FIG Working Week 2016

CHRISTCHURCH, NEW ZEALAND 2–6 MAY 2016

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Temperature Effects on the Vertical Movements of the Severn Suspension Bridge's Suspension Cables measured by GNSS

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Structural Health Monitoring using GNSS, towards Disaster Prevention

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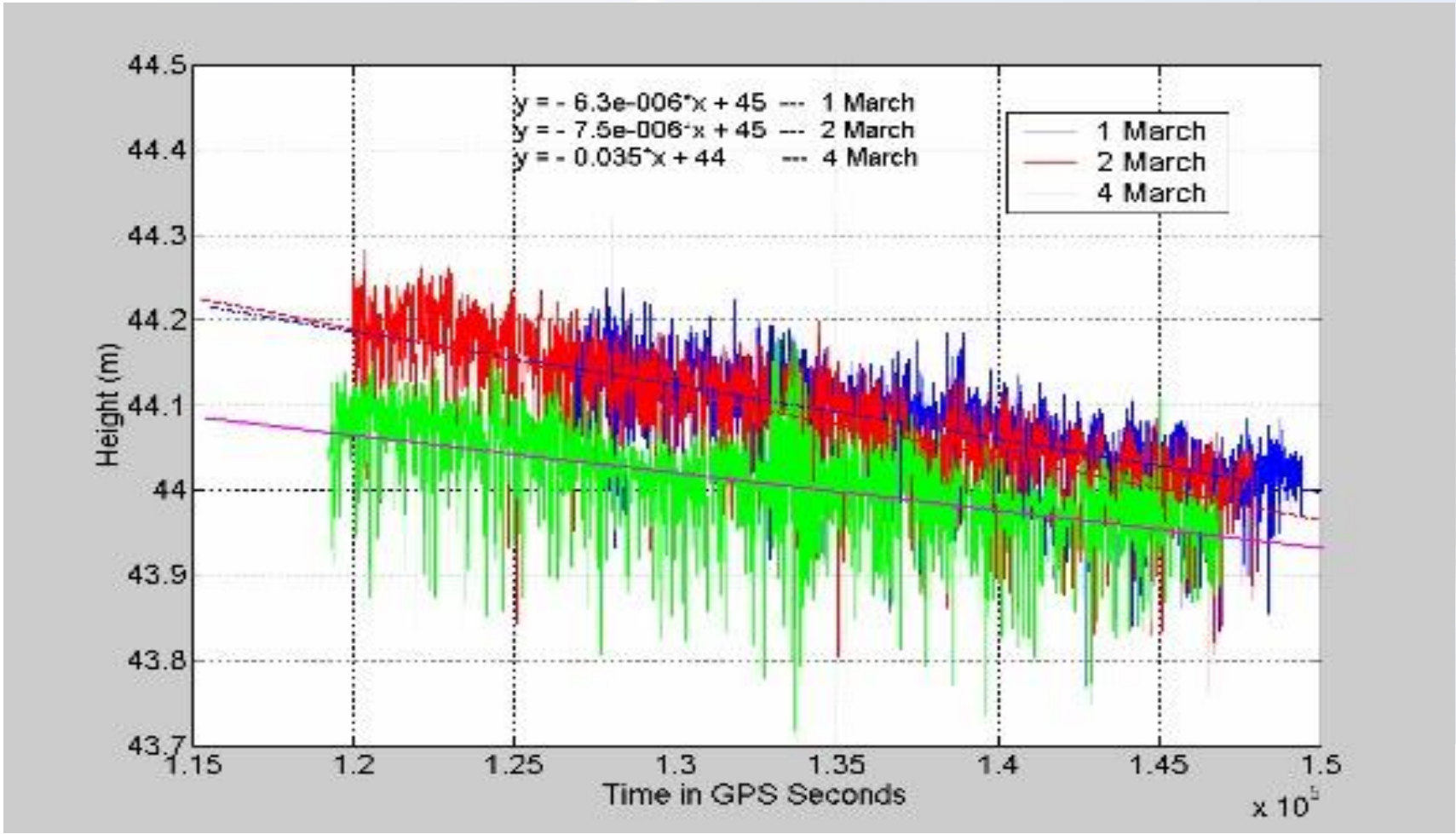
Outline

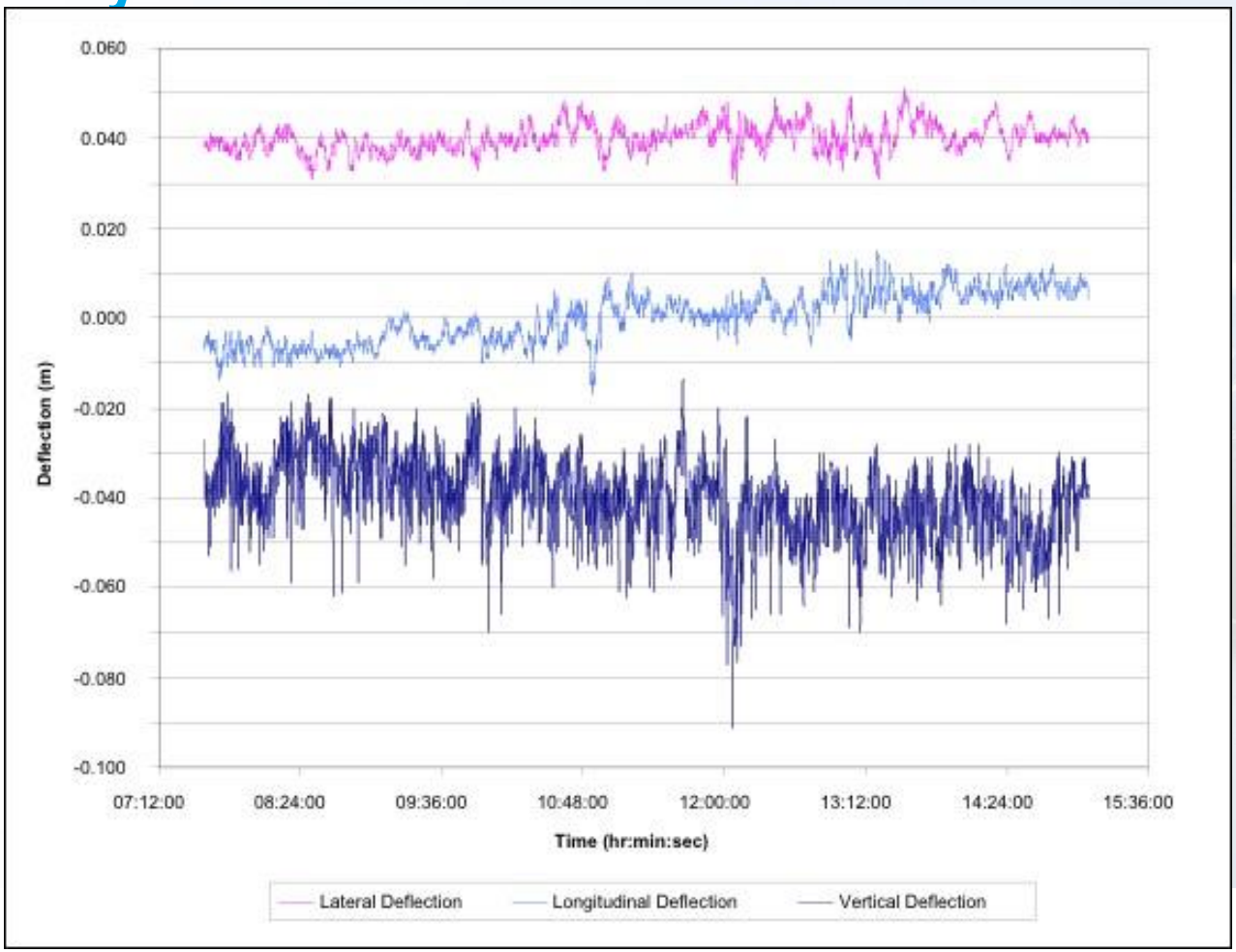
- Historical data
- Layout of the Severn Bridge experiment
- Focus on location B (2010) and B' (2015)
- Results
- Conclusions and future work

Humber Bridge



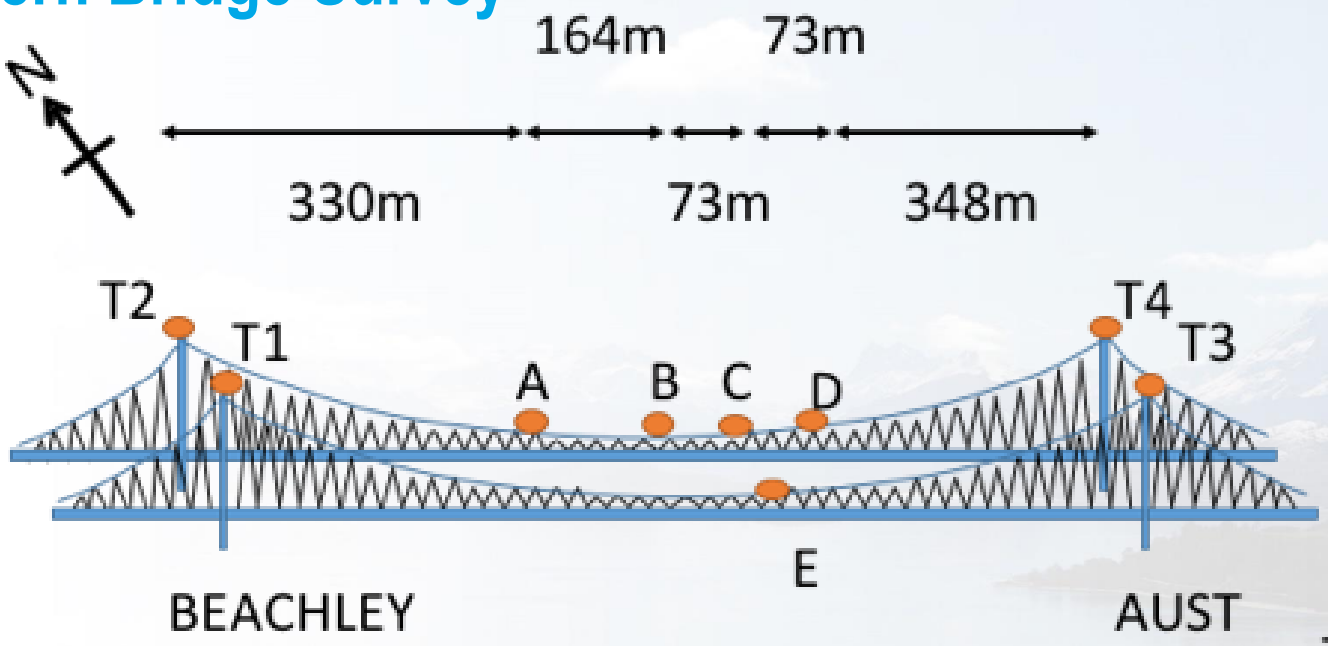
Roberts G.W.,Brown C.J.,Meng X.,The Use of GPS for Disaster Monitoring of Suspension Bridges, *Proceedings of the IAG Congress*, 21 – 25 August 2005, Cairns, Australia.

M5 Motorway viaduct



Roberts, G. W.; Brown, C. J.; Tang, X.; (2014) A Tale of Five Bridges; the use of GNSS for Monitoring the Deflections of Bridges. The Journal of Applied Geodesy. Volume 8 Issue 4. DOI:10.1515/jag-2014-0013. ISSN 1862-9024.

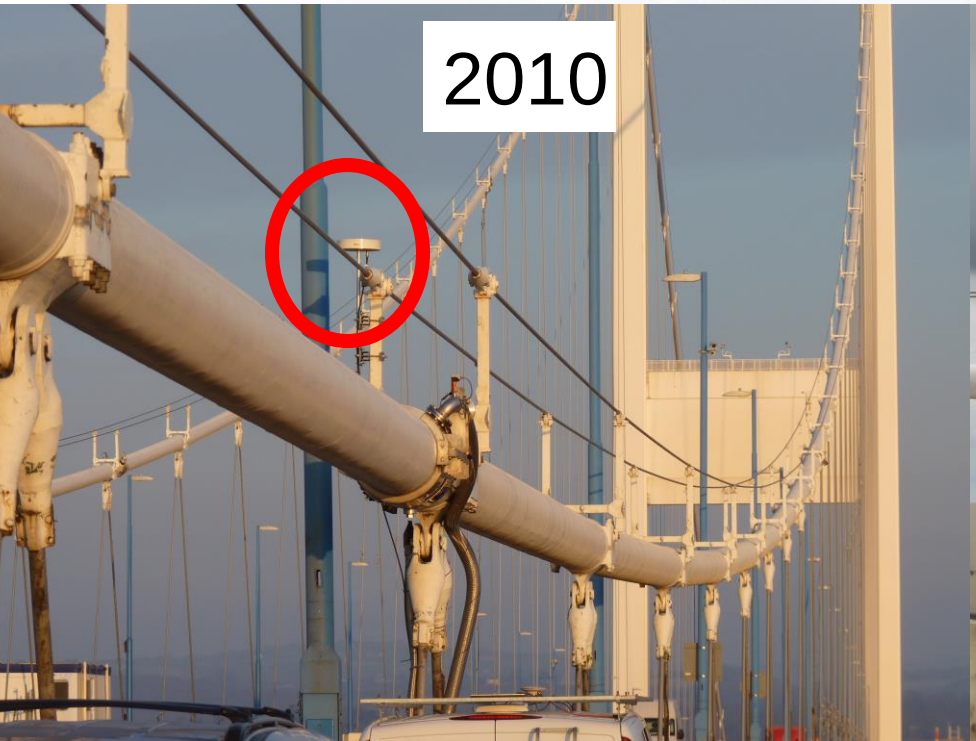
Severn Bridge Survey

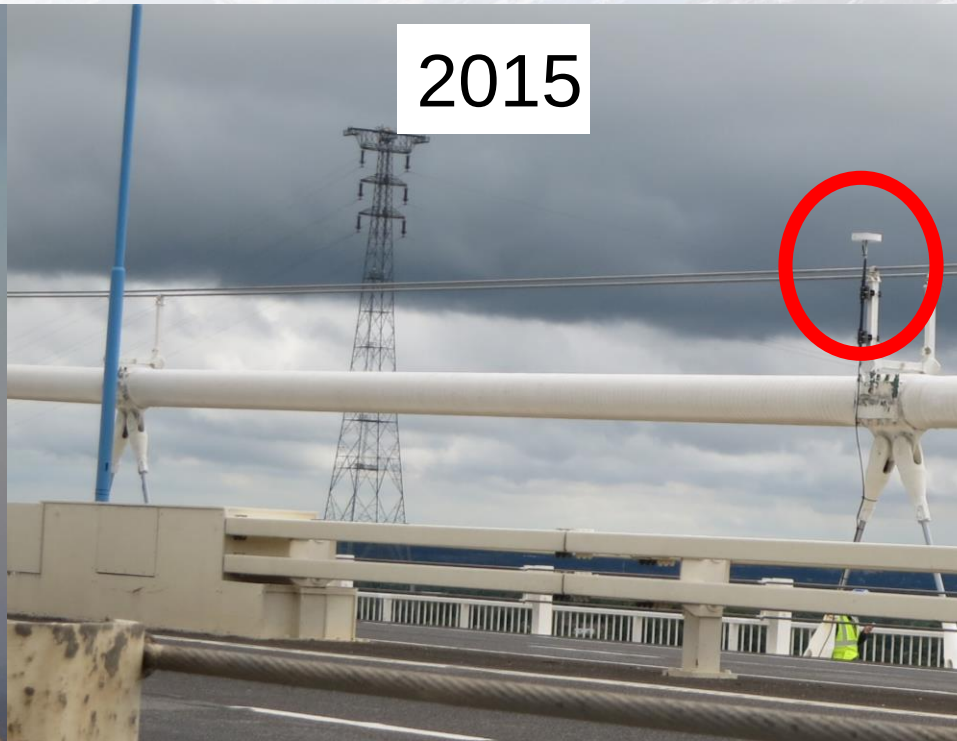


Not to scale

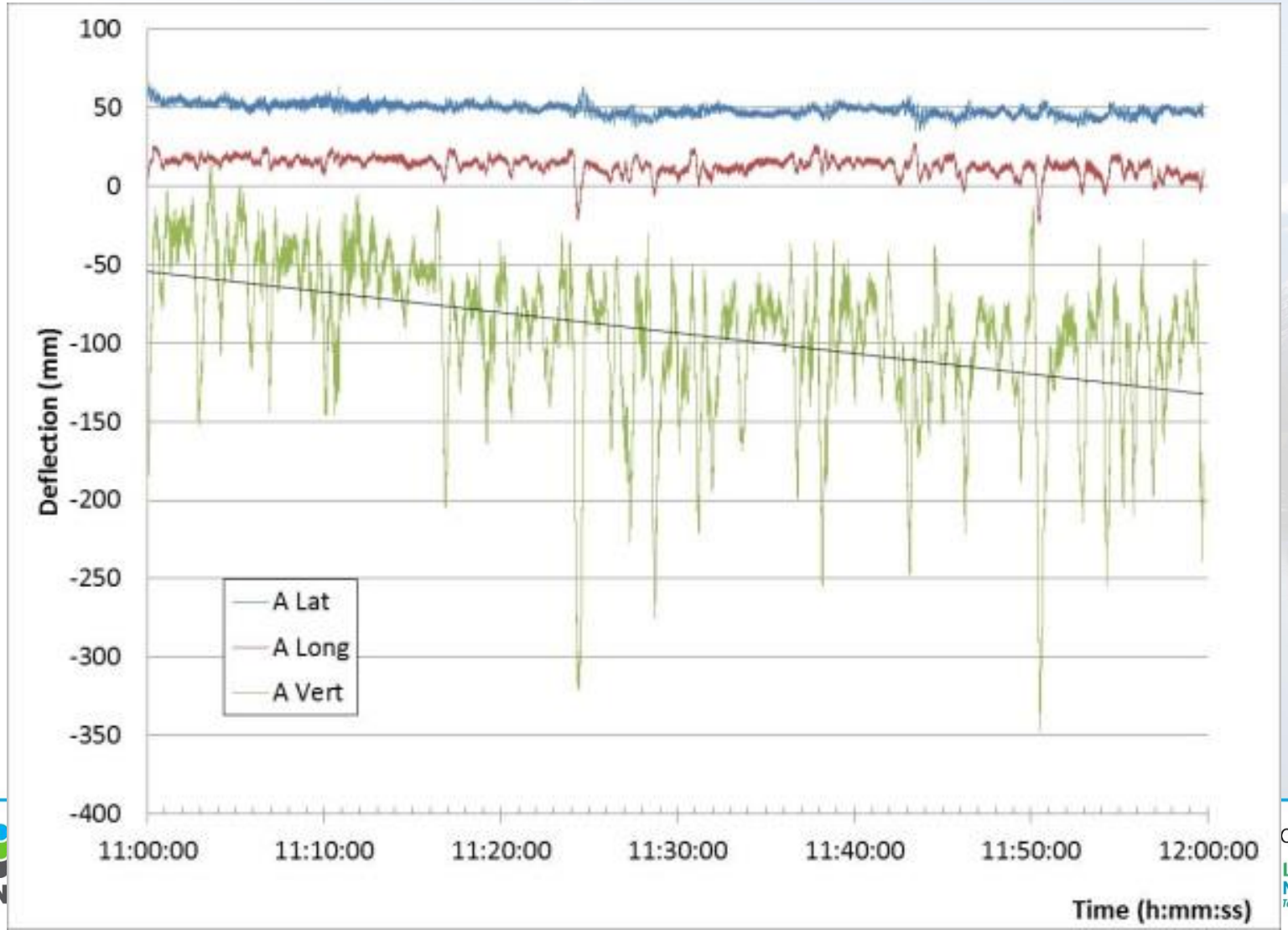
Toll Booths' Building with reference GNSS receiver located on top

- 2010, not ideal, close to a lamppost. Possible problems in processing some of the data
- 2015 much better
- 20Hz GNSS (GPS), 10min temperature

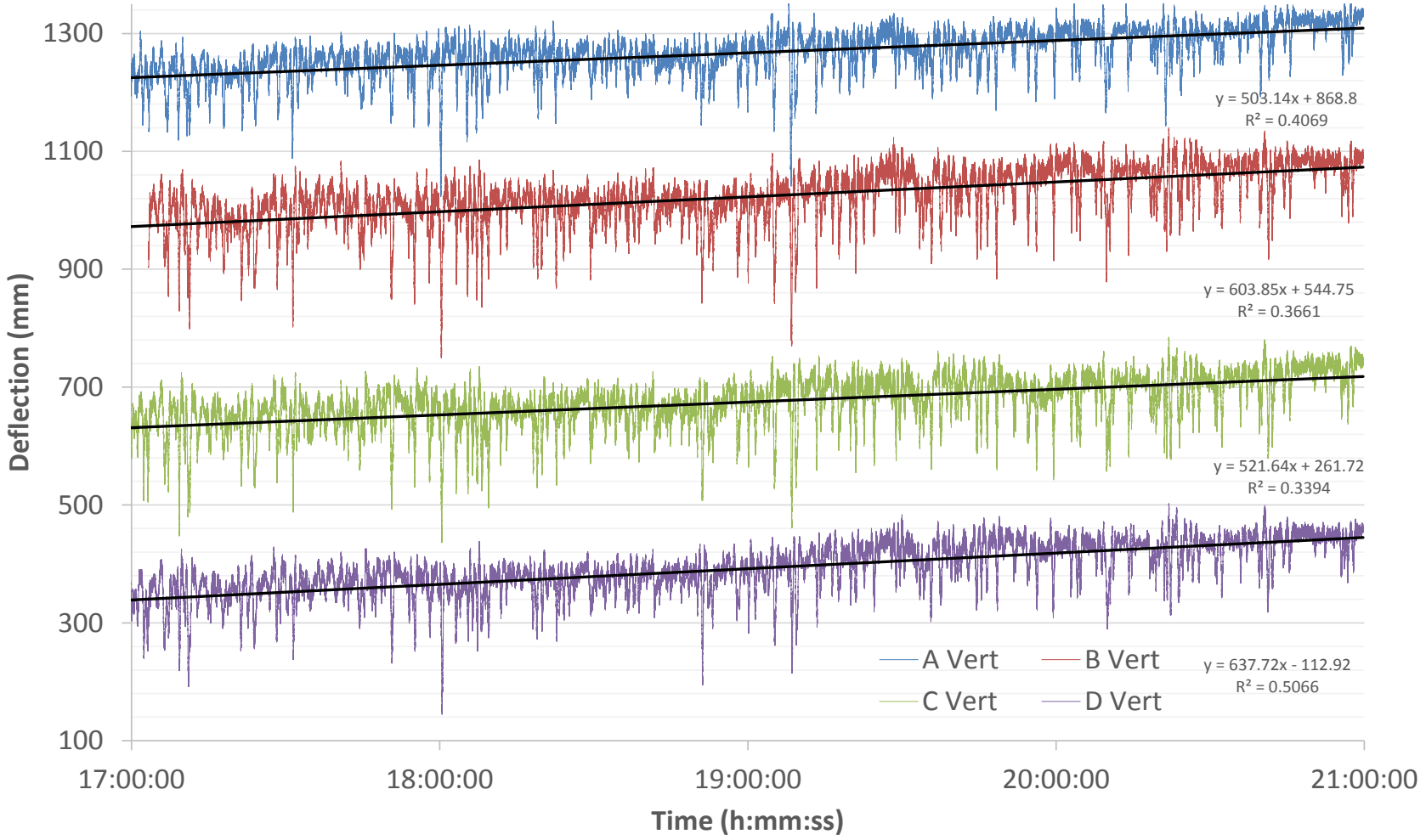




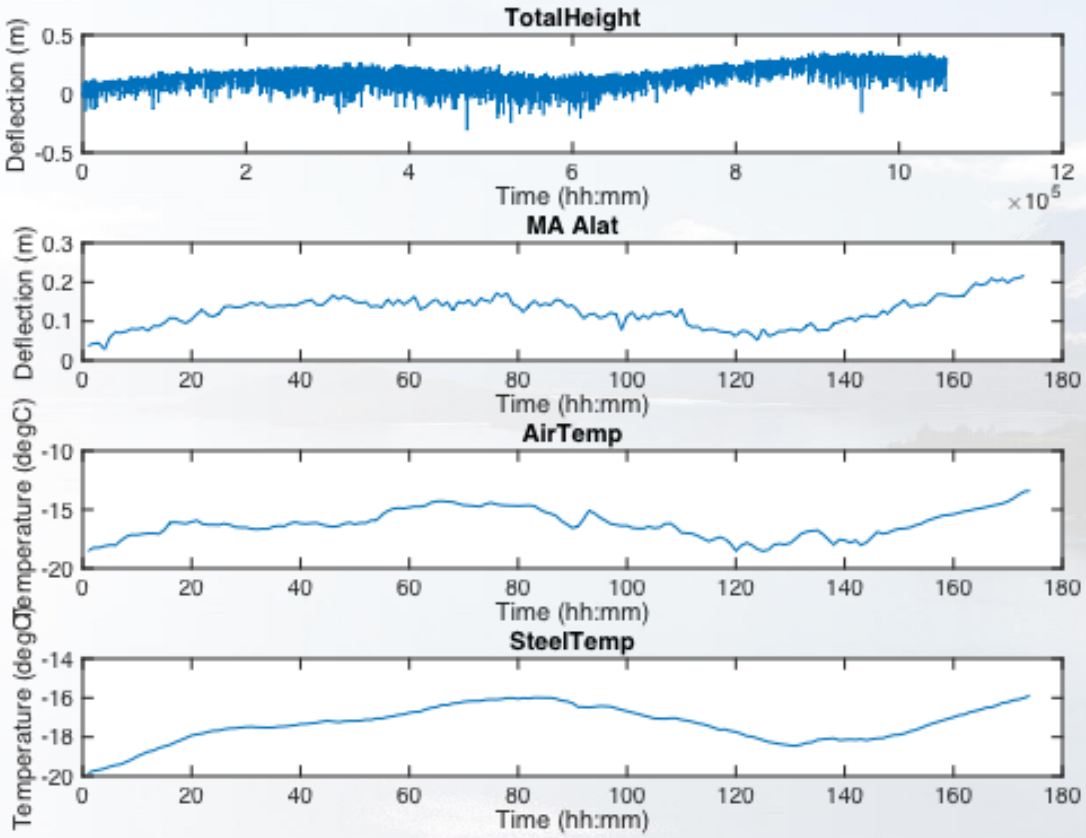
1 hour, A, 2010


100
50
0
-50
-100
-150
-200
-250
-300
-350
-400
Deflection (mm)
A Lat
A Long
A Vert
11:00:00
11:10:00
11:20:00
11:30:00
11:40:00
11:50:00
12:00:00
Time (h:mm:ss)

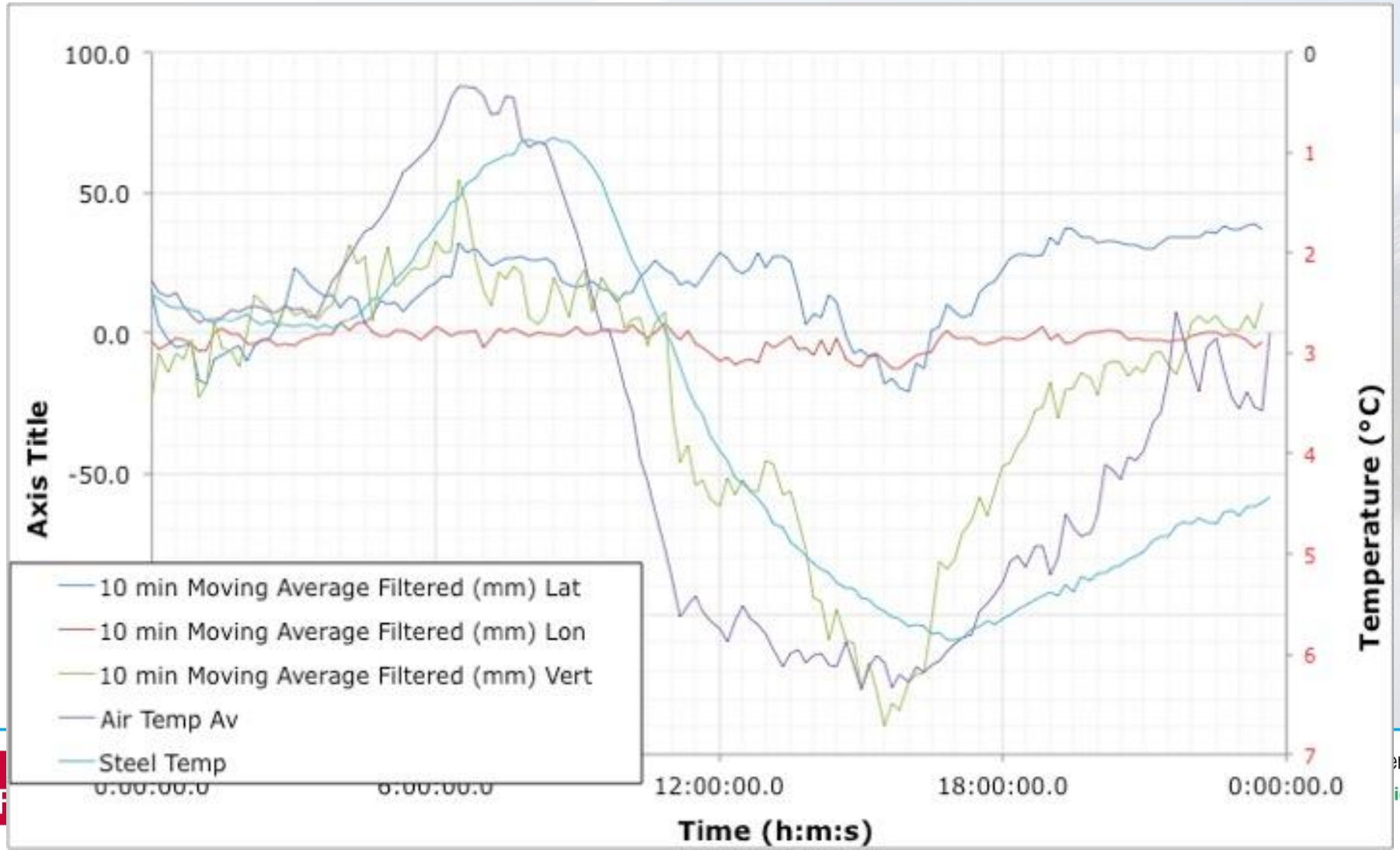
4 hours, Vert A, B, C, D, 2010



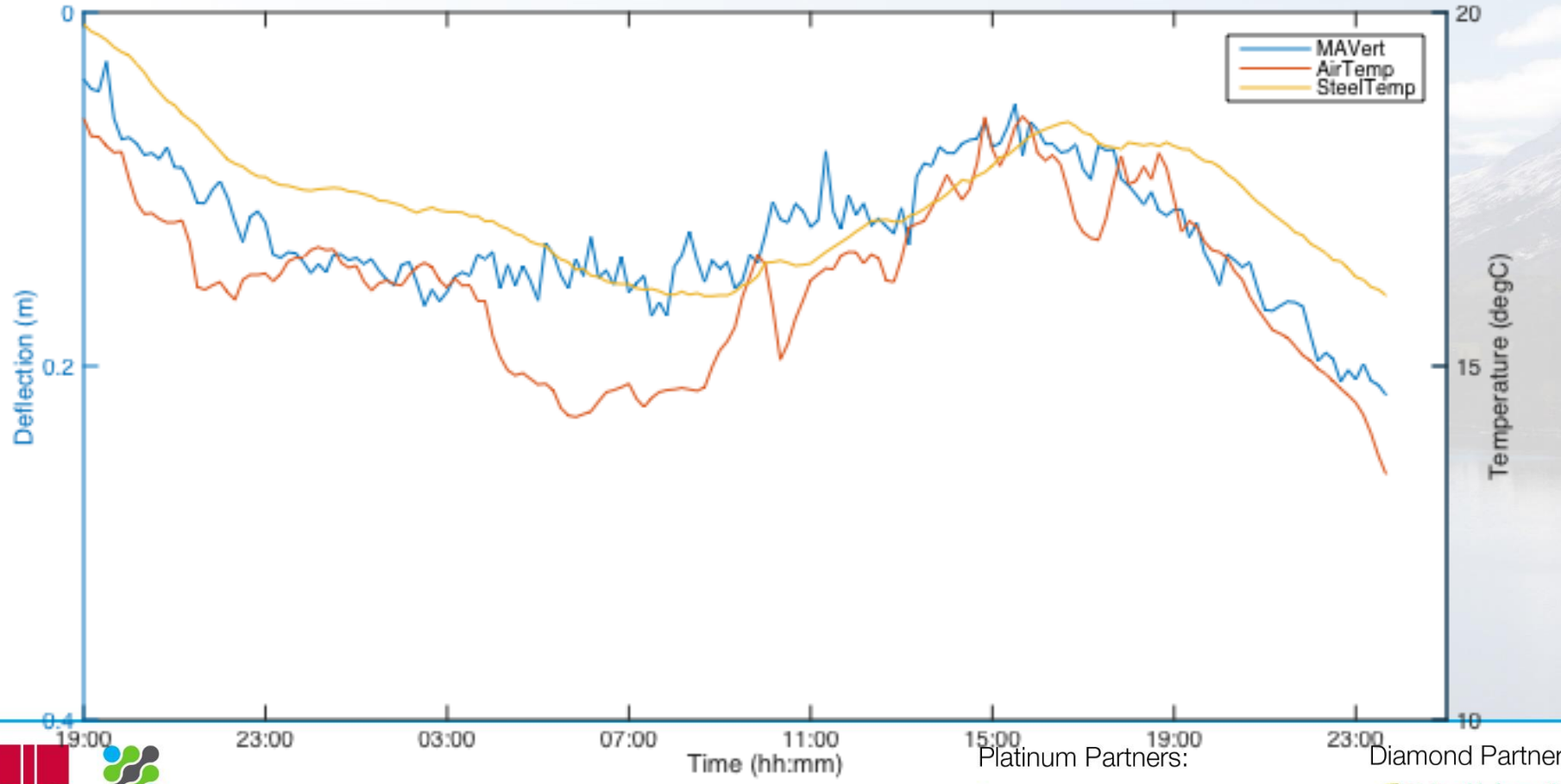
39 hours, Vert B', 2015

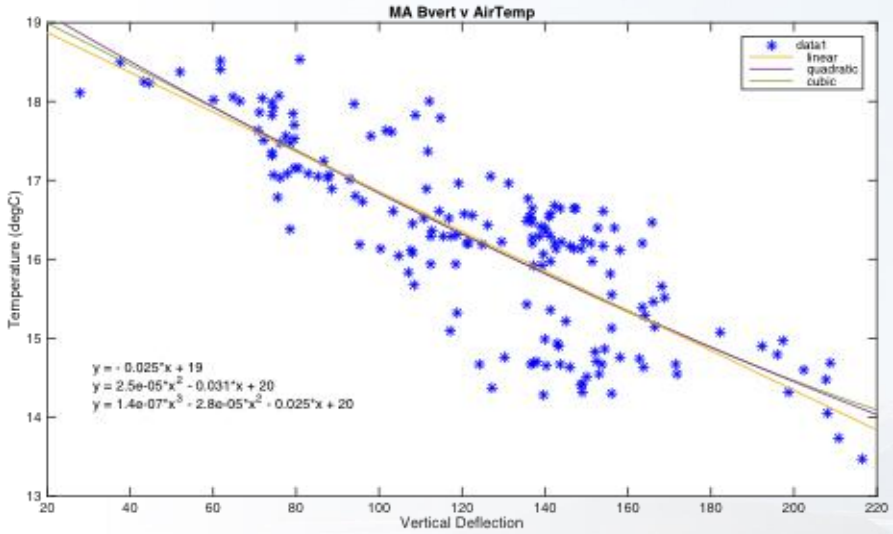


24 hours, A 11 March 2010



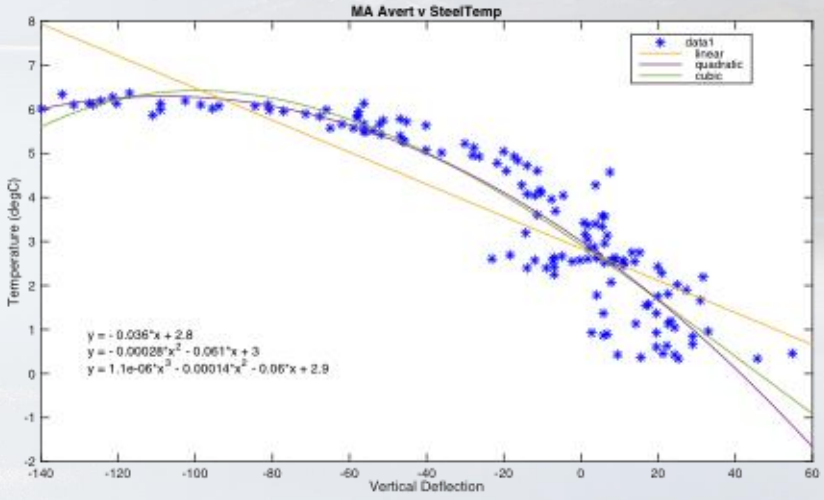
Location B, 2015





2015, Location B, 39 hours

2010, Location A 24 hours



Conclusions

- Clear relationship between temperature changes and vertical deflections
- Due to elongation of the Bridge's steel members
- Could be used in a Structural Health Monitoring model
- Clearance calculations
- Our results; 200mm over 6°C (air), 5°C (steel) changes
- Reality could be up to ~40°C in extremities over the lifetime of the Bridge. Linear this could be 1,300mm

Next Steps

- 4 days of data from 2010 at location B, 2°C to 16°C
- 4 days of data from 2015 at location B', 14°C to 22°C
- Investigate the advantages of multi-GNSS
- Correlate the two pieces of data
- Look at similar trends at the other locations
- Investigate the changes in the Bridge's frequencies with changes in temperature

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