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Upward angular distribution of light pollution at 10,000 ft

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The introduction of artificial light into the nighttime environment has only recently been recognized as a potentially serious environmental pollutant. Briefly, light can change behavior patterns related to vision (e.g. orientation and migration, predator-prey interactions), and is suspected to play a role in the development of specific illnesses (e.g. cancer) through the interruption of the circadian rhythm. Simulations of light pollution aim to predict the light levels within and far away from urban areas, and also under different meteorological conditions. These simulations require as an input either the angular distribution of light sources (and a model for horizontal shading), or else a presumed upward angular distribution of light pollution. Until now, this had not been available, and most simulations have used purely invented distributions. We present a measurement system based on two cameras with wide angle lenses, which is capable of measuring the upward angular distribution of light pollution of specific lights through approximately 140 degrees of zenith (i.e. from zenith to 20 degrees above the horizontal) and 360 degrees of azimuthal angle. We describe the physical system, its operation in a Cessna at 10,000 ft, optical calibration, and preliminary results based on measurement flights over Berlin in the fall of 2011. In addition to improving light pollution models, we believe this data will be of use in converting satellite measurements of surface brightness (taken at approximately nadir viewing angle) to estimated fluxes (for e.g. electrical use estimation), as well as for analysis of light pollution mitigation measures.