

Can environmental changes be linked to coral calcification in Fijian inshore reefs?



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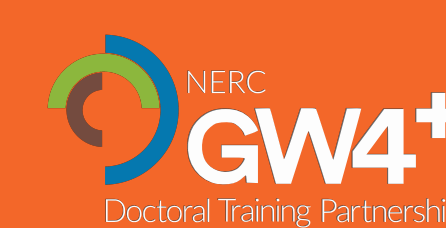
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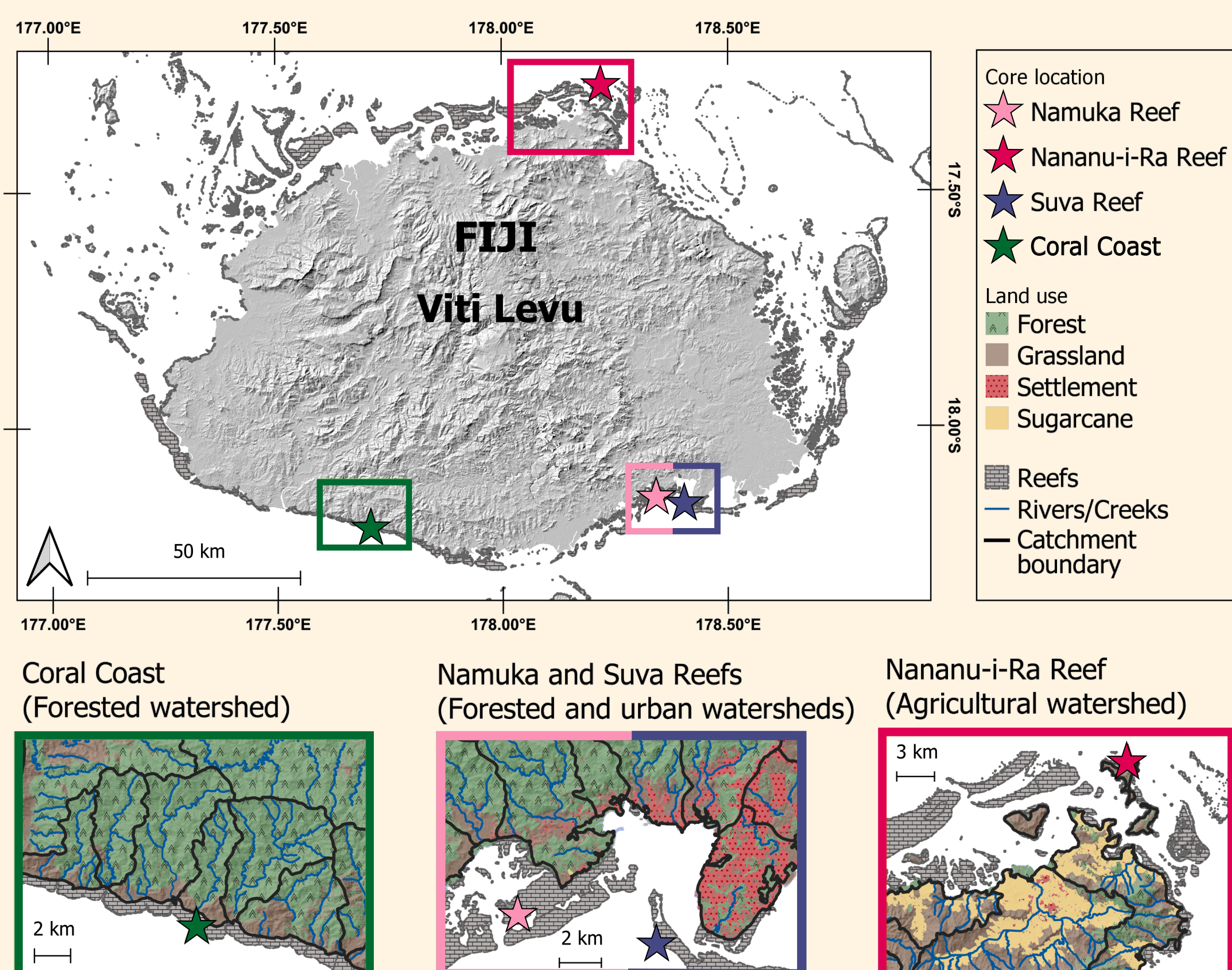
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What can coral records inform us about?

- Environmental conditions affect growth of reef-building corals^[1].
- In the next decades, corals are expected to experience both severe **thermal stress** and **chronic low water quality** in coastal regions^[2,3,4].
- Coral growth and geochemical records inform about **tolerance threshold** and aid understanding the **effects of changing environmental conditions** on reef ecosystems^[5].

Here we use *Porites* corals collected from 4 inshore reefs with different catchments to investigate **how coral growth has changed** in Fiji over the last 20 years, and to understand **sensitivity of reef-building corals to environmental changes**.



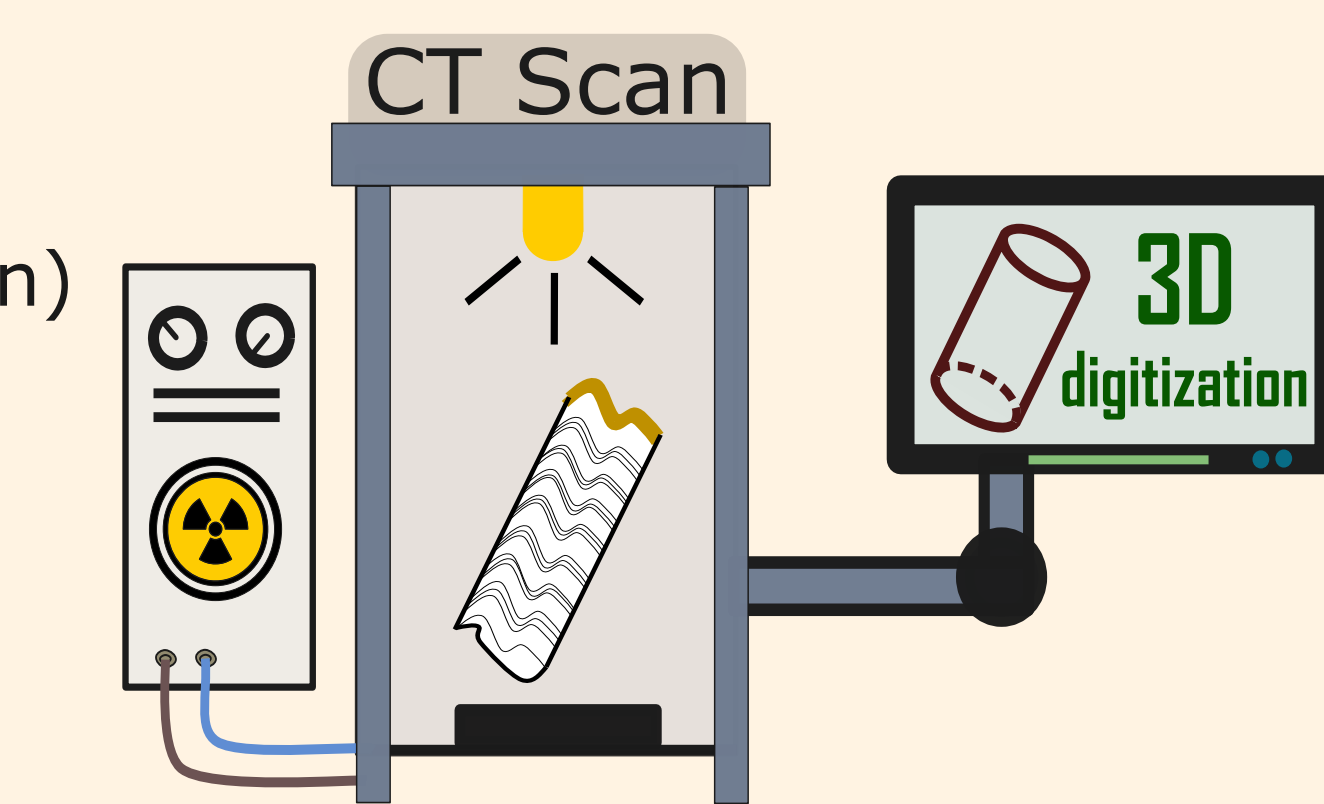
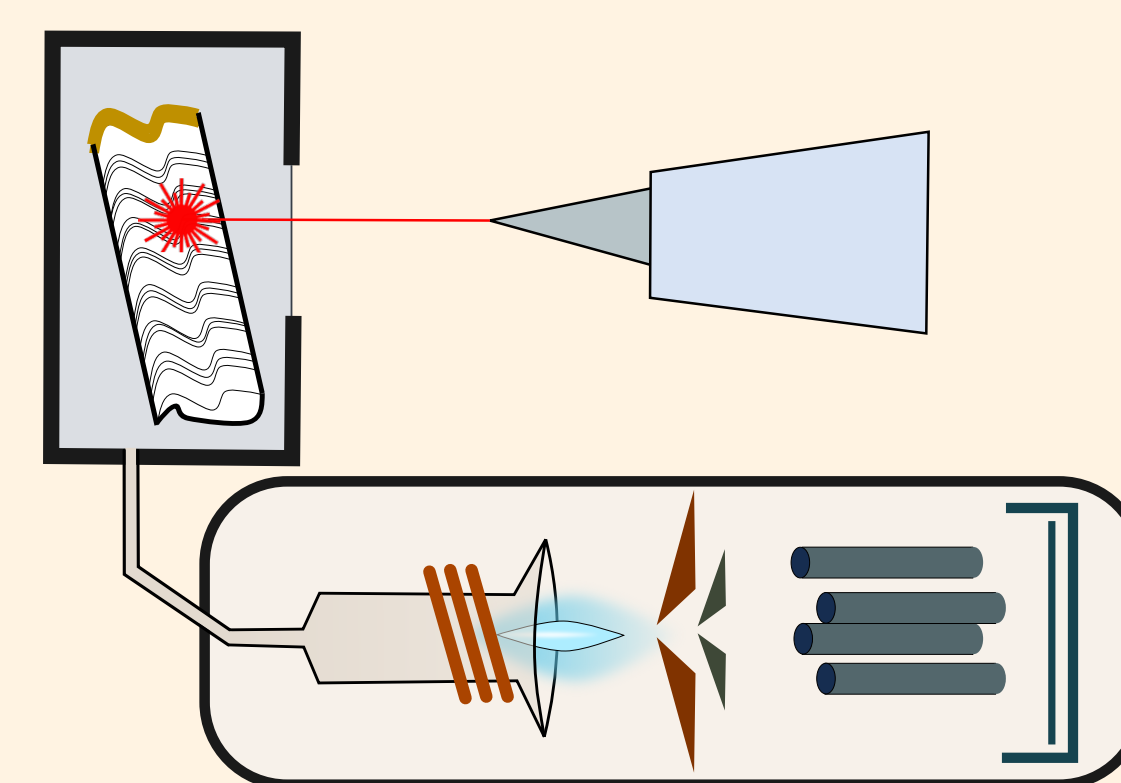
Methods

Sample collection

- 10 *Porites* cores from 4 locations

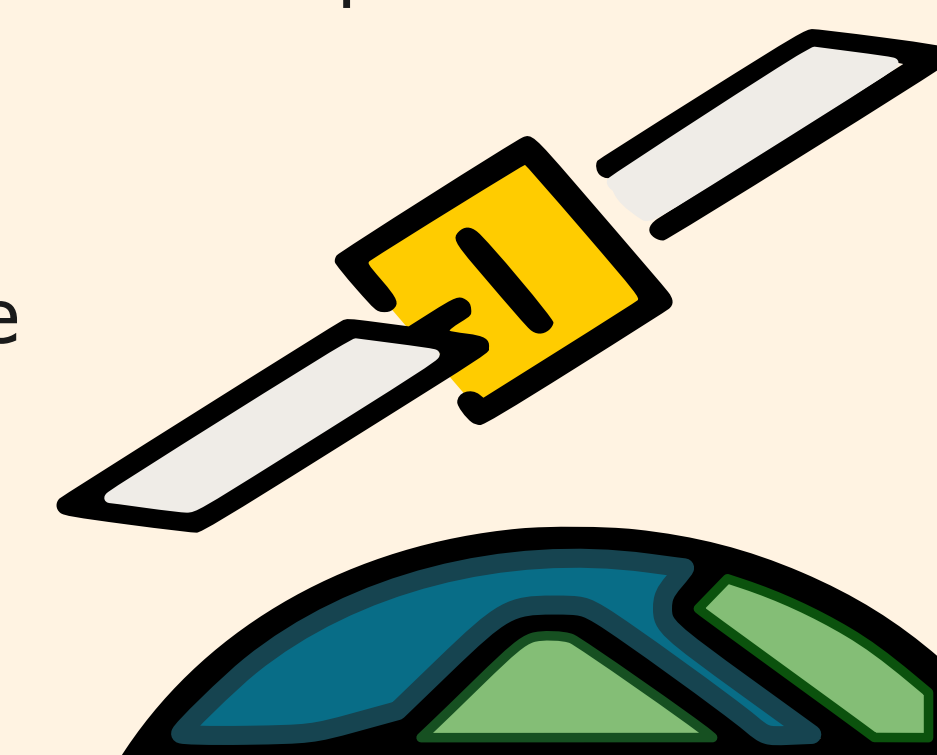
| Coral Coast | Namuka | Suva | Nananu-i-Ra |
|-------------|----------|---------|-------------|
| •VOT17-1 | •NAM17-1 | •FP17-1 | •NAN17-1 |
| •VOT17-2 | •NAM17-2 | | •NAN17-2 |
| | •NAV17-1 | | •NAN17-3 |
| | | | •NAN17-5 |

Growth parameters (annual extension, density and calcification) quantified by computed tomography (CT) for the 1998-2017 period.



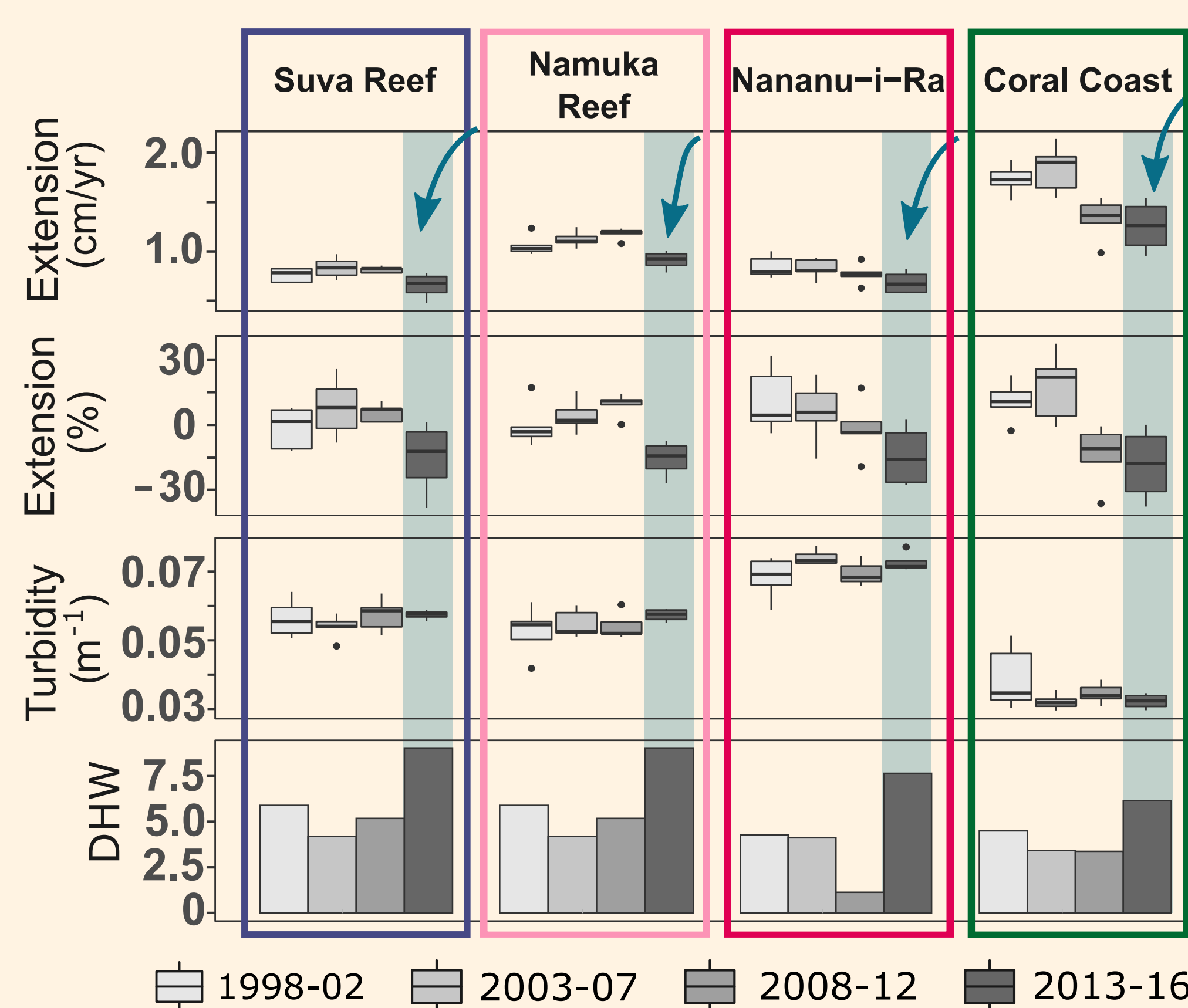
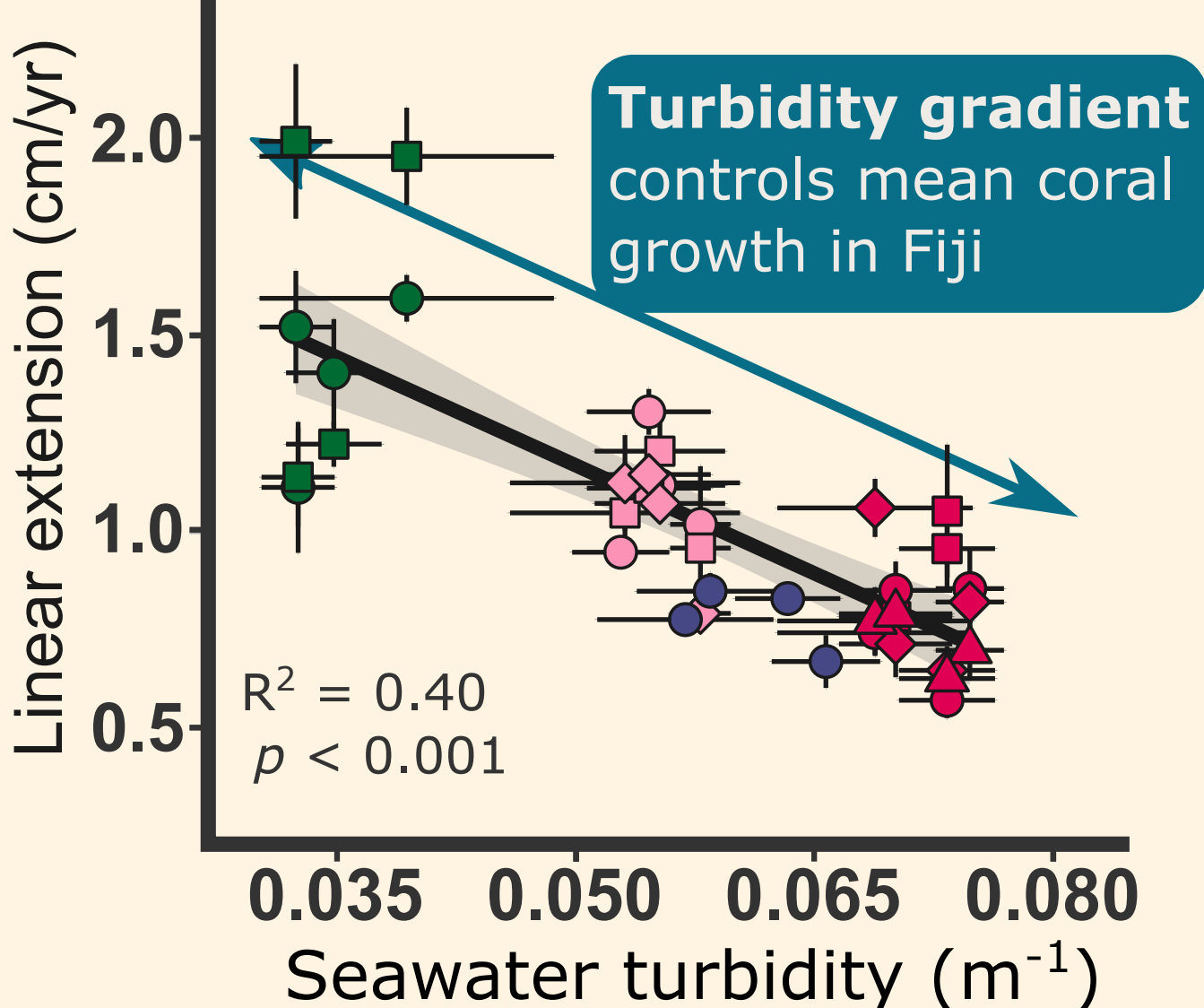
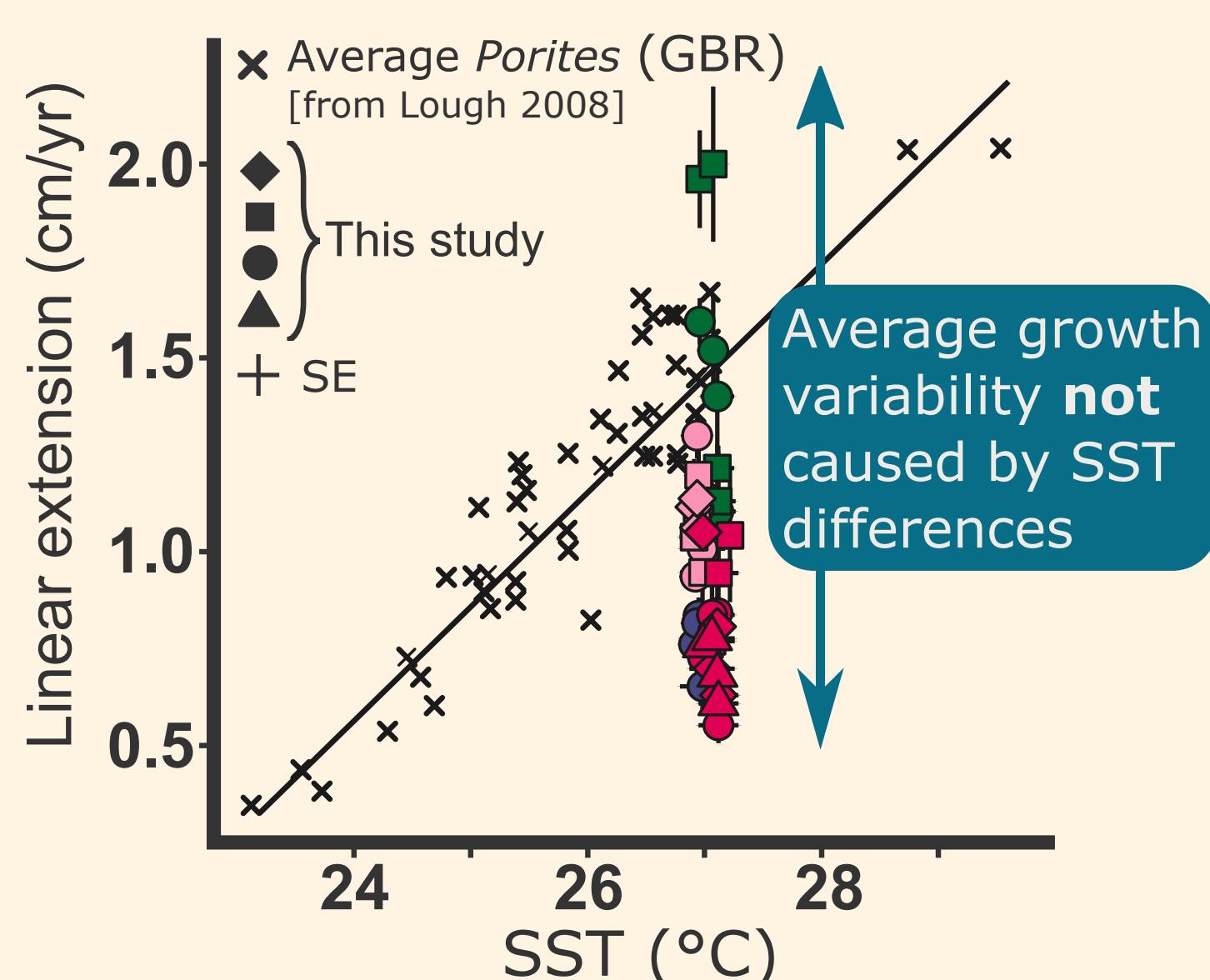
Coral trace metal composition of skeletal material measured using Laser Ablation (LA) - ICPMS for the 2000-2017 period.

Environmental data (Seawater temperature (SST), Degree Heating Weeks (DHW), seawater turbidity, wind speed, rainfall) retrieved via remote sensing for the period 1998-2017.



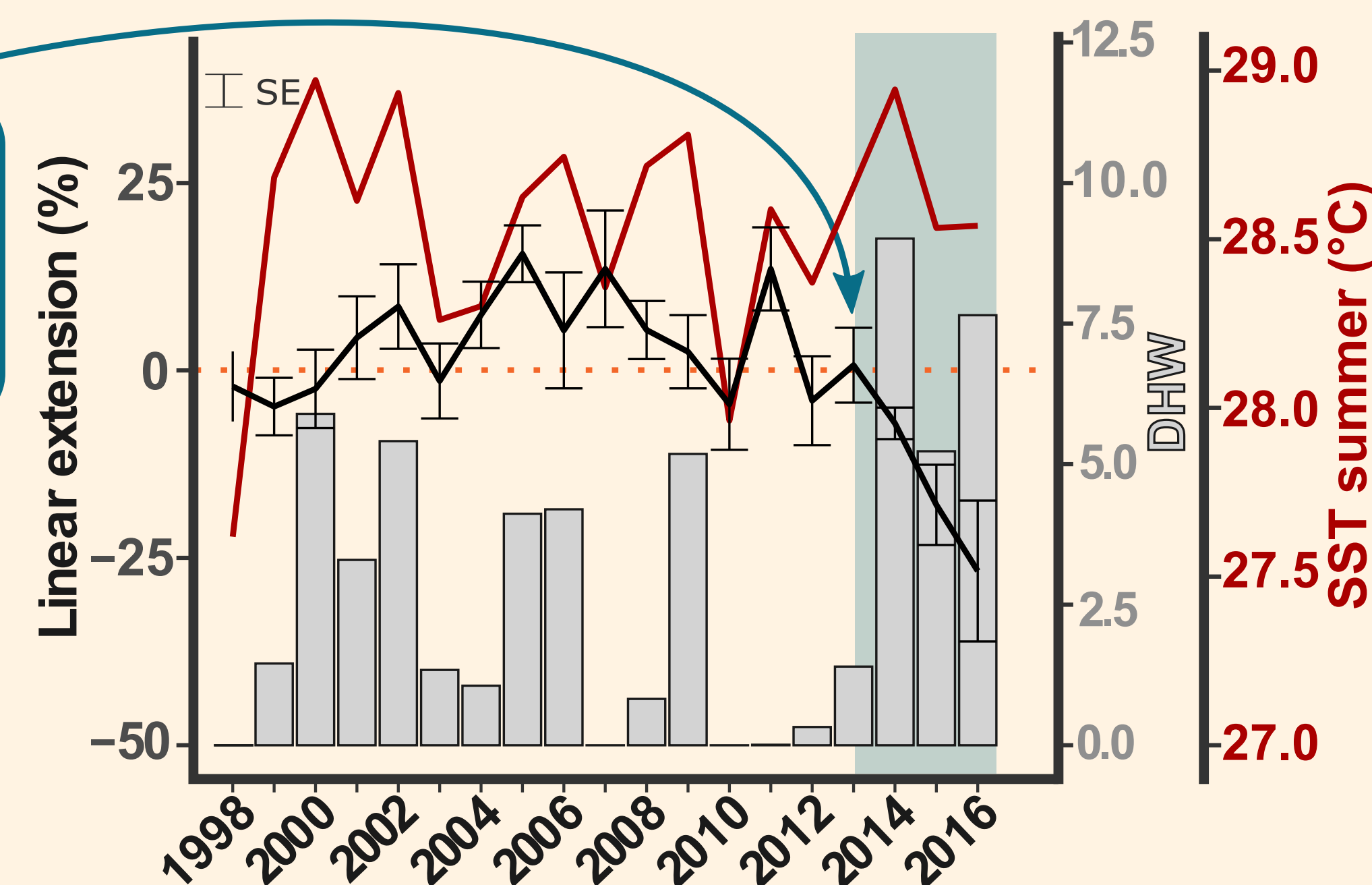
Coastal turbidity and thermal stress control coral growth in Fiji

5-year averaged linear extension and environmental data



Unprecedented decline in extension rates since 2013.

Relative annual extension records averaged from all locations

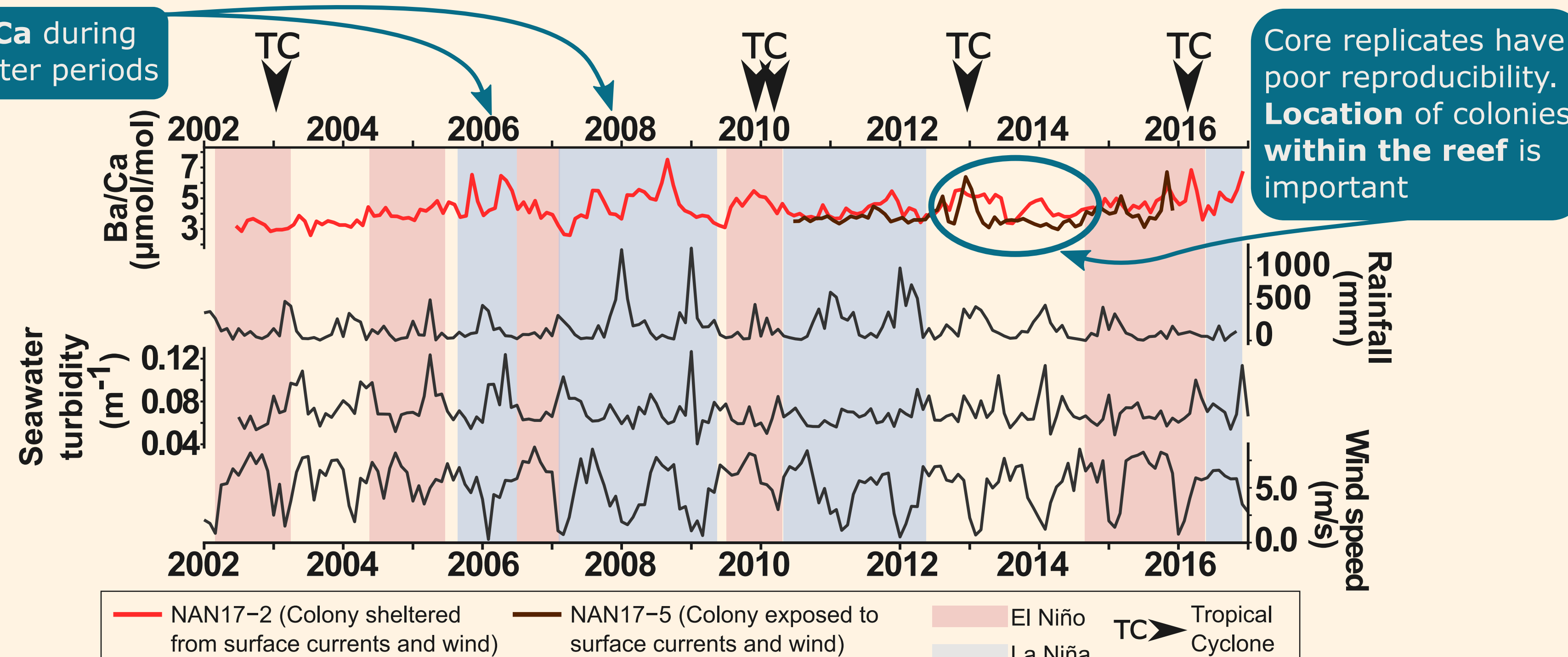


Growth rate gradient across Fiji are controlled by seawater turbidity, but heat stress plays an important role driving interannual variability.

Porites corals as inshore water quality archives: Findings from Nananu-i-Ra

- Trace element (Ba, Mn and REE) concentrations in *Porites* skeleton can be used as a proxy for water quality changes and tracing water pollutants^[6,7,8].
- Uncertainty remains in how to use these records to accurately characterise local water quality and its effects on corals^[9,10].
- Investigation of reef-specific conditions is needed to understand what drives incorporation of trace metals in coral aragonite.

Higher Ba/Ca during La Niña/wetter periods



Conclusion

- Coral growth gradients across Fiji are controlled by coastal water quality.
- Heat stress diminished coral growth across all inshore reefs in Fiji, independently of the local seawater quality factors.
- Ba/Ca proxies in Fiji record environmental variations and reflect wetter climatic periods, but careful examination of hydrology and reef morphology has to be carried out before interpreting environmental drivers.

[1]Lough & Cantin, 2014. Perspectives on Massive Coral Growth Rates in a Changing Ocean. *Biol. Bull.* **226**,187-202. [2]IPCC, 2014. Climate Change 2014: Synthesis Report. Fifth Assessment Report of the Intergovernmental Panel on Climate Change. [3]GCRMN, 2022. The Sixth Status of Corals of the World: 2020 Report. [4]Meissner et al., 2012. Large-scale stress factors affecting coral reefs: open ocean sea surface temperature and surface seawater aragonite saturation over the next 400 years. *Coral Reefs*, **31**, 309-319. [5]Jupiter et al., 2008. Linkages between coral assemblages and coral proxies of terrestrial exposure along a cross-shelf gradient on the southern Great Barrier Reef. *Coral Reefs*, **27**, 887-908. [6]McCulloch et al., 2003. Coral record of increased sediment flux to the inner Great Barrier Reef since European settlement. *Nature* **421**, 727-730. [7]Prouty et al., 2010. Coral Ba/Ca records of sediment input to the fringing reef of the southshore of Moloka'i over the last several decades. *Mar. Pollut. Bull.* **60**, 1822-1835. [8]LaVigne et al., 2016. Multi-colony calibrations of coral Ba/Ca with a contemporaneous in situ seawater barium record. *Geochim. Cosmochim. Acta* **179**, 203-216. [9]Tanzil et al., 2019. Multi-colony coral skeletal Ba/Ca from Singapore's turbid urban reefs: Relationship with contemporaneous in-situ seawater parameters. *Geochim. Cosmochim. Acta* **250**, 191-208. [10]Lewis et al., 2018. A critical evaluation of coral Ba/Ca, Mn/Ca and Y/Ca ratios as indicators of terrestrial input: New data from the Great Barrier Reef, Australia. *Geochim. Cosmochim. Acta* **237**, 131-154.