FIG WORKING WEEK 2017
Helsinki Finland
29 May - 2 June 2017

New Zealand's Long Term Tide Gauge Record and the effect of Seismically Induced Vertical Land Motion

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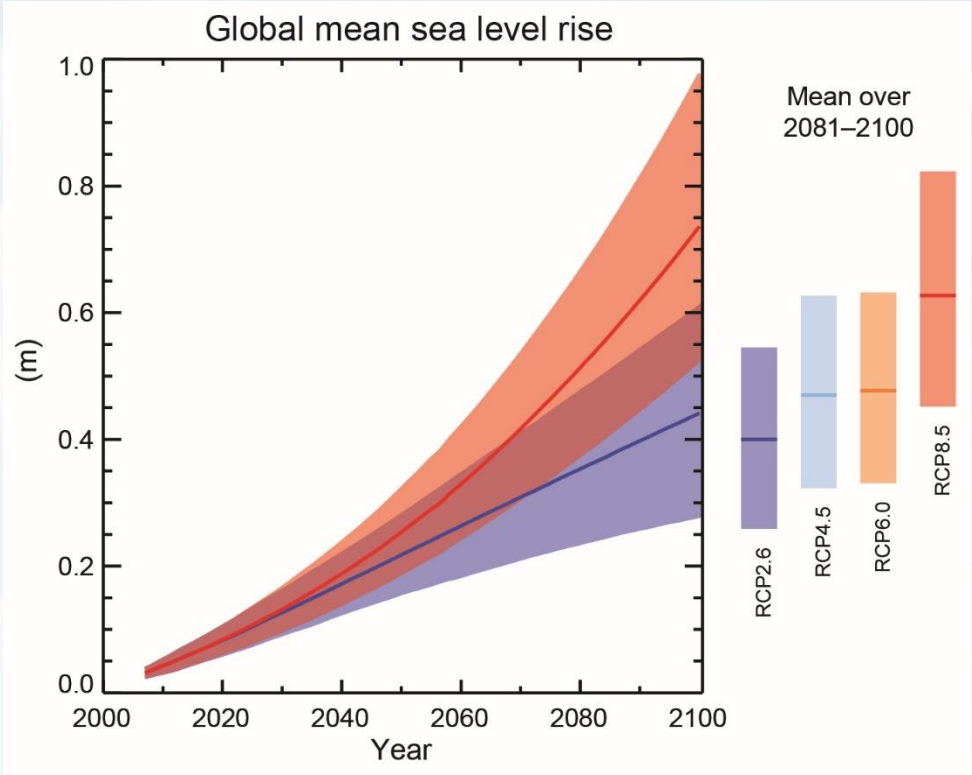
The IPCC Assessment



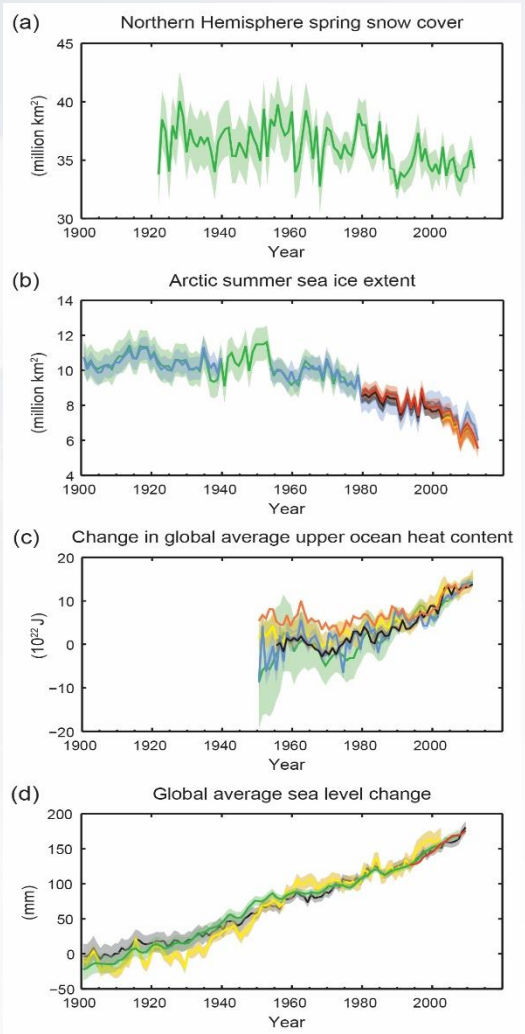
Source: IPCC (2013)

Snow cover

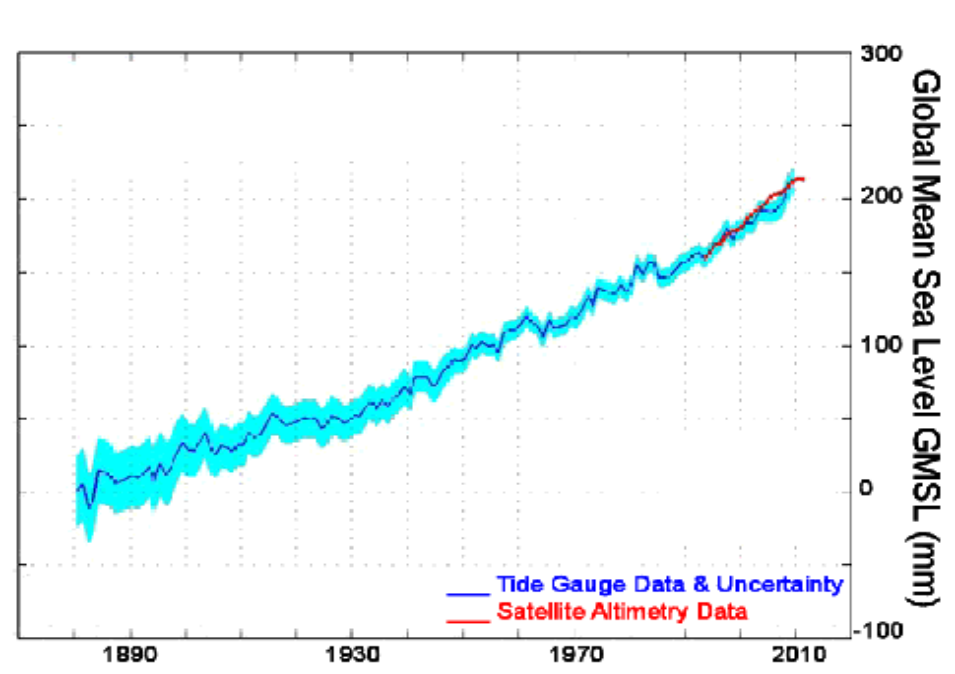
Ice extent

Ocean heat content

Sea level change



Rising global sea levels



Source: Church & White (2011)

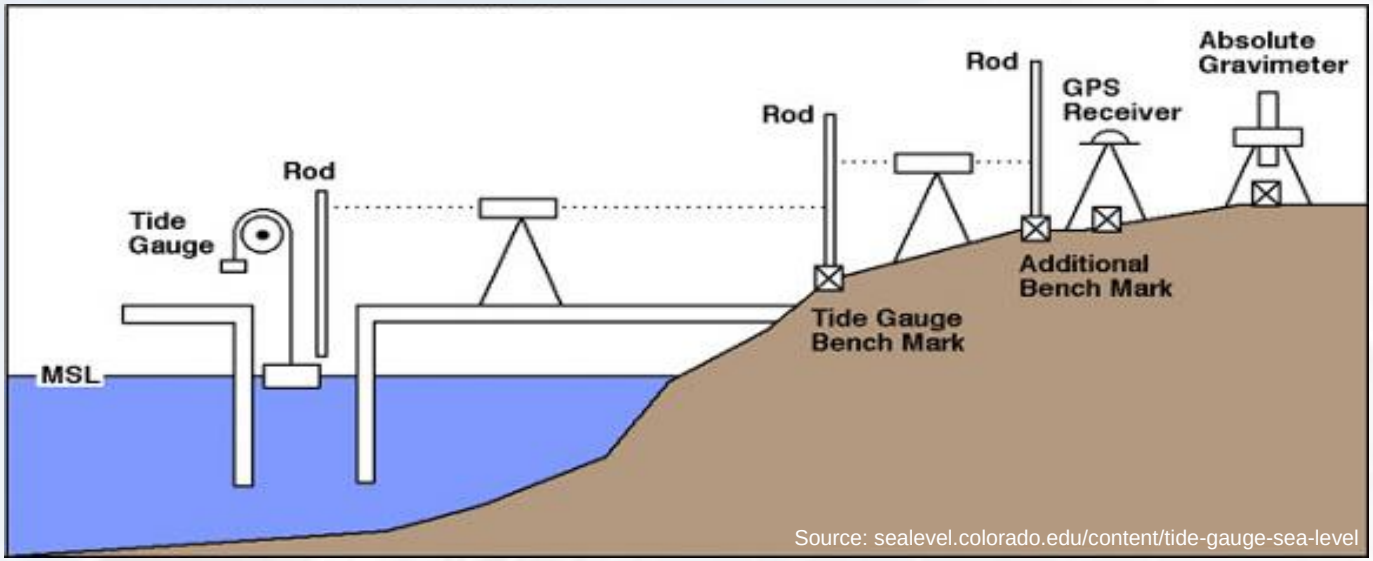
Globally distributed tide gauge data

Average since 1880 : **+1.7 ± 0.3mm/yr**

GSL has risen ~20cm during the C20th

Global Network of Tide Gauges

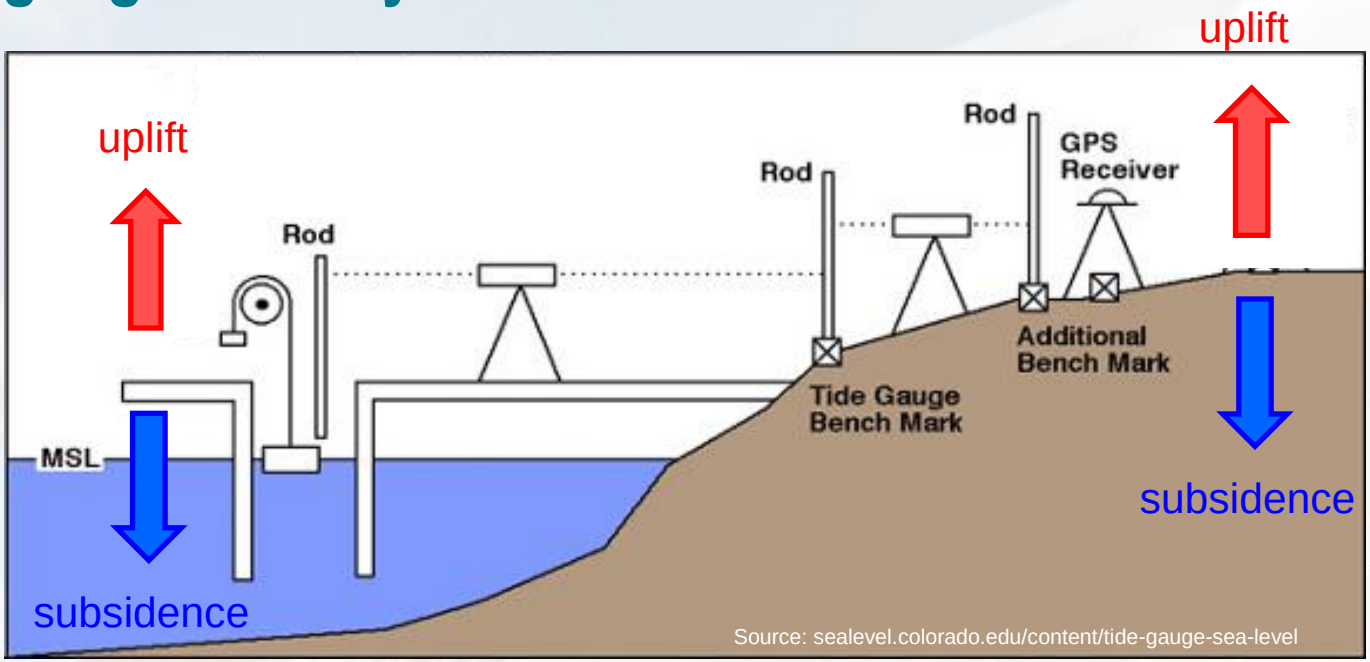
Tide gauge measurement system



The global network of tide gauges is a poorly distributed sea level measurement system

But, it offers the only source of historical, precise, long-term sea level data

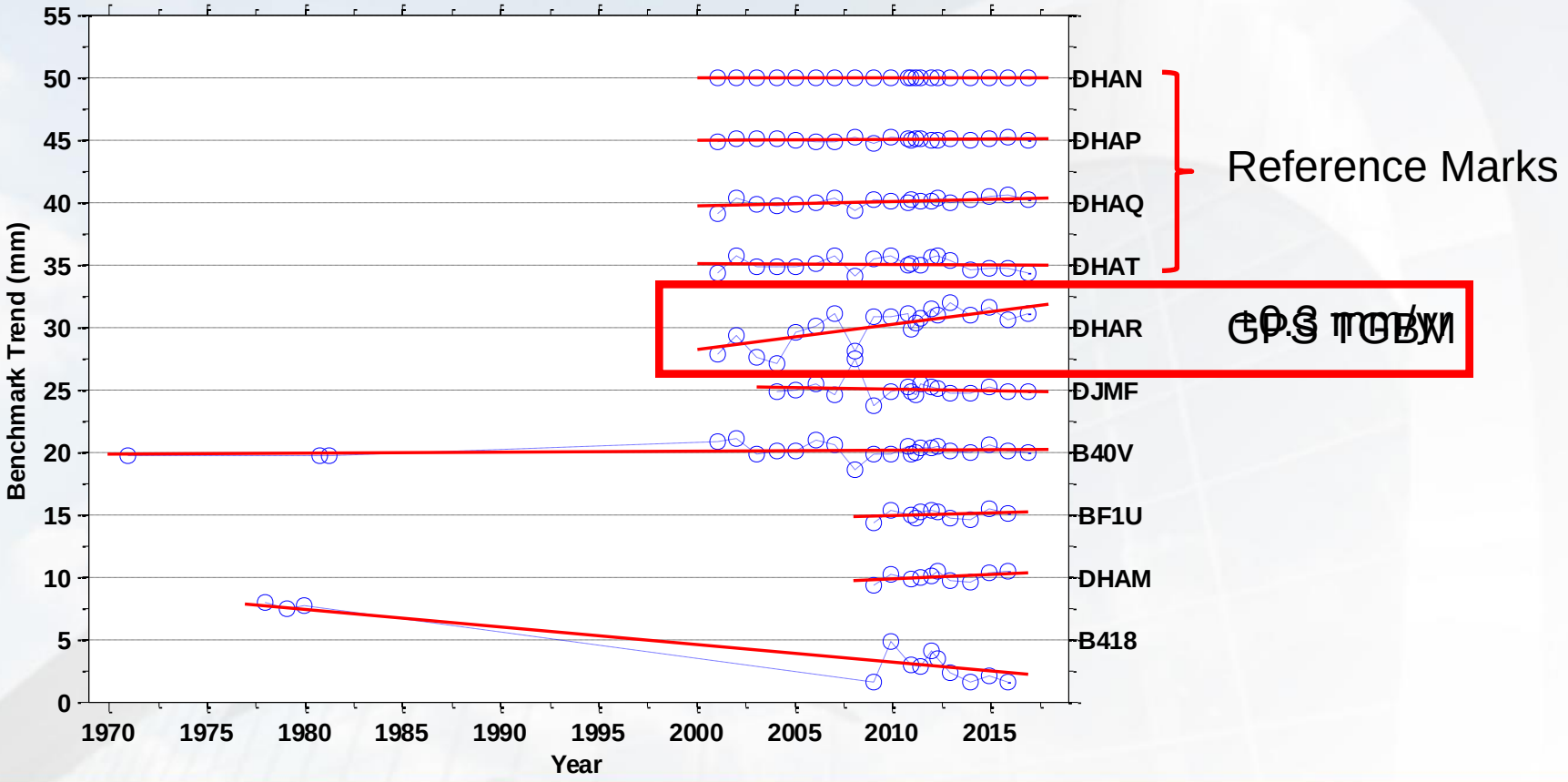
Tide gauge stability



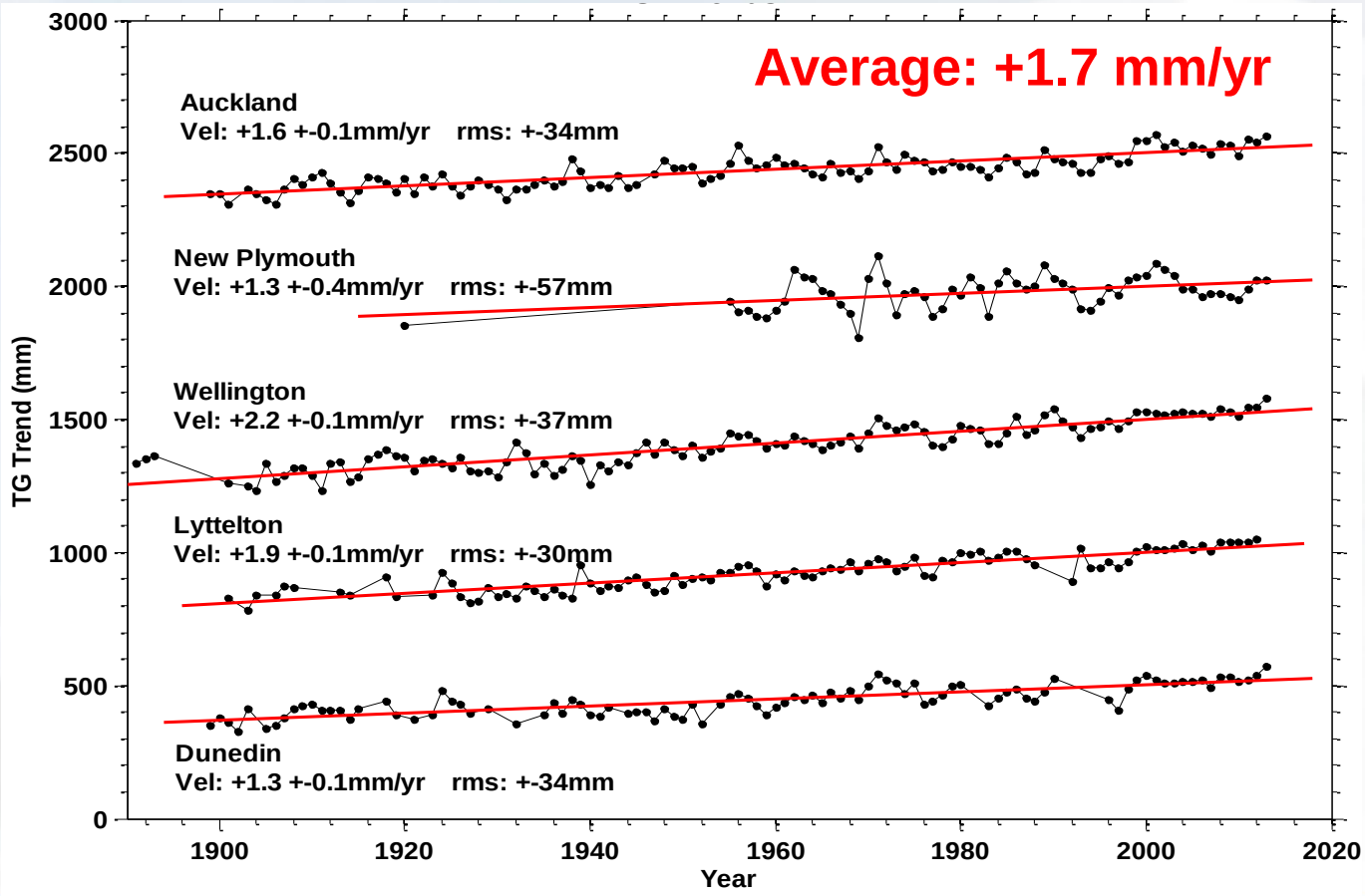
Levelling : local stability of the tide gauge structure

cGPS : regional stability

Lyttelton – Local stability levelling network



Relative sea level trends - NZ



Port environments – *challenging*

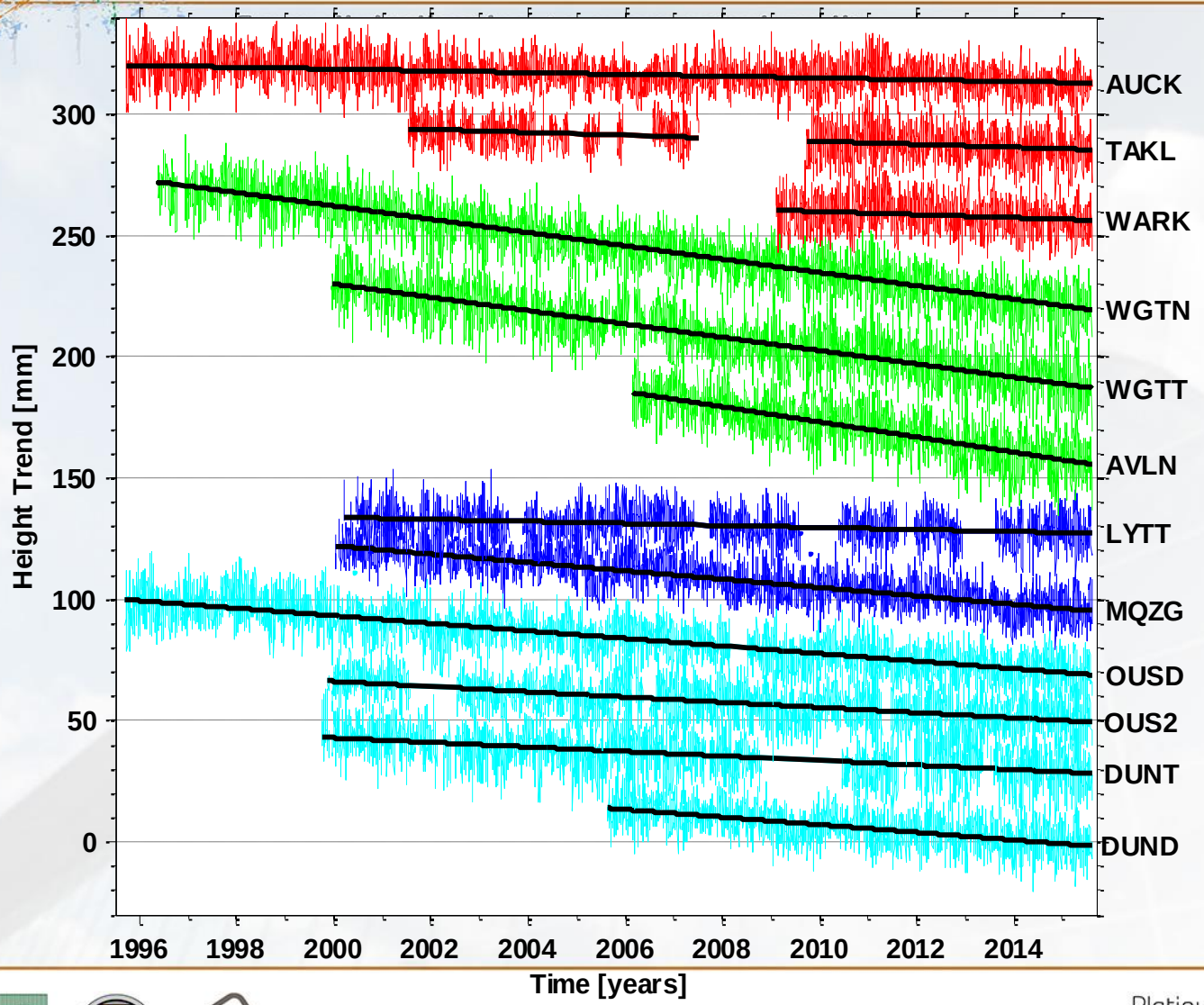
- GPS/GNSS often established in poor environments
  - High rise building
  - Topography e.g. volcanic crater
  - Reclaimed land → compaction
  - Wharf stability e.g. wooden
  - Port operations
  - Port construction

- Conflicting requirements
  - Unobstructed sky visibility and stability/bedrock

Auckland CDB

Port Lyttelton

GPS height time series



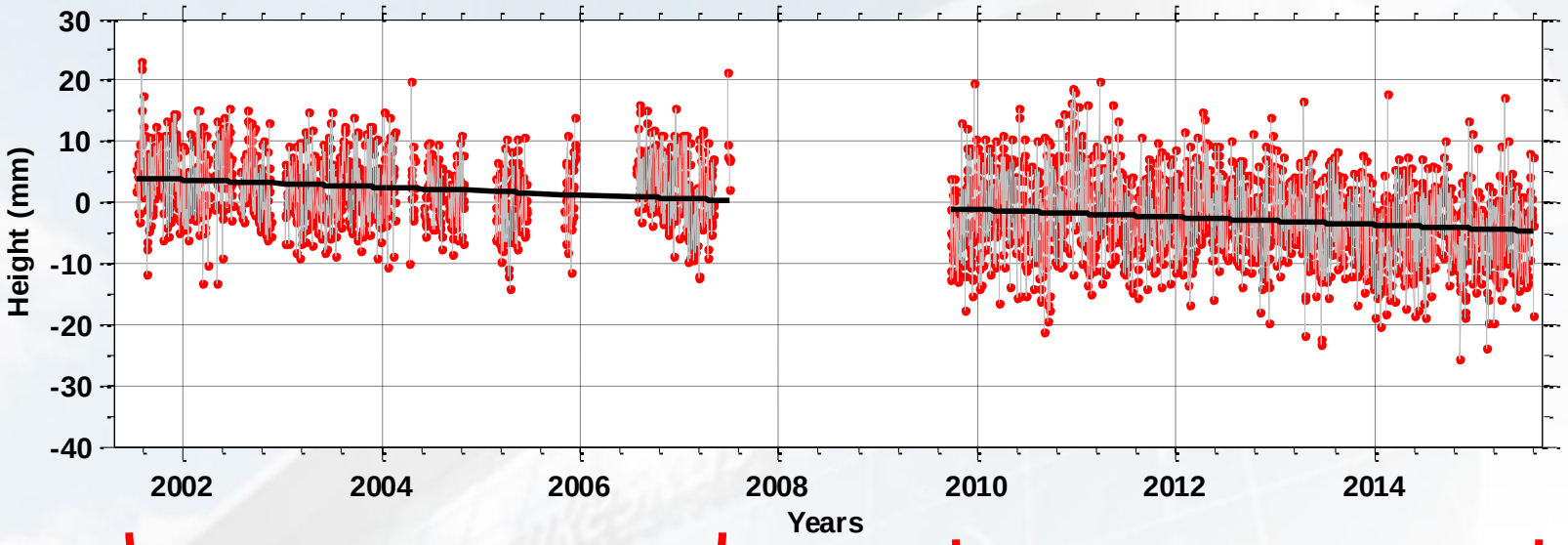
Auckland
-0.6 mm/yr

Wellington
-3.0 mm/yr

Lyttelton
-0.5 mm/yr
-1.4 mm/yr

Dunedin
-1.0 mm/yr

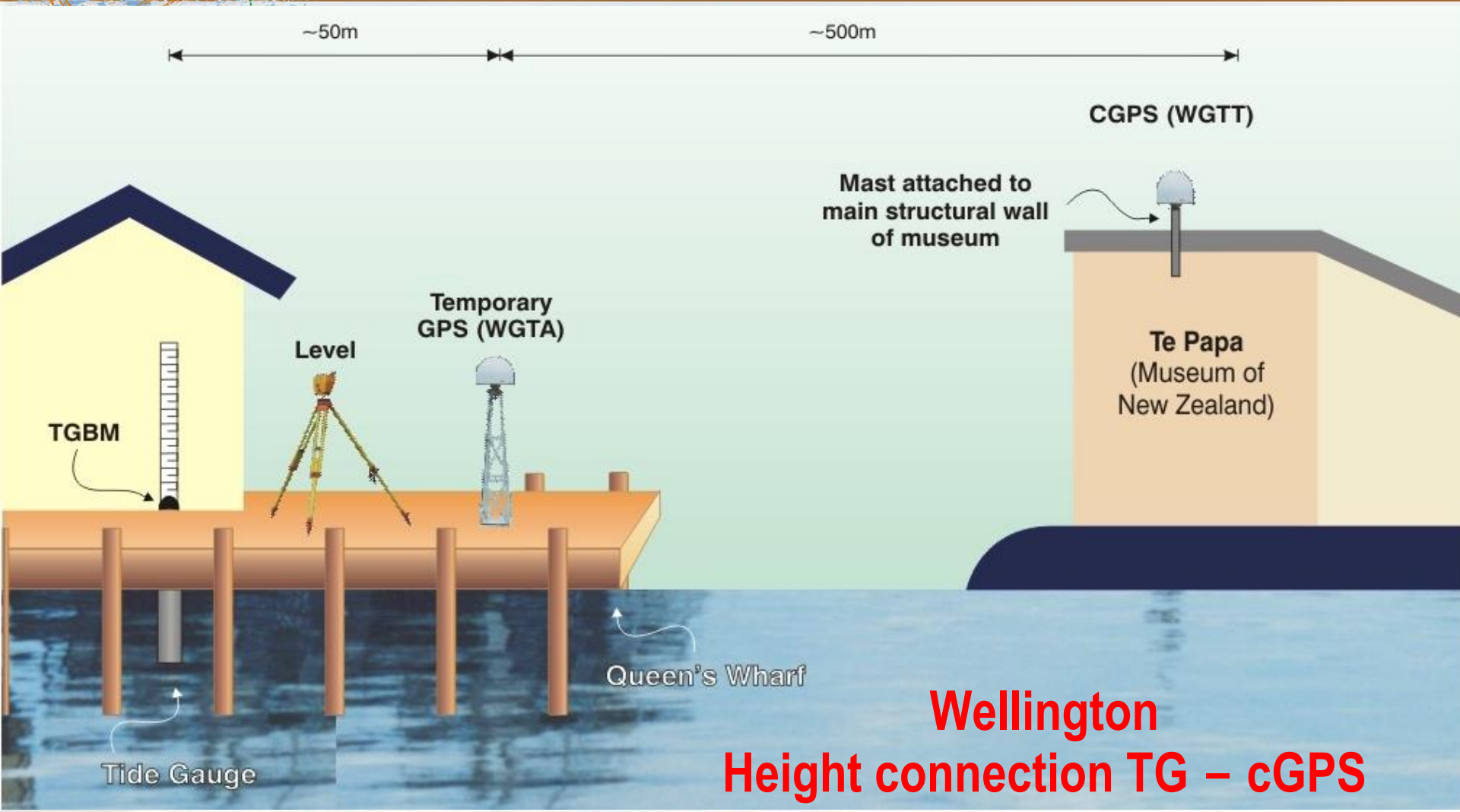
Auckland : cGPS replaced



TAKL: v_H = -0.54 mm/yr

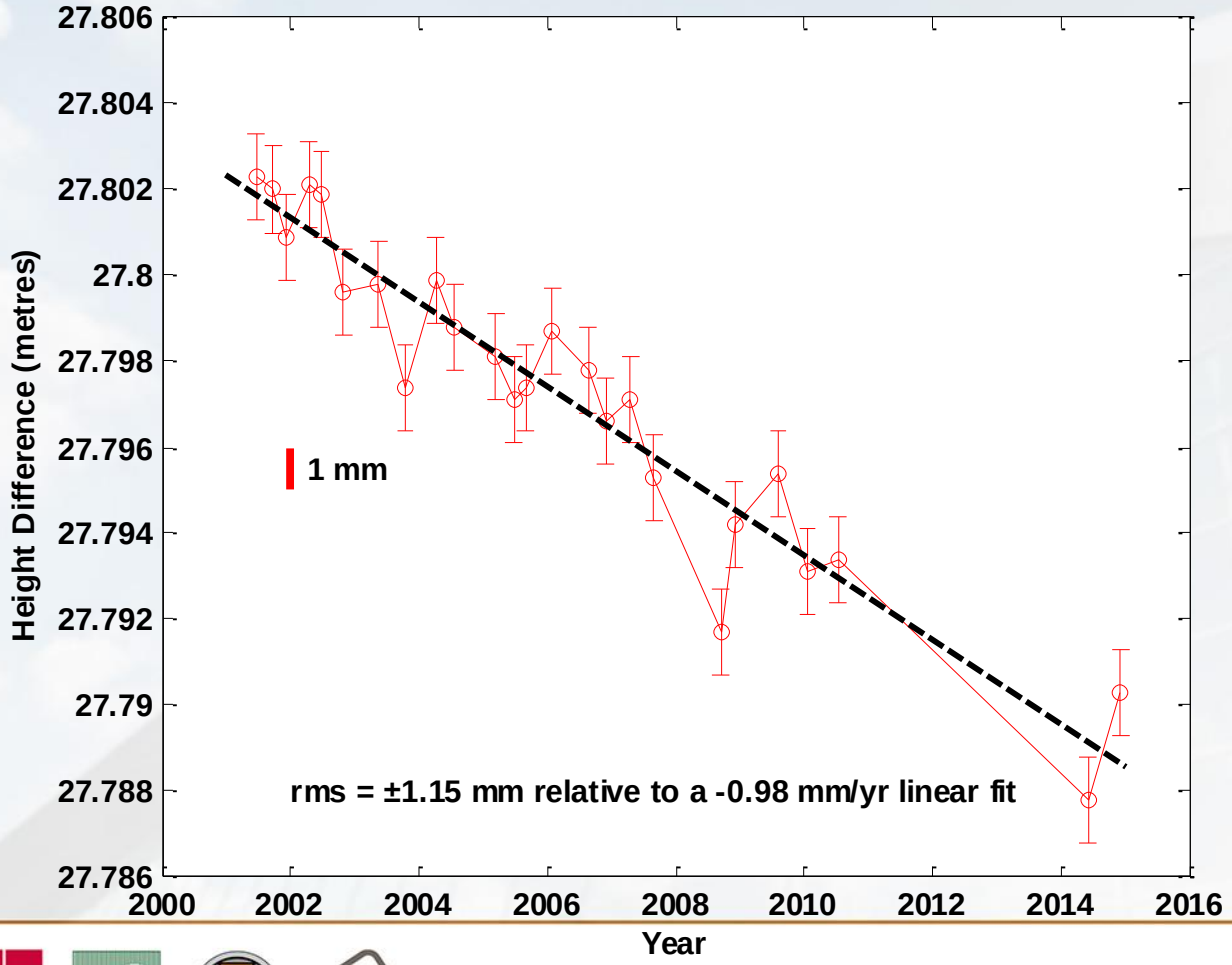
AUKT: v_H = -0.63 mm/yr

TAKL + AUKT: v_H = -0.62 mm/yr



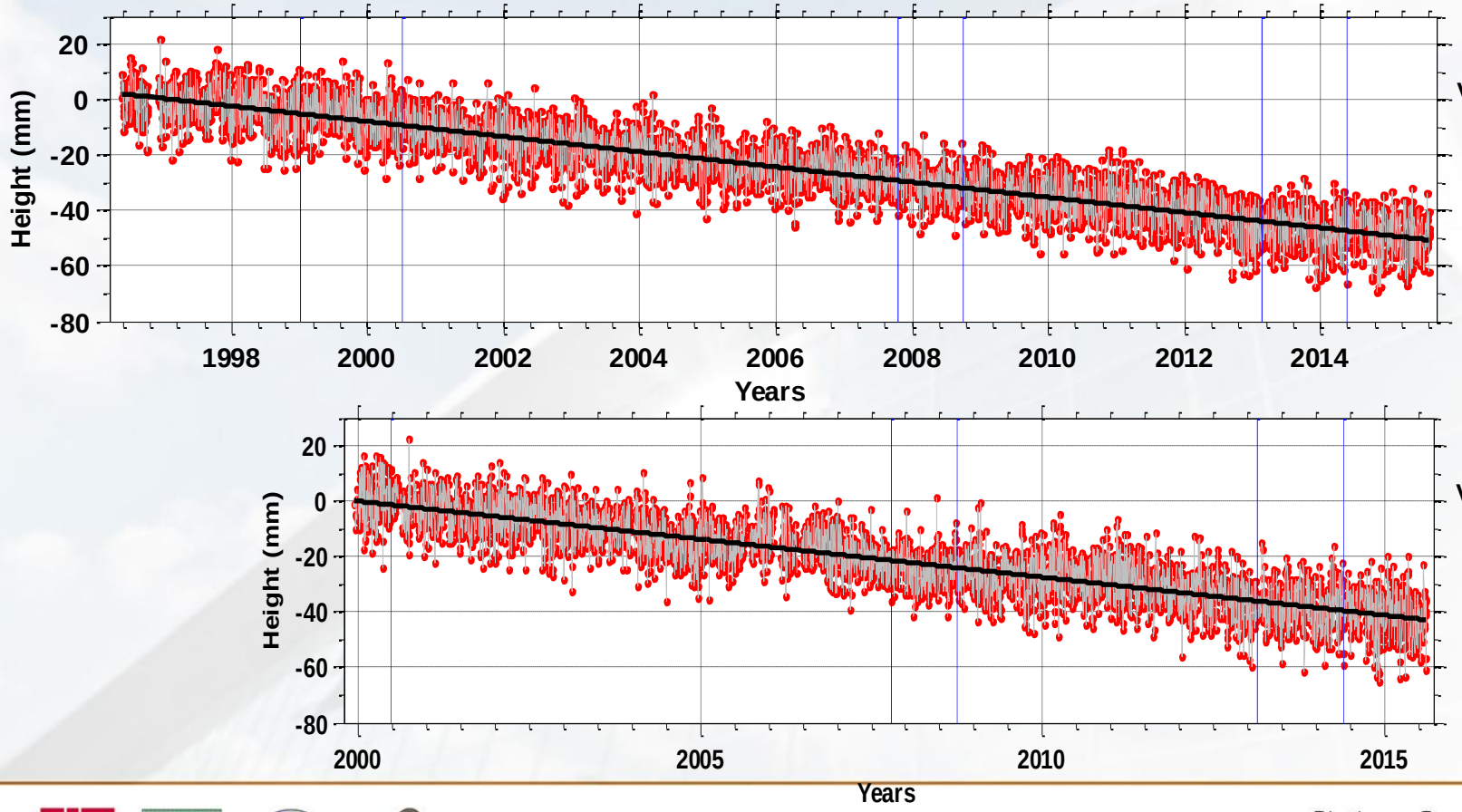
Wellington
Height connection TG – cGPS

Wellington – Height connection TG – cGPS



cGPS	-3 mm/yr
Hgt Diff	+1 mm/yr
TG	-2 mm/yr

Wellington – Vertical trend

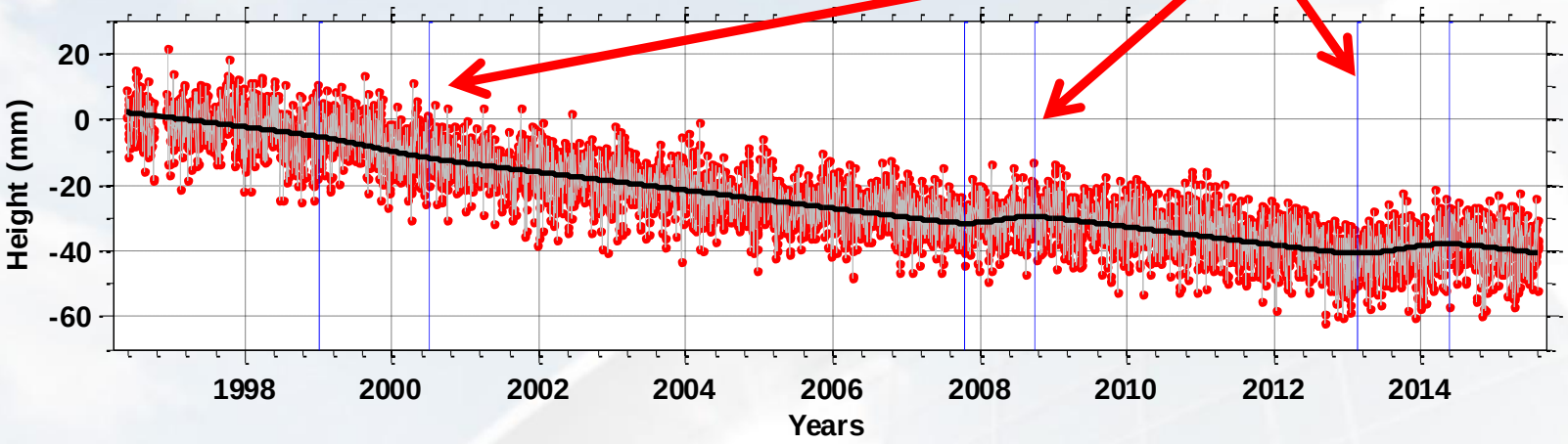


WGTN
v_H= -2.9 mm/yr

WGTT
v_H= -3.1 mm/yr

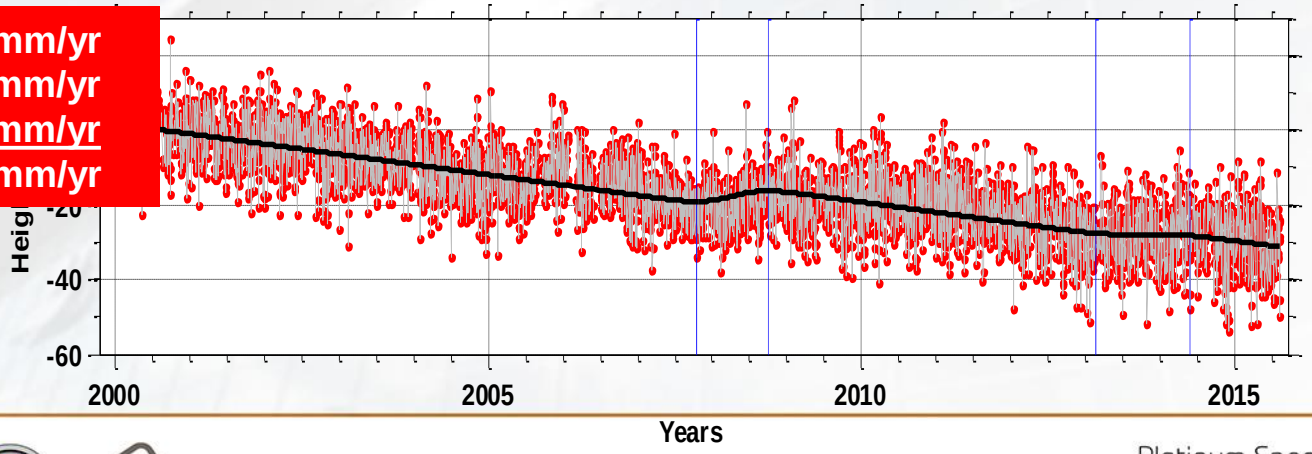
Wellington – Slow Slip Events

Kapiti Coast slow slip events



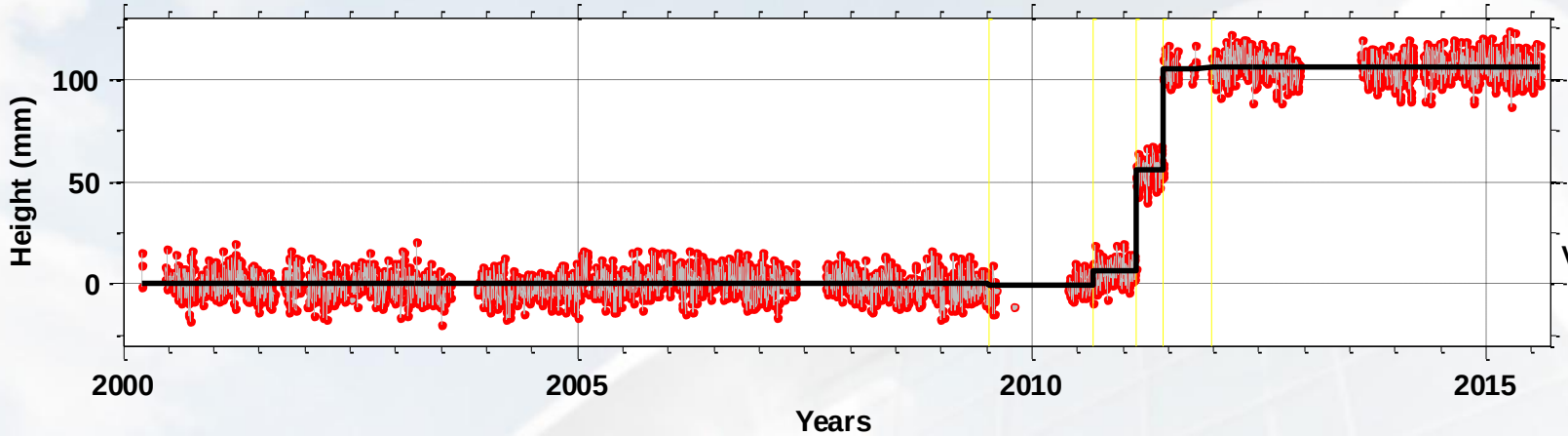
WGTN
+16.5 mm

cGPS	-3 mm/yr
Hgt Diff	+1 mm/yr
SSE	+1 mm/yr
TG	-1 mm/yr

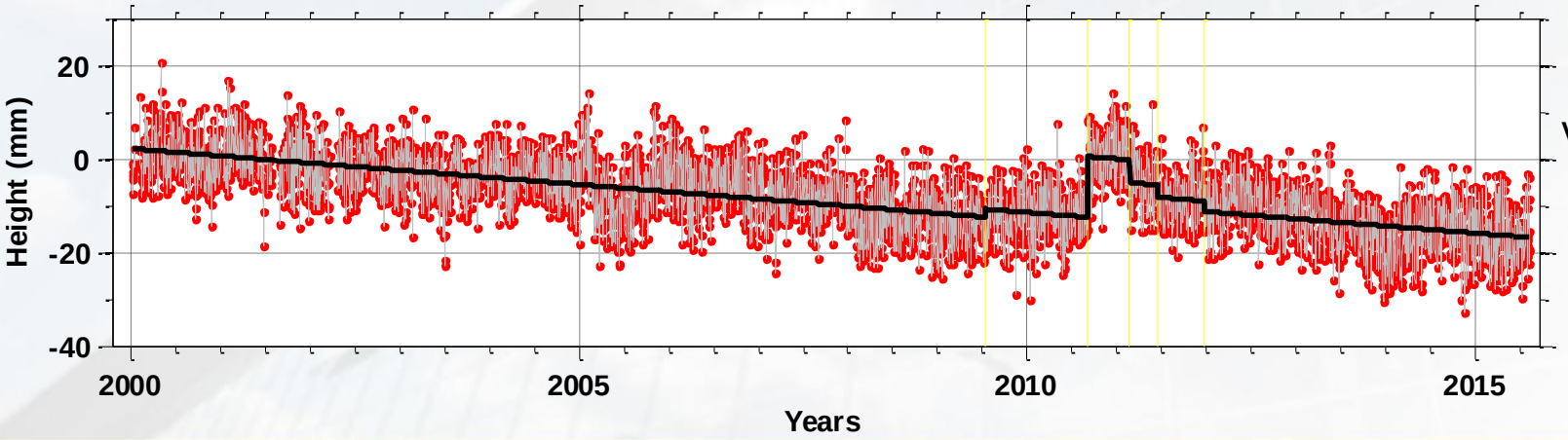


WGTT
+13 mm

Lyttelton – Christchurch earthquake events

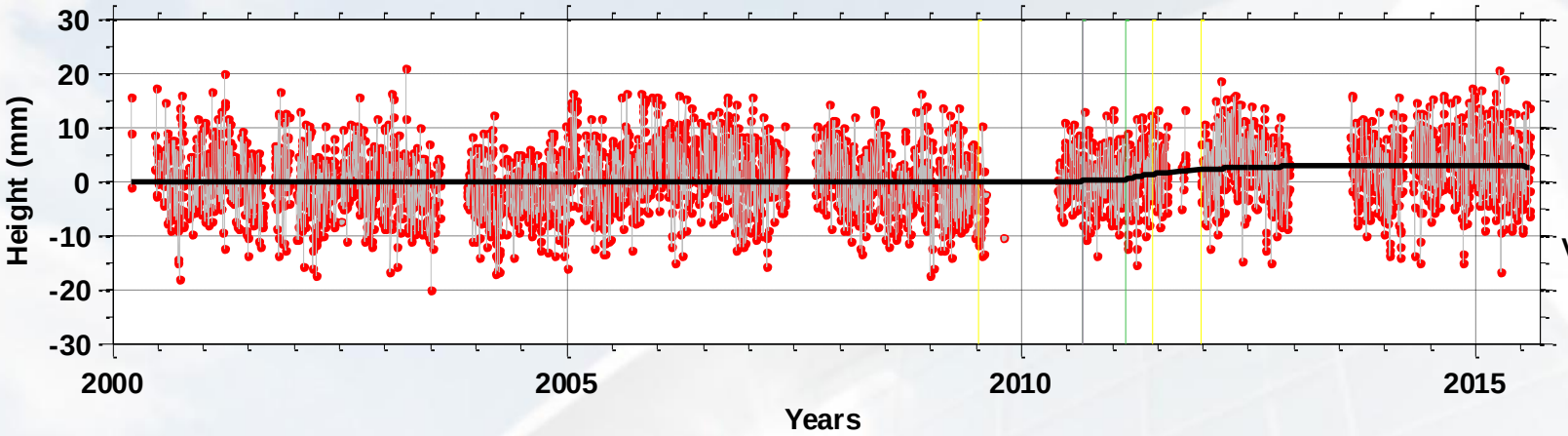


LYTT
v_H= -0.5 mm/yr

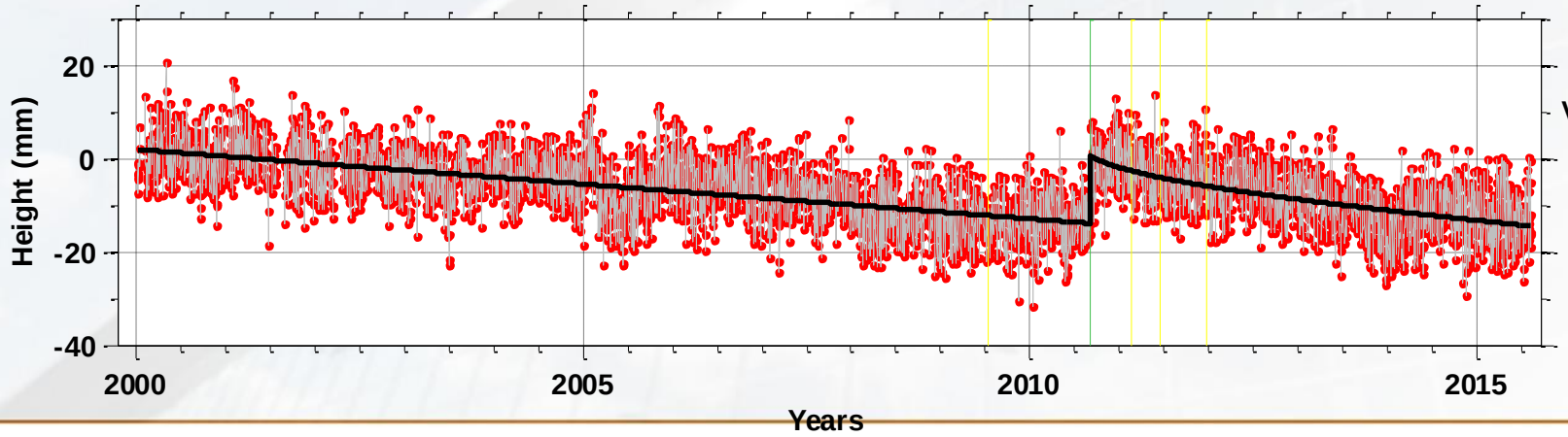


MQZG
v_H= -1.6 mm/yr

Lyttelton – Post-seismic decay

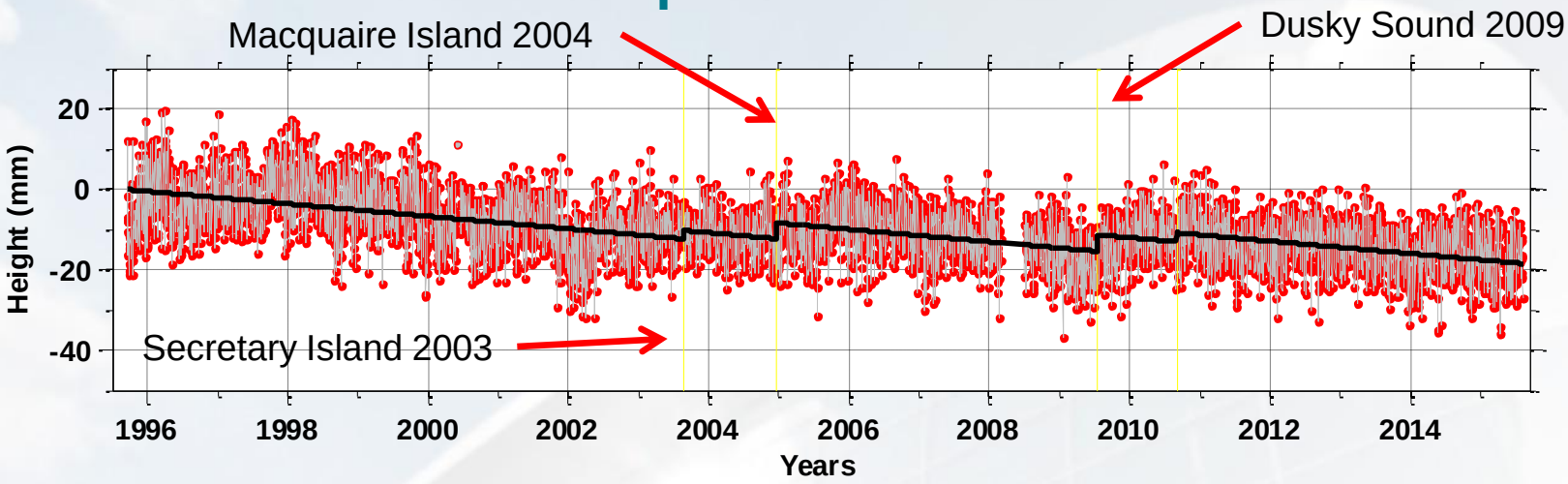


LYTT
v_H= -0.5 mm/yr

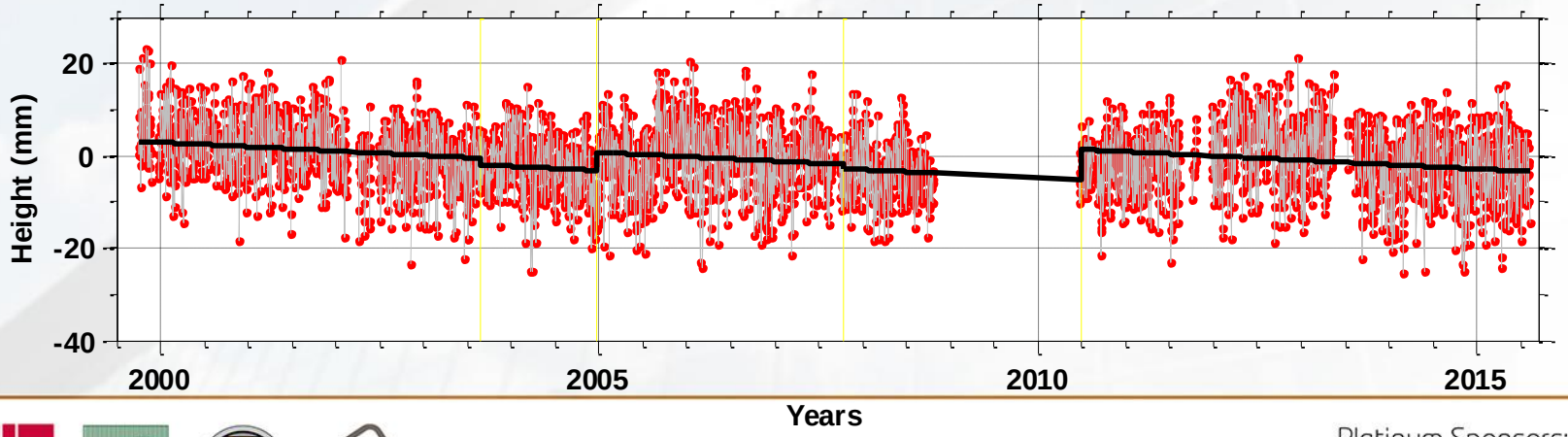


MQZG
v_H= -1.6 mm/yr

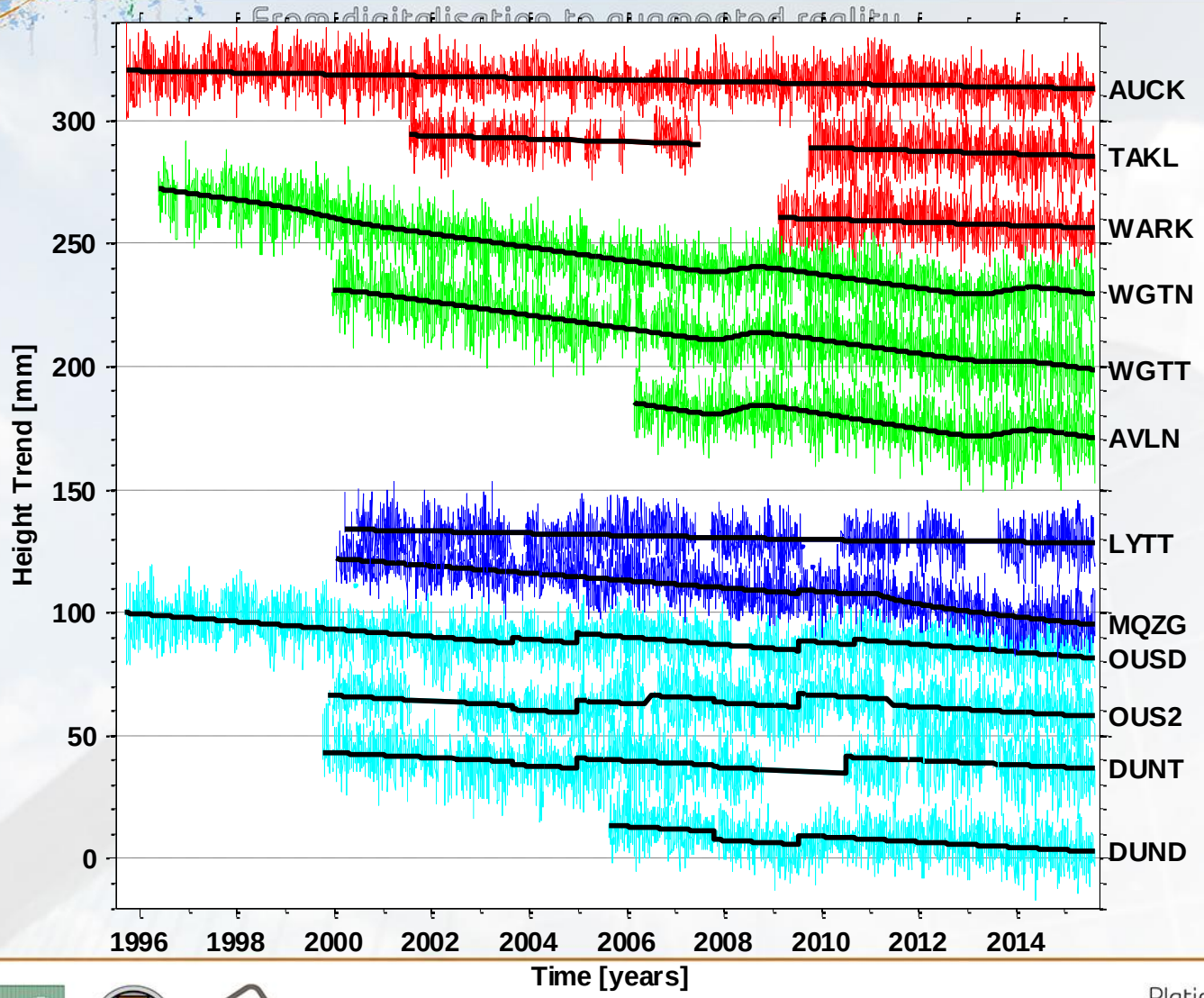
Dunedin – Far-field earthquake events



Uplift:
+5-8 mm



GPS Velocity Trends



Auckland

Wellington

Lyttelton

Dunedin

Vertical Land Motion

	Velocity (mm/yr)				
	GPS	SSE/EQ	Local	Sum	
Auckland	-0.6			-0.6	
Wellington	-3.0	*+1.0*	+1.0	-1.0	SSE velocity averaged over 15 years
Lyttelton	-0.5		-0.3	-0.8	
Dunedin	-1.2	*+0.5*		-0.7	*Earthquake coseismic displacement averaged over time series*

Sea Level

	Velocity (mm/yr)					
	RSL	GPS	SSE/EQ	Local	Sum	**Corrected**
Auckland	**+1.55**	-0.6			-0.62	**+0.93** ± 0.09
Wellington	**+2.14**	-3.0	*+1.0*	+1.0	-1.12	**+1.02** ± 0.19
Lyttelton	**+1.98**	-0.5		-0.3	-0.84	**+1.14** ± 0.19
Dunedin	**+1.36**	-1.2	*+0.5*		-0.67	**+0.69** ± 0.20
Mean :	**+1.7**					**+0.9** ± 0.16

Summary

- New Zealand's RSL is consistent with global trends: +1.7 mm/yr
- VLM needs to be taken into account
  - Local motion – levelling
  - Regional motion – continuous GPS/GNSS
- NZ's earthquake events appear to have a significant effect
  - WGTT : uplift is periodically caused by SSEs
  - LYTT : post-seismic deformation caused by ChCh events
  - DUNT : post-seismic deformation caused by (far-field) Fiordland events
  - Evidence sites are uplifting/subsiding <~1 mm/yr
  - Unclear what the long term effects of seismic activity are