

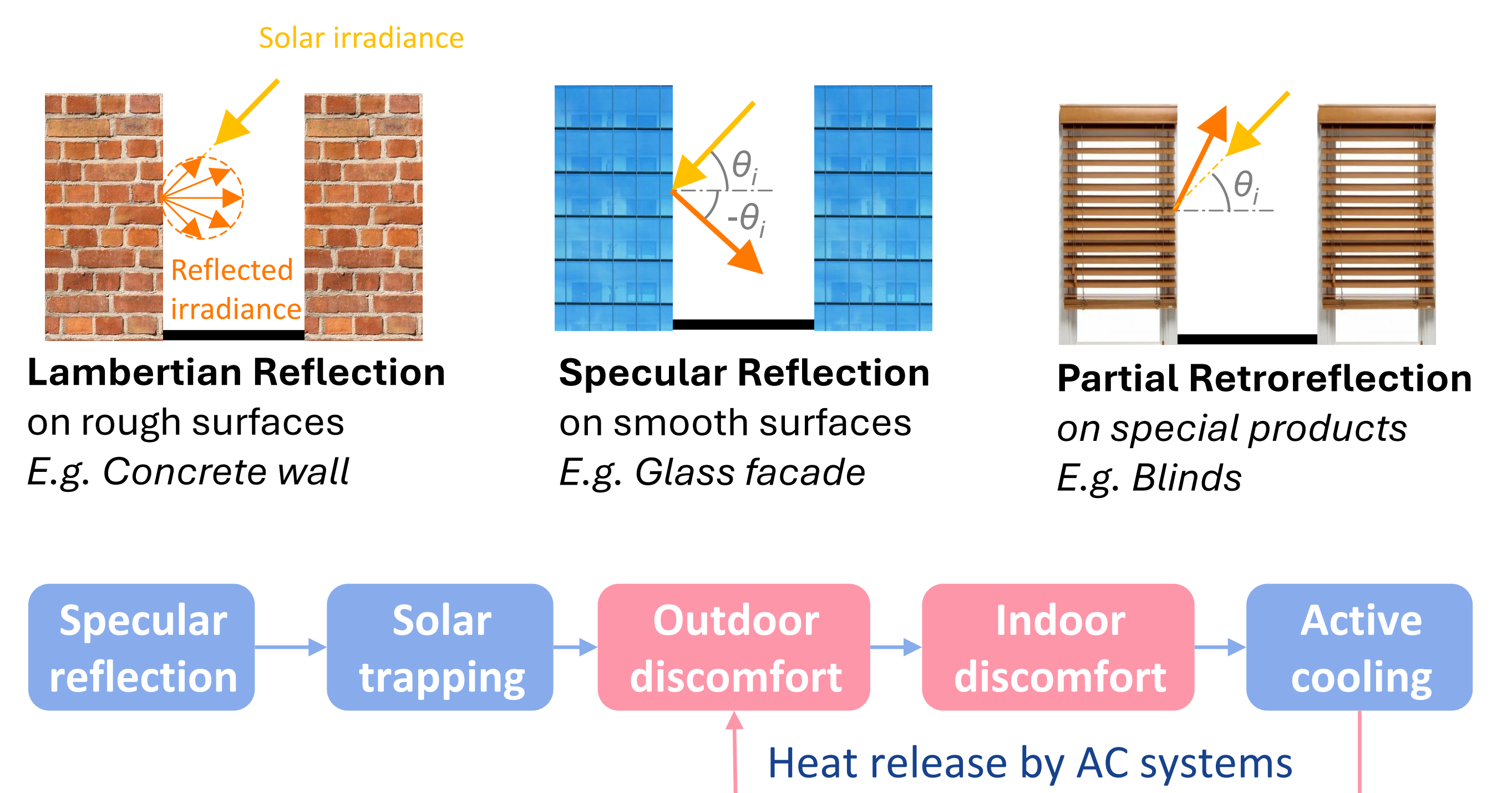
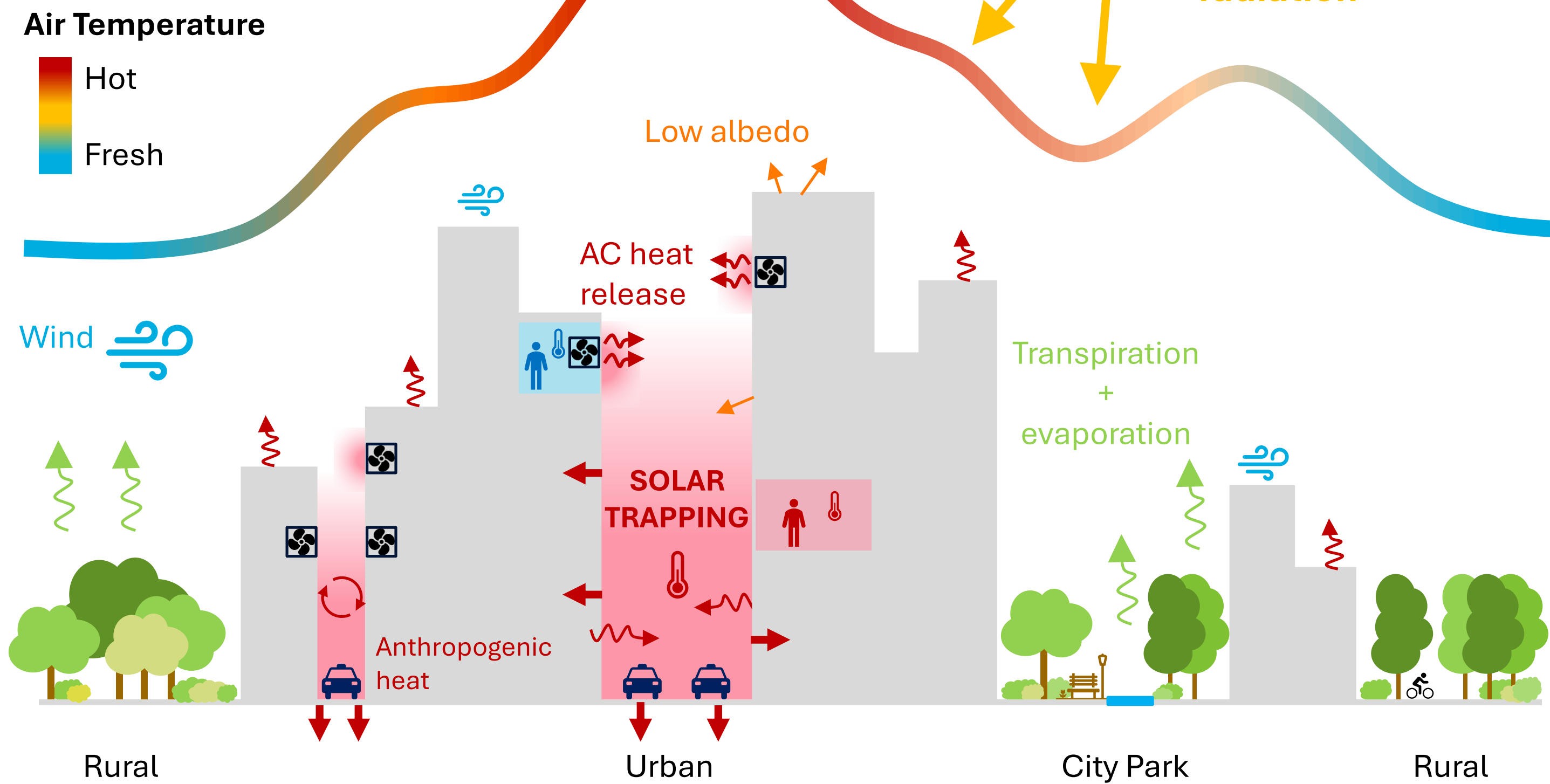


IMPROVING THERMAL COMFORT IN CITIES BY EXPLICIT MODELING GLAZED SURFACES OPTICAL BEHAVIOR

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GLASS FACADES & SOLAR TRAPPING



Key Scientific Challenges:

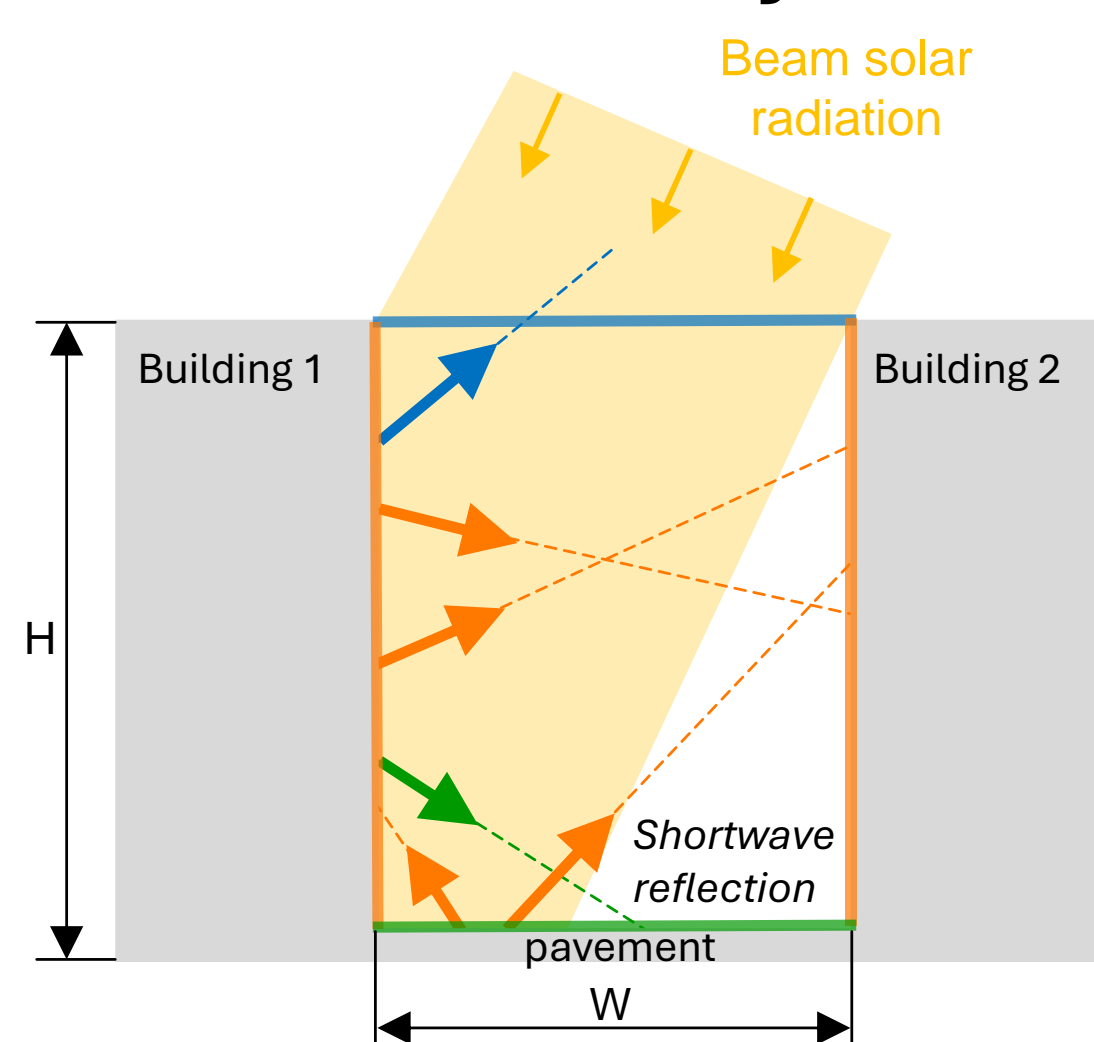
- Quantify the impact of the material properties of facades on indoor & outdoor thermal discomfort and building energy performance.
- Explore innovative solutions to overcome current limitations.

Solar trapping is a major contributor to urban overheating → Outdoor thermal discomfort.

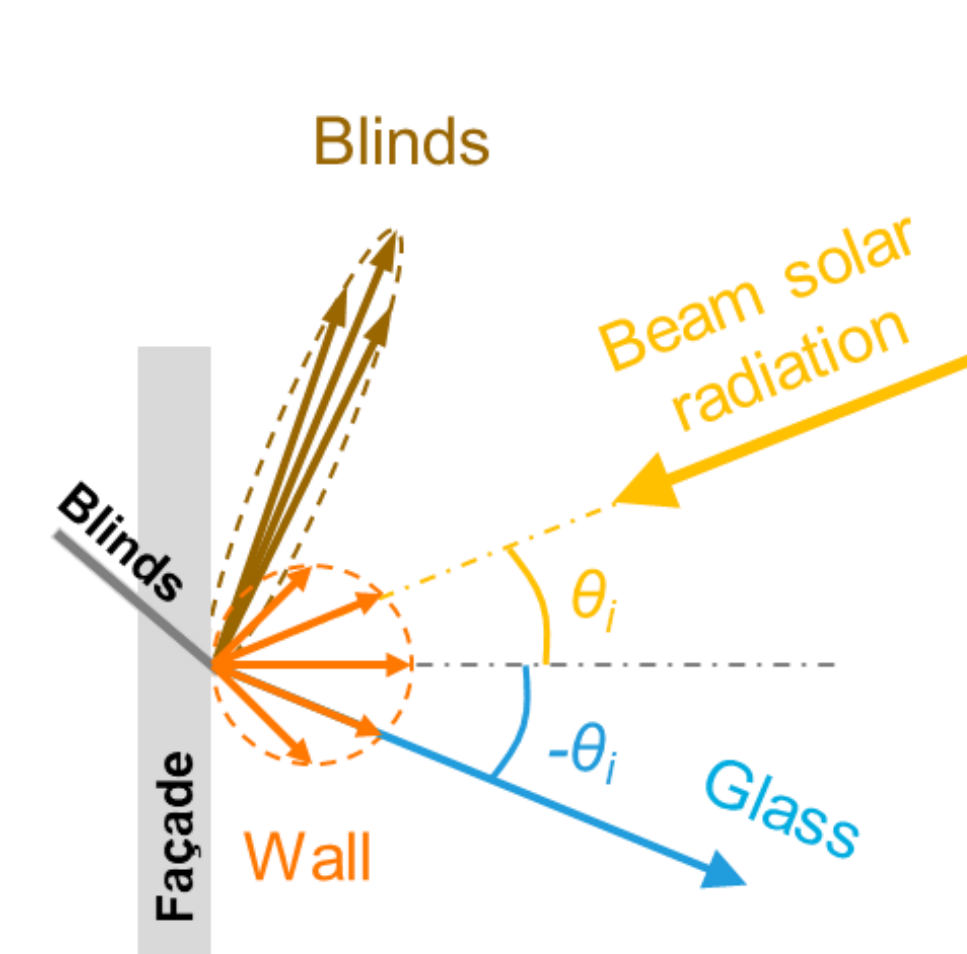
- Deep urban canyons with low sky view factor
- High-capacity materials
- Lack of green spaces and water bodies
- Higher Air/Radiant temperatures
- Reduced wind speed
- Air quality & Health problems

2D ANALYTICAL URBAN CANYON MODEL FOR SOLAR TRAPPING EVALUATION

Urban Canyon



Material Models

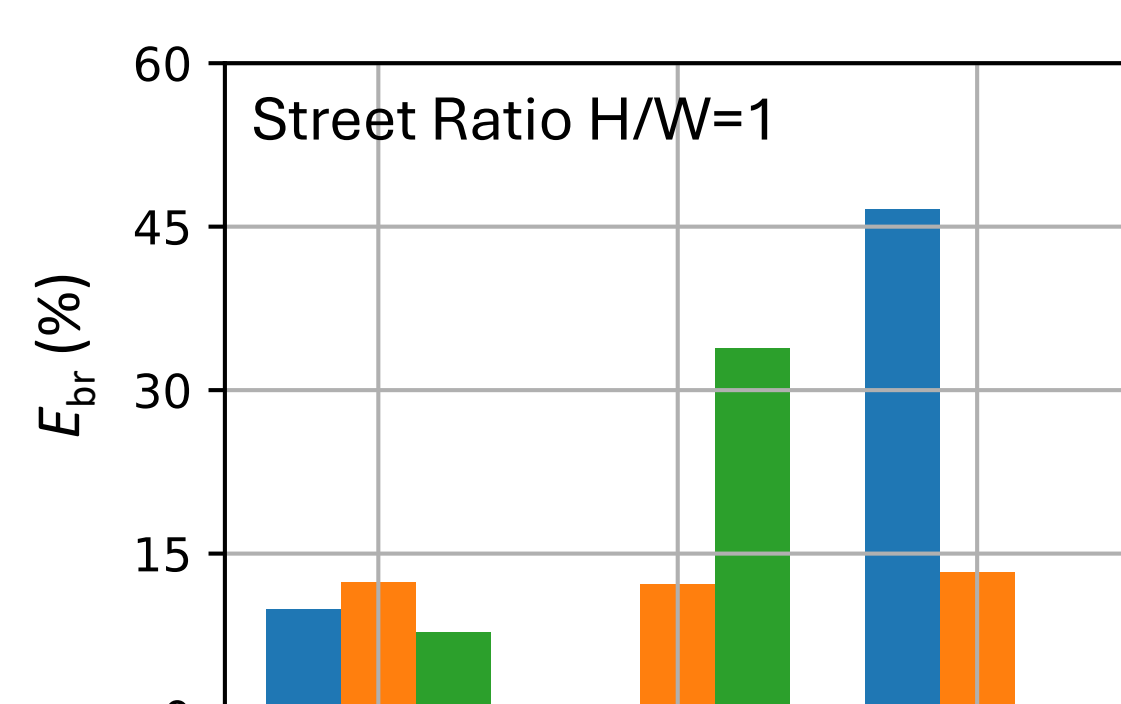


Model description and hypothesis:

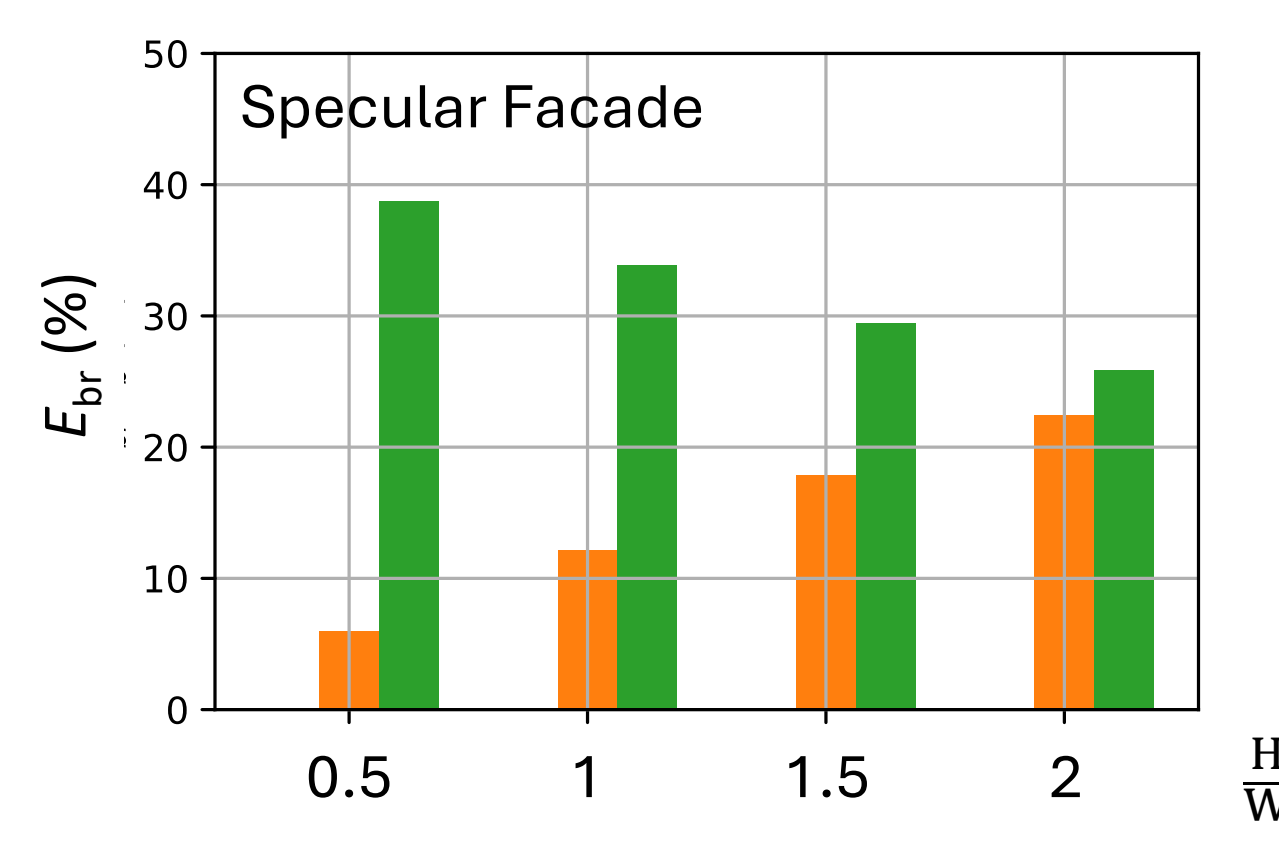
- Detailed shortwave reflection description of materials (wall, glass, blinds).
- Shortwave direct radiation and 1st reflection are considered.

RATIO OF REFLECTED SOLAR IRRADIANCE BY EAST FACADE (%)

Representative summer day



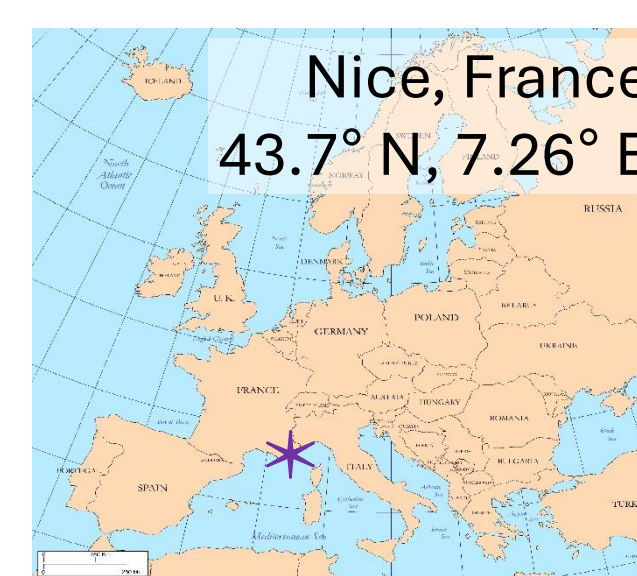
- Façade Materials: Lambertian Specular Partial RR
- Walls** reflect homogeneously.
 - Glass** reflects towards urban surfaces (ground and buildings).
 - Blinds** reflect >45% towards the sky.



Wide Street:
Reflection to ground.

Narrow Street:
Reflection to ground and buildings.

GLAZED FACADES VS LAMBERTIAN FACADES

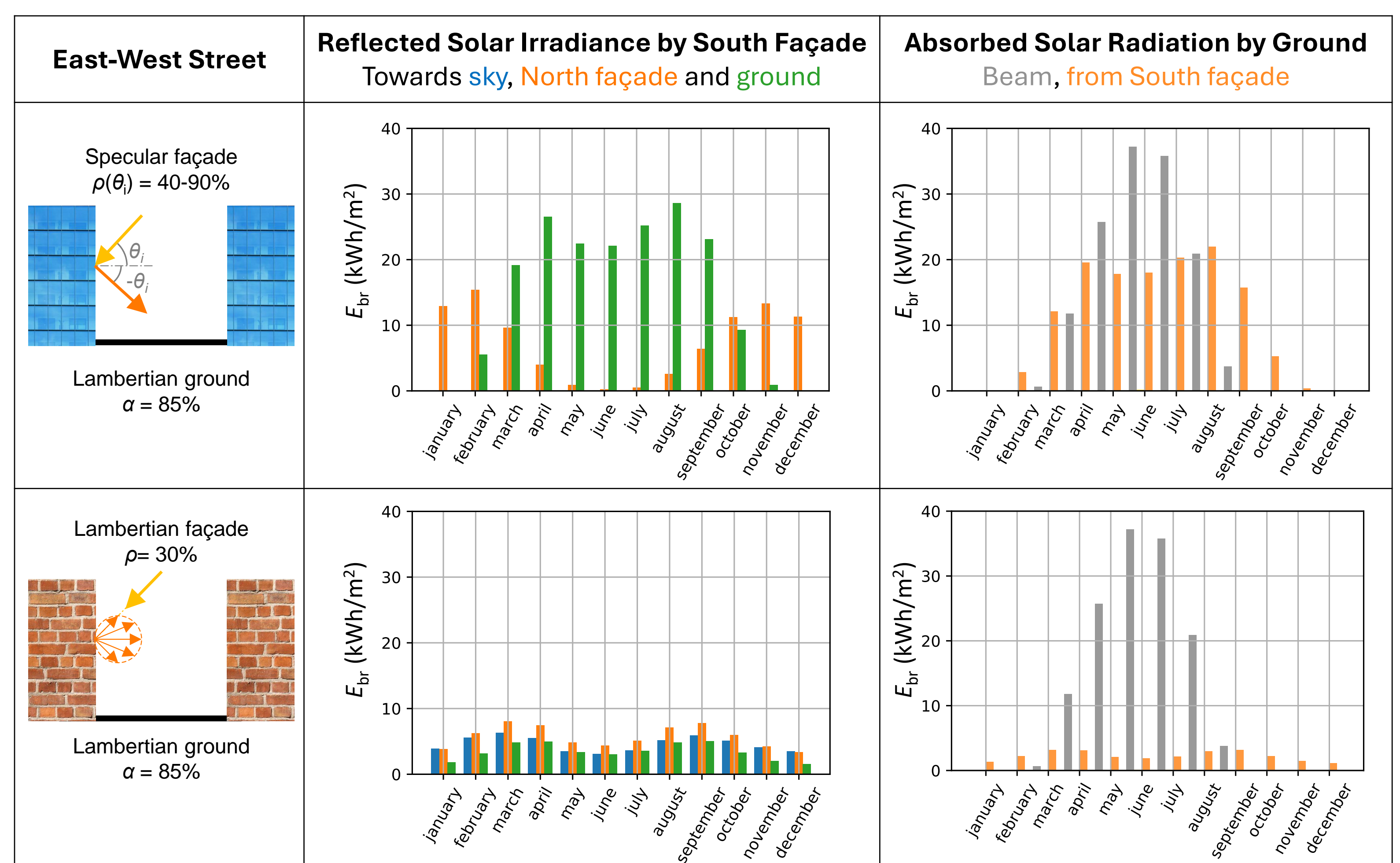


Annual evaluation at Nice, for an Urban Canyon H/W = 1.

During summer:

- Glazed facades are expected to cause thermal discomfort** due to higher mean radiant temperatures compared to Lambertian facades. → To be quantified with advanced modeling (next section).

- The energy absorbed by the ground increases by 50% due to the specular reflection of glazed facades** compared to Lambertian facades.

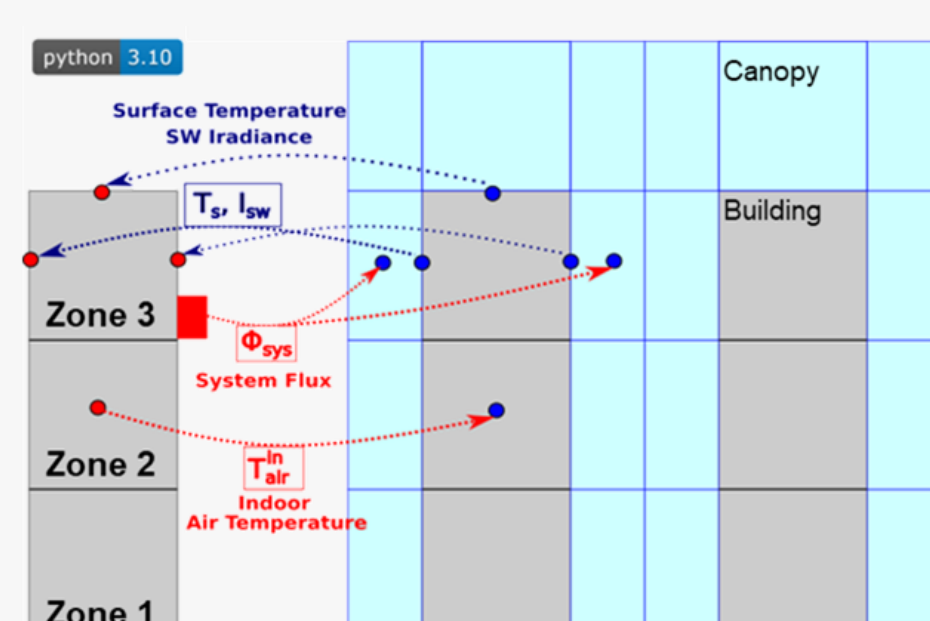


TOWARDS ADVANCED MODELING OF DISTRICTS FOR ENERGY AND THERMAL COMFORT ASSESSMENT

Indoor-Outdoor Neighborhood Thermal Model

EnviBatE – DIMOSIM – codeveloped by LaSIE & CSTB.

3D micro-model to evaluate the interactions between the energy performance of the buildings (heating, AC,...) and the outdoor environment at a given geolocation.



Target output:

- Air and radiant temperatures, wind speed
- Heat stress and thermal sensation indicators (UTCI...)
- Energy loads (cooling & heating) for a year period

Urban Building Energy Model

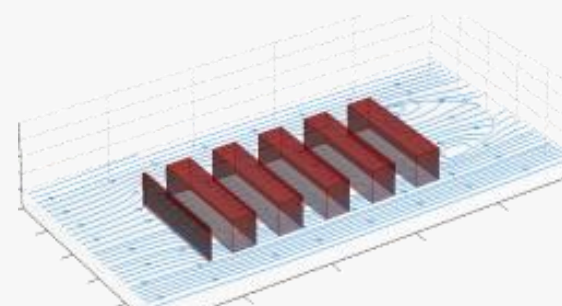
Multiscale energy system description and performance evaluation.



Solar Radiation Model



CFD model

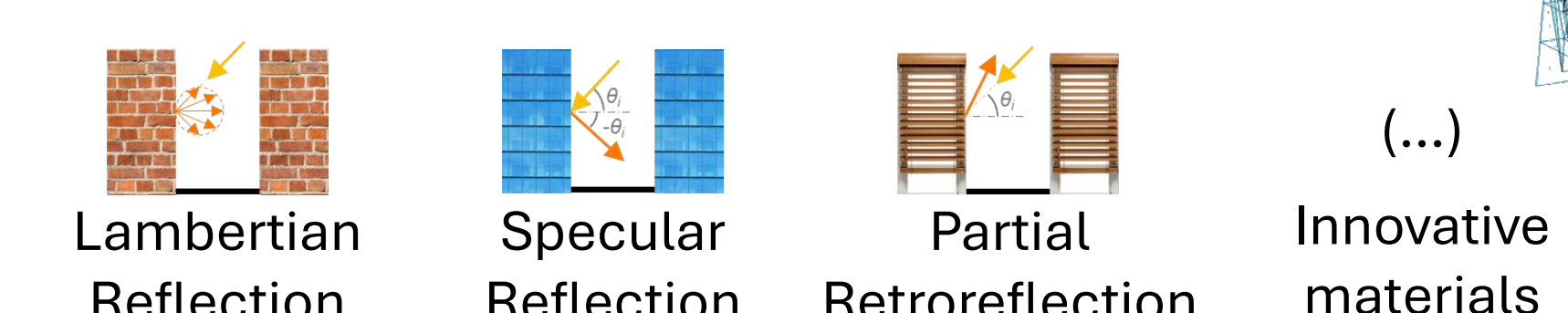


PhD ACTION PLAN

1. Upgrade radiation model by coupling ray tracing model

Ray tracing Model (Phanie) – developed by CSTB.

Lighting tool for radiative multispectral exchanges.



2. Advanced modeling of districts

- Integrate thermal comfort indicators to assess mitigation strategies.
- Define representative studies of different urban climate zones.
- Propose innovative strategies to improve thermal comfort and energy performance at neighborhood level.

EBC Annex (2025-2029)
Sustainable Cooling in Cities
EBC