scSTREAM

Cradle
MSC Software Company

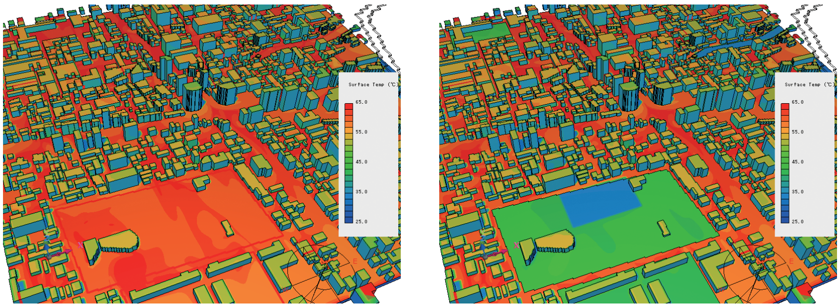
Evaluation of Urban Heat Island Phenomena

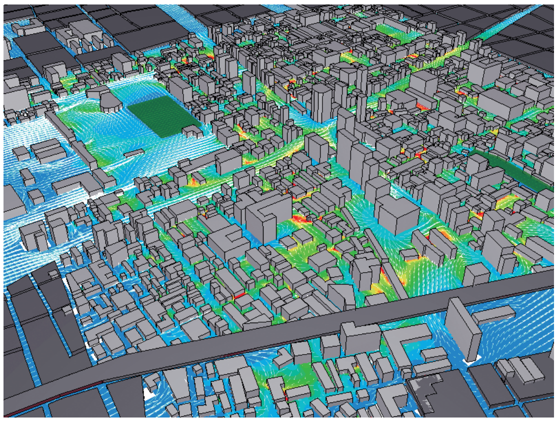
Using scSTREAM to determine the effect of building and ground surface

How Different Ground Surfaces Influence Surface and Air Temperatures

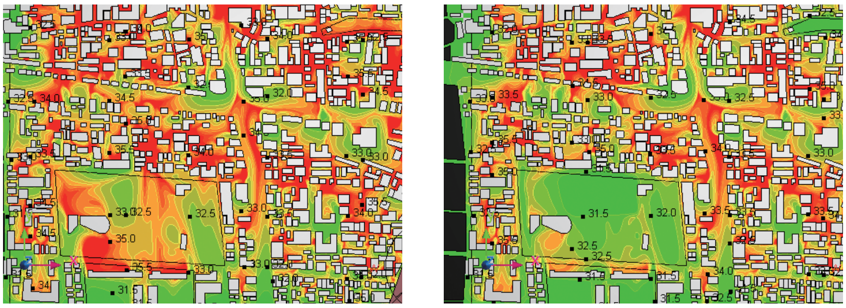
Transforming an asphalt/concrete parking lot into a public park with green lawns and trees can lower the ground surface temperature by 20°C in the sun, and 30°C in the tree shaded areas. The lower surface temperature and transpiration effect will also lower the air temperature.

Surface temperature (left: with asphalt/concrete, right: with green)





Air temperature (left: with asphalt/concrete, right: with green) at 1.5m



Setting Conditions

- Solar Radiation: 1 pm on July 23, 2013, Tokyo, Japan
- Wind Speed and Direction: 5.3m/s (reference height 6m), south wind
- Outdoor Temperature: 31°C
- Soil Temperature: 15°C at 10m below ground
- Latent heat of evaporation by trees is considered for total solar absorptance of trees

Calculation Conditions

- Number of Mesh Elements: 50,590,242
- Calculation Time: 250 cycles, approx. 14 hours (12 cores), steady state analysis

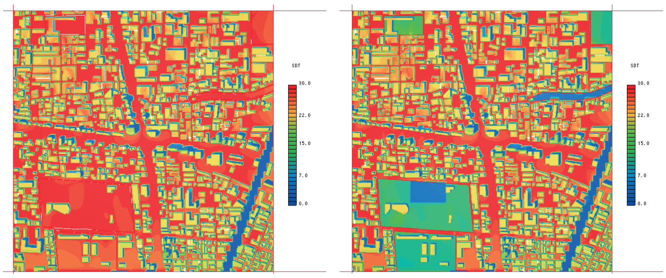
Effect on Air Temperature and Heat Island Potential index (HIP)

What is the Heat Island Potential index (HIP)?

HIP was developed to help quantify the effect of urban heat island phenomena on buildings and ground surface.
It is a percentage of the sensible heat generated by all the surfaces (including buildings and ground) over the district area.

ΔT b/w surface and base air Temp

(left: with asphalt/concrete, right: with green)



HIP: 27.82°C

HIP: 25.52°C

Air temp. and wind flow at 1.5m

Heat dissipated by effective ventilation

$HIP = \int (Ts - Ta)\, ds/A$

- Ts: Surface temperature in small area [degree C]
- Ta: Air temperature [degree]
- ds: Area of small area [m^2]
- A: Horizontal projected area [m^2]

Notes

Controlling heat island phenomena is a key to successful urban city development and environmental maintenance. This phenomena can be analytically simulated to assess the effects of ground surfaces, tree coverage, and airflow. When the air does not flow smoothly, heat is not sufficiently dissipated. This leads to the rise in temperature. scSTREAM enables engineers to visualize airflow and heat flow over a very wide area. The engineers can assess the impact of the urban heat island phenomena on the local temperature.