

N8 – Global Environmental Effects of Artificial Nighttime Lighting

N8 ≡ Night / Nacht / Nuit / Noche / Noite / ...

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Knowledge for Tomorrow





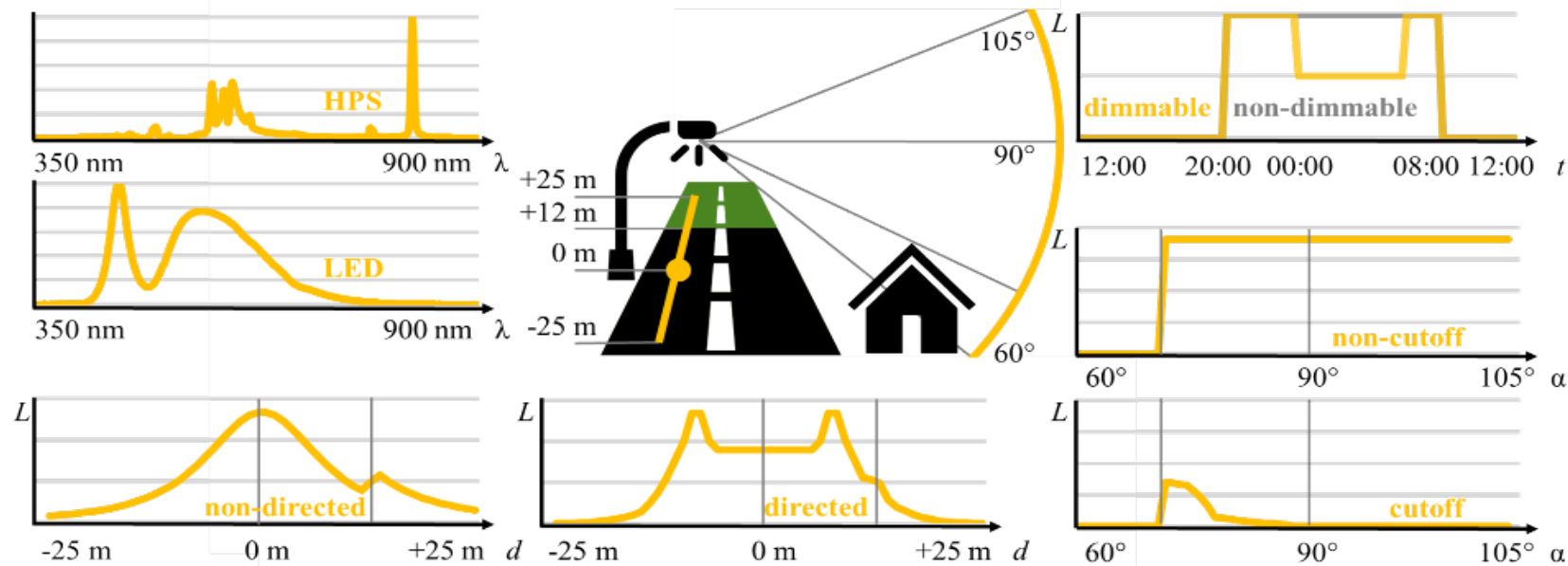


Overview

- N8 (Global Environmental Effects of Artificial Nighttime Lighting)
Mission Idea submitted as Earth Explorer 11
 - Scientifically recommended*
 - Technically not recommended due to feasibility wrt performance*
- “Mapping of [...] night-time artificial lighting [...] is a unique tool to globally monitor human presence and activity, and reveal changes [...] to] study the impact [...] on human health and environment [...] needed with high spatial resolution at different times“*

Mapping of the spectral-spatial-temporal variation in night-time artificial lighting through satellite imagery of night-time lights would be a unique tool to globally monitor human presence and activity, and reveal changes therein, e.g. economic activities, traffic, and energy access. N8 would study the impact of night-time lights on human health and the environment / ecology, providing much needed data. Long-term night-time light data have been only available from the US DMSP/OLS and VIIRS/DNB sensors. To monitor and understand the impact of global urbanization this observable is much needed with high spatial resolution at different times at night. However, because of N8's novelty, a couple of challenging processing steps and the retrieval of geophysical parameters need to be addressed. as outlined in the proposal and the review.

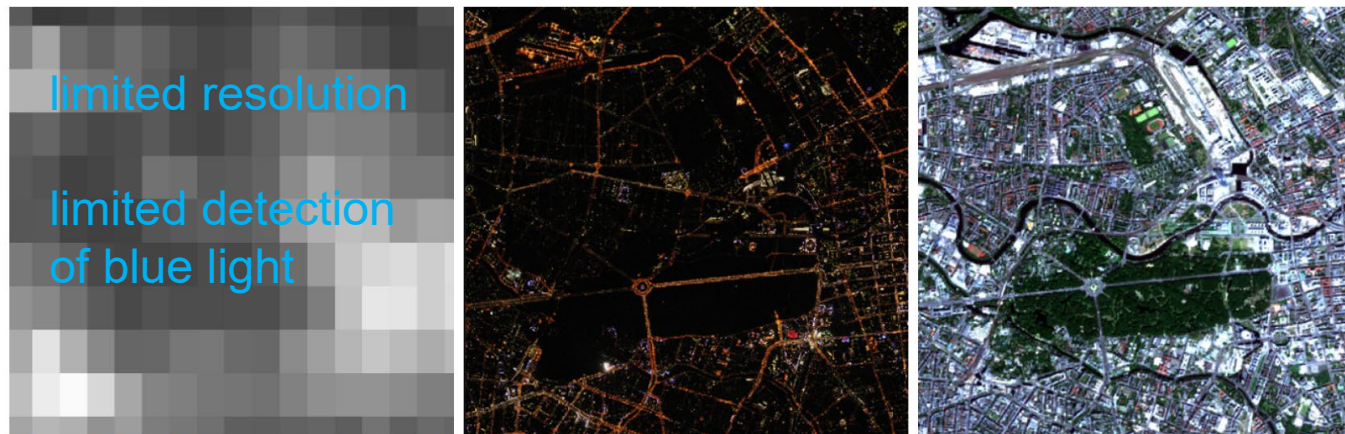
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sources associated with

- human settlements; public, private business and residential areas
- associated transport infrastructure; land, water, and air



Pan-750 m-nadir-single nighttime (left: by Suomi-NPP/VIIRS/DNB), tricolor-10 m-nadir-single nighttime (centre; by aerial photography) and daytime (right; by Sentinel-2/MSI) images covering Berlin, Germany (credit: NOAA/GFZ/ESA/EU).

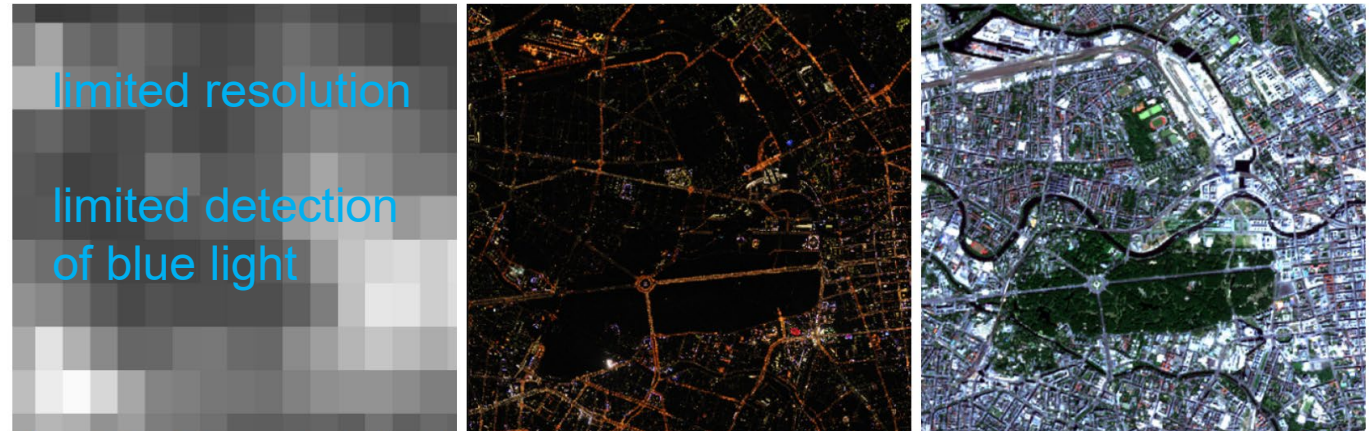
Scientifically

- Quantify the global environmental effects of artificial nighttime lighting (ANTL)
- Focus on biological risks and opportunities
- “Mapping of [...] night-time artificial lighting [...] is a unique tool to globally monitor human presence and activity, and reveal changes [...] to] study the impact [...] on human health and environment [...] needed with high spatial resolution at different times“*

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- Influences of Artificial Light on Human Health and Well-Being
- Influences of Artificial Light on Animals and Plants
- Energy Consumption for Artificial Light
- Urbanisation, Electricity Access and Socio-Economy
- Identification of Hazards, Risks and Disasters and Monitoring of Conflicts
- Natural Properties of the Atmosphere and the Surface
- Cross-Calibration

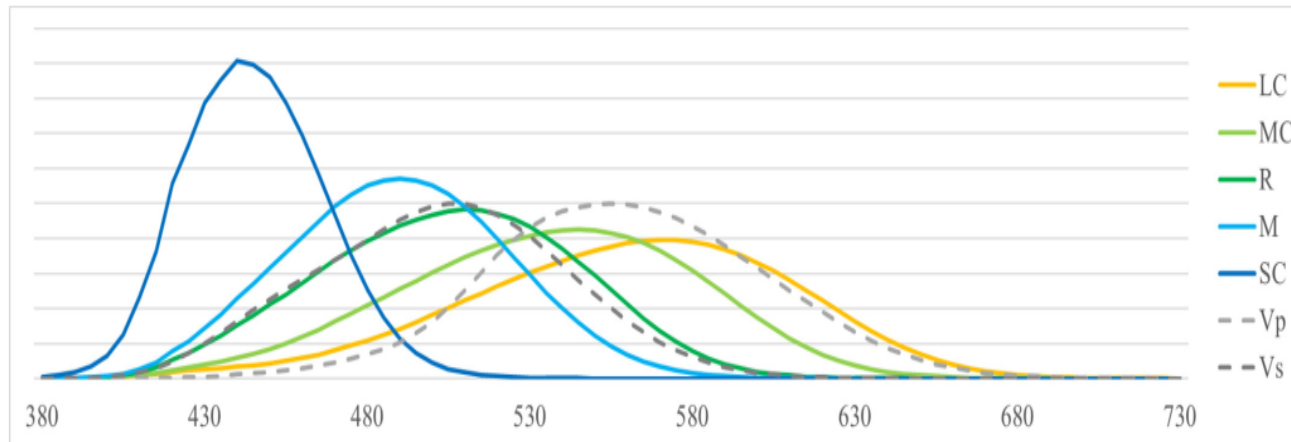


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Spectral sensitivity profiles of L-cone (LC), M-cone (MC), rod (R), melan (M) and S-cone (SC) opsins and photopic V_p and scotopic V_s visions (unit is nm).

- Influences of Artificial Light on Human Health and Well-Being

- Scientific Requirement

For each human populated area A (of size $20 \text{ m} \times 20 \text{ m}$) the α -opic radiances in the five human photoreceptor SC/Z/R/MC/LC, photopic V_p and scotopic V_s bands given by $\int_{\lambda} L_{A,t,\lambda,\alpha} \text{SC/Z/R/MC/LC}/V_p/V_s(\lambda) d\lambda$ shall be estimated for nighttime with an accuracy of: $\geq 80\%$ for view zenith angle 0° at ≥ 4 local times t for each quarter and for at least three years (measured); $\geq 60\%$ (modelled)

effects associated with

- e.g. sleep quality, obesity, breast and prostate cancer risk
 - α -opic radiances in the five human photoreceptor bands
 - photopic and scotopic bands
 - melatonin suppression index and circadian stimulus index

- $SZA \geq 96^\circ$

Note: SZA is Sun Zenith Angle.

Technically

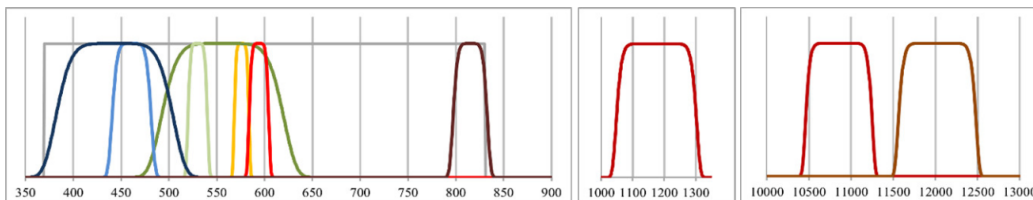
- Today not possible to evaluate and map associated biological risks and opportunities (as achieved for other anthropogenic pressures on the environment) for incorporation to policies addressing these pressures

- N8 creates and updates a globally consistent validated model of spectral (λ)-spatial (d, α)-temporal (t) dynamics artificial nighttime lighting based on

- global (-56° S to $+72^\circ$ N)
- multi-spectral (8 VIS/NIR)
- high-resolution (20 m)
- multi-angular (3 views)
- frequent (10 days, changing local times)

optical remote sensing nighttime light data

All land surfaces and inland water bodies between latitudes -82° S and $+82^\circ$ N (G) / -56° S and $+72^\circ$ N (G) with an area greater than 100 km^2 and coastal zones within 20 km distance from land shall be acquired (area-of-interest).



PAN: radiant flux. Broad green: luminous flux, photopic band. Broad blue: scotopic band, spectral G index. VIS/NIR: classification of lighting technology, correlated colour temperature, in-band radiances (humans, plants, other animals). SWIR: high accuracy for incandescent bulb, temperature. LWIR: temperature, atmosphere with total water vapour (unit is nm).

ISS/photography by astronaut



Berlin, Germany

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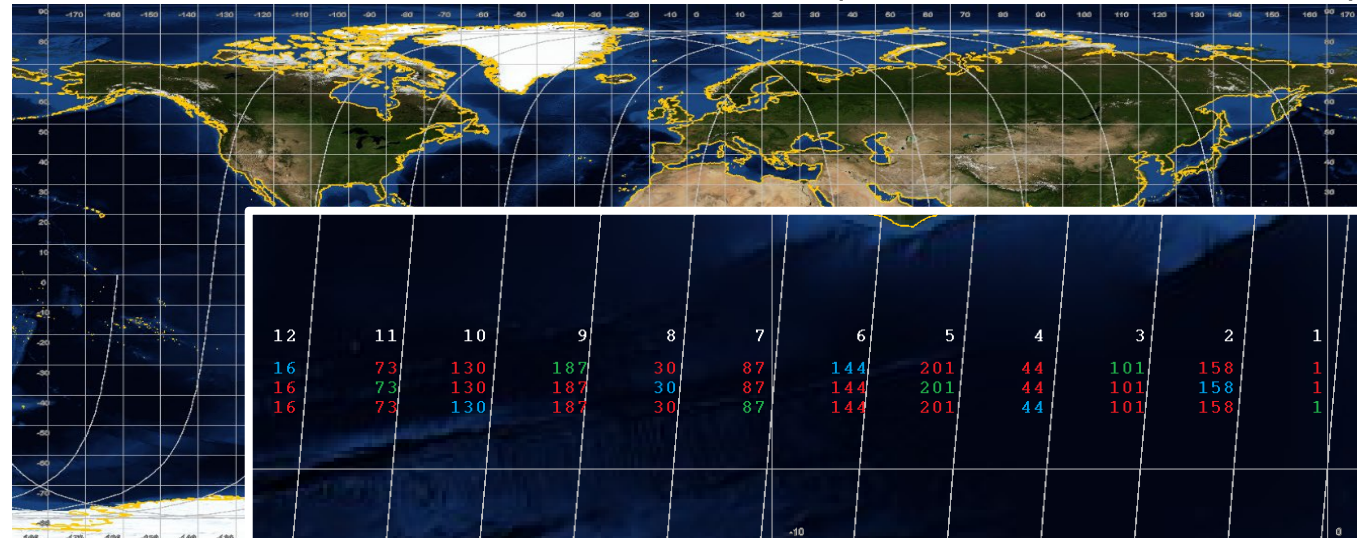
optical remote sensing nighttime light data

Acquisitions shall be performed with $VZA \leq 15^\circ$.Acquisitions shall be performed ≥ 2 with $75^\circ \leq VAA \leq 105^\circ$ and for the same area the same VZA between 45° and 2° less than limb view.

- **nadir view**
- **max along and max across view**

Note: VZA is View Zenith Angle (between view and surface).

- 214 orbits in 15 d with drift -480 sec/d ($= -2$ h/15 d $= -12$ h/90 d)



- Ground tracks separation: 188 km
- Across track swath: 284 km with 2× nadir, 1× along, 2× nadir, 1× across, ...

- 90 d with 2 h intervals, change in night and in year

Note: Even in 90 days, the area of interest shall be acquired ≥ 1 for each 2 (G) / 3 (T) hours range of local time, if at night.

Modifications, e.g.

- Quantify ~~the~~ global environmental effects of artificial nighttime lighting (ANTL)
- Focus on urbanisation and electricity access
- create consistent maps of ANTL based on
 - urban centers (and clusters)
 - multi-spectral (4 VIS/NIR)
 - high-resolution (~5 m)
 - multi-angular (~3 views)
 - regular (~90 days, changing local times)
 optical remote sensing NTL data
- would result in small satellite mission, e.g. using frame camera

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1st European Workshop on Artificial Nighttime Light Remote Sensing

Noordwijk (The Netherlands) 30 March - 1 April 2022



Thanks!

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