Clog and Crack: Hidden earthquakes unveil the dynamic evolution of a large-scale explosive eruption

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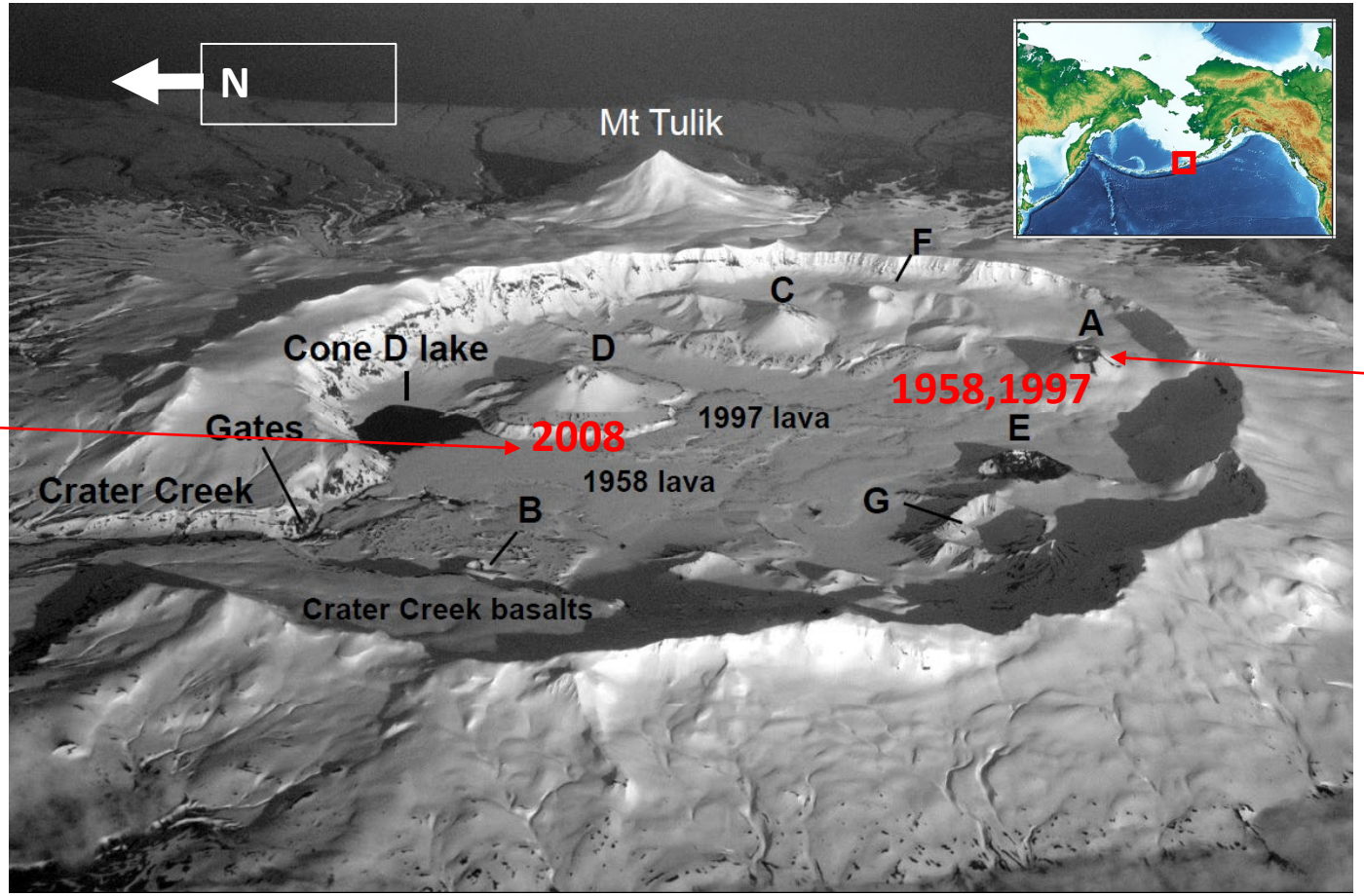
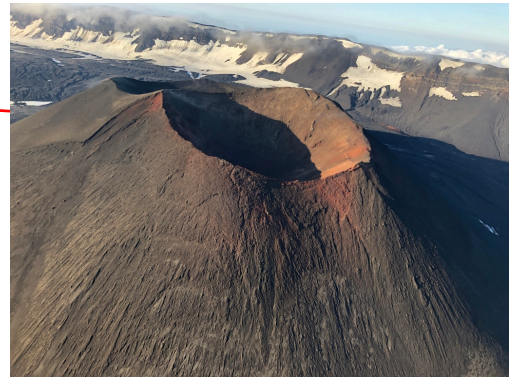
Okmok Caldera, Aleutian Islands 2008 eruption

Explosive

(Taken from Larsen et al., 2015; Photograph by J. Schaefer (DGGS).



Hawaiian/Strombolian

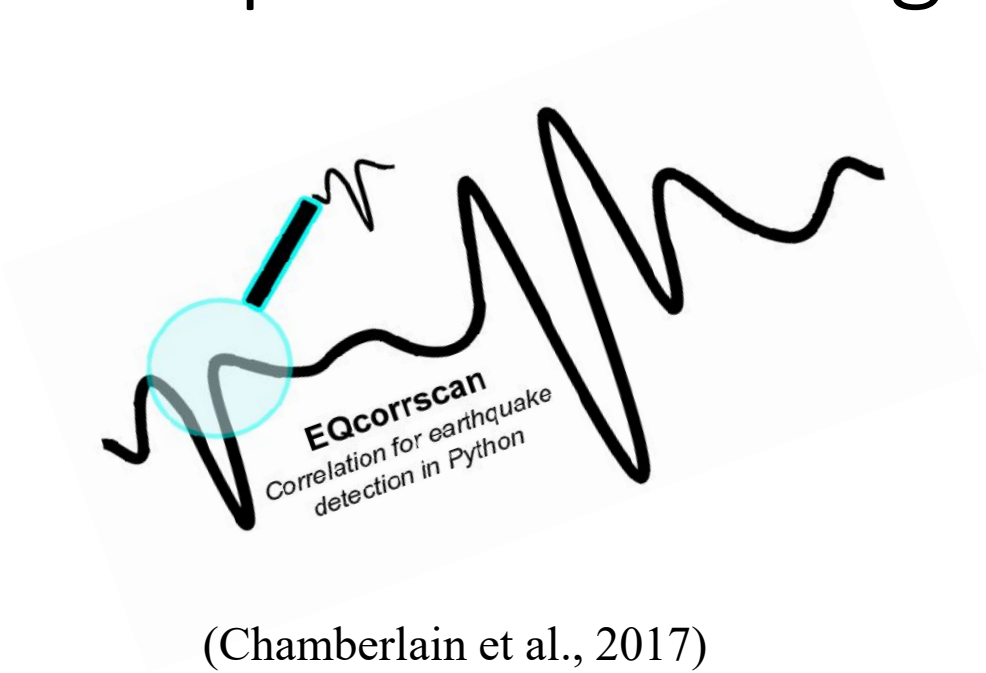


Aerial view of Okmok Caldera (10 km wide) looking to the south (Taken from Larsen et al., 2015; Photograph by C.Read (USGS), June 7 2007.

Earthquake detection

Supervised

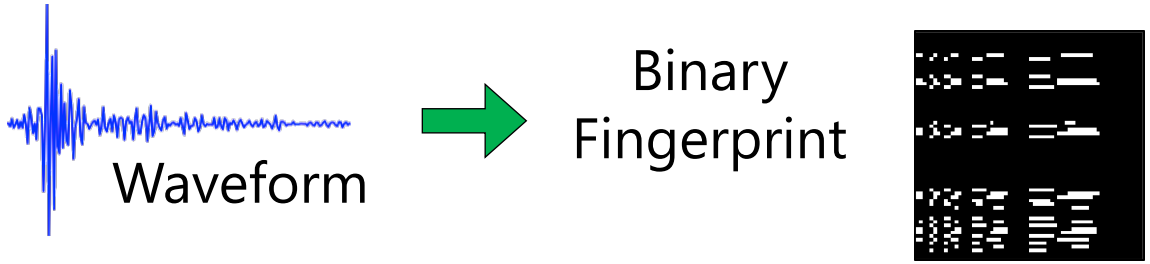
Template Matching



(Chamberlain et al., 2017)

Unsupervised

Fingerprint and Similarity Thresholding (FAST)

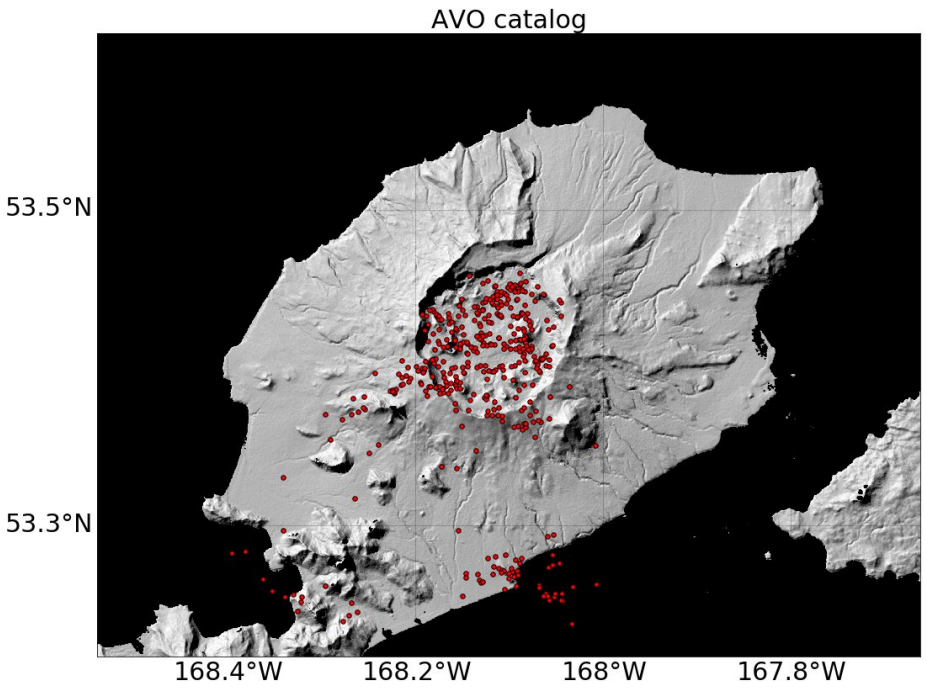


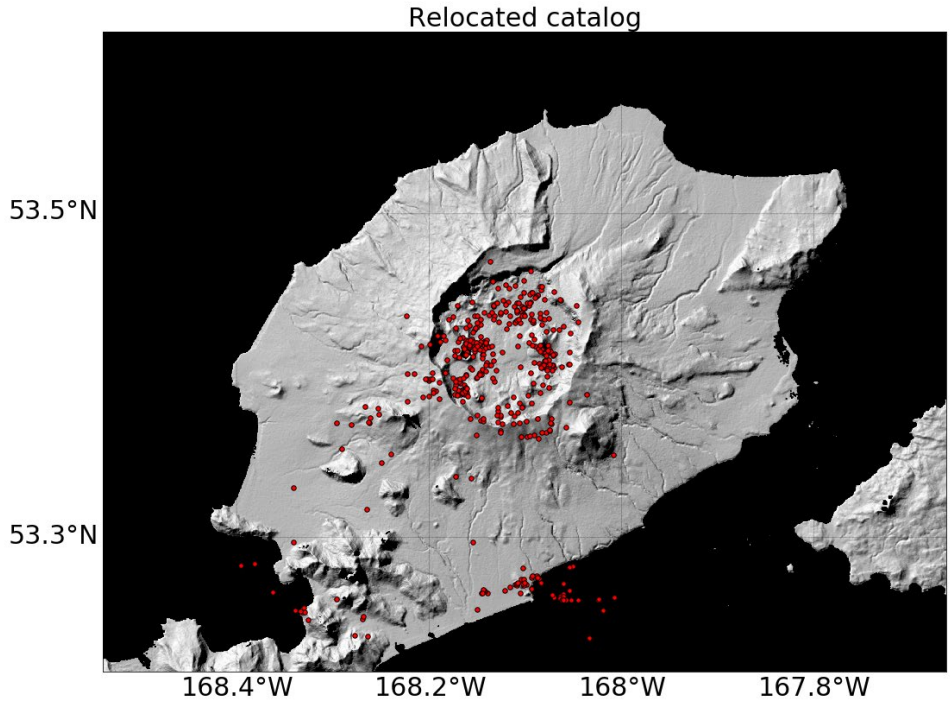
(Yoon et al., 2015)

Earthquake relocation of templates and FAST events

GrowClust – Hybrid (relocation/clustering) algorithm

Trugman & Shearer (2017)





Development of a local magnitude for Okmok

Local geometric spread/attenuation/station corrections

Calibrated during eruptive period

$$M_L = log_{10}(A) - log_{10}(A_{ref}) + 3$$

$$log_{10}(A_{ref}) = \alpha\left(\frac{R}{17}\right) + K(R - 17) - dM_L$$

Hutton and Boore (1987)

Development of a local magnitude for Okmok

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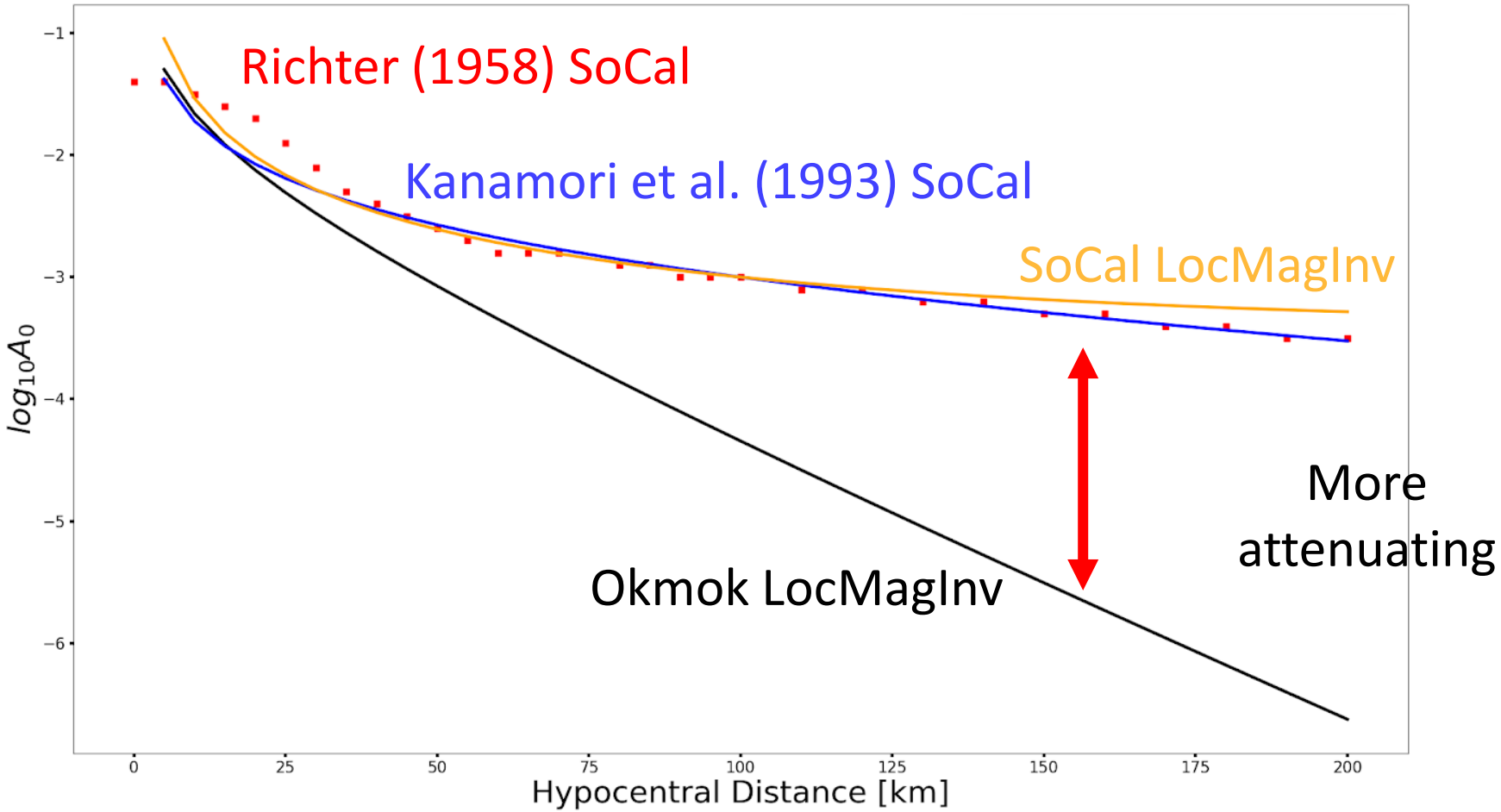
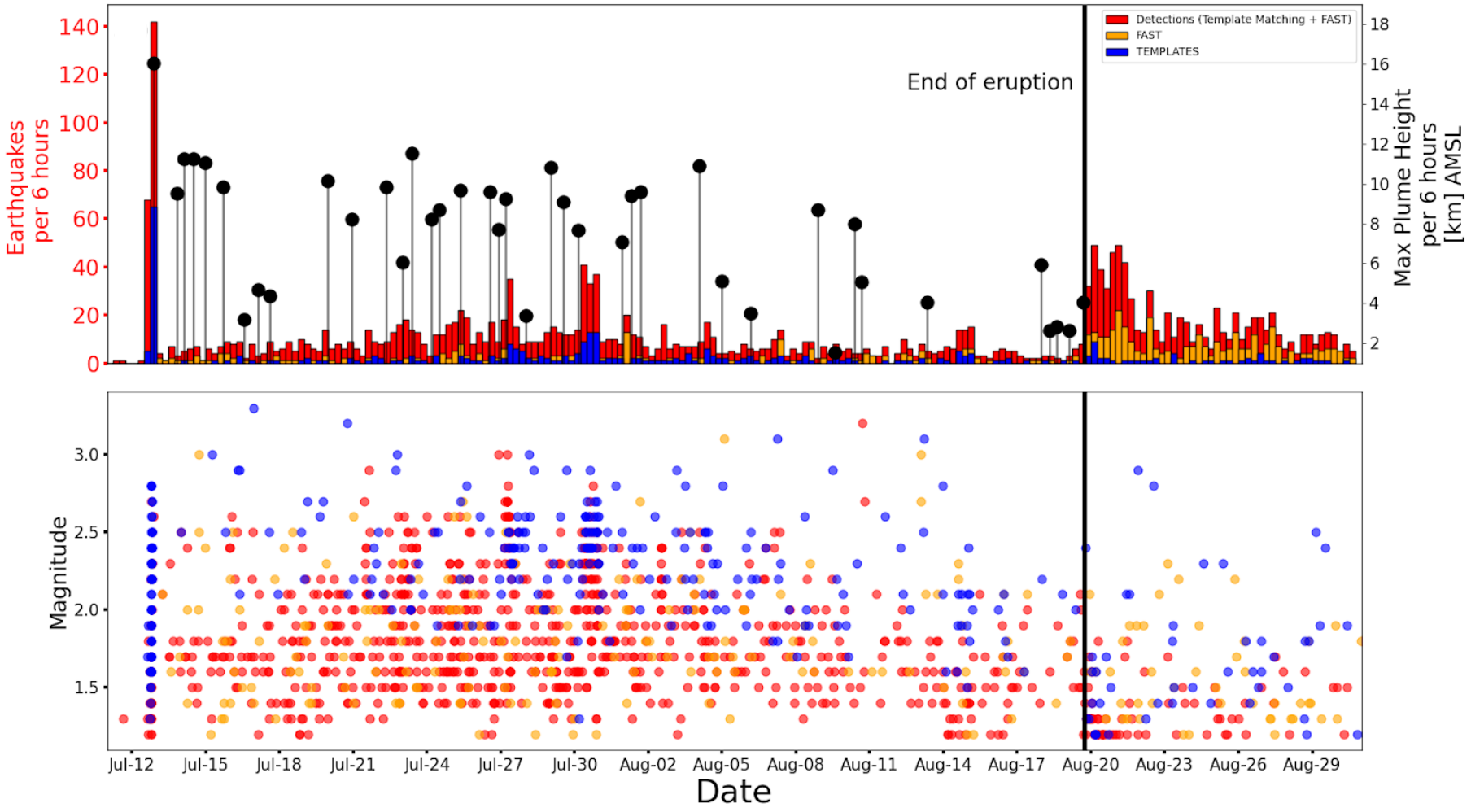
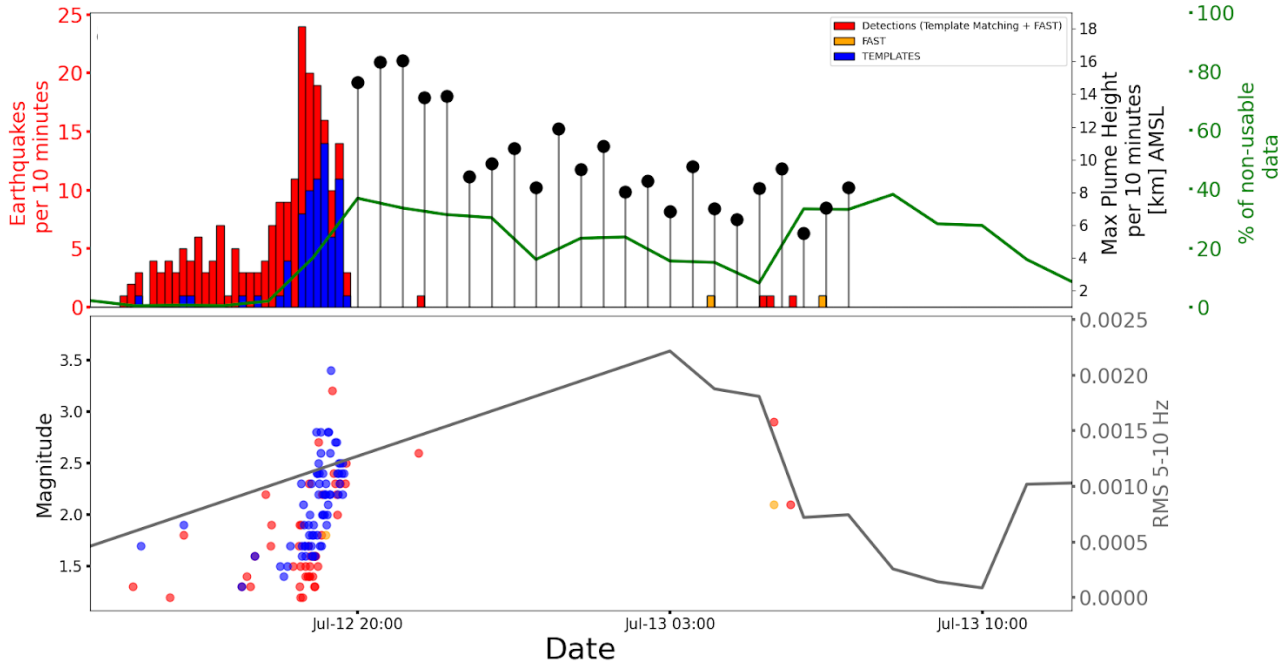
Calibrated during eruptive period

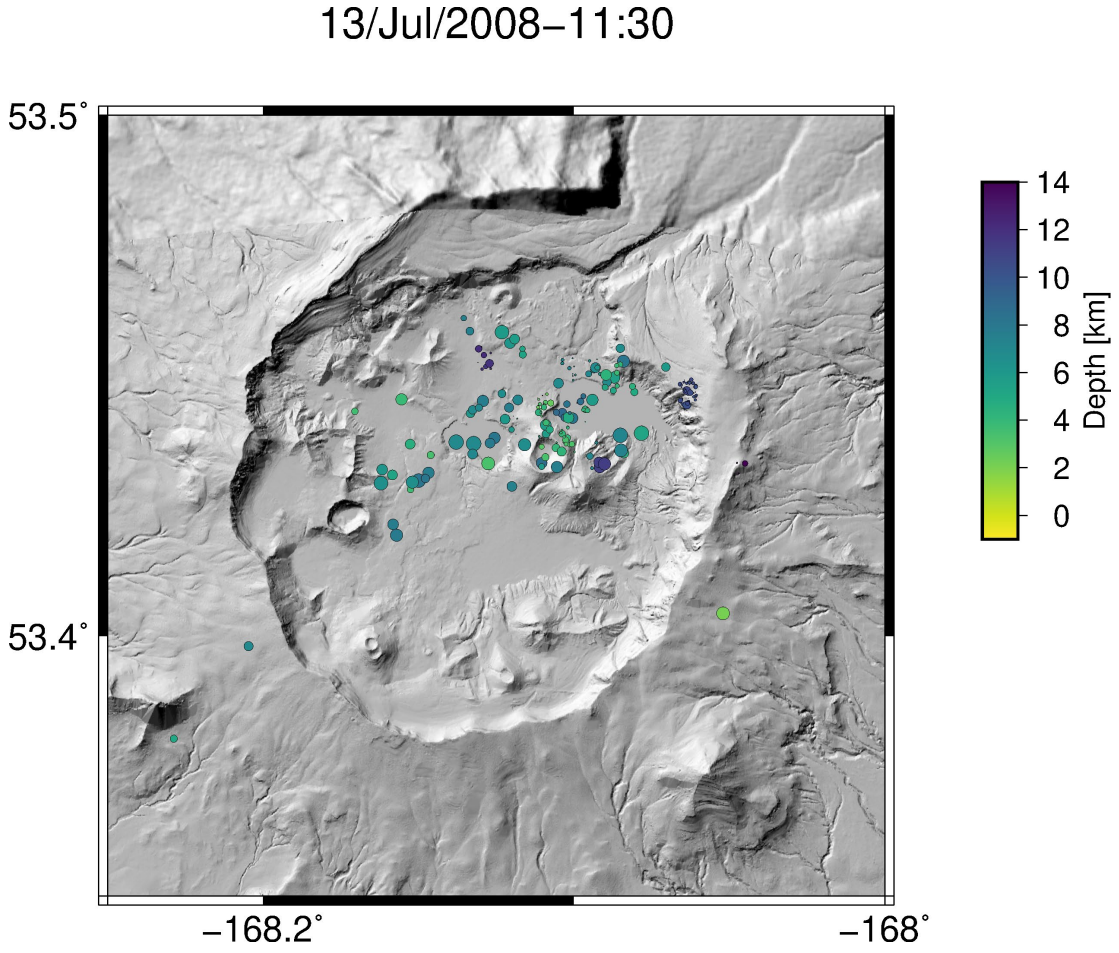


Time series of eruption

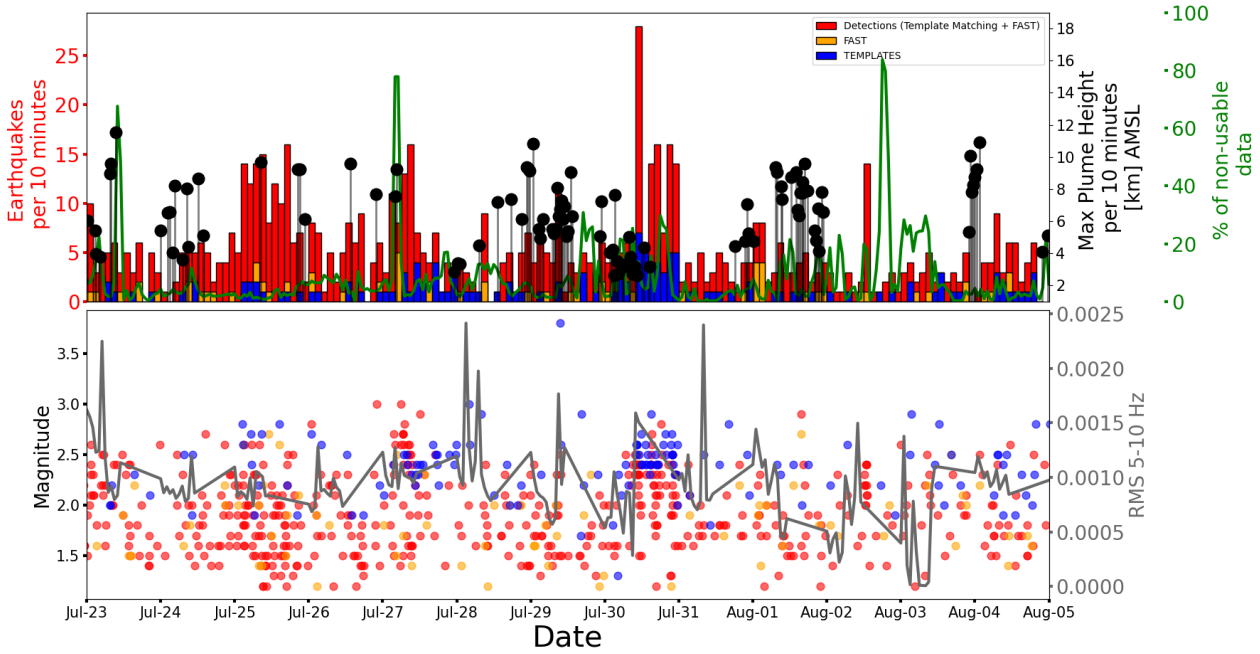


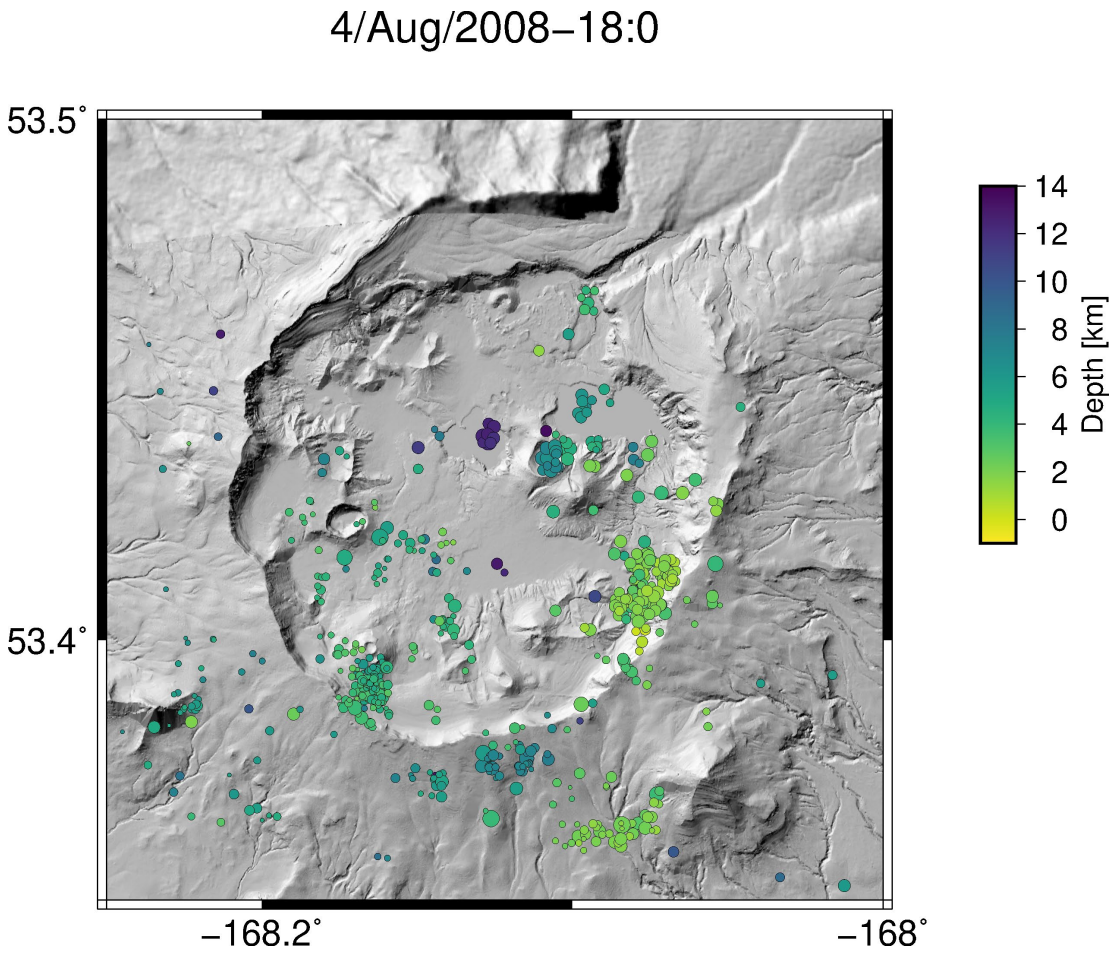
Opening


Detections (Template Matching + FAST)
FAST
TEMPLATES
Earthquakes per 10 minutes
Max Plume Height per 10 minutes [km] AMSL
% of non-usable data
Magnitude
RMS 5-10 Hz
Jul-12 20:00
Jul-13 03:00
Jul-13 10:00
Date

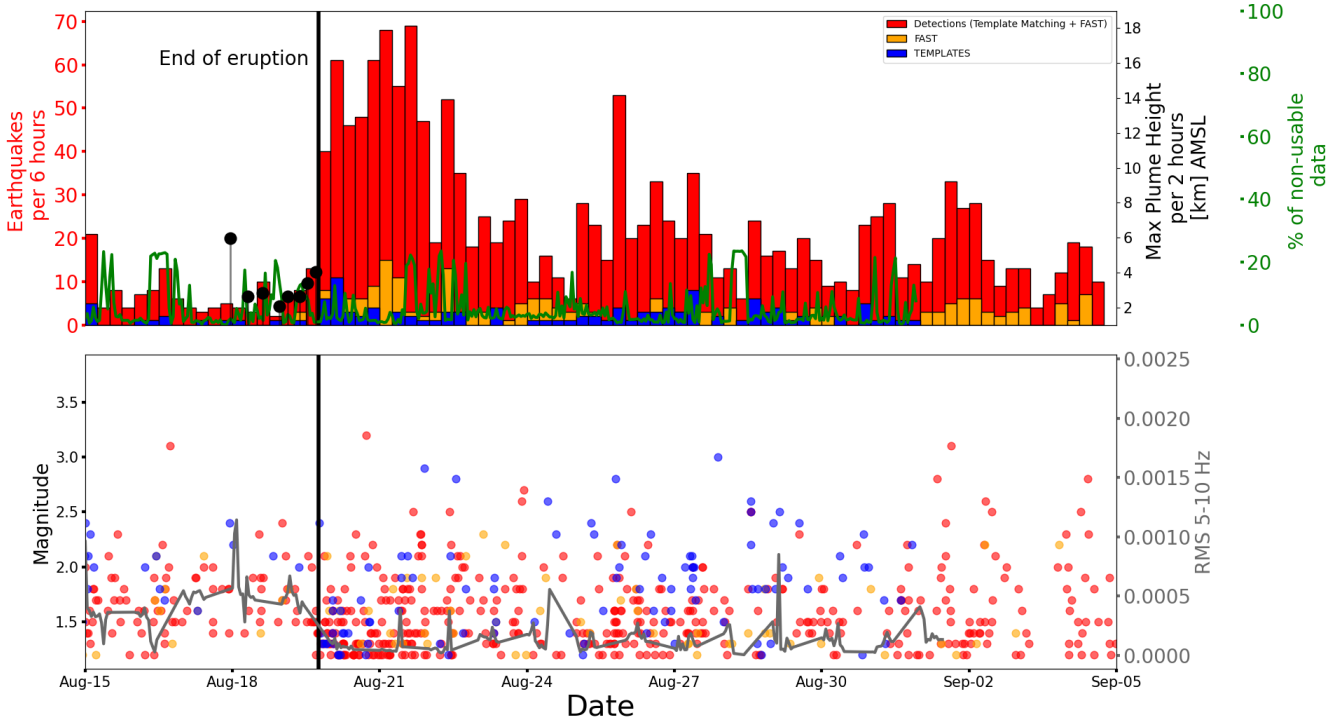

13/Jul/2008–11:30
53.5˚
53.4˚
–168.2˚
–168˚
Depth [km]

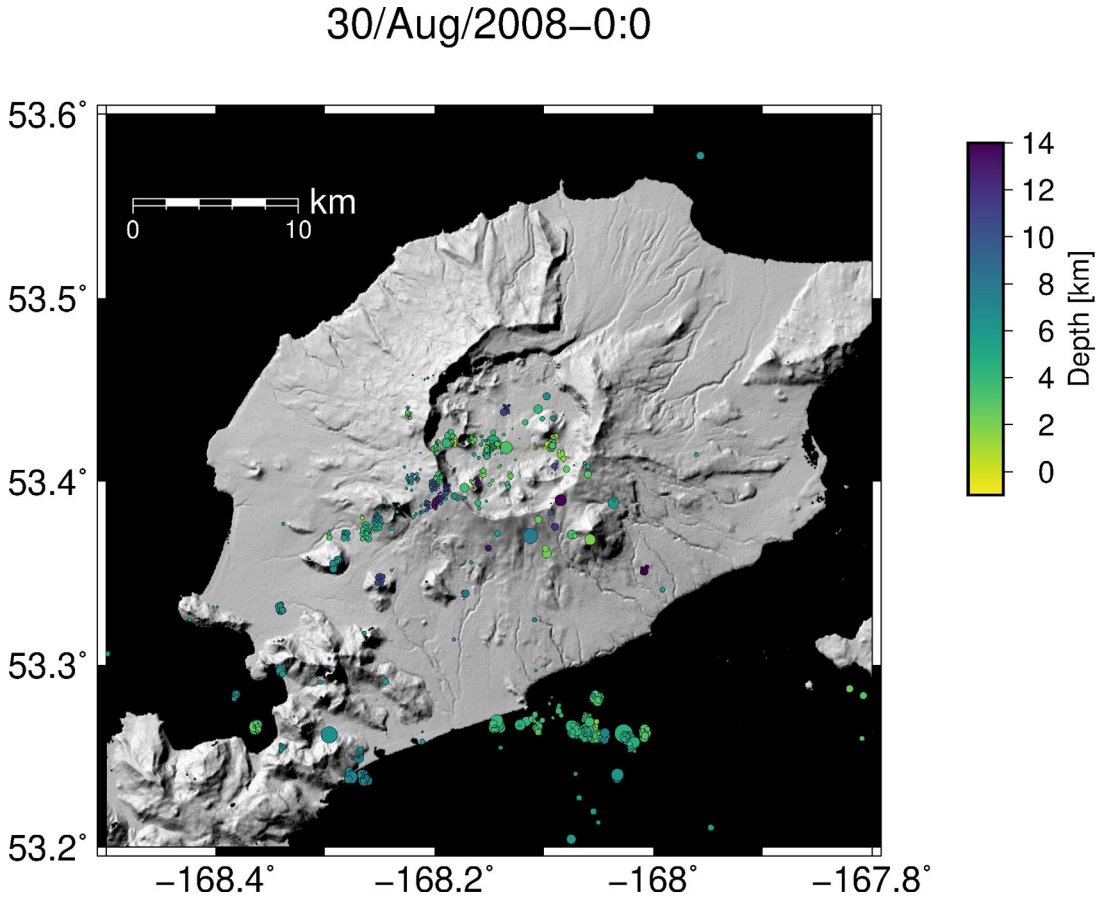
Vent widening (middle of eruption)





End of Eruption

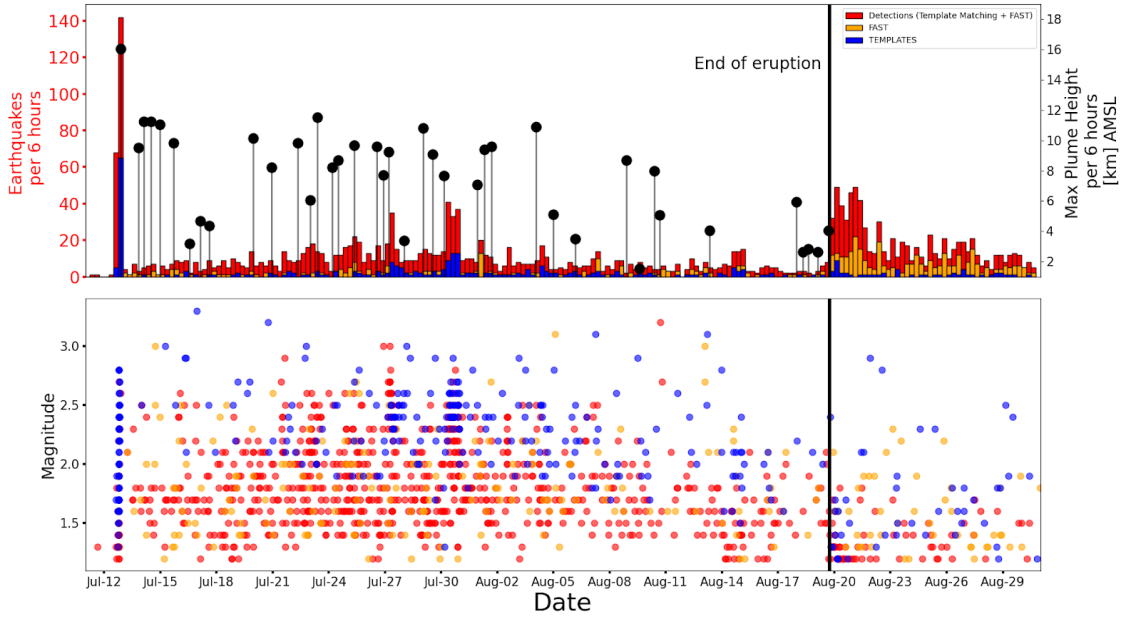




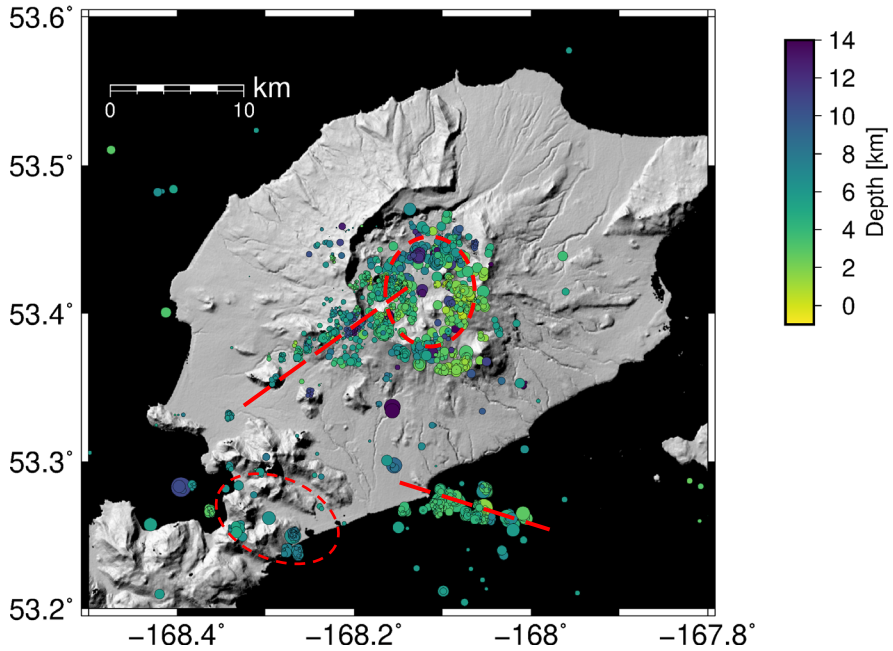
Conclusions

Main bursts of seismicity in the caldera do not correlate in time with plume episodes

This suggests that there is a “clog and crack” process regulating the dynamics of the eruption.



1/Sep/2008



Highlighting of structures

-Ring-fault

-Large NE-SW trending seismicity

-Off-shore NW-SE trending seismicity

} Fault? Dike? Draining system?

-Geothermal field