

Celestial compass obscured by urban light pollution

Scientists of Freie Universität Berlin and the Leibniz Institute of Freshwater Ecology and Inland Fisheries publish study in the „Journal of Geophysical Research“

Urban light pollution has been shown to reduce the visibility of not only the stars, but also of an important navigational signal for some nocturnal animals. During clear moonlit nights, a compass-like pattern of polarized light that is invisible to the human eye stretches across the sky. The nighttime skyglow over major cities renders this celestial compass unobservable over large areas, according to a new study written by a group of physicists and ecologists at Freie Universität Berlin and the Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB). The report, which is currently in press in the Journal of Geophysical Research, cautions that screening of the celestial compass may reduce the evolutionary fitness of certain nocturnal animals, including species of beetles, moths, crickets, and spiders, possibly leading to disruption of food webs and affecting entire ecosystems.

“The visibility of the celestial compass is related to the degree of polarization of skylight” says the lead author of the study, Dr. Christopher Kyba, physicist at the Institute for Space Sciences of Freie Universität. “In a natural area with clean air, the degree of polarization of skylight is typically around 70-80%, and in Berlin aerosols reduce this to around 55%. We measured the sky polarization at night using a digital camera equipped with a linear polarizing filter, and found that inside the city light pollution reduced it further, to 11%” says the lead author of the study, Dr. Christopher Kyba. “Because light can travel so far in clear air, this depolarization effect extends far outside of cities. In a rural area outside of Berlin we found that the degree of polarization was still only 30%, even though the sky appeared dark to our eyes.”

“The moonlit celestial compass is believed to be an important navigational signal for several species” says Dr. Franz Hölker, ecologist, study author, and leader of the research project “Verlust der Nacht” (Loss of the Night). “Nocturnal species of beetles, moths, crickets, and spiders are believed to navigate using the celestial compass. What our study shows is that the depolarizing effect of skyglow is a form of pollution with global reach”.

The researchers emphasize that these preliminary measurements from Berlin likely underestimate the problem. “We performed these measurements on perfectly clear nights in the winter, when the full moon rises higher than it does in the summer” explains Kyba. “On typical summer nights when insects are likely to be active, we expect the celestial compass to be even more obscured. In addition, Berlin and its surroundings are darker than most comparatively sized world cities.”

An unexpected result of the research was the discovery that urban skyglow can itself be polarized. "We expected the skyglow on moonless nights to be almost unpolarized, but instead found it have a 9% degree of polarization" remarks Kyba. "Our best guess is that street canyons channel the upward directed light into beams. If this is the case then the skyglow over grid cities in North America could be even more highly polarized."

The scientists do not address reduction of skyglow in the paper, but believe that it could be achieved without making city streets dark. "Much or most of the skyglow propagating large distances from the city is caused by lights that aren't pointed at the ground" says Kyba. "Municipalities that wish to reduce their skyglow can choose from a wide range of commercially available lamps that produce 0% uplight." He recommends that businesses, local governments, or citizens that seek assistance in modernizing their outdoor lighting get in contact with the International Dark Sky Association.

The research was funded by two interdisciplinary projects, MILIEU and Verlust der Nacht. The Verlust der Nacht project, funded by the German Ministry of Education and Research (BMBF), is specifically devoted to quantifying light pollution and investigating its impact on humans and the environment.

Internet

- Kyba CCM, Ruutz T, Fischer J, Hölker F (2011) Lunar Skylight Polarization Signal Polluted by Urban Lighting. Journal of Geophysical Research. doi: 10.1029/2011JD016698
- MILIEU: www.milieu.fu-berlin.de/en/index.html
- Verlust der Nacht: www.verlustdernacht.de/index.html

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