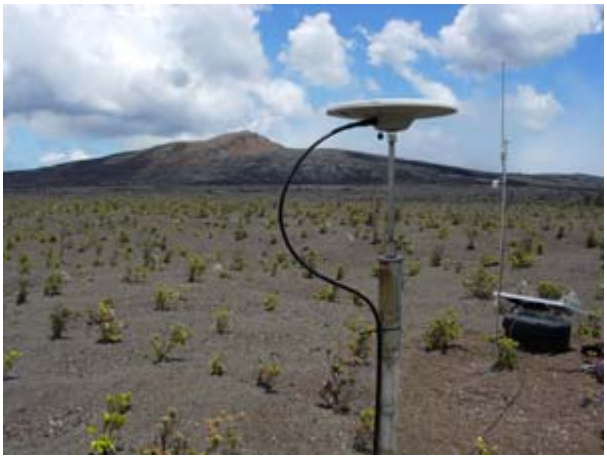
Global Positioning Systems (GPS)



GPS station KAMO, with Pu‘u ‘Ō‘ō in the background. The GPS antenna is in the foreground, with the solar panel, electronic box, and telemetry mast, and telemetry antennas at right. (2007/08/10)

The use of the Global Positioning System (GPS) in Earth sciences has only been prominent since the 1980s, but since then has become nearly ubiquitous in volcano deformation measurements around the world. The system relies on a ground-based receiver and antenna, which records signals broadcast by an array of orbiting satellites. Given enough data, GPS data can be used to determine positions to within a few mm horizontally and ~10 mm vertically. GPS can be used in campaign mode, where a receiver and antenna are moved frequently to measure a series of fixed benchmarks (emblems permanently cemented into the ground) or installed for continuous measurement of surface motion at a signle location. Typically, continuous GPS stations are powered by a combination of batteries and solar panels.

The data received by continuous GPS stations are susceptible to a number of environmental effects unrelated to volcano deformation. For example, snow buildup on a GPS antenna can cause path delays, rain can induce surface loading, small movements can be detected due to diurnal or seasonal temperature variations, and most importantly, storms and other atmospheric phenomena can introduce deformation artifacts. Fortunately, atmospherically-based problems are less likely to affect tightly-clustered GPS networks, since all stations in such a network will see the same phenomena, and such effects will be canceled out.

GPS Network at Pu‘u ‘Ō‘ō

There are over 60 continuously operating GPS stations on the Island of Hawai‘i, most of which are operated by the Hawaiian Volcano Observatory for the purpose of earthquake and volcano monitoring. All stations have a GPS antenna mounted on a mast which is cemented into solid rock. The antenna is connected to a receiver which is typically run using a combination of solar and battery power. Data are collected at least every 30s and, at some stations, every 1s, and periodically radioed to the Hawaiian Volcano Observatory where processing is completed and positions calculated.

Pu‘u ‘Ō‘ō GPS Stations

PUOC: located on the north rim of Pu‘u ‘Ō‘ō crater, installed in June 2006, currently operational.

SPIL: located on the southeast rim of Pu‘u ‘Ō‘ō crater, installed in July 2007, currently operational.

OKIT: located on the west flank of Pu‘u ‘Ō‘ō, installed in July 2007, currently operational.

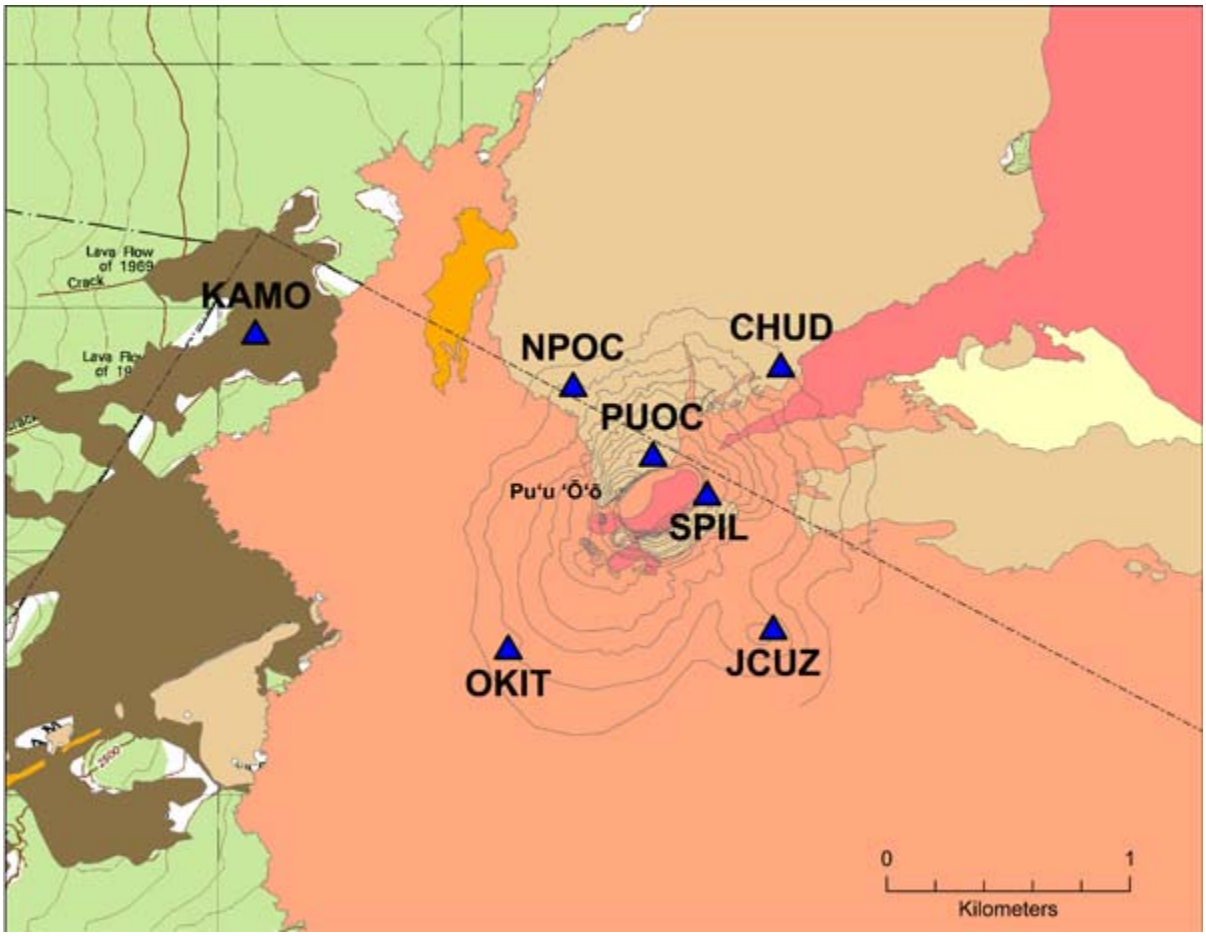
NPOC: located on the north flank of Pu‘u ‘Ō‘ō, installed in July 2007, currently operational.

JCUZ: located on the south flank Pu‘u ‘Ō‘ō, installed in July 2007, currently operational.

CHUD: located on the west flank Pu‘u ‘Ō‘ō crater, installed in July 2007, currently operational.

KAMO: located about 1.8 km northwest of Pu‘u ‘Ō‘ō crater, installed in August 2007, currently operational.

MKPM: International GPS Service (IGS) station located near the summit of Mauna Kea on the Island of Hawai‘i, currently operational. This site can be used as a stable reference (''Baseline Benchmark'' in the Data-VALVE3 interface) for plotting East, North, and Up compoents of the above Pu‘u ‘Ō‘ō stations.



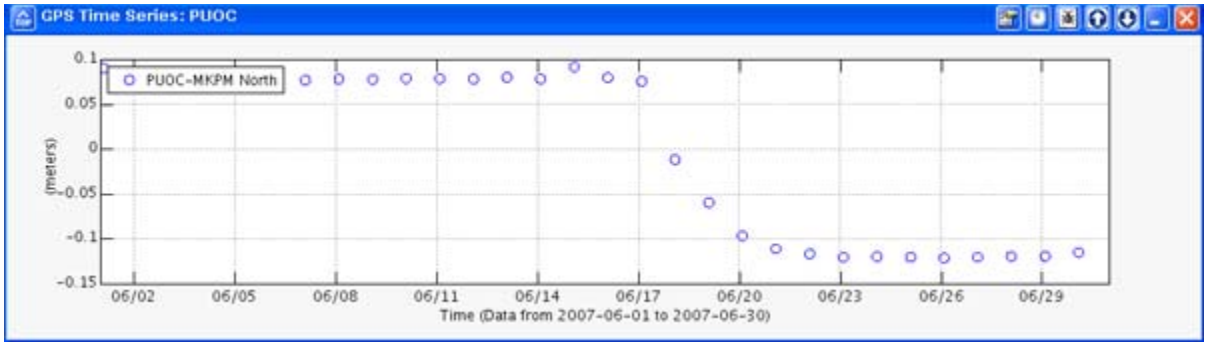
A map of the GPS network near Pu‘u ‘Ō‘ō. Base map colors correspond to different lava flow ages. See the History section for more information.

Data Availability

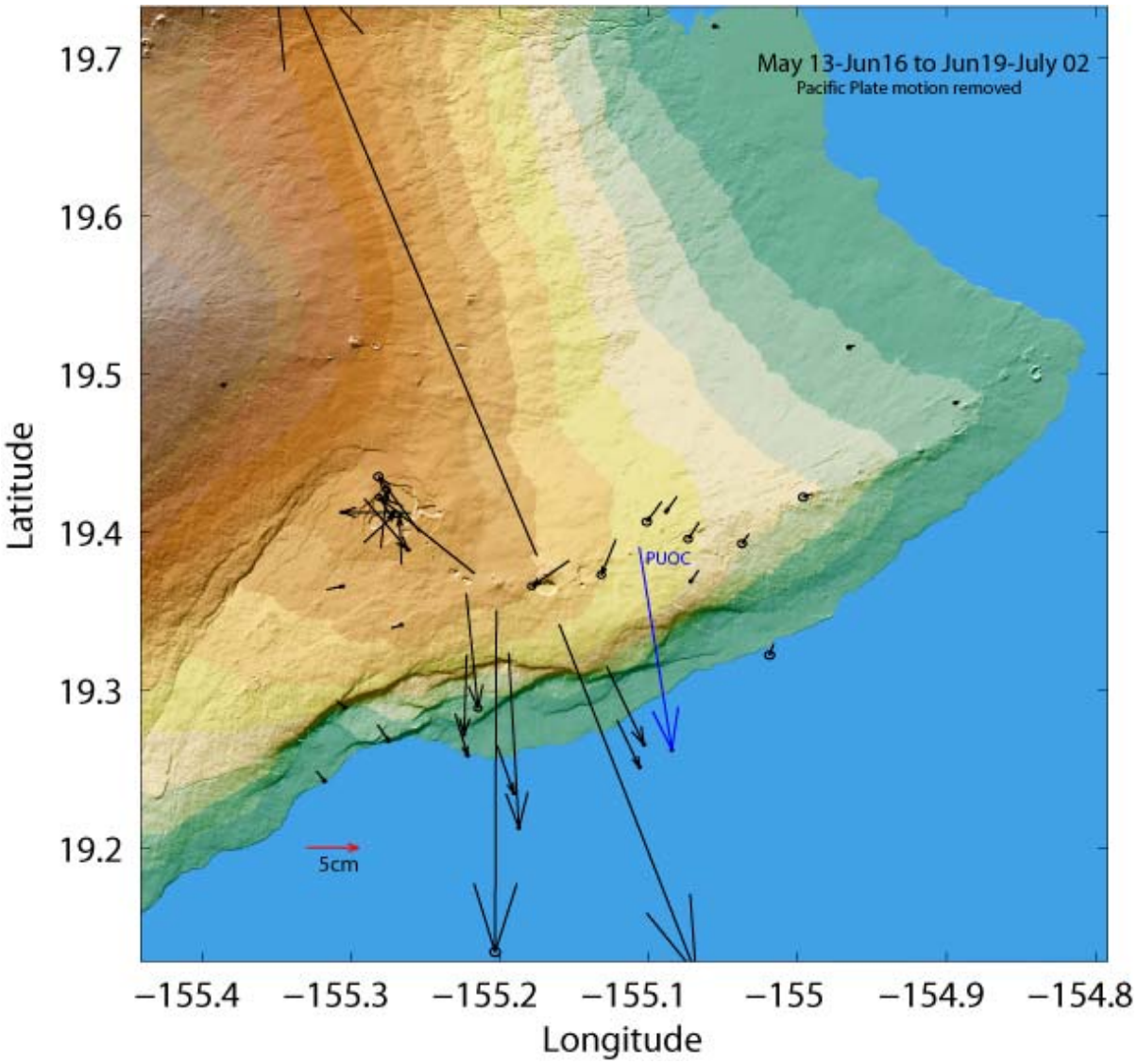
Dark blue filled areas correspond to periods when data is available.

PUOC							
SPIL							
OKIT							
NPOC							
JCUZ							
CHUD							
KAMO							
MKPM							
	1996	**1997-2005**	**2006**	**2007**	**2008-2009**	**2010**	**2011/Present**

Note: when ploting the East, North, or Up components of a station located near Pu‘u ‘Ō‘ō, the MKPM station should be listed in the ''Baseine Benchmark'' part of the Data-VALVE3 interface. This will plot the Pu‘u ‘Ō‘ō data relative to a stable reference, effectively removing Pacific Pate motion and other undesireable artifacts.



The time series above depicts northward motion of the PUOC GPS station, located on the north rim of Pu‘u ‘Ō‘ō crater, during June 2007. Starting on about June 17, the station began to move south as Pu‘u ‘Ō‘ō deflated and the crater floor collapsed in response to the interruption in magma supply. The motion continued until at least June 23.



Map of surface deformation of Kīlauea Volcano from GPS as a result of the June 17-19, 2007, east rift zone intrusion and eruption. Note that GPS stations around the summit of the volcano show contraction, while GPS stations on the east rift zone near Makaopuhi crater moved away from one another. This pattern is a result of magma draining from the summit into a dike beneath the surface near Makaopuhi Crater. GPS station PUOC (blue) was the only site located on Pu‘u ‘Ō‘ō at that time. The large southward motion of that site indicates deflation and collapse of Pu‘u ‘Ō‘ō crater as the magma supply to the eruption site was cut off by the up-rift intrusion and eruption.

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