Forecasting the Next Eruption at Axial Seamount Based on an Inflation-Predictable Pattern of Deformation

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November 21, 2022

Abstract

Axial Seamount is the most active submarine volcano in the NE Pacific Ocean, and is monitored by instruments connected to a cabled observatory (the US Ocean Observatories Initiative Cabled Array), supplemented by autonomous battery-powered instruments on the seafloor (at ~1500 m depth). Axial is a basaltic hot spot volcano superimposed on the Juan de Fuca spreading ridge, giving it a robust and apparently continuous magma supply. It has had three effusive eruptions in the last 21 years: in 1998, 2011, and 2015. Deformation measurements have been conducted at Axial Seamount since the late 1980's with bottom pressure recorders (BPRs) that can detect vertical movements of the seafloor with a resolution of ~1 cm. This monitoring has produced a 22+ year time-series including co-eruption rapid deflation events of 2.5-3.2 meters, separated by continuous gradual inter-eruption inflation at variable rates between 15-80 cm/yr. The overall pattern appears to be inflation-predictable, with eruptions triggered at or near a critical level of inflation. Using this pattern, the 2015 eruption was successfully forecast within a one-year time window, 7 months in advance. As of December 2019, Axial Seamount has re-inflated 1.98 m (~78%) of the 2.54 m it deflated during the 2015 eruption. We are exploring several methods to forecast the next eruption, including daily extrapolation of the average rate of inflation from OOI BPR data during the last 3 months forward in time until it intersects the threshold reached before the 2015 eruption. Using this method with the difference in inflation between two OOI BPR instruments located 3.5 km apart removes noise from tidal residuals and oceanographic signals that are common to both instruments. This method suggests the next eruption is likely between 2020 and 2024. However, this simple method is complicated by uncertainties in the next inflation threshold (the volcano inflated 20 cm higher before the 2015 eruption compared to 2011), changes in the rate of inflation with time, and by intermittent pauses in the inflation (and seismicity) observed since 2015 that have lasted from a week to several months.

Fall AGU 2019 - Poster OS51B-1489

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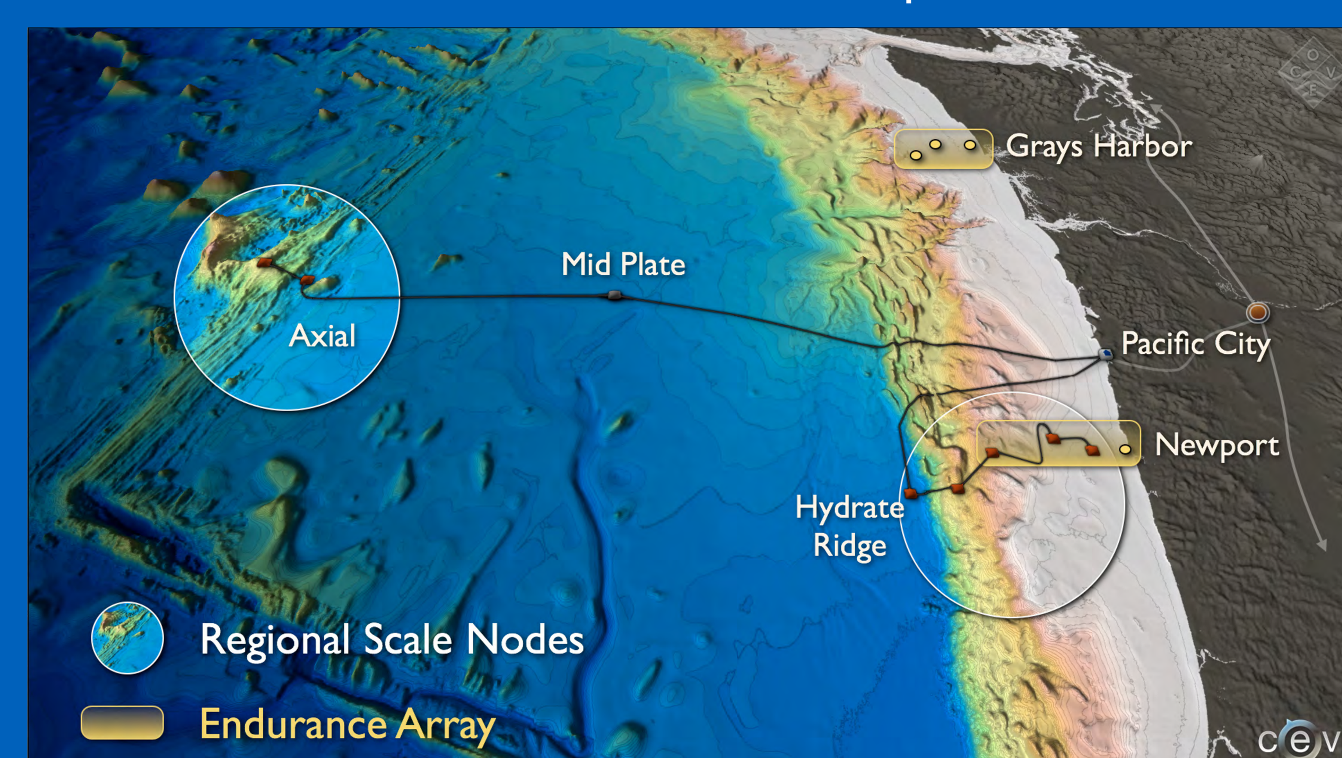
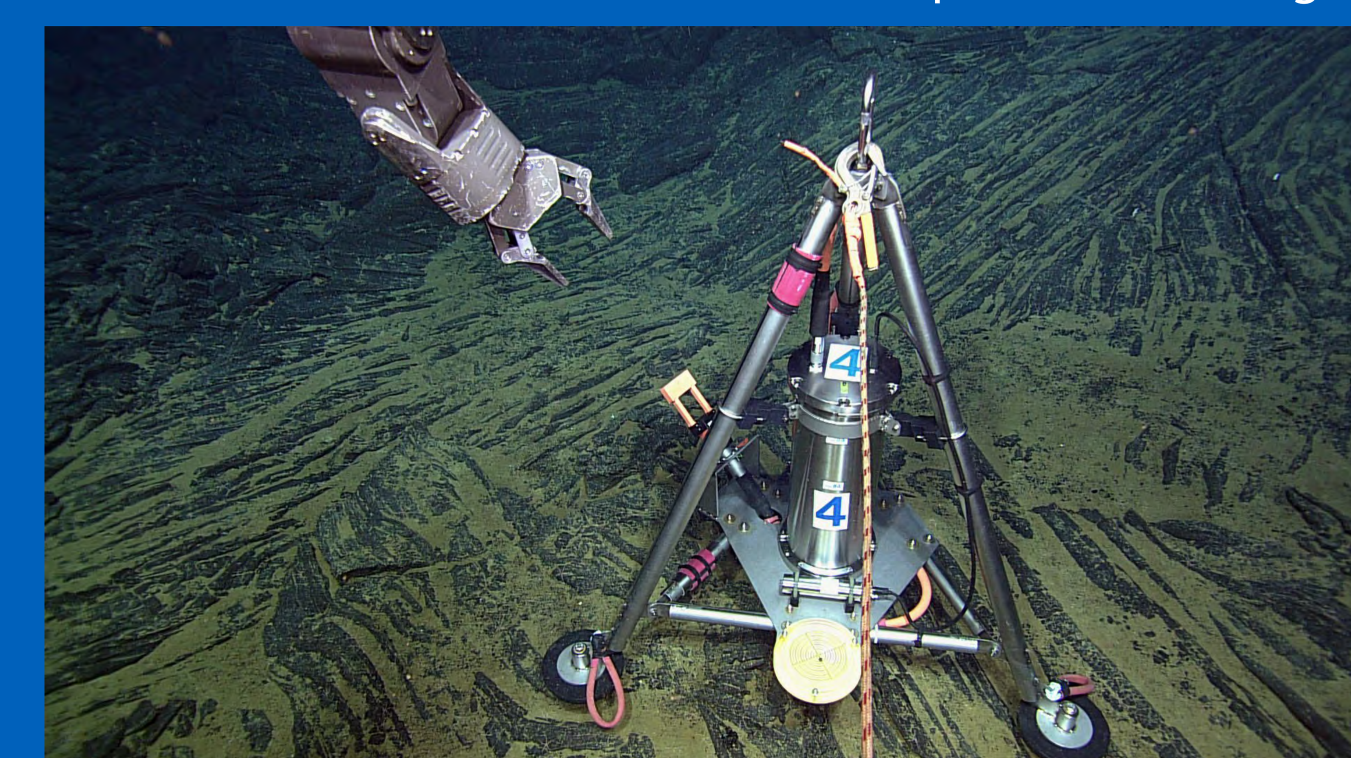
The next **eruption** of **Axial Seamount** is **forecast** to occur between **2020-2024**, based on a repeated pattern of volcanic **inflation** and **deflation**.

Ocean Observatories Initiative Cabled Array connects Axial Seamount to shore via a fiber-optic cable

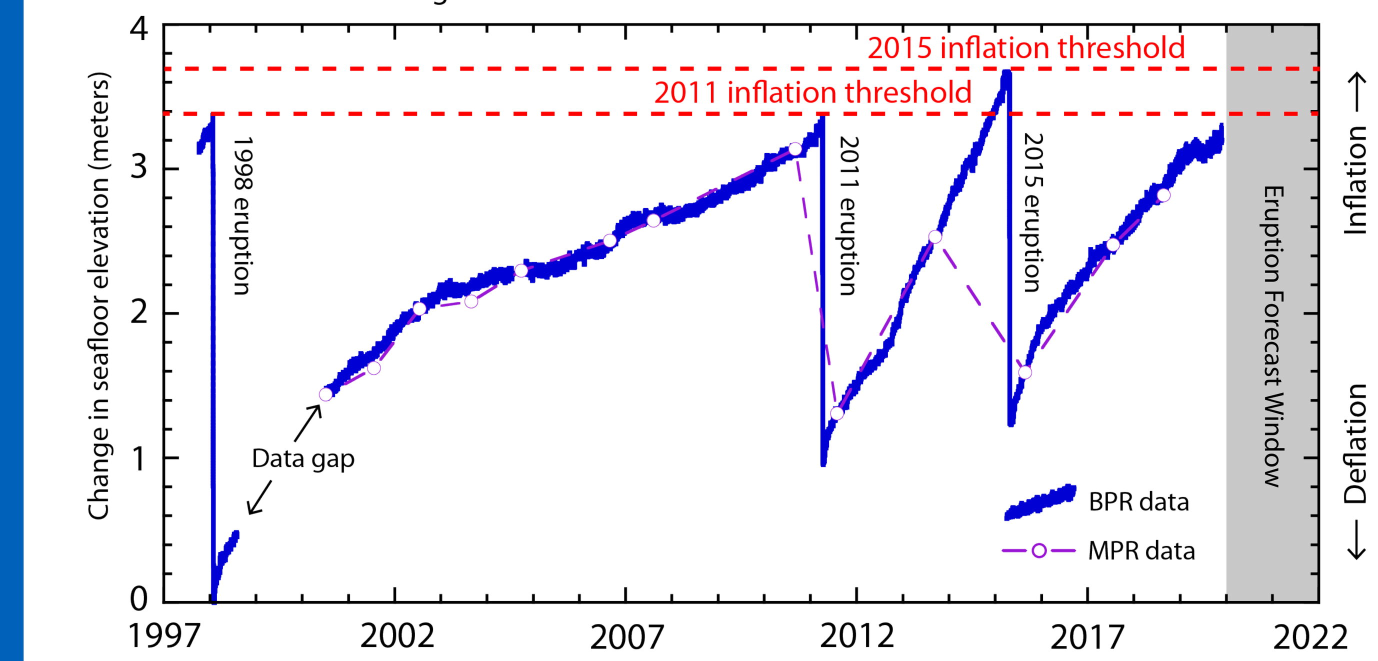


Bottom-pressure/tilt sensors provide real-time data on inflation/deflation that is used for eruption forecasting



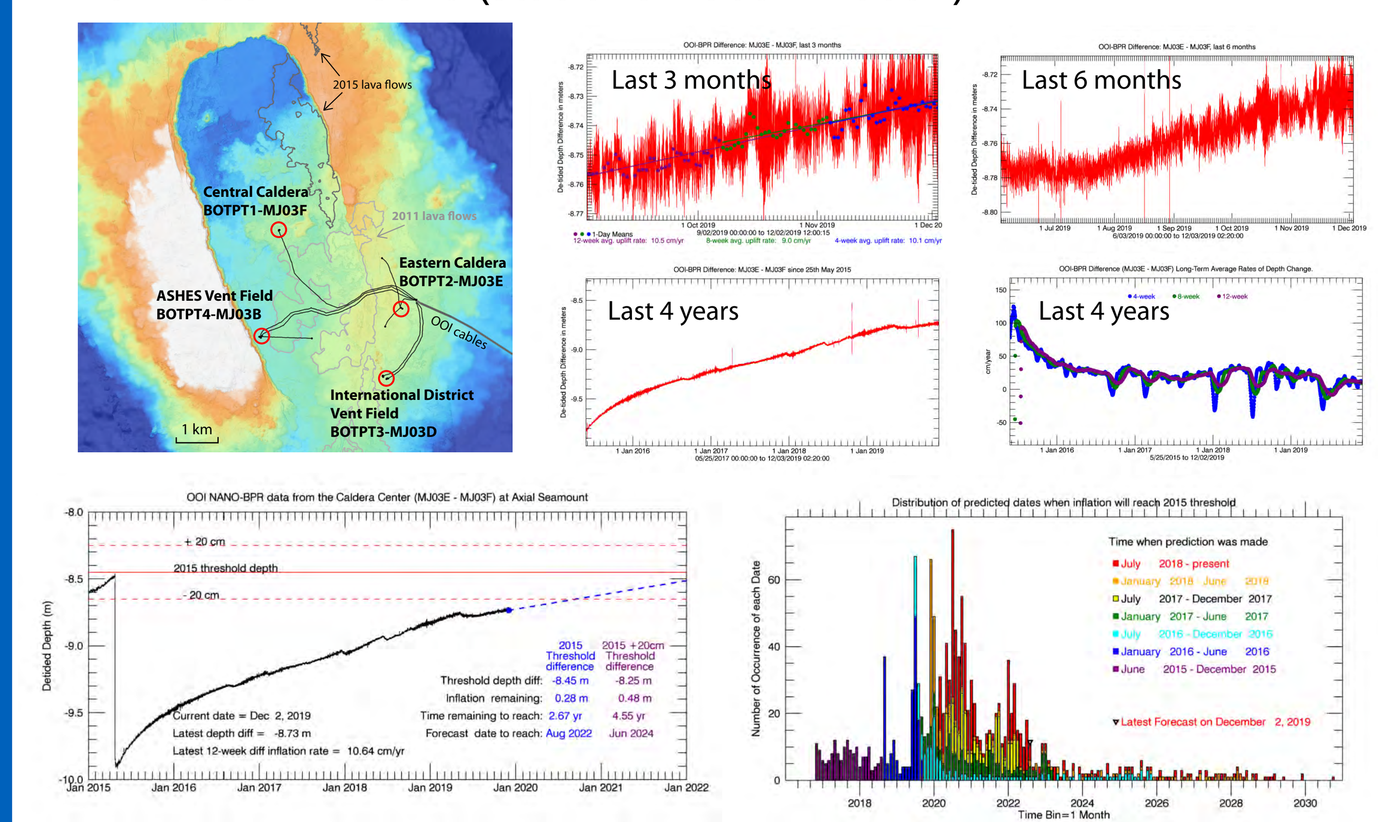
Take a picture to link to plots of real-time data from Axial Seamount at this web site:

https://www.pmel.noaa.gov/eoi/rsn/

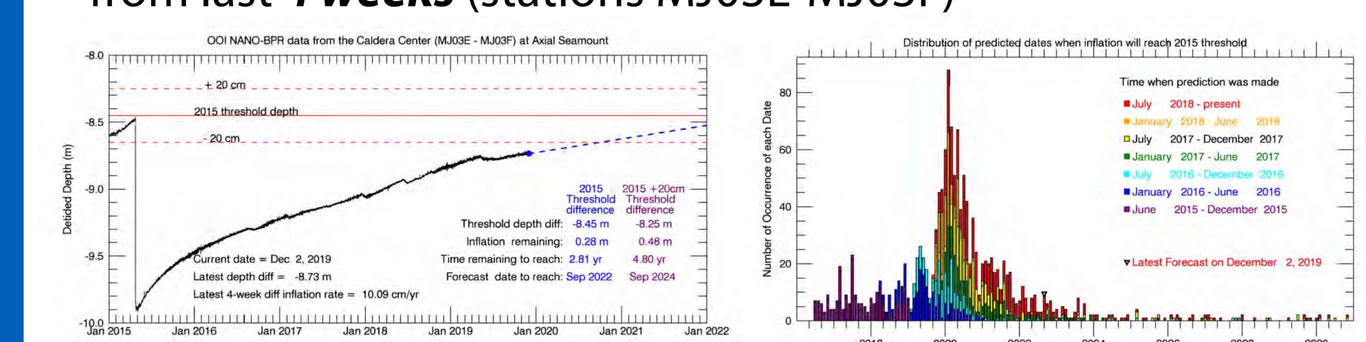


Comparison of 3 forecast methods

#3: Extrapolating average rate of ***differential*** inflation from last ***12 weeks*** (stations MJ03E-MJ03F)



#2: Extrapolating average rate of ***differential*** inflation from last ***4 weeks*** (stations MJ03E-MJ03F)



#1: Extrapolating average rate of ***single-station*** inflation from last ***12 weeks*** (station MJ03F only)