Improving New Zealand's Resilience to Wind Storms

EEA Asset Management Forum, SKYCITY, 19th and 20th June 2018

Presentation Outline

- Overview of wind research being funded through the Natural Hazards Research Platform (NHRP)
- Key findings to date
- Research project proposed for the Government's Resilience to Nature's Challenges (RNC2) associated with improved understanding of wind, snow and ice loading of exposed power transmission and communication towers

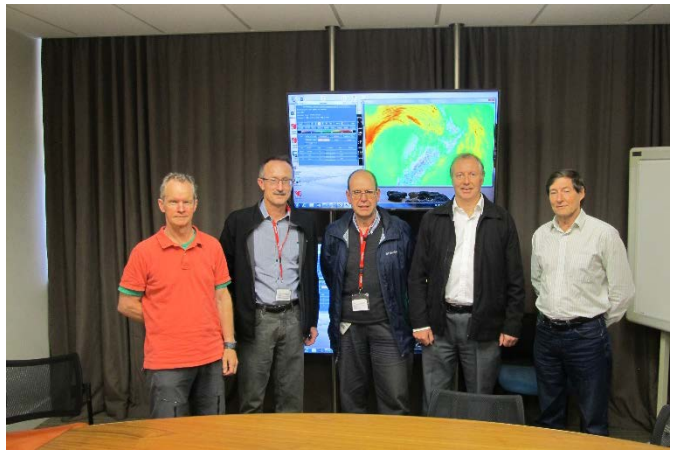
Project

"Tools and knowledge to improve New Zealand's long term resilience to wind storms"

Start Date: 1st January 2016
End Date: 31st October 2019

A four-year research programme funded by MBIE through the NHRP and carried out by the Wind Engineering Consortium comprising wind engineers and weather scientists from:

- WSP Opus
- NIWA
- University of Auckland



Research Goals

Inform and improve:

1. Current procedures for determining design wind speeds
2. Mitigation measures such as land-use planning, building code enforcement and retrofitting
3. Our understanding of how climate change may affect NZ's wind vulnerability so that appropriate actions can be taken to reduce the impact

Key Research Tasks

- Compare wind damage records and full-scale wind speed data with wind speed predictions from state-of-the-art numerical weather modelling
- Evaluate existing and historic full-scale wind data leading to procedures for standardised reporting of wind data
- Engage with the insurance industry and lifeline organisations to promote appropriate recording of wind-related damage
- Assess the potential effects of climate change on extreme wind speeds.

Why the Need?

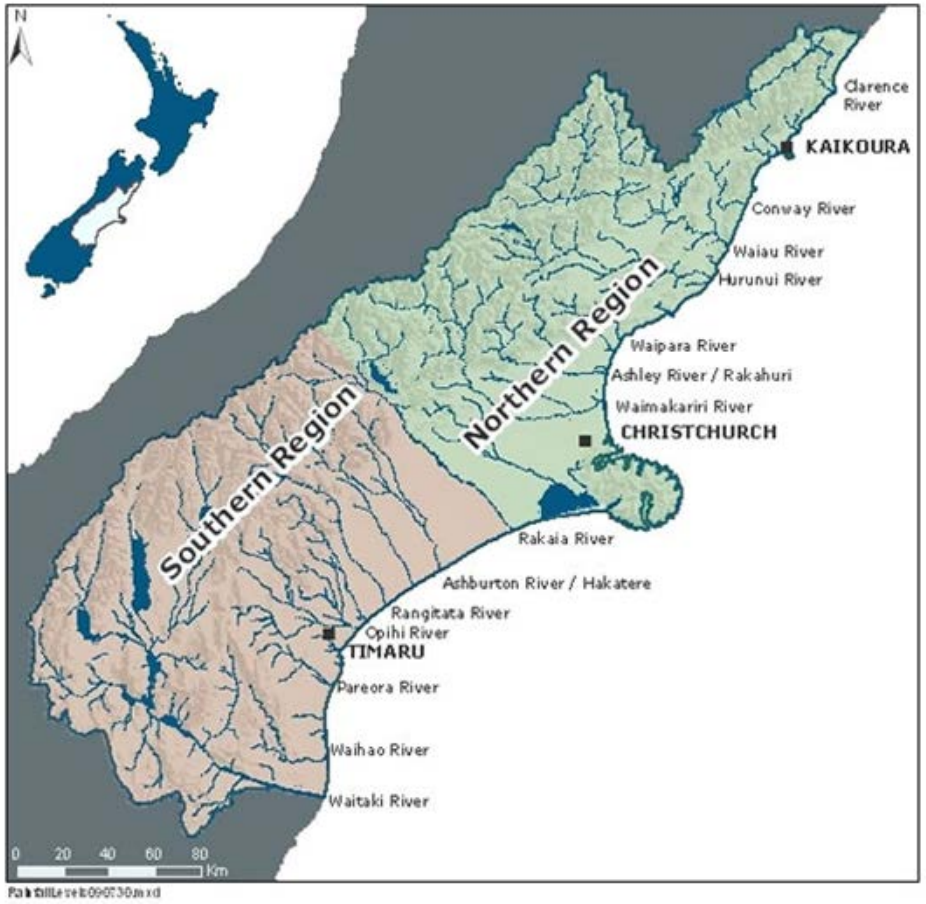
- From 2013 to 2017 insured weather-related losses have cost almost $800m (Source NZ Insurance Council)
- In 2018, losses to date amount to $138.9m comprising:
  - Cyclone Fehi (1 February) $38.5m
  - Ex-tropical cyclone Gita (20 February) $28.3m
  - Destructive winds and tornados Auckland & Taranaki (10-11 April) $72.1m
- Economic losses put at 4 times greater

First stage – modelling past events

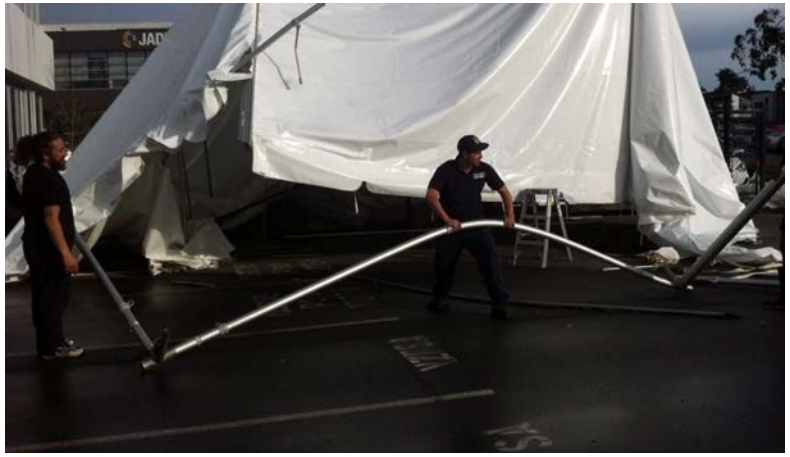
- Wind damage records compared with full–scale wind speed data and wind speed predictions
- NIWA's sophisticated high-resolution weather simulation model called the New Zealand Convective Scale Model (NZCSM) used retrospectively to model wind storms.
- Two storms modelled:
  - Canterbury wind storm (2013)
  - West Coast wind storm (2014)

Canterbury Wind Storm 10-11 September 2013

- Worst storm since 1975
- Extreme NW downslope winds
- Wind speeds at Mt Hutt 200km/h+
- Widespread damage & disruption
- 800+ irrigators damaged
- Power cut to 40,000 homes
- Schools closed
- Water supplies disrupted
- Sewage stations out of action
- Lightning strikes and downed power lines started fires
- Insured Costs - $68M+, Uninsured costs - $????



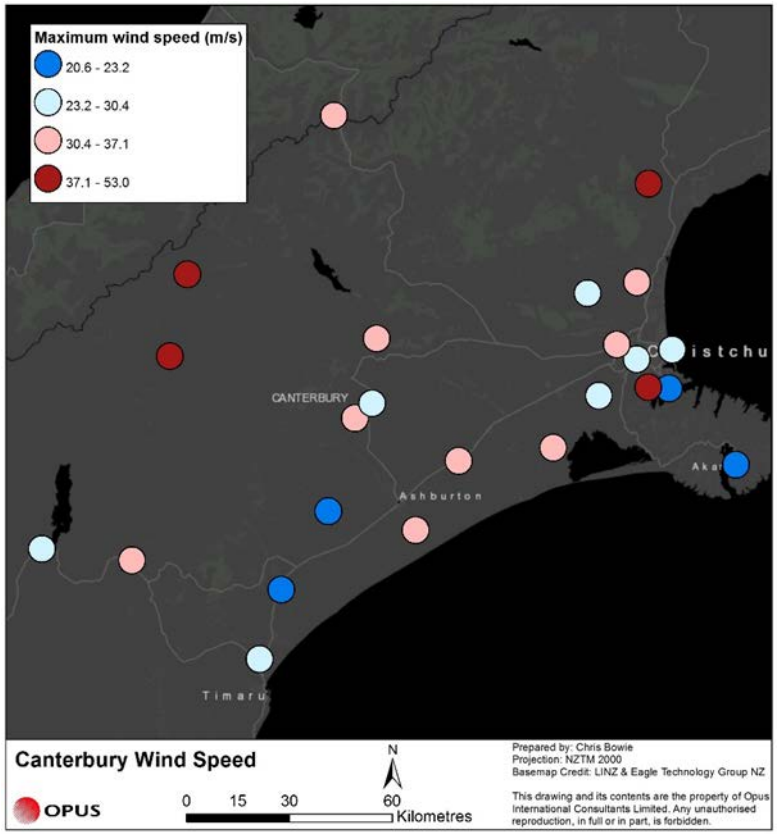
Canterbury Wind Storm 10-11 September 2013

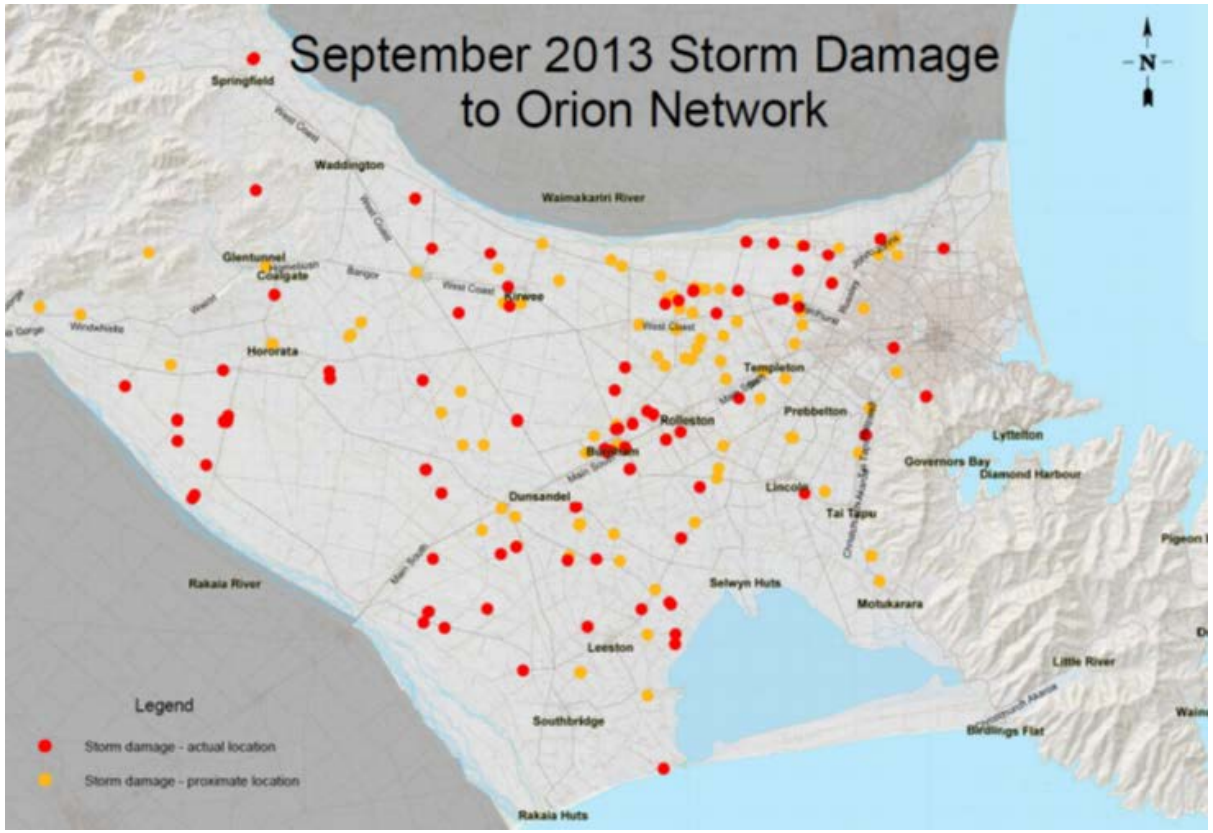


Canterbury Wind Storm 10-11 September 2013

Canterbury Wind Storm 10-11 September 2013

Wind speed and damage records collected by NIWA with help from insurance companies

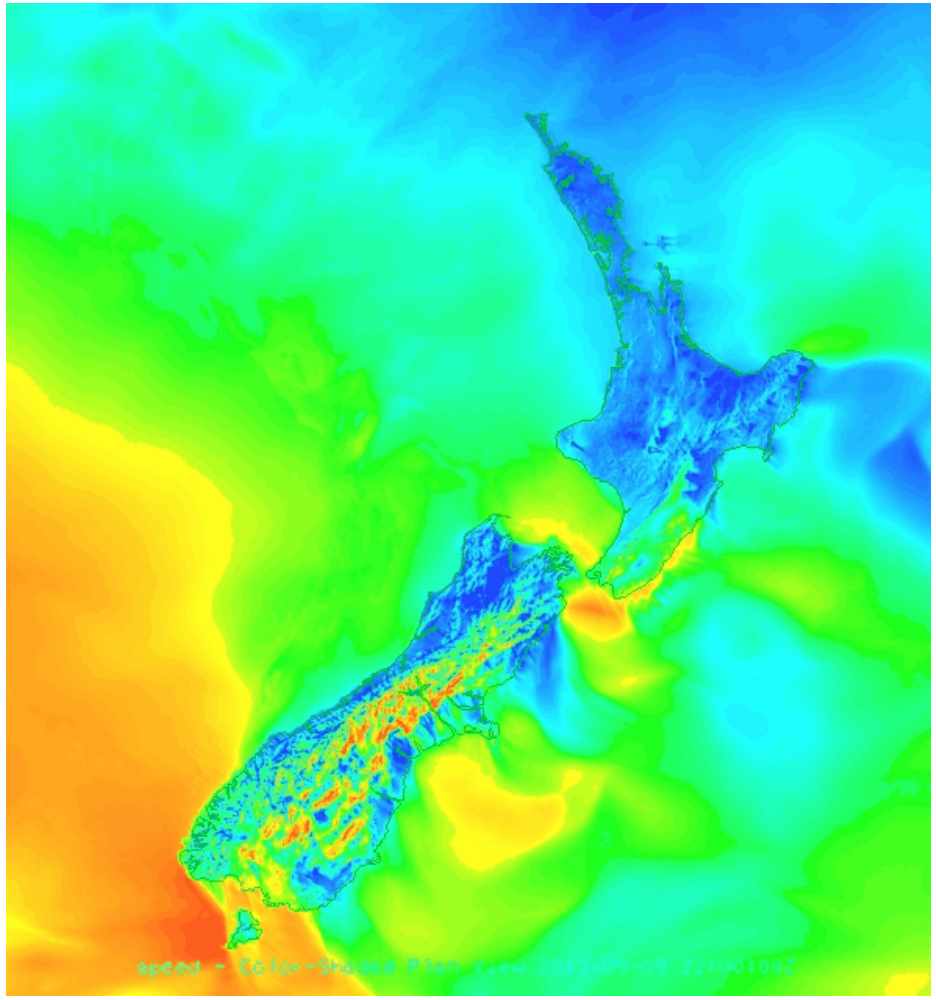




Modelling Storm Events with NZCSM

- NZCSM is a local configuration of UK Met Office Unified Model
- Developed and tested by NIWA and international collaborators
- Forecasts weather over NZ and surrounding ocean from ground level up to 40km every 6 hours
- Mean speed at 133m a.g.l found to be a good proxy for gust speeds at 10m

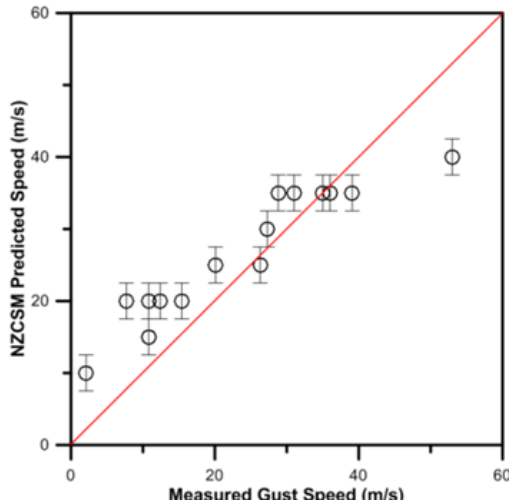
NZCSM: 10-11September 2013 Canterbury Storm

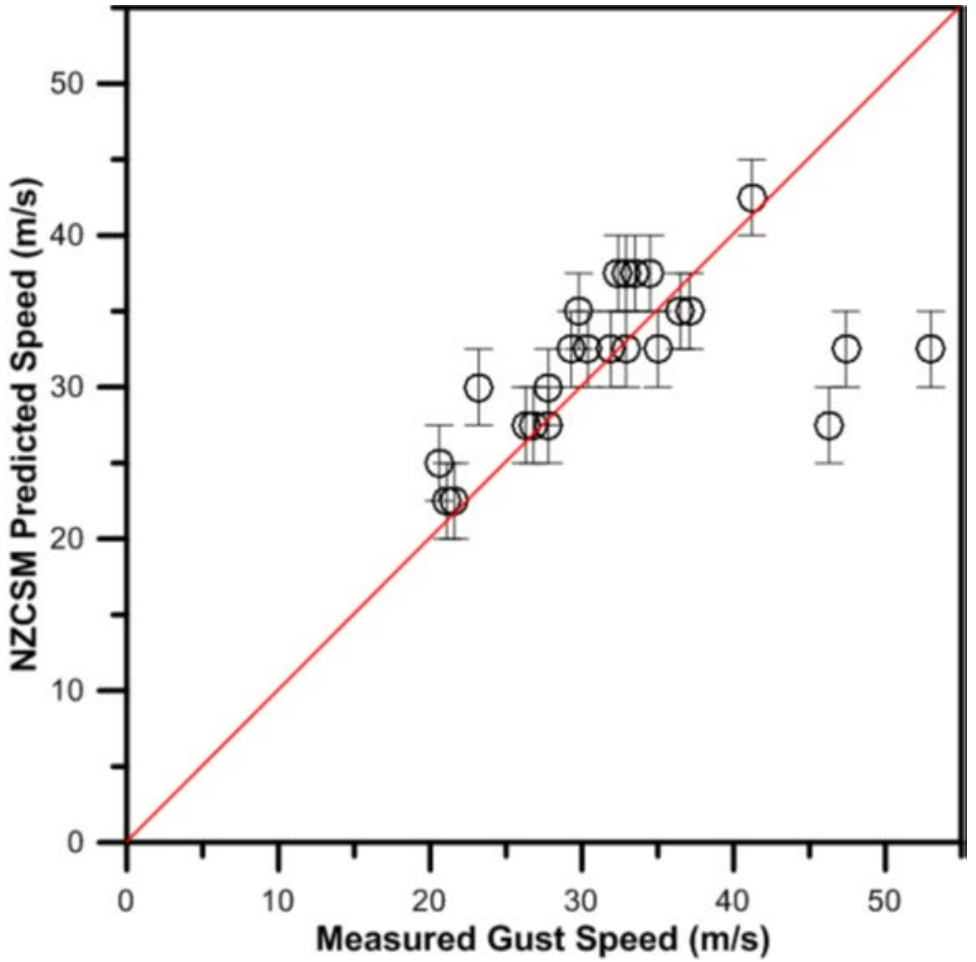


NZCSM: 10-11September 2013 Canterbury Storm

Comparison of measured gust speeds and NZCSM predictions:

- Generally good agreement
- NZCSM under-predicted highest wind speeds
- Similar results for 17 April 2014 West Coast wind storm

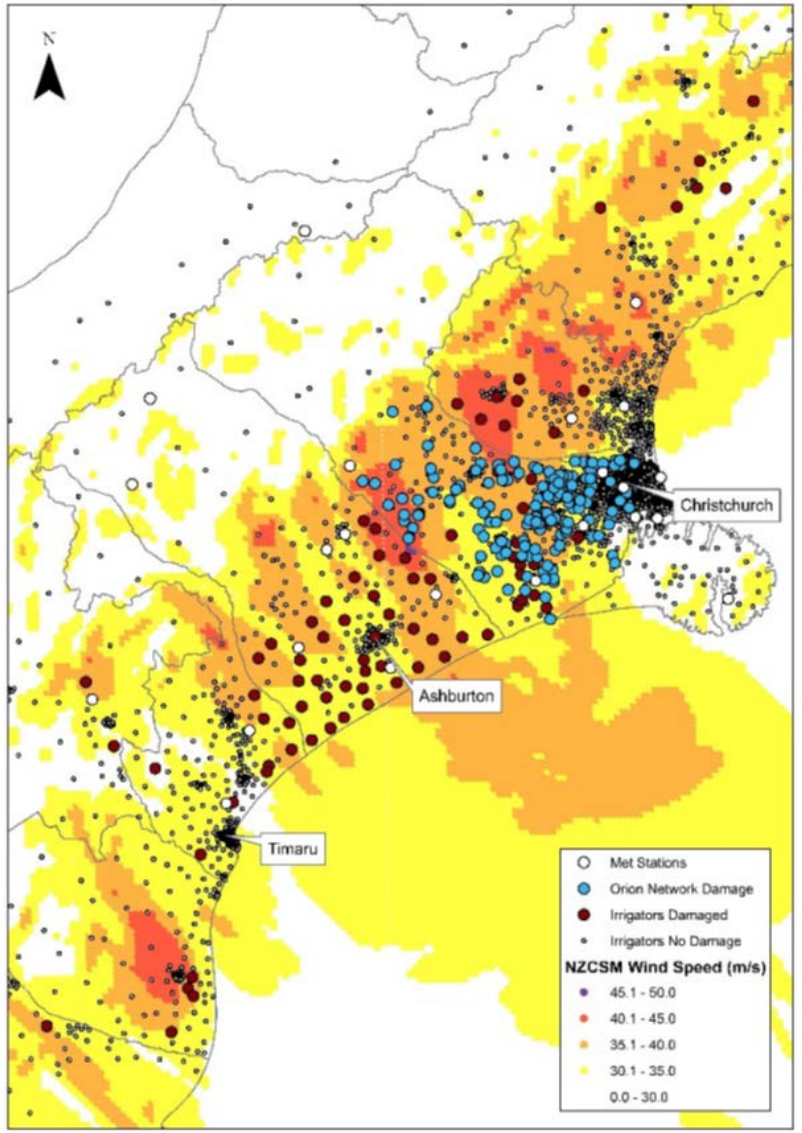




Correlation with Wind Damage

Irrigator Damage

- Most damage in areas with predicted gusts >30m/s
- Clusters of damage where predicted gusts >40m/s
- Current limitations in:
  - determining exact position of irrigators
  - determining number of irrigators in a mesh block area
  - identifying where measures were taken to protect them



Key Findings Regarding NZCSM

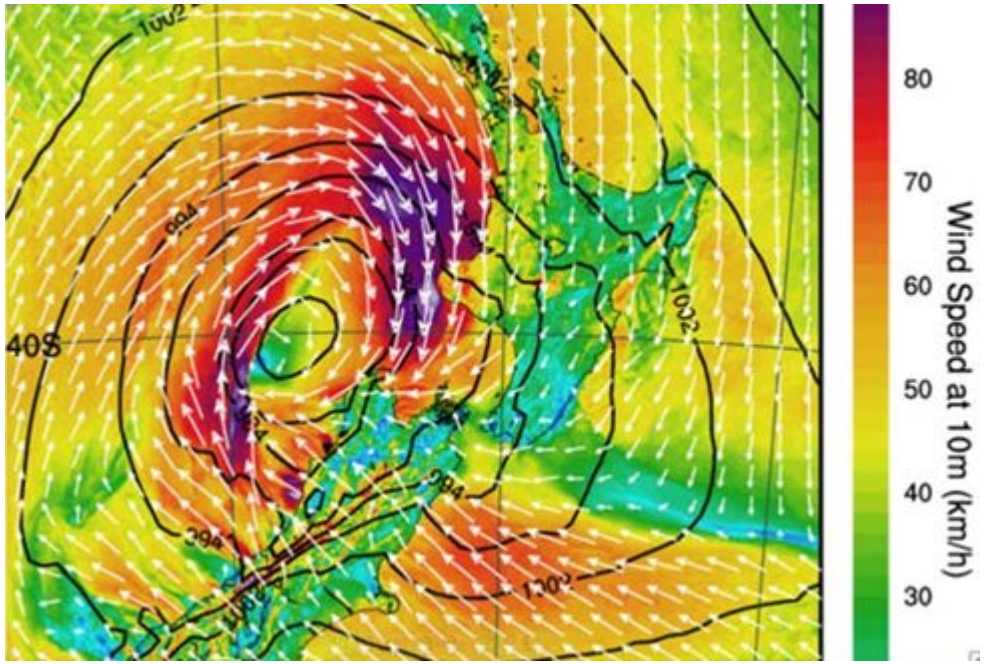
- Good agreement between full-scale wind speeds and the wind speeds predicted by NZCSM provided a degree of confidence that NZCSM was suitable for wider application across New Zealand.
- Greater wind damage usually occurred in areas where the model predicted higher winds speeds suggesting that NZCSM could have a role in early warning of areas likely to be at greater risk of wind damage as a wind storm approaches.
- Has a clear role in improving NZ design wind speed maps by enabling greater spatial definition.

More recent applications of NZCSM (1)

Ex-tropical cyclone Gita, 20th February 2018:

Screen shot of NZCSM predicted mean winds (purple areas are sustained at around 100 km/h) for around 5 pm tomorrow (Tues 20 Feb) .

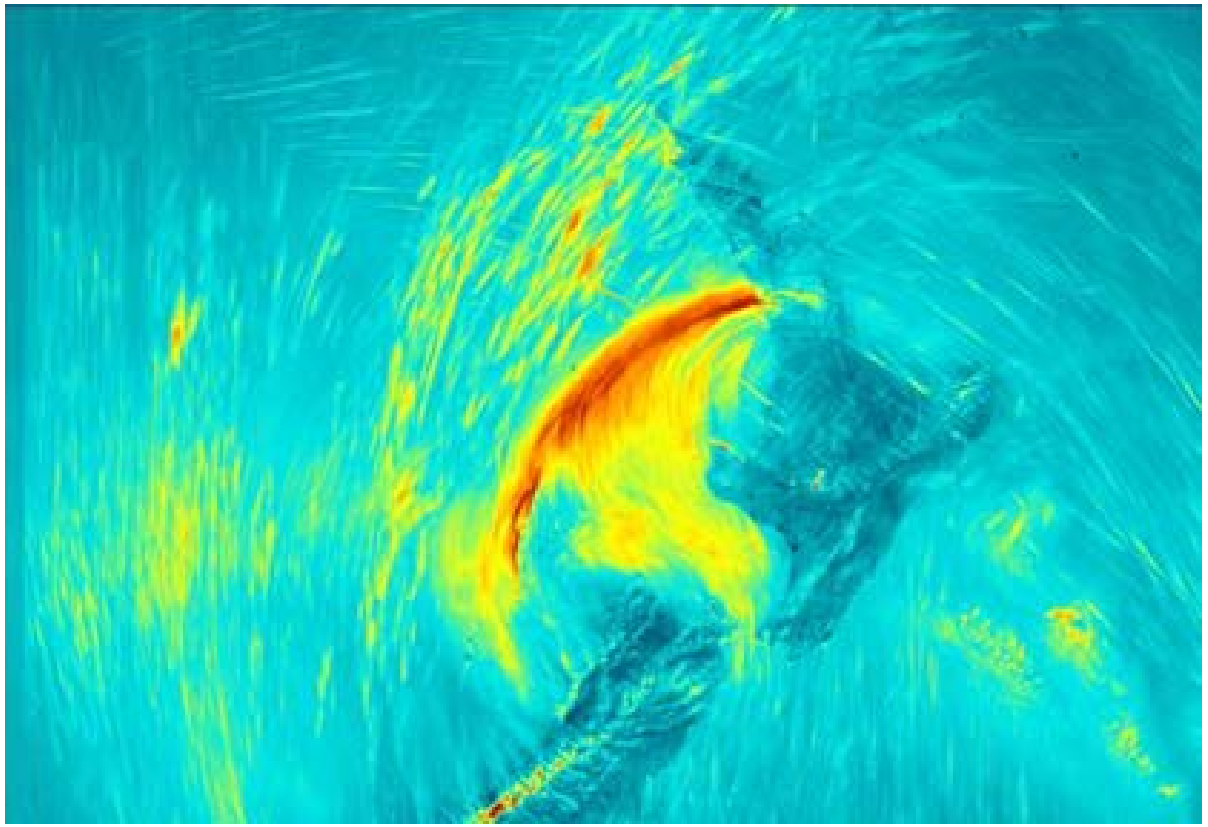
Taranaki, West Coast SI (lee), and Tasman and West Coast of lower NI look to get the worst winds.



More recent applications of NZCSM (2)

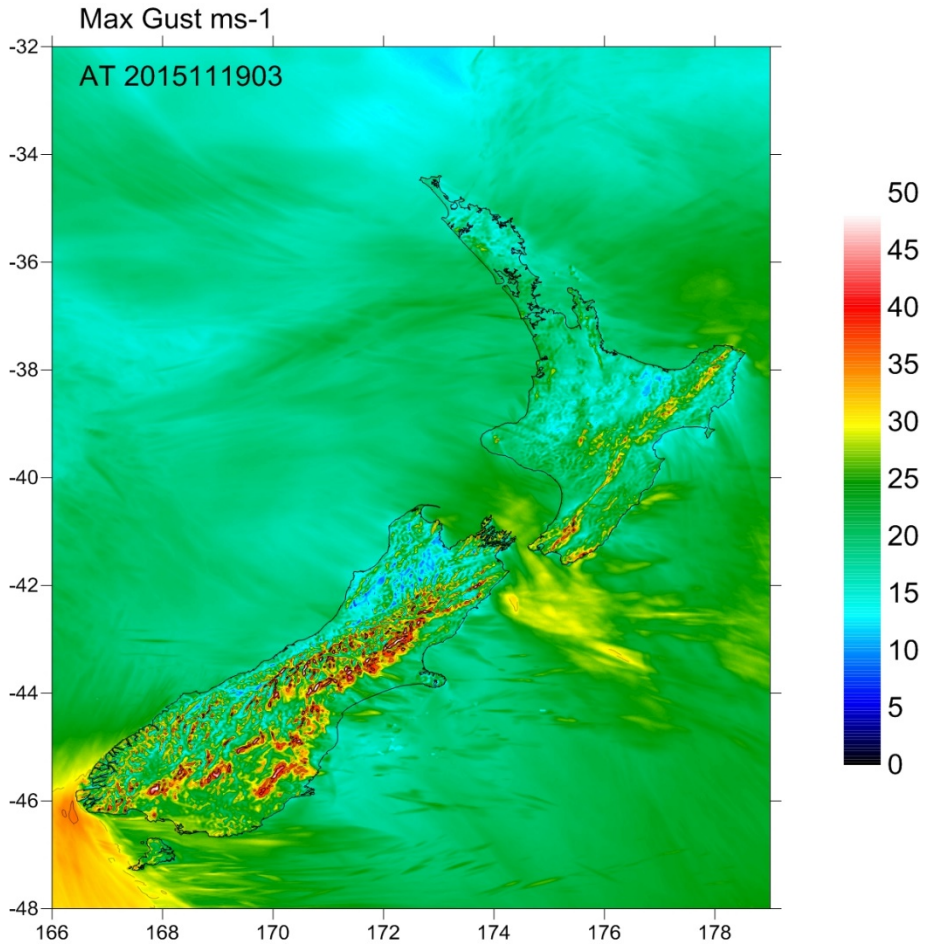
10-11 April 2018 Devastating Winds and Tornadoes

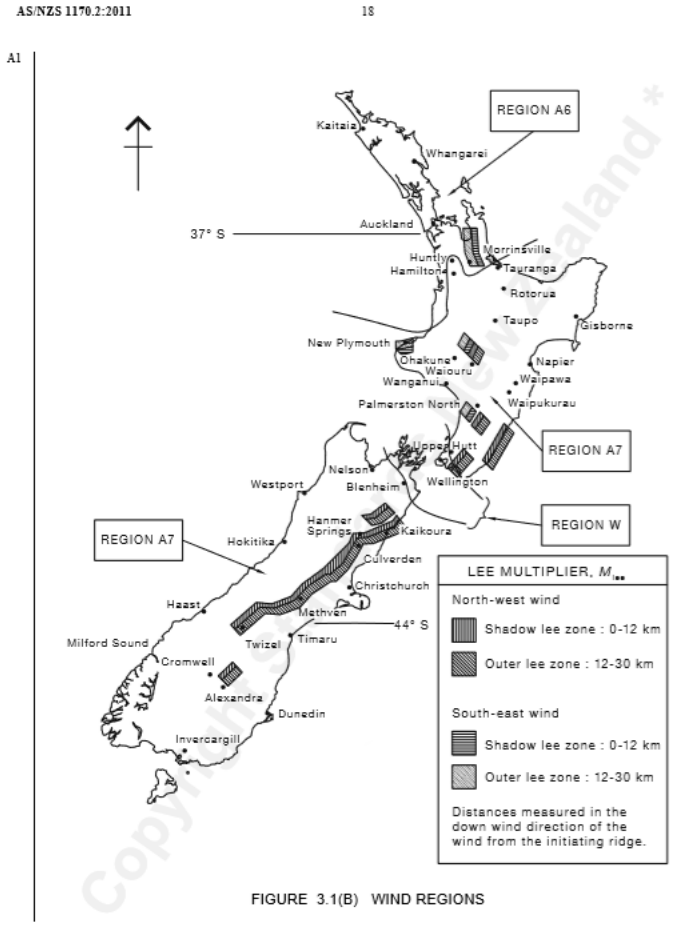
NZCSM has calculated the location of the strong wind band accurately



NZCSM Modelling – Lee Zones

- High – resolution modelling of all lee-events for the 4 years since April 2014 has been completed
- Key milestone and underpins a currently underway review of AS/NZS 1170.2 lee-zone boundaries





RNC2: Weather Sub-theme

Objective:

“To develop fine-scaled physical hazard datasets of extreme weather events over time and scales not previously available and use these in combination with scenarios selected to quantify the multi-component impacts (wind, flood, snow/ice, landslides etc.) on communities, infrastructure and economic activity from typical high-impact weather."

Candidate three scenarios are:

- A major ex-tropical cyclone hitting the city of Auckland, rural Northland and the Coromandel Peninsula
- A major storm in the lower South Island (wind, snow and icing)
- Flash-flooding and wildfire exacerbated by pre-existing drought

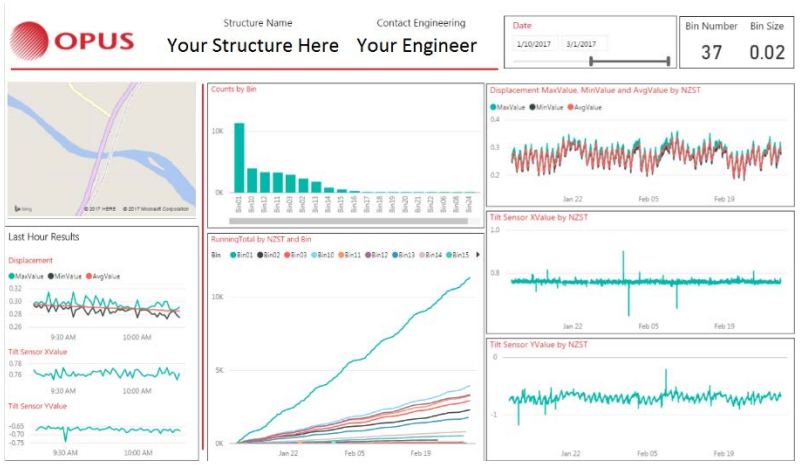
RNC2: Proposed Research Project

Measured and Calculated Response of Exposed Power Transmission and Communication Towers

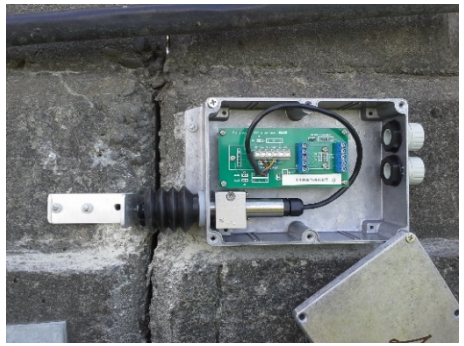
- Will inform winter storm scenario
- Selected towers in exposed locations instrumented to record their response to wind and wind and ice loading
- Acquired data used to identify:
    1. Design weaknesses in towers
    2. Deficiencies in existing wind/ice loading provisions of AS/NZS 1170:2. Particular emphasis on towers located in mountainous terrain and close to open bodies of water

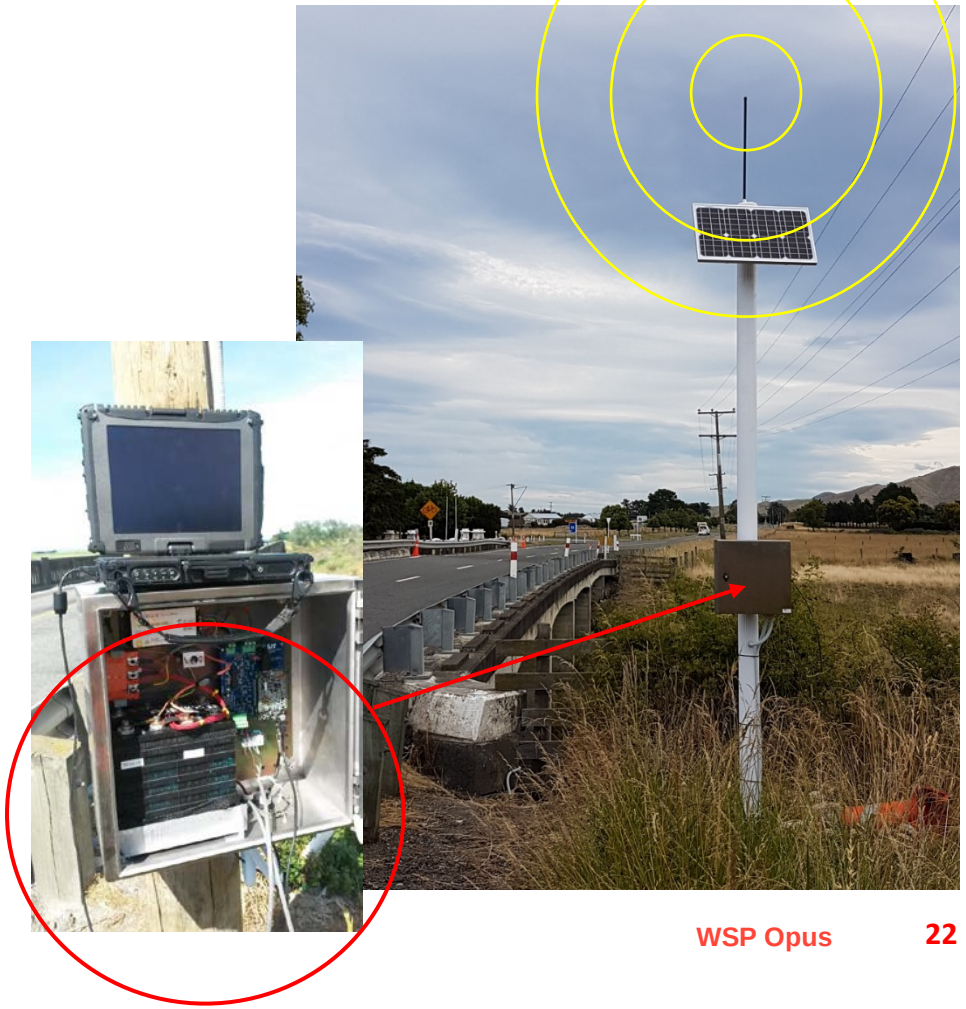
RNC2: Proposed Research Project

Will employ remote infrastructure monitoring instrumentation developed in-house by WSP Opus



- Accelerometers
- Strain gauges
- Tilt sensors
- Displacement transducers
- Crack sensors
- Wind speed/direction
- Temperature





How can EEA members assist?

- Contribute to the experimental design (to best address your weather related issues)
- Provide support in kind (letters of support, access to towers, existing tower response data etc.)
- Accurate records of when and where tower failures occur and the mode of failure

Thank you for your attention!

Contacts:

NZCSM:

Dr Richard Turner, NIWA (Richard.Turner@niwa.co.nz)

RNC2 Tower Research Project:

Peter Cenek, WSP Opus (peter.cenek@wsp-opus.co.nz)

Neil Jamieson, WSP Opus (neil.jamieson@wsp-opus.co.nz)