COP31 | EARTH INFORMATION DAY

Integrated observations for climate modelling and services

What do we observe well?
Where are the gaps, and why do they matter?



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Where do observations still limit climate information?

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We can track many global changes well. Regional processes and local extremes are less well observed.

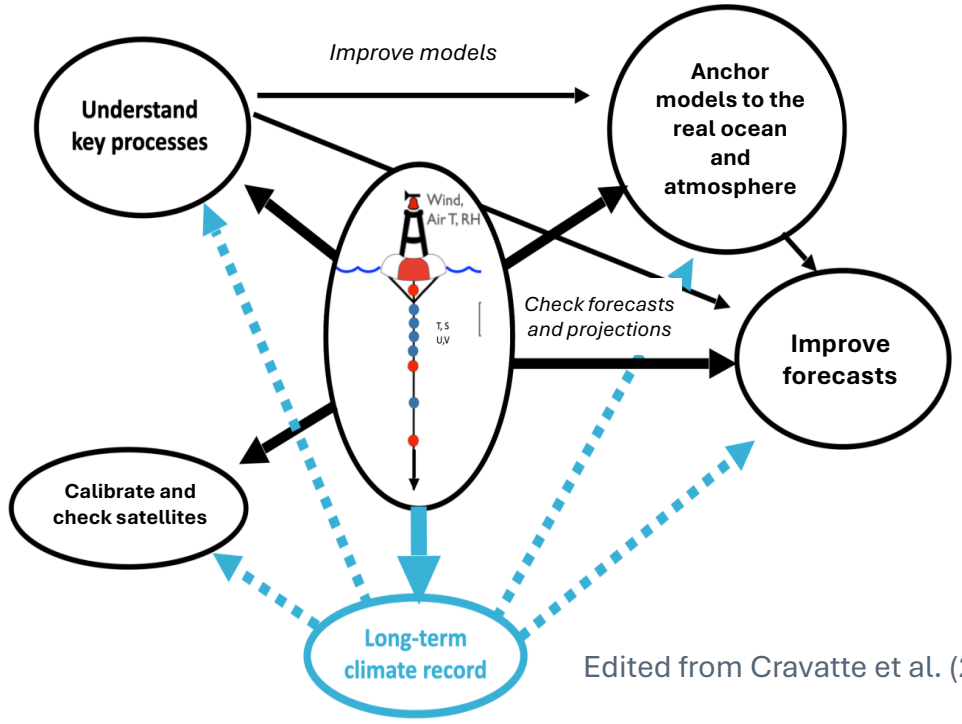
OCEAN AND SEA LEVEL
Coastal sea level, land motion and extremes

CRYOSPHERE (ICE SHEETS, GLACIERS, SEA ICE AND SNOW)
Sparse in situ observations of ice–ocean processes and permafrost

SMALL ISLANDS AND VULNERABLE COASTS
Local rainfall, ocean and sea-level change

DRYLANDS
Rain gauges, soil moisture and intense rainfall

How observations support models and forecasts



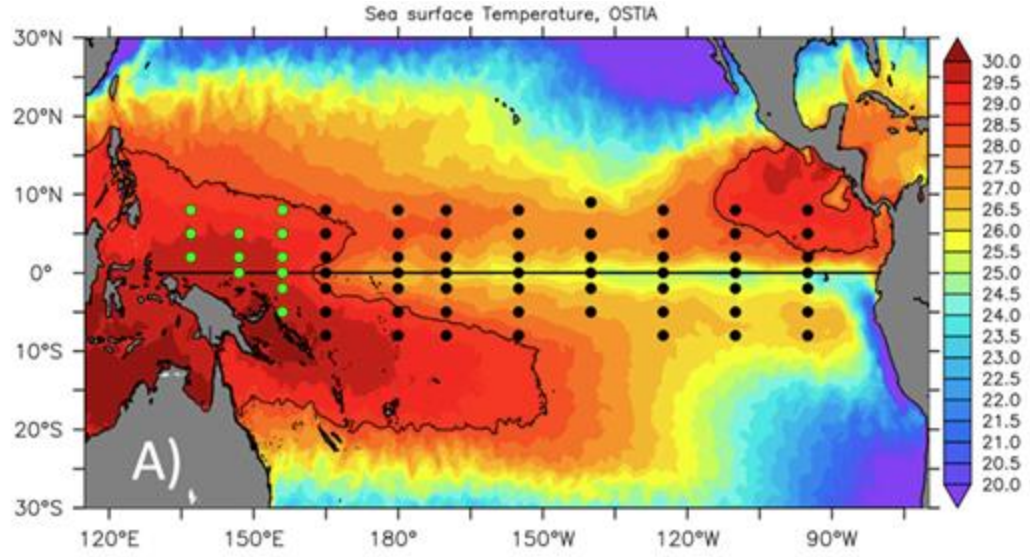
Edited from Cravatte et al. (2026)

Forecasts use observations to set their starting point and stay on track. Climate projections depend on sustained observations to understand processes and test models.

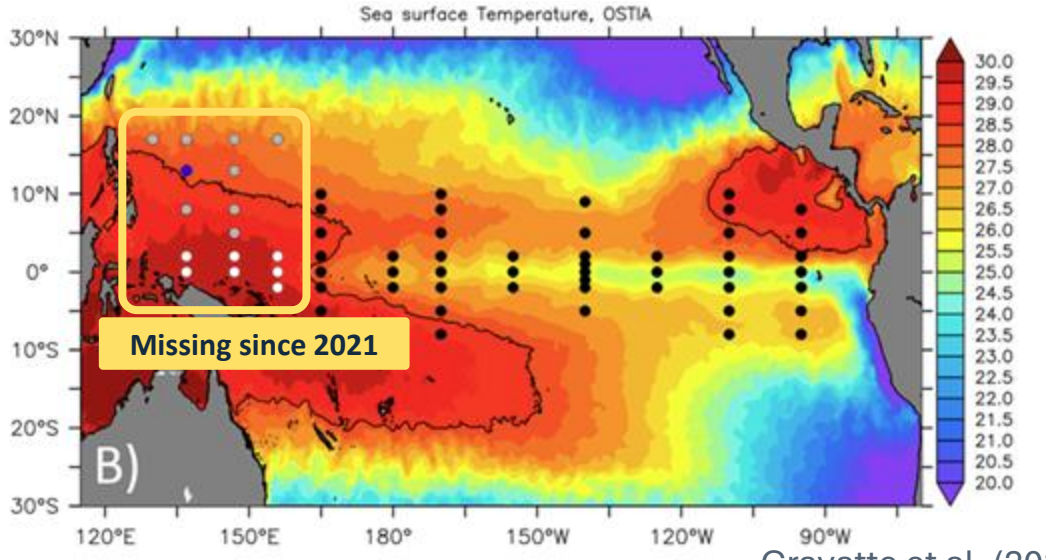
A major gap in the tropical Pacific observing system

No near-equatorial moorings west of 165°E since 2021

Historical moorings: 67



Current moorings: ~40



Cravatte et al. (2026)

OBSERVATION GAP

Missing high-frequency, co-located air–sea records

WHY IT MATTERS

El Niño processes and seasonal forecasts

And in situ observations remain deficient in parts of Africa, South America, Southeast Asia, the deep ocean and polar regions.

Sea level: well measured globally, much less so locally

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Global sea level is well monitored. Local sea level is not, and local factors must be included in models to project local sea-level change.

11 cm

Global average sea-level rise, 1993–2025

Source: WMO State of the Global Climate 2025

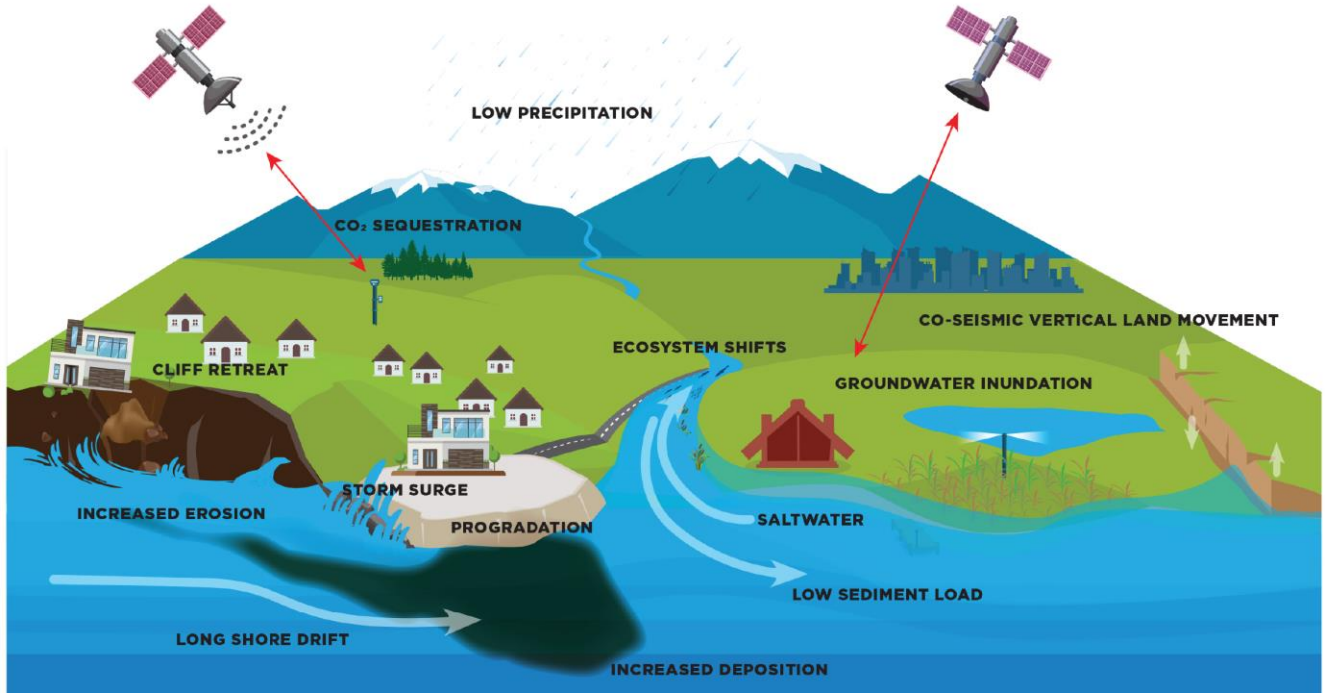
Local factors add to this

Up to 50 cm

Local (relative) sea-level rise, from local factors such as sinking land and ocean dynamics

Source: Nicholls et al. 2021; Dangendorf et al. 2023



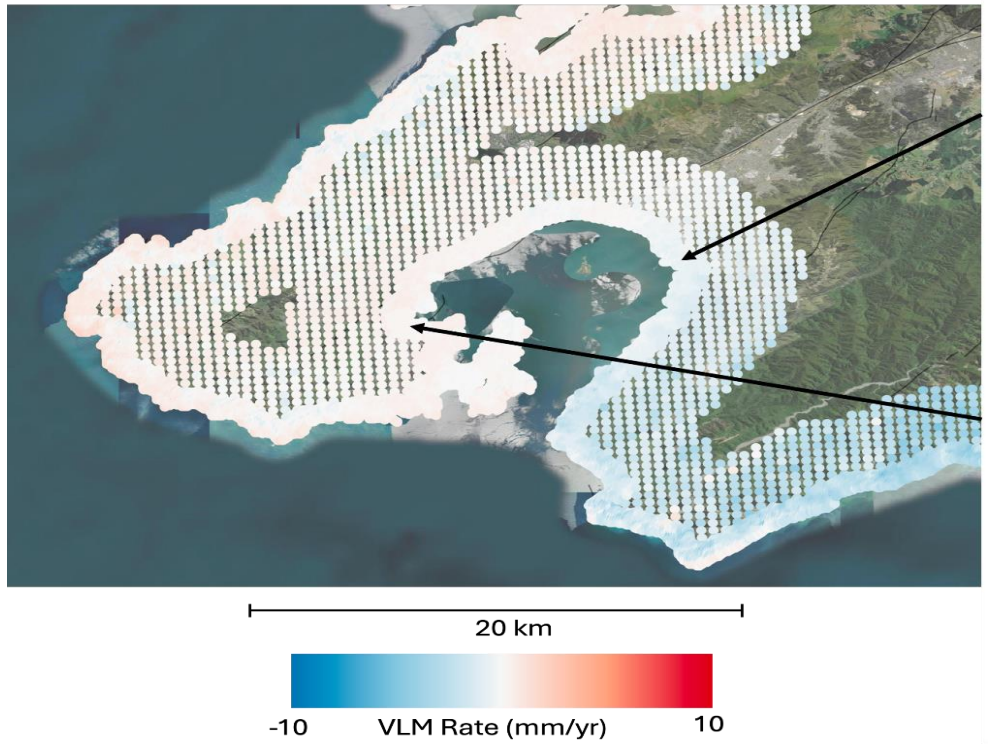


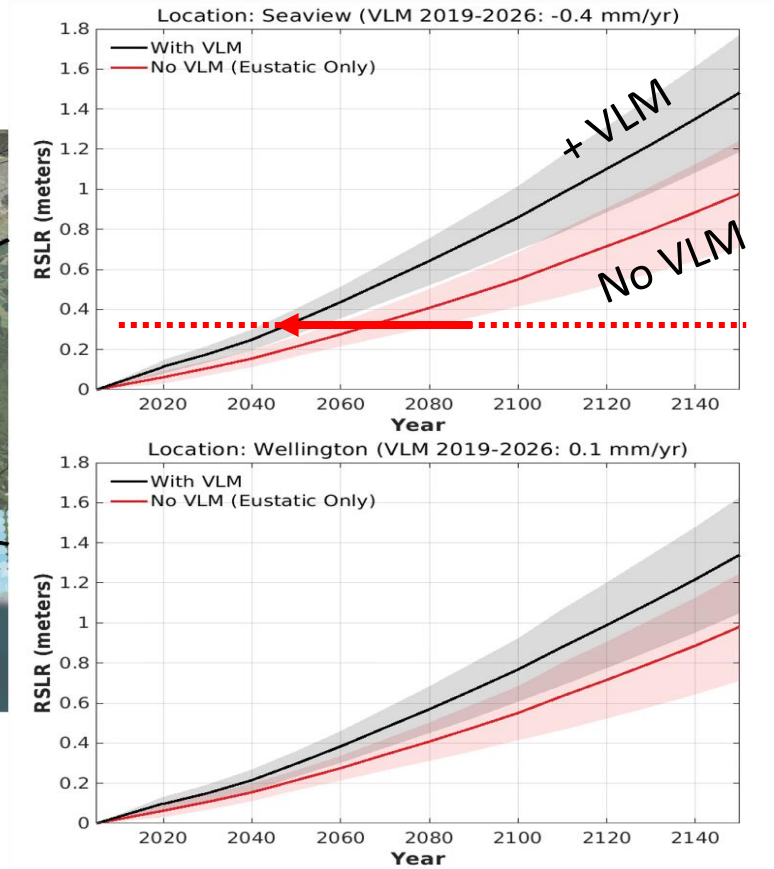
What is needed?

- Sustained and expanded observations around the Antarctic ice sheet and of ocean interactions
- Sustained coastal observations (tide gauges, land motion) and regional modelling to assess local sea-level risks.

Vertical land motion (VLM) changes local sea-level projections

Satellites, GNSS and tide gauges are complementary — all are needed for coastal planning.





Satellite systems

GNSS and InSAR measure land motion

Tide gauges

Measure relative sea level

Model local risk

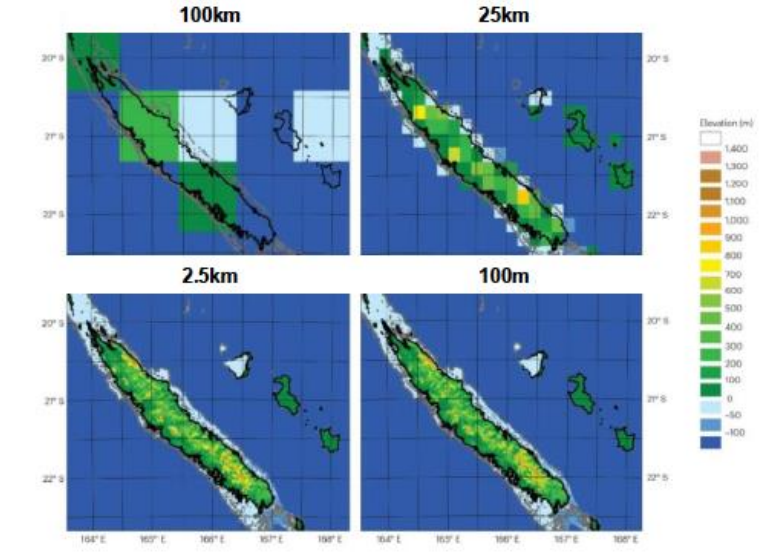
Assess when flood thresholds may be reached

Local vertical land motion map and relative sea-level projections: material supplied by Tim Naish / NZ RISE

Regional models need local observations

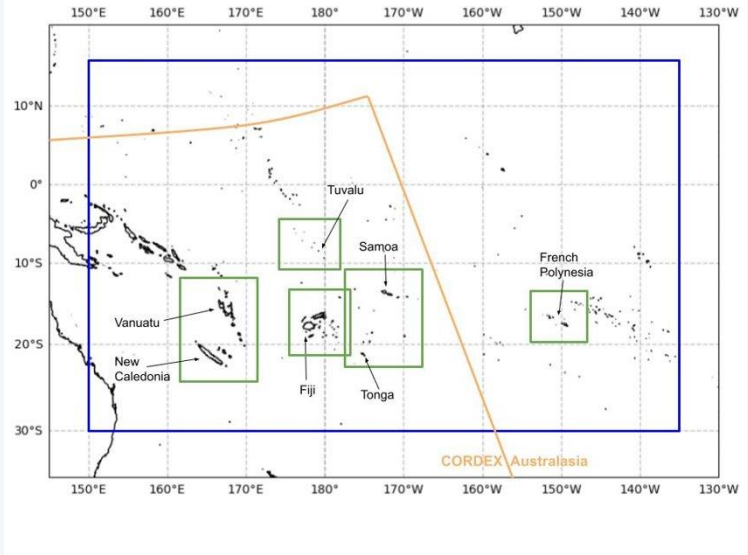
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Global models cannot see small islands. Regional models can, but only if local observations test them.



At global-model resolution, an island almost disappears

New Caledonia at 100 km, 25 km, 2.5 km and 100 m resolution. Evans et al. (2024)



Pacific island domains

CORDEX pilot study: high-resolution future projections to understand regional climate risks.

Local observations

Island rain gauges, coastal sea-level records and ocean observations test the models.

Regional models

Kilometre-scale simulations show coastal extremes and are checked against observations.

Hazard and risk tools

Model output feeds hazard maps, risk assessments, early warning and adaptation planning.

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Climate information inequity

Gaps in observations are not limited to sea level, and the capacity to fill them is uneven.

EXAMPLES OF PHYSICAL GAPS

- Tropical Pacific: buoys missing since 2021
- Coasts and small islands: local sea level poorly measured
- Drylands and polar regions: sparse local records

THE INEQUITY

The nations most exposed often have the least observational capacity.

Sea level is one example: it is not rising evenly, and neither is the ability to see it coming.

WHAT IS NEEDED

Keep long-term observations going, especially where capacity is weakest

Fill the gaps that matter most for decisions

Turn observations into lasting local services, not one-off projects

WCRP is contributing to this through...

Research that reveals which observations are needed for robust science, coordinates process research and model evaluation, and connects global and regional research communities.

Working with the Global Climate Observing System (GCOS), the Global Ocean Observing System (GOOS), observing agencies and national partners.

Thank you

wcrp-climate.org/

