**NASA DEVELOP National Program**

**2018 Summer Project Proposal**

**Virginia – Langley**

**US Urban Development**

*Validating Sky Glow Estimation Tools Using Suomi NPP VIIRS to Support Lighting Policies and Management Strategies in National Parks*

**Project Overview**

***Project Synopsis*:** This project will apply DEVELOP’s newly-created Sky Glow Estimation Toolbox to assess artificial sky brightness and light pollution in national parks using Suomi NPP VIIRS Day/Night band data. By testing the toolbox across several national park units, the National Park Service’s Night Skies Program will be able to validate its effectiveness between several systems that are impacted by artificial sky brightness. Once the software is updated to be functional across multiple physiographic and environmental regimes, this toolbox can be widely utilized by the national Night Skies Program to identify where changes in lighting policies and practices are necessary and may be effective in reducing light pollution in national park units.

***Community Concern:*** Brightening skies in wilderness areas within national parks can have many detrimental impacts on wildlife and visitors. Wildlife are adapted to specific diurnal cycles that influence their feeding, breeding, and general movement activities. As skies become brighter due to anthropogenic activities, these diurnal cycles are disrupted, which can lead to increased stress, ill-timed mating activities, and confusion amongst wildlife. Further, these brightened skies decrease nighttime sky quality and visibility, a major draw to park visitors.

***Source of Project Idea:*** This project stemmed from previous DEVELOP work (Wyoming Cross-Cutting I & II, Colorado Plateau Urban Development I) with other national park units interested in nighttime sky brightness. From these past collaborations, the Natural Sounds and Night Skies Division wanted to test this technology across multiple parks within their jurisdiction.

***National Application Area Addressed:*** Urban Development

***Study Location:*** United States (AK, FL, IN, NE, VA)

***Study Period:*** June 2014 – August 2017

***Advisor:*** Dr. Kenton Ross (NASA Langley Research Center)

**Partner Overview**

***Partner Organization:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **National Park Service, Natural Sounds and Night Skies Division, Night Skies Program** | Sharolyn Anderson, Physical Scientist;  Li-Wei Hung, Night Skies Research Scientist | End User | No |

***End User Overview***

***End User’s Current Decision-Making Process:***The Natural Sounds and Night Skies Program provides field data, modeled data, tools, and analyses to support the entire National Park Service (NPS) as needed. Their mission is to preserve and restore acoustic and photic environments, increase scientific understanding, and inspire public appreciation of soundscapes and the natural night skies. The program provides the scientific materials for park planning documents, including Natural Resource Condition Assessments (NRCA), Resource Stewardship Strategy reports, and Wilderness Management Plans. In addition, the Night Skies data and analyses are used in foundation documents for park missions’ documentation and National Environmental Policy Act (NEPA) reports, both of which establish existing conditions of night skies. Further, the group currently is responsible for measuring artificial sky brightness across many national parks, and synthesizing that information in a Night Skies Monitoring Database. This database includes information about night viewing sky quality within these parks based solely on *in situ* data collected by the NPS staff. These data are used to help parks become certified as meeting certain night sky quality standards, and also to create monitoring reports that provide tangible goals and metrics for park units to use in their management decisions.

***End-User’s Capacity to Use NASA Earth Observations:***

*National Park Service, Natural Sounds and Night Skies Division, Night Skies Program* – The Natural Sound and Night Skies Division is a relatively small division and enjoys working with other federal agencies and universities to help support the division’s mission. Since sound and light travel beyond park boundaries, it has been necessary to use satellite data to enhance modeling efforts and to understand the landscape. The Night Skies program mainly uses the Suomi NPP VIIRS Day/Night Band products in our models. They report the results to the individual parks both for natural resource management and monitoring and for project planning. Overall, the program is familiar with NASA Earth observations and uses Landsat and MODIS vegetation indices occasionally. Partners on this project are also key authors on several papers that used NASA Earth observations to monitor nighttime emissivity using Suomi-NPP VIIRS DNB.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** The Center Lead and the Project Lead will be the main POC for the project. Weekly emails and biweekly telephone calls will be used to discuss project progress and receive feedback from the partner.

***Transition Plan*:** A handoff at the end of the term will be conducted virtually via WebEx. All end products and project deliverables will be emailed to the partner after the handoff meeting, allowing time for feedback. The tools and scripts created by the project are already going through the software release process and will be made available once that process has completed. The partners will be consulted in advance before any changes to the existing tool are made. A separate handoff for those end products will be scheduled as needed if the process does not finish prior to the term ending.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter** | **Use** |
| **Suomi NPP VIIRS** | Day/Night Band (DNB) | Suomi NPP VIIRS will be used to highlight areas of artificial lighting which indicates encroachment upon national park units. |

***Ancillary Datasets:***

NPS Night Skies Program Night Sky Monitoring Database – validate Suomi NPP VIIRS data

NPS Natural Sounds and Night Skies Division field data – calibrate Sky Glow Estimation Toolbox

NPS Integrated Resource Management Applications (IRMA) park boundaries – use to identify park boundaries at time of analysis

***Software & Scripting:***

Esri ArcGIS – raster manipulation, statistical interpretation, map creation

Python – light path calculations, summation of sky glow contributions, and creation of regional skyglow estimates

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **3D Hemispheric Artificial Brightness Maps** | Radiance maps for each national park examined will assist partners in the identification of areas from where excess artificial light is emitted, as well as identify areas that are affected by excessive artificial light. Further, these maps will be used to validate current measurements and surveys taken by the NPS. | Suomi NPP VIIRS will be used to assess changes in nighttime artificial light during the study period. | N/A |
| **Sky Glow Estimation Toolbox** | The Sky Glow Estimation Toolbox will be used to assess how sources of anthropogenic light affect national park units across the country. | Python will be used to run the mathematical model over the study area. | IV\* |

***End User Benefit*:** The end users are currently relying on a combination of *in situ* measurements and data from the New World Atlas to make monitoring and management decisions regarding night sky brightness in national park units across the country. These data are limited in scope in that the *in situ* measurements are lengthy and costly processes, and the New World Atlas products only look directly above the monitoring instrument rather than the whole sky hemisphere. Thus, this work has the potential to provide direct access for parks to monitor or assess the sky glow in their region, find and incorporate night skies information in park planning documents, and provide information for the surrounding areas to aid in mitigation of artificial light. The novel advantage of this toolbox is that the park can display the sky glow at a certain altitude (horizon to zenith), not just at zenith or directly overhead.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 2 Terms: 2018 Summer to 2018 Fall

***Multi-Term Objectives:***

* **Term 1 (Proposed Term):** 2018 Summer (LaRC) – US Night Skies Urban Development
  + The first term of this project will focus on toolbox development and its validation across multiple national parks units across the country, specifically Denali National Park & Preserve (AK), Scotts Bluff National Monument (NE), Indiana Dunes National Lakeshore (IN), and Gulf Islands National Seashore (FL, MS). This refinement will be used to assess the efficacy of expanding the use of the toolbox to all parks within the Night Skies Program’s network.
* **Term 2:** 2018 Fall (LaRC) – US Night Skies Urban Development II
  + The second term of this project will build upon the first term’s validation efforts to finalize validation, refine usability, and focus on partner handoff. Once validation has been assessed across all of the national park units within the study region, usability and documentation will be refined in order to make this toolbox widely usable across the Night Skies Program network. In order to facilitate the adoption of the toolbox by the end users, a multi-day webinar handoff will be conducted with the partners once the toolbox has completed the software release process.

***Related DEVELOP Work:***

2017 Fall (VA) – Colorado Plateau Urban Development: A Perspective on Nighttime Sky Glow over the Colorado Plateau by Integrating the Suomi NPP VIIRS Day Night Band Sensor with a Customized Geolocation Data Processing Program

2017 Summer (VA) – Wyoming Cross-Cutting II: Detecting Changes in Nighttime Sky Brightness over Grand Teton National Park with Suomi NPP VIIRS Sensor

2017 Spring (VA) – Wyoming Cross-Cutting: Utilizing NASA Earth Observations to Detect Changes in Nighttime Sky Brightness in Grand Teton National Park

2013 Spring (SSC) – Continental United States Climate: Determining the Feasibility of Using VIIRS Global Combustion Source Detection Products to Estimate the Regional Contributions of Natural Gas Flaring to U.S. Greenhouse Gas Emissions

**Notes & References:**

***Notes*:**

Link to Night Sky Monitoring Database: <https://www.nps.gov/subjects/nightskies/skymap.htm>

This project will be utilizing code currently going through the software release process, but that has not been released.

***References:***

Cinzano, P., Falchi, F. and Elvidge, C.D. (2001). The first world atlas of the artificial night sky brightness. *Monthly Notices of the Royal Astronomical Society, 328*, 689–707. doi:10.1046/j.1365-8711.2001.04882.x

Falchi, F., Cinzano, P., Kyba, C., & Portnov, B. A. (2015). The new world atlas of artificial sky brightness. *IAU General Assembly, 22*, 47038.

Garstang, R. H. (1989). Night-sky brightness at observatories and sites. *Publications of the Astronomical Society of the Pacific, 101*, 306-329.