

The light pollution generated by Christmas lighting in Madrid is less than that produced by sports fields.

- Researchers from the GUAIX-UCM group, with the support of the Sky Protection Group, have taken new images from space to detect Christmas ornamental lighting, measure it directly and assess its environmental impact.
- The extraordinary lighting of the Real Jardín Botánico de Madrid, the cono de Sol and the large dynamic lighting ball at the junction between Alcalá and Gran Vía stand out as having the greatest and most undesirable environmental impact.

Madrid, 31 January 2022. For the first time it has been possible to obtain images from space of a city's Christmas lights. Previously, only the global increase of a large area had been detected using images from the Suomi-NPP satellite. The images obtained have a resolution of 50 cm/pixel compared to 750 m/pixel from the Suomi NPP satellite or 4 m/pixel from the International Space Station. The processing to obtain the 50 cm/pixel has been carried out by the Complutense team using super-resolution techniques. We now have more precise images that allow us to detect individual facilities and foci. **Researchers from the GUAIX group, with the support and disinterested contribution of the Sky Protection Group, have been monitoring the city of Madrid since 2018** with data from the Chinese satellite constellation Jilin-1 (Charming Globe) and since 2003 from the International Space Station.

With the new images taken during the Christmas season, it was possible not only to detect the Christmas lighting but also to measure it directly. In the absence of a more detailed analysis, **the images show that the contribution of sports fields and ornamental facade lighting is more important than the Christmas lighting itself.** This does not mean that Christmas lighting does not have a significant environmental impact, but that it is less than other sources.

The exception to this result is the extraordinary lighting of the Royal Botanical Garden, a park that should take special care of its darkness at night. The excessive

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lighting with its purple colour stands out as it is a space that is usually not illuminated. The increase is very significant and has undoubtedly had an undesirable environmental impact.

Other points of interest clearly highlighted are **the decorative motif in the form of the Sun cone, and the large dynamic lighting ball at the junction between Alcalá and Gran Vía.** Also noticeable are the illuminated street decorations between Cibeles and Puerta de Alcalá, and the illumination of Gran Vía.

As a result of this research it is shown how night-time satellite images are ideal for monitoring the level of light pollution and its environmental impact, even when these installations are relatively small such as Christmas lights. **To complete the study, reference images of the same quality obtained outside the Christmas period are needed.** Therefore, over the coming months, more images will be acquired for better comparison.

We must remember that **light pollution**, in addition to being a source of CO2 emissions and having other interactions with chemical air pollution (light pollution is also considered air pollution), **also has a myriad of other environmental impacts.** From the disappearance of certain species such as sea turtles, shearwaters and fireflies, disorientation of migratory birds, the apocalypse of insects, disruption of the predator-prey balance... and in humans it is a disruptive factor in circadian cycles, affecting issues such as sleep quality, obesity, diabetes and its relationship with various cancers (breast, prostate and colon) is being investigated. In particular, there is little research on the possible impacts of Christmas lights and these images may provide data on this particular issue. One of the possible effects may be falling branches on the most brightly lit trees.

The maps can be visited interactively in the following applications:

<https://pmisson.users.earthengine.app/view/madridchristmas> (Christmas lights)

<https://pmisson.users.earthengine.app/view/madridlight> (general purpose app)

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Fig 1: Image of Madrid city centre on 17 December 2021



Fig2 : Image of the centre of Madrid

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