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Using a wavelength-generalized version of the Garstang (1991) model, we evaluate overhead sky glow as a function of distance up to 300 km, from a variety of lamp types, including common gas discharge lamps and several types of LED lamps. We conclude for both professional, and especially cultural (visual), astronomy, that low-pressure sodium and narrowspectrum amber LED lamps cause much less sky glow than all broad-spectrum sources.

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The Effects of Lamp Spectral Distribution on Sky Glow over Observatories

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Abstract. Using a wavelength-generalized version of the Garstang (1991) model, we evaluate overhead sky glow as a function of distance up to 300 km, from a variety of lamp types, including common gas discharge lamps and several types of LED lamps. We conclude for both professional, and especially cultural (visual), astronomy, that low-pressure sodium and narrow-spectrum amber LED lamps cause much less sky glow than all broad-spectrum sources.

Keywords. atmospheric effects, scattering, site testing

We have modified the Garstang (1991) model to include wavelength-dependent scattering and absorption. We evaluate overhead ($z \leqslant 60°$) sky glow at distances from 0.1-300km from low-pressure sodium (LPS), amber LED (ALED; peak 590nm, FWHM 15nm), high-pressure sodium (HPS), white LED with CCT of 2400K (wLED) and 5100K (cLED), metal halide with CCT of 4100K (MH), and a white LED with a 500nm filter (FLED). All lamp types are set to emit equal luminous flux. Results are summarized in Fig. 1.

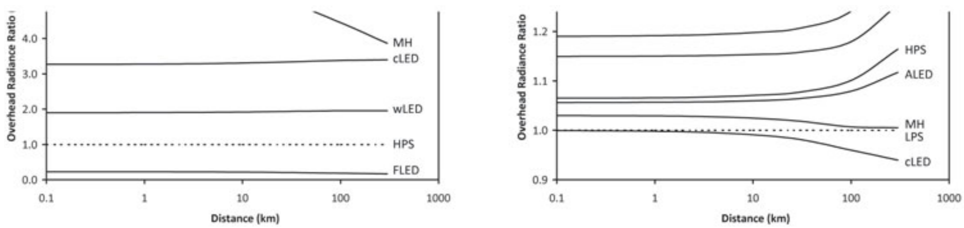

Figure 1. Ratio of overhead radiant sky glow as a function of distance. The left panel, relative to HPS, is for λ350-500nm (LPS/ALED have no emission here); the right panel, relative to LPS, is for λ500-650nm. (Does not include natural sky glow)

In the range λ500-650nm, wLED and FLED cause 15-35% more overhead radiant sky glow (RSG) than LPS or ALED. Increased scattering at short wavelengths is balanced by increased extinction when observed from $<$ 10km. At greater distances, RSG from MH and cLED decreases relative to LPS, while that from wLED, FLED and HPS increases. In the range λ350-500nm, wLED, cLED and MH contribute ∼2-5x more to the RSG than HPS. FLED has reduced blue RSG compared to broad-spectrum sources, but substantially greater blue and red RSG than LPS/ALED, especially at large distances.

Due to the Purkinje shift, narrow-spectrum yellow sources like LPS cause dramatically less visible sky glow ($1/2 - 1/9$) than all broad-spectrum sources, including FLED.

References

Garstang, R. H. 1991, *PASP*, 103, 1109