

# Model development for nighttime light radiative transfer and application to VIIRS Day Night Band remote sensing of aerosols

Meng Zhou<sup>a,\*</sup>, Xiaoguang Xu<sup>b</sup>, Jun Wang<sup>a</sup>, Sepehr Roudini<sup>a</sup>, Thomas Pongetti<sup>c</sup>, and Stanley Sander<sup>3</sup>

<sup>a</sup>University of Iowa, Iowa Advanced Technology Laboratories, Iowa City, IA 52242-1503, USA

<sup>b</sup>University of Maryland – Baltimore County, 1000 Hilltop Cir., Baltimore, MD 21250, USA

<sup>c</sup>NASA Jet Propulsion Laboratory (JPL), 4800 Oak Grove Dr., Pasadena, CA 91109, USA

\*Meng Zhou (meng-zhou-1@uiowa.edu)

The observation of nighttime aerosol condition is important because of aerosol effects on visibility, air quality, and public health. By measuring visible light at night from space, the Visible Infrared Imaging Radiometer Suite Day/Night Band (VIIRS DNB) [1] sensor onboard the NPP and JPSS-1 satellites provides the research and operational communities the capability to explore nighttime atmospheric optical and aerosol properties. To quantitatively use the DNB data for nighttime remote sensing, we developed a nighttime radiative transfer model based on the Unified Linearized Vector Radiative Transfer Model (UNL-VRTM) [2]. With the new development, the UNL-VRTM can simulate light transfer at night with careful consideration of surface light spectra from various types of artificial light sources, gas flares, and wildfires, as well as moonlight and DNB relative sensor response function (RSR).

We used this model to investigate questions key to the remote sensing of aerosol using VIIRS DNB observations: (1) How significantly can the VIIRS RSR impact the AOD retrieval? (2) How much AOD retrieval bias is there for different surface light spectra when a wavelength independent spectrum (or continuum) is used? (3) For cost efficiency, if only one channel is used to retrieve the AOD, what is the equivalent wavelength of our daily life lamps? Our results show the following. First, without considering the DNB RSR, there can be greater than a 100% bias when the AOD is relatively low (less than 0.5). This retrieval bias decreases as the AOD increases. Second, the AOD retrieval bias is spectrum dependent. When a wavelength independent spectrum is used to retrieve the AOD, the bias is around -10% for light-emitting diodes and fluorescent lamps. While for high pressure sodium lamp, this bias is around -30%. This retrieval bias also decreases with increasing AOD. Third, the equivalent wavelength with respect to the AOD retrieval for the chosen three lamp spectra is around 585 nm.

## References

- [1] Miller, S., *et al.*, 2013: Illuminating the capabilities of the Suomi National Polar-Orbiting Partnership (NPP) Visible Infrared Imaging Radiometer Suite (VIIRS) Day/Night Band. *Remote Sens.* **5**, 6717–6766.
- [2] Wang, J., *et al.*, 2014: A numerical testbed for remote sensing of aerosols, and its demonstration for evaluating retrieval synergy from a geostationary satellite constellation of GEO-CAPE and

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