

CoolVent

A multizone airflow and thermal analysis
simulator for natural ventilation in buildings

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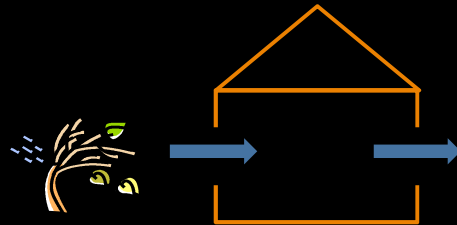
Massachusetts Institute of Technology

Today

- Motivation behind CoolVent
- Model description
- User interface
- Results
- Limitations and future work
- Conclusions

Natural ventilation

wind-driven



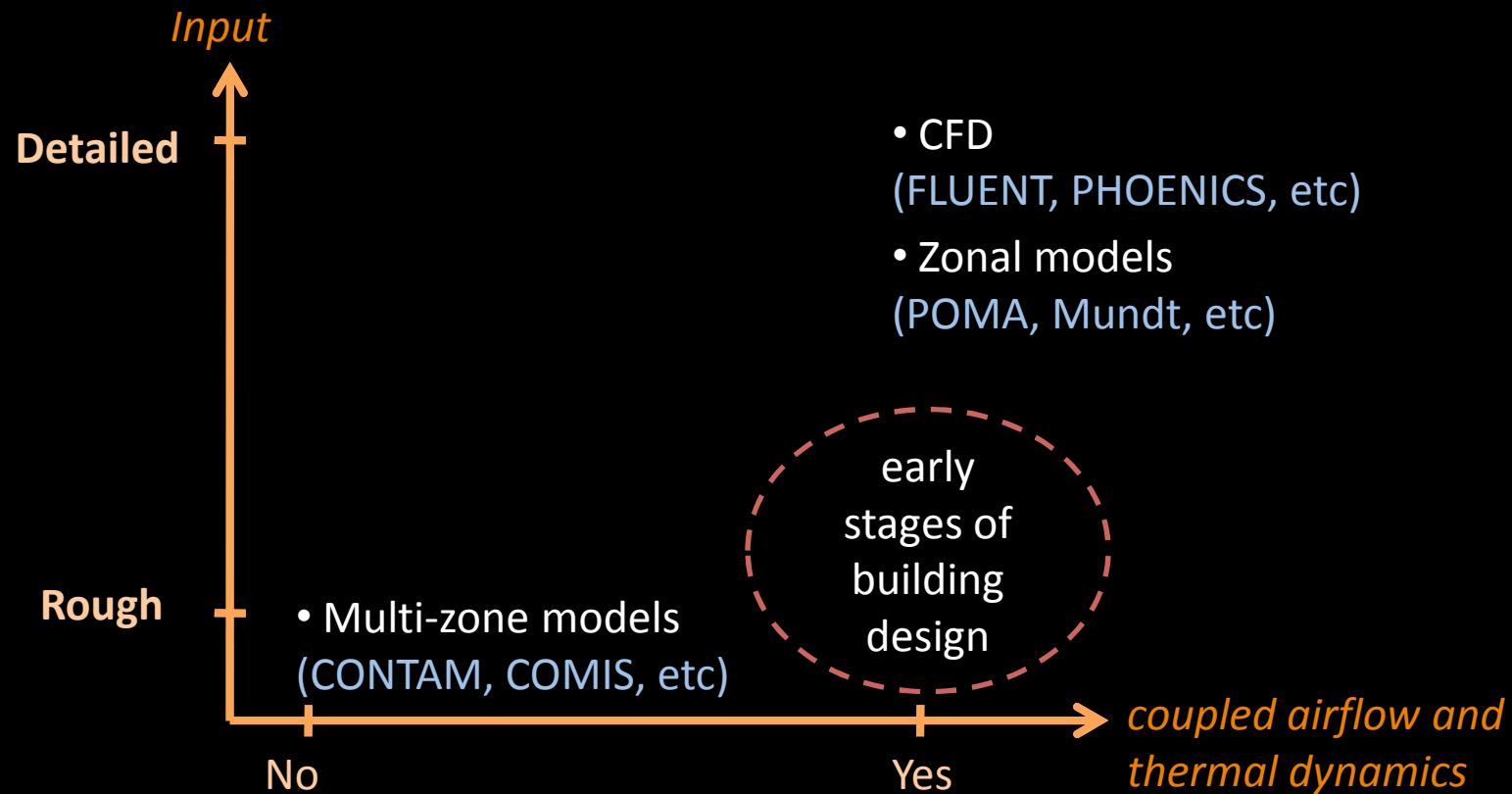
buoyancy-driven



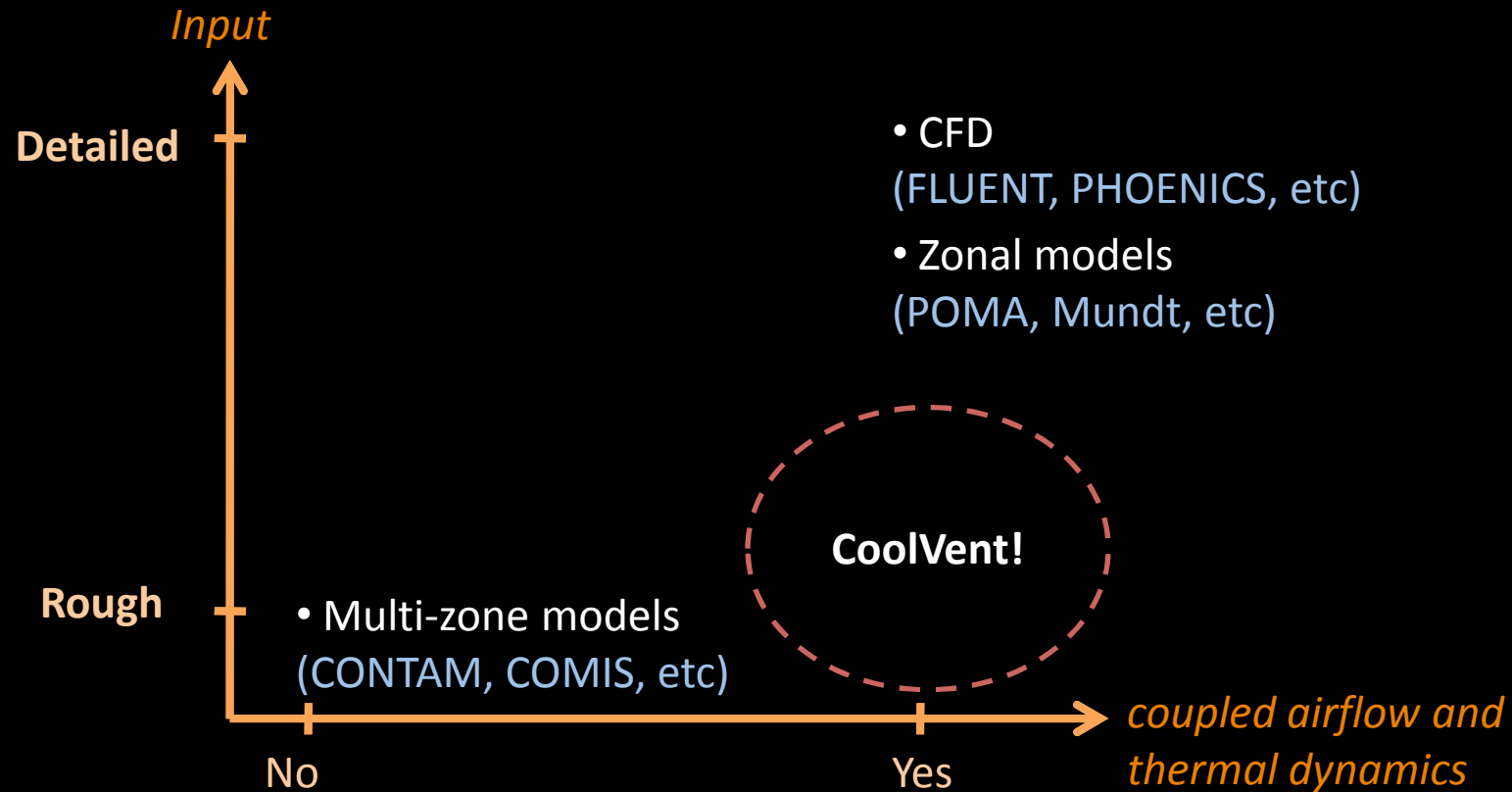
Advantages:

- **Considerable** reduction on the (HVAC) energy consumption
- Wider occupant comfort ranges
- Improved occupant productivity

Current simulation tools



Current simulation tools



CoolVent

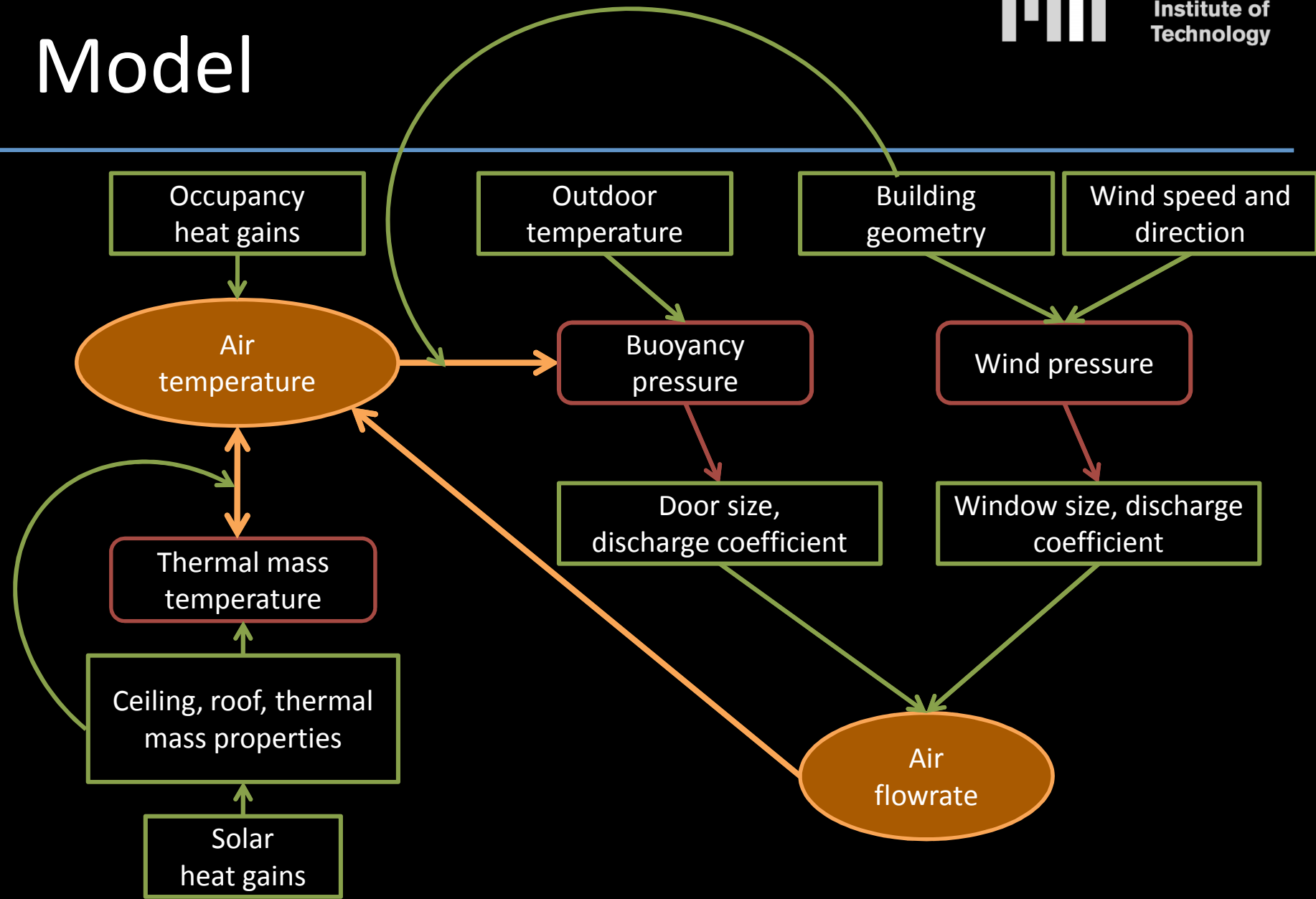
- Multi-zone simulation tool
- Solves for airflow and temperature simultaneously
- Accounts for thermal mass effects
- Performs steady and hour-by-hour transient simulations
- Output:
 - Air flowrate
 - Temperature
- Simple interface
- Allows to test several designs in an easy, fast way
- Requires little information about the building

CoolVent (cont'd)

Goals:

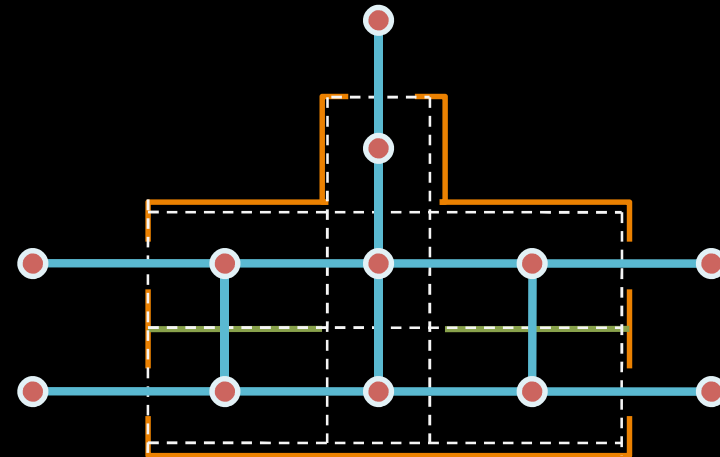
- Define natural ventilation potential for a specific design
- Select the best natural ventilation strategy
- Chose a basic, rough geometry of the building

Model



Assumptions

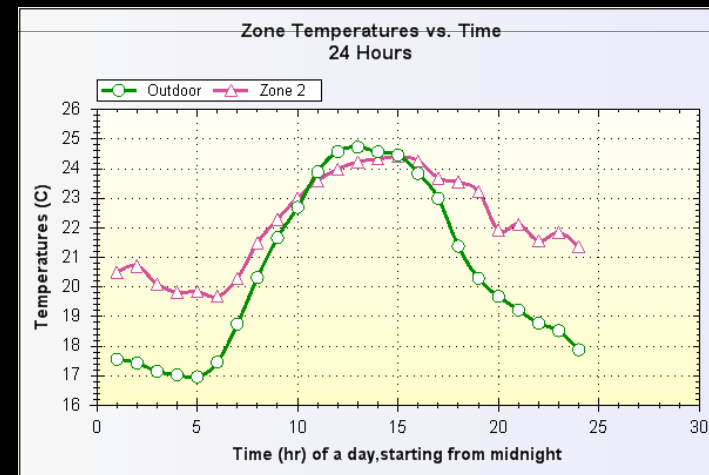
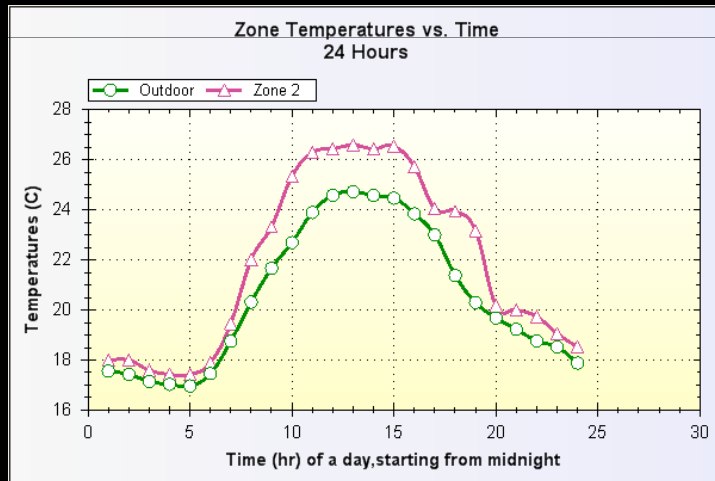
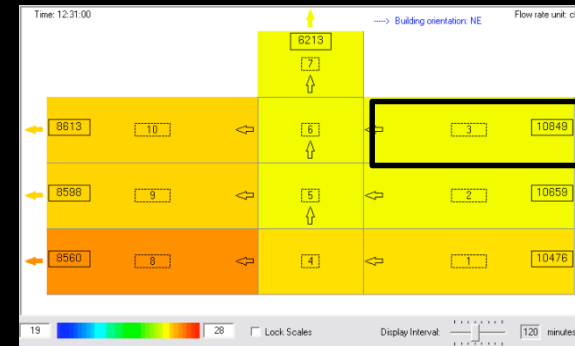
- Within a zone
 - Fully mixed air
 - Static pressure
 - No flow resistance
- Heat transfer
 - Conduction only through floor slabs
 - Radiation: solar → floor slabs



CoolVent demo
user interface and results

Additional results

Effect of thermal mass



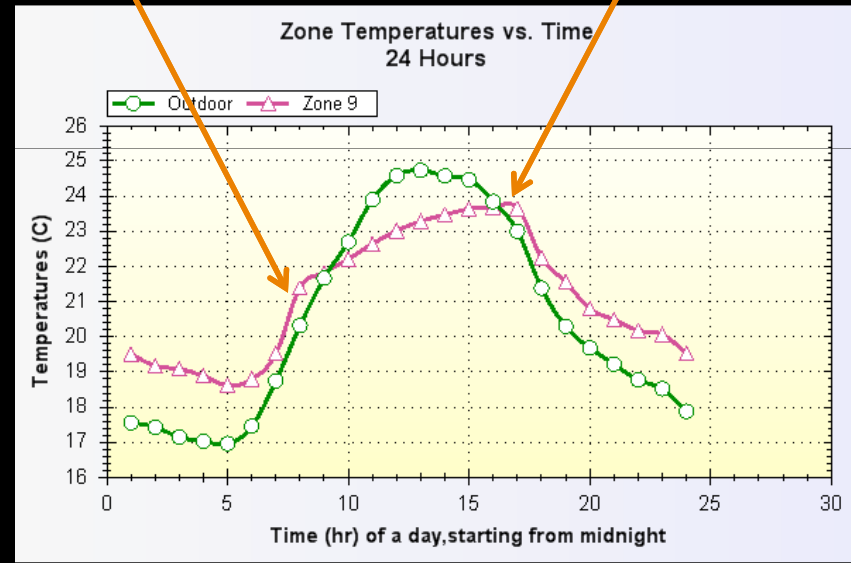
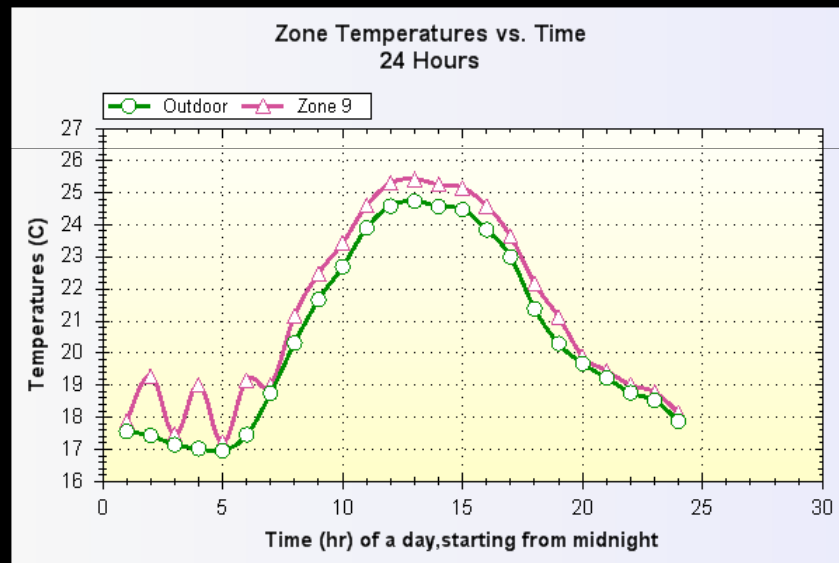
Boston. July. NE orientation. Office. Thermal mass: 20cm exposed concrete slabs.

Additional results

Effect of night cooling

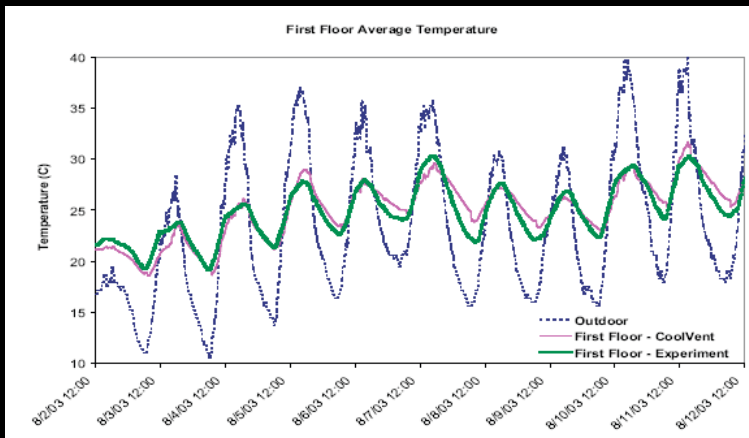
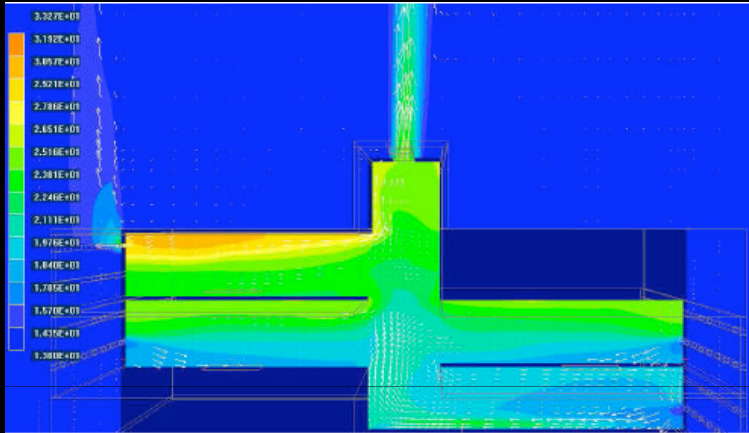
windows close

windows open



Houston. April. S orientation. Residential. Thermal mass: 20cm exposed concrete slabs. Nightcooling: 7am – 5pm.

Validation



- **CONTAMW**
 - ✓ Airflow: error <1%
- **PHOENICS (CFD)**
 - ✓ Average zone temperature: error <1%
 - ✗ Airflow on hottest zones: (error ~39%)
- **Transient field measurement**
 - ✓ Average zone temperature (error ~10%)

Limitations and future work

Wouldn't it be nice if CoolVent could...

- Account for air stratification
- Account for flow resistance inside each zone
- Provide information on humidity nor internal airspeed
- Allow to combine single-sided with other strategies

- Simulate a wider set of geometries / strategies
- Perform yearly runs
- Provide feedback
 - total energy savings
 - total hours per year outside comfort zone
 - fulfillment of minimum ventilation requirements
- Suggest changes in design to optimize performance

Conclusions

CoolVent

- Simple, robust tool
- To be used during early stages of design
- Requires very little
 - input information
 - running time
- Solves for airflow and temperature simultaneously
- Accounts for thermal mass effects

Impact

- Smarter, wider use of natural ventilation
- Reduction of energy consumption in buildings
- Insight for how natural ventilation works

Questions?

Thank you.



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