



Cartes d'albédo et d'émissivité des matériaux

Cartographie climatique urbaine par modélisation – Projet SuaBe

Jonathan Leon-Tavares

VITO



PRESENTATION OF THE SPEAKER

Jonathan's academic journey began far from our cities—among black holes and the extremes of the universe—where he built a rigorous foundation in quantitative physical modelling. He later redirected this expertise toward a challenge much closer to home: understanding the Earth's surface through satellite observations. By focusing on the physics of how cities and vegetation interact with radiation as seen from space, he became a specialist in extracting reliable, physically consistent information from Earth-observation data. At VITO, he has played a key role in the design, implementation, and operational deployment of advanced algorithms for the Copernicus Land Monitoring Service, one of Europe's flagship environmental monitoring programmes. His ability to translate complex remote-sensing signals into actionable knowledge has been recognized through competitive innovation funding from the Belgian federal science policy office, BELSPO.

Today, Jonathan leads and contributes to pioneering projects such as SuaBe and its successor EheCatL, which break new ground in urban climate research. For the first time, these projects aim to assemble radiative digital twins of Belgian cities, combining high-resolution satellite data with physical models of urban surfaces. The result is neighbourhood-scale information on key parameters such as surface albedo and emissivity-critical drivers of urban heat stress that are extremely difficult to measure comprehensively on the ground. By linking Earth-observation science directly to heat-stress mitigation strategies, Jonathan's work provides urban planners with powerful, evidence-based tools to design cooler, more resilient cities. Today's talk will show how Earth observation can directly inform practical, data-driven climate adaptation in the urban environment.



OBJECTIVES OF THE PRESENTATION

To present ongoing BELSPO-funded scientific research aimed at developing a radiative digital twin of the city of Brussels to support heat-stress mitigation strategies.



Table ES.3 Assessment of major risks

Climate risks for 'Health' cluster	Urgency to act	Risk severity			Policy characteristics		
		Current	Mid-century	Late century (low/high warming scenario)	Policy horizon	Policy readiness	Risk ownership
Heat stress – general population	Urgent action needed	+++	+++	+++	Long	Medium	National
Population/built environment due to wildfires (hotspot region: southern Europe)	Urgent action needed	+++	+++	+++	Medium	Medium	Co-owned
Population/built environment due to wildfires	More action needed	+++	++	++	Medium	Medium	Co-owned
Wellbeing due to non-adapted buildings (*)	More action needed	++	++	++	Long	Medium	Co-owned
Heat stress – outdoor workers (hotspot region: southern Europe)	More action needed	+++	+++	+++	Short	Medium	Co-owned
Heat stress – outdoor workers	Further investigation	+++	+++	+++	Short	Medium	Co-owned
Pathogens in coastal waters	Further investigation	+	+	+	Medium	Medium	Co-owned
Health systems and infrastructure	Sustain current action	+++	++	++	Medium	Medium	National
Infectious diseases	Watching brief	+++	++	++	Short	Advanced	Co-owned

Legends and notes

Urgency to act

- Urgent action needed
- More action needed
- Further investigation
- Sustain current action
- Watching brief

Risk severity

- Catastrophic
- Critical
- Substantial
- Limited

Confidence

Low: +
Medium: ++
High: +++

(*) Urgency based on high warming scenario (late century).



Thematic priorities

The thematic research priorities are as follows:

- Impact of climate change on terrestrial and marine environments (data exploitation, monitoring, modelling, mitigation strategies);
- Advanced Monitoring and Assessment of Hazards (including pandemics);
- Monitoring environment for improved environmental health and biodiversity;
- Geo-information for Sustainable and Green Cities.





Surface albedo and emissivity for Belgian cities (SuaBe)

Jean-Philippe Gastellu-Etchegorry
Nicolas Lauret
Zhijun Zhen



Jonathan León-Tavares



Strategies to mitigate heat pollution already exist

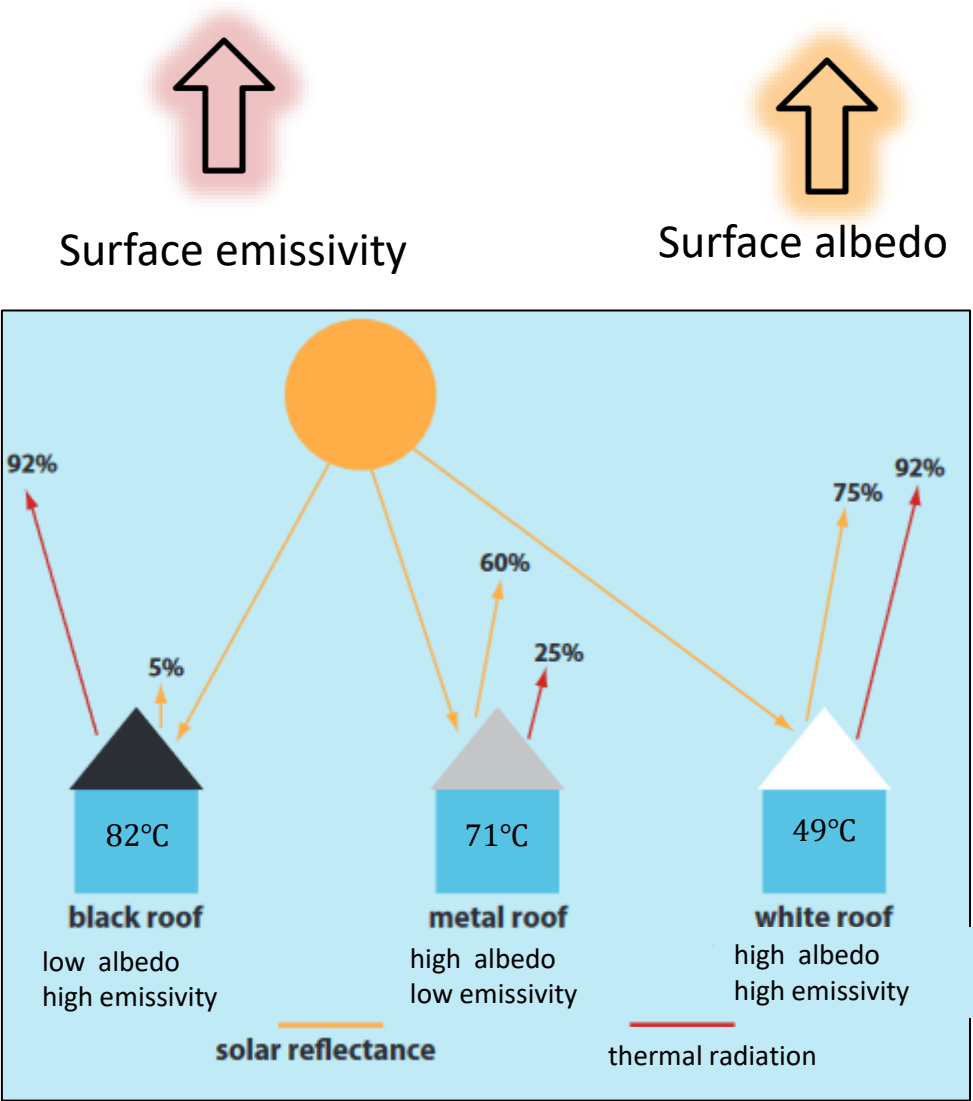
Green



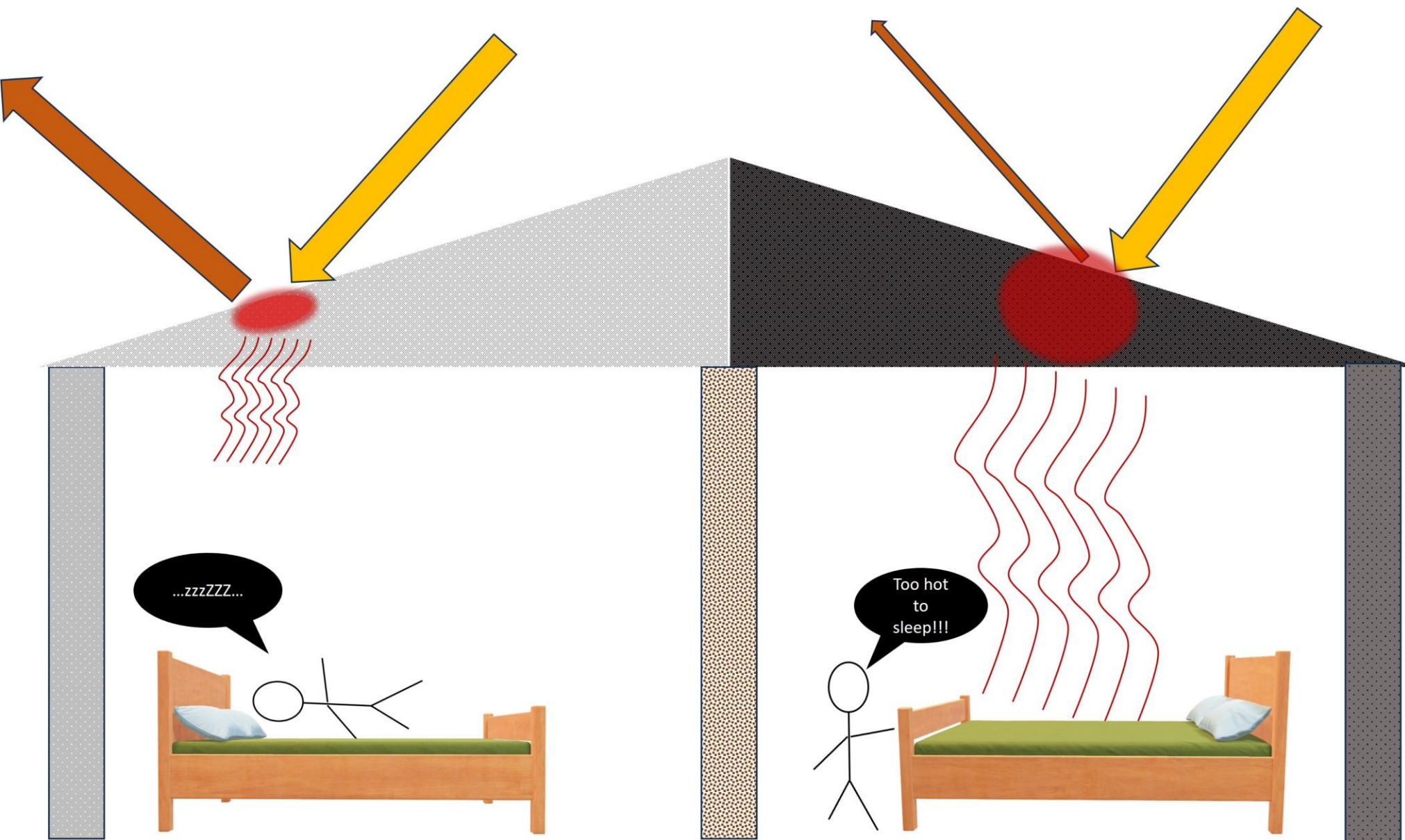
Blue



Grey



Modified from <https://www.epa.gov>



Surface with high surface albedo and high surface emissivity

Surface with low surface albedo and low surface emissivity

Solar incident radiation

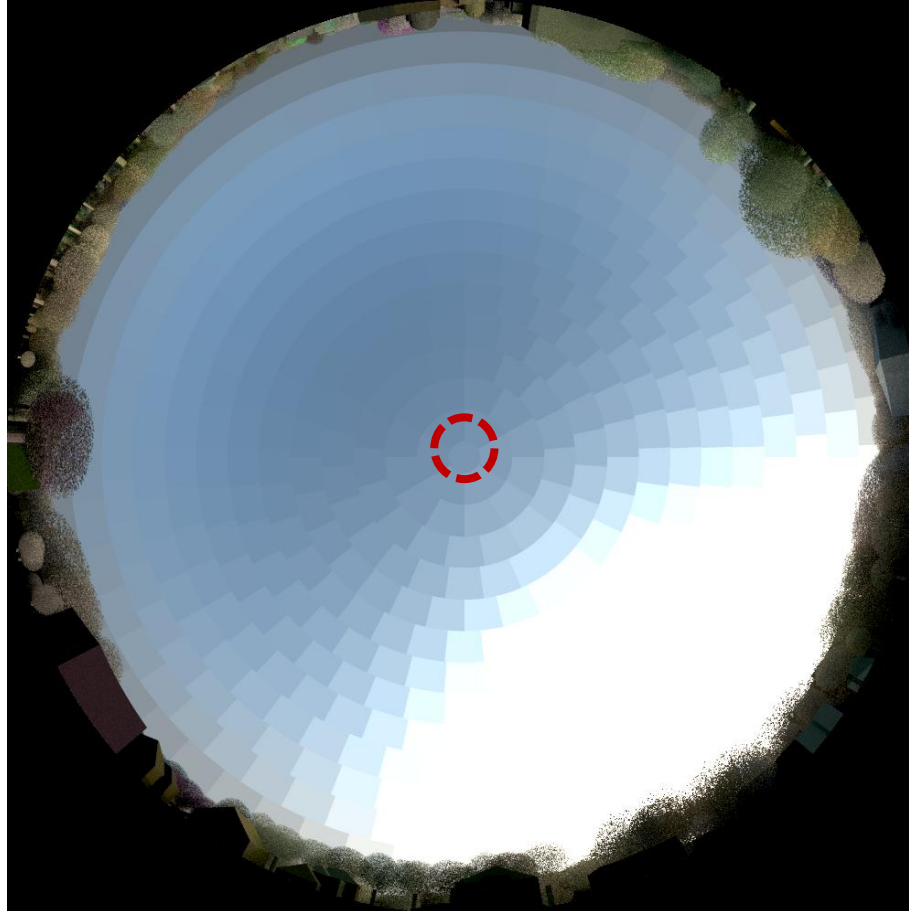
Solar reflected radiation

Solar absorbed radiation

Heat

High spatial resolution surface albedo?

$\int_{\Omega_+}$



Sentinel-2 typical Viewing Zenith Angle (VZA)

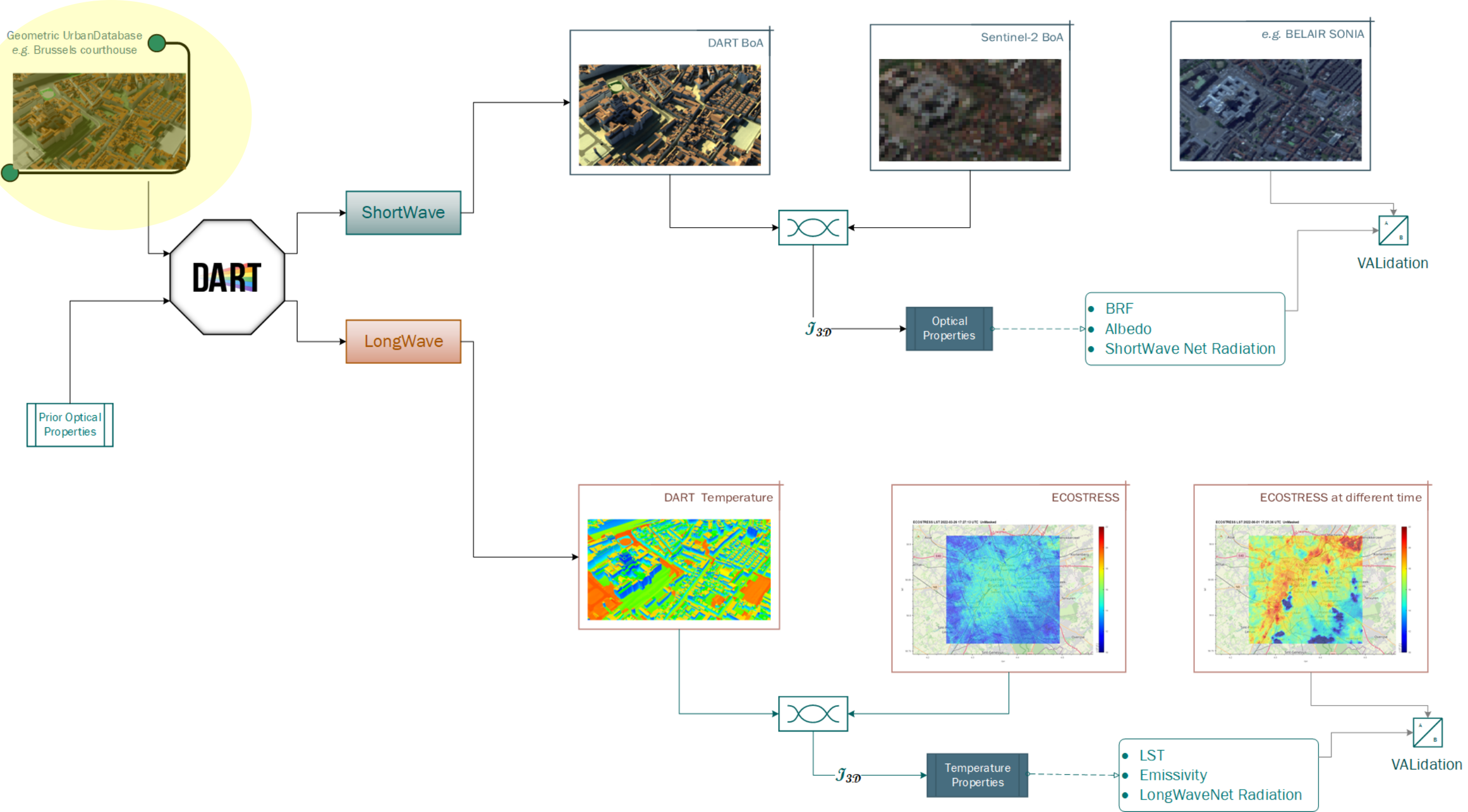
Surface albedo estimates involve the integration of radiance over the hemisphere.

However, current high spatial resolution satellites, like Sentinel-2 observed the Earth surface very close to nadir.

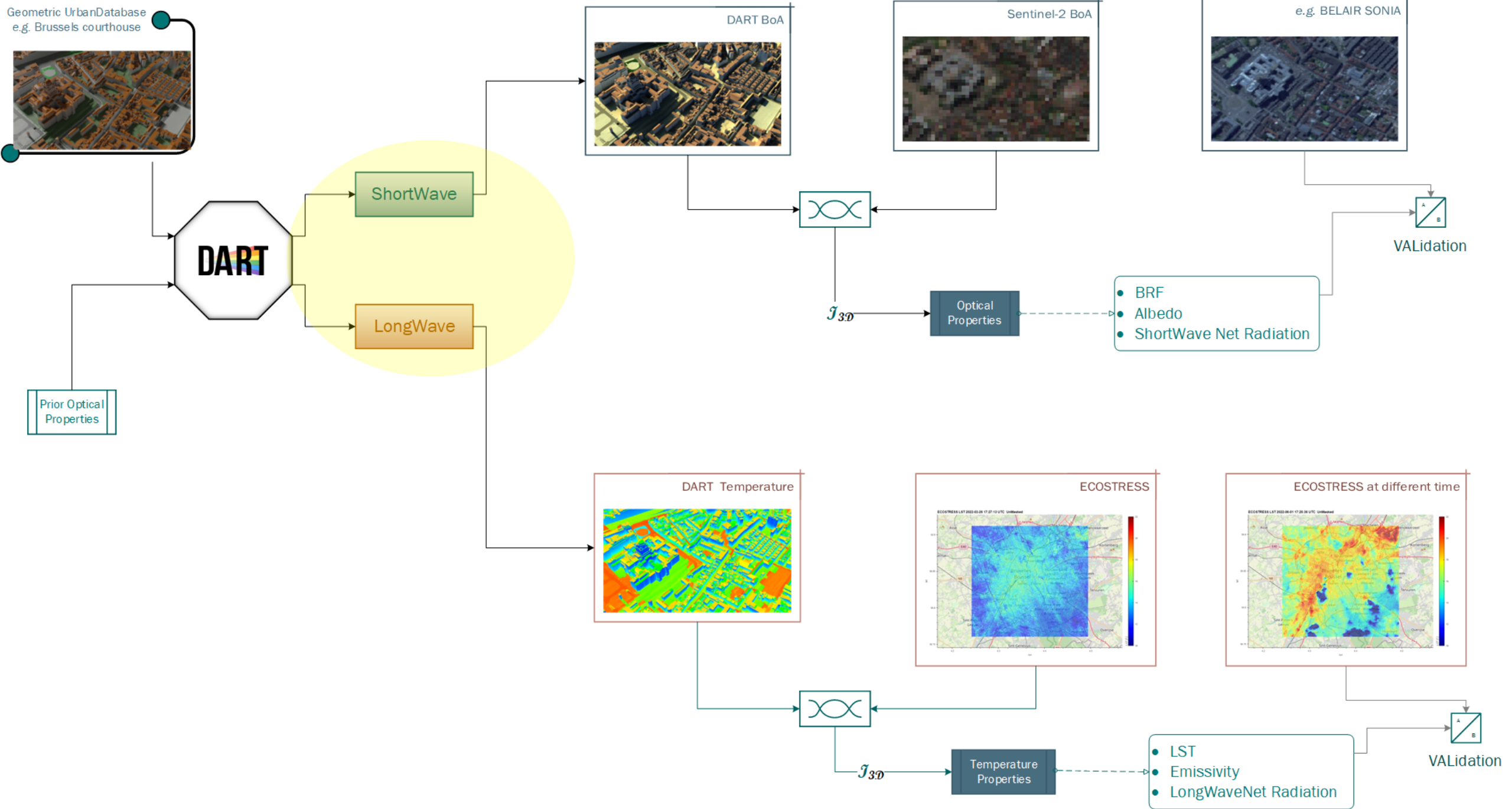
This limited angular sampling results in a significant lack of directional information, which poses a challenge for the estimation of accurate surface albedo.

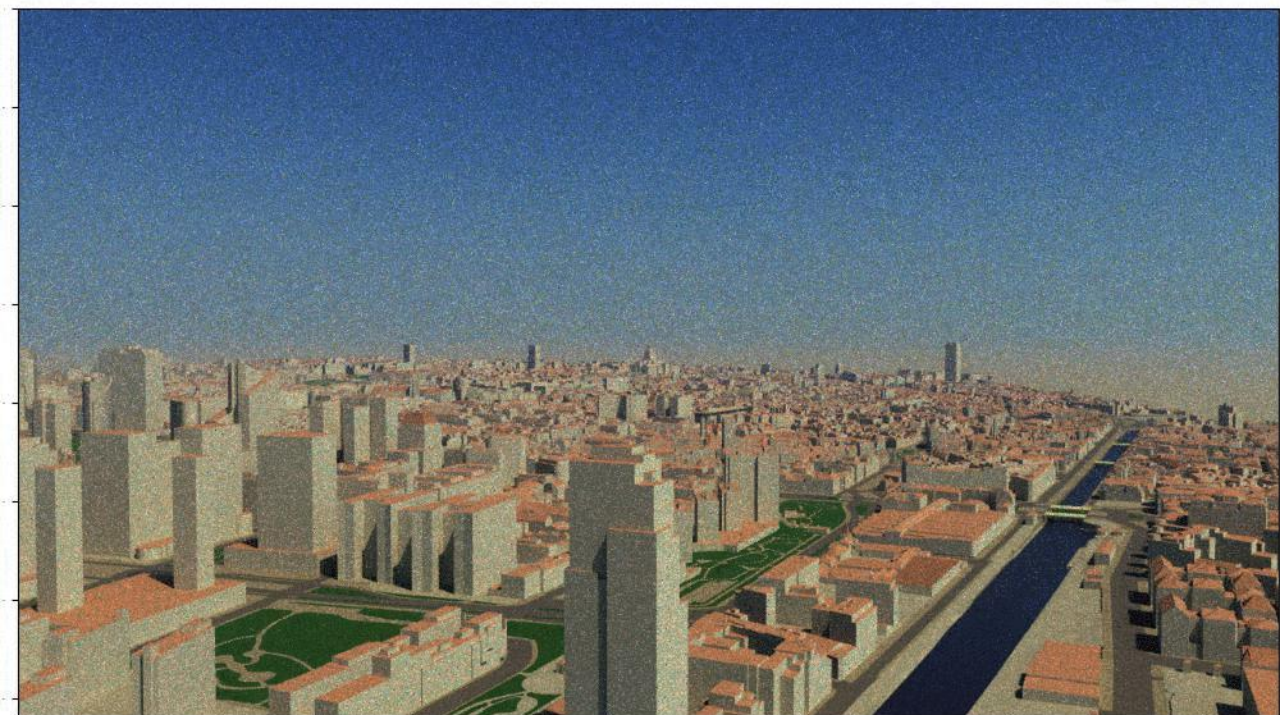
What shall urban elements be considered for a heat pollution mitigation intervention?
→ SuaBe catalogue



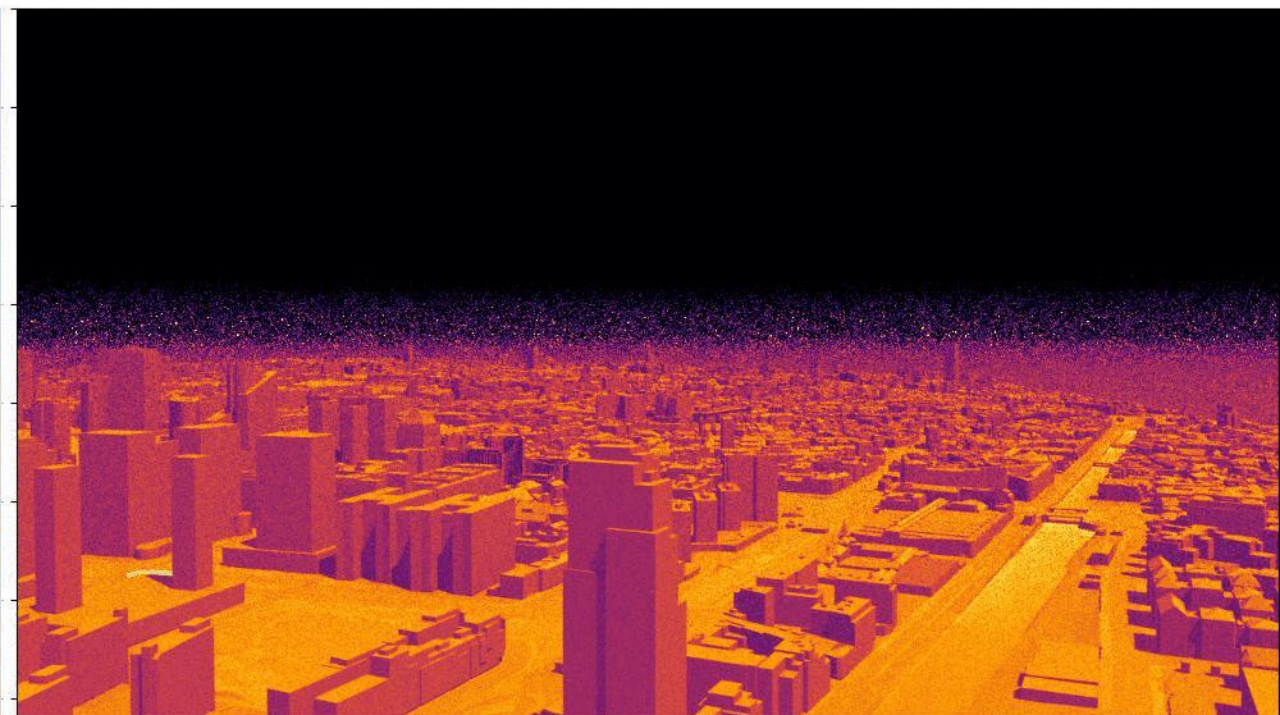




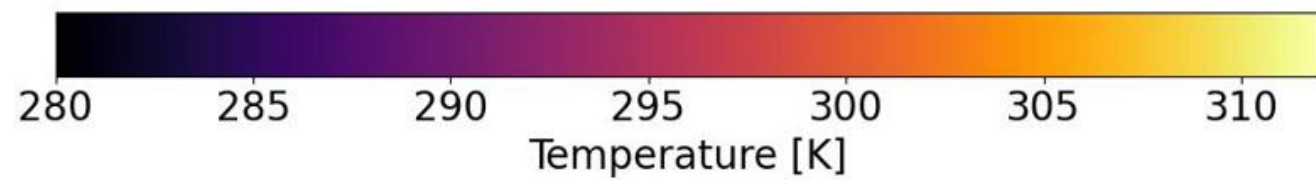


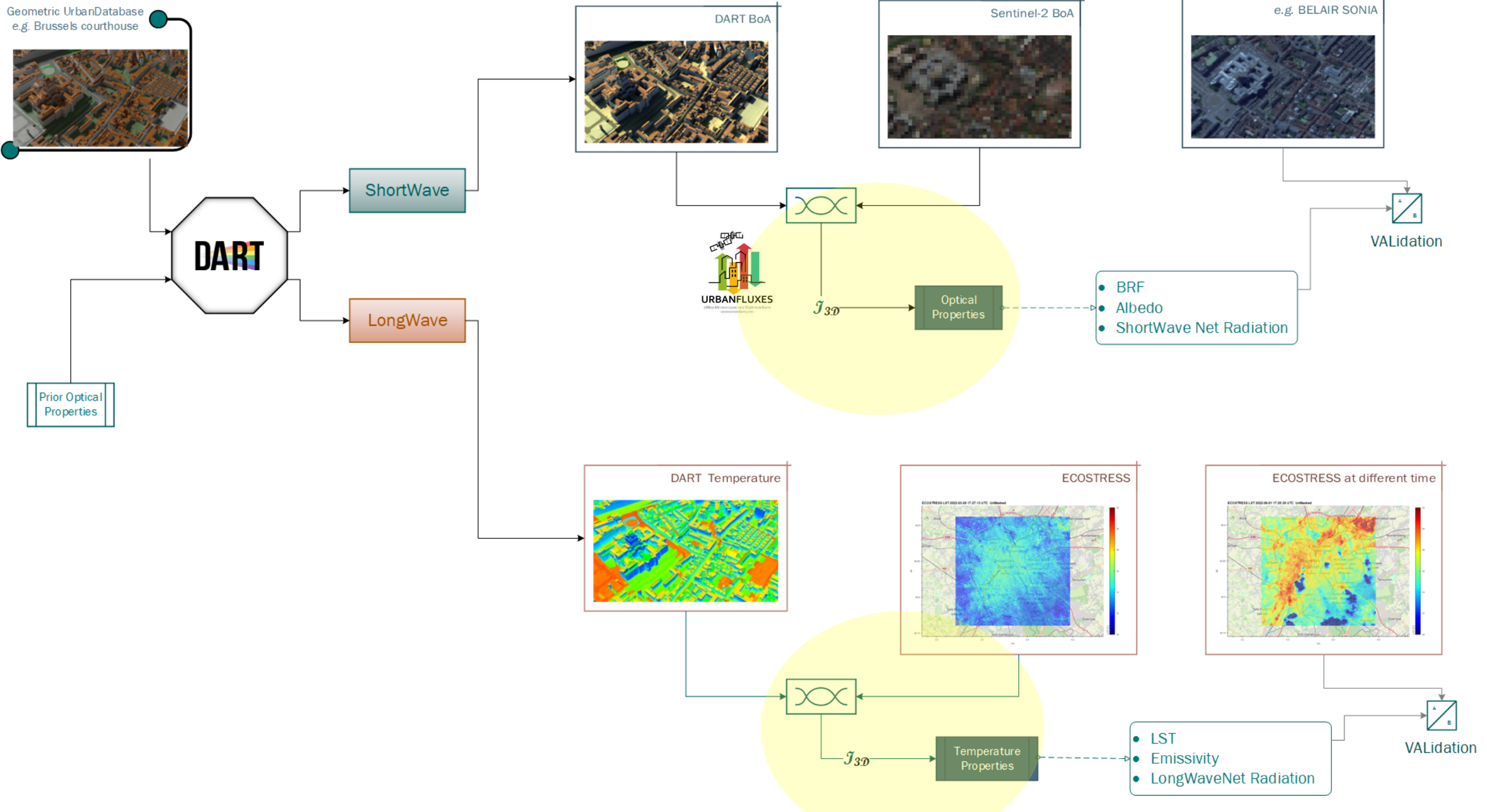


RGB ($0.66\,\mu m$, $0.55\,\mu m$, $0.49\,\mu m$)



TIR ($10\,\mu m$)





Results: VISNIR inversion



Sentinel-2 10m (B2, B3, B4)

24Feb2021 10:50 UTC



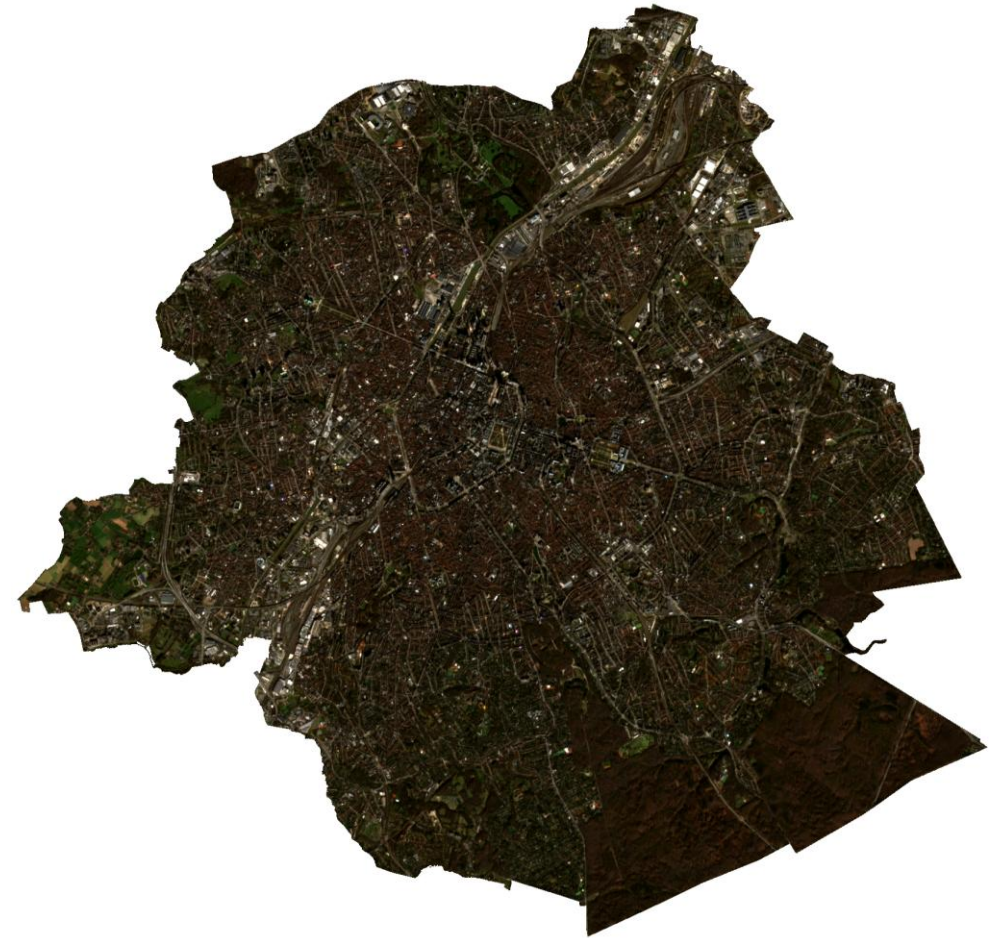
DART simulation

Results: VISNIR inversion



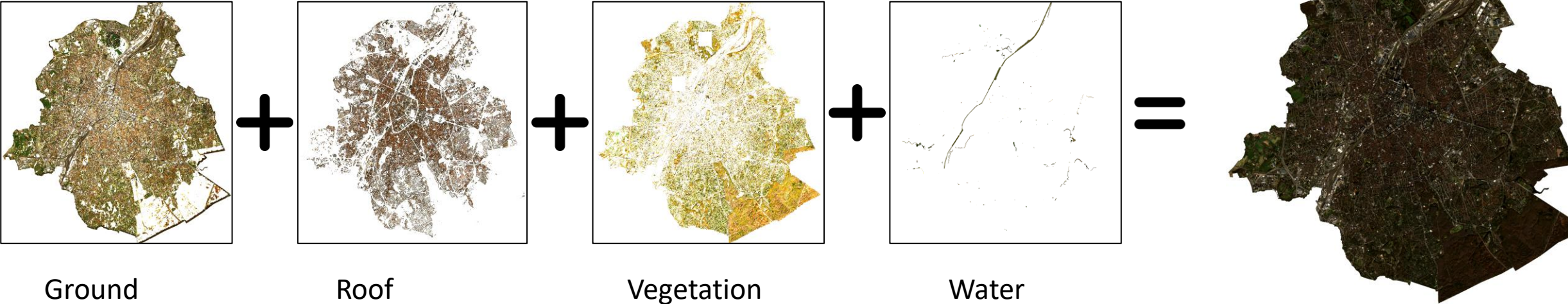
Sentinel-2 10m (B2, B3, B4)

24Feb2021 10:50 UTC



DART simulation

Results: VISNIR inversion



Remote Sensing of Environment

Volume 321, 1 May 2025, 114657

A gradient-based 3D nonlinear spectral model for providing components optical properties of mixed pixels in shortwave urban images

Zhijun Zhen^{a, b}, Shengbo Chen^{a, c}, Nicolas Lauret^b, Abdelaziz Kallel^d, Eric Chavanon^b, Tiangang Yin^e, Jonathan León-Tavares^f, Biao Cao^g, Jordan Guilleux^b, Jean-Philippe Gastellu-Etchegorry^b

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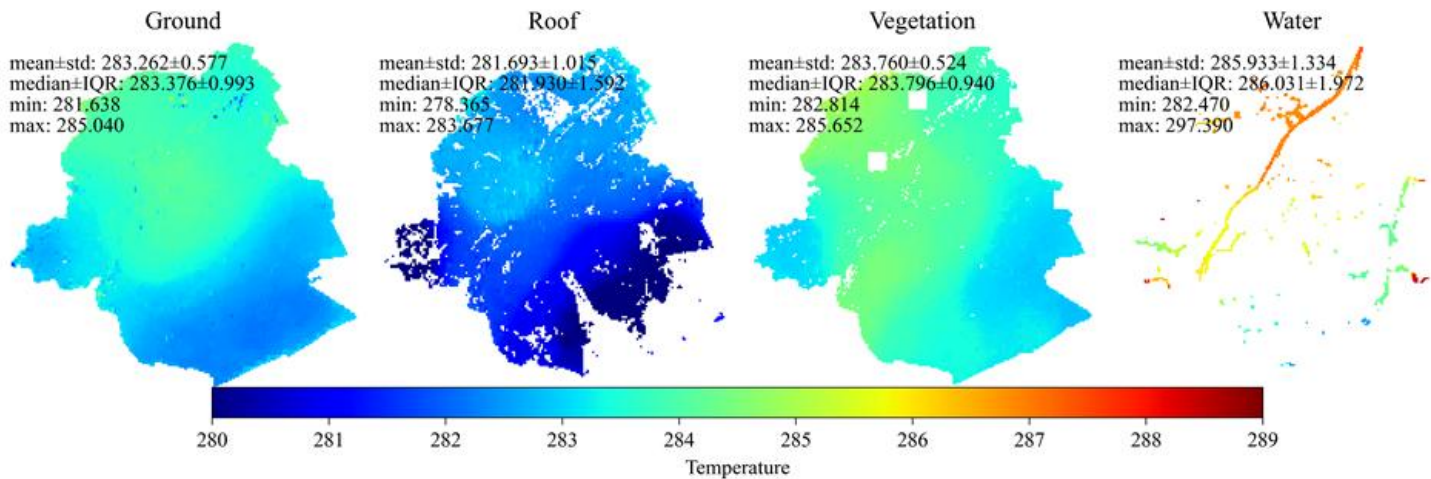
Results: TIR inversion



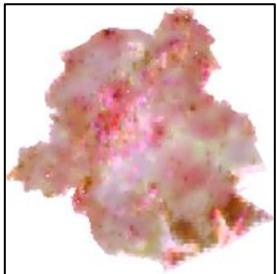
ASTER Temperature
26Sep2018 21:26 UTC



DART temperature



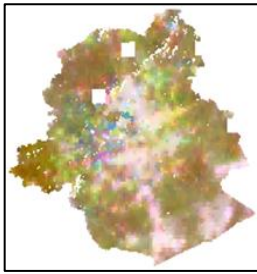
Surface emissivity



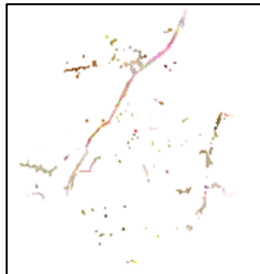
Ground



Roof



Vegetation



Water

Remote Sensing of Environment
Volume 324, 1 July 2025, 114738

A gradient-based nonlinear multi-pixel physical method for simultaneously separating component temperature and emissivity from nonisothermal mixed pixels with DART

ZhiJun Zhen ^{a,b}, Shengbo Chen ^{a,c}, Nicolas Lauret ^b, Abdelaziz Kallel ^d,
Tiangang Yin ^e, Jonathan León-Tavares ^f, Biao Cao ^g,
Jean-Philippe Gastellu-Etchegorry ^b

Show more

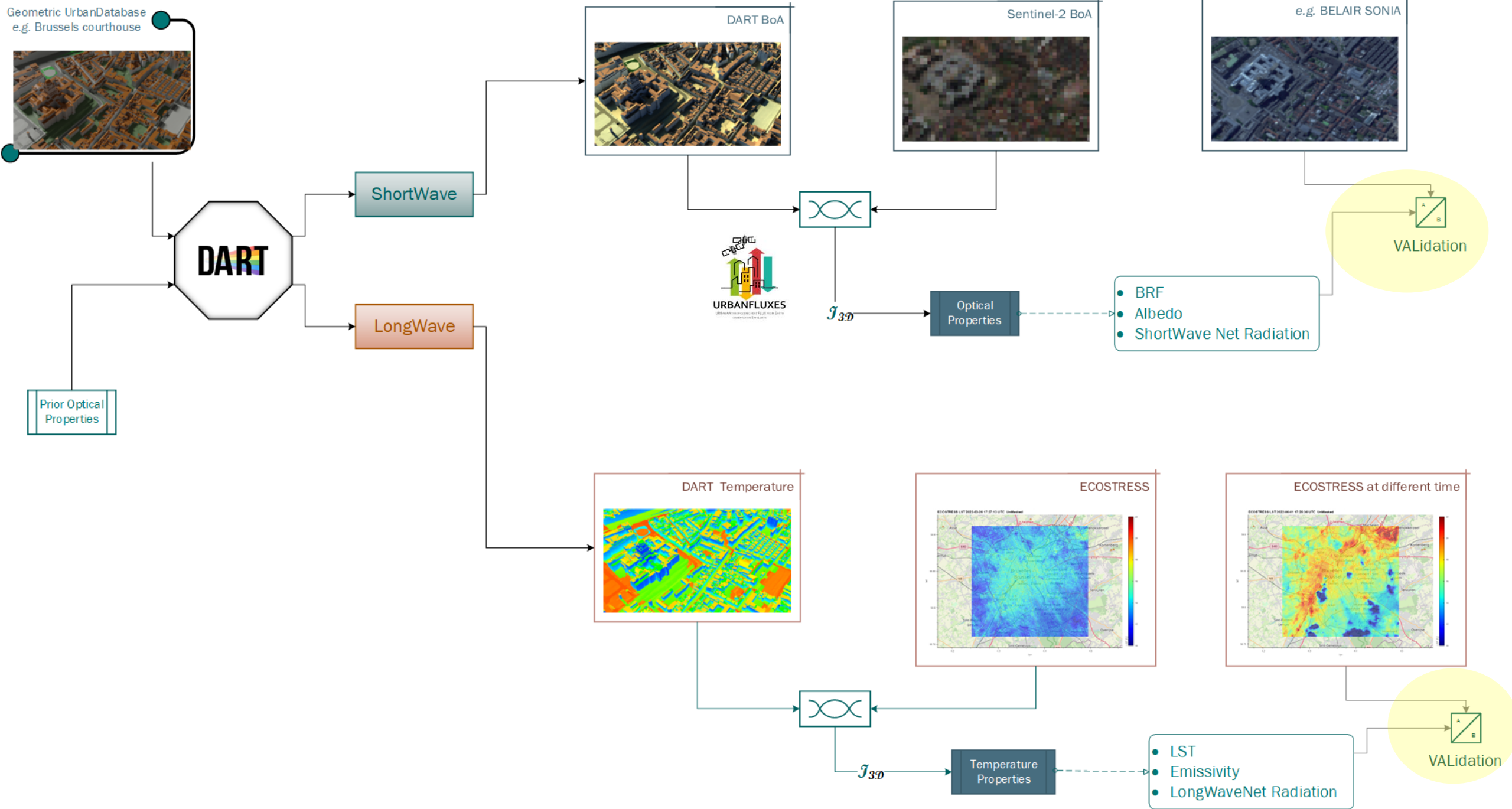
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Summary

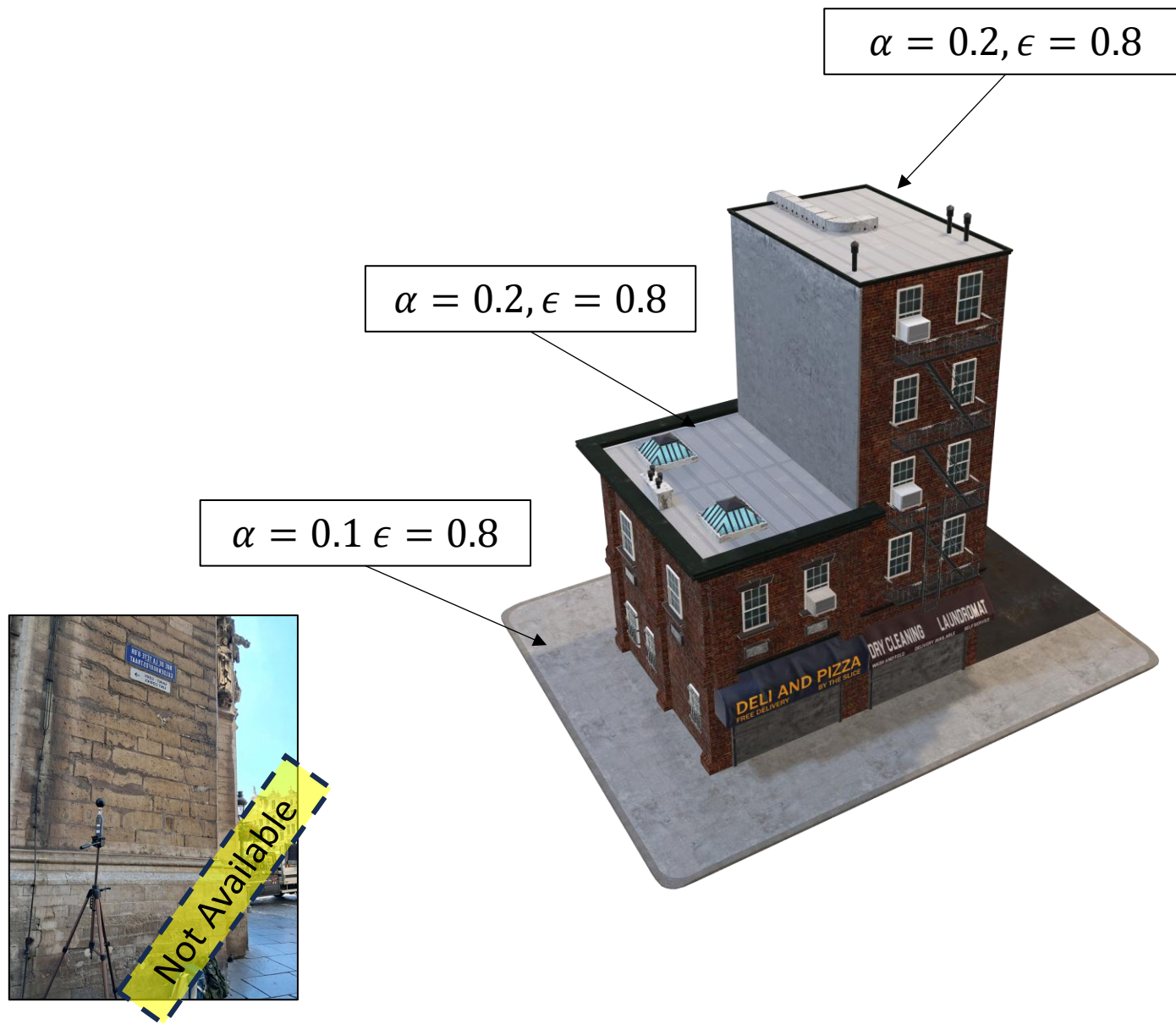
The **implemented SuaBe DART inversion methodology**, designed for **optical and temperature properties retrieval from urban elements**, demonstrates **promising outcomes**.

- Retrieved **optical properties in the Brussels scene allowed us to simulate BRF/Radiance images that closely match observed VISNIR/TIR images**, with **median relative errors < 5% in both spectral regimes**.
- **Validation (Net Radiation) is ongoing**.

SuaBe will:

- **Answer novel, urgent questions on how to efficiently mitigate the effects of heat waves in cities.**
- **Provide a surface albedo and emissivity inventory, allowing to underpin future policy for securing a sustainable development of cities (e.g. Brussels) and protect public health under climate change.**

Exploitation of SuaBe catalogue



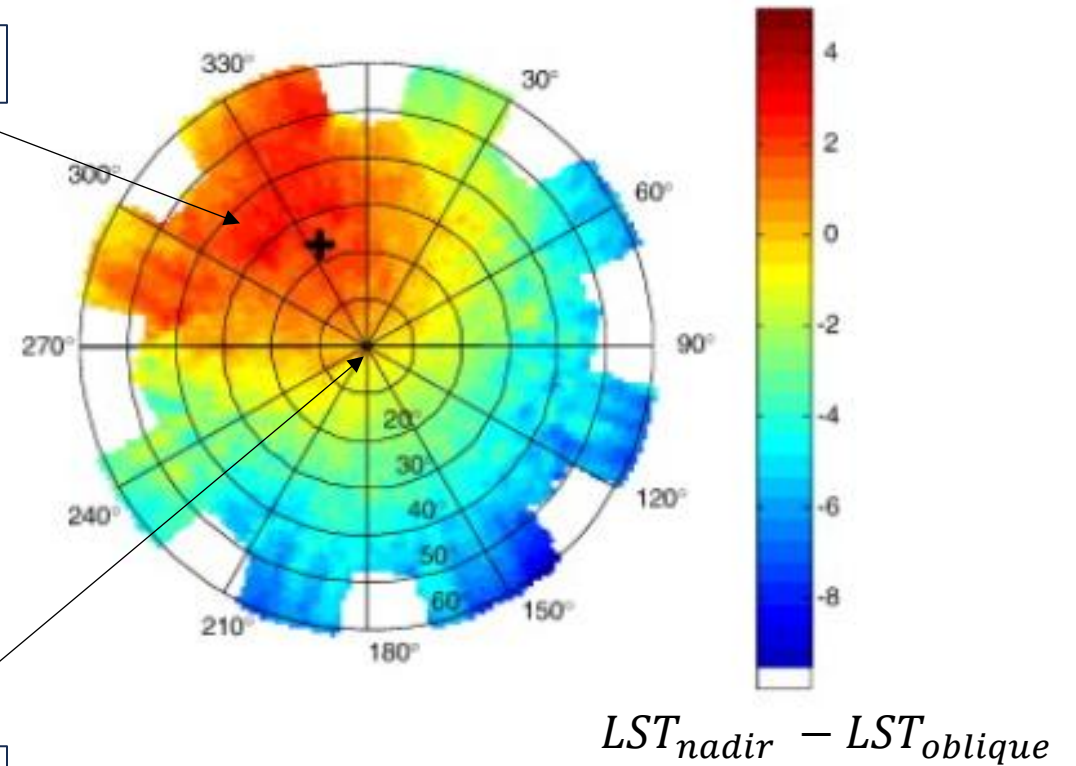
TIR anisotropy (BRDF)

Important anisotropy can lead up to 14 °C in difference of brightness directional temperature ([Lagouarde + 2010](#)).



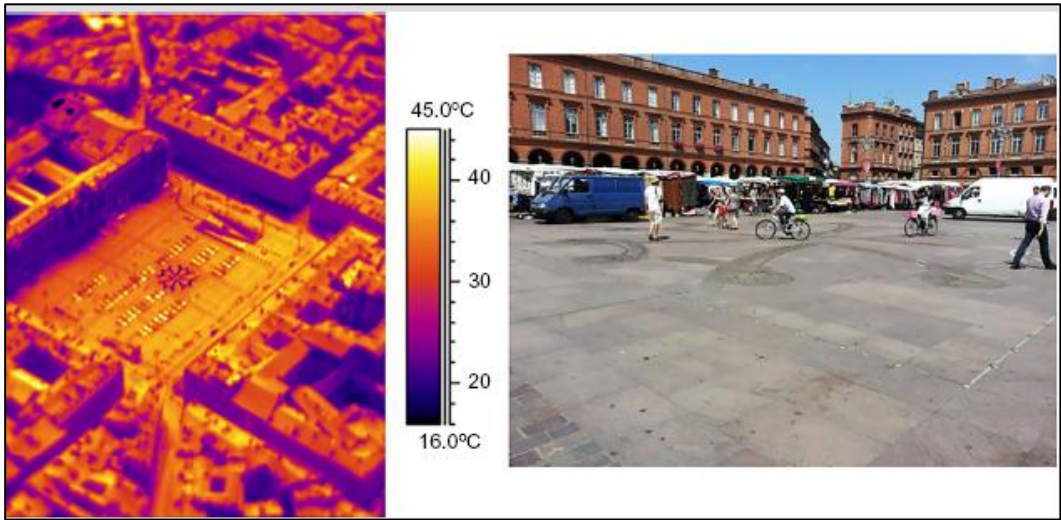
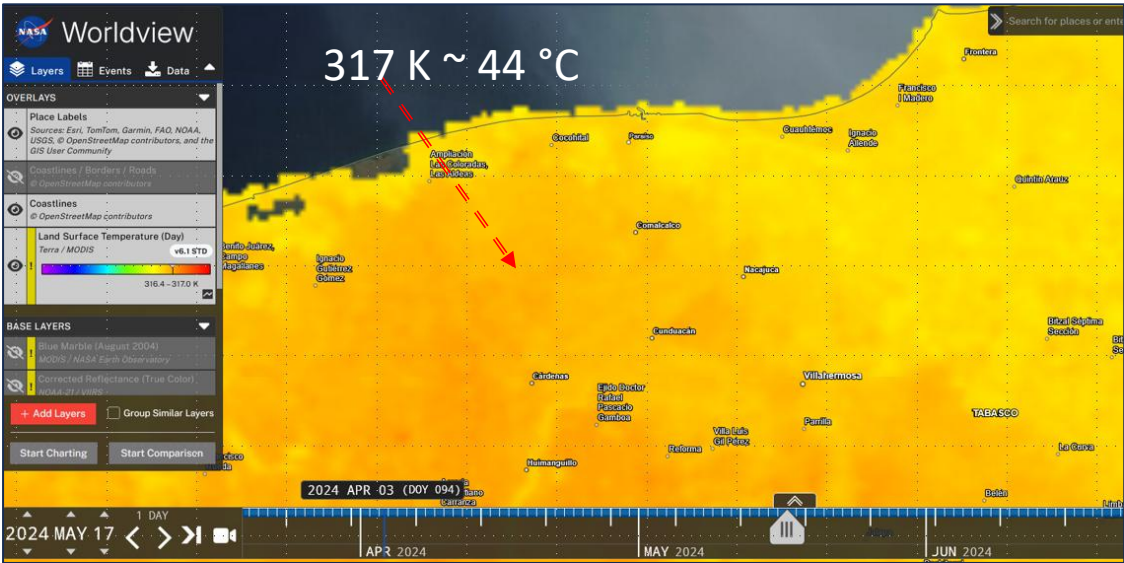
TRISHNA

Landsat



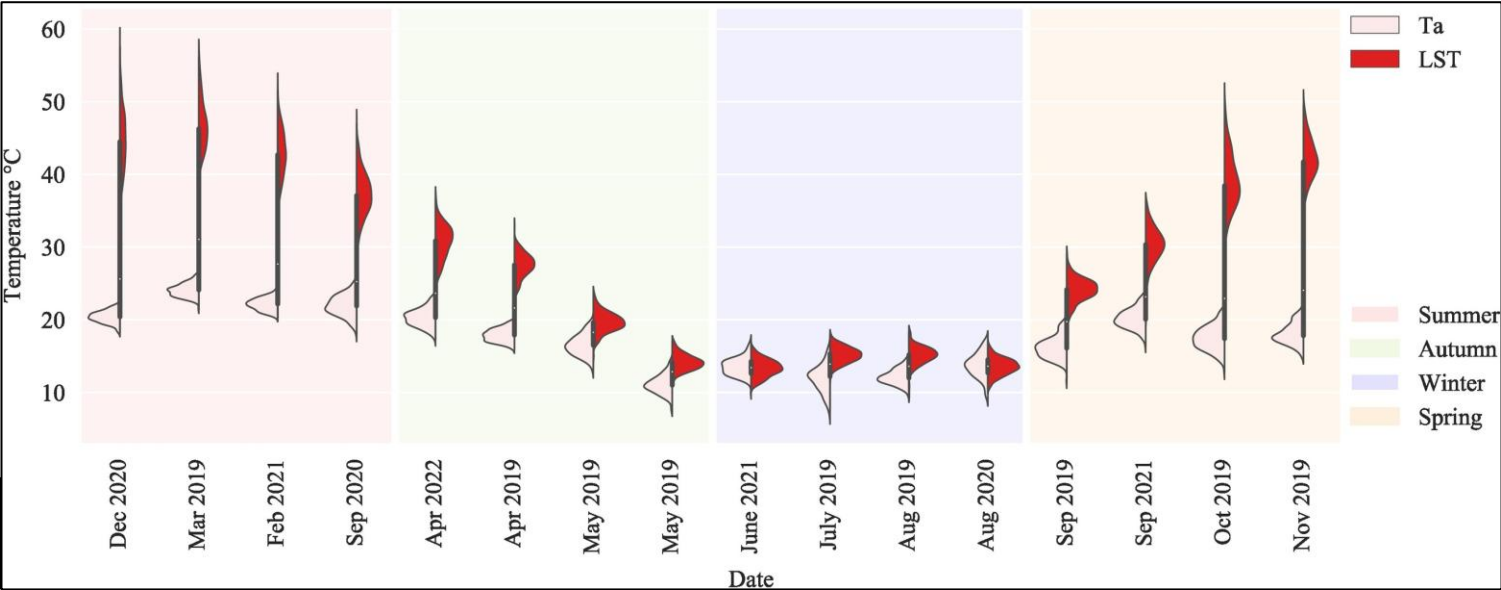
Polar plot showing the difference between LST at nadir and off-nadir directions.

Which temperature?



Hulley & Ghent 2019

Sydney metropolitan area



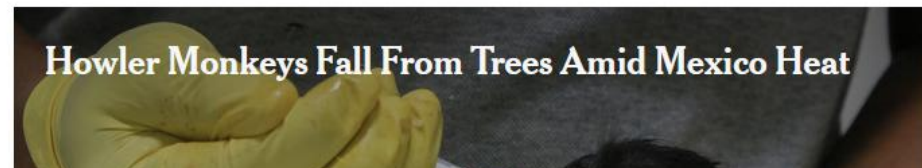
Naserikia + 2023

Dead Monkeys Are Falling From Trees Amid Brutal Heat in Mexico

The deaths of dozens of howler monkeys may be the latest sign of the danger extreme temperatures pose to wildlife around the world.

Listen to this article · 4:50 min [Learn more](#)

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Aristegui NOTICIAS

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jueves, 27 de junio de 2024

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Monos en Tabasco: Lluvias no resuelven la mortandad

COBIUS AC informó que hasta la fecha registraron 234 monos aulladores muertos en Tabasco, por las altas temperaturas y otras condiciones que no ceden a pesar de la lluvia.

Redacción AN / KC
25 Jun, 2024 11:54



Climate & Energy | Water Management | Climate Change

Mexico's howler monkeys dropping dead as heat toll mounts

By Luis Manuel Lopez and Raul Cortes

May 21, 2024 1:26 AM GMT+2 · Updated a month ago



Climate & Energy | Climate Change

Over 200 howler monkeys in Mexico perish in heatwave, says NGO

By Reuters

June 25, 2024 2:29 AM GMT+2 · Updated 3 days ago



Climate & Energy | Water Management | Climate Change

Mexico's howler monkeys dropping dead as heat toll mounts

By Luis Manuel Lopez and Raul Cortes

th ago

Dead Monkeys Are Falling From Trees Amid Brutal Heat in Mexico

The deaths of howler monkeys are a sign of the damage around the world caused by climate change.

Listen to this article more

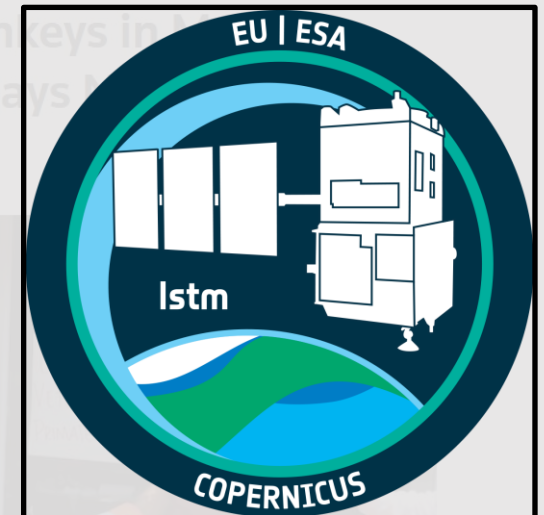
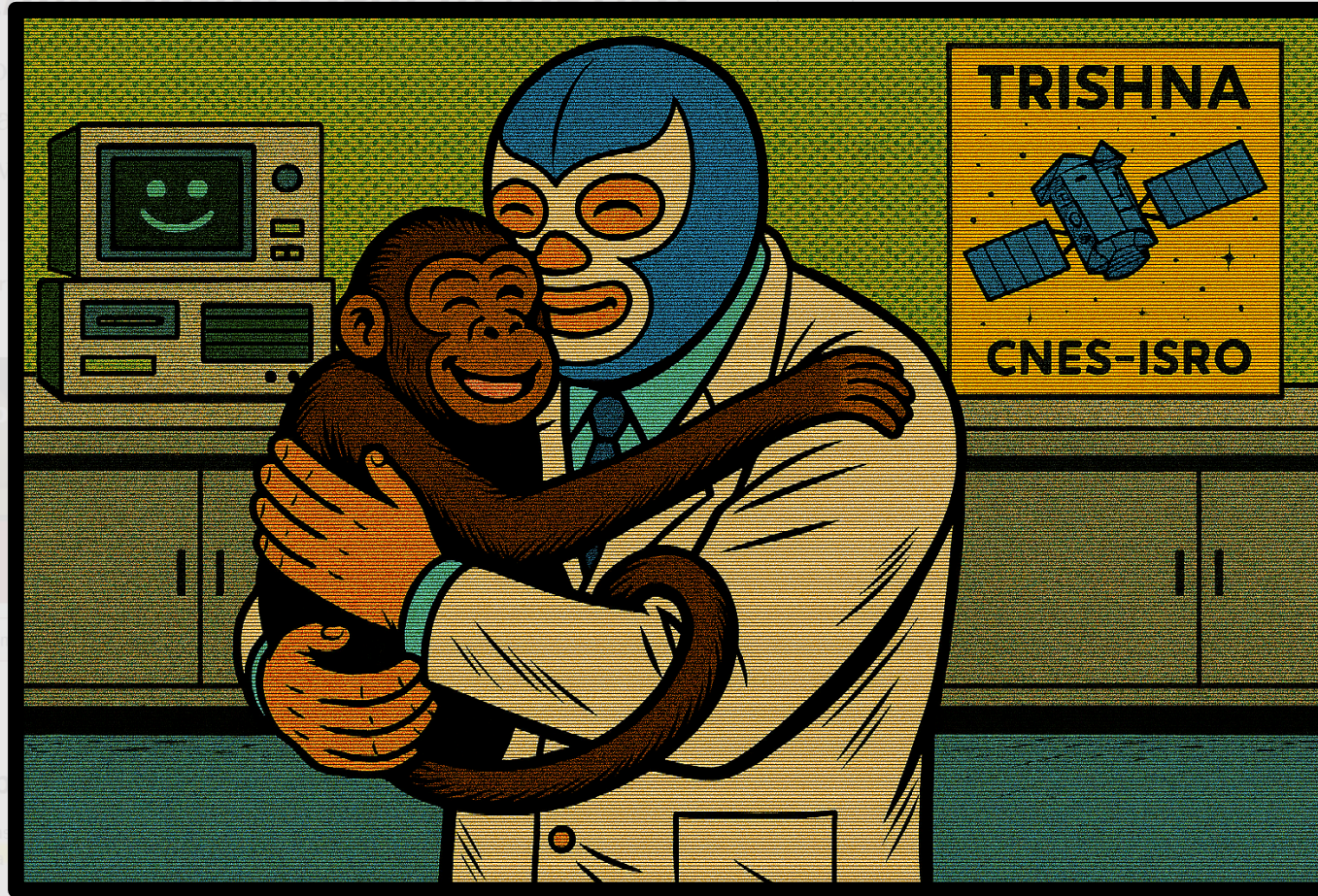
Howler Monkeys

Video México Economy

Monos en Tabasco

COBIUS AC informó que ha iniciado las actividades en condiciones que no ceden a las amenazas.

Redacción AN / KC
25 Jun. 2024 11:54





Emulating heat Comfort and air temperature in Brussels

EheCatL

Jean-Philippe Gastellu-Etchegorry
Nicolas Lauret
Zhijun Zhen

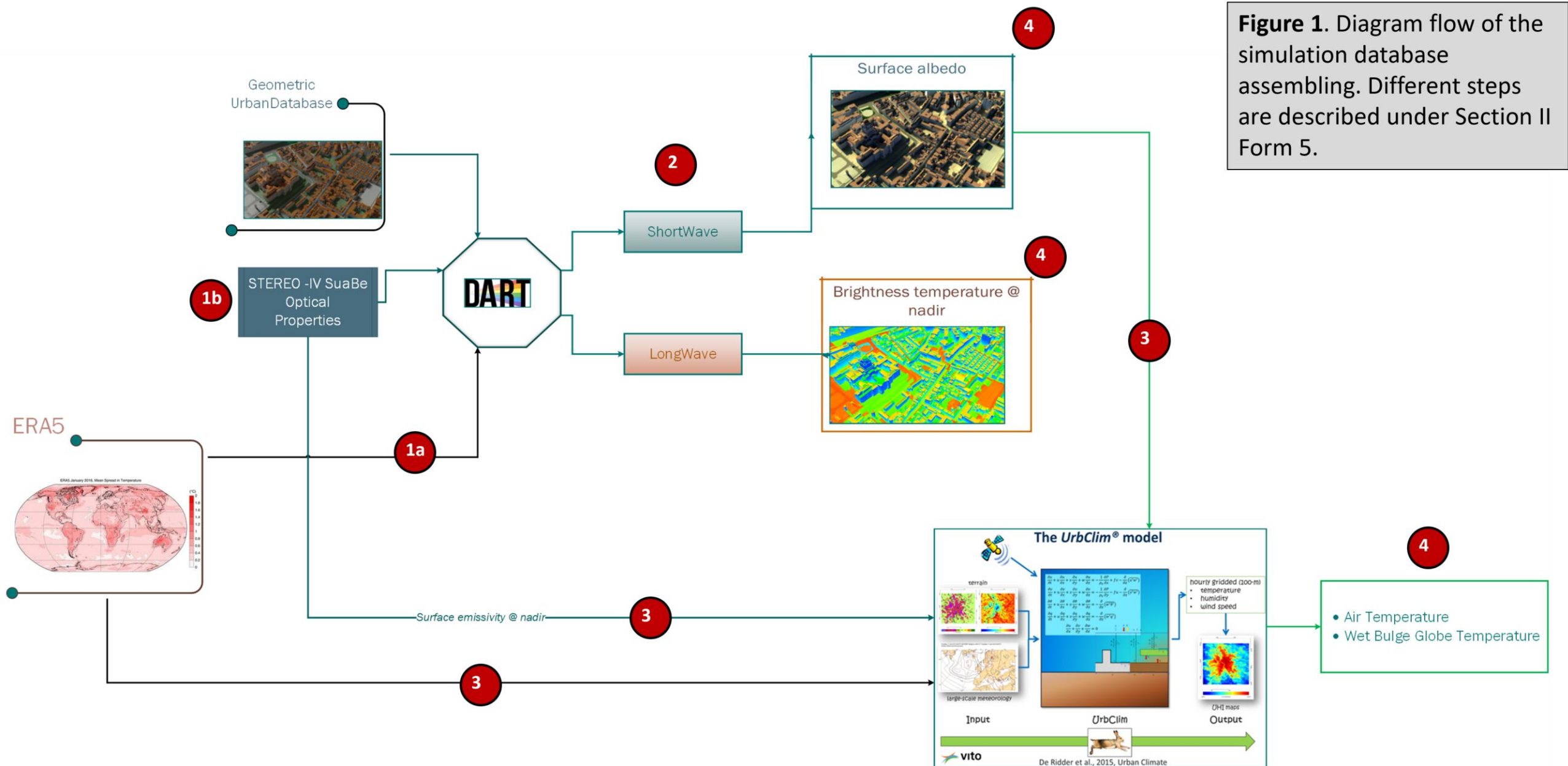


Dirk Lauwaet
Sacha Takacs



Jonathan León-Tavares





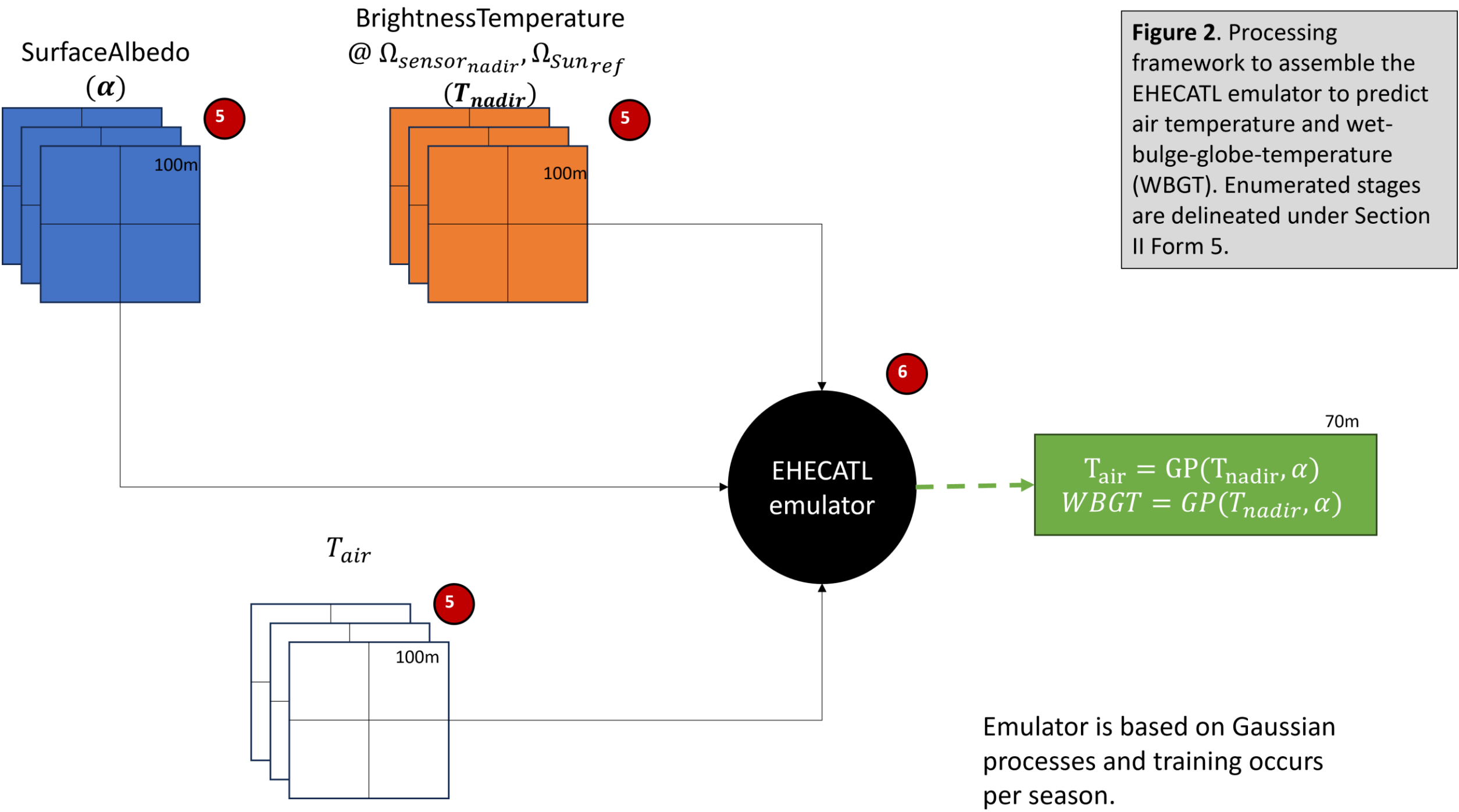
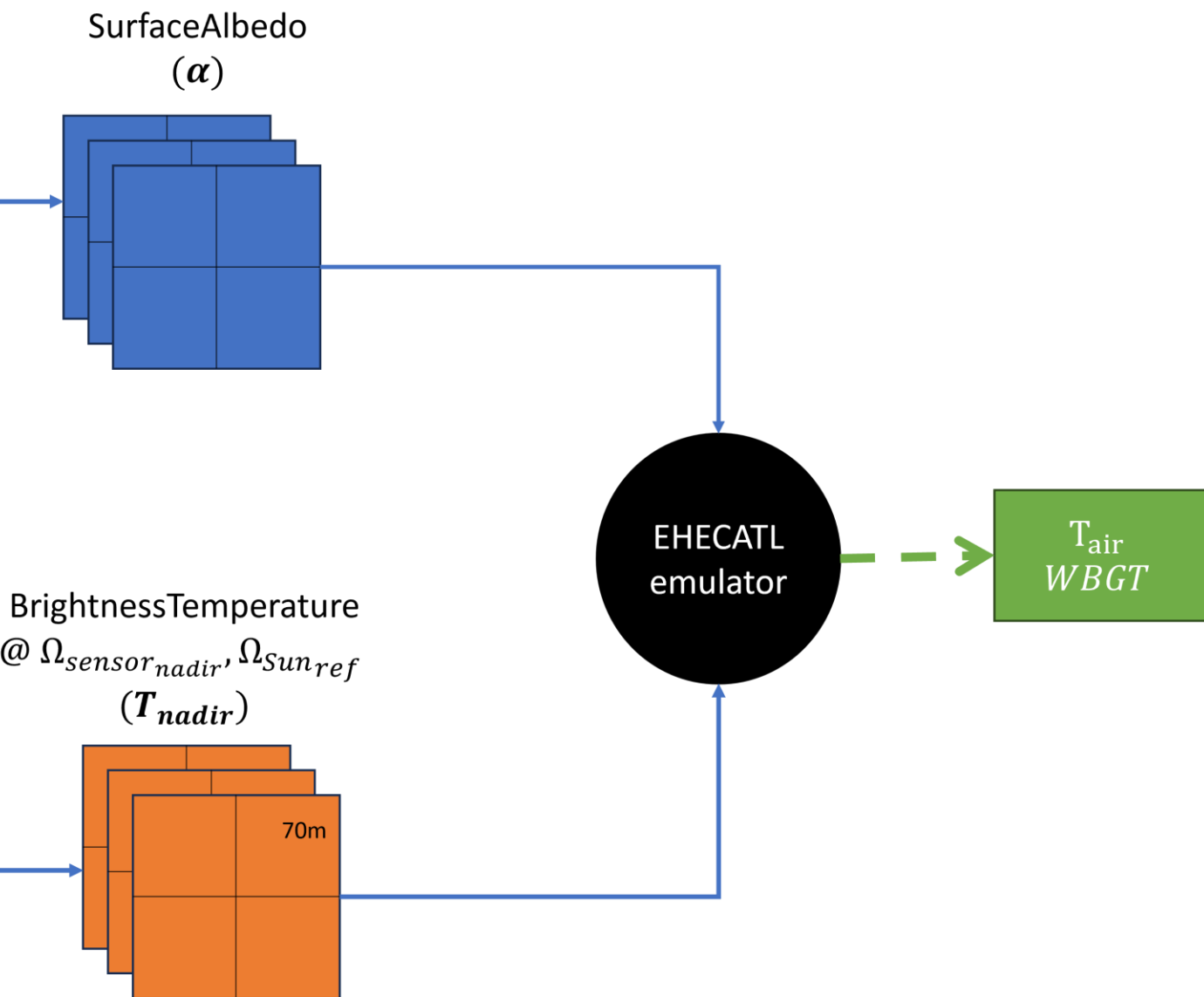


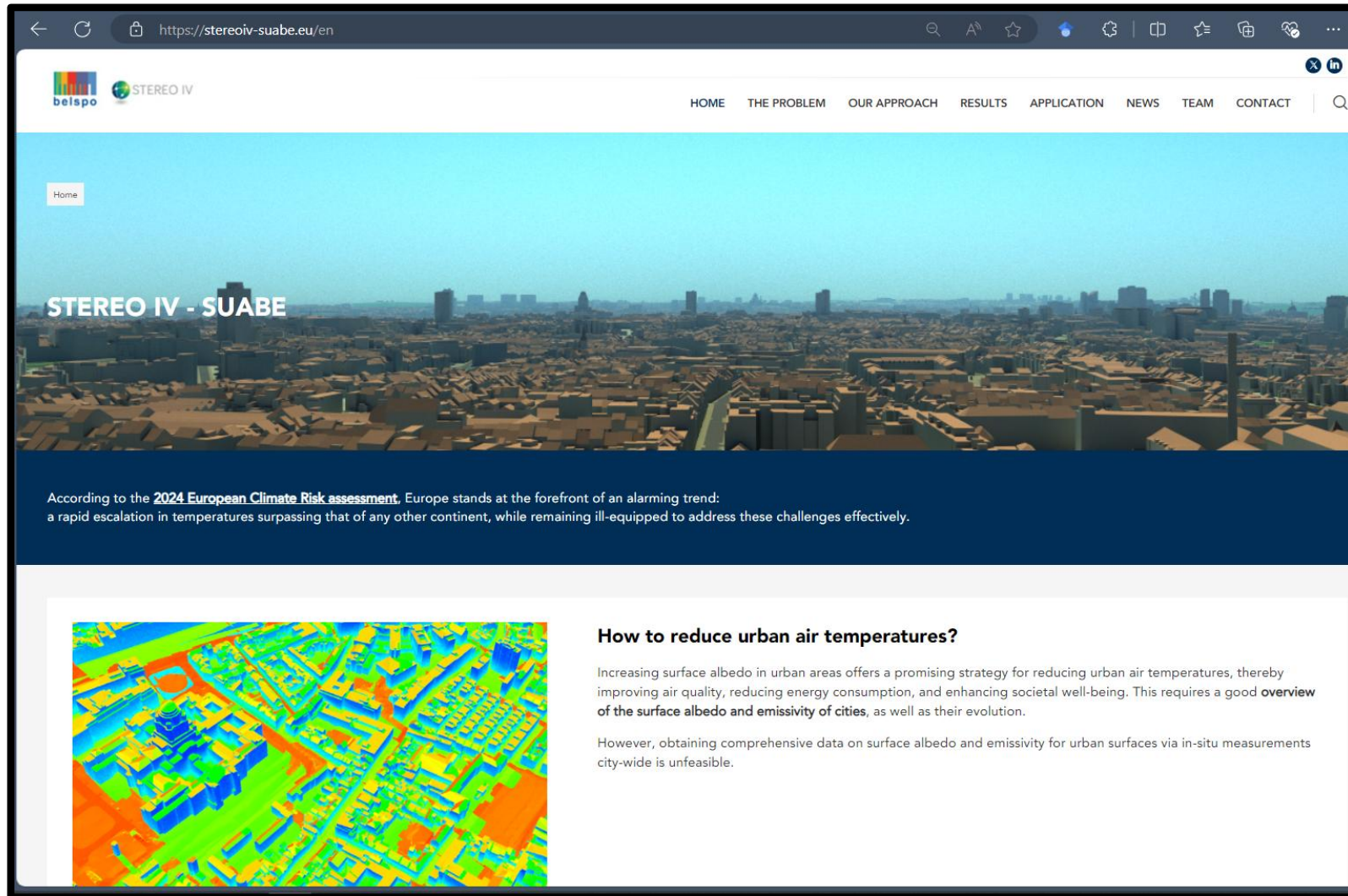
Figure 2. Processing framework to assemble the EHECATL emulator to predict air temperature and wet-bulge-globe-temperature (WBGT). Enumerated stages are delineated under Section II Form 5.



Validation campaign in Brussels
01 July 2025

Do you want to know more?

Surface albedo and emissivity for Belgian cities (SuaBe)



<https://stereoiv-suabe.eu/en>

jonathan.leontavares@vito.be

Emulating heat
Comfort and air
temperature in
Brussels

EheCatL



Aztec God of wind

KEY TAKEAWAYS

- **BELSPO is funding a scientific project focused on assembling a radiative digital twin for Brussels.**
- This radiative digital twin of Brussels is calibrated with satellite data.



TOOLS, WEBSITES, AND SOURCES

- <https://stereoiv-suabe.eu/en>
- <https://dart.omp.eu/#/>



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