Detecting Changes in Nighttime Sky Brightness over Grand Teton National Park with NASA’s VIIRS Sensor

Abstract
As more outdoor lighting is installed for safety and development, light pollution has become a growing problem that threatens the quality of life for humans and wildlife. The onset of light pollution in cities and dark sky areas not only hinders humans from seeing the stars and the Milky Way, but also has been linked to health disorders in humans and behavioral changes in flora and fauna.Park officials and Grand Teton National Park (GRTE) are concerned about light pollution’s impacts on visitor experience and the environment. Thus, in collaboration with the National Park Service and Wyoming Stargazing, our team created the Skyglow Estimation Toolbox (SET), a Python program that generates images of artificial skyglow from the vantage point of a viewer on the ground. SET processes visible light radiance imagery collected by the Suomi National Polar-orbiting Partnership Visible Infrared Imaging Radiometer Suite (VIIRS) Day/Night Band. By processing the pixel values in VIIRS imagery with convolution, SET applies Czirano (2001) and Garstang’s (1989) model of light propagation to create artificial skyglow maps to measure skyglow at a user-defined viewing angle and location. We applied this program to a 300 km buffer of our study area, GRTE, and created multi-annual composites of skyglow over the summer months (July, August, and September) of 2014, 2015, and 2016. With further development and model validation, SET will help local officials and communities quantify the impact of light sources on its night skies and will help inform decisions regarding lighting ordinances in Teton County.

Objectives
- **Assess** current research and policies addressing the environmental, economic, and social ramifications of artificial skyglow
- **Design** and publish a python program, the Skyglow Estimation Toolbox (SET), to model light propagation in the atmosphere from different viewing angles and for any given region
- **Visualize** the impact of anthropogenic light pollution on night sky brightness using artificial skyglow maps created in the SET
- **Provide** tools and documentation to inform the National Park Service and local communities on how to use the SET to understand current and historic night sky quality

Study Area

![Grand Teton National Park Study Area](image)

Conclusions
- The Skyglow Estimation Toolbox (SET) and Suomi NPP VIIRS imagery combined can model light pollution as viewed from the ground.
- Skyglow Artificial Maps identify sources of light pollution and show patterns of light scatter and propagation.
- Model validation will increase precision and accuracy of SET.
- SET offers broader, more dynamic capabilities and applications than handheld light meters, allowing park officials to expand the geographic scope of current measurement practices.

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Methodology & Results

![Radiance Values for September 2016](image)

SET takes a VIIRS image as an input along with several other variables and produces an Artificial Skyglow Map. This image uses the median VIIRS image compiled by our team.

Earth Observations

Suomi National Polar-orbiting Partnership (NPP) Visible Infrared Imaging Radiometer Suite (VIIRS) Day/Night Band (DNB)

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