A Look Inside

Presented By

Sam Taylor-Offord

Science Operations Specialist

With Slides From

GeoNet Programme

Who am I?

Geophysicist /

Artisan Hole Maker

10 years data science

Work spans:

- Sensor Network Development
- Data Science
- Data Management
- On-Call Seismology
- Outreach

Talk Outline

Act I: ESNZ & GeoNet

Act II: GeoNet Product and Service Pipeline

Act III: Data Science for Decision Making

S: I am giving a presentation on Thursday

F: Rocks or boring?

S: Data science

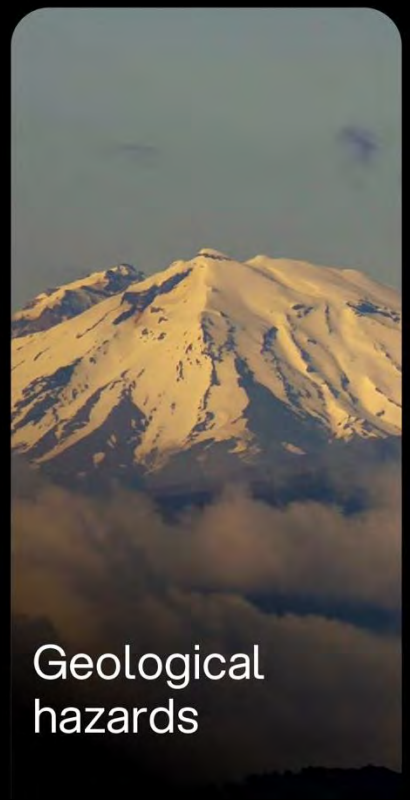
F: “oh boring”

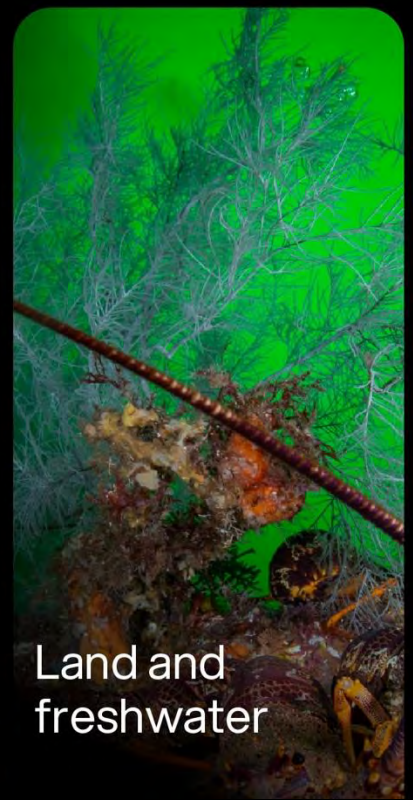
S: All rocks become statistics eventually

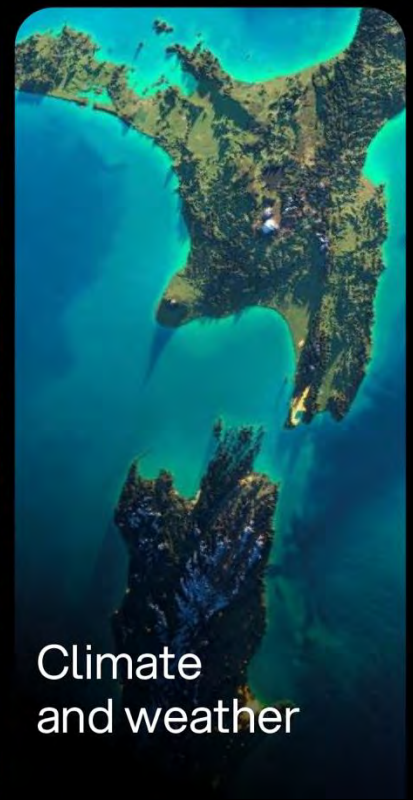
Who we are: **Earth Sciences New Zealand**

On July 1, 2025, the organisations NIWA and **GNS Science** merged to become the new Public Research Organisation Earth Sciences New Zealand (ESNZ). MetService, and parts of the Measurement Standards Laboratory, will be joining over the coming months.

ESNZ focuses on a wide range of research, with six significant science areas:







What is GeoNet?

- **New Zealand's nationwide land and geohazards monitoring system**
  - Collects, processes, stores, and shares **data** on New Zealand land and geohazards – earthquake, landslide, tsunami, volcano.
  - 24/7 monitoring services of Aotearoa land and geohazards – gathering, integrating, and sharing scientific info and advice about geohazards.

- **Physical and virtual infrastructure** – from remote field-based equipment to data centres to the cloud – that is always 'on' and enables **data to be free, open, and available** at any time.

- Public information and education about geohazards, 'telling it like it is' to help people understand and respond effectively to geohazards.

GeoNet's Purpose

Landslides

Earthquakes

Geohazards data for research

Science expertise for immediate event response

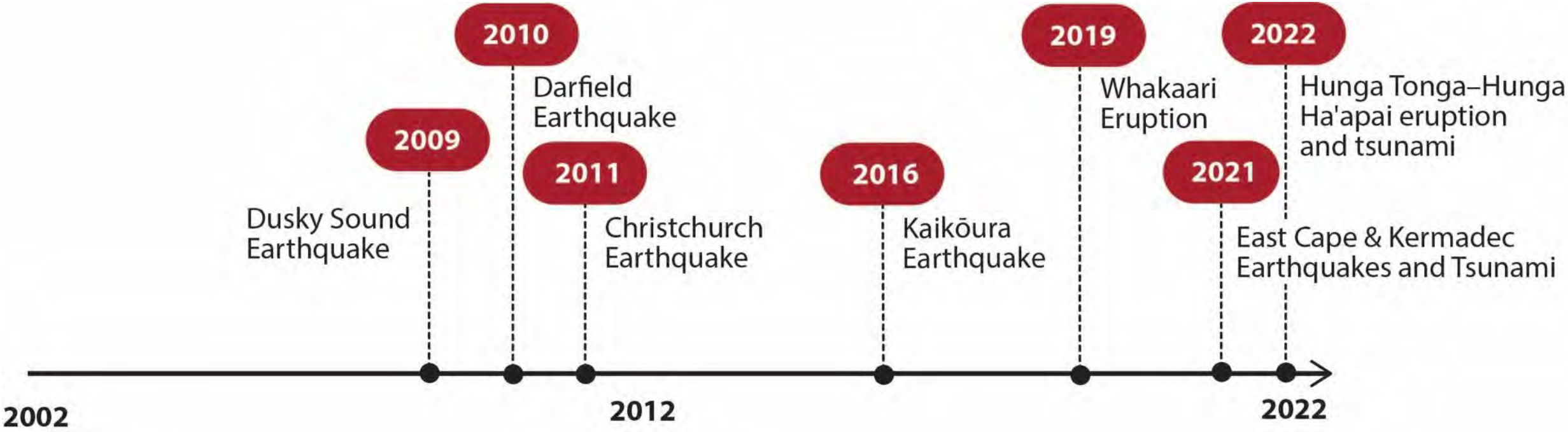
Geohazards data for monitoring and response

Community engagement and outreach

Volcanoes

Tsunami

Significant geohazard events - last 25 years



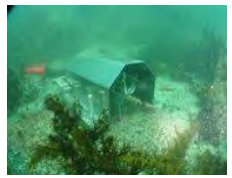
GeoNet sensor network

Over 1100 sensors across Aotearoa and beyond





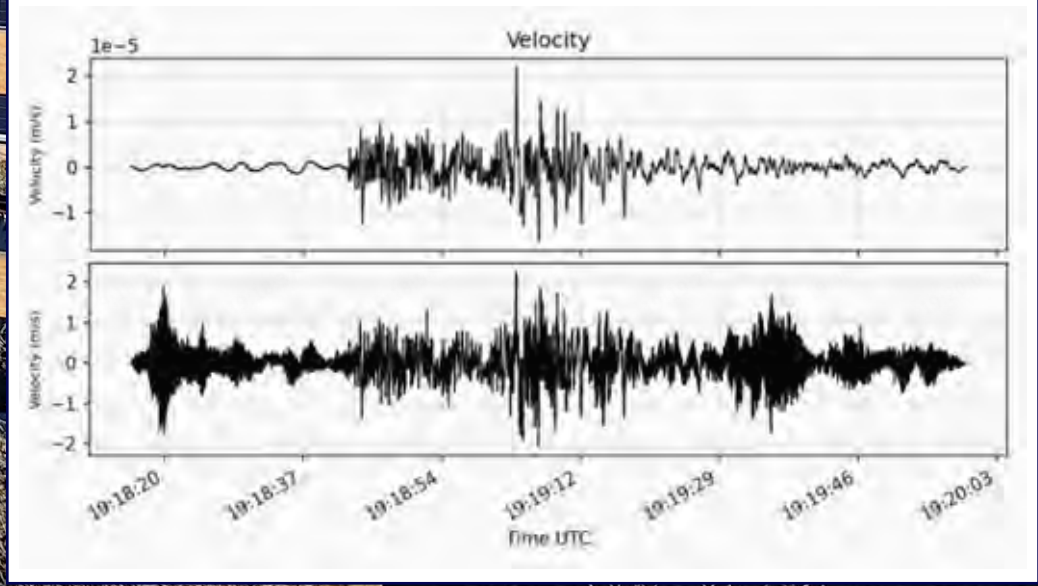


Upper Weld Road, Taranaki

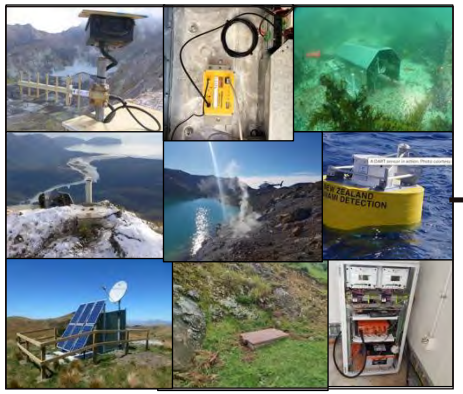
Erewhon Station, Canterbury

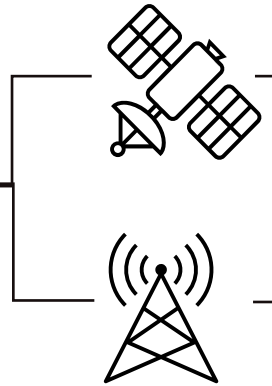
M4.3, Lake Hawea, Δ 180 km

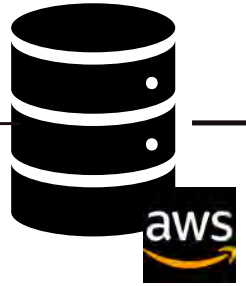


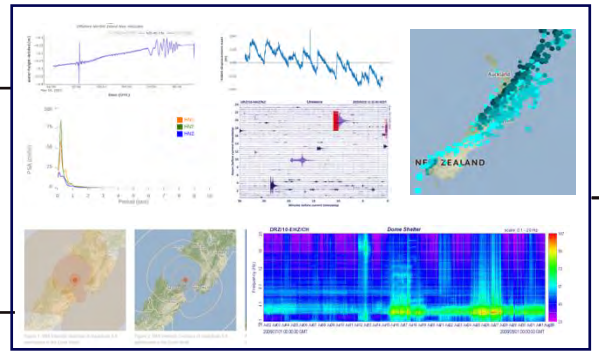
GeoNet data pipeline

Multidisciplinary data pipeline: from ground infrastructure to value-added products dissemination and **24/7 geohazards monitoring**









Data acquisition
Multi-sensor network
Over 1100 sensors, from Antarctica to Raoul Island

Data transport
multiple layers of redundancy
4G and satellite

Data collection, processing and storage
Over 350 TB of data
Mix of in-house and science software

Data dissemination services
Raw and derived data
Standard and in-house web services
General public communications
Monitoring, response and Science Advice (with wider ESNZ)

GeoNet Data

domain	raw/basic	derived	peril
seismic	Waveforms FELT data	Event data, Peak ground acceleration, Response spectra Intensity values Earthquake catalogue ($$), Moment tensors ($$)	Earthquakes Volcanoes Tsunami landslide
geodetic	GNSS raw and basic	Ground displacements	Earthquakes Volcanoes landslides
Ocean and lakes	Sea level waveforms	Relative sea level changes, tides	tsunami
camera	Camera images		volcanoes
geomagnetic	waveforms	Magnetic field changes	Space weather
acoustic	waveforms		volcanoes
Environmental	gas emissions, air and water temperature, soil moisture, rainfall, wind)	Gas and water geochemistry Volcano activity bulletins and alert levels	Volcanoes landslides
Manually collected		gas emissions, air and water temperature	volcanoes

GeoNet Data Archive

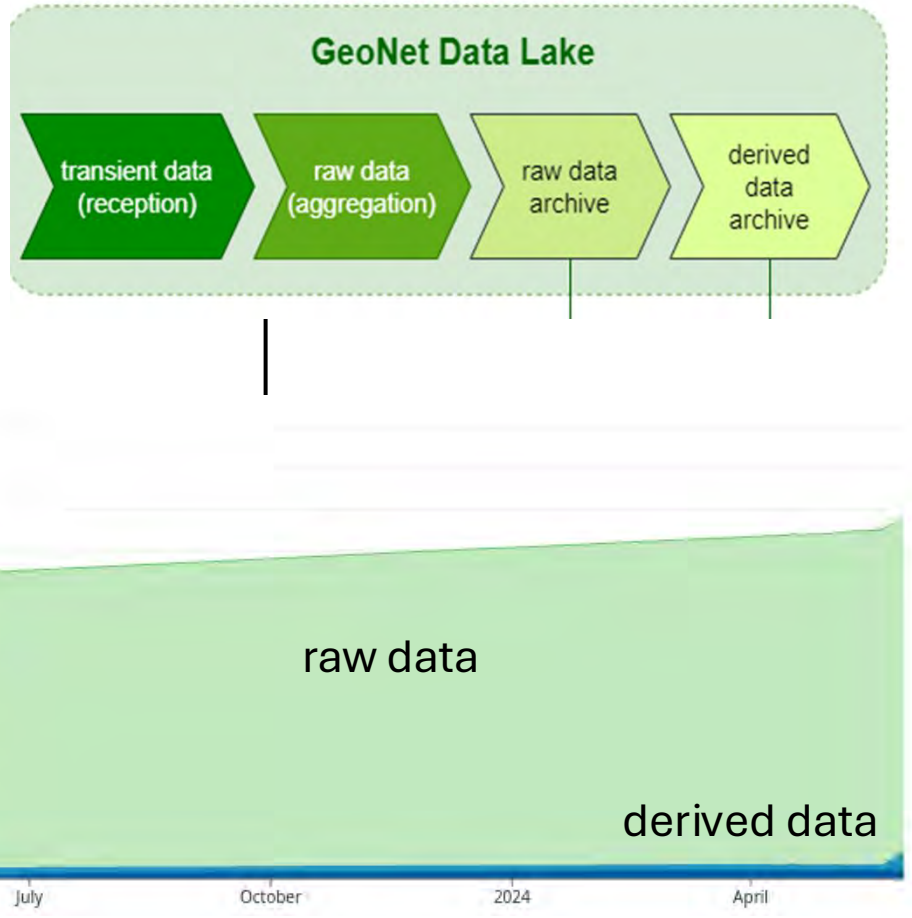
GeoNet data are collected, stored and processed in AWS (Amazon Web Services). Data are stored in a "data lake", with different levels of redundancy depending on how hard is to re-generate them.

Total data holdings volumes

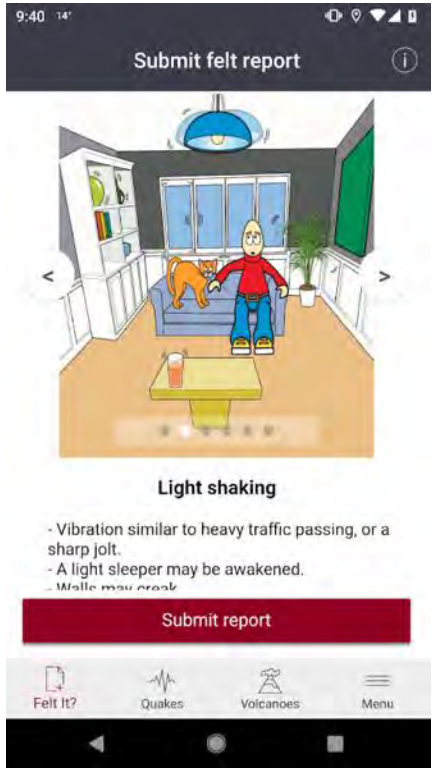
390 TB

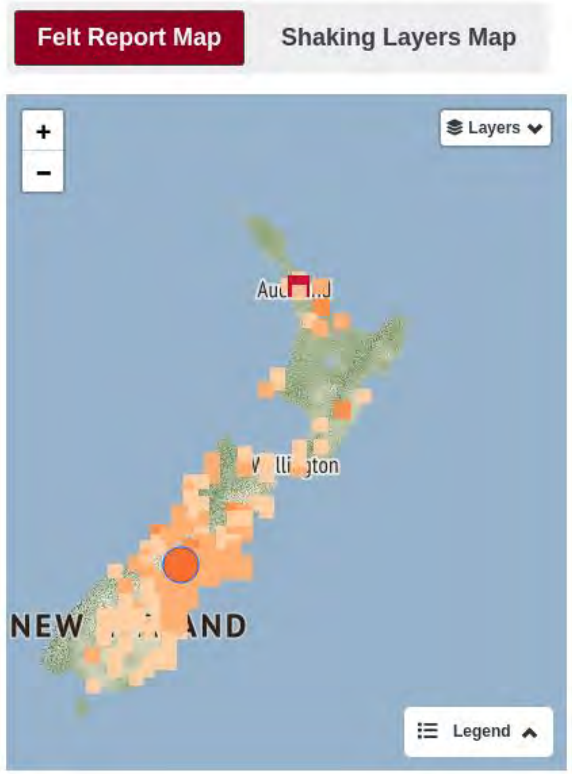
Raw data volume

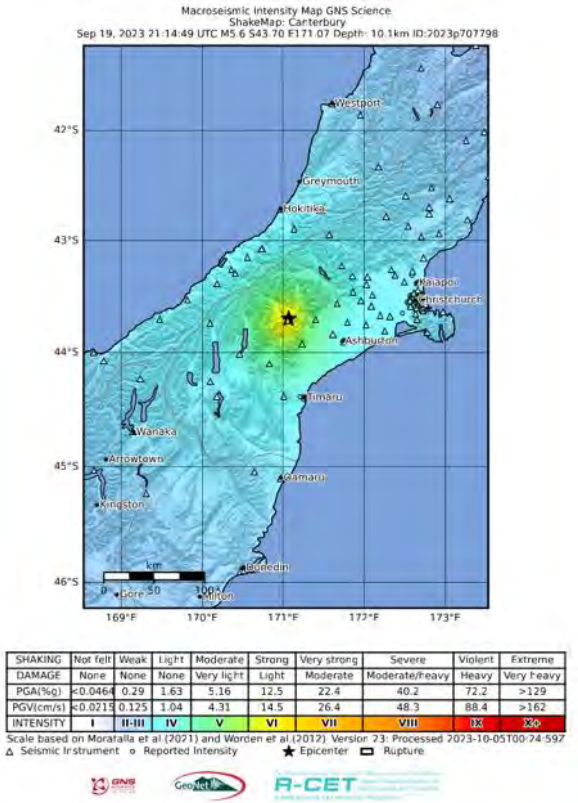
180 TB

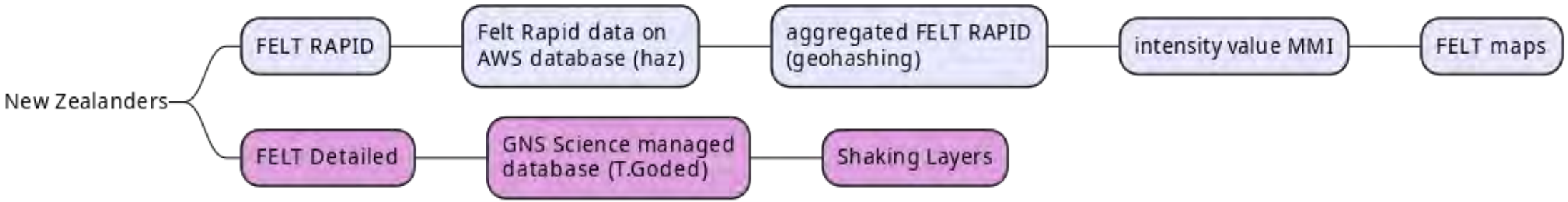


Citizen Science: Felt Reporting









Geohazard Monitoring

- The National Geohazards Monitoring Centre is a service within the GeoNet programme that monitors New Zealand geohazards.
- They keep close tabs on GeoNet data and networks – locating earthquakes, monitoring DART sensors and volcano cameras, and more.
- The NGMC works closely with on-call duty officers and peril-based expert panels to make decisions about the hazards being monitored.

Enhanced monitoring and Response

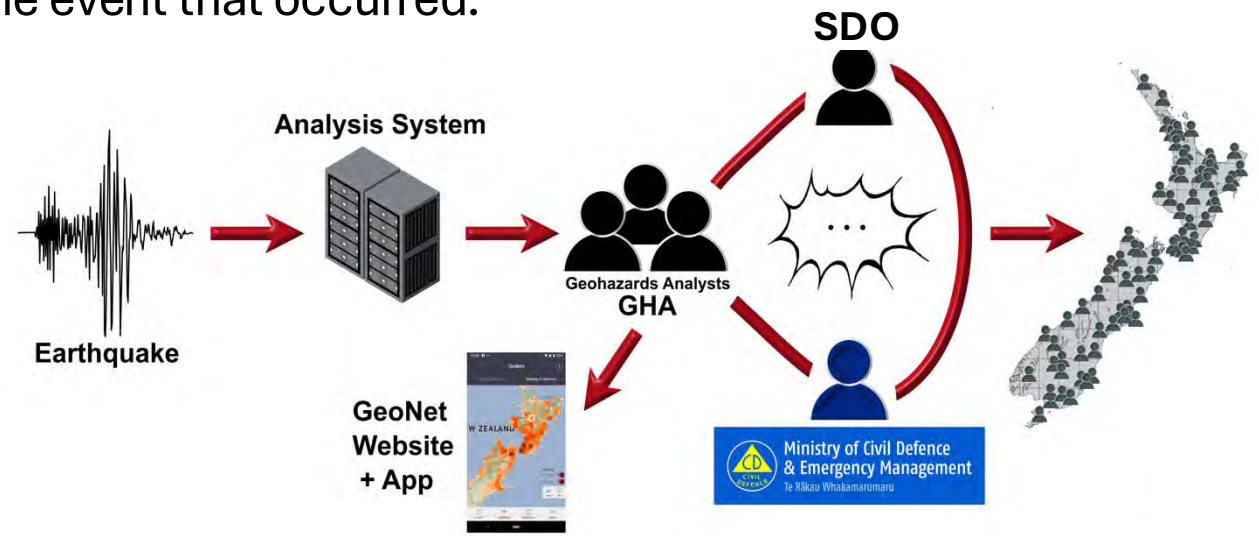
- Sometimes conditions, such as unrest at a volcano or significant expected rainfall, warrant enhanced monitoring. Conditions requiring enhanced monitoring can exist following an event as well.

- On-call duty teams and expert panels in volcanology and tsunami science (and soon, seismology as well) are also supported by the GeoNet programme.

- These teams and the NGMC work together to determine what additional action (enhanced monitoring) may be required.

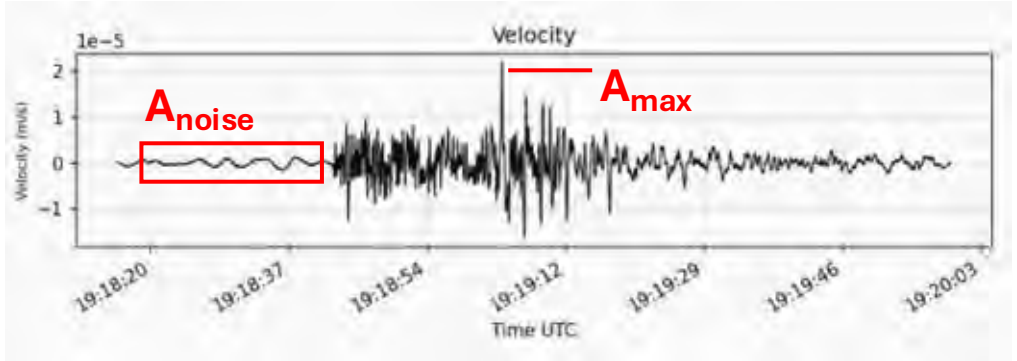
Response

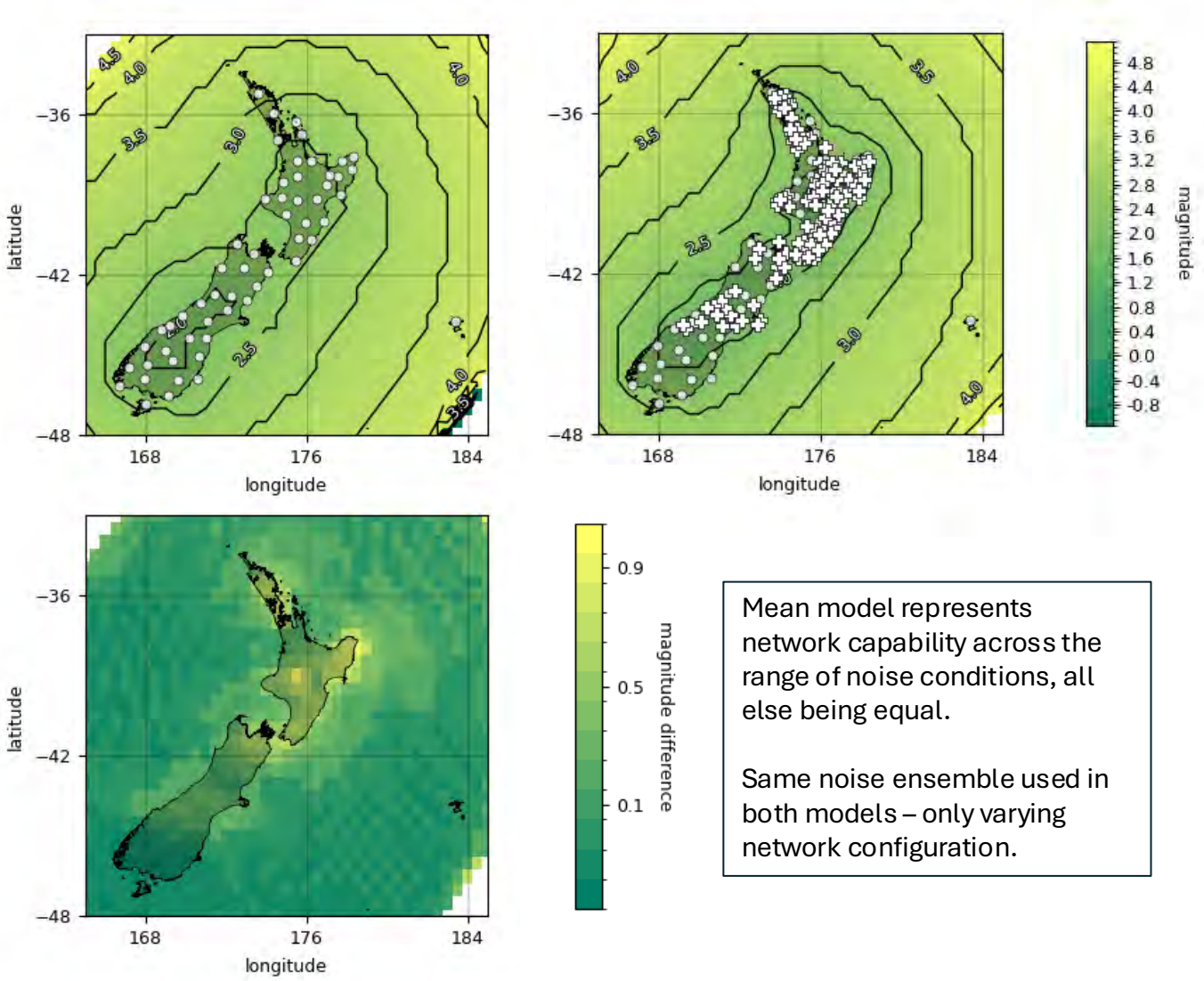
- When an event happens, the NGMC moves into response mode.
- The NGMC quickly escalates to the on-call duty teams and they work together to provide rapid bespoke advice.
- Expert panels can be called to further support rapid response.
  These are best endeavours panels who use bespoke science tools and expertise to quickly refine understanding of the event that occurred.



Sensor Network Capability Modelling

- Estimating the minimum detectable earthquake magnitude using noise ensembles
- Technique uses obspy, pandas, numpy, scipy, matplotlib, geopandas to process data and produce visualisations
- **Example:** with and without regional seismic networks



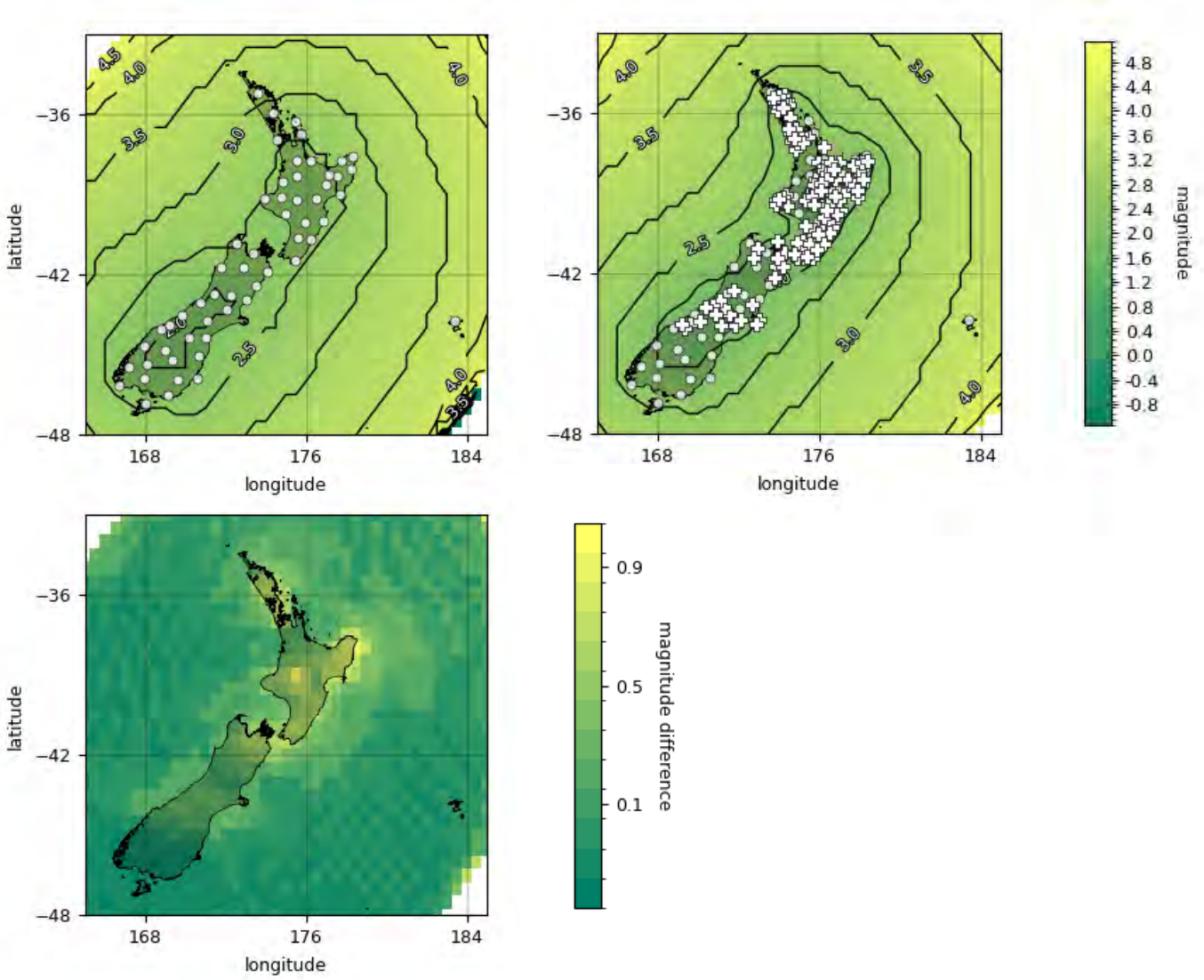


Sensor Network Capability Modelling

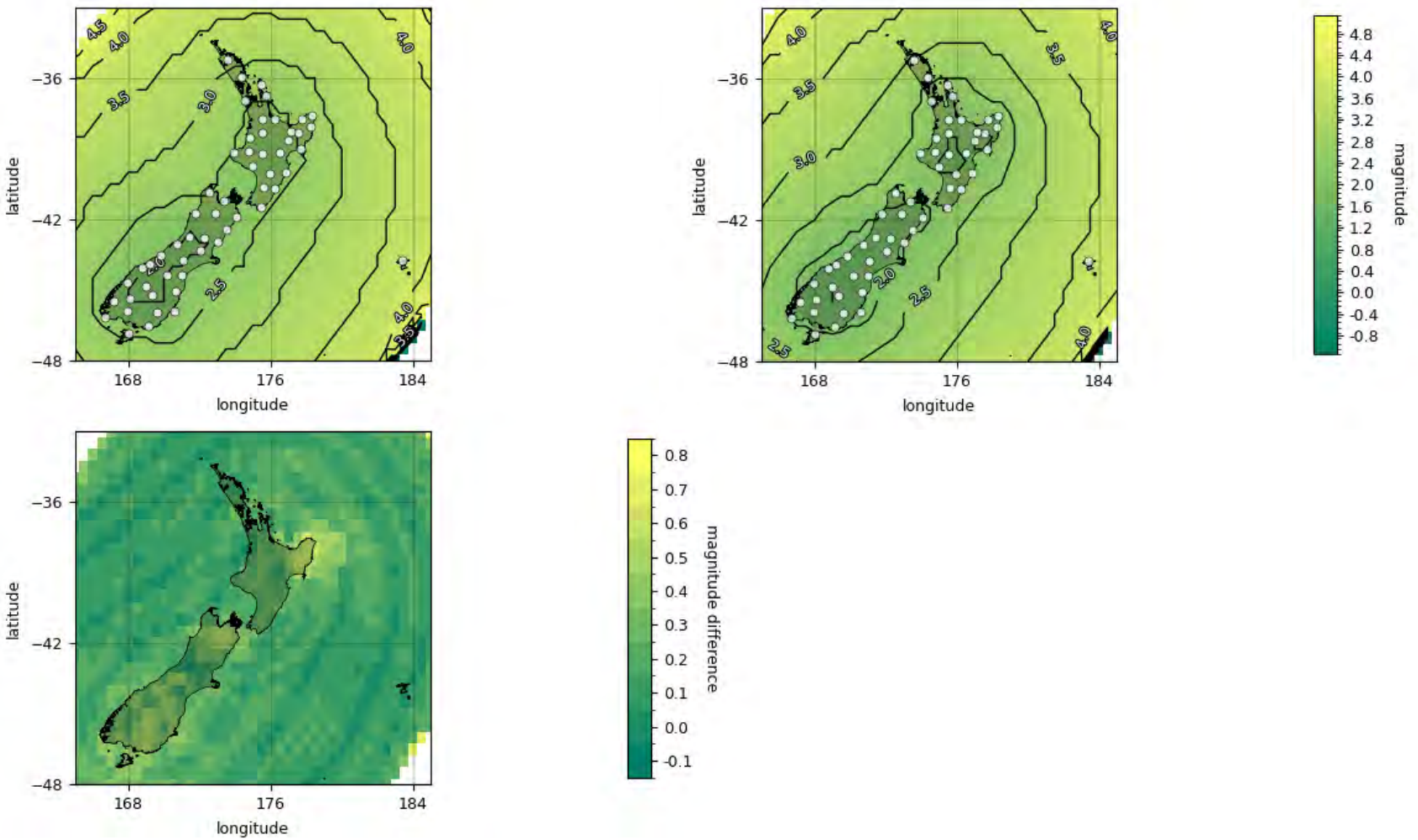
- The underpinning model can vary:
  - Detection threshold
  - Station threshold
  - Earthquake depth
  - Noise conditions
  - Network configuration

- Used for informing network development and management

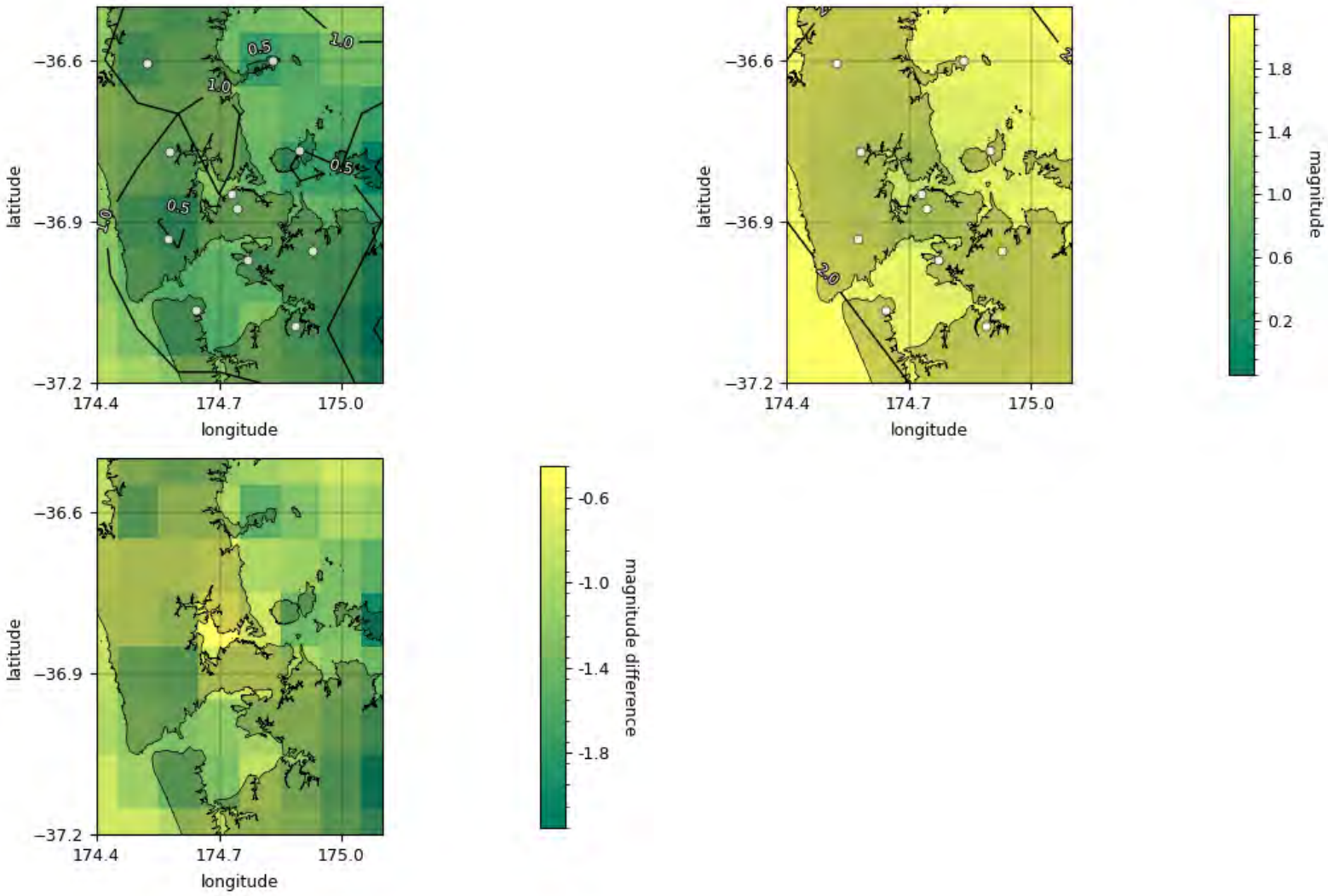
- **Audience:** network managers, stakeholders



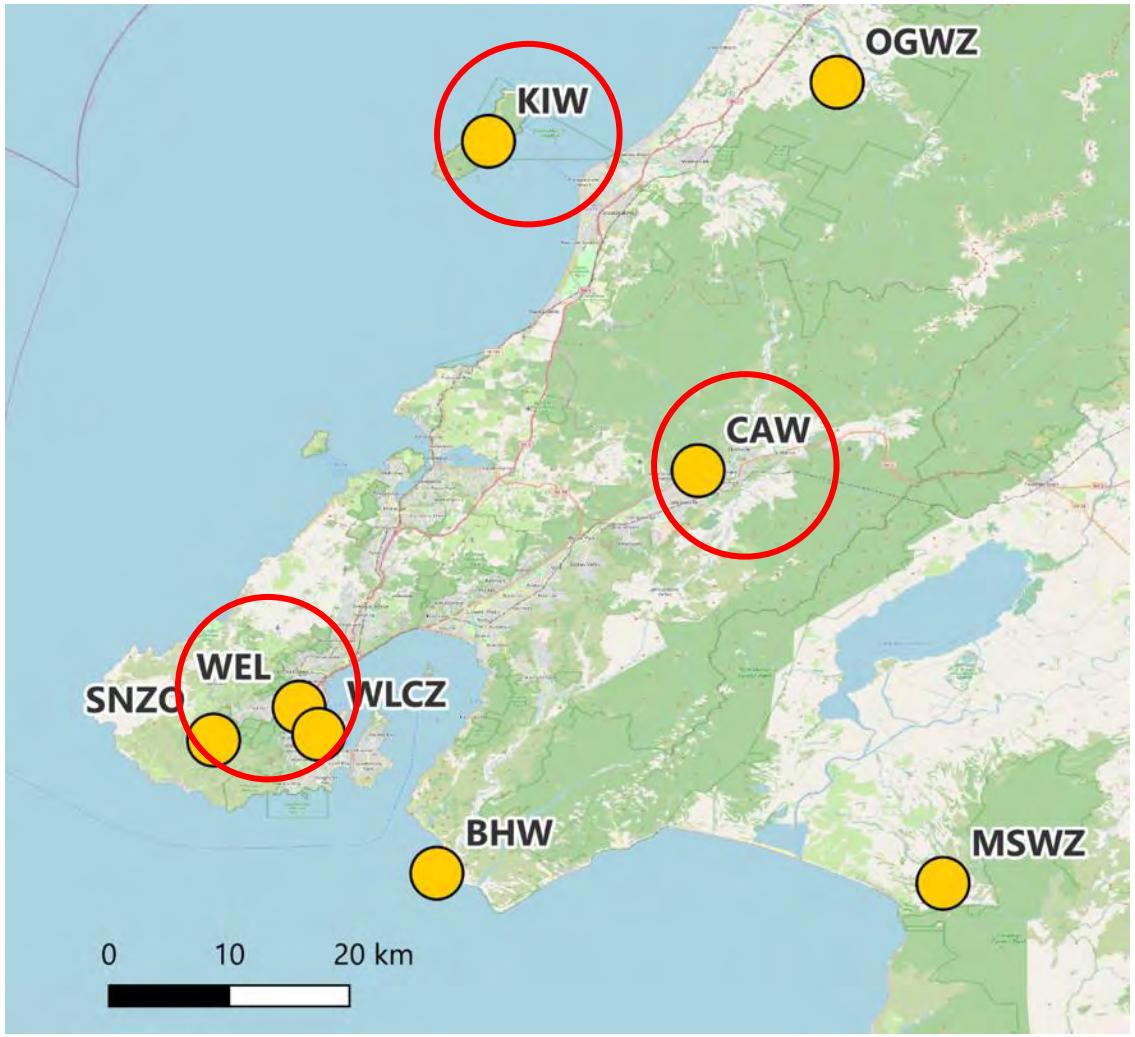
Example: 6 detections for an event

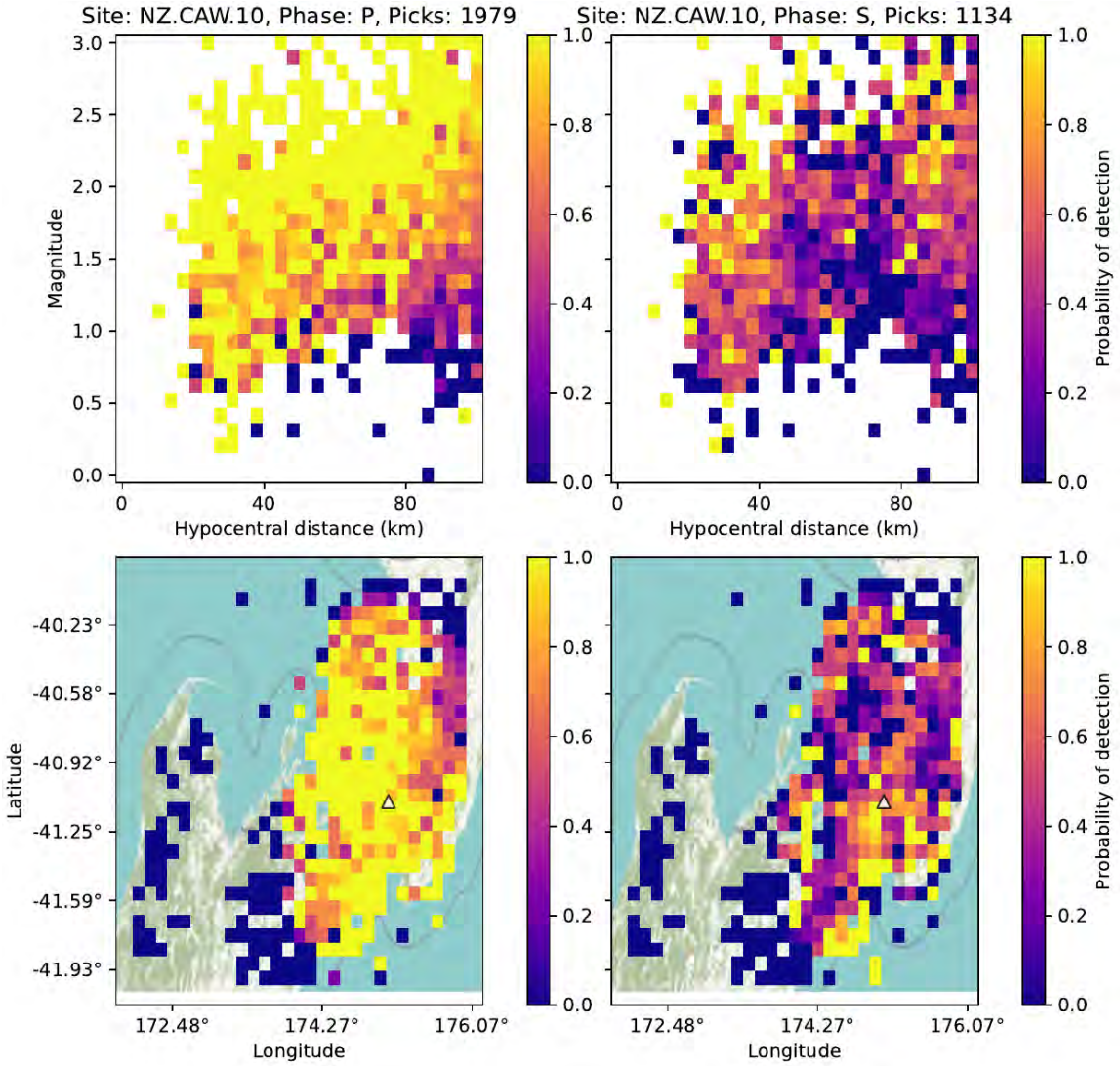


Example: Auckland Surface Seismometers



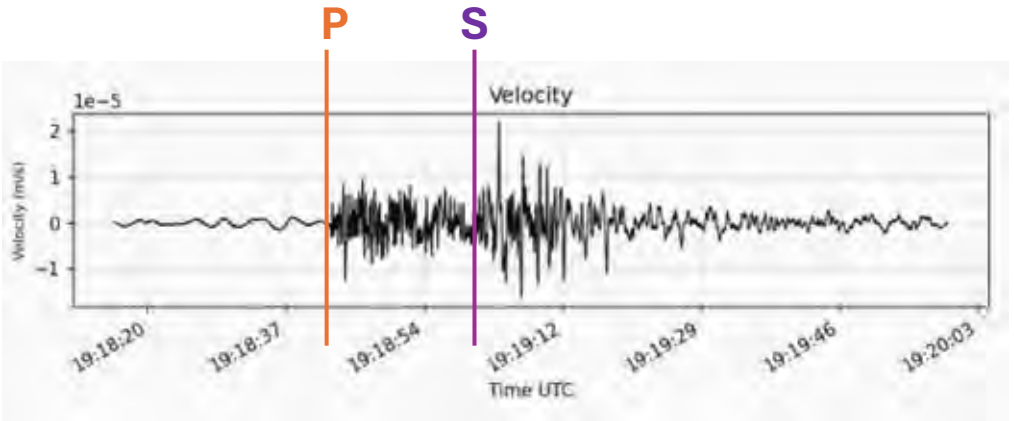
Station Capability Studies

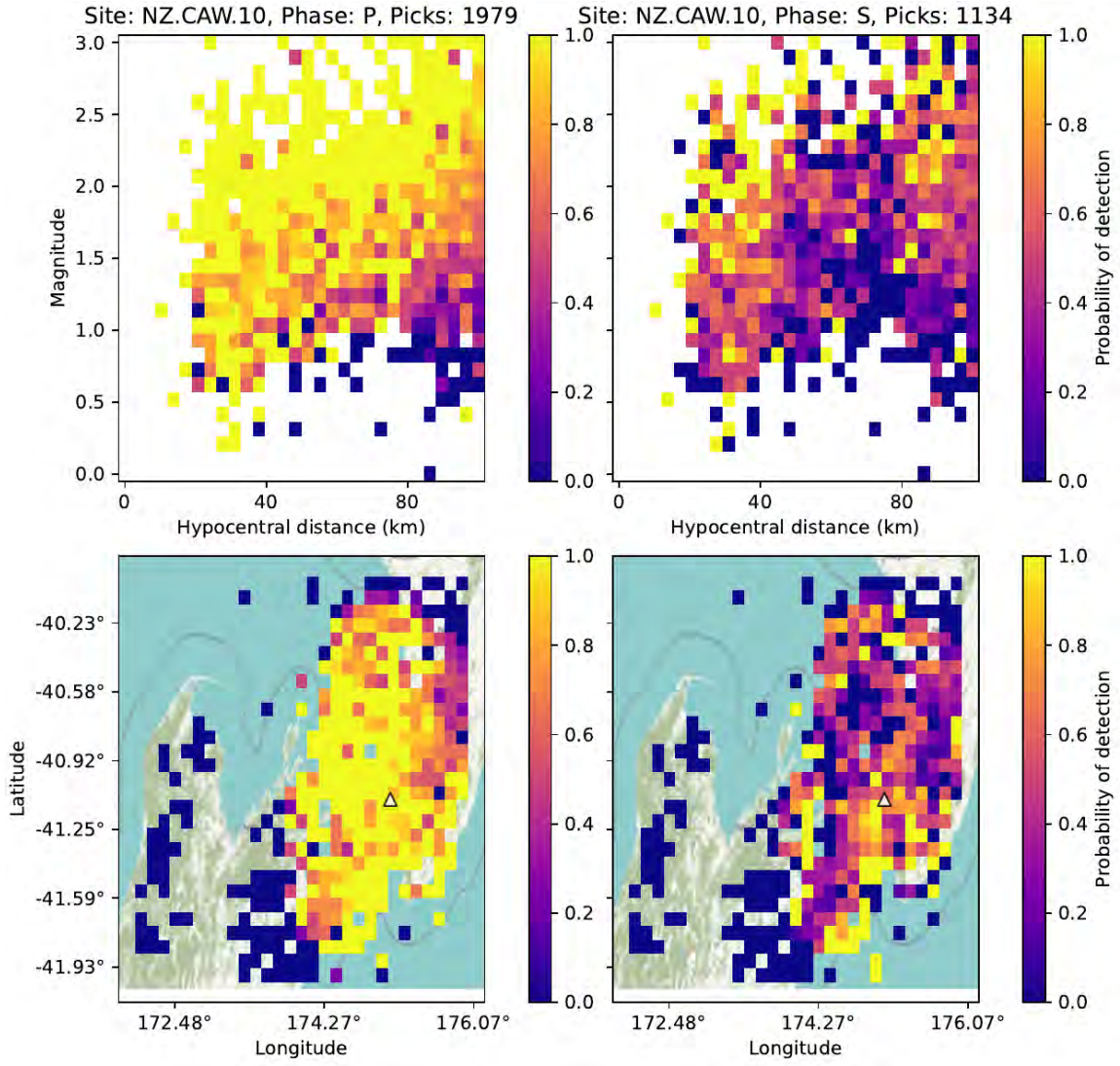




Station Capability Studies

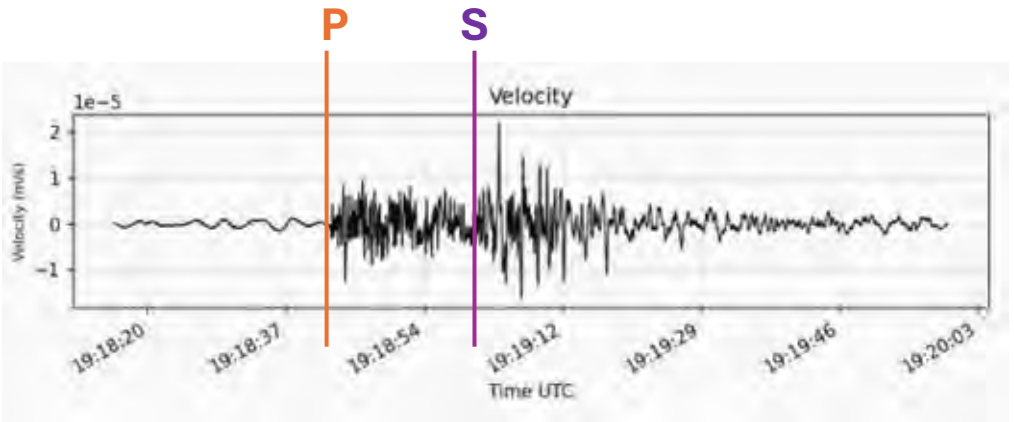
- Empirical representation of station capability for earthquake phase picking
- Holds full complexity of earthquake detection: source, path, site effects and noise variations
- **Example:** Cannon Point station

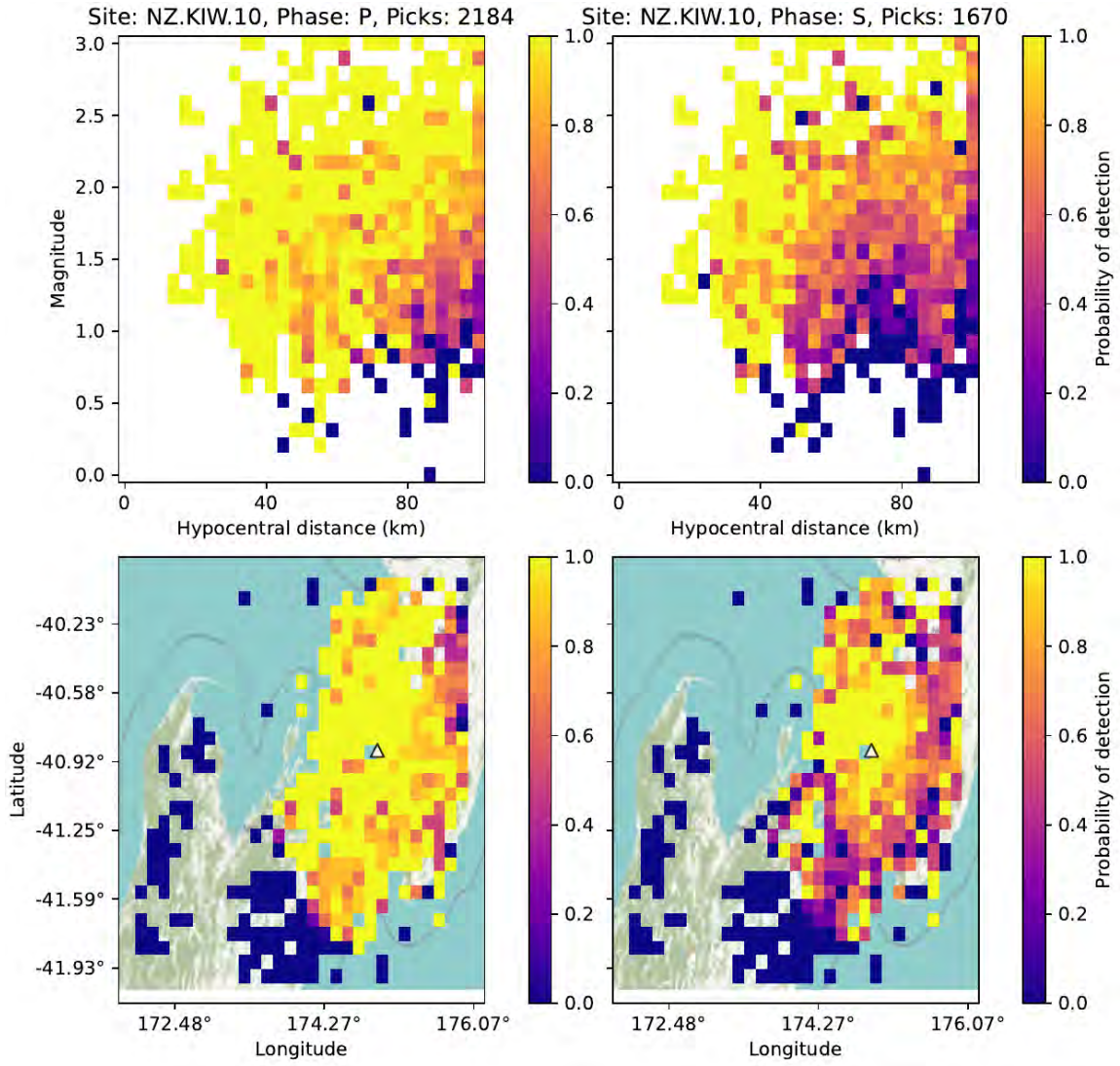




Station Capability Studies

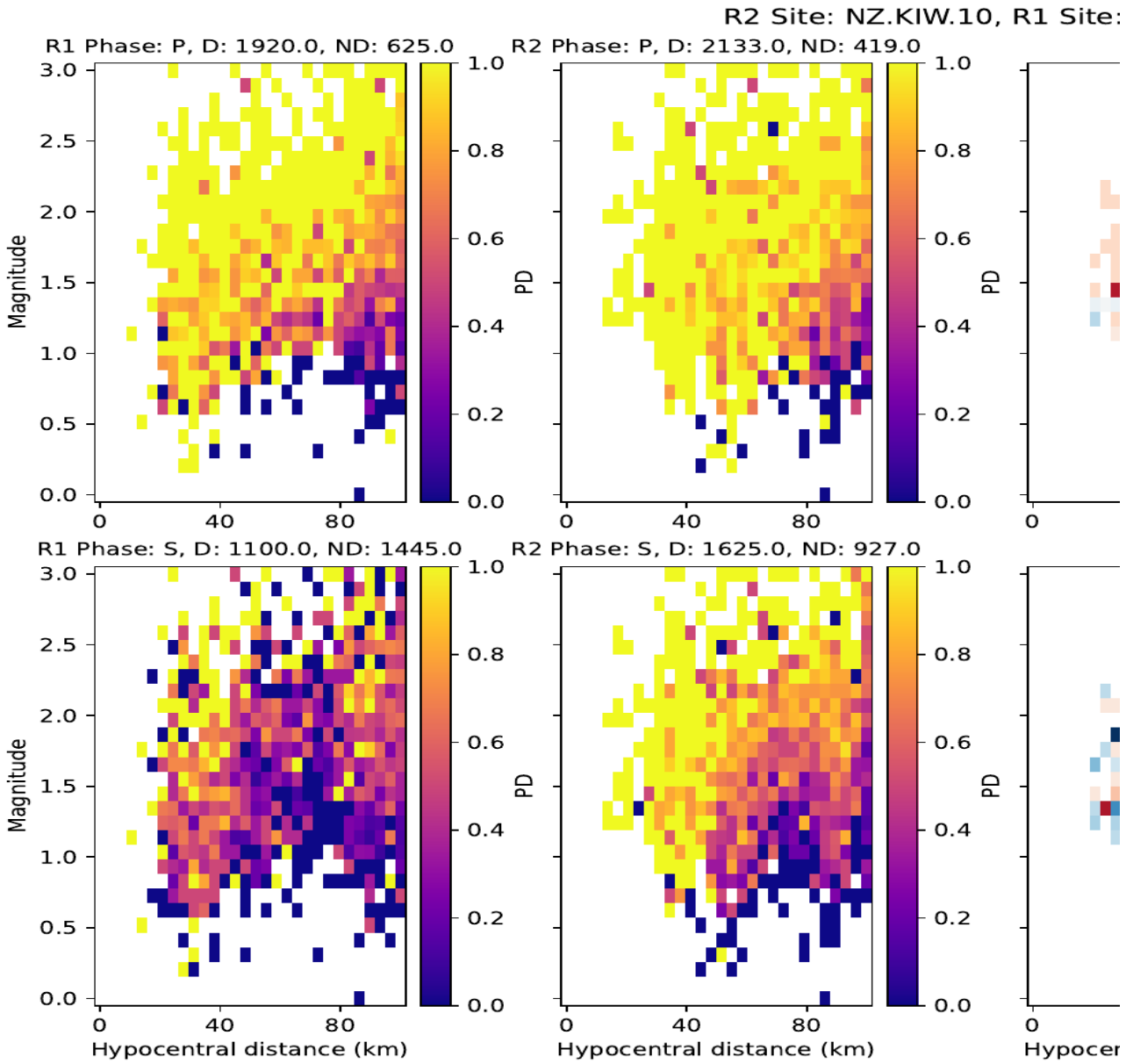
- Empirical representation of station capability for earthquake phase picking
- Holds full complexity of earthquake detection: source, path, site effects and noise variations
- **Example:** Kapiti Island station





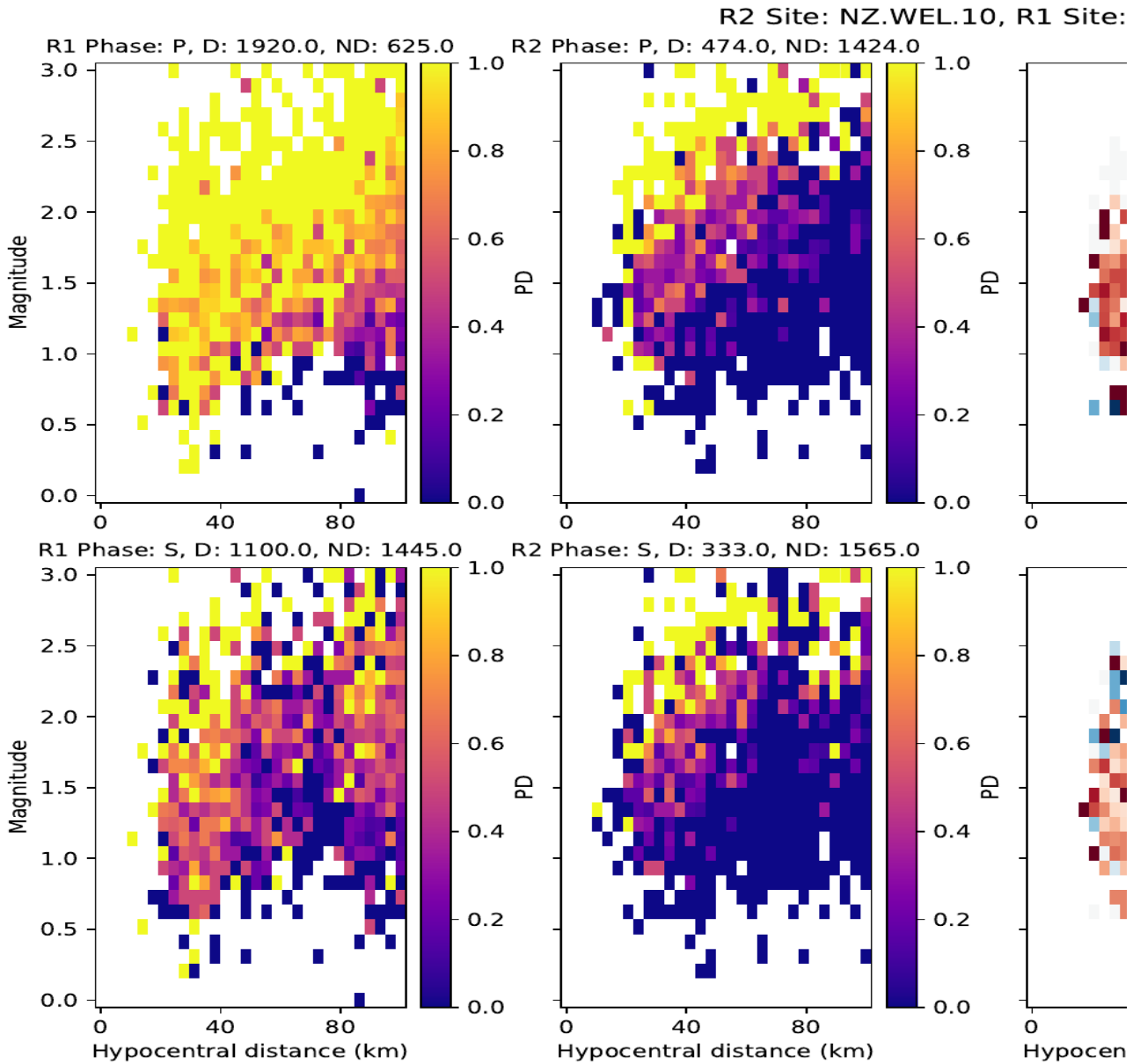
Station Capability Studies

- Can compare across stations by using equal bins
- Have to consider variances in data count in bins and underlying data
- Useful for identifying issues and comparing station performance
- **Example:** KIW – CAW
- **Audience:** seismologists, network managers



Station Capability Studies

- Can compare across stations by using equal bins
- Have to consider variances in data count in bins and underlying data
- Useful for identifying issues and comparing station performance
- **Example:** WEL - CAW
- **Audience:** seismologists, network managers



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