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Air space impact on the performance of a solar air heater

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Outline

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- Experimental set-up
- Numerical model
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    - *Boundary and Initial Conditions*
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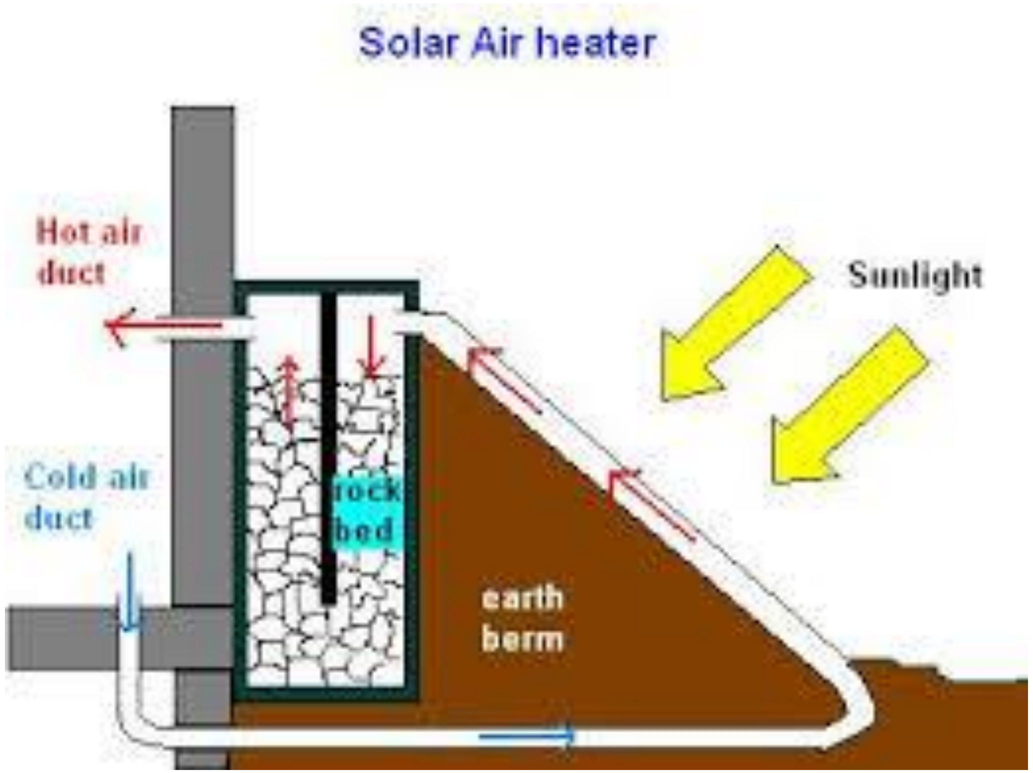
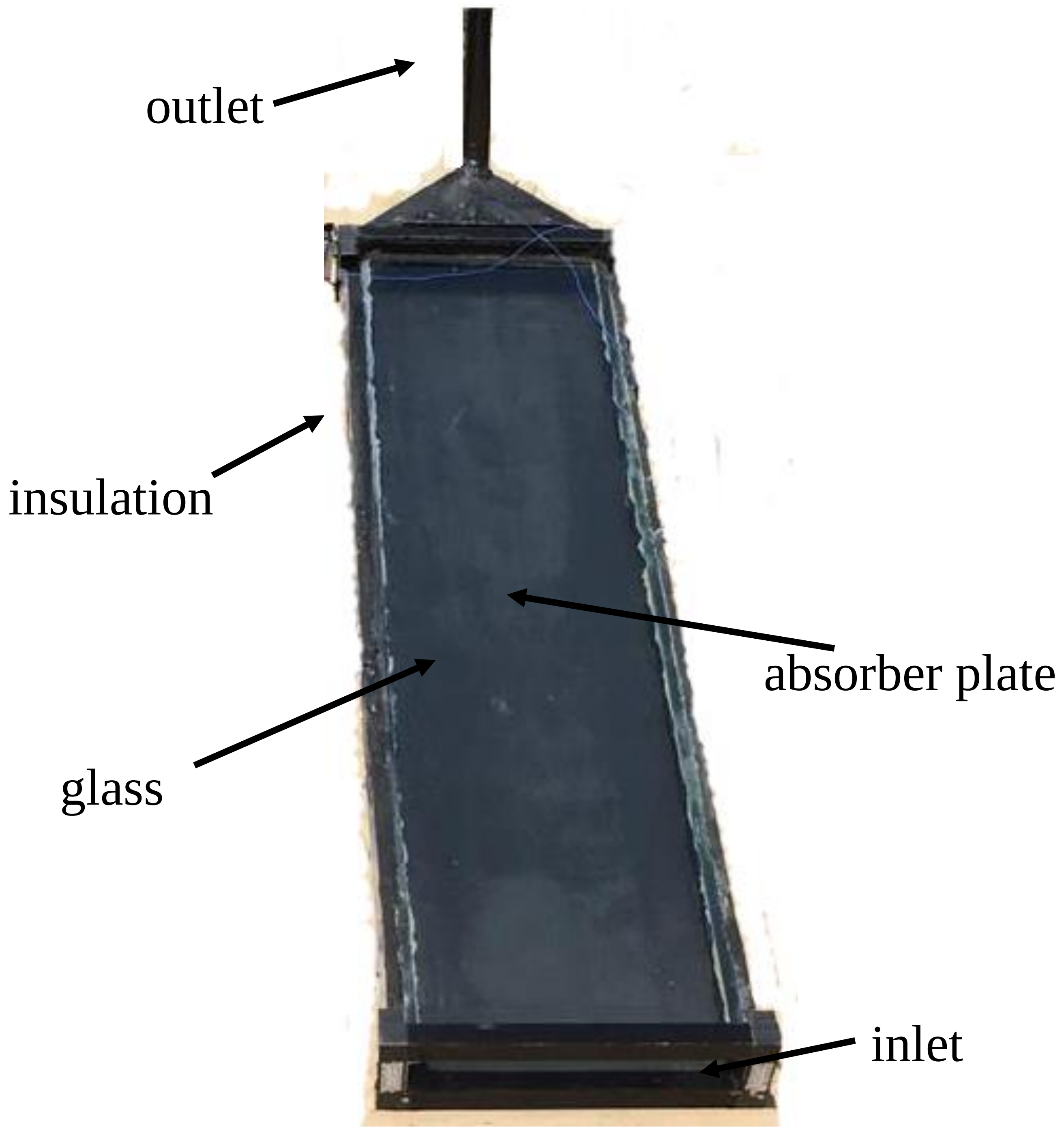
Introduction

Introduction

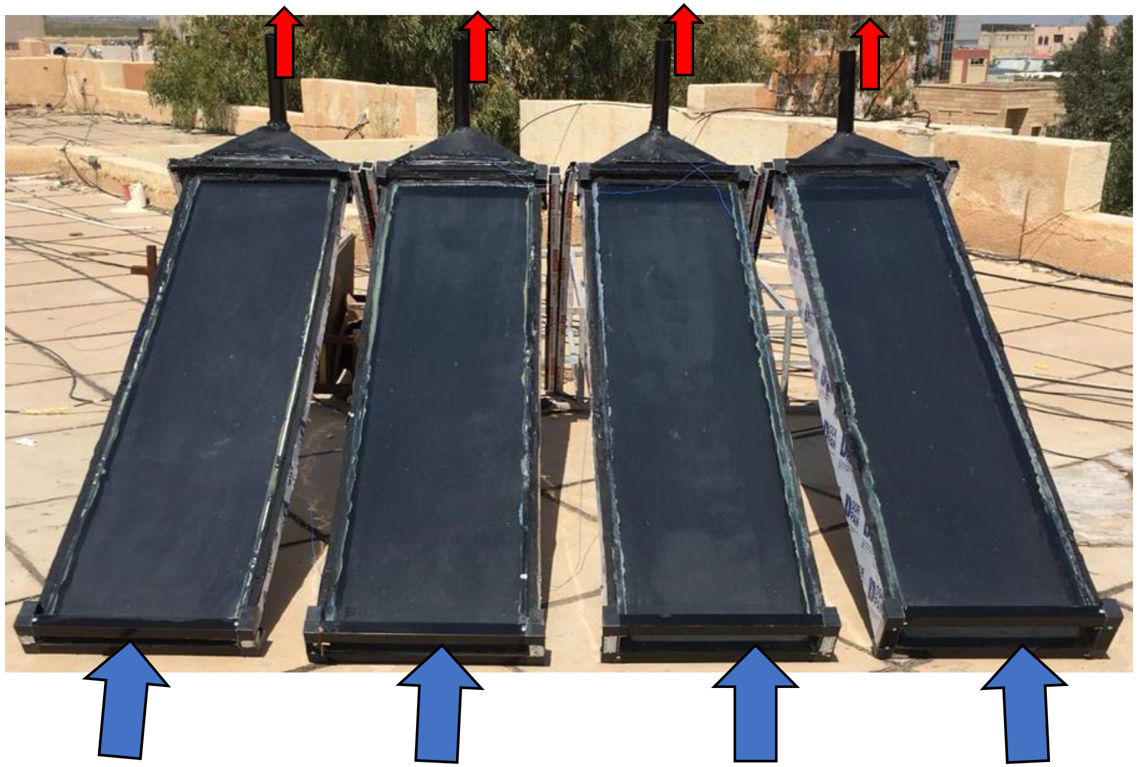


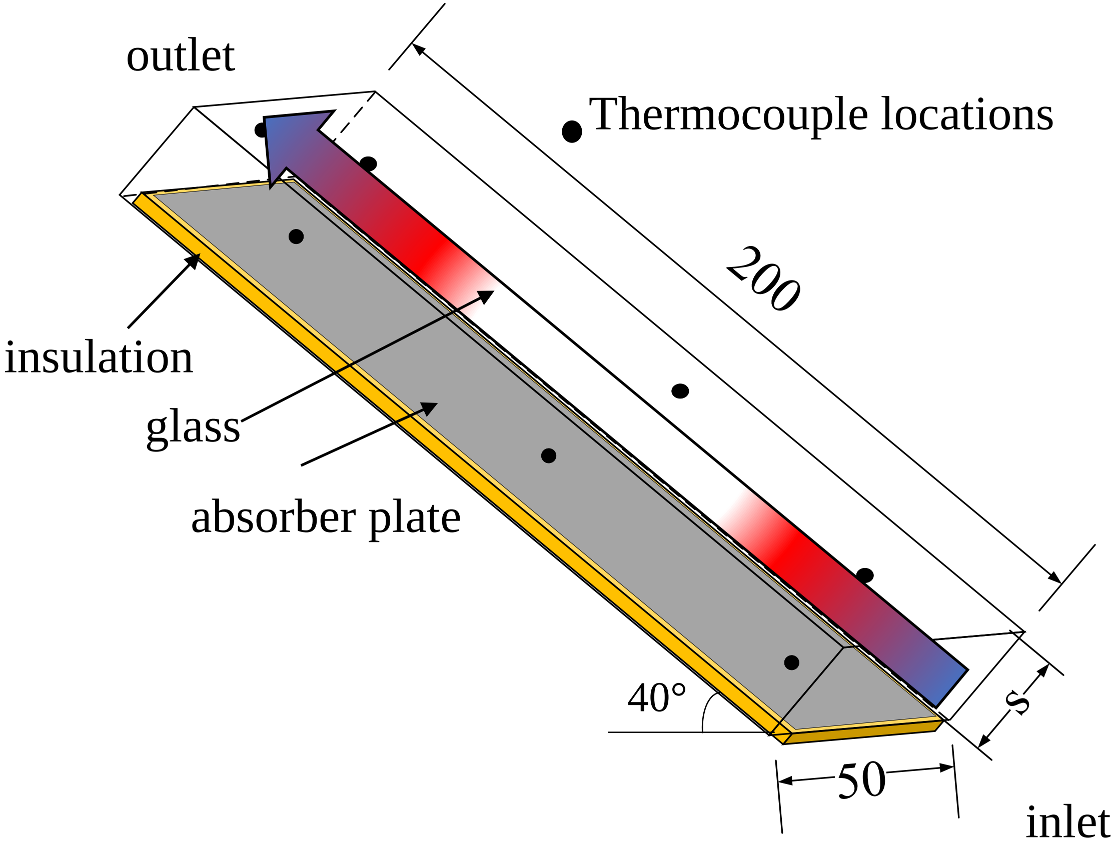
heating spaces

drying food


outlet
insulation
absorber plate
glass
inlet

Experimental Set-up





Numerical Model

Governing equations

Conservation of mass

$$\rho\nabla.U = 0$$

Conservation of momentum

$$\rho\frac{\partial U}{\partial t} + \rho(U.\nabla)U = \nabla.[-p + \mu\nabla U]$$

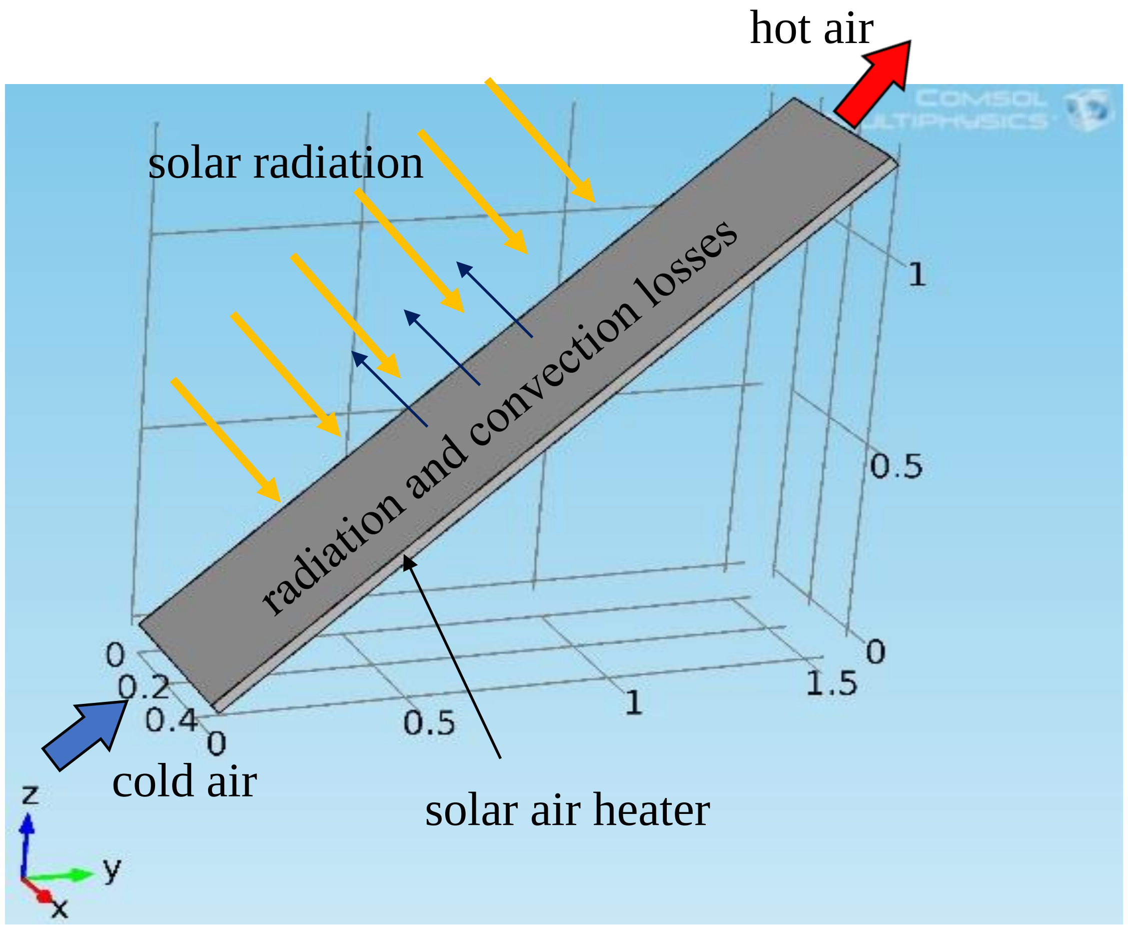
Conservation of Energy

$$\rho C_p\frac{\partial T}{\partial t} + \rho C_p U.\nabla T = \nabla.(k\nabla T) + Q$$

Numerical Model

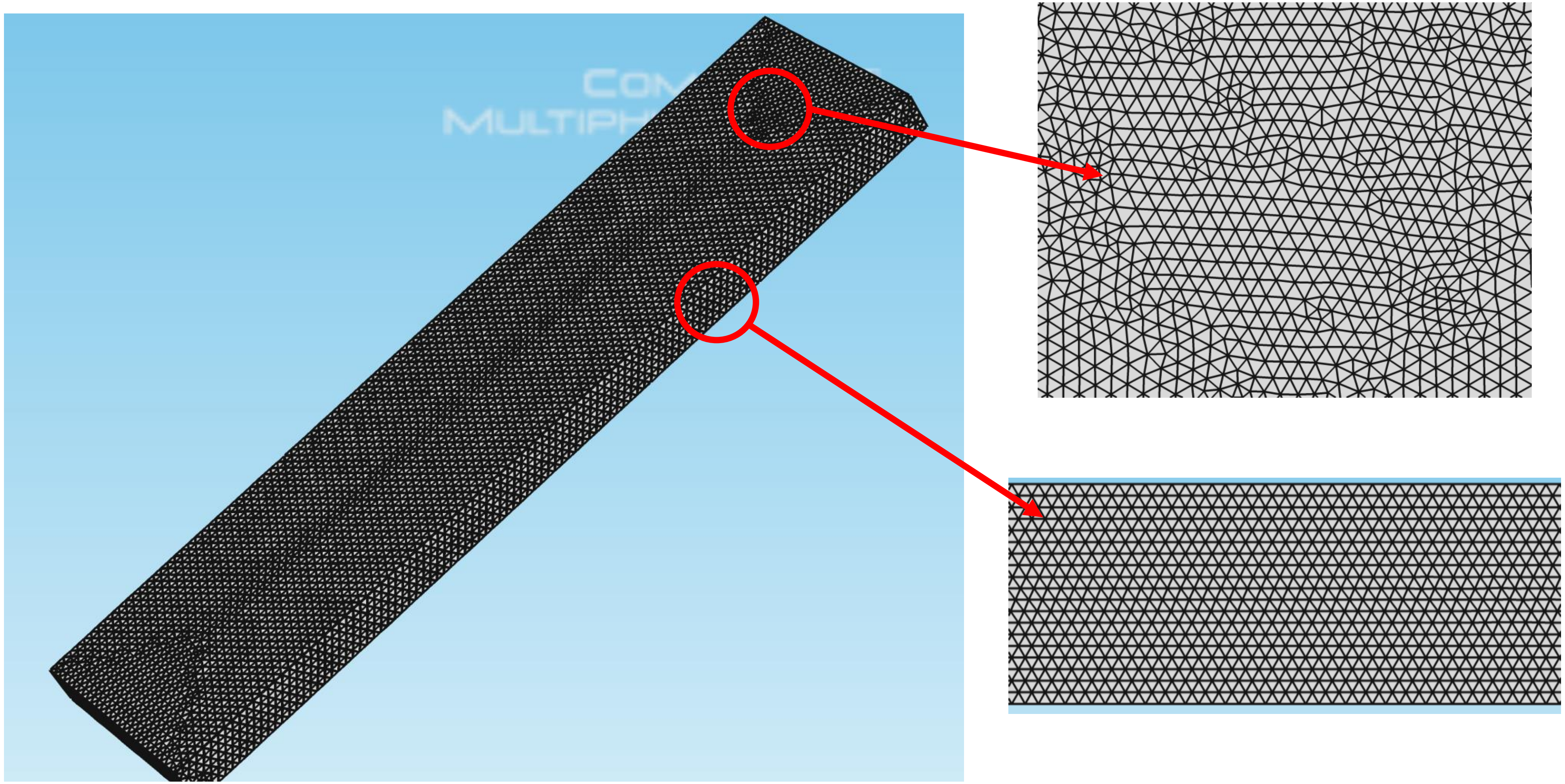
Boundary and Initial Conditions

Ambient	T= 31 °C, U= 4.6 m/s
Upper surface	$-\boldsymbol{n}.(-k\nabla T) = h.(T_{ext} - T) + \varepsilon\sigma(T_{amb}^4 - T^4)$
Sides surfaces	$-\boldsymbol{n}.(-k\nabla T) = 0$
Outlet	$-\boldsymbol{n}.(-k\nabla T) = 0$, $[\mu(\nabla\boldsymbol{u} + (\nabla\boldsymbol{u})^T)]\boldsymbol{n} = 0$, $p=p_{atm}$
Initial	T= 31 °C, U=0 m/s, $p=p_{atm}$

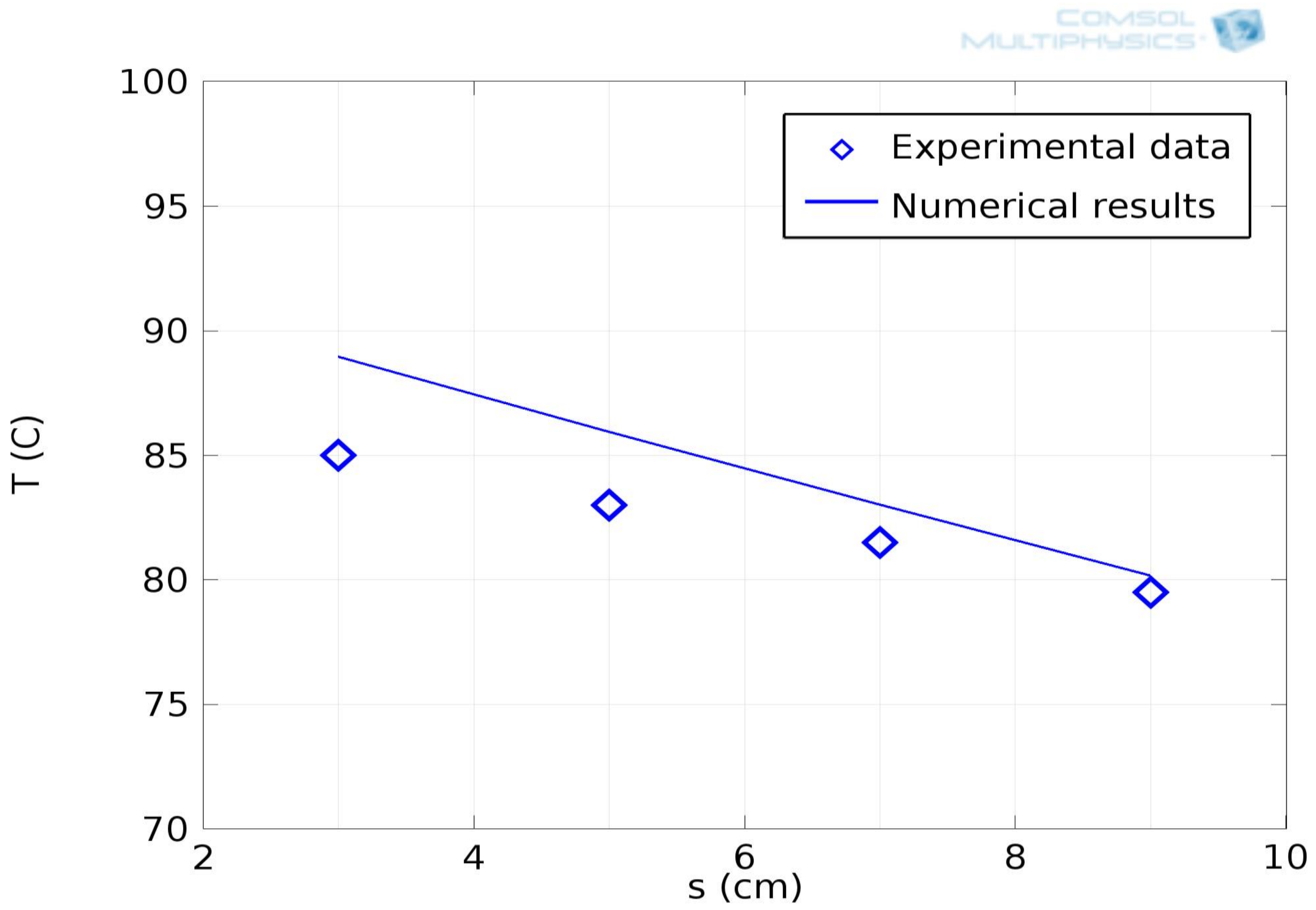


Numerical Model

Meshing

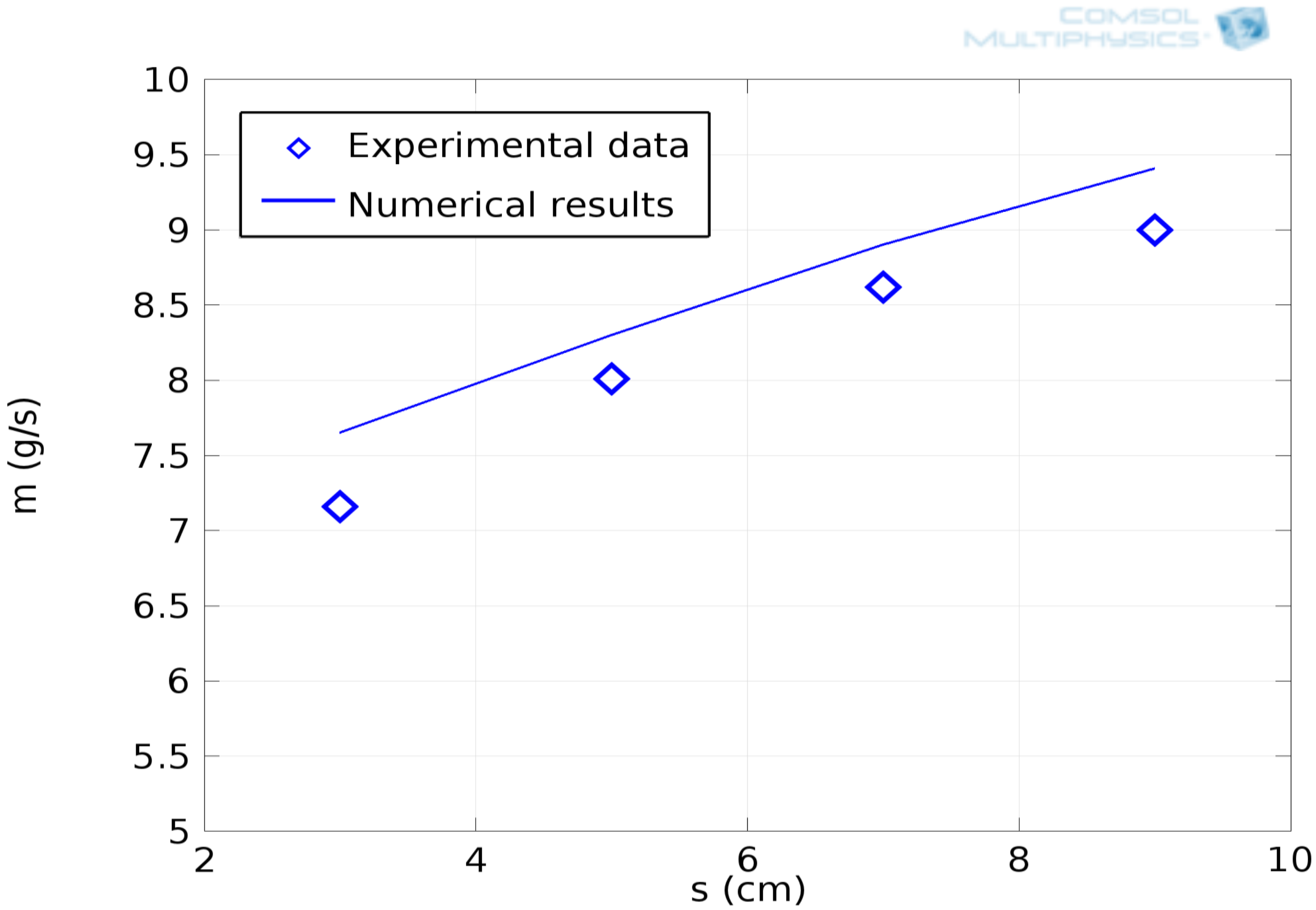


Results and Discussion



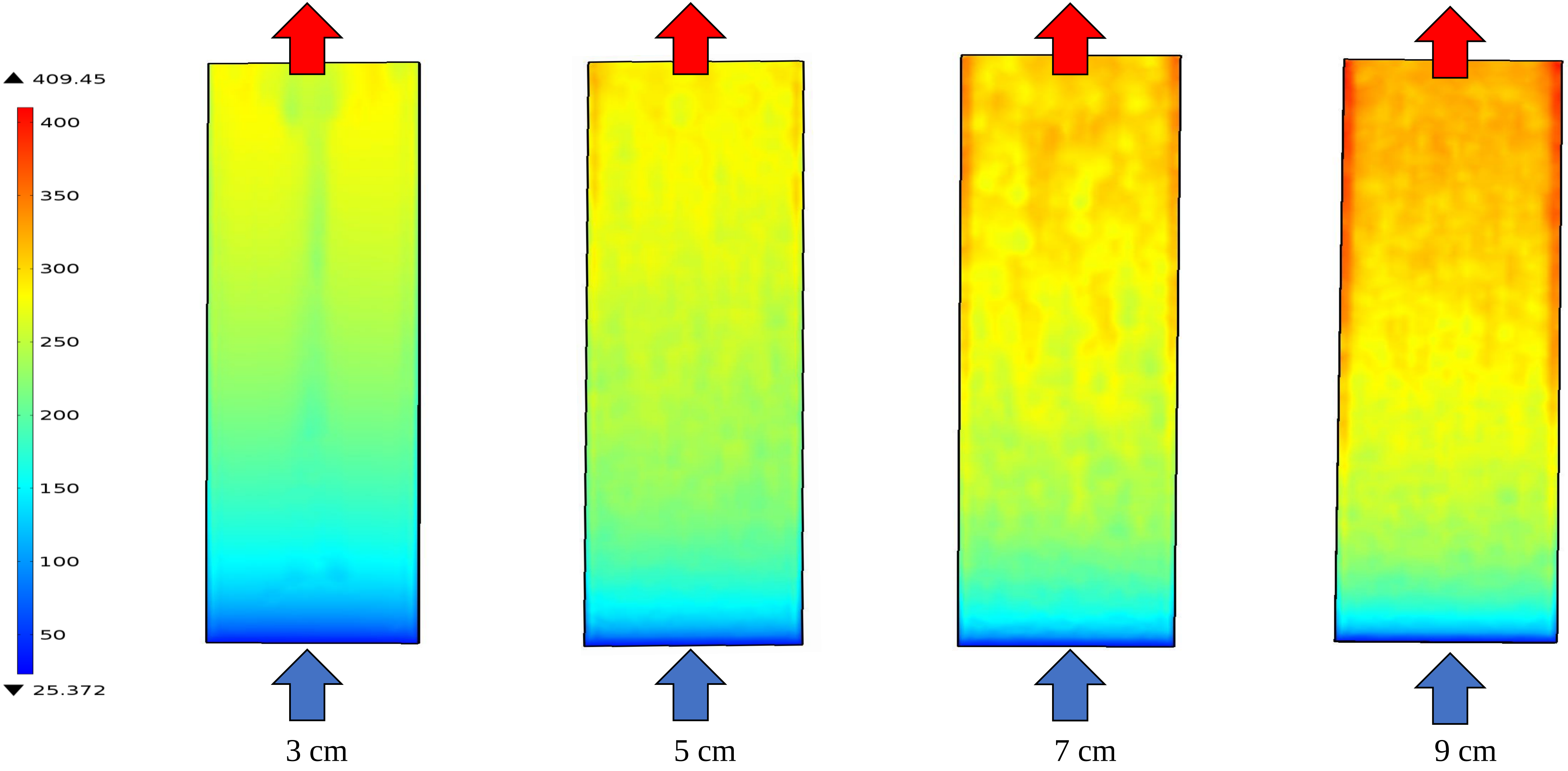
The air temperature at the exit of the solar air heater

Results and Discussion



The air mass flow rate at the exit of the solar air heater

Results and Discussion



Conclusions

- A reduction of 11% in the hot air temperature leaving the solar air heater was found. The reduction in the outlet air temperature resulted by high air volume associated with wide air space.
- An increase of 18.7% in the mass flowrate of the hot air leaving the solar air heater.
- The temperature of the solar air heater absorber was higher in wider air spaces than that of narrower ones. The high mass flowrate of the hot air associated with wider air space resulted in less time for the air to cool down the absorber.
- Optimization is required to reveal the best outlet air temperature and mass flow rate and achieve the highest performance for the solar air heater.

Thank you