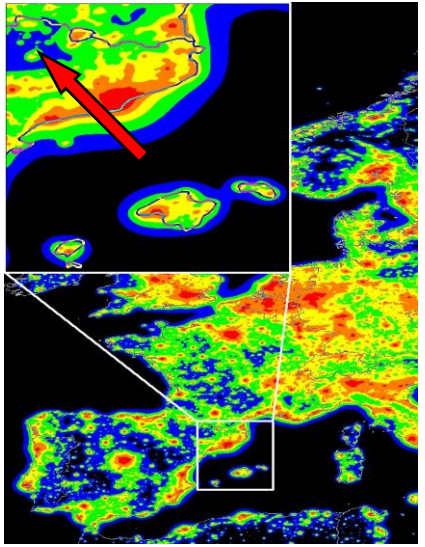
Measurements for Regional Monitoring

Dr. Salvador J. Ribas
Parc Astronòmic del Montsec

Measuring Night Sky Brightness

There are different approaches to evaluate Night Sky Brightness to estimate Light Pollution:

- From the space using satellites (e.g. Falchi et al 2016), from International Space Station (e.g. Sánchez de Miguel 2015) or from planes (e.g. Corbera et al 2013)
- Measuring the night sky brightness from the ground with telescopes (historical approach) or specially designed devices.

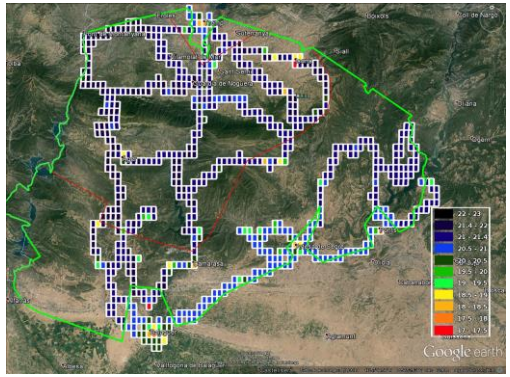


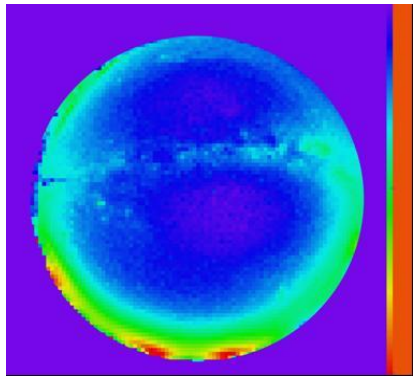
Cinzano et al, First World Atlas (2001)

Measuring Night Sky Brightness

In our case study, Catalonia, we have done measuring and monitoring with ground-based instruments:

- Sky Quality Meters on movement to monitor extended areas.
- SQM on permanent positions (network of measurements)
- Allsky measurements with ASTMON and Sky Quality Camera.

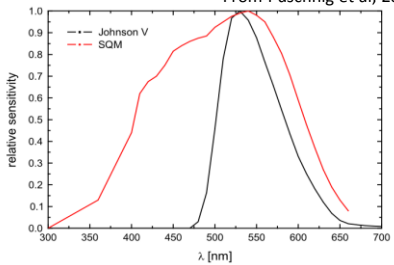




Instrumentation – One direction devices

- This kind of instruments provides information of one direction, so a single data is obtained.
- The most popular is Sky Quality Meter (developed by Unihedron) that exists on handheld and wired versions.
- SQM was developed to be a simple device to measure night sky brightness providing the result in astronomical-like units, so it is shown in magnitudes per square arcsec.
- Other devices are now on the market with very good performance and low cost as TESS-W developed by Stars4ALL EU project.

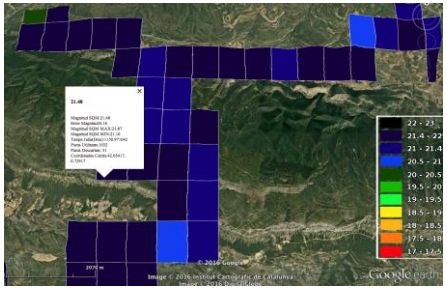
From Puschnig et al, 2014

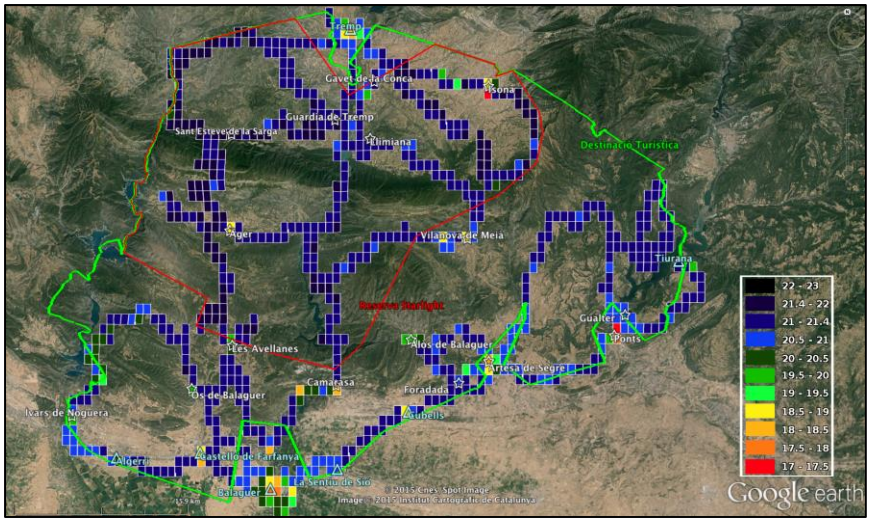


For detailed information on instrumentation see Haenel, Posch, Ribas et al. (2018) on JQSRT

Measuring with One direction devices

- Creation of ground based night sky brightness maps with device on a moving system.



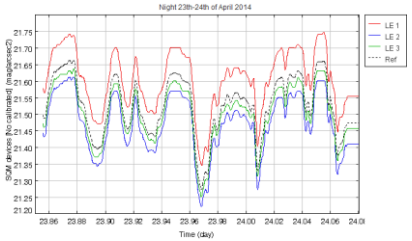


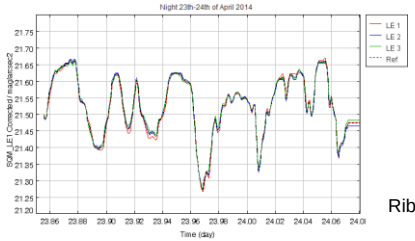
Montsec Starlight Reserve Map from Ribas PhD Thesis (2016)

Measuring with One direction devices

- Development of networks of instruments. There are many regional (e.g. Catalonia or Galicia) or global (e.g. Stars4ALL project) networks.
- Networks allow us to evaluate trends or atmospheric effects on ALAN (fog, clouds, etc).

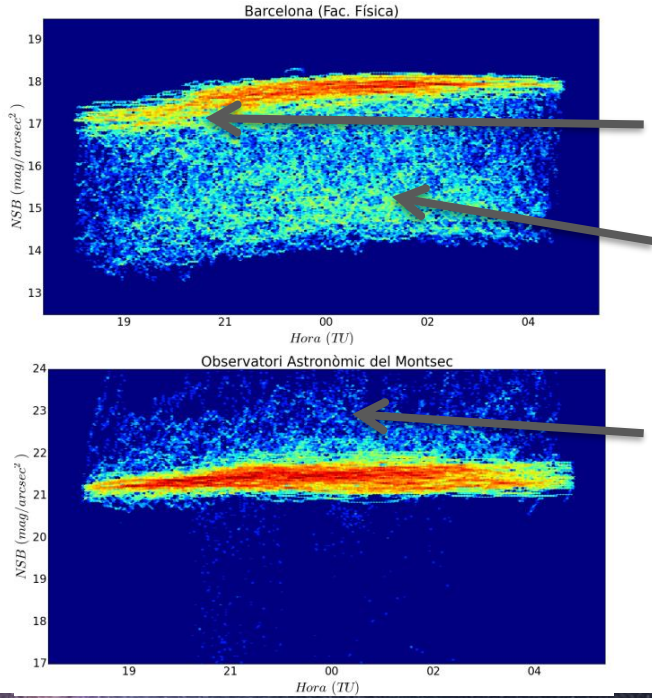
Attention! For networks is mandatory to verify intercalibration of devices used and in case of SQM an open problem is the aging of the device due to an issue with plastic coverage of the detector.





Ribas PhD Thesis (2016)

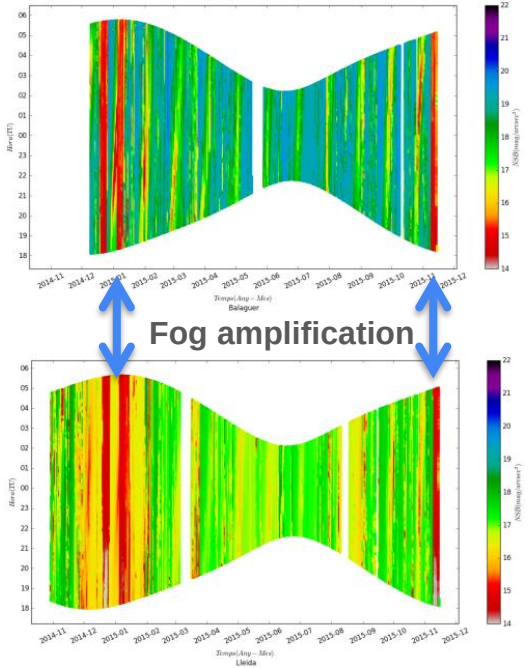
Measuring with One direction devices



Switch off trends

Clouds amplification

Clouds "darkening"



Fog amplification

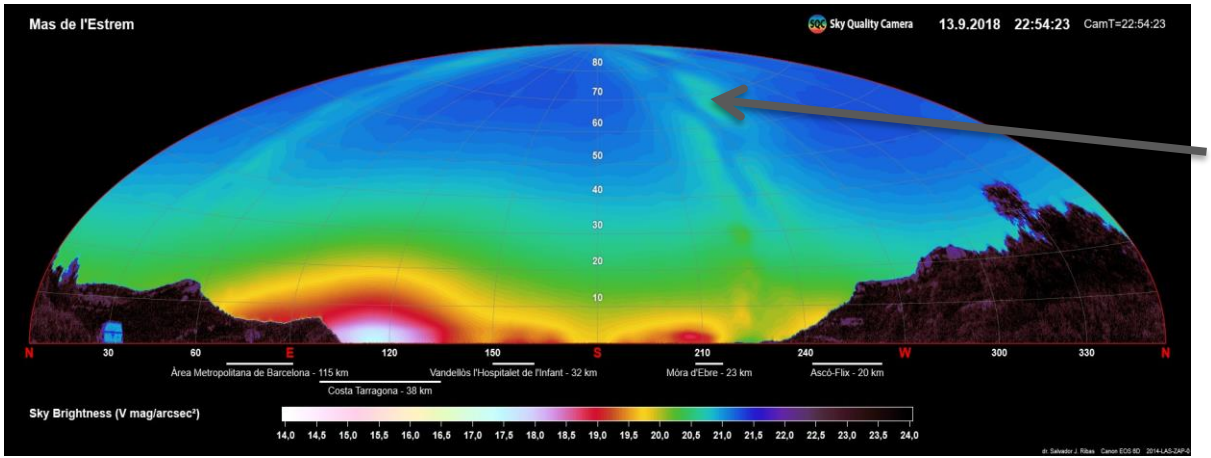
Instrumentation – All sky devices

- One direction instruments are not catching the whole reality, so multidireccional instruments provide a more reliable information.
- Two approaches are possible:
  - Mosaic or composition to obtain all sky imagery
  - Single-shot all sky image
- There are specially designed instruments as ASTMON, an all sky single-shot device with astronomical filters (see Aceituno et al. 2011)
- Recently the use of DSLR cameras with fisheye lenses are providing an easy solution option. Some free or payment software allow users to do calibration and data processing.

For detailed information on instrumentation see Haenel, Posch, Ribas et al. (2018) on JQSRT

Measuring with All sky devices

- All sky devices or mosaic to obtain all sky imagery can provide quantitative information of main pollution sources.

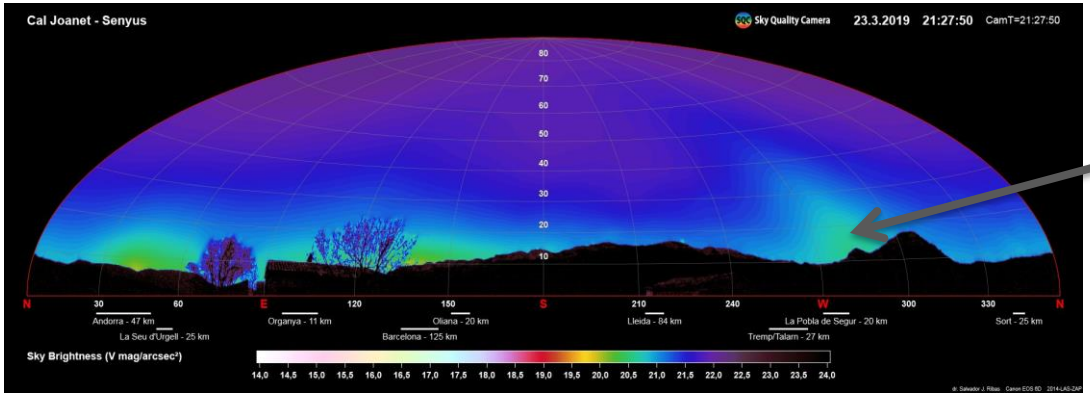


Milky Way

Sky Quality Camera processed image

and what about natural sources?

and what about natural sources?



Zodiacal Light

- Milky way, zodiacal light, starlight, airglow…
- To evaluate properly the effect of ALAN, a natural sky model is needed. Recently GAMBONS model has been released to evaluate natural sources (see https://gambons.fqa.ub.edu or Masana et al 2020 on MNRAS)

Final remarks

- Ground based data are necessary to get a detailed situation of ALAN impact on any location.
- One directional devices are very efficient for creation of maps and monitoring networks but one direction information could not be representative of a site, but in any case trends could be obtained.
- All sky techniques can provide a more reliable analysis of a site, but establishing networks is still complicated.
- Any kind of Night Sky Brightness measurement is affected by natural sources, so modelling of natural sources (stars, Milky Way, Zodiacal light, etc) is needed to extract information of real ALAN contribution to the night sky. Also atmospheric conditions could affect any measurement (aerosols, clouds, …)


DARK & QUIET SKIES
Thank you for your attention!
Contact: Dr. Salvador J. Ribas
Parc Astronòmic del Montsec
E-mail: sjribas@parcastronomic.cat
ASTRONÒMIC
Parc Astronòmic del Montsec