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## **Deploying dense Artificial Light At Night (ALAN) monitoring networks for territorial actions: the cases of Réunion Island and La Brière region, France**

Matthieu Renaud, Samuel Challéat, Sylvain Morvan, Christian Brouat, Mathieu Delsaut, Kévin Barré, Laurent Godet, Johan Milian, Béatrice Morel, Martin Riethmuller, et al.

### ► **To cite this version:**

Matthieu Renaud, Samuel Challéat, Sylvain Morvan, Christian Brouat, Mathieu Delsaut, et al.. Deploying dense Artificial Light At Night (ALAN) monitoring networks for territorial actions: the cases of Réunion Island and La Brière region, France. 9th International Conference On Artificial Light At Night ALAN 2025, Dark Sky Ireland; Friends of Mayo Dark Skies, Oct 2025, Westport, Ireland. <https://artificiallightatnight.org/alan-conference-2025/venue-alan-2025/>. <hal-05343777>

**HAL Id: hal-05343777**

**<https://hal.science/hal-05343777v1>**

Submitted on 3 Nov 2025

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# Deploying dense ALAN monitoring networks for territorial actions

## the cases of Réunion Island and La Brière region, France

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Mathieu Delsaut<sup>3,9</sup> Kévin Barré<sup>4,9</sup> Laurent Godet<sup>5,9</sup> Johan Milian<sup>6,9</sup> Béatrice Morel<sup>3,9</sup>  
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7 SEOR, Cambuston, Saint-André, La Réunion, France

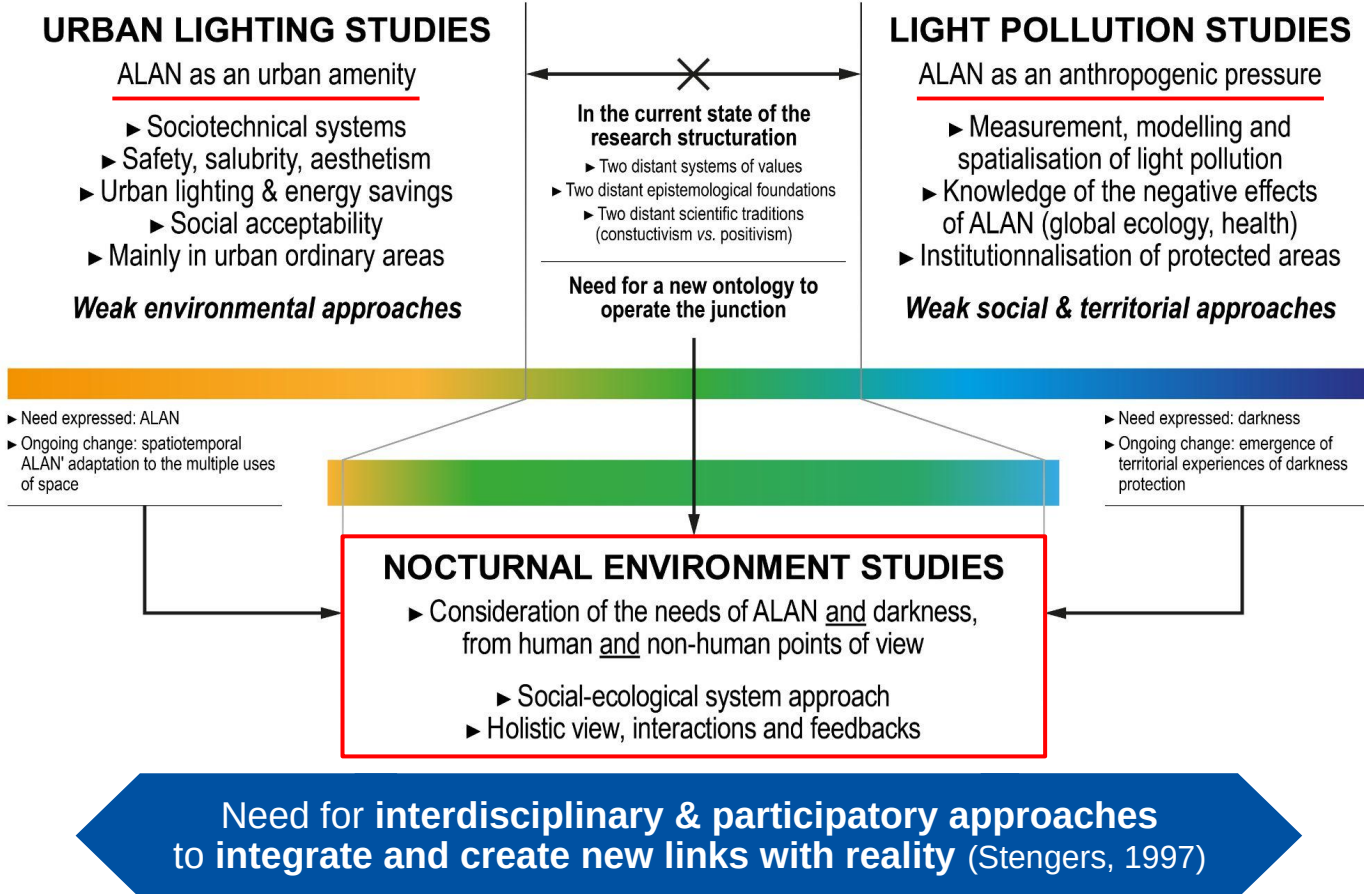
8 Brière Regional Natural Park, Saint-Joachim, France

9 Nocturnal Environment Observatory & GDR2202 LUMEN (CNRS)

\* *Equal contributions*



# The Nocturnal Environment Observatory (OEN) & GDR2202 LUMEN



# The Nocturnal Environment Observatory (OEN) & GDR2202 LUMEN

The Nocturnal Environment Observatory (NEO), a device to enable, facilitate and organize interdisciplinarity

Created in 2021, **27 members** from 4 CNRS Institutes

3 axes around **nocturnal SES** :

- a. Socio-territorial approaches*
- b. Ecology, metrology and modeling*
- c. Support for territorial initiatives to preserve the nocturnal environment*

The LUMEN Research Group to federate at national scale

Labelled in 2025, **60+ researchers** from 5 CNRS Institutes



<https://observatoire-environnement-nocturne.cnrs.fr/en/>



**GDR**  
**LUMEN**

Groupement  
de recherche

Lumière & environnement nocturne

# Context & purpose of dense Light Pressure Monitoring Networks (LPM•Net)

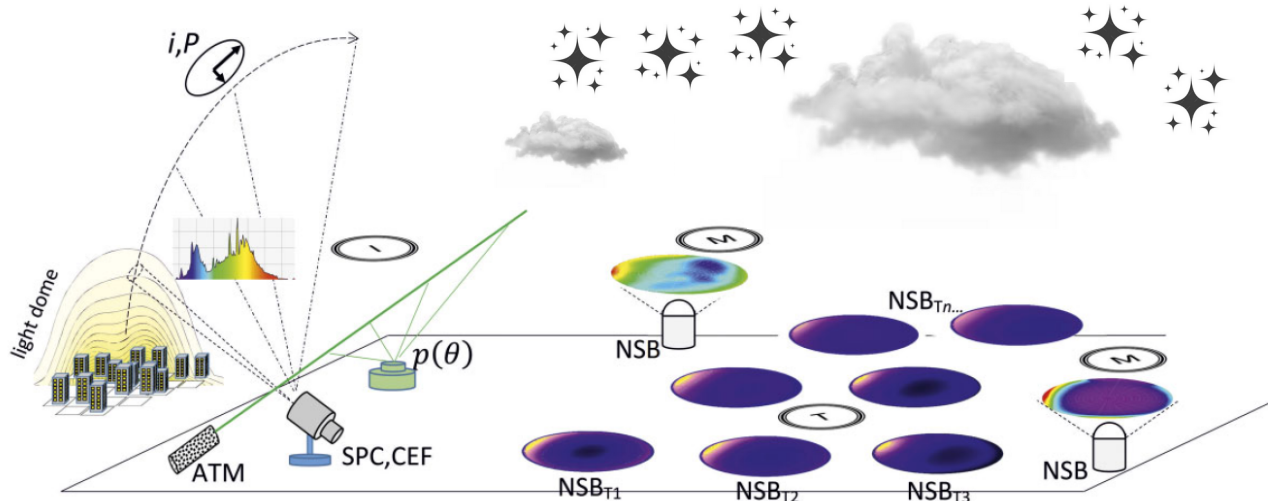
Monitoring the long-term effects of public action against light pollution within “proactive” territories such as National and Regional Parks, local authorities (Challéat et al. 2021)

Linking ALAN at fine spatio-temporal sampling (Solano Lamphar & Kocifaj 2013; Bara et al. 2019) with ecological issues at landscape scales regarding habitats and activity patterns (e.g. Barré et al. 2021)

>>> **Characterizing light pressure under real-world context** (e.g. Jechow et al. 2019, Kocifaj & Falchi 2025)

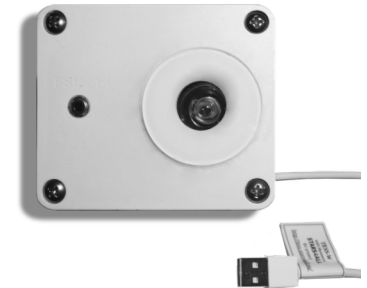
>>> **Choice directed to dense networks of photometric TESS-W sensors** (Zamorano et al. 2016)

(Adapted from Barentine et al. 2024)



Affordable / deployable

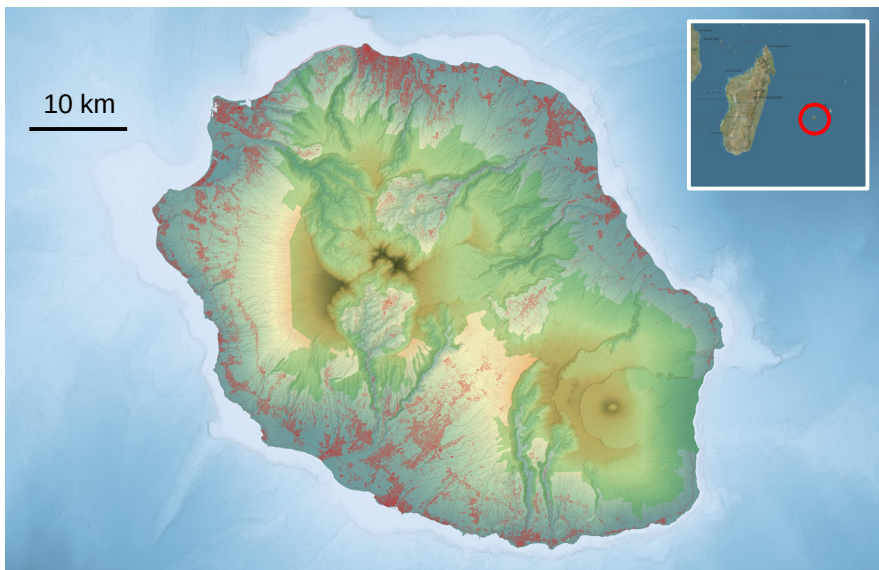
$T_{amb}$ ,  $T_{sky}$ ,  $NSB_{400-750nm}$ ,  $17^\circ$  FWHM  
recorded every minute



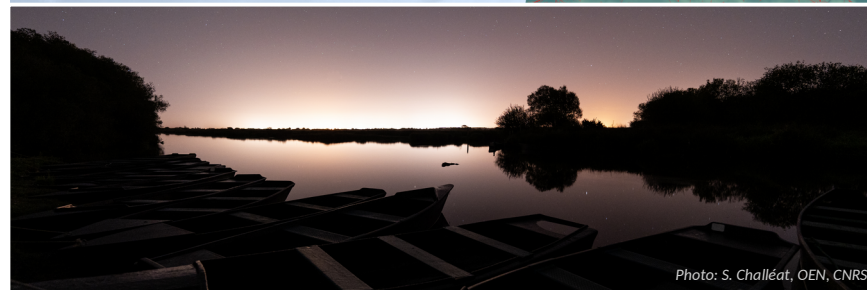
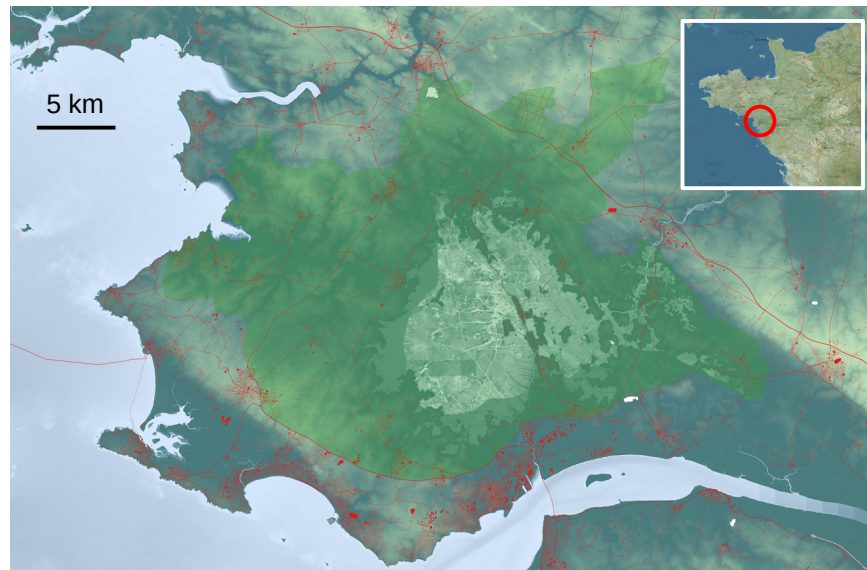
TESS-W

## Two field sites: La Réunion & la Brière

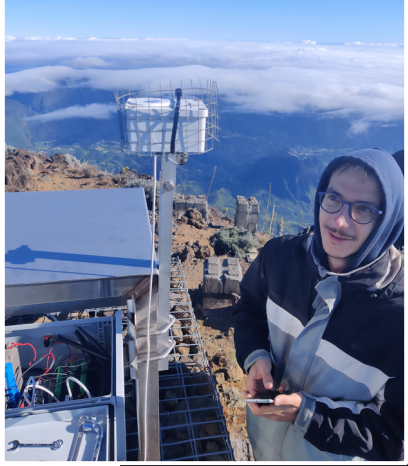
Réunion Island, French territory in the Indian Ocean with relief, biodiversity hotspot (National Park), and a strong urbanized coast



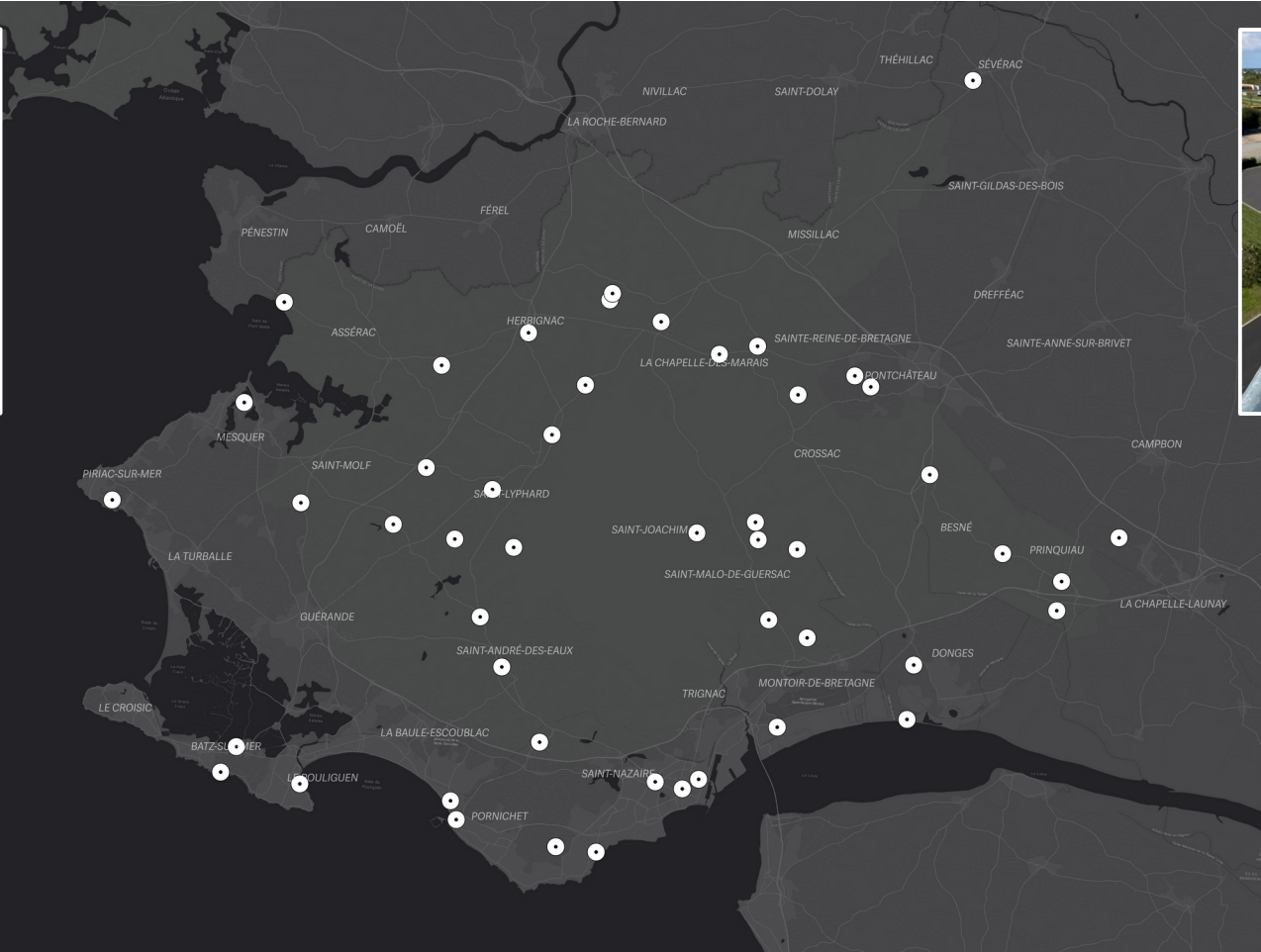
Brière region, a wetland near France's Atlantic coast, home to a Regional Natural Park and sensitive nocturnal ecosystems



# LPM•Net Réunion: cartography

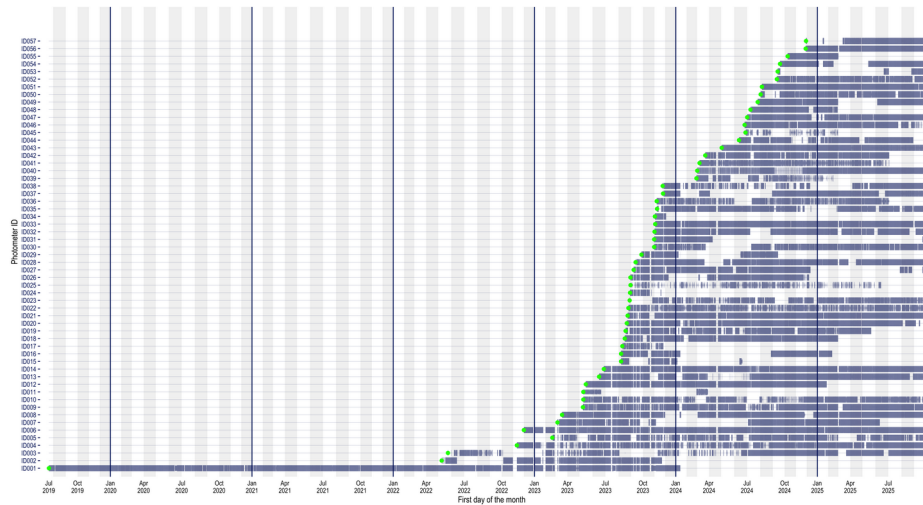


# LPM•Net Brière: cartography

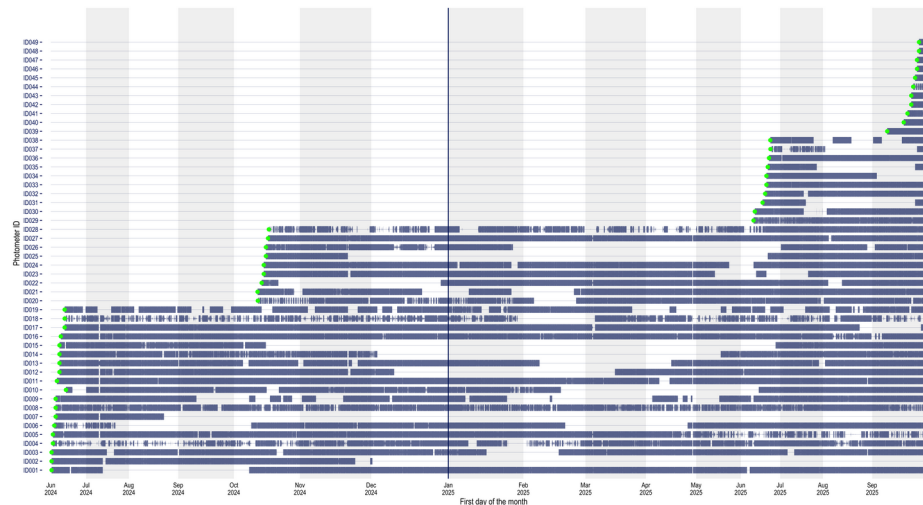


# LPM•Net Réunion & LPM•Net Brière: general statistics

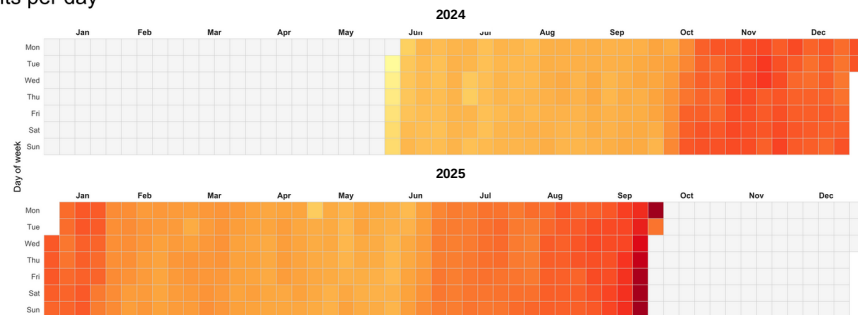
**Réunion:**  $+2 \times 10^7$  measurements at night and  $\sim 70\%$  efficiency



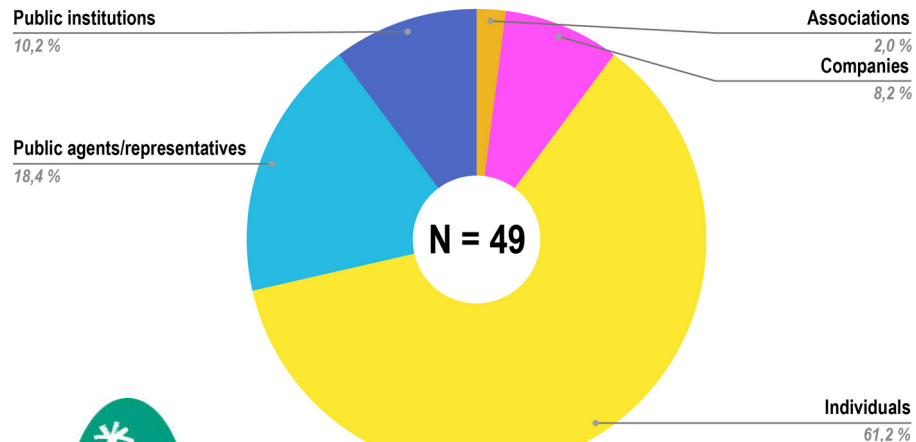
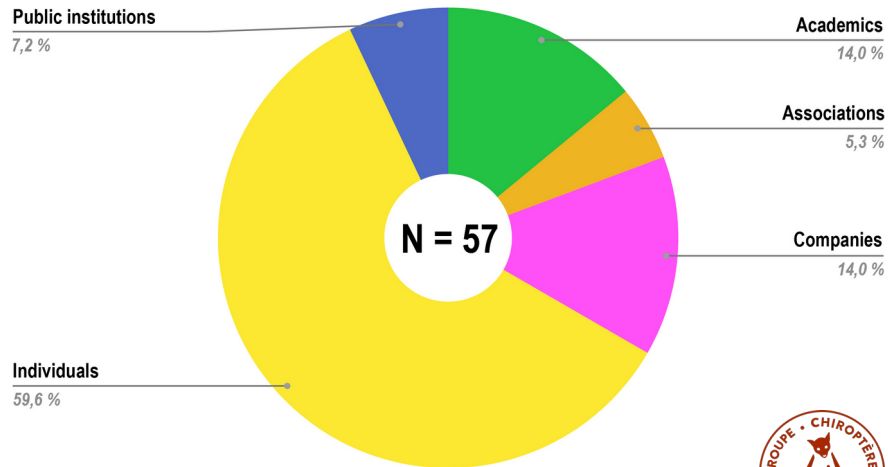
**Brière:**  $+7 \times 10^6$  measurements at night and  $\sim 80\%$  efficiency



Total measurements per day



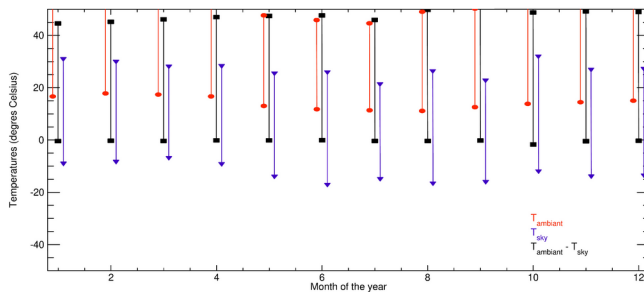
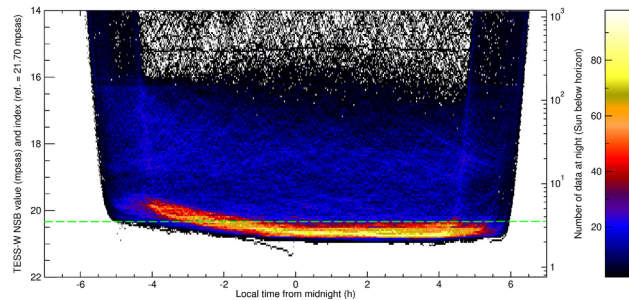
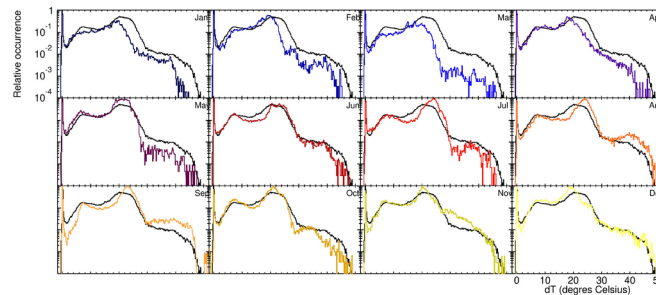
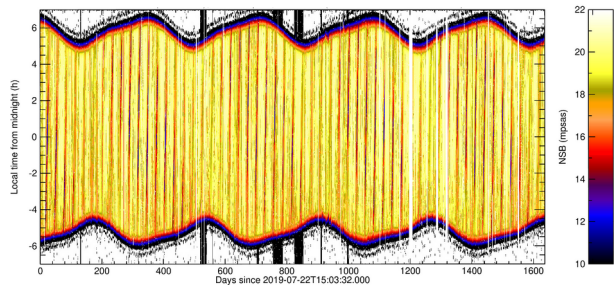
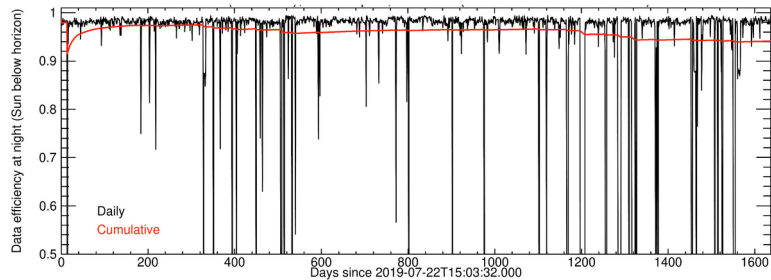
# LPM•Net Réunion & LPM•Net Brière: partners



Mairie de PRINQUIAU

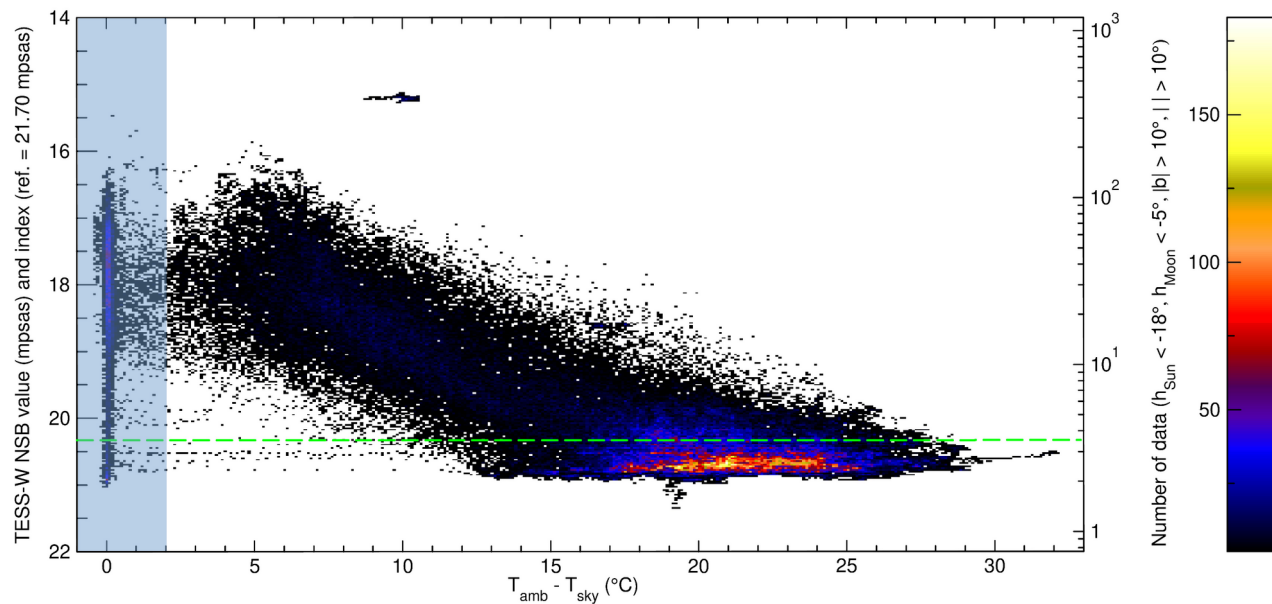
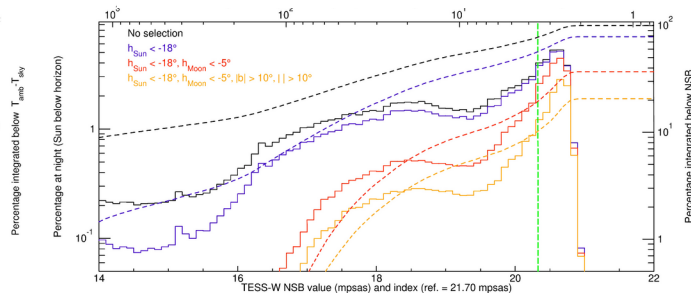
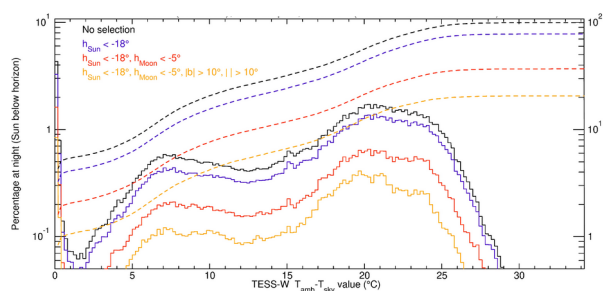


# LPM•Net Réunion & LPM•Net Brière: monitoring charts





# LPM•Net Réunion & LPM•Net Brière: monitoring charts



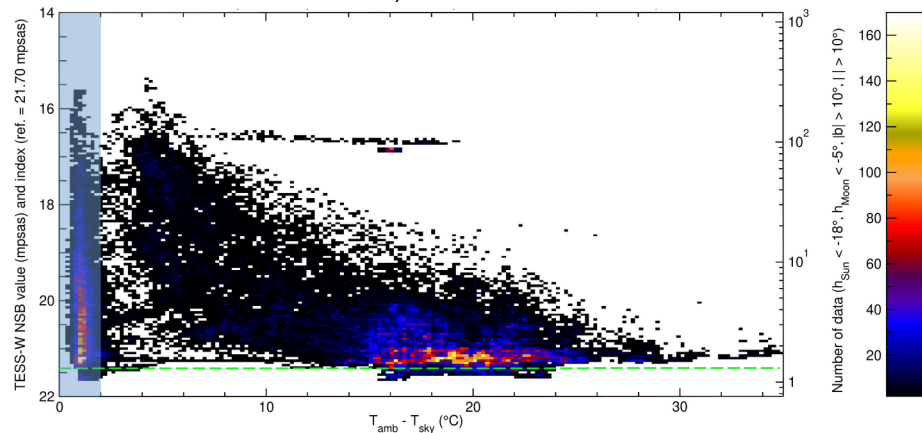
$dT < 2^\circ\text{C}$  unreliable (rain drops may remain on the IR sensor)

$\text{NSB}_{\text{zen}}$  increases with cloud cover / height in altered sites

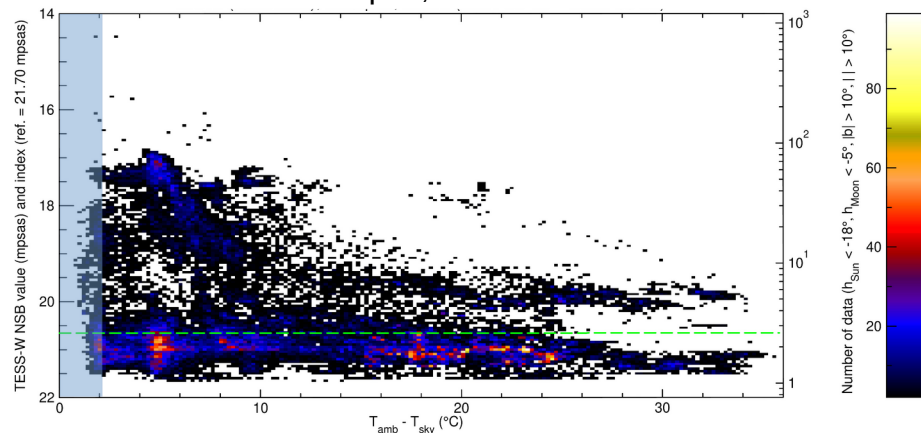
(Kyba et al. 2011, Aubé et al. 2016, Jechow et al. 2017, Sciezor 2020, Massetti et al. 2023)

# LPM•Net Réunion & LPM•Net Brière: cloud coverage

Cilaos, Réunion



Mesquer, Brière



Residential and touristic city with ~5000 inhabitants

Since 2021: light intensity reduction (20 % at 21:00), until complete switch-off at 04:00

Major ecological concerns with petrel's groundings every April

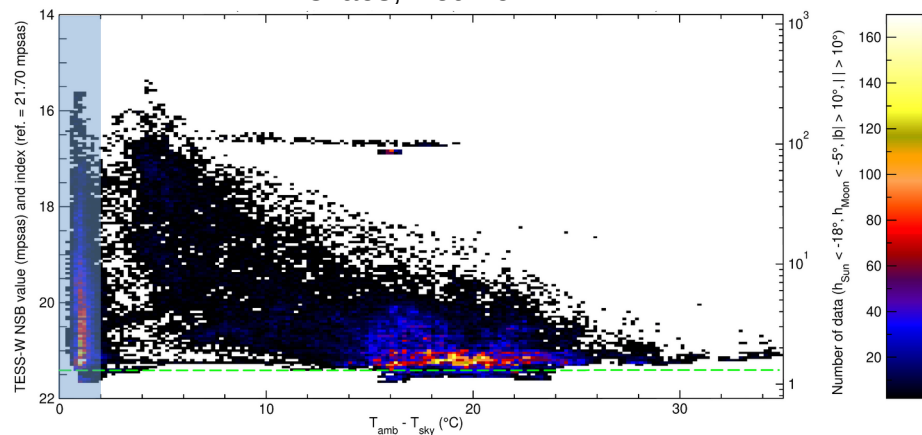
Residential and touristic city with ~2200 inhabitants

Public light extinction 23:00 – 06:00 along the year

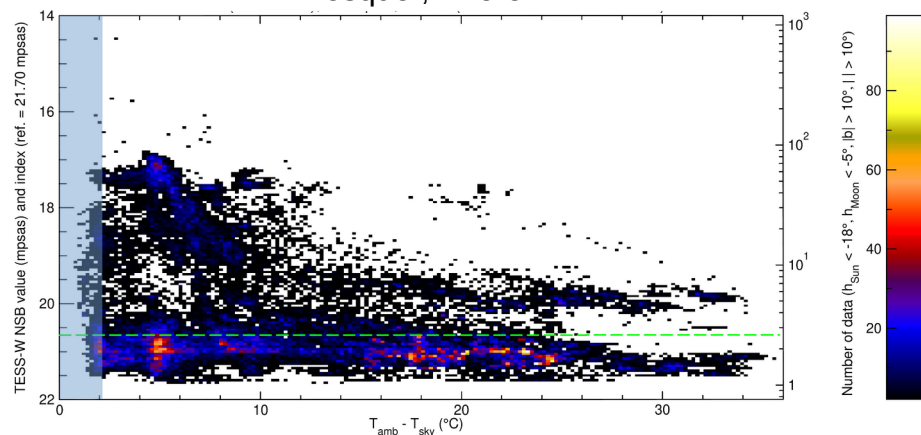
Except in July/August (pop. increase by ~8) in the most touristic (seashore) areas with reduced extinction window (02:00-06:00)

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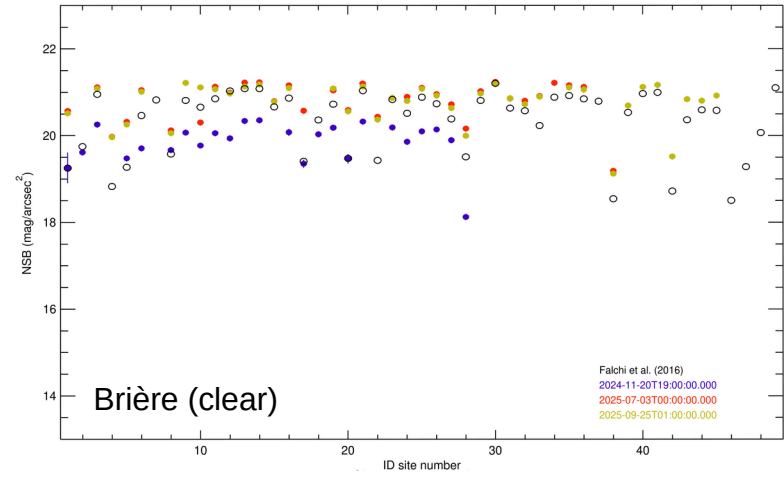
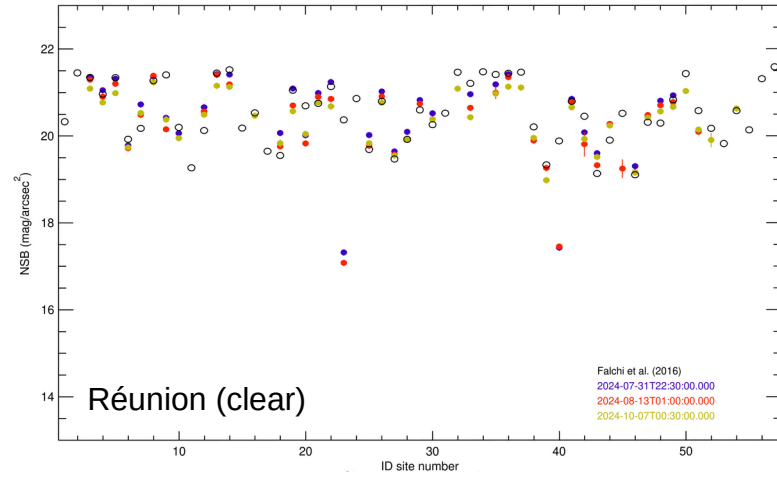
Complex light pressure patterns arising from the interplay between:

- diverse extinction and mitigation schemes
- varying meteorological and atmospheric conditions
  - local vs regional lighting contributions

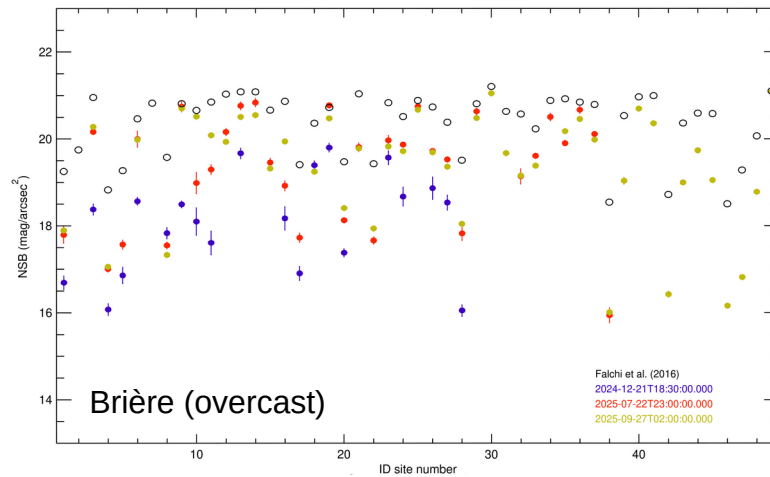
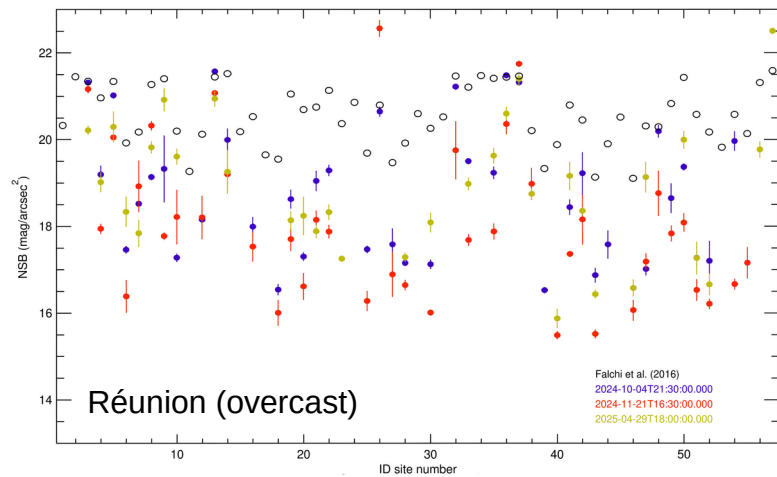
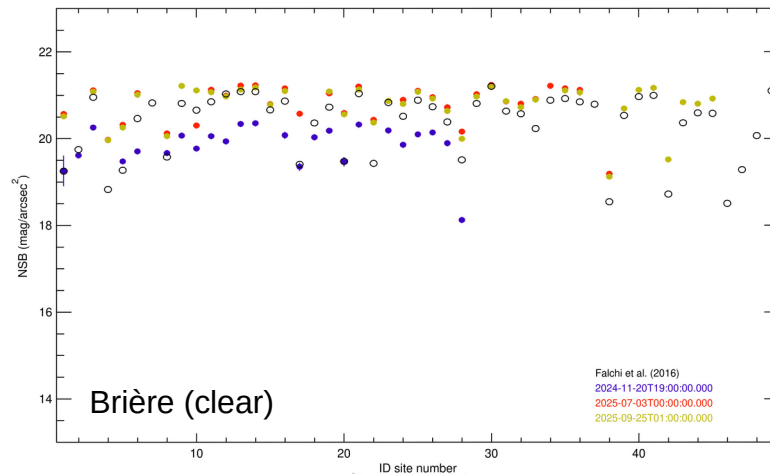
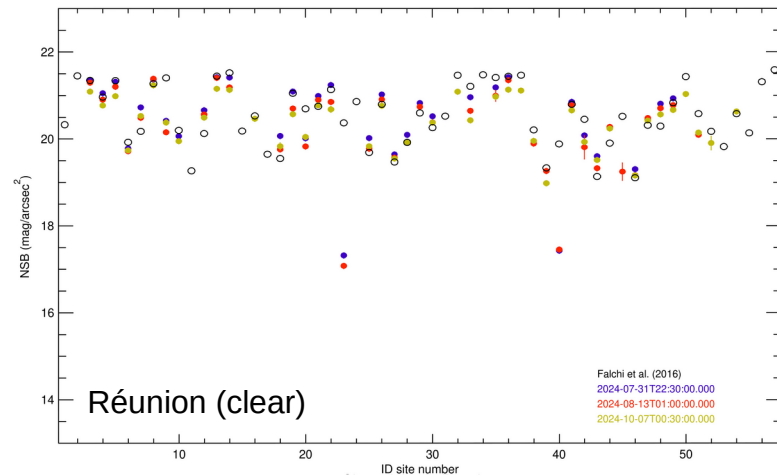
$$NDR = (N_b \cdot MAD_b) / (N_d \cdot MAD_d)$$

Can we really construct “an absolute light pollution indicator” (Deverchère et al. 2022), reliable and relevant for place-based action?

# LPM•Net Réunion & LPM•Net Brière: cloud coverage

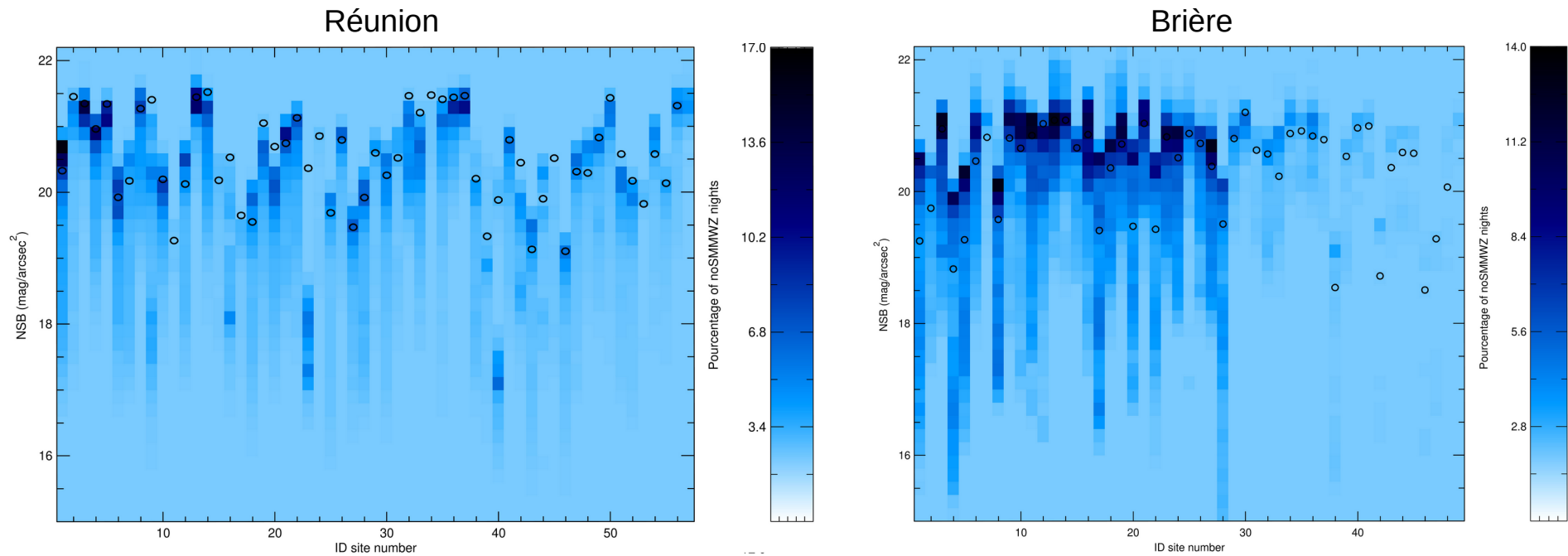


# LPM•Net Réunion & LPM•Net Brière: cloud coverage



# LPM•Net Réunion & LPM•Net Brière: cloud coverage

NSB distributions per site... complexity begins!



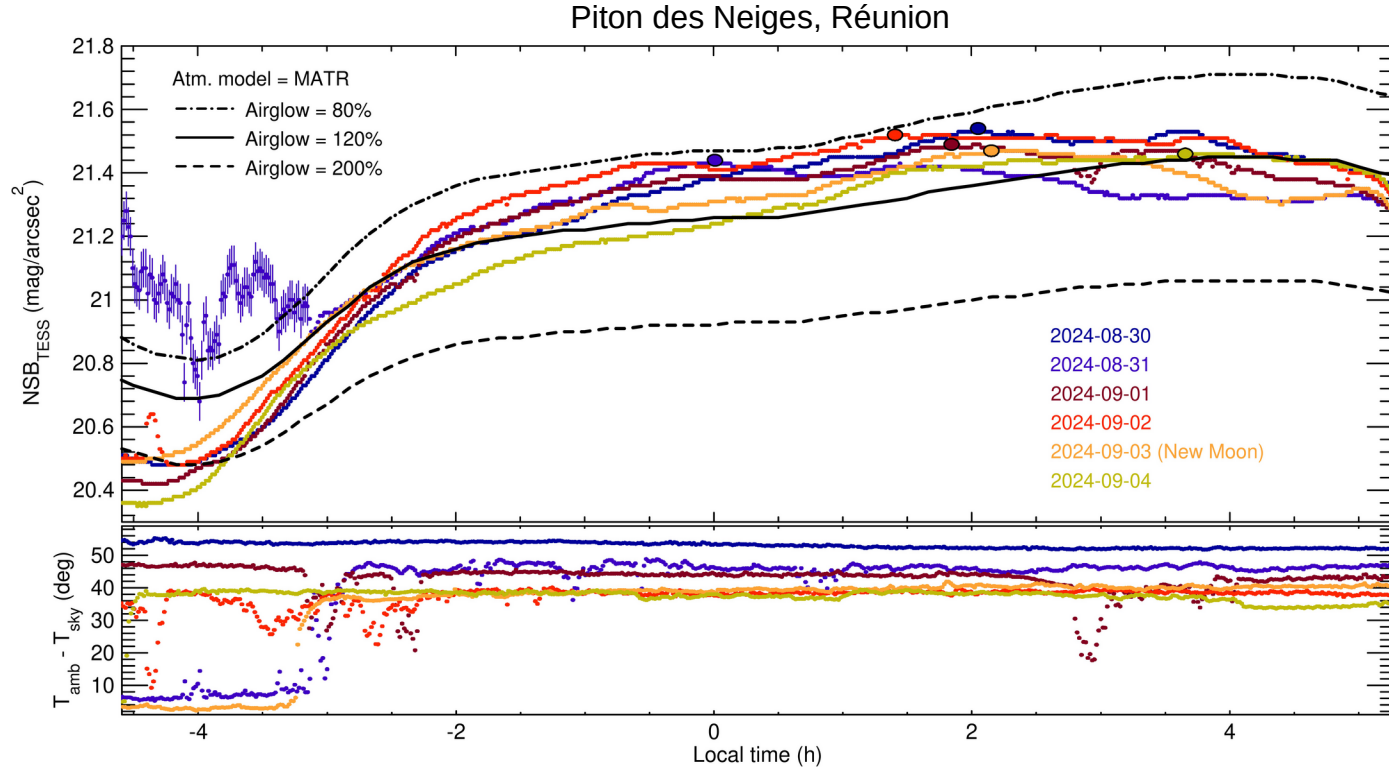
Relative light pressure increases as high as  $\sim 100$  in cloudy conditions

→ ELP (Hölker et al. 2010, Gaston et al. 2021, Sciezor et al. 2025) e.g. Petrel's groundings in Reunion (Chevillon et al. 2022)

# LPM•Net Réunion & LPM•Net Brière: valuable for other research topics

1- Studying the temporal evolution of NLAN (airglow) depending on atmospheric conditions on dark sites

Modeling NLAN with *Gambons* (Masana et al., 2021; 2022) and comparing it with data during consecutive moonless nights





# Conclusion & Perspectives

## On-going work:

These two dense *LPM•Net* networks allow us to:

- understand how LP gets redistributed depending on meteorological conditions
- monitor specific ecological issues on long-term timescales
- set up perennial pedagogical and citizen science projects

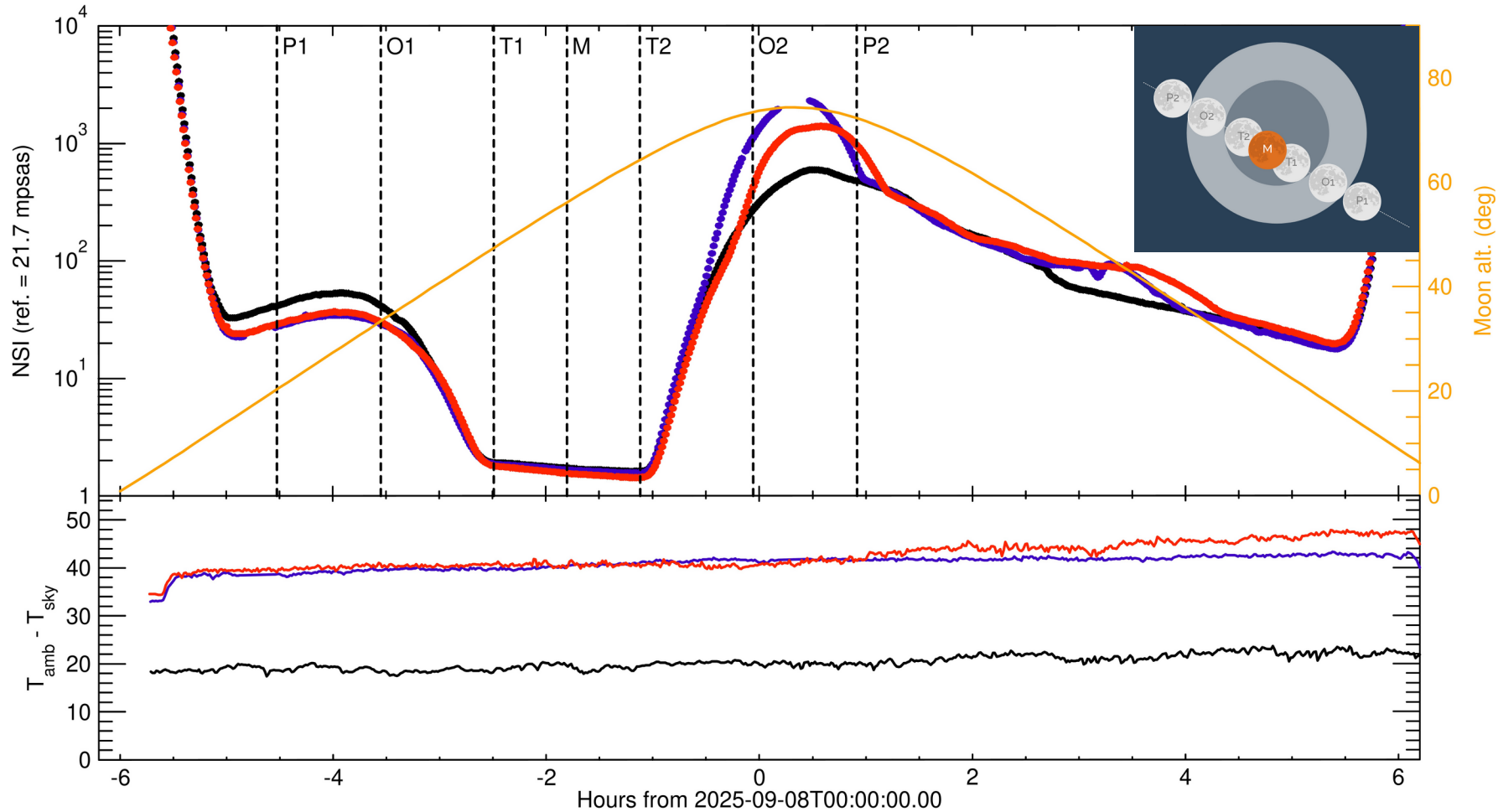
Public release of these two datasets scheduled by mid-2026



## Future work:

- Detailed modeling of NLAN with the atmospheric parameters (aerosols) measured at Maïdo Observatory to grasp the airglow (e.g. Grauer et al. 2019; 2021)
- Continuation of the TESS-W deployment in schools, through individuals and other institutions to reach the final extents of *LPM•Net*-Réunion (+120) and *LPM•Net*-Brière (+60)

# Bonus track... lunar eclipse on September the 7<sup>th</sup> 2025



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