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Inter-annual precipitation variability reconstructed from a Cook Islands stalagmite record: insights on SPCZ localisation and ENSO dynamic during the Holocene

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Speleothem records from tropical Pacific Islands provide a powerful means to investigate the position and intensity of the South Pacific Convergence Zone (SPCZ) and changes in regional coupled ocean-atmospheric circulation. Rainfall pattern in Atiu (Southern Cook Islands) exhibits strong seasonality with 70% of the mean total annual rainfall (TAR = 1930 $\pm$365 mm/yr) occurring in the wet season from December to May. However, during the drier season strong rainfall events are not unusual, and some years are characterised by and almost continuous infiltration in the highly porous Pleistocene reef host-rock. Interannual rainfall is strongly modulated at decadal timescales by El Niño-Southern Oscillation (ENSO), with lower rainfall associated with La Niña events.

We present a composite Holocene stalagmite record from five U-Th dated stalagmites, characterised by slow to intermediate growth rates (5 – 100 μm/yr) and close- to open- columnar fabric, collected in three different caves.

In faster growing stalagmites stable isotope, high-resolution Synchrotron-Radiation based micro X-ray fluorescence and petrographic changes reveal centennial, quasi-decadal (ENSO type) and, inferred, annual periodicity. In Anatakitaki cave, a highly ventilated cave on the Western side of Atiu, modern stalagmites are characterised by annual lamina couplets composed by alternating compact high-Sr and porous low-Sr calcite layers reflecting seasonal changes in the infiltration.
In Pouatea cave, an extensive maze solution cave on the Eastern side of Atiu, the lower and middle Holocene records are characterised by thin clay layers suggesting periodic tsunami or cyclones events. Thin clay associated with micro charcoal layers are also present in the last 1000 years of the stalagmite record and testify the frequentation of the caves by the Polynesians who colonised the Cook Islands from around 1000 AD.