Smoke movement in fire situations

CFD-utilization in car park Fleerde

Hegeman, S.T.G.D.

Award date:
2009

Appendices

BSB

Index:

Appendix 1: Numerical setup for the Roomfire-case

FLUENT

Version: 3d, segregated, ske, unsteady (3d, segregated, Standard k-epsilon, unsteady)
Release: 6.2.16
Title:

Models

Model	Settings
Space	3D
Time	Unsteady, 1st-Order Implicit
Viscous	Standard k-epsilon turbulence model
Wall	Treatment Standard Wall Functions
Heat	Transfer Enabled
Solidification	and Melting Disabled
Radiation	None
Species	Transport Disabled
Coupled	Dispersed Phase Disabled
Pollutants	Disabled
Soot	Disabled

Boundary Conditions

Zones

name	id	type
other	2	fluid
heating	3	fluid
outflow1	8	pressure-outlet
fire_source	10	interior
fire_source_b	13	interior
fire_source_a	12	interior
symmetrie2	4	symmetry
floor	5	wall
walls	6	wall
symmetrie1	7	symmetry
symm_back_fire_source	1	symmetry
floor_fire_source	9	wall
symm_front_fire_source	11	symmetry

Material Properties

Material: air (fluid)

Property	Units	Method	Value(s)		
Density	kg/m3	incompressible-ideal-gas	#f		
Cp	(Specific	Heat)	j/kg-k	constant	1006.43
Thermal	Conductivity	w/m-k	constant	0.0242	
Viscosity	kg/m-s	constant	1.79E-05		
Molecular	Weight	kg/kgmol	constant	28.966	
L-J	Characteristic	Length	angstrom	constant	3.711
L-J	Energy	Parameter	k	constant	78.6
Thermal	Expansion	Coefficient	1/k	constant	0
Degrees	of	Freedom	constant	0	
Speed	of	Sound	m/s	none	#f

Material: aluminum (solid)

Property	Units	Method	Value(s)		
Density	kg/m3	constant	2719		
Cp	(Specific	Heat)	j/kg-k	constant	871
Thermal	Conductivity	w/m-k	constant	202.4	

Solver Controls

Equations

Equation	Solved
Flow	yes
Turbulence	yes
Energy	yes

Numerics

Numeric	Enabled
Absolute	Velocity Formulation yes
Unsteady	Calculation Parameters

Time	Step	(s)	1		
Max.	Iterations	Per	Time	Step	5

Relaxation

Variable	Relaxation	Factor
Pressure	0.3	
Density	1	
Body	Forces	1
Momentum	0.7	
Turbulence	Kinetic	Energy 0.8
Turbulence	Dissipation	Rate 0.8
Turbulent	Viscosity	1
Energy	1	

Linear Solver

Solver Variable	Termination Type	Residual Criterion	Reduction Tolerance		
Pressure	V-Cycle	0.1			
X-Momentum	Flexible	0.1	0.7		
Y-Momentum	Flexible	0.1	0.7		
Z-Momentum	Flexible	0.1	0.7		
Turbulence	Kinetic	Energy	Flexible	0.1	0.7
Turbulence	Dissipation	Rate	Flexible	0.1	0.7
Energy	Flexible	0.1	0.7		

Discretization Scheme

Variable	Scheme				
Pressure	Second	Order			
Momentum	Second	Order	Upwind		
Turbulence	Kinetic	Energy	Second	Order	Upwind
Turbulence	Dissipation	Rate	Second	Order	Upwind
Energy	Second	Order	Upwind		

Solution Limits

Quantity	Limit		
Minimum	Absolute	Pressure	1
Maximum	Absolute	Pressure	5.00E+10
Minimum	Temperature	1	
Maximum	Temperature	5000	
Minimum	Turb.	Kinetic	Energy 1.00E-14
Minimum	Turb.	Dissipation	Rate 1.00E-20
Maximum	Turb.	Viscosity	Ratio 100000

Appendix 2: Relevant graphs form the TNO-CvB Report

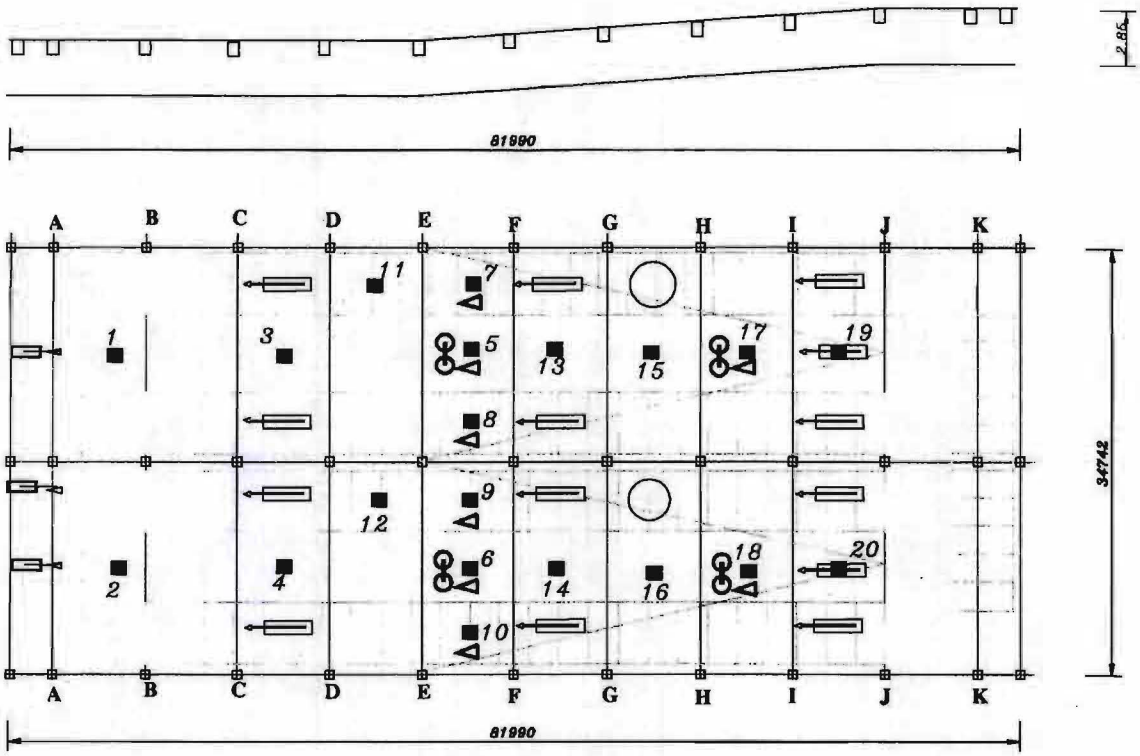


Figure A-X: "Horizontale meetposities", TNO-report

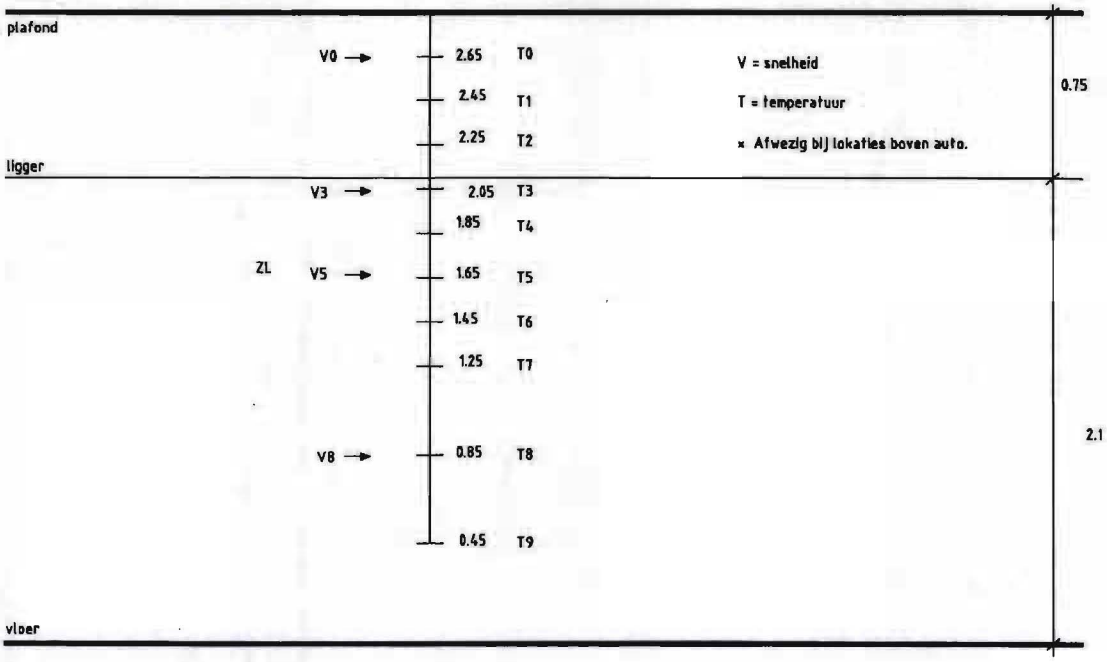


Figure A-X: "Verticale meetposities", TNO-report

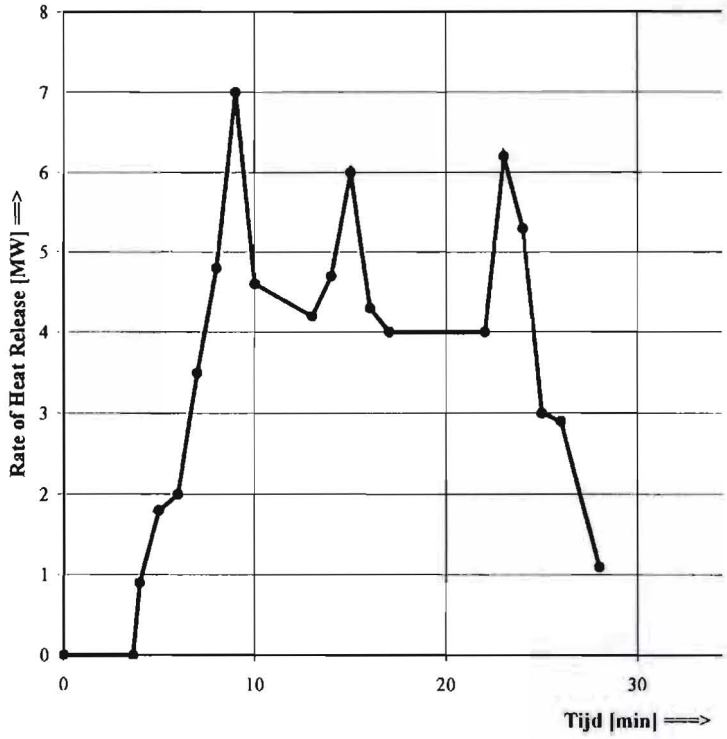


Figure A-X: "RHR curve gebruikt voor CFD-simulaties" Figure H, appendix TNO-report

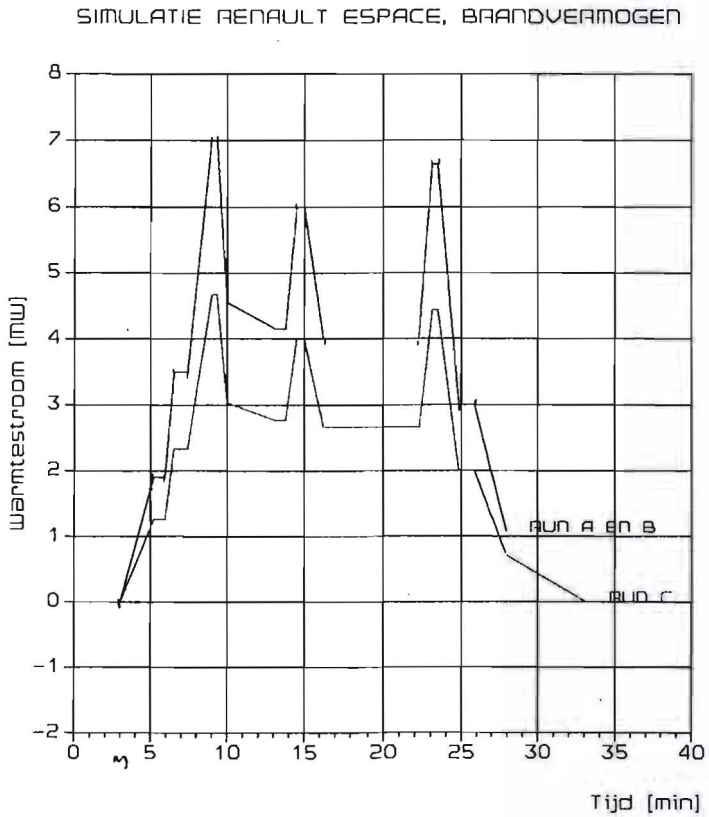
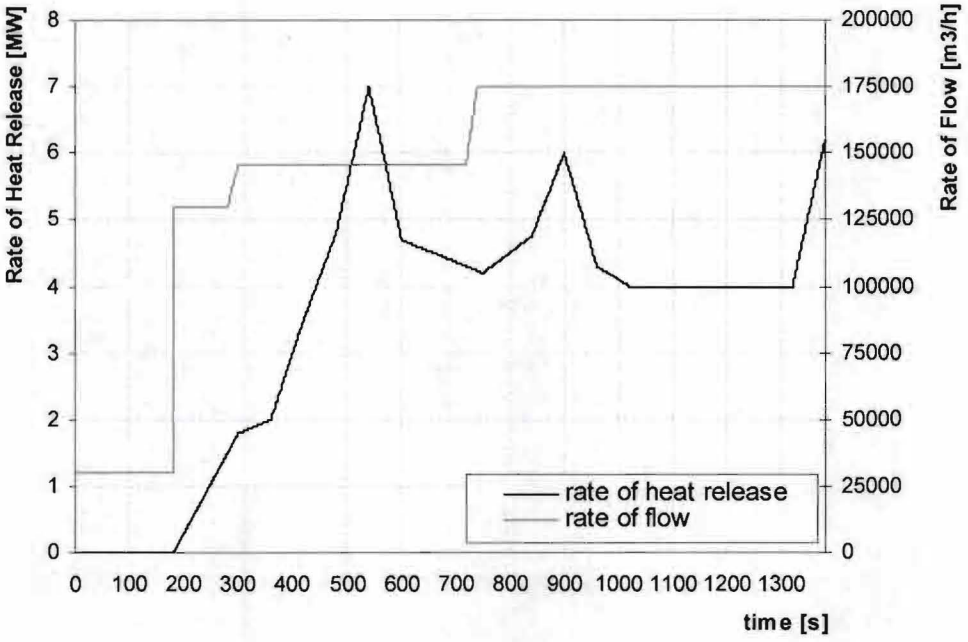
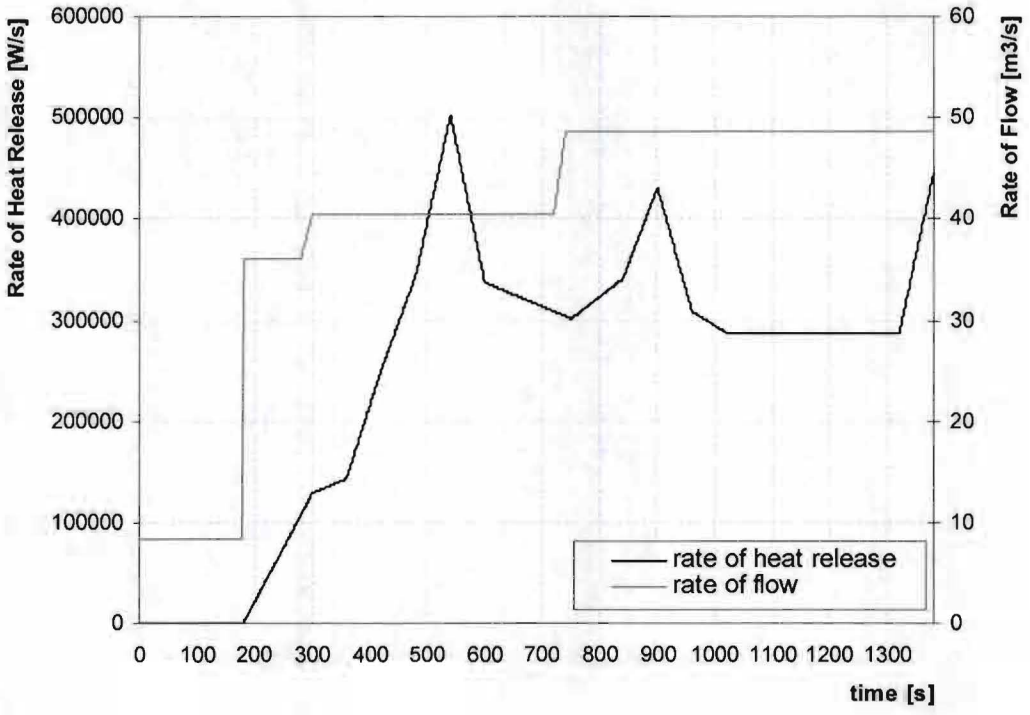


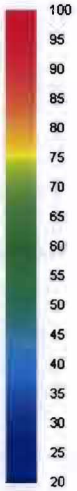
Figure A-X: "Het toegevoerde brandvermogen" Figure 3, appendix TNO-report

Transient profiles for heat release and exhaust ventilation





Appendix 3: Graphs comparing measurement data with right-x gravity simulation results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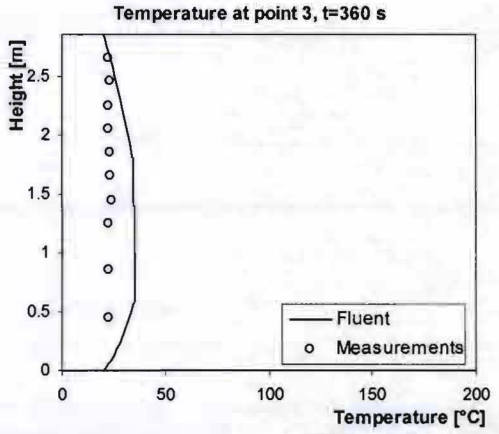
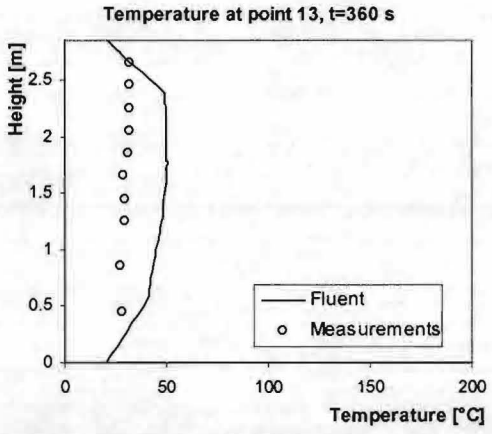
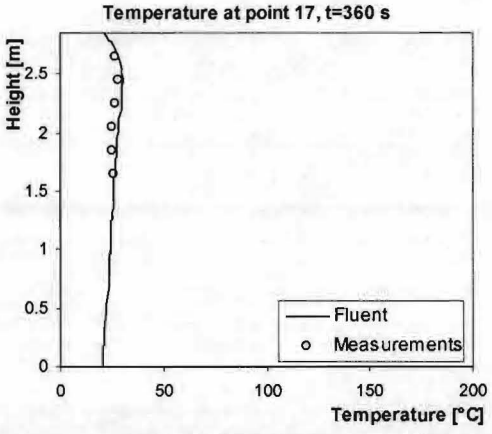
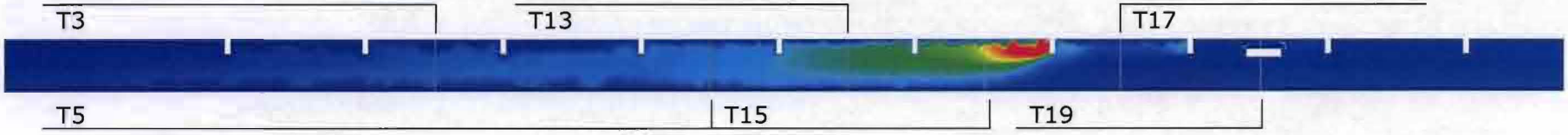
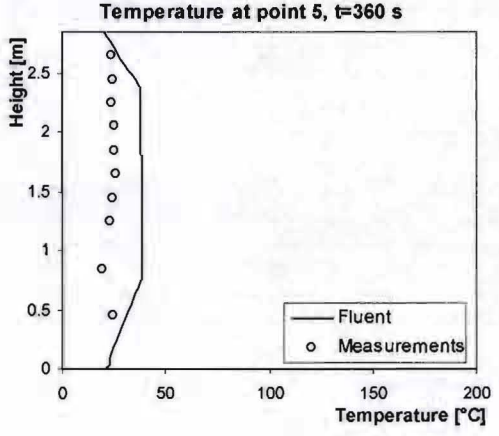
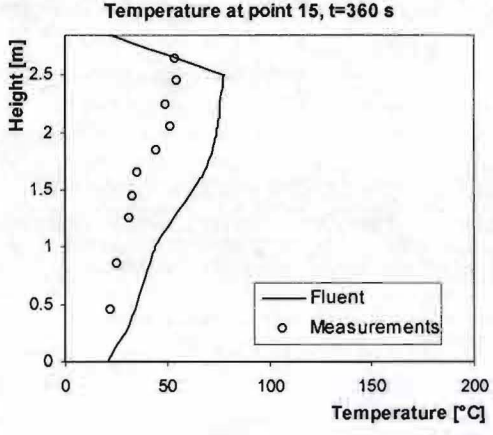

Temperature at point 3, t=360 s
Height [m]
Temperature [°C]
Fluent
Measurements

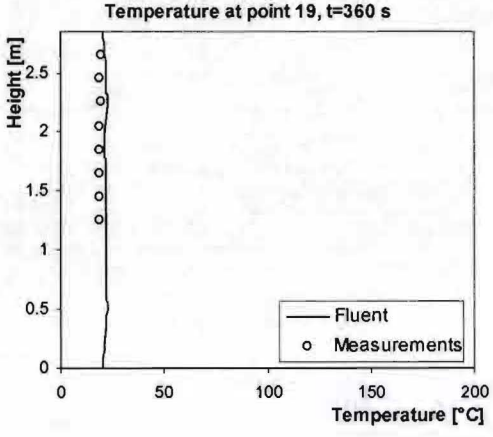

Temperature at point 13, t=360 s
Height [m]
Temperature [°C]
Fluent
Measurements


Temperature at point 17, t=360 s
Height [m]
Temperature [°C]
Fluent
Measurements


T3
T13
T17
T5
T15
T19

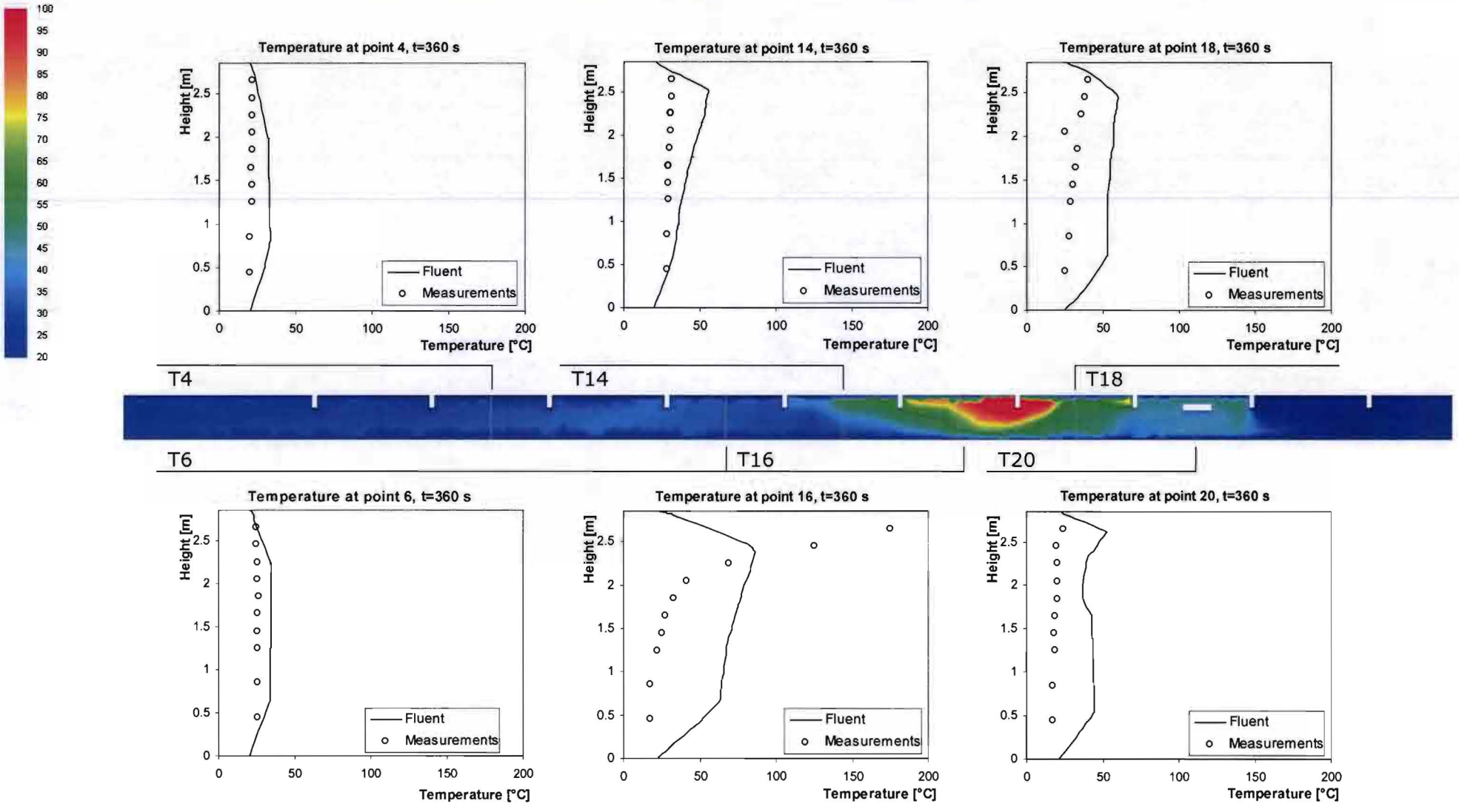

Temperature at point 5, t=360 s
Height [m]
Temperature [°C]
Fluent
Measurements


Temperature at point 15, t=360 s
Height [m]
Temperature [°C]
Fluent
Measurements

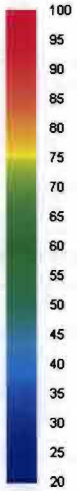

Temperature at point 19, t=360 s
Height [m]
Temperature [°C]
Fluent
Measurements

z = 8,25

Comparison with measurements: Temperature [°C] at t = 360 s Gravitational correction in right x-direction



z = 25,05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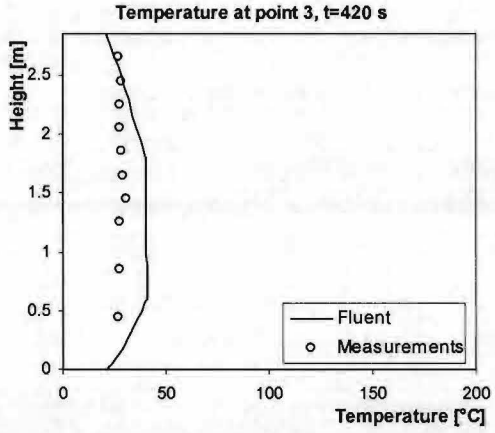
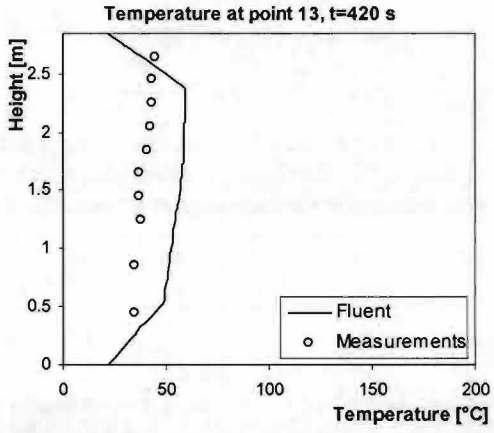
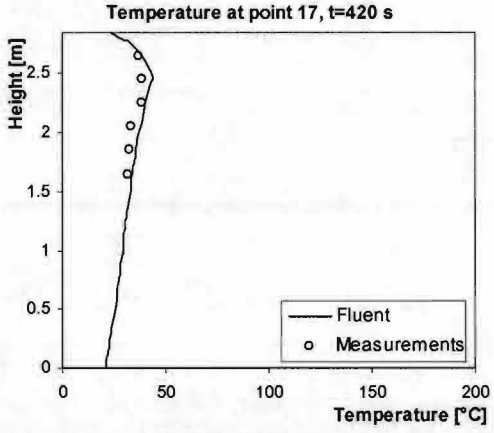
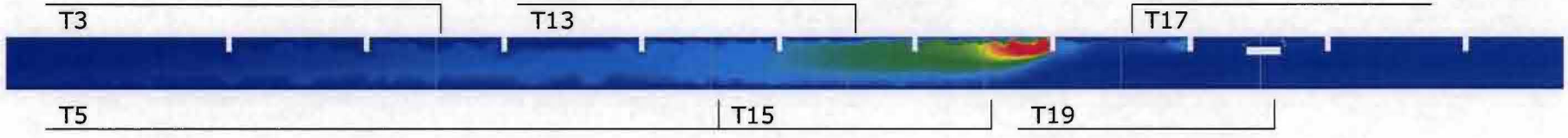
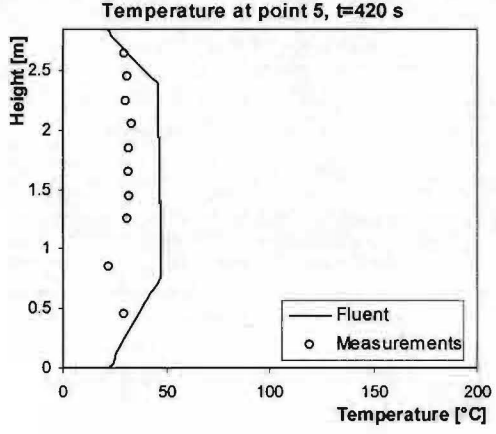
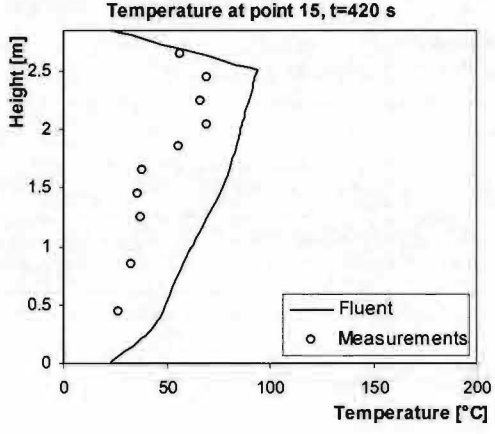

Temperature at point 3, t=420 s
Height [m]
Temperature [°C]
Fluent
Measurements

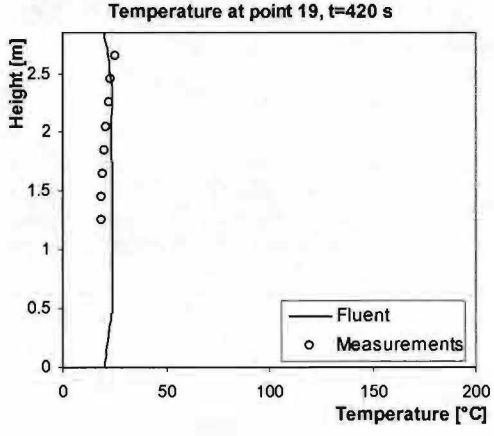

Temperature at point 13, t=420 s
Height [m]
Temperature [°C]
Fluent
Measurements


Temperature at point 17, t=420 s
Height [m]
Temperature [°C]
Fluent
Measurements


T3
T13
T17
T5
T15
T19

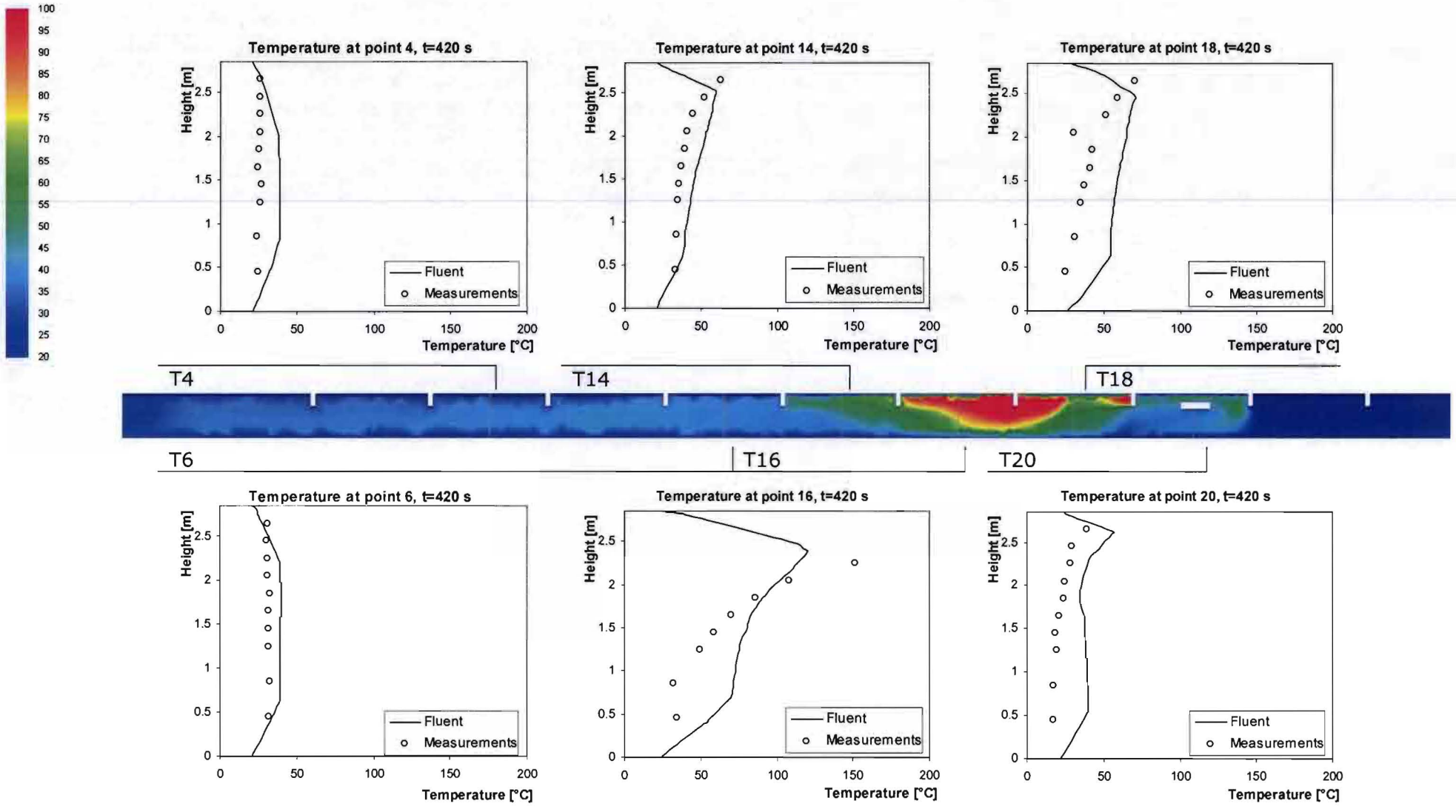

Temperature at point 5, t=420 s
Height [m]
Temperature [°C]
Fluent
Measurements


Temperature at point 15, t=420 s
Height [m]
Temperature [°C]
Fluent
Measurements

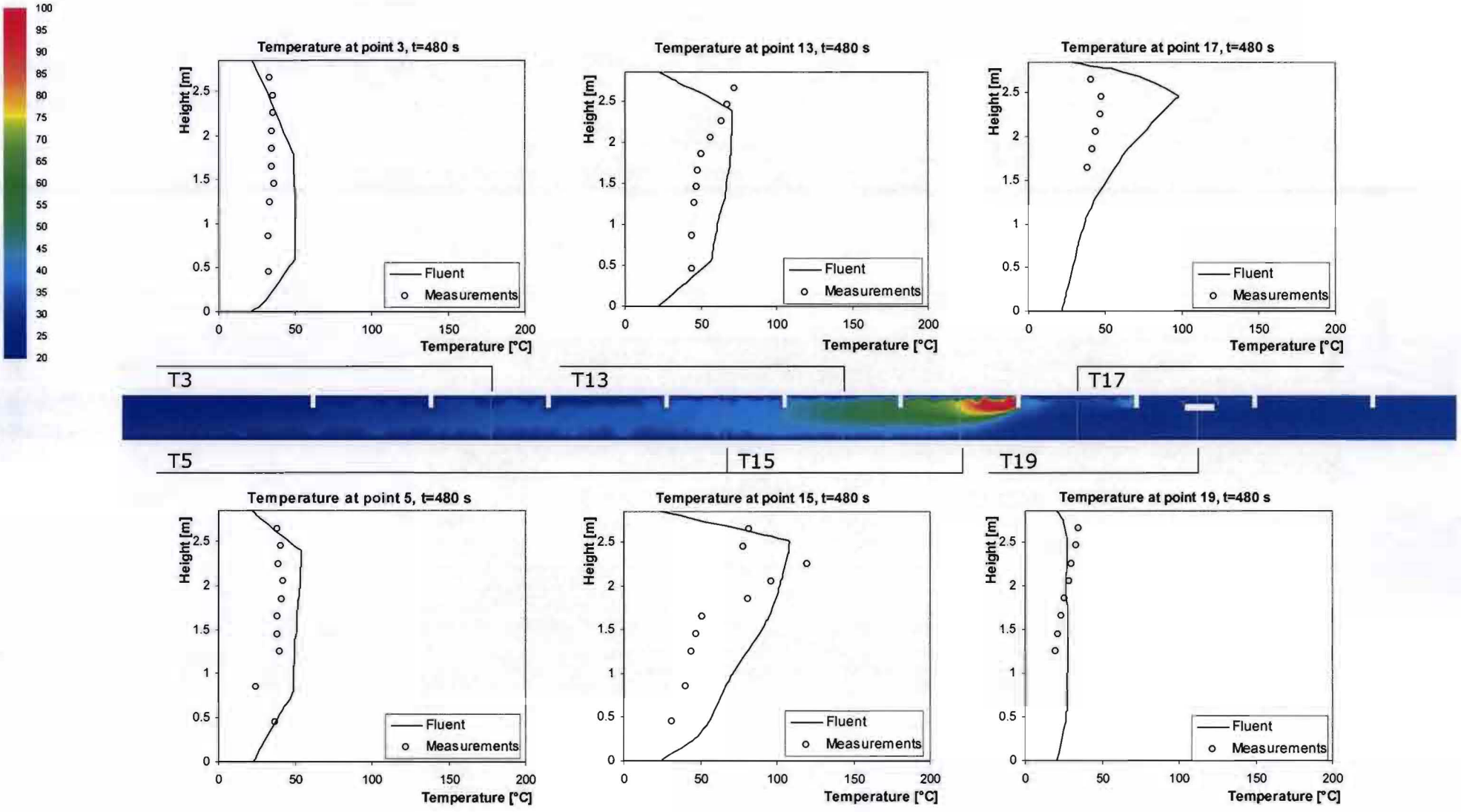

Temperature at point 19, t=420 s
Height [m]
Temperature [°C]
Fluent
Measurements

z = 8,25

Comparison with measurements: Temperature [°C] at t = 420 s Gravitational correction in right x-direction



z = 25,05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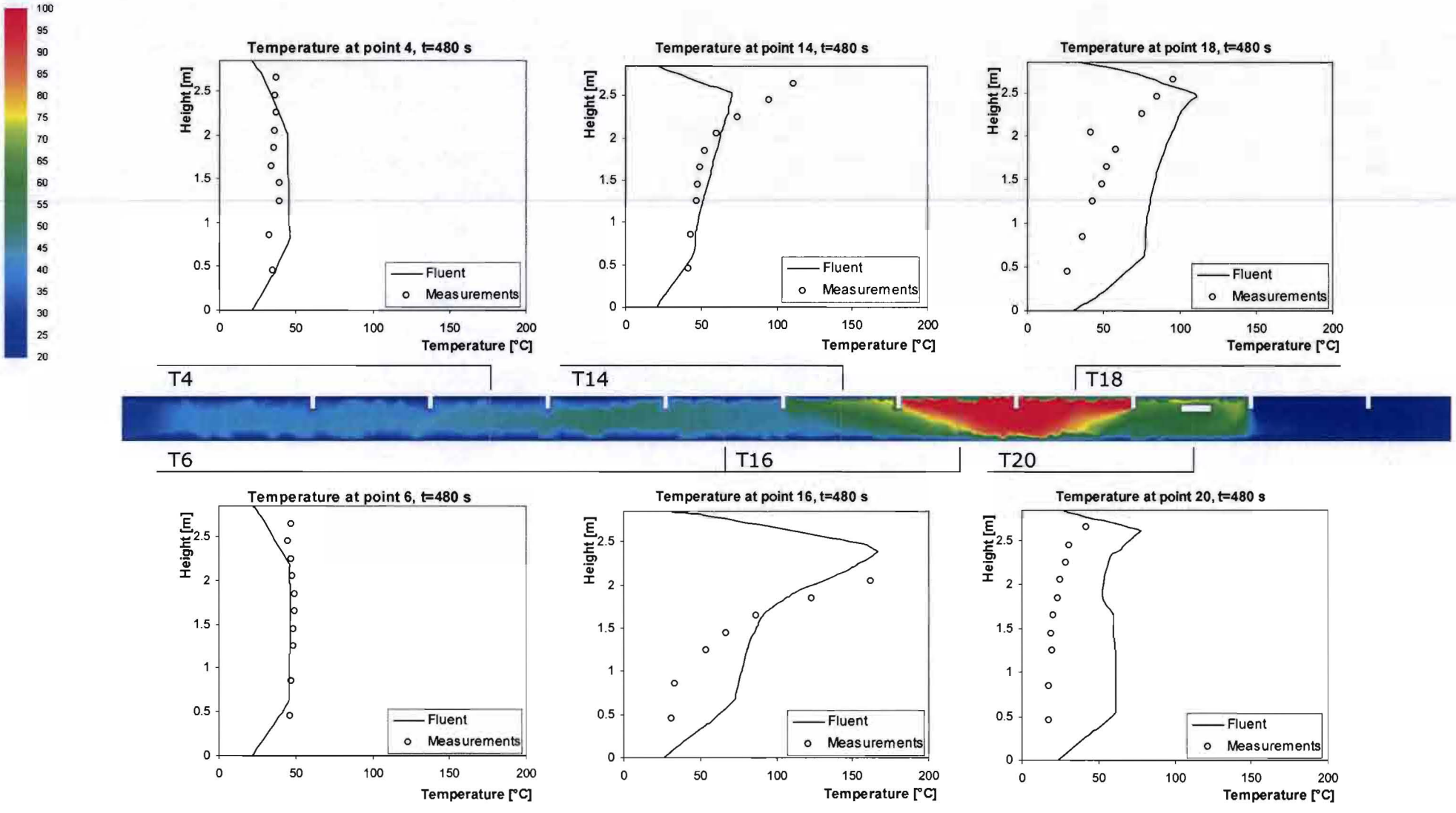
Temperature at point 3, t=480 s
Temperature at point 13, t=480 s
Temperature at point 17, t=480 s
Height [m]
Temperature [°C]
Fluent
Measurements
T3
T13
T17
T5
T15
T19
Temperature at point 5, t=480 s
Temperature at point 15, t=480 s
Temperature at point 19, t=480 s

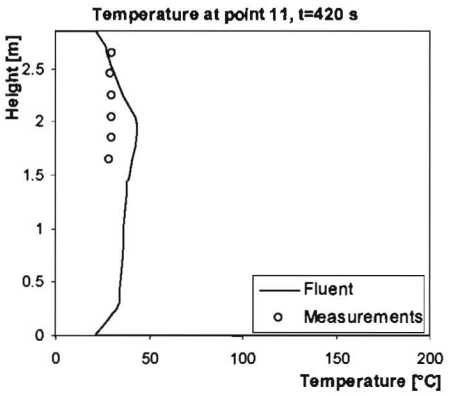
z = 8,25

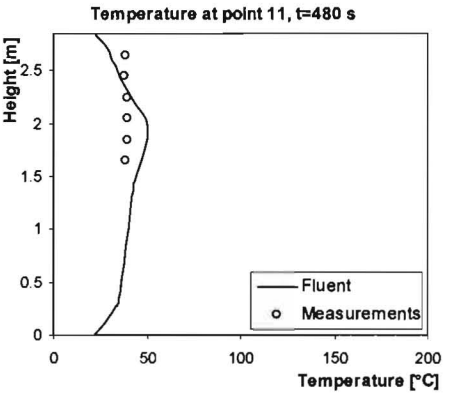
Comparison with measurements: Temperature [°C] at t = 480 s Gravitational correction in right x-direction

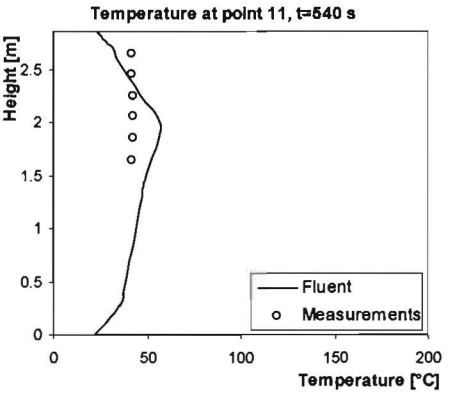


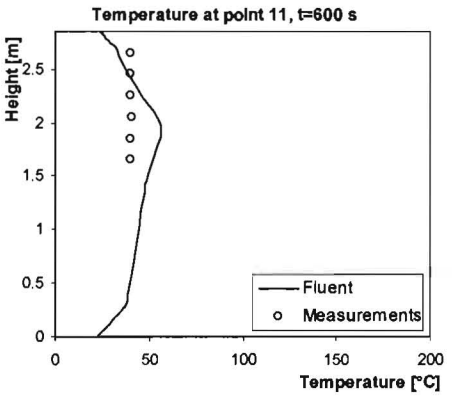
z = 25,05

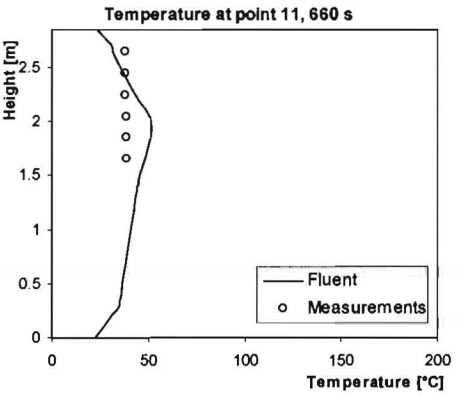
Comparison with measurements: gravitational correction in right x-direction

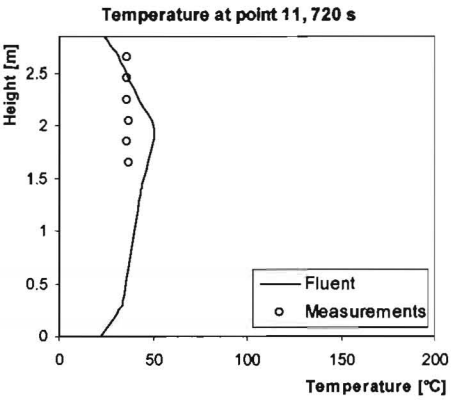


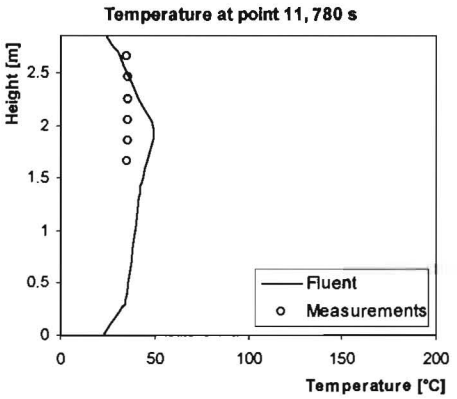


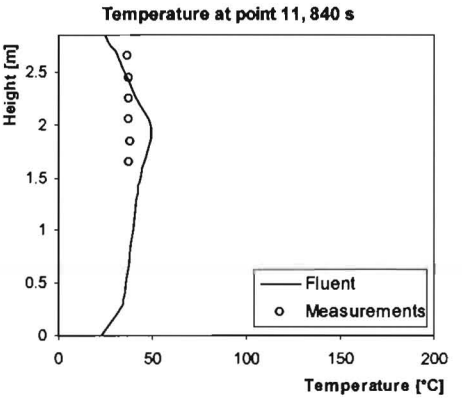


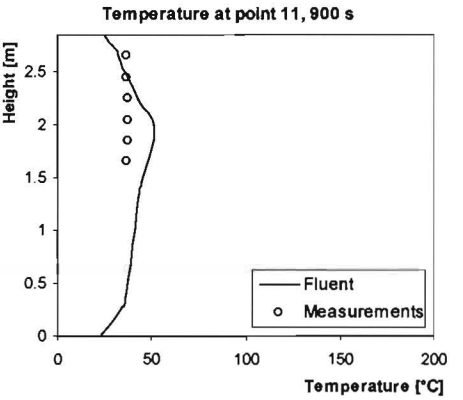


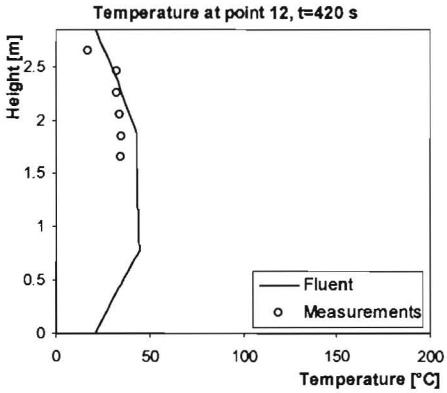


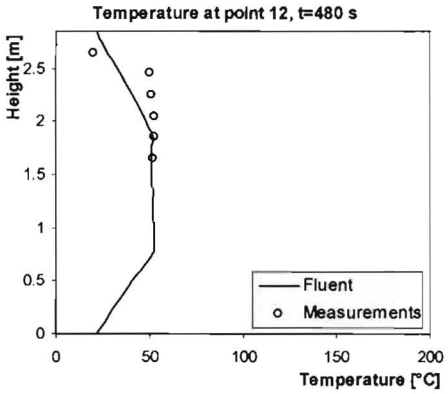


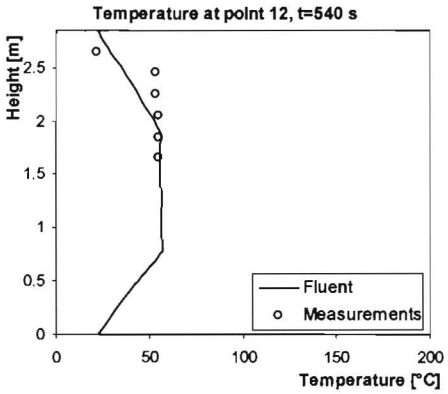


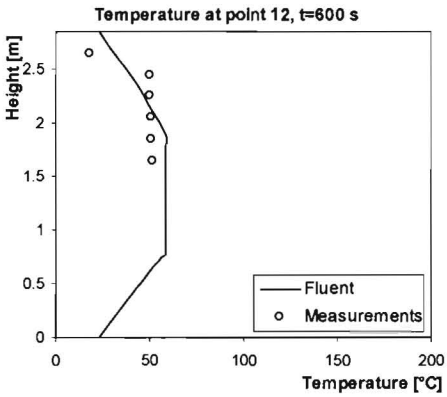


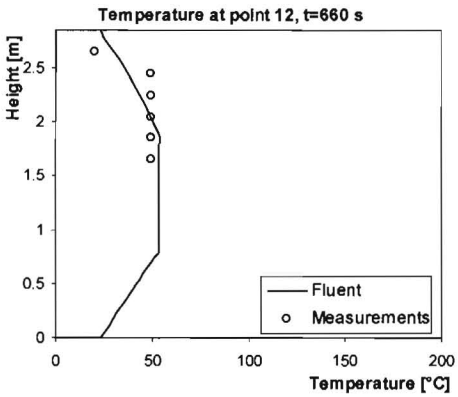


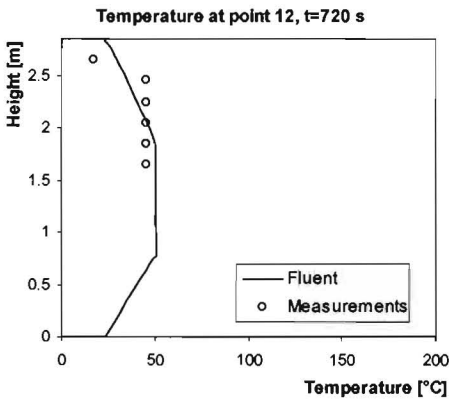

Temperature at point 12, t=420 s
Height [m]
Temperature [°C]
Fluent
Measurements

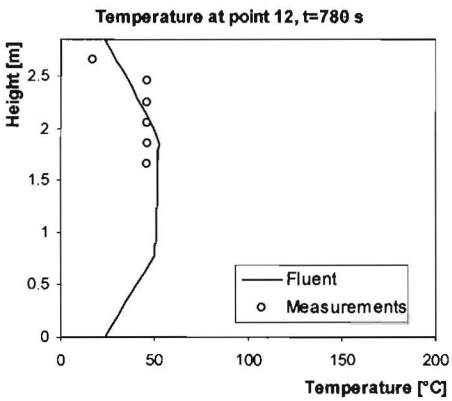

Temperature at point 12, t=480 s
Height [m]
Temperature [°C]
Fluent
Measurements

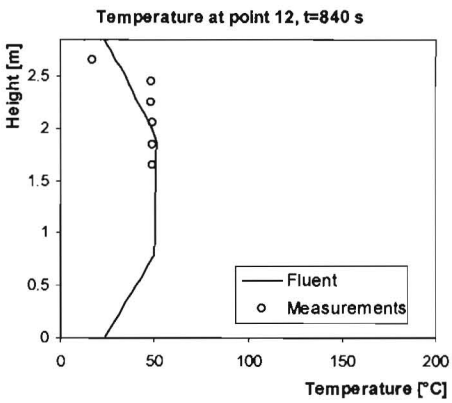

Temperature at point 12, t=540 s
Height [m]
Temperature [°C]
Fluent
Measurements

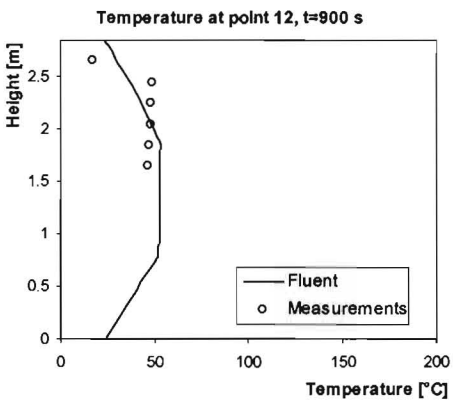

Temperature at point 12, t=600 s
Height [m]
Temperature [°C]
Fluent
Measurements


Temperature at point 12, t=660 s
Height [m]
Temperature [°C]
Fluent
Measurements

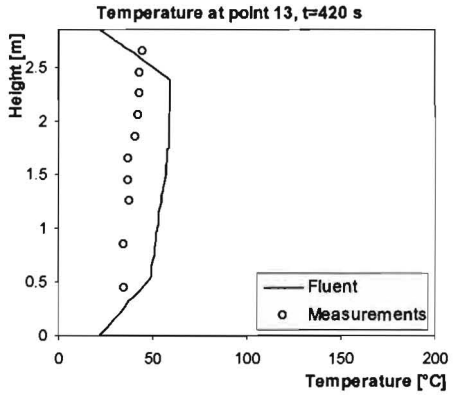

Temperature at point 12, t=720 s
Height [m]
Temperature [°C]
Fluent
Measurements

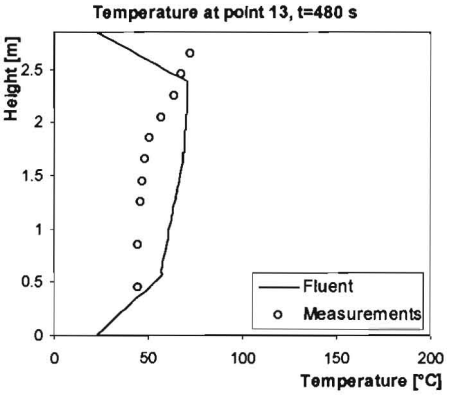

Temperature at point 12, t=780 s
Height [m]
Temperature [°C]
Fluent
Measurements

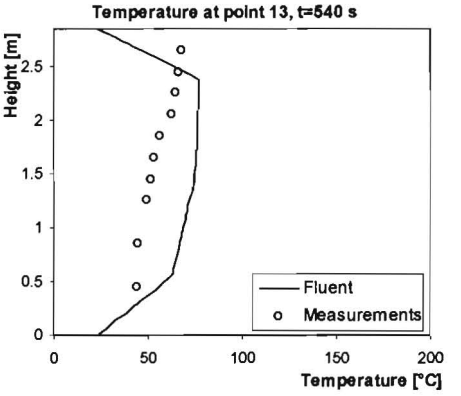

Temperature at point 12, t=840 s
Height [m]
Temperature [°C]
Fluent
Measurements

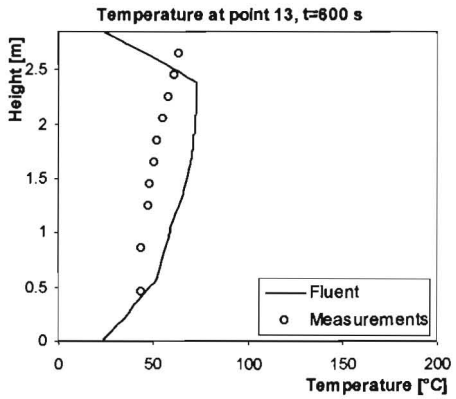

Temperature at point 12, t=900 s
Height [m]
Temperature [°C]
Fluent
Measurements

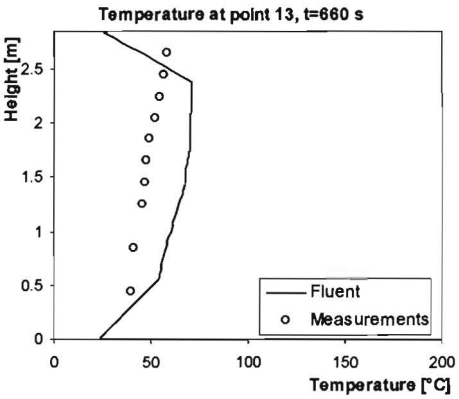
Comparison with measurements: gravitational correction in right x-direction

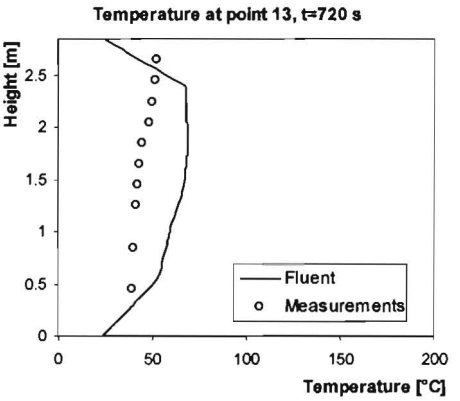


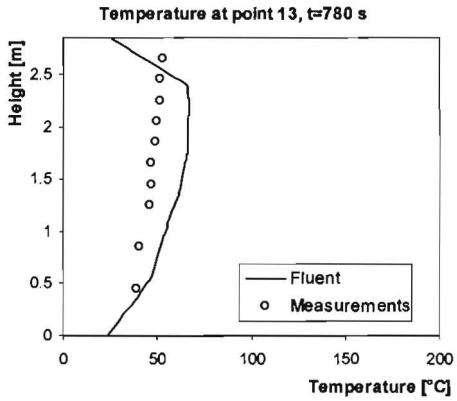


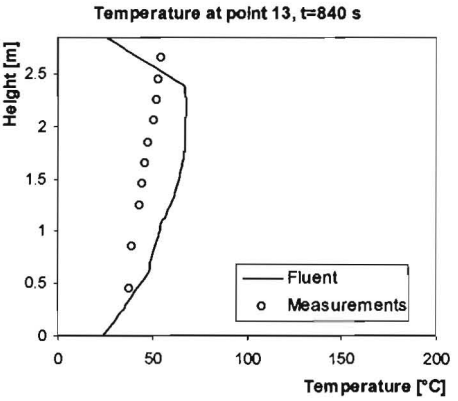


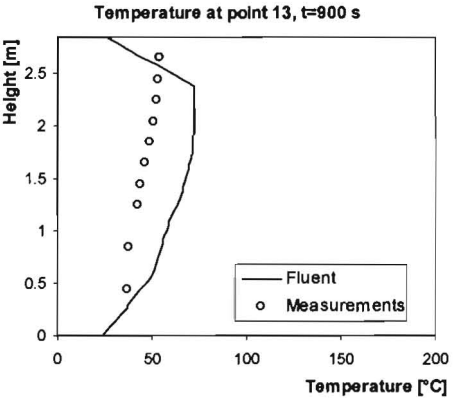




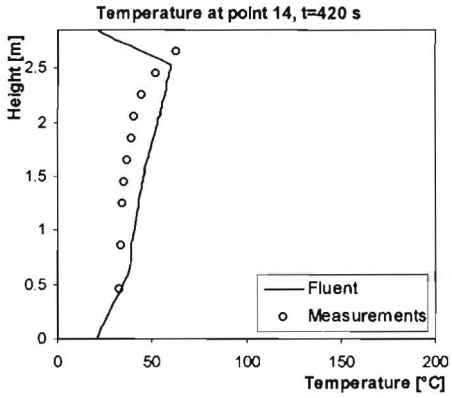


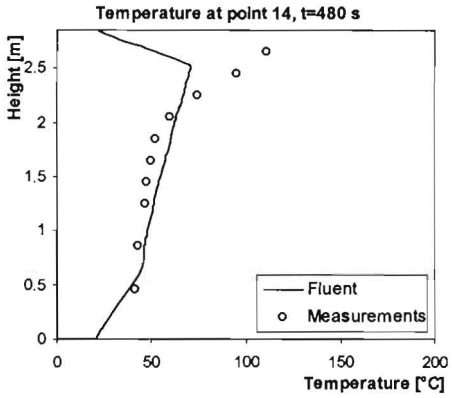


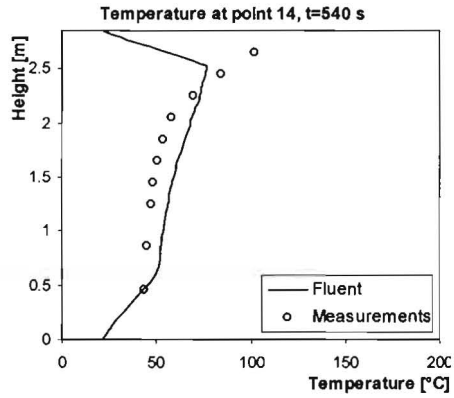


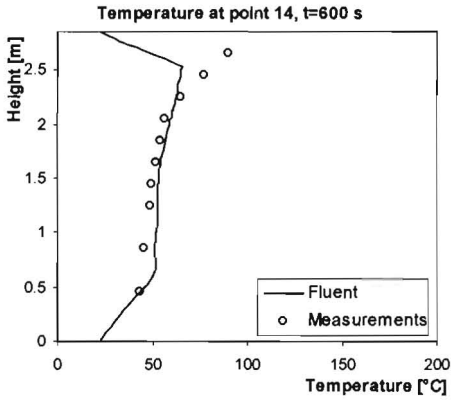


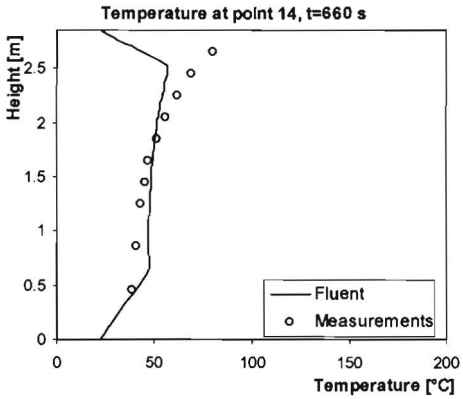
Comparison with measurements: gravitational correction in right x-direction

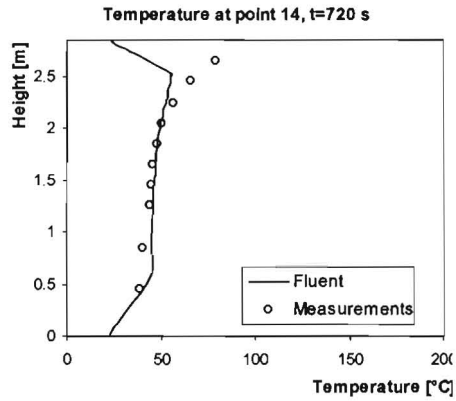


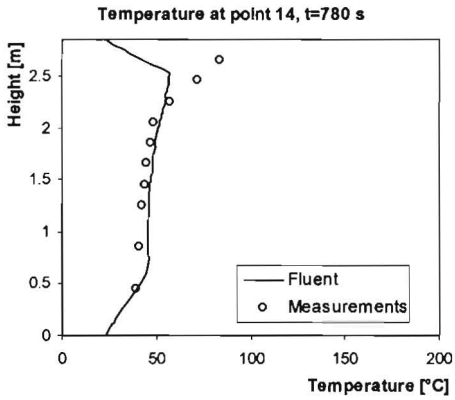


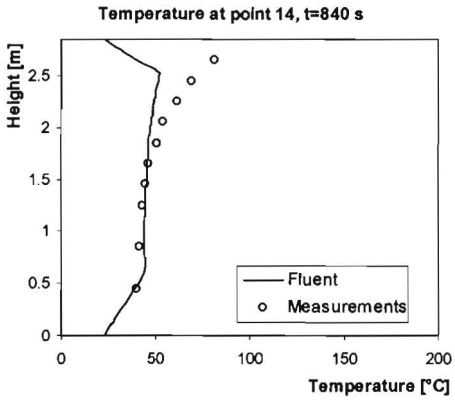


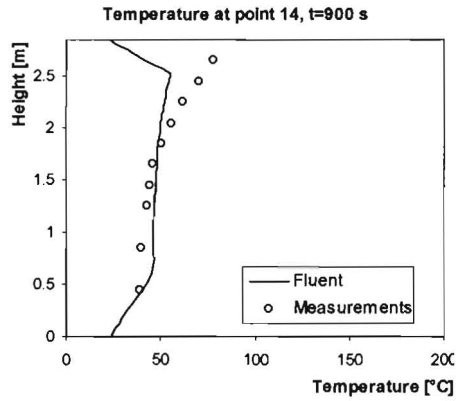


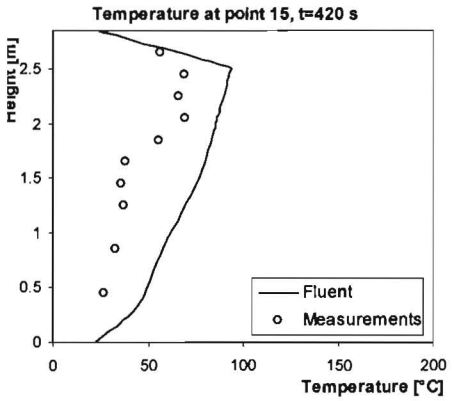


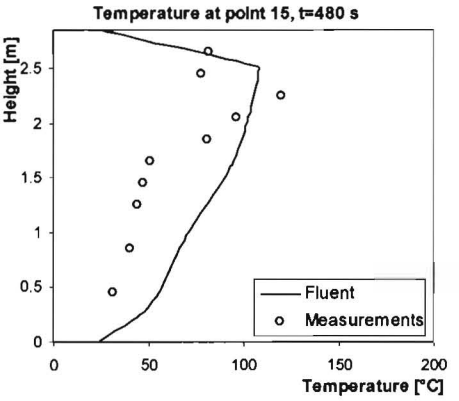


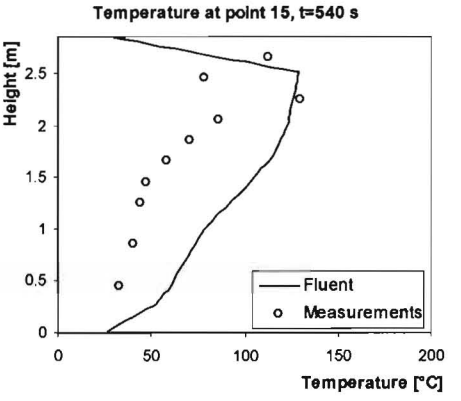


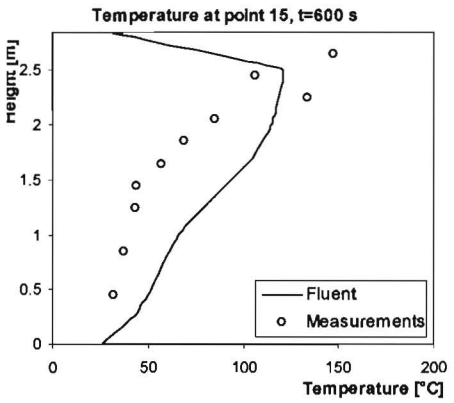


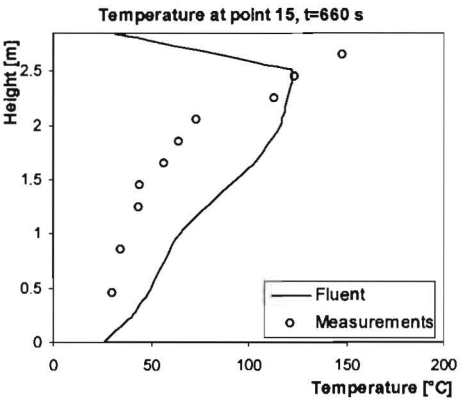


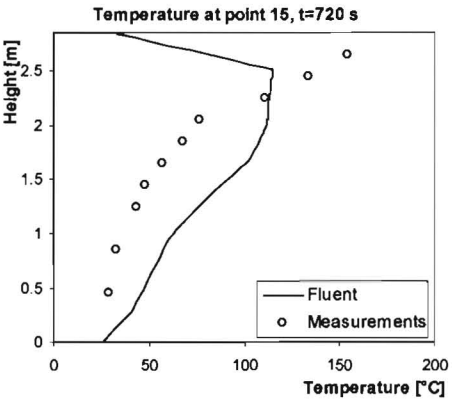

Temperature at point 15, t=420 s
Height [m]
Temperature [°C]
Fluent
Measurements

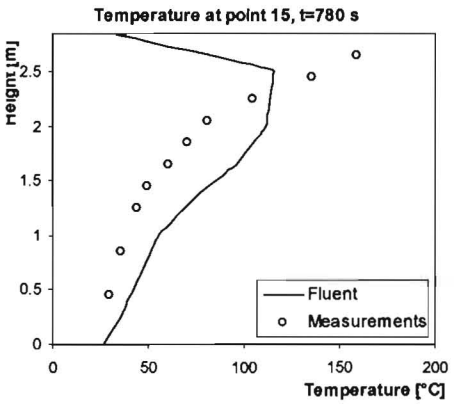

Temperature at point 15, t=480 s
Height [m]
Temperature [°C]
Fluent
Measurements

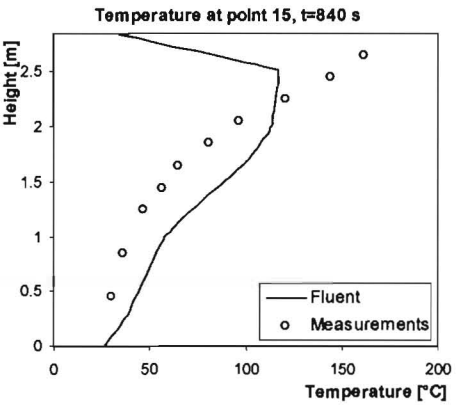

Temperature at point 15, t=540 s
Height [m]
Temperature [°C]
Fluent
Measurements

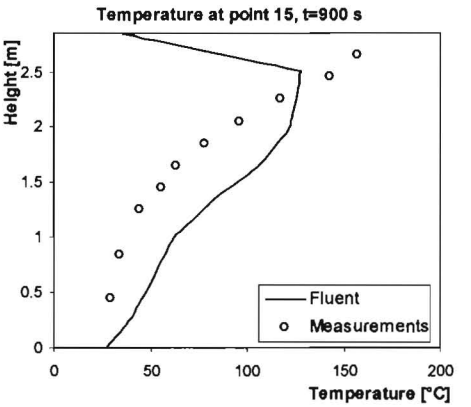

Temperature at point 15, t=600 s
Height [m]
Temperature [°C]
Fluent
Measurements

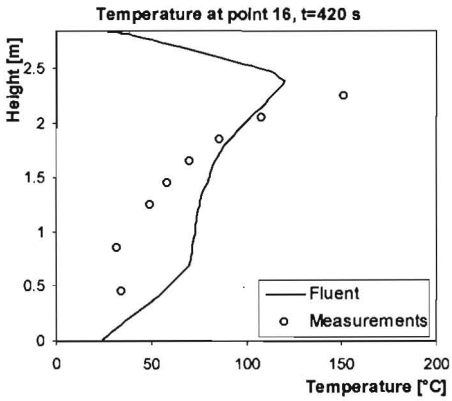

Temperature at point 15, t=660 s
Height [m]
Temperature [°C]
Fluent
Measurements

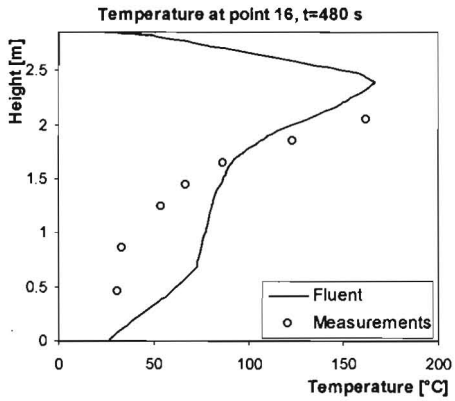

Temperature at point 15, t=720 s
Height [m]
Temperature [°C]
Fluent
Measurements

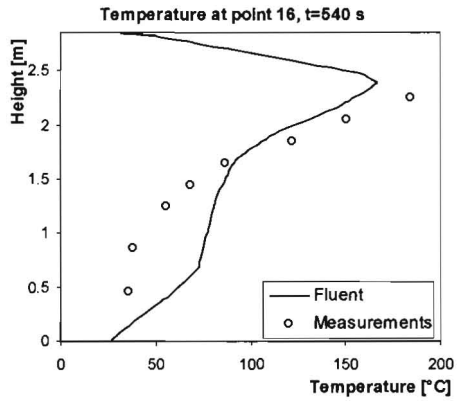

Temperature at point 15, t=780 s
Height [m]
Temperature [°C]
Fluent
Measurements

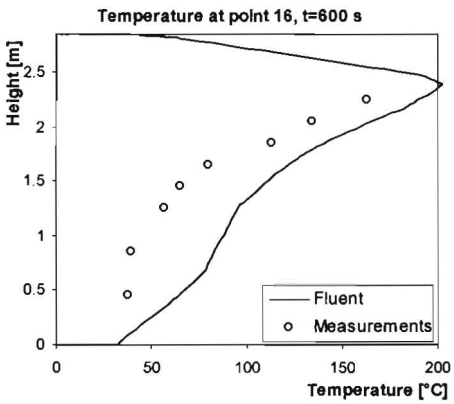

Temperature at point 15, t=840 s
Height [m]
Temperature [°C]
Fluent
Measurements

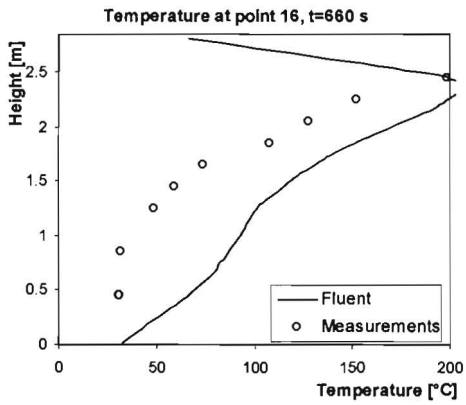

Temperature at point 15, t=900 s
Height [m]
Temperature [°C]
Fluent
Measurements

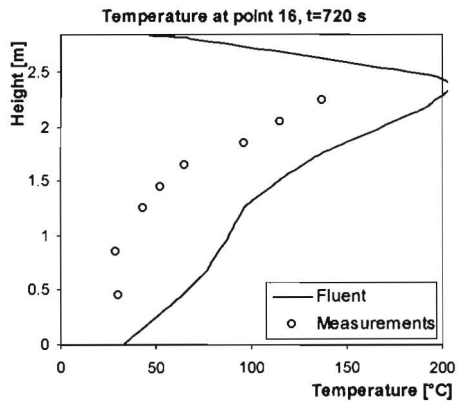

Temperature at point 16, t=420 s
Height [m]
Temperature [°C]
Fluent
Measurements

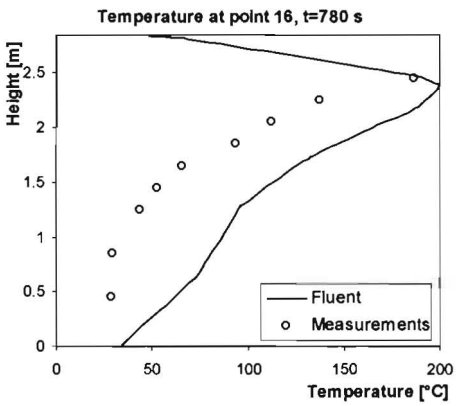

Temperature at point 16, t=480 s
Height [m]
Temperature [°C]
Fluent
Measurements

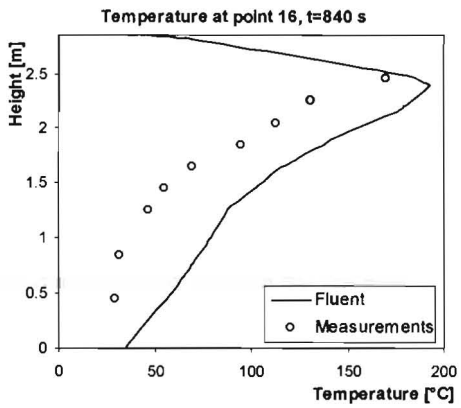

Temperature at point 16, t=540 s
Height [m]
Temperature [°C]
Fluent
Measurements

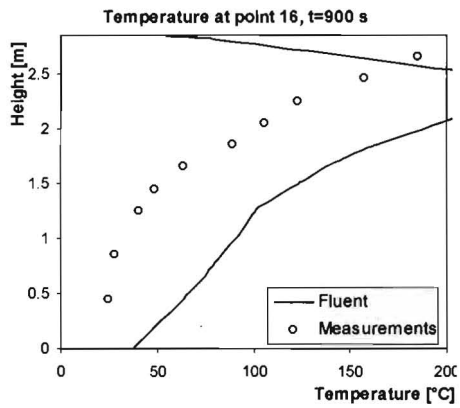

Temperature at point 16, t=600 s
Height [m]
Temperature [°C]
Fluent
Measurements


Temperature at point 16, t=660 s
Height [m]
Temperature [°C]
Fluent
Measurements

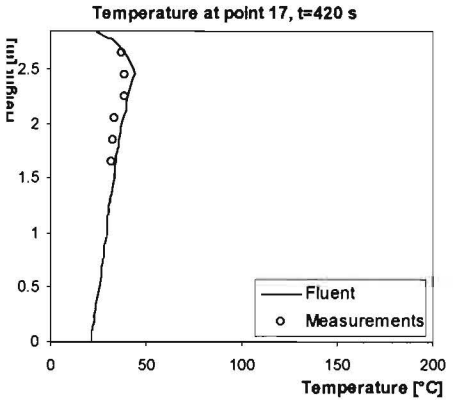

Temperature at point 16, t=720 s
Height [m]
Temperature [°C]
Fluent
Measurements

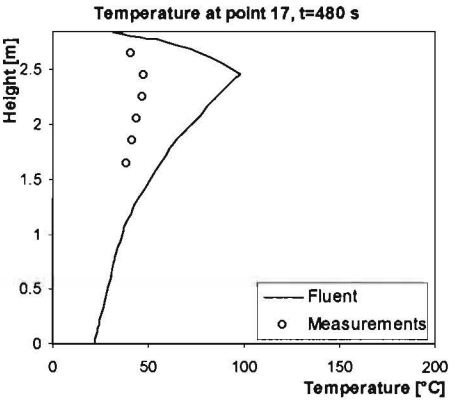

Temperature at point 16, t=780 s
Height [m]
Temperature [°C]
Fluent
Measurements

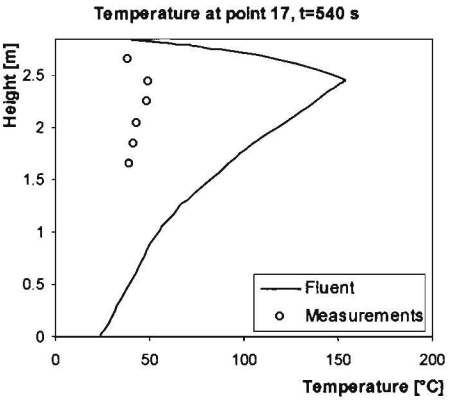

Temperature at point 16, t=840 s
Height [m]
Temperature [°C]
Fluent
Measurements

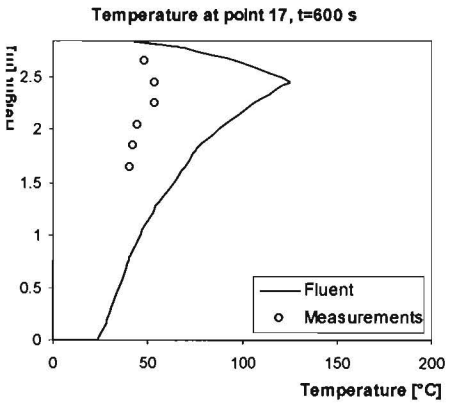

Temperature at point 16, t=900 s
Height [m]
Temperature [°C]
Fluent
Measurements

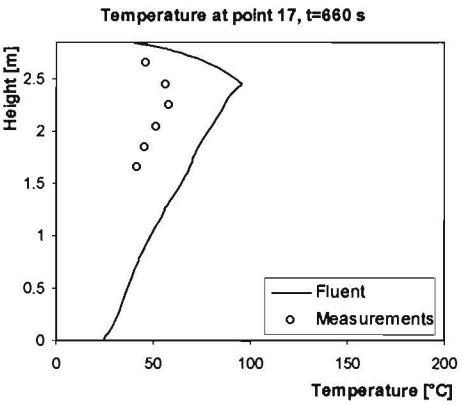
Comparison with measurements: gravitational correction in right x-direction

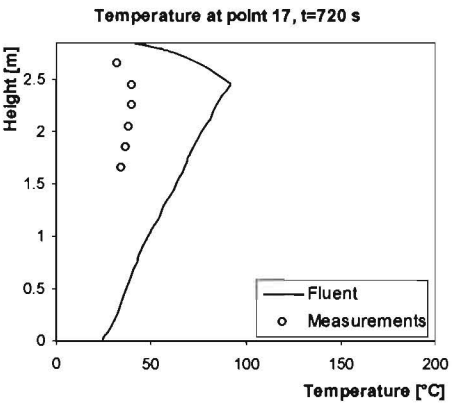


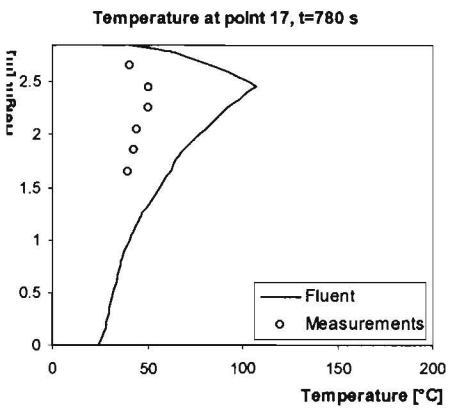


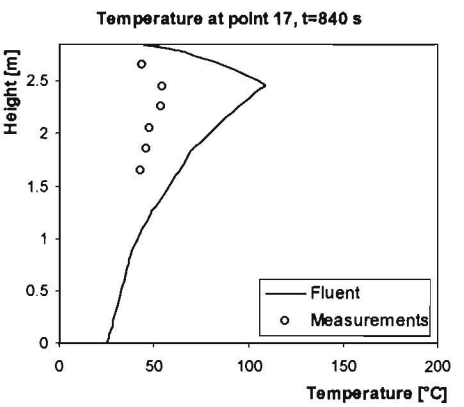


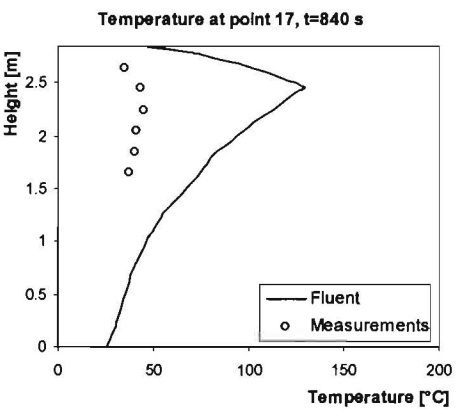


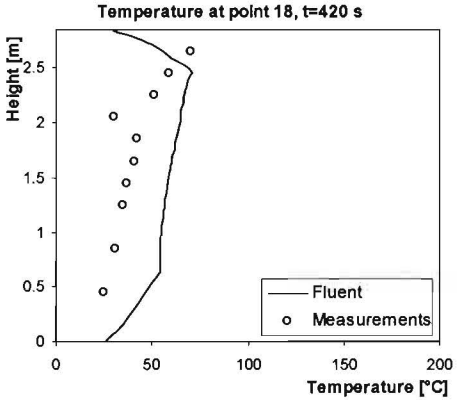


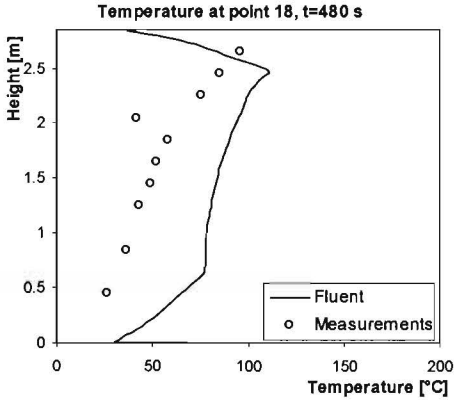


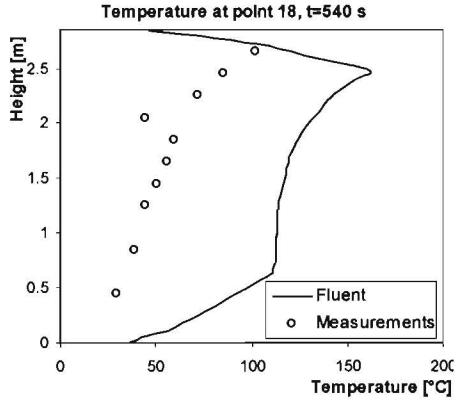


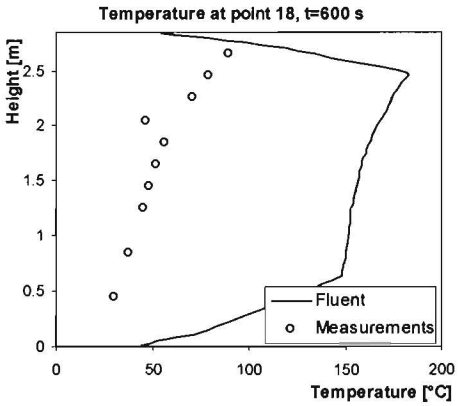


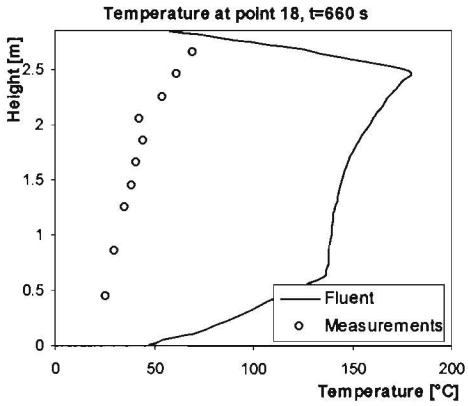


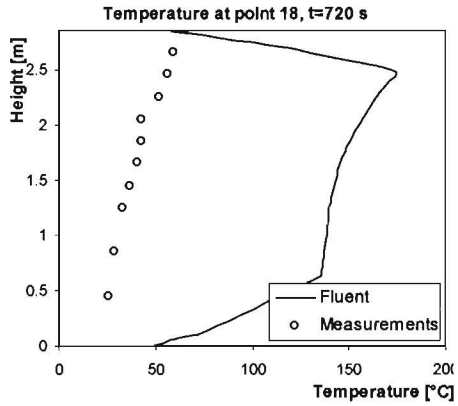

Temperature at point 18, t=420 s
Height [m]
Temperature [°C]
Fluent
Measurements

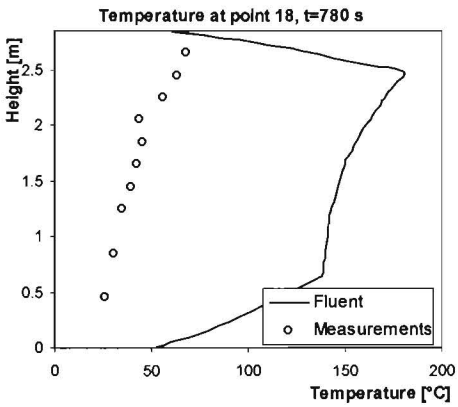

Temperature at point 18, t=480 s
Height [m]
Temperature [°C]
Fluent
Measurements

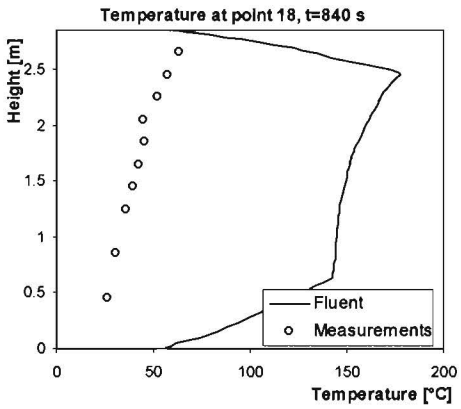

Temperature at point 18, t=540 s
Height [m]
Temperature [°C]
Fluent
Measurements

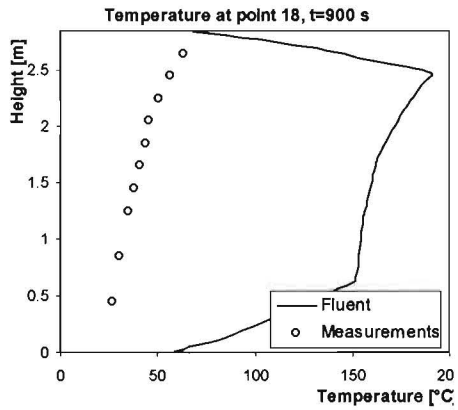

Temperature at point 18, t=600 s
Height [m]
Temperature [°C]
Fluent
Measurements

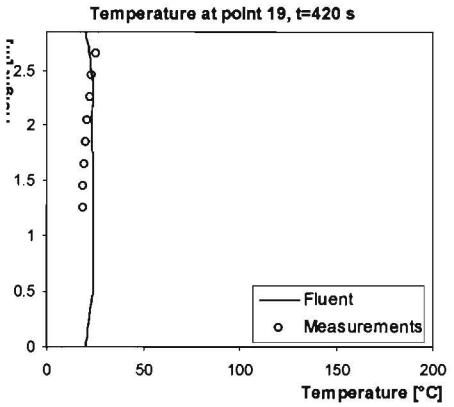

Temperature at point 18, t=660 s
Height [m]
Temperature [°C]
Fluent
Measurements

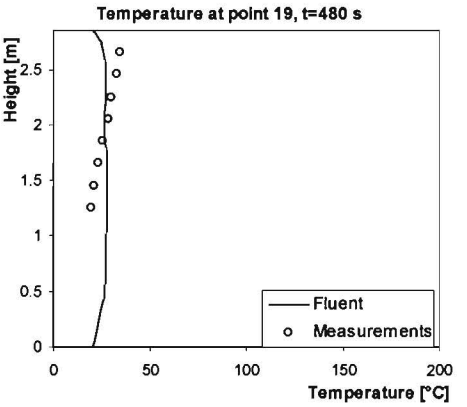

Temperature at point 18, t=720 s
Height [m]
Temperature [°C]
Fluent
Measurements

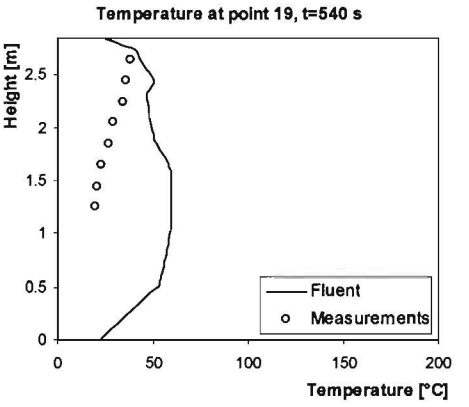

Temperature at point 18, t=780 s
Height [m]
Temperature [°C]
Fluent
Measurements

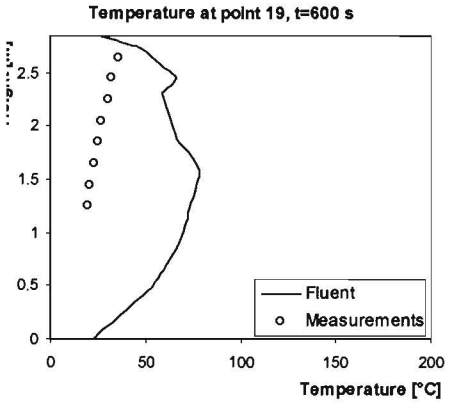

Temperature at point 18, t=840 s
Height [m]
Temperature [°C]
Fluent
Measurements

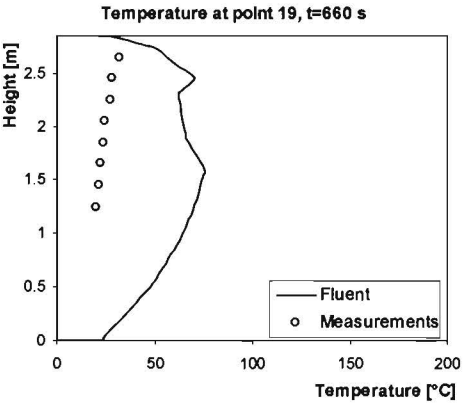

Temperature at point 18, t=900 s
Height [m]
Temperature [°C]
Fluent
Measurements

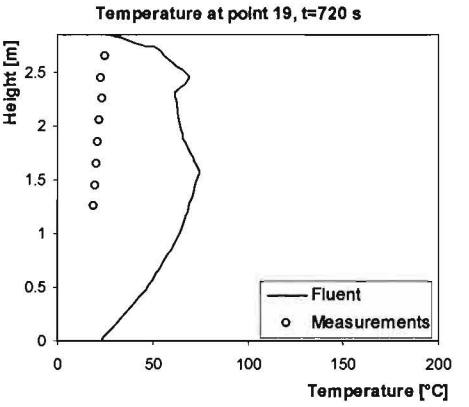

Temperature at point 19, t=420 s
Height [m]
Temperature [°C]
Fluent
Measurements

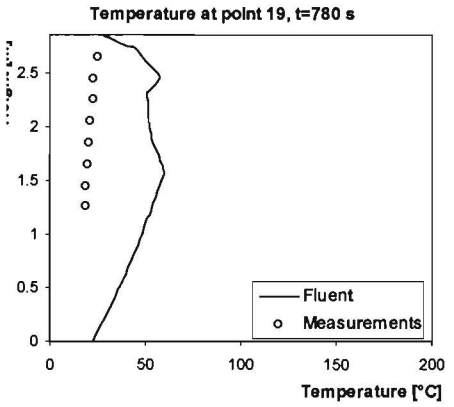

Temperature at point 19, t=480 s
Height [m]
Temperature [°C]
Fluent
Measurements

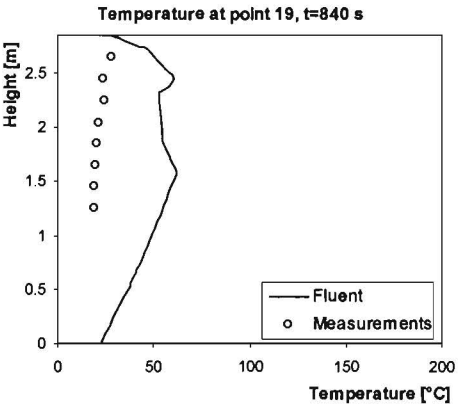

Temperature at point 19, t=540 s
Height [m]
Temperature [°C]
Fluent
Measurements

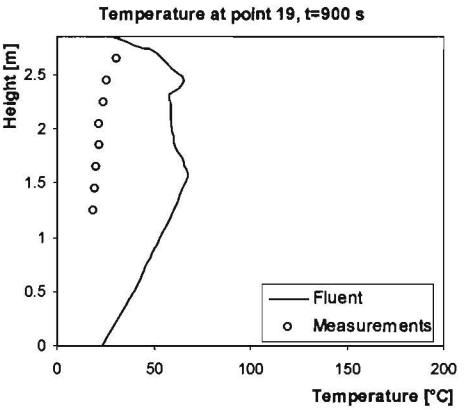

Temperature at point 19, t=600 s
Height [m]
Temperature [°C]
Fluent
Measurements

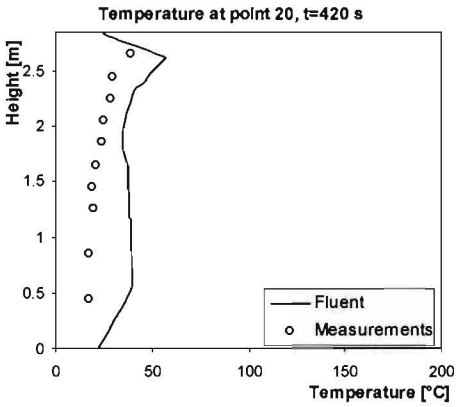

Temperature at point 19, t=660 s
Height [m]
Temperature [°C]
Fluent
Measurements

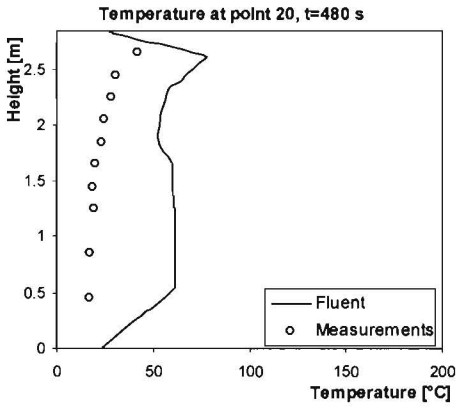

Temperature at point 19, t=720 s
Height [m]
Temperature [°C]
Fluent
Measurements

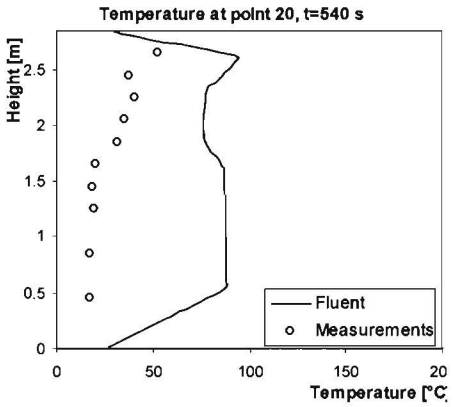

Temperature at point 19, t=780 s
Height [m]
Temperature [°C]
Fluent
Measurements

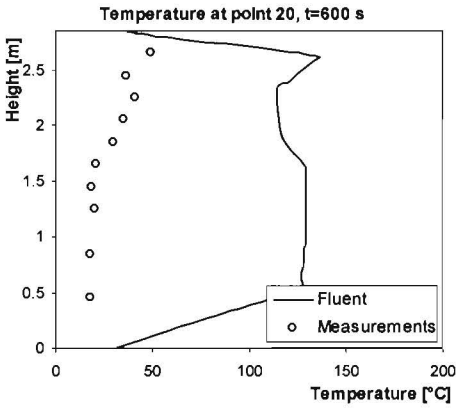

Temperature at point 19, t=840 s
Height [m]
Temperature [°C]
Fluent
Measurements

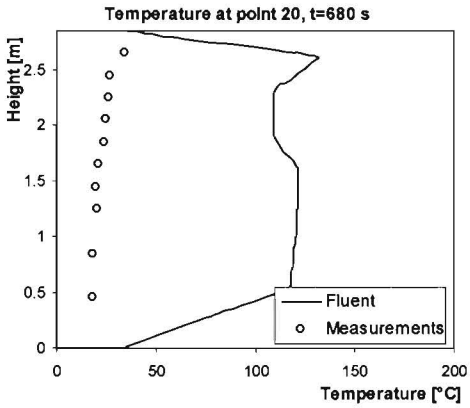

Temperature at point 19, t=900 s
Height [m]
Temperature [°C]
Fluent
Measurements

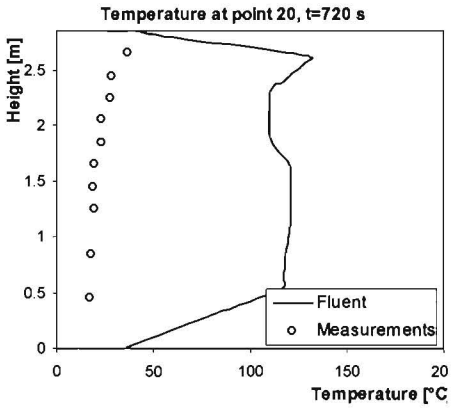

Temperature at point 20, t=420 s
Height [m]
Temperature [°C]
Fluent
Measurements

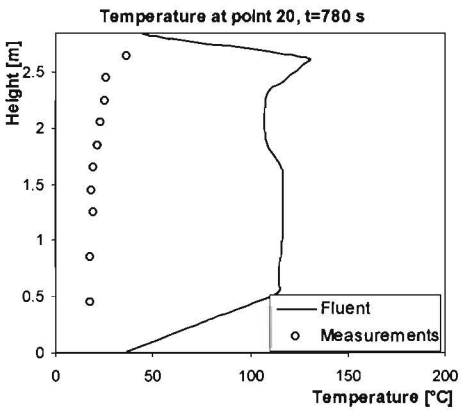

Temperature at point 20, t=480 s
Height [m]
Temperature [°C]
Fluent
Measurements

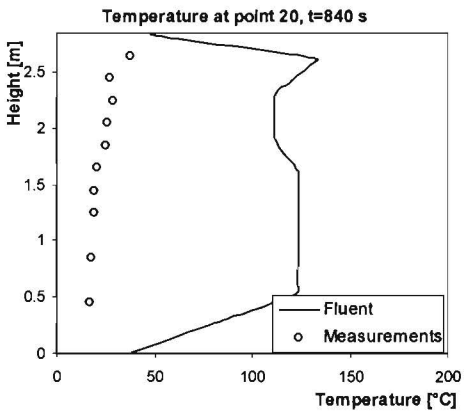

Temperature at point 20, t=540 s
Height [m]
Temperature [°C]
Fluent
Measurements

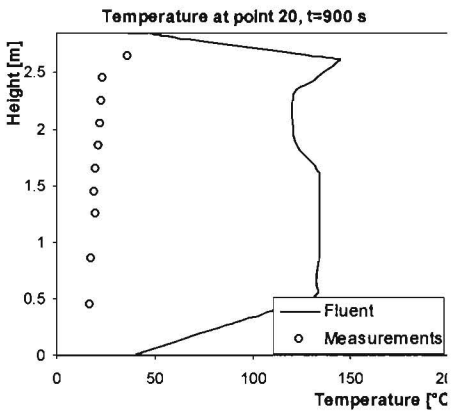

Temperature at point 20, t=600 s
Height [m]
Temperature [°C]
Fluent
Measurements

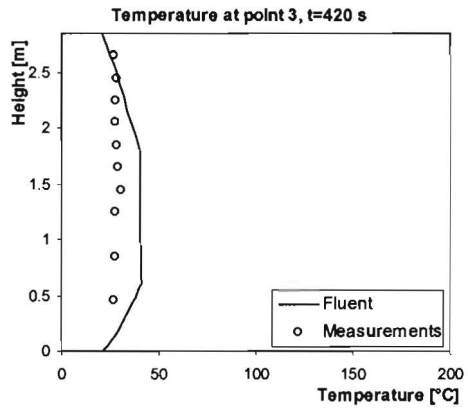

Temperature at point 20, t=680 s
Height [m]
Temperature [°C]
Fluent
Measurements

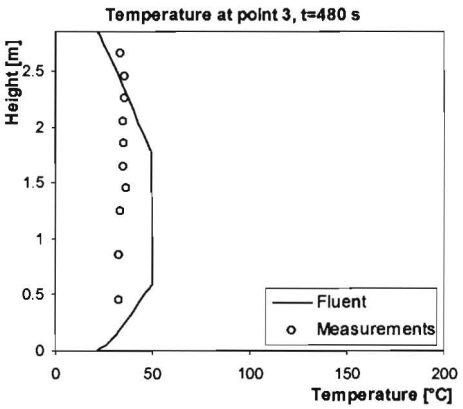

Temperature at point 20, t=720 s
Height [m]
Temperature [°C]
Fluent
Measurements

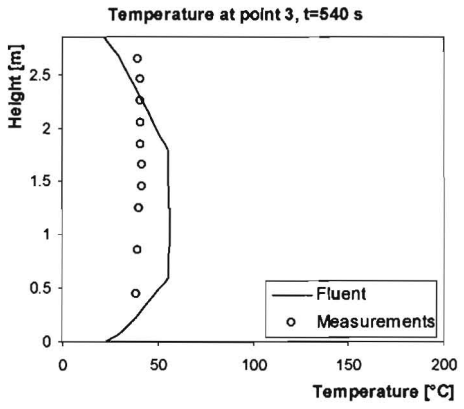

Temperature at point 20, t=780 s
Height [m]
Temperature [°C]
Fluent
Measurements

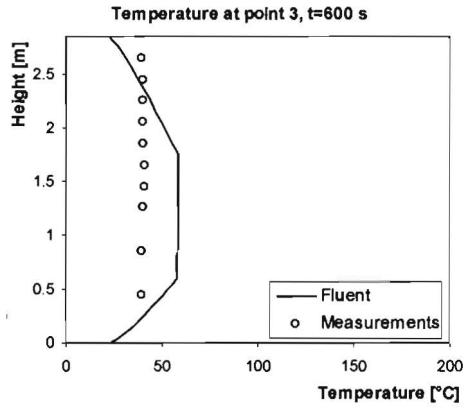

Temperature at point 20, t=840 s
Height [m]
Temperature [°C]
Fluent
Measurements

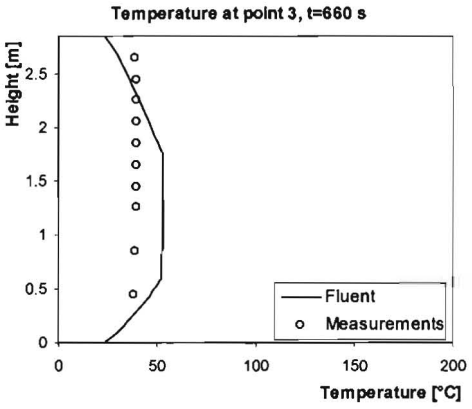

Temperature at point 20, t=900 s
Height [m]
Temperature [°C]
Fluent
Measurements

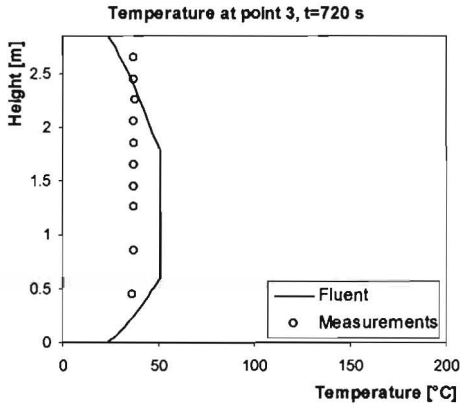

Temperature at point 3, t=420 s
Height [m]
Temperature [°C]
Fluent
Measurements

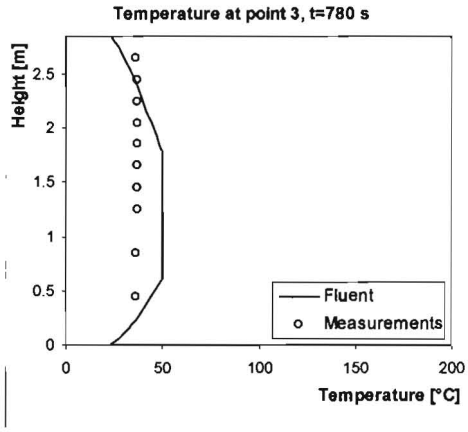

Temperature at point 3, t=480 s
Height [m]
Temperature [°C]
Fluent
Measurements

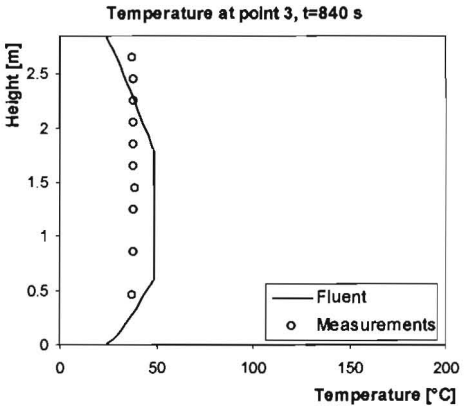

Temperature at point 3, t=540 s
Height [m]
Temperature [°C]
Fluent
Measurements

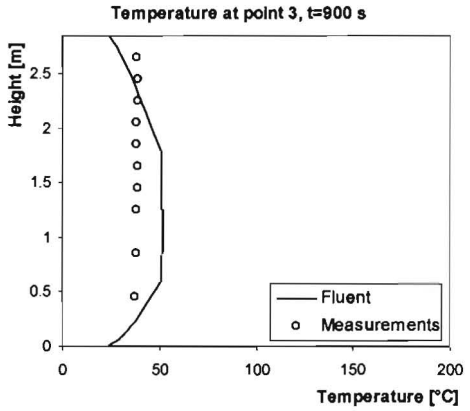

Temperature at point 3, t=600 s
Height [m]
Temperature [°C]
Fluent
Measurements

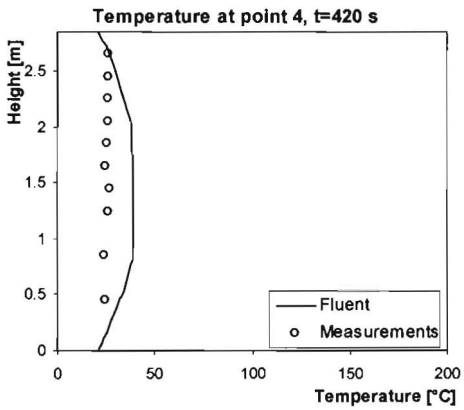

Temperature at point 3, t=660 s
Height [m]
Temperature [°C]
Fluent
Measurements

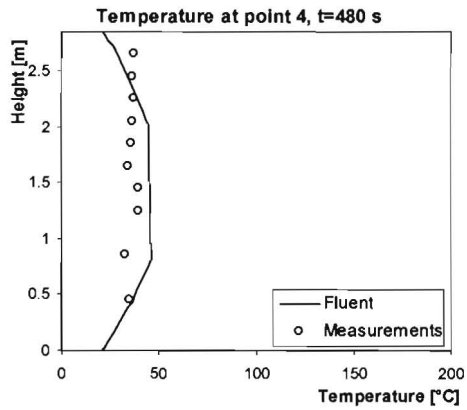

Temperature at point 3, t=720 s
Height [m]
Temperature [°C]
Fluent
Measurements

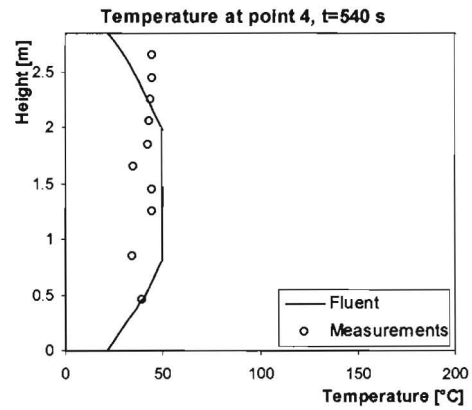

Temperature at point 3, t=780 s
Height [m]
Temperature [°C]
Fluent
Measurements

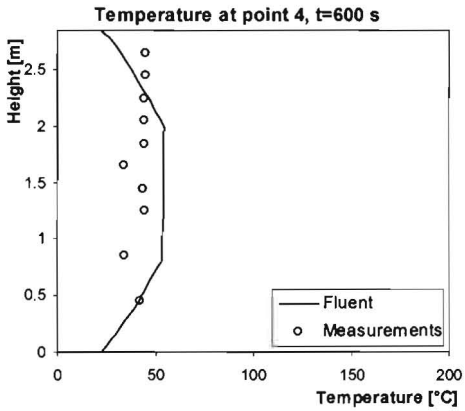

Temperature at point 3, t=840 s
Height [m]
Temperature [°C]
Fluent
Measurements

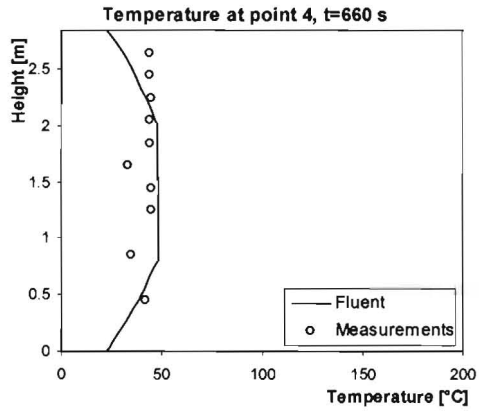

Temperature at point 3, t=900 s
Height [m]
Temperature [°C]
Fluent
Measurements

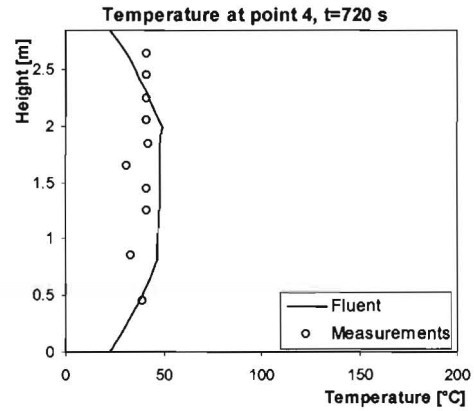

Temperature at point 4, t=420 s
Height [m]
Temperature [°C]
Fluent
Measurements

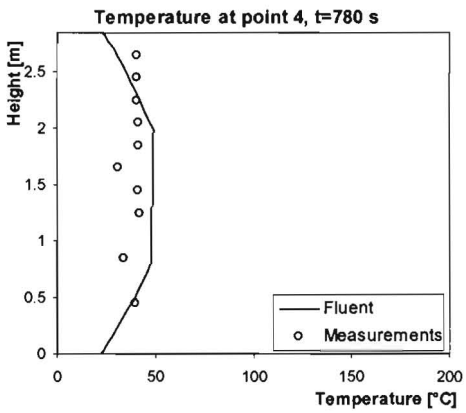

Temperature at point 4, t=480 s
Height [m]
Temperature [°C]
Fluent
Measurements

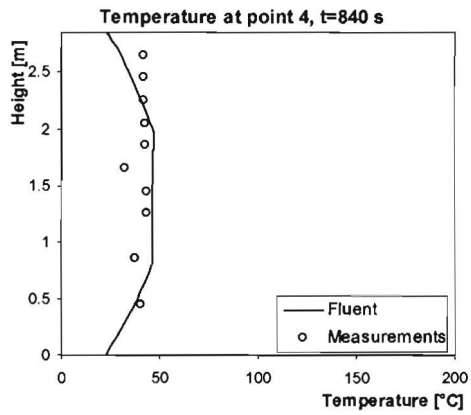

Temperature at point 4, t=540 s
Height [m]
Temperature [°C]
Fluent
Measurements

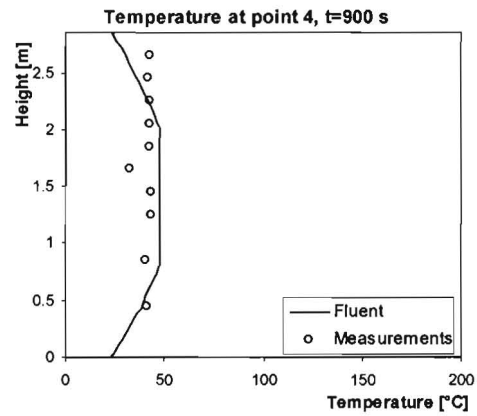

Temperature at point 4, t=600 s
Height [m]
Temperature [°C]
Fluent
Measurements

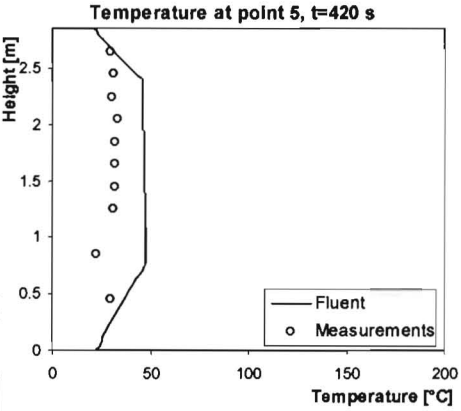

Temperature at point 4, t=660 s
Height [m]
Temperature [°C]
Fluent
Measurements

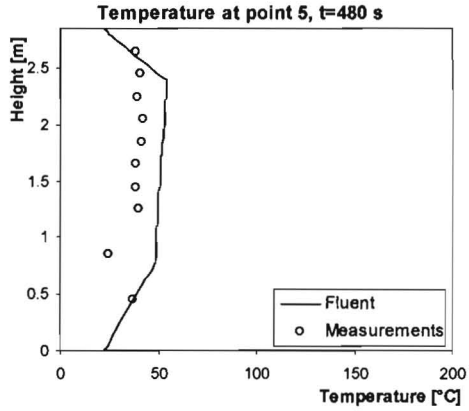

Temperature at point 4, t=720 s
Height [m]
Temperature [°C]
Fluent
Measurements

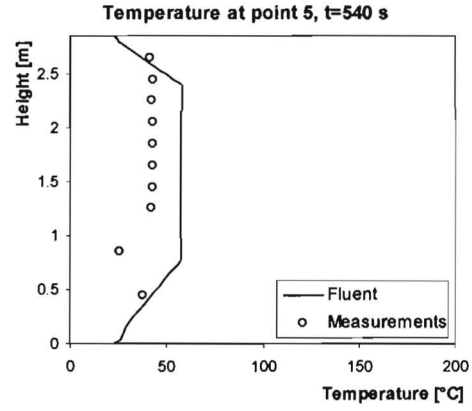

Temperature at point 4, t=780 s
Height [m]
Temperature [°C]
Fluent
Measurements

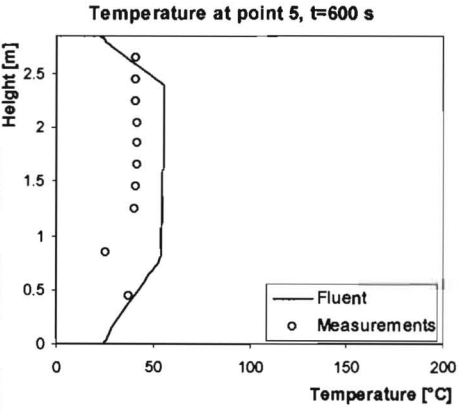

Temperature at point 4, t=840 s
Height [m]
Temperature [°C]
Fluent
Measurements

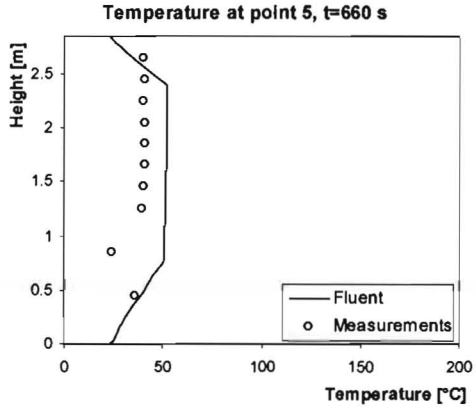

Temperature at point 4, t=900 s
Height [m]
Temperature [°C]
Fluent
Measurements

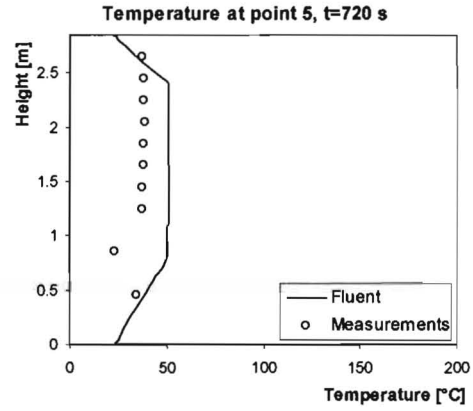

Temperature at point 5, t=420 s
Height [m]
Temperature [°C]
Fluent
Measurements

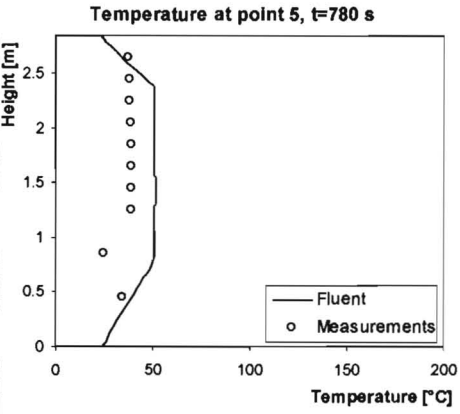

Temperature at point 5, t=480 s
Height [m]
Temperature [°C]
Fluent
Measurements

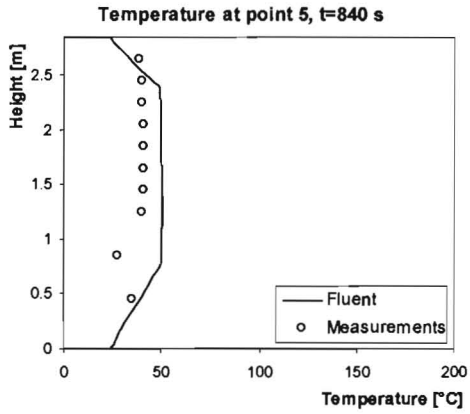

Temperature at point 5, t=540 s
Height [m]
Temperature [°C]
Fluent
Measurements

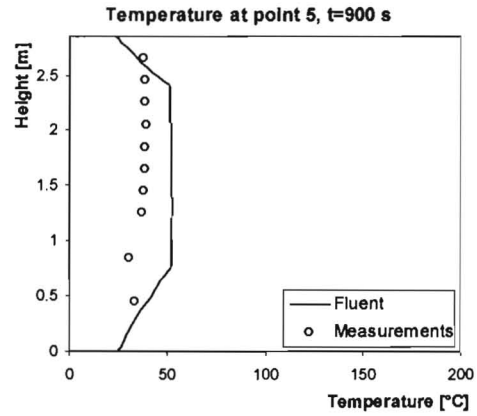

Temperature at point 5, t=600 s
Height [m]
Temperature [°C]
Fluent
Measurements

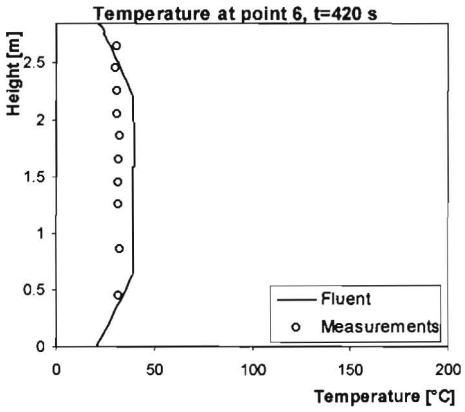

Temperature at point 5, t=660 s
Height [m]
Temperature [°C]
Fluent
Measurements

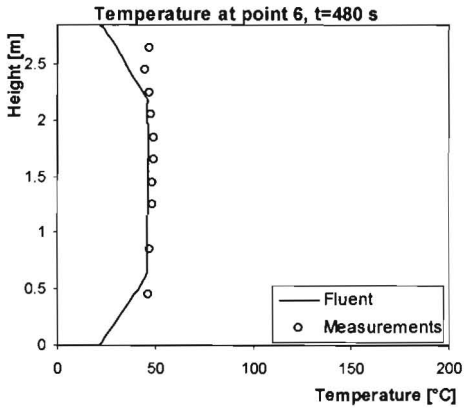

Temperature at point 5, t=720 s
Height [m]
Temperature [°C]
Fluent
Measurements

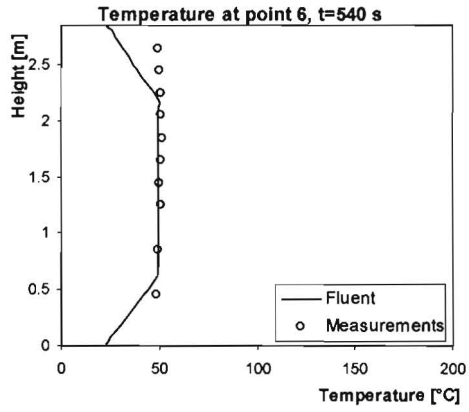

Temperature at point 5, t=780 s
Height [m]
Temperature [°C]
Fluent
Measurements

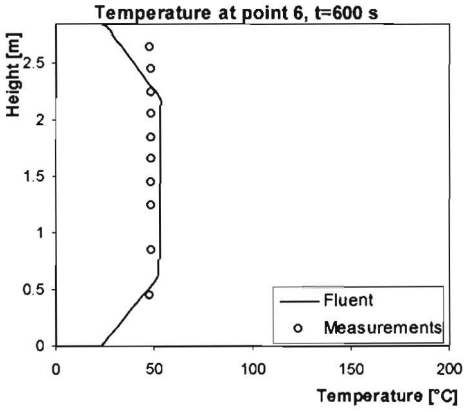

Temperature at point 5, t=840 s
Height [m]
Temperature [°C]
Fluent
Measurements

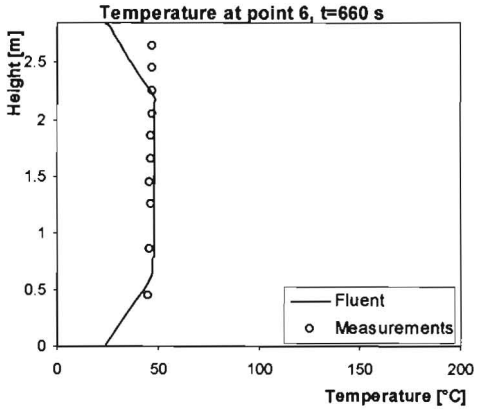

Temperature at point 5, t=900 s
Height [m]
Temperature [°C]
Fluent
Measurements

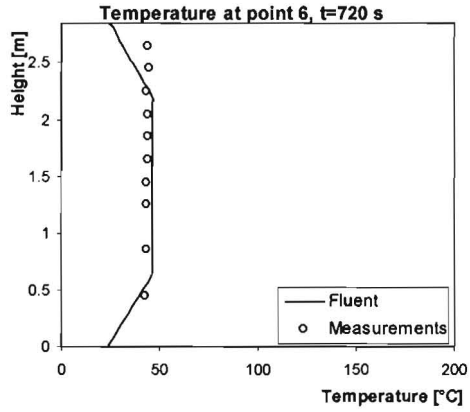

Temperature at point 6, t=420 s
Height [m]
Temperature [°C]
Fluent
Measurements

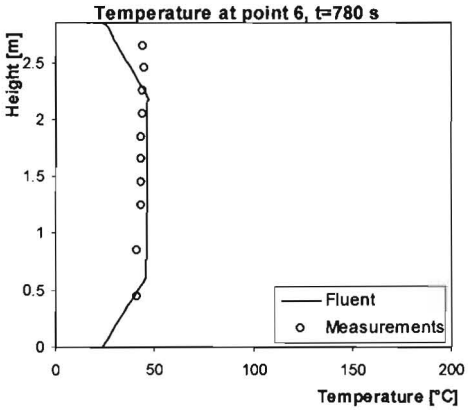

Temperature at point 6, t=480 s
Height [m]
Temperature [°C]
Fluent
Measurements

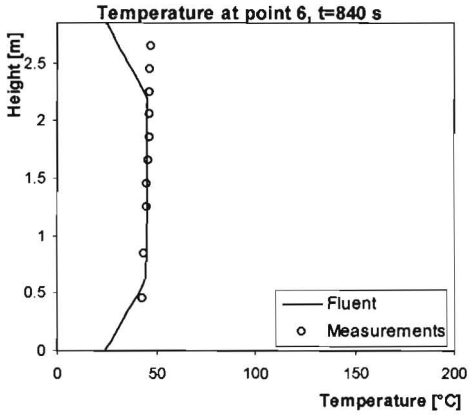

Temperature at point 6, t=540 s
Height [m]
Temperature [°C]
Fluent
Measurements

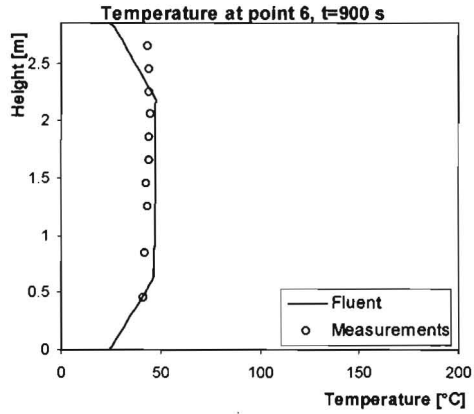

Temperature at point 6, t=600 s
Height [m]
Temperature [°C]
Fluent
Measurements

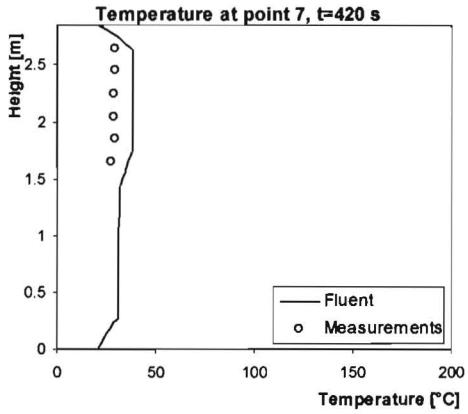

Temperature at point 6, t=660 s
Height [m]
Temperature [°C]
Fluent
Measurements

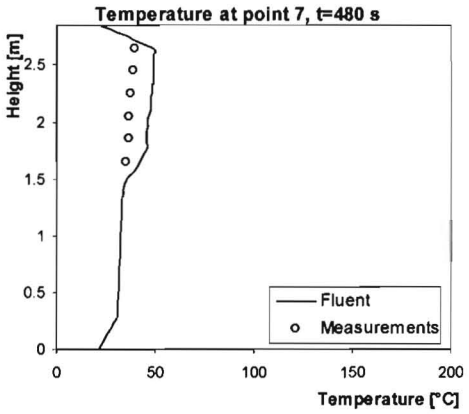

Temperature at point 6, t=720 s
Height [m]
Temperature [°C]
Fluent
Measurements

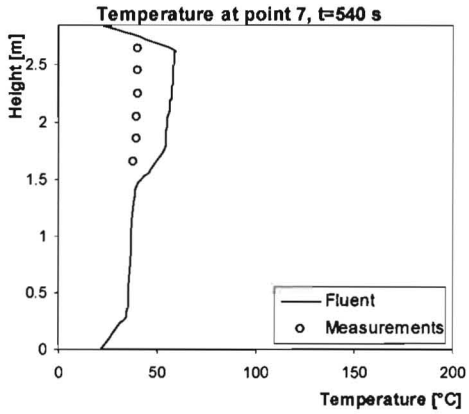

Temperature at point 6, t=780 s
Height [m]
Temperature [°C]
Fluent
Measurements

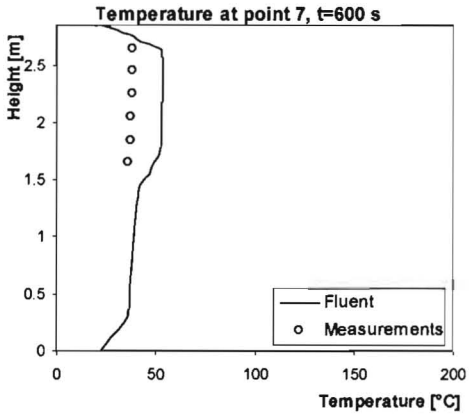

Temperature at point 6, t=840 s
Height [m]
Temperature [°C]
Fluent
Measurements

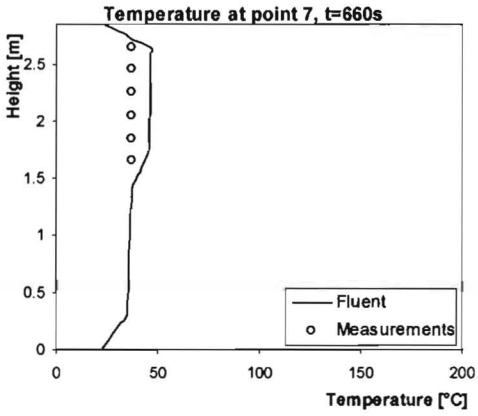

Temperature at point 6, t=900 s
Height [m]
Temperature [°C]
Fluent
Measurements

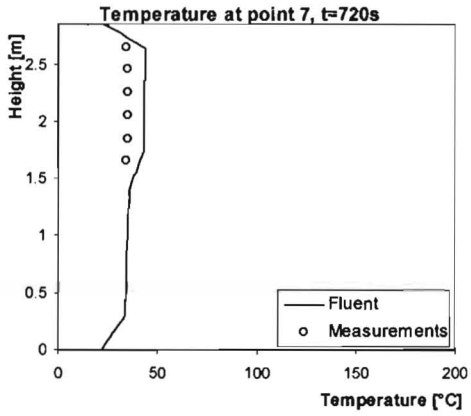

Temperature at point 7, t=420 s
Height [m]
Temperature [°C]
Fluent
Measurements

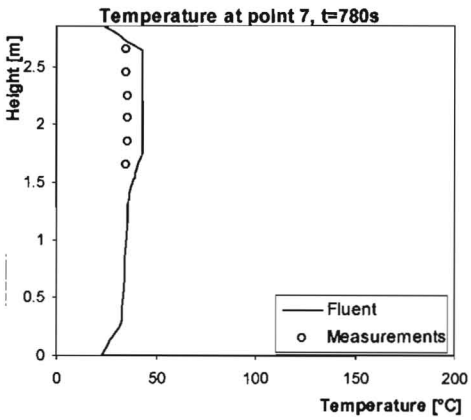

Temperature at point 7, t=480 s
Height [m]
Temperature [°C]
Fluent
Measurements

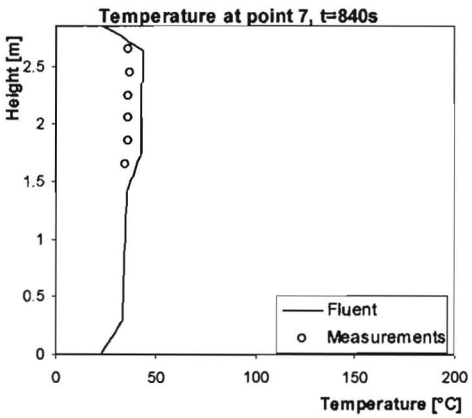

Temperature at point 7, t=540 s
Height [m]
Temperature [°C]
Fluent
Measurements

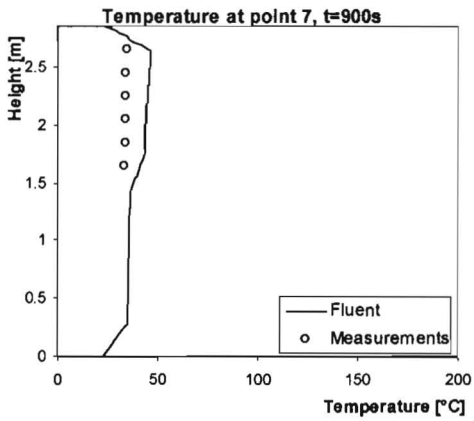

Temperature at point 7, t=600 s
Height [m]
Temperature [°C]
Fluent
Measurements

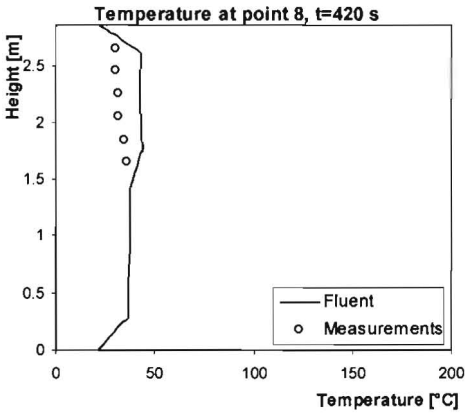

Temperature at point 7, t=660s
Height [m]
Temperature [°C]
Fluent
Measurements

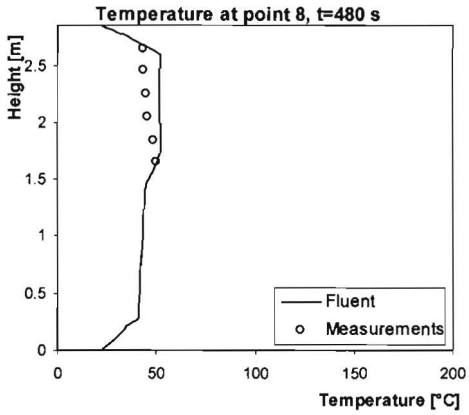

Temperature at point 7, t=720s
Height [m]
Temperature [°C]
Fluent
Measurements

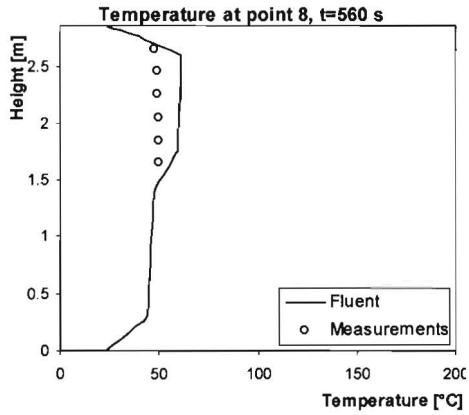

Temperature at point 7, t=780s
Height [m]
Temperature [°C]
Fluent
Measurements

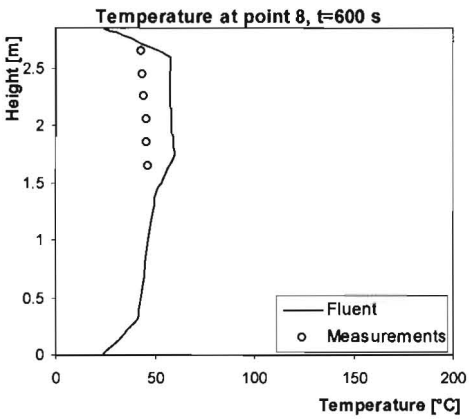

Temperature at point 7, t=840s
Height [m]
Temperature [°C]
Fluent
Measurements

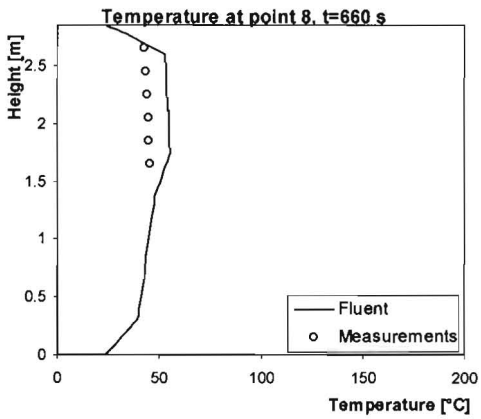

Temperature at point 7, t=900s
Height [m]
Temperature [°C]
Fluent
Measurements

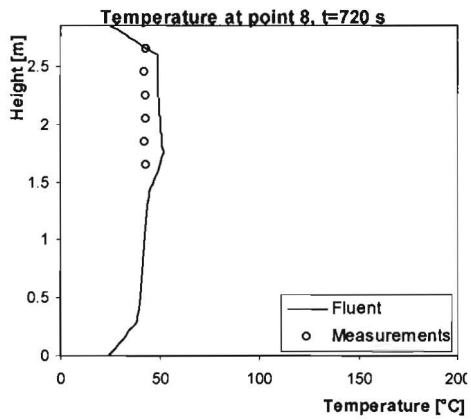

Temperature at point 8, t=420 s
Height [m]
Temperature [°C]
Fluent
Measurements

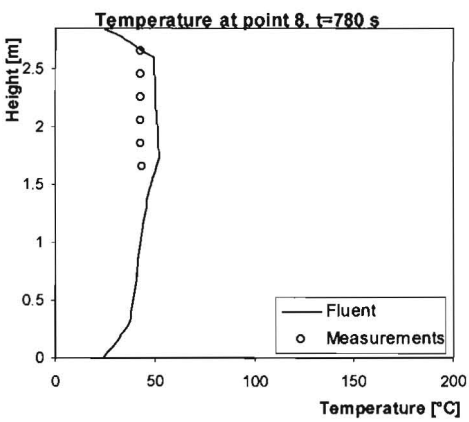

Temperature at point 8, t=480 s
Height [m]
Temperature [°C]
Fluent
Measurements

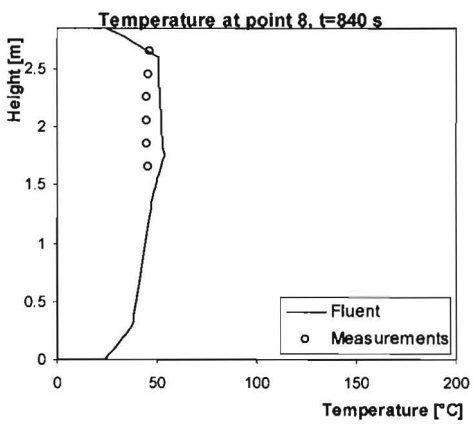

Temperature at point 8, t=560 s
Height [m]
Temperature [°C]
Fluent
Measurements

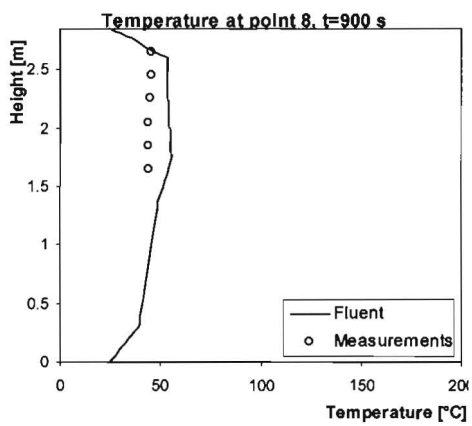

Temperature at point 8, t=600 s
Height [m]
Temperature [°C]
Fluent
Measurements


Temperature at point 8, t=660 s
Height [m]
Temperature [°C]
Fluent
Measurements

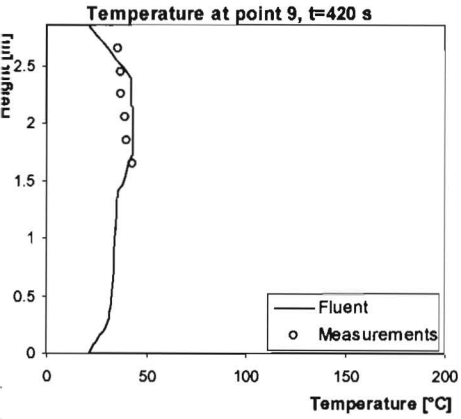

Temperature at point 8, t=720 s
Height [m]
Temperature [°C]
Fluent
Measurements

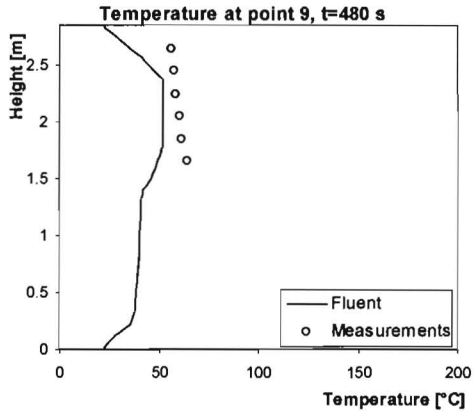

Temperature at point 8, t=780 s
Height [m]
Temperature [°C]
Fluent
Measurements

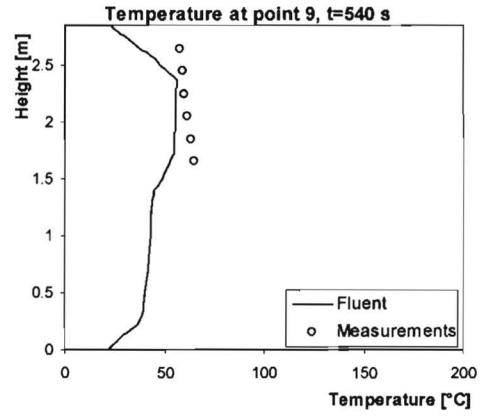

Temperature at point 8, t=840 s
Height [m]
Temperature [°C]
Fluent
Measurements

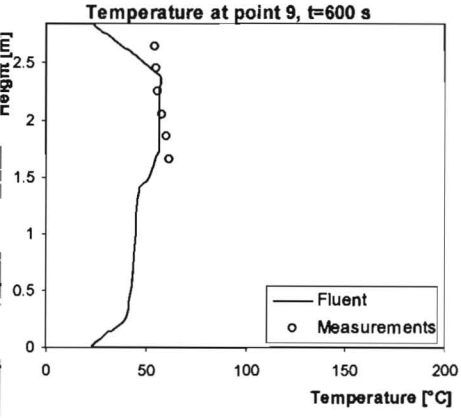

Temperature at point 8, t=900 s
Height [m]
Temperature [°C]
Fluent
Measurements

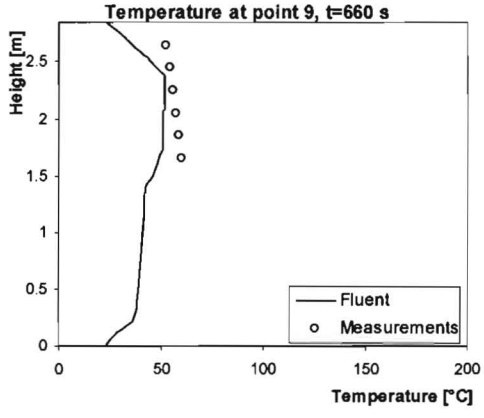
Comparison with measurements: gravitational correction in right x-direction

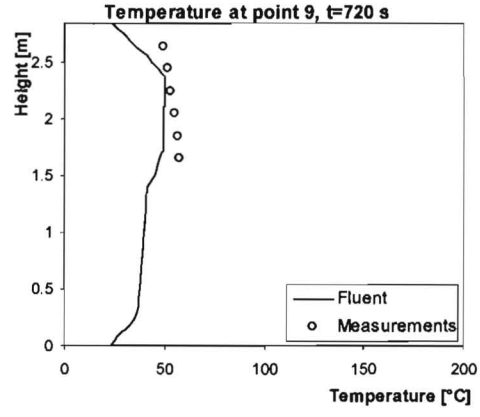


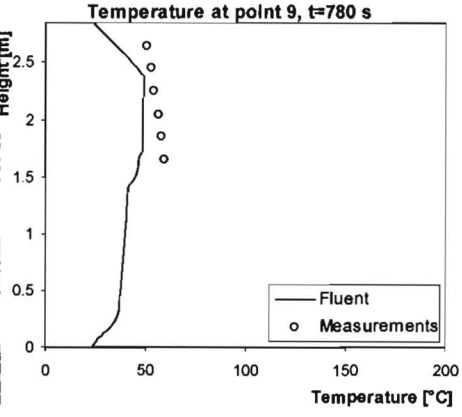


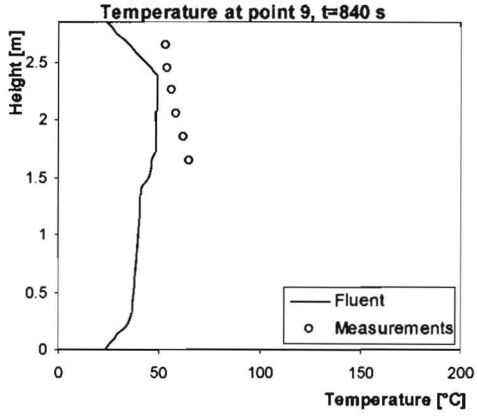


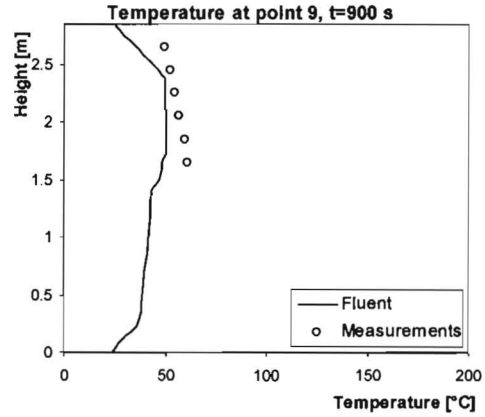






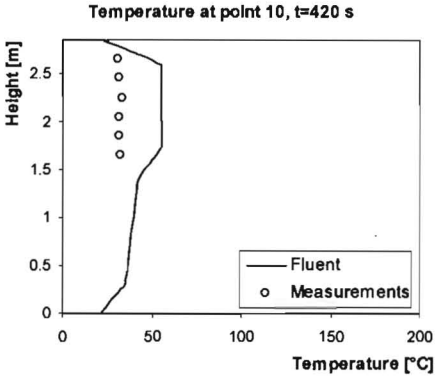


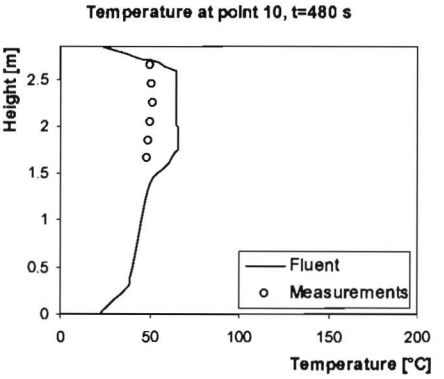


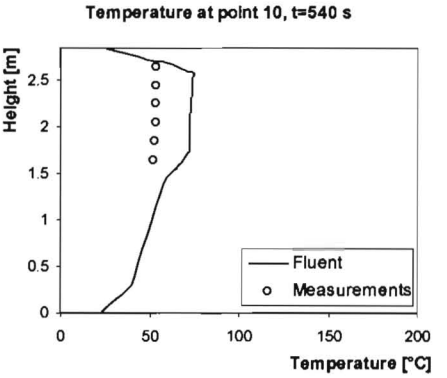


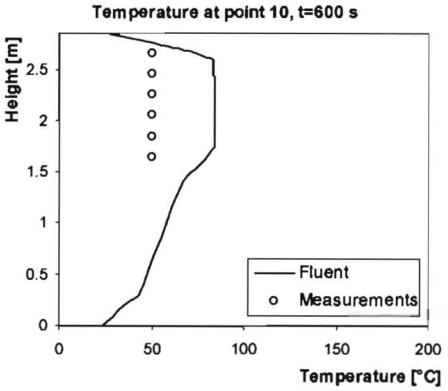
Appendix 4: Graphs comparing measurement data with no-gravity simulation results

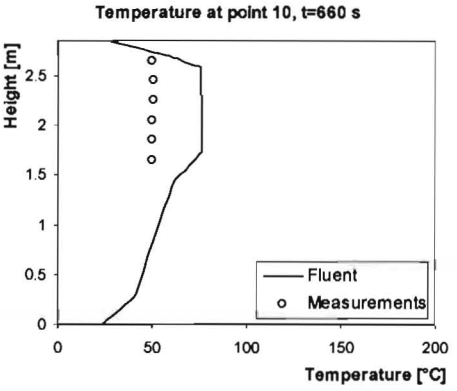
Comparison with measurements: no gravitational correction

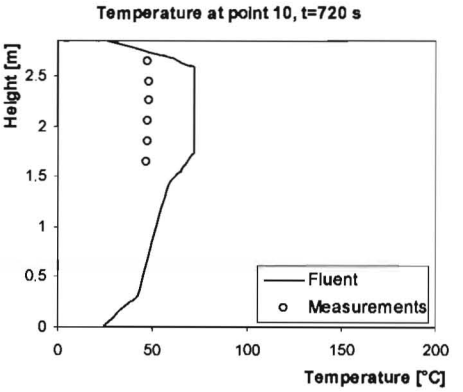


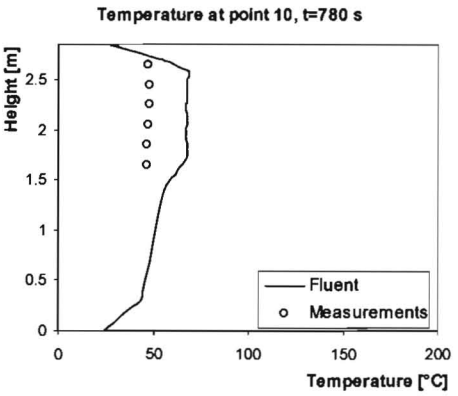


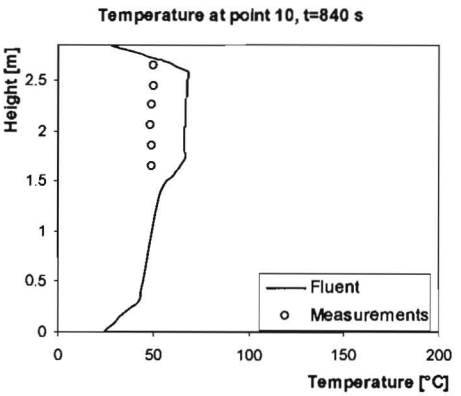


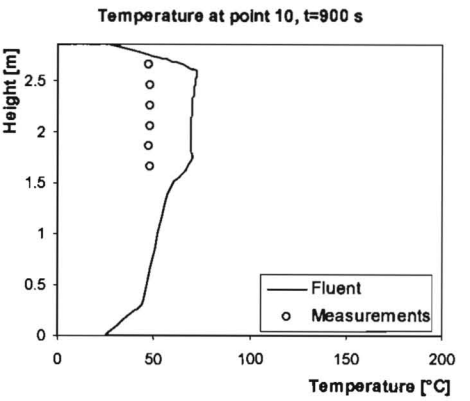




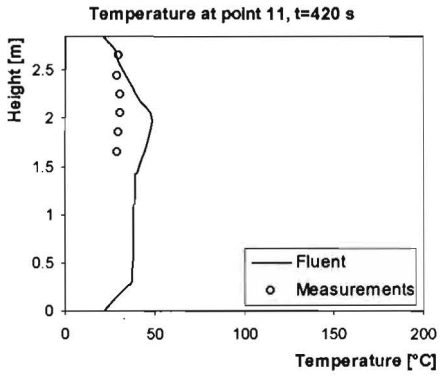


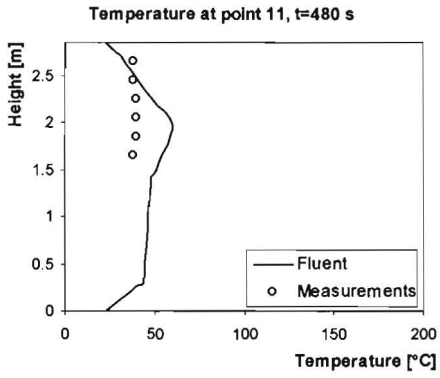


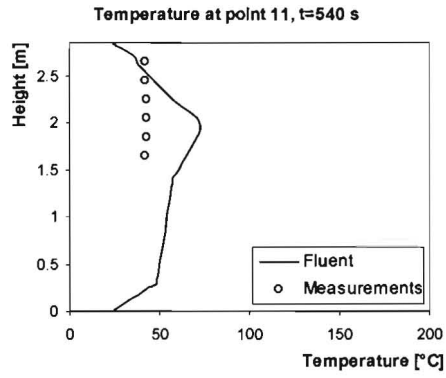


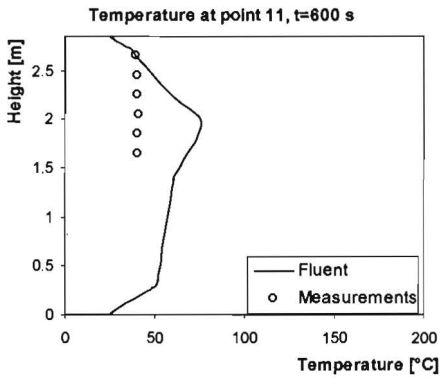


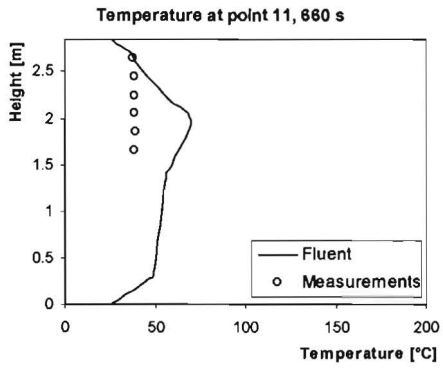
Comparison with measurements: no gravitational correction

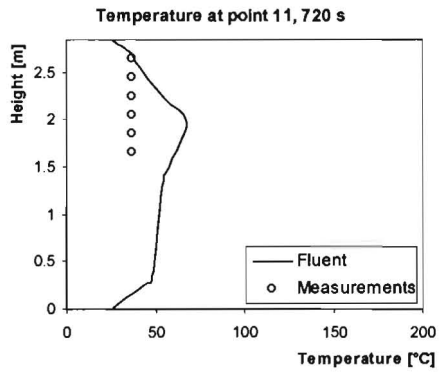


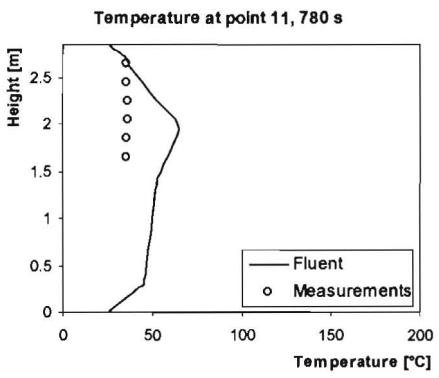


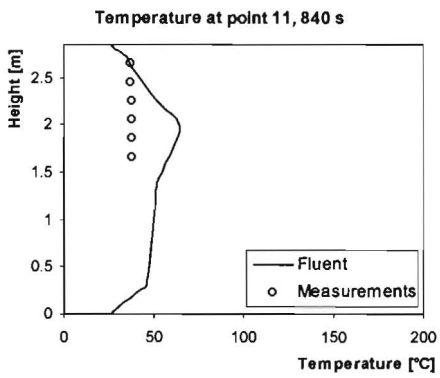


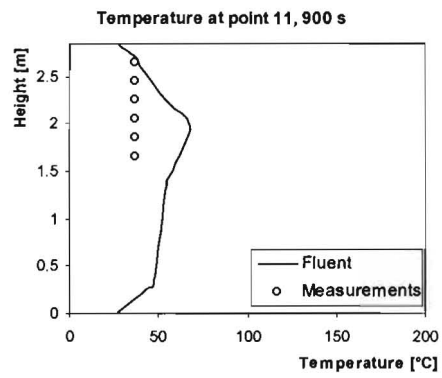




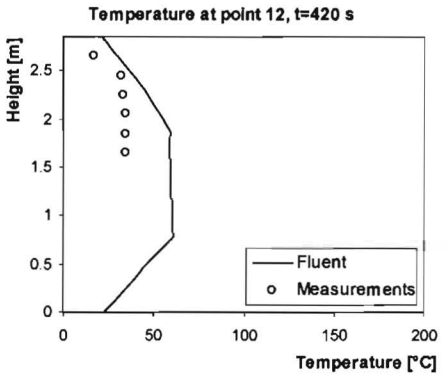


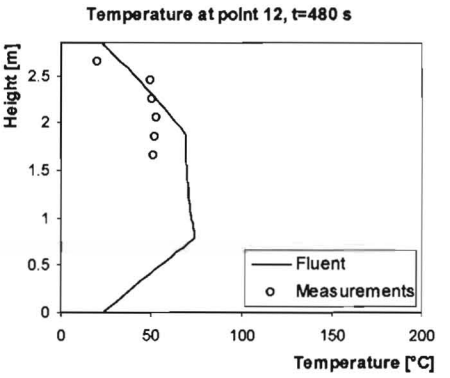


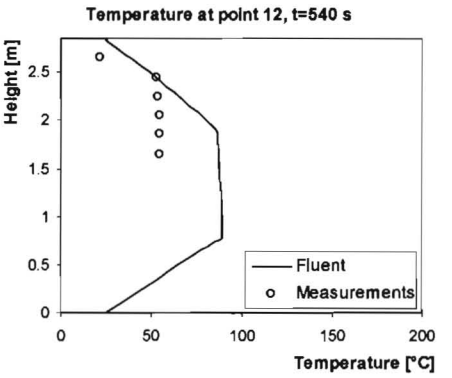


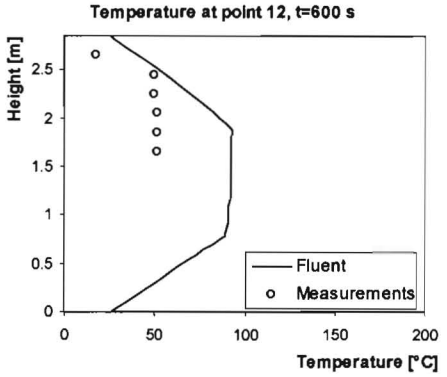


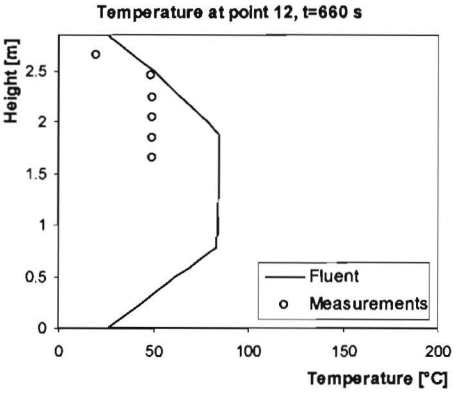
Comparison with measurements: no gravitational correction

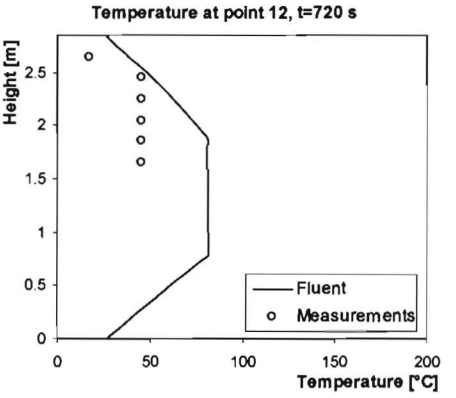


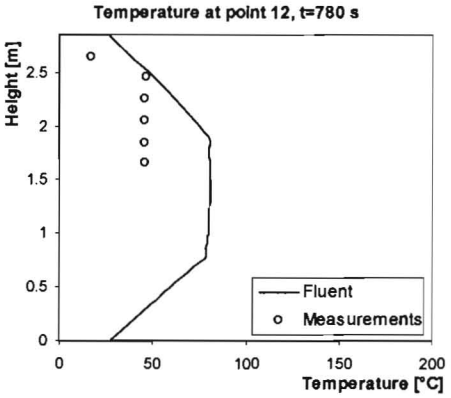


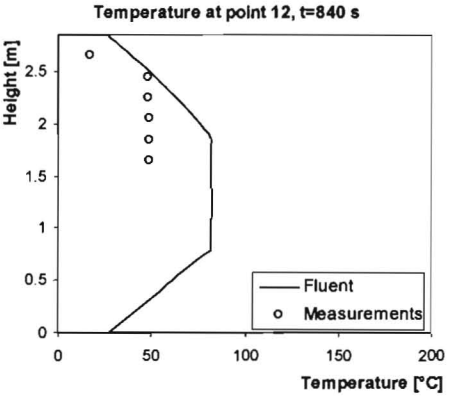


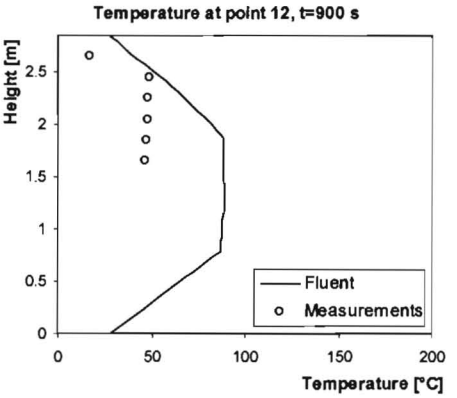


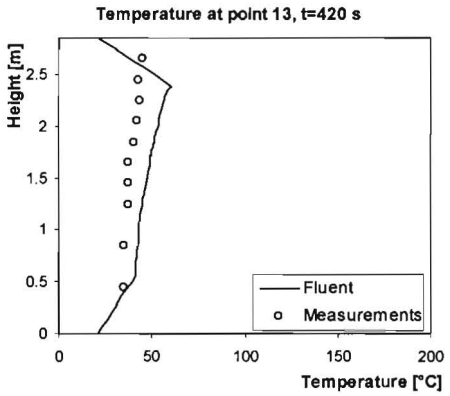


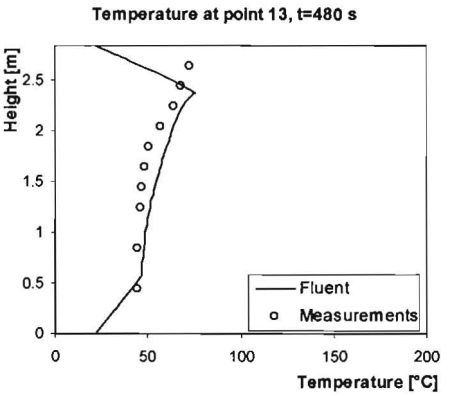


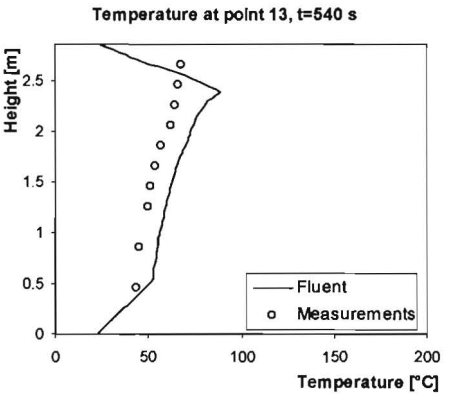


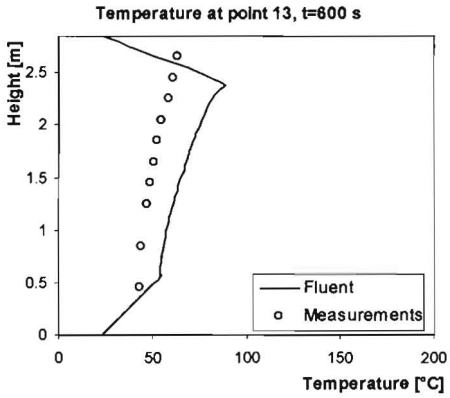


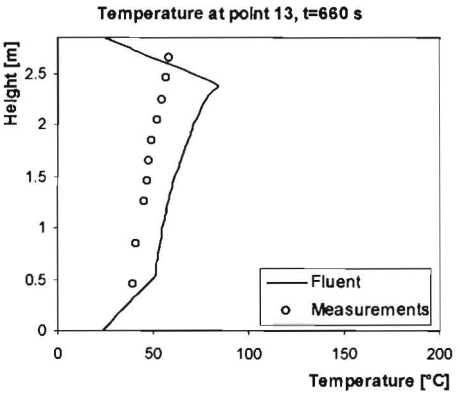


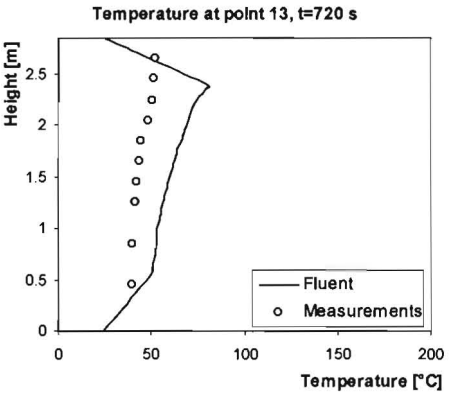

Temperature at point 13, t=420 s
Height [m]
Temperature [°C]
Fluent
Measurements

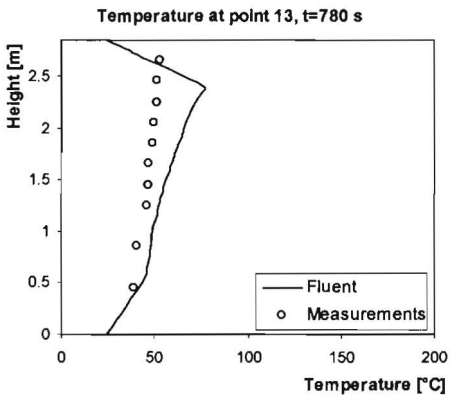

Temperature at point 13, t=480 s
Height [m]
Temperature [°C]
Fluent
Measurements

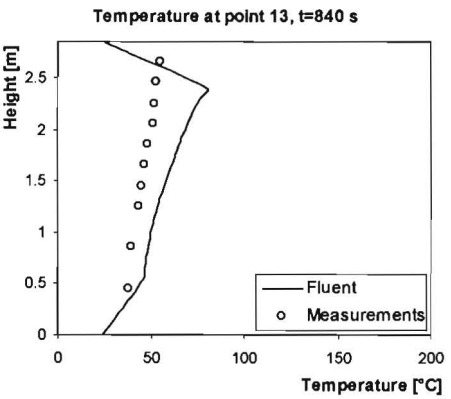

Temperature at point 13, t=540 s
Height [m]
Temperature [°C]
Fluent
Measurements

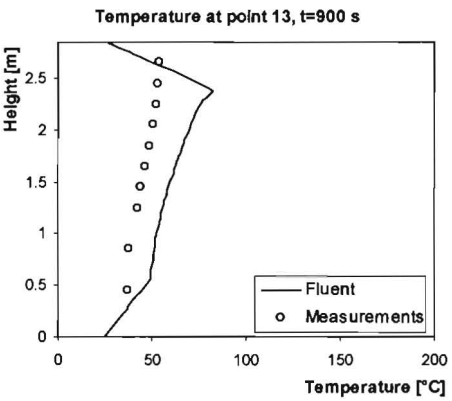

Temperature at point 13, t=600 s
Height [m]
Temperature [°C]
Fluent
Measurements


Temperature at point 13, t=660 s
Height [m]
Temperature [°C]
Fluent
Measurements

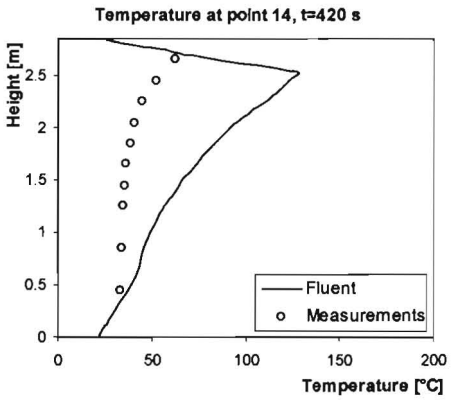

Temperature at point 13, t=720 s
Height [m]
Temperature [°C]
Fluent
Measurements

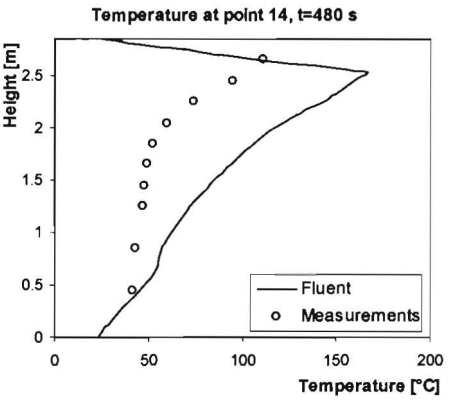

Temperature at point 13, t=780 s
Height [m]
Temperature [°C]
Fluent
Measurements

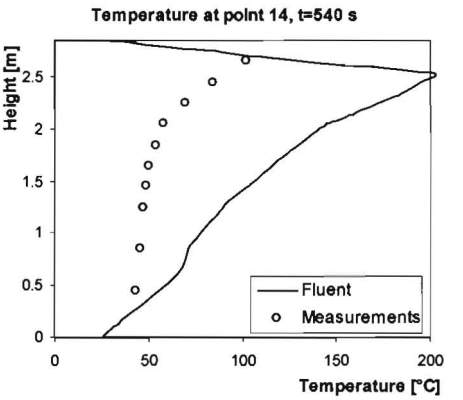

Temperature at point 13, t=840 s
Height [m]
Temperature [°C]
Fluent
Measurements

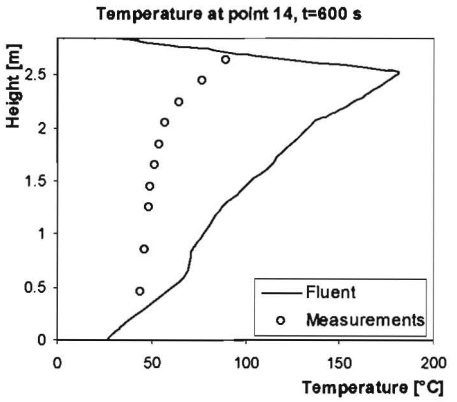

Temperature at point 13, t=900 s
Height [m]
Temperature [°C]
Fluent
Measurements

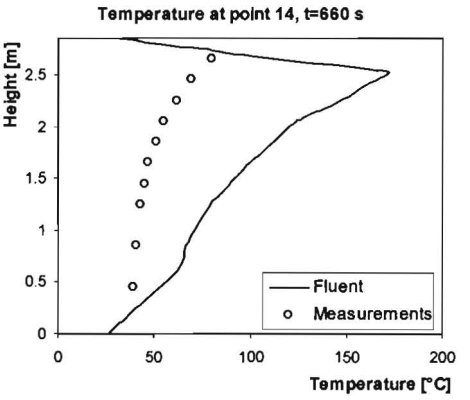
Comparison with measurements: no gravitational correction

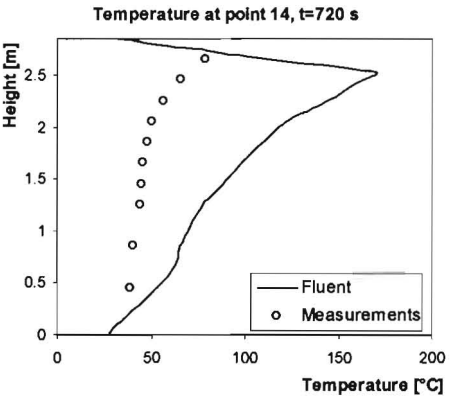


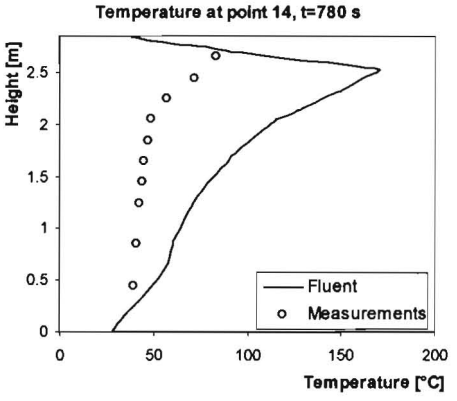


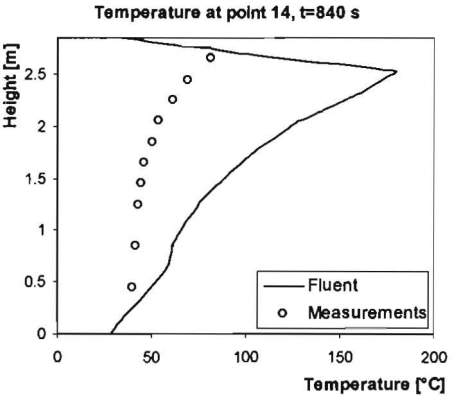


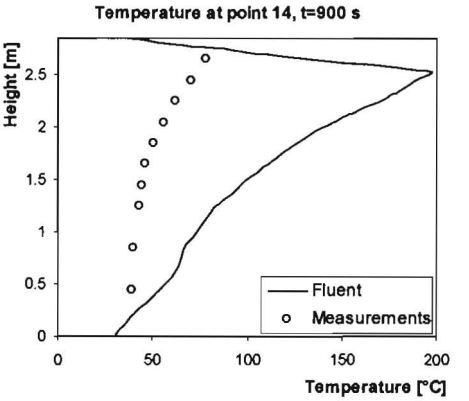


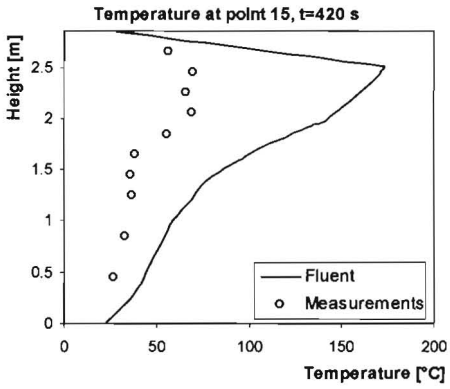


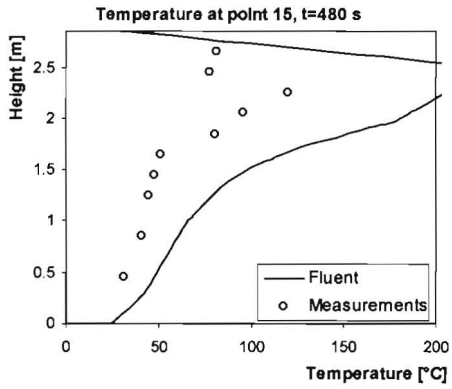


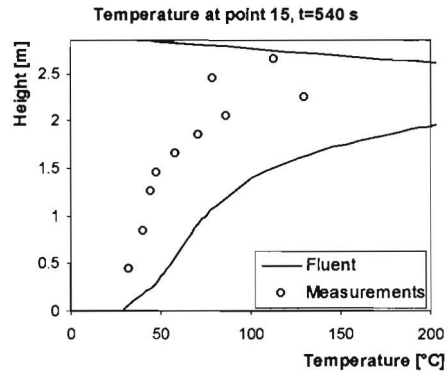


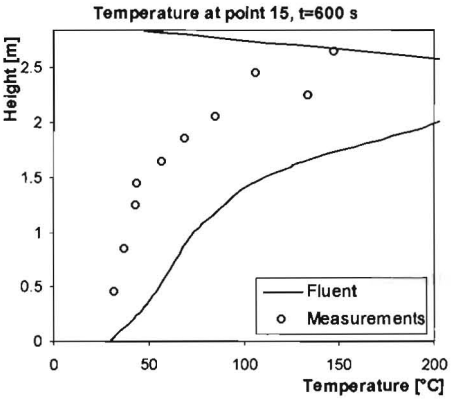


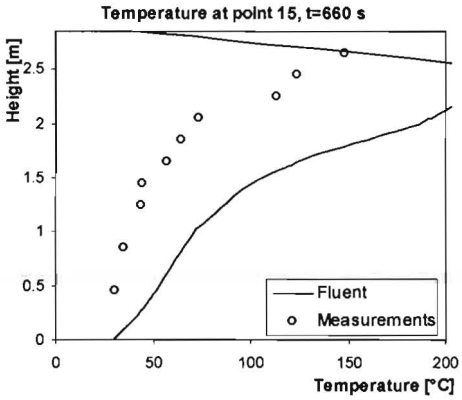


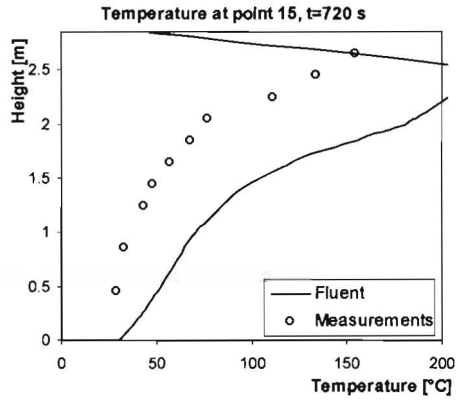

Temperature at point 15, t=420 s
Height [m]
Temperature [°C]
Fluent
Measurements

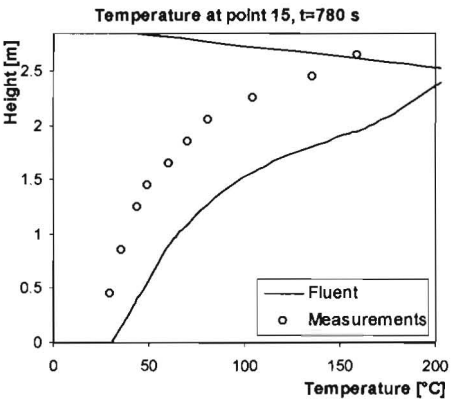

Temperature at point 15, t=480 s
Height [m]
Temperature [°C]
Fluent
Measurements

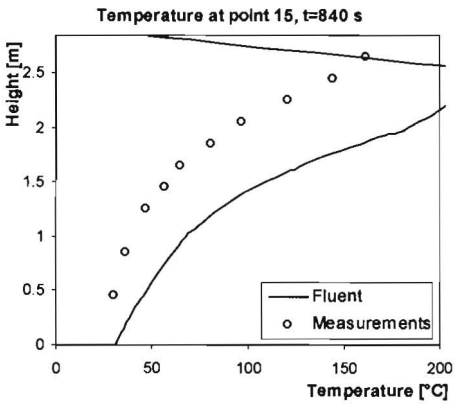

Temperature at point 15, t=540 s
Height [m]
Temperature [°C]
Fluent
Measurements

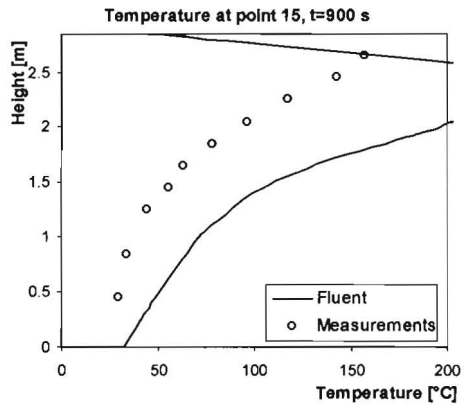

Temperature at point 15, t=600 s
Height [m]
Temperature [°C]
Fluent
Measurements


Temperature at point 15, t=660 s
Height [m]
Temperature [°C]
Fluent
Measurements

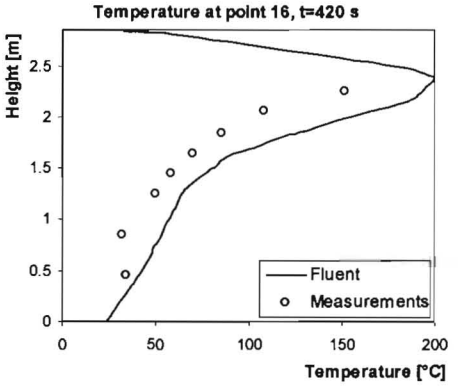

Temperature at point 15, t=720 s
Height [m]
Temperature [°C]
Fluent
Measurements

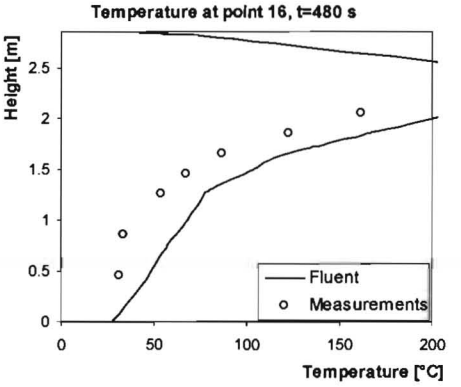

Temperature at point 15, t=780 s
Height [m]
Temperature [°C]
Fluent
Measurements

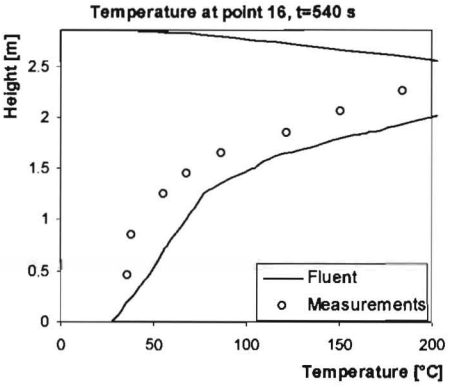

Temperature at point 15, t=840 s
Height [m]
Temperature [°C]
Fluent
Measurements

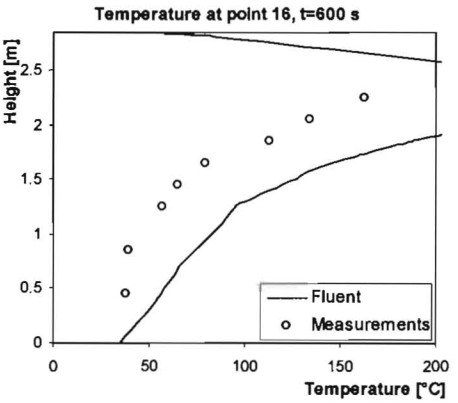

Temperature at point 15, t=900 s
Height [m]
Temperature [°C]
Fluent
Measurements

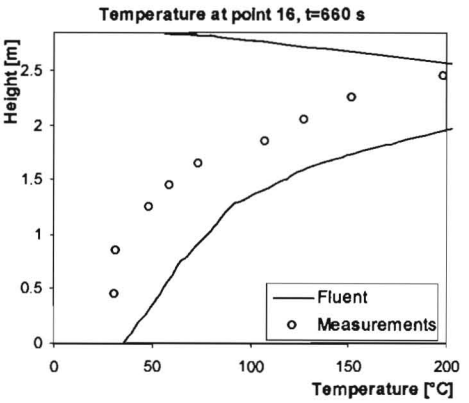
Comparison with measurements: no gravitational correction

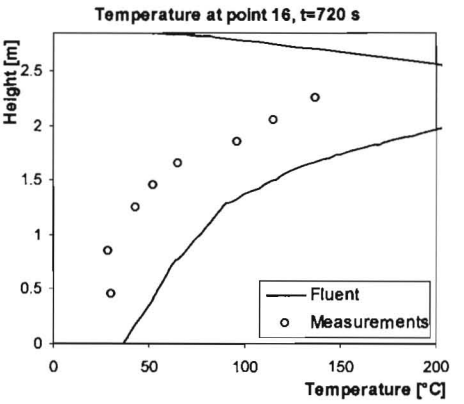


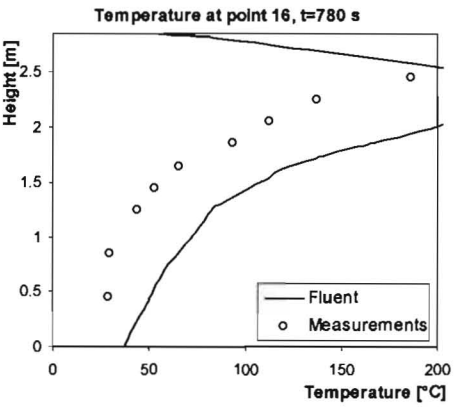


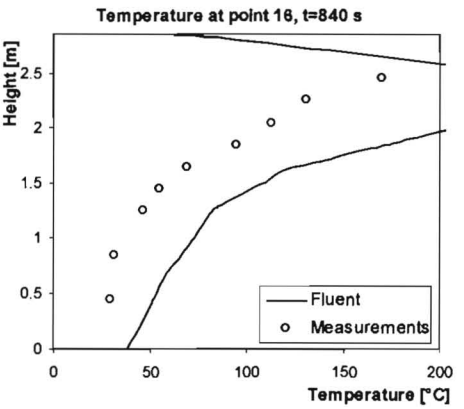


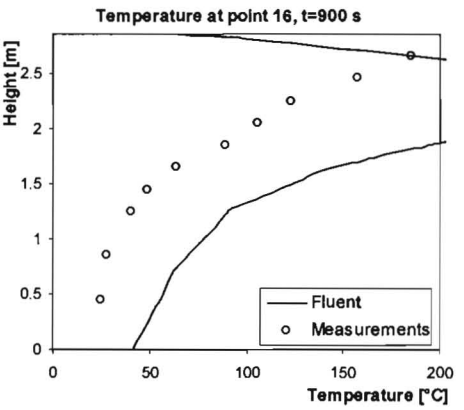


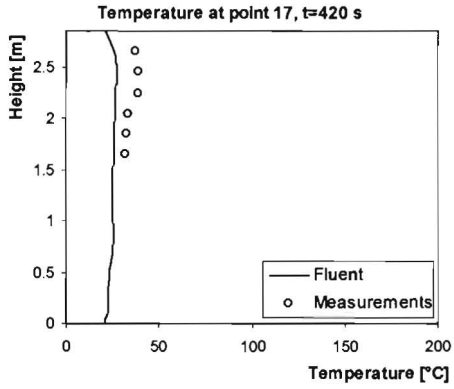


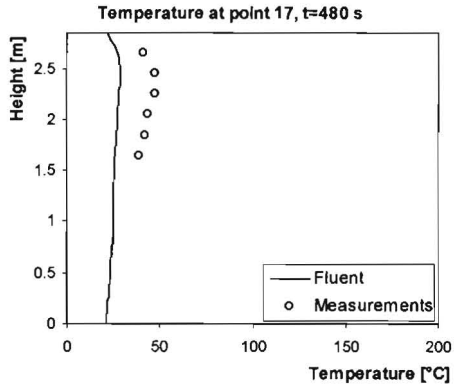


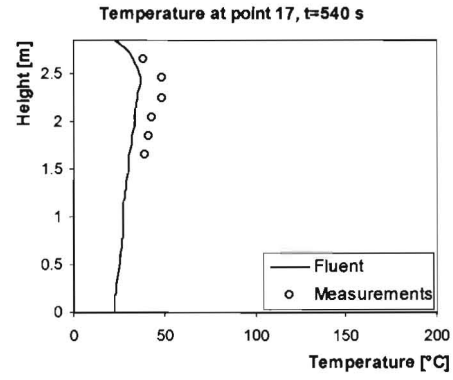


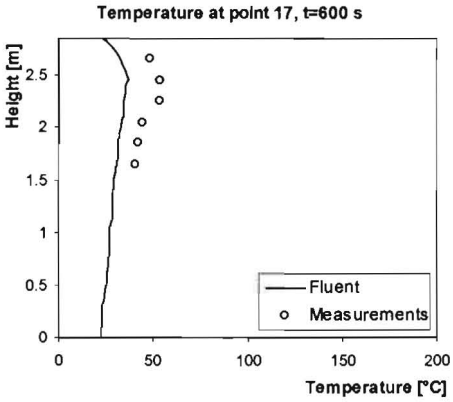


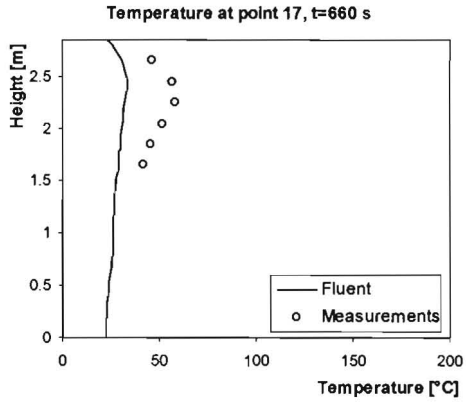


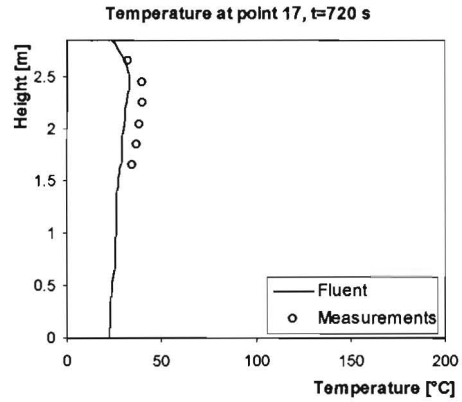

Temperature at point 17, t=420 s
Height [m]
Temperature [°C]
Fluent
Measurements

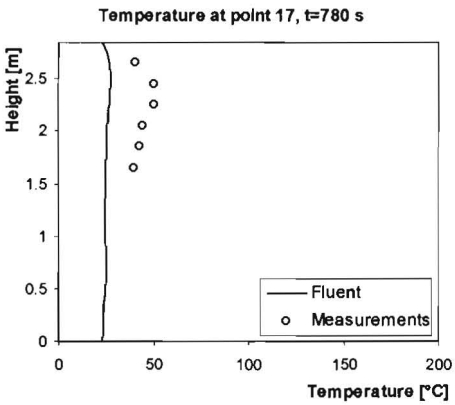

Temperature at point 17, t=480 s
Height [m]
Temperature [°C]
Fluent
Measurements

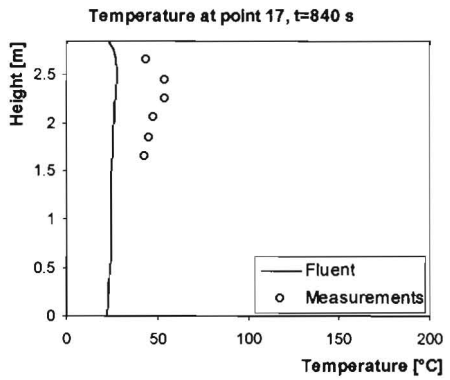

Temperature at point 17, t=540 s
Height [m]
Temperature [°C]
Fluent
Measurements

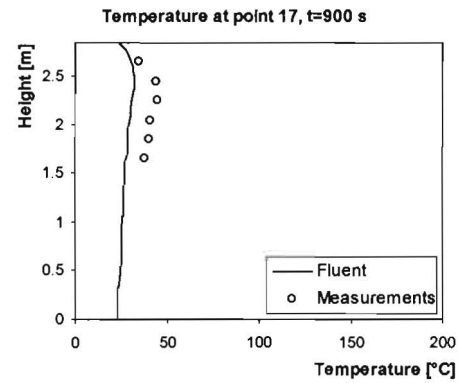

Temperature at point 17, t=600 s
Height [m]
Temperature [°C]
Fluent
Measurements

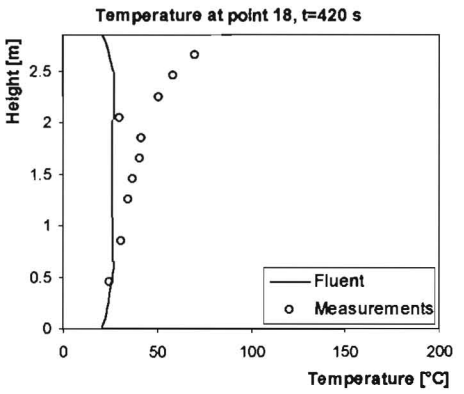

Temperature at point 17, t=660 s
Height [m]
Temperature [°C]
Fluent
Measurements

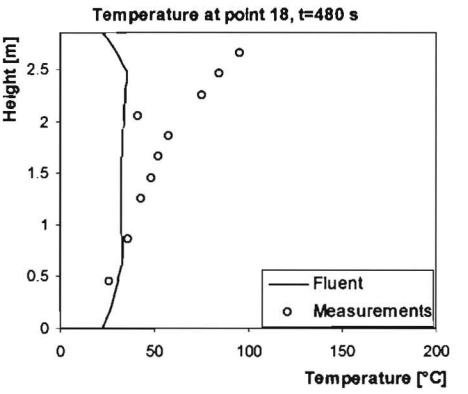

Temperature at point 17, t=720 s
Height [m]
Temperature [°C]
Fluent
Measurements

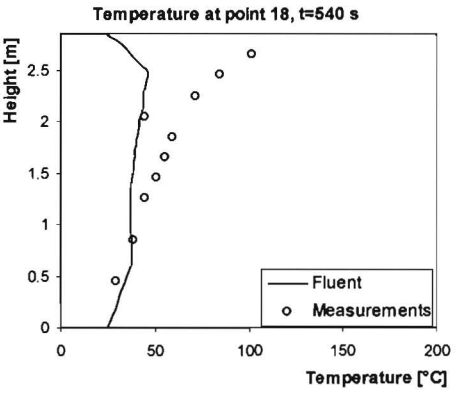

Temperature at point 17, t=780 s
Height [m]
Temperature [°C]
Fluent
Measurements

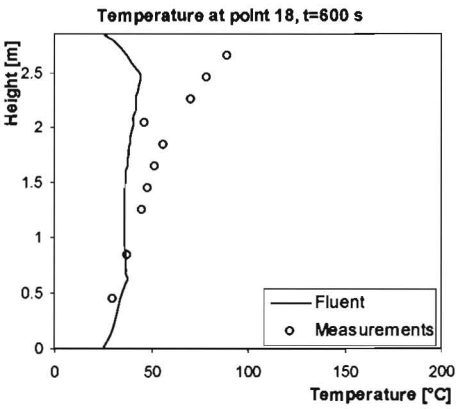

Temperature at point 17, t=840 s
Height [m]
Temperature [°C]
Fluent
Measurements

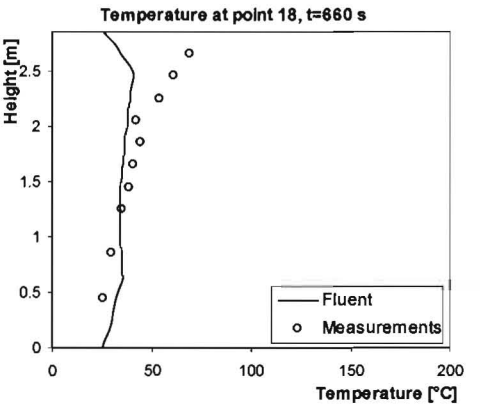

Temperature at point 17, t=900 s
Height [m]
Temperature [°C]
Fluent
Measurements

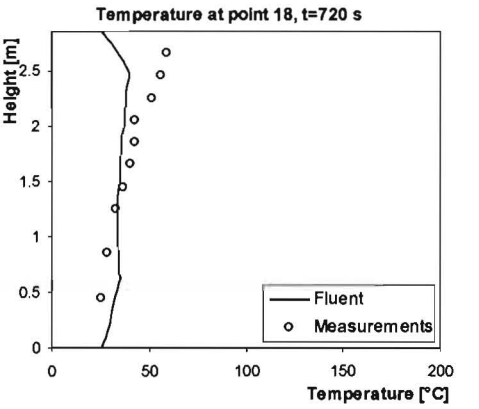

Temperature at point 18, t=420 s
Height [m]
Temperature [°C]
Fluent
Measurements

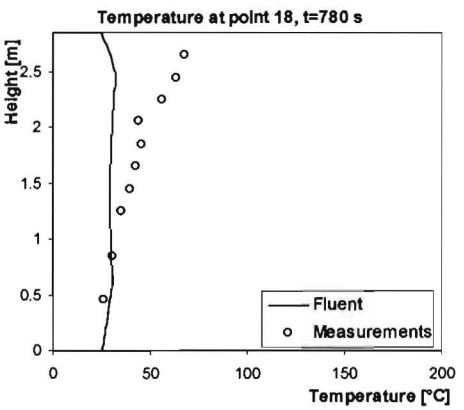

Temperature at point 18, t=480 s
Height [m]
Temperature [°C]
Fluent
Measurements

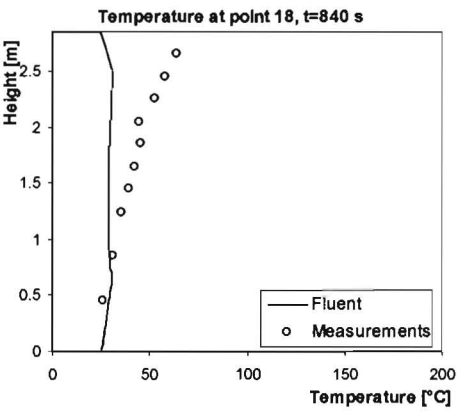

Temperature at point 18, t=540 s
Height [m]
Temperature [°C]
Fluent
Measurements

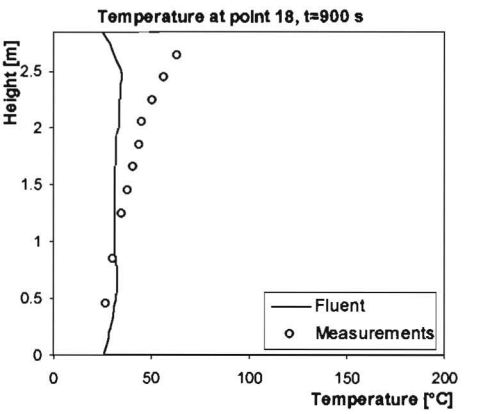

Temperature at point 18, t=600 s
Height [m]
Temperature [°C]
Fluent
Measurements


Temperature at point 18, t=660 s
Height [m]
Temperature [°C]
Fluent
Measurements

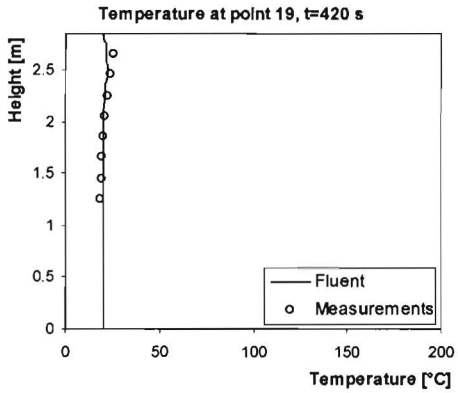

Temperature at point 18, t=720 s
Height [m]
Temperature [°C]
Fluent
Measurements

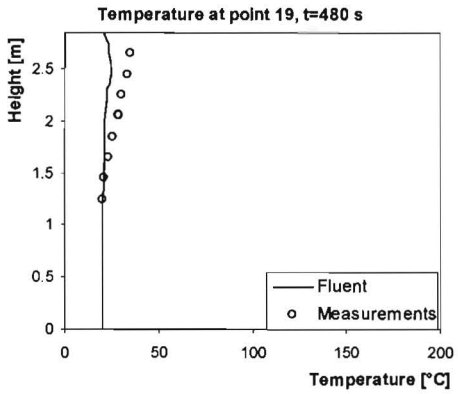

Temperature at point 18, t=780 s
Height [m]
Temperature [°C]
Fluent
Measurements

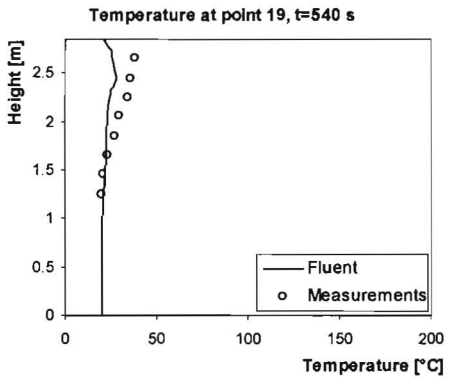

Temperature at point 18, t=840 s
Height [m]
Temperature [°C]
Fluent
Measurements

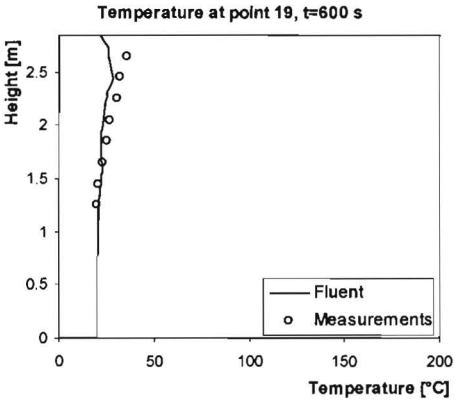

Temperature at point 18, t=900 s
Height [m]
Temperature [°C]
Fluent
Measurements

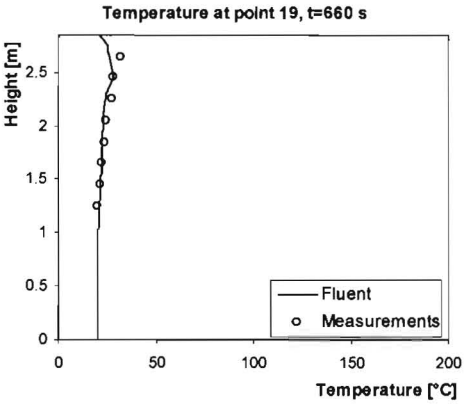
Comparison with measurements: no gravitational correction

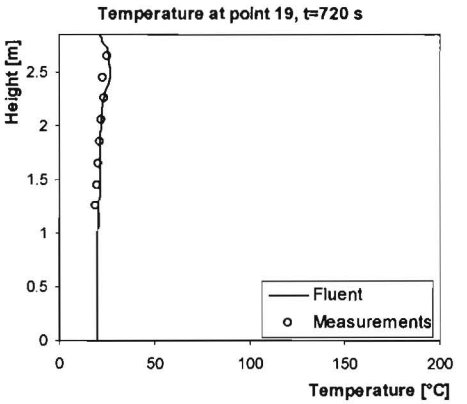


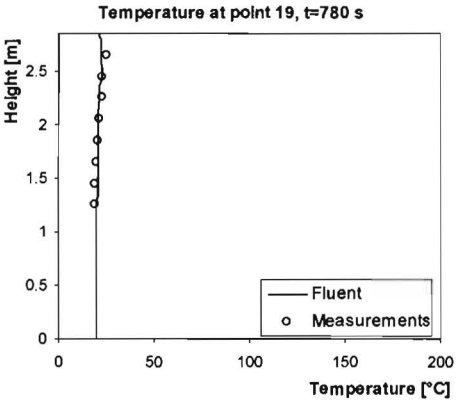


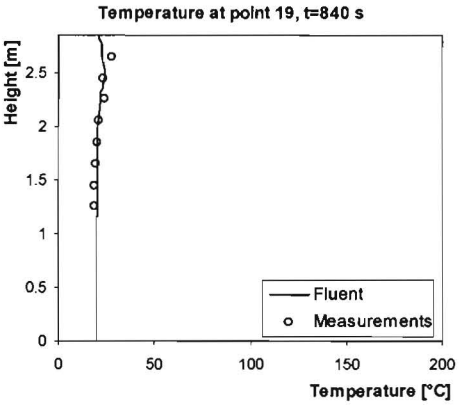


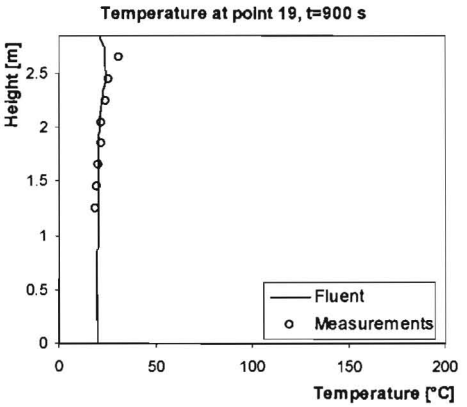


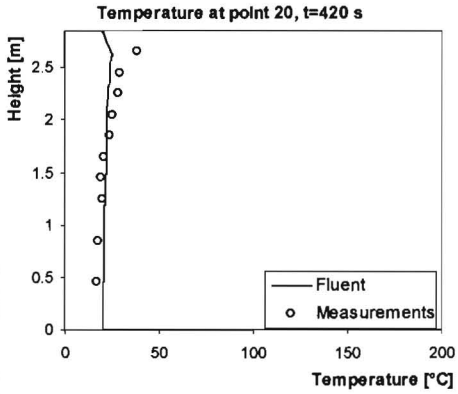


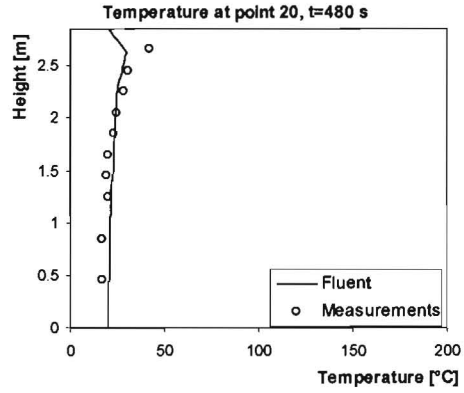


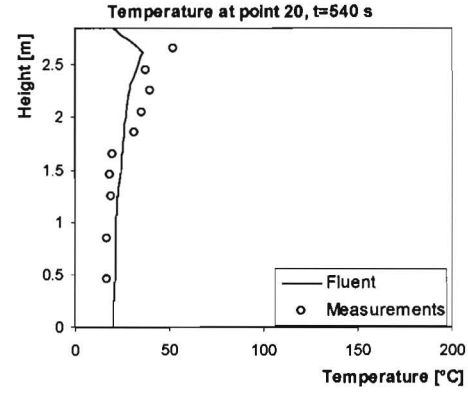


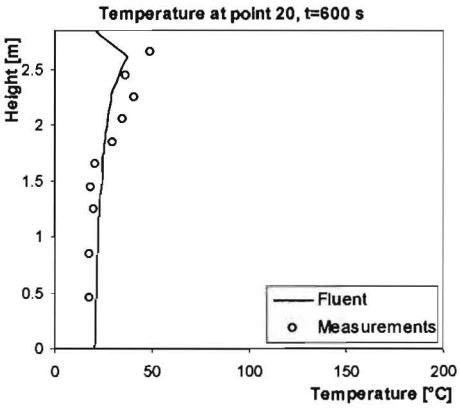


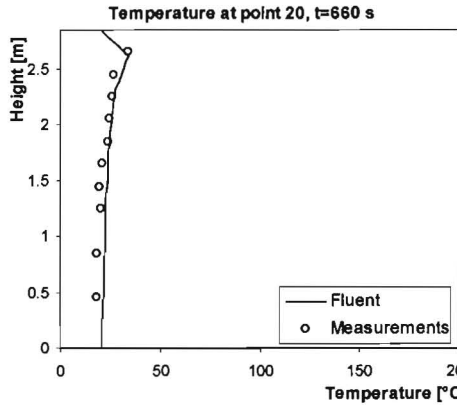


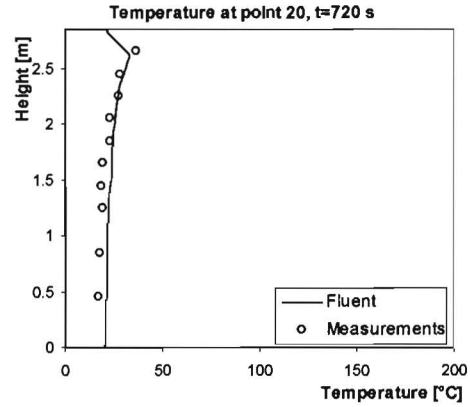

Temperature at point 20, t=420 s
Height [m]
Temperature [°C]
Fluent
Measurements

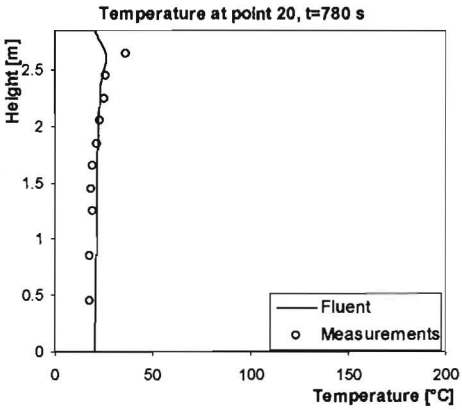

Temperature at point 20, t=480 s
Height [m]
Temperature [°C]
Fluent
Measurements

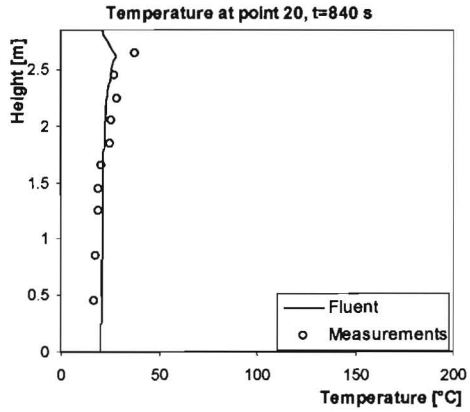

Temperature at point 20, t=540 s
Height [m]
Temperature [°C]
Fluent
Measurements

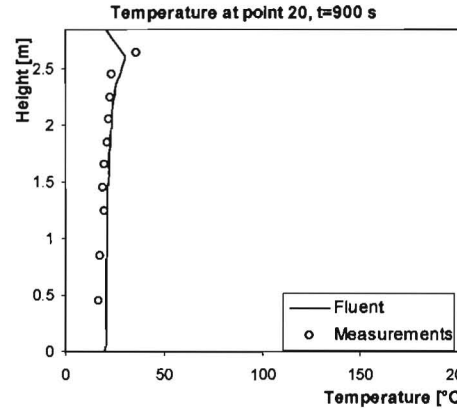

Temperature at point 20, t=600 s
Height [m]
Temperature [°C]
Fluent
Measurements


Temperature at point 20, t=660 s
Height [m]
Temperature [°C]
Fluent
Measurements

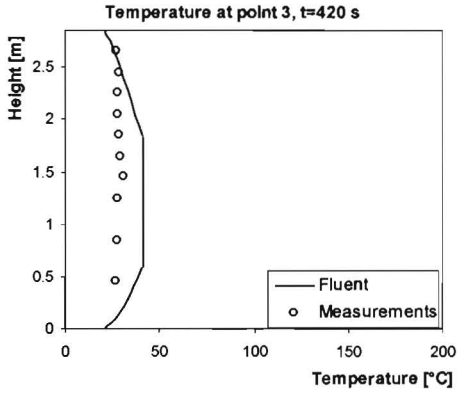

Temperature at point 20, t=720 s
Height [m]
Temperature [°C]
Fluent
Measurements

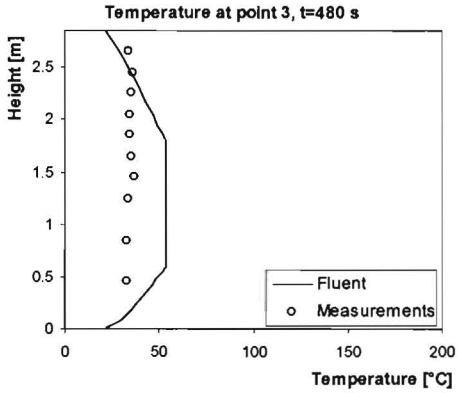

Temperature at point 20, t=780 s
Height [m]
Temperature [°C]
Fluent
Measurements

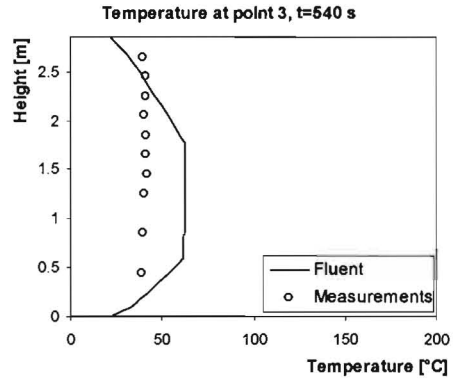

Temperature at point 20, t=840 s
Height [m]
Temperature [°C]
Fluent
Measurements

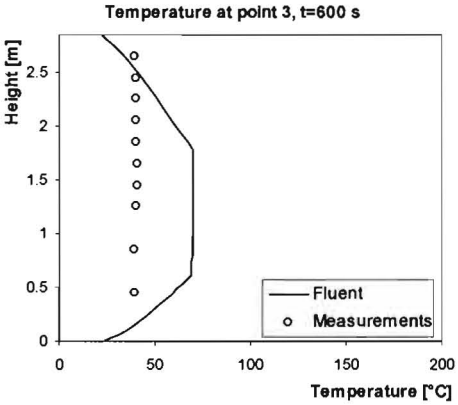

Temperature at point 20, t=900 s
Height [m]
Temperature [°C]
Fluent
Measurements

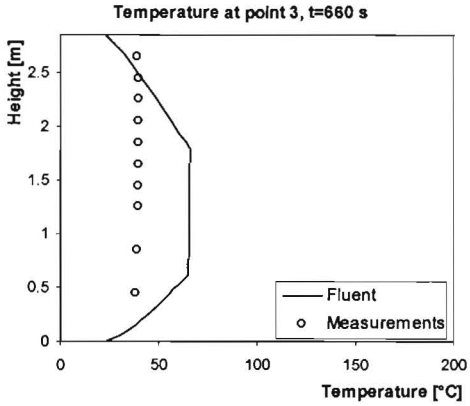
Comparison with measurements: no gravitational correction

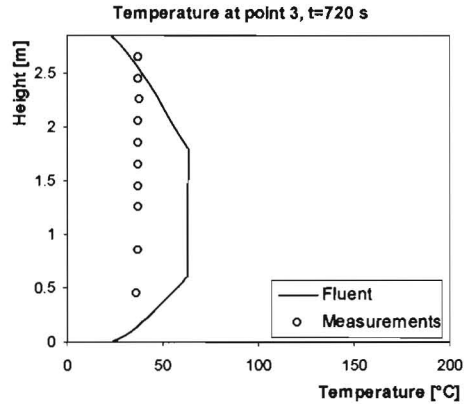


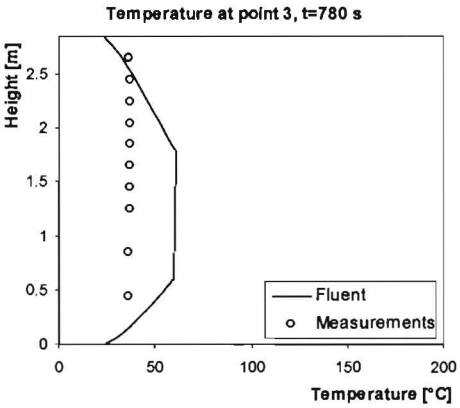


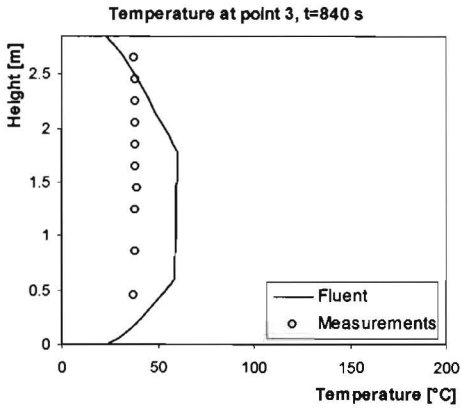


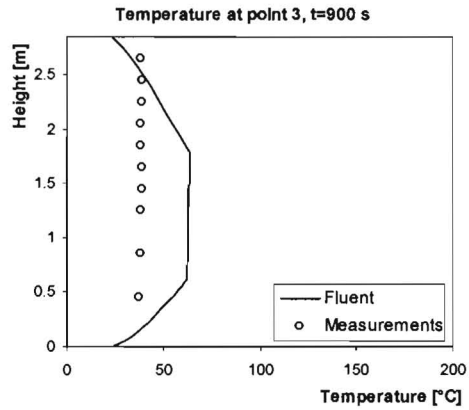


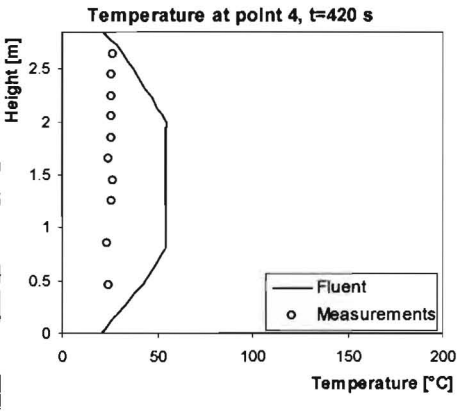


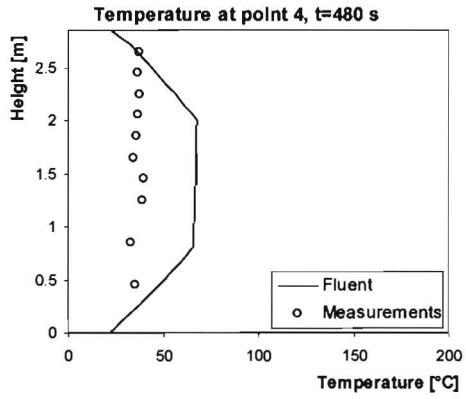


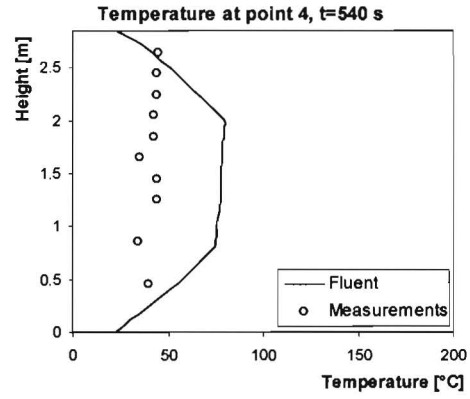


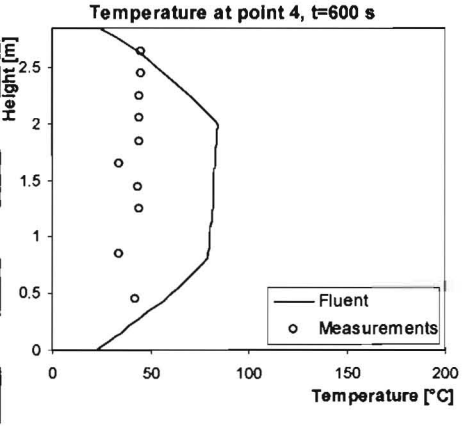


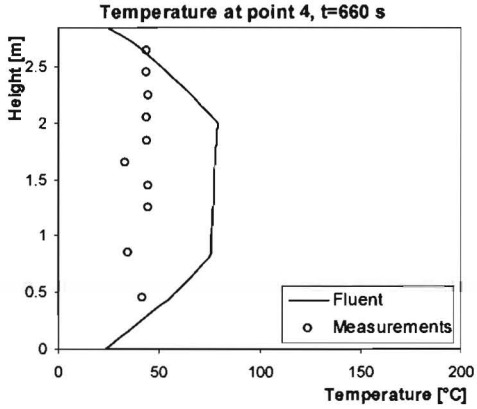


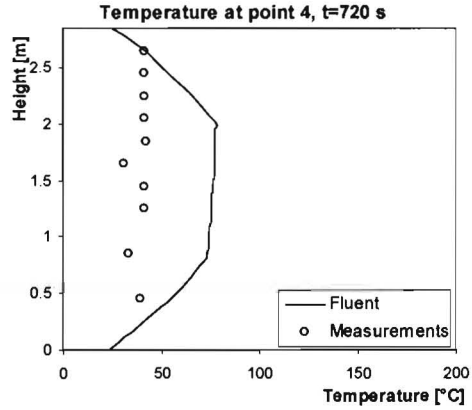

Temperature at point 4, t=420 s
Height [m]
Temperature [°C]
Fluent
Measurements

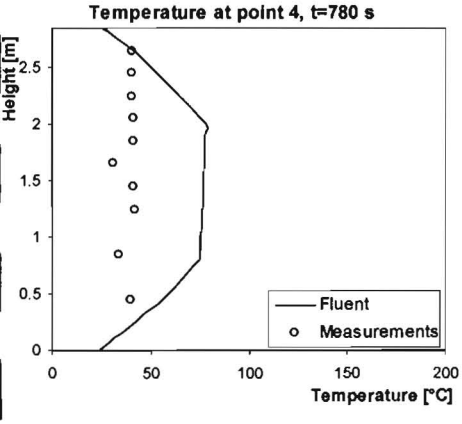

Temperature at point 4, t=480 s
Height [m]
Temperature [°C]
Fluent
Measurements

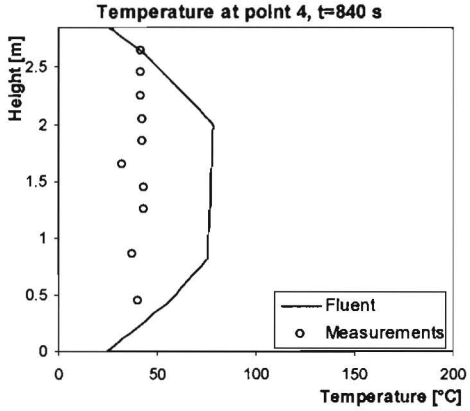

Temperature at point 4, t=540 s
Height [m]
Temperature [°C]
Fluent
Measurements

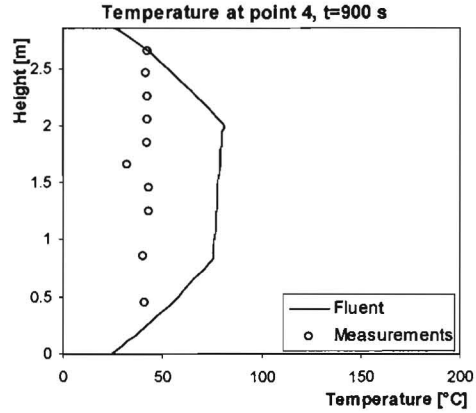

Temperature at point 4, t=600 s
Height [m]
Temperature [°C]
Fluent
Measurements


Temperature at point 4, t=660 s
Height [m]
Temperature [°C]
Fluent
Measurements

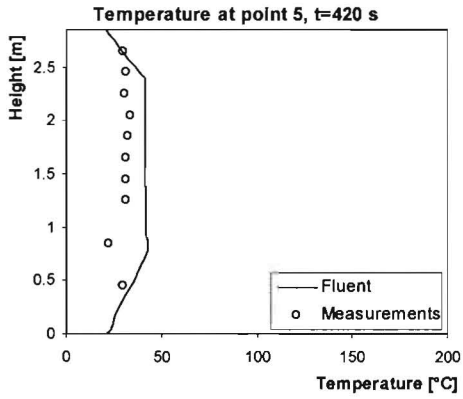

Temperature at point 4, t=720 s
Height [m]
Temperature [°C]
Fluent
Measurements

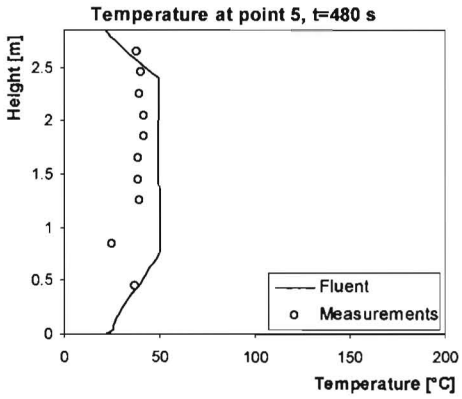

Temperature at point 4, t=780 s
Height [m]
Temperature [°C]
Fluent
Measurements

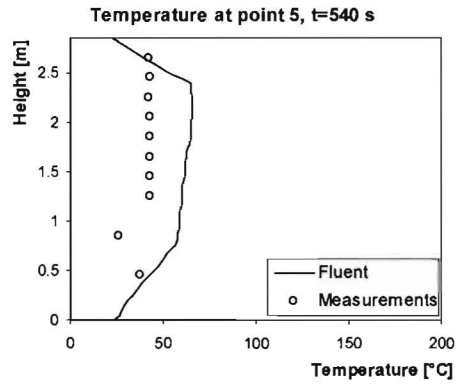

Temperature at point 4, t=840 s
Height [m]
Temperature [°C]
Fluent
Measurements

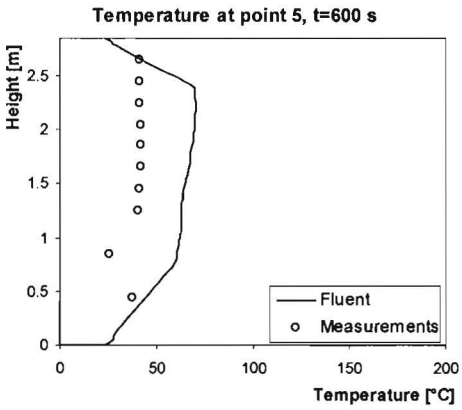

Temperature at point 4, t=900 s
Height [m]
Temperature [°C]
Fluent
Measurements

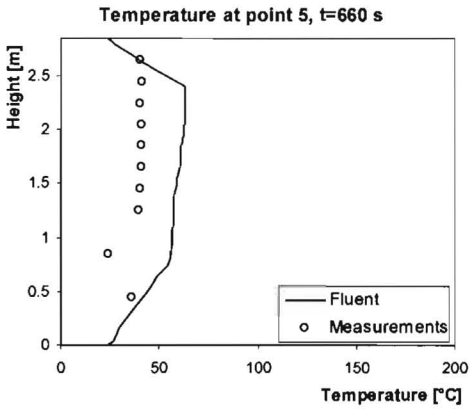
Comparison with measurements: no gravitational correction

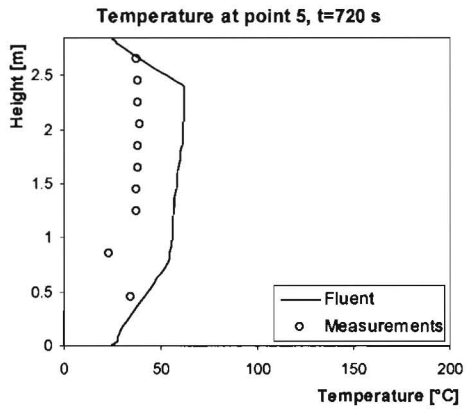


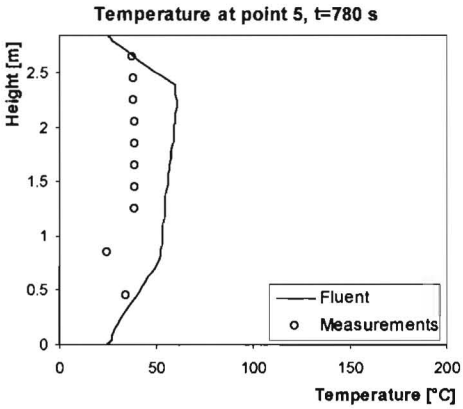


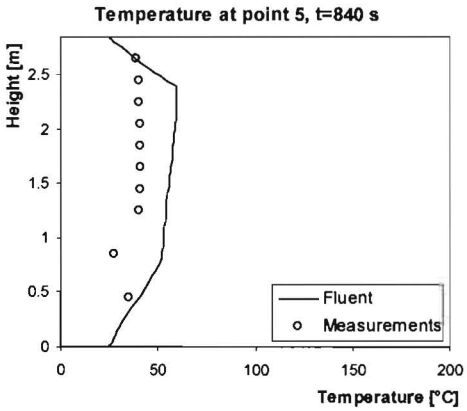


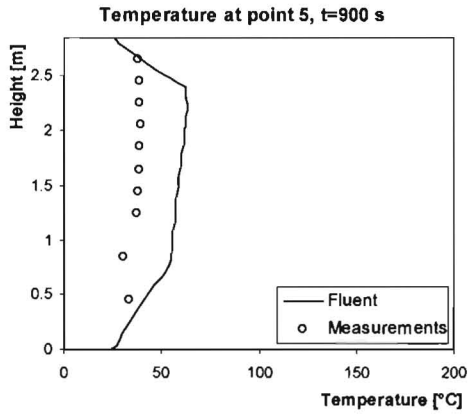


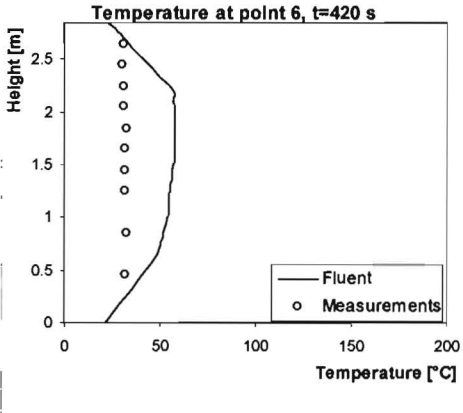


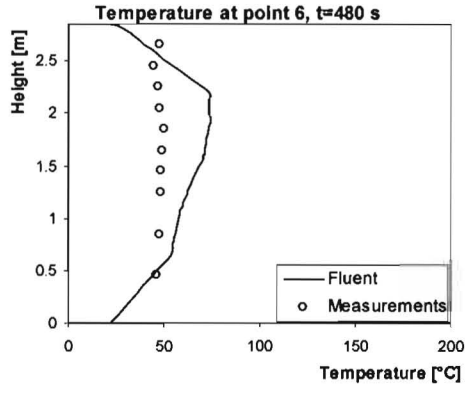


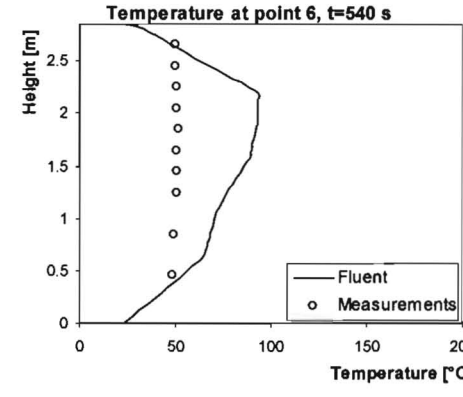


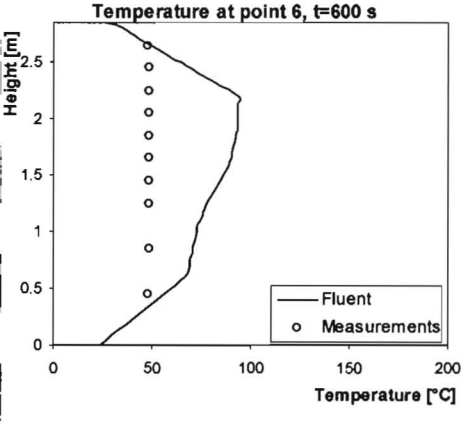


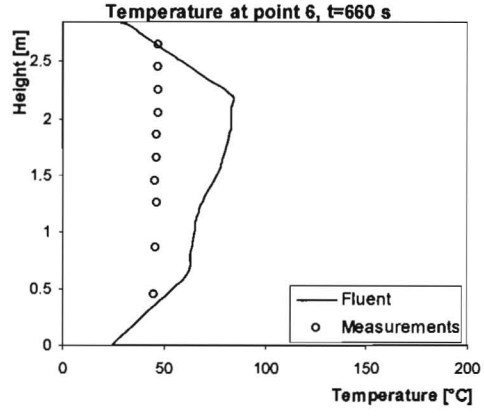


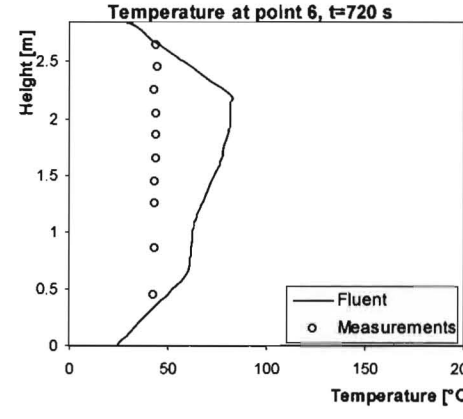

Temperature at point 6, t=420 s
Height [m]
Temperature [°C]
Fluent
Measurements

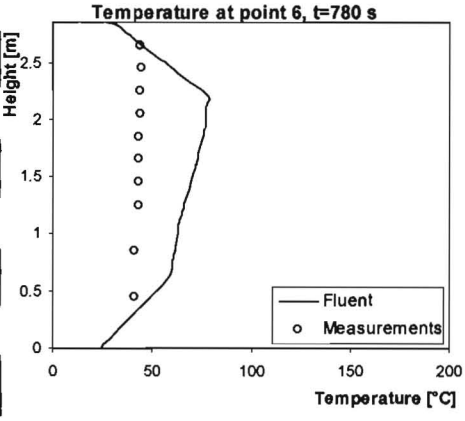

Temperature at point 6, t=480 s
Height [m]
Temperature [°C]
Fluent
Measurements

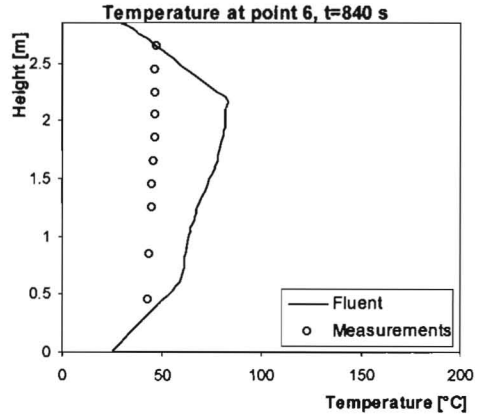

Temperature at point 6, t=540 s
Height [m]
Temperature [°C]
Fluent
Measurements

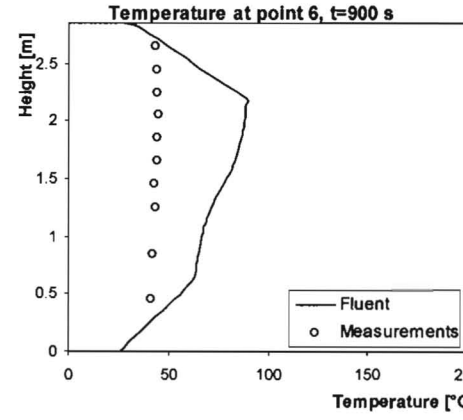

Temperature at point 6, t=600 s
Height [m]
Temperature [°C]
Fluent
Measurements

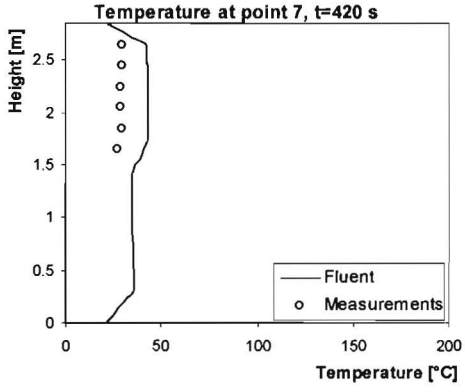

Temperature at point 6, t=660 s
Height [m]
Temperature [°C]
Fluent
Measurements

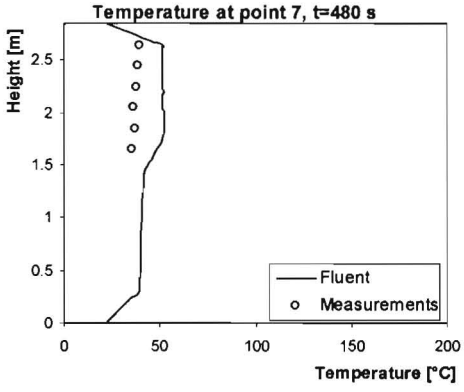

Temperature at point 6, t=720 s
Height [m]
Temperature [°C]
Fluent
Measurements

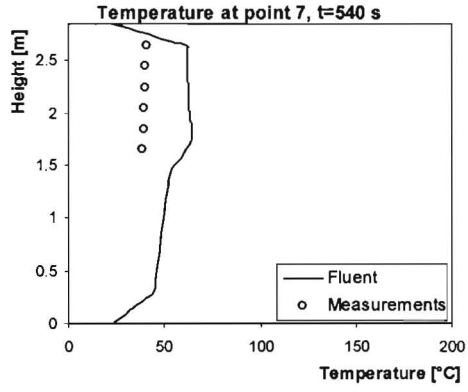

Temperature at point 6, t=780 s
Height [m]
Temperature [°C]
Fluent
Measurements

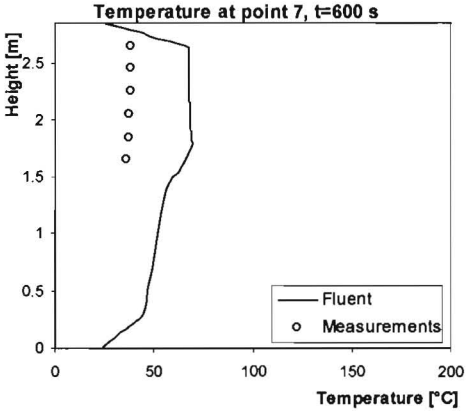

Temperature at point 6, t=840 s
Height [m]
Temperature [°C]
Fluent
Measurements

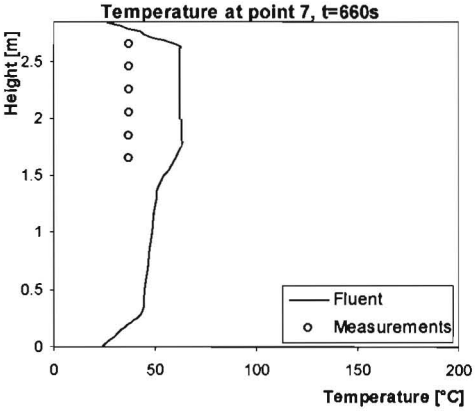

Temperature at point 6, t=900 s
Height [m]
Temperature [°C]
Fluent
Measurements

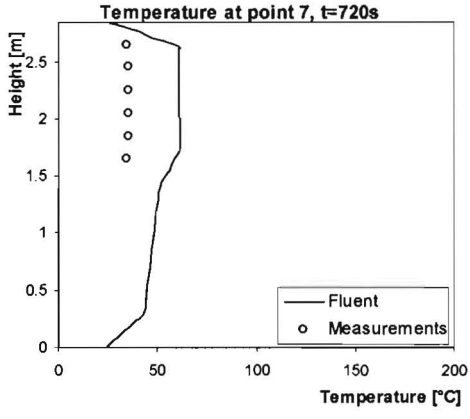

Temperature at point 7, t=420 s
Height [m]
Temperature [°C]
Fluent
Measurements

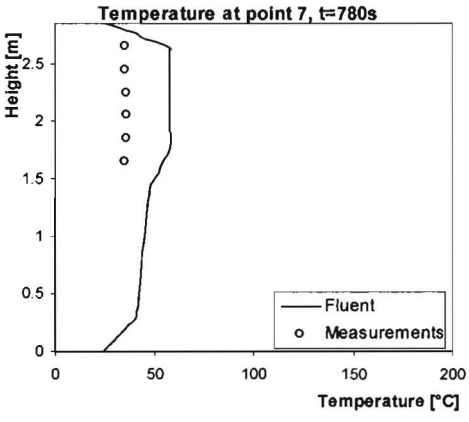

Temperature at point 7, t=480 s
Height [m]
Temperature [°C]
Fluent
Measurements

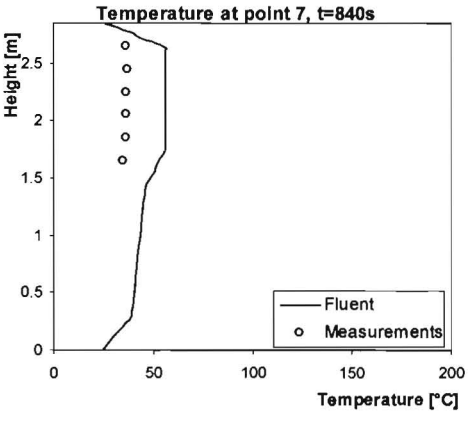

Temperature at point 7, t=540 s
Height [m]
Temperature [°C]
Fluent
Measurements

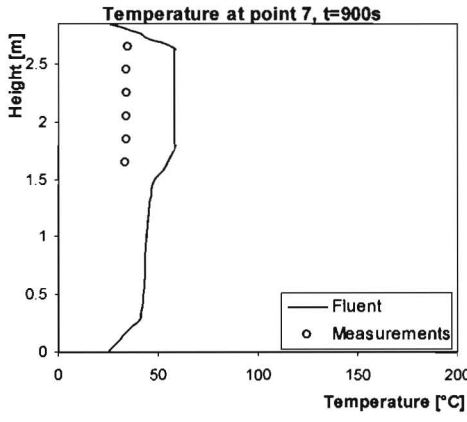

Temperature at point 7, t=600 s
Height [m]
Temperature [°C]
Fluent
Measurements

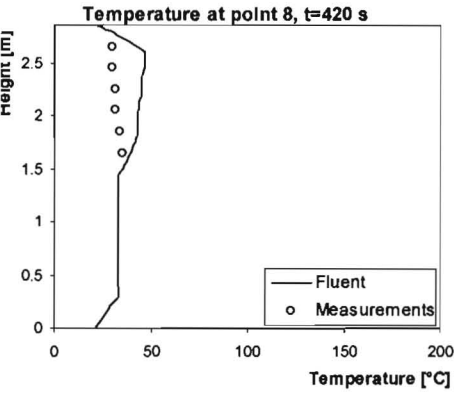

Temperature at point 7, t=660s
Height [m]
Temperature [°C]
Fluent
Measurements

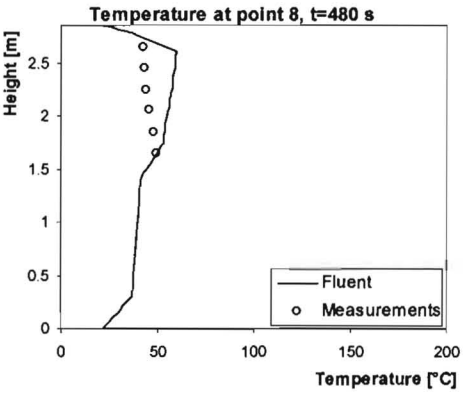

Temperature at point 7, t=720s
Height [m]
Temperature [°C]
Fluent
Measurements

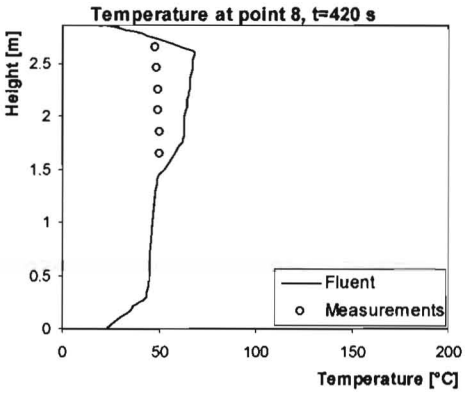

Temperature at point 7, t=780s
Height [m]
Temperature [°C]
Fluent
Measurements

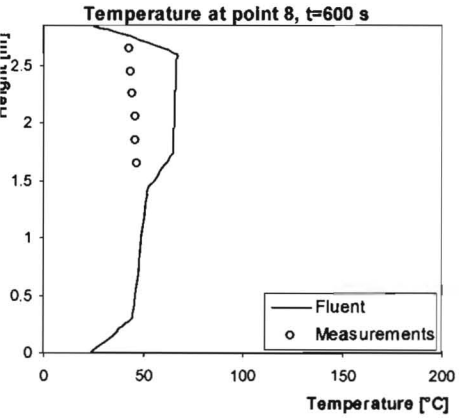

Temperature at point 7, t=840s
Height [m]
Temperature [°C]
Fluent
Measurements

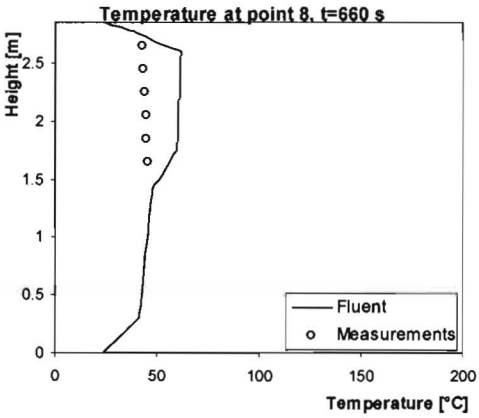

Temperature at point 7, t=900s
Height [m]
Temperature [°C]
Fluent
Measurements

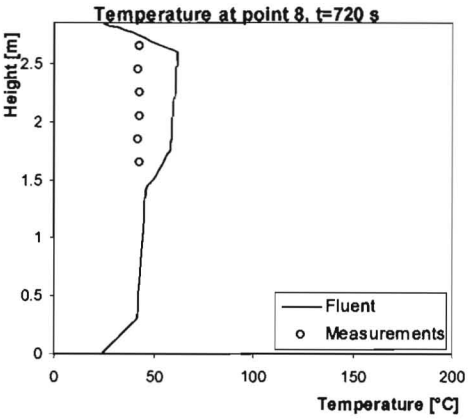

Temperature at point 8, t=420 s
Height [m]
Temperature [°C]
Fluent
Measurements

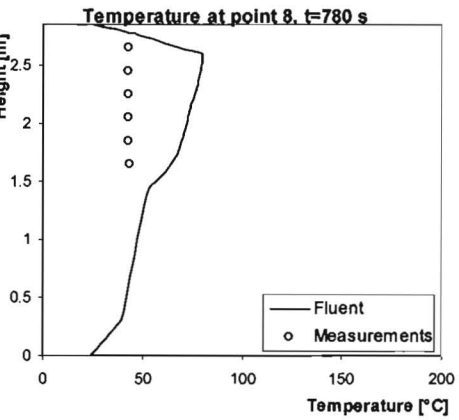

Temperature at point 8, t=480 s
Height [m]
Temperature [°C]
Fluent
Measurements

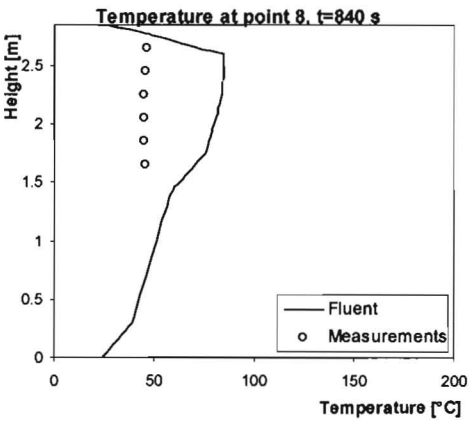

Temperature at point 8, t=420 s
Height [m]
Temperature [°C]
Fluent
Measurements

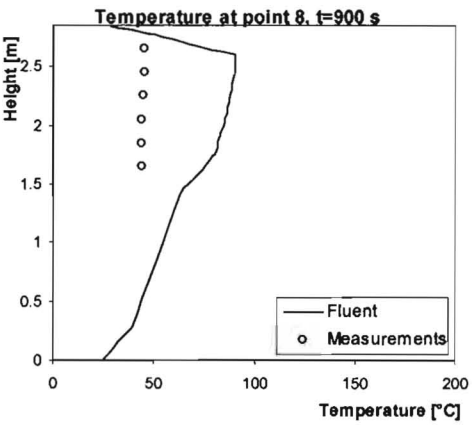

Temperature at point 8, t=600 s
Height [m]
Temperature [°C]
Fluent
Measurements

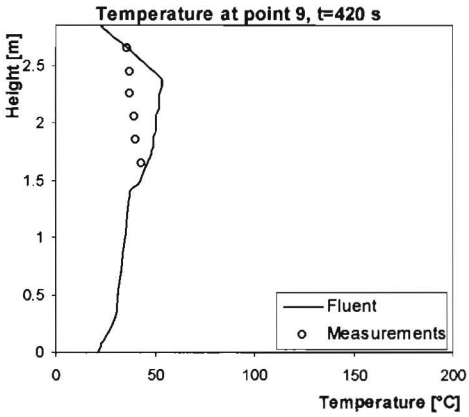

Temperature at point 8, t=660 s
Height [m]
Temperature [°C]
Fluent
Measurements

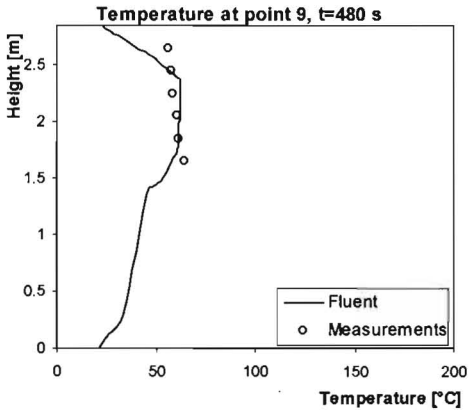

Temperature at point 8, t=720 s
Height [m]
Temperature [°C]
Fluent
Measurements

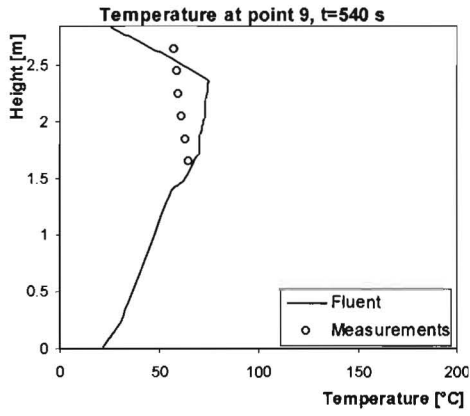

Temperature at point 8, t=780 s
Height [m]
Temperature [°C]
Fluent
Measurements

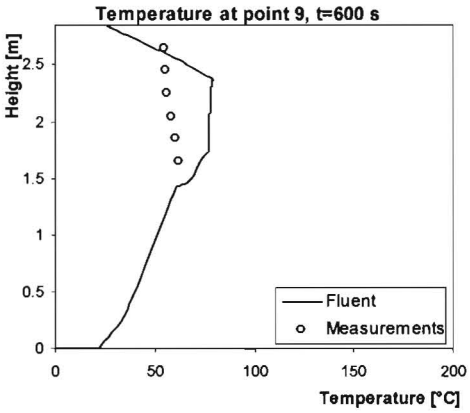

Temperature at point 8, t=840 s
Height [m]
Temperature [°C]
Fluent
Measurements

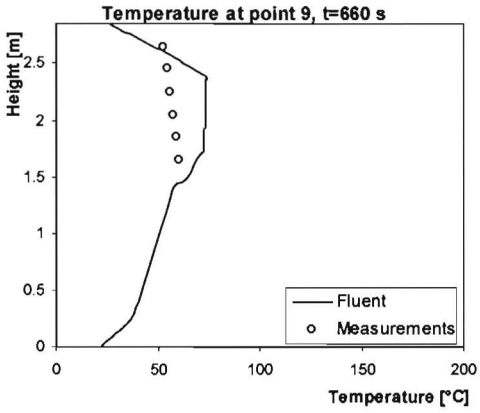

Temperature at point 8, t=900 s
Height [m]
Temperature [°C]
Fluent
Measurements

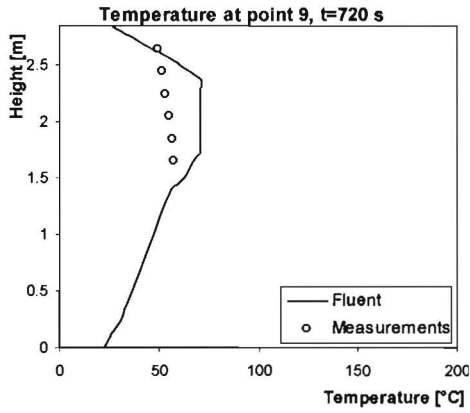

Temperature at point 9, t=420 s
Height [m]
Temperature [°C]
Fluent
Measurements

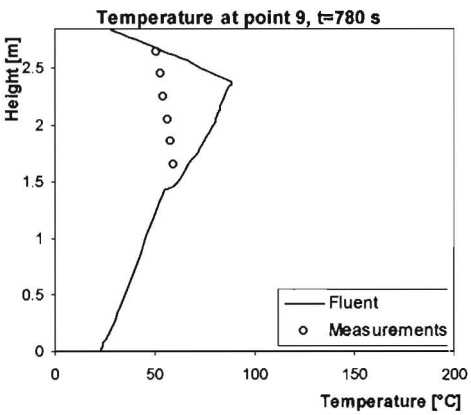

Temperature at point 9, t=480 s
Height [m]
Temperature [°C]
Fluent
Measurements

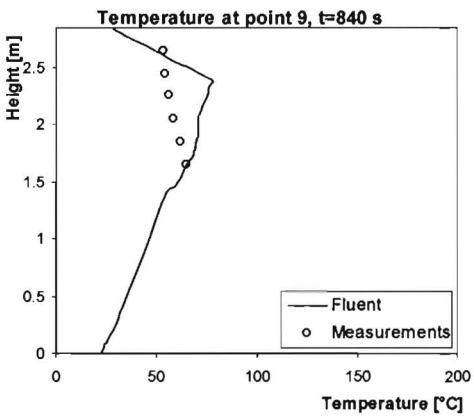

Temperature at point 9, t=540 s
Height [m]
Temperature [°C]
Fluent
Measurements

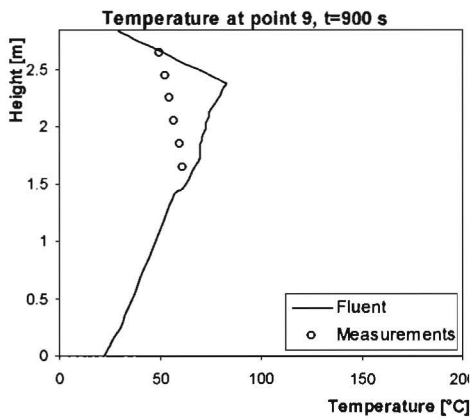

Temperature at point 9, t=600 s
Height [m]
Temperature [°C]
Fluent
Measurements


Temperature at point 9, t=660 s
Height [m]
Temperature [°C]
Fluent
Measurements


Temperature at point 9, t=720 s
Height [m]
Temperature [°C]
Fluent
Measurements


Temperature at point 9, t=780 s
Height [m]
Temperature [°C]
Fluent
Measurements


Temperature at point 9, t=840 s
Height [m]
Temperature [°C]
Fluent
Measurements


Temperature at point 9, t=900 s
Height [m]
Temperature [°C]
Fluent
Measurements

Appendix 5: List of FLUENT-coordinates for data points

The comparison between measurement points and Fluent-data is made based on values found at several points in the car park. These measurement points are schematically denoted in the TNO-report, but no numerical values are assigned to these points. Based on known positions from several objects in the car park (like fire location and placing of the structural beams and jet fans), the following numerical list of data points is compiled.

The upper left point of the figure of the car park represents (0,0) in the imaginary system of coordinates. The last column in the table denotes whether this point is an all-height data point (-), or a data point for which in addition 4 specific heights are assigned (-4, respectively at 0,85m, 1,45m, 1,85m and 2,45m); used in the relative comparison between basic case and variants/measurements.

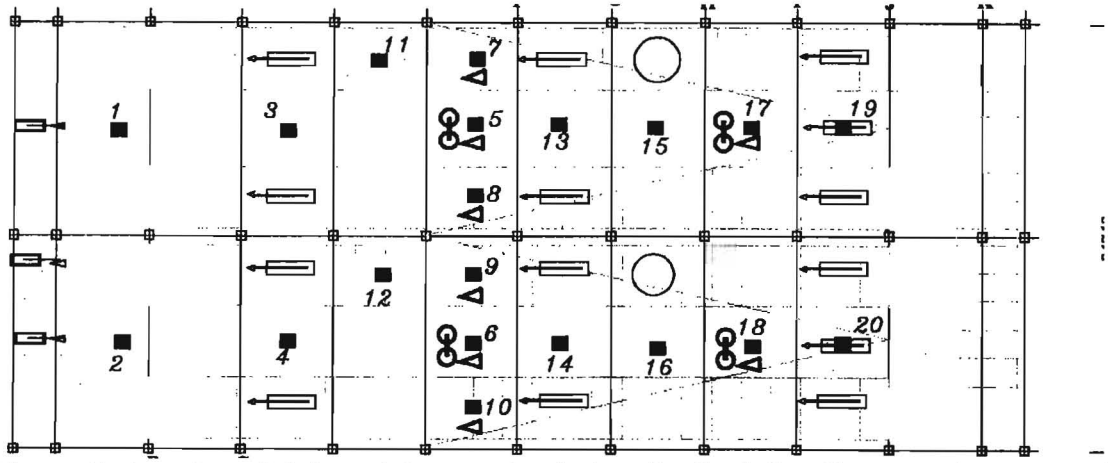


Figure X: location of data points, x-value in longitudinal direction, y-value perpendicular

Point no.	x-value	y-value	-/-4
1			
2			
3	23,5	8,25	-
4	23,5	25,05	-4
5	38,5	8,25	-4
6	38,5	25,05	-
7	38,5	2,9	-
8	38,5	13,6	-
9	38,5	19,4	-
10	38,5	30,1	-
11	31,0	2,9	-
12	31,0	19,4	-
13	46,0	8,25	-
14	46,0	25,05	-4
15	53,4	8,25	-4
16	53,4	25,05	-
17	60,9	8,25	-
18	60,9	25,05	-4
19	68,5	8,25	-4
20	68,5	25,05	-

Appendix 6: Mesh difficulties

For all models with a tetrahedral grid, the geometry was build before a meshing command was executed; using the journal-file as a text user interface (TUI). Although the GUI, input by using the graphical buttons in the interface, should have provided the same result, the use of a journal file has some advantages in this particular situation.

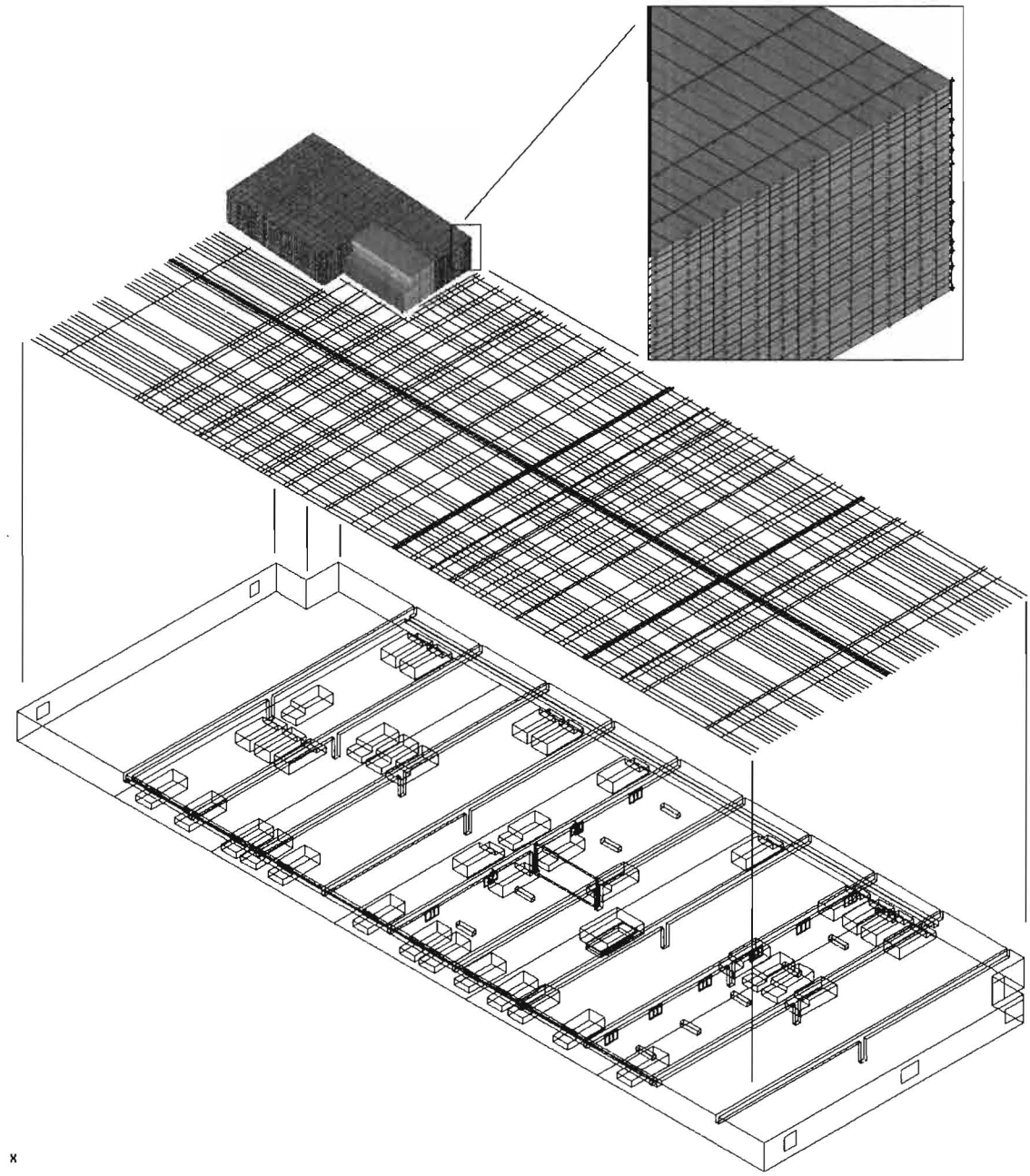
First of all, using a textual approach the access to the GAMBIT-software is only necessary when the journal-file is read-in, not while it is created. This means that every word processor can be used to write the command lines, and the file can be manipulated on different computer systems without moving the large data files created by GAMBIT using the GUI.

Second, the geometrical data already was available (hardcopy output) from Efectis, as the geometry was modelled in 1999 using VESTA. By using the journal file as input for the creation of the model, the total geometry could be build up in a relatively time-efficient way by copy/pasting the command lines for the various volumes in the geometry. Since the geometrical data output from VESTA and the input used for the journal file are build up in rather the same way, probably an even higher level of automation is possible. However, no attempts are made to develop this script.

At last, the input data can be checked for input mistakes more easily, as all data points are available in a quick sight. Possible incorrectness can be restored by correcting the basic input and re-reading the journal file in GAMBIT.
Unfortunately, not all operations can be integrated easily in the journal file. For some extended functions, the GUI of GAMBIT provides useful tools, especially when selection of large numbers of faces or volumes is needed.

```
.....
volume move "AutD_A_01_M" offset 15.2 0.9 1.6
volume unite volumes "Auto_A_01_M" "AutD_A_01_M"
volume create "AutD_A_01_M_copy" width 2.2 depth 0.5 height 3.1 offset 1.1
0.25 \
  1.55 brick
volume move "AutD_A_01_M_copy" offset 15.2 0.9 1.6
volume unite volumes "Auto_A_01_M_copy" "AutD_A_01_M_copy"
volume create "AutD_B_01_L" width 2.2 depth 0.5 height 3.1 offset 1.1 0.25 \
  1.55 brick
.....
```

Figure X: Example of a part of one of the journal-files.



x

Figure X: Creating and meshing the orthogonal grid; the principle

The mesh scheme used is the T-grid structure, creating a tetrahedral mesh. One of the major disadvantages of this meshing type is the high skewnesses that can occur in the domain. Cells with high skewness are known to decrease the accuracy and destabilize the solution.

The tetrahedral mesh used in the Fleerde case shows a large variety in skewness, including ranges that are to be avoided. Figure X shows the bar chart, which in a favourable state should line up from right to left. In this case, 60% of the cells know a skewness value in between 0,3 and 0,5.

Total Elements: 865273
Active Elements: 521996 (60.33%)

Skewness	
0 - 0.1	1,42 %
0.1 - 0.2	5.94 %
0.2 - 0.3	19.07 %
0.3 – 0.4	32.13 %
0.4 – 0.5	28,20 %

Figure X: mesh examination - values for skewness

In addition, figure X shows the location at which high skewness occurs: near the fixed-velocity field values ranging from 0,8 to 0,9 occur. This was to be expected, since these fields know a small thickness (0,1m) and are therefore hard to include in the meshing. Fortunately only 0,05% of all grid cells has a value within this range, but still this is a point of attention which can have serious drawback on results or stability.

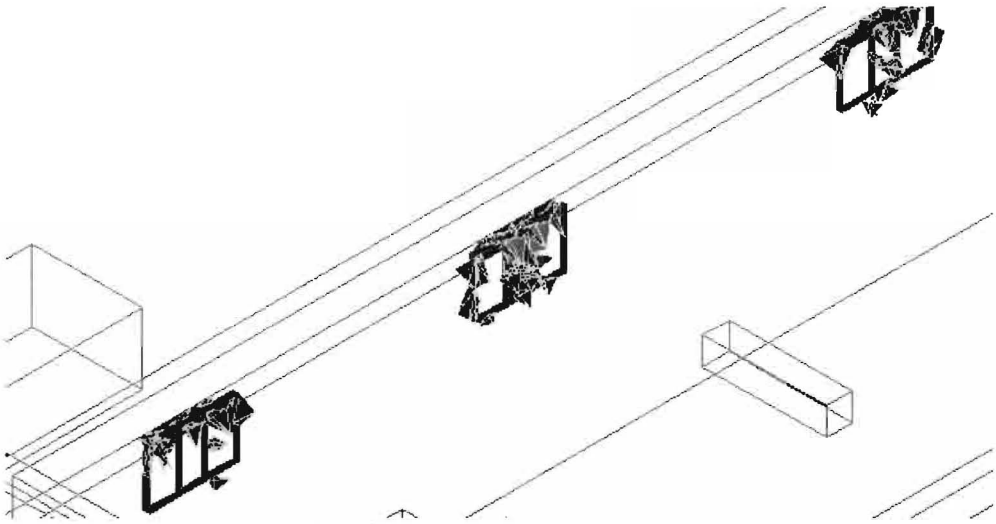


Figure X: peak values for skewness

Appendix 7: Numerical setup for the Fleerde-case

Models

Model	Settings
Space	3D
Time	Unsteady, 1st-Order implicit
Viscous	Standard k-epsilon turbulence model
Wall treatment	Standard wall functions
Heat transfer	Enabled
Solidification and melting	Disabled
Radiation	Discrete ordinate model
Species transport	Disabled
Coupled dispersed phase	Disabled
Pollutants	Disabled
Soot	Disabled

Boundary Conditions

Zones

name	id	type
middle	2	fluid
leftright	3	fluid
vlammen	4	fluid
lucht	5	fluid
wall	6	wall
vel_fields_front	7	interior
vel_fields_rear	8	interior
vuur	9	interior
j1	10	velocity-inlet
i1	11	velocity-inlet
h1	12	velocity-inlet
g1	13	velocity-inlet
f1	14	velocity-inlet
e1	15	velocity-inlet
d1	16	velocity-inlet
c1	17	velocity-inlet
b1	18	velocity-inlet
a1	19	velocity-inlet
j	20	velocity-inlet
i	21	velocity-inlet
h	22	velocity-inlet
g	23	velocity-inlet
f	24	velocity-inlet
e	25	velocity-inlet
d	26	velocity-inlet
c	27	velocity-inlet
a	28	velocity-inlet

b	29	velocity-inlet
espace	30	wall
muur	31	wall
autos	32	wall
liggers	33	wall
plafond	34	wall
wanden	35	wall
vloer	36	wall
toevoer	37	pressure-inlet
afvoer	38	velocity-inlet
default-interior	40	interior
wall:001	1	wall
wall:039	39	wall
vel_fields_front:041	41	interior
vel_fields_front:042	42	interior
vel_fields_rear:043	43	interior
vel_fields_rear:044	44	interior
vel_fields_rear:045	45	interior
vuur:046	46	wall
vuur:047	47	wall
autos:048	48	wall
autos:049	49	wall
liggers:050	50	wall
liggers:051	51	wall
default-interior:052	52	interior
default-interior:053	53	interior
default-interior:054	54	interior

Material Properties

Material: air (fluid)

Property	Units	Method	Value(s)
Density	kg/m3	incompressible-ideal-gas	
Cp (Specific heat)	j/kg-k	constant	1006,43
Thermal conductivity	w/m-k	constant	0.0242
Viscosity	kg/m-s	constant	1.79E-05
Molecular weight	kg/kgmol	constant	28.966
L-J Characteristic length	angstrom	constant	3.711
L-J energy parameter	k	constant	78.6
Absorption coefficient	1/m	user-defined	(abswsgm)
Scattering coefficient	1/m	constant	0
Scattering phase function		isotropic	
Thermal expansion coefficient	1/k	constant	0
Refractive index		constant	1
Degrees of freedom		constant	0
UDS diffusivity	kg/m-s	user-defined	(turbdiffu)
Speed of sound	m/s	none	

Appendix 8: Conservation of mass and energy (jet fan)

Jet fans, using manual linkage between supply and exhaust opening

Basic case, gravity in wrong direction at t=300; mass flow rate

	exhaust [kg/s]	supply [kg/s]	decrease [%]
(a):	2.056	2.026	-1.414
(b):	2.058	2.029	-1.414
(c):	2.059	2.030	-1.414
(d):	2.057	2.028	-1.414
(e):	2.060	2.031	-1.414
(f):	2.060	2.031	-1.414
(g):	1.758	1.733	-1.413
(h):	1.772	1.747	-1.416
(i):	1.698	1.673	-1.421
(j):	1.783	1.758	-1.411

Netto mass flow rate: 1,975 kg/s (total domain), 4,4% difference relative to zones contributing highest flow rates, the ventilation openings:

zone	37	(supply):	43.47578
zone	38	(afvoer):	41.22693

Basic case, gravity in wrong direction at t=900; mass flow rate

	exhaust [kg/s]	supply [kg/s]	decrease [%]
(a):	2.059	2.030	-1.414
(b):	2.060	2.031	-1.414
(c):	2.060	2.031	-1.414
(d):	2.059	2.029	-1.414
(e):	2.060	2.031	-1.414
(f):	2.060	2.031	-1.414
(g):	1.823	1.797	-1.417
(h):	1.883	1.857	-1.413
(i):	1.796	1.770	-1.446
(j):	1.787	1.762	-1.411

Netto mass flow rate: 2,472 kg/s (total domain), 5% difference relative to zones contributing highest flow rates, the ventilation openings:

zone	37	(supply):	48.13186
zone	38	(afvoer):	50.3252

Appendix 9: Journal-file used for Gambit geometry generation

```
/ Journal File for GAMBIT 2.2.30, Database 2.2.14, ntx86 BH04110220
/ Identifier "Fleerde_met_auto"
/ File opened for write Thu May 17 17:11:29 2007.
identifier name "Fleerde_met_auto" new nosaveprevious
/ geometrie
volume create "Garage" width 85 depth 2.85 height 33 offset 42.5 1.425 16.5 brick
volume create "Trappenhuis_L" width 3.5 depth 2.85 height 3.6 offset 1.75 \
  1.425 1.8 brick
volume create "Trappenhuis_R" width 3.5 depth 2.85 height 3.6 offset 1.75 \
  1.425 1.8 brick
volume move "Trappenhuis_R" offset 81.5 0 0
volume create "Muur" width 7.1 depth 2.85 height 0.2 offset 3.55 1.425 0.1 brick
volume move "Muur" offset 42.4 0 16.4
/ liggers
volume create "Ligger_2" width 0.3 depth 0.75 height 33 offset 0.15 0.375 \
  16.5 brick
volume move "Ligger_2" offset 12.1 2.1 0
volume create "Ligger_3" width 0.3 depth 0.75 height 33 offset 0.15 0.375 \
  16.5 brick
volume move "Ligger_3" offset 19.6 2.1 0
volume create "Ligger_4" width 0.3 depth 0.75 height 33 offset 0.15 0.375 \
  16.5 brick
volume move "Ligger_4" offset 27.1 2.1 0
volume create "Ligger_5" width 0.3 depth 0.75 height 33 offset 0.15 0.375 \
  16.5 brick
volume move "Ligger_5" offset 34.6 2.1 0
volume create "Ligger_6" width 0.3 depth 0.75 height 33 offset 0.15 0.375 \
  16.5 brick
volume move "Ligger_6" offset 42.1 2.1 0
volume create "Ligger_7" width 0.3 depth 0.75 height 33 offset 0.15 0.375 \
  16.5 brick
volume move "Ligger_7" offset 49.5 2.1 0
volume create "Ligger_8" width 0.3 depth 0.75 height 33 offset 0.15 0.375 \
  16.5 brick
volume move "Ligger_8" offset 57 2.1 0
volume create "Ligger_9" width 0.3 depth 0.75 height 33 offset 0.15 0.375 \
  16.5 brick
volume move "Ligger_9" offset 64.5 2.1 0
volume create "Ligger_10" width 0.3 depth 0.75 height 33 offset 0.15 0.375 \
  16.5 brick
volume move "Ligger_10" offset 72 2.1 0
volume create "Ligger_11" width 0.3 depth 0.75 height 33 offset 0.15 0.375 \
  16.5 brick
volume move "Ligger_11" offset 79.5 2.1 0
/ kolommen
volume create "Staand_M_2" width 0.3 depth 2.1 height 0.6 offset 0.15 1.05 \
  0.3 brick
volume move "Staand_M_2" offset 12.1 0 16.2
volume create "Staand_M_3" width 0.3 depth 2.1 height 0.6 offset 0.15 1.05 \
  0.3 brick
volume move "Staand_M_3" offset 19.6 0 16.2
volume create "Staand_M_4" width 0.3 depth 2.1 height 0.6 offset 0.15 1.05 \
  0.3 brick
volume move "Staand_M_4" offset 27.1 0 16.2
volume create "Staand_M_5" width 0.3 depth 2.1 height 0.6 offset 0.15 1.05 \
  0.3 brick
volume move "Staand_M_5" offset 34.6 0 16.2
volume create "Staand_M_6" width 0.3 depth 2.1 height 0.6 offset 0.15 1.05 \
  0.3 brick
volume move "Staand_M_6" offset 42.1 0 16.2
volume create "Staand_M_7" width 0.3 depth 2.1 height 0.6 offset 0.15 1.05 \
  0.3 brick
volume move "Staand_M_7" offset 49.5 0 16.2
volume create "Staand_M_8" width 0.3 depth 2.1 height 0.6 offset 0.15 1.05 \
  0.3 brick
volume move "Staand_M_8" offset 57 0 16.2
volume create "Staand_M_9" width 0.3 depth 2.1 height 0.6 offset 0.15 1.05 \
  0.3 brick
volume move "Staand_M_9" offset 64.5 0 16.2
volume create "Staand_M_10" width 0.3 depth 2.1 height 0.6 offset 0.15 1.05 \
  0.3 brick
volume move "Staand_M_10" offset 72 0 16.2
```

```
volume create "Staand_M_11" width 0.3 depth 2.1 height 0.6 offset 0.15 1.05 \
  0.3 brick
volume move "Staand_M_11" offset 79.5 0 16.2
/ extra ventilatiebuizen
volume create "Vent_buis_A" width 60.2 depth 0.4 height 0.5 offset 30.1 0.2 \
  0.25 brick
volume move "Vent_buis_A" offset 12.1 1.7 0.5
volume create "Vent_buis_V" width 60.2 depth 0.4 height 0.5 offset 30.1 0.2 \
  0.25 brick
volume move "Vent_buis_V" offset 12.1 1.7 32
/ stuwdruk
volume create "Stra_Vent_05" width 1.9 depth 0.42 height 0.4 offset 0.95 0.21 \
  0.2 brick
volume move "Stra_Vent_05" offset 45.2 1.89 4.7
volume create "Stra_Vent_06" width 1.9 depth 0.42 height 0.4 offset 0.95 0.21 \
  0.2 brick
volume move "Stra_Vent_06" offset 45.2 1.89 11.4
volume create "Stra_Vent_07" width 1.9 depth 0.42 height 0.4 offset 0.95 0.21 \
  0.2 brick
volume move "Stra_Vent_07" offset 45.2 1.89 21.2
volume create "Stra_Vent_08" width 1.9 depth 0.42 height 0.4 offset 0.95 0.21 \
  0.2 brick
volume move "Stra_Vent_08" offset 45.2 1.89 27.9
volume create "Stra_Vent_01" width 1.9 depth 0.42 height 0.4 offset 0.95 0.21 \
  0.2 brick
volume move "Stra_Vent_01" offset 67.7 1.89 2.7
volume create "Stra_Vent_09" width 1.9 depth 0.42 height 0.4 offset 0.95 0.21 \
  0.2 brick
volume move "Stra_Vent_09" offset 67.7 1.89 8.05
volume create "Stra_Vent_02" width 1.9 depth 0.42 height 0.4 offset 0.95 0.21 \
  0.2 brick
volume move "Stra_Vent_02" offset 67.7 1.89 13.4
volume create "Stra_Vent_03" width 1.9 depth 0.42 height 0.4 offset 0.95 0.21 \
  0.2 brick
volume move "Stra_Vent_03" offset 67.7 1.89 19.2
volume create "Stra_Vent_10" width 1.9 depth 0.42 height 0.4 offset 0.95 0.21 \
  0.2 brick
volume move "Stra_Vent_10" offset 67.7 1.89 24.85
volume create "Stra_Vent_04" width 1.9 depth 0.42 height 0.4 offset 0.95 0.21 \
  0.2 brick
volume move "Stra_Vent_04" offset 67.7 1.89 29.9
/ auto's
volume create "Auto_A_01_L" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
volume move "Auto_A_01_L" offset 13 0.3 0.5
volume create "Auto_A_01_M" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
volume move "Auto_A_01_M" offset 15.2 0.3 0.5
volume create "Auto_B_01_L" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
volume move "Auto_B_01_L" offset 13 0.3 11.8
volume create "Auto_C_01_L" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
volume move "Auto_C_01_L" offset 13 0.3 17
volume create "Auto_C_01_M" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
volume move "Auto_C_01_M" offset 15.2 0.3 17
volume create "Auto_C_01_R" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
volume move "Auto_C_01_R" offset 17.4 0.3 17
volume create "Auto_D_01_L" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
volume move "Auto_D_01_L" offset 13 0.3 28.3
volume create "Auto_D_01_R" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
volume move "Auto_D_01_R" offset 17.4 0.3 28.3
volume create "Auto_B_02_L" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
volume move "Auto_B_02_L" offset 20.5 0.3 11.8
volume create "Auto_B_02_M" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
volume move "Auto_B_02_M" offset 22.7 0.3 11.8
volume create "Auto_B_02_R" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
volume move "Auto_B_02_R" offset 24.9 0.3 11.8
volume create "Auto_D_02_M" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
```

```
  2.1 brick
volume move "Auto_D_02_M" offset 22.7 0.3 28.3
volume create "Auto_D_02_R" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
volume move "Auto_D_02_R" offset 24.9 0.3 28.3
volume create "Auto_A_03_L" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
volume move "Auto_A_03_L" offset 28 0.3 0.5
volume create "Auto_A_03_M" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
volume move "Auto_A_03_M" offset 30.2 0.3 0.5
volume create "Auto_D_03_L" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
volume move "Auto_D_03_L" offset 28 0.3 28.3
volume create "Auto_A_04_M" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
volume move "Auto_A_04_M" offset 37.7 0.3 0.5
volume create "Auto_B_04_M" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
volume move "Auto_B_04_M" offset 37.7 0.3 11.8
volume create "Auto_B_04_05" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
volume move "Auto_B_04_05" offset 41.7 0.3 11.8
volume create "Auto_C_04_M" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
volume move "Auto_C_04_M" offset 37.7 0.3 17
volume create "Auto_C_04_05" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
volume move "Auto_C_04_05" offset 41.7 0.3 17
volume create "Auto_D_04_M" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
volume move "Auto_D_04_M" offset 37.7 0.3 28.3
volume create "Auto_B_05_R" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
volume move "Auto_B_05_R" offset 47.8 0.3 11.8
volume create "Auto_D_05_M" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
volume move "Auto_D_05_M" offset 45.2 0.3 28.3
volume create "Auto_D_05_L" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
volume move "Auto_D_05_L" offset 43 0.3 28.3
volume create "Auto_D_05_06" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
volume move "Auto_D_05_06" offset 49.2 0.3 28.3
volume create "Auto_A_06_M" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
volume move "Auto_A_06_M" offset 52.9 0.3 0.5
volume create "Auto_D_06_M" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
volume move "Auto_D_06_M" offset 52.9 0.3 28.3
volume create "Auto_D_06_R" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
volume move "Auto_D_06_R" offset 55.3 0.3 28.3
volume create "Auto_A_07_R" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
volume move "Auto_A_07_R" offset 62.8 0.3 0.5
volume create "Auto_B_07_R" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
volume move "Auto_B_07_R" offset 62.8 0.3 11.8
volume create "Auto_D_07_M" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
volume move "Auto_D_07_M" offset 60.4 0.3 28.3
volume create "Auto_A_08_L" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
volume move "Auto_A_08_L" offset 65.5 0.3 0.5
volume create "Auto_A_08_R" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
volume move "Auto_A_08_R" offset 70.3 0.3 0.5
volume create "Auto_B_08_L" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
volume move "Auto_B_08_L" offset 65.5 0.3 11.8
volume create "Auto_B_08_M" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
volume move "Auto_B_08_M" offset 67.7 0.3 11.8
volume create "Auto_B_08_R" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
```

```
volume move "Auto_B_08_R" offset 70.3 0.3 11.8
volume create "Auto_A_08_M" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
volume move "Auto_A_08_M" offset 67.7 0.3 0.5
volume create "Auto_D_08_M" width 1.7 depth 0.6 height 4.2 offset 0.85 0.3 \
  2.1 brick
volume move "Auto_D_08_M" offset 67.7 0.3 28.3
volume create "AutD_A_01_L" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
  1.55 brick
volume move "AutD_A_01_L" offset 13 0.9 1.6
volume unite volumes "Auto_A_01_L" "AutD_A_01_L"
volume create "AutD_A_01_M" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
  1.55 brick
volume move "AutD_A_01_M" offset 15.2 0.9 1.6
volume unite volumes "Auto_A_01_M" "AutD_A_01_M"
volume create "AutD_B_01_L" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
  1.55 brick
volume move "AutD_B_01_L" offset 13 0.9 11.8
volume unite volumes "Auto_B_01_L" "AutD_B_01_L"
volume create "AutD_C_01_L" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
  1.55 brick
volume move "AutD_C_01_L" offset 13 0.9 18.1
volume unite volumes "Auto_C_01_L" "AutD_C_01_L"
volume create "AutD_C_01_M" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
  1.55 brick
volume move "AutD_C_01_M" offset 15.2 0.9 18.1
volume unite volumes "Auto_C_01_M" "AutD_C_01_M"
volume create "AutD_C_01_R" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
  1.55 brick
volume move "AutD_C_01_R" offset 17.4 0.9 18.1
volume unite volumes "Auto_C_01_R" "AutD_C_01_R"
volume create "AutD_D_01_L" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
  1.55 brick
volume move "AutD_D_01_L" offset 13 0.9 28.3
volume unite volumes "Auto_D_01_L" "AutD_D_01_L"
volume create "AutD_D_01_R" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
  1.55 brick
volume move "AutD_D_01_R" offset 17.4 0.9 28.3
volume unite volumes "Auto_D_01_R" "AutD_D_01_R"
volume create "AutD_B_02_L" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
  1.55 brick
volume move "AutD_B_02_L" offset 20.5 0.9 11.8
volume unite volumes "Auto_B_02_L" "AutD_B_02_L"
volume create "AutD_B_02_M" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
  1.55 brick
volume move "AutD_B_02_M" offset 22.7 0.9 11.8
volume unite volumes "Auto_B_02_M" "AutD_B_02_M"
volume create "AutD_B_02_R" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
  1.55 brick
volume move "AutD_B_02_R" offset 24.9 0.9 11.8
volume unite volumes "Auto_B_02_R" "AutD_B_02_R"
volume create "AutD_D_02_M" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
  1.55 brick
volume move "AutD_D_02_M" offset 22.7 0.9 28.3
volume unite volumes "Auto_D_02_M" "AutD_D_02_M"
volume create "AutD_D_02_R" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
  1.55 brick
volume move "AutD_D_02_R" offset 24.9 0.9 28.3
volume unite volumes "Auto_D_02_R" "AutD_D_02_R"
volume create "AutD_A_03_L" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
  1.55 brick
volume move "AutD_A_03_L" offset 28 0.9 1.6
volume unite volumes "Auto_A_03_L" "AutD_A_03_L"
volume create "AutD_A_03_M" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
  1.55 brick
volume move "AutD_A_03_M" offset 30.2 0.9 1.6
volume unite volumes "Auto_A_03_M" "AutD_A_03_M"
volume create "AutD_D_03_L" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
  1.55 brick
volume move "AutD_D_03_L" offset 28 0.9 28.3
volume unite volumes "Auto_D_03_L" "AutD_D_03_L"
volume create "AutD_A_04_M" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
  1.55 brick
volume move "AutD_A_04_M" offset 37.7 0.9 1.6
volume unite volumes "Auto_A_04_M" "AutD_A_04_M"
volume create "AutD_B_04_M" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
```

```
  1.55 brick
volume move "AutD_B_04_M" offset 37.7 0.9 11.8
volume unite volumes "Auto_B_04_M" "AutD_B_04_M"
volume create "AutD_B_04_05" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
  1.55 brick
volume move "AutD_B_04_05" offset 41.7 0.9 11.8
volume unite volumes "Auto_B_04_05" "AutD_B_04_05"
volume create "AutD_C_04_M" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
  1.55 brick
volume move "AutD_C_04_M" offset 37.7 0.9 18.1
volume unite volumes "Auto_C_04_M" "AutD_C_04_M"
volume create "AutD_C_04_05" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
  1.55 brick
volume move "AutD_C_04_05" offset 41.7 0.9 18.1
volume unite volumes "Auto_C_04_05" "AutD_C_04_05"
volume create "AutD_D_04_M" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
  1.55 brick
volume move "AutD_D_04_M" offset 37.7 0.9 28.3
volume unite volumes "Auto_D_04_M" "AutD_D_04_M"
volume create "AutD_B_05_R" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
  1.55 brick
volume move "AutD_B_05_R" offset 47.8 0.9 11.8
volume unite volumes "Auto_B_05_R" "AutD_B_05_R"
volume create "AutD_D_05_M" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
  1.55 brick
volume move "AutD_D_05_M" offset 45.2 0.9 28.3
volume unite volumes "Auto_D_05_M" "AutD_D_05_M"
volume create "AutD_D_05_L" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
  1.55 brick
volume move "AutD_D_05_L" offset 43 0.9 28.3
volume unite volumes "Auto_D_05_L" "AutD_D_05_L"
volume create "AutD_D_05_06" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
  1.55 brick
volume move "AutD_D_05_06" offset 49.2 0.9 28.3
volume unite volumes "Auto_D_05_06" "AutD_D_05_06"
volume create "AutD_A_06_M" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
  1.55 brick
volume move "AutD_A_06_M" offset 52.9 0.9 1.6
volume unite volumes "Auto_A_06_M" "AutD_A_06_M"
volume create "AutD_D_06_M" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
  1.55 brick
volume move "AutD_D_06_M" offset 52.9 0.9 28.3
volume unite volumes "Auto_D_06_M" "AutD_D_06_M"
volume create "AutD_D_06_R" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
  1.55 brick
volume move "AutD_D_06_R" offset 55.3 0.9 28.3
volume unite volumes "Auto_D_06_R" "AutD_D_06_R"
volume create "AutD_A_07_R" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
  1.55 brick
volume move "AutD_A_07_R" offset 62.8 0.9 1.6
volume unite volumes "Auto_A_07_R" "AutD_A_07_R"
volume create "AutD_B_07_R" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
  1.55 brick
volume move "AutD_B_07_R" offset 62.8 0.9 11.8
volume unite volumes "Auto_B_07_R" "AutD_B_07_R"
volume create "AutD_D_07_M" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
  1.55 brick
volume move "AutD_D_07_M" offset 60.4 0.9 28.3
volume unite volumes "Auto_D_07_M" "AutD_D_07_M"
volume create "AutD_A_08_L" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
  1.55 brick
volume move "AutD_A_08_L" offset 65.5 0.9 1.6
volume unite volumes "Auto_A_08_L" "AutD_A_08_L"
volume create "AutD_A_08_R" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
  1.55 brick
volume move "AutD_A_08_R" offset 70.3 0.9 1.6
volume unite volumes "Auto_A_08_R" "AutD_A_08_R"
volume create "AutD_B_08_L" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
  1.55 brick
volume move "AutD_B_08_L" offset 65.5 0.9 11.8
volume unite volumes "Auto_B_08_L" "AutD_B_08_L"
volume create "AutD_B_08_M" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
  1.55 brick
volume move "AutD_B_08_M" offset 67.7 0.9 11.8
volume unite volumes "Auto_B_08_M" "AutD_B_08_M"
volume create "AutD_B_08_R" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
```

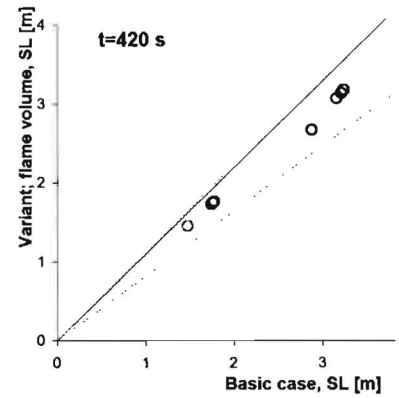
```
  1.55 brick
volume move "AutD_B_08_R" offset 70.3 0.9 11.8
volume unite volumes "Auto_B_08_R" "AutD_B_08_R"
volume create "AutD_A_08_M" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
  1.55 brick
volume move "AutD_A_08_M" offset 67.7 0.9 1.6
volume unite volumes "Auto_A_08_M" "AutD_A_08_M"
volume create "AutD_D_08_M" width 1.7 depth 0.5 height 3.1 offset 0.85 0.25 \
  1.55 brick
volume move "AutD_D_08_M" offset 67.7 0.9 28.3
volume unite volumes "Auto_D_08_M" "AutD_D_08_M"
volume create "Weegschaal" width 1.7 depth 0.3 height 3.7 offset 0.85 0.15 \
  1.85 brick
volume move "Weegschaal" offset 52.9 0 17.5
volume create "Espace" width 1.7 depth 0.39 height 4.2 offset 0.85 0.195 2.1 brick
volume move "Espace" offset 52.9 0.51 17
volume create "Vuur_copy" width 3.1 depth 1.07 height 4.2 offset 1.55 0.535 \
  2.1 brick
volume move "Vuur_copy" offset 52.2 0.63 17
volume create "Vuur" width 3.1 depth 1.07 height 4.2 offset 1.55 0.535 2.1 brick
volume move "Vuur" offset 52.2 0.63 17
volume subtract "Garage" volumes "Trappenhuis_L"
volume subtract "Garage" volumes "Trappenhuis_R"
volume subtract "Garage" volumes "Muur"
volume subtract "Garage" volumes "Ligger_2"
volume subtract "Garage" volumes "Ligger_3"
volume subtract "Garage" volumes "Ligger_4"
volume subtract "Garage" volumes "Ligger_5"
volume subtract "Garage" volumes "Ligger_6"
volume subtract "Garage" volumes "Ligger_7"
volume subtract "Garage" volumes "Ligger_8"
volume subtract "Garage" volumes "Ligger_9"
volume subtract "Garage" volumes "Ligger_10"
volume subtract "Garage" volumes "Ligger_11"
volume subtract "Garage" volumes "Staand_M_2"
volume subtract "Garage" volumes "Staand_M_3"
volume subtract "Garage" volumes "Staand_M_4"
volume subtract "Garage" volumes "Staand_M_5"
volume subtract "Garage" volumes "Staand_M_6"
volume subtract "Garage" volumes "Staand_M_7"
volume subtract "Garage" volumes "Staand_M_8"
volume subtract "Garage" volumes "Staand_M_9"
volume subtract "Garage" volumes "Staand_M_10"
volume subtract "Garage" volumes "Staand_M_11"
volume subtract "Garage" volumes "Vent_buis_A"
volume subtract "Garage" volumes "Vent_buis_V"
volume subtract "Garage" volumes "Stra_Vent_05"
volume subtract "Garage" volumes "Stra_Vent_06"
volume subtract "Garage" volumes "Stra_Vent_07"
volume subtract "Garage" volumes "Stra_Vent_08"
volume subtract "Garage" volumes "Stra_Vent_01"
volume subtract "Garage" volumes "Stra_Vent_09"
volume subtract "Garage" volumes "Stra_Vent_02"
volume subtract "Garage" volumes "Stra_Vent_03"
volume subtract "Garage" volumes "Stra_Vent_10"
volume subtract "Garage" volumes "Stra_Vent_04"
volume subtract "Garage" volumes "Auto_A_01_L"
volume subtract "Garage" volumes "Auto_A_01_M"
volume subtract "Garage" volumes "Auto_B_01_L"
volume subtract "Garage" volumes "Auto_C_01_L"
volume subtract "Garage" volumes "Auto_C_01_M"
volume subtract "Garage" volumes "Auto_C_01_R"
volume subtract "Garage" volumes "Auto_D_01_L"
volume subtract "Garage" volumes "Auto_B_02_L"
volume subtract "Garage" volumes "Auto_B_02_M"
volume subtract "Garage" volumes "Auto_B_02_R"
volume subtract "Garage" volumes "Auto_D_02_M"
volume subtract "Garage" volumes "Auto_D_02_R"
volume subtract "Garage" volumes "Auto_A_03_L"
volume subtract "Garage" volumes "Auto_A_03_M"
volume subtract "Garage" volumes "Auto_D_03_L"
volume subtract "Garage" volumes "Auto_A_04_M"
volume subtract "Garage" volumes "Auto_B_04_M"
volume subtract "Garage" volumes "Auto_B_04_05"
volume subtract "Garage" volumes "Auto_C_04_M"
volume subtract "Garage" volumes "Auto_C_04_05"
```

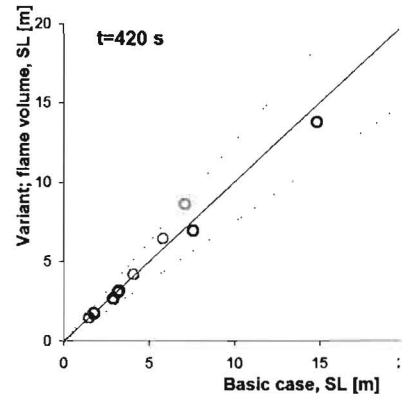
```
volume subtract "Garage" volumes "Auto_D_04_M"
volume subtract "Garage" volumes "Auto_B_05_R"
volume subtract "Garage" volumes "Auto_D_05_M"
volume subtract "Garage" volumes "Auto_D_05_L"
volume subtract "Garage" volumes "Auto_D_05_06"
volume subtract "Garage" volumes "Auto_A_06_M"
volume subtract "Garage" volumes "Auto_D_06_M"
volume subtract "Garage" volumes "Auto_D_06_R"
volume subtract "Garage" volumes "Auto_A_07_R"
volume subtract "Garage" volumes "Auto_B_07_R"
volume subtract "Garage" volumes "Auto_D_07_M"
volume subtract "Garage" volumes "Auto_A_08_L"
volume subtract "Garage" volumes "Auto_A_08_R"
volume subtract "Garage" volumes "Auto_B_08_L"
volume subtract "Garage" volumes "Auto_B_08_M"
volume subtract "Garage" volumes "Auto_B_08_R"
volume subtract "Garage" volumes "Auto_A_08_M"
volume subtract "Garage" volumes "Auto_D_08_M"
volume subtract "Garage" volumes "Weegschaal"
volume subtract "Garage" volumes "Espace"
volume subtract "Garage" volumes "Vuur_copy"
physics create "Lucht" ctype "FLUID" volume "Garage"
physics create "Vlammen" ctype "FLUID" volume "Vuur"
vertex create coordinates 81.5 0 2.2
vertex create coordinates 81.5 0 3.6
vertex create coordinates 81.5 2.1 2.2
vertex create coordinates 81.5 2.1 3.6
vertex create coordinates 85 0.9 3.6
vertex create coordinates 85 0.9 5.6
vertex create coordinates 85 2.31 3.6
vertex create coordinates 85 2.31 5.6
vertex create coordinates 85 0.9 15.5
vertex create coordinates 85 0.9 17.5
vertex create coordinates 85 2.31 15.5
vertex create coordinates 85 2.31 17.5
vertex create coordinates 85 0.9 29.4
vertex create coordinates 85 0.9 30.8
vertex create coordinates 85 2.31 29.4
vertex create coordinates 85 2.31 30.8
vertex create coordinates 0 0.9 5.6
vertex create coordinates 0 0.9 6.5
vertex create coordinates 0 2.1 5.6
vertex create coordinates 0 2.1 6.5
vertex create coordinates 0 0.9 29.4
vertex create coordinates 0 0.9 30.8
vertex create coordinates 0 2.1 29.4
vertex create coordinates 0 2.1 30.8
vertex create coordinates 11 0 0
vertex create coordinates 11 0 33
vertex create coordinates 22 0 33
vertex create coordinates 22 0 0
vertex create coordinates 36 0 0
vertex create coordinates 36 0 33
vertex create coordinates 50 0 33
vertex create coordinates 50 0 0
vertex create coordinates 66 0 0
vertex create coordinates 66 0 33
vertex create coordinates 51 0 33
vertex create coordinates 51 0 0
vertex create coordinates 51 0 0
```

Appendix 10: Numerical data for sight length (variants)

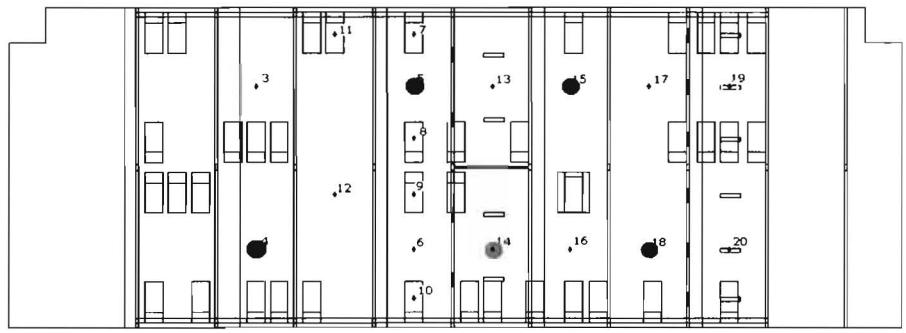
Variant: Flame volume

		Basic	Variancy
p4	0,85	1.74669	1.72715
blue	1,45	1.75373	1.73545
	1,85	1.76441	1.74876
	2,45	1.77347	1.76058
p5	0,85	3.2413	3.17832
red	1,45	3.2476	3.17703
	1,85	3.2133	3.13561
	2,45	3.16205	3.07244
p14	0,85	7.09142	8.61536
green	1,45	5.80524	6.44319
	1,85	4.10276	4.18537
	2,45	1.47879	1.45088
p15	0,85	33.522	31.4322
black	1,45	14.8362	13.7517
	1,85	7.57878	6.95362
	2,45	2.88029	2.67029
p18	0,85	477.443	496.392
purple	1,45	500.191	523.15
	1,85	498.518	521.146
	2,45	478.037	497.694
p19	0,85	6266.03	5846.53
yellow	1,45	1483.6	1463.63
	1,85	876.842	880.055
	2,45	406.068	420.515



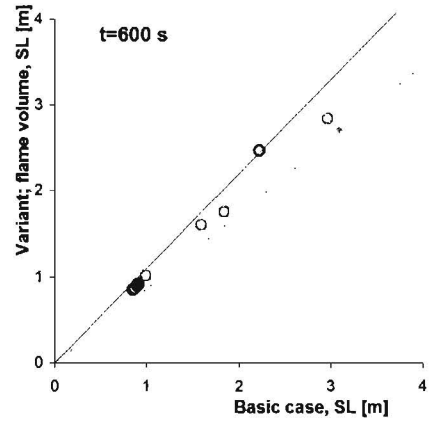


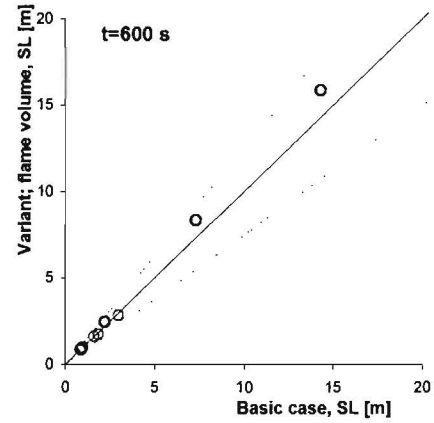
x	y	
0	0	4 blue
200	200	5 red
0	0	14 green
200	150	15 black
0	0	18 purple
200	250	19 yellow



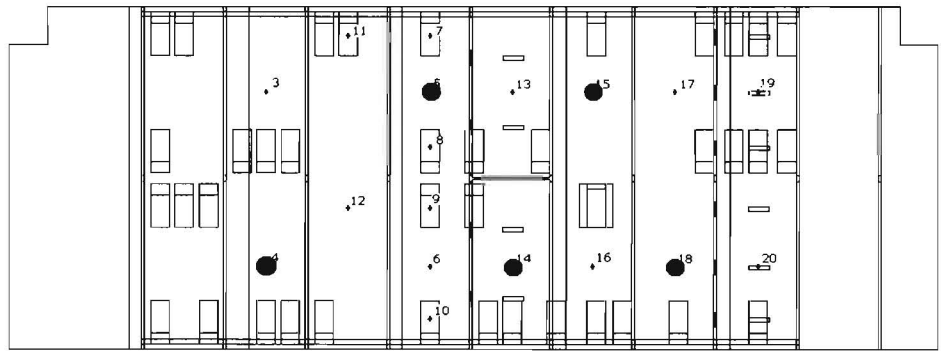
Alternative flame volume: sight length for t=420 s

		Basic	o Variancy
p4	0,85	0.913633	0.914389
blue	1,45	0.882885	0.882146
	1,85	0.864623	0.862944
	2,45	0.851173	0.848728
p5	0,85	0.909822	0.918535
red	1,45	0.911117	0.918411
	1,85	0.906641	0.912485
	2,45	0.896043	0.901181
p14	0,85	2.96808	2.83702
green	1,45	1.83558	1.75052
	1,85	1.59671	1.5972
	2,45	0.994223	1.01849
p15	0,85	30.302	32.4064
black	1,45	14.3128	15.8664
	1,85	7.33584	8.33538
	2,45	2.21709	2.46473
p18	0,85	210.934	227.868
purple	1,45	241.057	254.344
	1,85	246.092	258.331
	2,45	227.174	240.531
p19	0,85	2143.1	1251.47
yellow	1,45	529.496	464.925
	1,85	318.977	300.831
	2,45	148.147	150.891



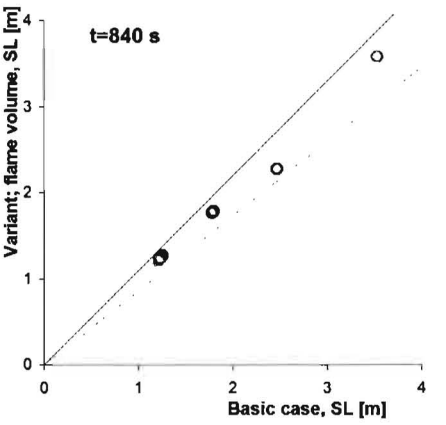


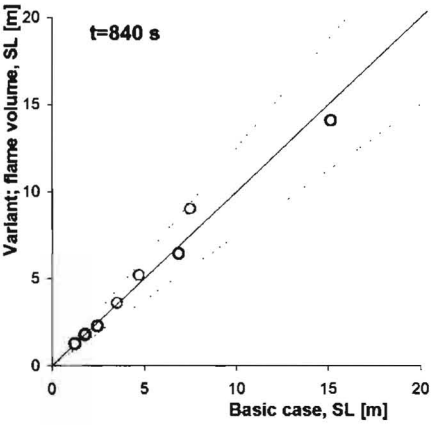
x	y	
0	0	4 blue
200	200	5 red
0	0	14 green
200	150	15 black
0	0	18 purple
200	250	19 yellow



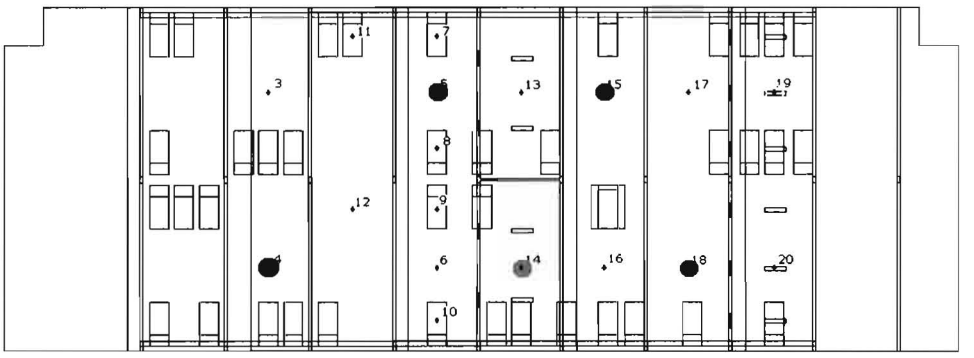
Alternative flame volume: sight length for t=600 s

		Basic	Variancy
p4	0,85	1.25492	1.27031
blue	1,45	1.23797	1.24657
	1,85	1.23051	1.23516
	2,45	1.22098	1.22281
p5	0,85	1.79616	1.78154
red	1,45	1.79992	1.78366
	1,85	1.79192	1.77656
	2,45	1.77869	1.76463
p14	0,85	7.48697	9.02402
green	1,45	4.70125	5.19795
	1,85	3.53017	3.58094
	2,45	1.21447	1.20736
p15	0,85	45.9804	41.1595
black	1,45	15.1401	14.0761
	1,85	6.8869	6.4425
	2,45	2.4707	2.27603
p18	0,85	427.348	337.41
purple	1,45	473.548	358.537
	1,85	470.755	358.087
	2,45	420.21	335.327
p19	0,85	21768.7	1017.01
yellow	1,45	5307.57	896.667
	1,85	2875.7	815.991
	2,45	792.38	451.058





x	y	
0	0	4 blue
200	200	5 red
0	0	14 green
200	150	15 black
0	0	18 purple
200	250	19 yellow



Alternative flame volume: sight length for t=840 s

Appendix 11: Relative imbalances

Table 5: relative difference for imbalances

Δ time [s]	Energy imbalance	Surface imbalance	Mass-weighted integral for total energy	Difference	Relative difference [%]
420	1083800	2364116	614257590	1 280 316	0.20
480	1037830	3713134	549172820	2 675 304	0.48
540	975240	5894660	487201130	4 919 420	1.00
600	434120	5179612	476012850	4 745 492	0.99
660	211510	4729680	492695520	4 518 170	0.91
720	111350	4431977	502055950	4 320 627	0.86
780	98740	4499131	515718100	4 400 391	0.85
840	146330	4623430	514322920	4 477 100	0.87

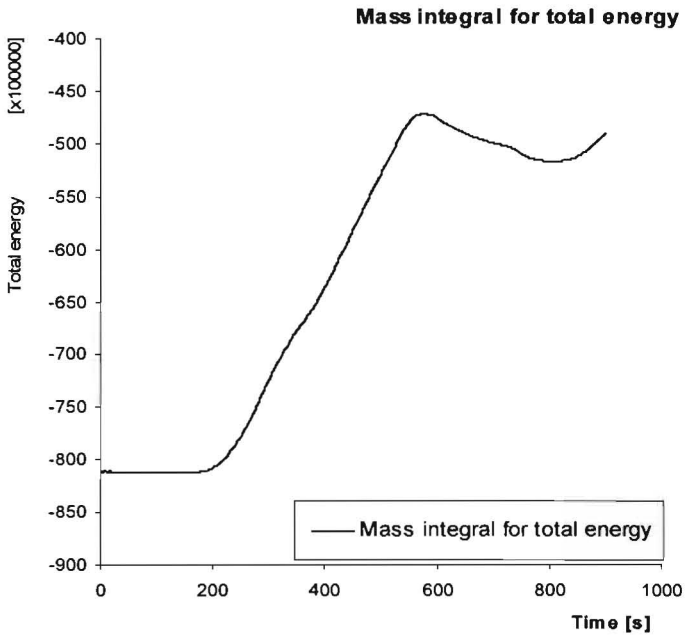


Figure 52: mass-weighted integral for total energy