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NixNox procedure to build Night Sky Brightness maps from SQM photometers observations

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Abstract

The NixNox procedure to build all-sky maps of the nocturnal night sky brightness using SQM photometers is described. Astronomers belonging to amateur associations in Spain are using this observational method to obtain data of their preferred sites of observation to characterize the astronomical quality of the sky and the sources of light pollution.

1. Introduction

The NixNox project, promoted and sponsored by the Spanish Astronomical Society¹, is a Pro-Am collaboration with the aim of finding and characterizing sites with dark skies. Night sky brightness data are obtained by amateur astronomers using Sky Quality Meter (SQM) photometers. We are not looking for remote locations because the places should be easily accessible by people with children. Our goal is to motivate citizens to observe the night sky. NixNox will provide information to answer the question: where can I go to observe the stars with my family?

NixNox contributes to outreach in Astronomy and it is a help to dark skies fights but it is also a scientific project. Our objectives are to locate sites with dark skies with easy access, to encourage local authorities to preserve them and finally to help citizens to enjoy the starry skies.

The Sky Quality Meters (SQM) [1] are photometers designed to measure the night sky brightness in a photometric band that encompasses the Johnson B and V astronomical bands trying to mimic the human eye spectral response. These simple devices have a field of view of FWHM=20 degrees [2].

The observations are provided by amateur astronomers in places where they usually observe. They are using 12 SQM-L photometers acquired by SEA that were cross-calibrated at UCM (Laboratorio de Investigación Científica Avanzada, LICA) [3] [4].

¹ NixNox at SEA webpages: <http://www.sea-astronomia.es/drupal/nixnox>

2. Observations

The observations are being made on clear and moonless nights following simple instructions. The SQM photometers should be fitted to a photographic tripod and aimed to several points on the sky.

SQM-L mounted on tripod



Multiple SQM-L pointings to create an all-sky NSB map

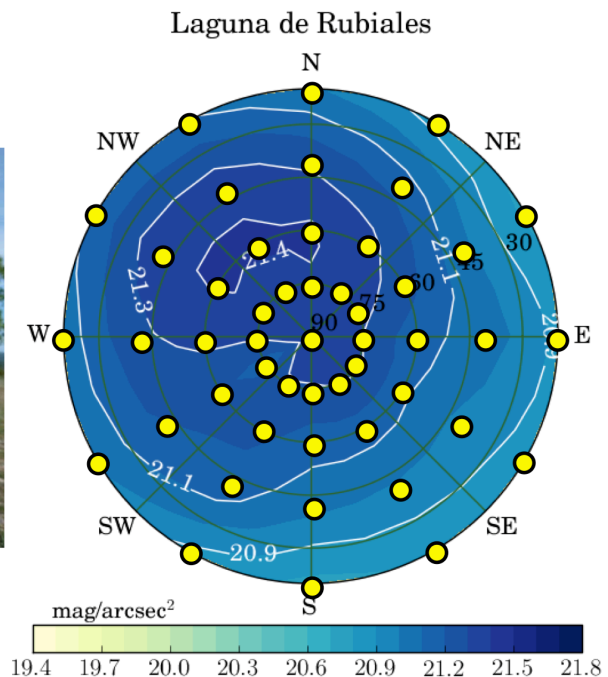


Figure 1. SQM on tripod as used to obtain NixNox data and NixNox map at Laguna de Rubiales. Yellow points mark the pointing positions.

The original spatial sampling is a trade-off between resolution and the time needed to complete a map. The brightness of the sky in a particular direction changes along the night due for instance to natural sources as the Milky Way crossing the sky. But there are also variations due to changes in light pollution sources. We intend to obtain a snapshot of the sky at the observation time. We decided that the complete set of observations should be obtained in a maximum of 30 minutes.

Since SQM-L photometers have a field of view of 20 degrees (FWHM), we select to observe, besides zenith, 12 positions in azimuth at 20, 40, 60 and 80 degrees of altitude. After setting up the tripod with the SQM (leveling and orienting the tripod), the observer should point to zenith to get the first data and then change to the next altitude (80) and measure all around at the 12 positions in azimuth (one measure every 30 degrees) and so on. Finally the zenith value is measured again.

This procedure is easy to carry on during the night using a photographic tripod with the scale of angles marked in degrees for both axes. A team of two persons: one for moving the tripod and for reading the values and another one for writing down the measures is enough. Some observers who work alone are using a voice recorder to annotate the values. A trained person could obtain all the data in 15-20 minutes.

3. The all-sky maps

To build the maps we are using simple Python code with Matplotlib. The map is plotted after an interpolation with the observed values on a denser mesh grid. The resulting all-sky maps (in units of magnitudes per square arcsecond) are similar to calibrated fish eye pictures of the sky and they inform us of the sources of light pollution. Evolution of the light pollution will be measured with repeated observations over the next years.

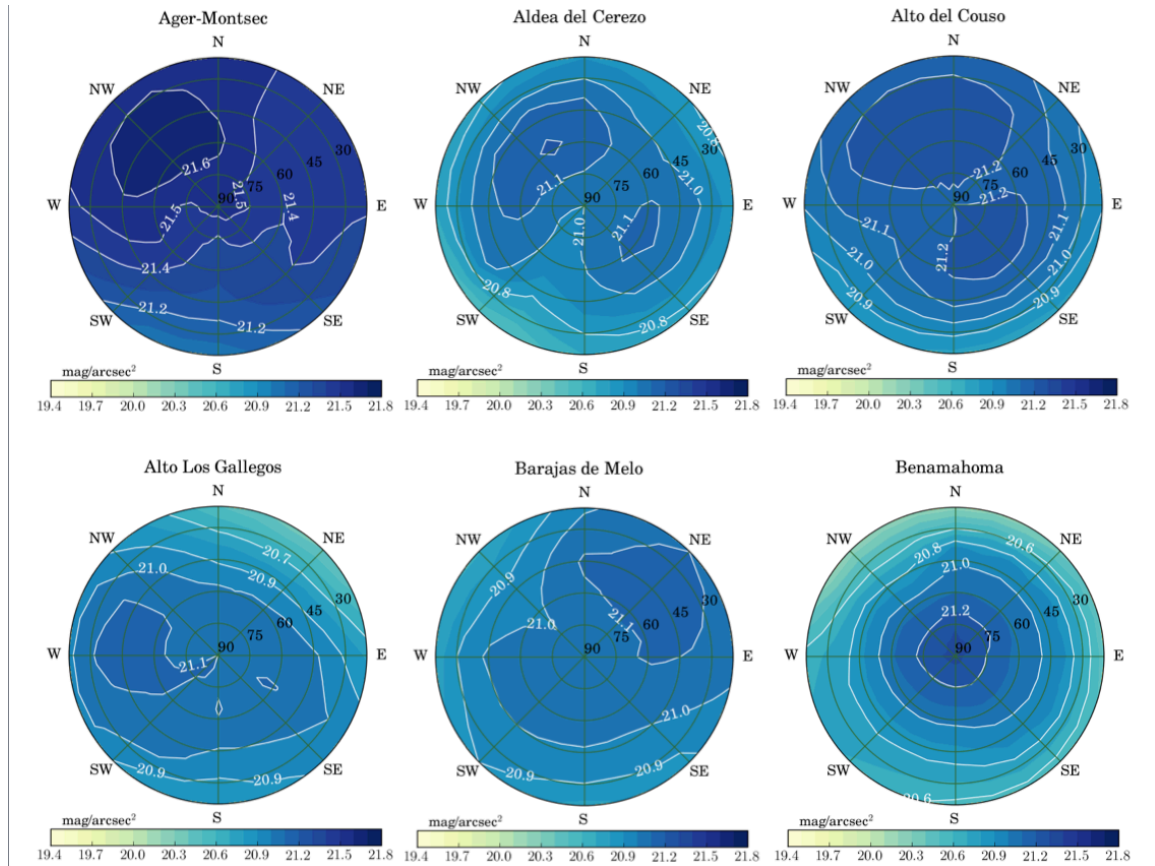


Figure 2. Example of NixNox maps in different locations of Spain.

All-sky maps of the night sky brightness could be obtained with astronomical cameras or with digital photographic cameras (DSLR) with a fisheye lens. These devices are expensive and difficult to calibrate. This is way we intend to build realistic all-sky maps using cheap devices. To test the reliability of the results we have compared the maps build with SQM data and the NixNox procedure with other maps obtained at the same time and location with professional all-sky cameras.



Villaverde del Ducado UCM 2014/08/25

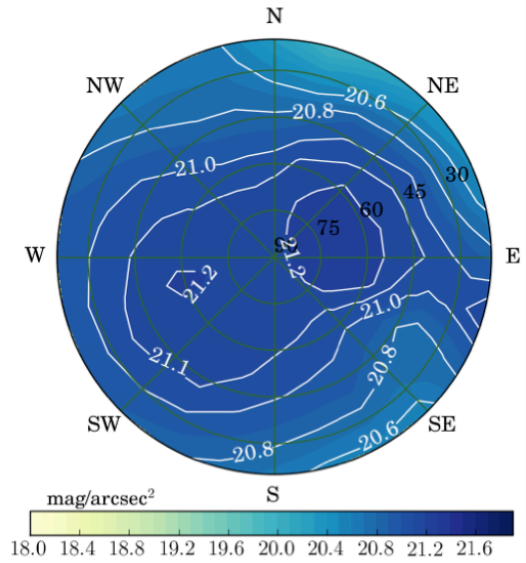


Figure 3. Milky way effect is apparent in this map obtained at Villaverde del Ducado with the Milky Way crossing the sky. The all-sky picture and the observations for the map were obtained the same night but not in the same time.

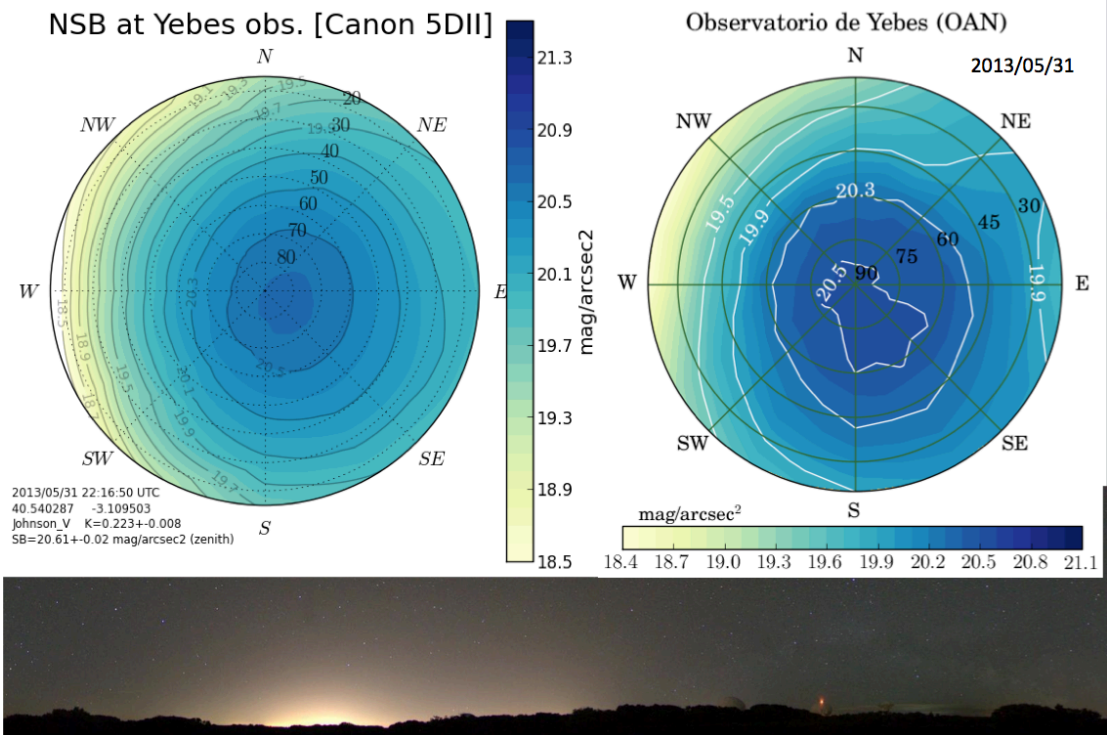


Figure 4. Comparison of Night Sky Brightness map obtained with a DSLR camera and the one build using the NixNox procedure. The observations were made at Observatorio Astronómico de Yebes 70 km from Madrid whose light pollution is clearly apparent at west in the panorama and in the maps.

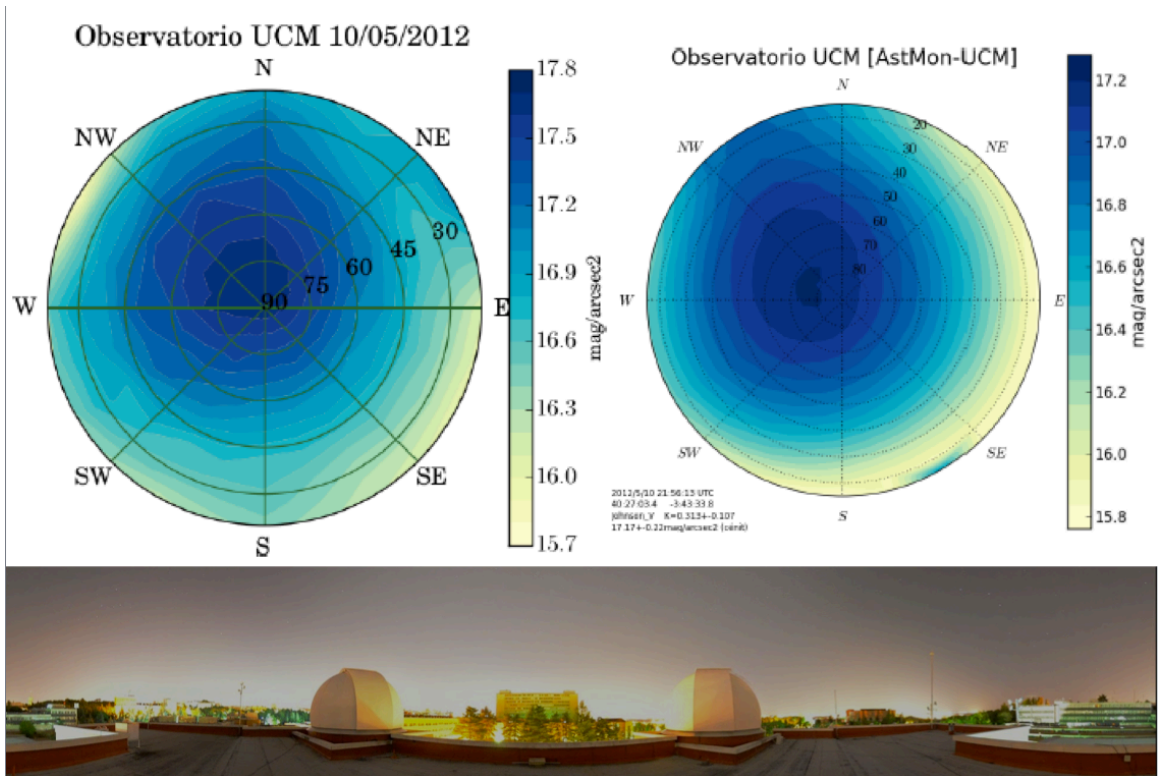


Figure 5. Comparison of Night Sky Brightness map obtained with the Astronomical Monitor of Observatorio UCM and the one build using the NixNox procedure. The astronomical observatory is highly polluted by Madrid.



Figure 6. The light pollution originated at Madrid is registered by the NixNox map obtained at Villaverde del Ducado, 130 km from Madrid.

4. Final remarks

The all-sky representation of the night sky brightness is represented in the same way as geographic maps. With this orientation it is easy to find the sources of light pollution.

Although the night sky brightness changes along the night and from one night to other the all-sky maps built with data from different dates are similar.

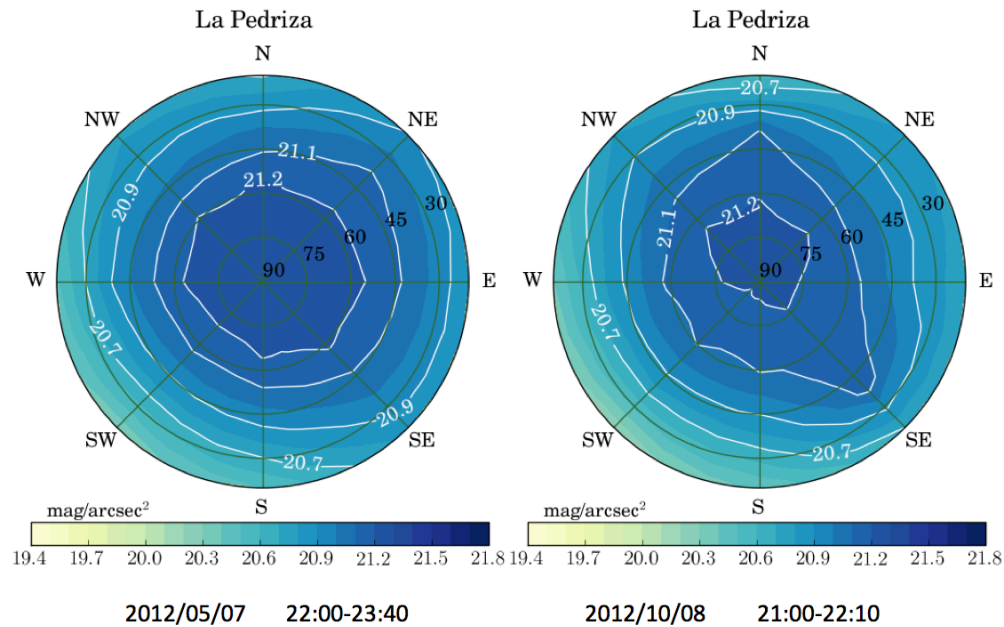


Figure 7. Night Sky Brightness all-sky maps obtained at the same place on different dates. The maps are similar although some differences are expected due to natural variations from night to night and also for changes in the sources of light pollution.

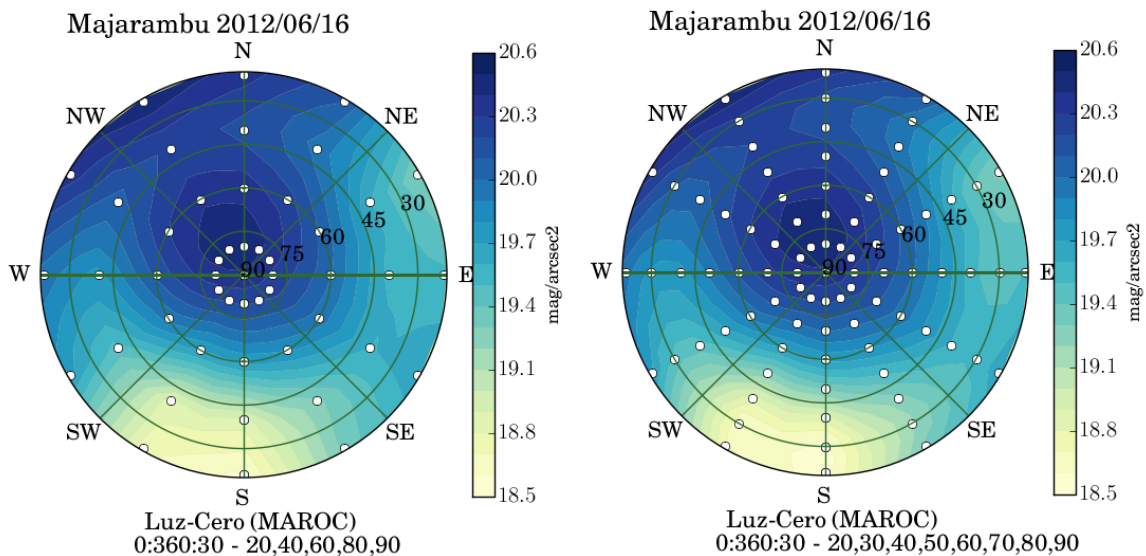


Figure 8. NixNox maps obtained with different sampling using MAROC a motorized mount designed and developed by Luz-Cero, Asociación Astronómica del Campo de Gibraltar [5]

We have tried a denser observation scheme but the small increase in resolution does not balance the penalty of longer observation time. When using automatic mounts this observation time could be drastically reduced. In this case a device with the capability to connect to a computer should be used, as the SQM-LU photometer.

References

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