ALAN2018) in Salty Lake City, Utah, and received very good feedback on our use of the SQM. Further processing of the data could include the zodiacal light and airglow contributions.

Most frequent SQM readings (mag/arcsec²)		
	Sun below -18° Moon below -5°	Sun below -18° Moon below -5° Galactic latitude >45°
June 2016 to May 2017	21,60	22,00
June 2017 to May 2018	21,70	22,10
June 2018 to May 2019	22,05 *(missing July and August)	22,20

Following a strong lightning storm in the summer of 2018, the SQM-LE stopped recording for approximately 2 months before it was repaired and reinstalled. The ethernet module was repaired by the manufacturer and the SQM matched the reference value for calibration following the repair. We preferred to keep this SQM instead of replacing it with a new unit in order to avoid the risk of adding variability in the data from different units. Measurements during July and August are normally filtered out in our analysis because the Milky Way is near zenith so this data loss should not affect too much our year-over-year analysis. We will keep an eye in the next years to make sure the repaired SQM stay consistent with past measurements. For now, if there is a difference, it doesn't appear to be more than 0,1 mag/arcsec².

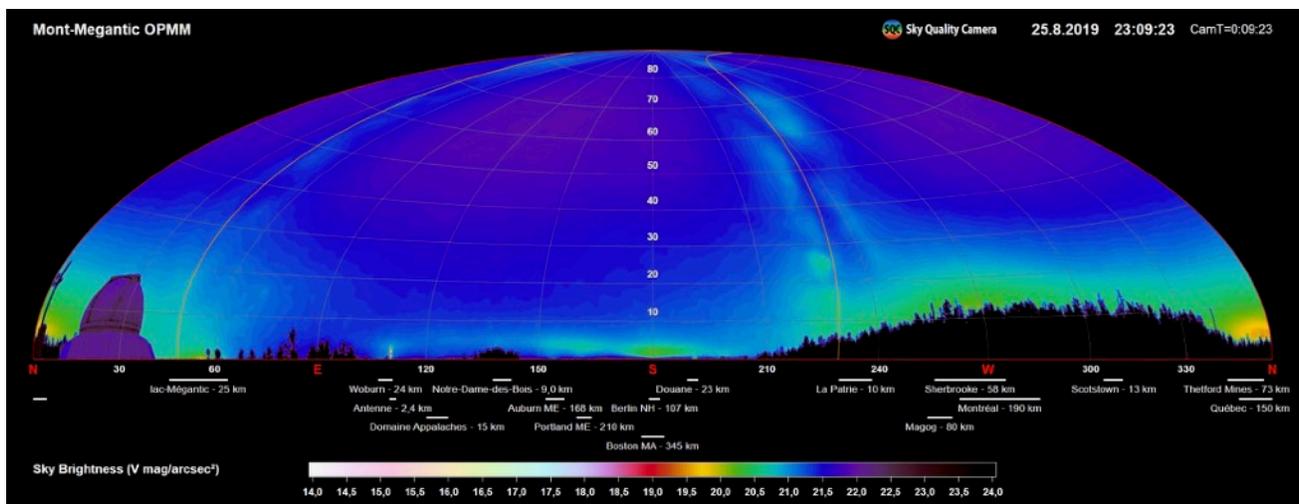
Although we are now confident to report that there is no light pollution at zenith under normal conditions, we could question the monitoring of light pollution with this method for the Mont Mégantic site. On the other hand, we do believe it is important to continue this longterm monitoring to make sure no light pollution becomes measurable in the future, but also because it will allow us to see the effects of the next solar cycle on airglow and the natural night sky brightness.

ALL-SKY BRIGHTNESS

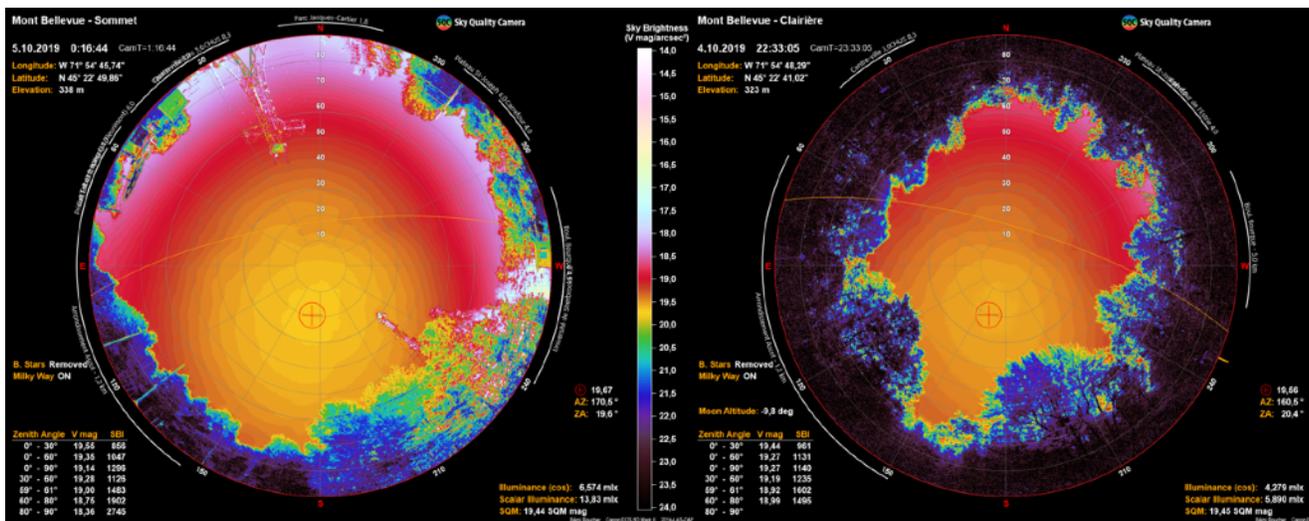
We are happy to report a big leap forward in our ability to take all-sky measurements. In 2007 and 2017, we relied on a collaboration with the NPS and the University of Colorado to take all-sky imagerie of the sky above Mont Mégantic. While we were extremely pleased with the results and the analysis, we were also looking for means to do all-sky monitoring by ourselves. This year, we acquired a Sky Quality Camera (from Euromix, Andrej Mohar, Slovenia) and we are very excited by the results and the new possibilities it offers us.

Key findings from the summit of Mont Mégantic:

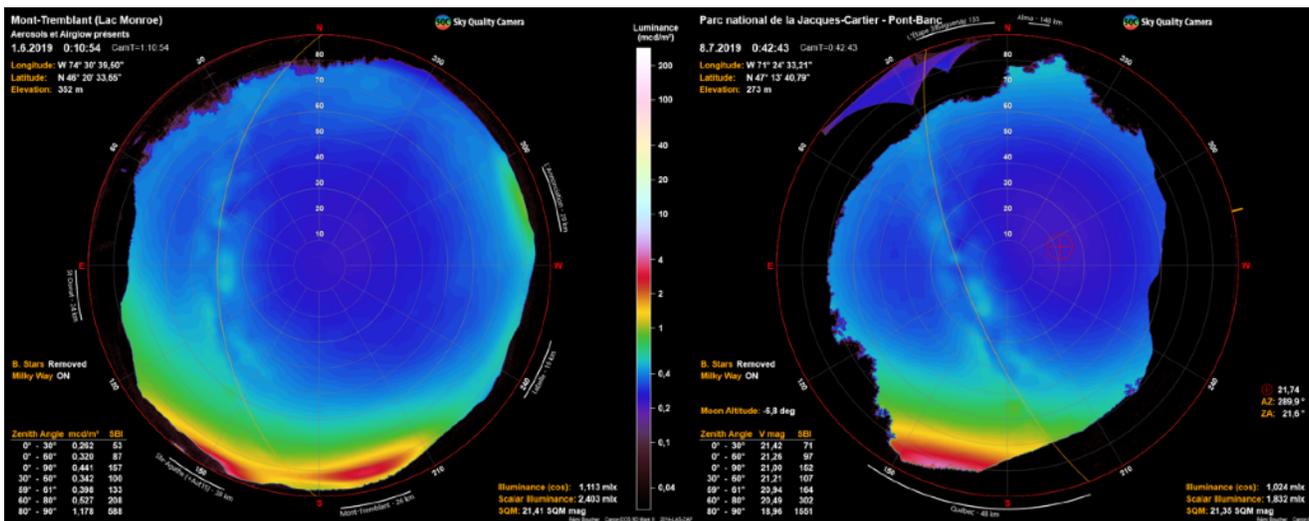
- The new method provides similar results to the NPS datasets. While the NPS method gives better resolution and allow for the subtraction of natural sky brightness, the SQC and its software provide other useful tools for analysis and easy sharing and outreach.
- The short exposure time for a single measurement will allow for time-dependant analysis.
- Weather conditions can have a huge impact on sky brightness, so we are taking measurements on nights with different conditions of transparency, humidity and cloudiness. In the next year, we plan on analyzing and comparing those.
- Consistent with the NPS data, artificial light is mainly present toward West and North, and light domes don't go higher than $\sim 30^\circ$ above the horizon. From North-East to South-West, the conditions are very dark and only very small light domes can be shown with the camera.
- Under very clear and transparent conditions, we could see the light pollution dome of Boston, MA, which is more 350 km away! This is possible because very few sources of light are present on our southern horizon. In comparison, Montreal, at 190 km is hidden behind the light dome of Sherbrooke, but Québec City (150km) is recognizable when looking North.



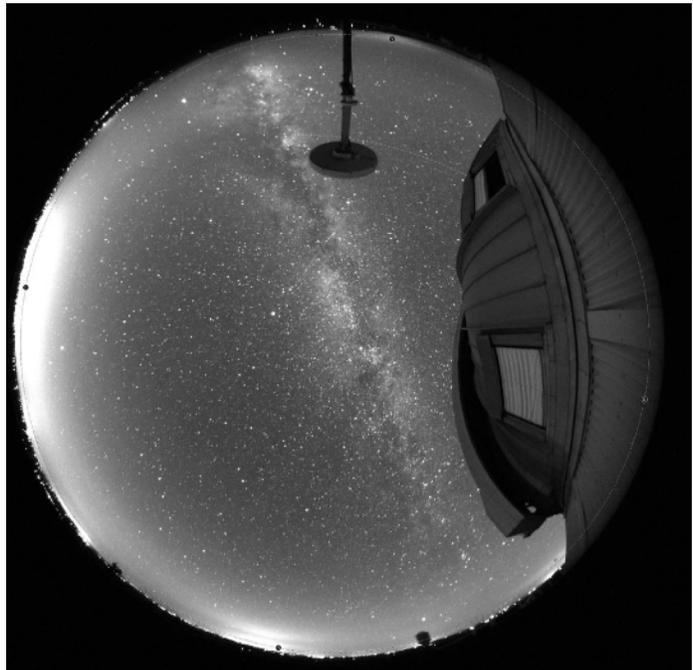
We are also using the SQC elsewhere inside and outside the Reserve. For example, we took measurements inside the Mont Bellevue municipal park, in Sherbrooke. The data is used in a project currently underway and led by Martin Aubé and Johanne Roby, from the CEGEP de Sherbrooke, to create a place where the Milky Way could be easily visible inside the city. Multiple actions are planned to reduce light pollution and a shared across teams of students for the CEGEP. If successful, the project would be a great candidate for a new Urban Night Sky Place.



We also used the SQC in a few other national parks in the Province of Québec to acquire better knowledge inside the network of parks managed by the SÉPAQ. We plan to continue with more parks in the coming years to provide a good portrait of light pollution across the Province's natural landscapes and see its dark sky potential.



Lastly, we are now in the commissioning period of a new permanent all-sky CCD camera installed next to the Mont-Mégantic Observatory (OMM). The camera is shared between the OMM and us, and is equipped with Johnson astronomical filters that will allow us to measure light pollution over time and in multiple colours. For now, the OMM is mostly using it to monitor the night sky during observation and keep an eye on the changing weather. The final site for the installation camera is not yet determined, but it will stay relatively close to the observatory, while being far enough from it to provide the clearest possible view of the horizon and the sky.



Outreach

As usual for us, most of the outreach is done inside the national park and the ASTROLab. Astronomy evenings are done both at the ASTROLab and at the Mont-Mégantic People's Observatory, with special nights at the bigger Mont-Mégantic Observatory during the annual Astronomy Festival, and all-night observation during the Perseids meteor shower. The themes of light pollution and the Dark-Sky Reserve are addressed during our astronomy evenings, observatory visits and across many interpretative signs.

Outside the park, we were also present with our telescopes for different events, such as an outside astronomy evening in East-Angus, the "24 hours of science" event in Sherbrooke or the BESIDE festival in Boucherville (near Montréal).

We also gave many conferences about light pollution inside and outside the IDSR :

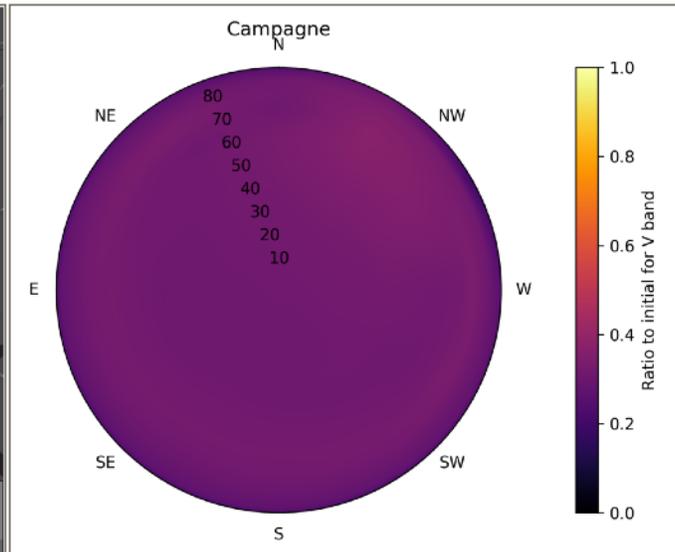
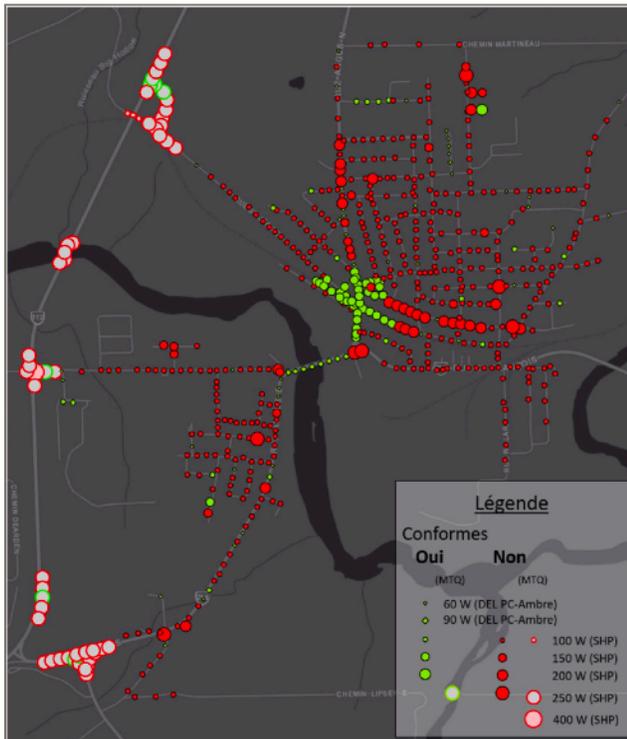
- for ALAN2018, in Salt Lake City, where Rémi Boucher and Sébastien Giguère presented 2 talks about the monitoring of light pollution and the social engagement inside the Mont-Mégantic IDSR.

- in Marrakech, Morocco, for the "Atlas Dark-Sky Morocco Workshop". They are currently working on a Dark-Sky Reserve project that would encompass the Oukaimeden Observatory.
- at the [Canadian Parks Conference](#), in Québec City, where we presented our light pollution monitoring methods and results to the Canadian parks and conservation community.
- at Montréal's Rio Tinto Alcan Planetarium, for the International Astronomy Day.
- in Lac-Mégantic, as part of their first conference linked to the [Cittaslow project](#).
- in La Patrie, with Martin Aubé, organized by the Fédération des Astronomes Amateurs du Québec.
- for the students of the Montignac High School, in Lac-Mégantic, as part of their "Environment Week".
- for the Coaticook RCM and municipalities councils, who are interested in doing their part in reducing light pollution. The Coaticook RCM shares borders with our IDSR and has a good potential for dark sky.
- at a [big event in Baie-Saint-Paul](#), in the Charlevoix region, where the municipality started a plan to reduce light pollution and maybe seek dark-sky certification in the future. Three conferences were given in the same day : for the elementary school kids, for the municipality's elected officials and employees, and for the citizens of Baie-Saint-Paul.

Conservation and Research

A group of 4 students, doing their master degree in Environment at the Université de Sherbrooke, made a study about the economic benefits of the Mont-Mégantic IDSR. As part of their project, they built tools to analyse where visitors came from, what brought them in the region and how and where are they spending. While the study and their presentation was very interesting, it is still very hard to differentiate the Dark-Sky Reserve, the national park, the ASTROLab and the Observatory, to really know the economic impact of the IDSR creation. Our feeling is that the Dark-Sky Reserve has an impact on our attractiveness to international visitors, while people from the Province of Québec already knew "Mégantic" as a place synonym with "astronomy" or might be coming for the national park's activities at first.

Another student, Aude Kalcina, who was doing a master degree in Environment Engineering at the École des Technologies Supérieures, spent a few months with us to make a project about the cost and methods of converting the streetlights of East Angus. Approximately a quarter of the streetlights not yet replaced in the Mont-Mégantic IDSR (apart from the city of Sherbrooke) are in East Angus. This gave us an opportunity to look at the economics of a conversion to PC-Amber LED, analyse a few scenarios, get information about different models of luminaires currently available and model how it would impact the night sky. Aude completed a precise inventory of every streetlights in East Angus with information about the physical environment around each lights. A collaboration with Alexandre Simoneau and Martin Aubé allowed us to obtain modelizations of the predicted reduction in light pollution. The findings were presented to the municipality officials, who responded very positively to the analysis. We hope this will translate into actions in the near future.



Converting every HPS cobrahead (shown in solid red) to PC-Amber LED would result in a ~65% skyglow reduction for a theoretical observer 4km outside East Angus. This does not take into account private lights contribution to skyglow, but shows how much the city could reduce its impact.

We also visited two more national park in Québec, Mont Tremblant and Frontenac, to do a complete exterior lighting inventory and propose a plan to make them more dark-sky friendly in the future. The year before, we did the the same with the Mont Orford National Park. We are working to help more and more parks and installations part of the SÉPAQ network to adopt good lighting practices.

Community and Media Relations

Some media appearances we are aware of :

- CNN's "Dark Skies : 23 best places in the world to stargaze", July 2018.
- "Dark Skies are the new black", Grownup Travels, Oct 2018.
- LaTribune newspaper, covering our presence at the Atlas Dark-Sky Morocco Workshop, Nov 2018.
- A 4 pages articles in the french astronomy magazine "Ciel et Espace" about the first decade of the Mont-Mégantic IDSR, March 2019.
- Mentioned in an article about Dark Sky Reserves in Costco's magazine, May-June 2019.
- Featured in GEO magazine's "Tour du monde des plus ciels étoilés", June 2019.
- Listed in the new Lonely Planet's astrotourism guide "Dark Skies", Sept 2019.
- Many news articles about our presence at the Baie-Saint-Paul event about reducing light pollution, Sept 2019.
- National Geographic, "These are the best world's best stargazing spots", Oct 2019.



