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SBAS-InSAR analysis of a decade of surface deformation at Mauna Loa (Hawai'i): Preliminary results

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The Big Island of Hawai'i consists five coalesced volcanoes: Hualālai, Mauna Loa, Kilauea, Mauna Kea, Kohala. Mauna Loa, the largest, has erupted 39 times since 1832, with the last eruption in 1984. The volcano summit hosts the Moku'aweoweo caldera from which two volcanic rift zones radiate: the Northeast Rift Zone (NERZ) and Southwest Rift Zone (SWRZ). These rifts are the reflection of past dike intrusions combined with instability of the SE flank of the volcano, possibly related to slip along a low angle decollement thrust fault 12-14 km beneath the volcano.

Geodetic (InSAR, GPS) and seismic data have been used to characterize recent periods of unrest at Mauna Loa. InSAR studies spanning the period between 2002 and 2005 suggest a magma chamber 4.7-km depth below the summit, with a radius of 1.1 km, and a dike intrusion at 4 to 8-km depth and 8 km-long. These studies, however, are focused on relatively short-term processes (up to a few years), and a longer-term reconstruction of the volcano's evolution is lacking.

In this work, we use SAR data, exploiting the SBAS technique, to study deformation of Mauna Loa from 2003 to 2014, and we try to relate this overall evolution to that the neighboring Kilauea. We use acquisitions from two satellites: ENVISAT (descending track 200 and ascending track 365), spanning from 2003 to the end of 2010, and COSMO-SkyMed (descending and ascending orbits), spanning from 2012 to the middle of 2014. These data are merged time series data from 24 continuously operating GPS stations, which allows us to calibrate the InSAR SBAS time series. Results show an overall good agreement between the InSAR and GPS time series. The displacement of each portion of the volcano between 2003-2014 has been thus constrained in detail.

The summit area of Mauna Loa has under gone a long-term inflation from 2003 to 2014, with a peak of about 8 cm of vertical deformation between mid-2004 to mid-2005, especially on the summit. Part of this deformation may be related to the instability of the flank.

We identified several distinct periods with linear deformation behavior. This deformation is now being used to obtain the best-fit parameters for the sources in each of these periods through analytical modeling. Subsequently, we will incorporate these model parameters in a 3D model that employs the finite element method to include complexities like topography and vertical/lateral heterogeneities.