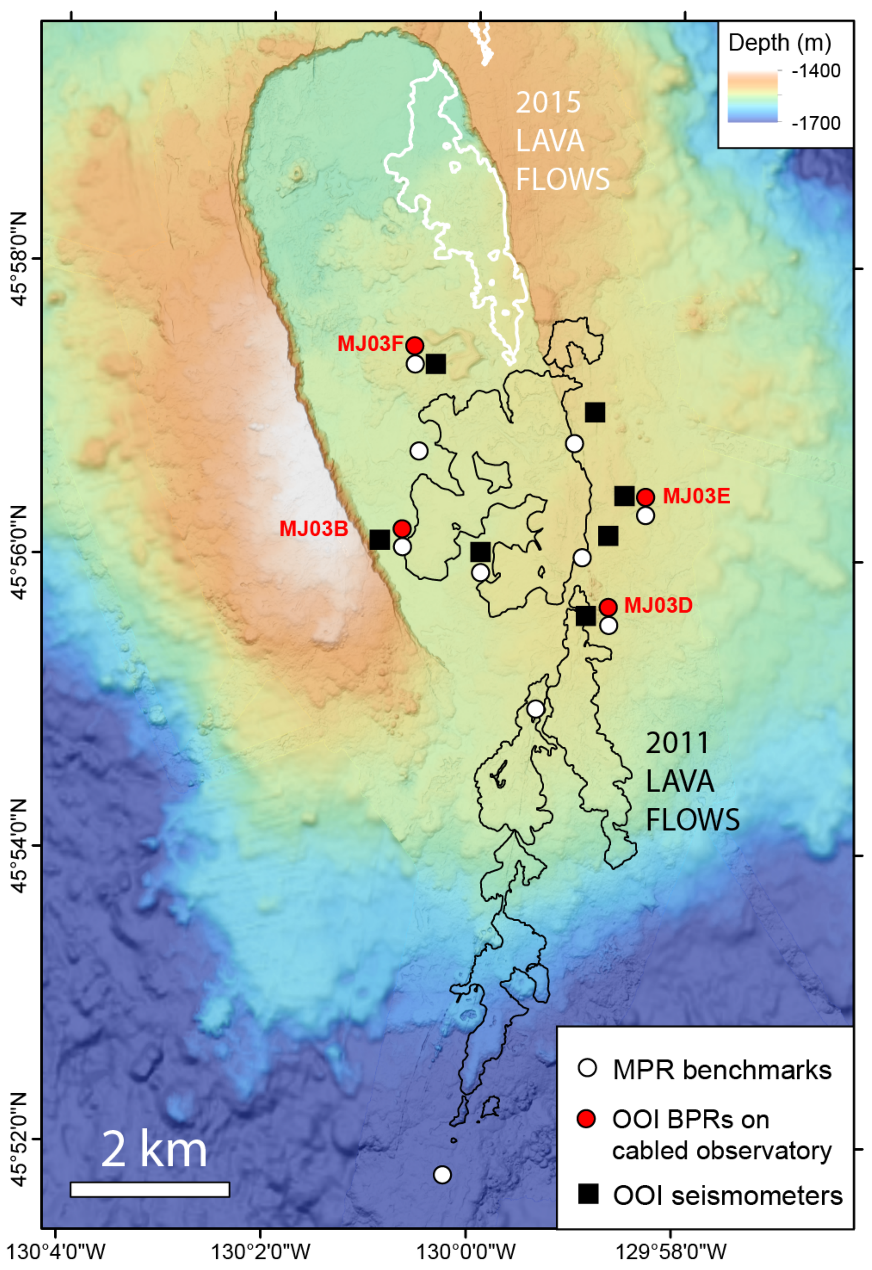
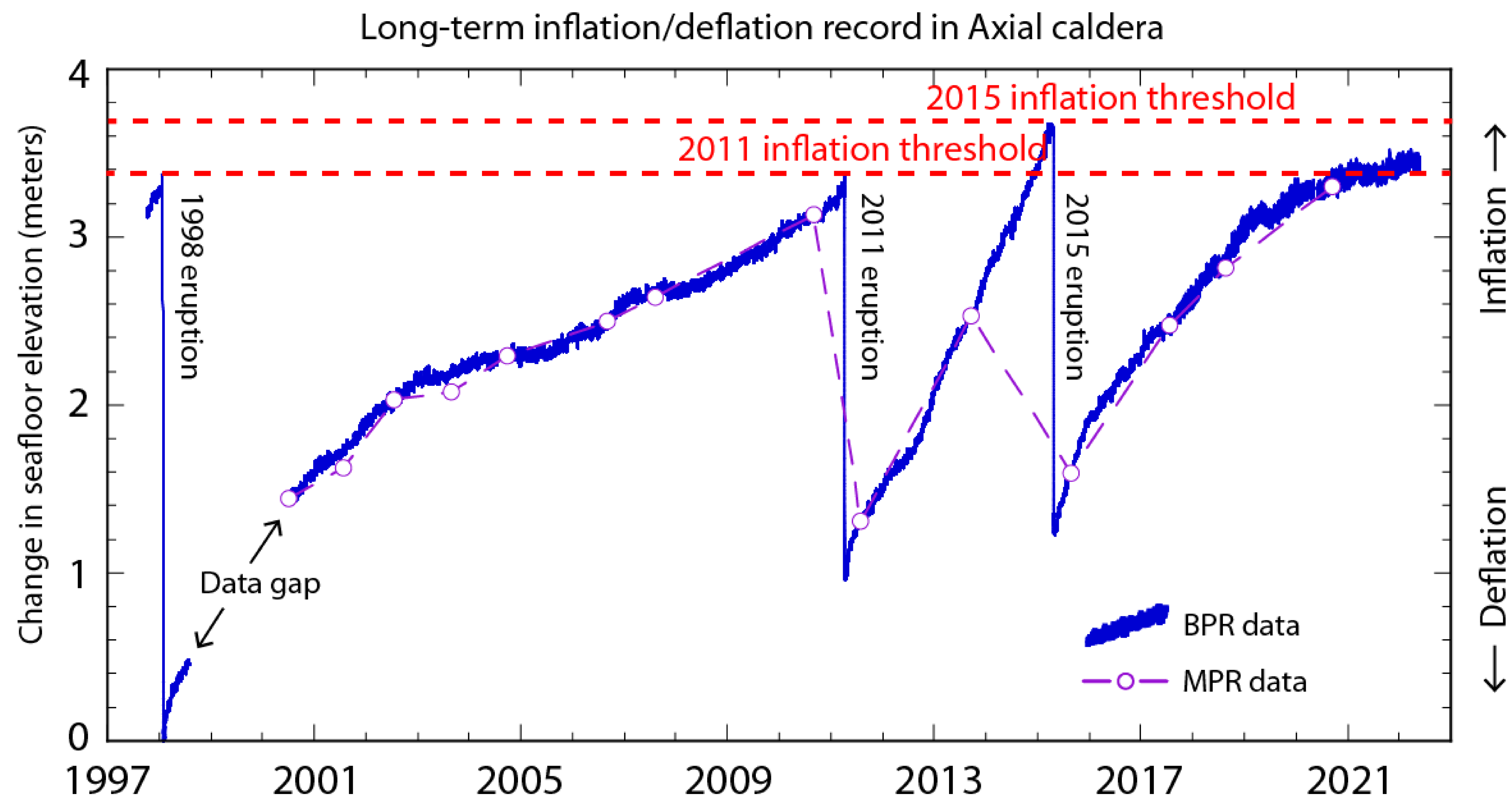
Inflation at Axial Seamount since its 2015 eruption

William W. Chadwick, Jr., *Oregon State University*
william.w.chadwick@gmail.com
Co-authors:
Scott L. Nooner, William S. D. Wilcock, Jeff W. Beeson

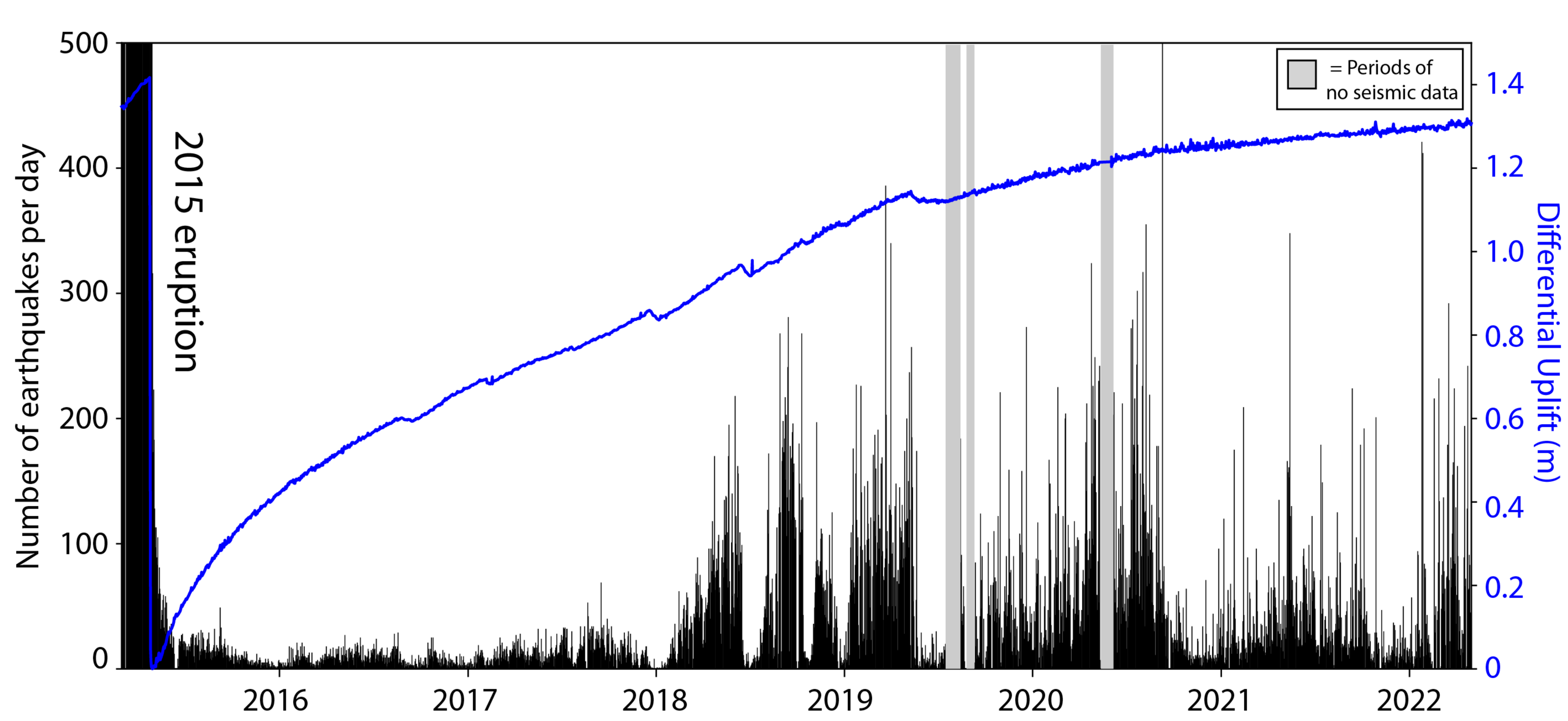
Oregon State University



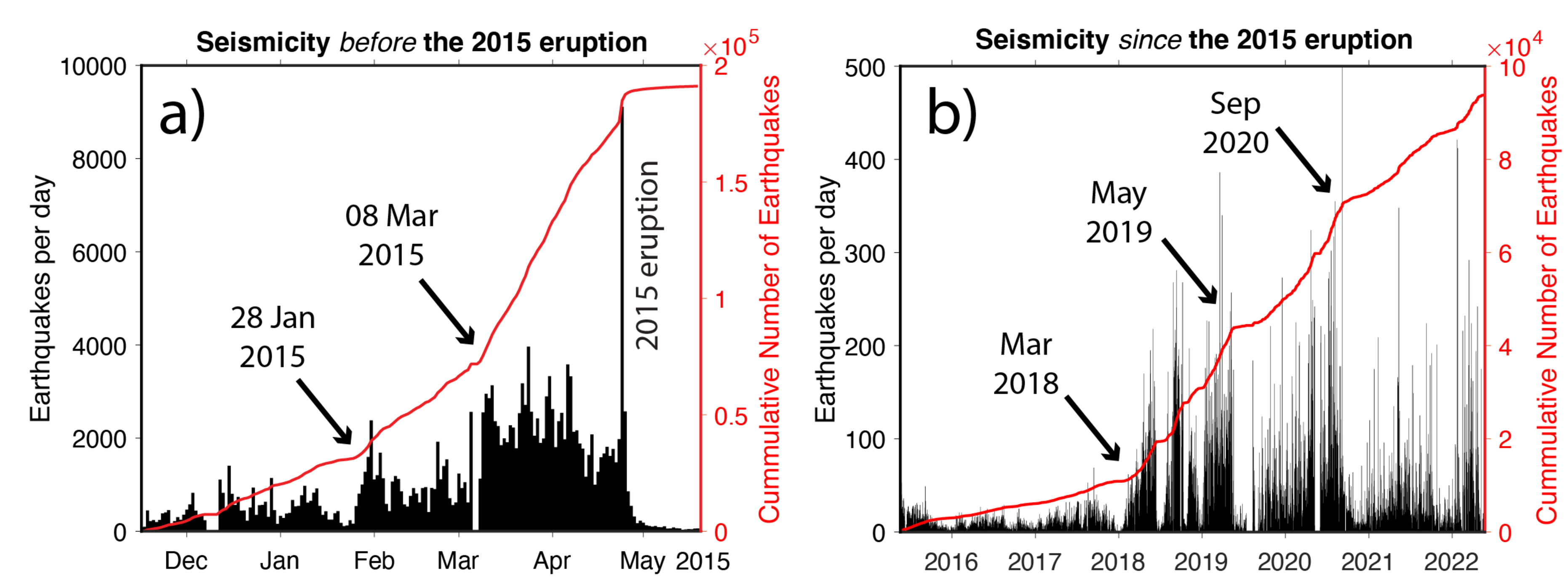
Map of the summit caldera of Axial Seamount showing the 4 bottom pressure/tilt (BOTPT) instruments (red dots) and 7 seismometers (black squares) connected to the OOI-RCA cabled observatory. White dots are seafloor benchmarks where MPR pressure measurements are made.



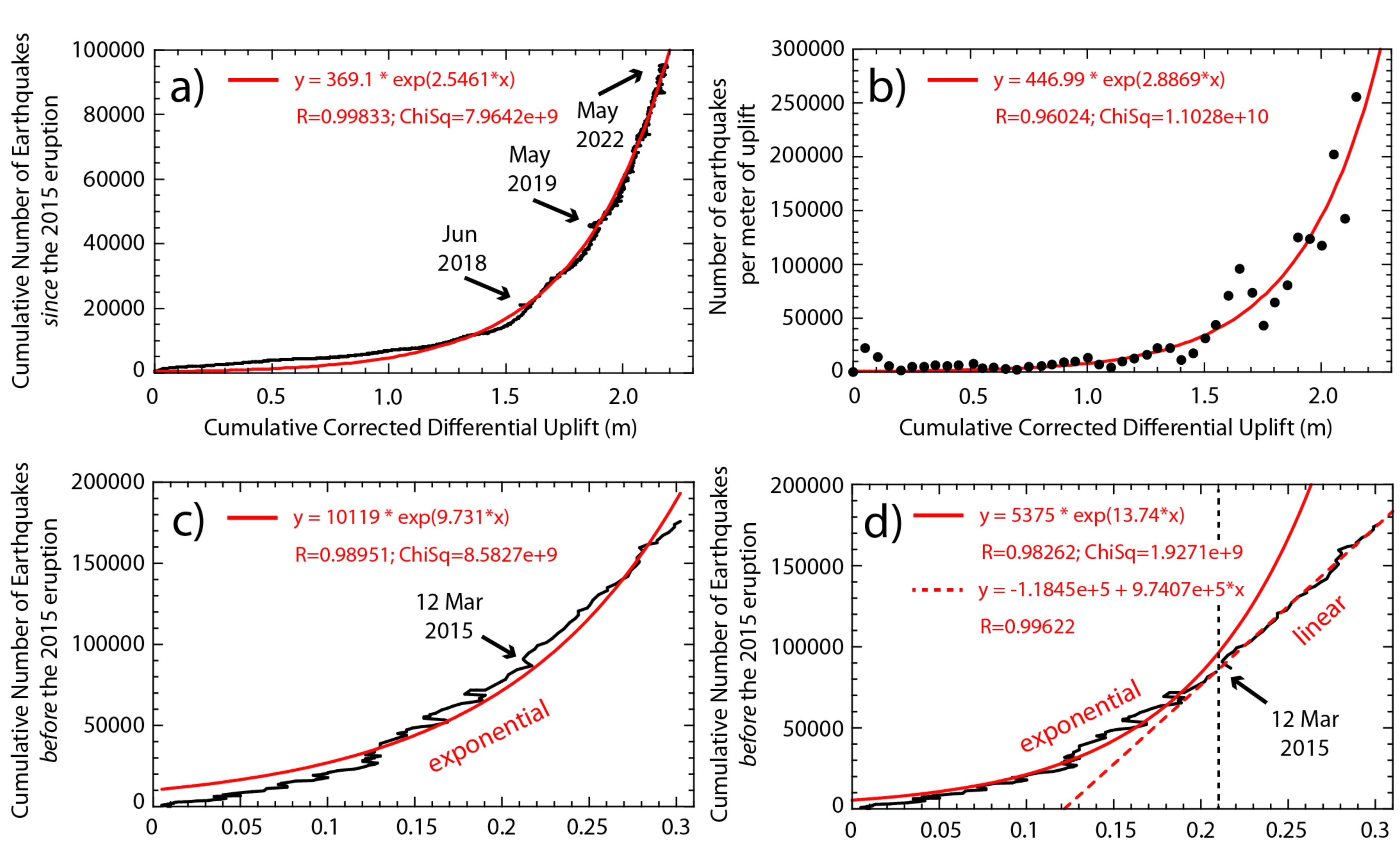
Bottom Pressure Recorder (BPR) data from the Central Caldera at Axial Seamount showing vertical movements of the seafloor over time. Plot shows the major short-term deflation during eruptions in 1998, 2011, and 2015 and long-term re-inflation between eruptions at variable rates. The overall deformation cycle appears to be "inflation-predictable", which can be used to forecast eruptions. Axial has now re-inflated 92% of the amount of deflation during the 2015 eruption. However, the next eruption is likely still years away due to the current low rate of inflation.



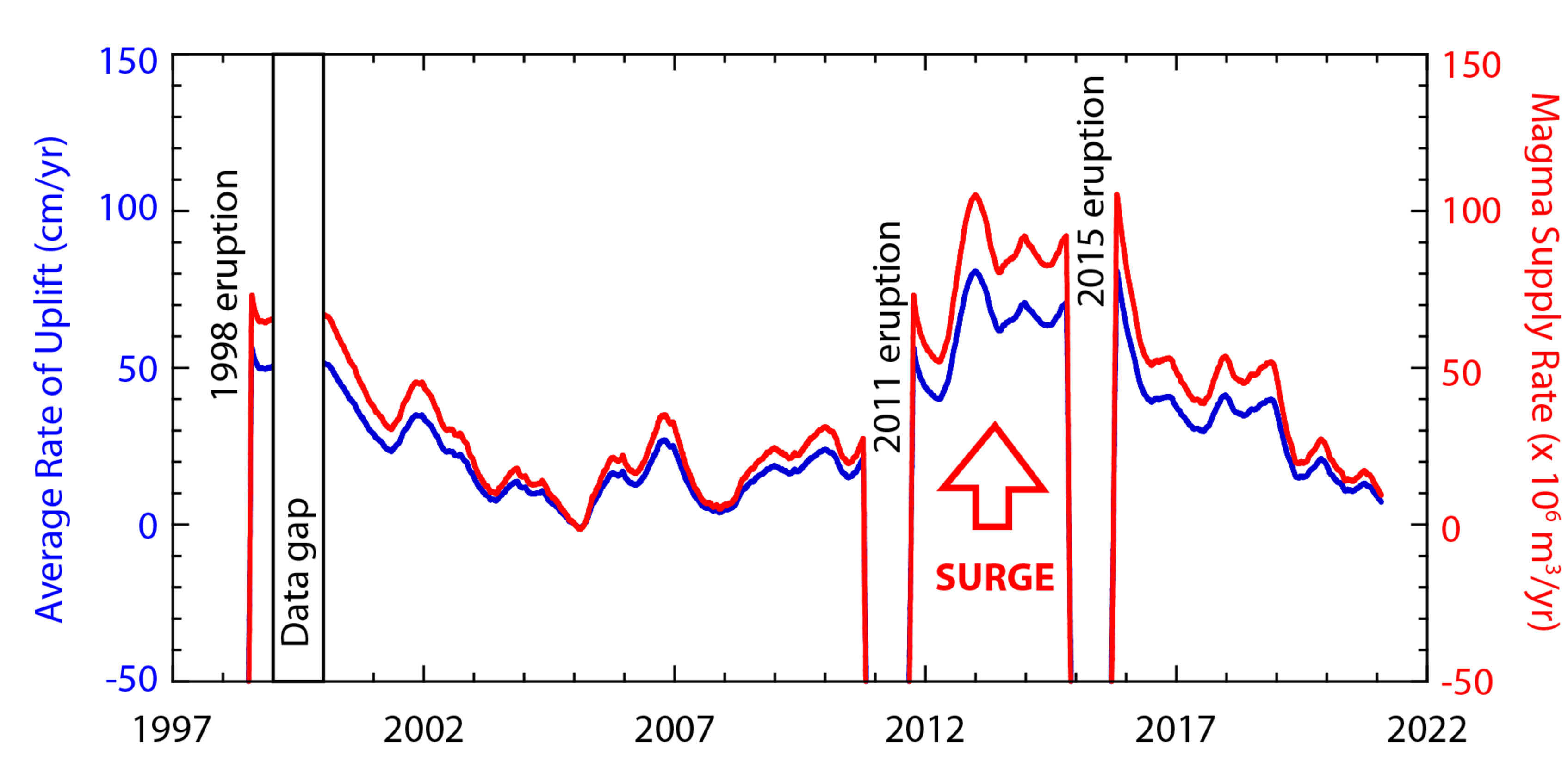
Plot of *differential* OOI-BPR data (blue curve) over histogram of the number of earthquakes per day (black bars) showing how deformation and seismicity have co-varied since the 2015 eruption. Grey vertical stripes show times when no seismic data are available from the Wilcock et al. (2017) catalog (including 3-week period of a multi-channel seismic survey in August 2019). Differential BPR data are calculated by subtracting the Eastern Caldera BPR (MJ03E) from the Central Caldera BPR (MJ03F).



Histograms of earthquakes per day (black bars) and cumulative number of earthquakes (red curves) over time from the Wilcock et al. (2017) catalog. (a) Seismicity before the 2015 eruption. (b) Seismicity since the 2015 eruption. Arrows point to times of significant changes in the rate of earthquakes - the changes in May 2019 and Sep 2020 corresponded with major decreases in the rate of inflation (see blue curve in plot at left). Note the current rate of seismicity is about an order of magnitude lower than that observed before the 2015 eruption, also suggesting that the next eruption is still years away.



Plots showing exponential relationship between rates of seismicity and deformation. (a) Black curve is cumulative number of earthquakes vs. total uplift *since* the 2015 eruption. Red curve is best-fitting exponential equation. (b) Earthquake rate per meter of uplift *since* the 2015 eruption, showing that it also follows an exponential relationship (red curve). (c) Cumulative number of earthquakes vs. total uplift *before* the 2015 eruption, starting in Nov 2014, fit to one exponential curve (red curve). (d) Same data as in (c) but separated into two time periods before and after 12 March 2015 (vertical dashed line), and fit to an exponential curve before (solid red line) and to a linear curve after (red dashed line), which could indicate an increasing component of inelastic deformation precursory to the eruption. The current rate of earthquakes per meter of uplift is ~2.6 x 10^5 m^{-1}, which is about 26% of the rate of ~10^6 m^{-1} seen in the 6 weeks prior to the 2015 eruption. The exponential model would predict that Axial will erupt again when the uplift reaches ~2.8 m, or ~0.6 m above its current level of ~2.2 m. Given that the current rate of inflation is <10 cm/yr, the next eruption is likely still years away.



Long-term plot showing variation in uplift rate from 1997-2022, derived from the single-station BPR record at the center of the caldera, averaged over a 1-year moving time window (blue curve, left y-axis) and magma supply rate calculated from the averaged uplift rate and the best-fit deformation model of Nooner and Chadwick (2016) (red curve, right y-axis). Note that magma supply decreased after the 1998 eruption, then there was a surge in the magma supply between the 2011-2015 eruptions, and the supply has waned by an order of magnitude since then.

FOR MORE INFORMATION :

Chadwick, W. W., Jr., W. S. D. Wilcock, S. L. Nooner, J. W. Beeson, A. M. Sawyer, and T.-K. Lau (2022), Geodetic Monitoring at Axial Seamount Since its 2015 Eruption Reveals a Waning Magma Supply and Tightly Linked Rates of Deformation and Seismicity, *Geochem. Geophys. Geosyst.*, 22, e2021GC010153, doi:10.1029/2021GC010153.

Realtime plots of OOI bottom pressure data: **https://www.pmel.noaa.gov/eoi/rsn/**
Realtime plots of OOI seismic data: **http://axial.ocean.washington.edu/**