**NASA DEVELOP National Program**

**2017 Summer Project Proposal**

**Wise County Clerk of Circuit Court’s Office**

**Wyoming Cross-Cutting II**

*Utilizing NASA Earth Observations to Detect Changes in Nighttime Sky Brightness in Grand Teton National Park*

**Project Overview**

***Project Synopsis*:** This project will continue to assist Wyoming’s Grand Teton National Park by monitoring changes in light pollution using the Suomi National Polar-orbiting Partnership (NPP) Visible Infrared Imaging Radiometer Suite (VIIRS). The Sky Glow Visualization Toolbox will build upon the work conducted during the previous term to help personnel at Grand Teton National Park identify areas where changes in lighting policy and practices have been effective in reducing light pollution as well as areas where further mitigation is needed.

***Community Concern:*** Anthropogenic lighting has detrimental effects on nighttime sky quality and visibility, which has caused changes in wildlife feeding and breeding habits and human activity. Historically, Grand Teton National Park and the surrounding area have had some of the clearest night skies in the country due to the region’s low humidity and isolation from human development. However, as light from Jackson, WY and Idaho Falls, ID has increased and suburban areas have encroached on the park, this world class night sky visibility has decreased. In addition to diminishing star-gazing opportunities, increased artificial light has the potential to alter wildlife behavior.

***Source of Project Idea:*** This project idea originated from conversations between Bob VanGundy, DEVELOP Science Advisor for the Wise County node, and Michael Brooke, Center Lead for the Wise County node.

***National Application Area Addressed:*** Cross-Cutting

***Study Location:*** Grand Teton National Park, WY

***Study Period:*** January 2014 – May 2017

***Advisors:*** Dr. Kenton Ross (NASA Langley Research Center), Dr. DeWayne Cecil (NOAA National Centers for Environmental Information, Global Science & Technology, Inc.), Bob VanGundy (The University of Virginia’s College at Wise)

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| National Park Service, Intermountain Region | Randy Stanley, Night Skies and Sounds Coordinator | End-User | No |
| National Park Service, Grand Teton National Park | Dan Greenblatt, Colter Bay District Interpreter | End-User | No |
| International Dark-Sky Association | John Barentine, Program Manager | Collaborator | Yes |
| Wyoming Stargazing | Samuel Singer, Program Director | End-User | Yes |

***End-User Overview***

***End-User’s Current Decision-Making Process:***Grand Teton National Park monitors nighttime visibility at point locations using handheld light meters and multispectral cameras. These readings are used to quantify the effect that modifications to the lighting of surrounding areas has on visibility within the park. By tracking these readings over time, the lighting practices employed within the park and nearby cities can be addressed to maximize night sky viewing and minimize impacts on wildlife.

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

*National Park Service, Intermountain Region* – Park managers at the National Park Service are familiar with NASA Earth observations and use Landsat and MODIS vegetation indices in daily operations. Personnel at NPS are aware of Suomi NPP VIIRS Day/Night Band (DNB) data and have used it operationally. They do not currently use it to monitor changes in nighttime lighting in near real-time. This project would introduce our partners to the capabilities of the Suomi NPP VIIRS DNB for near real-time light pollution monitoring.

*National Park Service, Grand Teton National Park* – Park Managers and Rangers at Grand Teton National Park (GRTE) are familiar with NASA Earth observations and uses Landsat and MODIS vegetation indices in daily operations. Personnel at GRTE are aware of Suomi NPP VIIRS DNB data, however, they do not use it to monitor changes in nighttime lighting in near real-time. This project would introduce our partners to the capabilities of the Suomi NPP VIIRS DNB for near real-time light pollution monitoring.

*Wyoming Stargazing* – Wyoming Stargazing is a 501(c)3 organization based in Jackson, Wyoming that is dedicated to educating and inspiring visitors through observation of Wyoming’s extraordinary skies. The organization has an extensive log of *in situ* measurements from sky quality meters that will be shared with the DEVELOP team.

***Collaborator & Boundary Organization Overview***

***Collaborator Support:***

*International Dark-Sky Association* – The International Dark-Sky Association (IDA) devises and supports worldwide initiatives aimed to protect the night skies and fragile ecosystems found within parks and protected areas. The IDA also hosts the Artificial Light at Night (ALAN) Research Literature Database. Their wealth of knowledge on the subject of light pollution will contribute to the overall value and scope of the project.

***Dissemination by Boundary Organizations*:**The IDA will distribute the results of this project through their ALAN Literature Database and may also highlight the project on their website (www.darksky.org). The results of this project may aid GRTE in gaining status as an International Dark-Sky park, which would be publicized by the NPS. Additionally, Wyoming Stargazing will distribute the video produced by the team on its website (www.wyomingstargazing.org).

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** The team lead will serve as point of contact between project partners and arrange bi-weekly calls to discuss project progress with Dan Greenblatt (Grand Teton National Park), Randy Stanley (National Park Service Intermountain Region), and Samuel Singer (Wyoming Stargazing), John Barentine (International Dark-Sky Association).

***Transition Plan*:** A project hand off will be conducted either over teleconference with a shared screen or Google Hangout. The tools produced by this project will be used by the partner to identify areas where mitigation of artificial light is needed.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **Suomi NPP VIIRS** | Day/Night Band (DNB) | This sensor will be used to highlight areas of artificial lighting which encroach upon Grand Teton National Park. |

***Ancillary Datasets:***

National Park Service, Grand Teton National Park – Sky brightness survey – used to correlate VIIRS DNB data with ground truth

Center for the Advancement of Science in Space (CASIS) – International Space Station (ISS) Astronaut Photography – used to assess areas with updated LED lights not sensed by VIIRS DNB

Partner *In situ* Data – Wyoming Stargazing Sky Quality Measurements – used to correlate VIIRS DNB data with ground truth

***Software & Scripting:***

ESRI ArcGIS – raster manipulation, statistical interpretation, map creation

NumPy – integration of equations into script

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product(s)** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Monthly Nighttime Radiance Map** | This end product 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. | Suomi NPP VIIRS DNB will be used to assess changes in nighttime artificial light during the study period | N/A |
| **Sky Glow Visualization Toolbox** | This end product will allow partners to assess how sources of anthropogenic light within the study area propagates through the atmosphere and affects areas within and around Grand Teton National Park. | NumPy will be used to run the mathematical model over the study area. | II |

***End-User Benefit*:** Grand Teton National Park will use the Yearly Nighttime Radiance product to assess recent changes made to nighttime lighting in nearby communities. Additionally, this product will identify areas within the park and surrounding communities that need further mitigation of artificial light. These products will augment existing ground-based sky brightness readings within the park and provide a comprehensive, park-wide approach to the measurements.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 2 Terms: 2017 Spring (Start) to 2017 Fall (Completion)

***Multi-Term Objectives:***

* **Term 1:** 2017 Spring (WC) – Wyoming Cross-Cutting
  + This project researched the methodologies involved in the propagation of artificial light through the atmosphere. The team used a “best-fit” method to replicate the findings of Falchi, *et al.* (2015). The first term also explored implementing the equations used by Cinzano, *et al.* (2001) in ArcGIS and Google Earth Engine, setting the stage for more precise calculations in the second term. Communication was frequent from all partners with data provided by Wyoming Stargazing and the National Park Service.
* **Term 2 (Proposed Term):** 2017 Summer (WC) – Wyoming Cross-Cutting II
  + The second term aims to accurately implement the equations outlined in Cinzano *et* *al.* (2001) for propagation of light through the atmosphere. The team will produce a Sky Glow Visualization Toolbox to be used by the partners in the future to react to changes in lighting practices in real-time. Using this toolbox, the team will create an updated map of nighttime sky glow for Grand Teton National Park for the study period. The team will also work closely with NPS personnel to coordinate *in situ* sky quality measurements with the overpass of the Suomi NPP satellite.

***Related DEVELOP Work:***

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

***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.