ProtoDUNE-SP CFD Update

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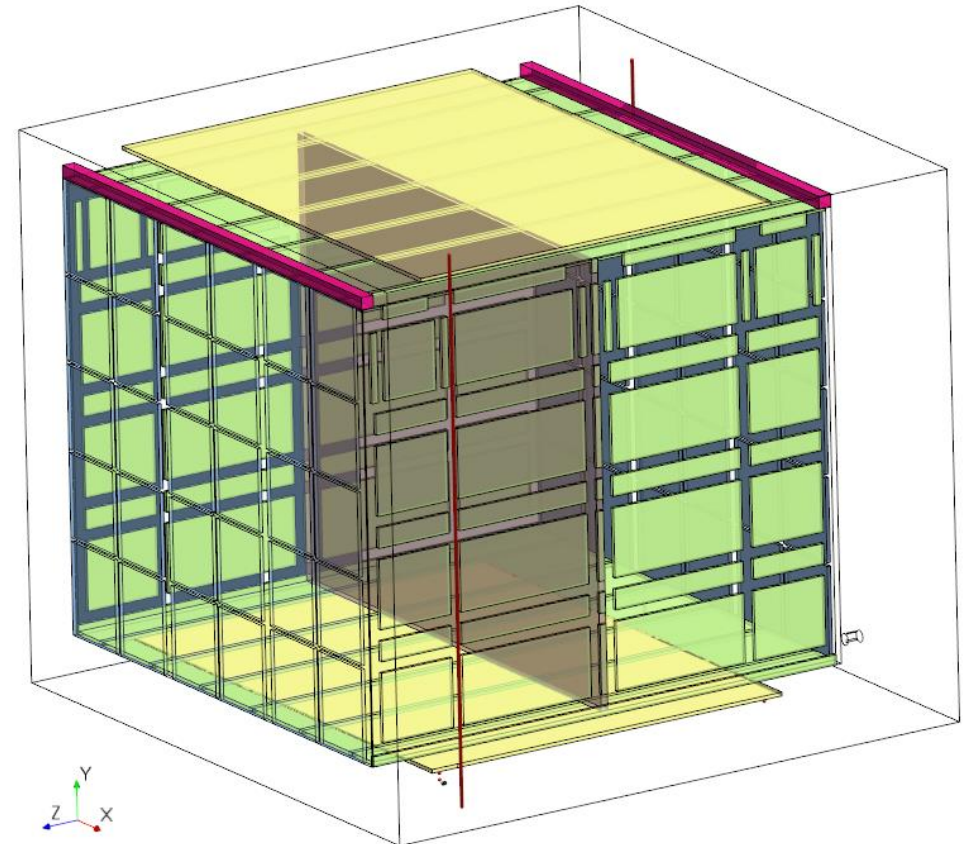**August 5, 2020**

ProtoDUNE Modeling

**Goal:** Further improve agreement between experimental and CFD modeled temperatures.

Model Inputs

Surface temperature: 87.595 K

Liquid argon inlet temp: 87.795 K = Surface + 0.2 K

Liquid argon height: 7.40 m

Liquid argon flow rate: 1.668 kg/s (split among 4 pipes)

Electronics heat input: 336 W (on two regions)

ProtoDUNE Modeling

- Existing Solution
  - Results reported at **converged stopping point**, 100,000 iterations (instantaneous)
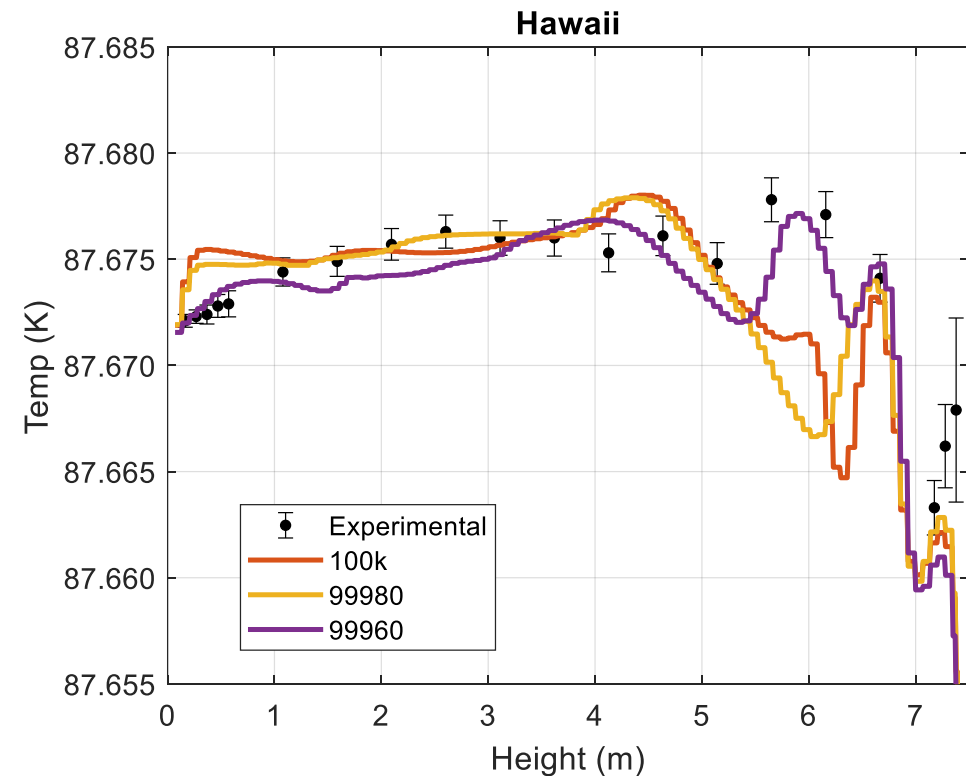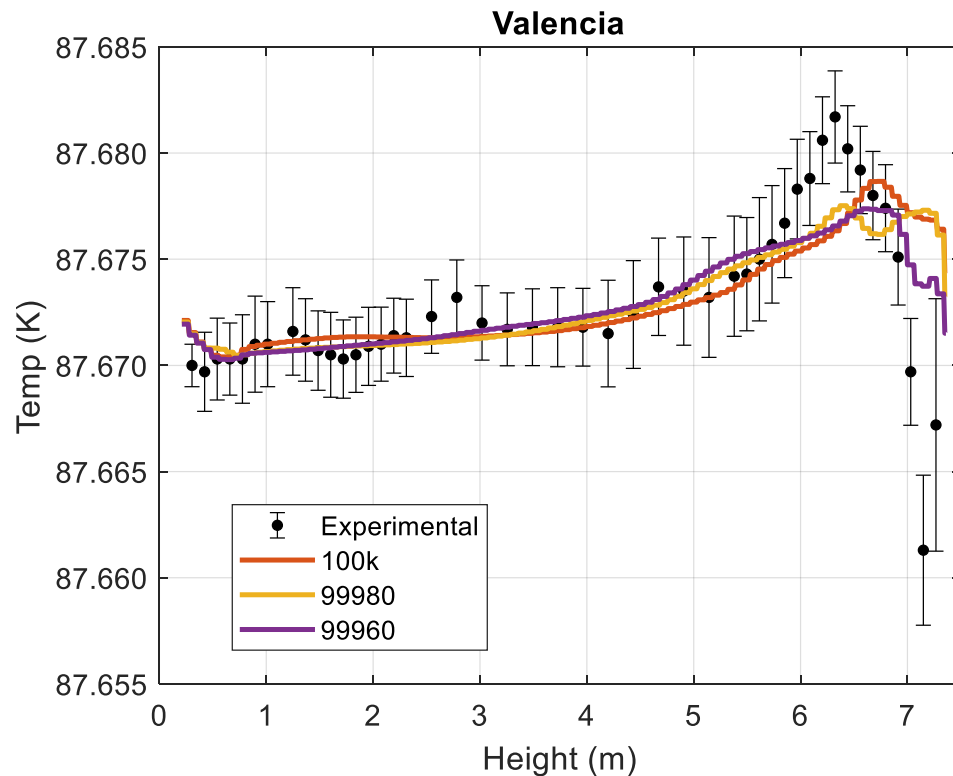
# ProtoDUNE Modeling – Current Work

- **Investigate effects** of & **develop methodology** for Iteration-Averaged Temperature for solution reporting.

- New Solution
  - Temperature solution = average of last "*n*" iterations
  - Goals: assess convergence, avoid iteration-to-iteration variation in solution, gain statistical information about solution
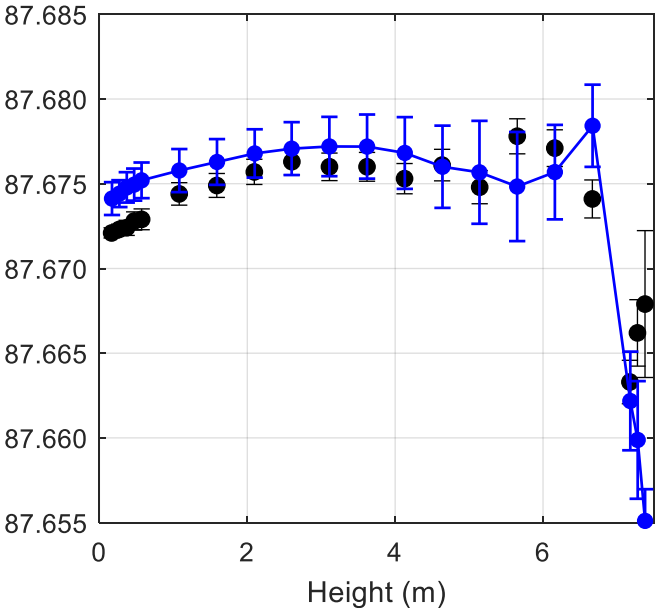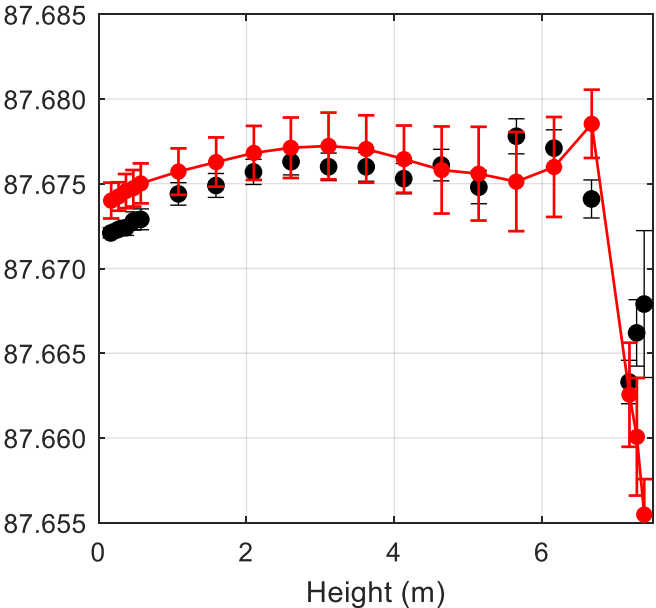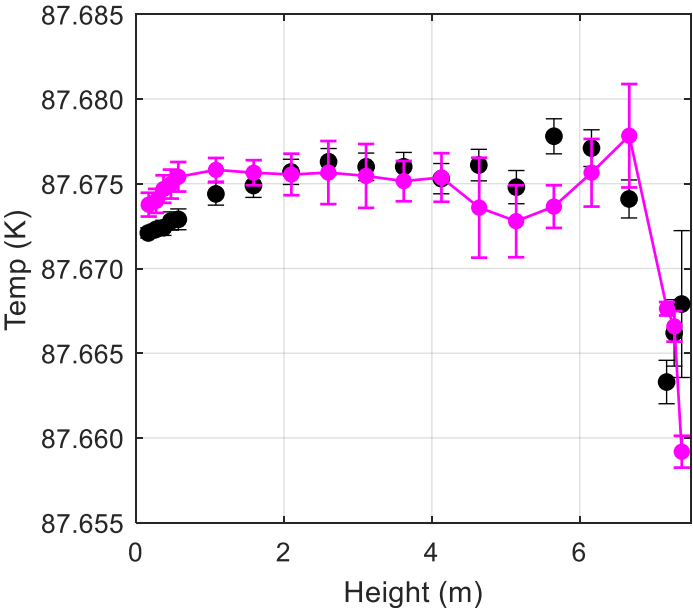
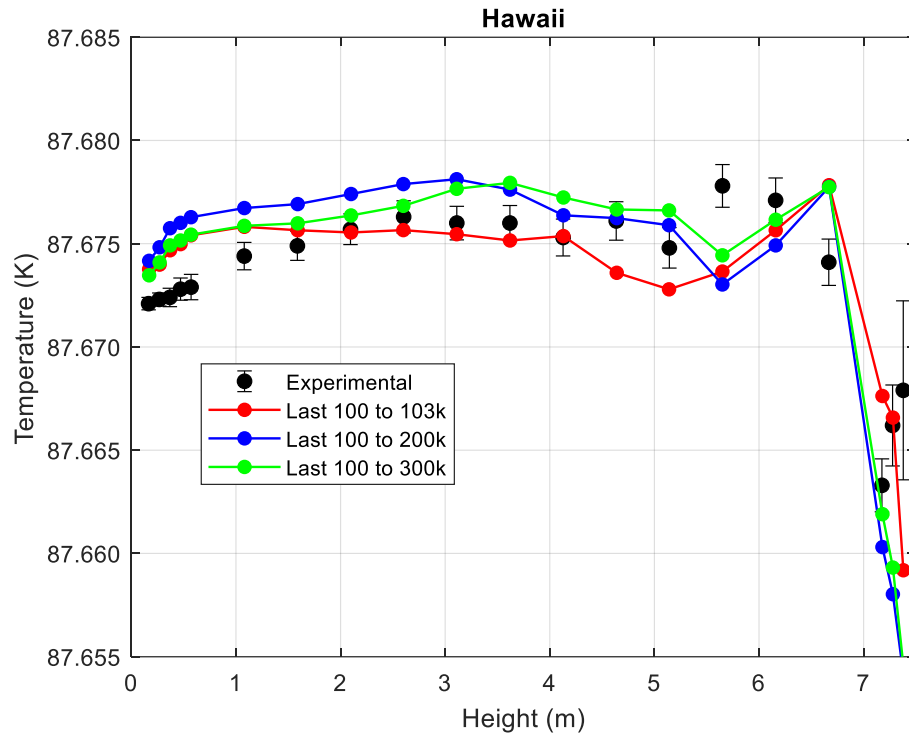At a stopping point of 103,000 iterations: Mean of Last 100, 1,000 and 2,000 iterations
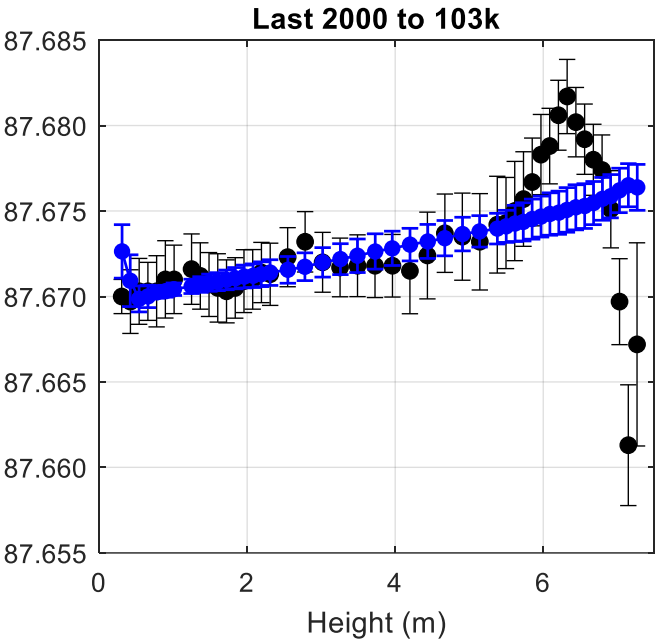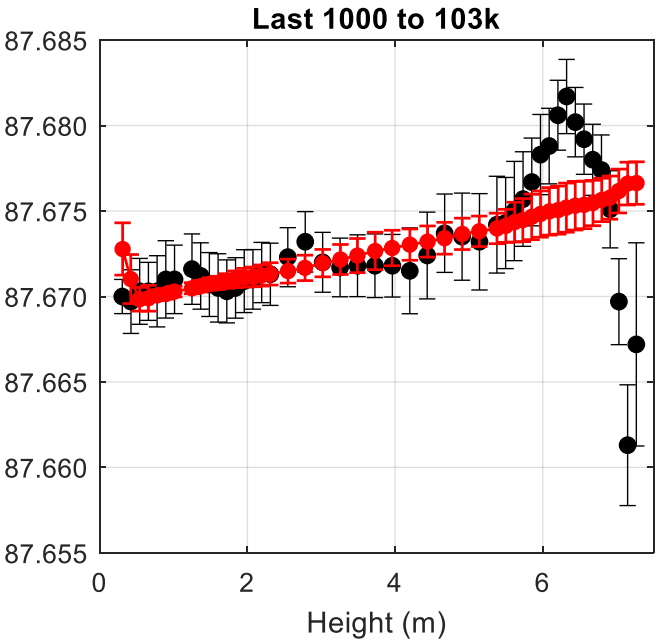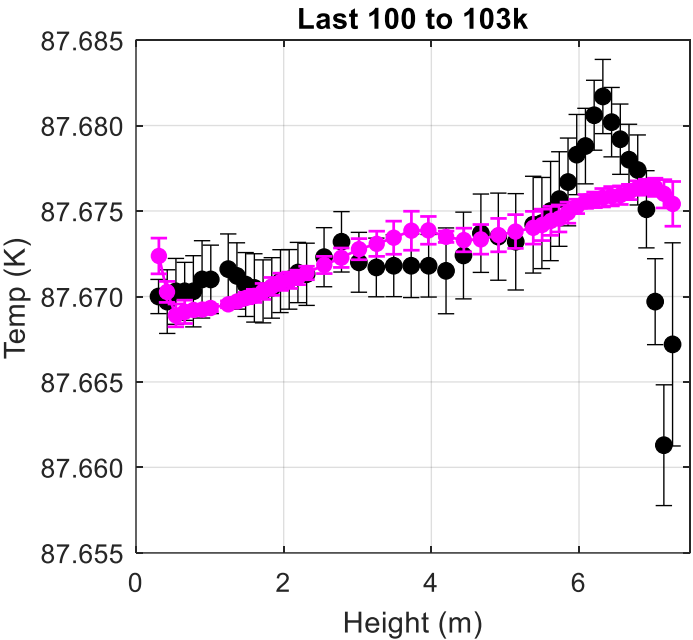
At iteration stopping points of 103,000, 200,000, and 300,000:

Mean of Last 100 iterations — Mean of Last 1000 iterations — Mean of Last 2000 iterations

Solution at 300k ~= Solution at 200k

Mean of final 1000 iterations ~= Mean of Final 2000 iterations
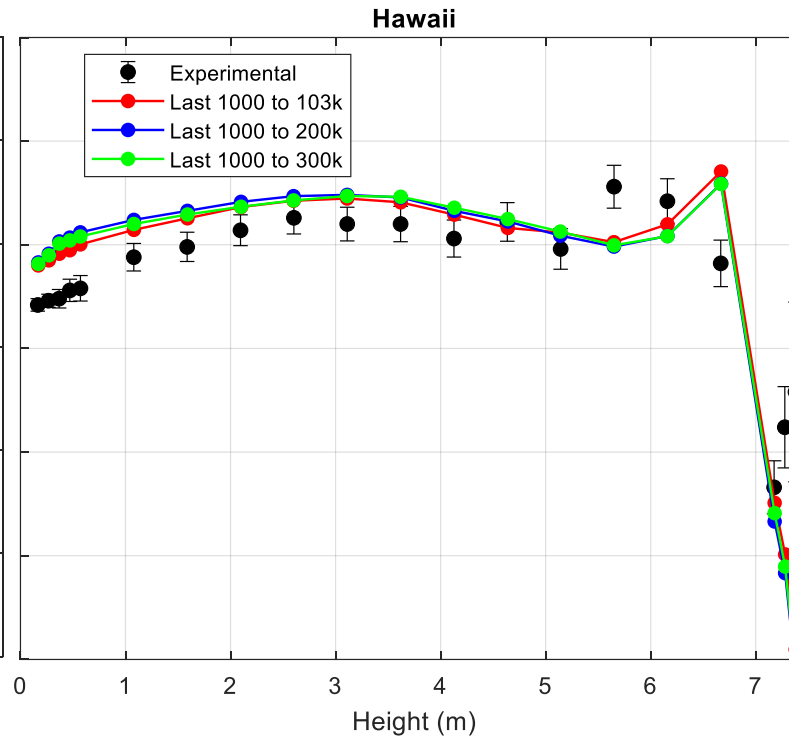
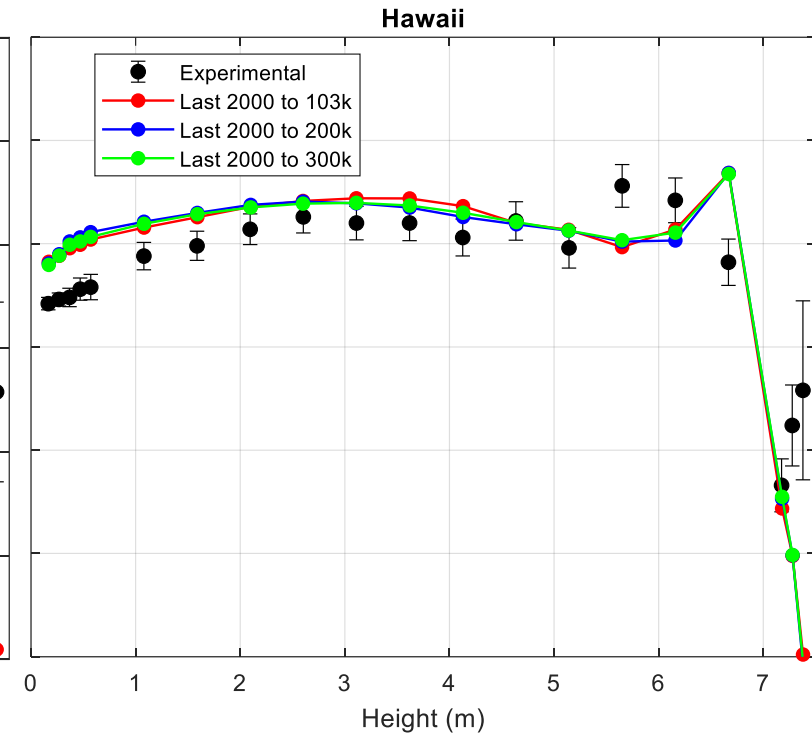# At iteration stopping points of 103,000, 200,000, and 300,000:

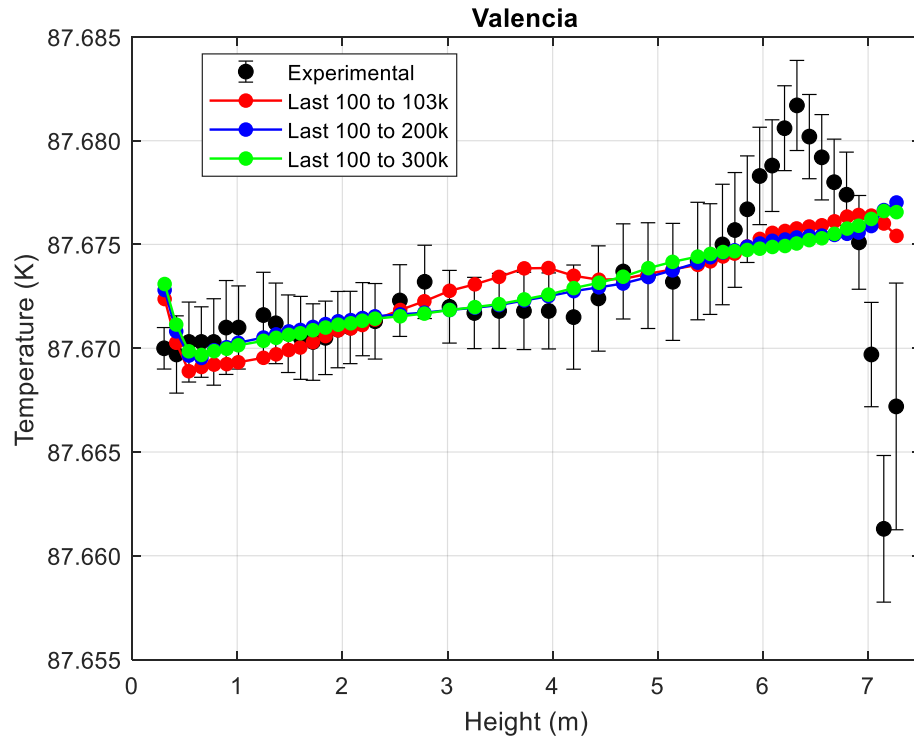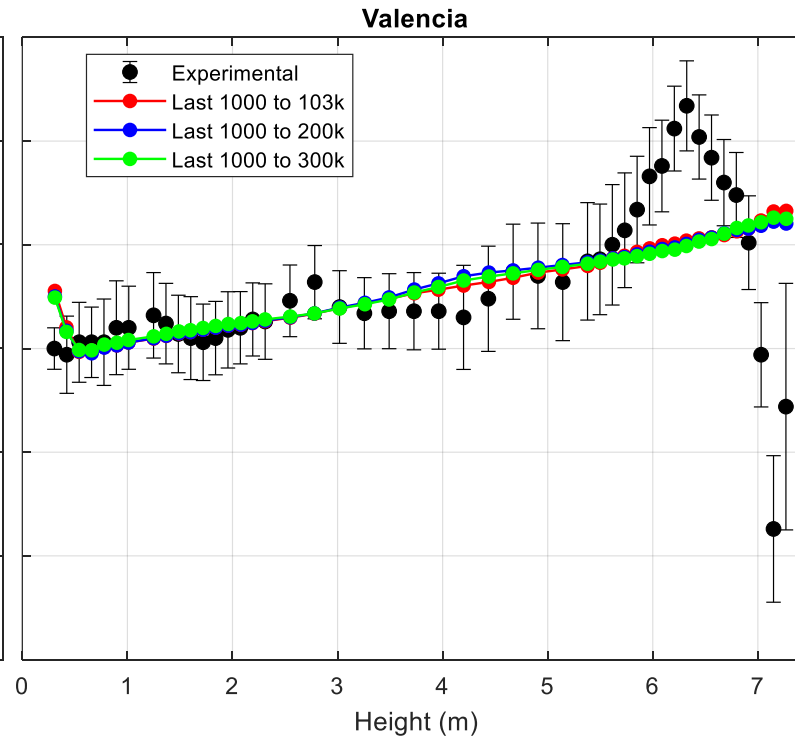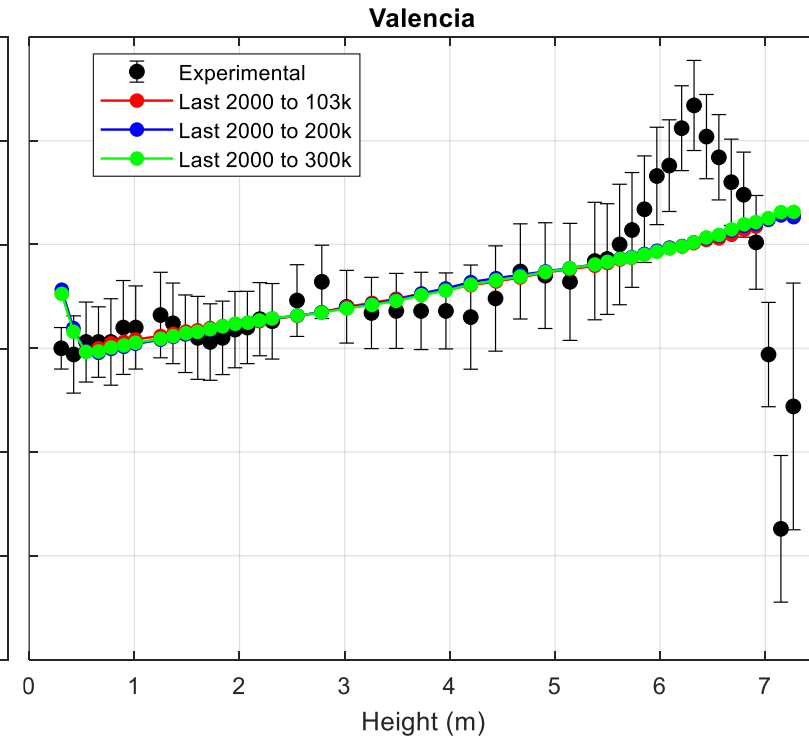Mean of Last 100 iterations — Mean of Last 1000 iterations — Mean of Last 2000 iterations

Solution at 300k ~= Solution at 200k

Mean of final 1000 iterations ~= Mean of Final 2000 iterations

Observations to Date

- For PD-SP LAr temperature modeling:
  - **200,000 iterations** is a sufficient stopping criteria
  - The **mean of the final 1,000 iterations** is sufficient for solution reporting

- Needed Clarifications:
  - Geometry, location, and heat input of **missing heat sources** to include in model
  - LAr **flow rate** into cryostat