SUCCESS **STORIES**

# Cradle CFD

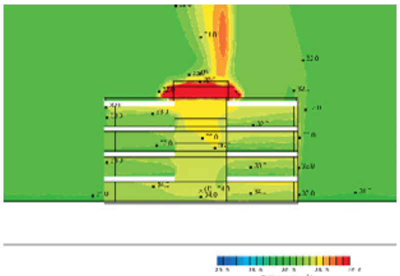
Building and Architecture

## scSTREAM

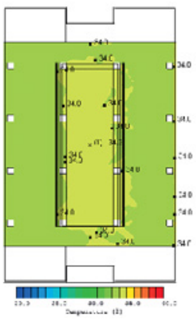
### Ventilation Analysis of an Office Building Using an Earth Tube Cooling System

Effect of an earth tube cooling system on indoor temperature during the summer Baseline Analysis without Earth Tube Cooling System

Temperature distribution of the building cross section

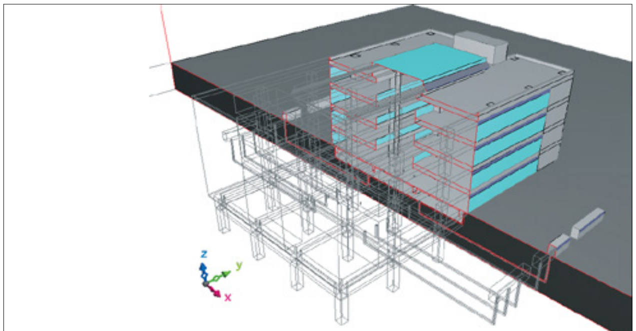


Temperature distribution of the first floor  (1m above the floor)



Office space temperature is 32 to 35°C Existing air conditioning is ineffective.

Temperature of the first floor central space, 1m above the floor, is 34.3°C.



Analysis Model

**Setting Conditions**

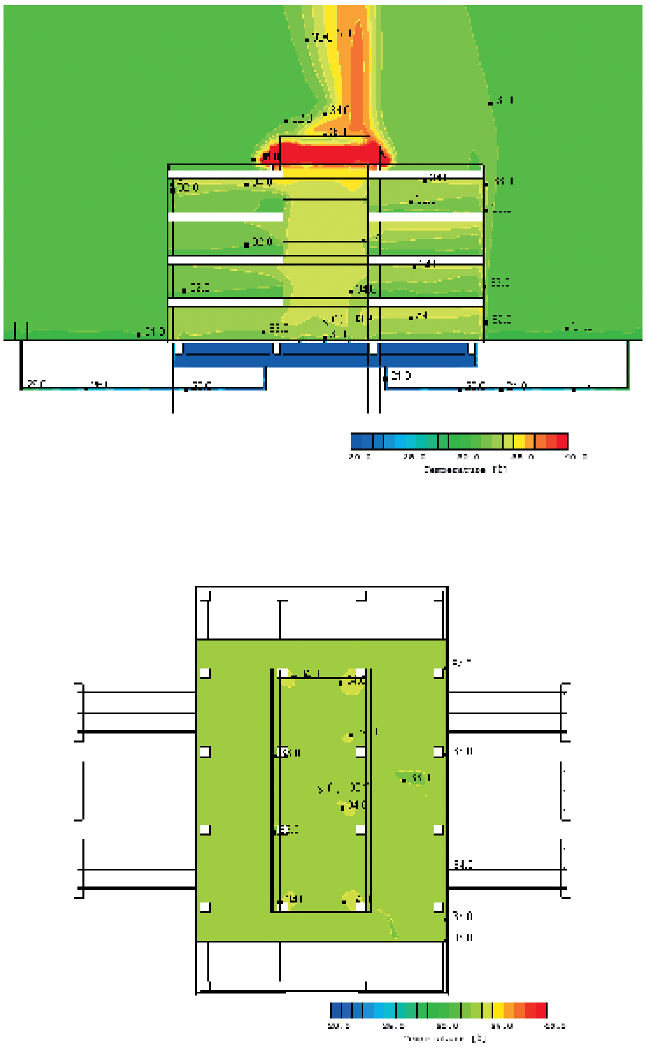
| | |
|---|---|
| Outdoor Temperature: | 31°C, calm. Solar radiation is simulated by using panel heat sources on the windows. Transmitted radiation is simulated by using volumetric heat sources near the top light. |
| Air Conditioning within Office Space: | 4kW (cooling) |
| Windows: | Only windows on the top floor are open. |

**Calculation Conditions**

| | |
|---|---|
| Number of Mesh Elements: | 911,160 |
| Calculation Time: | 300 cycles, 2-3 hours (8 cores used), steady state analysis. |

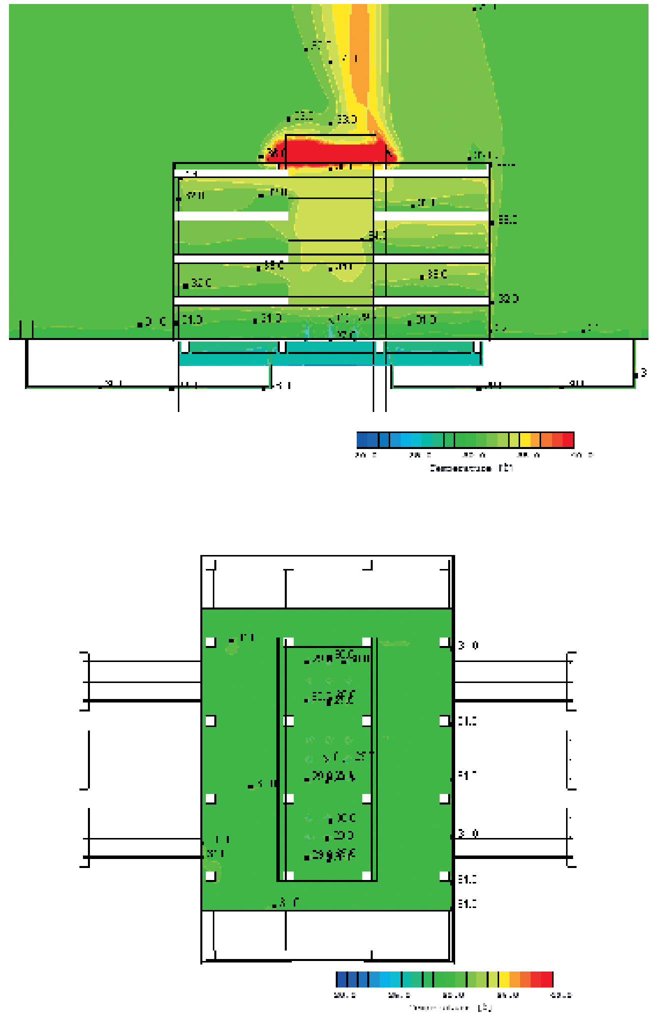
The Effects of Earth Tube Cooling and Under-Floor Air Ventilation*

Difference in earth tube cooling system with and without under-floor air ventilation



Without fans (volume of under-floor air ventilation: 0.0 m3/h)

- Natural ventilation is not sufficient to circulate air; earth tube cooling by itself is largely ineffective
- Temperature of the first floor is 33.9°C



With fans (volume of under-floor air ventilation: 100 m3/h)

- Cool air is released from below ground
- Earth tube and under-floor ventilation produce temperature of the first floor of 29.7°C, a temperature drop of 4-5°C.

### Notes

An earth tube cooling system, which uses underground pipes to supply cool air and under-floor ventilation fans, can effectively provide passive air conditioning for an office building. Maximizing system effectiveness requires controlling the volume of the air that has been cooled and heat exchange ability of the tubes. With scSTREAM, engineers can simulate real-world scenarios and improve the air conditioning system design.

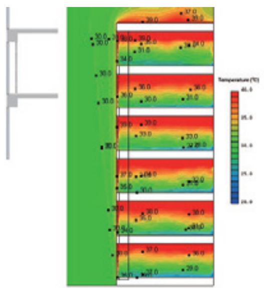
**scSTREAM**

# Effectively Reducing Thermal Load on External Walls

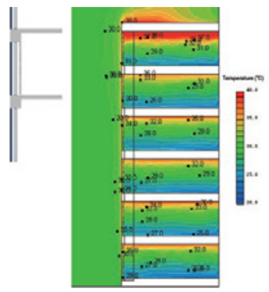
scSTREAM estimates the effect of low-e glass and double skin facade application

## Less Solar Radiation Effect by Low-E Glass Application

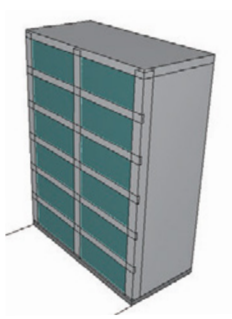
Difference between ordinary glass and low-e glass



- Indoor temperature distribution with ordinary glass (FL10)
- Average indoor temperature is 35.4°C



- Indoor temperature distribution with low-e double glazed glass (Low-E8+AS6+FL8)* Average indoor temperature is 29.5°C



- Same indoor air-conditioning setting applied. Outdoor temperature is 30°C.
- Indoor blinds are drawn

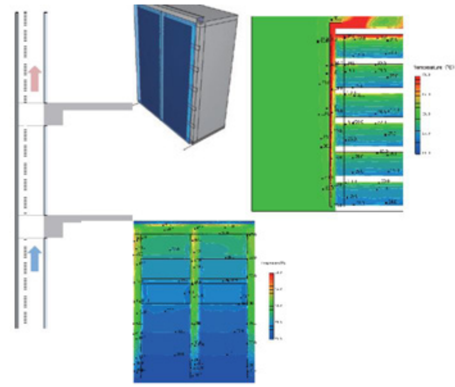
Low-E8: Low-E glass, AS: Layer of air, i.e. 6mm, FL: Float glass

## Setting Conditions

- Solar Radiation:
- 12pm on Sept. 1, Tokyo
- Wind Speed: Calm
- Outdoor Temperature: 30°C
- Solar Radiation is mostly absorbed/reflected by double skin facade and indoor blinds.
- Half open louvers are placed at inlets/outlets of double skin facade.
- Indoor Air-Conditioning:
- Air supply temperature 24°C (6.6 air changes per hour)
- Calculation Conditions
- Number of Mesh Elements: 5,499,792
- Calculation Time: Approx. 5 hours for 1000 cycles (degree of parallelism of 8), steady state calculation

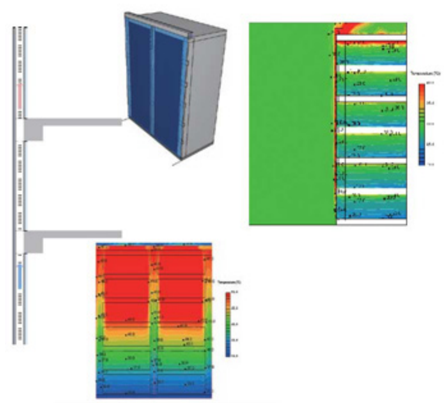
## Estimating Indoor Temperature Change by Double Skin Facade Application

Effect of different double skin facade widths



- Indoor temperature distribution with 700mm double skin facade
- Average temperature of middle floor space: 27.3°C

## Temperature distribution in central section of double skin facade



- Indoor temperature distribution with 200mm double skin facade
  Average temperature: 28.2°C

## Temperature distribution in central section of double skin facade

*Same indoor air-conditioning setting applied, and outdoor temperature at 30°C.
* Blinds inside the double skin facade are drawn horizontally.
* Ordinary glass (FL10) is used for both outdoor/indoor double skin facade.

### Notes

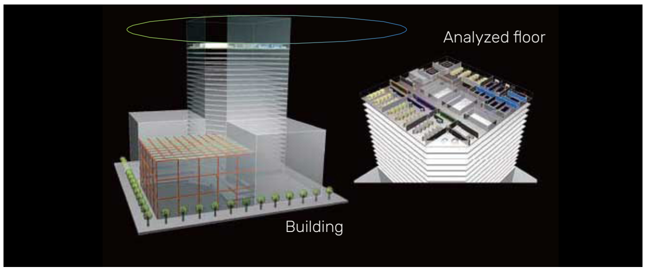
Studying heat resistance in window and door openings is one of the most important factors when evaluating thermal load on buildings. scSTREAM provides detailed prediction of indoor-outdoor temperature difference and spatial distribution. This helps determine if further adjustments are necessary, for example when the window side still remains hot even though the indoor temperature is average, or when the heat balancing effect appears to be less functional towards upper floors.

## scSTREAM

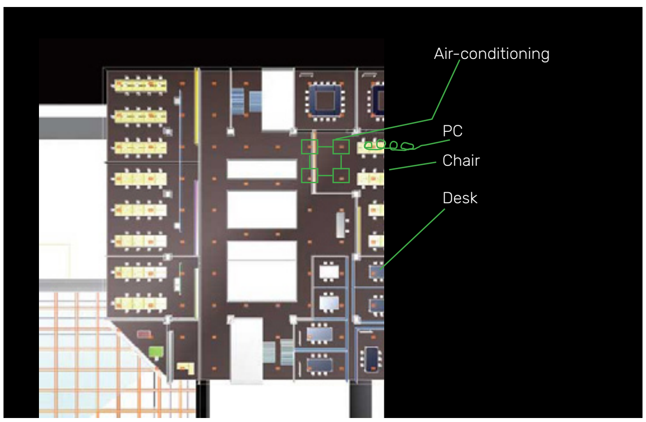
### Simulation of Thermal Environment in an Office

Simulation of one floor in a building with scSTREAM

#### Analysis Model Overview



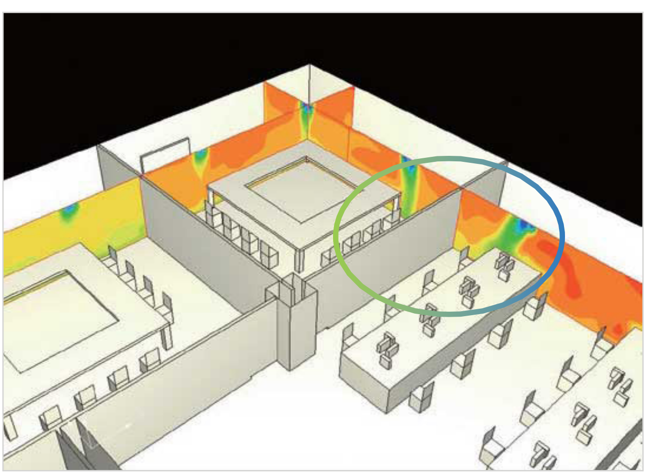

#### Analysis Model Overview

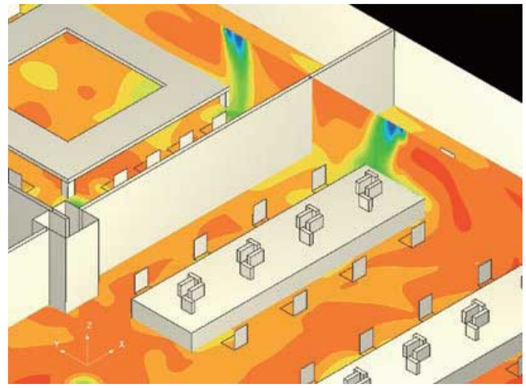



## Analysis Results

#### Temperature Contour

Visualizes temperature contour on arbitrary cut plane Shows three-dimensional temperature distribution in the office



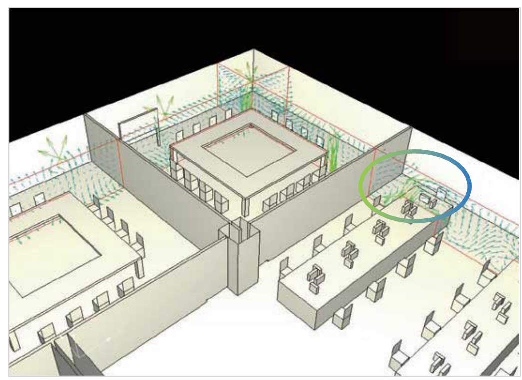


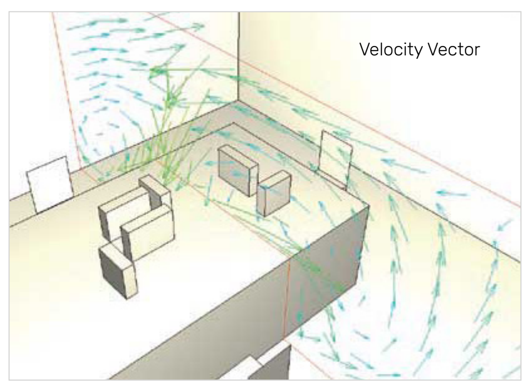
#### Advantage of CFD

CFD (Computational Fluid Dynamics) helps decrease modification of layouts before construction and accomplish designing facilities effectively in a short period.

#### Velocity Vector

Visualizes direction of the velocity by arrowhead






**Notes**

It is a general request to maintain comfort in indoor environment to keep warm in winter and cool in summer. To obtain such comfort, innovative construction structure or appropriate temperature control by air-conditioning is necessary. On the other hand, energy saving and ecological approaches are being key factors for designing a floor layout in a building. CFD simulation helps improve comfort in the floor as well as energy efficiency and environmental friendliness by calculating and predicting the performance of various design ideas ahead of time.

## SC/Tetra

# Research and Development of Personal Air-Conditioning System with Radiant Cooling

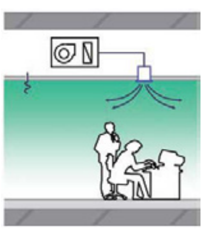
Case Study for Takenaka Corporation and Waseda University

Predict the thermal environment of an office using thermoregulation model (JOS) of SC/Tetra

## Main Purpose

In recent years, tenants are increasingly demanding a higher-quality office working environment. Use of personal diffuser unit to control their thermal environment improves environmental quality or thermal conditions in the office. And this localized air-conditioning system could improve worker's satisfaction with thermal environment. In the process of developing air-conditioning system, thermal environment of an office and cooling effect on a human body are analyzed using thermoregulation model of SC/Tetra.

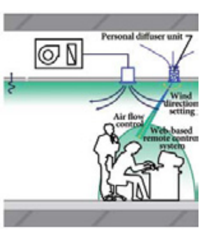

### Air-conditioning system with radiant cooling



1. Convective air-conditioning system for the whole room

   General air-conditioning system for the whole room

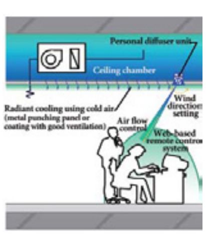
   High level of thermal comfort system control for occupant space Low level of thermal comfort system control for individuals




2. Convection-driven personal air-conditioning system

   Use of personal air-conditioning unit on the ceiling and the desk together

   Individual airflow preference or range of ventilation options available




3. Personal air-conditioning system with radiant cooling

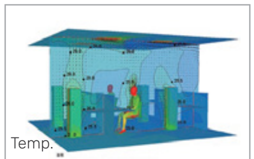
   Use of radiant cooling with cold air in addition to #2 functions

   Sensible temperature is lower because of the radiation from the cooling surface

   Temperature control and the energy saving are expected

## Comparative analysis using SC/Tetra

Analysis model / conditions: An office is simulated in a hot climate, and it is ventilated by an air-conditioning system. Heat source conditions are applied to lighting, equipment, and human bodies to account for heat generation in the office. He flow rate and supply air temperature is set to bring the indoor average temperature to the desired temperature. In the following system 3, a material with good aeration property is used for the ceiling to provide fresh air into the room.

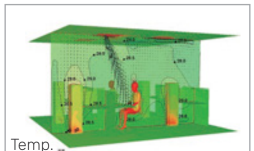



Temperature: 25 °C
Man in business suits

1. Convective air-conditioning system for the whole room

   Anemostat air outlet
   Outlet air temperature: 17.4 [°C]
   Anemostat outlet air ow rate: 370 [m³/h]

   - Air velocity around a man is slow
   - The temperature of entire room is low



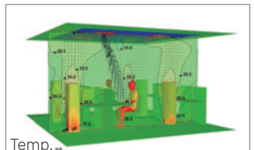

Temperature: 20.4 °C Man in light-duty garment

2. Convection-driven personal air-conditioning system

   Anemostat and personal air outlet
   Outlet air temperature: 20.4 [°C]
   Anemostat outlet air ow rate: 310 [m³/h]

   Personal air-conditioning system Outlet air ow rate: 30 [m³/(h•unit)]

- Because air is blowing from personal diuser unit to a man's chest, the air velocity around the man's chest is fast




Temperature: 28 °C Man in light-duty garment

3. Personal air-conditioning system with radiant cooling

   Personal air outlet
   Outlet air temperature: 20.4 [°C] Personal air-conditioning system Outlet air ow rate: 30 [m3/(h•unit)]

   [Ceiling used for radiant cooling]
   Outlet air temperature: 22.8 [°C]
   Outlet air ow rate: 310 [m3/h]
   Surface temperature: 23.5 [°C]air ow rate: 30 [m³/(h•unit)]

- Radiant cooling on the ceiling, air temperature near the ceiling is lower
- Human body can be eciently cooled because the temperature of ow, which reaches to a body, is lower than #2

### Experiment and conclusions

As a result of measuring the amount of sensible heat loss using thermal mannequin, cooling eect on the human body is greater in the system 3, and the air from personal diuser unit tends to be cooler, which is consistent with the simulation using SC/Tetra.

Experiment using thermal mannequin

## Customer Comments

In the conduct of our research and development of the radiant cooling or the personal air-conditioning system, a key question is how to cool a human body eciently with certain amount of energy. Since SC/Tetra enables the users to simulate an oce with air-conditioning system by coupling with thermoregulation model (JOS), eective analysis can be performed on what part of body gets cool by radiant cooling or on which air-conditioning system has a higher sensible heat loss on human body. Personal air-conditioning system will remain one of the important topics, and SC/Tetra is powerful and indispensable simulation software for its development.

[Reference]

"Task Ambient KOOL System with Ceiling Radiation Membrane (Part1-5)", Summaries of Technical Papers of Annual Meeting of Architectural Institute of Japan, Hokuriku, Sept.2010 (in Japanese)

## scSTREAM

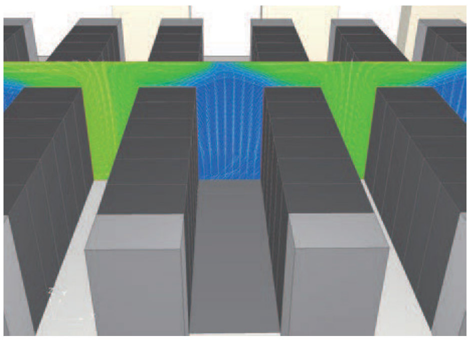
# Management of Airow and Temperature of a Data Center

Case Study of scSTREAM

scSTREAM simulates the control of cold aisle & under-oor airow and the temperature variation during recovery after power outage

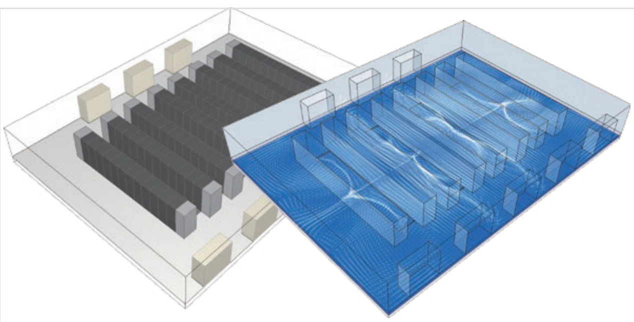
## Thermal Management in the Data Center

Thermal management of the data center is important for operations. Designers of the data center examine many dierent cases of thermal management in the design phase.



## Management of under-oor airow

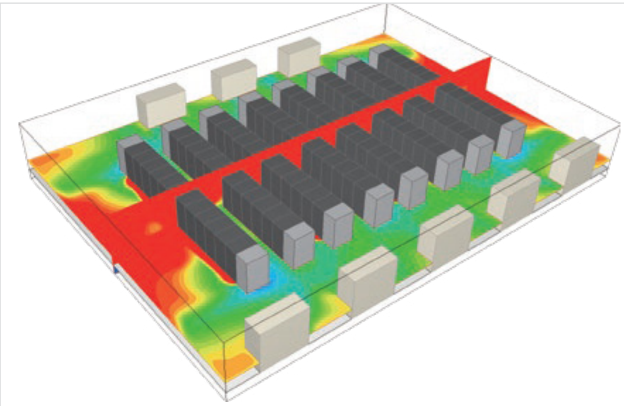
The under-oor airow is studied to prevent stagnations of airow and unevenness of ow volumes going into cold aisles.



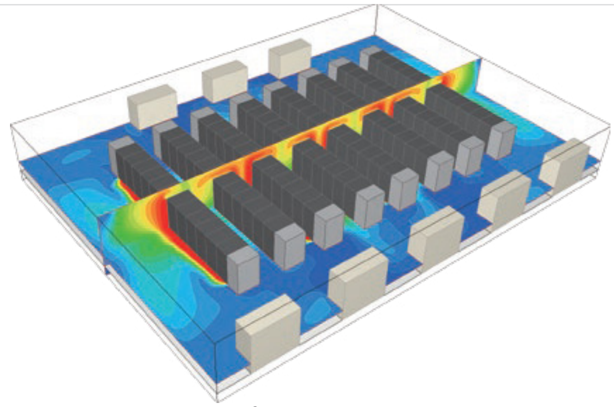
Vector plot of under-oor airow

## Prediction of temperature change during power recovery

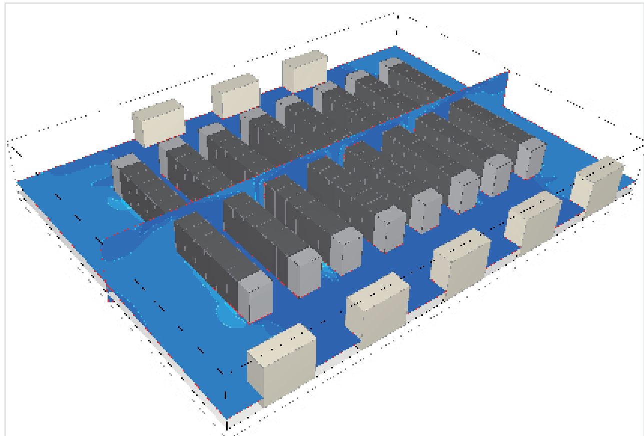
scSTREAM can predict the temperature variation of the data center with the consideration of power recovery process of air-conditioning equipment.



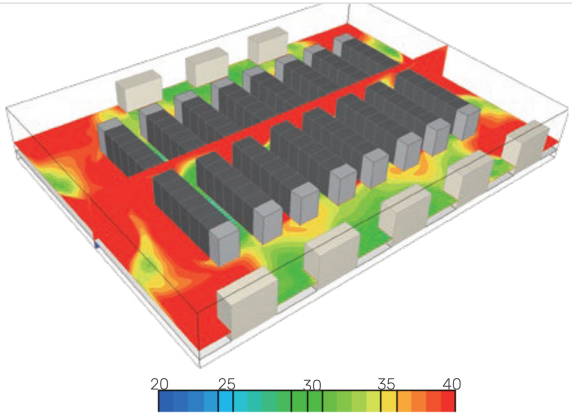
After 60 seconds



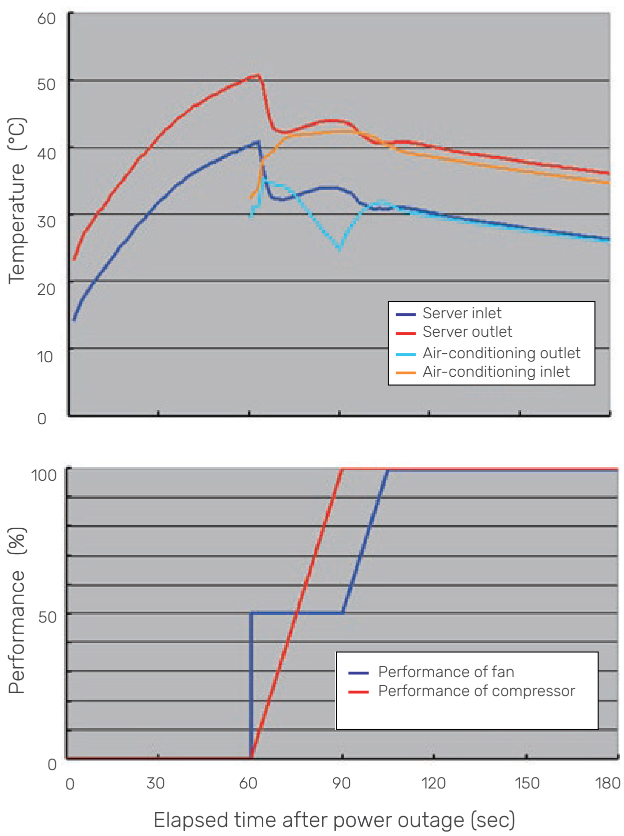
After 30 seconds

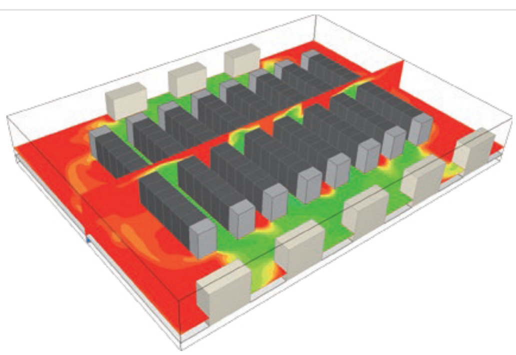


After 0 seconds

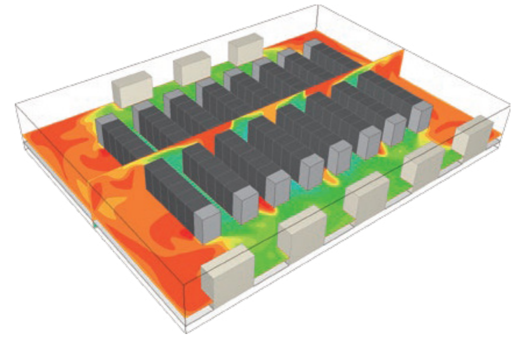



After 90 seconds

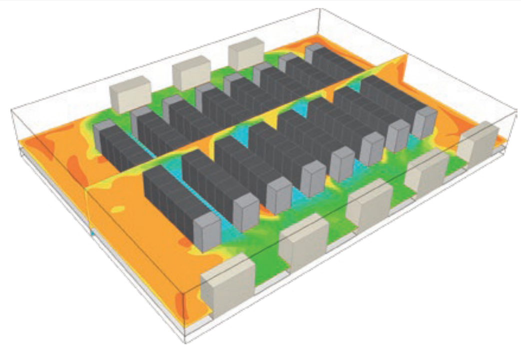


After 120 seconds



After 150 seconds



After 180 seconds

### Notes

The performance of air-conditioning equipment is decided based on the rate of heating of servers to design the air-conditioning of the data center. The examination of 3D distributions of airow in the data center is essential to achieve an ecient air supply to servers, and 3D CFD analysis using scSTREAM enables the user to execute the study easily and eectively. scSTREAM can also predict temperature change over time such as the simulation during the power recovery process.

## scSTREAM

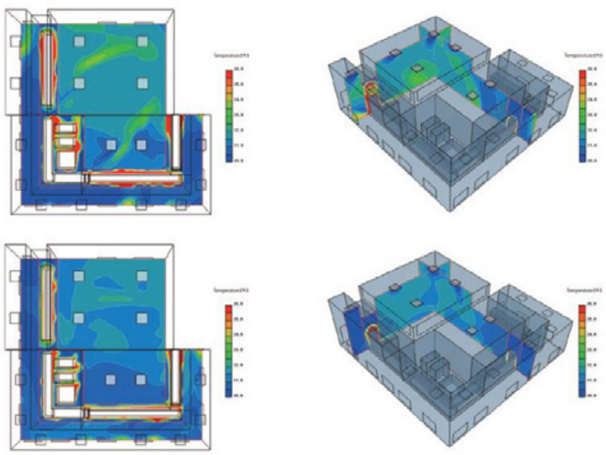
# Airow Control in a Cleanroom

Improving ventilation eectiveness and temperature control in a room containing heat generating equipment.

## Temperature Control in Operational Area

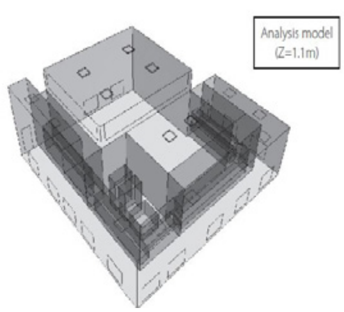
The airflow is improved by adjusting the opening ratio of the ventilation orifice on the lower part of the wall.

### Indoor temperature distribution



Existing plan (upper diagrams) and revised plan (lower diagrams)

The airflow is adjusted to minimize turbulent interactions with other air supply jets within operational area




**Setting Conditions**

Air Exchange Rate: 40 times per hour
Measure of Efficiency: SVE3*
Indoor Heat Generation: 92 [kW]

**Calculation Conditions**

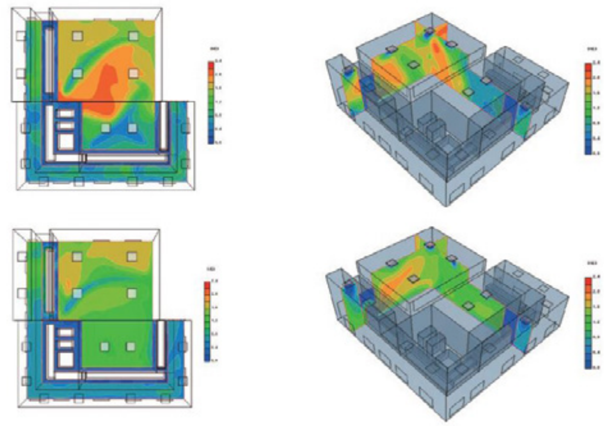
No. of Mesh Elements: 3,303,720
Calculation Time: 500 cycles, approx. 5 hours (8 cores), steady state analysis

* SVE 3 is the index of the age of air is represented by a ratio of concentration of diusive species to that of contaminants which are diused instantaneously and uniformly over the entire room.

## Enhancement of Cleanliness by Applying Airow Control

The degree of cleanliness can be assessed using ventilation efficiency index in scSTREAM.

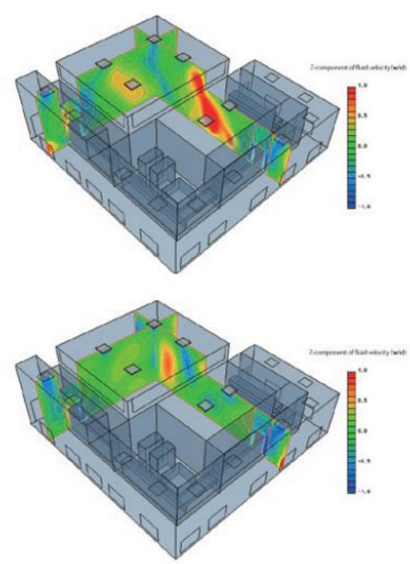
### Ventilation efficiency distribution



Existing plan (upper diagrams) and revised plan (lower diagrams)

Removing eddies from the airflow improved ventilation efficiency

### Ventilation efficiency distribution



**Notes**

A cleanroom can contain physical objects and temperature generating equipment that challenge achievement of a well-ventilated, air space. Using scSTREAM to predict the complex airflow patterns inside the cleanroom and assess solutions early in the design process can simplify installation set-up and ensure robust operation during production.

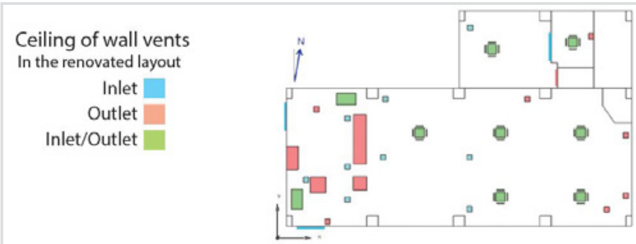
# scSTREAM

## Ventilation Prediction of the Rest Area Facility

Case Study for a Client

scSTREAM veries the improvement of energy-ecient ventilation

## A Simulation Model and Conditions

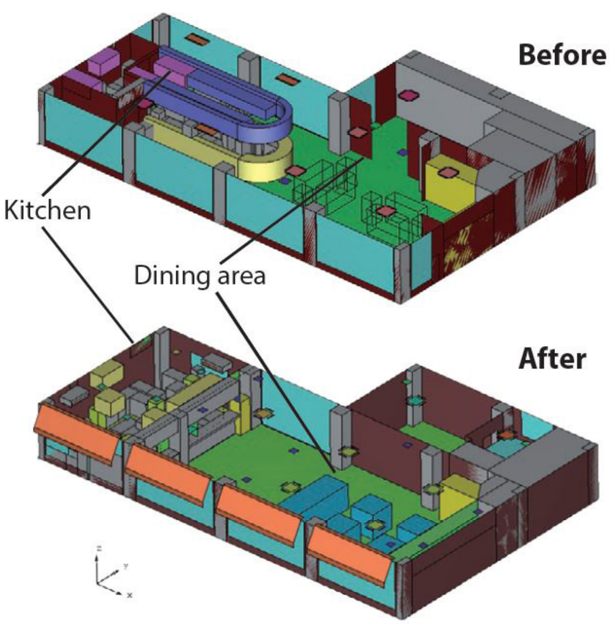



Conditions:
Steady-state analysis, turbulent model (standard k-model)

Summer:
August 1, 2 pm (solar radiation considered), 35 deg C

Winter:
February 1, 3 pm (summer radiation neglected), 1 deg C

Total heat generation from kitchen appliances:
121,563 W (before), 123,779 W (after)

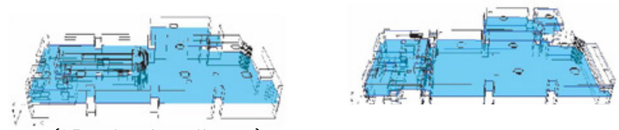



## Indoor Temperature Comparison (1.5m above oor)

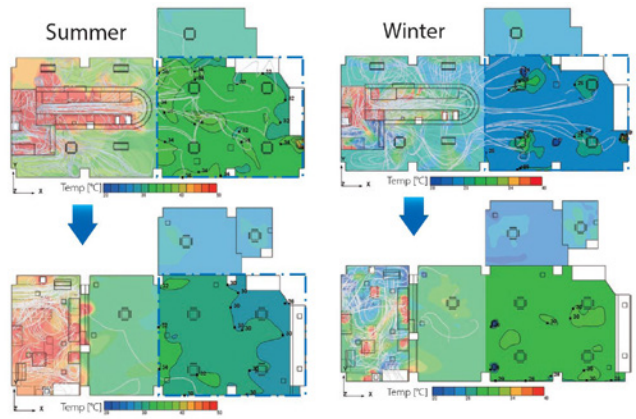
### Approx. 8.2 million elements

Before renovation

Renovated layout



(1.5 meter above the oor)




| | Summer | Winter |
|---|---|---|
| The entire facility (including kitchen) | 3.9 °C Down | 1.4 °C Up |
| The dining area | 2.9 °C Down | 3.8 °C Up |

Simulation results show…
Room temperature in the dining area

- Cooler in summer and warmer in winter (better thermal environment)

Hot air outowing from the kitchen

- Less spreads to the dining area

### Customer Comments

For energy conservation, replacement and rearrangement of ventilation equipment area planned for the facility renovation. Thermal uid simulation by scSTREAM is conducted to compare ventilation eciency before and after the renovation. The result indicates that the enhancement in thermal comfort can be expected as the ventilation eciency is improved.

# scSTREAM

## Simulation on Dew Condensation on Sash

Case Study for a Sash Maker

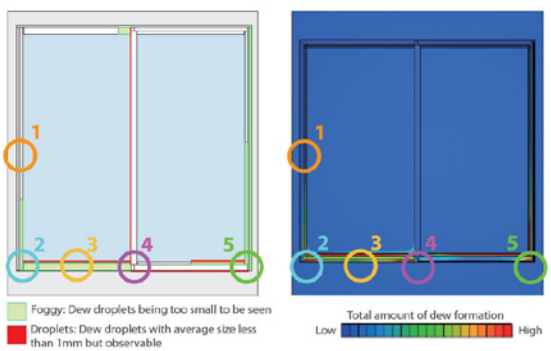
Predict the dew formation by using humidity & dew condensation of scSTREAM

## The Importance of Dew Condensation Prevention

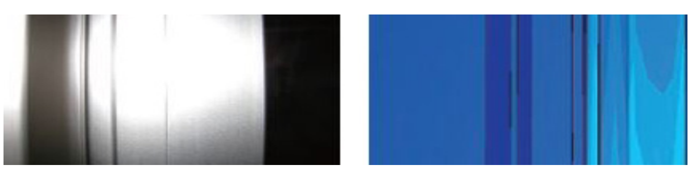
Condensation can cause undesirable corrosion of building materials. An important part of the product development is to control and to prevent the dew formation by grasping the generation status of moisture. Analysis using Computational Fluid Dynamics (CFD) is performed using the same analysis conditions as the performance test (JIS A 1514) of condensation prevention with the use of a full-sized sash, and the results are compared to see the dew formation.

### The result comparison (observation of anti-dew formation performance vs. scSTREAM)

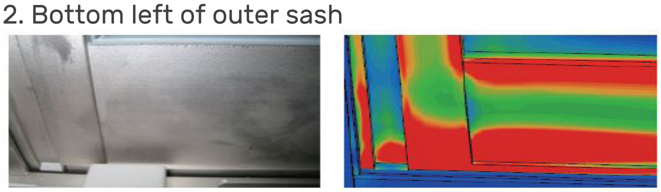
| Testing / Analysis Condition | | | Part Property | |
|---|---|---|---|---|
| The entire facility (including kitchen) | Air temp | 20°C | Sash | Aluminium |
| | Relative humidity | 50% | | |
| Low temp room | Air temp | 0°C | Glass | Multiple glass (inner & outer panes: 6mm float glass, intermediate space: 6mm) |



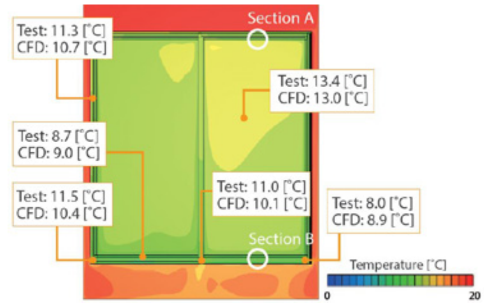

### 1. Middle of stile of outer sash



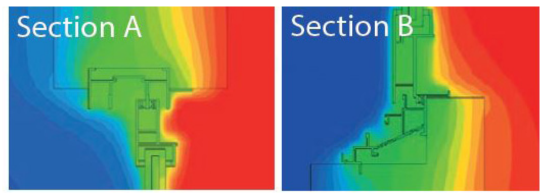
### 2. Bottom left of outer sash



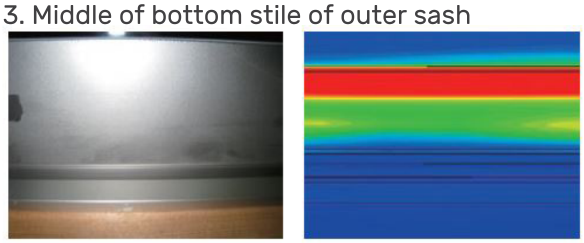
### Comparison of Sash Surface Temperature (test vs scSTREAM)



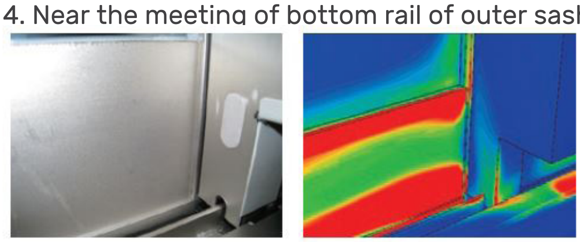

### Section temperature




### 3. Middle of bottom stile of outer sash



### 4. Near the meeting of bottom rail of outer sash



### 5. Bottom right of inner sash

### Customer Comments

In a comparison of dew formation between CFD result of scSTREAM and observation, a lot of condensation occured on the rail of outer sash in both cases, showing high delity of scSTREAM. scSTREAM also predicted the surface temperature with very small dierence, therefore, it should receive high commendation for it. I am well convinced that scSTREAM can contribute to predict the dew formation even where it is dicult to be observed since it provided an unprecedented degree of prediction in dew formation.

# scSTREAM

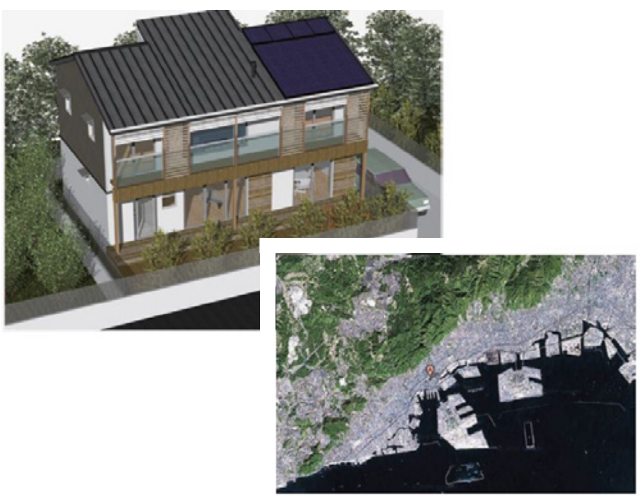
## Passive Solar Wooden House Tailored to Local Climate and Environment

Case Study for Kobe Design University

A passive solar house design to best take advantage of Kobe climate using scSTREAM can provide functionality, usability, and safety

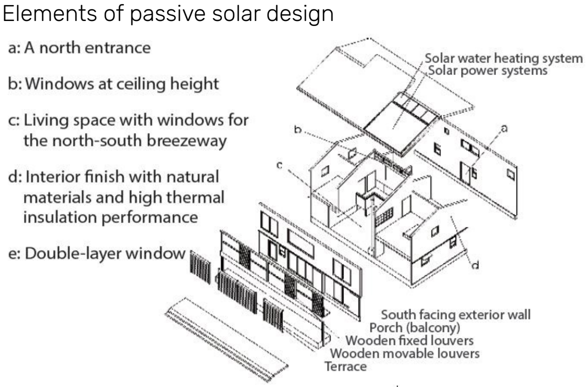
## Forest in Kobe Eco-yaBAOBAB

Condensation can cause undesirable corrosion of building materials. An important part of the product development is to control and to prevent the dew formation by grasping the generation status of moisture. Analysis using Computational Fluid Dynamics (CFD) is performed using the same analysis conditions as the performance test (JIS A 1514) of condensation prevention with the use of a full-sized sash, and the results are compared to see the dew formation.

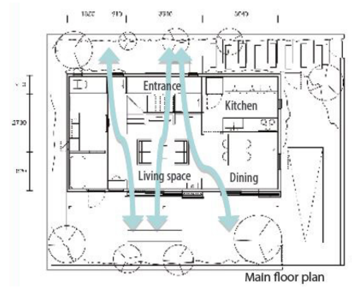


### Analysis model

Taking advantage of natural energy
Elements of passive solar design




Open house plan designed to create the north-south breezeway in the house

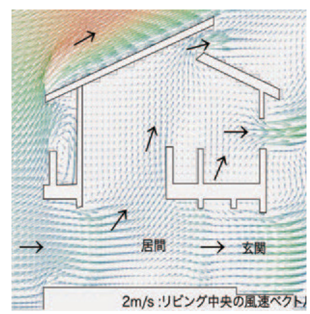



Model plan A
Main floor : 54.6 m$^2$
2nd floor : 45.9 m$^2$

### Purpose

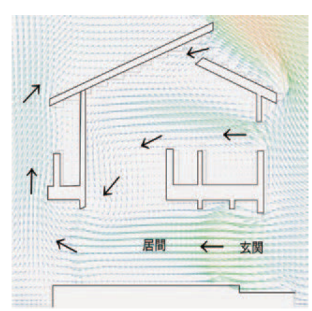
Kobe area is sandwiched by Mt. Rokko in north and Osaka Bay in south. There is sea breeze from south in the morning, and land breeze from northeast in the evening. When they are weak or absent, north wind blows. Passive solar design for Kobe housing is about the orientation of a building and the placement of windows to maximize the function of breezeway. It helps make alternative design patterns of house plan for seasons and local life scenes.

### Purpose




### Living space with breeze

Well positioned windows at oor and ceiling height maximize the ow of natural breezes to further enhance the passive design used in a house. It will provide a living space that feels like an outdoor porch, yet it is inside.



House design to achieve summer comfort through natural breeze

After sunset, entrance and windows capture cool land breezes from north and provide a cool living space. Shading is eective in reducing the amount of heat transfer to the house through windows, walls, and slabs during the hottest times of the day.

Customer Comments

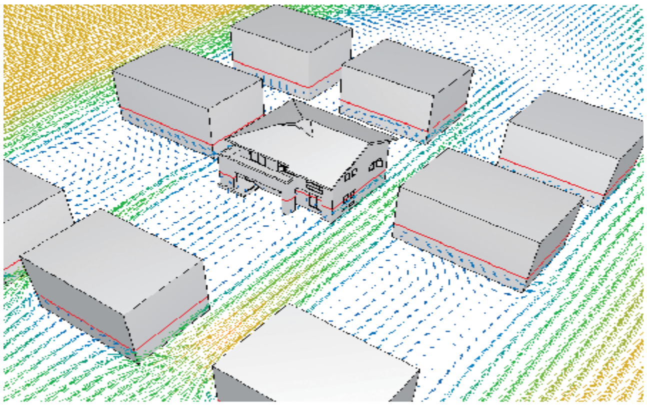
"Natural passive house tailored to local climate" is an innovative architectural design based on the traditional techniques suited to the local climate. It is the true environmentally-friendly house in that it provides comfort from natural winds and lights. It is built of natural materials and oer superior comfort. scSTREAM enables the designer to examine the ventilation design on passive house for Kobe climate.

## scSTREAM

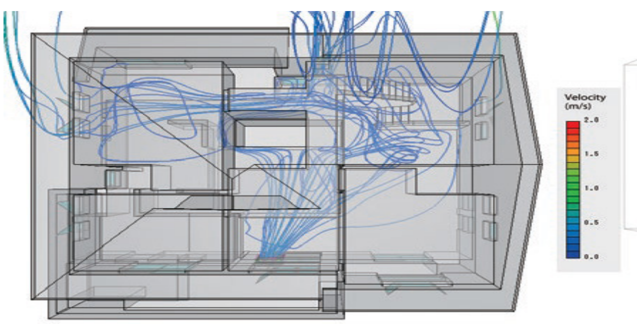
### Evaluating Ventilation Eect on a House

Evaluating how natural ventilation inside a house can lower energy use scSTREAM is used to examine the energy savings potential of a natural home ventilation.

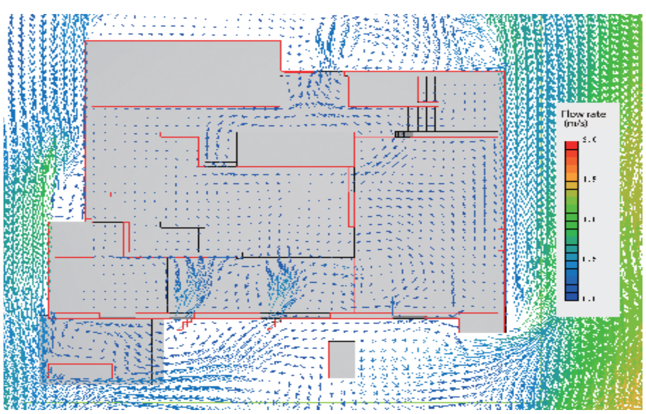
### Identifies influence of surrounding buildings



### Visualizes streamlines of air through windows




### Creates vector flow diagram of airflow on each floor of the house




#### Setting Conditions

Outdoor Air (m/s):
Wind Velocity 3m/s (reference height 74.5m)

Outdoor Temperature (°C):
Wind Velocity 3m/s (reference height 74.5m)

Internal Heat Generation:
Based on the volumetric heat generation model fromthe Architectural Institute of Japan

#### Calculation Conditions

Number of Mesh Elements:
5,553,060 (multi-block meshes)

Calculation Time:
300 cycles in 4 hours 15 minutes (2 cores) for steady-state analysis (fluid flow and heat)5040 cycles in 9 hours 30 mins (2 cores) for transient analysis (heat only)

### Estimate of Internal Heat Generation and Ventilation Effects over 24 Hour Period

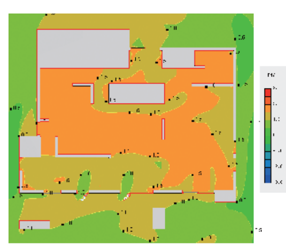
Evaluation of the contribution of natural ventilation to the reduction in hourly thermal load is performed using scSTREAM.

Indoor temperature distribution at 21:00

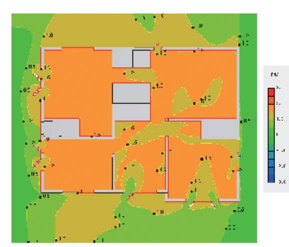
First floor

Second floor

PMV* index distribution at 21:00



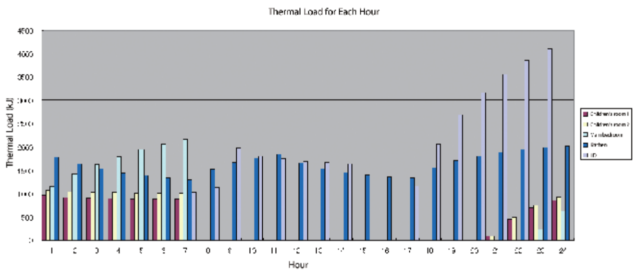
First floor



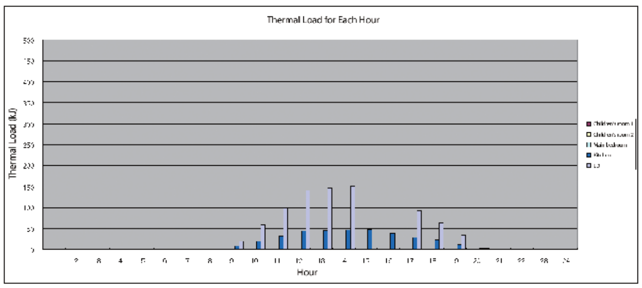
Second floor

* PMV = Predicted Mean Vote

## Cooling load for each room (no ventilation)




## Cooling load for each room (ventilation active)




Based on the air-conditioning setting for indoor temperature of 27°C

### Notes

scSTREAM enables engineers to perform complex home thermal load calculations over extended periods of time and visualize the invisible airflow that is difficult to observe in actual tests. The simulation accounts for changes in environmental conditions, internal heat generation, and natural ventilation.

**scSTREAM**

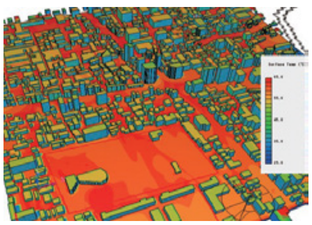
# Evaluation of Urban Heat Island Phenomena

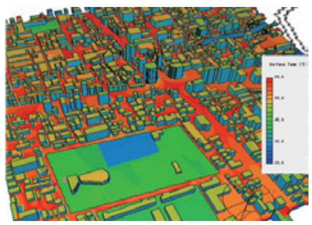
Using scSTREAM to determine the effect of building and ground surface

## How Dierent Ground Surfaces Inuence Surface and Air Temperatures

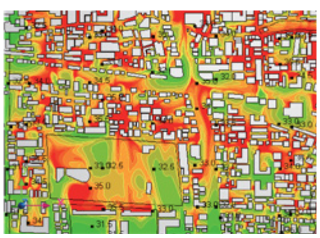
Transforming an asphalt/concrete parking lot into a public park with green lawns and trees can lower the ground surface temperature by 20°C in the sun, and 30°C in the tree shaded areas. The lower surface temperature and transpiration effect will also lower the air temperature.

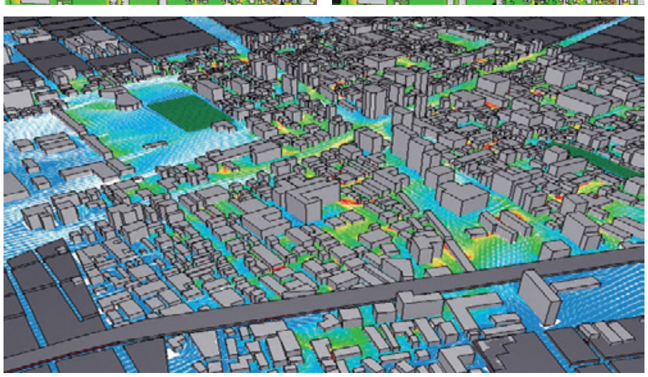
### Cooling load for each room (no ventilation)





### 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

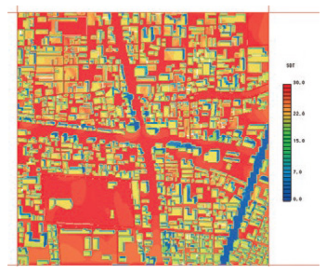
- Number of Mesh Elements: 50,590,242
- Calculation Time: 250 cycles, approx. 14 hours
- cores), steady state analysis

## Eect on Air Temperature and Heat Island Potential index (HIP)

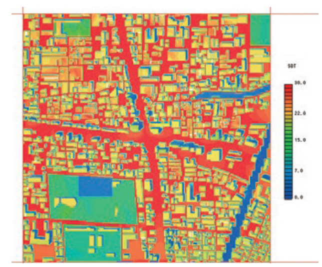
**What is the Heat Island Potential index (HIP)?**

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.

### ˜T b/w surface and base air Temp

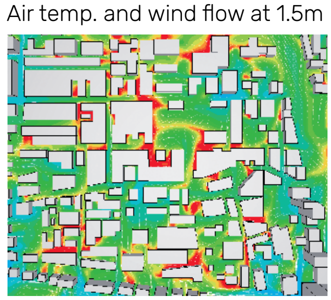


HIP: 27.82°C



HIP: 25.52°C

### Air temp. and wind flow at 1.5m



Heat dissipated by effective ventilation

HIP = ( Ts - Ta ) ds/A

Ts: Surface temperature in small area [degree C]
Ta: Air temperature [degree]
ds: Area of small area [m²]
A: Horizontal projected area [m²]

### 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.

## scSTREAM

# Case Study for Murata Machinery, Ltd.

Case Study for Kobe Design University

Simulating the use of a fan to prevent external air incursion into a moving clean room OHS

## Analysis Objectives

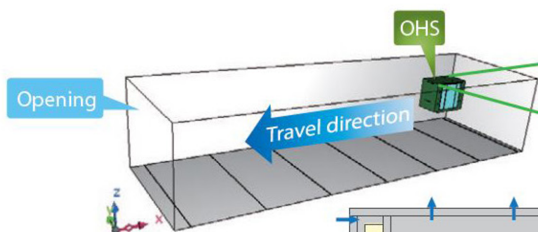
As the OHS transiently travels through the clean room (including starts and stops), dust contaminated external air can enter the OHS through the OHS openings. In this model, the effectiveness of a clean room countermeasure using a fan at the front of the OHS to increase the pressure inside the OHS was assessed. The effect of fan flow rate is reviewed.

## Penetration Conditions at the Moving Object Surfaces

High, medium, and low fan flow rates were simulated and compared for the presence, or absence, of external air inside the OHS. Different concentrations of diffusive species were specified inside and outside of the OHS, and the distribution of the concentrations was calculated as the OHS moved through the room.

### Functions used

- Transient analysis
- Diffusive species
- Multiblock
- Moving object (inflow/outflow conditions applicable on the surfaces)




Overview of analysis model

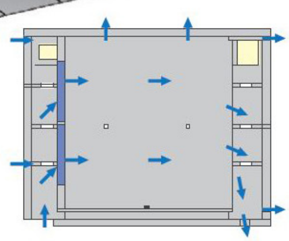
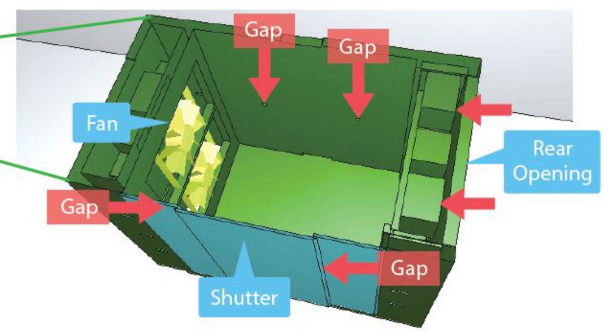


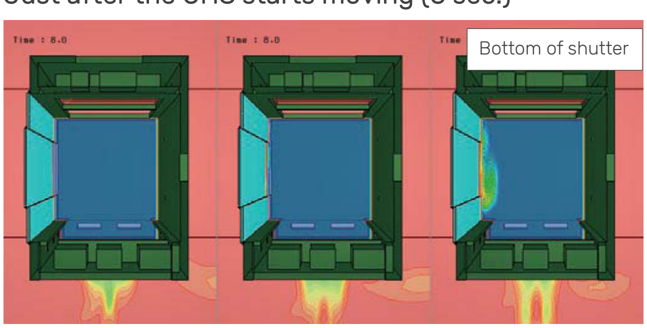
Illustration of internal airflow for a cross section of the OHS




## Simulation Results

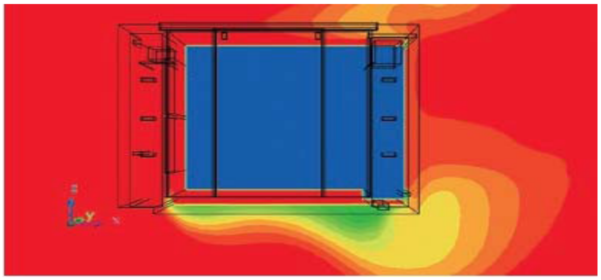
When the ow rate of the fan is low, some penetration of external air through the shutter was observed at start-up and through the rear opening near the top of the OHS during deceleration and stop. Virtually no penetration of external air into the OHS occurs when the fan ow rate is high.

### Just after the OHS starts moving (8 sec.)

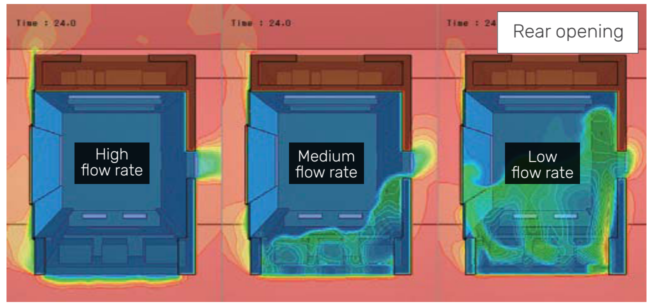



### During deceleration (19 sec.)

## When the OHS stops (24 sec.)



24 sec. Figure of Y-plane for high flow rate No penetration of external air




### Customer Comments

Being able to simulate inflow/outflow conditions on the surfaces of a moving object enabled the modeling of the fan inside the OHS. The simulations were used to evaluate the effectiveness of clean room countermeasures to prevent penetration of dust contaminated external air into the OHS.

**scSTREAM**

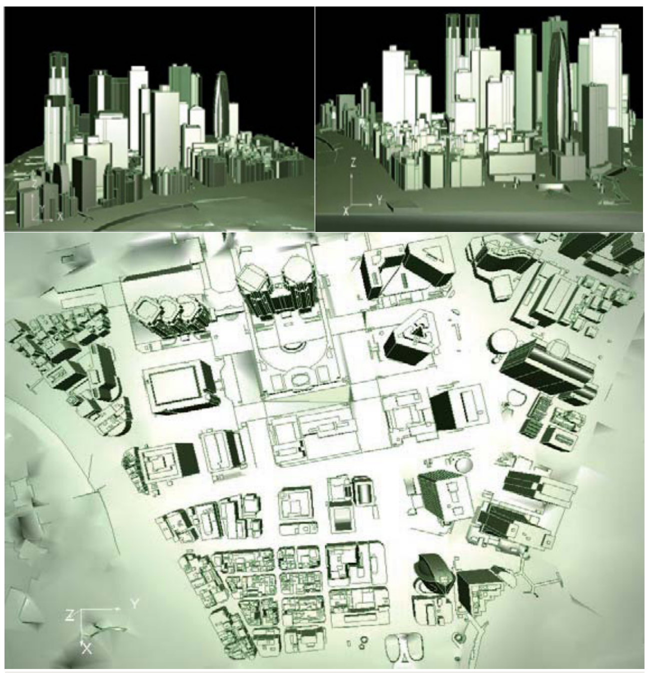
# Simulation of Wind Environment

Case Study of scSTREAM

Simulation of wind environment in urban area by scSTREAM

## Overall View

As the OHS transiently travels through the clean room (including starts and stops), dust contaminated external air can enter the OHS through the OHS openings. In this model, the effectiveness of a clean room countermeasure using a fan at the front of the OHS to increase the pressure inside the OHS was assessed. The effect of fan flow rate is reviewed.



### Analysis data

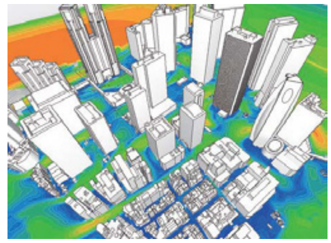
Urban area: Tokyo, Japan

Size of domain: 900m x 1100m

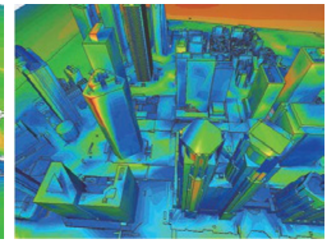
Geometry data provided by Sora Technology Corporation

## Analysis Results

### Velocity Contour

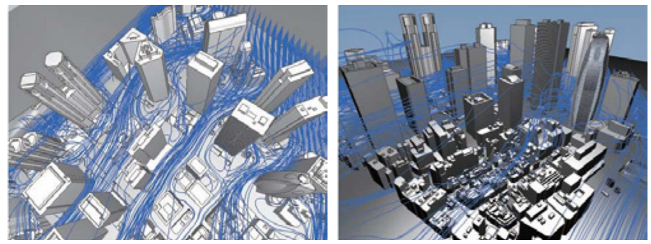


Visualizes wind velocity by color



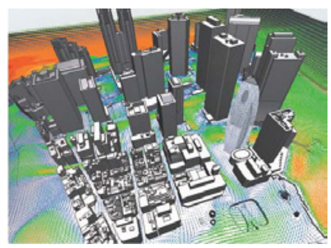
Velocity contour near building

### Sreamline



Visualizes wind direction by streamline

### Velocity Vector



Visualizes wind direction and velocity by arrowhead and color

### Advantages of CFD

CFD simulation helps predict and assess the wind environment in a short term ahead of construction, while actual measurements require a long-term investigation.

It also saves cost and time for wind-tunnel experiments.

### Note

CFD simulation helps predict and assess the wind environment around a newly designed building ahead of construction and inform neighborhood residents of the environmental effects of the building.

Visualizing three-dimensional flow helps investigate possible wind hazards and prevent them by planting windbreak trees, i.e. green space, ahead of time.

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