Quantifiable Systematic Errors of the Aquatrak-era Sea Level Record

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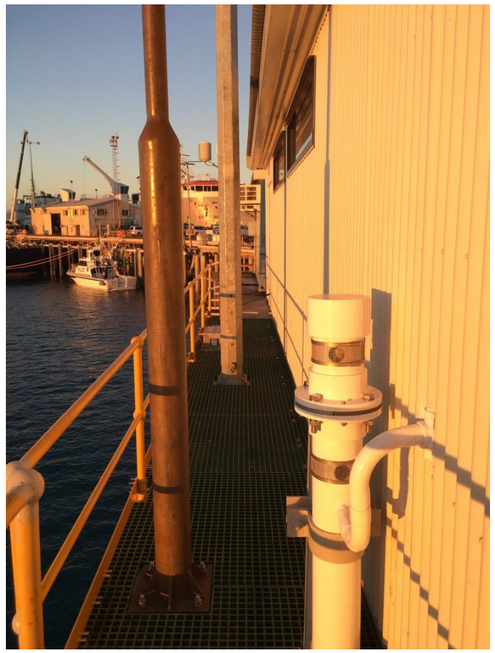
The Aquatrak sensor is the immediate past standard for sea level observations worldwide, encompassing the global record from the 1980's through to the mid-2010's.
This sensor is subject to 2 thermally driven systematic error types;

- Thermal Gradient Effect
- Thermal Expansion Effect

Data exists for the correction of these errors, specifically the **environment tube temperature data**. Tide Gauge data custodians are requested to search their archives and retrieve that data.



Wharf level of the Tide Gauge at Broome, Australia.

The Thermal Gradient Effect
Arises from a non-constant thermal profile along the length of the sounding tube causing discrepancies in the assumed constant speed of sound.
The thermal profile of the interior of an environment tube can be viably modelled as;

$$T(z)^{\frac{3}{2}} = \alpha z^2 + \beta z + \gamma$$

With temperature; $\mathrm{T}(z)$, in units of **degrees Kelvin**.
The three parameters; α, β and γ, can be obtained using the environment tube temperature data. The airgap correction; AG_{corr}, can then be computed;

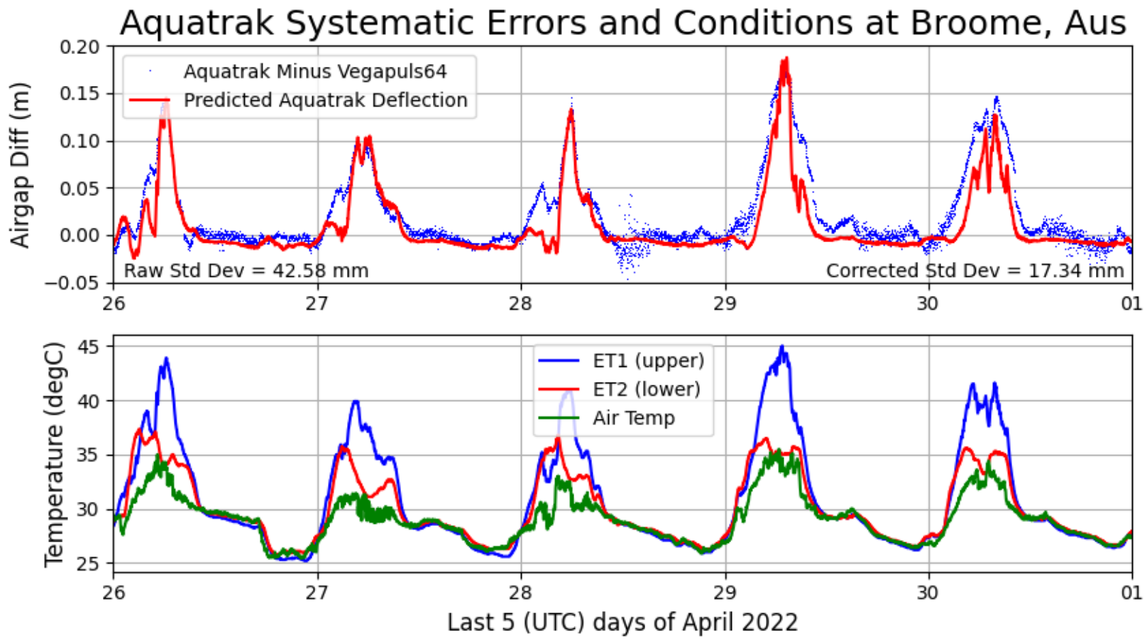
$$AG_{\mathrm{corr}} = AG\frac{6\gamma - \beta h + \left(\frac{4\beta^2}{9\gamma} - \frac{2}{3}\alpha\right)h^2}{6\gamma - \beta AG + \left(\frac{4\beta^2}{9\gamma} - \frac{2}{3}\alpha\right)AG^2} - AG$$

Where; h = 1.2192 m (4 ft)

The Thermal Expansion Effect
Caused by thermal expansion physically repositioning the calibration target away from the assumed 4 ft.[1] The impact on the output of the Aquatrak sensor then becomes;

$$AG_{\mathrm{corr}} = AG\ \alpha_{exp}\left(T_{upper} - \mathrm{T_{cal}}\right)$$

Where; α_{exp} – linear thermal expansion coefficient of the sounding tube material
$\mathrm{T_{upper}}$ – Upper most environment tube temperature reading
$\mathrm{T_{cal}}$ – Temperature the Aquatrak was calibrated at (usually 20°C)



An example of the observed deflection of the Aquatrak sensor against a co-located Vegapuls64 sensor at Broome, Australia, together with the errors predicted by these equations.

Conclusion
The size and persistence of these systematic errors are too large to ignore and are almost certainly responsible for researchers observing apparent "scaling errors" in the Aquatrak data. The environment tube temperature data needs to be retrieved and historical sea levels updated to account for these effects.

1. J.R. Hunter. J. Atmospheric & Oceanic Technology, Vol 20. Pg 1230 – 1235. (2003)