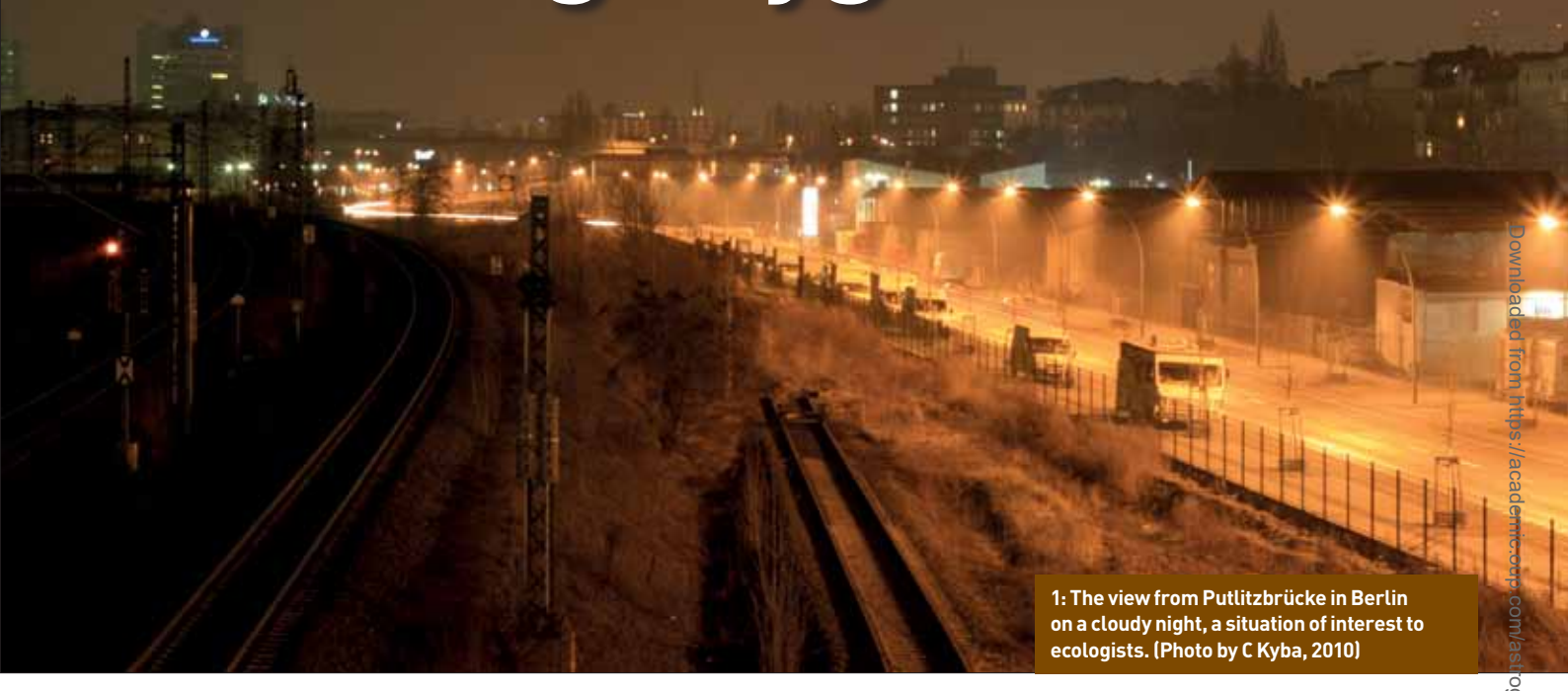
A community standard for recording skyglow data



1: The view from Putlitzbrücke in Berlin on a cloudy night, a situation of interest to ecologists. (Photo by C Kyba, 2010)

Christopher Kyba and Dorien Lolkema describe a standard format for recording skyglow data developed by the light at night research community, with the goal of improving data exchange between researchers.

The history of quantitative measurements of the radiance or irradiance of the artificially illuminated night sky now spans more than four decades (Walker 1970, Bertiau *et al.* 1973, Hoag 1973, Berry 1976). Despite this considerable history, there does not yet exist a standard for how to report such measurements. The free exchange of skyglow measurements has been greatly hampered by the lack of a common data format. To address this, a standard format for recording skyglow data has been developed by the light at night (LAN) research community. This article is intended to introduce the format to the wider astronomy community, to describe how it was developed, and to explain the guiding principles used in its development.

Recent advances in scotobiological research (concerning biological processes directly affected by darkness) have provided a strong motivation for increased understanding of the nocturnal environment (Rich and Longcore 2006, Navara and Nelson 2007). Concurrently, low-cost night-sky radiance and irradiance meters have been developed, such as the Sky QualityMeter (SQM) from Unihedron and the International Year of Astronomy Lightmeter (IYAL) from K2W Lights KG, respectively.

This confluence has resulted in geographically widespread (Barringer *et al.* 2011, Biggs *et al.* 2012) and often continuous (Müller *et al.* 2011) monitoring of the night sky, both at sites polluted by urban skyglow (Pun and So 2012) and at pristine sites naturally lit by celestial sources (Kolláth 2010), as well as with different meteorological conditions, including under full cloud cover (Kyba *et al.* 2011, Lolkema *et al.* 2011) and with snow on the ground (Falchi 2011). While initiatives exist to combine data from multiple observers, these efforts have been greatly complicated by the different data formats used by the researchers taking the measurements.

Announcement

We are pleased to formally announce the adoption of a standard data format for reporting skyglow measurements. A preliminary version of the standard was developed at a workshop of the Cabauw Lightmeter InterComparison campaign on 9 May 2012 and sent out for consultation by the LAN research community. Over a period of several months the data format was repeatedly revised as feedback was received. In order to ensure that it was vetted by as wide a segment of the measurement community as possible, the format was presented at the 28th General Assembly of the International Astronomical Union (IAU), at the 12th European Symposium for the Protection of the Night Sky, and to IAU commission 50. The final format presented here has been endorsed by 49 people (listed under "Supporters"), including researchers from astronomy and interdisciplinary LAN studies, the manufacturers of the SQM, the author of the commonly used "SQM Reader" program, the managers of the IYAL data archive, and the International Dark Sky Association.

A guiding principle in the development of the format was that it should be easily readable by both machines and humans. For this reason, all data are recorded in ASCII format. Each data file contains a header with information about the station (e.g. geographical location and name), as well as about the lightmeter used (e.g. type of device, internal calibration parameters). The number of data channels is specified in the header to allow devices with multiple look directions (e.g. the Night Sky Brightness Monitor from the International Dark Sky Association [IDA], McKenna 2008) or multiple filters (e.g. Kyba *et al.* 2012). Because the format is intended for devices with a small number of channels, it is not appropriate for the storage of image data (e.g. fisheye photographs), unless those data have been reduced to a small number of channels.

2: Skyglow from aerosol scattering above Berlin, almost entirely below the planetary boundary layer. (Ralf Steikert. Image available under CC-BY-SA 3.0 at http://tinyurl.com/8q7u4zo)

Following the header, a series of data lines describe the individual observations. These lines begin with a universal timestamp (UTC) and the local time. The local time is included because some relevant events may occur at specific periodic local times (e.g. turning off of lights on a stadium). The individual raw data from each channel follow, and a new line is begun for each new temporal observation. Although most lightmeters are permanently located and view the zenith, the format specifies a standard for moving and/or scanning stations.

Online description

A detailed description of the format exists, but as this documentation could be changed (for clarification) in the future, the International Dark Sky Association has agreed to permanently host a webpage containing the detailed definition of the standard at http://www.darksky.org/measurements, with links to example files for the SQM and IYAL. Developers of new instruments should check the IDA webpage to ensure compliance with the most up-to-date standard.

The format was officially adopted on 15 September 2012 at the 12th European Symposium. While it is our hope that this data format has fully anticipated the needs of both data analysers and the developers of new instruments, it is conceivable that after gaining experience using the format the community will find that it needs to be modified. It was agreed that the definition of the format should be reconsidered in five years (2017), and changed if necessary. The widespread use of this data format should allow the creation of a database of worldwide light-at-night observations. The availability of sky brightness time series would be an invaluable tool for skyglow monitoring, and for light pollution abatement efforts. ●

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