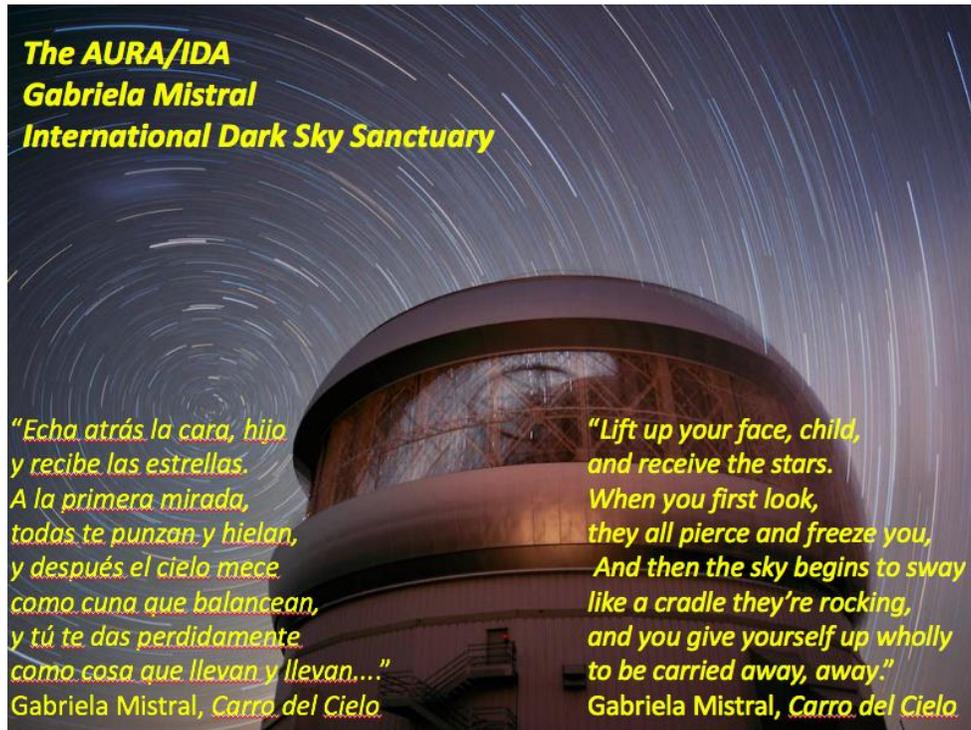


Gabriela Mistral International Dark Sky Sanctuary

2017-2018 Annual Report to the International Dark Sky Association



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Site Lighting Management: Mario Gonzalez, AURO-O

Gabriela Mistral International Dark Sky Sanctuary

2017-2018 Annual Report September 2017

1. Introduction

The AURA-O site in the Elqui valley was the world's first IDA Dark-Sky Sanctuary. This yearly report to the IDA describes our progress in maintaining and improving the dark sky qualities of this unique site, particularly as new construction occurs on our site. Our new telescope facility, LSST, will have a long lifetime in the Sanctuary. As LSST building construction work continues on Cerro Pachón, we want to make sure that lighting in both locations is exemplary and can be used as illustrative educational models. A Lighting Management Plan was provided to the LSST architectural team for inclusion in the final stages of construction of the building, although there is little, if any, exterior lighting planned for this facility.

Although not directly related with the lighting that occurs in the Sanctuary, we have begun construction of the new AURA Base Facility buildings on our campus in La Serena. We have also given instructions to the architects and construction company to encourage use of exemplary lighting on and around the La Serena campus as well. This of course is an important opportunity for demonstrating effective and sustainable lighting in the cities and towns in the region around the Sanctuary.

The OPCC (led by Pedro Sanhueza) has been increasing the level of engagement and commitment of the Chilean government in dark sky friendly outdoor lighting. In collaboration with the Chilean Astronomical Society (SOCHIAS), the OPCC has organized training seminars in northern Chile for municipal authorities on the importance of dark skies and, specifically, the details of the lighting regulations that were published in 2013. During 2017, three of these seminars were carried out in the region around the Sanctuary, one in Coquimbo, one in Monte Patria, and one in La Serena. So far, in 2018, three more seminars have been carried out, in Illapel, Ovalle, and La Serena. These were organized with the support and collaboration of the local authorities of the Ministry of the Environment together with the Superintendency of the Environment and the Ministry of Energy.

Our main activity for 2018, is the International Seminar "Proteccion del Cielo Estrellado" (Protection of the Starry Sky), to be held in La Serena next October 10th. It will be financed by the Ministry of Foreign Affairs, OPCC, SOCHIAS, and Ministry of the Environment, with the collaboration Superintendency of Environment, Superintendency of Electricity and Fuel, and the Ministry of Energy. The main speaker for this conference is Fabio Falchi, principal author of the *The*

World Atlas of Artificial Night Sky Brightness. Dr Falchi is affiliated with The Light Pollution Science and Technology Institute of Thiene, Italy.

Of particular interest to AURA and the IDA is OPCC's work with the Municipality of Vicuña. Vicuña is now working to finance the replacement of all its 1,500 luminaires with a type of filtered PC amber lighting without any of the wider, blue-inclusive spectrum. This should provide the population with better color perception than narrow-band sodium.

During the last 12 months or so, increasingly effective contact with the Chilean national government has continued. As reported last year, in August 2017, AURA hosted the national director of the "Superintendencia de Medio Ambiente" (SMA) on a visit to Cerro Tololo to see both the stars over the Sanctuary as well as the lights from surrounding cities. The SMA is the enforcement arm of the Chilean Ministry of Environment, and is responsible for the enforcement of the new lighting regulation that came into effect in 2014.

AURA representatives also attended the inauguration of the SMA's new regional office in La Serena. As reported last year, both the national director and new local representatives in the regional office indicated their commitment to collaborating with AURA to protect the dark skies of the region. During mid-May, 2018, three municipal training meetings took place in the area – each on a successive day in Illapel, Ovalle and finally La Serena. After the meeting on that last day, a Dark Sky Task Force group led by Mark Phillips (from the Las Campanas Observatory) visited Cerro Tololo.

In September 2017, AURA hosted the Chilean Minister of Foreign Affairs (the equivalent of the U.S. Secretary of State) on Cerro Tololo for an evening visit to the telescopes. This visit was also capped off with the combination of stargazing and noting of the city lights in the distance. The Minister reiterated his support, as well as that of the current, newly-elected administration in general, for astronomy and the protection of the dark skies, both for their value in astronomy and for their patrimonial value for Chilean citizens and the world.

Evidence of this national government interest is the publication by the Chilean Ministry of the Environment (in June, 2018) of an e-book (30 pages in Spanish and these pages also translated into English) "Cielos De Chile: Desde La Tierra Al Universo" - "Chilean Skies: From Earth to The Universe". (Note that the following quotes include mention of the "70% of the world's large telescopes" that will be in Chile. This, however would only be true if the TMT came to Chile – instead of the primary northern sites, Hawaii or the Canary Islands; in that case read ~55% rather than 70%.) The Minister of the Environment, Marcela Cubillos Sigall, has written in her forward:

Northern Chile is one of the most privileged places in the world for astronomical observation, due to its geography and climate. Currently, 40% of all astronomical observation infrastructure in the world exists in Chile, and in a few years, this level will reach 70%, elevating our nation to the fore in the field of astronomy.

However, one of the greatest threats to the observational quality of our skies is the light pollution generated by outdoor lighting. To combat it, since 1998, Chile has an environmental standard that regulates light pollution in the regions of Antofagasta, Atacama and Coquimbo. This standard was updated in 2012, establishing more stringent requirements and incorporating new technologies. This regulation was one of the first environmental regulations in the country.

The Chilean sky is part of our national heritage and a source of scientific research for the entire globe, from where important questions regarding the universe have been unveiled. The discoveries in this matter have been fundamental, not only to understanding a little more about our origin, but also to the pursuit of technological innovation in the field of astronomy.

Certainly, we have the privilege of being the eyes to the universe, which also implies a great responsibility. Therefore, as the Ministry of the Environment, we want to promote the value of our skies; by communicating our night skies' benefits, our hope is to foster an appreciation of this important national treasure, and understand the need to protect it.

The regulation of light pollution is a complex task, and where much remains to be done. It has implications not only in relation to astronomical observation but also to biodiversity and in the livelihoods of people. Although we still have a lot to do in this matter, we are pleased to be taking the necessary course of action to protect our skies.

Her page is backed up by a second "Forward" page written by Dr Mario Hamuy, the President of La Comisión Nacional de Investigación Científica y Tecnológica (CONICYT), the National Commission of Scientific and Technological Research. Mario is a former member of the AURA-Cerro Tololo staff. The cover page is a photograph taken shortly after sunset from the summit of Cerro Tololo by another AURA/CTIO Chilean staff member, Daniel Munizaga. The introduction to this document reads as follows:

"The privileged sky conditions of northern Chile have allowed it to become a window from which scientists improve their understanding of the place and time in the Universe we are living in. The important astronomical capacity already installed in the northern regions of the country, which will increase over the next decade to 70 percent of the total global existing capacity, is evidence of the need to value and protect this heritage, which is not only Chilean, but of humanity. This publication seeks to contribute to the understanding and the recognition of the

importance that the scientific work on astronomy being developed in Chile has for everyone. In a collaborative endeavor, without borders, it has been possible to unveil areas of the Universe that were un-thought of and provide answers to several questions that have accompanied humans since our origins.”

Three short paragraphs of “Background Information” are then included, which describe our work as:

“Also in September 2017, AURA led participation in IMPAC4, a major international conference on the protection and sustainable use of the oceans that was held in La Serena. In addition to hosting invited speakers on a visit to Cerro Tololo, we were assigned a session on the impacts of light pollution of marine wildlife. It was a small session, attended by about 10-15 people, but the discussion reached a community we usually do not work with, and we established some excellent contacts that we are working to see if these can be developed into broader national collaborations on dark sky protection throughout Chile.”

2. Sky Quality

We also continue our efforts to monitor sky quality over the Sanctuary. We are still exploring the development of imaging systems at several of the AURA-O telescopes. These systems may include ground as well as sky in order to provide the option of monitoring (at least spatially) the key sources of light pollution around the observatory. For example, the Gemini South telescope produces a high-resolution nightly digital movie with images every minute for each of three key directions from the Gemini dome on Cerro Pachón. These short videos, which are displayed in the telescope control room and recorded each night, are also powerful outreach opportunities. However, each movie takes over 100MB of storage space, so we are considering the methods to store just a subset of the most useful records (e.g. those obtained on clear, new-moon nights) in order to create a usable archive.

Our most recent set of Sky Quality Meter (SQM-L) readings from the summit of Cerro Tololo were made at new moon in March, 2018. As explained in last year’s report, March is generally a better time of year than August for such measurements. In March, the Milky Way and the Zodiacal light are not high in the sky. Our SQM-L measurements were made towards the visually darkest regions of the sky (zenith and ~45 degree zenith distance, NNE). The overall, average, SQM-L reading was 21.4mag/square arcsecond.

With a correction to V band of 0.13 mag, the corrected sky brightness reading was equivalent to $V \sim 21.5$ mag/square arcsecond, pending further residual correction for any remaining foreground stars in the aperture. We remain aware of the need to keep these manual measurements as straightforward as possible to ensure consistency until we have simple and robust quantitative monitoring systems installed that have proven reliability.

As discussed earlier, new construction at the LSST site, and some additional improvements near the entrance to the Sanctuary are areas that need to be monitored to insure no additional light trespass.

3. Conservation and Research

We propose next year to accelerate our co-operation with biological research and outreach work in the region in collaboration with the Center for Advanced Studies of Arid Zones (CEAZA, <http://www.ceaza.cl>), especially in the area surrounding the Dark Sky Sanctuary and a nearby Biosphere Reserve, Parque Fray Jorge. Our goal is to encourage eco-tourism and the preservation of the skies of the region around the Sanctuary. AURA/CTIO is part of the national program “Comunidades Sustentables” (<http://www.ceaza.cl/2016/09/09/mas-de-200-educadores-ambientales-aprenden-contenidos-para-trabajar-por-el-desarrollo-sustentable/>) and continues to work with the program “Protegiendo la Calidad de los Cielos de la Region de Coquimbo” (Protecting the Quality of the Skies of the Region of Coquimbo).

4. Funding

Funding for Sanctuary-specific activities comes from a combination of AURA and its Observatories and programs. This includes NOAO/CTIO, Gemini-South, SOAR, and LSST. Funding for the activities of OPCC comes from AURA and the partner international observatories, including Las Campanas Observatory, the European Southern Observatory, and the Giant Magellan Telescope Observatory. Additional funding comes through collaborations with Chilean partners, such as SOCHIAS and Ministry of Foreign Affairs.

The replacement of Vicuña’s 1,500 lights is being provided (as a test project) to the Vicuña Municipality by a combination of the support of the Chilean Energy Ministry and the Agencia Chilena de Eficiencia Energética. There is no charge to the Municipality of Vicuña for this pilot project.

5. Legislation:

The Chilean legislature is currently discussing a draft law bill that will require that light contamination codes and statutes become an integral part of the compulsory Environmental Impact Studies for the installation of new industrial projects in the North of Chile. This legislation has the potential to strengthen our dark skies preservation efforts.

6. Education & Outreach:

We continue to promote the IDA education initiatives on dark skies education in Region 4 and indeed throughout Chile. The development of kit and demonstration materials includes further to promote quality lighting using problem-based learning teaching kits. As reported last year, the materials in these Quality Lighting Teaching Kits have now been translated into Spanish and we are looking for sponsors to fund the distribution of these kits in Chile. NOAO

is working with a kit manufacturer and distributor in order to distribute the kits worldwide. The potential kit distributor has contacted a Chilean-based kit distributor who may be a potential partner once an agreement is signed with AURA.

Our outreach programs continue to touch thousands of the Chilean public. On the grounds of the sanctuary, we hosted over 4,000 visitors in our open tours of Cerro Tololo, which happen every Saturday when weather permits travel. There are also about 300 visitors per year at Gemini on Cerro Pachon.

Our Gemini program hosted two massive public events (AstroDay and Viaje al Universo), which together with smaller events had a total reach of over 10,000 people, while our CTIO program reached over 9,000 through a variety of off-site programs. CTIO works closely with schools and does many workshops on lighting, spectroscopy. Dark skies is also part of its work with the touristic observatories and teacher trainings.

In addition to public visits, we also feature visits to the Sanctuary in other educational activities, such as the La Serena School for Data Science. In 2018 we hosted 36 students (out of a list of 193 applicants), mostly from the U.S. and Chile for an opportunity to explore the current and future tools and techniques in “Big Data”. As it has become a tradition on this event, the School included an evening visit to the Sanctuary and stargazing on Cerro Tololo.

For the third consecutive year we received at our AURA facilities the members of the “Astronomy in Chile Education Ambassador Program (ACEAP), which is a collaborative project of AUI, NRAO and AURA that focuses on building a diverse and lasting community of educators who visit NSF astronomy sites in Chile. These ambassadors then share the newfound knowledge and experiences they get from their visits with their local communities in the US through a range of informal science-education activities. The Program has brought a total of 20 amateur astronomers, planetarium personnel, and K-16 formal and informal astronomy educators to CTIO, Gemini, SOAR and ALMA. While at these facilities, ACEAP Ambassadors have received extensive training about the instruments, the science, data products, the site, and communicating science, technology, engineering, and mathematics (STEM) concepts. When they have returned home, the Ambassadors have shared their experiences and observatory resources with schools and community groups across the US. Several of the latest ambassadors are Chilean teachers, and play a similar role in bringing knowledge of darks skies and facilities back to their communities and classrooms.

AURA staff also participated in the 4th Chilean Astronomy Education and Public Outreach Summit in August 2018 in the southern city of Concepción. This meeting was organized by CONICYT, the Chilean equivalent of the U.S. National Science Foundation. The meeting brought together EPO representatives from all

of the international observatories, Chilean universities, Chilean museums and public institutions, and Chilean government representatives to discuss how better to communicate, coordinate, and collaborate on EPO initiatives in Chile.

A major advance in Chile's government involvement in Light-Pollution education is now on-line as a 32-page slide show (16 in each of Spanish and English) prepared in conjunction with the IAU outreach to UNESCO.

The cover photograph of this 16-page document was taken by Daniel Munizaga, a CTIO/EPO department staff member. The document is available on request.

7. Community and Media

The importance of dealing with light pollution over the International Dark Sky Sanctuary is reflected in a number of articles in the Chilean local and national press. A basic search of the web using "contaminación lumínica" in one of the local La Serena newspapers "El Día" located a number of local media references in 2017, which include:

- <http://www.diarioeldia.cl/region/contaminacion-luminica-ataca-nuestra-condicion-capital-astronomia> (13th March, 2017)

which includes a good photograph of the La Serena/Coquimbo conurbation as seen at night from the Cerro Grande (in the line of sight between most of the conurbation and the IDA Gabriela Mistral Dark Sky Sanctuary).

- <http://www.diarioeldia.cl/cultura/taller-abordara-como-afecta-contaminacion-luminica-desarrollo-astronomia> (21st August, 2017)

which discusses how light pollution affects the development of astronomy.

An example of national-level media coverage of medical issues and astronomical input related to night-time blue light can be found at:

- <http://www.economiaynegocios.cl/noticias/noticias.asp?id=330032>

which includes quotes (translated into Spanish) from the American Medical Association's warnings about the effects of blue light at night, as well as Pedro Sanhueza's explanation of the negative aspects of blue and ultraviolet light on astronomy.

A list of some additional 2016, 2017 and 2018 local ("El Dia") Chilean (Spanish-language) press sources relevant to the mission of the IDA Gabriela Mistral Dark-Sky Sanctuary is given below:

- <http://www.diarioconstitucional.cl/noticias/asuntos-de-interes-publico/2018/08/31/comision-de-medioambiente-de-la-camara-de-diputados-aprobo-incluir-la-contaminacion-luminica-en-regulacion-medioambiental/> (August 31, 2018)

- <https://www.latercera.com/tendencias/noticia/diputados-presentan-proyecto-frenar-avance-contaminacion-luminica-zonas-donde-se-desarrolla-la-astronomia/268012/> (August 3, 2018)
- <http://www.semanariotiempo.cl/2018/09/07/concejo-de-vicuna-aprueba-ordenanza-para-la-proteccion-del-cielo-en-la-comuna-elquina/> (September 07, 2018)
- <http://www.diarioeldia.cl/region/responden-criticas-por-falta-fiscalizacion-emision-luz-en-ciudad> (23rd March, 2017)
- <http://www.diarioeldia.cl/economia/pantallas-publicidad-led-deberan-adequarse-nueva-normativa-luminica> (18th August, 2016)
- <http://www.diarioeldia.cl/region/coquimbo/invitan-escolares-participar-en-concurso-que-concientice-sobre-contaminacion> (26th July, 2016)
- <http://www.diarioeldia.cl/region/ministro-medio-ambiente-da-conocer-nueva-norma-contaminacion-luminica> (25th July, 2016)
- <http://www.diarioeldia.cl/cultura/con-concurso-istan-evitar-contaminacion-luminica> (17th July, 2016)
- <http://www.diarioeldia.cl/region/buscan-protger-cielos-region-con-iluminacion-sustentable> (17th July 2016)

In addition to these separate stories, there was extensive press coverage of the XIII Congreso Panamericano de Iluminación - LUXAMERICA 2016.

Most recently we have started to distribute some copies of the August 2018 edition of *National Geographic* magazine in Spanish. The 36-page illustrated cover article is “Sueño. Como Sobrevivir en la Era del Insomnio” (“Sleep. How to survive in the era of sleeplessness”). The article describes how blue light can prevent sleep and how around the clock engagement with devices like cell phones can be detrimental to proper sleep patterns. The article (which also appears in the English-language edition of *National Geographic* edition of August 2018) includes explanation of the functioning of the body clock.

8. Conclusion

AURA Observatories has remained highly engaged in preserving the unique dark sky characteristics of the Gabriela Mistral International Dark Sky Sanctuary. We are committed to long-term extensive engagement with the Chilean government at both national and regional levels in order to maintain the qualities of this special place. Our educational programs with visitors, at schools, at community events, and with touristic observatories have dark skies as a central focus. With a long-term focus on Chile’s role in being the astronomical capital of the world, we sincerely hope that our work in this IDA Sanctuary can be a model for others in Chile and around the world to emulate.