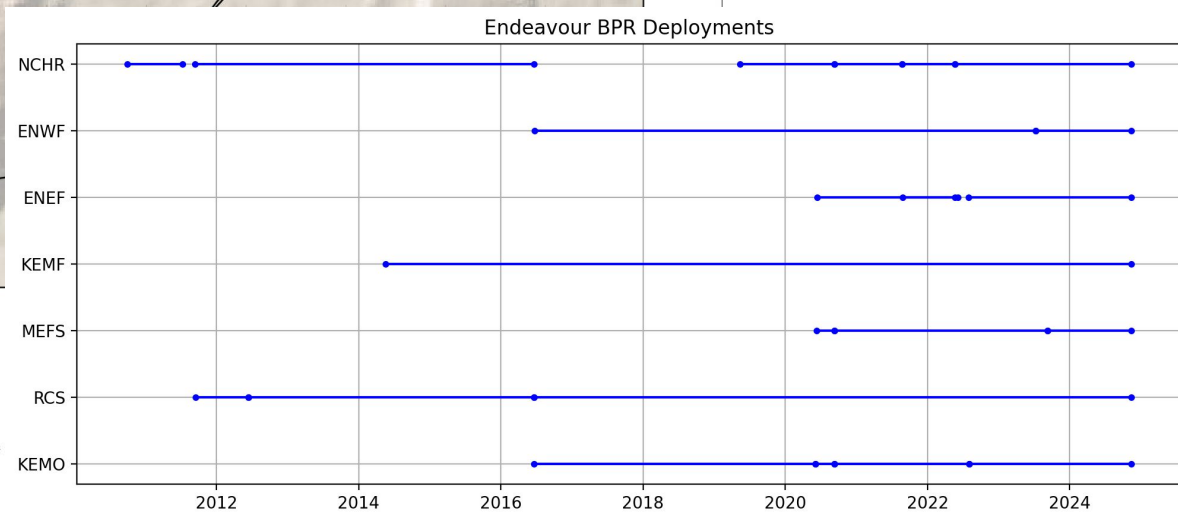
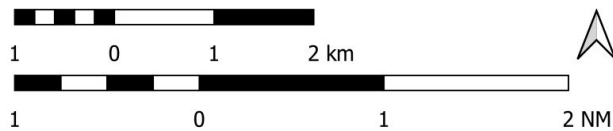
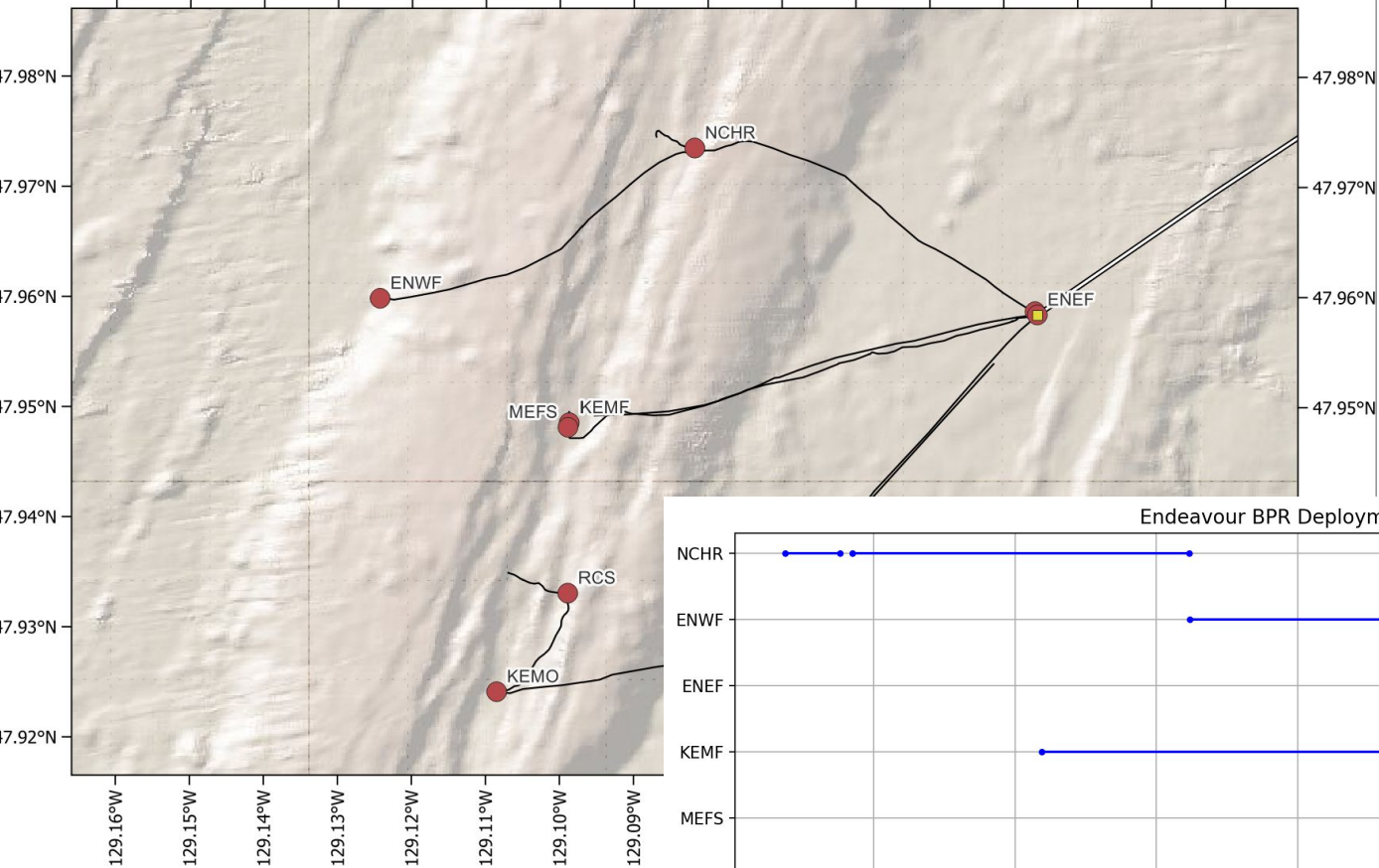


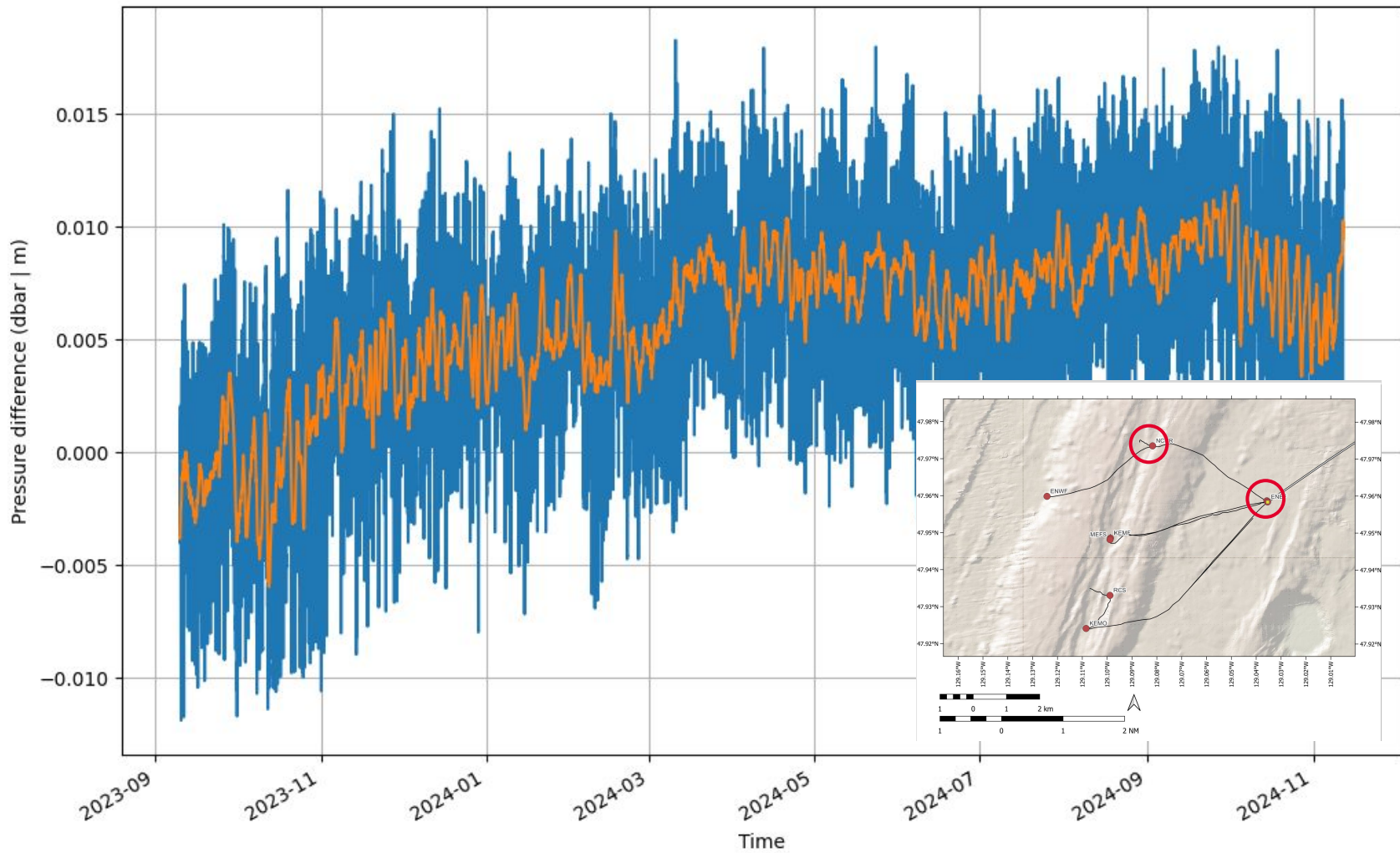
Using tilt meters and pressure sensors to monitor an event

Martin Heesemann (ONC) & Erik Fredrickson (University of Texas)

Endeavour Workshop | Nov 12, 2024 | Victoria, BC



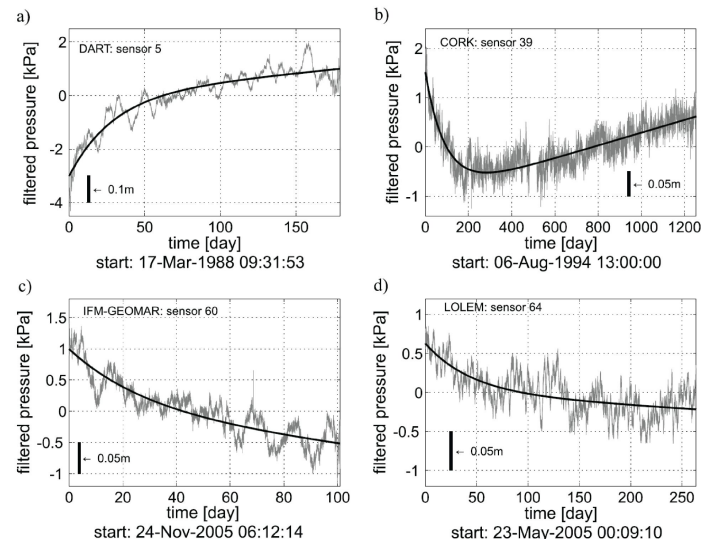
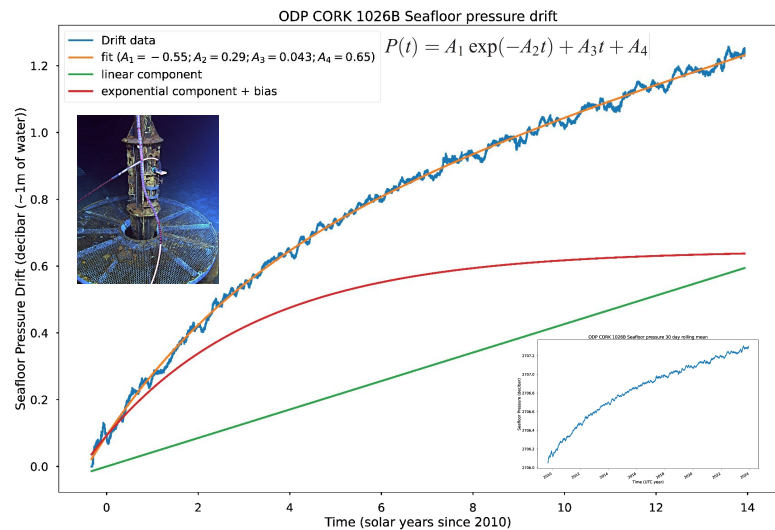
East Flank - North BPR



Why Self-Calibrating Bottom Pressure Recorders?

The Problem:

- Paroscientific pressure gauges typically used for long-term high-resolution absolute seafloor pressure measurements have been shown to have a long term drift.
- The drift is rather smooth and typically well represented by an exponential and a linear term.



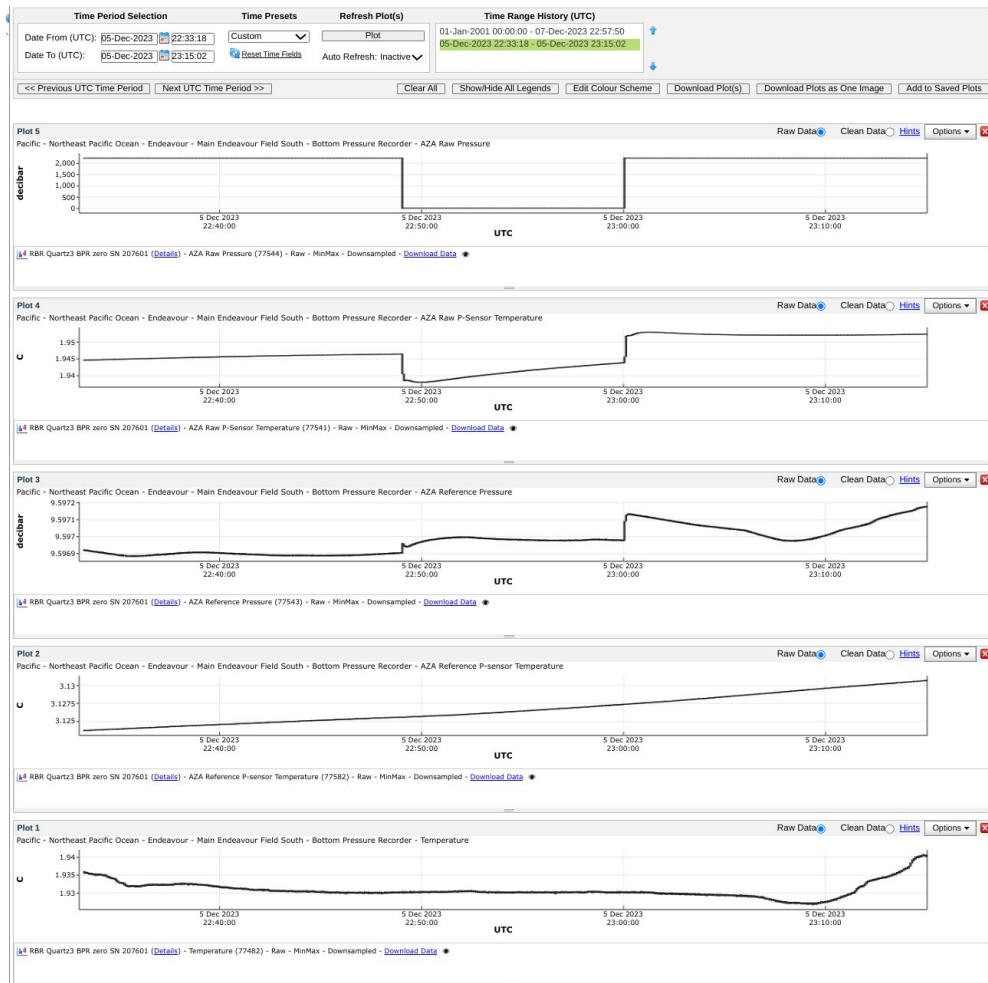
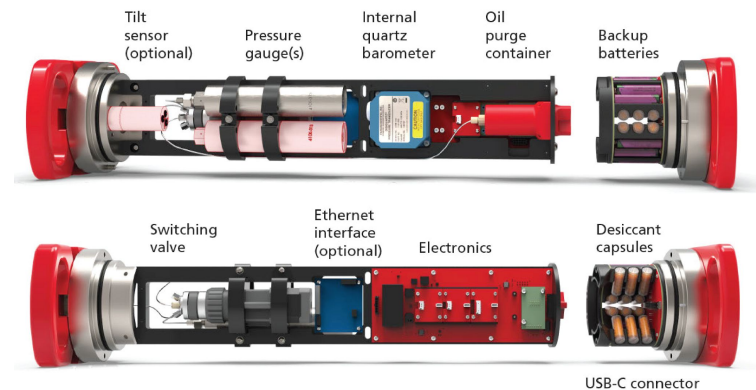
Above: Polster et al. (2009) looked at a range of long-term pressure measurements using Paroscientific gauges and found that the drift is not predictable but well modelled using a combination of an exponential term and a linear term.

Left: This holds even for the 14 year long time series of CORK 1026B seafloor pressure that is recorded in realtime through ONC's [NEPTUNE Observatory](#) at [Cascadia Basin](#).

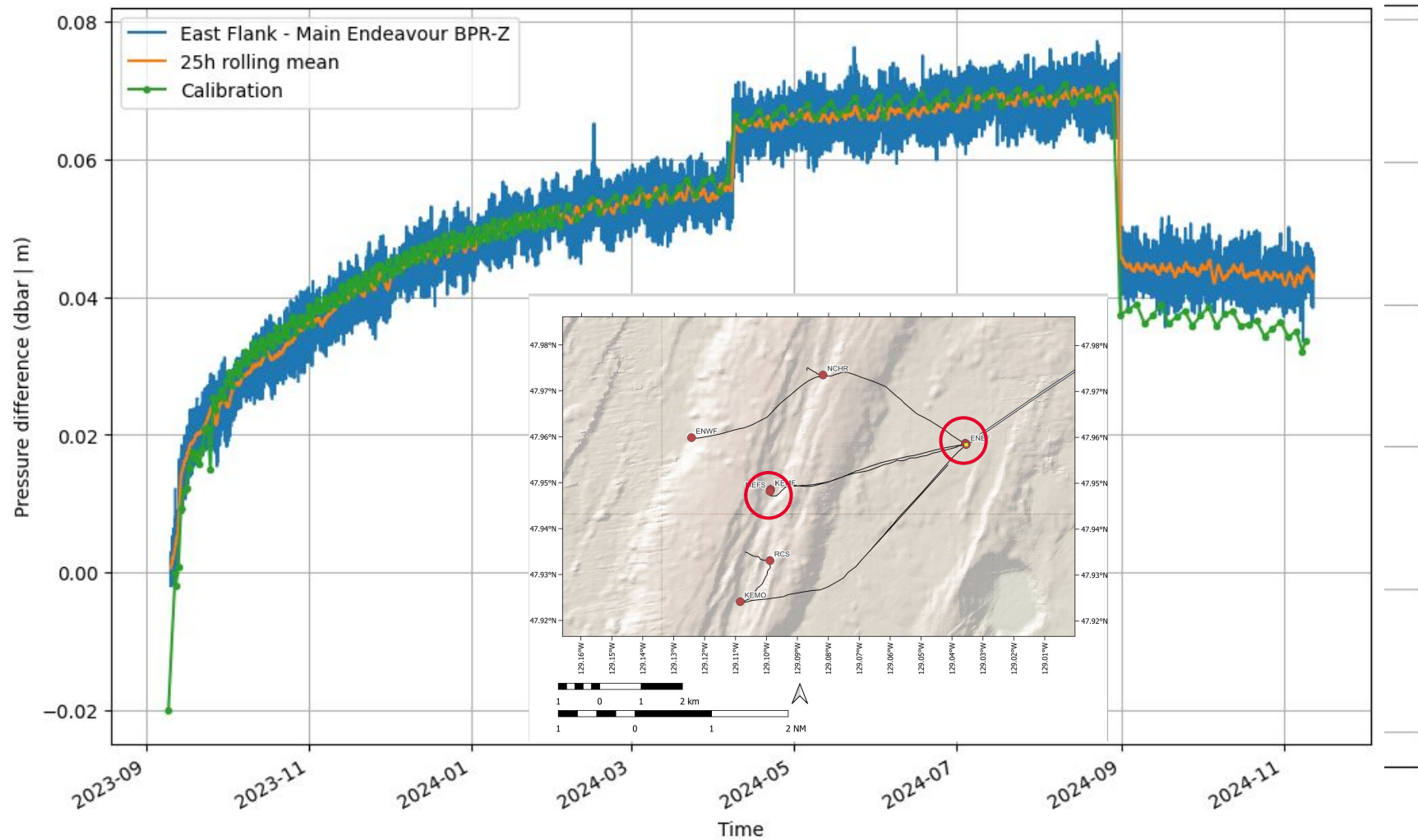
RBR BPR|Zero

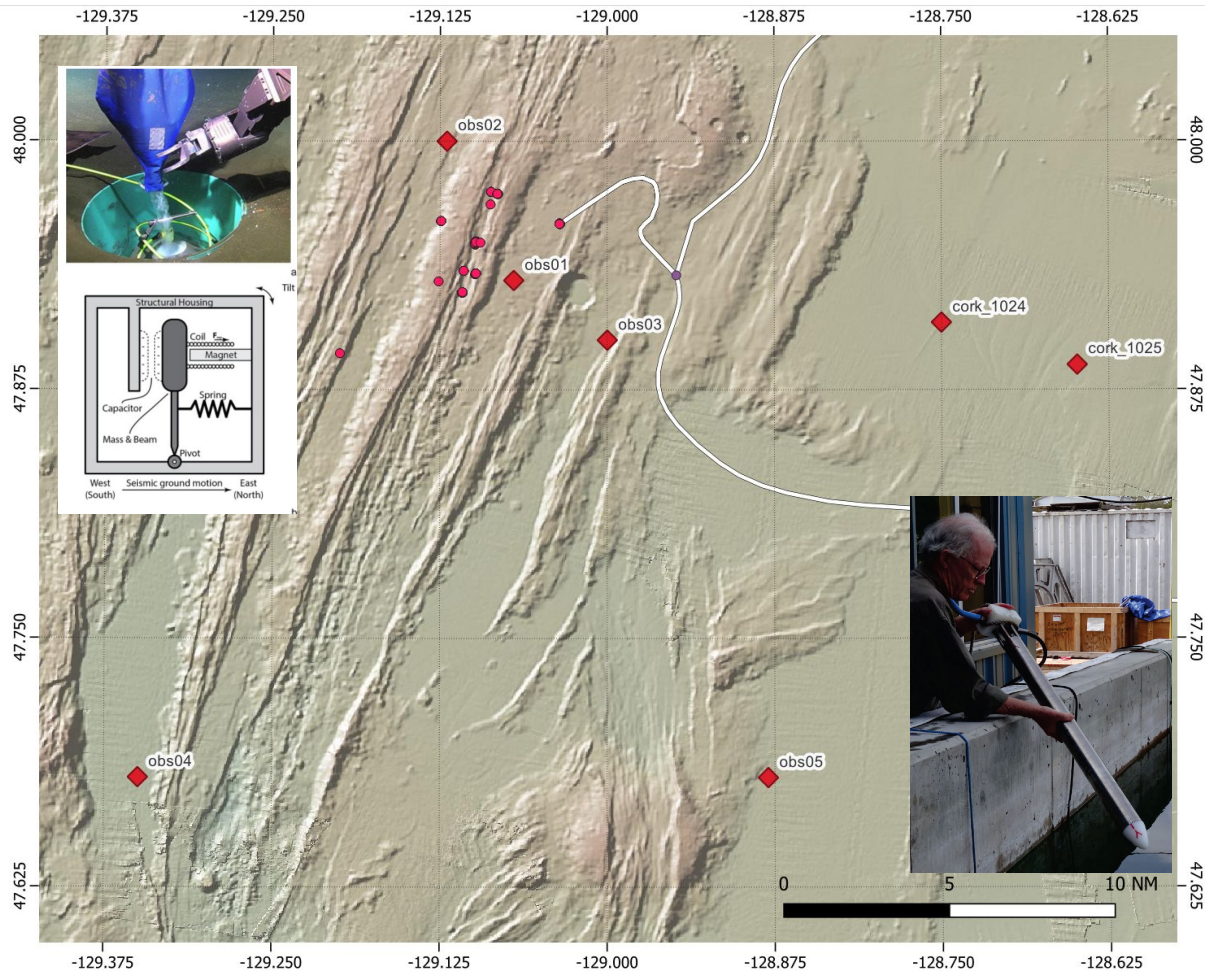
The RBR BPR|Zero is an AZA pressure recorder that can be connected to a cabled observatory or can run on batteries for 3-5 years while sampling at up to 16 samples per second.

We are still processing data from two autonomous deployments at the Deformation Front Laboratory. Data from two cabled test deployments are available in ONC's [Oceans 3.0 Data Portal](#). Scan the QR code to the right to jump right into the data from the latest [Endeavour](#) deployment. Plotted data are Transfer Pressure, Transfer Gauge Temperature, Reference Pressure, Reference Gauge Temperature, and Seawater Temperature, respectively.



East Flank vs Main Endeavour BPR Zero





- Broadband Seismometers can be used for tilt (how well does Aquarius sensor work?)
- ONC has an APT tiltmeter that could be installed
- CORK 1024 pressure instrument was installed in 2024.
- Are other self-calibrating instruments available?
- Should more CORKs be re-fitted?

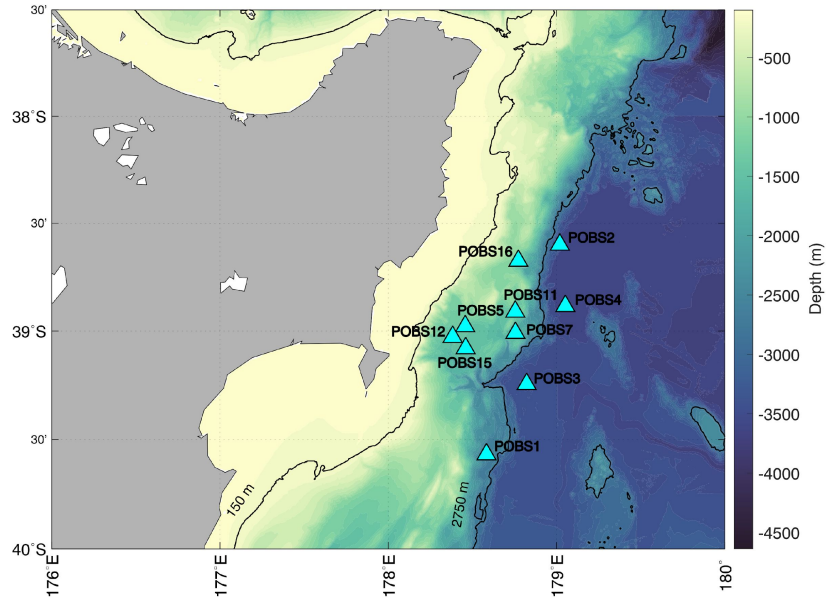
Earl E. Davis, Martin Heesemann, Anthony Lambert, Jianheng He, Seafloor tilt induced by ocean tidal loading inferred from broadband seismometer data from the Cascadia subduction zone and Juan de Fuca Ridge, Earth and Planetary Science Letters, Volume 463, 2017

Erik

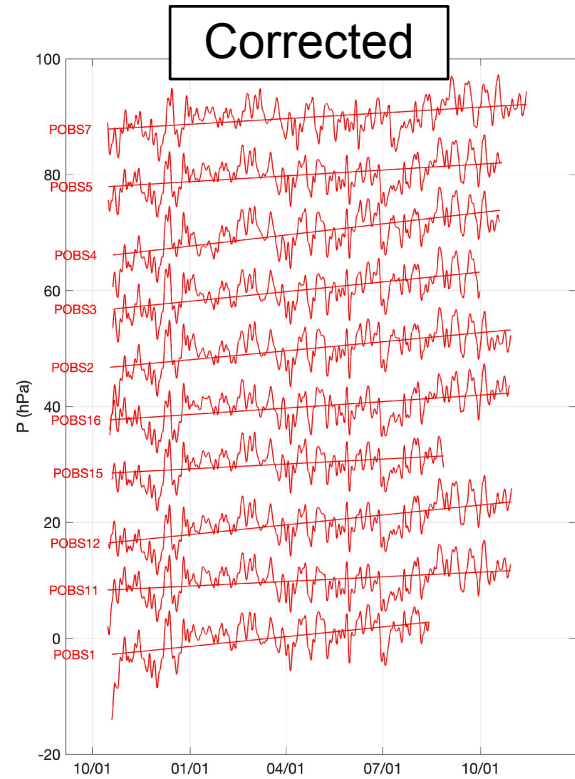
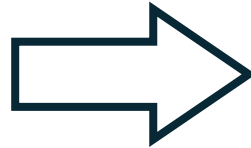
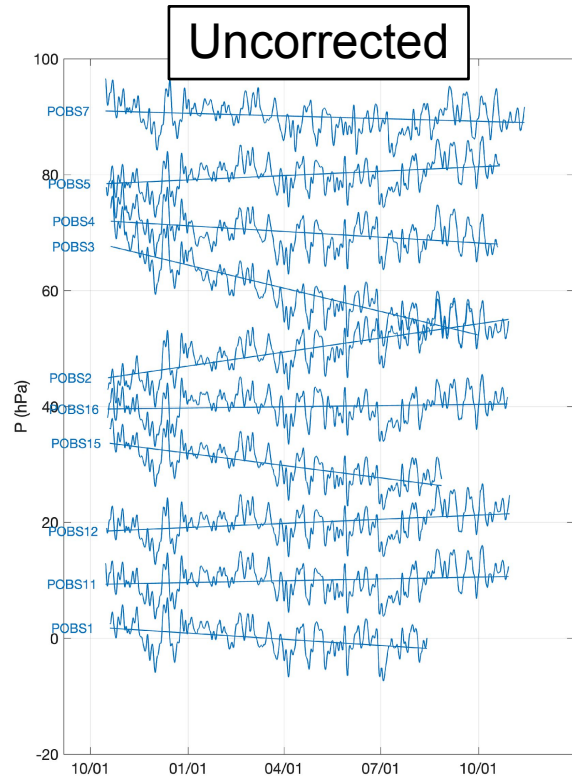
Ongoing experiment in Hikurangi includes many A-O-A instruments



- 12 self-calibrating instruments recovered and redeployed in late 2023
- Additional data recovered just this past month
- Tectonically quiescent time interval good candidate for resolving secular strain

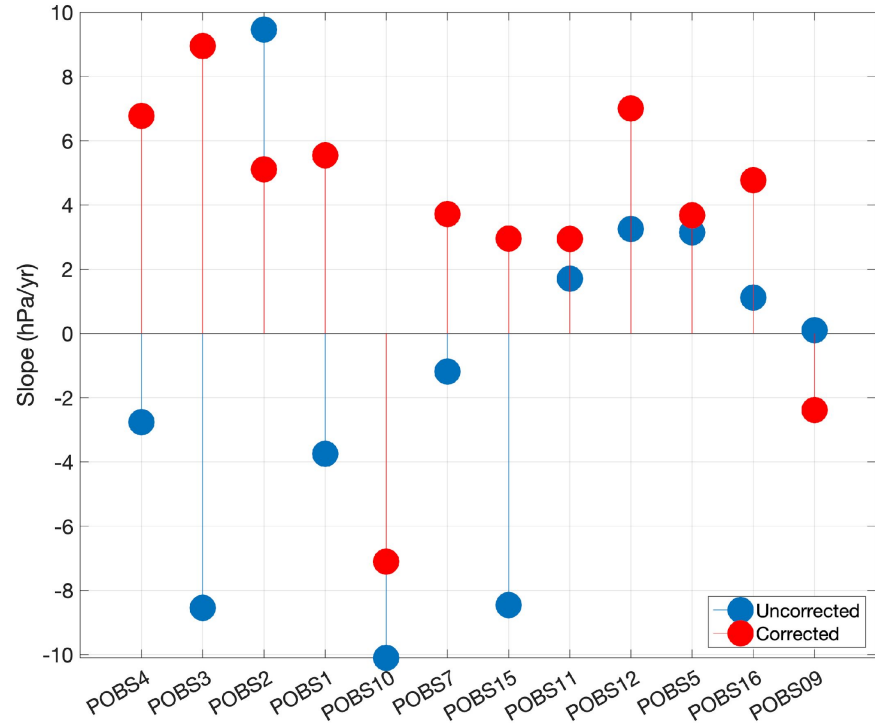


A-O-A drift corrections



A-O-A drift corrections

- Variable drift rates
 - 1–20 cm/yr
- Correction reverses the sign of the trend in many cases
- **You can't make meaningful interpretations without these corrections**

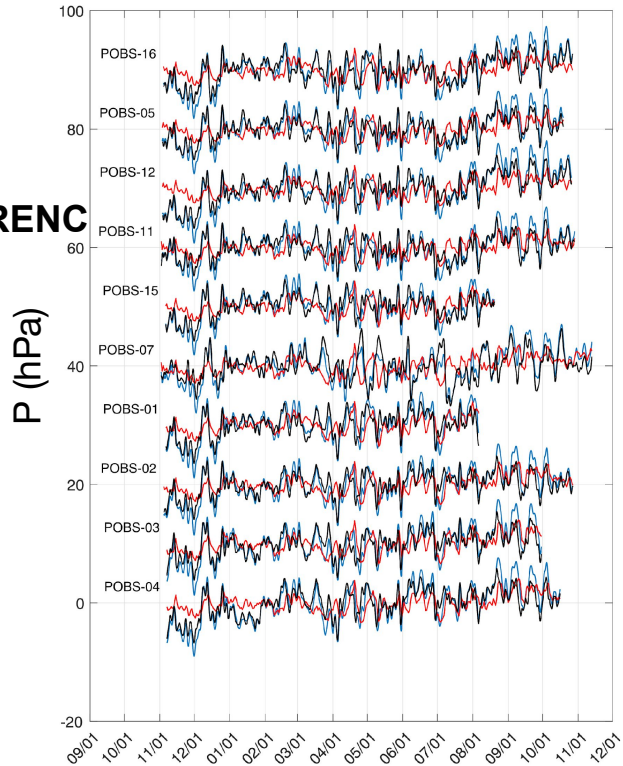


Comparisons with global ocean circulation models

A-0-A

Model

DIFFERENCE

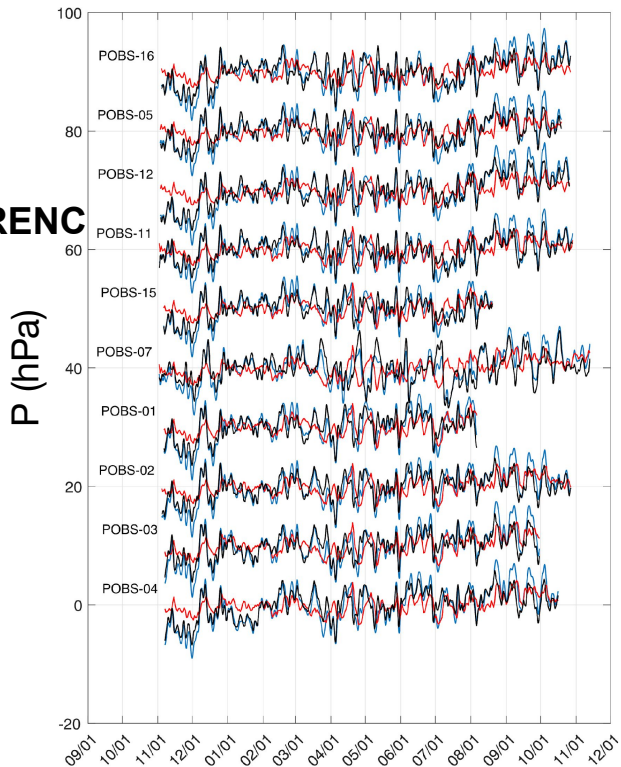


Comparisons with global ocean circulation models

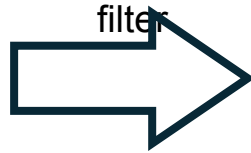
A-0-A

Model

DIFFERENCE



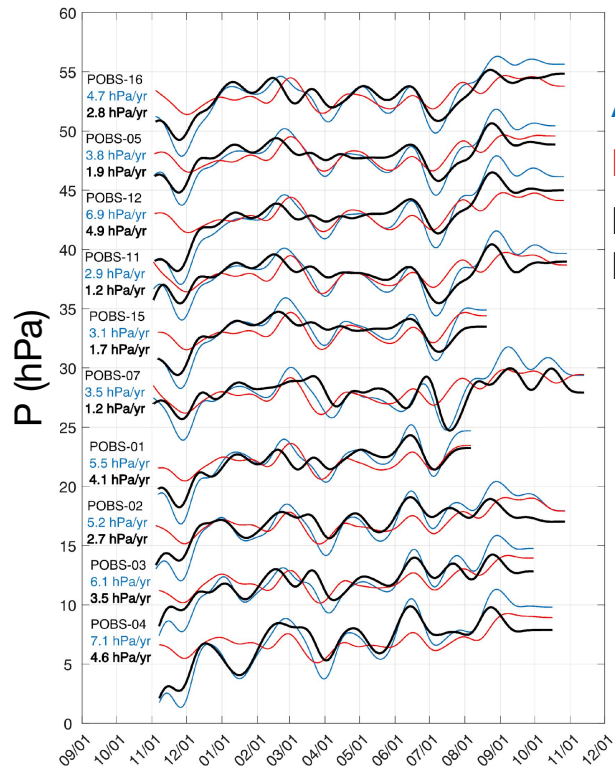
30-day
lowpass
filter



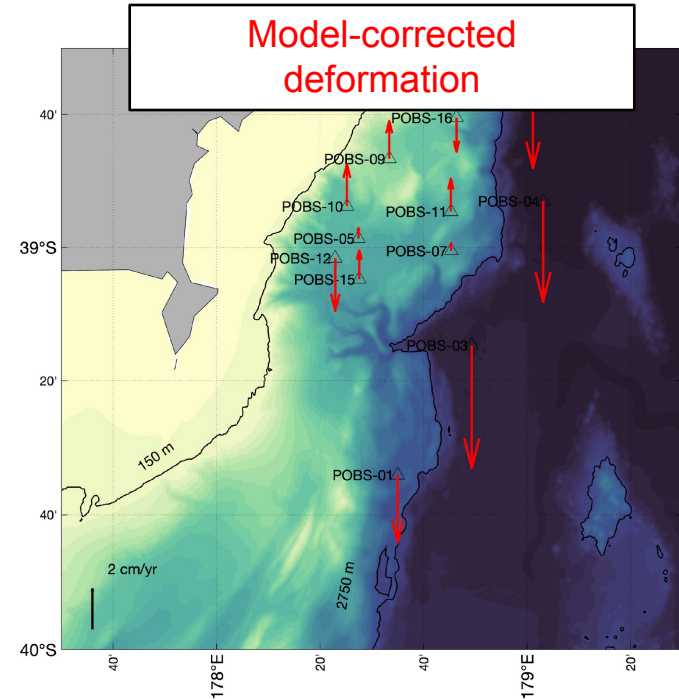
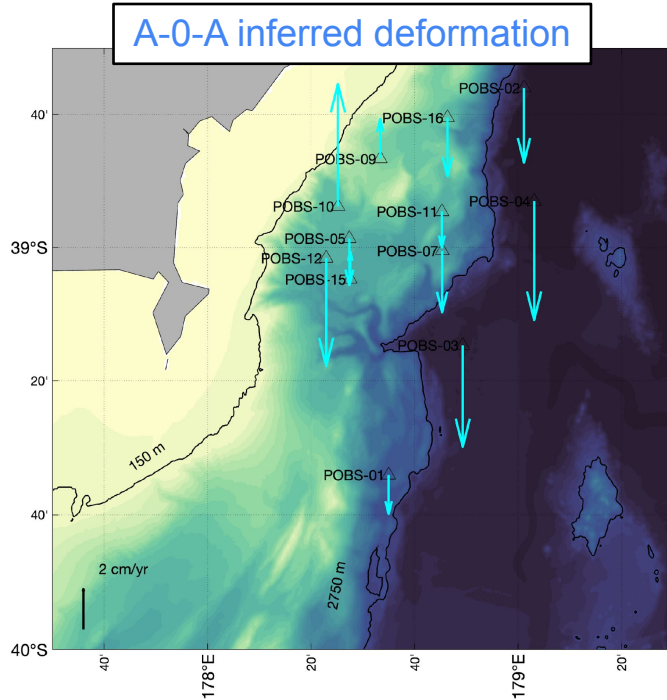
A-0-A

Model

DIFFERENCE

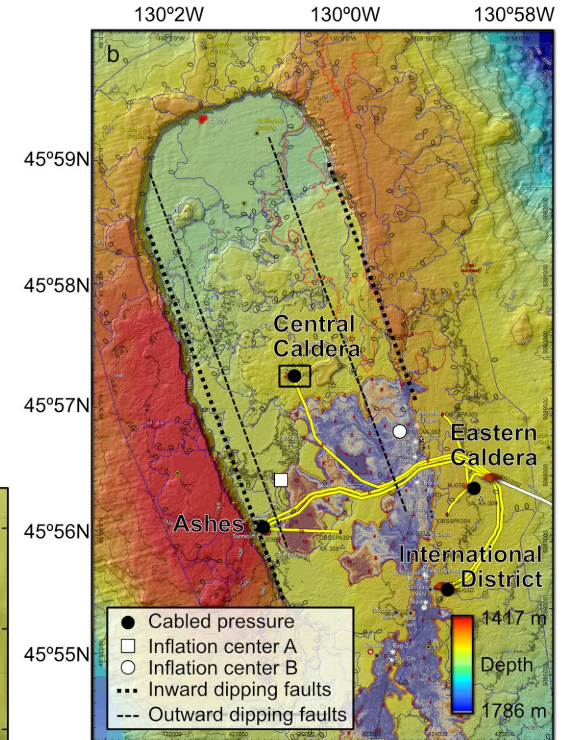
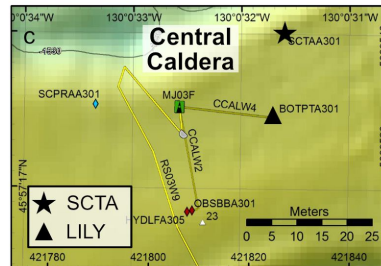
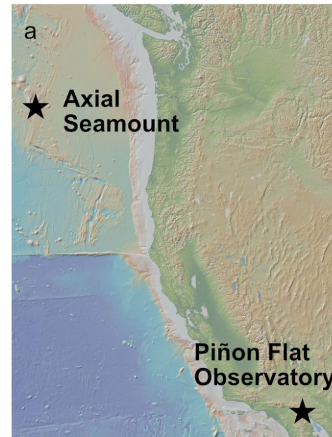


Ongoing: are the model corrections meaningful?



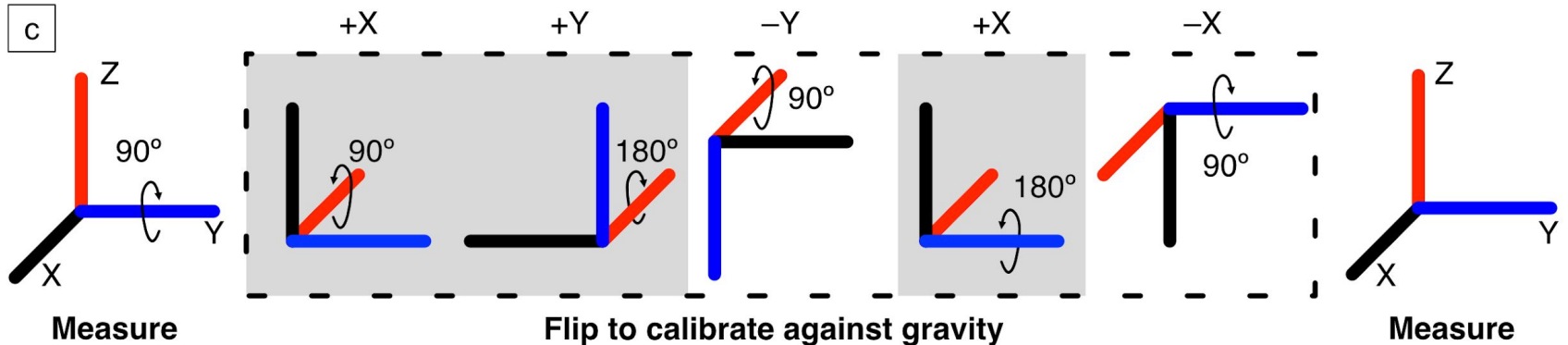
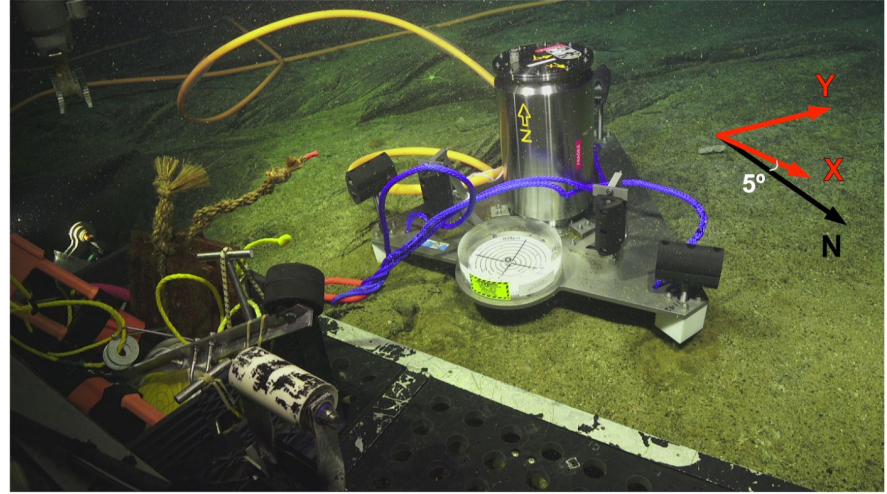
Self-Calibrating Tilt Accelerometer (SCTA)

- One deployment on land at Pinon Flats Observatory in Southern California
 - Little deformation expected
- Other deployment on the seafloor at Axial Seamount on the Juan de Fuca Ridge
 - Ongoing deformation of volcano recorded by other sensors (including tiltmeters)



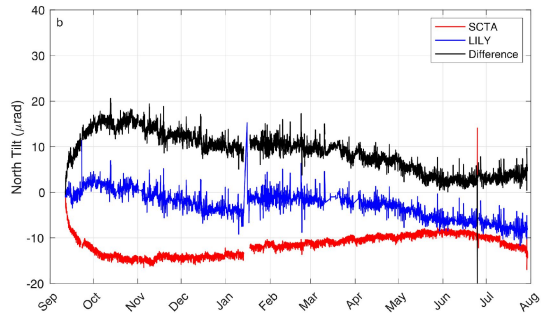
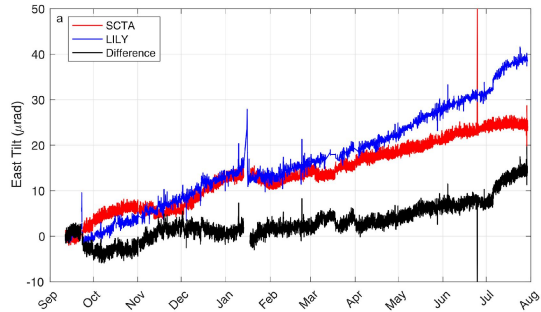
Self-Calibrating Tilt Accelerometer

- 3-component accelerometer
- Horizontal channels measure tilt as $g \sin \theta \approx g\theta$
- Vertical channel measures $g \cos \theta \approx g$



Corrected tilt data match expectations and show large improvement over uncorrected data

Axial Seamount



Pinon Flat Observatory

