Ph.D. Defense Announcement
Chandra Pasillas
Wednesday, February 15, 2023, at 2:00 pm

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Defense
CIRA Commons or Teams

Post Defense Meeting
Riehl Conference Room (211 ACRC)

Committee:
Christian Kummerow (Advisor)
Michael Bell (Co-advisor)
Steven Miller
Kristen Rasmussen
Steven Reising (Electrical and Computer Engineering)

Turning Day into Night: The creation, validation, and application of synthetic lunar reflectance values from the Day Night Band and Infrared Sensors for use with JPSS VIIRS and GOES ABI.

Satellite remote sensing revolutionized weather forecasting and observing in the 1960s providing a true birds eye view of the weather beyond what could be achieved from balloon and aircraft reconnaissance. With the advances in observing came the desire for more capability and the understanding of the Earth system and radiation budget grew rapidly. The most popular imager products come from solar reflective radiation in the form of visible imagery as they are the most intuitive to users. The benefits of equivalent nighttime imagery have been seen through the use of the operational line scanner (OLS) and day night band (DNB) but these sensors have limited revisit time. This presentation focuses on the creation and implementation of a machine learning model to turn day into night by transforming satellite retrieved radiances into representative full moon lunar reflectance values that provide quantifiable metrics and visible like imagery to its users.

First, a method is described that utilizes a feed-forward neural network to replicate DNB lunar reflectance using brightness temperatures and wavelength differences in the short and long-wave infrared (IR) spectrum as primary input. The goal is to improve upon the performance of the DNB during new moon periods, and lay the foundation for transitioning the algorithm to Geostationary Operational Environmental Satellite (GOES) Advanced Baseline Imager (ABI). Results from this method are the first to quantitatively validate low-light visible nighttime imagery with lunar reflectance calculated from DNB radiances. This work further demonstrated that there is a relationship between full moon lunar reflectance and IR that can be captured to create imagery that is visually consistent across the full lunar cycle regardless of moon phase and angle.

Next, the machine learning (ML) nighttime visible imagery (NVI) model is applied to the GOES ABI utilizing wavelength relationships and satellite inter-calibrations information. This demonstrates that a model trained and validated on VIIRS polar orbiting imagery can work on sensors aboard geostationary satellites. It also confirms why

the 10.3 micron channel is the preferred substitution for the 10.7micron centered band over the 11.1 micron. Furthermore, it demonstrates that lunar reflectance from IR can be replicated across cross platform sensors with similar spectra response functions providing enhanced geographic and temporal resolution that is not possible on the JPSS platforms.

The final portion of the presentation demonstrates forecaster applications by examining case studies concerning tropical cyclones and fog in greater detail. Focused on low cloud detection, NVI provides additional information not possible from IR and current analysis products available. It can detect tropical cyclone low level circulations through cirrus cloud and identify fog extent more easily. The findings presented will advance remote sensing of clouds at night, further reducing weather now-casting errors and increasing weather related safety.

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