Understanding Future Sea-level Change Around Antarctica

Matt King[1], Richard Levy[2], Terry Wilson[3], Fraser Morgan[4], Tim Naish[5]

1. The Australian Centre for Excellence in Antarctic Science and University of Tasmania; 2. GNS Science and Victoria University of Wellington; 3. Ohio State University; 4. Manaaki Whenua Landcare Research; 5. Victoria University of Wellington

Summary

Sea levels around the Antarctic coastline will change in the future. In some locations, sea levels could *fall*. This has implications for how we operate in, manage, and protect the region. Research related to sea-level change is ongoing, but key relevant information is presented here.

- Sea-level change around the Antarctic coastline will vary significantly, especially if more ice mass is lost from a particular region than others (e.g., West Antarctica). Under the highest global carbon-emissions scenarios, and if 'low-confidence' ice sheet processes play out, sea-level will 'likely' *rise* by as much as ~1.2 m in some regions of Antarctica by the end of the century and *fall* by as much ~2.2 m in other regions at the same time.
- Accurate anticipation of sea-level change for the coastline of Antarctica, and its associated impacts, requires improved location-specific knowledge of (i) changes in vertical land elevation due to Earth processes and ice mass loss; and (ii) changes in sea level elevation due to ice mass loss and associated changes in Earth's gravitational field and rotation (see **Figure 1**).
- The impacts on Antarctic built infrastructure, operations including science and science support, heritage sites, bioregions, ecosystems and specially protected and managed areas will be complex. Understanding that complexity will depend on accurate knowledge of the rate and direction of future sea-level change. **Figure 2** shows one example.
- Making substantial improvements to current sea-level projections for Antarctic coastlines is included within the work plans for SCAR INSTANT for the period leading up to ATCM XLVI (2024).
- Accurate knowledge of rates of vertical land motion depend on national programs deploying and maintaining geodetic quality GNSS equipment at sites potentially sensitive to sea-level rise. There are many locations where land motion is not understood (**Fig. 3**)
- Further information may be found in ATCM XLV (2023) Information Paper 095.

Figure 2: Example of potential sea level changes in Antarctica. The figure shows local sea-level projections for Scott Base with different ice sheet melt and vertical land motion (see Levy et al., 2020 for methods). Zero point is 2000 for 'Kopp 2014' and 'Bamber 2019 H' projections, 1998 for Stocchi LGM-RCP8.5 projection, and the mean annual value for 2003 for the Scott Base tide gauge. Photo at right shows waves breaking over reverse osmosis (RO) water intake at Scott Base. Future sea level rise *or fall* is dependent on our future emissions pathway, but any change will affect the RO unit and associated infrastructure.

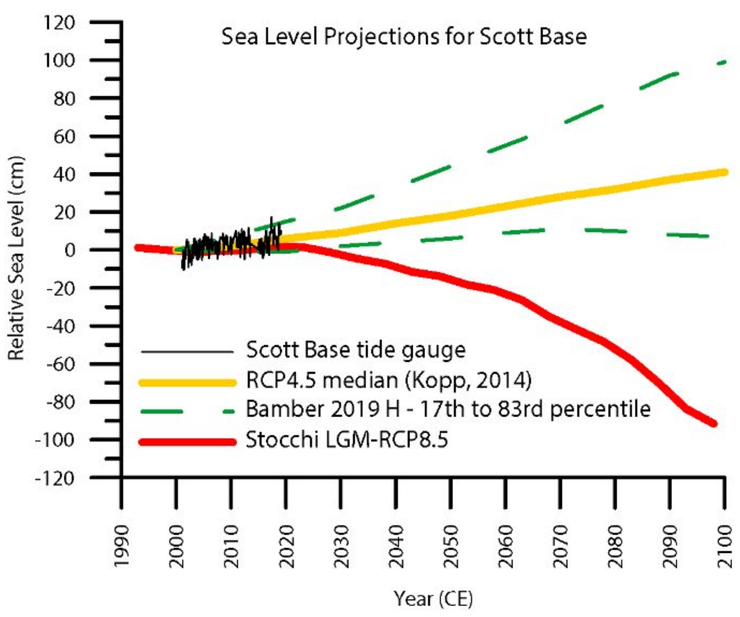
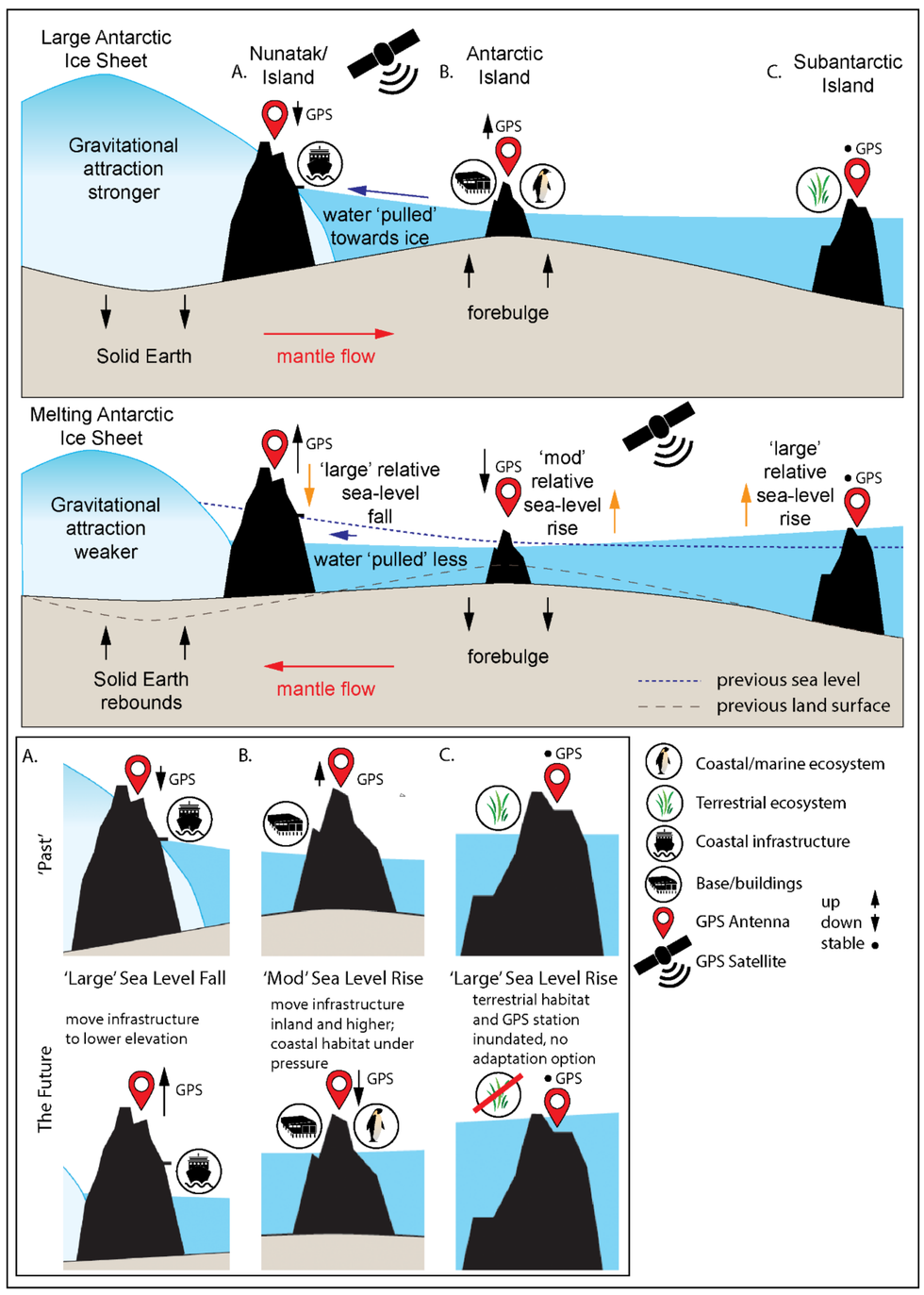


Figure 1: Conceptual diagram showing spatial variability in sea level due to changing ice mass and its effect on gravitational attraction and load on the solid Earth. A large ice sheet depresses the crust on which it sits and attracts water close to its margin – the sea floor rises in response to mantle flow away from the large ice mass forming a forebulge that causes a local decrease in relative sea level. Sea level falls next to a melting/retreating ice sheet (area A – Nunatak/Island) as the gravitational attraction decreases, despite land uplift due to isostatic rebound. Sea level rise occurs in areas where the forebulge subsides (area B – Antarctic Island) and in regions far from the ice sheet margin (area C – for example, a Subantarctic island) due to meltwater flux to the ocean and negligible gravitational attraction.



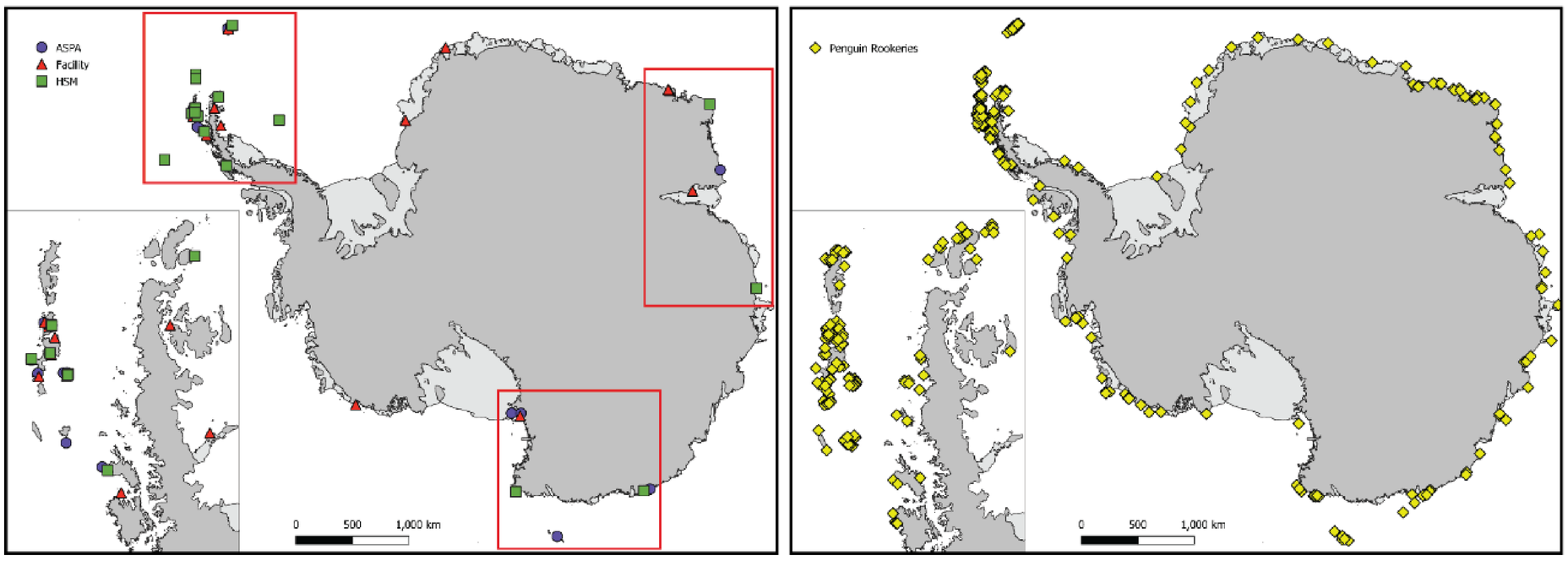


Figure 3: Sites of interest without precisely measured vertical land motion. Symbols indicate sites where we do not have a nearby (located within a radius of 50km - West Antarctica, or 100 km - East Antarctica) high quality GNSS time series from which present-day vertical land motion can be estimated. Note that assessment of quality and fitness of purpose of the existing GNSS records requires further work through SCAR's INSTANT and GIANT programs and the number of sites without requisite information may change. National programs are urged to deploy, maintain and release geodetic-quality GNSS data at sites potentially sensitive to sea-level rise.

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References: Levy, R., Naish, T., Golledge, N., Bell, R., Stocchi, P., Kopp, R., et al. (2020). Sea-level projections for New Zealand's Scott Base rebuild. *GNS Science report, 2020/13*, 18.