Earth Sciences New Zealand

What if Tropical Cyclone Gabrielle had hit Auckland?

Compound inundation from ~~waves~~, storm-surge and rainfall from Tropical Cyclone Gabrielle

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GNS SCIENCE
TE PŪ AO

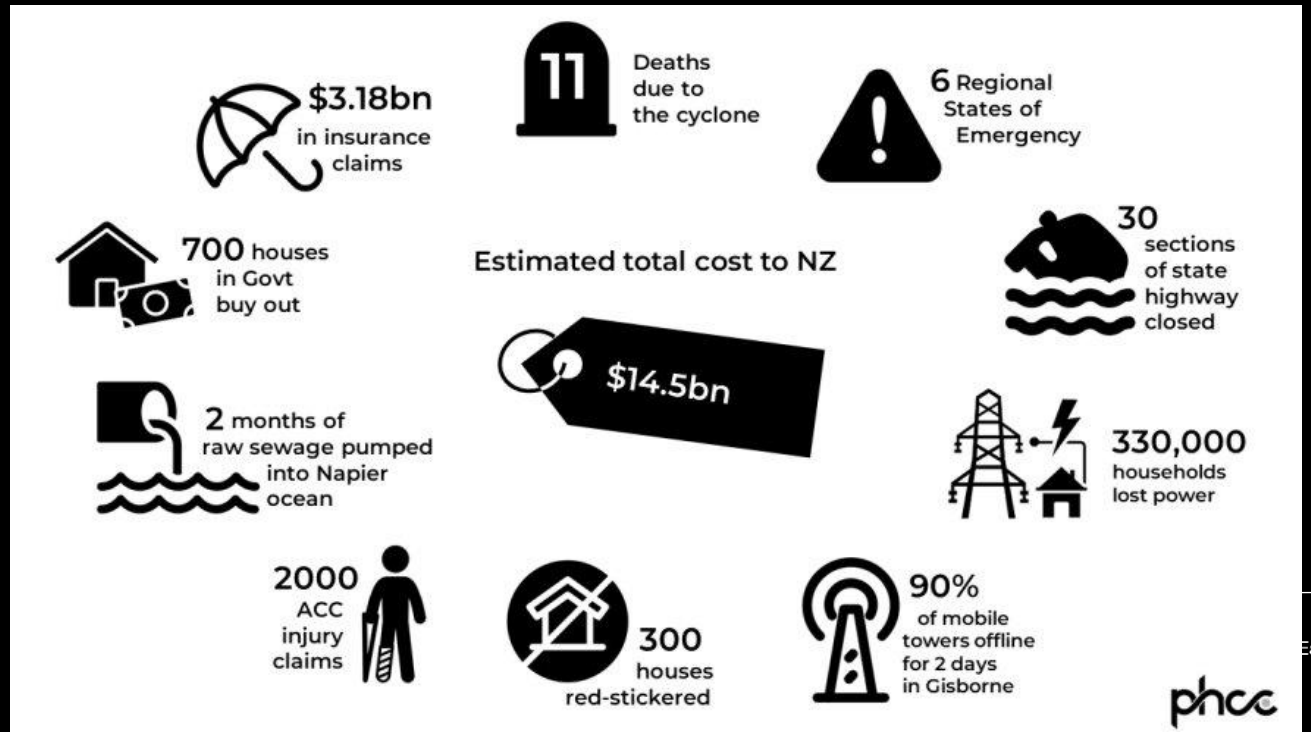
Earth Sciences
New Zealand

Ex-Tropical Cyclone Gabrielle

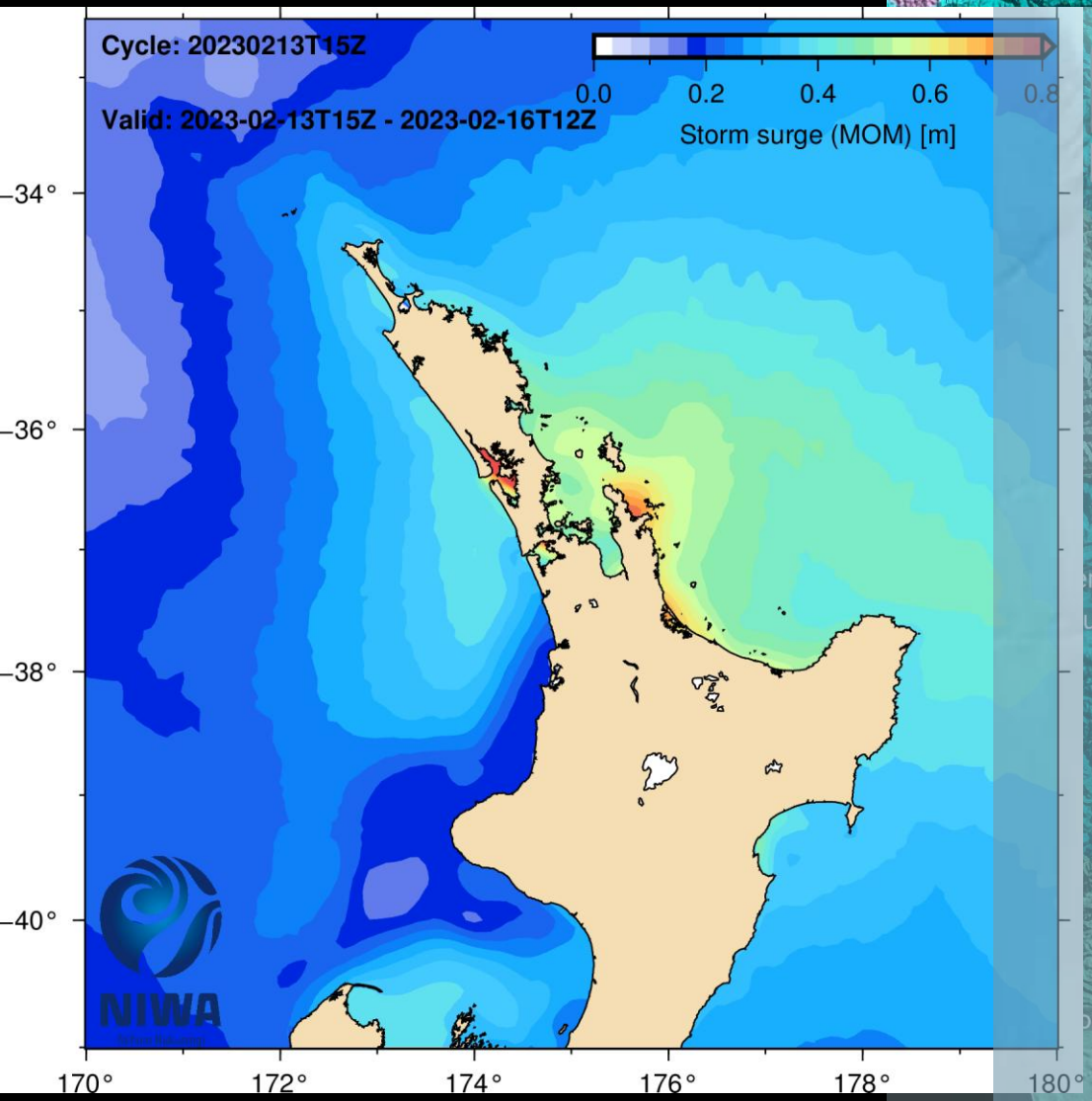
- Ex-TC …Transitioning
- Quasi-stationary for 24 h due to blocking high pressure system
- Heavy rainfall and high Storm surge
- No trapped swell
- All ex-TC with name starting with “G” are bad for NZ. (e.g. Giselle, Gita, Gabrielle)

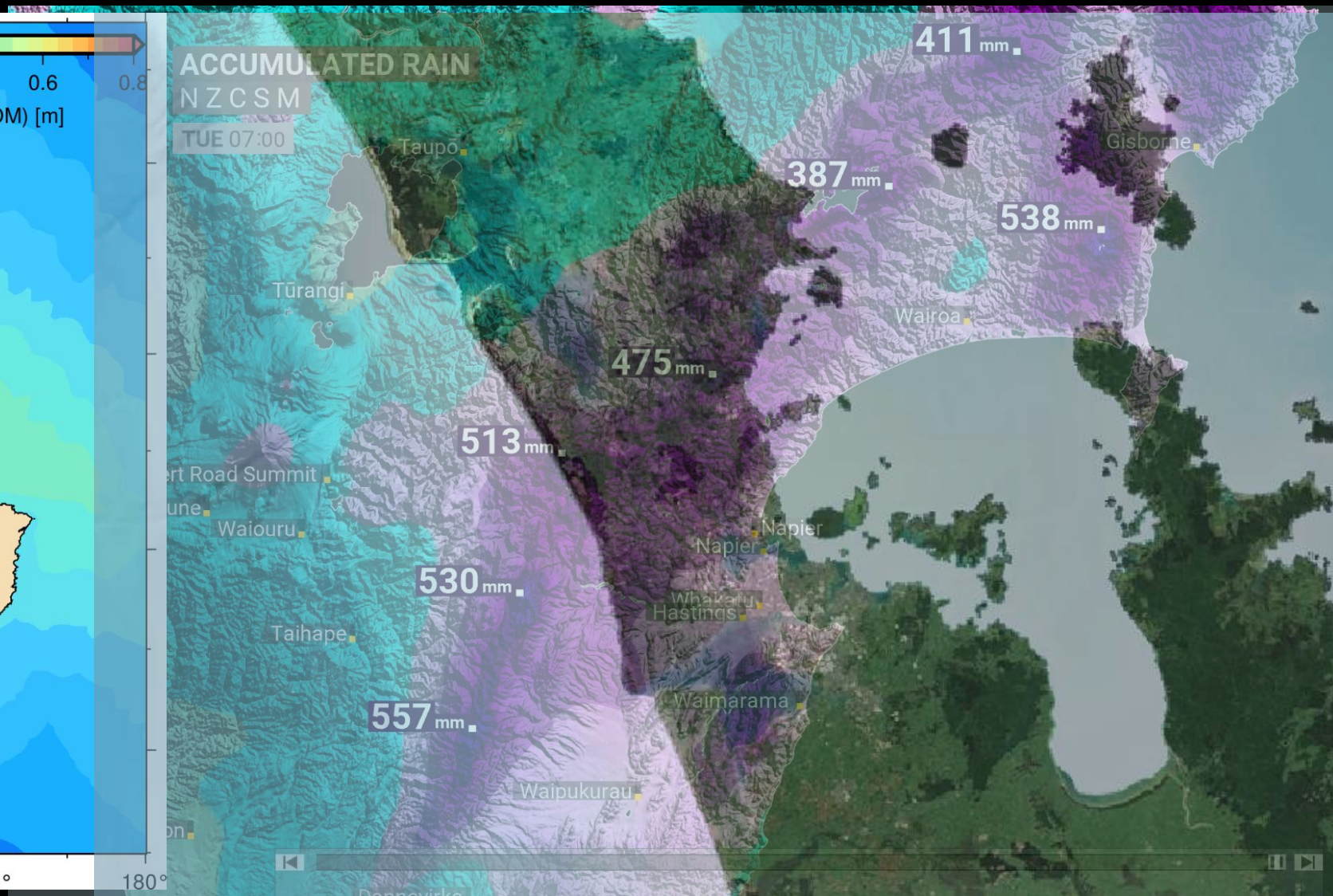
Impact in NZ

Photo: NZ Herald



Highest impact was in East Coast due to rain





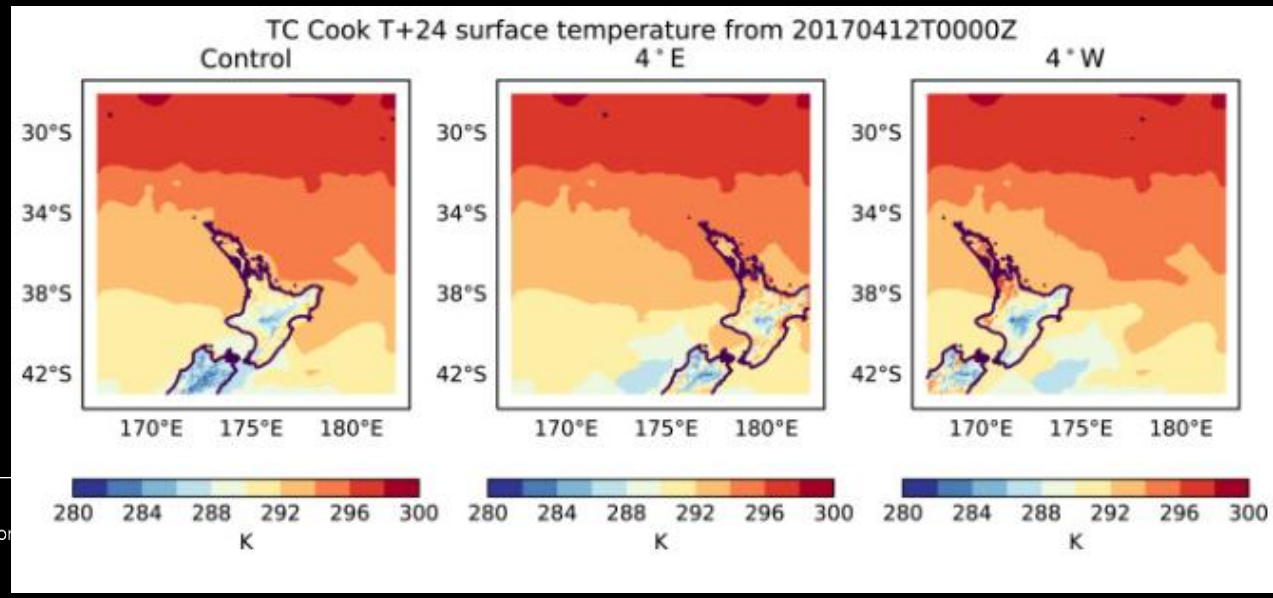
Moving Earth (not heaven)

Boutle et al. (2021). https://doi.org/10.1016/j.wace.2021.100395

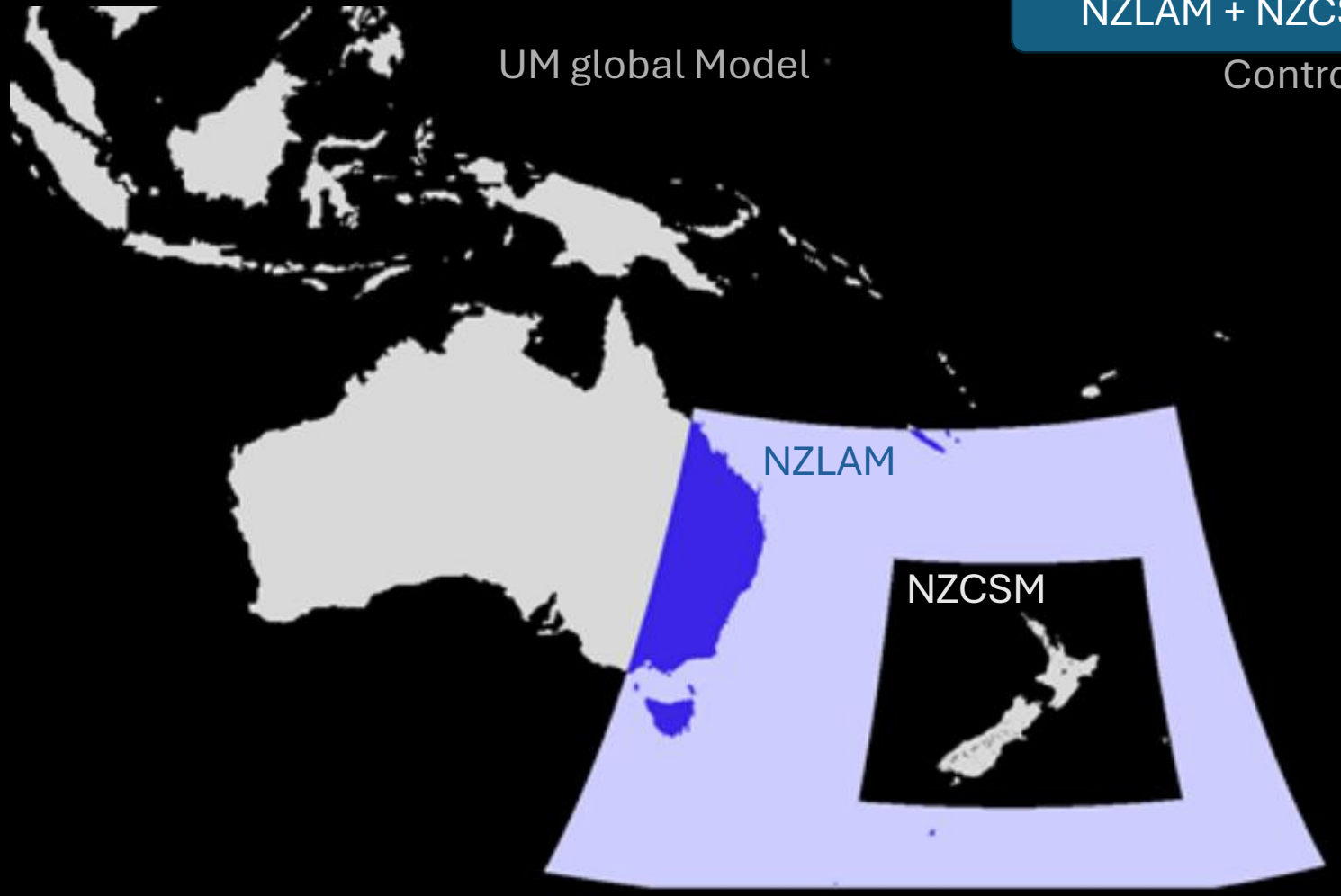
We can't move the cyclone track so we move the landmass

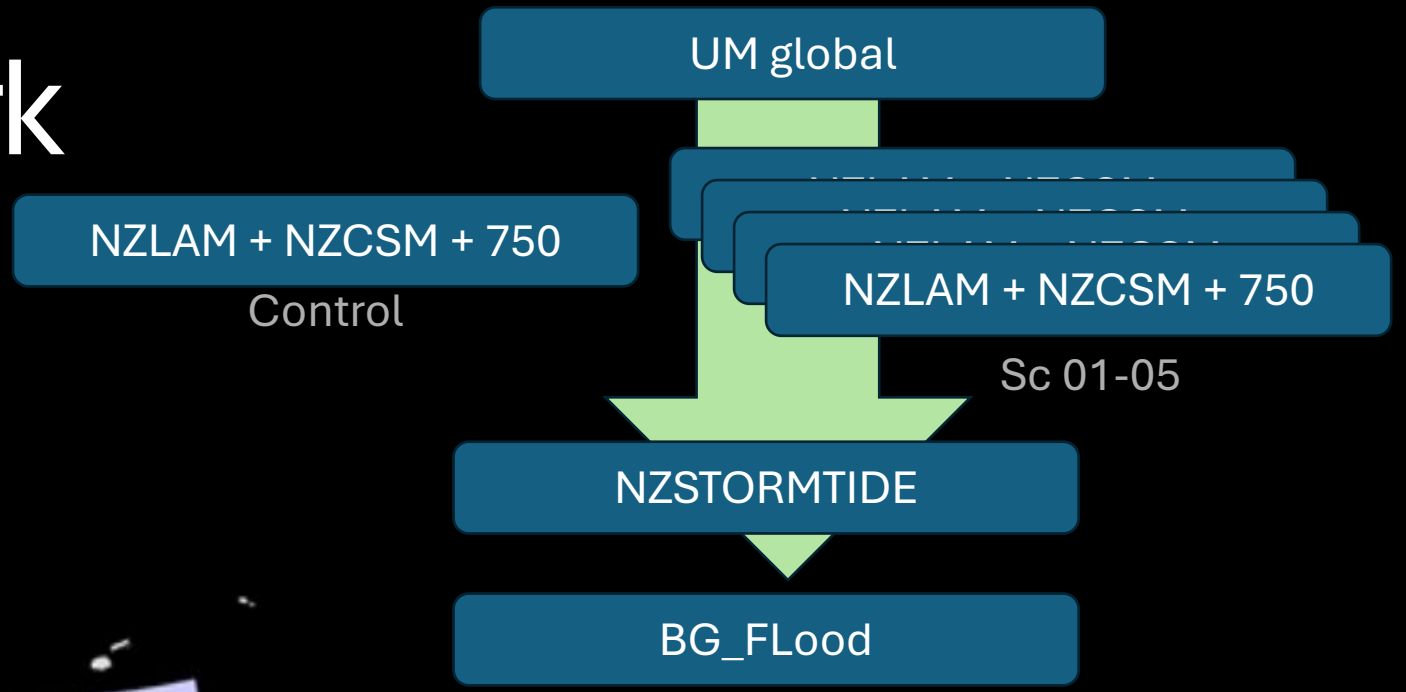
+ meteorological fields within the simulation are self consistent
  - Boundary (sides, Upper Atm and SST) are unchanged
  - Orography and impact of landmass on track is simulated

- SST is not shifted
- Also need to shift back forcing when analyzing impact (or shift assets)

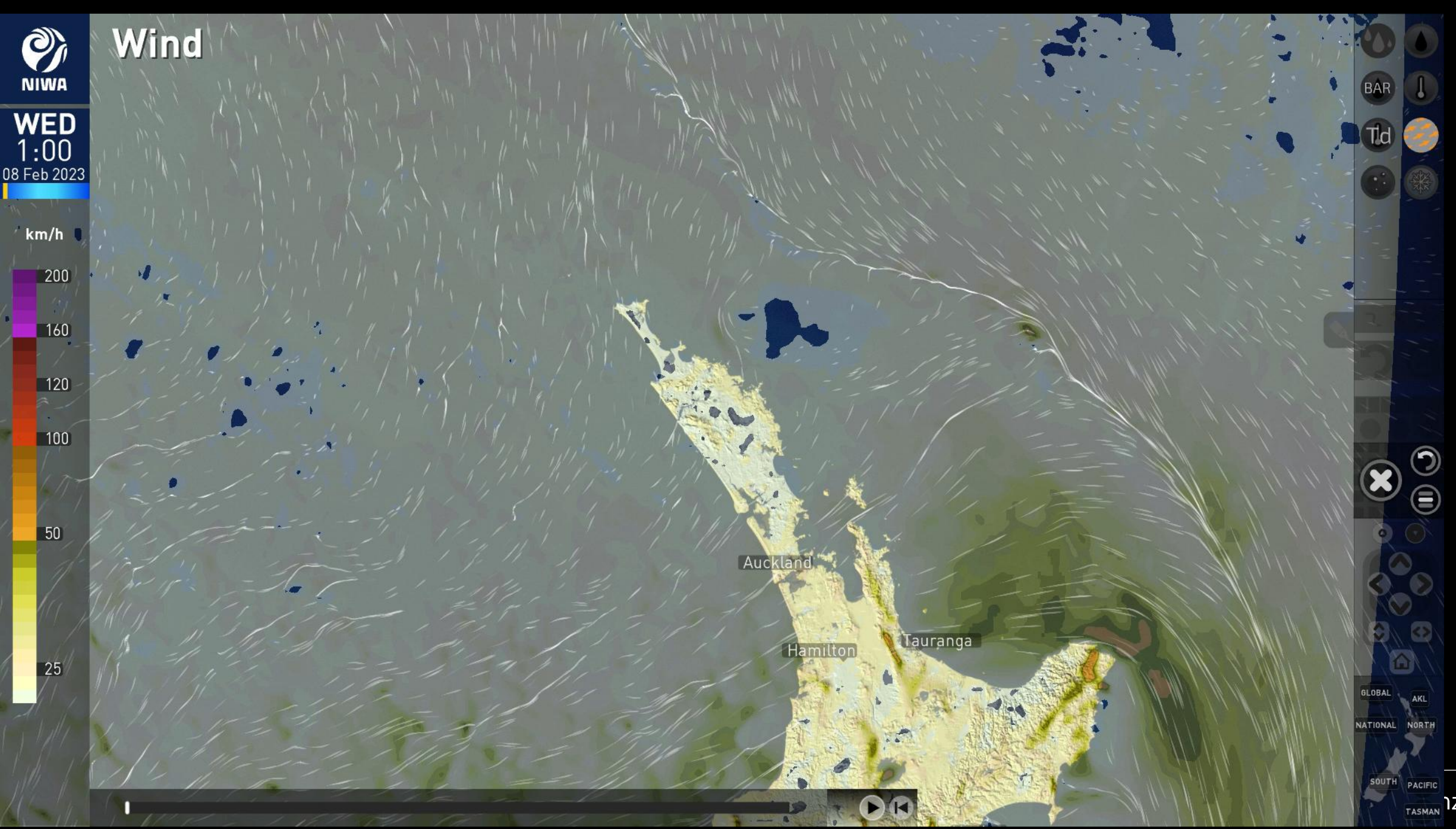


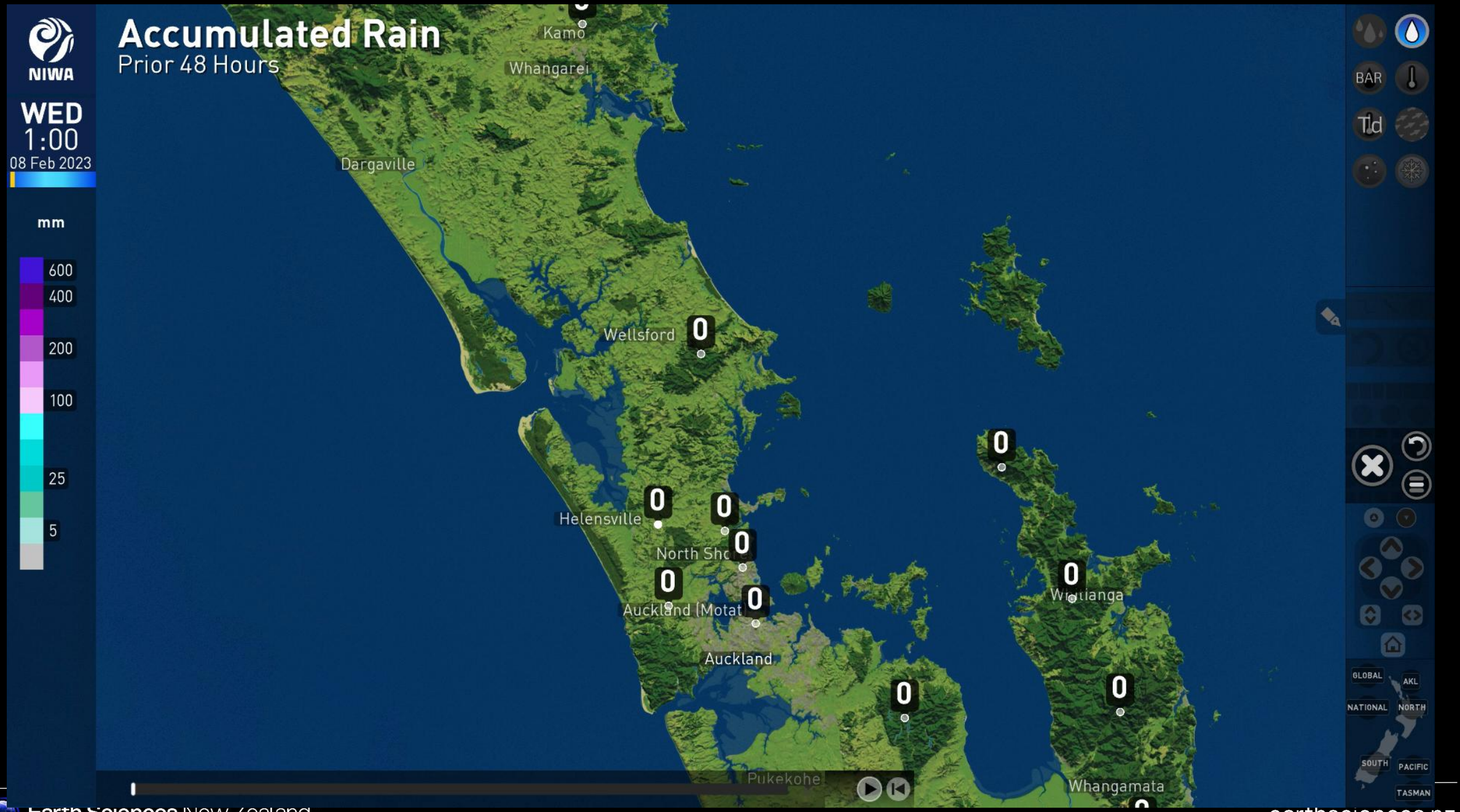
Modelling framework



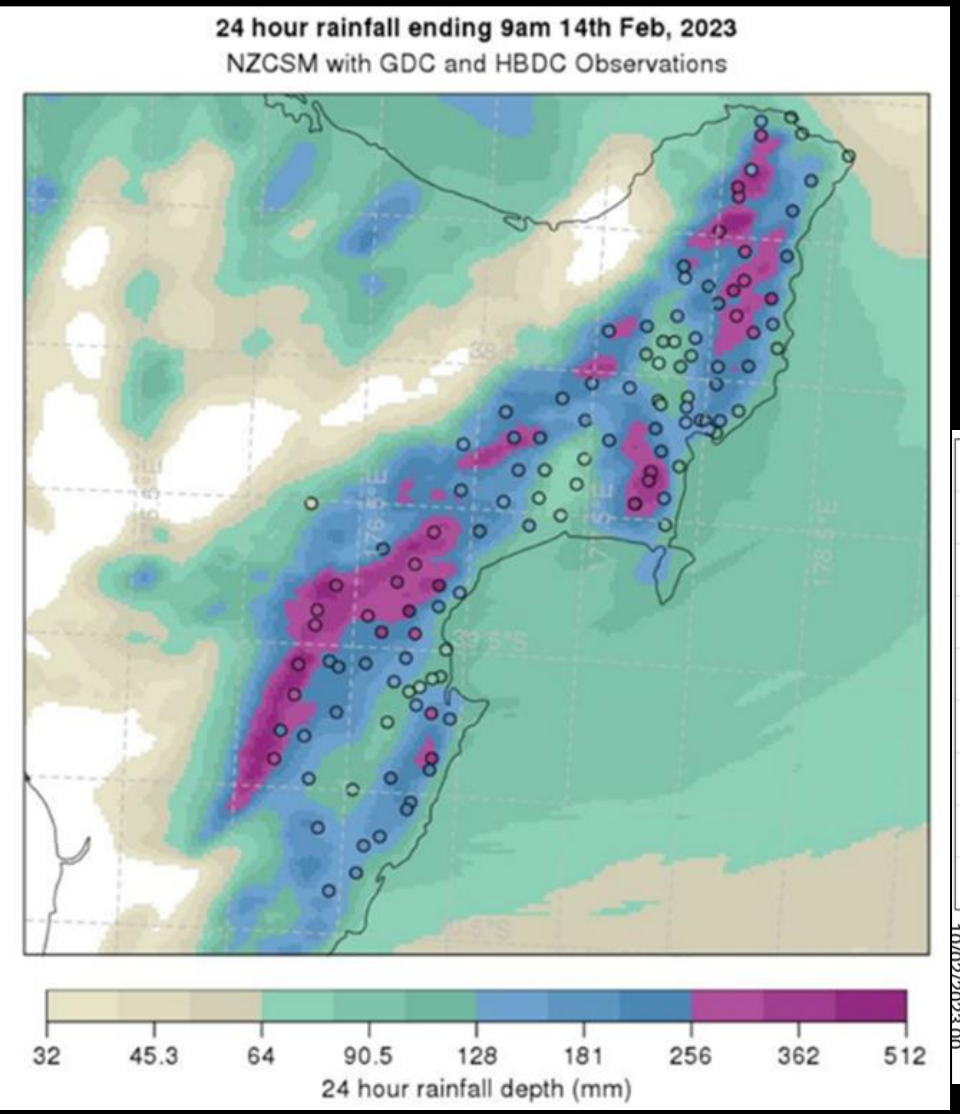


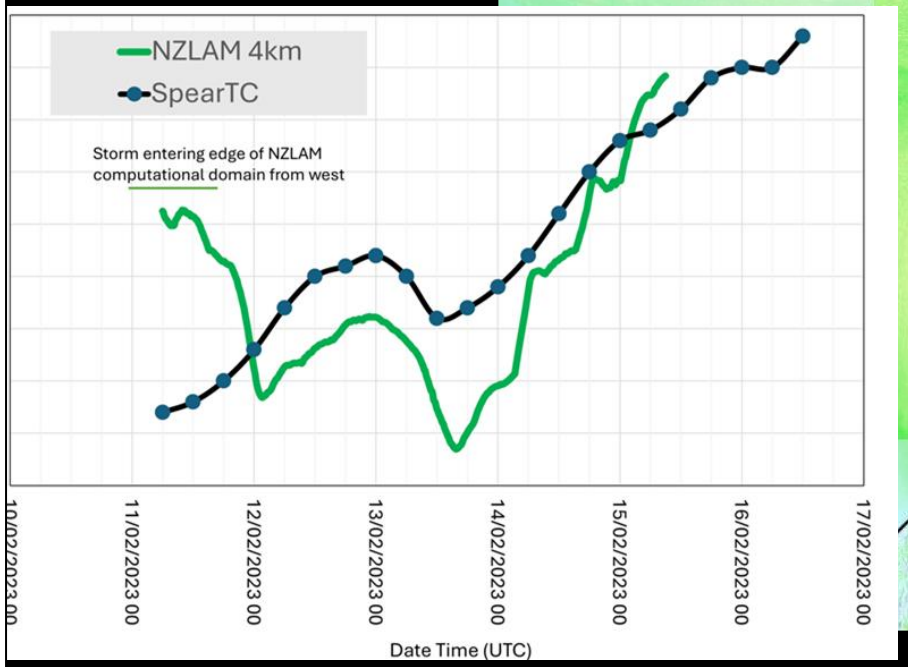
Case ID	Shift East (deg)	Shift South (deg)	Comment
Control	0.0	0.0	Check on ability to reproduce actual event
GABSE01	2.4	2.3	Expect strongest winds and heavy rain in Auckland Area
GABSE02	2.6	2.3	Sensitivity to more E shift than SE01
GABSE03	2.6	2.5	Sensitivity to more SE shift than SE01
GABSE04	2.4	2.5	Sensitivity to more S shift than SE01
GABSE05	1.5	-0.2 (N)	Centre comes over North Shore

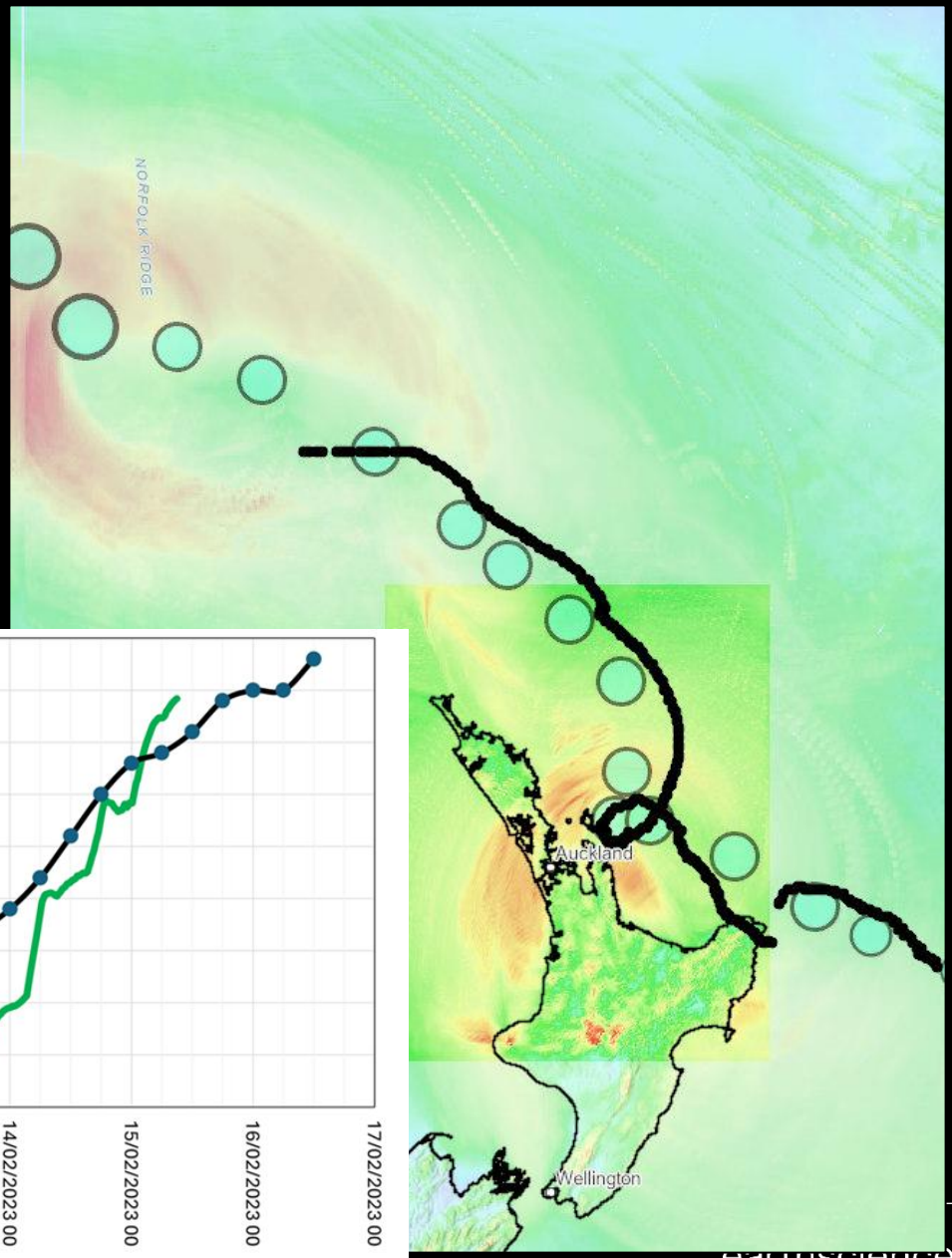

Wind
NIWA
WED
1:00
08 Feb 2023
km/h
200
160
120
100
50
25
Auckland
Hamilton
Tauranga
BAR
GLOBAL
AKL
NATIONAL
NORTH
SOUTH
PACIFIC
TASMAN



Control Validation



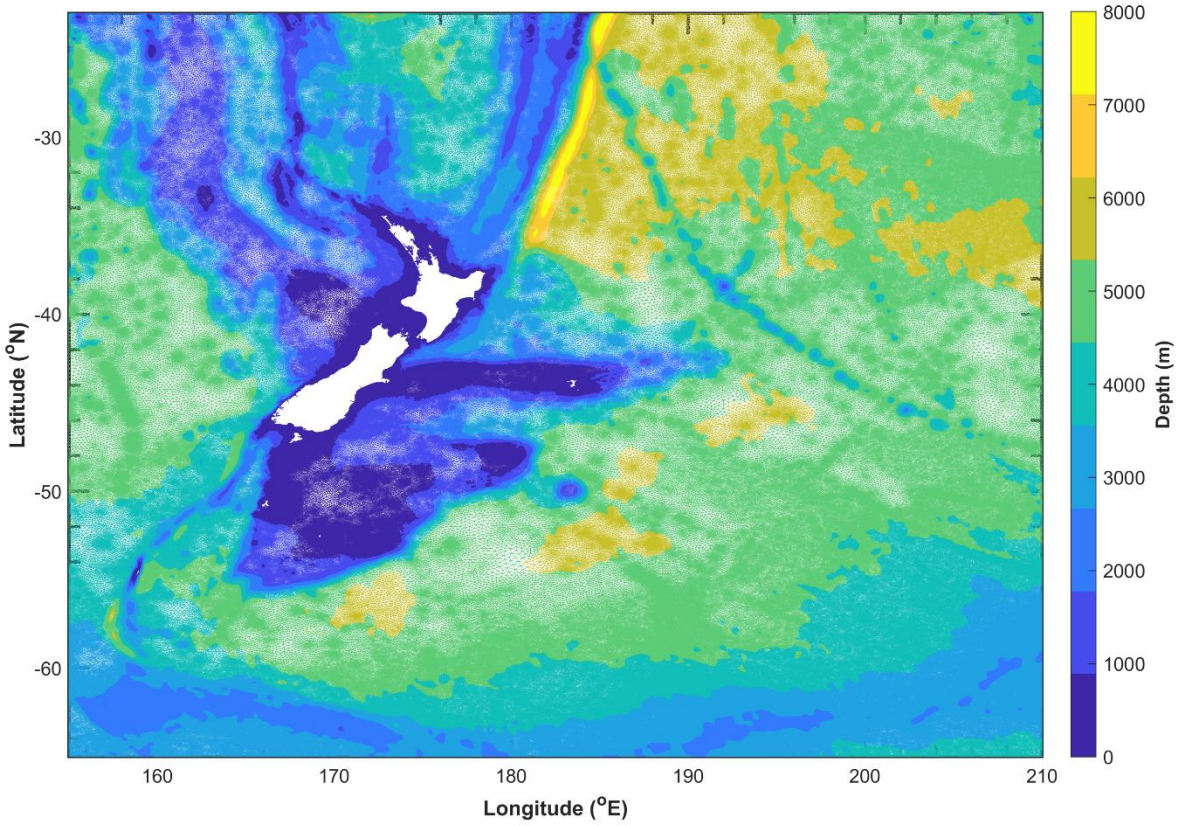


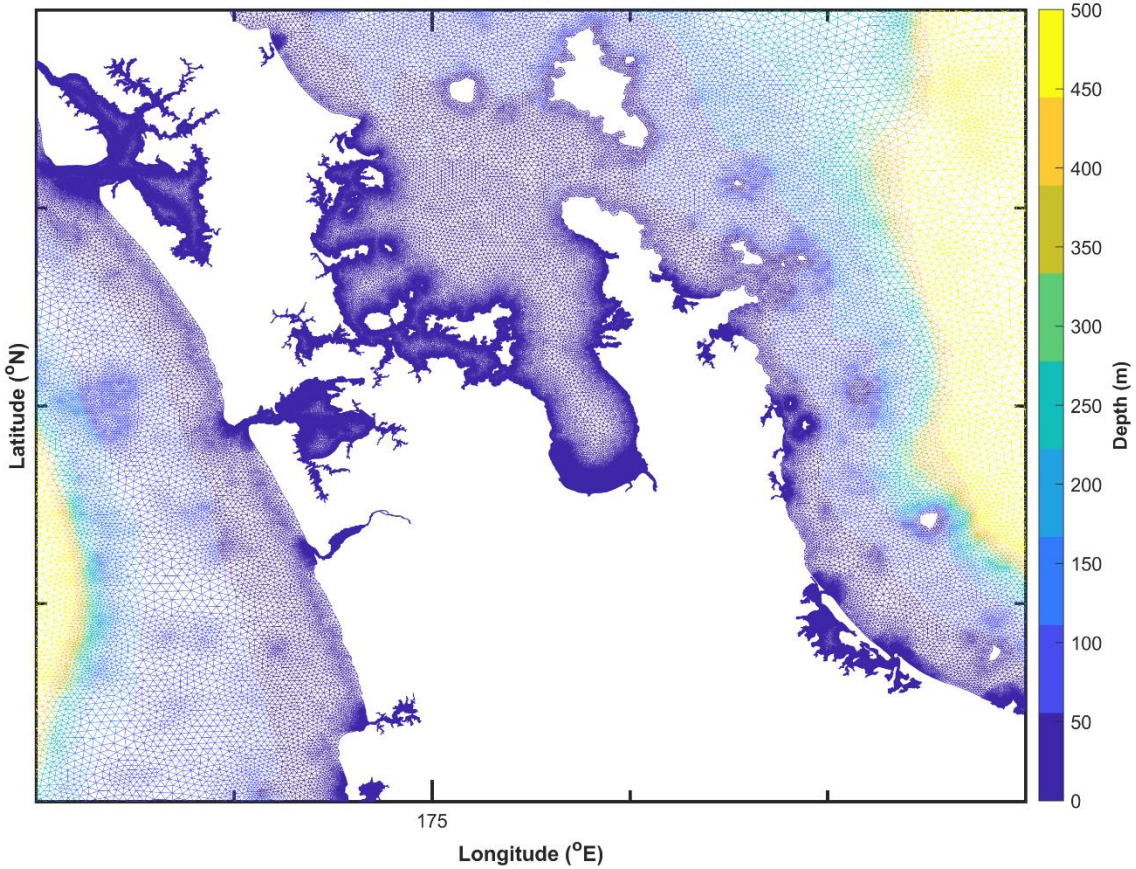


Modelling system

Telemac2D – Flexible Mesh

- Grid size ~10 m in some estuaries to 40 km offshore resolution.
- >50 – Estuaries, Harbours, Tidal inlets and Fiords.
- Increase mesh elements from **~60,000 to ~5.2M**



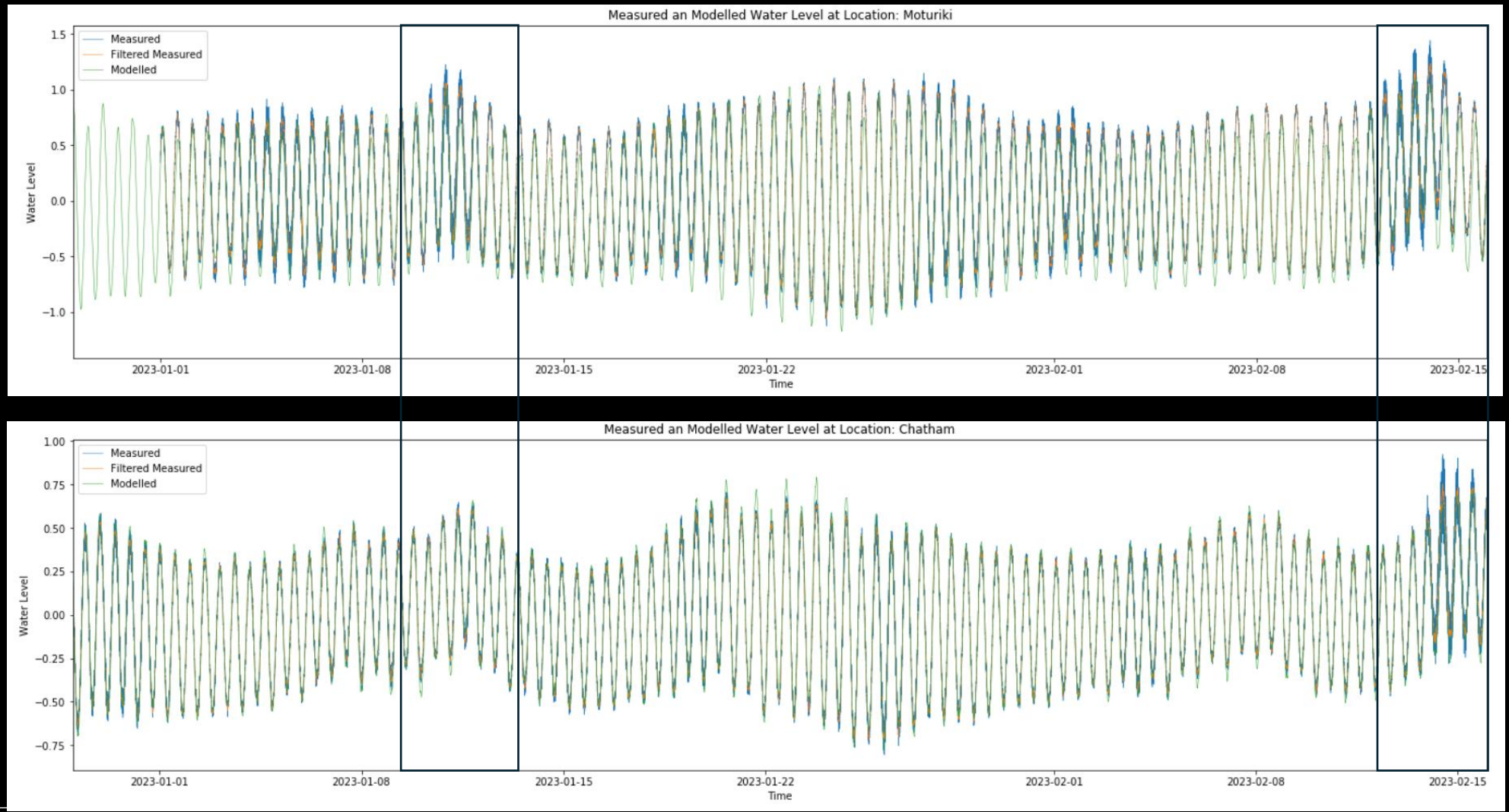


Validation

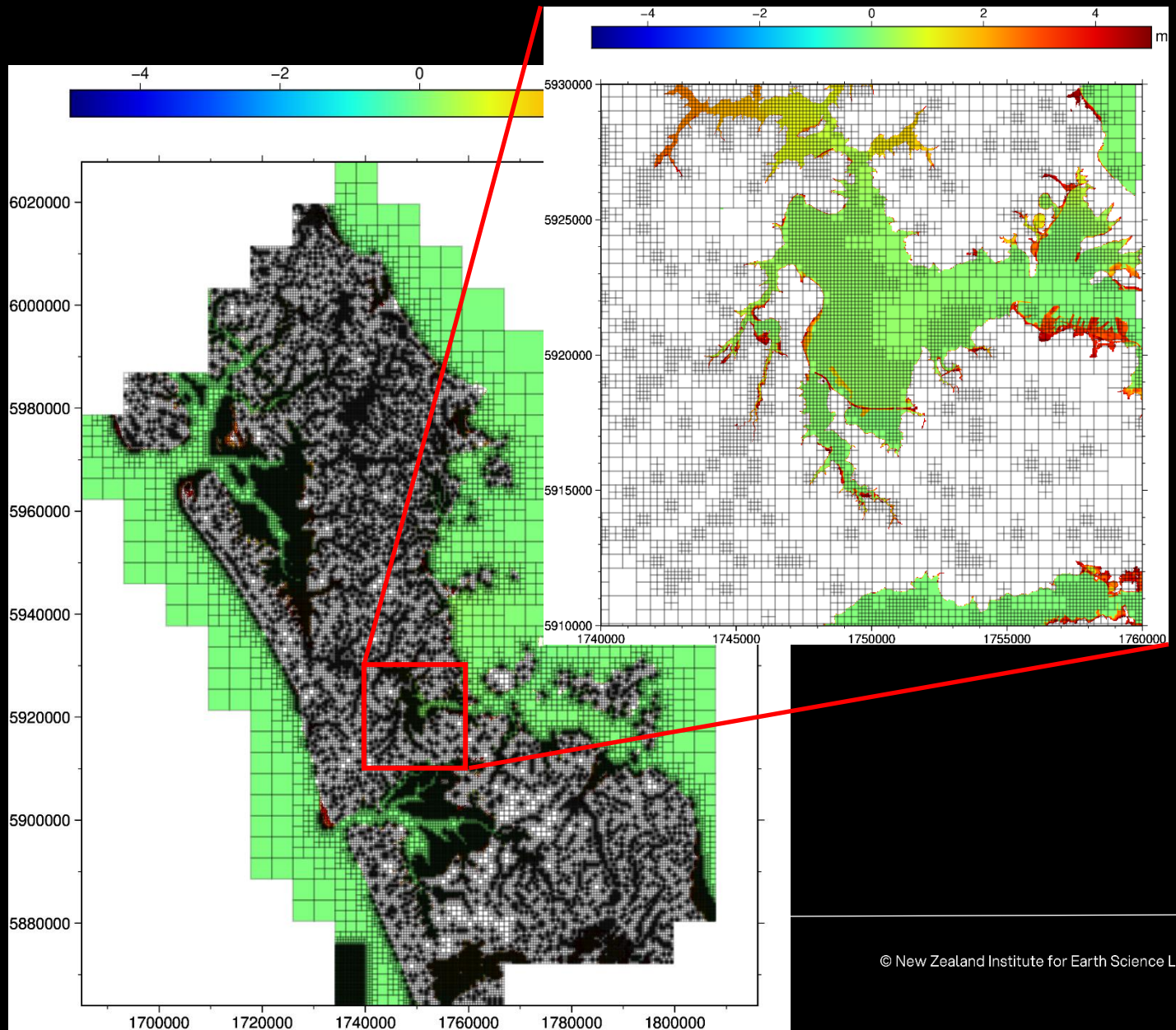
- **North Cape**
- Pouto Point
- Raglan
- Whitianga
- Lottin Point
- Ports of Auckland
- Chatham Island
- Great Barrier (Korotiti)
- Moturiki
- **Dargaville**
- Tararu
- **Gisborne**
- Kawhia
- Napier
- Wellington

Hale

Gabrielle

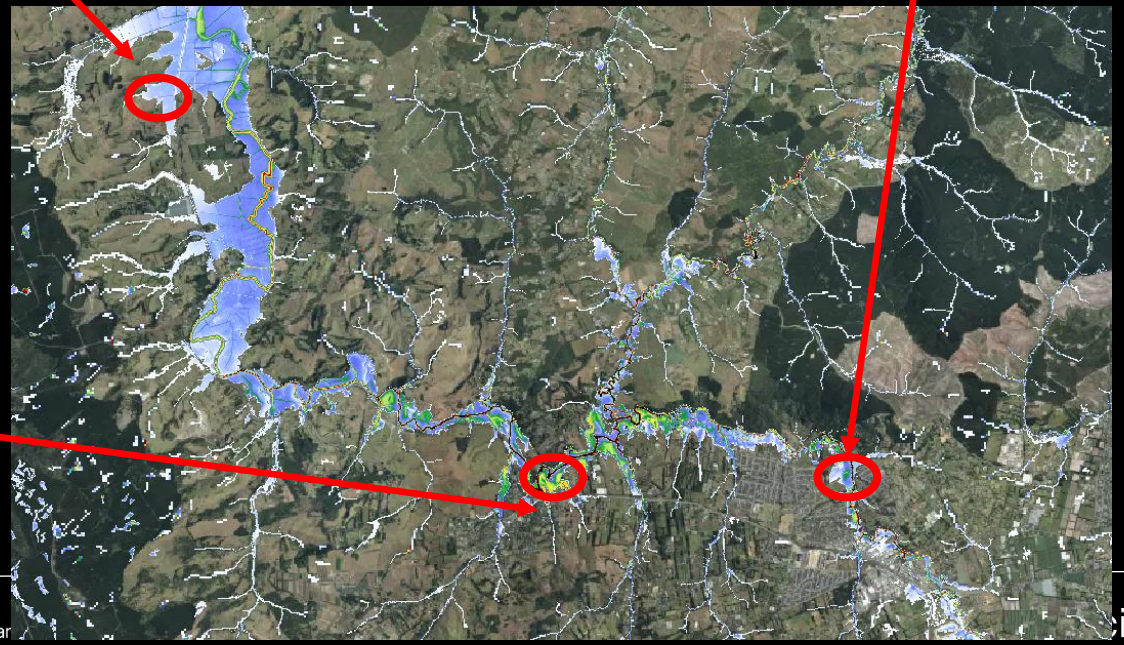


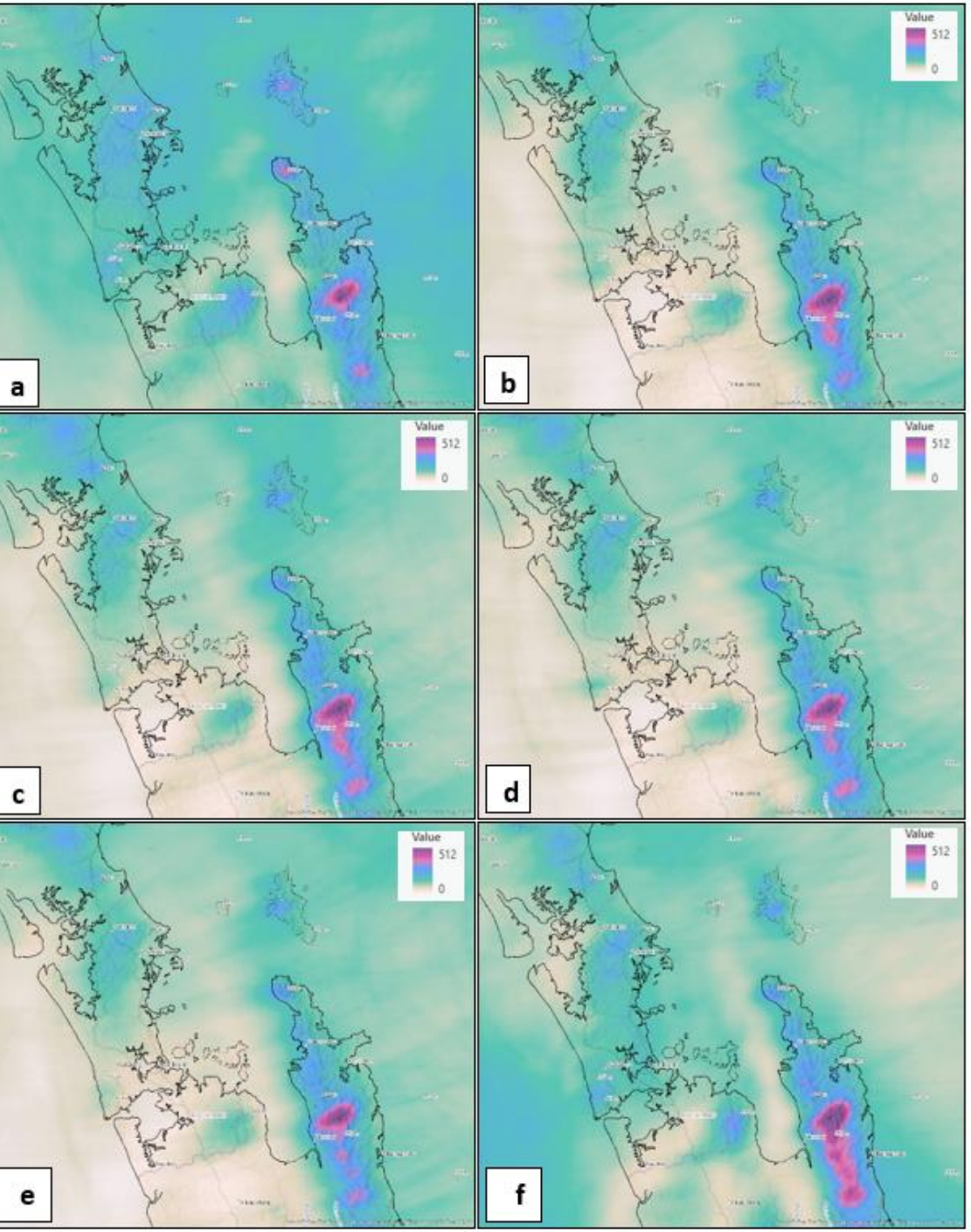
Flood-inundation Model

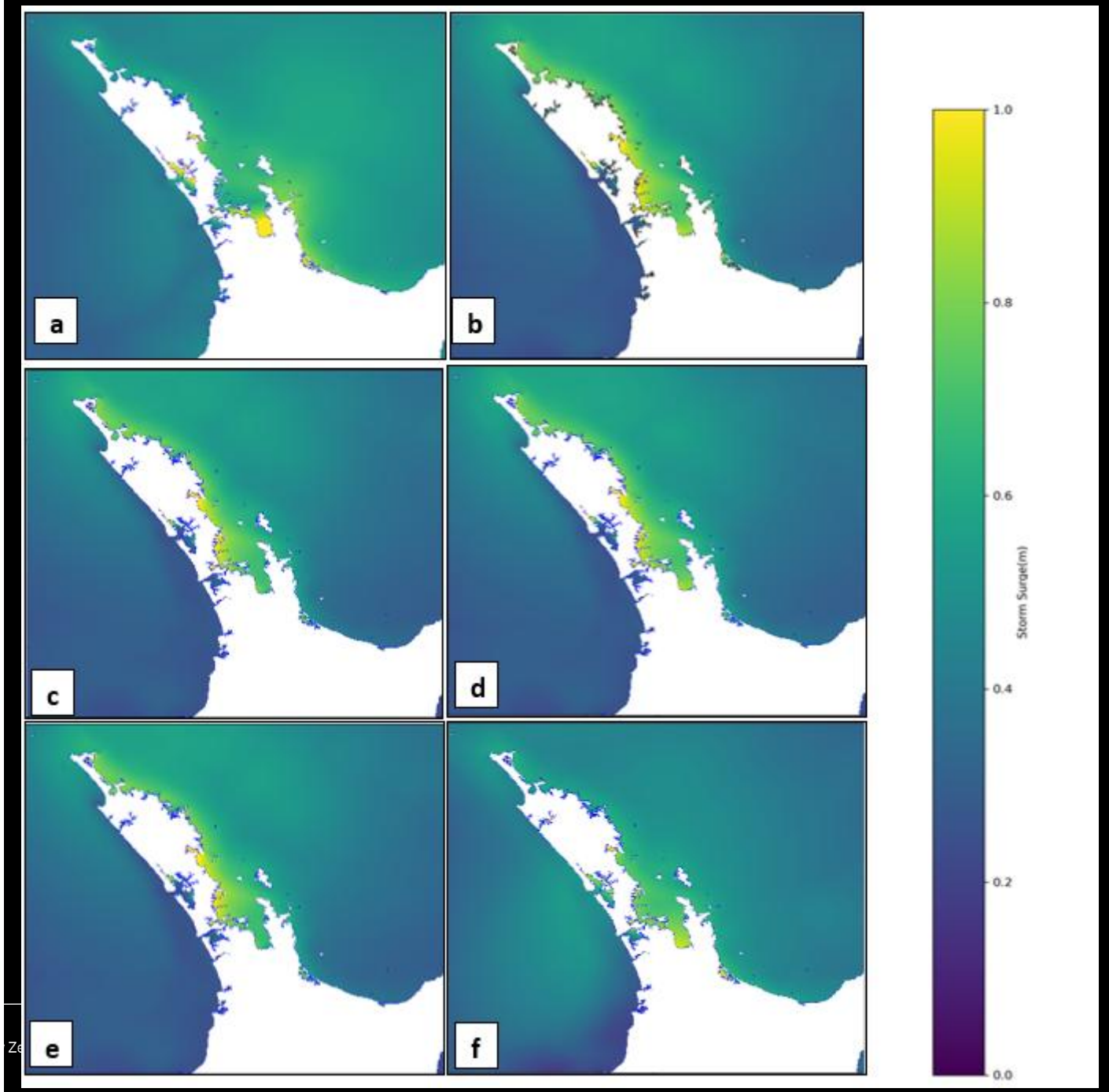


- BUQ static mesh
- Downstream bnd from Storm-tide model
- Rain-on-Grid everywhere
- Variable roughness
- Wind and ATM Pressure forcing also included
- Infiltration
- Implicit (inlet/outlet) storm water system

Flood Model

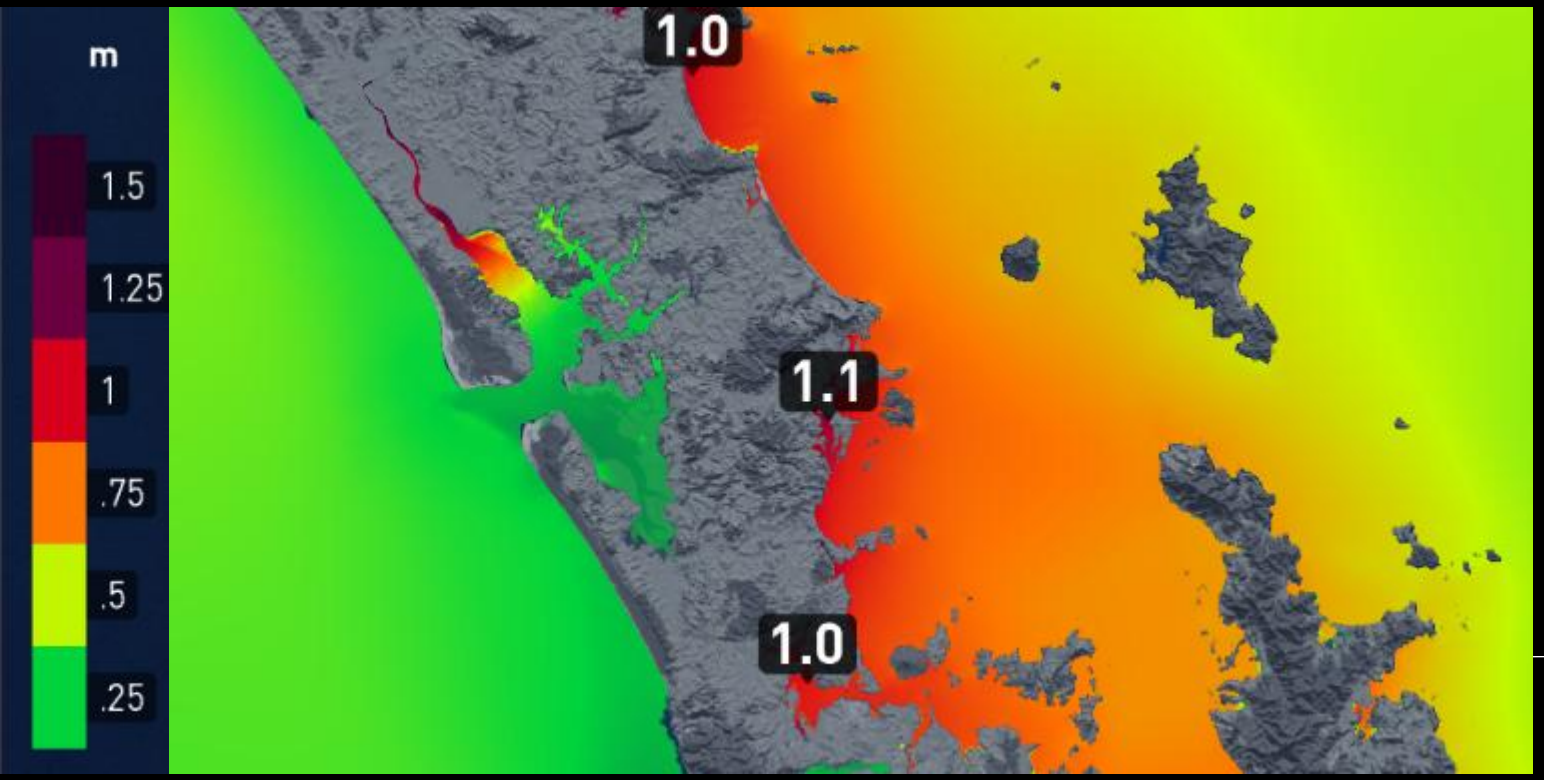


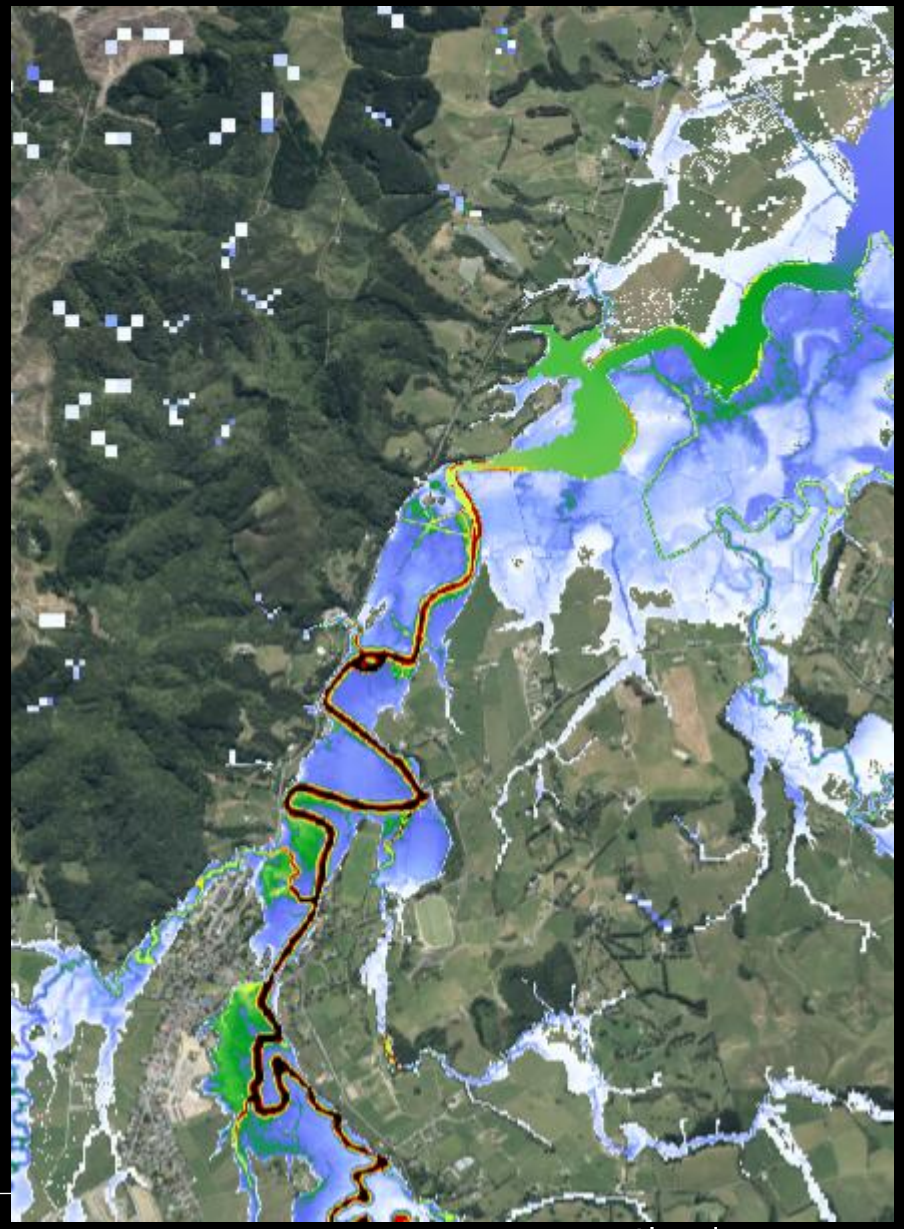

a
b
c
d
e
f
Value
512
0


a
b
c
d
e
f
1.0
0.8
0.6
0.4
0.2
0.0
Storm Surge(m)

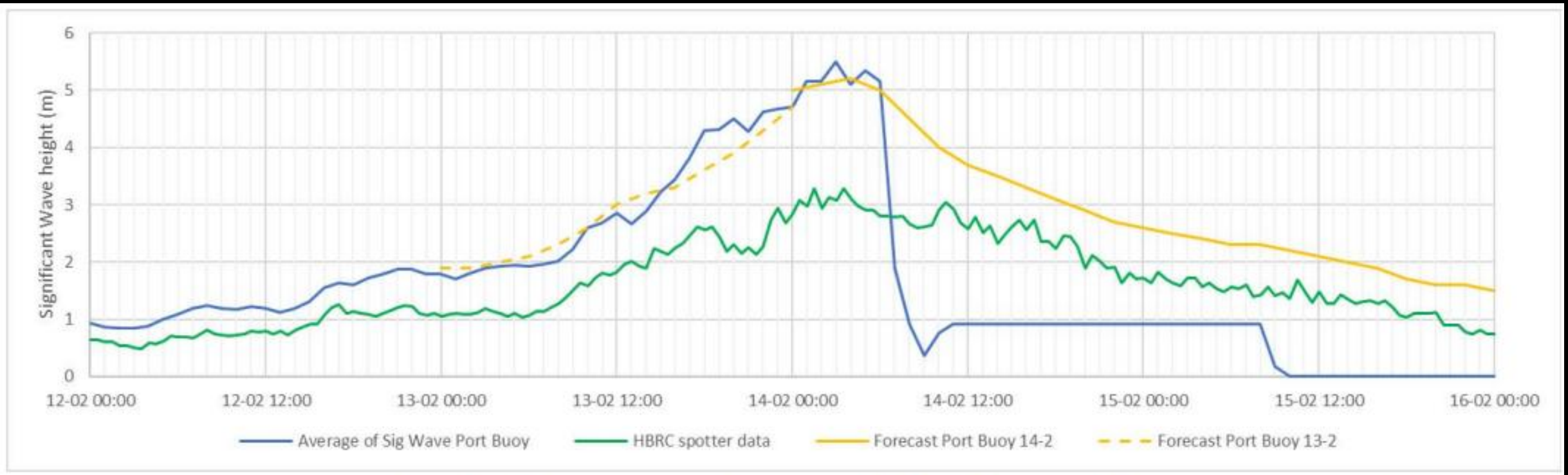
Results

- Control run (i.e. hindcast) produces the worst inundation
- Scenario 2 causes the largest storm-tide (at Auckland Port)
- Rainfall impact accounts for most of the inundation in all cases





Tropical Cyclone Gabrielle Waves



Significant wave height during Cyclone Gabrielle measured and forecasted at the Port Buoy and at the HBRC buoy in front of Westshore (Source: HBRC).

Impact of waves on river mouth opening

Imagery: LINZ 2023

Thank you
Nga Mihi
Gracias

ITWS: It’s That Wan Stupid!