Fire Dynamics
Computer fire modeling

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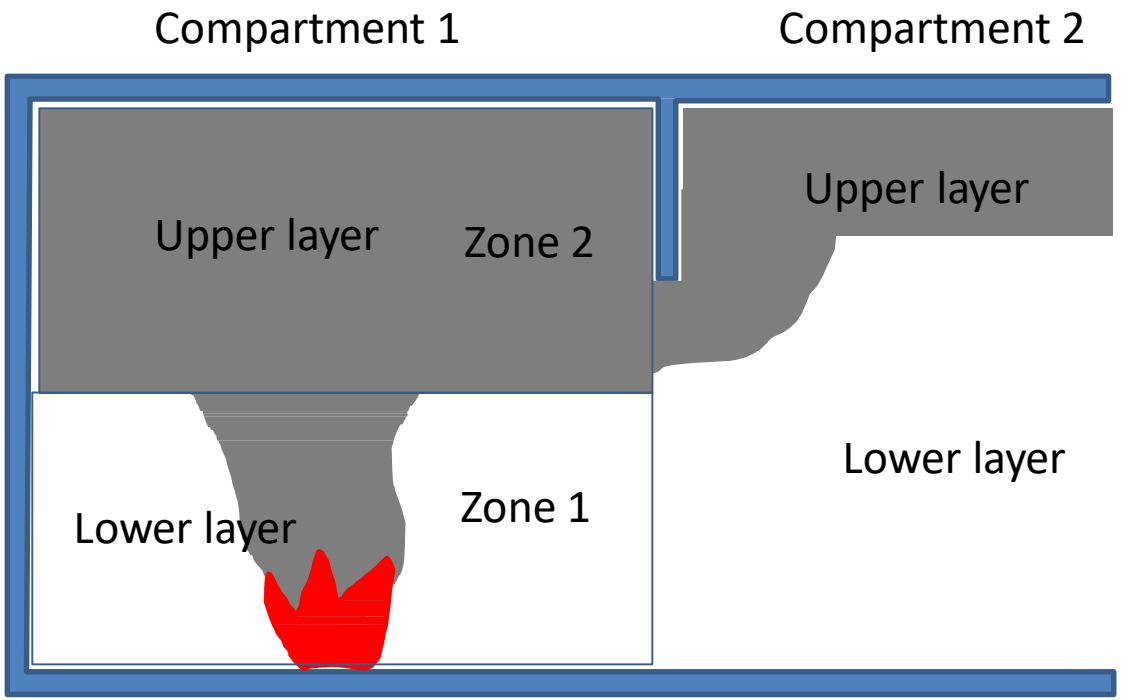
Objectives

- Understanding CFAST and FDS

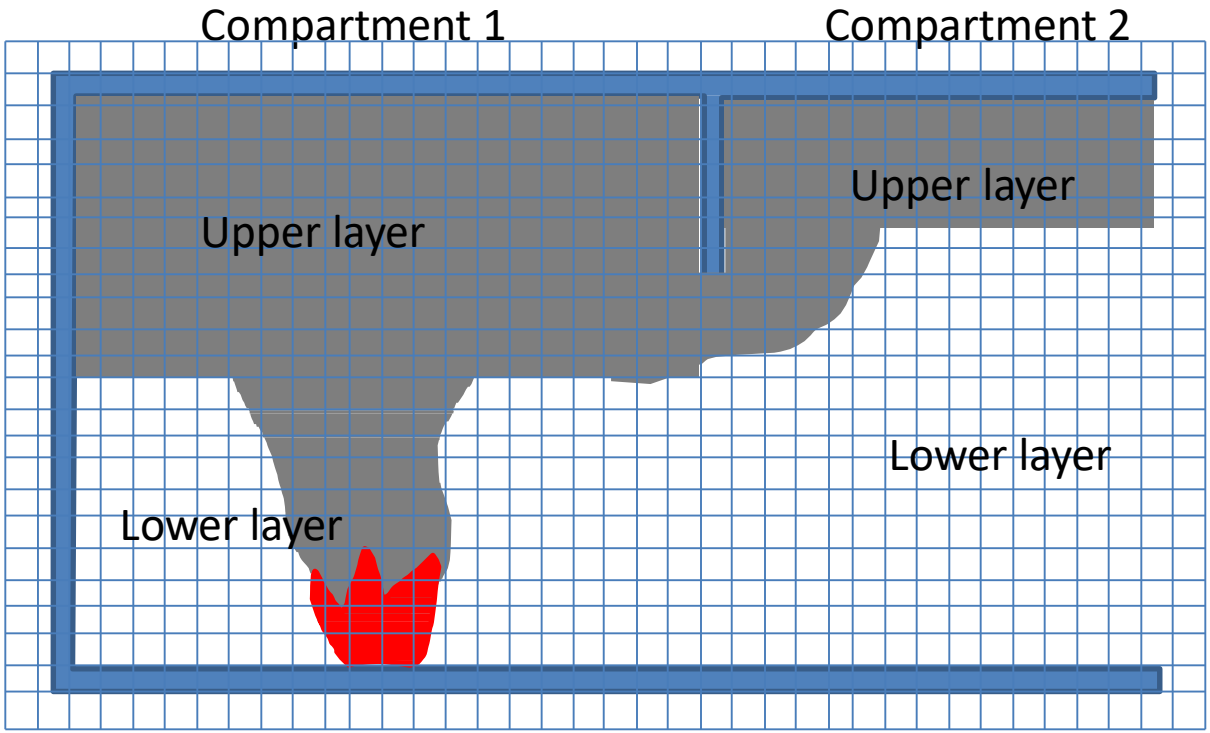
Fire modeling tools

- Hand calculations
- Spreadsheet based calculations
- Fire modeling software
  - Zone model: CFAST, BRANZFIRE, OZONE,
  - Field model: FDS, SMARTFIRE

Zone model


Compartment 1
Compartment 2
Upper layer
Zone 2
Upper layer
Lower layer
Zone 1
Lower layer

Field model


Compartment 1
Compartment 2
Upper layer
Upper layer
Lower layer
Lower layer

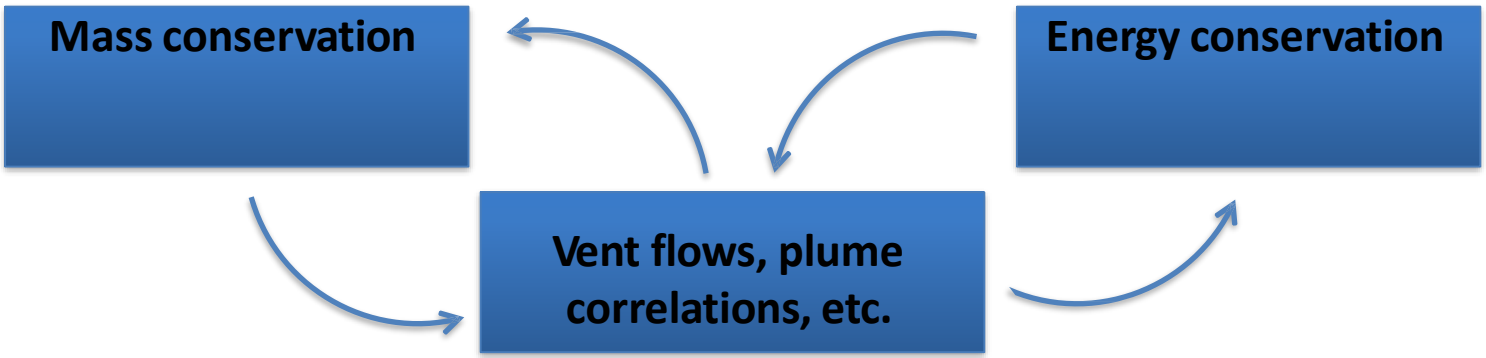
Governing equations

- Representative variables
  - Mass: density
  - Energy: temperature
  - Momentum: velocity
- FDS
  - Mass, Momentum, and Energy conservation
- CFAST
  - Mass and Energy conservation
  - No momentum conservation?

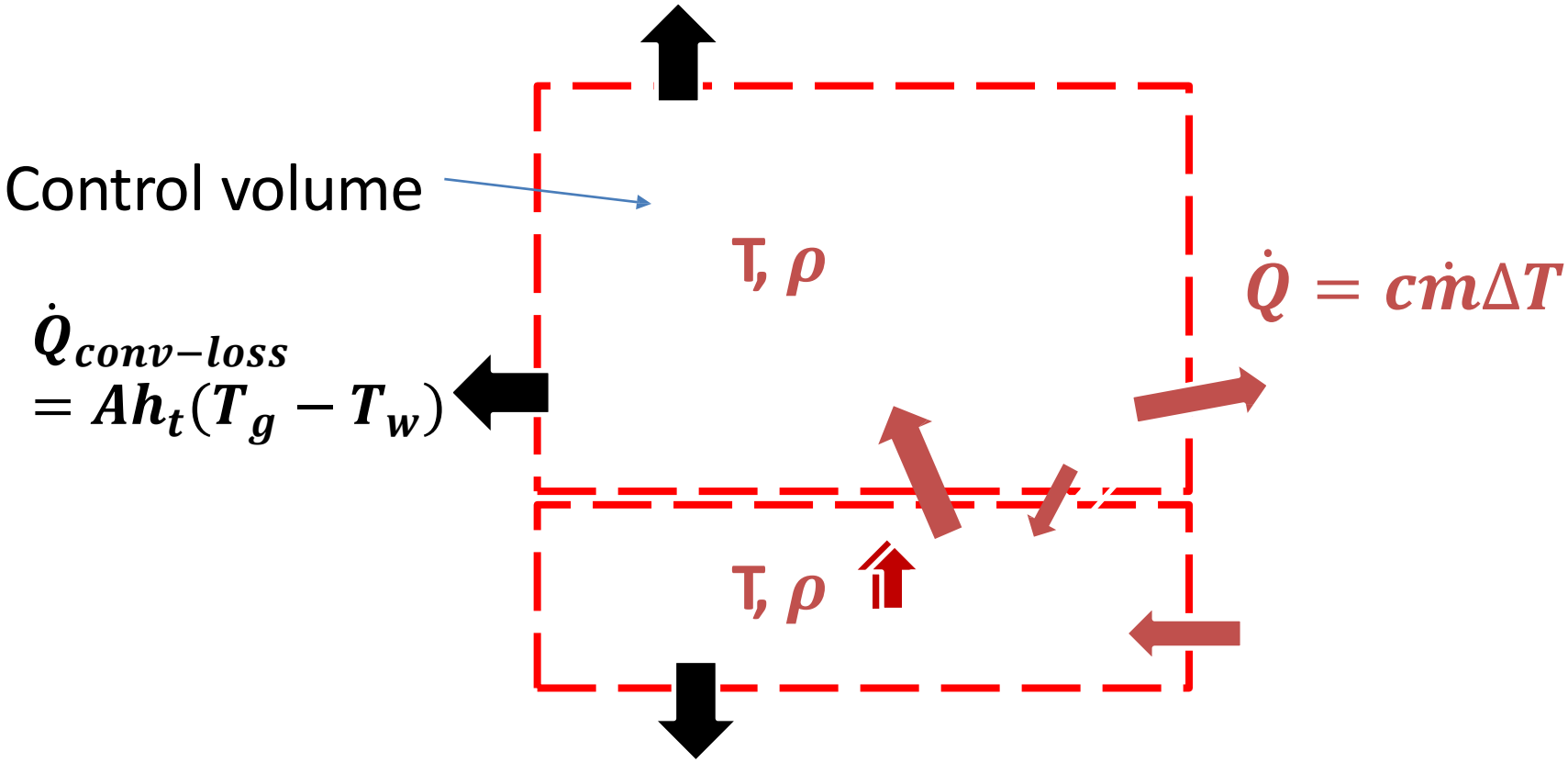
Governing equations

- Field models

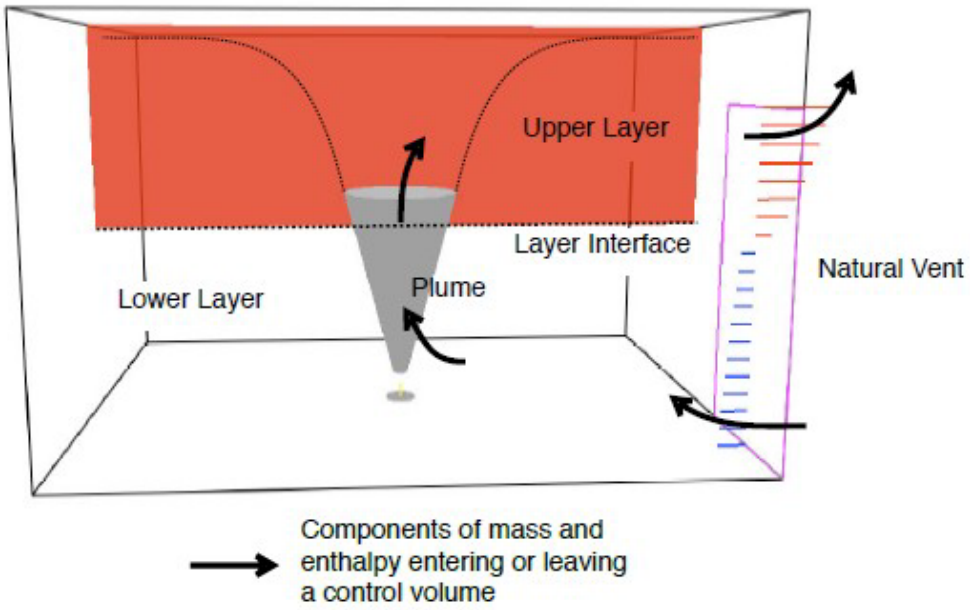
- Zone models

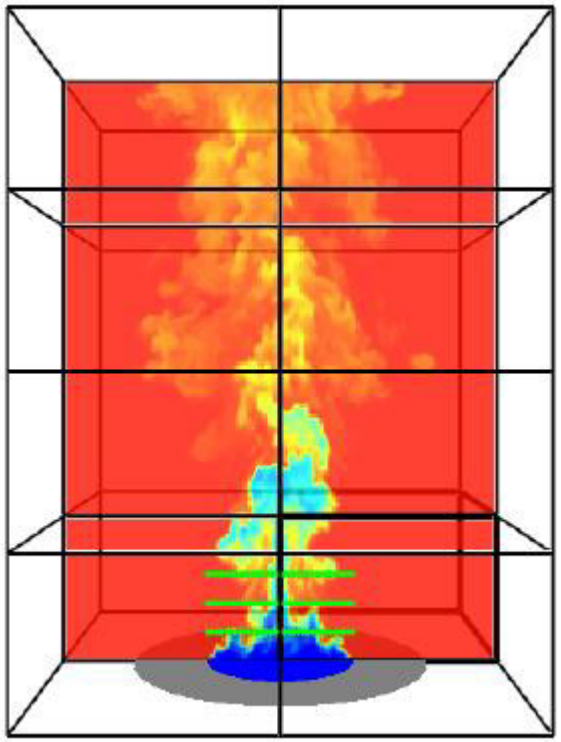


Field model mass & energy flows



Snapshots


Upper Layer
Layer Interface
Lower Layer
Plume
Natural Vent
Components of mass and
enthalpy entering or leaving
a control volume



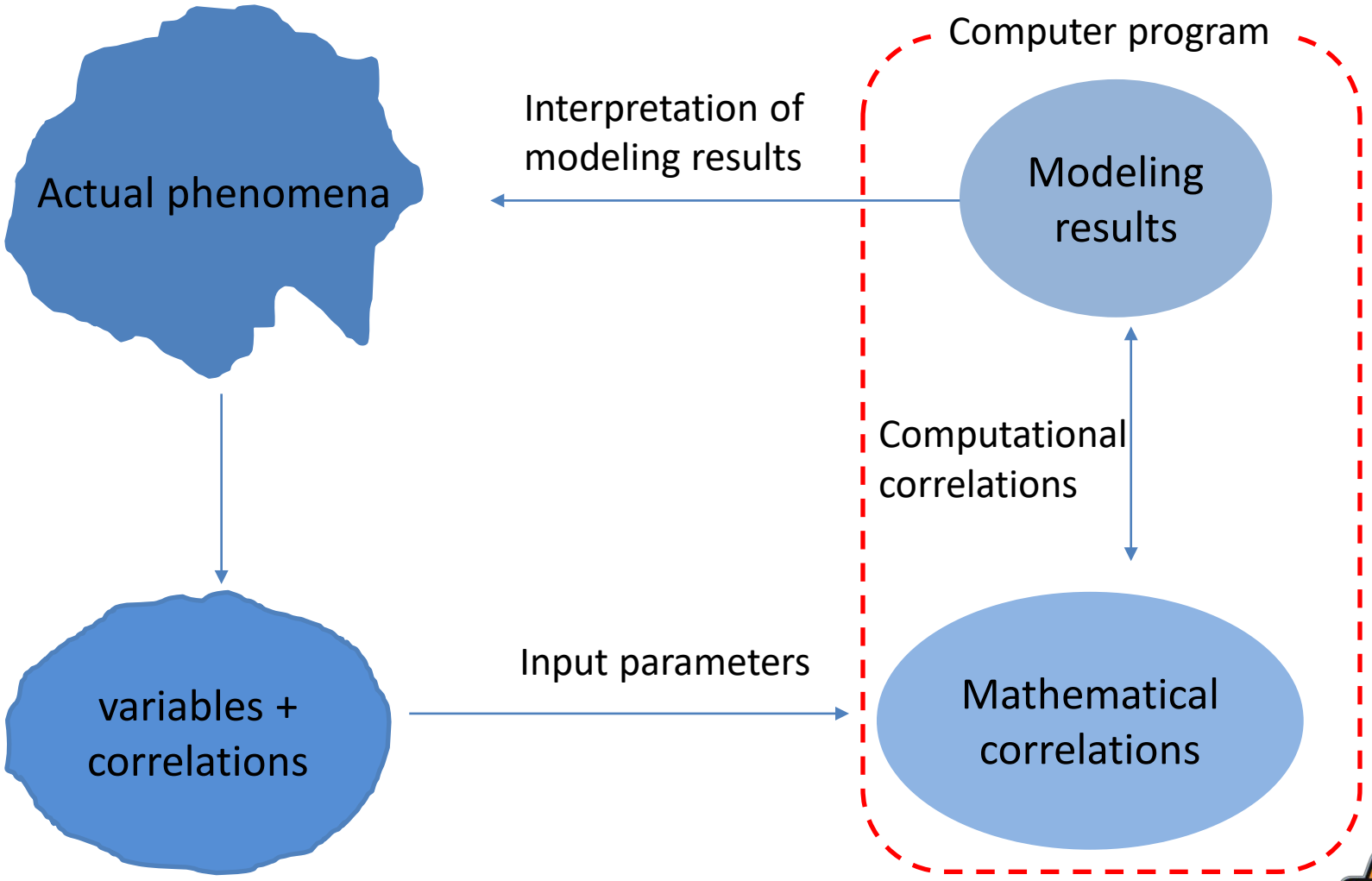
Good and bad?

- Zone model
  - Short simulation time, lack of details
  - Often believed less accurate than field models, but nobody knows!
- Field model
  - Long simulation time and more advanced
  - Detailed and visually attractive simulation outcomes

Physical principles vs. mathematical model

- Understanding ‘fire phenomena’ based on ‘physical principles’
- Understanding ‘model’ based on ‘mathematical correlations’
- Model outcomes are different from actual fire phenomena as mathematical correlations can not perfectly match physical principles.

Physical principles vs. mathematical model



Physical principles vs. mathematical model

- Gaps between ‘fire phenomena’ and ‘model’
  - One mass value, one temperature value in one zone regardless of the size of the compartment
  - Specific local phenomena may not be captured
  - Long corridor, high ceiling, large room with a small fire, large fire in a small room
  - Alternative ways to model?
  - Or inappropriate tool!

FDS Examples