

MULTI-DISCIPLINARY CHARACTERIZATION OF THE JUNE 2019 ERUPTIONS OF RAIKOKE, KURIL ISLANDS AND ULAWUN, PAPUA NEW GUINEA VOLCANOES USING REMOTE TECHNOLOGIES

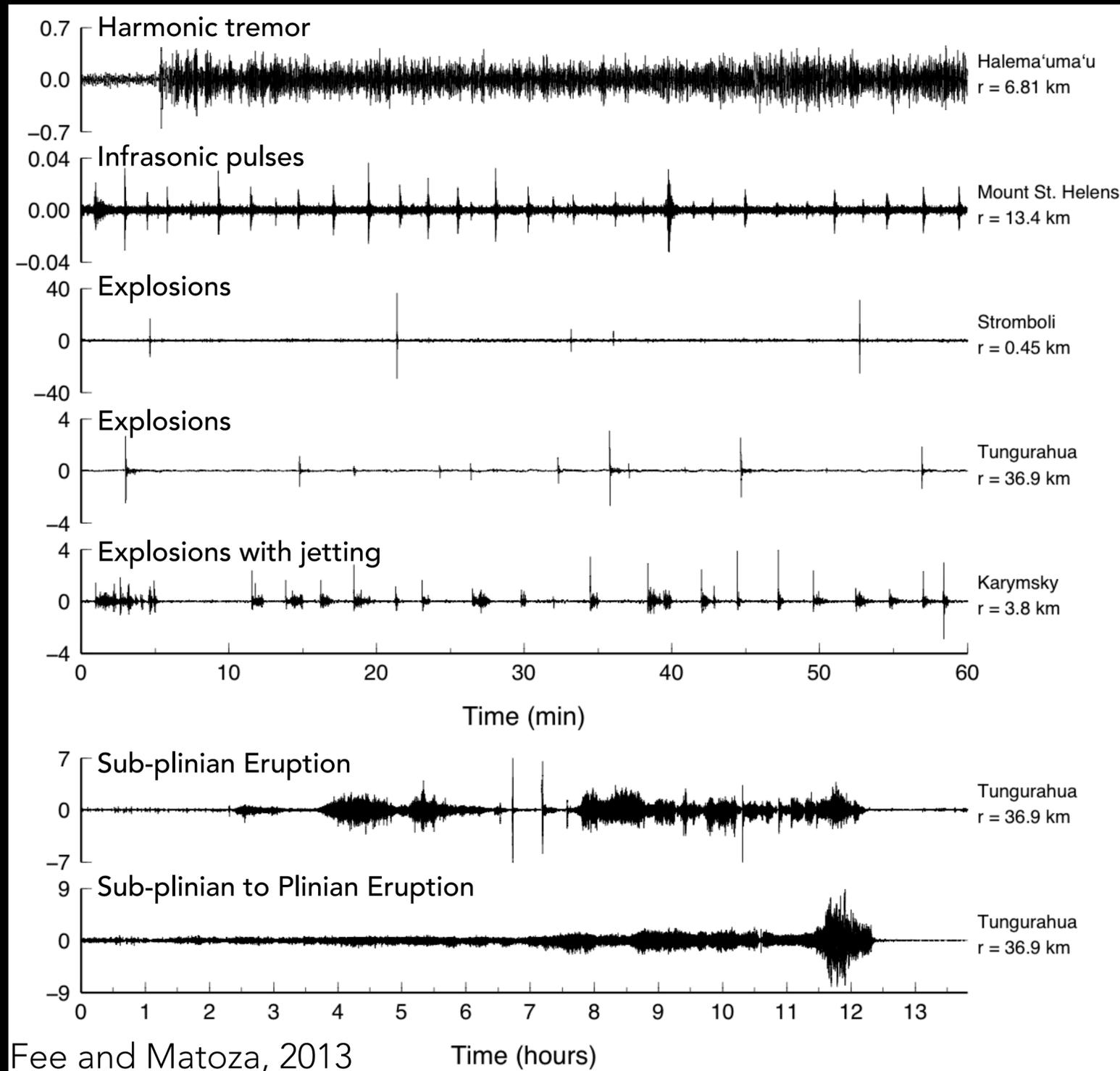
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VOLCANO ACOUSTICS



Fee and Matoza, 2013

- Detect
- Locate
- Determine duration
- Characterize
- Confirm subaerial activity (particularly useful for remote volcanoes)

2019 Eruption of
Ulawun Volcano, Papua New Guinea

WHAT VOLCANO ERUPTED?

WHEN DID THE ERUPTION
START? AND END?

DOES THE ERUPTION CHANGE
THROUGH TIME? AND HOW?



Photo credit: Craig Powell, 2019

AIRPLANES & VOLCANIC ASH

Global Commercial Flight Paths



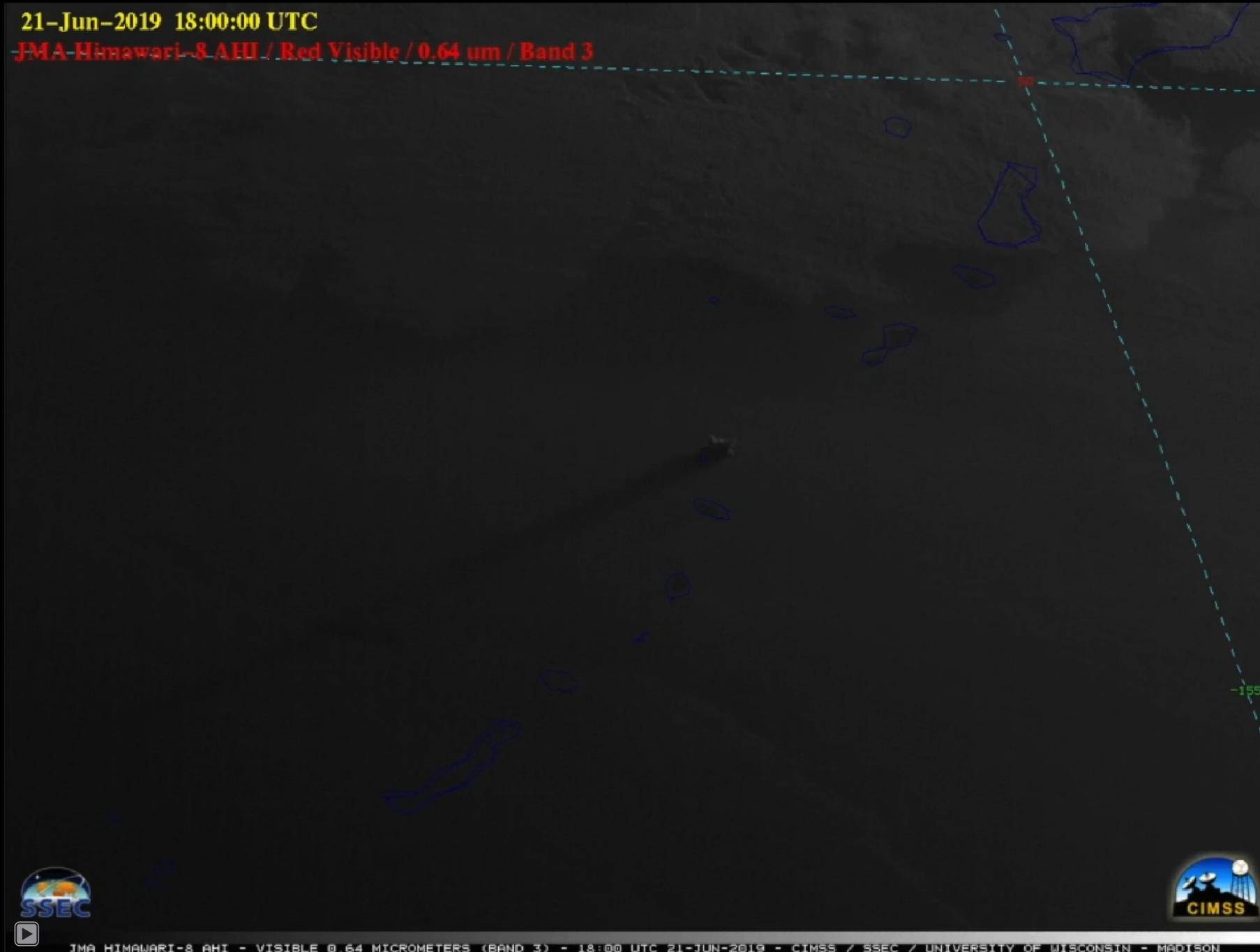
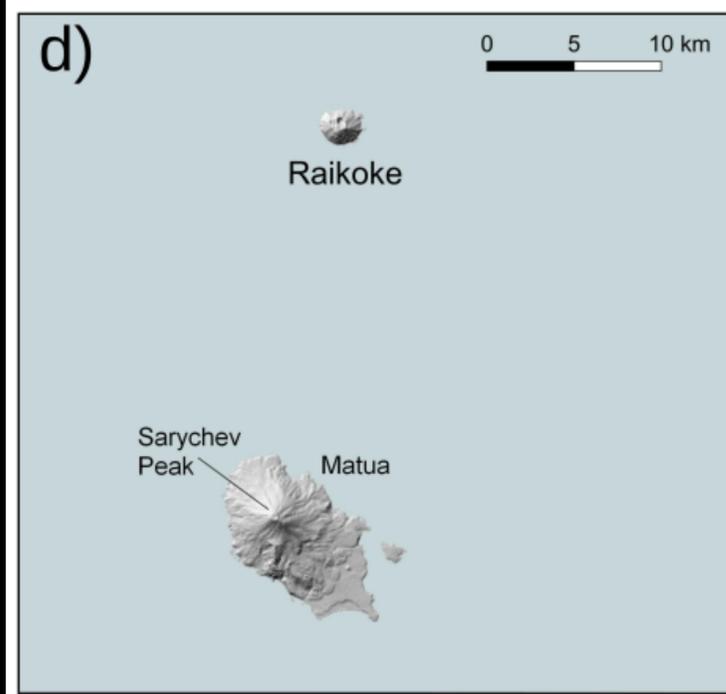
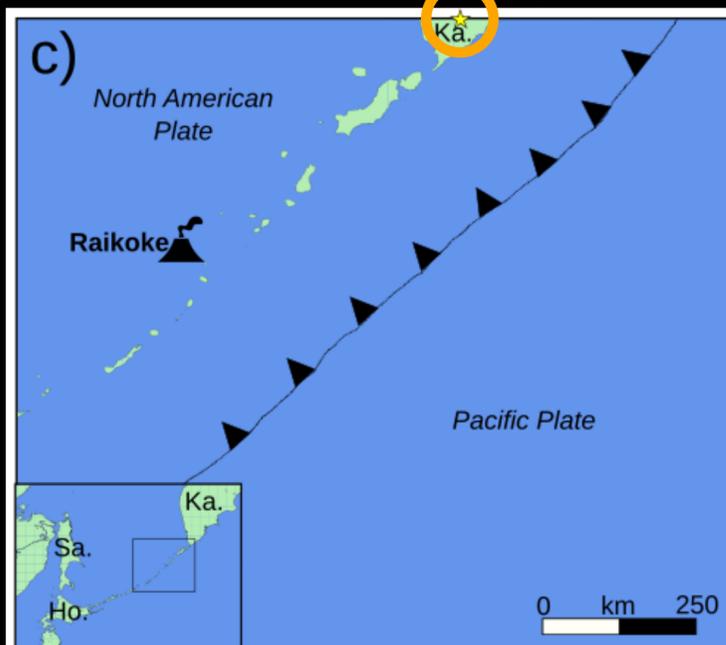
Volcanic ash deposits on a parked McDonnell-Douglas DC-10-30 during the 1991 eruption of Mount Pinatubo, causing the aircraft to rest on its tail.



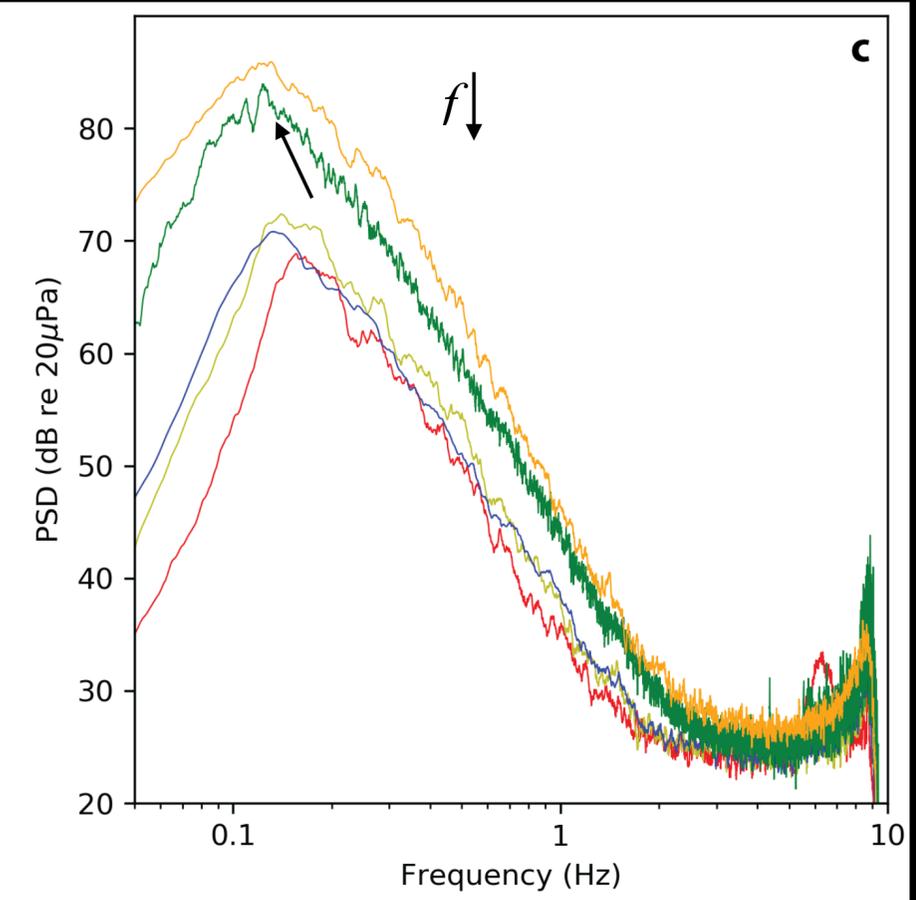
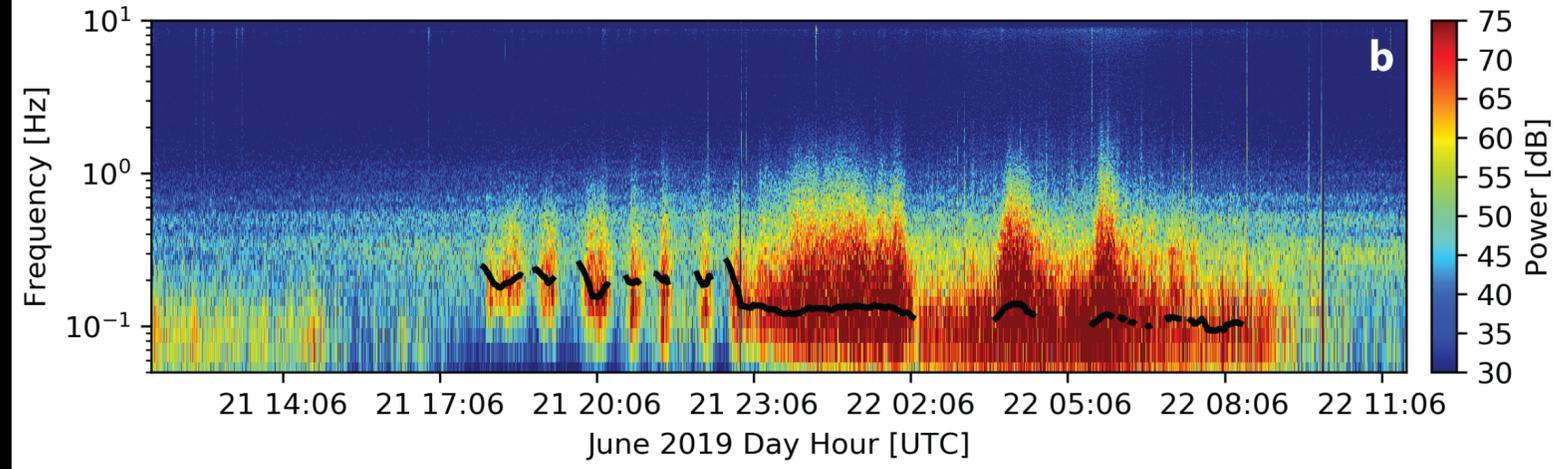
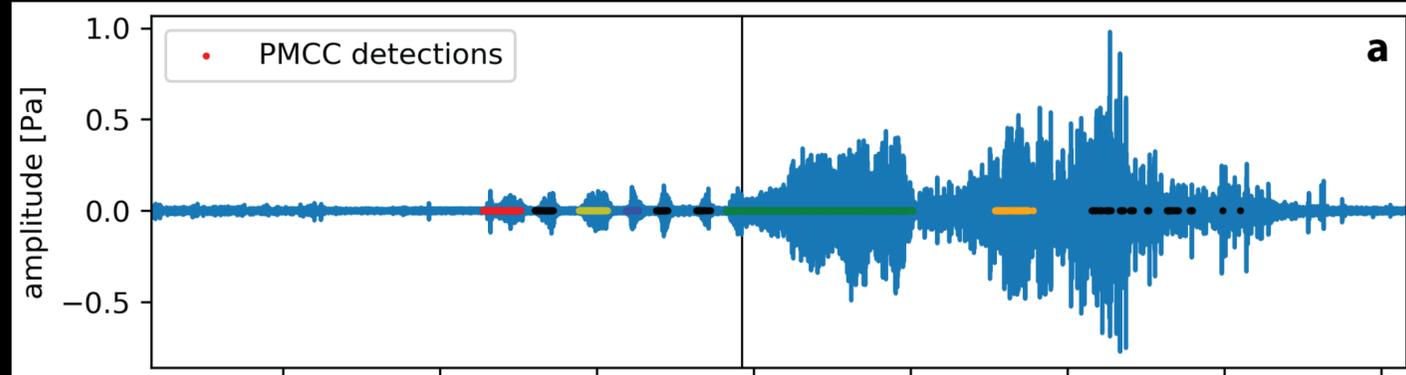
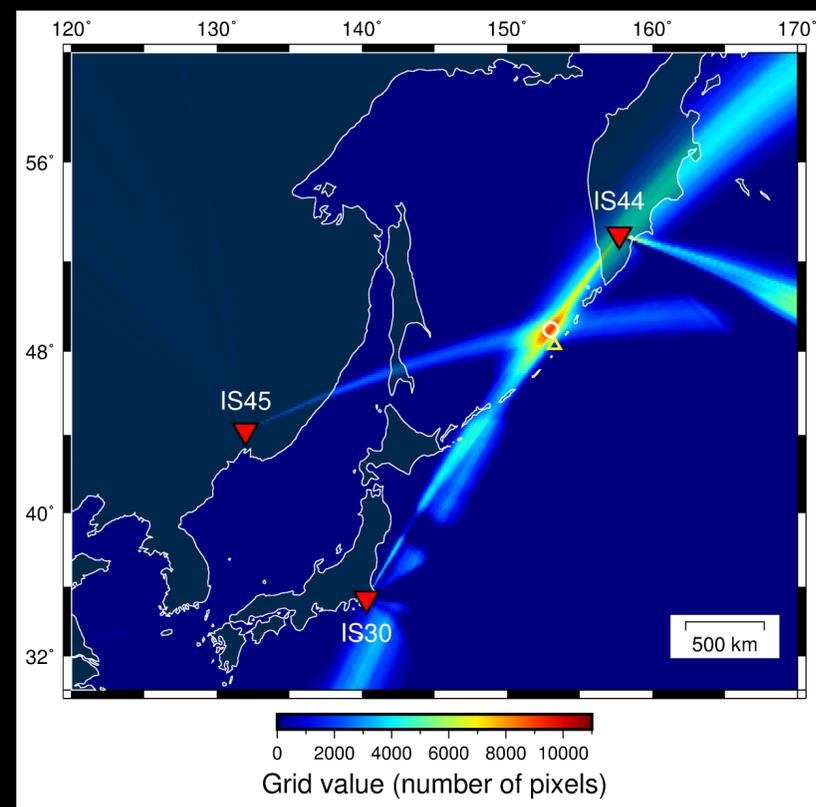
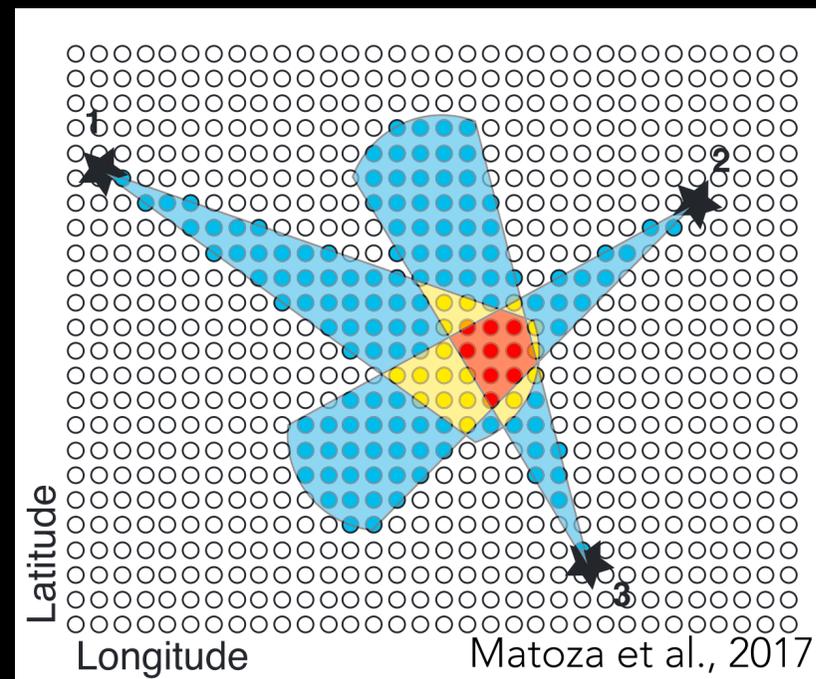
60,000 passengers/day and 60,000 planes/year pass over Alaska, Kamchatka, and Kuril Island volcanoes

RAIKOKE VOLCANO, KURIL ISLANDS 21 JUNE 2019 ERUPTION

IS44 array

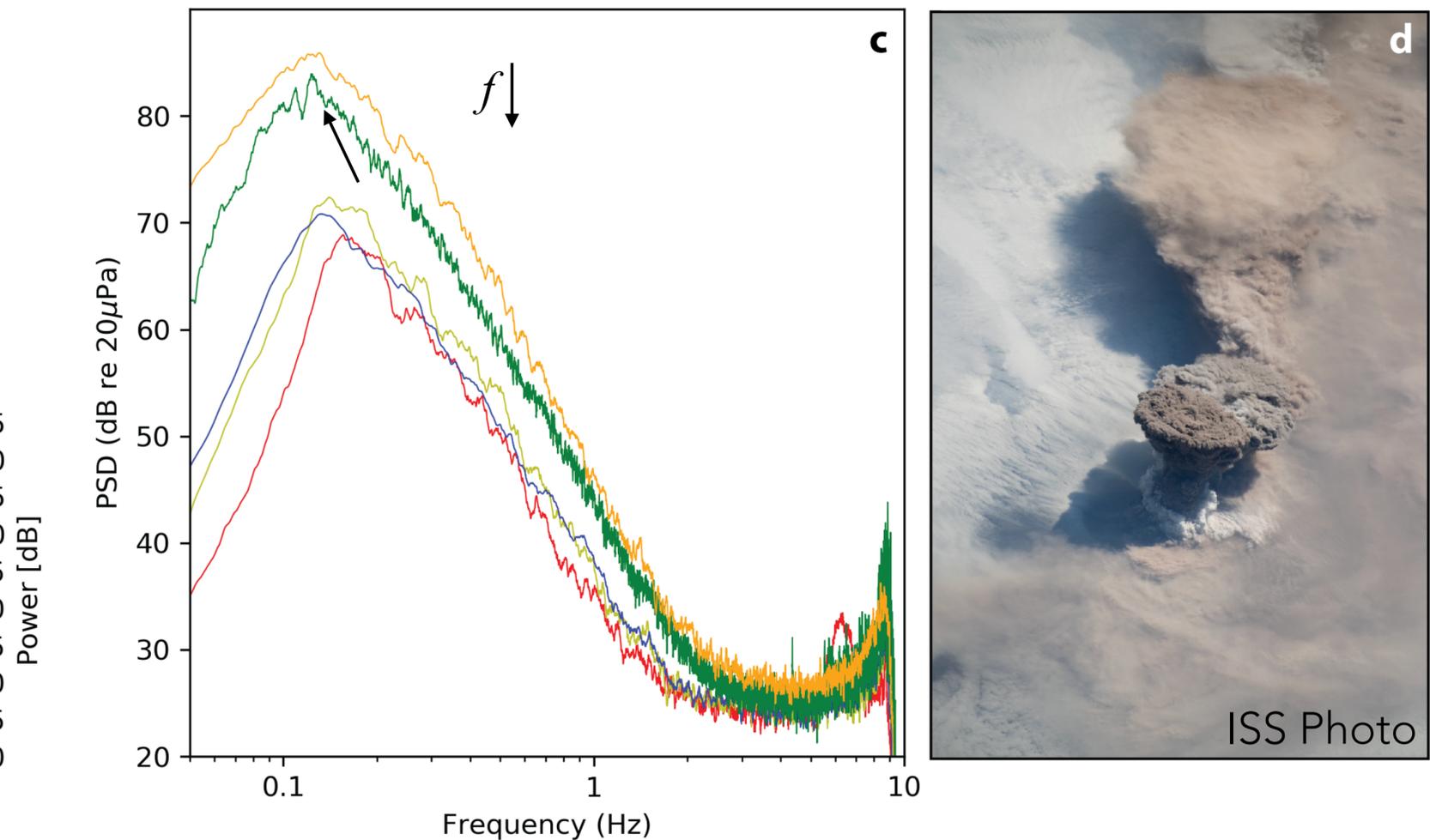
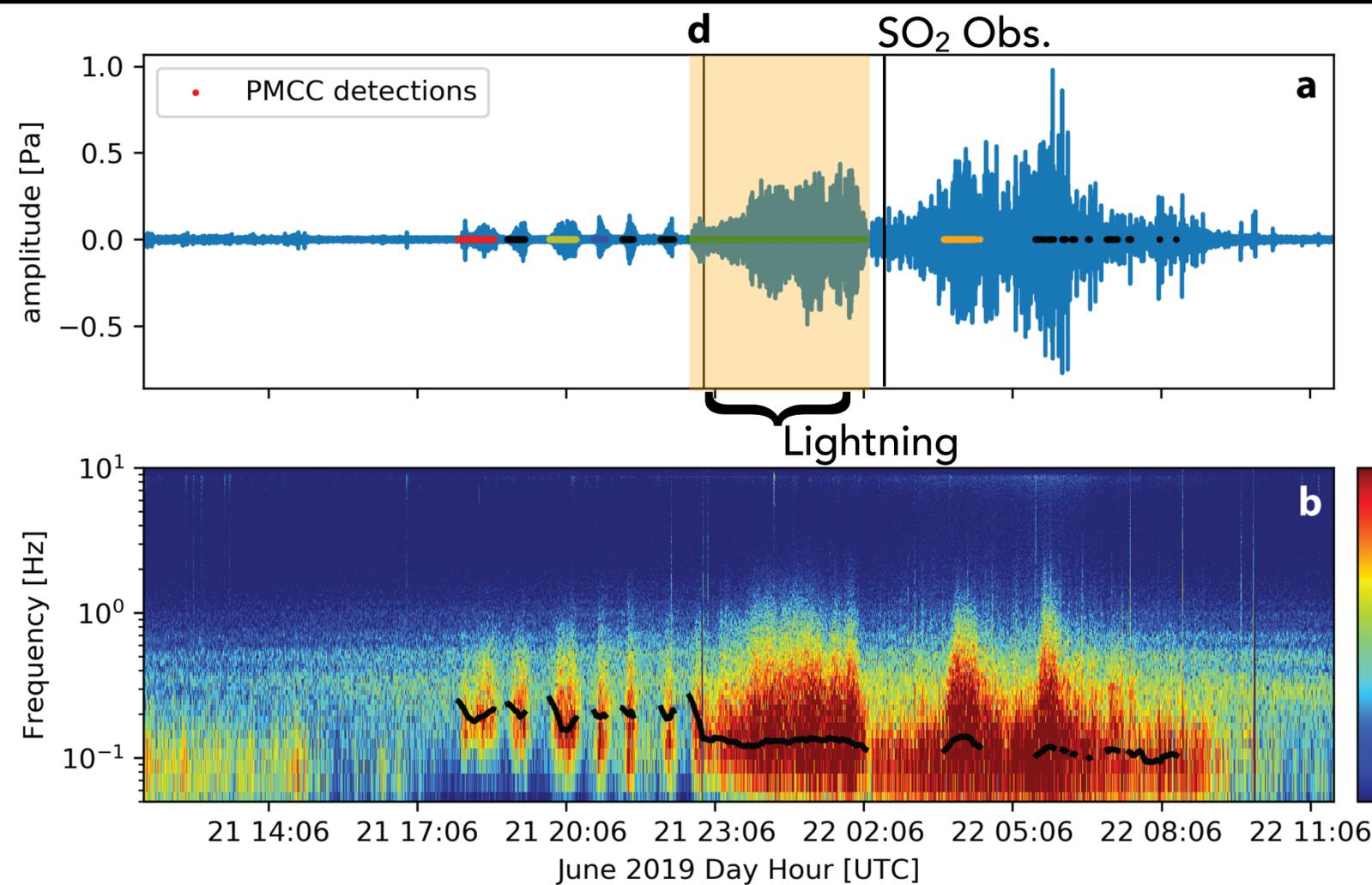
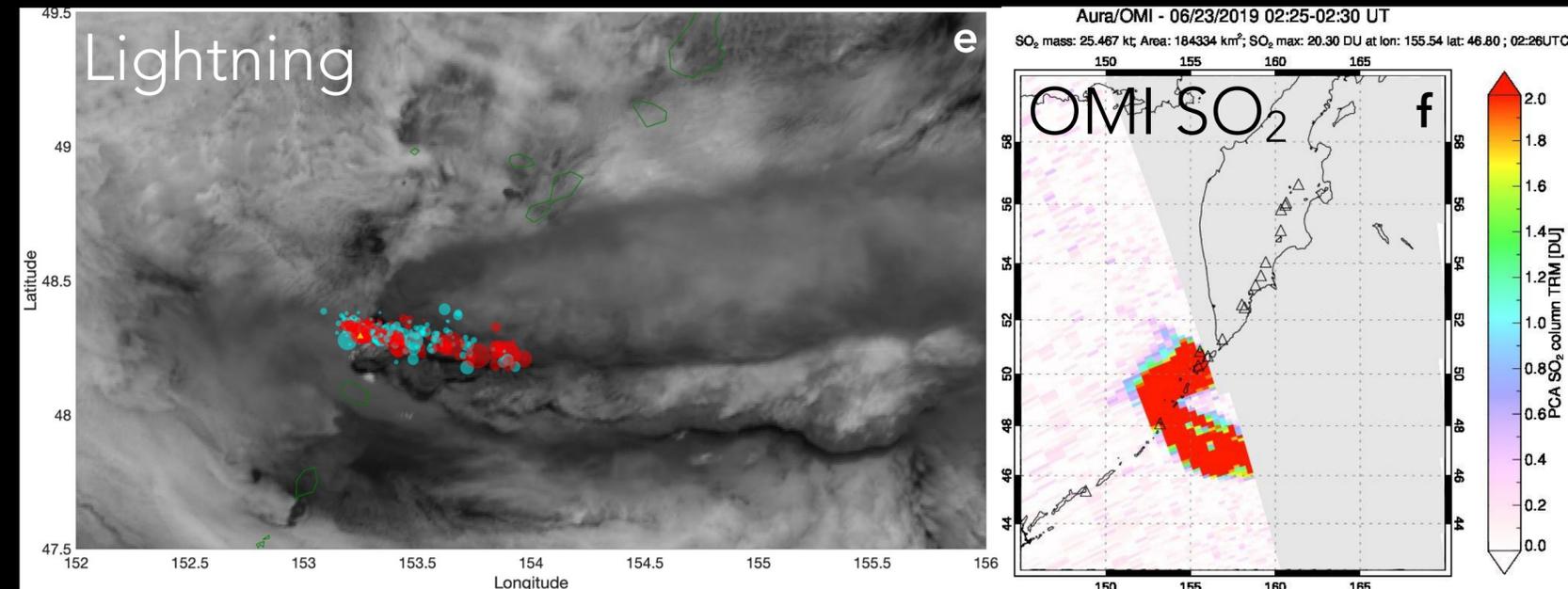


RAIKOKE VOLCANO - 21 JUNE 2019 ERUPTION



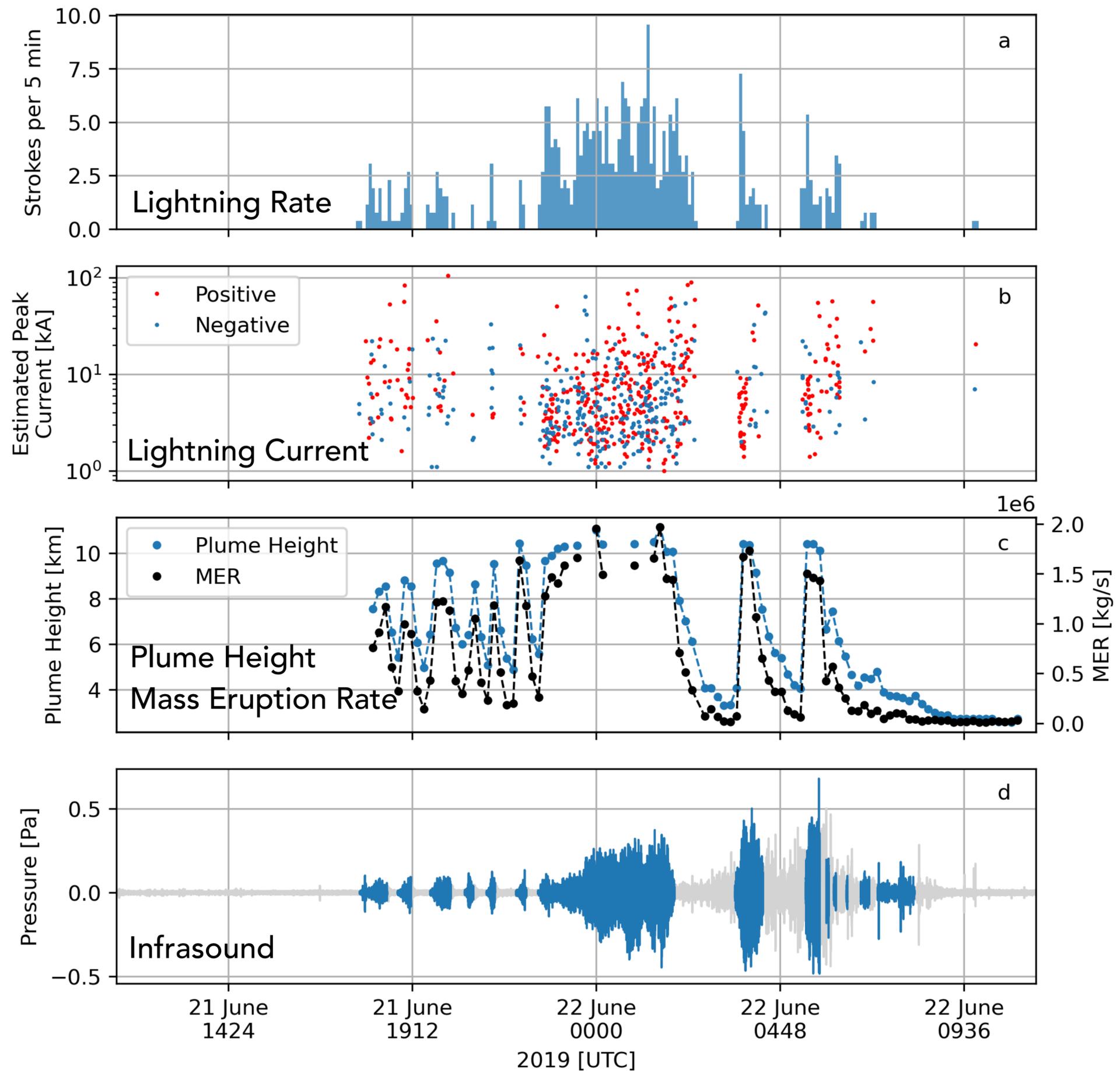
79 km from true
 Array distances:
 620 km
 1690 km
 1792 km

RAIKOKE VOLCANO 21 JUNE 2019 ERUPTION



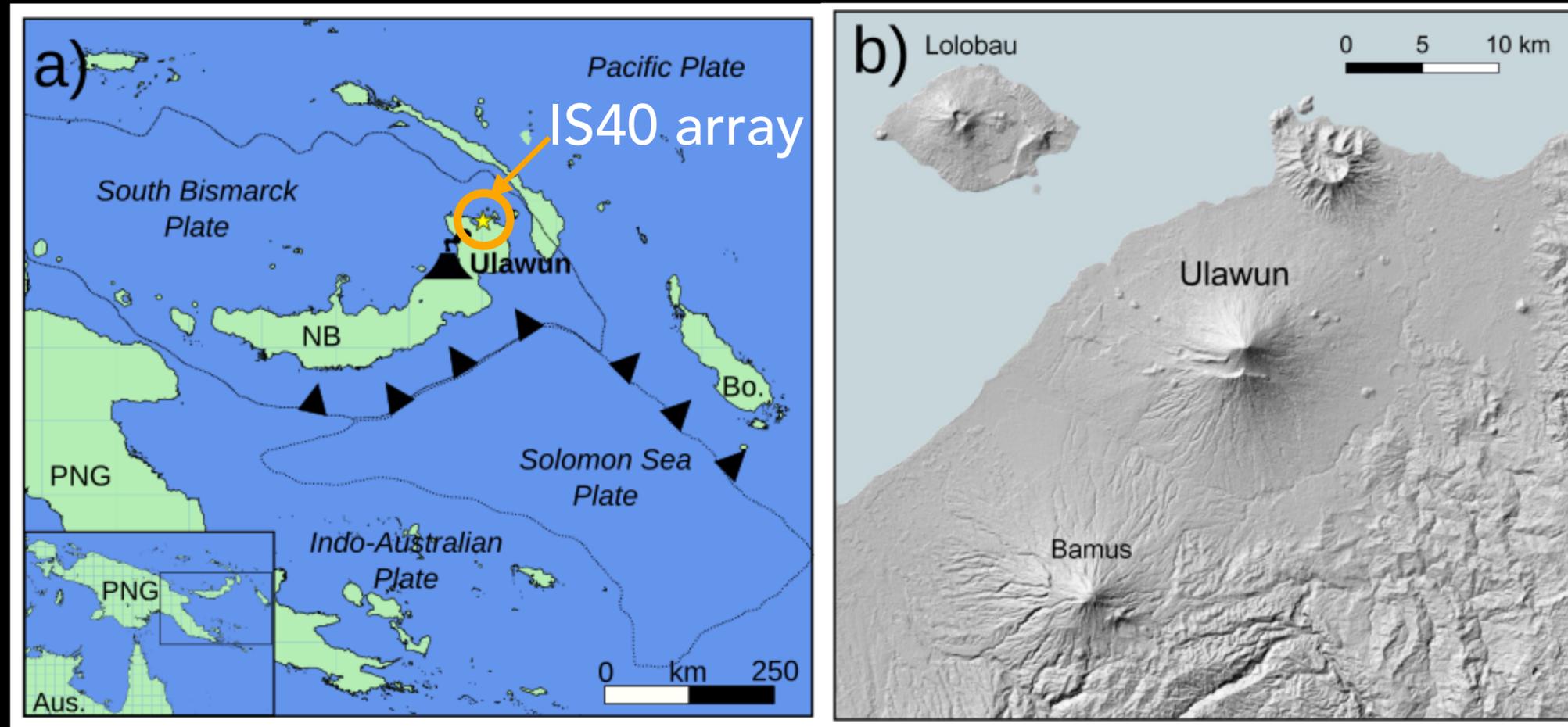
RAIKOKE VOLCANO 21 JUNE 2019 ERUPTION

- Lightning, plume height, and infrasound correlate well
- Lightning, plume height, and infrasound data capture the 6 initial pulses of the eruption and the main Plinian phase
- The Plinian phase shows decrease in infrasound peak frequency, increase in lightning stroke rate, and an increase in plume height



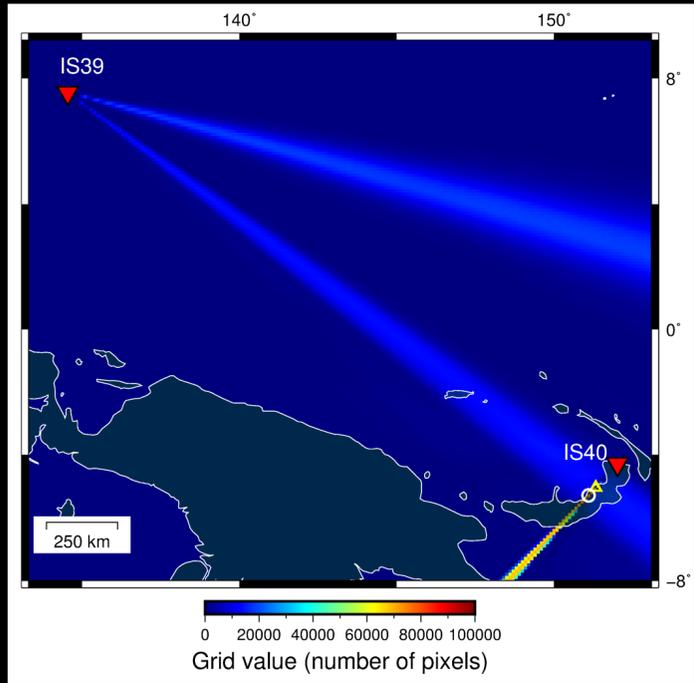
ULAWUN VOLCANO, PAPUA NEW GUINEA

25 JUNE 2019

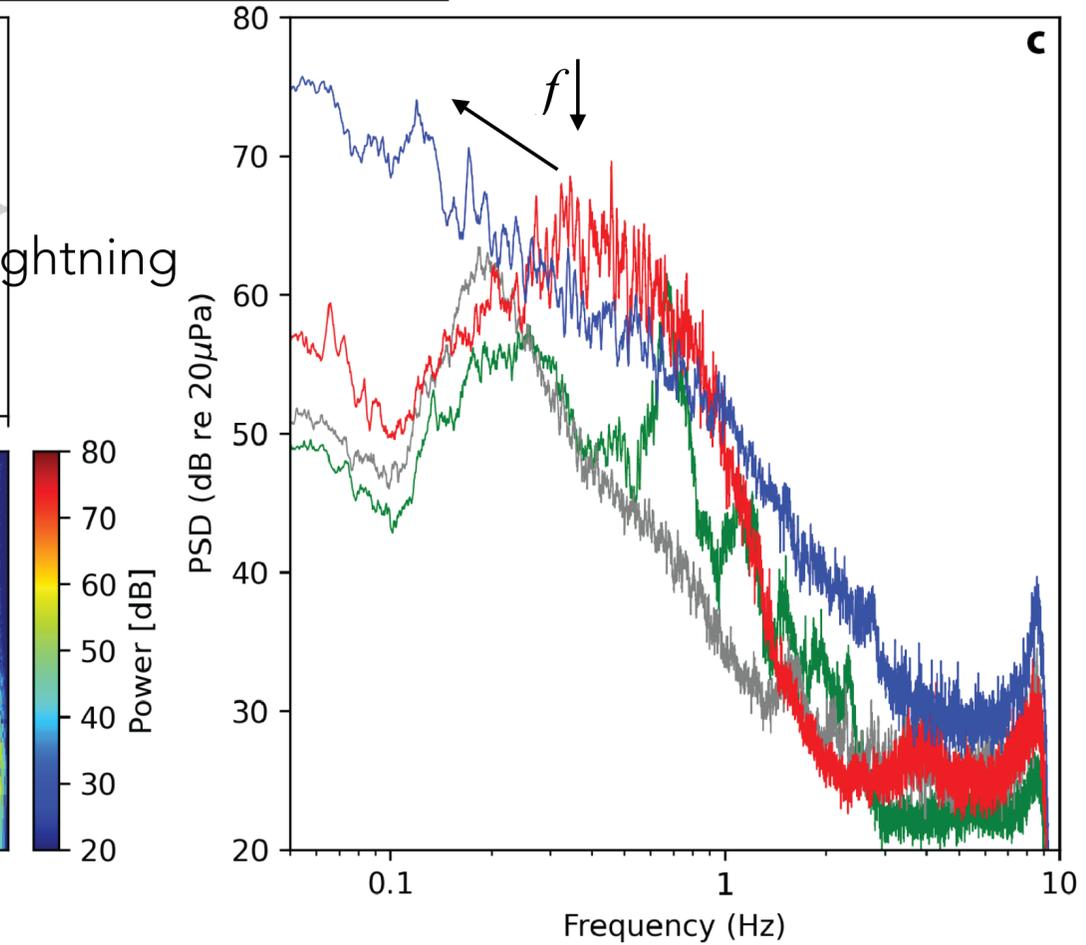
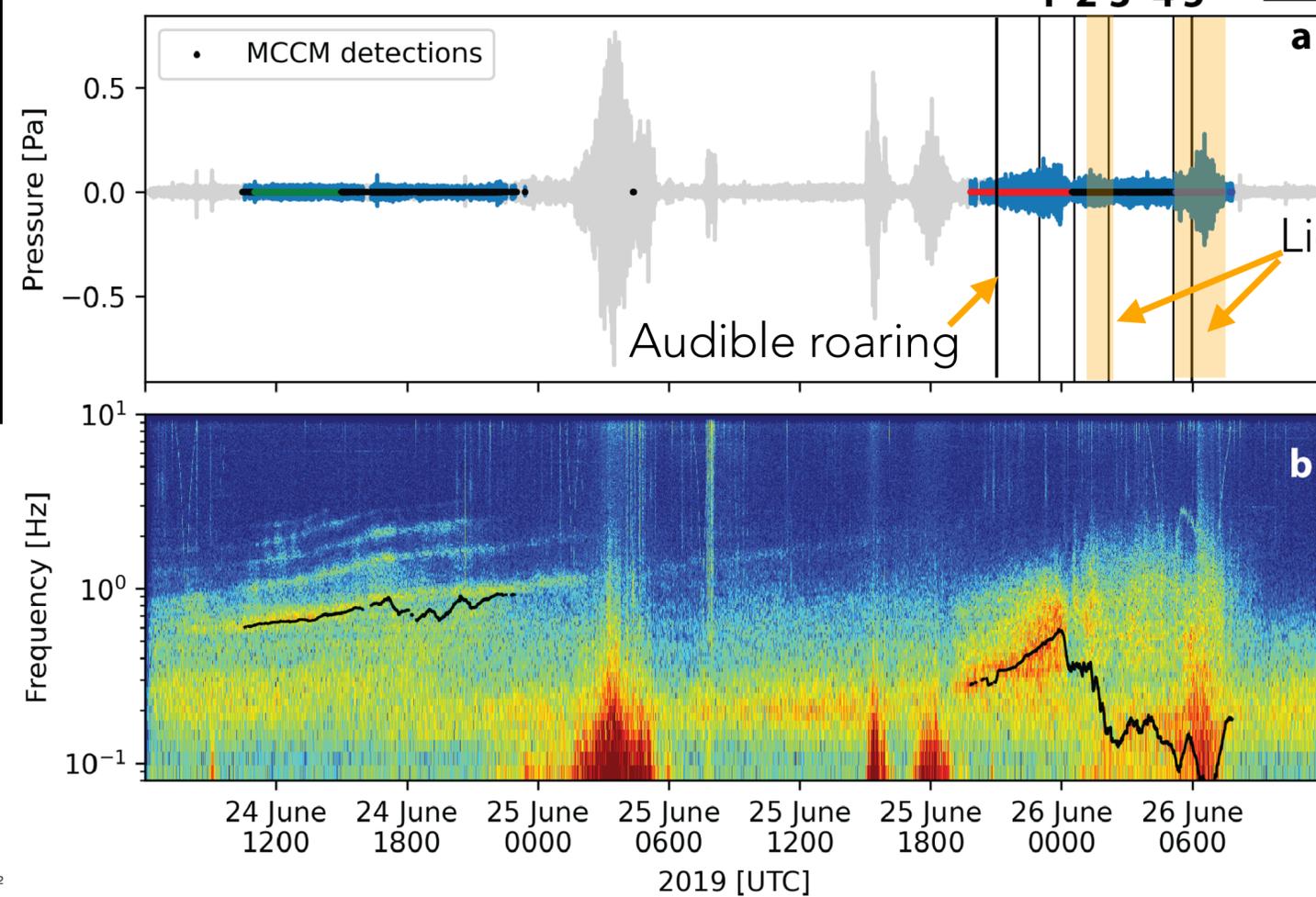
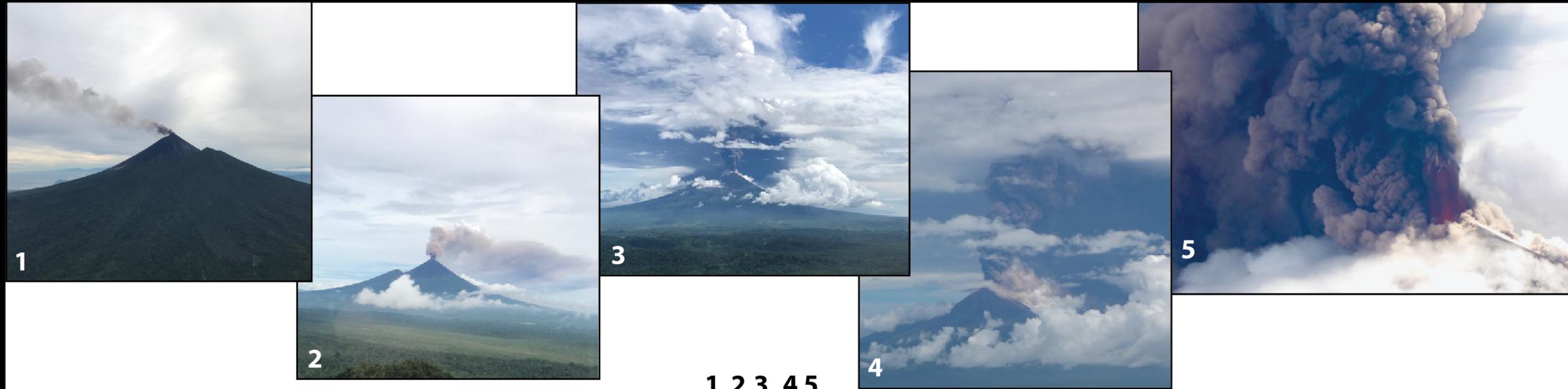
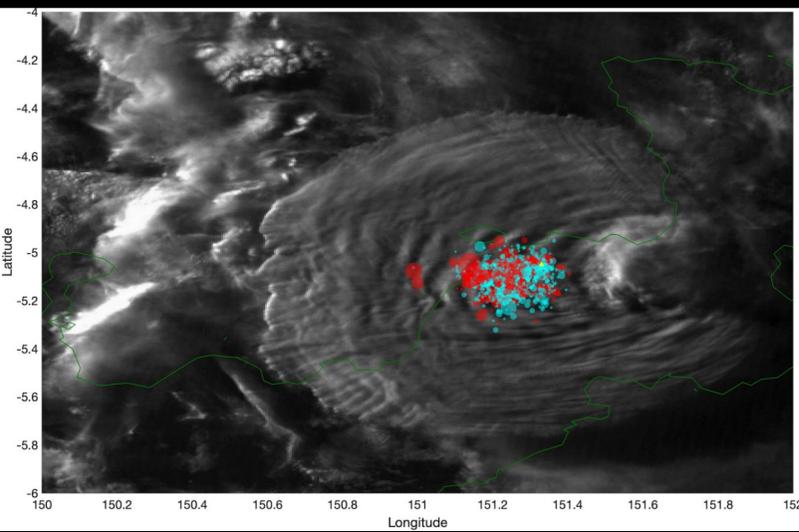


~11,000 people fled the eruption

ULAWUN VOLCANO 25 JUNE 2019 ERUPTION

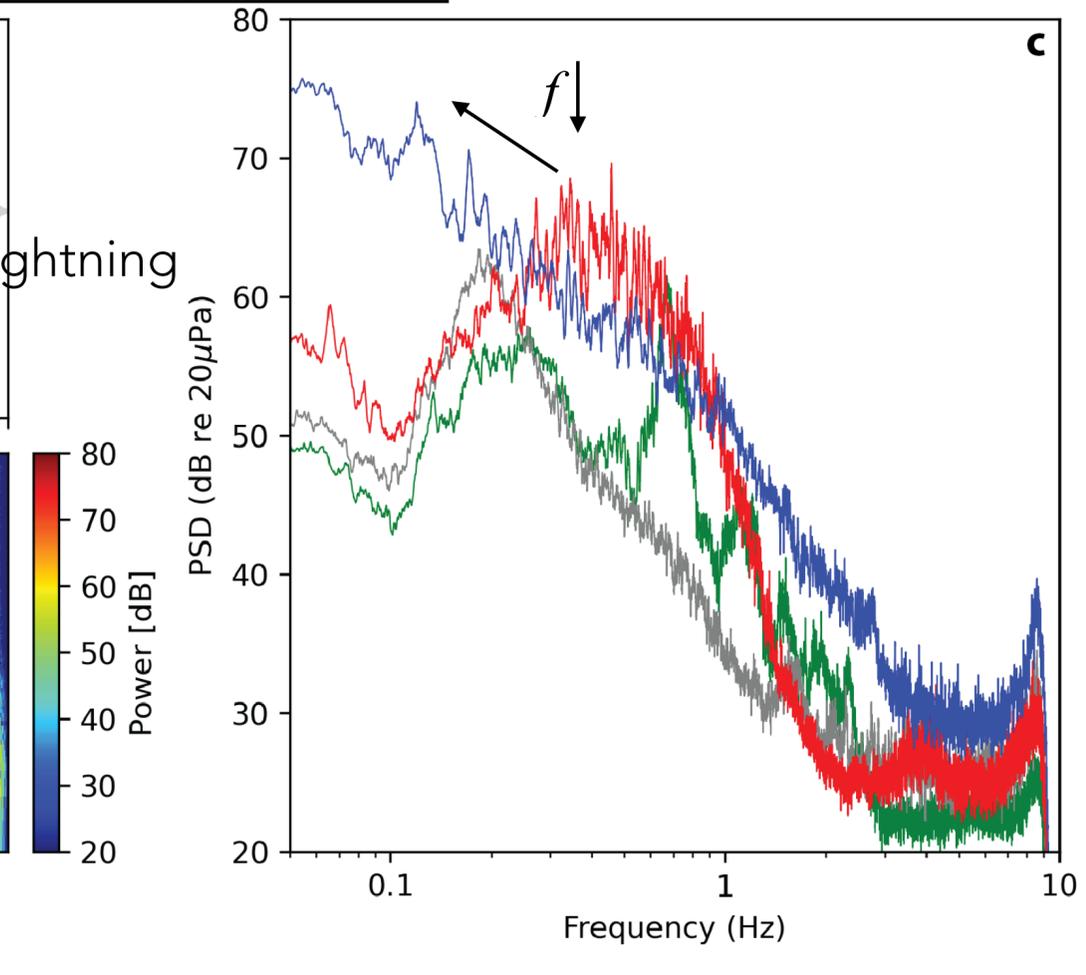
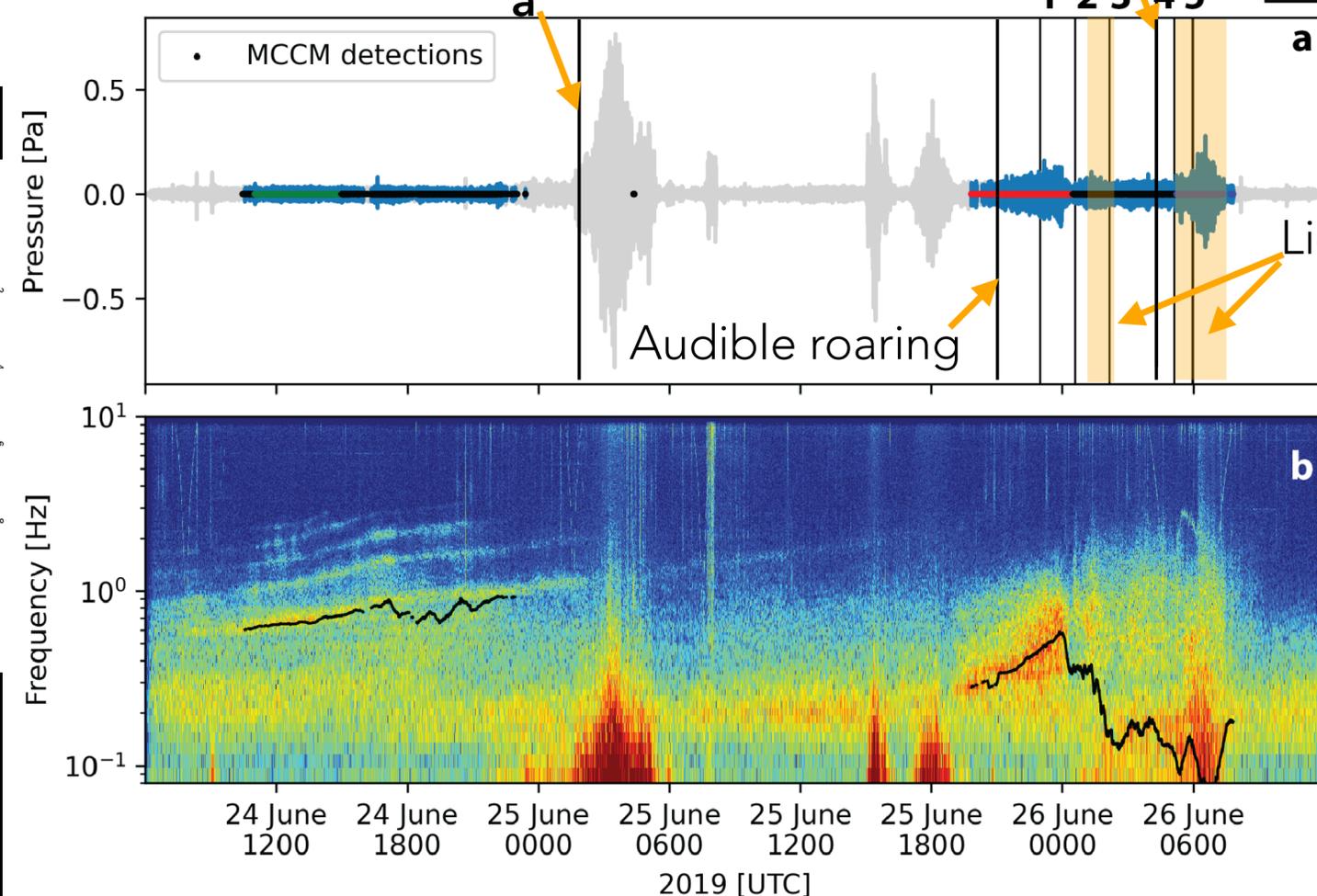
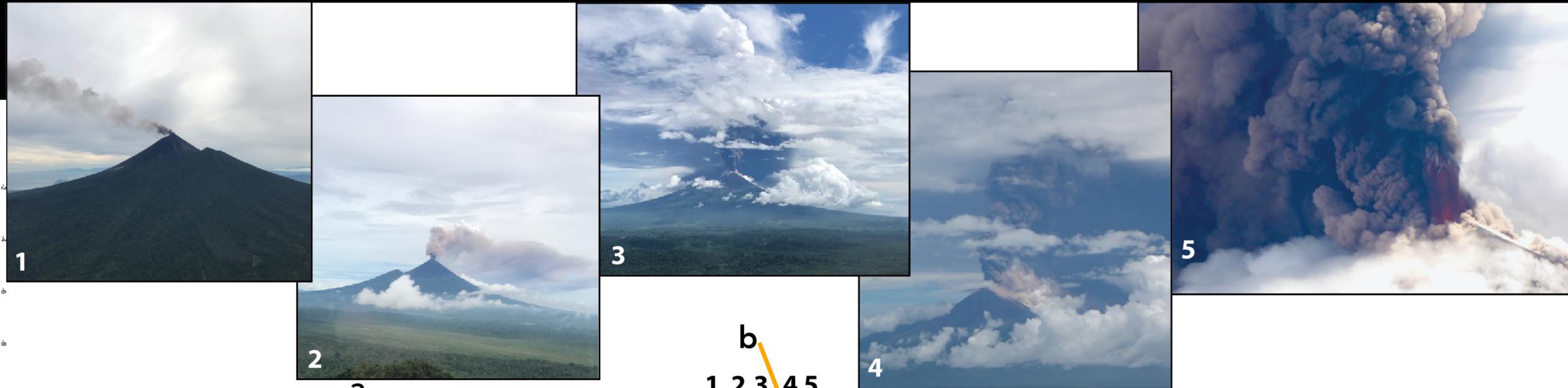
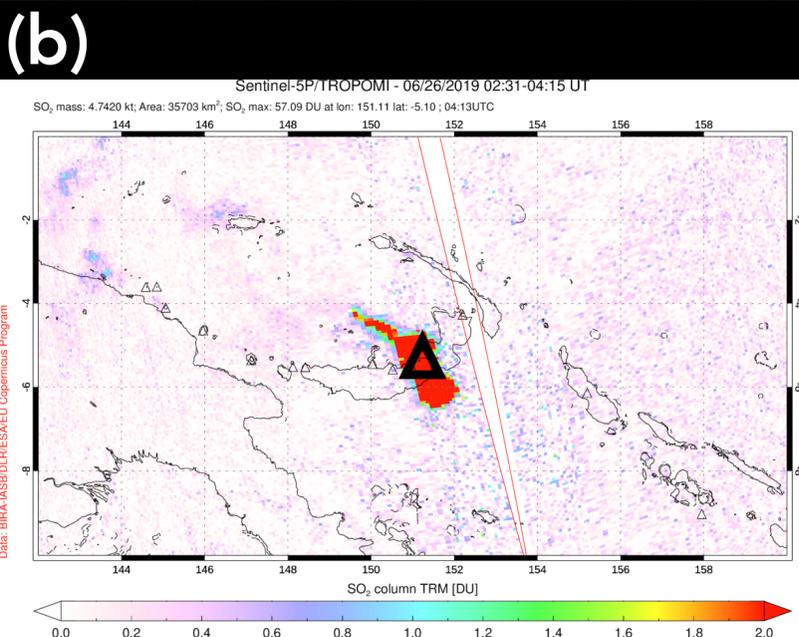
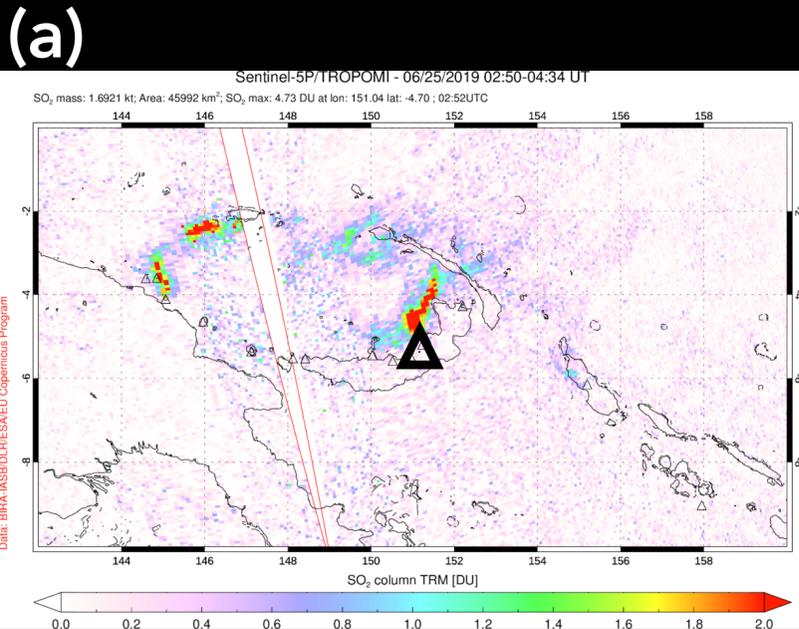


22 km from true
Array distances: 113 km
and 2328 km
Lightning



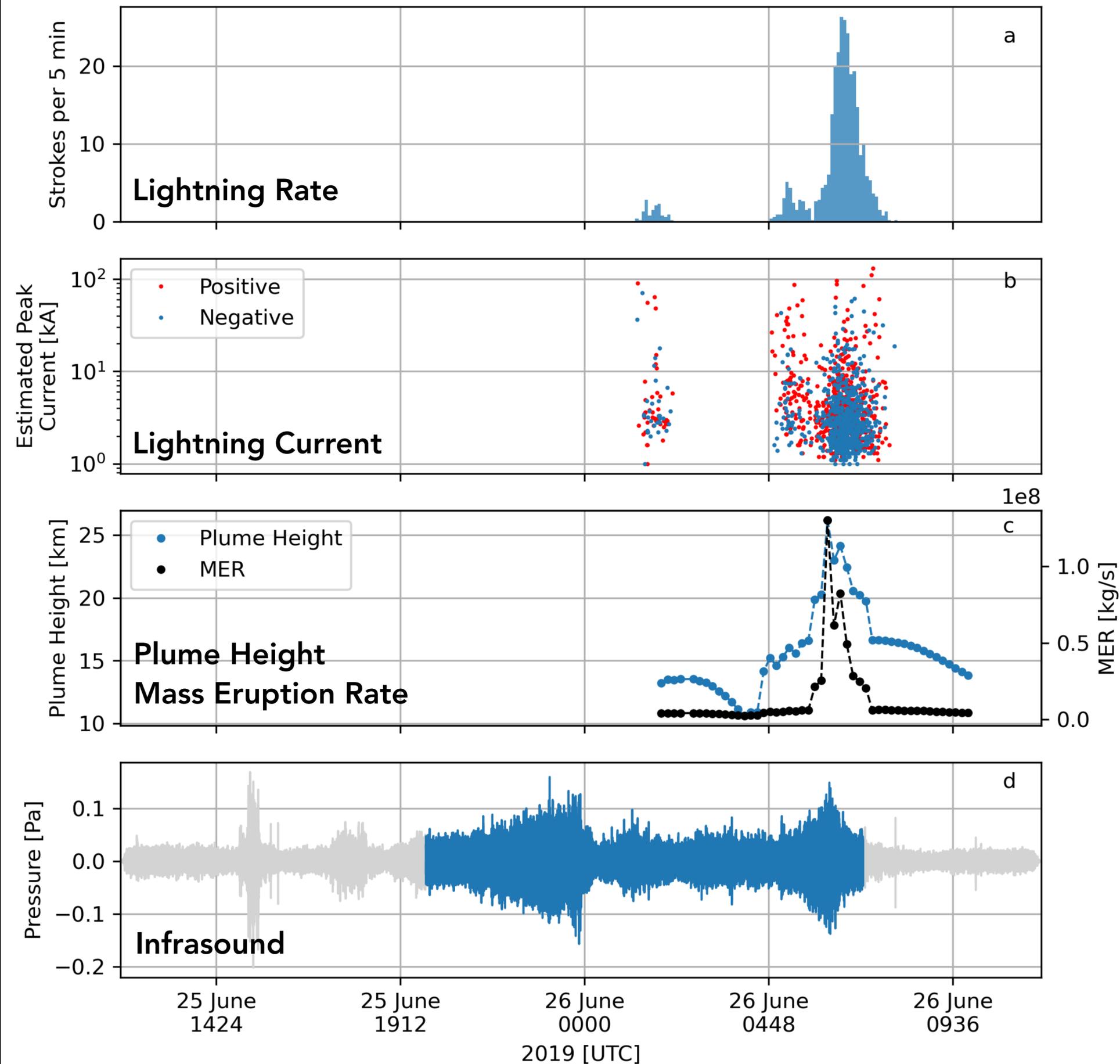
ULAWUN VOLCANO 25 JUNE 2019 ERUPTION

TROPOMI SO₂

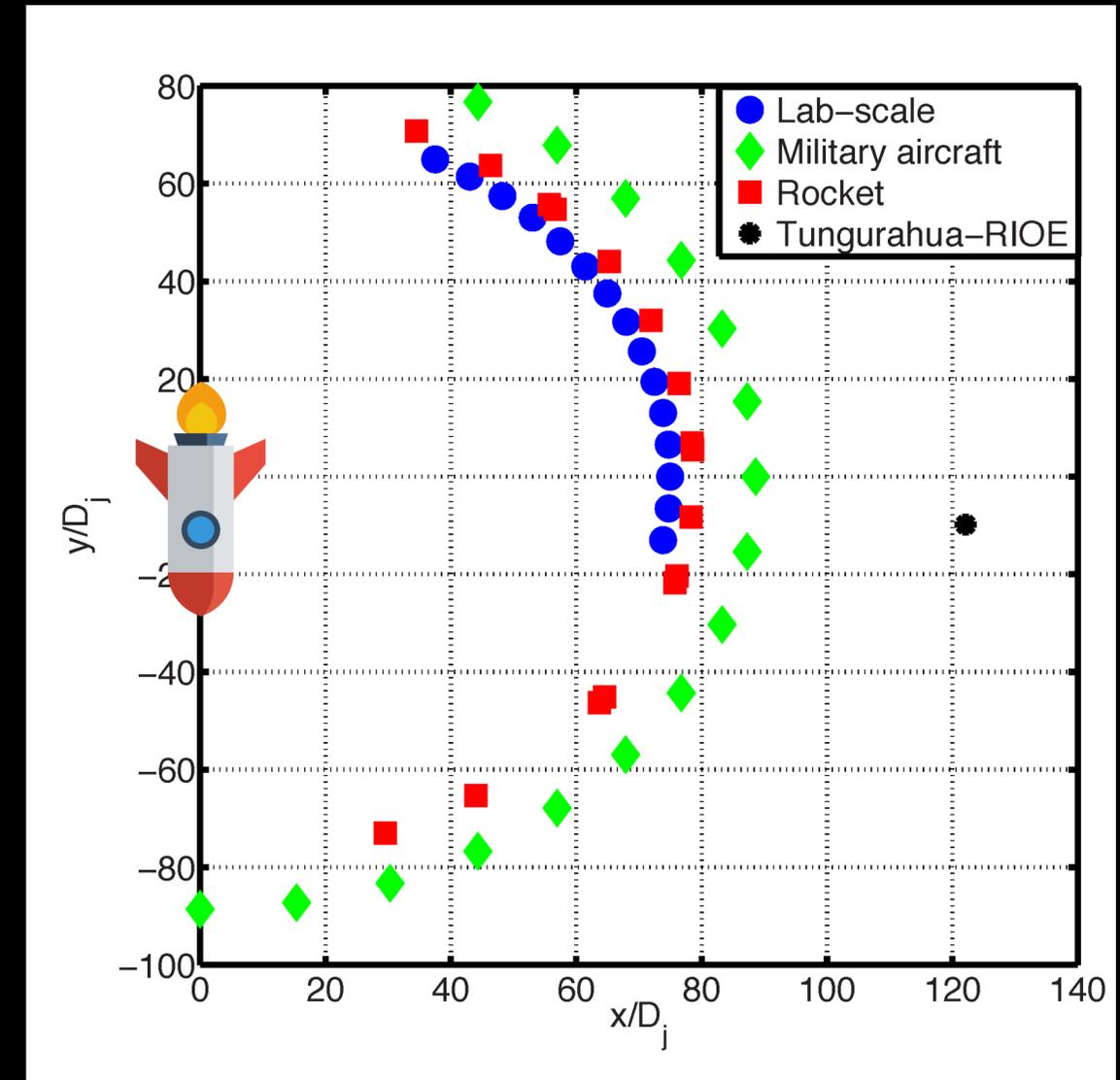
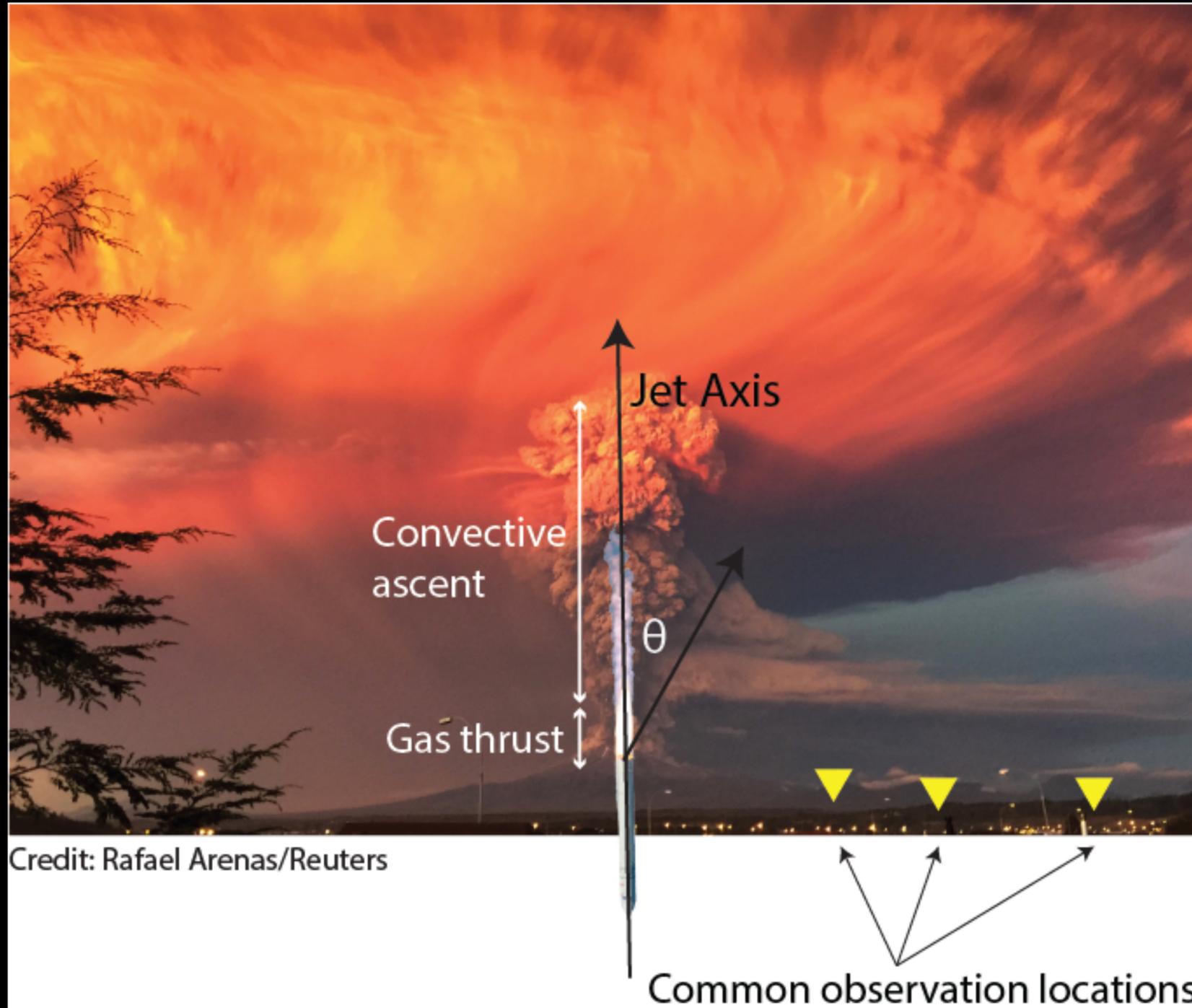


ULAWUN VOLCANO 25 JUNE 2019 ERUPTION

- Lightning, plume height, and infrasound correlate for the Plinian phase of the eruption
- Infrasound detections start earlier than satellite and lightning



VOLCANO JET NOISE



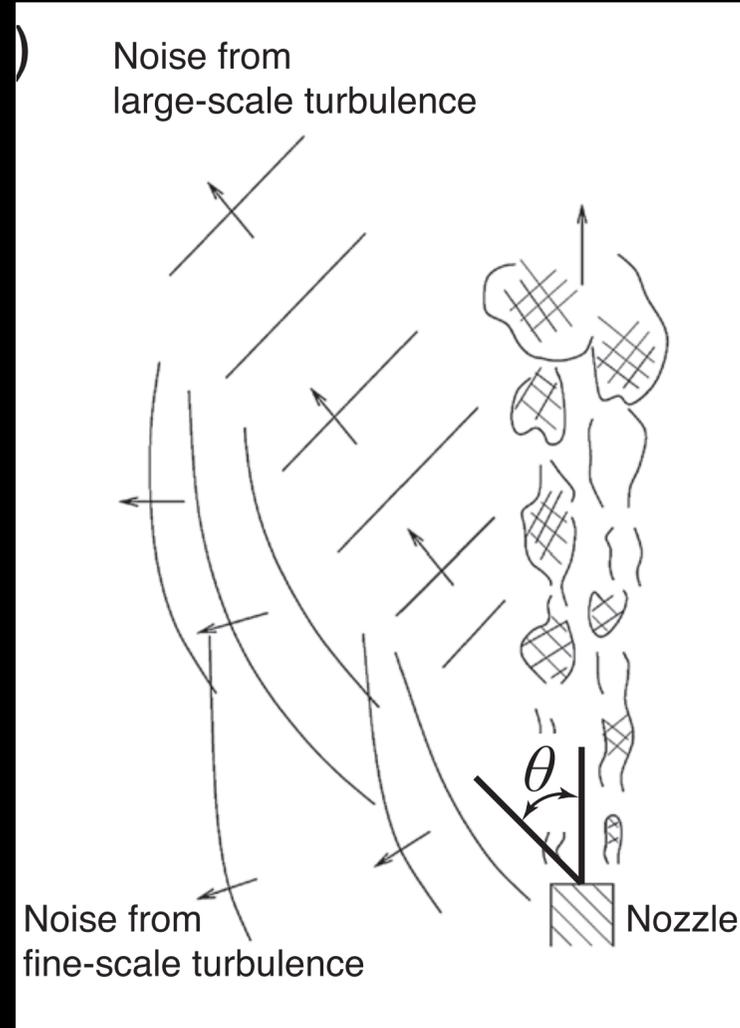
Matoza et al., 2013

VOLCANO JET NOISE

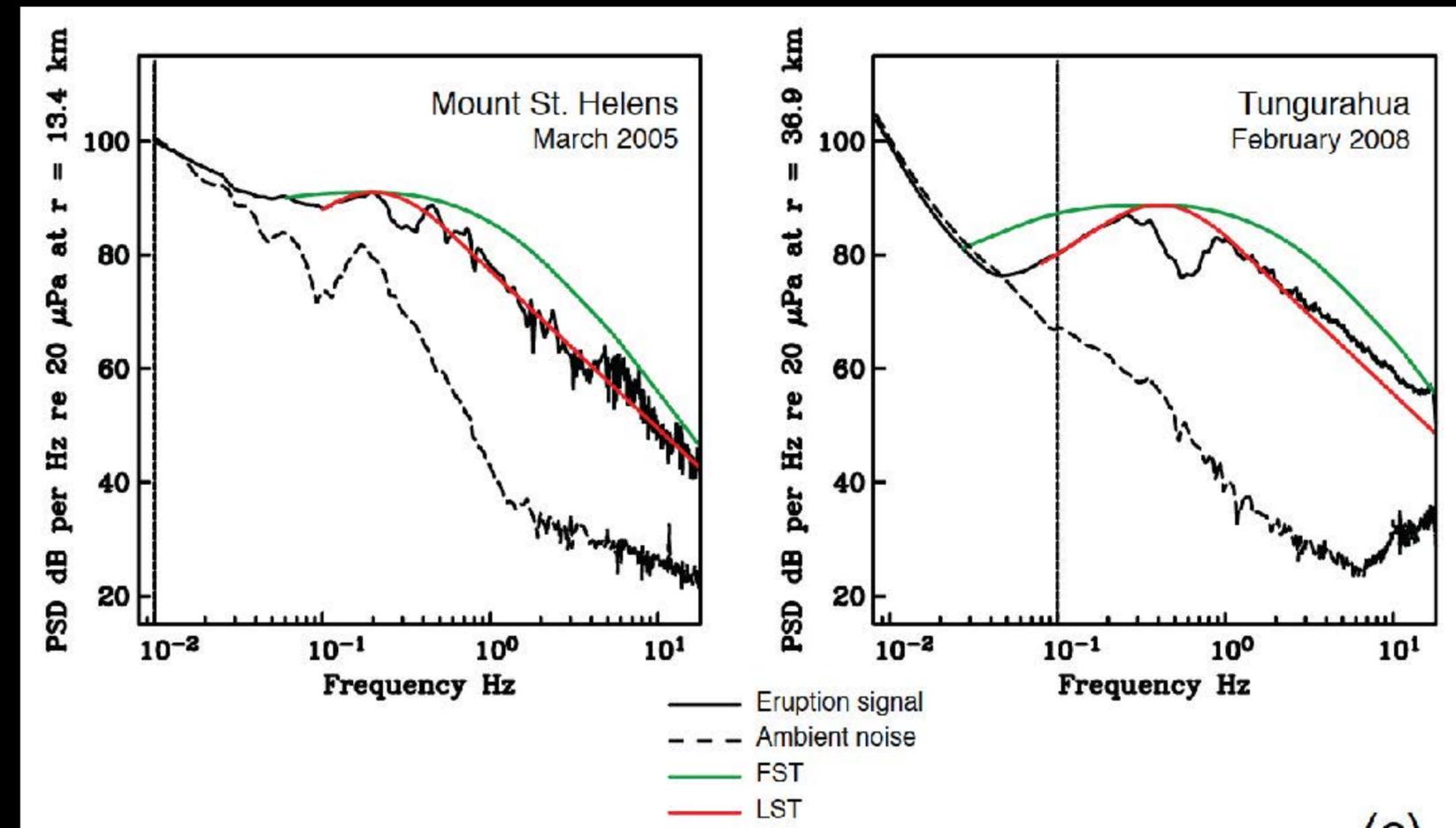
1980 eruption of Mount St. Helens Volcano, USA



USGS



Matoza et al., 2013



Matoza and Fee, 2018 after Matoza et al., 2009

CHANGE IN PEAK FREQUENCY

St = Strouhal Number

$$St = \frac{fD_j}{U_j}$$

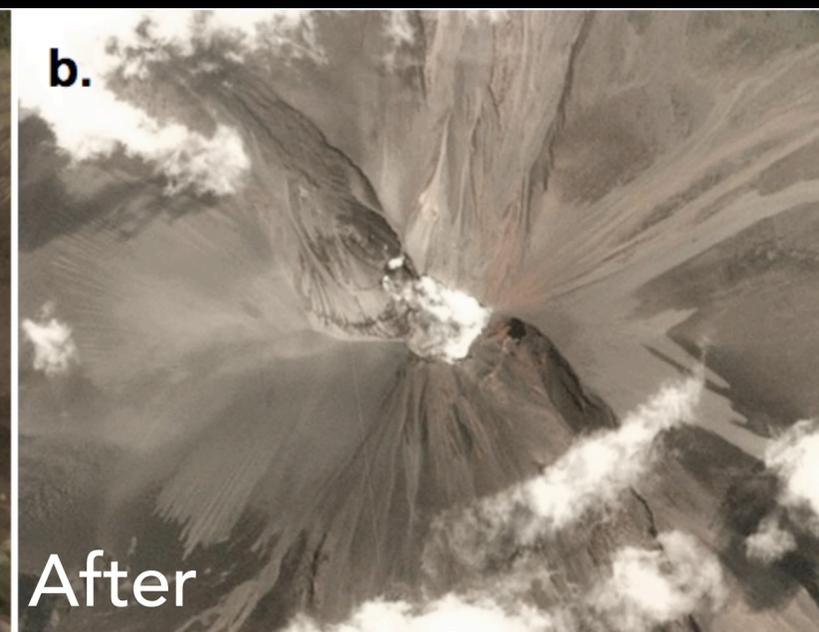
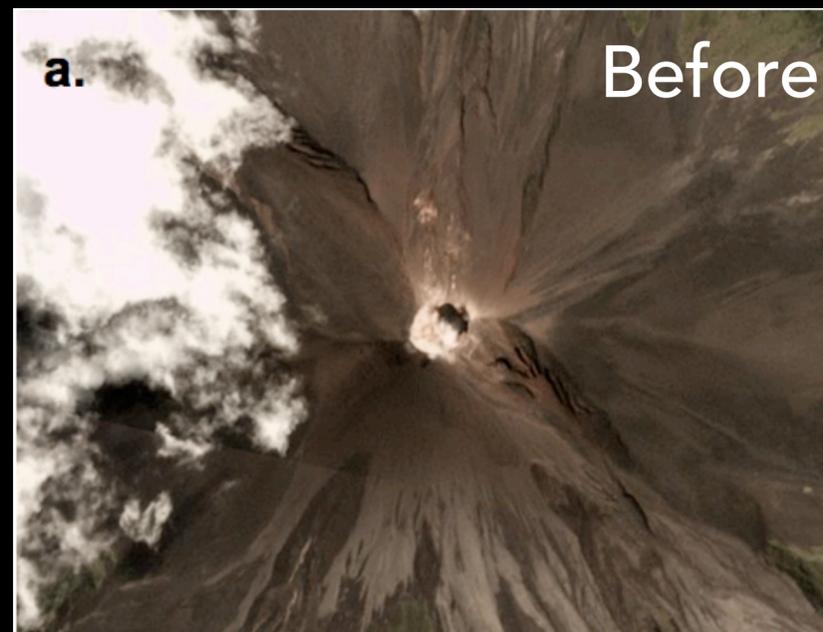
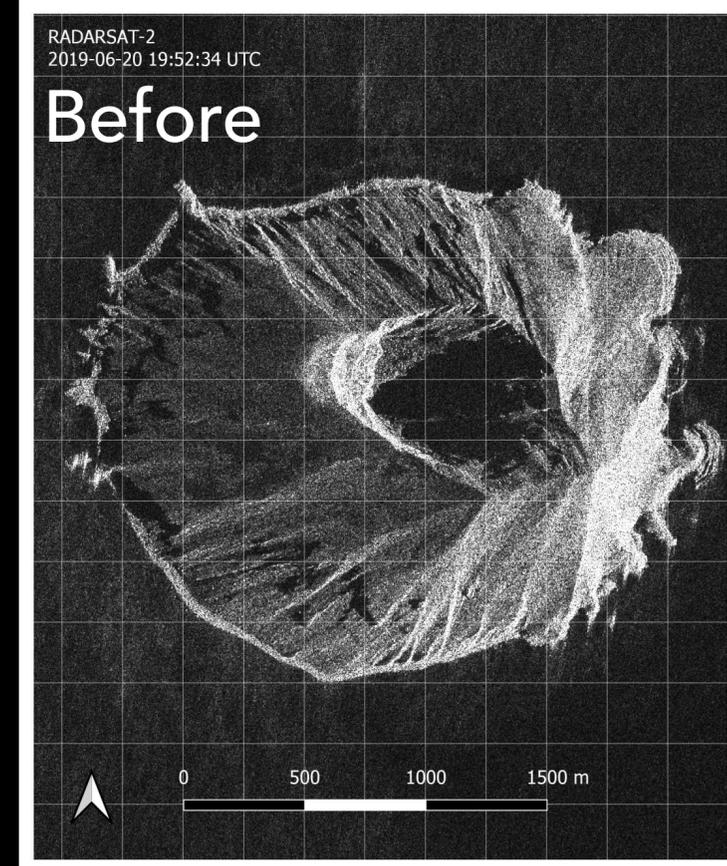
f = Peak Frequency

D_j = Jet diameter

U_j = Jet velocity

Ulawun Volcano

Raikoke Volcano



SUMMARY

- Infrasound provides high time resolution of timing and intensity and maybe useful for anticipating Plinian phase
- Observe infrasound frequency drop for both eruptions
- Decrease in infrasound frequency likely due to increase in vent diameter
- Pre- and post-eruption satellite imagery show increase in crater diameter supporting interpretation of infrasonic frequency changes
- Increase in crater diameter relative to decrease in infrasonic frequency suggests volcanic jet velocity also increased