

Abstract

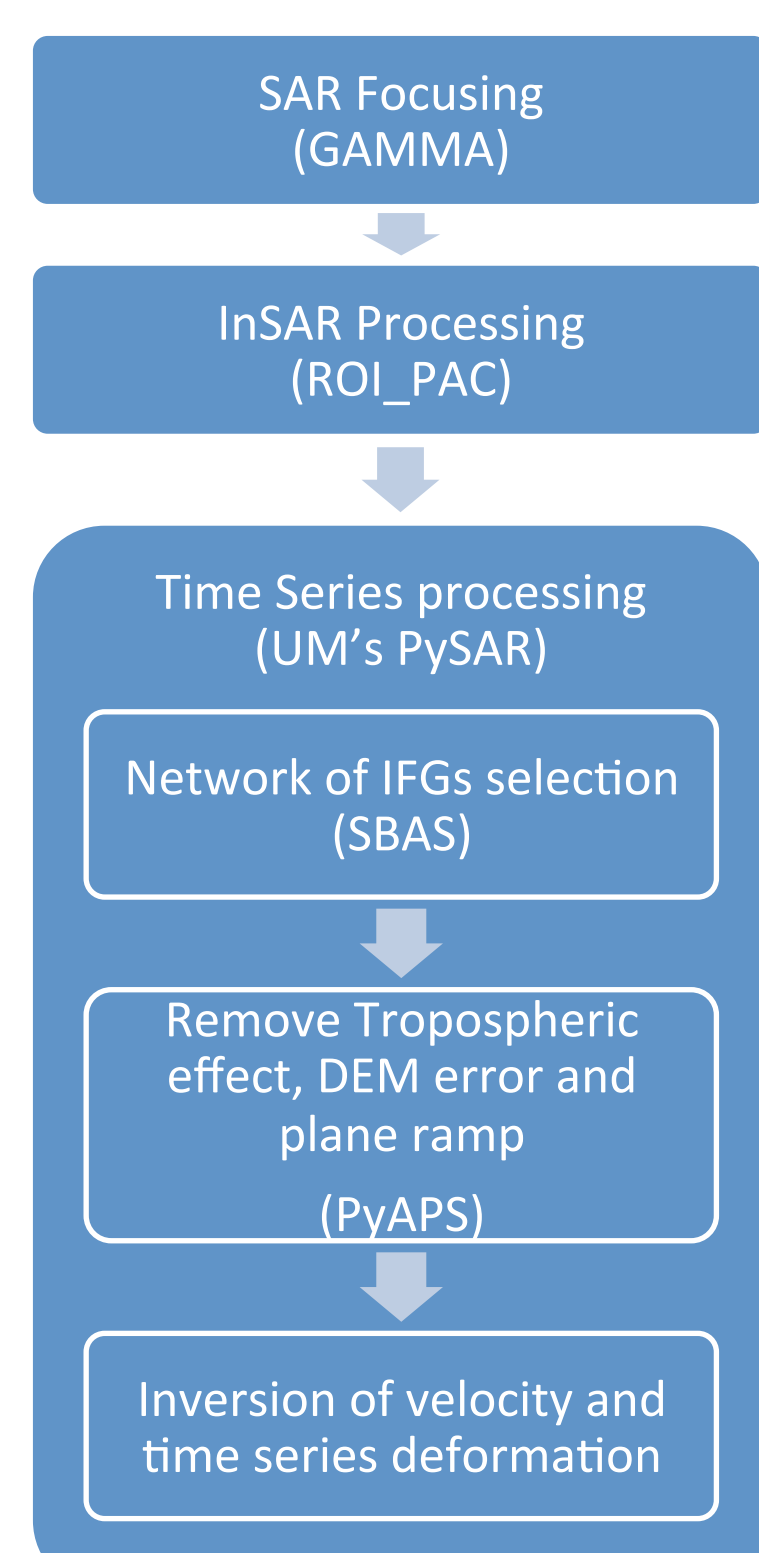
Sangihe volcanic arc is a unique example of a collision between facing volcanic arcs, along with Halmahera volcanic arc in the Molucca Sea region of northeastern Indonesia. It's approximately 500 km in length and 70 km in width. Even though the arc contains 25 volcanoes along its length, almost half (5 volcanoes) of its active volcanoes (12 in total) are constrained to the northeast tip of Sulawesi.

Ryukyu volcanic arc is Japan's triple junction formed by the subduction of the Philippine Sea Plate beneath the Eurasian Plate. Laying on the north end of the chain, the south Kyushu island contains Kirishima volcanic group (more than 20 young and old volcanoes) and 4 other volcanoes.

To monitor these volcanoes' deformation, we use 4 years (2007-2011) of ALOS PALSAR data (L-band) to perform time series InSAR surveys of the Sangihe volcanic arc of the north Sulawesi (Indonesia) and the Ryukyu volcanic arc of Kyushu (Japan). 4 volcanoes are found to have deformation during this time period:

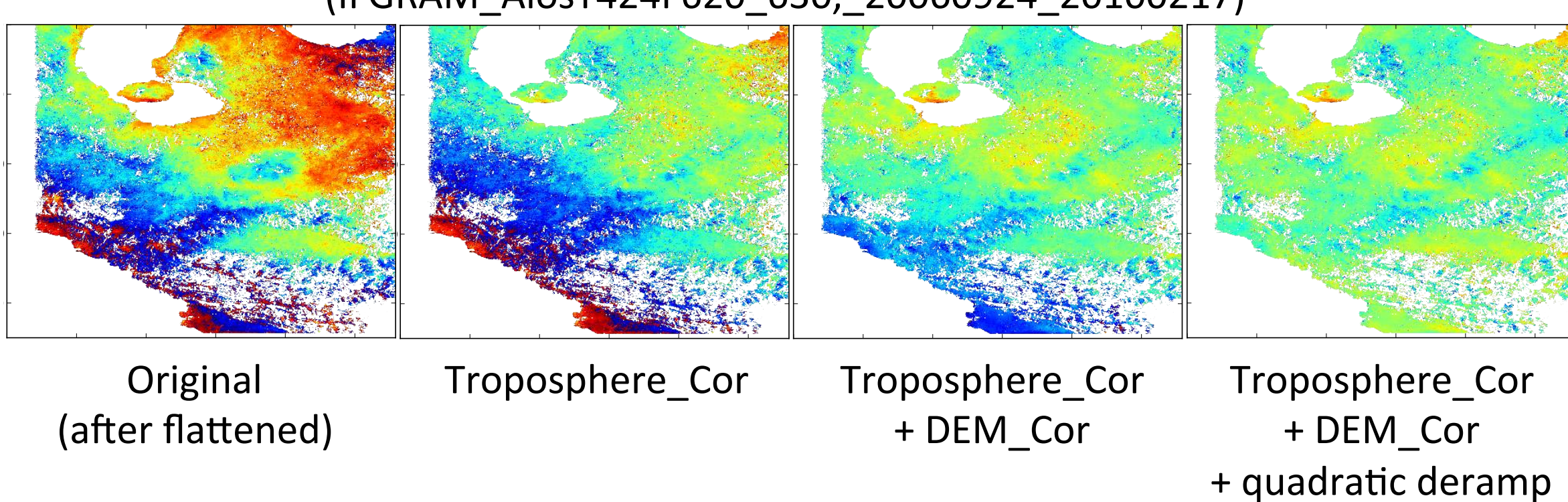
- 1) In Indonesia, craters of the Soputan and Lokon-Empung twin volcanoes were subsiding, and the west lava dome of Soputan was inflating.
- 2) In Japan, half of Sakurajima's lava dome was inflating, Shinmoedake and Ohachi's crater have some deflation, and two other areas with subsidence are found within the Kirishima volcanic group.

Methodology



- Dataset: 75 ALOS images obtained from ASF, 2007-2011 for Sangihe arc, and 58 ALOS images obtained from JAXA, 2006-2011 for Ryukyu arc.
- InSAR processing: ~260 interferograms produced by ROI_PAC after generating SLCs with GAMMA.
- Time series processing: Small Baseline Subset (SBAS) [Berardino *et al.*, 2002] method with University of Miami's PySAR package.
 - Pairs selection: all interferograms within the limits of perpendicular spatial, temporal baselines and Doppler center frequency difference, plus interferograms with the same month (seasonal decorrelation); then drop the low coherent manually.
 - Pixel selection: temporal coherence above a threshold of 0.7 [Tizzani *et al.*, 2007].
 - Noisy phase correction: tropospheric estimation using ECMWF weather re-analysis with PyAPS [Jolivet *et al.*, 2011], DEM error correction [Fattahi and Amelung, 2013] and quadratic/plane ramp removal.
 - Velocity inversion: drop interferograms with obvious ionosphere effect.

(IFGRAM_AlosT424F620_630_20060924_20100217)



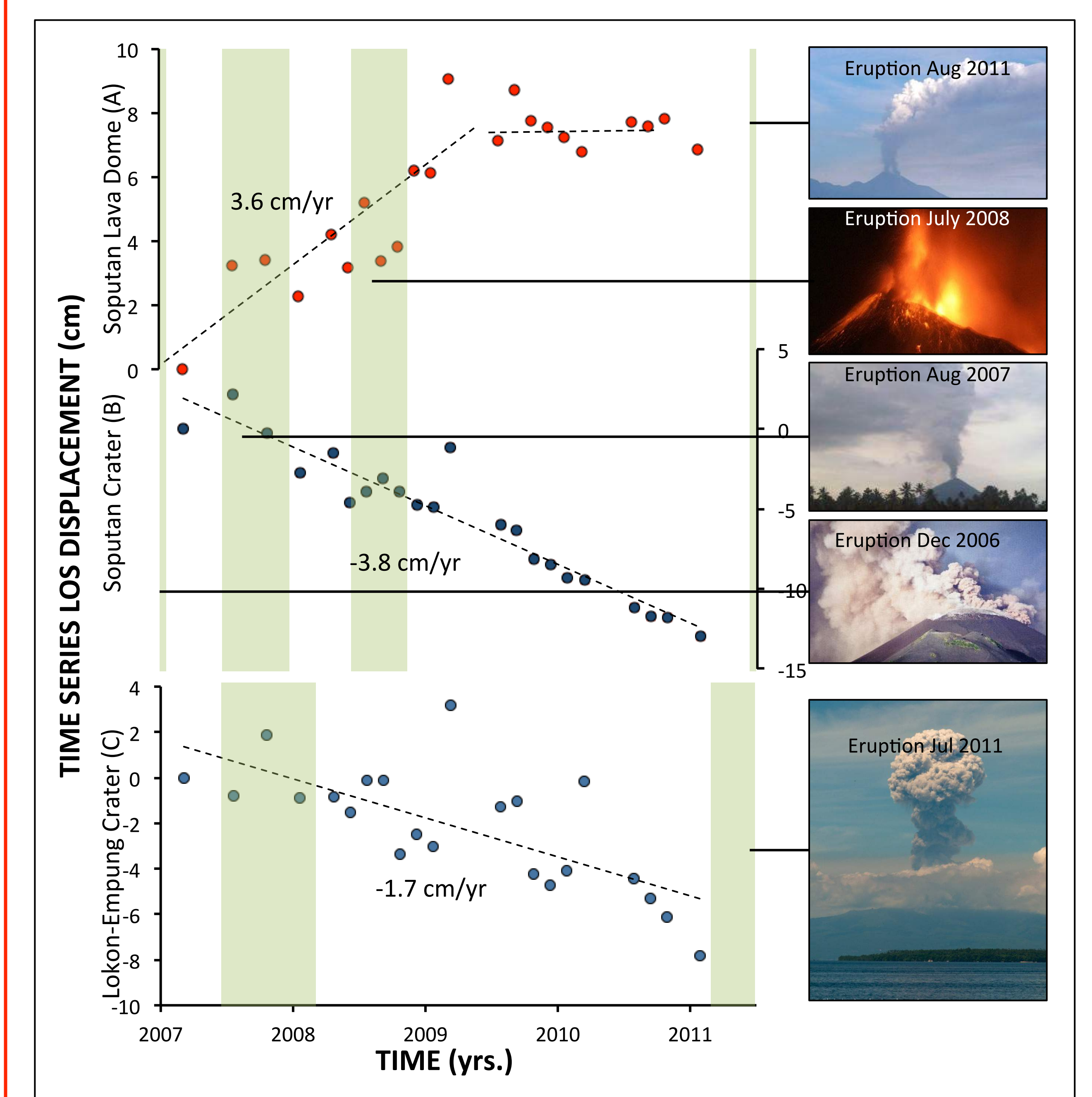
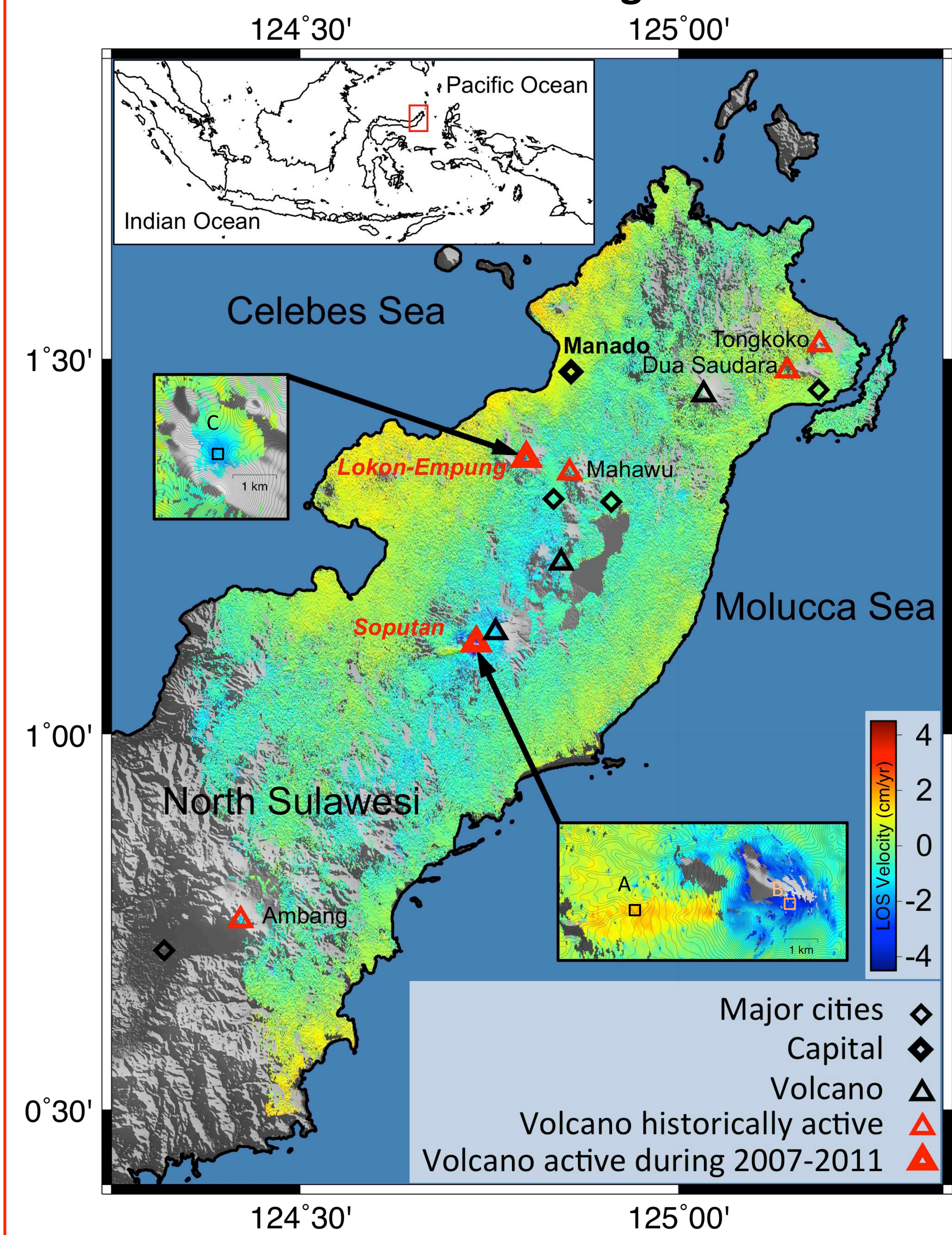
Conclusion

- L-band time series InSAR is a valuable tool for volcanic deformation monitoring. Substantial phase ramp still remains after the correction of tropospheric delay and topographic residual. This phase ramp (mainly due to ionospheres' delay) can be eliminated partially by plane or quadratic de-ramp method.
- Soputan and Lokon-Empung twin volcanoes in North Sulawesi, eastern Indonesia have been deflating during 2007-2009 time period; and an interesting uplift was detected on the west lava dome of Soputan volcano.
- Minami-dake of Sakurajima volcano and Shinmoedake of Kirishima volcanic group in Kyushu, southern Japan had intensive surface deformation on their craters detected by our time series InSAR survey. Both spaceborne and airborne InSAR results agree with corresponding volcanic bulletin reports

Reference

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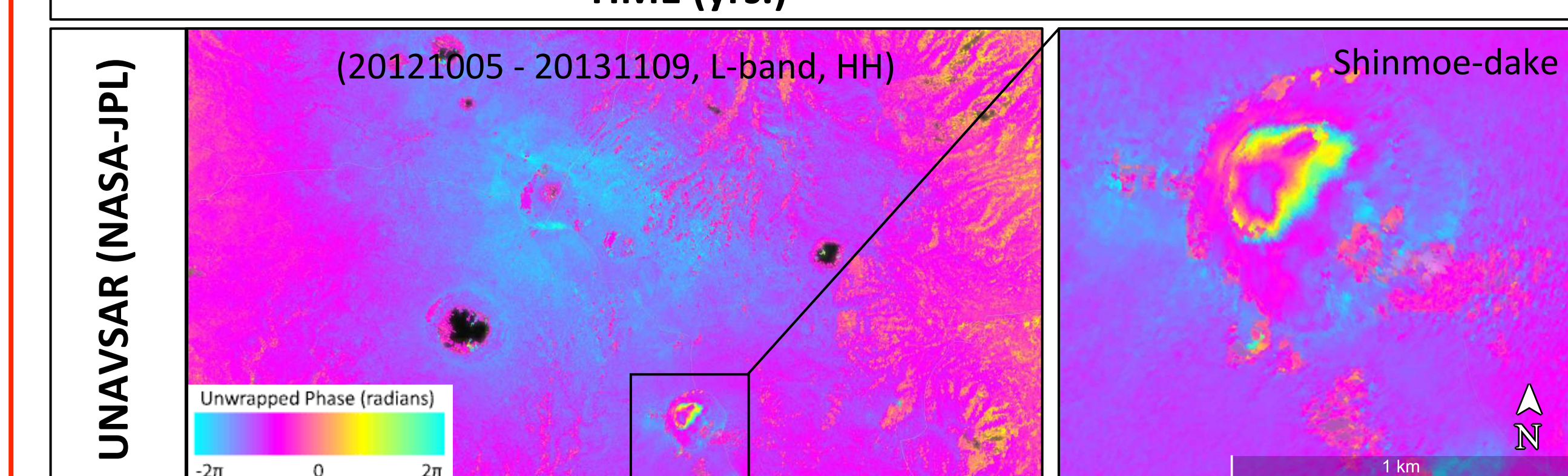
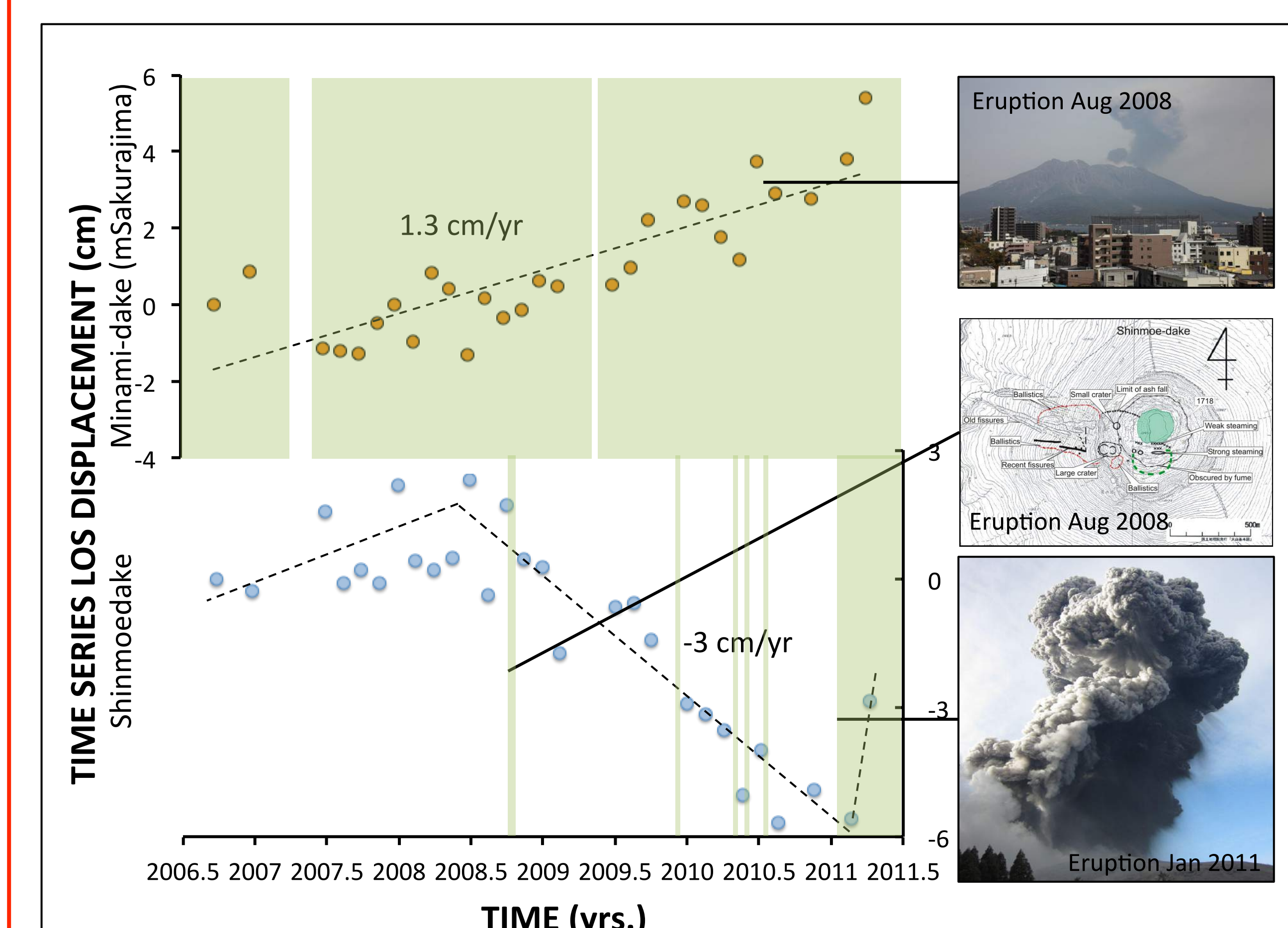
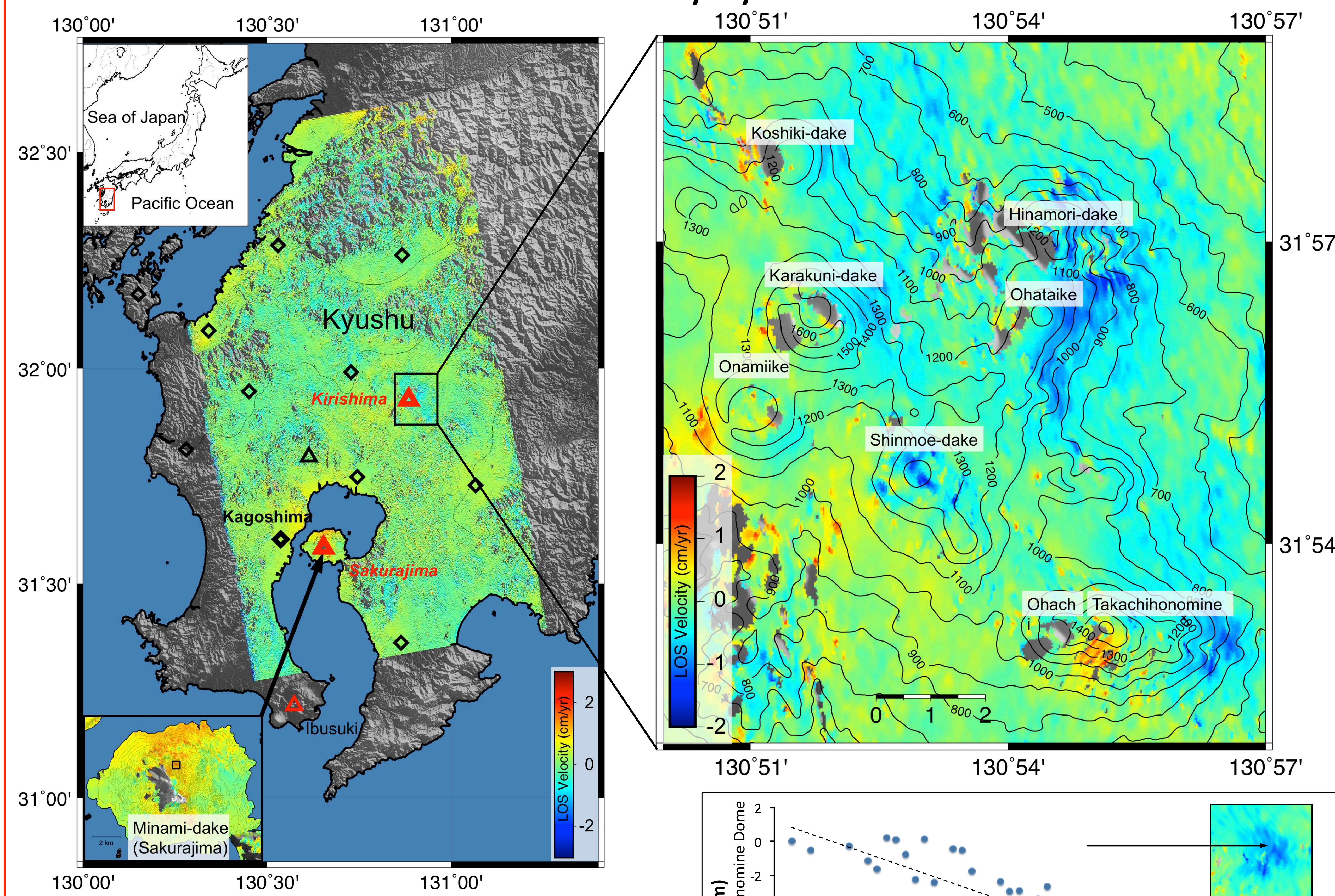
Time Series Deformation of Sangihe Volcanic Arc



- Continuous linear subsidence for the crater of Soputan and Lokon-Empung twin volcanoes.
- Temporary uplift for the west lava dome of Soputan volcano.

InSAR successfully detects pre-eruptive uplift and post-eruptive deflation.

Time Series Deformation of Ryukyu Volcanic Arc



- Continuous linear uplift for the north part of Minami-dake of Sakurajima volcano.
- Only Shinmoedake of Kirishima volcanic group has suffered periodic and obvious deformation, which is successfully detected by satellite geodesy, and with good agreement of the Bulletin Report and airborne InSAR result.

