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# MONT-MÉGANTIC INTERNATIONAL DARK-SKY RESERVE



2018 ANNUAL REPORT

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## Summary

Well before the Mont-Mégantic IDSR was created, the construction of the Mont-Mégantic Observatory (OMM) started to bring the stars at the forefront of the region. Celebrating its 40th anniversary this year, the Observatory was an important factor in the creation of the national park in 1994 and one of the primary reason for the establishment of IDA's first International Dark Sky Reserve in 2007.

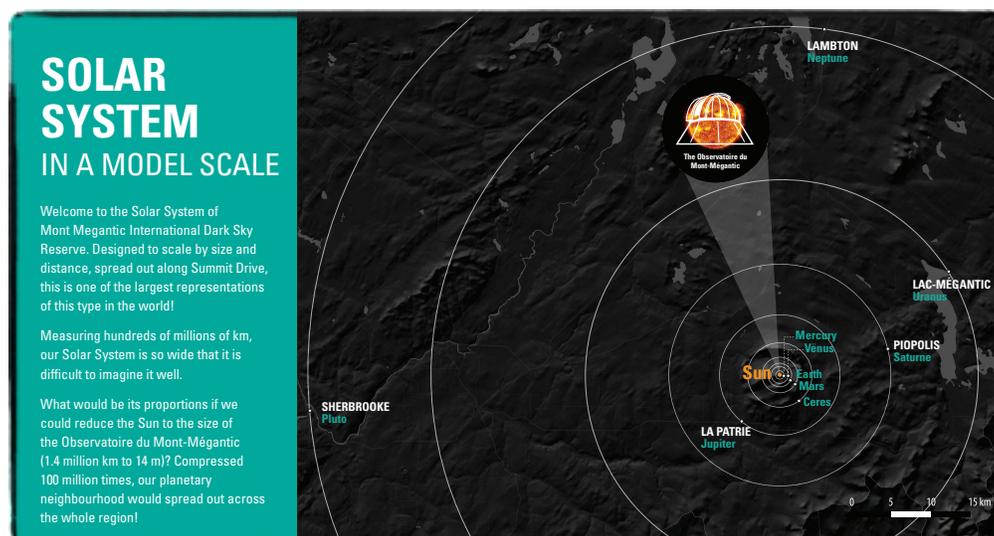
Continuous efforts in education and outreach have always been important for the institutions that orbit around Mont-Mégantic, especially for the ASTROLab and the national park who carry most of those activities and who lead the Mont-Mégantic IDSR. In the words of René Racine, the Mont-Mégantic Observatory's first director : *"Of the main goals that we set for Mégantic before it was built, the flourishing of astronomy in Quebec's culture is the most important to me today. I've written 150-200 scientific papers in my life... nobody reads them nowadays. But, there is still a lot of people visiting the observatory and the park! So, for everybody engaged in outreach, thank you."*

The installation of PC-amber LED fixtures is still continuing, with a lot of new lights installed in Sherbrooke. We don't have the exact numbers, but at least many hundreds were installed in new development, both for street lighting and for commercial, institutional and industrial buildings. Smaller cities are also installing them, at a slower pace, converting old HPS luminaires in the process.

## Outreach

- The Mont-Mégantic national park is still welcoming more and more people during our astronomy activities, with an increase of 15% between May and August. The Astronomy Festival in July and the Perseids Festival in August were especially busy for 2018, with respective increases of 74% and 46%, and totals of 2050 and 3335 visitors.
- Our number Facebook followers is steadily growing. We now have 18 000 people liking the ASTROLab's page, an increase of 12,5% from last year.
- Press :
  - A four pages article covering the 10 years of the Mont-Mégantic IDSR. Québec Science, January 2018, <https://www.quebecscience.qc.ca/espace/sous-un-ciel-etoile/>

- An editorial by Paul Journet about the loss of the night sky. La Presse, January 7th, 2018, <http://www.lapresse.ca/debats/editoriaux/paul-journet/201712/27/01-5148455-pollution-lumineuse-rallumez-les-etoiles-.php>
- A newspaper article announcing the upcoming art sculptures for the Dark Sky Reserve to be installed in Sherbrooke and Nantes. La Tribune, September 6th, 2018, <https://www.latribune.ca/actualites/un-peu-du-ciel-etoile-au-bout-de-la-610-303480086896d43ab8125529f36ec0b4>
- An article relating the experience of a journalist during an astronomy evening at the ASTROLab and the work done for the Mont-Mégantic IDSR. Le Devoir, June 30th, 2018, <https://www.ledevoir.com/vivre/531343/reportage-cinq-etoiles-pour-des-astrotours>
- Building a Solar system to scale has always been a challenge. Most of them choose to show either the size of the planets or the distance between them. The immense difference between the scales of the solar system bodies and their orbits makes it really difficult to show both characteristics at the same time. Using the large size of the Mont-Mégantic IDSR (still IDA's largest Dark Sky Reserve) and the Mont-Mégantic Observatory, we built a solar system respecting both scales! By shrinking the Sun to the size of the Mont-Mégantic Observatory (100 millions : 1) and using it as the center of our scaled solar system, we installed interpretation panels for each planet, including dwarf-planets Pluto and Ceres, inside the national park and in many of the IDSR's cities. Each panel has it's own scaled celestial body (a polished metal sphere or a metal ring for the biggest planets) and display informations to help understand the size of the solar system. When possible, the sites were chosen so that the Observatory would be visible on the horizon. This installation is part of the efforts made for the visibility of the Mont-Mégantic IDSR and to continue building the identity of the region.





Pluto, Sherbrooke



Uranus, Lac-Mégantic

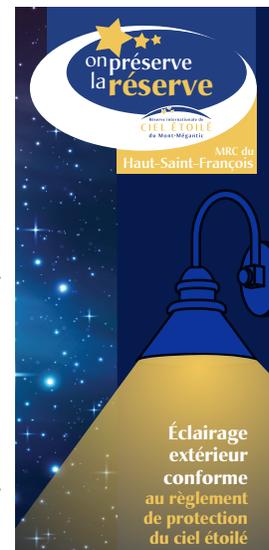
- A great article covering the conservation efforts in reducing light pollution around Mont-Mégantic was recently published in "Le Naturaliste Canadien", a Canadian scientific journal specialized in nature and environment. The efforts to control light pollution for the last 10 years are explained and our results from the monitoring of the evolution of artificial night sky brightness are shown. Written by Camille-Antoine Ouimet, Mont-Mégantic National Park's conservation coordinator, the article should help to bring awareness to light pollution in the larger conservation field.
- Many conferences outside of our normal activities were given during the last year. Most of them were at the request of organizations from outside of the ISDR :
  - Part of a program for "Planning the sky", the National Capital Commission (NCC) in Ottawa (Canada's capital) invited three speakers to share their expertise on green infrastructures, bird collisions avoidance and light pollution. With an expert invited for each of those elements, Rémi Boucher, our scientific coordinator for the MMIDSR, gave a very well received talk about light pollution to both the staff of the NCC and to the public. More information on : <http://ncc-ccn.gc.ca/posts/planning-the-sky>
  - We were invited by the Sierra Club Hudson Mohawk Group in Albany, NY, to give a talk about the concept of Dark Sky Reserve and the negative impacts of light pollution on the environment. A videoconference was given to the attendance to minimize travel but the presentation was very appreciated and many questions followed the talk.
  - The Laurentides' Regional Council of the Environment (CRE Laurentides) also asked us to present during their climate change forum in the city of St-Sauveur, QC. Using the

example of the MMIDSR, the mitigation of light pollution was shown to help reduce the consumption of energy and to reduce the negative impacts of light at night.

- The results and analysis of our measurements of the night sky brightness were presented to the annual meeting of the Center for Research in Astrophysics of Quebec (CRAQ), which regroups the scientific of the Mont-Mégantic Observatory and the affiliated universities. Our work was very appreciated and collaborations with some researchers will follow in the future.
- We also visited the Montignac High School in Lac-Mégantic to speak about light pollution and the MMIDSR. This was part of the school's special activities for the students during their Week of the Environment.
- The town of Ayer's Cliff, which is approximately 25 km outside the border of the MMIDSR, asked us to come and do a public talk about the issues of light pollution. Many people participating in different municipal committees were present, including the mayor. The talk was very appreciated, and we will provide them with future help depending on their needs.
- We will also be present to two upcoming international conferences :
  - Later in October, Rémi Boucher will be presenting as a key speaker for the Atlas Dark Sky Morocco symposium (<http://atlasdarksky.com>). Two talks are planned: one for the symposium attendance and one in the evening open to the people of Marrakech.
  - We will also be present during the ALAN 2018 conference in Salt Lake City. Both Rémi Boucher and Sébastien Giguère will be presenting keynotes linked to the 10 years of the MMIDSR. The lessons learned in the social engagement aspect will be explained by Giguère while the monitoring and evolution of the protected night sky brightness will be presented by Boucher. (<https://artificiallightatnight.weebly.com>)
- Early this summer, we met with people interested in protecting the night sky over Katahdin Woods and Water National Monument in Maine, USA. Our experience in creating the Reserve was very helpful to them. We discussed in length the challenges and benefits of different types of dark sky designations and the realities associated with their region. We wish them good luck to protect one of the darkest parts of New-England.

## Regulation

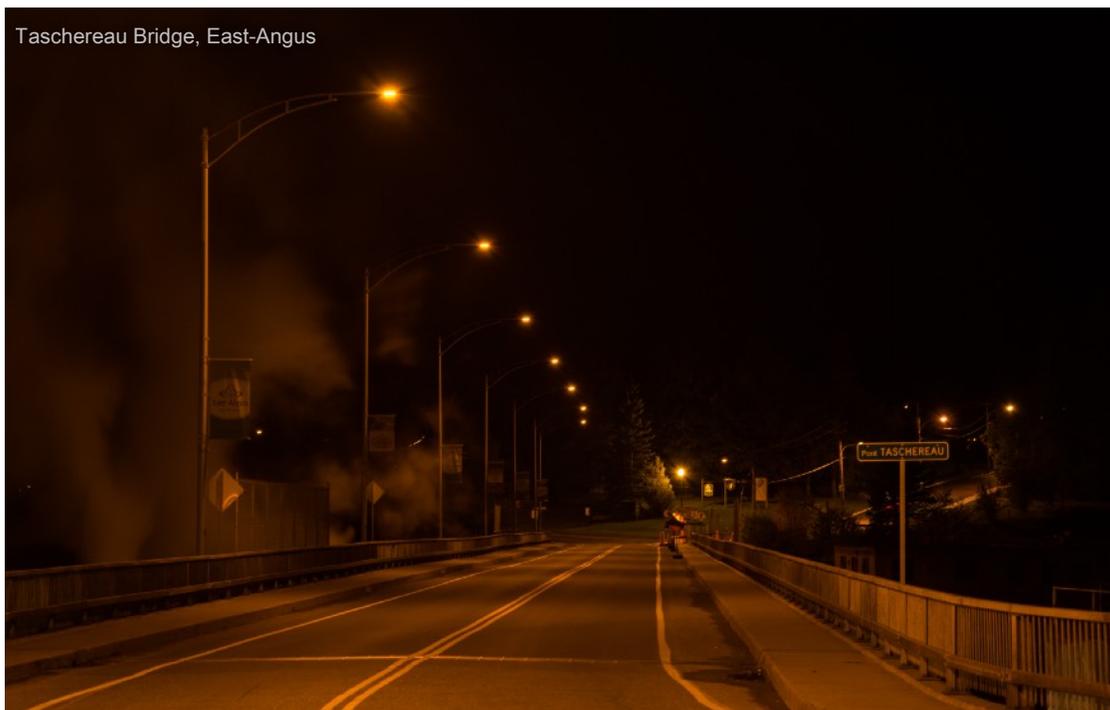
- We are still working on updating the regulations covering the 2 main regional county municipalities (RCM, county-like political entities), the Granit RCM and the Haut-Saint-François RCM. While the updates are taking longer than we thought at first, the process should be completed by the end of 2018. The updates carry on with most of the original regulations, but will better address the changes in the lighting technologies and market of the last decade. For example, color temperature (CCT) will be used instead of to technologies themselves to reduce the emission of blue light. Having a simplified table will also help to identify the characteristics that need to be controlled depending on the applications.
- The Haut-Saint-François RMC, which represent approximately half of the MMIDSR, decided to start a program to help the residents and the different officials of the IDSR in protecting the dark skies. The project, called "*On préserve la Réserve*" (meaning "We preserve the reserve"), started with a large press conference and a formation by Rémi Boucher was given to city officials, inspectors, and electricians to better understand and respect the regulations. Pamphlets about the IDSR are being distributed, lists of available luminaires can be found on the municipalities websites, and astronomy activities are being held on different occasion throughout region. By approaching many sides at the same time (residents, electricians, city officials, etc.), the project hopes to reduce the potential installations of bad fixtures and the amount of work that would be needed without some kind of prevention.
- A new job will soon be opened to assist the municipalities and RMCs in regard to the regulations and applications. Sometimes, people don't know who to refer to when formulating a complaint or they simply don't understand the regulations well enough. Also, lighting technologies, methods and evolving concepts are still fields that are not well known for most, even by electricians who regularly install lighting fixtures. By having an expert who can give advices, follow particular cases and assist professionals, it will be easier for the municipalities to participate in reducing light pollution in the region. Adding this new position to the team will help in spreading the increasing amount of work currently done by the MMIDSR coordinators and allow us to continue our progression in outreach, monitoring and conversion efforts.



## Conversion

With more and more PC-amber LED and low-blue light content luminaires continuously being installed, it is increasingly difficult to keep track of everything that was installed in the last year. Some of the projects that are identified here might have been made before the last year, but they weren't shown or documented before :

- The city of East-Angus was approached by a third-party company to do a complete replacement of its luminaires to LED, but where only offered 3000K and 4000K solutions. Following a meeting we had with the council of East Angus, they decided to go with a more gradual approach for the conversion of its more than 500 streetlights. The council mentioned that they would instead be replacing approximately 10% of the luminaires per year to PC-Amber LED. This will allow them to keep the cost of replacement under the normal budget of operation, while gradually lowering light pollution. This does not exclude the possibility of a future larger conversion project in the coming years and we are planning to use the city of East Angus for a study on the cost and benefits of a future conversion scenario.
- Replacement of a dozen of old HPS cobrahead with PC-amber LED fixtures near and on the Taschereau bridge in East-Angus. 200W HPS were reduced to 90W PC-Amber LED and 100W HPS to 60W PC-Amber LED. East-Angus is situated at 40 km from the center of the MMIDSR.



- Agriculture Canada’s Research and Development Center on the eastern border of Sherbrooke (54 km from Mont-Mégantic) also proceeded with the conversion of approximately 30 luminaires to PC-Amber. More lights could still be replaced on the site, especially a few old dusk-to-dawn white lights on the farms and stables buildings, but it’s good to see conversion projects like this one that didn’t need our input to be done. The center is neighbor to the Bishop’s University, which installed PC-amber LED on its campus a few years ago.



- Very large numbers of PC-Amber or low-blue light content LED luminaries were installed in Sherbrooke. While continuing to gradually replace older fixtures, the city is also constructing and illuminating new roads in developing areas.

Some of the biggest projects, in the western part of the city and approximately 65 km from Mont-Mégantic, are the prolongation of the Portland Boulevard and the new René Lévesque Boulevard. Both roads are completely illuminated by PC-amber LED and many buildings in this area are using the same technology. Some white LED fixtures are used for pedestrian crossings.

We’ve also seen a few variations, like the use of 2000K LED fixtures and what looks like filtered LED emitting a greenish tint (Sherbrooke’s regulation require light sources with less than 10% of blue light for most uses). For example, a gas station is using PC-amber LED sconces on the walls of the main building and car wash, while using 3000K for the pump area for better color rendering and 2000K for the parking area.



Motorcycle dealership, Sherbrooke



PC-amber LED luminaire, Sherbrooke



Parking lot, Sherbrooke



Filtered LED, Sherbrooke



Boulevard René Lévesque, Sherbrooke



Gas station, Sherbrooke



School and roundabout, Boulevard René-Lévesque, Sherbrooke



Boulevard Portland, Sherbrooke



Commercial building, Sherbrooke

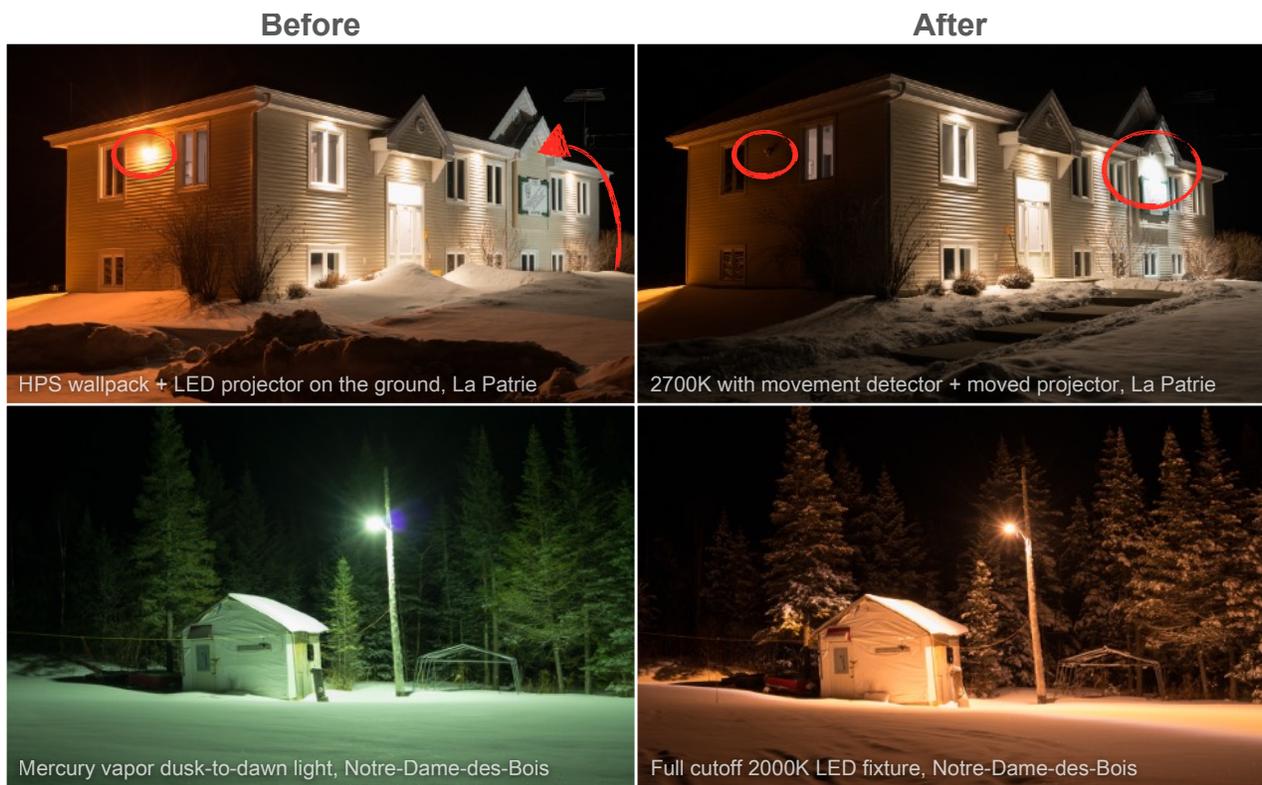


Loading zone of manufacturing company, Sherbrooke



Manufacturing company, Sherbrooke

- The pilot project with Nature Cantons-de-l'Est was completed in the winter. The project aimed to convert a small number of privately owned luminaires that did not meet the regulations of the MMIDSR. The luminaires were selected with visual and photographic observation from the summit of mount Megantic. Being able to see the lights from the summit meant that the lights were either not fully shielded or badly installed and that modifications needed to be made. The color of the lights and their distance was also important for choosing where to intervene. While the budget was limited, we did manage to convert old luminaires that were not changed a decade ago and reduce uplight and/or blue light content. A good number of interventions were simply to modify the orientation of HPS wallpacks and the project allowed us to try a new model of luminaires from RC Lighting equipped with 2000K LEDs.
  - 11 wallpacks reoriented to have no uplight.
  - 3 high intensity dusk-to-dawn MH fixtures (400W and 250W) replaced by 2000K LED luminaires (95W and 64W).
  - 1 non-cutoff wallpack was replaced by 2700K PAR30 with movement detector.
  - 1 white LED projector used for illuminating a sign from the ground was repositioned to be above the sign, sending light downward instead of upward.



- We made great progress on our goal of expanding good lighting practices inside the SÉPAQ, the agency of the Government of Québec managing the parks and wildlife reserves. Not only did we give a formation to the direction team managing the assets, which should translate in revised lighting practices in the future, but we also provided our expertise for the replacement and installation of good lighting fixtures in two parks :
  - In the Mont Orford National Park, neighbours across the lake complained about glare coming from light fixtures. The inspection revealed that some old fixtures and recently added ones were indeed non-cutoff and should be changed to fully shielded, amber LED luminaires. Recommendations on good models were given, and the lights should have been changed by now.
  - We also provided assistance for the lighting of the new access and camping area of a brand new national park. The Parc National d'Opémican is situated along the border between the provinces of Quebec and Ontario and benefits of a very dark sky. Monochromatic Amber LED luminaires models were chosen and installed in minimal numbers. Those luminaires will help in maintaining very low levels of light pollution, while preserving the dark environment for the campers.

## Monitoring and measurements

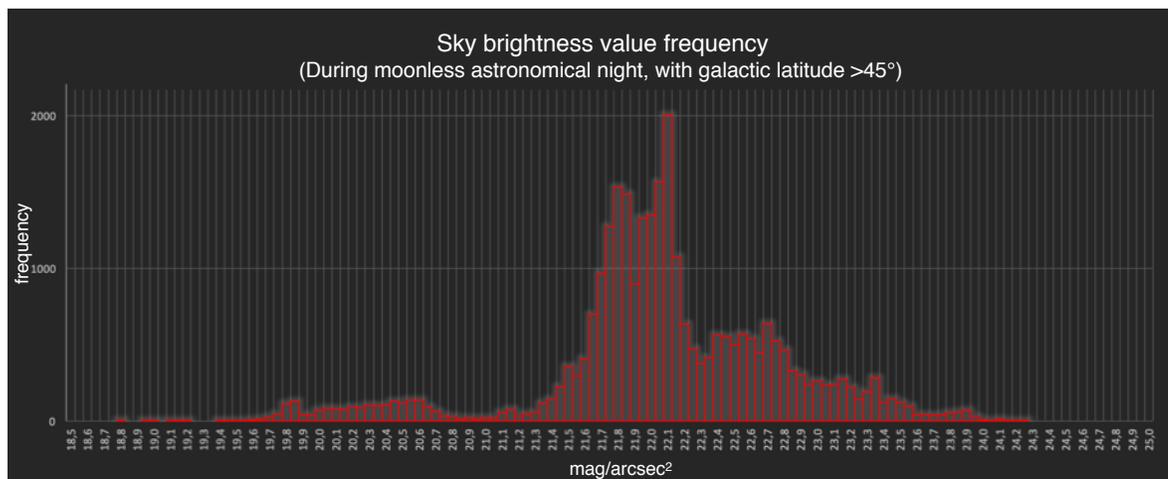
- Zenithal sky brightness :
  - We completed our second full-year data collection of zenith sky brightness with the SQM-LE installed in June of 2016 at the summit of mount Mégantic. As a reminder, we found from last year's measurements that the amount of light pollution at zenith was extremely low, which meant that most of the variations we saw was mostly due to natural conditions changing. Apart from some occasional light used from the observatories activities and astronomers installations that can produce short peak in brightness for the instrument, the main contributors to sky brightness at night are the Moon, the Milky way and sky glow. The first two can be more easily filtered out of the data with ephemeris to get measurements associated with the darkest reading in clear conditions. Sky glow is less predictable and harder to account for, but it should be relatively low on average during the low solar activity years we currently are experiencing.

Last year, we found that our zenithal SQM measurements taken between June 2016 to May 2017 (under every types of weather conditions) revealed that the most frequent

readings were around 21.6 mag/arcsec<sup>2</sup>. This is by only using the data when the Sun was at least 18° and the Moon 5° below the horizon. Looking at this year data (June 2017 to May 2018), we have a peak of frequency slightly darker at 21,70 mag/arcsec<sup>2</sup>. This slightly darker sky brightness for the 2017-2018 period is also apparent when using the measurements taken with a galactic latitude above 45°. Under these restrictions, we get 22,10 mag/arcsec<sup>2</sup>, compared to 22,00 mag/arcsec<sup>2</sup> the year before. Measurements were binned in 0,05 intervals to count the frequency.

### Most frequent SQM readings (mag/arcsec<sup>2</sup>)

	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



While the difference between the two periods is quite small, it is possible that lower airglow could explain the darker measurements for 2017-2018. Indeed, the 10.7cm solar radio flux, which has been shown to be related to airglow, was very quiet in the last 2 years but slightly lower on average for the period between June 2017 to May 2018 than June 2016 to May 2017. Differences in weather and the exact timing of some downtime for the SQM could also be responsible. It will be interesting to follow the evolution in the next years, especially if the Solar flux becomes more intense.

- We are currently working to acquire and install a high-resolution all-sky camera to monitor light pollution across the sky. The project is done in collaboration with the Mont-Mégantic Observatory

(OMM), which will also be able to use the camera for weather monitoring and other atmospheric measurements. The main goal is to combine the capability of measuring light pollution across the sky (like we did with the NPS in 2007 and 2017) with the high frequency of data offered by the SQM-LE. This high temporal resolution has revealed itself to be very important to identified changes associated with natural causes (Moon cycle, Milky way position, air glow, clouds, transparency, etc.).

The camera will also allow us to measure light pollution in different direction, instead of being restricted to the zenith. Because our SQM showed us that there is virtually no measurable light pollution at zenith in clear conditions, if we want to follow the evolution of light pollution, we need the ability to measure it lower in the sky and on the horizon. Changes associated with different clouds conditions or when there is snow on the ground will be very interesting to document.

The camera will be equipped with a filter wheel to make measurement on different part of the visible spectrum. This will give us the ability to get color information on light pollution, and possibly get better measurements of air glow or aurora activity. The filter wheel should also be beneficial for the Observatory activities.

## Management

Sébastien Giguère, the ASTROLab scientific coordinator, and Rémi Boucher, the Mont-Mégantic IDSR scientific coordinator, are leading the main activities of the Dark Sky Reserve.

Camille-Antoine Ouimet is supervising the efforts in the monitoring of light pollution and the projects linked to conservation.

Operation of the Reserve is carried out by the ASTROLab corporation, with great support from the Mont-Mégantic National Park (SEPAQ).