

## Biennial report for Permanent Supersite/Natural Laboratory

### *Hawai'i Supersite*

History	<a href="https://geo-gsnl.org/supersites/permanent-supersites/hawaiian-volcanoes-supersite/">https://geo-gsnl.org/supersites/permanent-supersites/hawaiian-volcanoes-supersite/</a>
Supersite Coordinator	<i>Michael Poland (U.S. Geological Survey)</i> <i>USGS – CVO</i> <i>1300 SE Cardinal Ct., Suite 100</i> <i>Vancouver, WA 98660, USA</i>  <i>Ingrid Johanson (U.S. Geological Survey)</i> <i>USGS – HVO</i> <i>PO BOX 1026</i> <i>Hilo, HI 96721</i>

## 1. Abstract

*In 2008, the Hawaiʻi Supersite was established to encourage collaborative research into volcanic processes on the Island of Hawaiʻi, and to aid with the assessment and mitigation of volcanic hazards to the local population. Made permanent in 2012, the Supersite now hosts a diverse array of data from a variety of sources. Comprehensive ground-based monitoring, conducted by the Hawaiian Volcano Observatory and collaborators, consists of deformation, seismic, gravity, gas emissions, camera observations, and geochemical analyses. Space-based data include thousands of Synthetic Aperture Radar (SAR) images provided by numerous national space agencies, as well as unique optical and thermal datasets that can be used to detect changes in topography and variations in thermal and gas emissions. Using these datasets, a variety of insights have been gained into how Hawaiian volcanoes work. For example, magma supply to Kīlauea appears to fluctuate on timescales of just a few years and has a direct impact on eruptive activity. Magma accumulation at Kīlauea can promote slip on nearby faults, triggering M4+ earthquakes. Magma storage and transport pathways were mapped at both Kīlauea and Mauna Loa volcanoes, providing a basis upon which to interpret past, present, and future monitoring data. In addition, Supersite data, particularly SAR, have been invaluable for operational monitoring of deformation and eruptive activity—critical information for understanding the evolving nature of volcanic hazards in Hawaiʻi. The wealth of available data also has facilitated the development of new methodologies for processing and analyzing SAR data, given the large number of images, availability of ground-based data for calibration/validation, and continuous volcanic activity against which to test new methods. A long list of published research details the success of the initiative, but the most significant results are still to come. A decade after the Supersite was established, a major rift eruption, flank earthquake, and summit caldera collapse occurred at Kīlauea Volcano. The exceptional availability of data spanning this event—the most significant to have occurred at Kīlauea is over 200 years and the best-observed caldera collapse sequence ever—facilitated not just hazards assessment and mitigation efforts, but also scientific research into Hawaiian volcanism. Insights from Supersite data have become invaluable to stakeholders on the Island of Hawaiʻi, and results provide exceptional fodder for scientific exploration into how volcanoes work.*

## 2. Scientists/science teams

<b>Falk Amelung</b>	Department of Marine Geosciences, Rosenstiel School Of Marine And Atmospheric Sciences, University of Miami, 4600 Rickenbacker Causeway, Miami, FL, 33149, USA, <a href="mailto:famelung@rsmas.miami.edu">famelung@rsmas.miami.edu</a> , <a href="http://www.rsmas.miami.edu/personal/famelung/Home.html">http://www.rsmas.miami.edu/personal/famelung/Home.html</a>
<b>Simone Atzori</b>	Istituto Nazionale di Geofisica e Vulcanologia, via di Vigna Murata 605, Roma, 00143, ITALY, <a href="mailto:simone.atzori@ingv.it">simone.atzori@ingv.it</a>
<b>Scott Baker</b>	UNAVCO, 6350 Nautilus Drive, Boulder, CO 80301, USA, <a href="mailto:baker@unavco.org">baker@unavco.org</a>
<b>Roland Bürgmann</b>	University of California at Berkeley, Dept. of Earth and Planetary Science, 307 McCone Hall, Berkeley, CA, 94720-4767, USA,

	<a href="mailto:burgmann@seismo.berkeley.edu">burgmann@seismo.berkeley.edu</a> , <a href="http://eps.berkeley.edu/people/roland-burgmann">http://eps.berkeley.edu/people/roland-burgmann</a>
<b>Yunmeng Cao</b>	Central South University, Changsha, Hunan, 410083, CHINA, <a href="mailto:ymcch93@gmail.com">ymcch93@gmail.com</a>
<b>Gilda Currenti</b>	Istituto Nazionale di Geofisica e Vulcanologia, Piazza Roma 2, Catania, 95125, ITALY, <a href="mailto:gilda.currenti@ct.ingv.it">gilda.currenti@ct.ingv.it</a> , <a href="http://www.ct.ingv.it/en/component/content/article/97-curriculumpersonale/600-currenti-gilda.html">http://www.ct.ingv.it/en/component/content/article/97-curriculumpersonale/600-currenti-gilda.html</a>
<b>Kurt Feigl</b>	Department of Geoscience, University of Wisconsin – Madison, 1215 W Dayton St, Madison, WI, 53706, USA, <a href="mailto:feigl@wisc.edu">feigl@wisc.edu</a> , <a href="http://geoscience.wisc.edu/geoscience/people/faculty/feigl">http://geoscience.wisc.edu/geoscience/people/faculty/feigl</a>
<b>Liu Guang</b>	Institute of Remote sensing and Digital Earth, Chinese Academy of Sciences, No.9 Dengzhuang South Road, Haidian District, Beijing, 100094, CHINA, <a href="mailto:liuguang@radi.ac.cn">liuguang@radi.ac.cn</a>
<b>Minjeong Jo</b>	NASA Goddard Space Flight Center, 8800 Greenbelt Rd, Bldg 33 G415, Greenbelt, MD, 20771, USA, <a href="mailto:minjeong.jo@nasa.gov">minjeong.jo@nasa.gov</a> , <a href="https://science.gsfc.nasa.gov/sed/bio/minjeong.jo">https://science.gsfc.nasa.gov/sed/bio/minjeong.jo</a>
<b>Hyung-Sup Jung</b>	Department of Geoinformatics, The University of Seoul, 90 Jeonnong-dong, Dongdaemun-gu, Seoul 130-743, REPUBLIC OF KOREA, <a href="mailto:hsjung@uos.ac.kr">hsjung@uos.ac.kr</a>
<b>Paul Lundgren</b>	Jet Propulsion Laboratory, M/S 300-233, 4800 Oak Grove Drive, Pasadena, CA 91109, USA, <a href="mailto:paul.r.lundgren@jpl.nasa.gov">paul.r.lundgren@jpl.nasa.gov</a> , <a href="https://science.jpl.nasa.gov/people/Lundgren/">https://science.jpl.nasa.gov/people/Lundgren/</a>
<b>Michael Poland</b>	USGS – Cascades Volcano Observatory, 1300 SE Cardinal Ct., Suite 100, Vancouver, WA 98683, USA, <a href="mailto:mpoland@usgs.gov">mpoland@usgs.gov</a> , <a href="https://profile.usgs.gov/mpoland/">https://profile.usgs.gov/mpoland/</a>
<b>Nicole Richter</b>	Observatoire Volcanologique du Piton de la Fournaise (OVPF-IPGP), 14 RN3, KM 27, Plaine des Cafres, La Réunion, FRANCE, <a href="mailto:richter@ipgp.fr">richter@ipgp.fr</a> , <a href="http://www.ipgp.fr/fr/richter-nicole">http://www.ipgp.fr/fr/richter-nicole</a>
<b>Sergey Samsonov</b>	Canada Centre for Mapping and Earth Observation, Natural Resources Canada, 560 Rochester Street, Ottawa, ON K1A 0E4, CANADA, <a href="mailto:sergey.samsonov@nrcan-rncan.gc.ca">sergey.samsonov@nrcan-rncan.gc.ca</a> , <a href="http://www.insar.ca/">http://www.insar.ca/</a>
<b>Eugenio Sansosti</b>	National Research Council (CNR), Istituto per il Rilevamento Elettromagnetico dell'Ambiente, IREA – CNR, via Diocleziano, 328, Napoli, 80124, ITALY, <a href="mailto:sansosti.e@irea.cnr.it">sansosti.e@irea.cnr.it</a> , <a href="http://www.irea.cnr.it/en/index.php?option=com_comprofiler&amp;task=userprofile&amp;user=119&amp;Itemid=100">http://www.irea.cnr.it/en/index.php?option=com_comprofiler&amp;task=userprofile&amp;user=119&amp;Itemid=100</a>
<b>Manoochehr Shirzaei</b>	School of Earth and Space Exploration, Arizona State University, PO Box 876004, Tempe, AZ 85287-6004, USA, <a href="mailto:shirzaei@asu.edu">shirzaei@asu.edu</a> , <a href="http://ratlab.asu.edu/">http://ratlab.asu.edu/</a>
<b>Pietro Tizzani</b>	National Research Council Institute for the environment electromagnetic survey (CNR – IREA), Via Diocleziano 328, Napoli, 80124, ITALY, <a href="mailto:tizzani.p@irea.cnr.it">tizzani.p@irea.cnr.it</a> , <a href="http://www.irea.cnr.it/en/index.php?option=com_comprofiler&amp;task=userprofile&amp;user=134&amp;Itemid=100">http://www.irea.cnr.it/en/index.php?option=com_comprofiler&amp;task=userprofile&amp;user=134&amp;Itemid=100</a>
<b>Antonio Valentino</b>	Advanced REMote-sensing SYStems, Via Bistolfi 49, Milano, 20134, ITALY,

	<a href="mailto:antonio.valentino@aresys.it">antonio.valentino@aresys.it</a>
<b>Teng Wang</b>	Nanyang Technological University, Earth Observatory of Singapore, N2-01C-65, 50 Nanyang Avenue, Singapore, 639798, SINGAPORE, <a href="mailto:wang.teng@ntu.edu.sg">wang.teng@ntu.edu.sg</a> , <a href="https://earthobservatory.sg/people/wang-teng">https://earthobservatory.sg/people/wang-teng</a>
<b>Thomas Walter</b>	Deutsches GeoForschungsZentrum GFZ, Telegrafenberg, 14473 Potsdam, GERMANY, <a href="mailto:thomas.walter@gfz-potsdam.de">thomas.walter@gfz-potsdam.de</a> , <a href="http://www.gfz-potsdam.de/en/section/physics-of-earthquakes-and-volcanoes/staff/profil/thomas-walter/">http://www.gfz-potsdam.de/en/section/physics-of-earthquakes-and-volcanoes/staff/profil/thomas-walter/</a>
<b>Bing Xu</b>	School of Geoscience and Info-physics, Central South University, Changsha, Hunan, 410083, CHINA, <a href="mailto:xubing@csu.edu.cn">xubing@csu.edu.cn</a>
<b>Howard Zebker</b>	Stanford University, 397 Panama Mall, Mitchell Building 101, Stanford, CA 94305-2210, USA, <a href="mailto:zebker@stanford.edu">zebker@stanford.edu</a> , <a href="https://profiles.stanford.edu/howard-zebker">https://profiles.stanford.edu/howard-zebker</a>

### Scientists/science teams issues

The science team grew by several participants during this reporting period as a result of the 2018 lower East Rift Zone eruption and summit collapse at Kīlauea Volcano. That activity has stimulated renewed interest in the Supersite, and a number of new science products will be generated in the coming years. Communication between the science teams and PoCs remains limited, and better coordination would be helpful, especially given the recent eruptive crisis and numerous resulting research efforts (which will probably overlap to varying degrees in terms of subject matter and/or datasets). A listserv or other online communication tool might be an effective means of improving communications among Supersite users. Right now, Supersite scientists and science teams are independent, and there is no mechanism in place to facilitate discussions between groups.

Note that the list of Supersite users provided above is made up of individuals who have requested access to CSK data, which are the only Supersite data that truly require PoC involvement. Other users who may access data via other means (for example, via their own PI agreements with space agencies) are not listed.

## 3. In situ data

Type of data	Data provider	How to access	Type of access
<b>GPS</b>	USGS – HVO	<a href="#">UNAVCO</a>	Unregistered public
<b>Seismic</b>	USGS – HVO	<a href="#">IRIS</a>	Unregistered public
<b>Gas emissions</b>	USGS – HVO	Published USGS Open-File Reports*	Unregistered public
<b>Gravity</b>	USGS – HVO	Published manuscripts*	Unregistered public
<b>Tilt</b>	USGS – HVO	Contact USGS – HVO**	GSNL Scientists
<b>Camera</b>	USGS – HVO	Contact USGS – HVO**	GSNL Scientists
<b>Strain</b>	USGS – HVO	Contact USGS – HVO**	GSNL Scientists

*\* Denotes data that are only released when published because significant data processing is necessary to achieve useable results. Peer review is required to assure the quality of the processed data.*

*\*\* Denotes data that are not made publically available due to lack of a suitable archive, but that can be obtained through collaboration with scientists at the USGS Hawaiian Volcano Observatory.*

### In situ data issues

A few datasets, like gas emissions and gravity, require significant post-processing. Because of the need for stringent quality control, such data are not made publically available until they have been through the peer review process and published (either in academic journals or USGS Open-File Reports). Other datasets, including tilt, visual/thermal camera, and strain, are only available by contacting the data provider, since there are no established archives or agreed-upon formats for storing such data. The data may also be difficult to understand, requiring the provider to offer guidance on processing and interpretation. Data availability, however, is evolving. The USGS now requires all datasets that are published to be made available in a “durable archive.” For GPS and seismic data, the UNAVCO and IRIS archives, respectively, meet this requirement. For datasets where there is no community database, like gravity and tilt, the data must be stored in the USGS Science Base archive, where metadata are also available (<https://www.sciencebase.gov/catalog/>). There is no clear mechanism for archiving continuous data (like electronic tilt) in Science Base, but this is a problem that USGS – HVO is currently working on, and we anticipate having a solution in place within the next two years, so that in-situ data are more openly available than is currently possible.

## 4. Satellite data

Type of data	Data provider	How to access	Type of access
<b>ENVISAT</b>	ESA	<a href="http://eo-virtual-archive4.esa.int/?q=Hawaii">http://eo-virtual-archive4.esa.int/?q=Hawaii</a>	Registered public
<b>RADARSAT-1</b>	CSA	Uncertain*	Registered public
<b>ALOS-1</b>	JAXA	Uncertain*	Registered public
<b>TerraSAR-X</b>	DLR	Available after acceptance of PI proposal by DLR	GSNL scientists
<b>Cosmo-SkyMed</b>	ASI	POC requests access from ASI for individual users, data then accessible via <a href="#">UNAVCO</a>	GSNL scientists
<b>RADARSAT-2</b>	CSA	POC requests access from CSA for individual users, data then accessible via <a href="#">UNAVCO</a> **	GSNL scientists
<b>ALOS-2</b>	JAXA	POC requests access from JAXA for individual users, data then accessible via <a href="#">UNAVCO</a> ***	GSNL scientists
<b>Sentinel-1 a/b</b>	ESA	<a href="https://scihub.copernicus.eu/">https://scihub.copernicus.eu/</a>	Registered public

<b>Pleiades</b>	CNES	POC requests access from CNES for individual users	GSNL scientists
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*NOTE: This list only includes SAR and Pleiades optical data, which typically require payment or approval of a research proposal. Freely available data (e.g., MODIS, Landsat) are not listed.*

*\* Radarsat-1 and ALOS-1 data were available via the legacy Supersite pages, but those links have not worked for over 2 years, and the new Supersite pages do not contain any links to archive data.*

*\*\* Radarsat-2 data have been discontinued as of 2016 owing to an expiration of the SOAR proposal for Hawai'i Supersite data. The Supersite would benefit from a renewal of this proposal, but it is unclear if the project is supported by CSA.*

*\*\*\* All ALOS-2 data for Hawaii are supplied via RA-4 and RA-6 data grants to the PoC.*

### Satellite data issues

*Issues regarding data availability and accessibility have not changed over the life of the Hawai'i Supersite. These issues include:*

*- Links to RADARSAT-1 and ALOS-1 data on the legacy Supersite web pages do not work. Some potential users have asked about this, and the PoCs have suggested that these individuals look for other avenues for accessing these data (through the space agencies themselves). There are no data links on the new Hawai'i Supersite web page.*

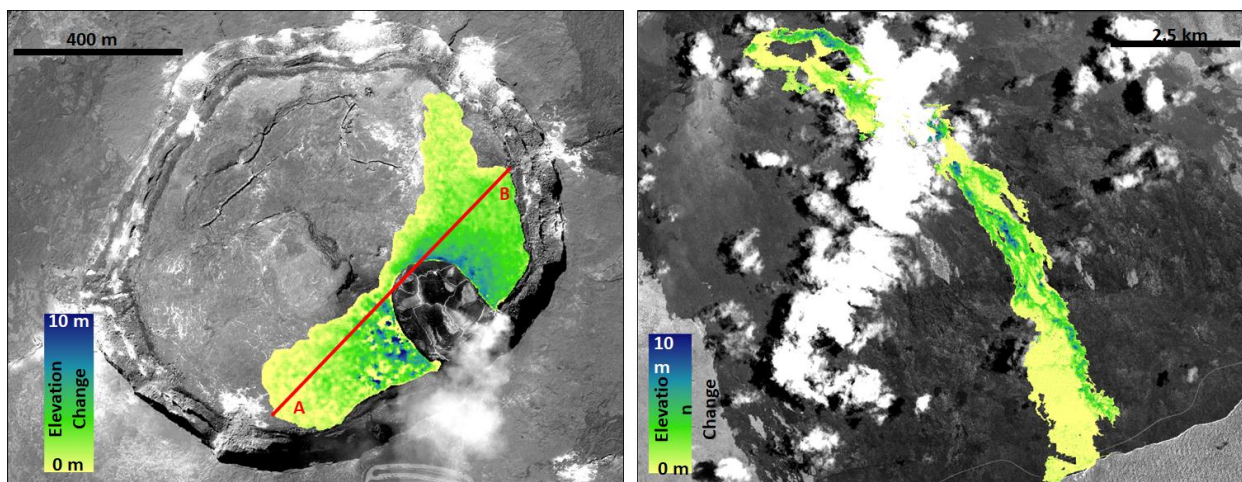
*- There is no streamlined method for requesting user access to SAR data; each space agency has a different access policy, some of which require PoC approval (e.g., ASI and CSA), others of which do not (e.g., DLR). A single method for "joining" a Supersite and accessing restricted data (mostly SAR imagery) would be preferable, but would obviously be difficult to implement.*

*- There is no Supersite-specific archive for non-SAR satellite data, like EO-1, Landsat, MODIS, ASTER, and other usually free datasets (although the USGS Hazards Data Distribution System has been stockpiling some imagery of Kīlauea since 2014, and this archive was expanded in 2018 due to the eruptive crisis at Kīlauea). This imagery constitutes an important source of information for synergistic studies using SAR and ground-based data. Developing an archive for visual and thermal remote sensing data, as well as other relevant resources (e.g., DEMs, many of which were acquired during Kīlauea's 2018 summit collapse), would be an important next step in growing the Hawai'i Supersite to a new level of capability and utility. This step will probably require some level of additional funding and personnel, but may occur naturally in part in the next two years as a consequence of the response to the 2018 eruption crisis.*

## 5. Research results

*A new dataset for the Hawai'i Supersite, available as of late 2016, is worthy of special mention—Pleiades tri-stereo imagery. These data, when cloud-cover is sufficiently low, can be used to construct DEMs of rapidly changing areas—for example, around eruptive vents at the summit and East Rift Zone of Kīlauea Volcano. An examination of data collected from Kīlauea*

during 2016 and 2017 shows topographic changes around both eruptive vents (Figure 1). These data can be used to update DEMs as well as assess volumes of lava that have been erupted over time.



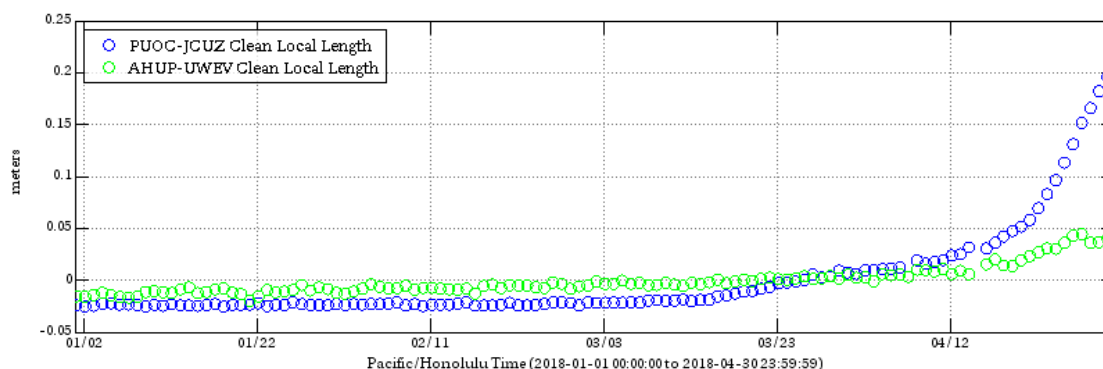
**Figure 1. Maps of topographic change over time based on Pleiades imagery (which forms background). Left is Halema'uma'u crater at Kīlauea's summit, with change spanning a DEM created from lidar data in 2009 and Pleiades data from 2016. The topographic change occurred mostly in 2015, when the summit eruptive vent overflowed. The total volume of the overflows based on these Pleiades data is 33,000 m<sup>3</sup>. Right is the East Rift Zone eruptive vent, with topographic change that occurred based on Pleiades imagery acquired in November 2016 and May 2017. During this time period, continuous emission of lava flows added a volume of at least 8.9 million m<sup>3</sup> to the land (some areas of topographic change are obscured by cloud cover, and lava did enter the sea, so this is not the total volume of lava erupted during the time spanned).**

In March 2018, Kīlauea's East Rift Zone eruptive vent began to inflate, followed a few weeks later by the summit. This inflation culminated on April 30, when the East Rift Zone eruptive vent collapsed as magma traveled downrift and eventually erupted from a series of vents 40 km from the summit and within the Leilani Estates subdivision. Over the ensuing 3 months, about 0.8 million cubic kilometers erupted from the vent system, destroying over 700 homes and covering 35.5 square kilometers. At the same time, the summit of the volcano collapsed, deepening in places by about 500 meters. There was also a M6.9 earthquake on Kīlauea's south flank during the early part of the activity. This sequence is the best observed caldera collapse and flank eruption anywhere on Earth and will provide fodder for research for years to come. The Supersite was instrumental in ensuring timely data acquisition and global engagement with the event. The combination of remote sensing and in situ datasets will form the basis for a better understanding of the 2018 collapse and eruption of Kīlauea Volcano.

Here, we detail noteworthy results associated with Kīlauea's 2018 activity.

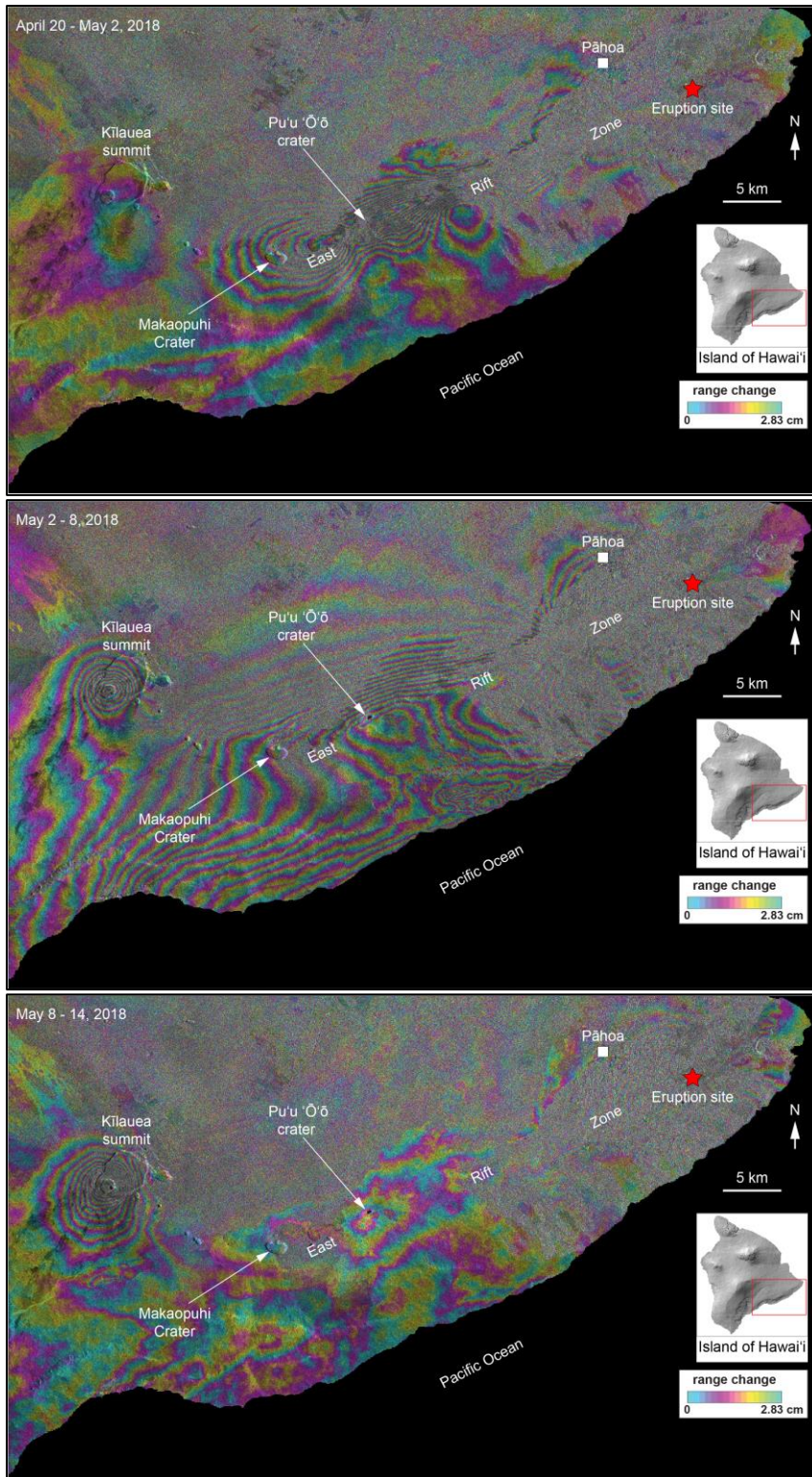
Continuous GPS stations were the first to identify anomalous magma accumulation in the subsurface, with inflation of the East Rift Zone eruptive vent beginning in March 2018, and at the summit starting that April (Figure 2). In the past, such inflation has often resulted in the

formation of a new eruptive vent on the East Rift Zone (for example, as occurred in 2011) or an intrusion, possibly beneath the summit (which occurred in 2015).



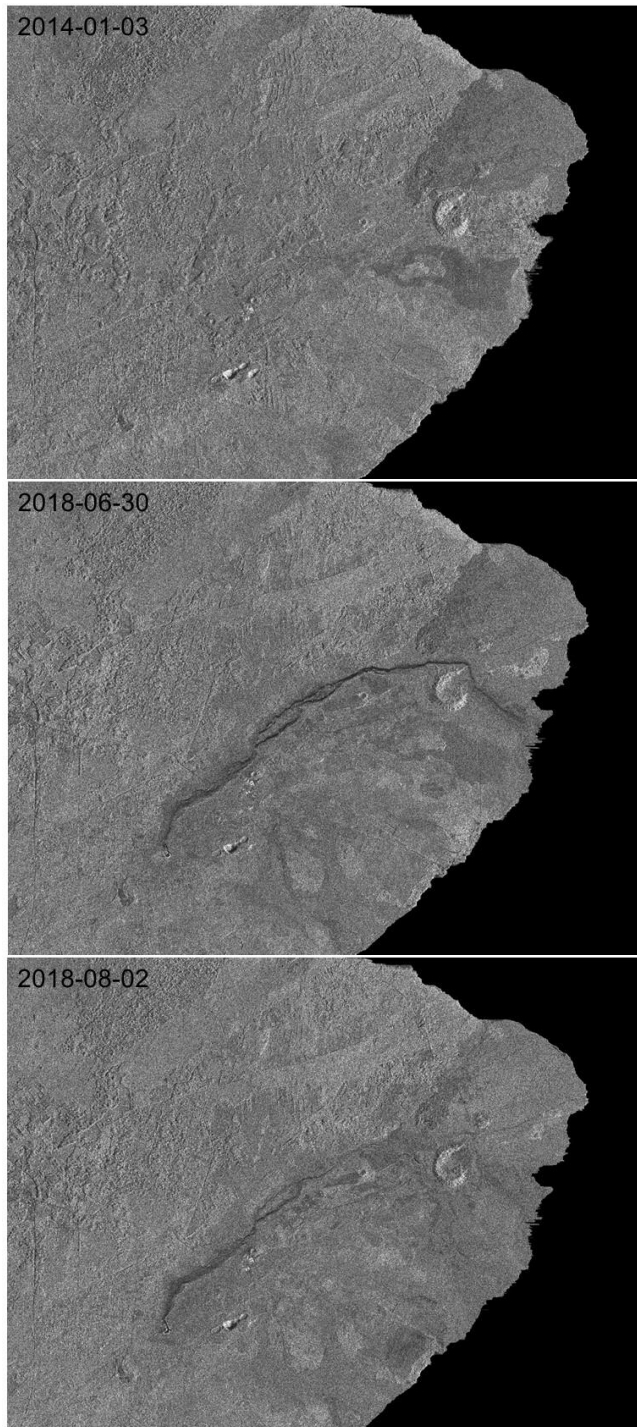
**Figure 2. GPS data from the summit (green) and East Rift Zone (blue) eruptive vents spanning January 1 to April 30, 2018. Positive change indicates inflation. East Rift Zone inflation began in mid-March, while summit inflation did not start until mid-April.**

On April 30, the inflation culminated with the collapse of Pu'u 'Ō'ō crater (the East Rift Zone eruptive center) as magma withdrew to feed an intrusion that propagated downrift into areas that had not seen intrusive or eruptive activity since 1960. The downrift magma migration was captured by GPS, tilt, and seismic data, which prompted warnings to communities in populated areas. A Sentinel-1 acquisition on May 2 (evening of May 1, local time), when compared to a previous acquisition on April 20, showed the extent of the magmatic activity, with subsidence of the middle East Rift Zone and spreading of the lower East Rift Zone due to the emplacement of a dike (Figure 3, top). Magma reached the surface in the lower East Rift Zone on May 3, starting an eruption that lasted for over 3 months and ultimately destroyed 700 homes, inundated 35.5 km<sup>2</sup>, and created 875 acres of new land along the island's southeast coast. The start of the eruption as followed on May 4 by a magnitude 6.9 earthquake on the volcano's south flank, which resulted in tens of centimeters of seaward displacement and was captured by interferograms (Figure 3, middle). Deformation rates in the middle East Rift Zone declined after the initial dike emplacement and earthquake (Figure 3, bottom), and by mid-May was much reduced as magma flow from summit storage area to the lower East Rift Zone eruption site reached a steady state. In the lower East Rift Zone, significant deformation continued through the first part of May. In mid-May, the eruption transitioned from producing more-viscous and slow moving material to erupting more fluid and fast-moving lavas. At this time, deformation abruptly stopped, indicating that no more magma storage was occurring in the lower East Rift Zone; any material entering the system was quickly erupted. Deformation in the area was best captured by L-band SAR data due to extensive vegetation that led to decorrelation in C- and X-band data. ALOS-2 interferograms were key for visualizing the extent of deformation and quickly modeling the dike intrusion.



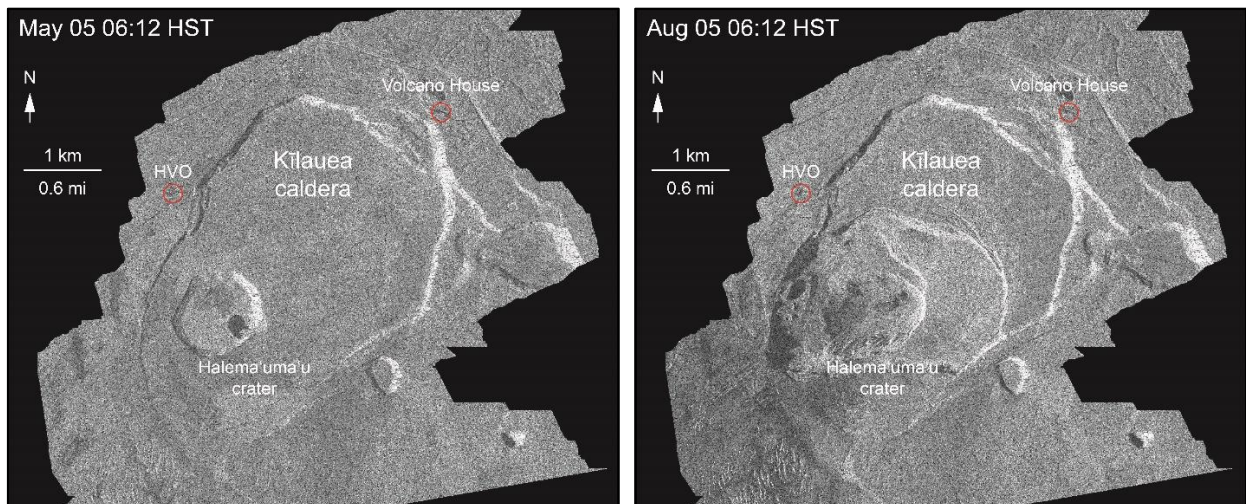
**Figure 3. Sequence of Sentinel-1 interferograms spanning the initiation of the lower East Rift Zone dike intrusion (top), onset of lower East Rift Zone eruption and M6.9 south flank earthquake (middle), and co-eruption, post-earthquake time periods (bottom).**

*The development of the lower East Rift Zone lava flow field was captured by high-resolution SAR amplitude imagery. Co-polarized data from TerraSAR-X provided exceptional views of the evolution of a channel that transported lava from the main eruption site to the ocean (Figure 4).*



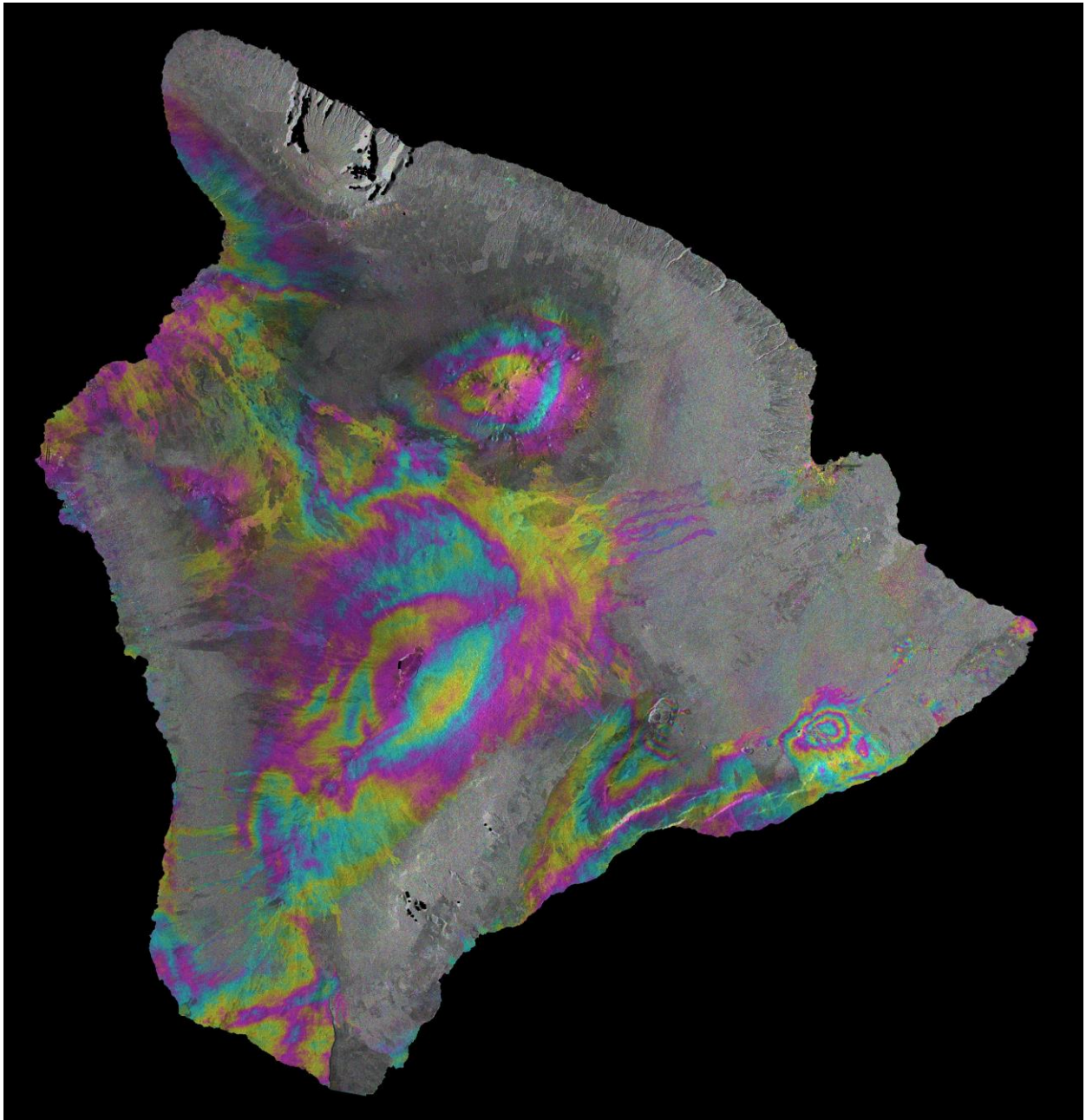
**Figure 4.** TerraSAR-X amplitude images of the lower East Rift Zone of Kīlauea Volcano from before (top), during (middle), and near the end (bottom) of the 2018 eruptive activity. The data capture the development and subsequent degradation of a lava channel (indicated by dark sinuous lines).

*As lava drained from summit magma storage areas to feed the high-volume lower East Rift Zone eruption, the summit experienced a piecemeal collapse, accompanied by intense felt seismicity (including over 60 M5+ earthquakes). Minor explosive activity occurred at the summit during mid- late-May, and the subsidence rate accelerated in late May and early June. By the time lava effusion in the lower East Rift Zone largely ceased in early August, summit subsidence exceeded 500 m in places, and a new caldera had formed within the bounds of the existing caldera. High-resolution COSMO-SkyMed amplitude images documented the collapse in exceptional detail (Figure 5).*



**Figure 5. Cosmo-SkyMed amplitude data from before (left) and after (right) collapse of Kīlauea's summit caldera. Images are registered to a LIDAR DEM, which has no data in areas that are black. Red circles indicate the locations of the Hawaiian Volcano Observatory (HVO) and Volcano House hotel on the rim of Kīlauea caldera.**

*The end of major eruptive activity at Kīlauea in early August did not mean the end of surface deformation. Interferograms from all platforms spanning post-eruptive time periods all indicate subsidence of the south part of Kīlauea's summit as well as inflation of the middle East Rift Zone (Figure 6), perhaps due to ongoing magma transport processes.*



**Figure 6. Sentinel-1 interferogram of the Island of Hawai'i spanning August 9 – November 1, 2018. One fringe equals 2.8 cm of line-of-sight displacement (range change scale is the same as that of Figure 3). At Kilauea's summit, subsidence is occurring in the south part of the caldera, while uplift is ongoing in the middle East Rift Zone.**

*Supersite data offered important insights into volcanic activity at Kilauea during 2018 that contributed to interpretations that guided the response of the Hawaiian Volcano Observatory, County of Hawai'i, and Hawai'i Volcanoes National Park to the crisis. Scientific exploitation of these results to better understand magmatic and tectonic processes in Hawai'i has just begun. During the next two years, we anticipate a flood of research that make use of Supersite data. In addition, post-eruptive remote sensing imagery acquired via the Supersite will provide critical*

*insights into the recovery of Kīlauea's magmatic system, including the potential for any future hazardous activity.*

## Publications

### Peer reviewed journal articles

**Moore, S., Wauthier, C., Fukushima, Y., and Poland, M.P., 2018. A retrospective look at the February 1993 east rift zone intrusion at Kīlauea volcano, Hawaii. *Journal of Volcanology and Geothermal Research*, 358, p. 241–251.**

**Dzurisin, D. and Poland, M., 2018. Magma supply to Kīlauea Volcano, Hawai'i, from inception to now: Historical perspective, current state of knowledge, and future challenges. *Geological Society of America Special Papers*, 538, p. 275–295.**

**Swanson, D.A., Fiske, R.S., Thornber, C.R., and Poland, M.P., 2018. Dikes in the Koa'e fault system, and the Koa'e–east rift zone structural grain at Kīlauea Volcano, Hawai'i. *Geological Society of America Special Papers*, 538, p. 247–274.**

**Pepe, S., D'Auria, L., Castaldo, R., Casu, F., De Luca, C., De Novellis, V., Sansosti, E., Solaro, G. and Tizzani, P., 2018. The Use of Massive Deformation Datasets for the Analysis of Spatial and Temporal Evolution of Mauna Loa Volcano (Hawai'i). *Remote Sensing*, 10(6), 968.**

**Anderson, K.R. and Poland, M.P., 2017. Abundant carbon in the mantle beneath Hawai'i. *Nature Geoscience*, 10(9), p. 704.**

**Fernández, J., Pepe, A., Poland, M.P. and Sigmundsson, F., 2017. Volcano Geodesy: Recent developments and future challenges. *Journal of Volcanology and Geothermal Research*, 344, p. 1–12.**

### Conference presentations/proceedings

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**NOTE:** It would be impossible to list all presentations that make use of Hawai'i Supersite data (there would be several dozen), especially without direct input from science team members; therefore, the table has been left blank. The most important research results are contained within the publication list.

## Research products

*In a strict sense, the Hawai'i Supersite has yet to directly produce any formal community research products. The data have been used by individual investigators to develop products, however, which are having an impact on the overall field. Chief among these are:*

- new methods for extracting three-dimensional displacement data from SAR imagery
- deformation maps and time series generated by numerous investigators
- schemes for mapping change due to active volcanism, particularly associated with the emplacement of lava flows (via coherence, amplitude, and topographic data)
- strategies for modeling atmospheric delay

*Because these products are either in development for release as part of InSAR processing software (for example, Multiple Aperture Interferometry methods) or are primary research results or operational tools with specific applications (for example, interferometry time series, topographic change due to lava flow emplacement, and atmospheric modeling strategies), they should not yet be considered research products, and the table below has been left blank.*

Type of product	Product provider	How to access	Type of access
<b>Range change time series</b>	Falk Amelung, University of Miami	<a href="http://insarmaps.miami.edu">http://insarmaps.miami.edu</a>	public
<b>Interferogram</b>	Various	<a href="https://winsar.unavco.org/insar/">https://winsar.unavco.org/insar/</a>	registered

### Research product issues

*There are currently few publically available research products for the Hawai‘i Supersite. Time series products from the University of Miami are available to the public, but currently require interacting with a GUI in a manner that may be cumbersome for large-scale analysis. The WInSAR consortium of UNAVCO provides a portal for users to upload and assign DOI numbers to products, like interferograms and time series (<https://winsar.unavco.org/insar/>). Some interferogram products are available, but users have yet to take widespread advantage of this resource. Several investigators have provided links to time series and deformation maps on their personal websites. Most Supersite researchers, however, have yet to make products available beyond their own publications (although published data are, in most respects, considered open source, and so should be available in manuscript supplements or by contacting the authors). Funding, staff, and other assistance are needed to aid with the dissemination of research products. Few organizations have the funding to develop a resource to its full potential, especially once the research has been published (the “end game” for many scientists). The only exceptions include projects that have been created to specifically develop a resource—for example, the GMTSAR software from the Scripps Oceanographic Institution and the JPL ARIA project—but these are few in number.*

## 6. Dissemination and outreach

*The primary means of informing the public of the existence and benefits of the Hawai‘i Supersite are outreach efforts, including newspaper articles, social media, and lectures. Interferograms posted by many groups on Twitter and Facebook during the 2018 eruption were well received by the public and highlighted both the utility of SAR and InSAR for mapping deformation and surface change, and also the existence of this resource for better understanding Hawaiian volcanoes. For example, public presentations on the Island of Hawai‘i as part of “Volcano Awareness Month” (every January) and weekly “Volcano Watch” newspaper articles have highlighted the benefit of the Supersite for the assessment and mitigation of volcanic hazards in Hawai‘i, and also the greater understanding of Hawaiian volcanoes that the Supersite makes*

*possible (through better access to data and by attracting scientific innovators to work on those data). Outreach to the scientific community has done via conference presentations (highlighting the available datasets and encouraging their exploitation), especially at the American Geophysical Union and the European Geosciences Union annual conferences, and personal visits to research institutions and universities around the world, where Supersite researchers share their results and encourage new users to participate in the work. These efforts have yielded fruit. For example, researchers at the GFZ German Research Center for Geosciences are examining localized deformation of actively erupting volcanic vents using GPS and high-resolution X-band SAR data, and researchers at the University of Leeds (U.K.) successfully recruited a Ph.D. student to study SAR amplitude imagery as a tool for better understanding volcanism in Hawai'i (and elsewhere by extension).*

## 7. Funding

*There is no dedicated nor specific funding for the Hawai'i Supersite. The Volcano Hazards Program of the U.S. Geological Survey, however, supports the Supersite by directing the PoCs (who is a USGS employees) to manage the effort and cultivate a user community. This includes the use of funds from the Volcano Hazards Program's InSAR project to archive and manage SAR data from Hawai'i and to build computing resources for SAR data processing and analysis. Individual project scientists have obtained research funding from various organizations—like the U.S. National Science Foundation—and have leveraged the availability of Supersite data in their proposals, but no proposals that were specifically targeted to exploit the Hawai'i Supersite have been submitted.*

## 8. Stakeholders interaction and societal benefits

*The most direct beneficiary of the Hawai'i Supersite is the U.S. Geological Survey's Hawaiian Volcano Observatory (HVO). Founded, in 1912, HVO maintains a dense network of geophysical stations around the island (which have been made available to the Supersite) and also collects geochemical and geological data on volcanic and seismic activity. These measurements fulfill a US Congressional mandate (the Stafford Act) to provide volcano and earthquake hazard warnings, supported by research, to local populations, emergency managers, and land-use planners. SAR data constitute a critical resource for this monitoring and research, but would be cost-prohibitive if not for the Supersite.*

*HVO communicates hazards information, much of which is aided by Supersite data, to a number of other organizations—primarily the National Park Service and Hawai'i County Civil Defense. These agencies are tasked with managing responses to volcanic and earthquake crises in the lands they oversee, while HVO is responsible for providing the information needed by responders to make decisions. This level of cooperative interaction was no better demonstrated than by the 2018 eruptive crisis at Kīlauea, which involved major seismic activity and minor explosions at the volcano's summit while lava effusion on the volcano's lower East Rift Zone inundated several populated areas. Supersite data were especially important for tracking the*

*status of subsurface magma (and particularly whether magma was likely to migrate away from established eruptive vents), and for tracking the collapse of the summit and emplacement of lava flows. These data were used in combination with in situ data to draft multiple public documents about the potential hazards of continued eruptive activity. These documents were released to the public and formed the basis for the response by both Hawai'i Volcanoes National Park and the County of Hawai'i. SAR results were published on HVO's website as well, so that the general public could track the evolution of activity in amplitude imagery and interferograms.*

*Both during and before/after volcanic and seismic crises, Supersite data contribute to the development of interpretations that are communicated to the public as part of daily volcanic activity updates, weekly newspaper articles, online content, and community outreach events (presentations, open houses, exhibits, etc.).*

## 9. Conclusive remarks and suggestions for improvement

*The Hawai'i Supersite provided resources that were critical in the response to the 2018 Kīlauea lower East Rift Zone eruption and collapse. That sequence—the most significant volcanic event to have occurred on the Island of Hawai'i in over 200 years—will be a subject of scientific investigations for years to come. These efforts will rely to a large extent on data acquired via the Hawai'i Supersite, and we anticipate profound new insights into how Hawaiian volcanoes work, and especially into such important topics as caldera collapse, flank instability, and magma storage and transport. These insights, which will contribute to hazards assessments and mitigation efforts in Hawai'i, will add to the existing based of knowledge that has been built especially over the past several years. Supersite data have had an especially important impact on these research results, including:*

- understanding of magma supply variations to Kīlauea Volcano and the impact of these variations on eruptive activity*
- elucidation of the magma plumbing systems at Kīlauea and Mauna Loa volcanoes, which provide an essential framework for interpreting past, present, and future unrest*
- investigations into interactions between magmatism and tectonism at Hawaiian volcanoes*
- tracking of geophysical changes—especially deformation and seismicity—at Kīlauea and Mauna Loa, which provides situational awareness of potential future eruptions or changes to ongoing eruptions*
- development of new tools for tracking lava flow emplacement, including both areal coverage and effusion rate, and implementation of these tools in an operational framework to aid volcano monitoring efforts*
- testing of new algorithms for determining 3D displacements from InSAR data*

*- high-resolution views of small-scale processes, including the formation and evolution of pit craters (at both Kīlauea and Mauna Kea)*

*As has been the case since the Supersite was established, a few issues continue to prevent even more comprehensive work by Hawai'i Supersite researchers:*

*- The scientific teams operate independently, and so there is no organized effort to promote any specific scientific goals. Improved coordination between investigators could generate better exploitation of research opportunities and collaboration between scientists.*

*- There is no specific funding for the Hawai'i Supersite, outside of that provided in-kind by the U.S. Geological Survey to support the efforts of the PoC. If funding were available, it could be used to better organize the user community and support collaborations and better dissemination of results.*

*- The revised website for the Hawai'i Supersite does not contain any links to data (including freely available SAR datasets). A more dynamic web presence would allow for posting of research results and products, and it could also be used for dissemination and outreach efforts aimed at not only scientific users and agencies, but also stakeholders and the general public.*

*A few operational challenges also exist:*

*- RADARSAT-2 is no longer part of the Supersite. Any RADARSAT-2 data from Hawaii have been acquired via contracts between <DA and the US Government, and the raw data cannot be made available via the Supersite.*

*- Non-SAR satellite data from Hawai'i are not archived anywhere. Such an archive would facilitate data fusion efforts that would merge SAR, visual, and thermal remote sensing imagery to gain new insights into Hawaiian volcanism.*

*- There is no archive for user-generated supporting data, like DEMs, which could be useful to Hawai'i Supersite investigators, as well as the general public and stakeholders. These items could be stored in the InSAR product archive hosted by WInSAR, but that resource has not yet been used for this purpose.*

*These challenges should not dissuade support for the continued operation of the Hawai'i Supersite, however, especially given the importance of Supersite datasets in the interpretation and investigation of Kīlauea's 2018 lower East Rift Zone eruption and collapse. The full value of the Hawaii Supersite, will likely be realized during the 2019-2020 period, when research results associated with 2018 activity are completed and published.*

*In short, it is a very exciting time for the Hawai'i Supersite. The 2018 activity has reignited activity in Hawaiian volcanism, and we expect that research generated in the next few years will result in great strides in understanding how Hawaiian volcanoes work.*

#### DATA REQUESTS FOR FUTURE OPERATIONS

*SAR and Pleiades data acquisitions have been exceptional during 2018. The only data that are not easily accessible, even though there are number acquisitions, are from RADARSAT-2. We therefore request that CSA consider reopening their archives of already collected RADARSAT-2 data for access by Supersite researchers. These data, due to their unique resolution and polarization, constitute critical value added that will not be available from any other source.*