

# PASS-SWIO

Portagauge and Satellite Sea level monitoring  
system for the Southwest Indian Ocean

## Measuring Sea Level. Tide Gauges and Satellites

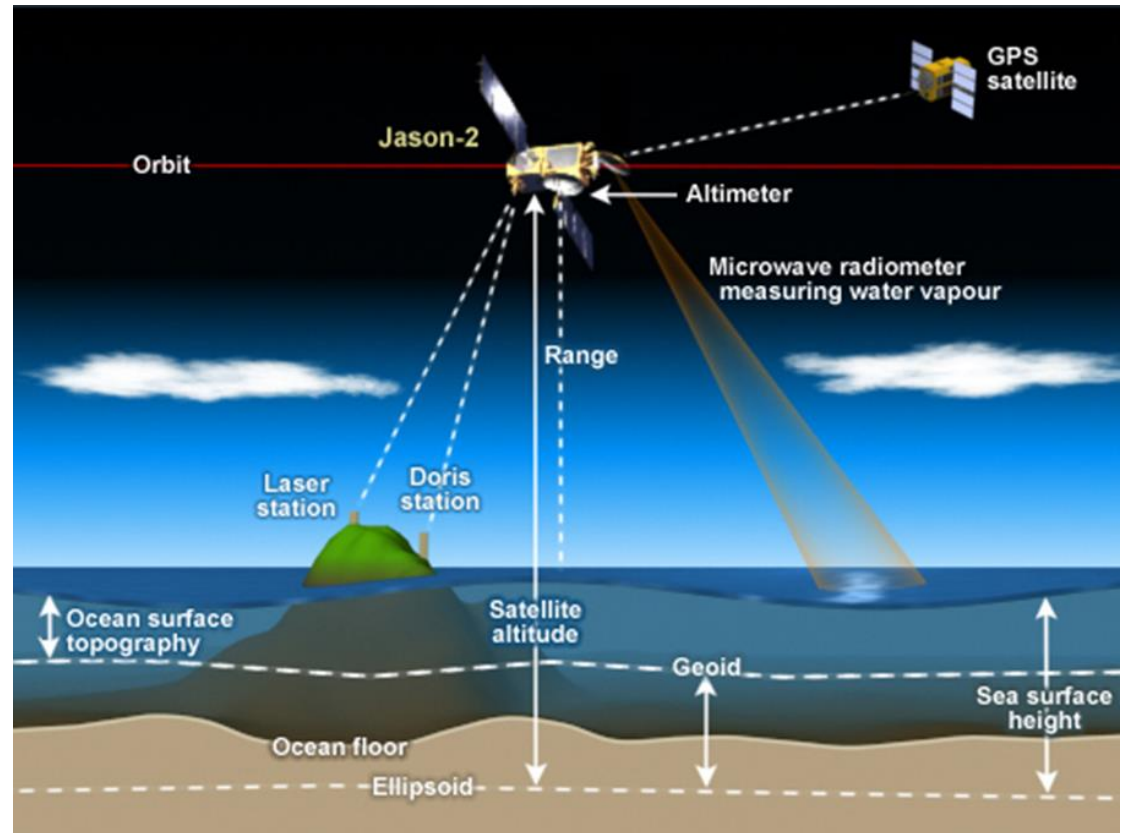
David Cotton (SatOC) and Angela Hibbert (NOC)

# Measurement Method 1. Satellite Altimetry

Radar altimeters transmit signals to the earth, and receive the echo from the surface

By timing it, we measure the distance between satellite and sea (**range**)

We know the position of satellite (precise **orbit**), and so determine **height** of sea surface with respect to the reference ellipsoid

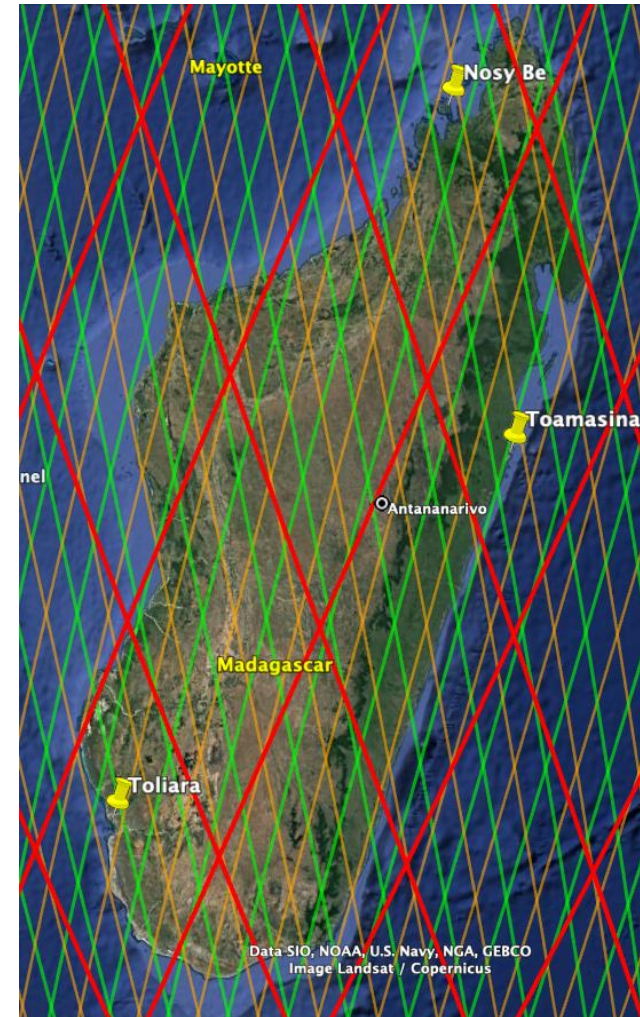


# Altimetry is “along-track”

Measurements are made at regular intervals (~250m) directly under the satellite track.

Each track is repeated every 10 days for the Jason satellites (red), or every 27 days for the Sentinel 3 satellites (green and brown).

So we have a measurement for each location once every 10, or 27, days



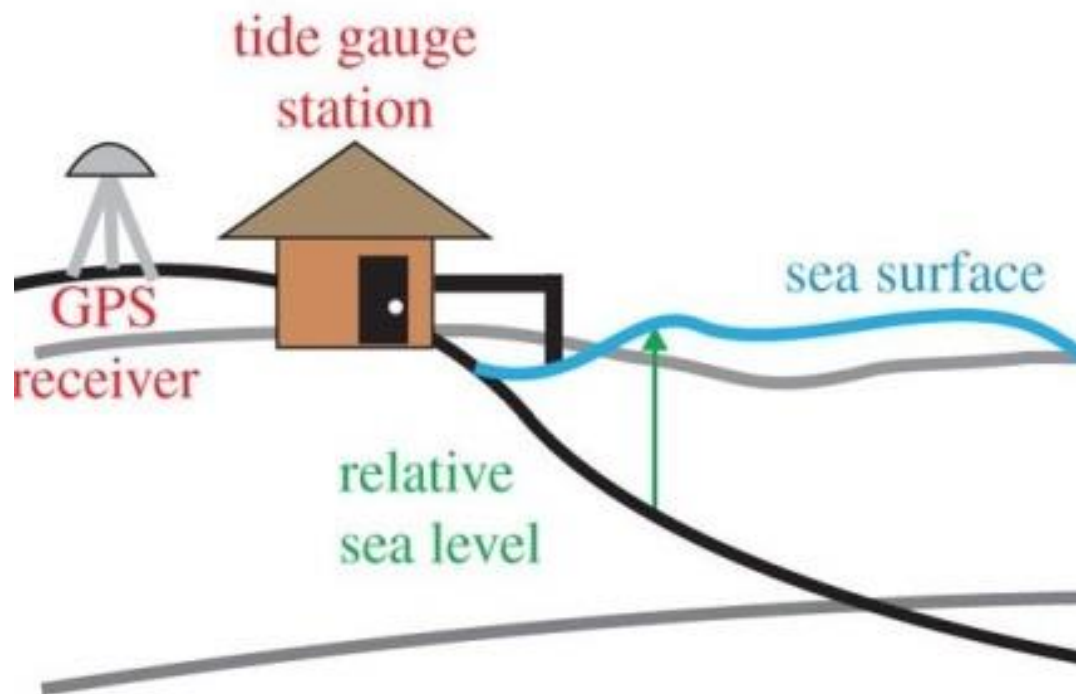
## Measurement Method 2. Tide Gauges

Tide gauges make spot-measurements or averages (called integrations) over regular time intervals.

They are coastal instruments, measuring sea level relative to land.

Types of Tide Gauge:

- Tide poles (or tide staffs)
- Float tide gauges
- Acoustic gauges
- Pressure gauges
- Radar gauges



*Tamisiea et al. (2014)*

## Tide pole



## Float and stilling well gauges



## Acoustic gauge



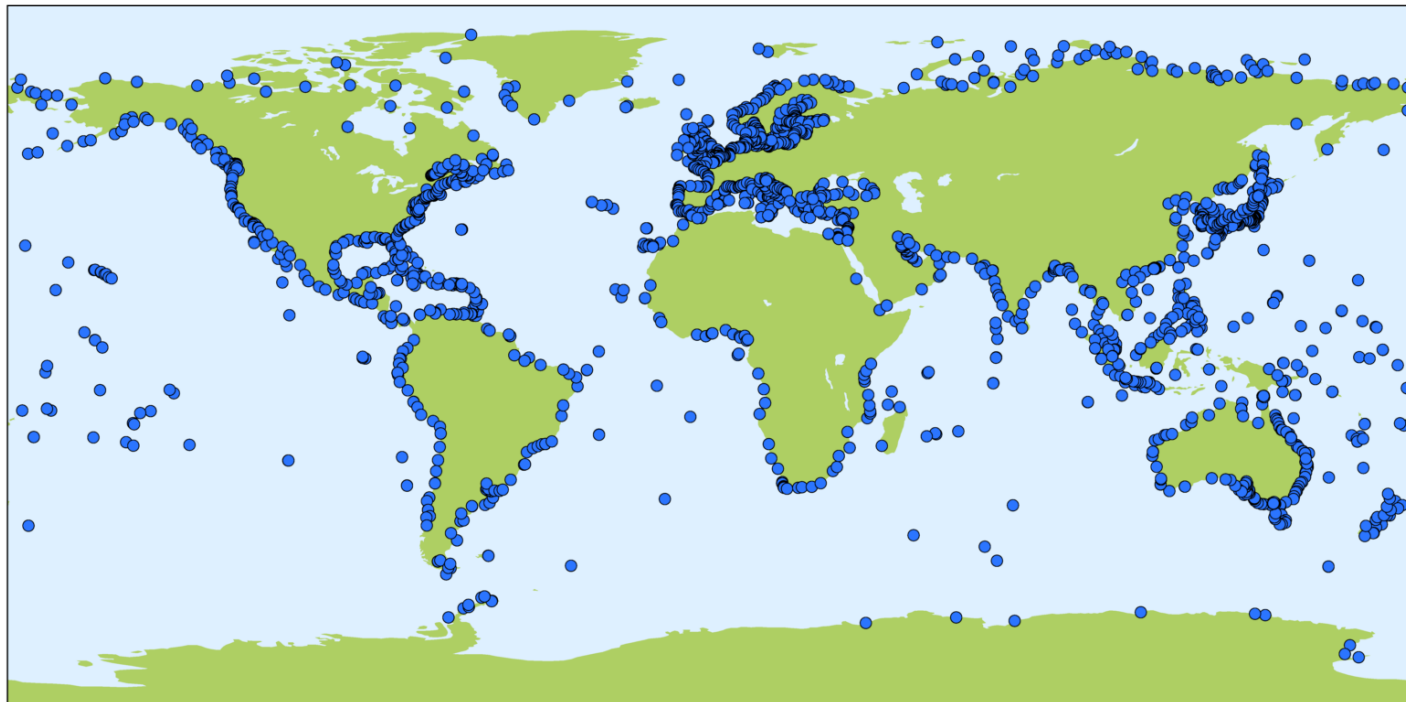
## Radar Sensor



# Tide Gauges

Measures relative sea level

Biased towards coasts, islands, Northern Hemisphere

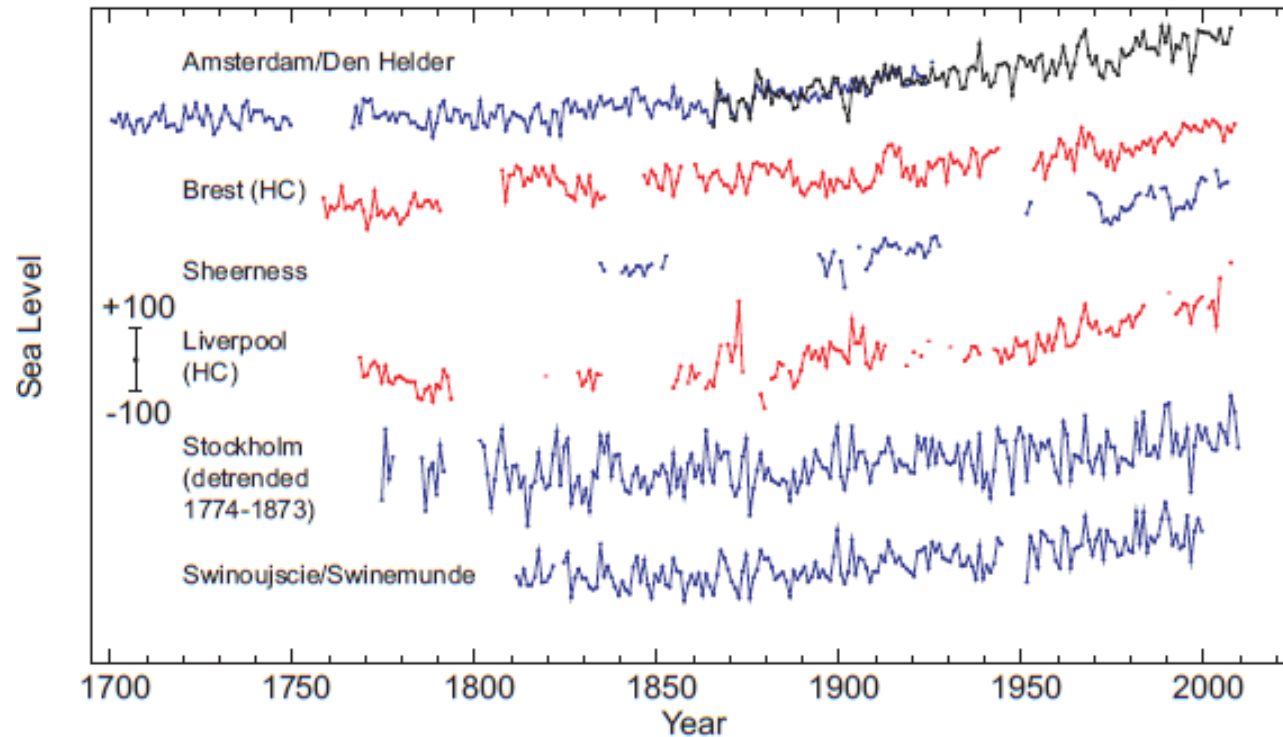


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All stations  
(2318)

## Tide Gauges

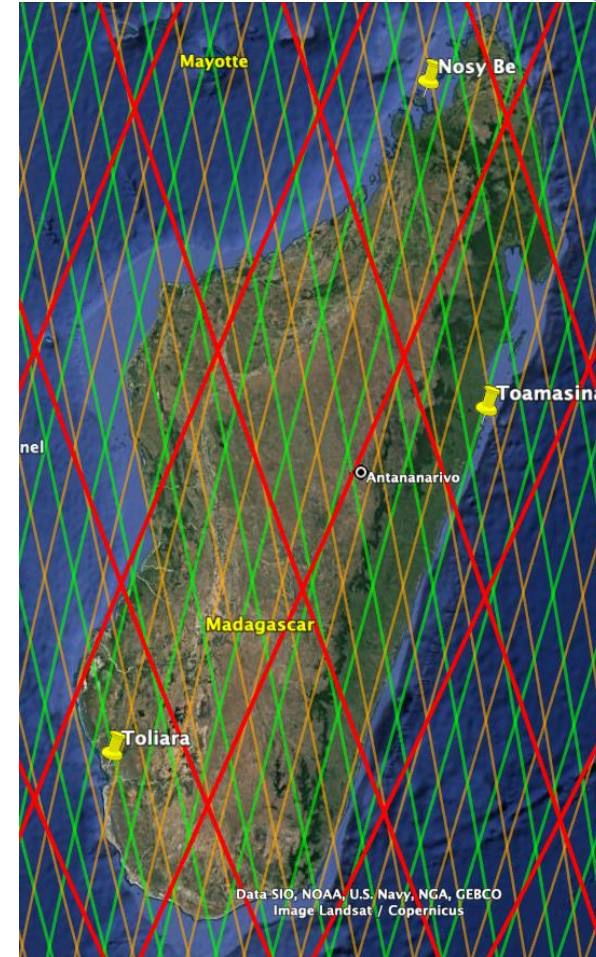
- Continuous, high frequency record (for storms, tides etc)
- Captures most variability
- Long records available (compared to altimetry)

Altimetry  
era starts



## Satellite Altimetry

- Near-global, gridded spatial coverage
- Measures absolute sea level
- Lower frequency sampling
- Does not capture higher frequency variations e.g. waves, seiches, tides
- Observations since 1992



— 10-day repeat  
 (Jason, Sentinel-6)

— 27-day repeat  
 (Sentinel-3a, 3b)



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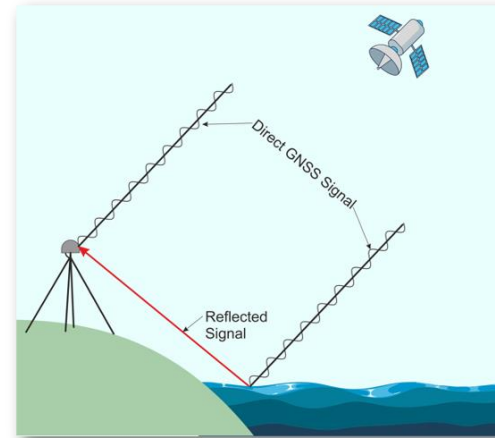
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**Tide gauge and altimetry data are complementary**

# New Measurement Method - GNSS Interferometric Reflectometry

- Receives direct GNSS signal, and signal reflected off the sea surface
- Phase delay between direct and reflected signal because of extra travel time - function of sea level
- One measurement every ~15 minutes
- Provides sea level relative to the geoid - and so can be directly related to altimeter sea level data.



# NOC Portagaugage and PASS-SWIO

- The NOC Portagaugage includes both a radar tide gauge and a GNSS-IR instrument.
- By installing a Portagaugage at Toamasina, and cross-validating against Sentinel-3 altimeter data, PASS-SWIO will link tide gauge and altimeter data, and provide the benefits of both.

