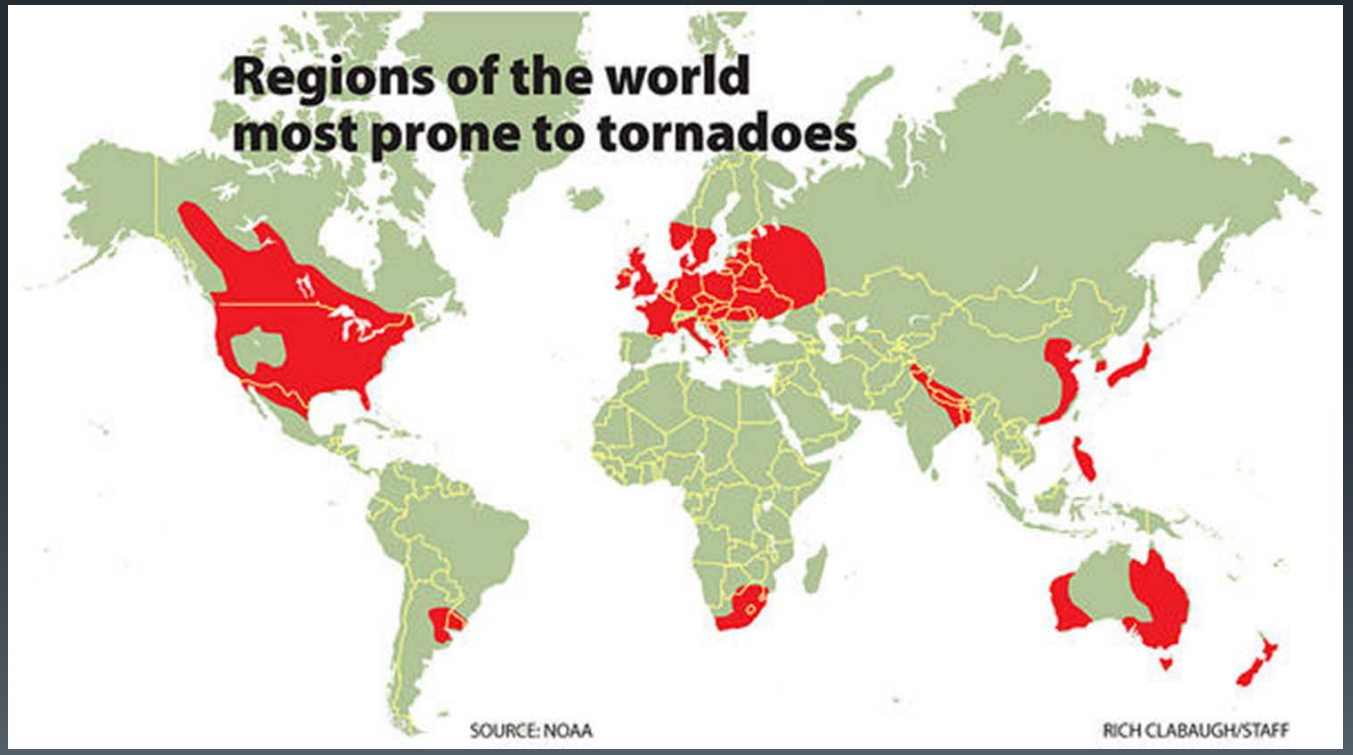
Observations from the Goderich Tornado

Sarah Stenabaugh

Overview

- Tornado development
- Environment Canada watch vs warning
- Fujita Scale
- Case Study: Goderich F3
- Current wind tunnel research

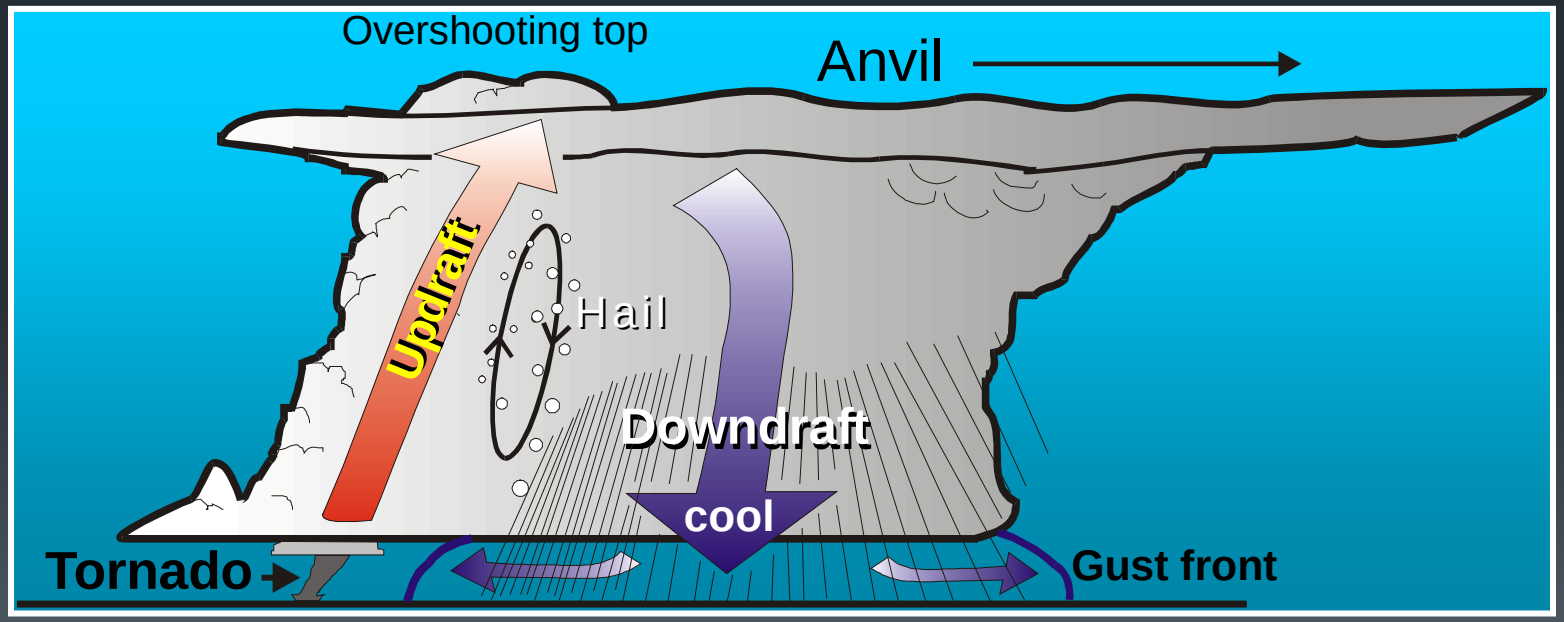
Regions at risk



Required elements for tornado development

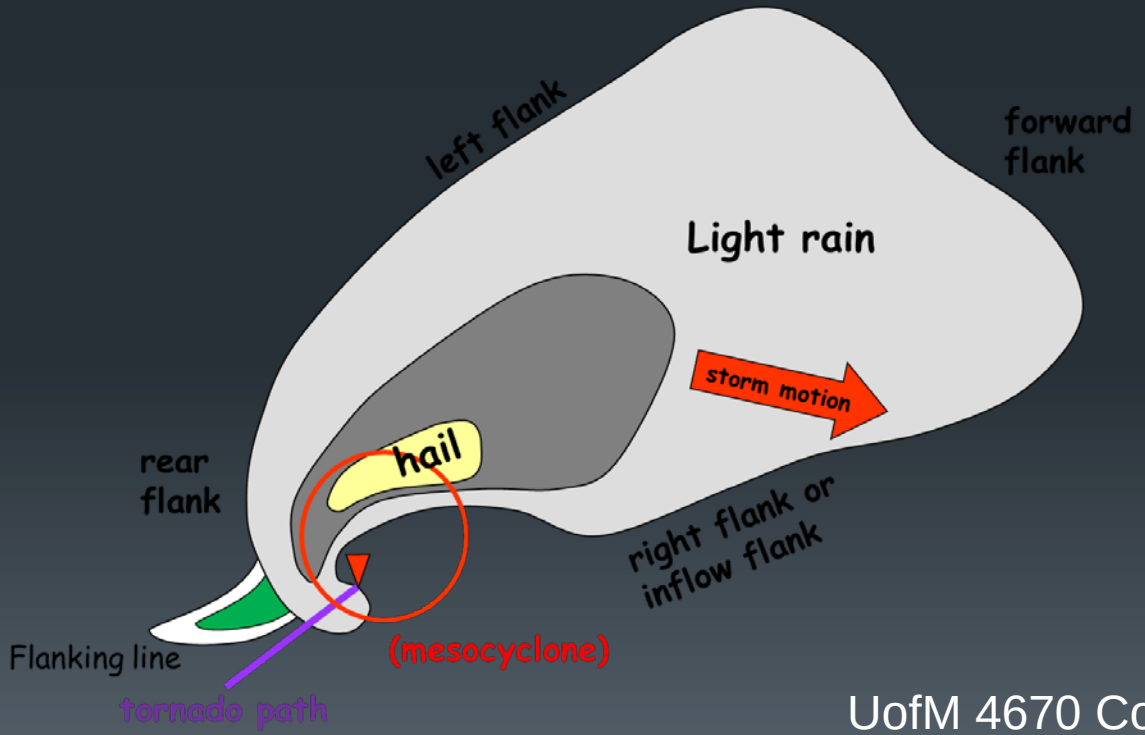
- Moisture
- Instability
- Capping inversion
- Shear
- Trigger

Supercell



UofM 4670 Course Notes

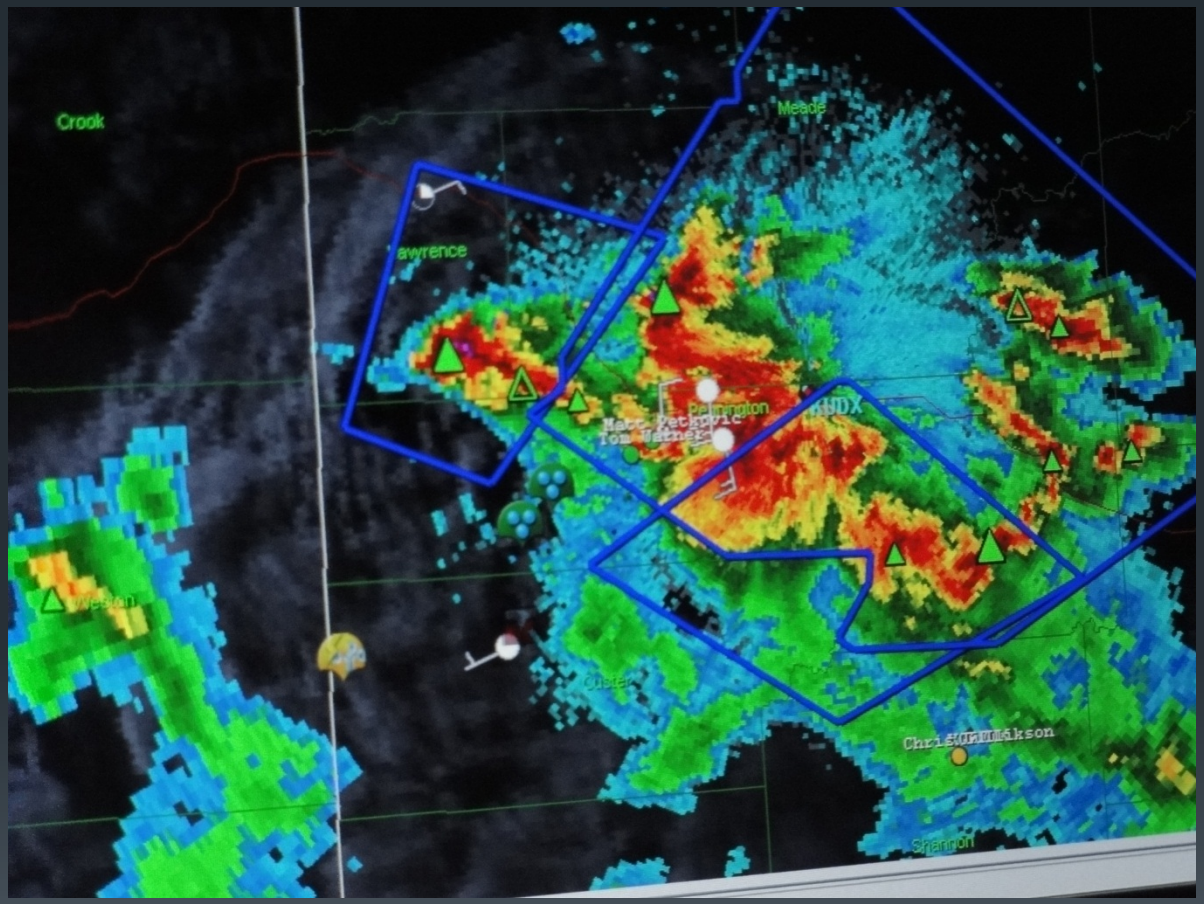
Supercell



UofM 4670 Course Notes

Storm Chasing with U of M

4 Vans and a Camera Crew


Crook
Meade
awrence
Pennington
UDX
Custer
Shannon

Tornado Watch vs Warning

- **Watches** - favourable for a storm or severe weather
- **Warnings** - urgent message that severe weather is either occurring or will occur

Damage Surveys

- After the event
- Assess the damage
- Assist Environment Canada with the damage (Fujita) rating
  - Damage Indicator (DI)
  - Degree of Damage (DoD)

Fujita Scale

F-Scale	Intensity	Wind Speed km/h (mph)
F0	Gale	64-116 (40-72)
F1	Moderate	117-180 (73-112)
F2	Significant	181-253 (113-157)
F3	Severe	254-332 (158-206)
F4	Devastating	333-418 (207-260)
F5	Incredible	419+ (261+)

Degrees of Damage for a House

DoD	
1	Threshold of visible damage
2	Loss of roof covering, gutters, awnings, vinyl siding
3	Broken glass in windows
4	Loss or roof decking and significant loss of roof covering, collapse of chimney
5	House shifts off the foundation
6	Roof structure removed
7	Exterior walls removed
8	Most walls collapsed
9	All walls collapsed
10	Destruction of well constructed home

Escalating Damage – DoD 2

TTU 79409-1023 (2006)

Escalating Damage – DoD 4

TTU 79409-1023 (2006)

Escalating Damage – DoD 6

TTU 79409-1023 (2006)

Escalating Damage – DoD 7

TTU 79409-1023 (2006)

Escalating Damage – DoD 10

TTU 79409-1023 (2006)

21 August 2011
4pm local time
F3
1 Fatality

Goderich Tornado

Chris Wilson (2011)

Chris Wilson (2011)

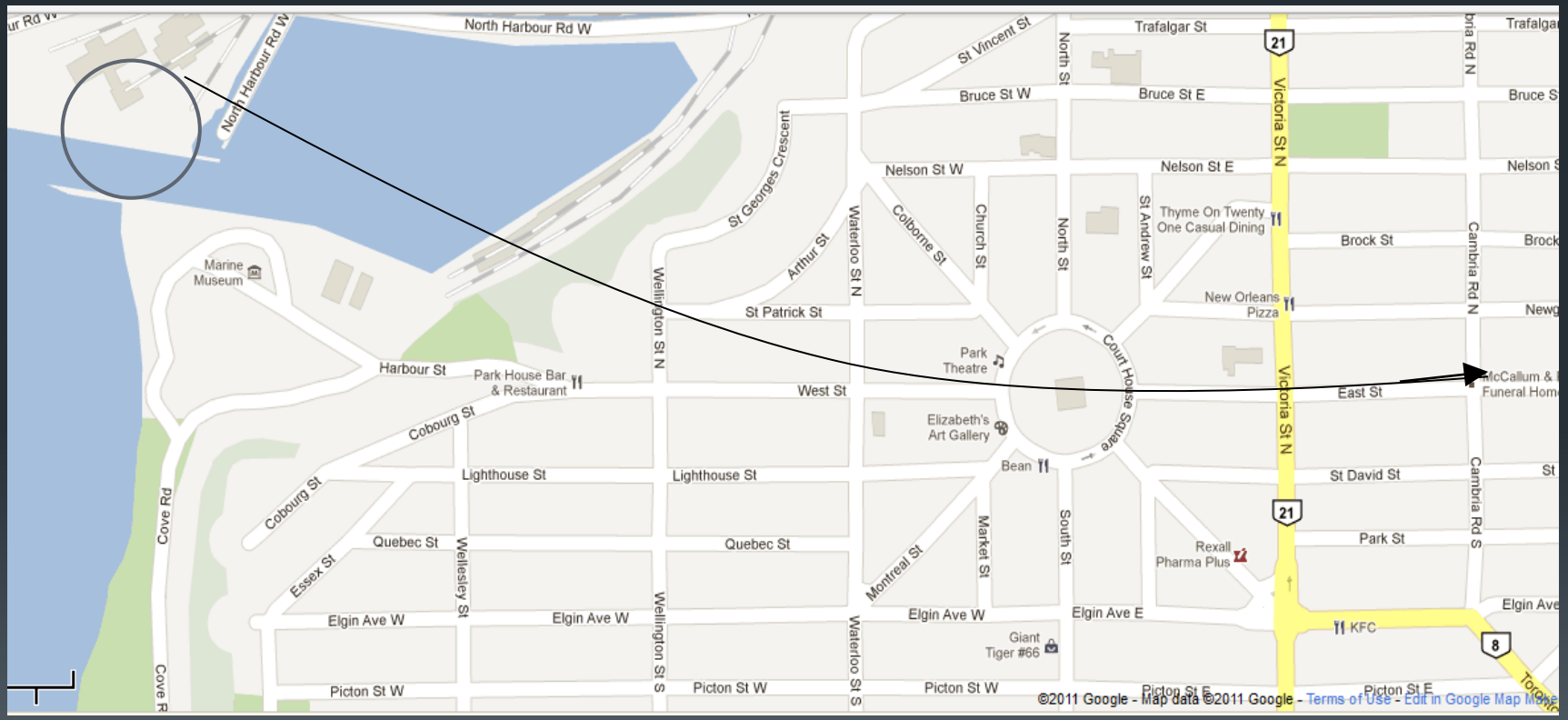

POLICE
POLICE


Scotiabank

Goderich Damage Survey

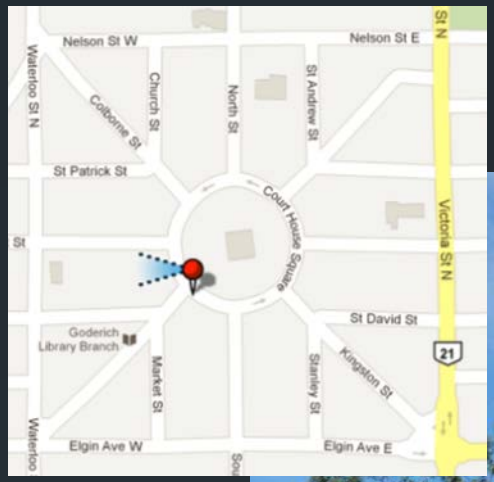
- Damage path
- Downtown core – masonry structures
- Trees – 3 main failure mechanisms
- Debris impact

Damage Path – Landfall and Downtown Core



lfpress.com

Downtown Core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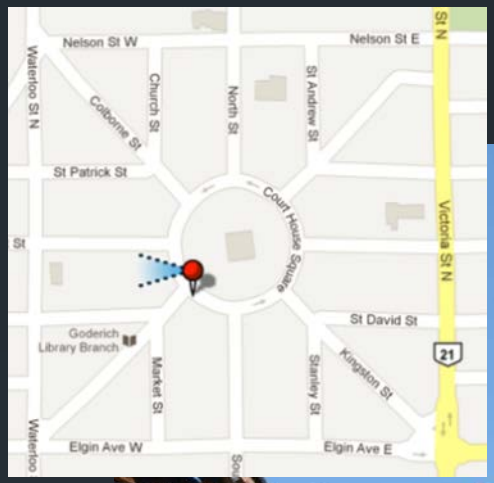
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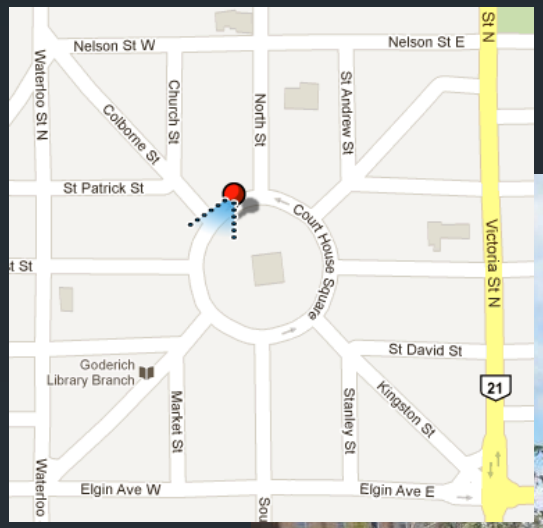
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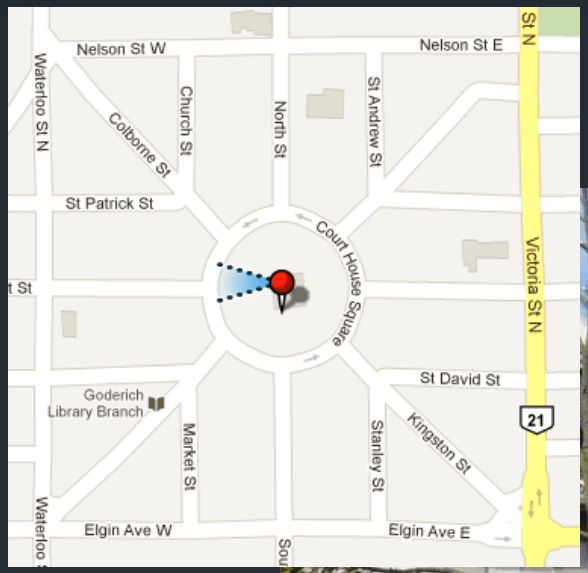
Carman's
foto source
Carman's
Bailey's
Lighthouse


MAIN FLOOR 3 ROOM
OFFICE SUITE
FOR LEASE (519) 395-5908 or (519) 525-2222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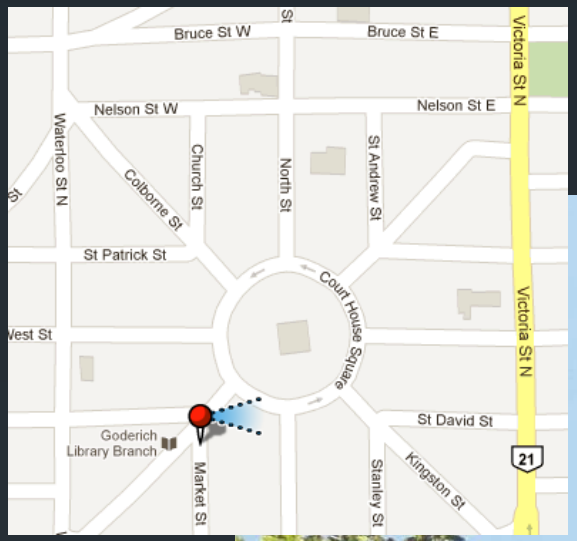
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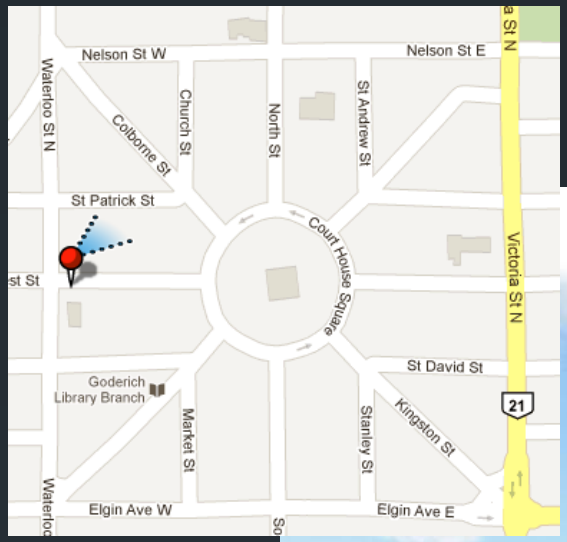
MARKET ST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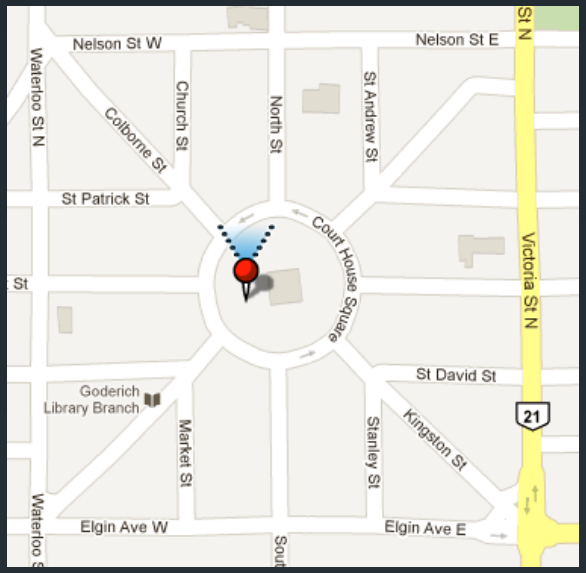
68 West Street
VEOLIA
WATER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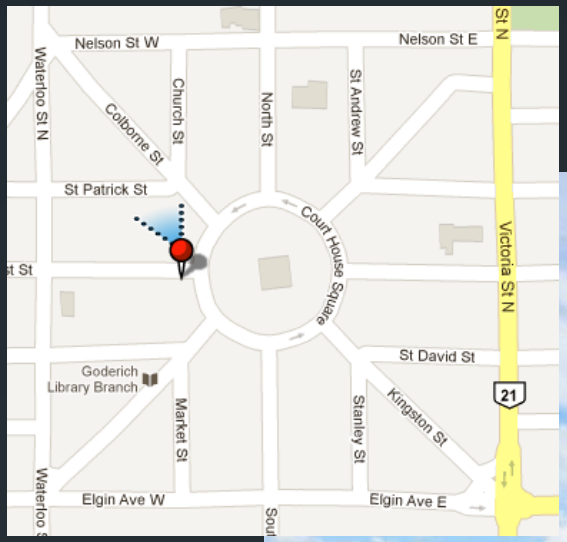
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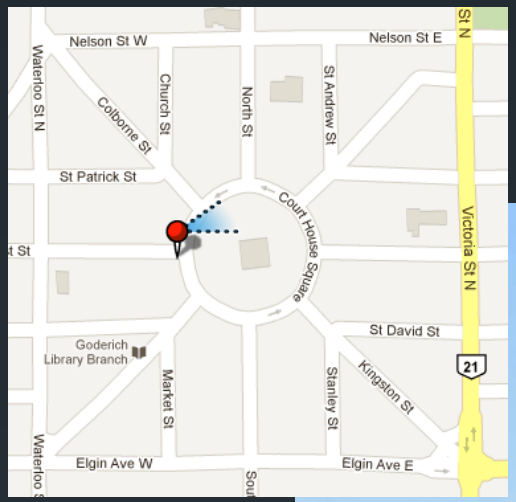
Quilters Square

Tree Failures

Debris field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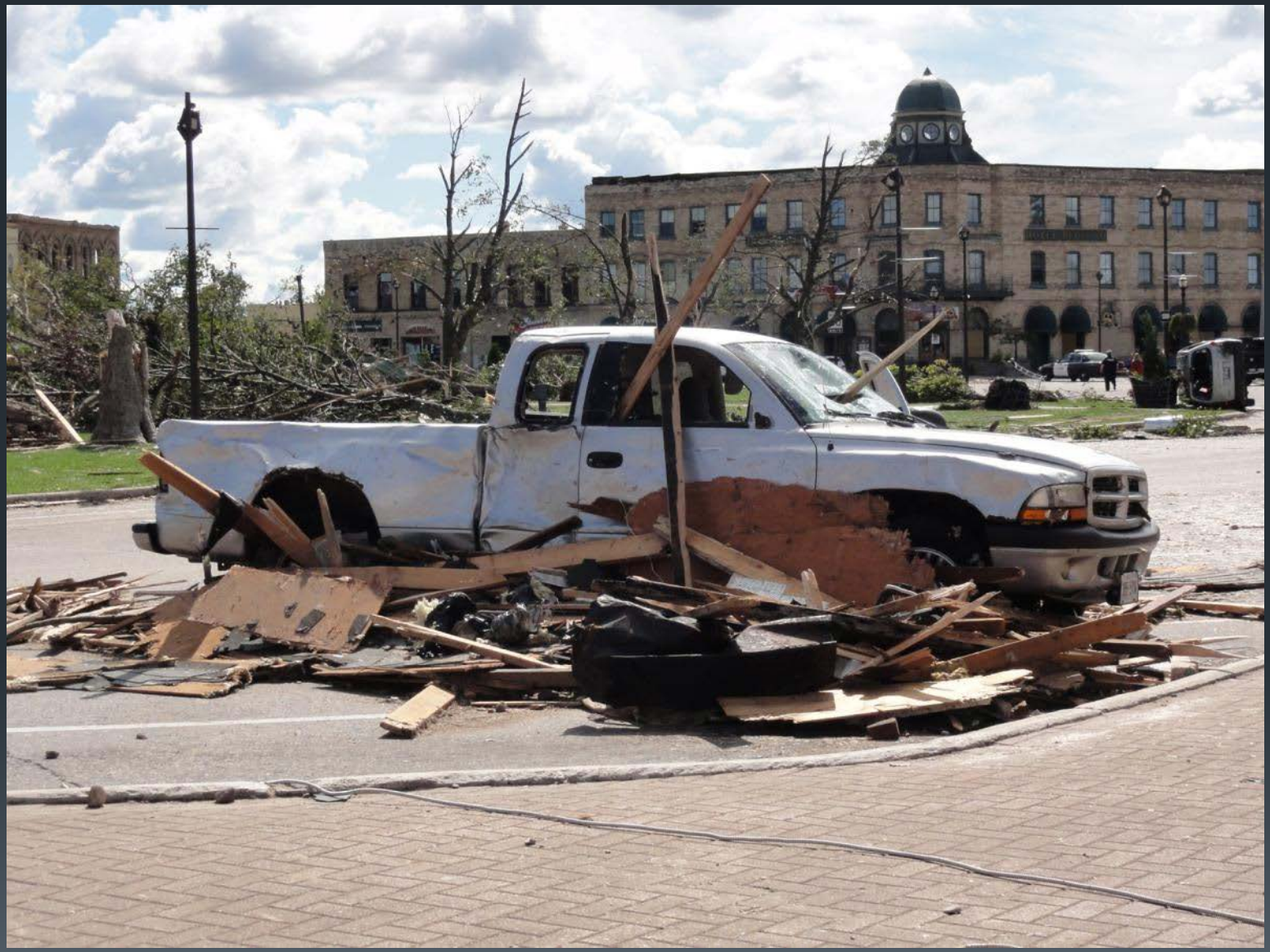


DEPARTMENT OF EDUCATION


BEND 968
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CURRENT RESEARCH

Insurance Research Labs for Better Homes

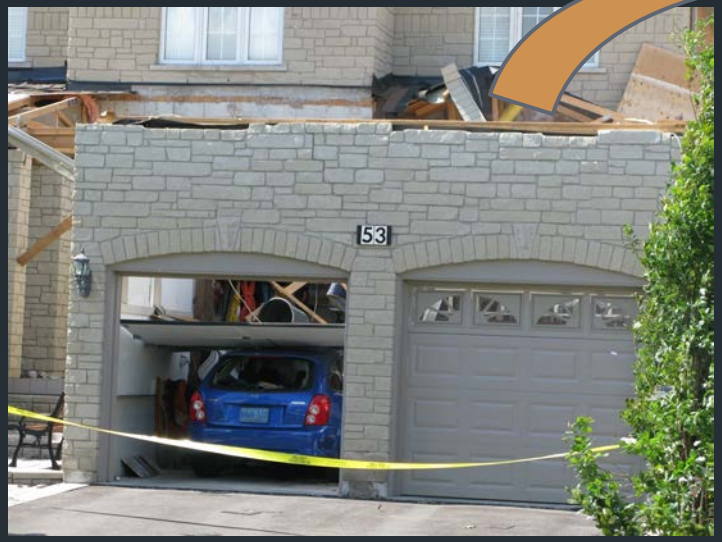
- Roof-to-wall connections
- Pressure Equalization across wall systems
- Sheathing
- Cladding
- Windows

The Boundary Layer Wind Tunnel Laboratory

- Pressure and uplift on residential roofs
- Vehicles, street signs and trees as damage indicators
- Wind loads on solar panels mounted on sloped residential roofs

Global Roof Failures - Flight

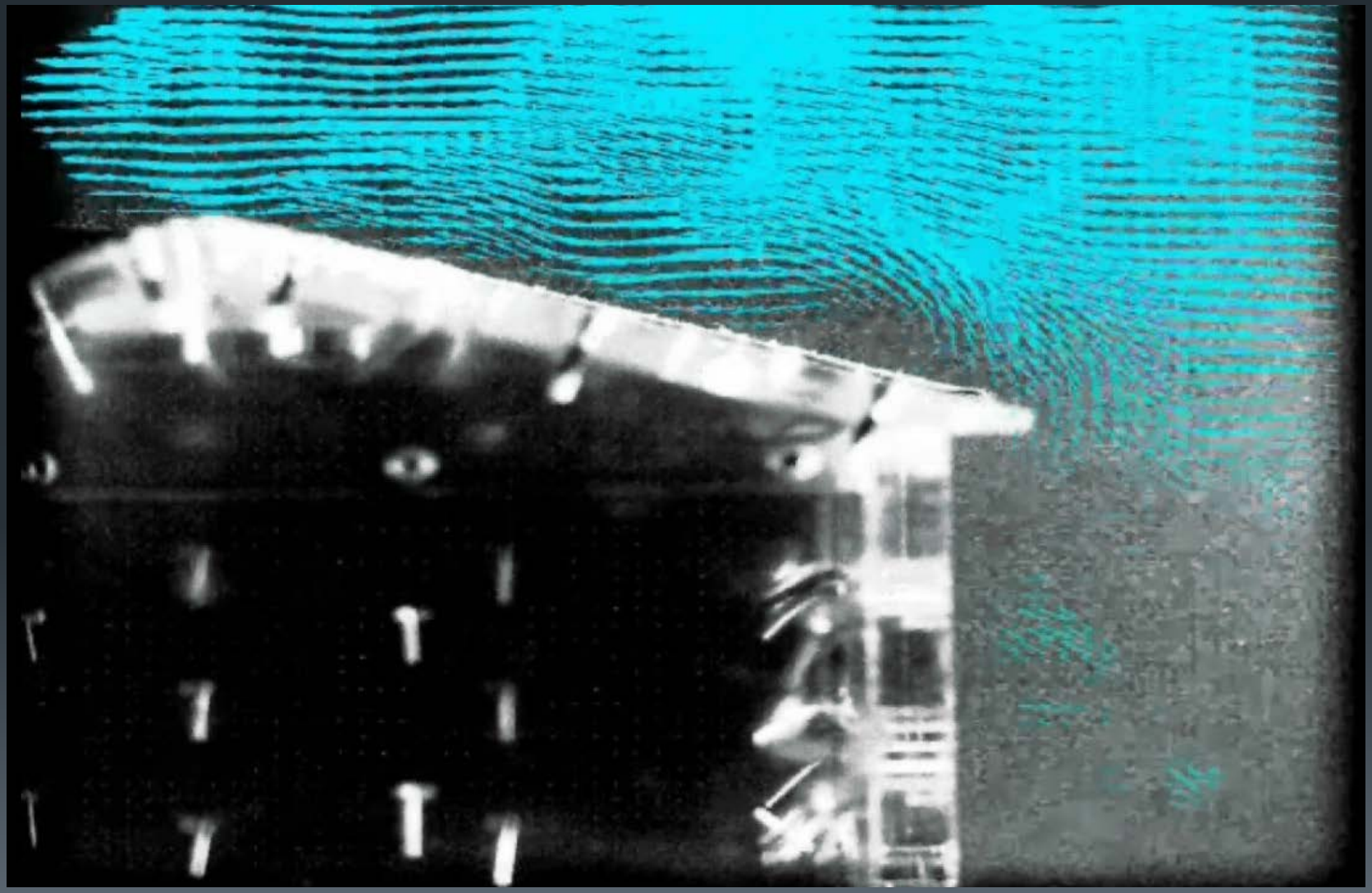
Global Roof Failures - Flight



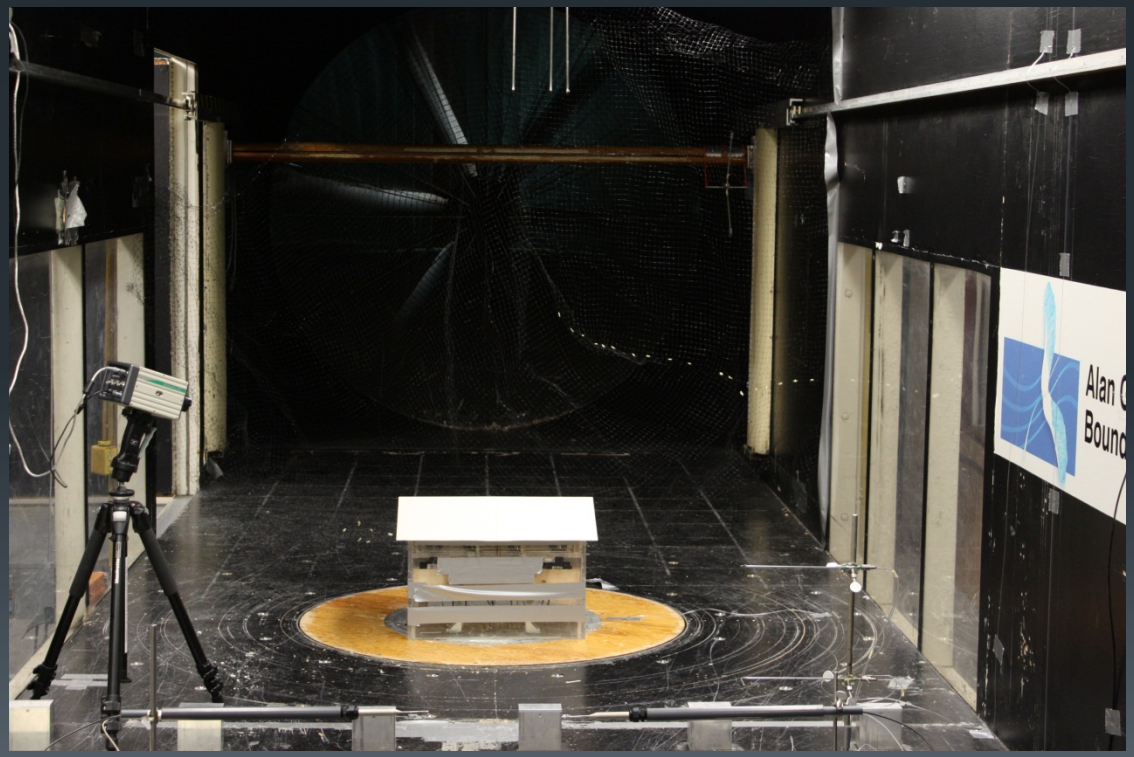
Global Roof Failures - Failure

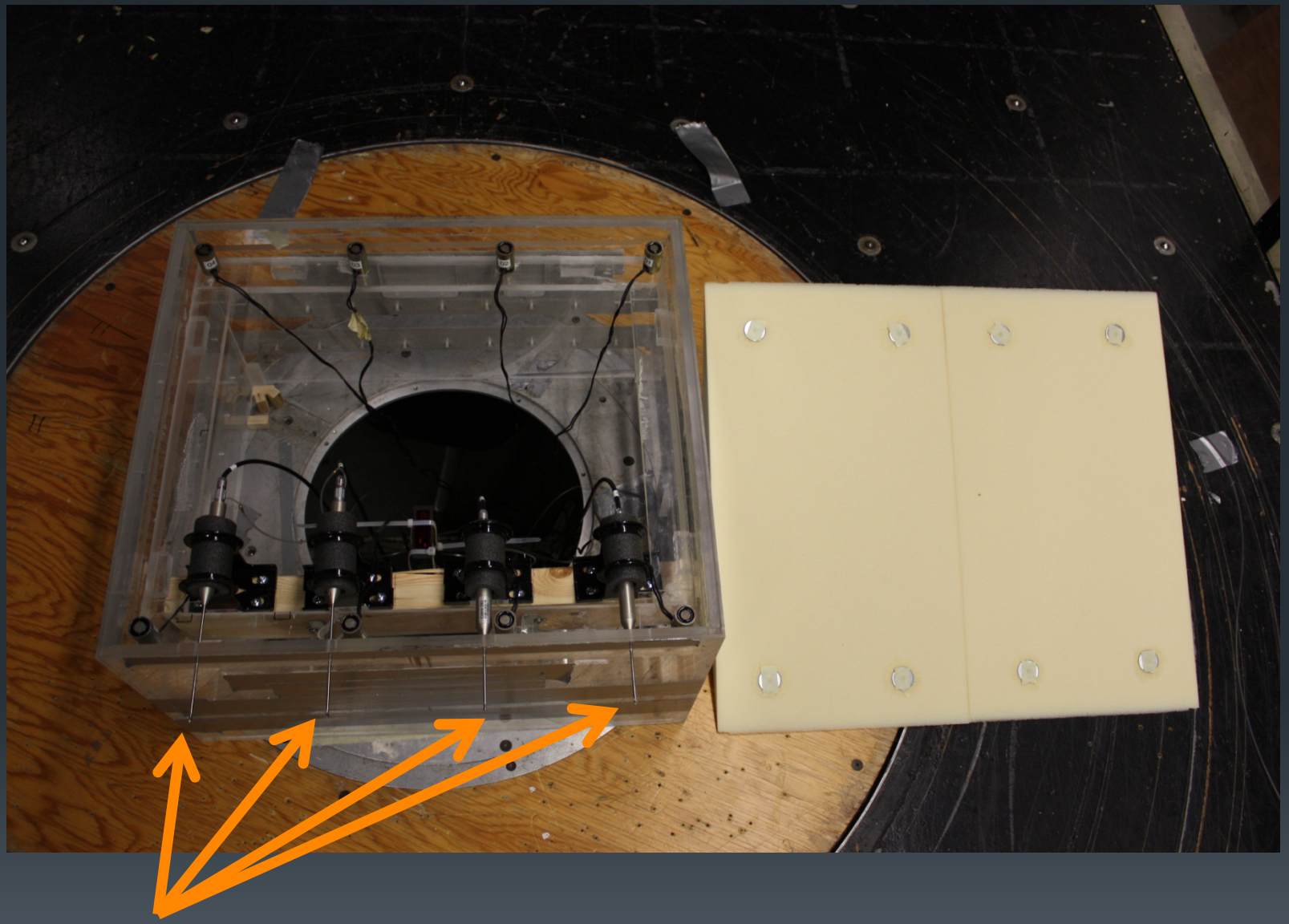
http://www.jcu.edu.au/cts/research_reports/index.htm

Failure wind speed

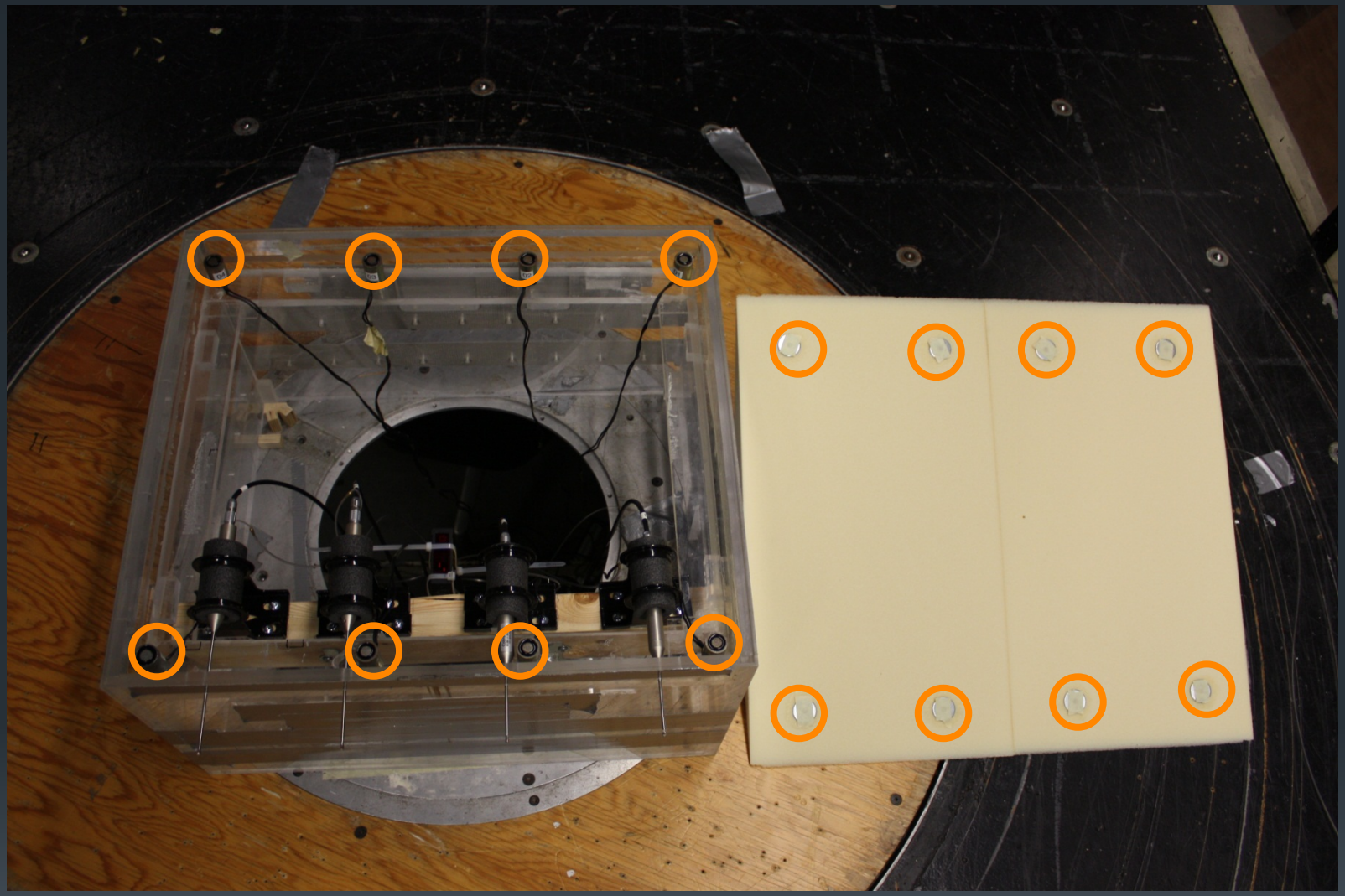


Testing set-up

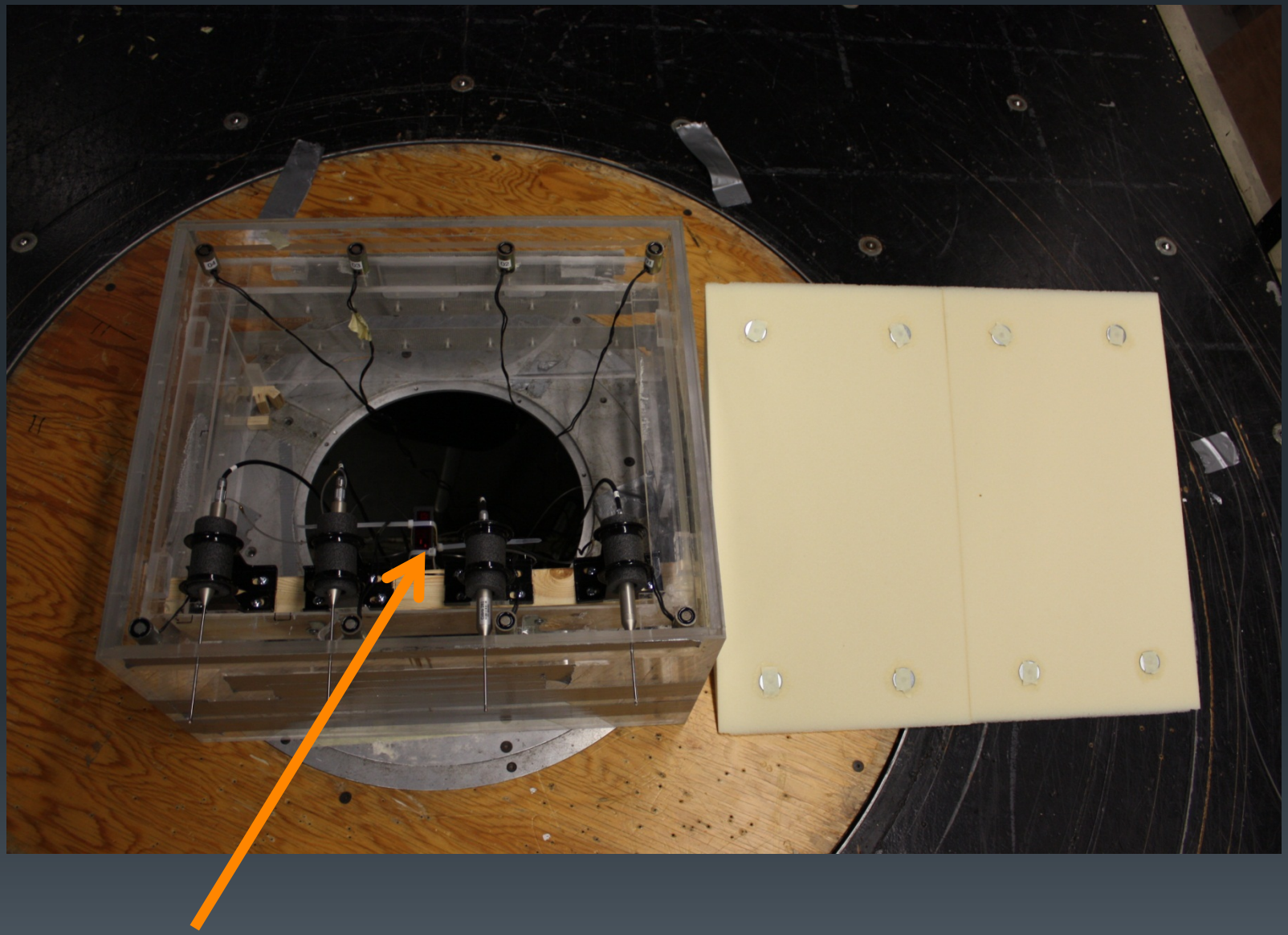




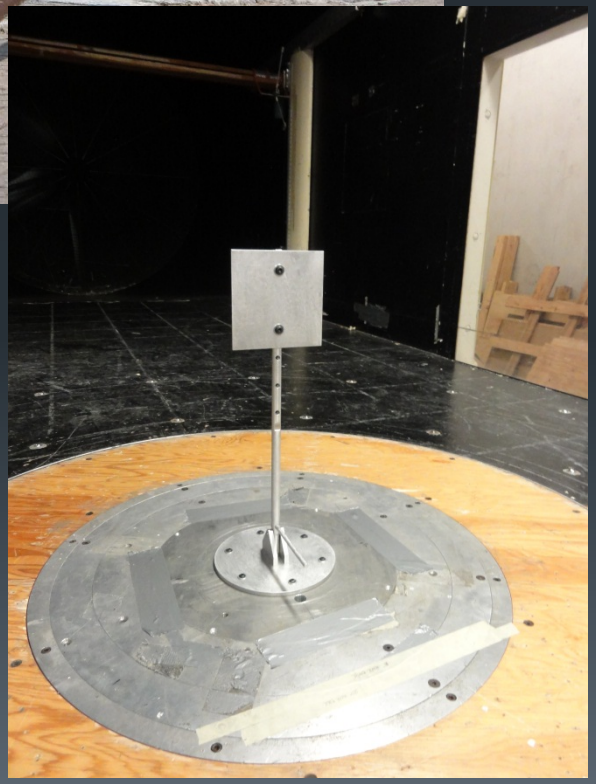
Velocity Probes



Electromagnets and contacts


Laser

Complimentary Research



Summary

- An updated damage scale will more accurately predict wind speeds responsible for the damage
- Damage surveys and current research will increase our knowledge and lead to more resilient structures

Acknowledgements

- Dr. G. A. Kopp
- Dr. P. Karava
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