Follow the references provided in the image.

**Death of Darkness**

Many species (including ours) need darkness to survive and thrive yet light pollution in the anthropocene has received scant attention in the media or in Earth System Models (ESMs). Anthropic aerosols can brighten background sky brightness and reduce the contrast between skylight and starlight. Previous studies (e.g., Falchi et al. at right) show that light pollution already prevents nearly half the world’s population from seeing the Milky Way. Light pollution poses both aesthetic and health-related issues due to its accompanying disruption of circadian rhythms. We quantify aerosol contributions to light pollution using a single-column night sky model, NiteLite, suitable for implementation in ESMs. NiteLite accounts for physiological (photopic and scotopic vision, retinal diameter/age), anthropogenic (light and aerosol pollution properties), and natural (surface albedo, trace gases) effects on background brightness and threshold visibility. We find that stratospheric aerosol injection contemplated as a stop-gap measure to counter global warming would increase urban night-sky brightness by ~25%. If ESMs incorporate light pollution, then the associated societal impacts can be better quantified for inclusion in policy deliberations.

**Photometric Units**

Results are presented in photometric units and thus correspond to human-perceived light intensity rather than radiometric energy. Photometric luminance (brightness) and illuminance are derived by applying CIE photopic bandpass applied to model-computed radiometric intensity and irradiance, respectively.

**Methods**

We assess light pollution due to Stratospheric Aerosol Injection (SAI) with a column radiation model (Zender, 1999). We spread sulfate aerosol throughout the 10-100 mb region of a standard mid-latitude summer atmosphere whose troposphere already contains the current global mean natural and anthropogenic background aerosol.

Assumptions:
- Stratospheric aerosol (natural+anthropic) boundary layer AOD = 0.12
- Stratospheric sulfate AOD to counteract 2xCO2 = 0.17 (at 10-100 mb)
- Sulphate effective radius, geometric standard deviation = 0.3 μm, 0.4
- Color temperature of artificial light = 3000 K
- Surface reflectance of land, ocean = 0.2, 0.05
- Natural dark sky brightness = 177 μcd/m²
- Artificial light per capita = 1000 lm emitted isotropically at surface
- Urban, Remote population density = 10⁴/m², 10²/m²
- Surface reflectance of land, ocean = 0.2, 0.05

NiteLite simulations employ clear sky (no clouds) conditions with 92 levels and four streams.

**Conclusions**

How would Stratospheric Aerosol Injection (SAI), the leading stopgap measure to slow or reverse global warming, affect light pollution?
1. Significantly increases (by ~25%) zenith-looking urban night sky brightness.
2. Effects strengthen toward horizon so total downwelling illuminance increases more than zenith-looking brightness.
3. Insensitive to surface albedo (single scattering regime).
4. Slightly reduces remote zenith-looking night sky brightness (and stellar visibility) in remote regions due to backscattered starlight.
5. Artificial night light, unlike sunlight, is all diffuse. However, SAI significantly increases (by ~50%) diffuse fraction of starlight.

**Health Impacts**

The IAU defines skies where artificial brightness exceeds 10% of natural above 45° as light-polluted. A review by Chepessik (2009) describes how light pollution 1) disorients turtle navigation, 2) disrupts bird migration, 3) inhibits frog mating, 4) alters bat feeding, 5) is suspect in declines of nocturnal mammal populations. Human studies show that light pollution disrupts circadian cycles and melatonin production, implicating it in increased depression, insomnia, shift-work sleep disorder, heart disease, and breast cancer.

**Future Improvements**

1. Replace isotropic with directional emission.
2. Horizontal connectivity via successive orders of scattering.
3. Stellarity visibility

**Citations**


**Support**


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