15th Canadian Conference on Building Science and Technology

November 6-8, 2017

Vancouver, BC, Canada

MORRISON HERSHFIELD

Quantifying the Benefit of Venting Glazed Spandrels to Reduce Glass Breakage

Julien Schwartz, M.Eng.

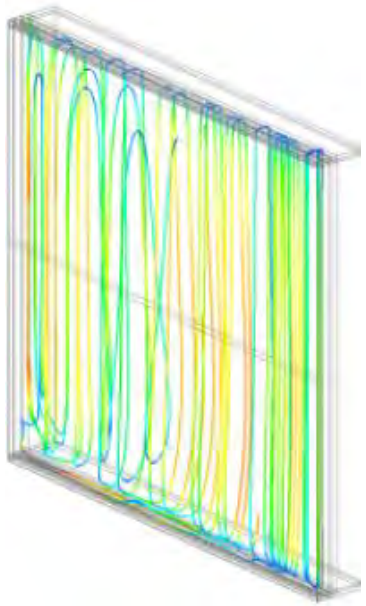
Introduction

- Why is this project being completed?
  - Venting cited to be a benefit to control heat buildup in spandrel glass
    - Benefit of venting not well quantified
  - Several recent instances of glass breakage in IGUs in spandrel applications
    - Breakage due to excessive thermal stress
    - In both sealed and vented configurations
    - Is venting effective when using IGUs?
  - Practical design implication
- Objective #1: validate and quantify the effectiveness of venting

Introduction

- What are we doing?
  - Field study

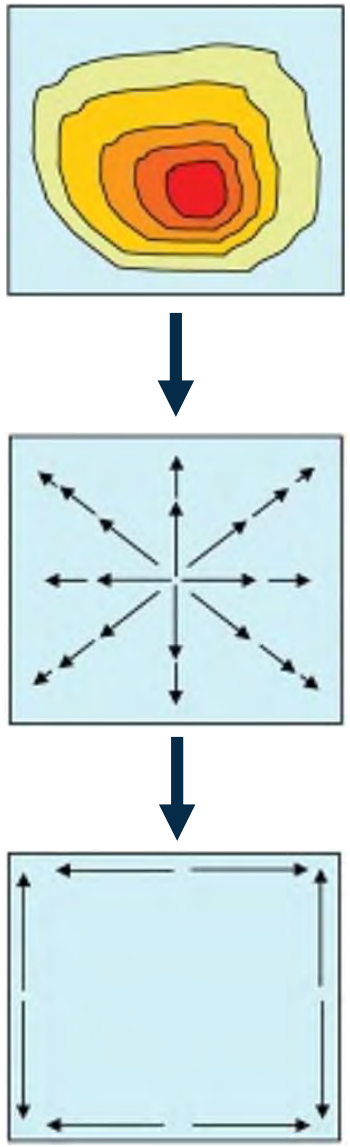
  - Computer modelling



- Objective #2: Feasibility of using advanced computer simulations

Thermal Stress and Glass Breakage

- What causes thermal stress in spandrel glass?
  - Temperature difference between center of glass and edge of glass
- What factors impact thermal stress?
  - Glass type, Coating type and location
  - Shadowing
  - Framing system
  - Venting
- Range of maximum allowable temperature differences
  - Annealed glass: 28°C to 40°C
  - Heat strengthened glass: 56°C to 100°C
  - Tempered glass: 111°C to 250°C

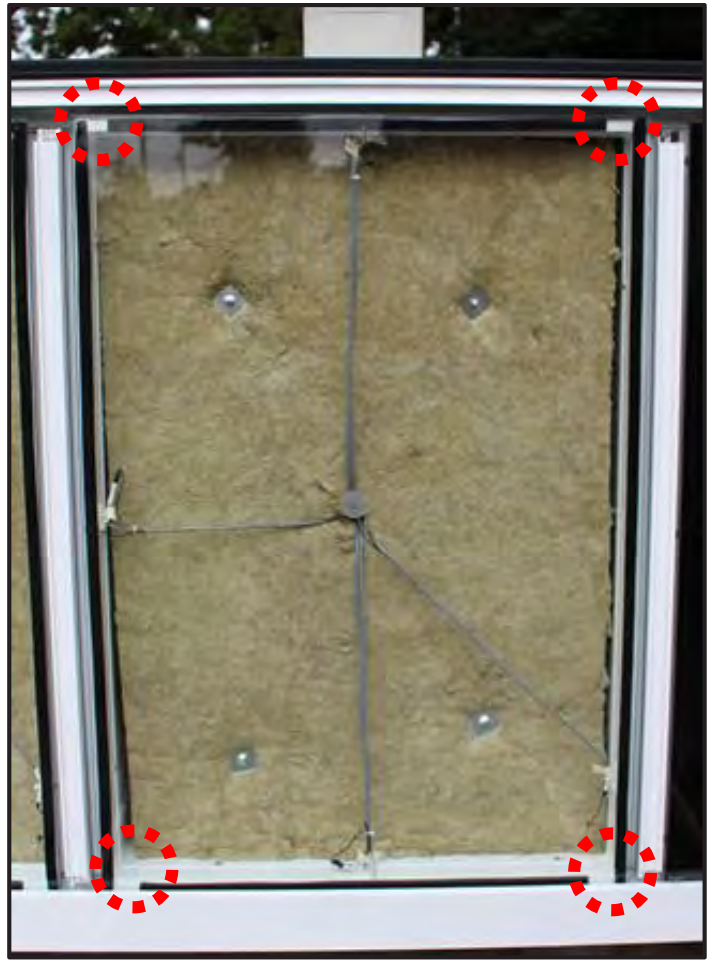


Approach

1. Instrument experimental setup
   - Single glazed and double glazed units
   - Clear and opacified glass
   - 3 different ventilation strategies
2. Develop detailed computer models
3. Calibrate/cross-validate models using measured data
4. Use calibrated model to evaluate different designs and assess the impact of various parameters

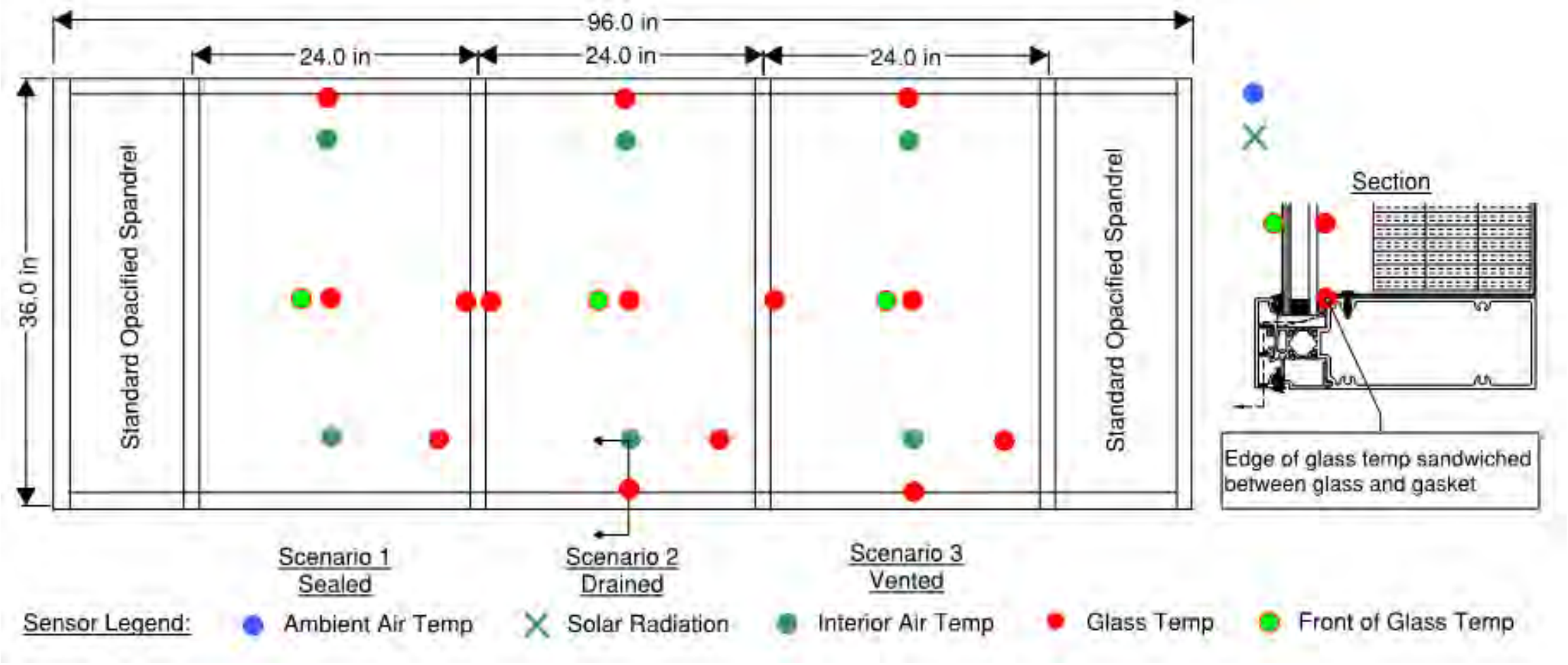
Experimental Setup

Three Venting Strategies



Experimental Setup with Opacified Glass

Instrumentation



Field monitoring results

- Maximum temperature difference

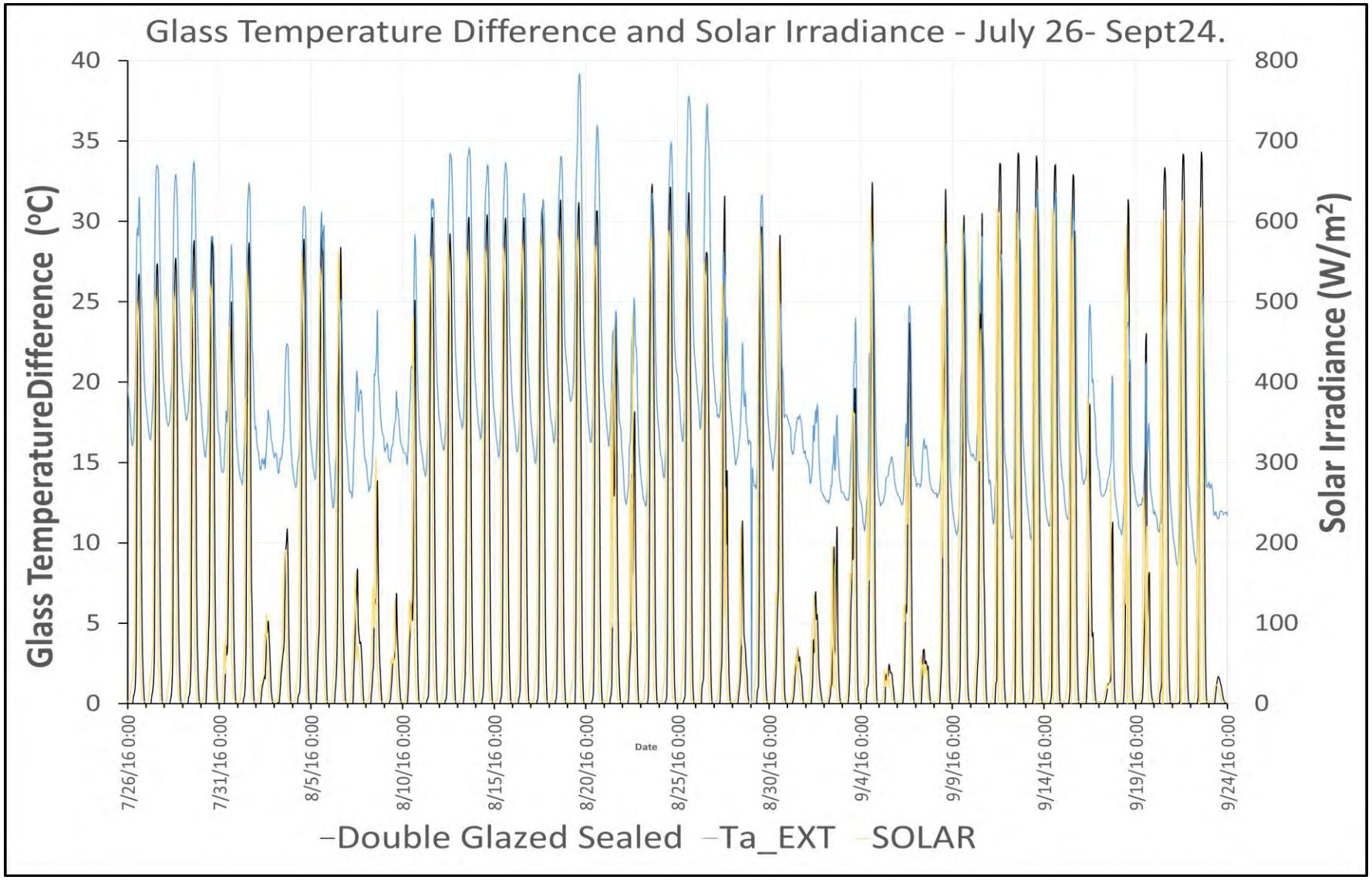
Glass Type	Venting Strategy	Maximum Glass Temperature Difference, Centre of Glass – Specified Location			
		Double-Glazed Module		Single-Glazed Module	
		Max ΔT	Location	Max ΔT	Location
Clear	Sealed	34.3	Top Edge	24.7	Top Edge
	Drained	38.5	Bottom Edge	22.5	Top Edge
	Vented	30.4	Top Edge	21	Bottom Edge
Opacified	Sealed	42.6	Top Edge	34.5	Top Edge
	Drained	46.9	Top Edge	35.3	Bottom Edge
	Vented	53.3	Bottom Edge	39.5	Bottom Edge

Field monitoring results

- Temperature difference and frequency of occurrence

Glass Type	Venting Strategy	Glass Temperature Difference, Centre of Glass – Top Edge of Glass, % of Total Observed Time									
		Double-Glazed Module					Single-Glazed Module				
		Above 40°C	Between 30 - 40°C	Between 20 - 30°C	Between 10 - 20°C	Below 10°C	Above 40°C	Between 30 - 40°C	Between 20 - 30°C	Between 10 - 20°C	Below 10°C
Clear	Sealed	0%	0%	44%	27%	29%	0%	0%	32%	45%	24%
	Drained	0%	2%	41%	27%	29%	0%	0%	14%	61%	25%
	Vented	0%	2%	41%	27%	29%	0%	0%	0%	54%	46%
Opacified	Sealed	4%	14%	13%	19%	50%	0%	12%	23%	15%	50%
	Drained	7%	13%	14%	18%	49%	0%	4%	26%	19%	51%
	Vented	6%	14%	13%	18%	49%	0%	0%	28%	18%	54%

Field monitoring results



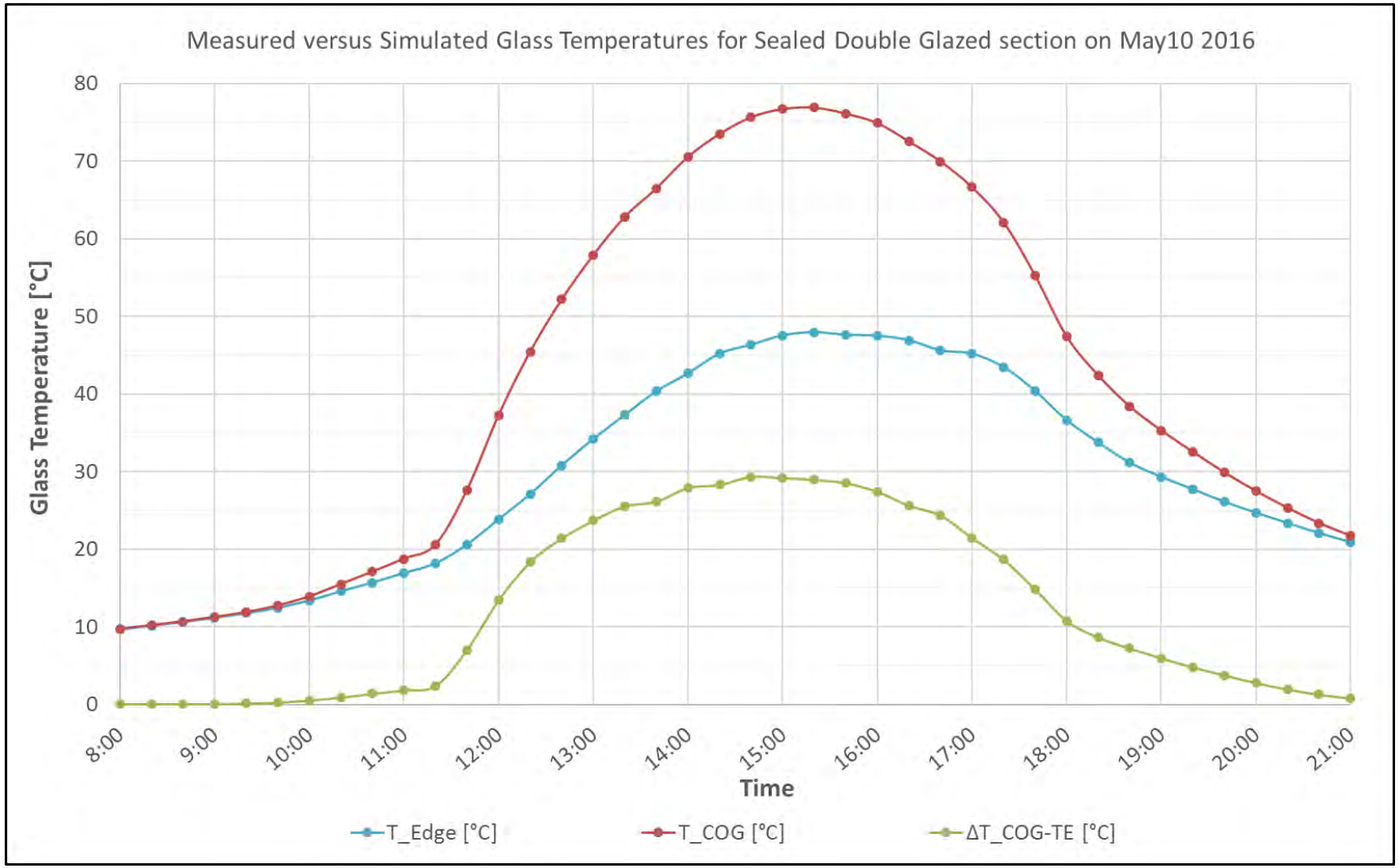
Field monitoring results

Modelling Glazed Spandrels

- Detailed geometry
- Complete physics
- Time-varying environmental conditions

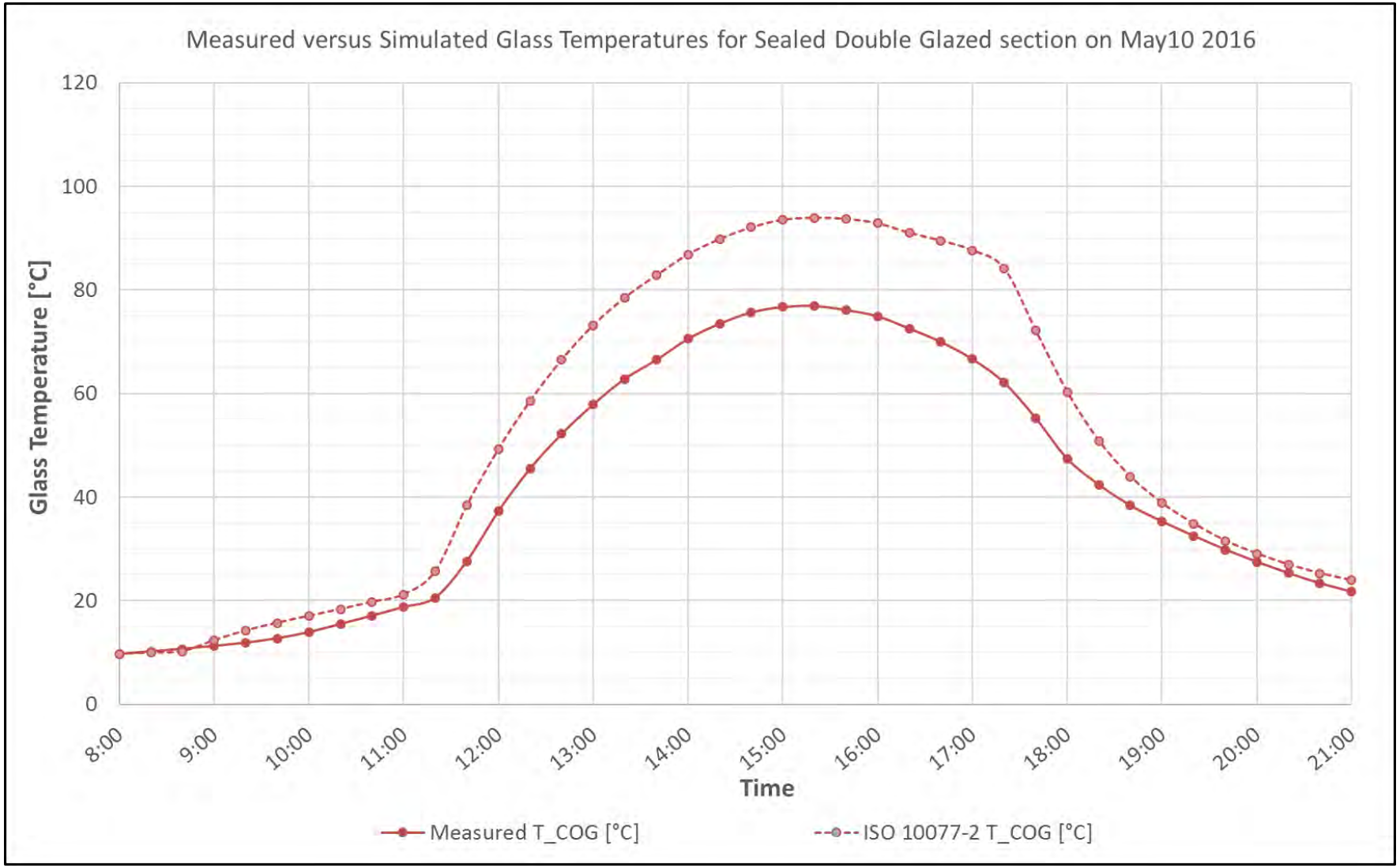
- Cross-validation process involves several steps
  - 1-D WINDOW software
  - Steady-state
  - Simplified “equivalent” geometry model
  - Full transient model

Simulations results



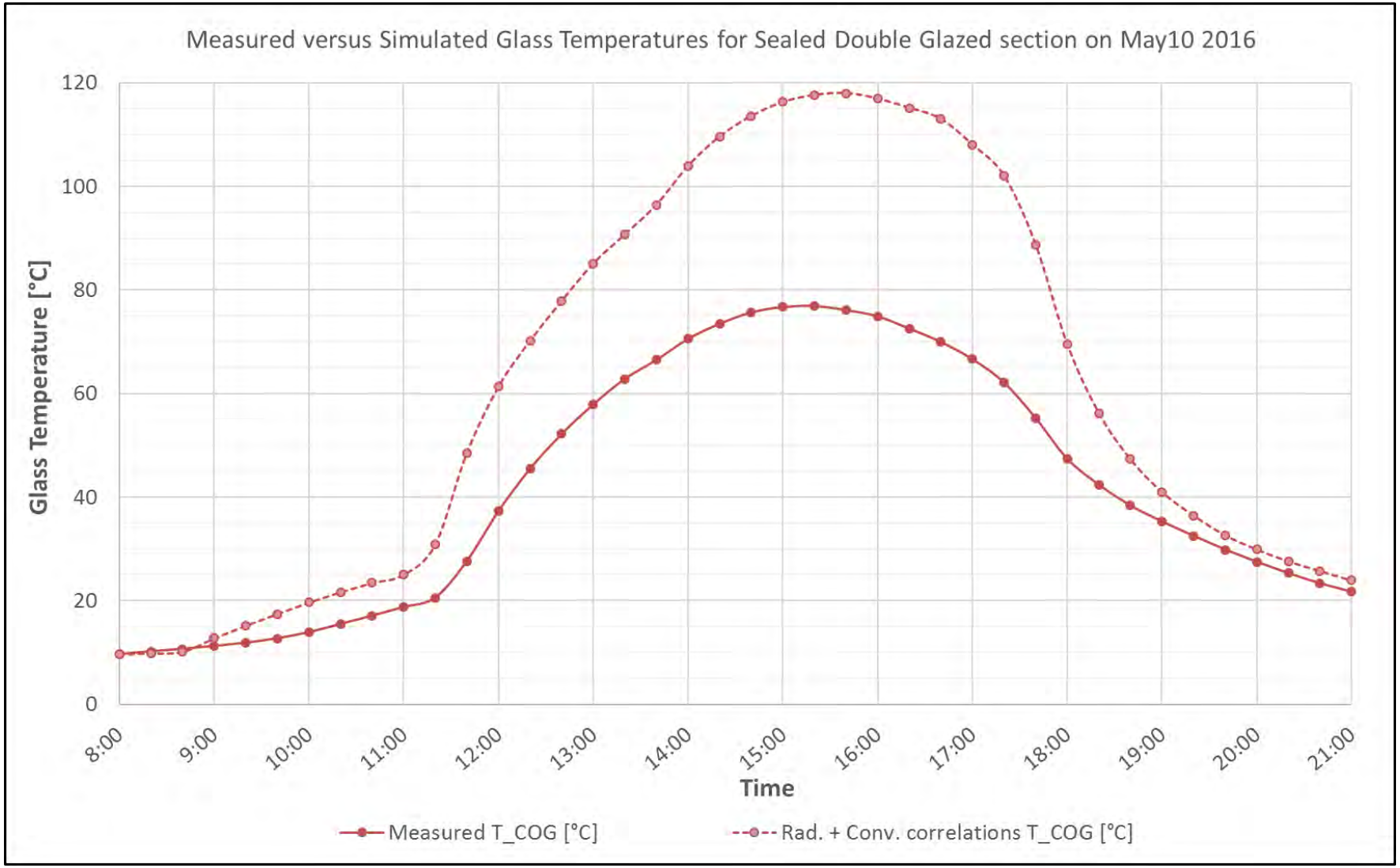
- Measured
- ISO 10077-2
- Rad. + Conv. correlations
- Convection correlation only
- Radiation correlation only
- Explicit Rad. + Conv. calculations

Simulations results



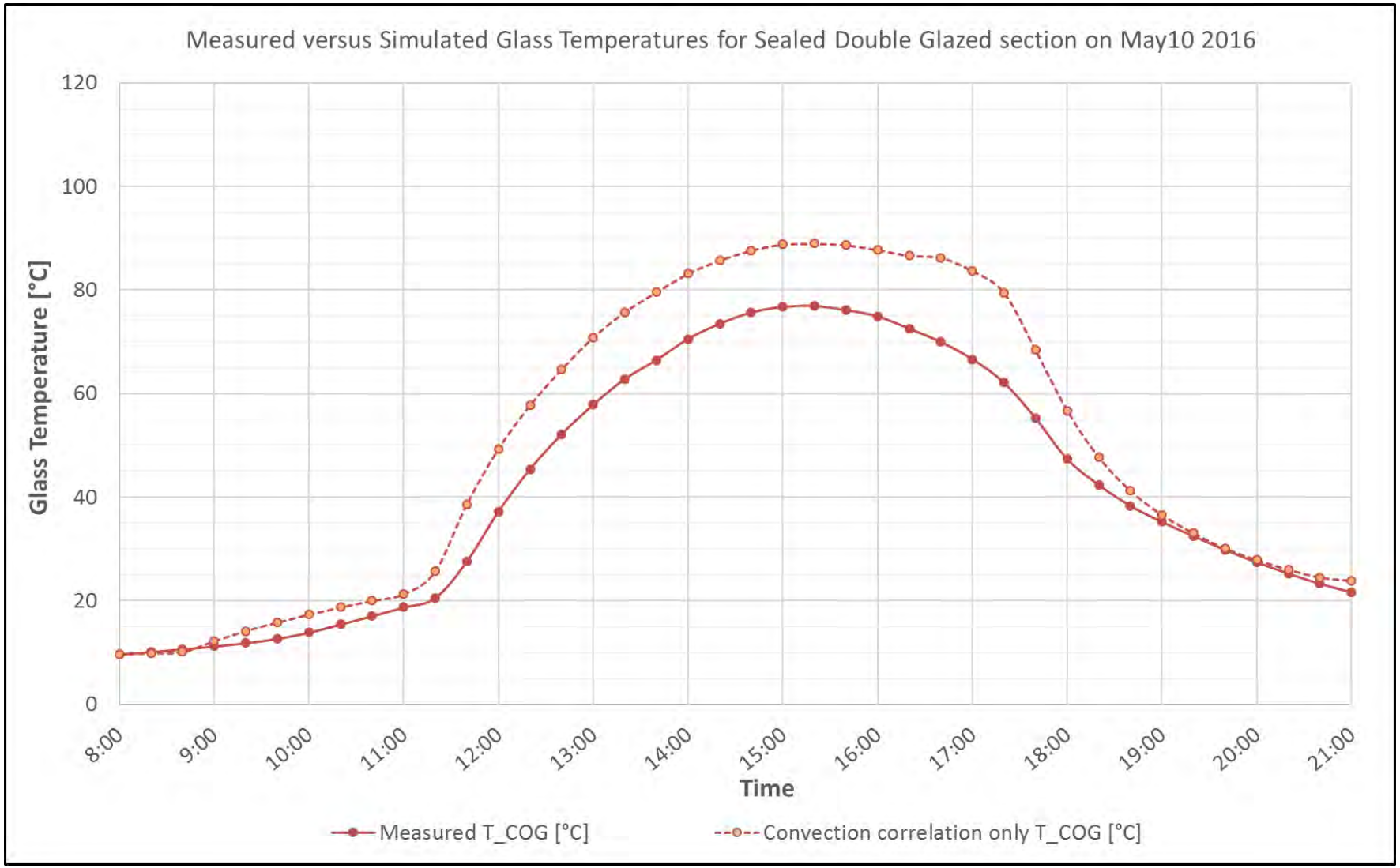
- Measured
- ISO 10077-2
- Rad. + Conv. correlations
- Convection correlation only
- Radiation correlation only
- Explicit Rad. + Conv. calculations

Simulations results



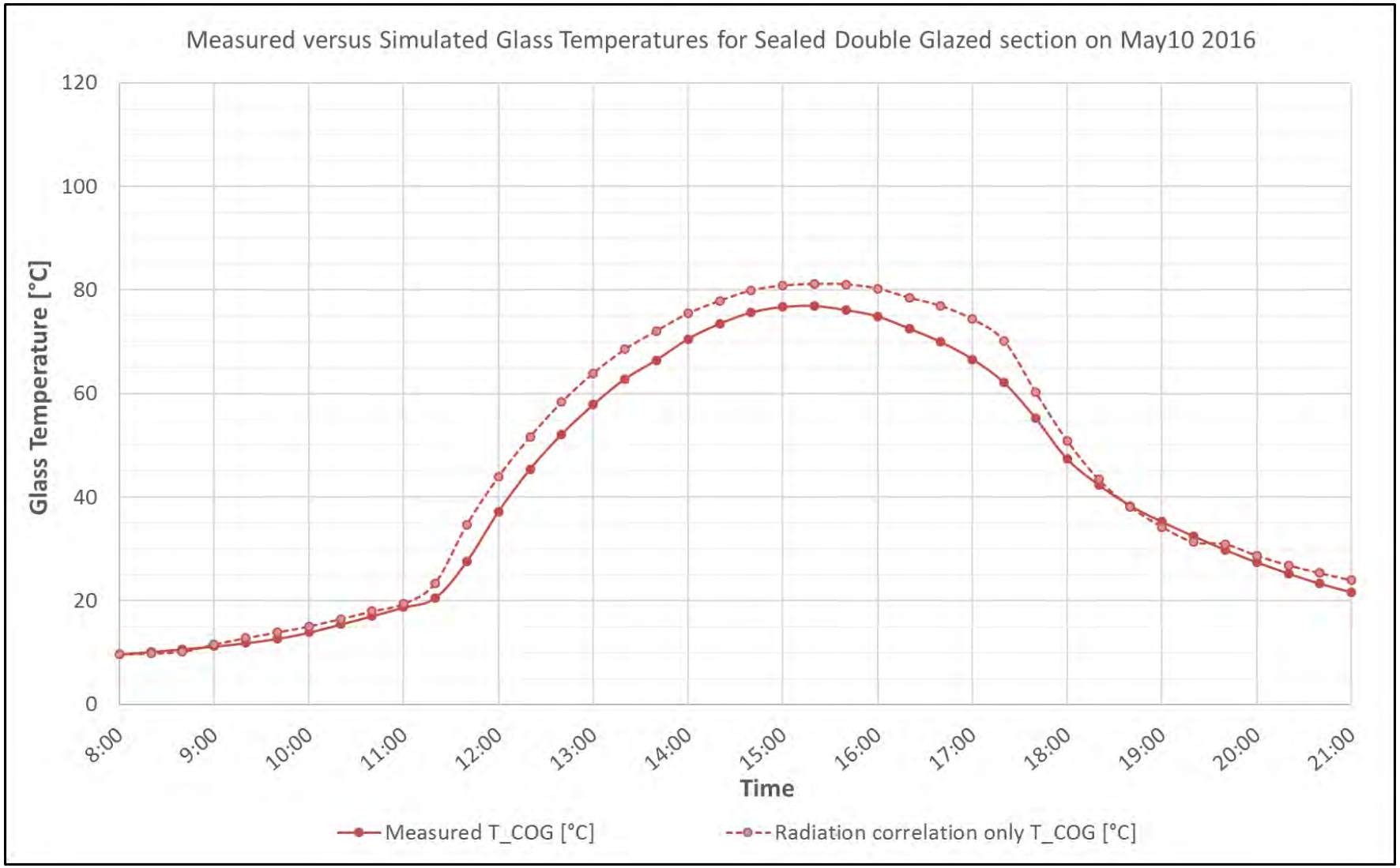
- Measured
- ISO 10077-2
- Rad. + Conv. correlations
- Convection correlation only
- Radiation correlation only
- Explicit Rad. + Conv. calculations

Simulations results



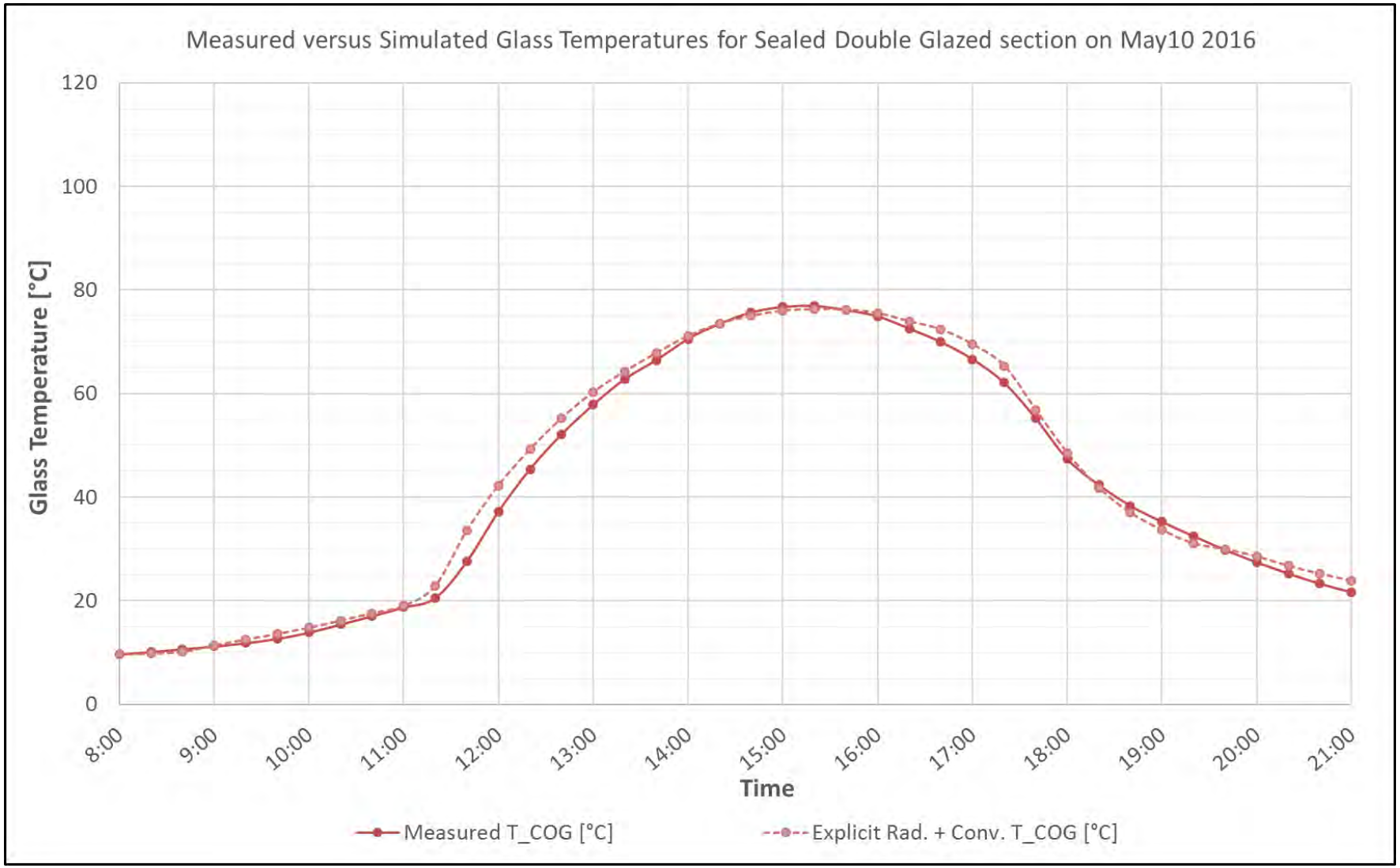
- Measured
- ISO 10077-2
- Rad. + Conv. correlations
- Convection correlation only
- Radiation correlation only
- Explicit Rad. + Conv. calculations

Simulations results



- Measured
- ISO 10077-2
- Rad. + Conv. correlations
- Convection correlation only
- Radiation correlation only
- Explicit Rad. + Conv. calculations

Simulations results



- Measured
- ISO 10077-2
- Rad. + Conv. correlations
- Convection correlation only
- Radiation correlation only
- Explicit Rad. + Conv. calculations

Conclusion and future work

- Double-glazed assemblies can be exposed to significantly higher temperature differences that may approach the lower range where there is a risk of breakage with heat-strengthened glass
- While there is some benefit of venting single-glazed spandrel assemblies, these benefits do not extend to double-glazed spandrels
- With more solar-absorbing glass in IGUs, venting shows even less impact on reducing thermal stress
- Explicit 3-D radiation and flow calculations (CFD) are necessary to closely simulate spandrel assemblies exposed to natural conditions
- Next steps consist in using the validated model to broaden the relevance of the findings through the investigation of other conditions including different spandrel designs, venting scenarios, and climates.

Thank you

Contact information:
Julien Schwartz, M.Eng.
Building Energy Consultant
jschwartz@morrisonhershfield.com
604.454.0402

MORRISON HERSHFIELD