２００６・１０・３０

つくば環境研

数値シミュレーション及び風洞実験による都市キャノピー層の不安定成層流の研究

(A Comparison of Numerical Simulation and Wind Tunnel Experiment on Unstable Stratified Flow within and above a Modeled Urban Canopy)

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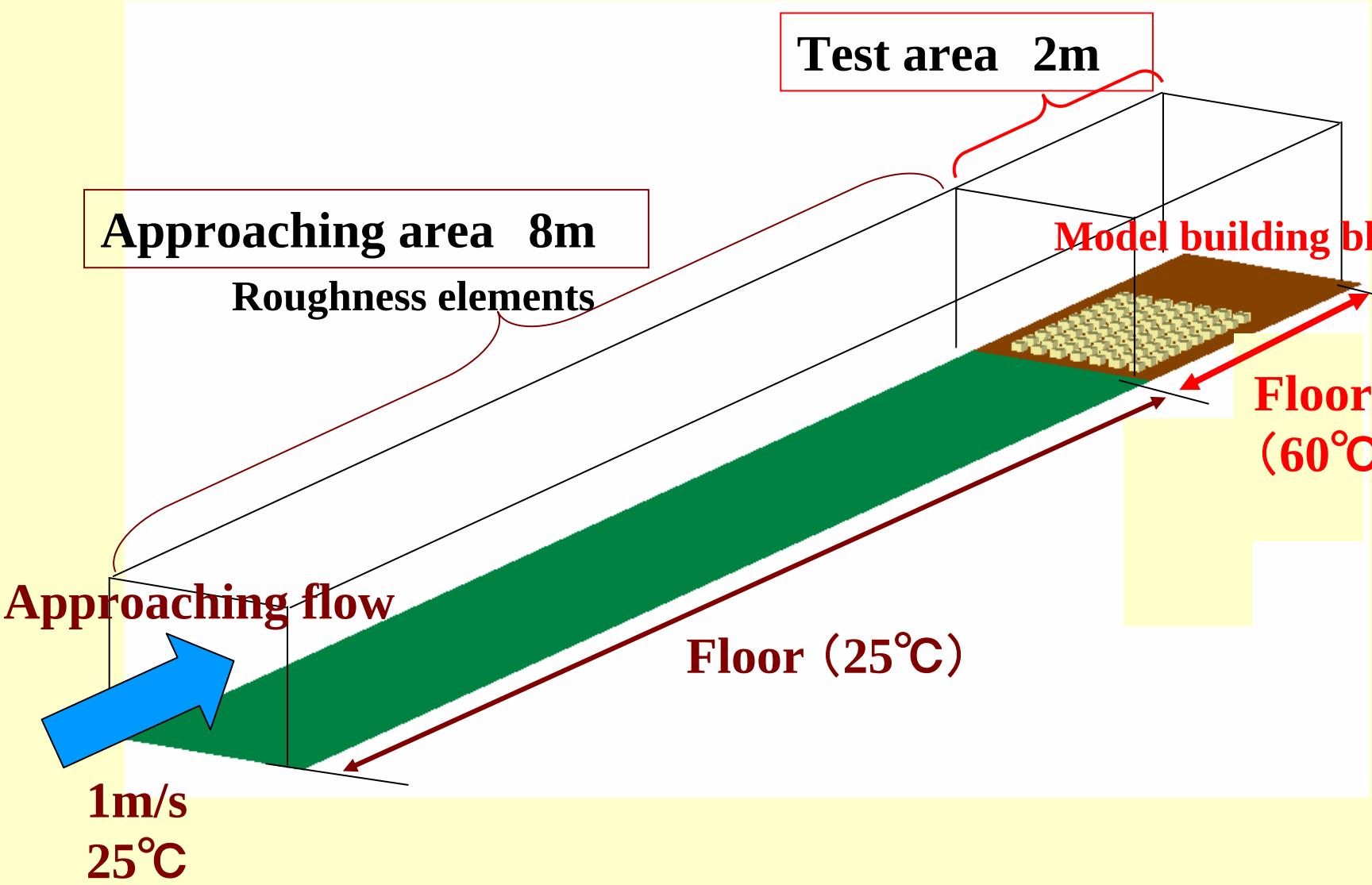
Topic

Thermodynamic environmental evaluation for an urban residential area
--- wind-tunnel experiment and CFD modeling ---

成層風洞とCFDモデリング解析による都市熱環境評価
＊建築研温度成層風洞データとモデルのCFD結果を
比較、LES解析による都市熱環境評価に対する
詳細な検討、都市境界層に対する新たな見知

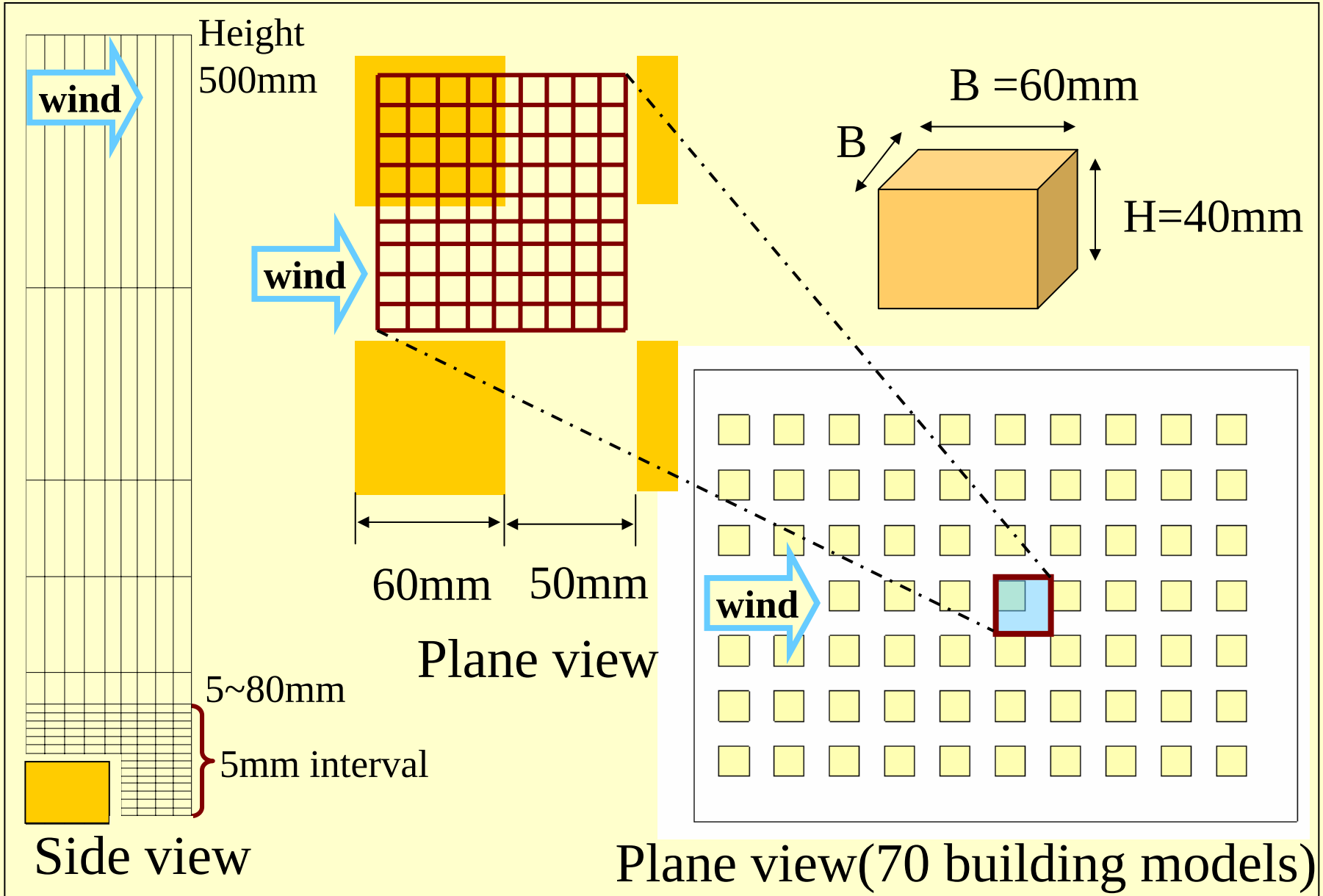
Outline of the wind tunnel and experiment in Building Research Institute, Japan

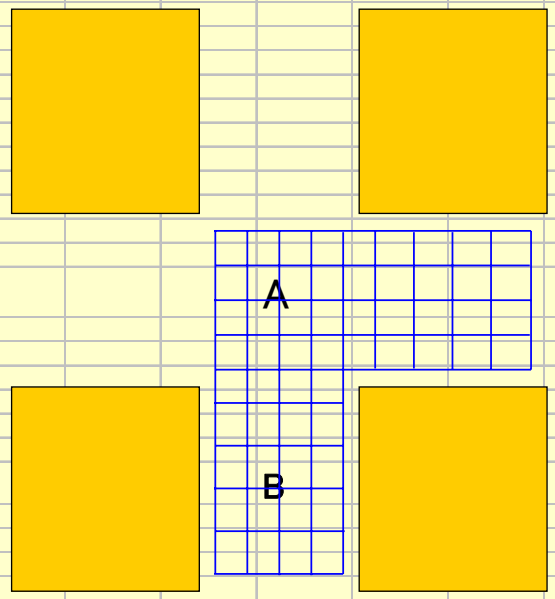


風洞試験概要

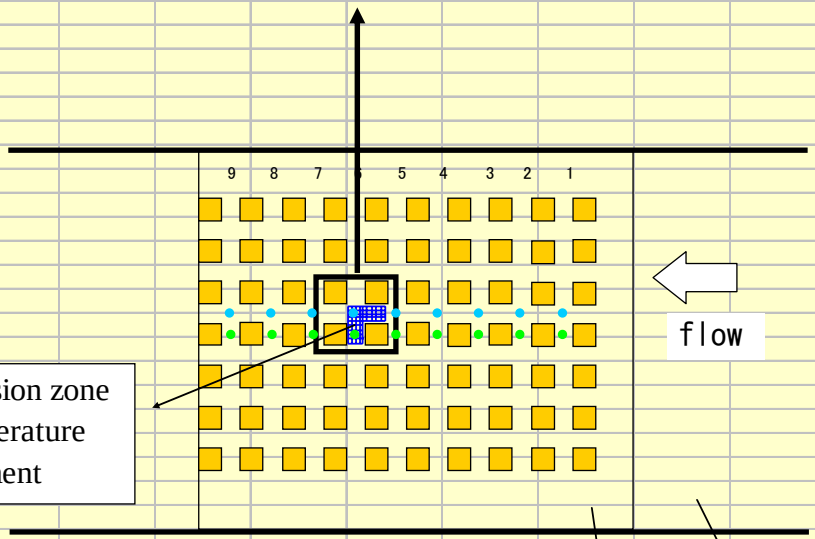
試験設備	建築研究所　温度成層風洞 （全長10m×縦1m×横1m）
試験条件	風速　1m/s、　気温25℃
模型	200分の1の建物模型　（×70個）
床面	模型群域の床面部を60℃に設定
計測項目	（1）気温　　1,900点 （2）風速　　1,775点

Model building blocks and Measurement points





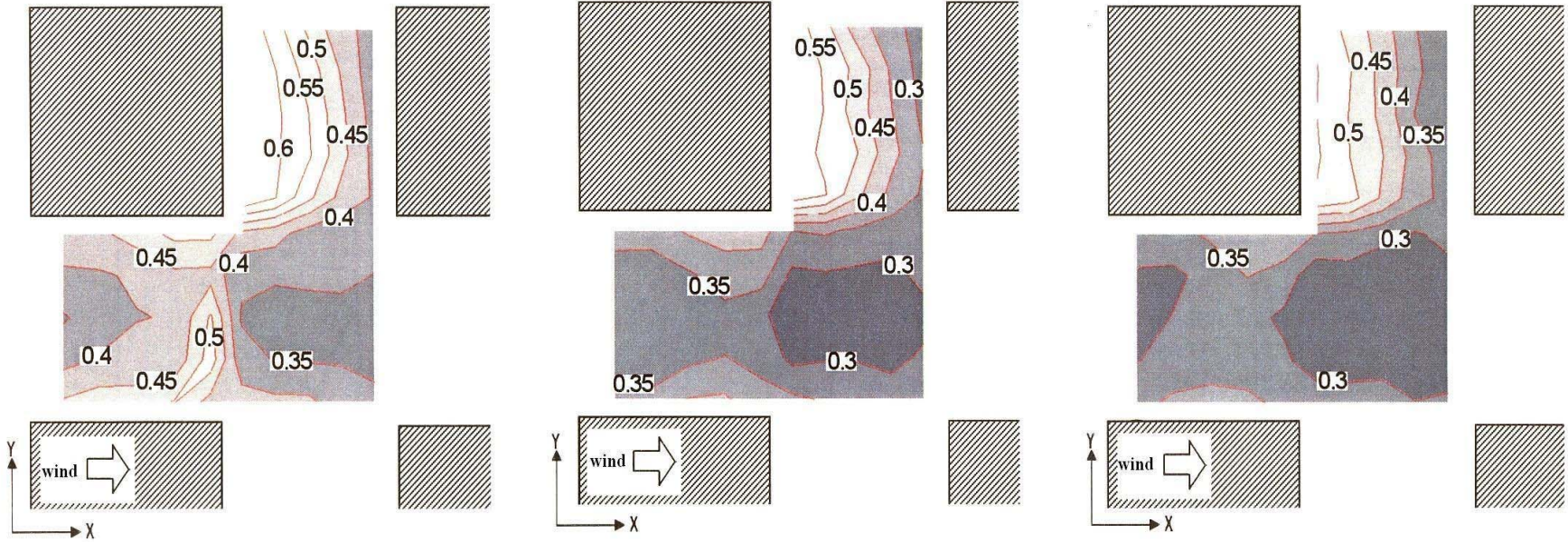
At locations A and B,the mean vertical profiles of u and T have also been measured.



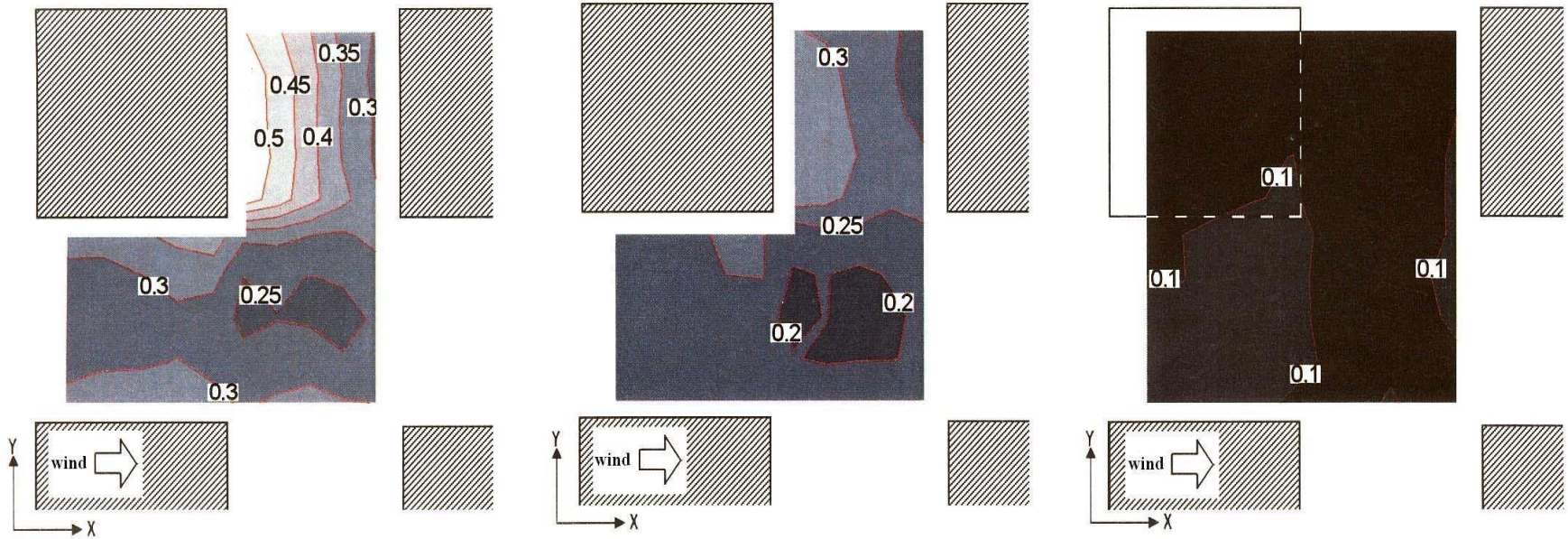
3 demension zone for temperature measurment

floor temperatur 60℃

floor temperature 25℃



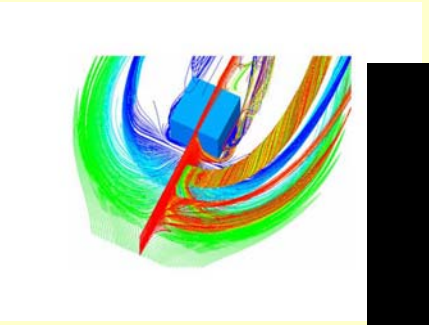
(a) Z=5mm　(b) Z=10mm(=1/4H)　(c) Z=15mm

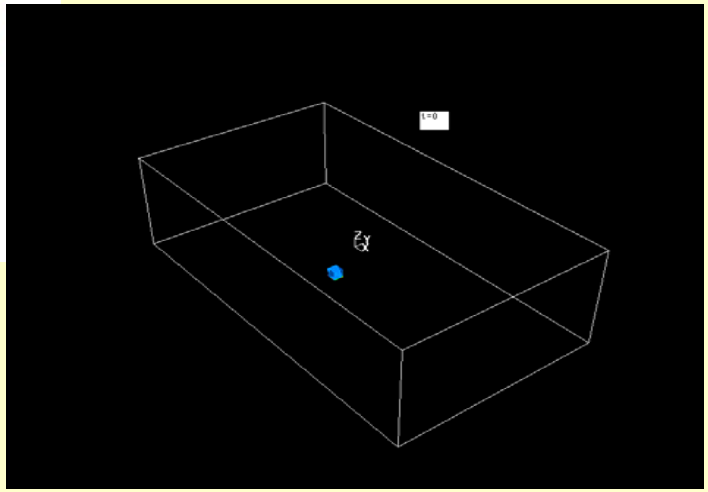


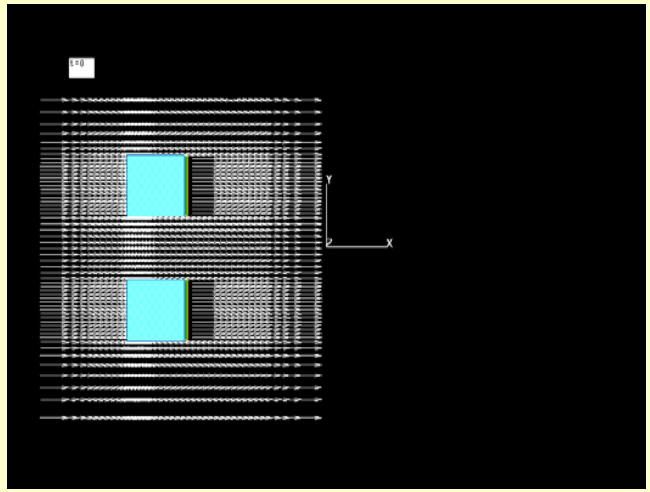
(d) Z=20mm(=1/2H)　(e) Z=40mm(=1H)　(f) Z=80mm(=2H)

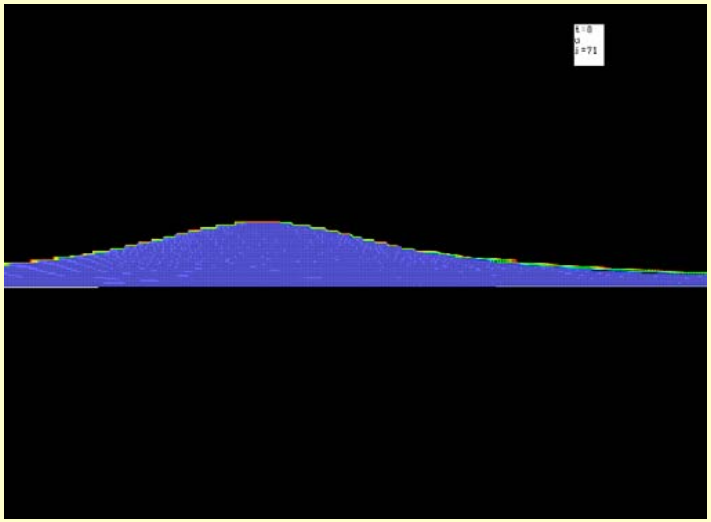
5 minutes averaging horizontal temperature distributions measured at different heights　$\theta_t=(\theta_a-\theta_0)/(\theta_f-\theta_0)$

Development and Applications of a High-resolution Local Meteorological Numerical Model in Cartesian Coordinate









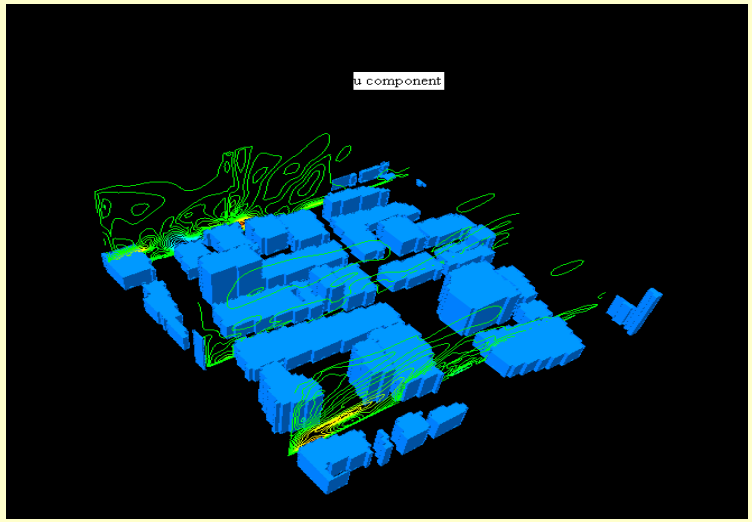


Table Outline of the numerical model

Basic equations	Non-hydrostatic/compressible
Coordinate	Cartesian
Discretization approach	Finite volume method
Grid system	Staggered
Time integration scheme	Implicit
Advection Scheme	3rd upwind scheme(QUICK) *Leonard(1979); Hayase et al.(1992)*
Solution method for the equations	SIMPLER algorithm *Patankar(1980); Sha et al.(1991)*
Technique for handling complex geometries	Blocking-off Method *Patankar(1980); Sha(2002)*
Turbulence scheme	LES *Lilly(1962); Smagorinsky(1963)*

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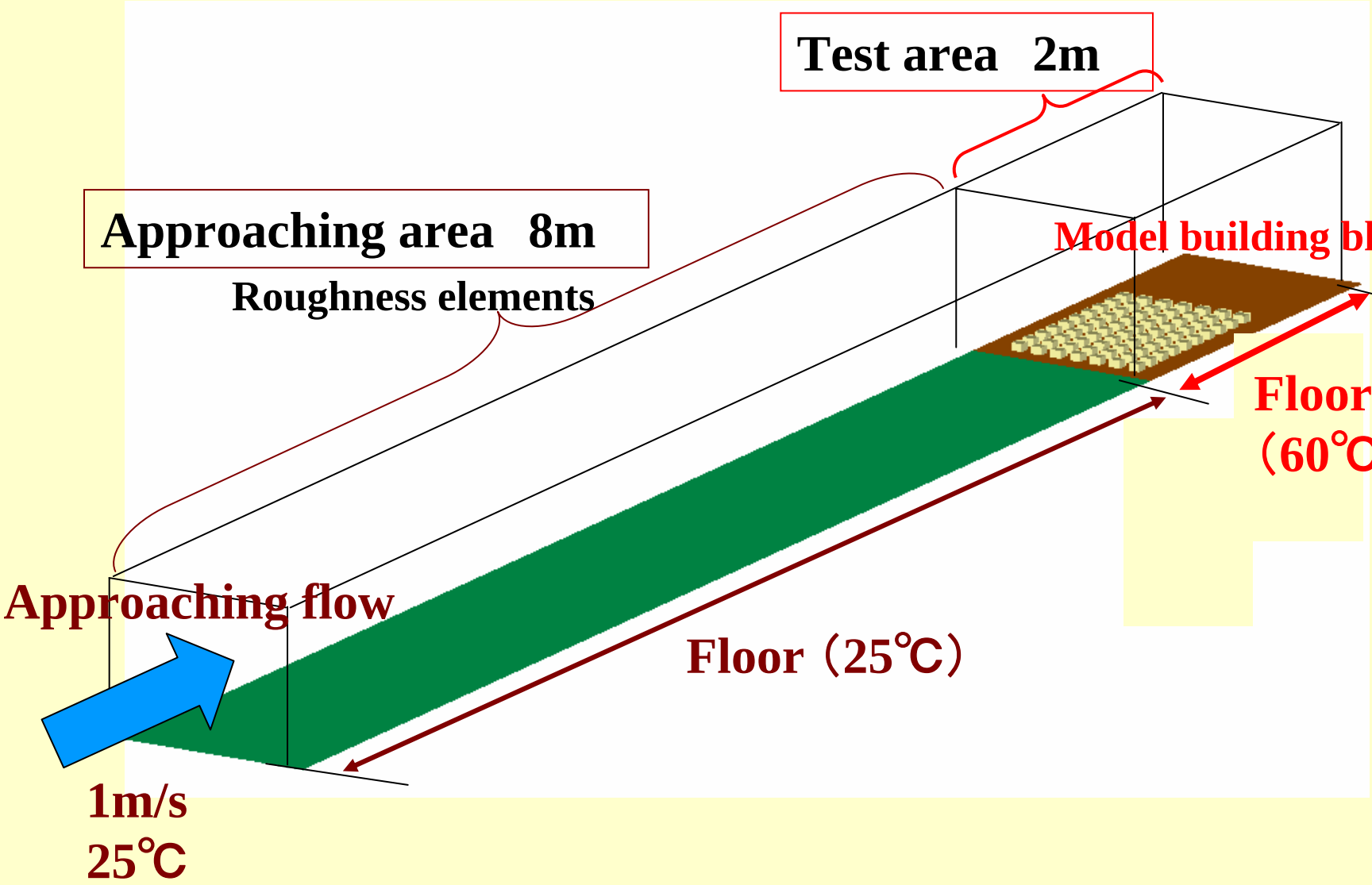
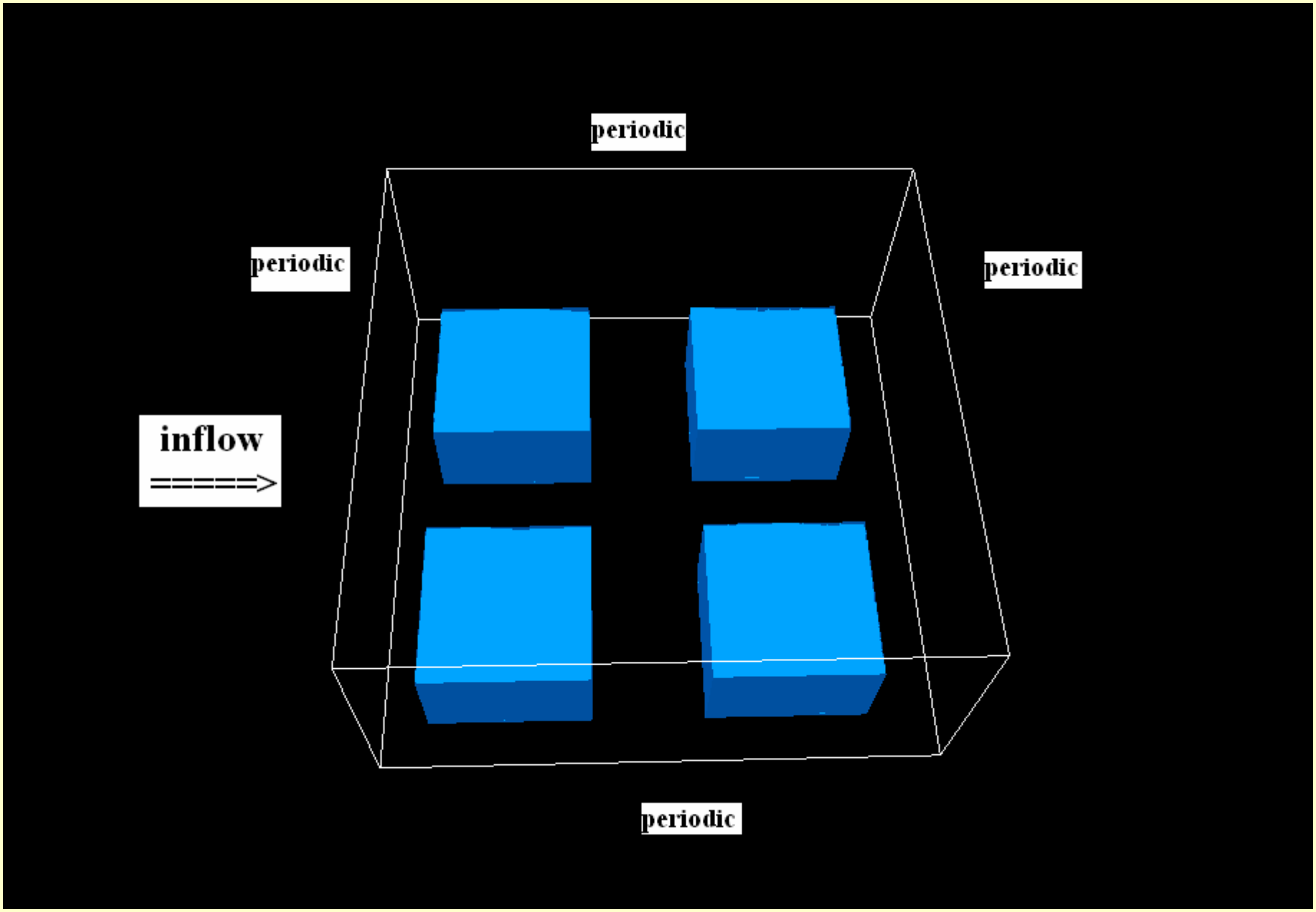
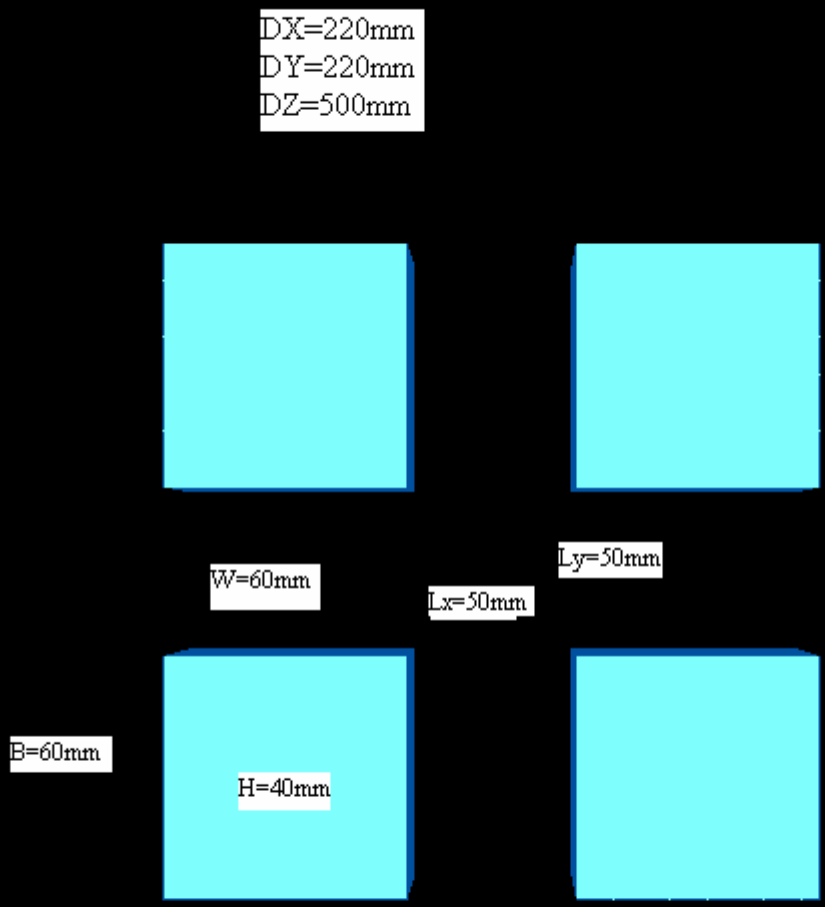
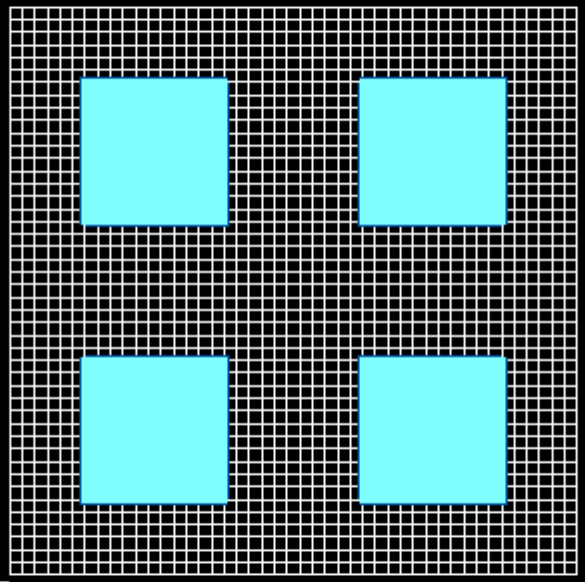



periodic
periodic
periodic
inflow
=====>
periodic


DX=220mm
DY=220mm
DZ=500mm
W=60mm
Lx=50mm
Ly=50mm
B=60mm
H=40mm

DX=225mm
DY=225mm
DZ=500mm

grid size:
dx=dy=dz=5mm
grid number:
x(46)*y(46)*(100)



y
j=1,,, 46

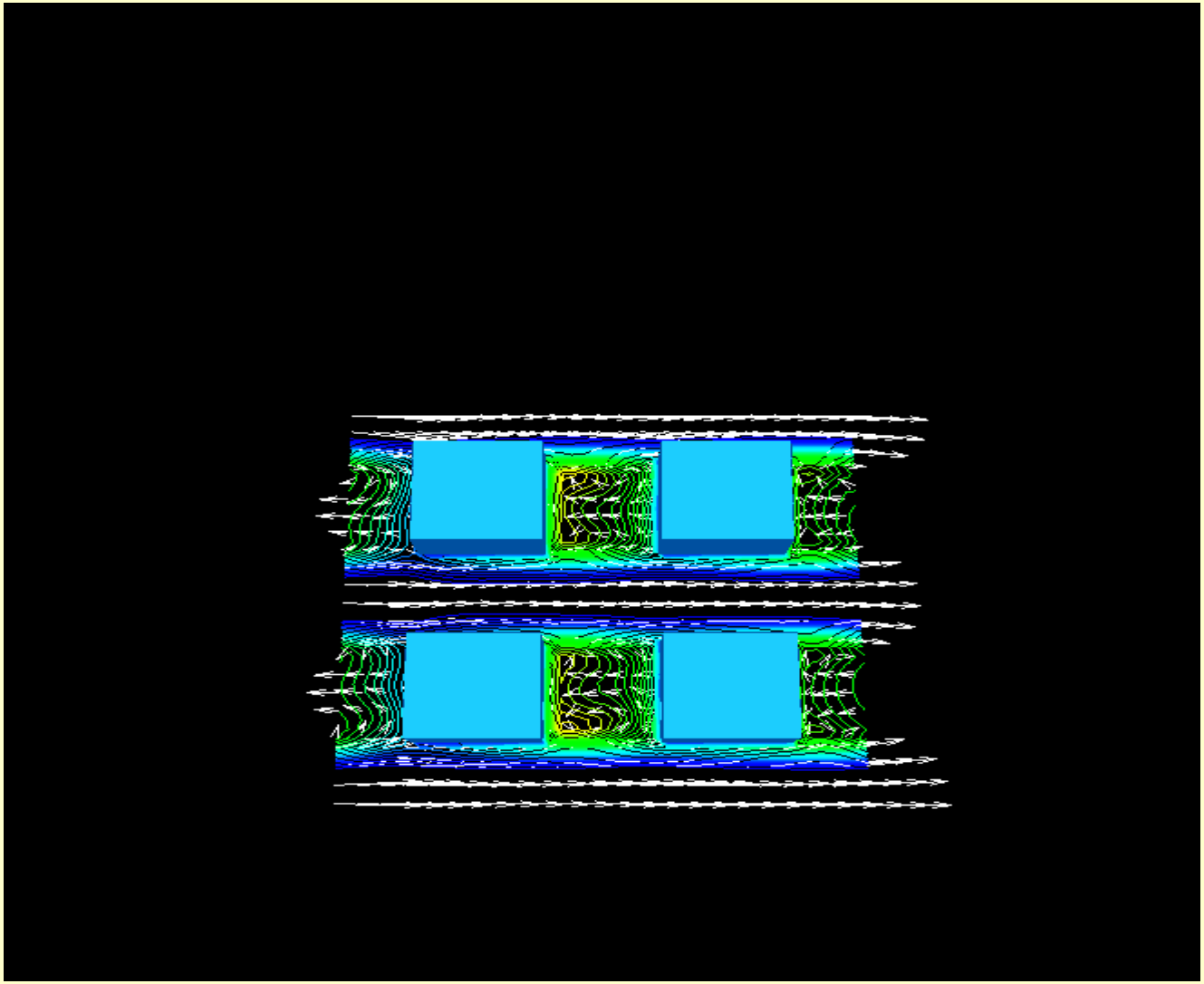
o

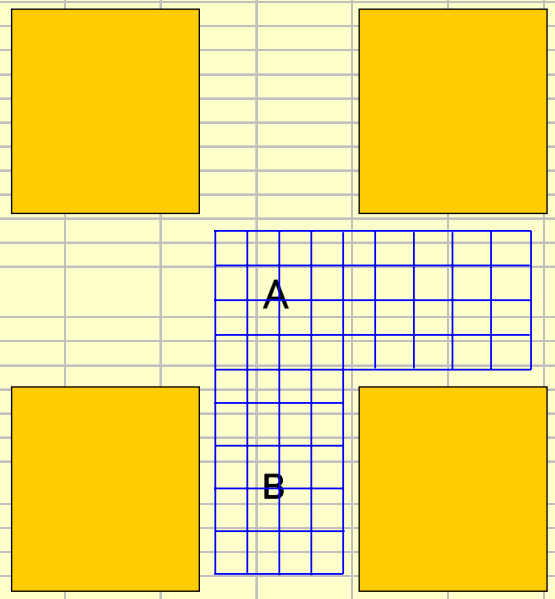
x
i=1,,, 46

Calculation Settings

* inflow conditions:
  vertical profiles of velocity u and
  temperature T obtained from wind-tunnel
  measurement *(Re=2667,Rb=-0.2)*
* domain size:
  DX=DY=225mm, DZ=500mm
* grid numbers: 46(x),46(y), 100(z)
* grid spacing: dx=dy=dz=5mm
* time step Δ t= 0.001s
* integrated time 360s
* cyclic boundary conditions for (u,v.w,T) at
  inflow/outflow and lateral boundaries
* pressure loss setting between inflow and
  outflow boundary (Murakami, S., etc.,1990)

計算結果：床近くの平均速度ベクトルと温度
（z=5mm; T’: max 0.71,min 0.44)





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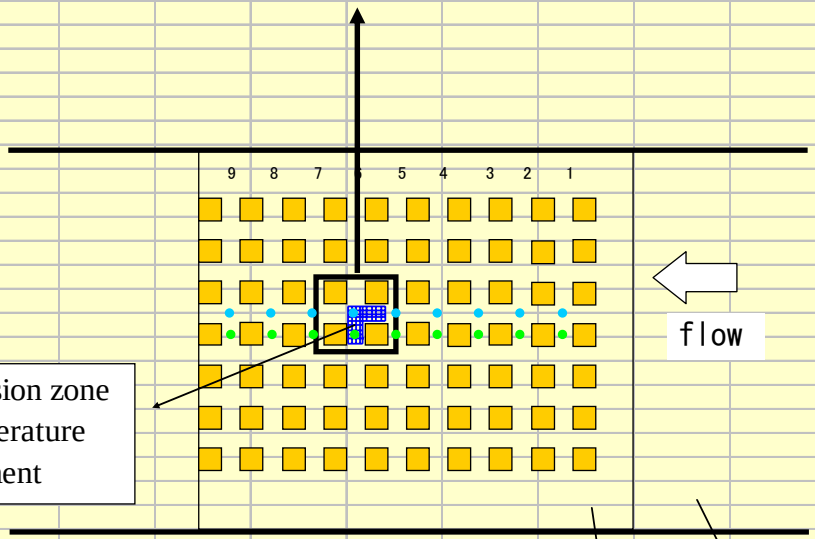

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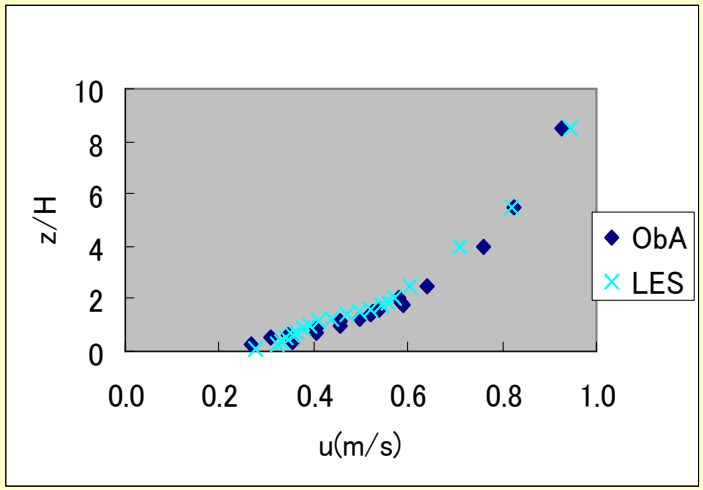
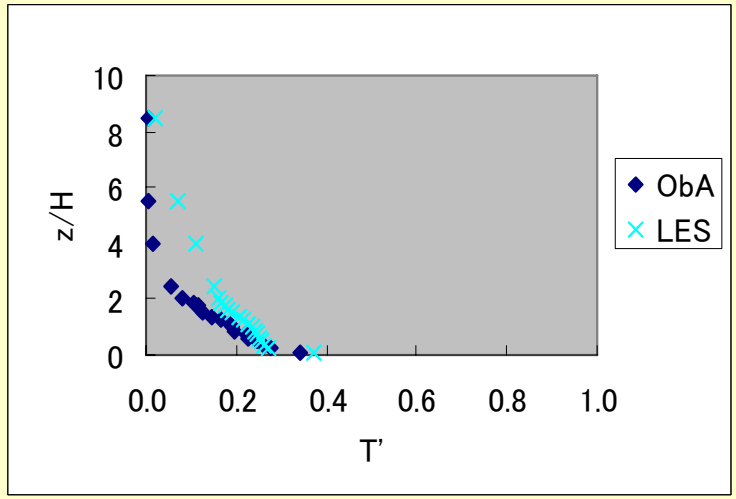
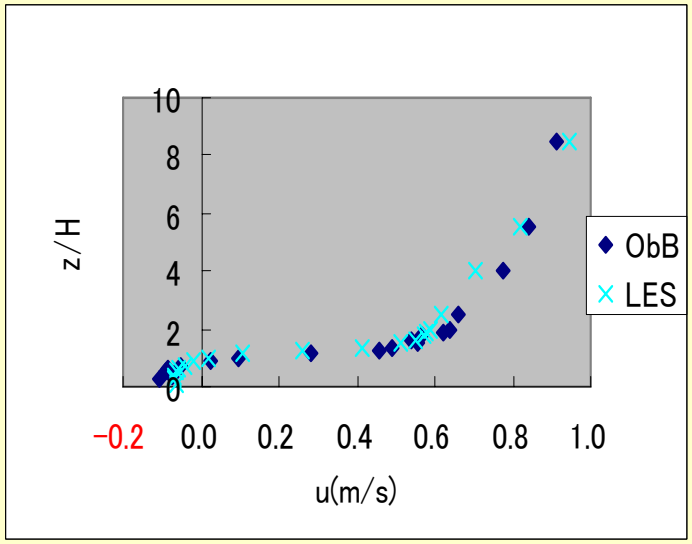
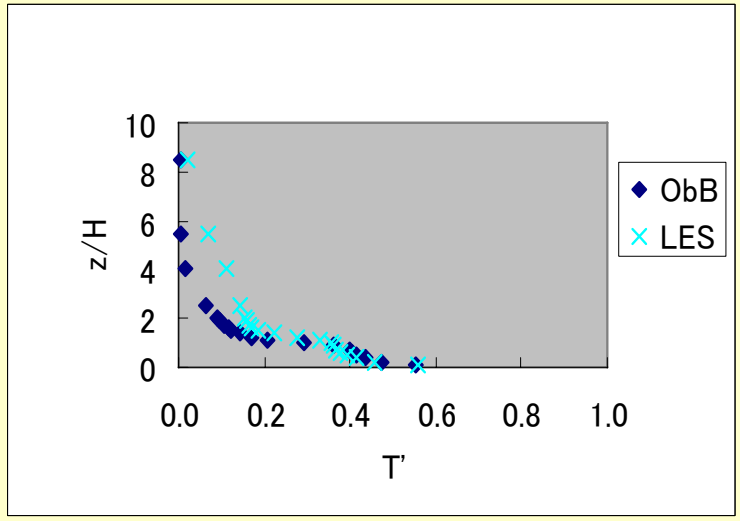
風洞実測とCFD結果の定量比較









Next work …

*Improve the CFD modeling accuracy more, especially on the temperature distributions, and then make the comparison quantitatively with the wind-tunnel experiment

* Thermodynamic environmental evaluations for building residential area

* Urban sub-grid parameterisations used in Meso model

* Understanding the urban boundary layer