Impact of Urbanization on the Continental US Surface Climate

L. Bounoua, P. Zhang, G. Mostovoy, K. Thome, J. Masek, M. Imhoff, M. Shepherd, D. Quattrochi, J. Santanello, J. Silva and R. Wolfe

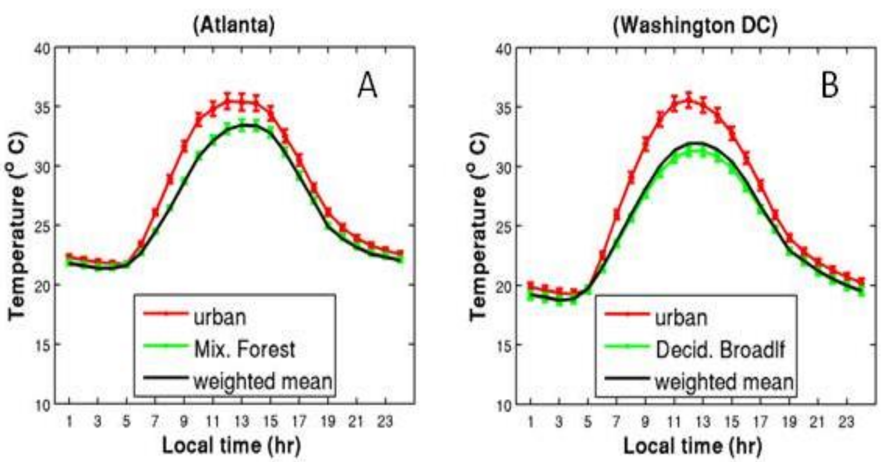

Figure 1: June-July-August mean diurnal cycle of surface temperature for urban (red), dominant vegetation fraction (green) and the weighted average surface temperature for all land cover types (excluding urban) (black) for Atlanta (a) and Washington DC (b),

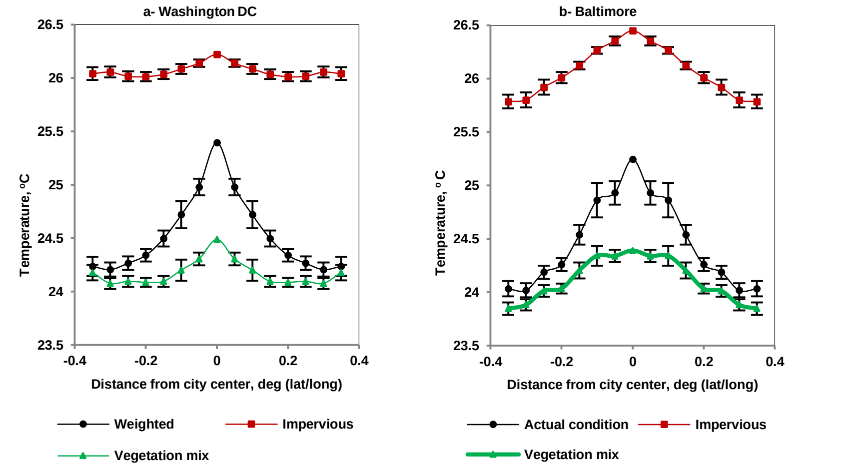

Figure 2: Average surface temperature profile across the centers of Washington DC and Baltimore cities for summer (June-July-August). The "**Impervious**" scenario represents a 'fully urbanized' area; the "**Weighted"** scenario represents the 'actual situation' and the "**Vegetation mix**" scenario is a proxy for a 'pre-urban' situation.. Urbanization has increased urban core temperature by **0.9° C** in Washington DC and **0.5° C** in Baltimore.

Synopsis: Scientists at NASA use data fusion from Landsat and MODIS to characterize US urbanization and model its impact on surface climate. Impervious surfaces occupy 1.1% of the CONUS area and are warmer than vegetated lands by **1.9 °C** during summer (JJA). They expel **12%** of precipitation as surface runoff compared to **3.2%** over vegetated lands and reduced carbon uptake by 1.8% of the CONUS total.

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References:

Bounoua L., P. Zhang, G. Mostovoy, K. Thome, J. Masek, M. Imhoff, M. Shepherd, D. Quattrochi, J. Santanello, J. Silva and R. Wolfe: Impact of Urbanization on the US Surface Climate, in review in ERL, manuscript #: 101401.
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Data Sources: Landsat-based National Land Cover Dataset to characterize the impervious surface area (urban) and MODIS 500m-land cover classification along with the 8-day NDVI used in SiB2 to generate the annual (8-day) biophysical parameters required for the land surface model. The North American Land Data Assimilation System NLDAS-2 are used to force the Biospheric model at half-hourly time step.

Technical Description of Figures:

Figure 1: June-July-August mean diurnal cycle of surface temperature for urban (red), dominant vegetation (green) and the weighted average for all land cover types (excluding urban) (black) for Atlanta (a) and Washington DC (b), These temperatures are simulated by the Simple Biosphere model (SiB2) forced by half hourly meteorological data at 5kmx5km obtained from the North American Land Data Assimilation System NLDAS-2, for the year 2001.
Figure 2: Average surface temperature profile across the centers of Washington DC and Baltimore cities for summer (June-July-August). The **"Impervious**" scenario represents the surface temperature if the area was fully (100%) impervious. The "**Weighted**" scenario represents the average surface temperature weighted by fractions of all existing LC classes including urban (**Actual situation**). The "**Vegetation mix**" temperature profile is obtained by replacing the impervious surface area with a mixture of all vegetation classes co-existing in the area and is a proxy for pre-urban "**Pre-Urba**n".

Scientific significance, societal relevance, and relationships to future missions:
Scientific significance:

- Urbanization has conflicting attributes, small area but high ecological impact
- Transpiration cooling is an important modulator of surface temperature.
- In the US urbanization reduced carbon uptake by 1.8% and contributed an average summer warming of 1.9ºC.

societal relevance:
US cities are home to more than 50% of the population and this is where climate change will be felt the most. Urban communities will be interested to know how cities interact with climate and the scientific community is interested to include the urban ecosystem functions in climate models.
relationships to future missions : Defines the need for a high resolution global mapping of urban settings to assess their interaction with the global environment.

Improving S-NPP VIIRS Reflective Solar Bands On-orbit Calibration

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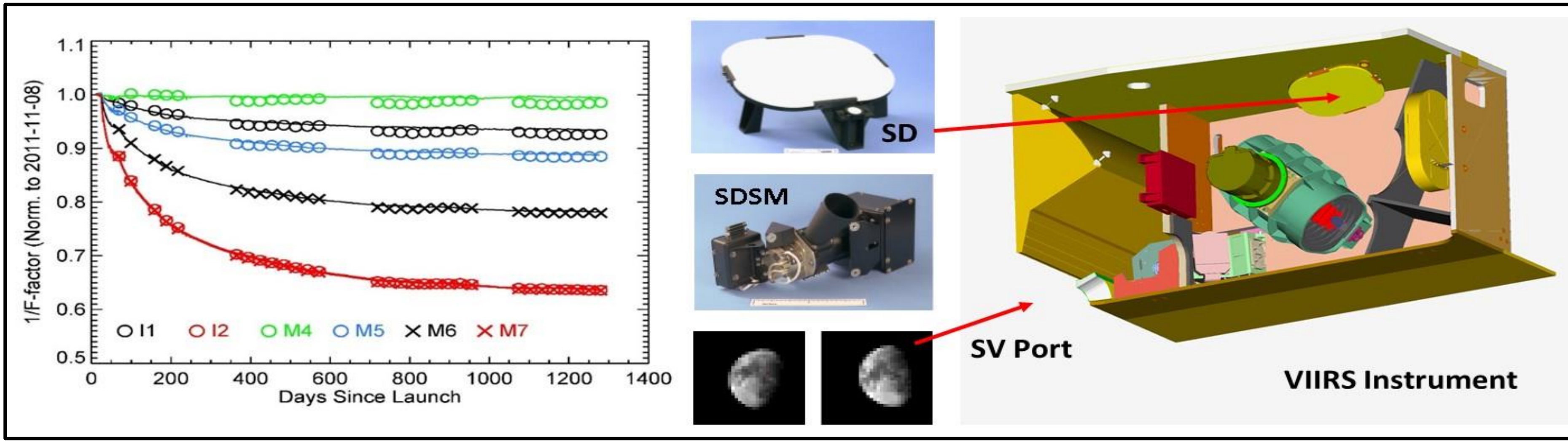
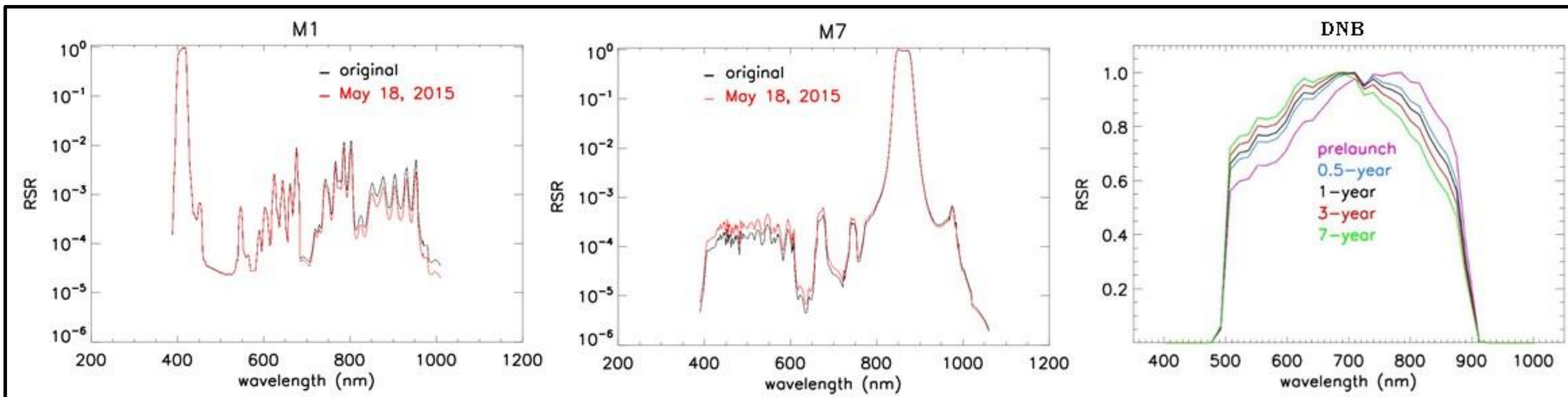


(a) VIIRS Reflective Solar Band (RSB) Responses from Its On-board Solar Diffuser (SD) and the Moon



(b) Pre-launch Measured and On-orbit Modulated Relative Spectral Response (RSR) for M1, M7, and DNB

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References:

Xiong X., J. Butler, K. Chiang, B. Efremova, J. Fulbright, N. Lei, J. McIntire, H. Oudrari, J. Sun, Z. Wang, and A. Wu, 2014: VIIRS On-orbit Calibration Methodology and Performance. *Journal of Geophysical Research*, Vol. 119, Issue 9, pp 5065-5078, DOI: 10.1002/2013JD02042

Lei, N., X. Xiong, and B. Guenther, 2015: Modeling the Detector Radiometric Gains of the Suomi NPP VIIRS Reflective Solar Bands. *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 53, Issue 3, pp 1565-1573, 10.1109/TGRS.2014.2345481

Data Sources: All sensor calibration raw data used in this work are from S-NPP Interface Data Processing Segment (IDPS) via NASA GSFC Level 1 and Atmosphere Archive and Distribution System (LAADS). The lunar calibration reference irradiances are provided by the USGS Robotic Lunar Observatory (ROLO). The pre-launch relative spectral responses are from S-NPP VIIRS pre-launch measurements processed by the NASA VIIRS Characterization Support Team (VCST).

Technical Description of Figures:

Graphic a): S-NPP VIIRS reflective solar band (RSB) responses derived from the instrument on-board SD (lines) and lunar observations (symbols) for bands I1 (600 – 680 nm), I2 (846 – 885 nm), M4 (545 – 565 nm), M5 (662 – 682 nm), M6 (739 – 754 nm), and M7 (846 – 885 nm). A solar diffuser stability monitor (SDSM) is used to track on-orbit changes in SD reflectance property, Regular lunar observations are made through the instrument space view (SV) port in support of RSB on-orbit calibration.

Graphic b): S-NPP VIIRS pre-launch measured (marked as original) and on-orbit modulated relative spectral response (RSR) for M1 (402 – 422 nm), M7, and day night band (DNB; 500 – 900 nm). For on-orbit modulated RSR, the out-of-band (OOB) response is relatively smaller than the in-band (IB) response for M1. For M7, the OOB response is relatively larger than the IB response. The changes in DNB IB RSR are much larger than other bands with narrow bandwidths.

Scientific significance, societal relevance, and relationships to future missions: The VIIRS instrument was built with a set of on-board calibrators as the quality of its environmental data records (EDRs) strongly depends on the sensor's calibration accuracy. The RSRs are sensor's key performance parameters that are used in both calibration and retrievals. Due to the strong wavelength-dependent degradation of the VIIRS optics, a times-dependent on-orbit modulated RSR becomes necessary for each spectral band in order to maintain its calibration quality. Through the modeling of sensor radiometric gains, the NASA VIIRS Characterization Support Team has produced modulated RSRs of high fidelity for all reflective solar bands (RSB), including the DNB, thereby mitigating the impact of the degradation on both the SD and lunar calibrations.