Studying urban land-atmospheric interactions by coupling an urban canopy model with a single column atmospheric model

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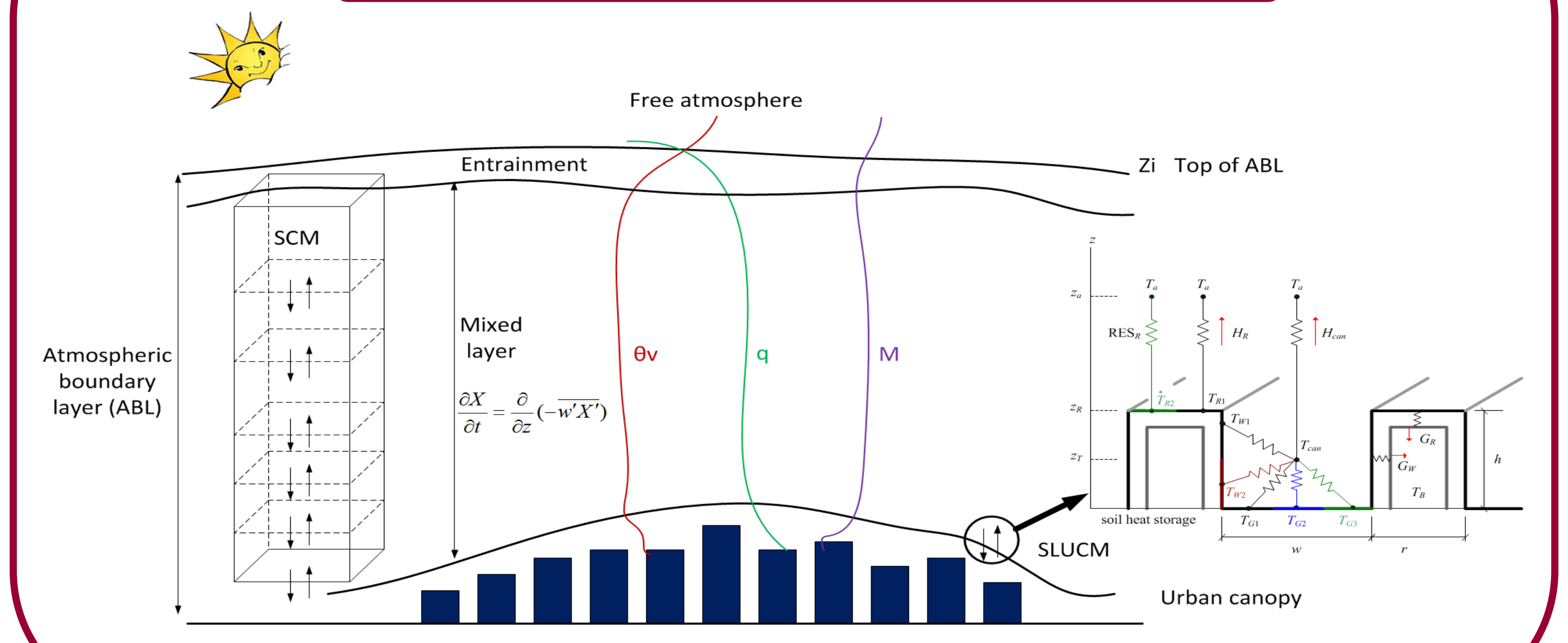
Problem Statement

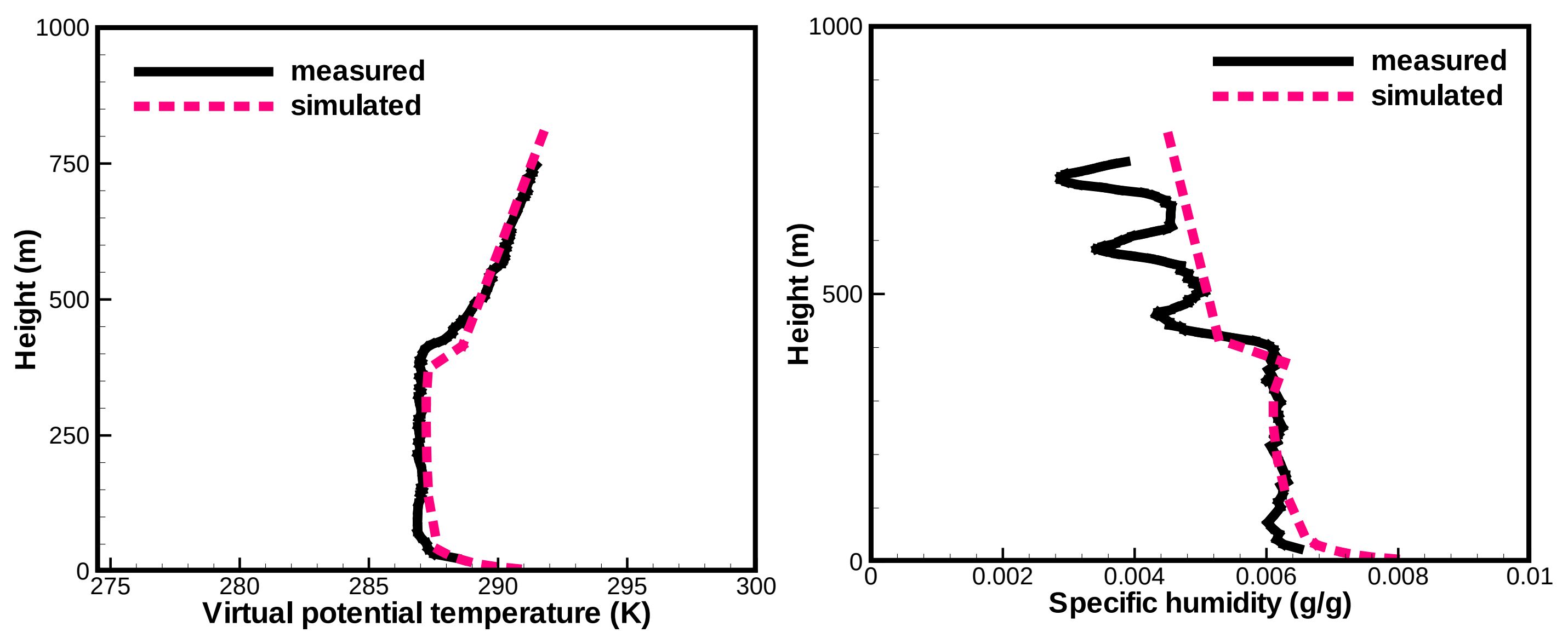
Land use land cover changes (LULCC) in urban area will modify surface energy budgets and turbulent fluxes, which will further change the dynamic and thermodynamic structures of the overlying atmospheric boundary layer (ABL).

Question: How will the overlying atmosphere be influenced by urban LULCC?

Coupling Methodology

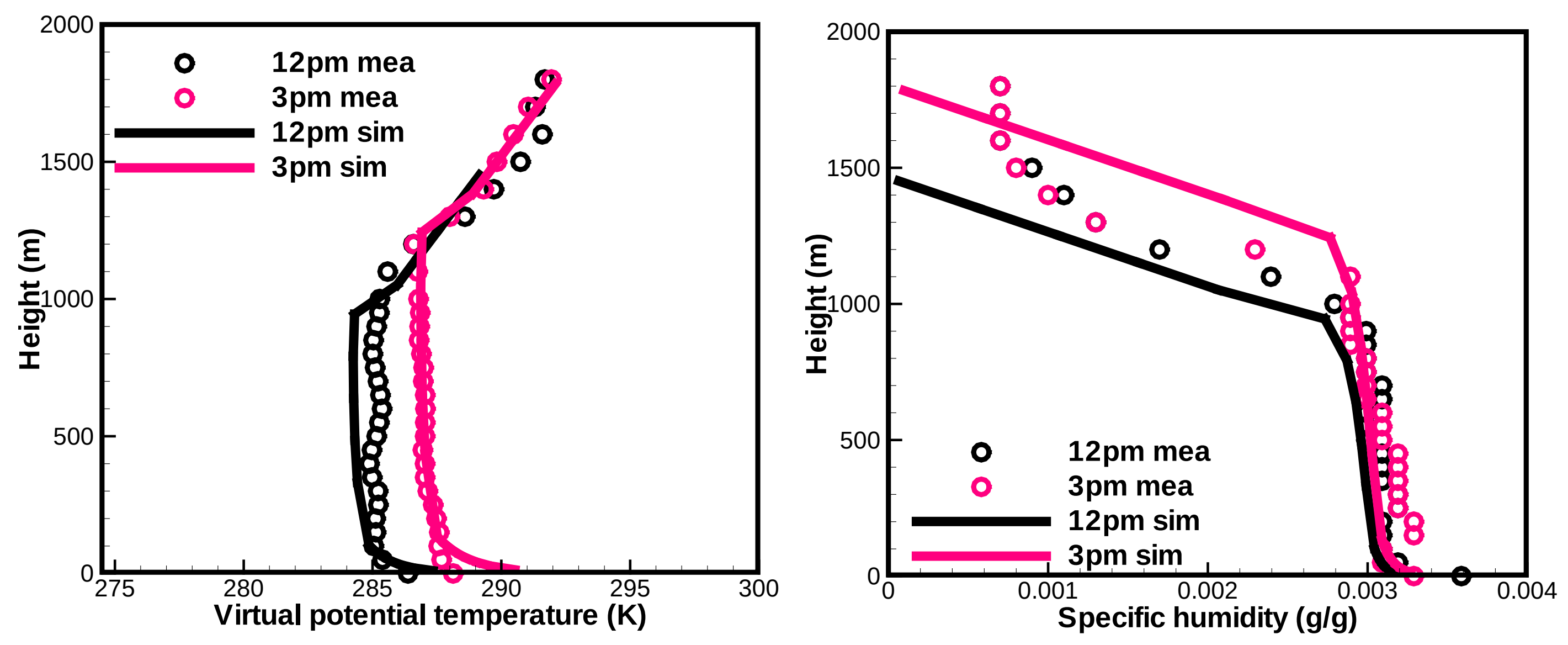


Single Column Model (SCM)



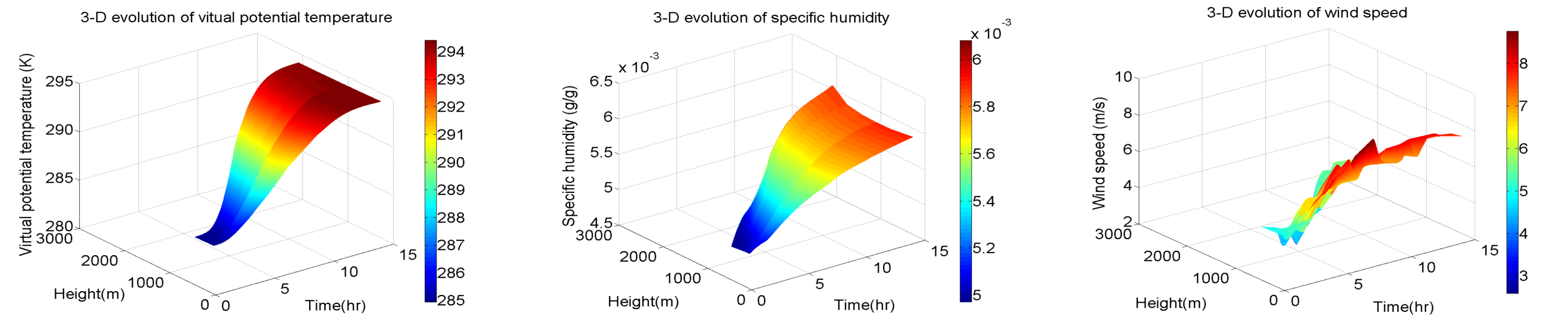
2005/03/26 9:30am Point Reyes, CA

SCM-Slab Model Coupling



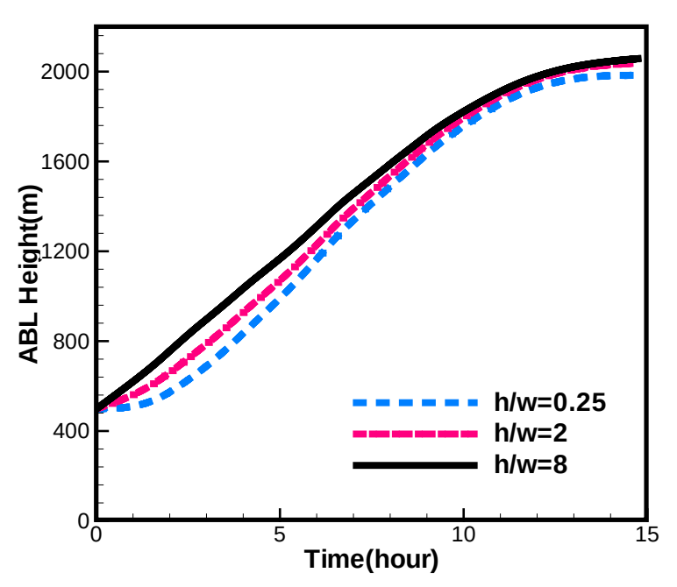
Wangara Day 33 12:00 pm 3:00pm in Australia

SCM-SLUCM Coupling

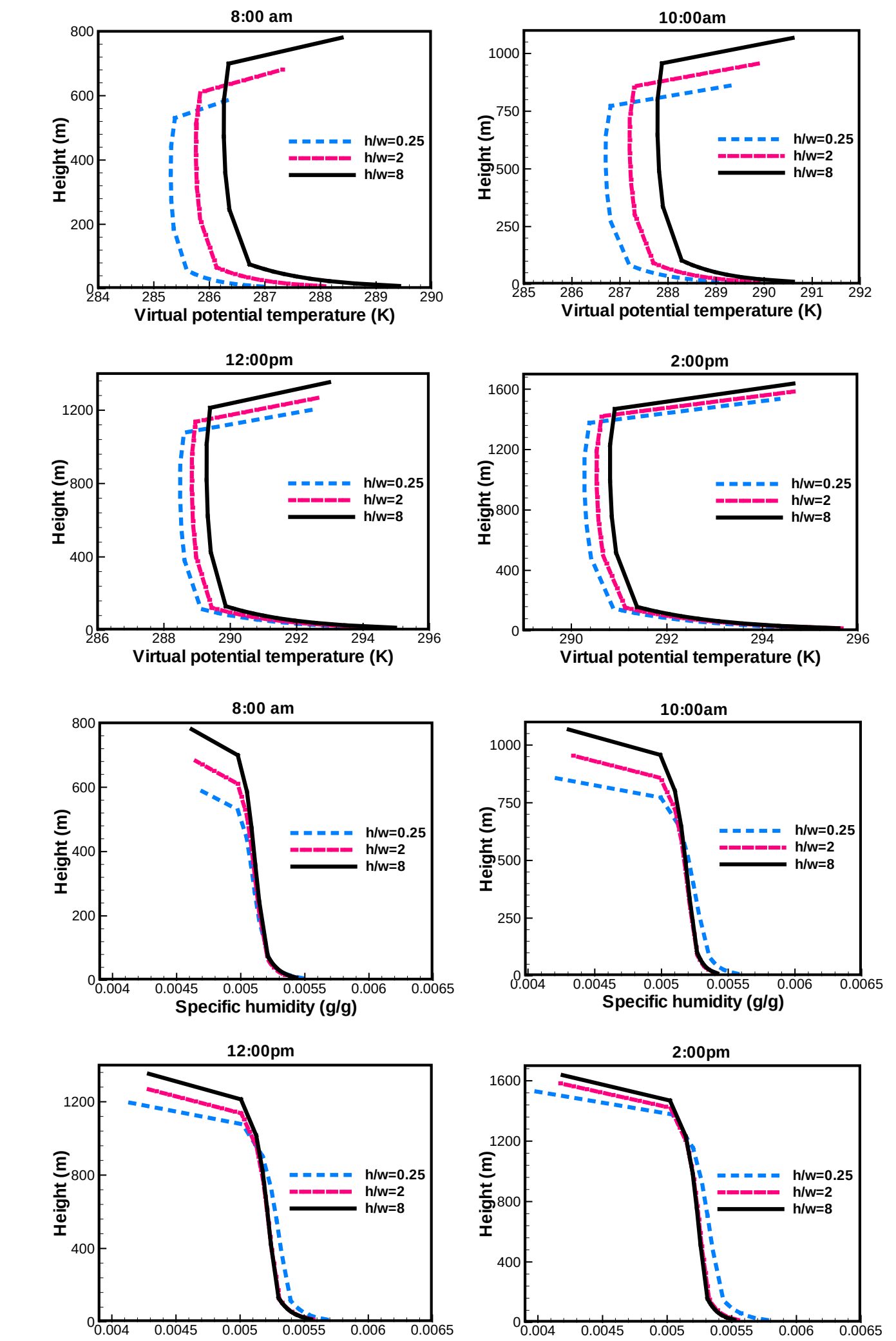


Temporal evolution:
The height of atmospheric boundary layer (ABL) will increase due to the influence of turbulent heat fluxes at daytime.
The virtual potential temperature, specific humidity, and wind speed will change due to effects of surface fluxes at daytime.
Spatial evolution:
The values of virtual potential temperature and specific humidity are almost constant in the mixed layer.

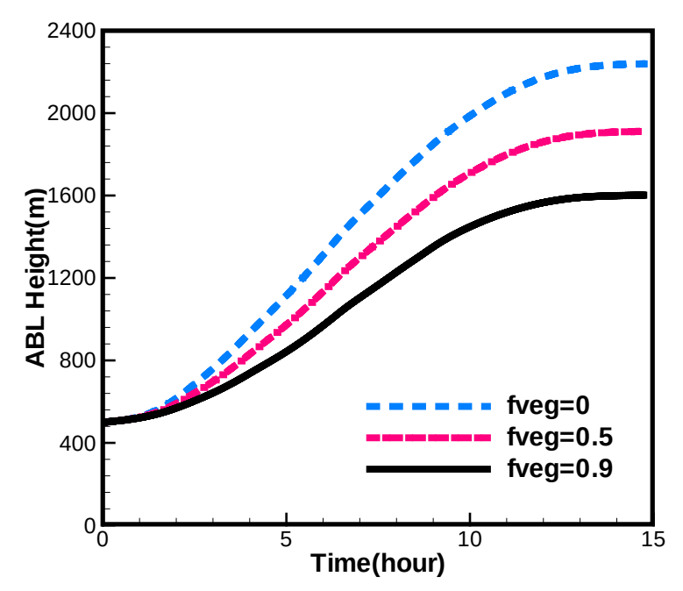
Effects of geometry



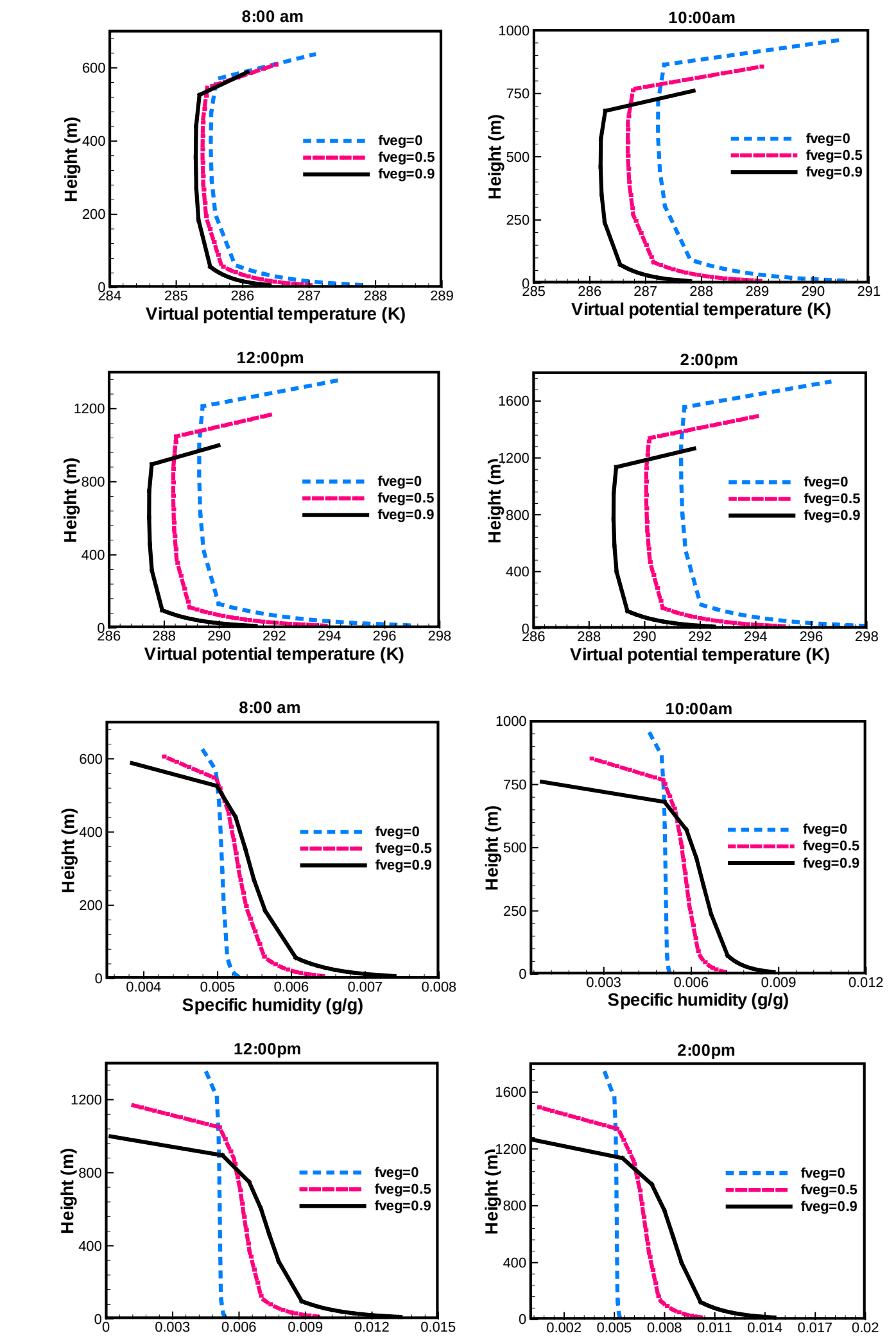
Higher building (shadow effects, incident angle impacts) will lead to:
- ➢ higher ABL.
- ➢ higher virtual potential temperature
- ➢ slightly lower specific humidity



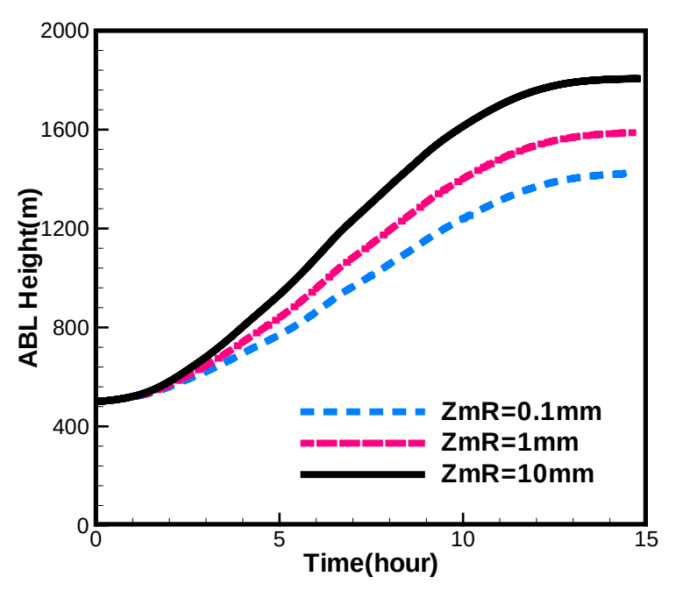
Effects of vegetation fraction



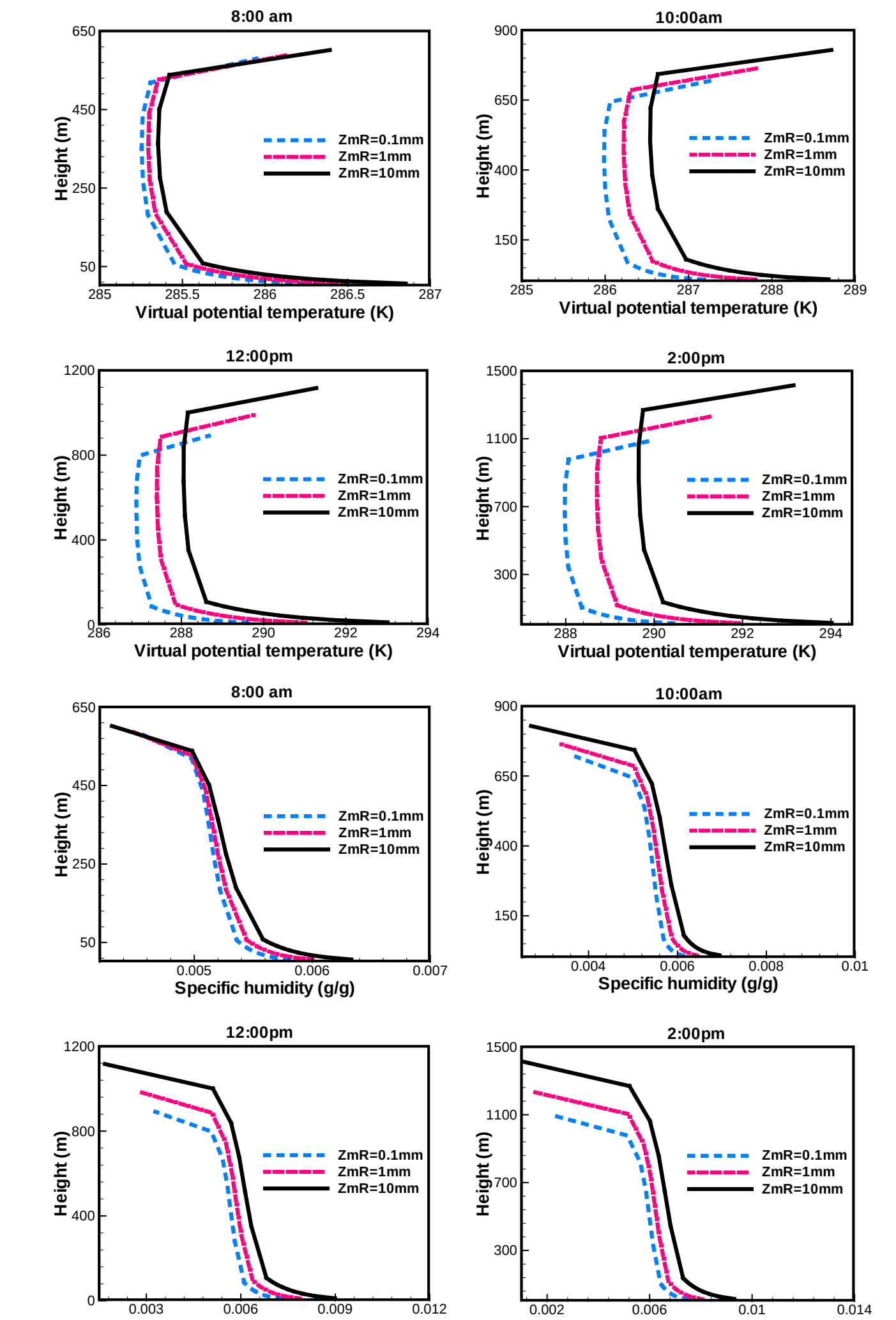
Higher vegetation fraction will lead to:
- ➢ lower ABL
- ➢ lower virtual potential temperature
- ➢ higher specific humidity.



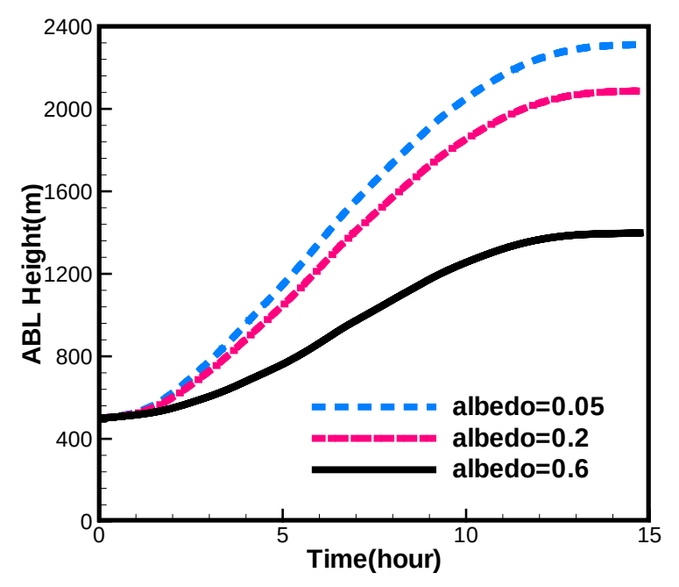
Effects of roughness length of momentum



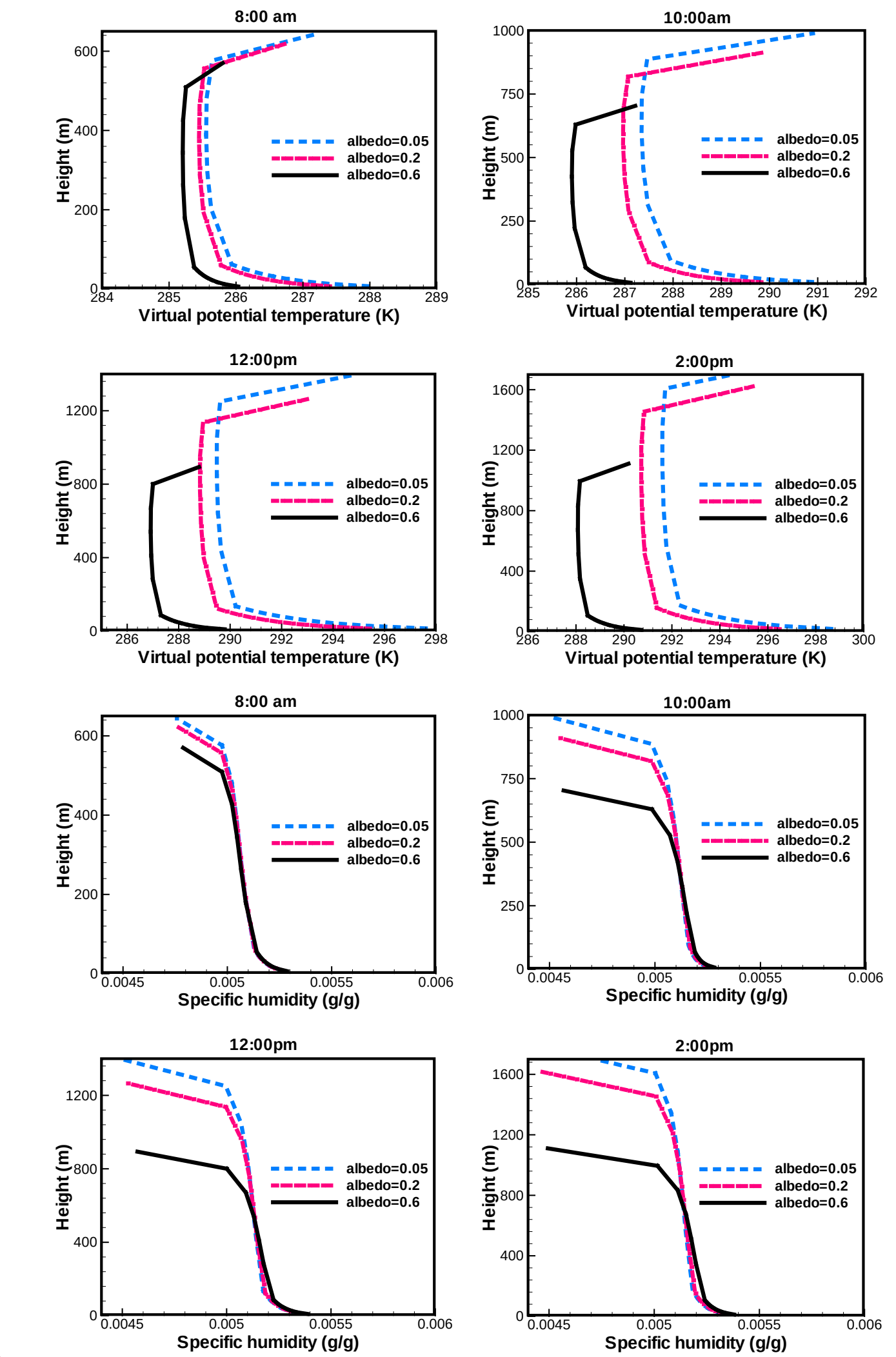
Higher roughness length of momentum above roof will lead to:
- ➢ higher ABL
- ➢ higher virtual potential temperature
- ➢ higher specific humidity.



Effects of roof albedo



Higher roof albedo will lead to:
- ➢ lower ABL
- ➢ lower virtual potential temperature
- ➢ slightly higher specific humidity.



2012/06/13 in pre-monsoon season at Phoenix, AZ

Conclusions and Perspectives

- ❖ We implemented an advanced urban canopy model (UCM) with an improved representation of urban hydrological processes.
- ❖ We simulated urban land – atmosphere interactions for different urban land surfaces with different geometry, vegetation fraction, roughness of length for momentum, and albedo.
- ❖ We are implementing our advanced UCM into WRF to improve regional climate modeling.

Acknowledgements

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References

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