

Geophysical constraints of volcanic processes: Observations of mass flux at volcanic systems



*Results presented here
would not have been
possible without*

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several students who
helped with field work

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BMBF
NSF Antarctic Progr.
Univ. Firenze, Italy
MeTeK*

Video by Benedikt Weiss

Why bother?



Photo by A. Gerst

Learn something about:

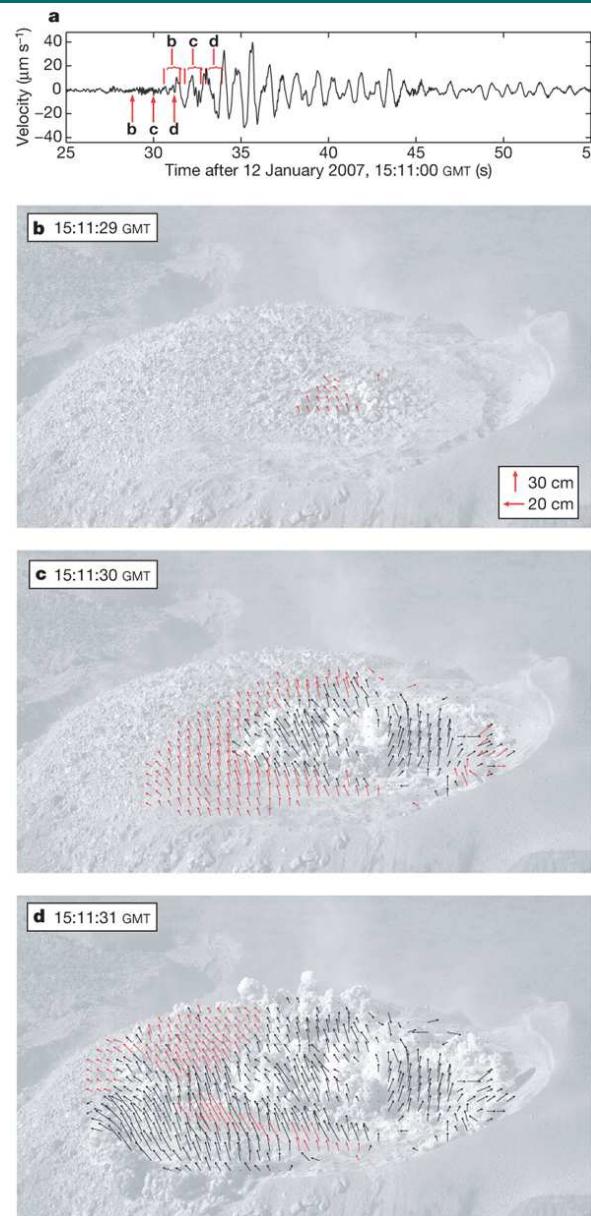
Eruption dynamics

- Conduit processes
- Pressures
- Transport velocities

Mass flux at the vent

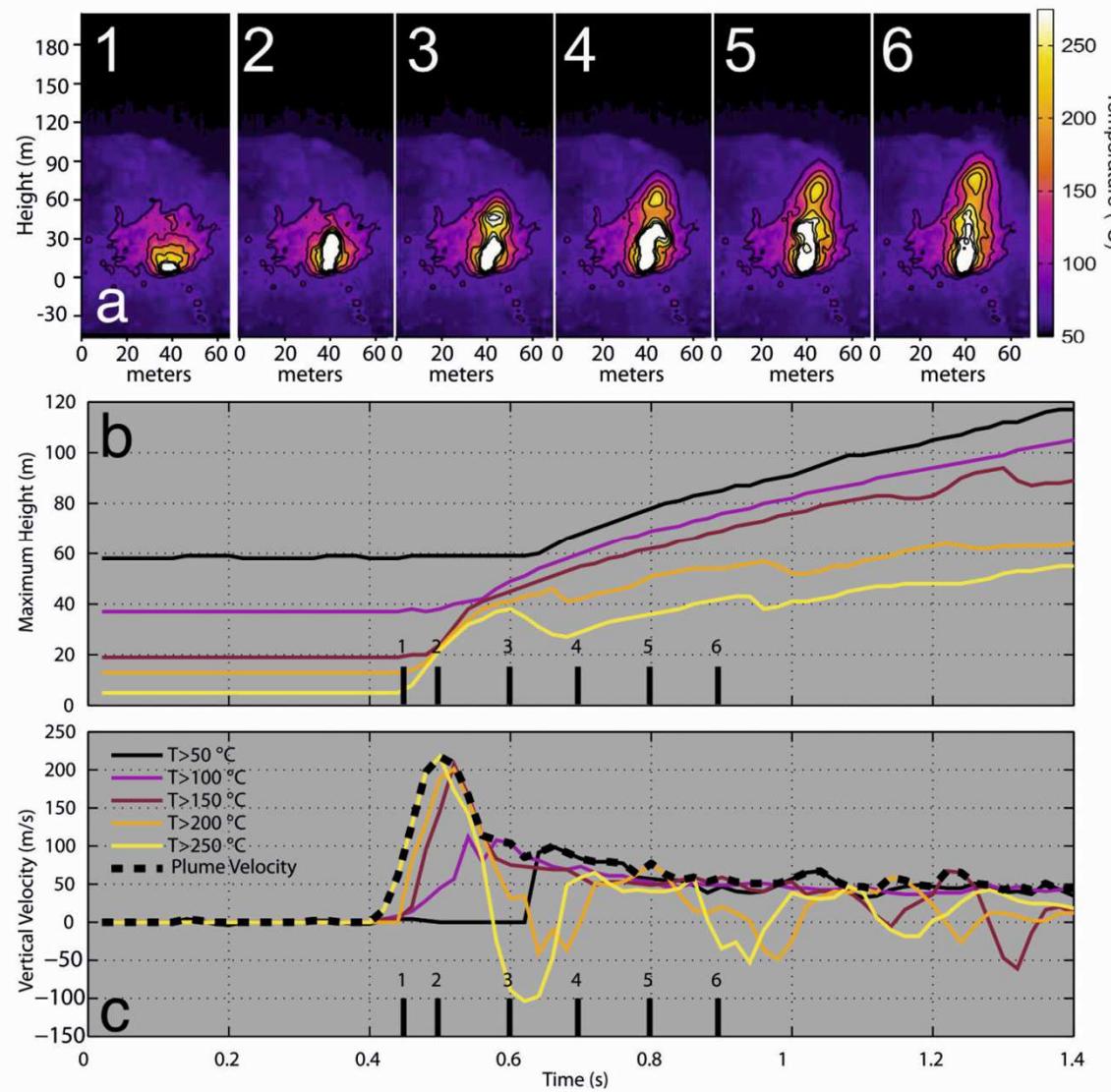
- Dispersion of ash
- Aviation
- Global climate

Visual observations



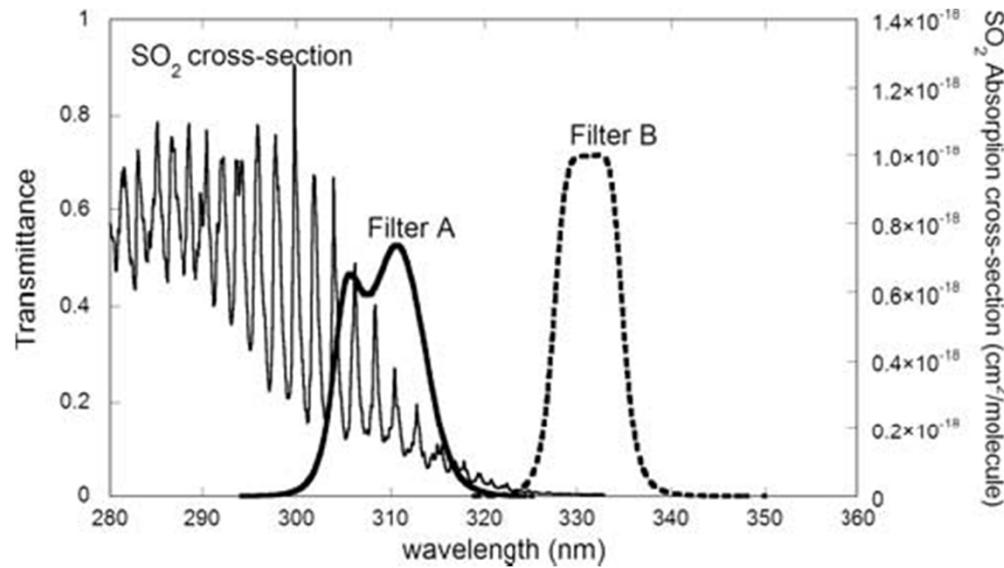
Johnson *et al.* (2008)

IR observations



Donne and Ripepe (2012)

UV measurements



Bluth et al. (2007)



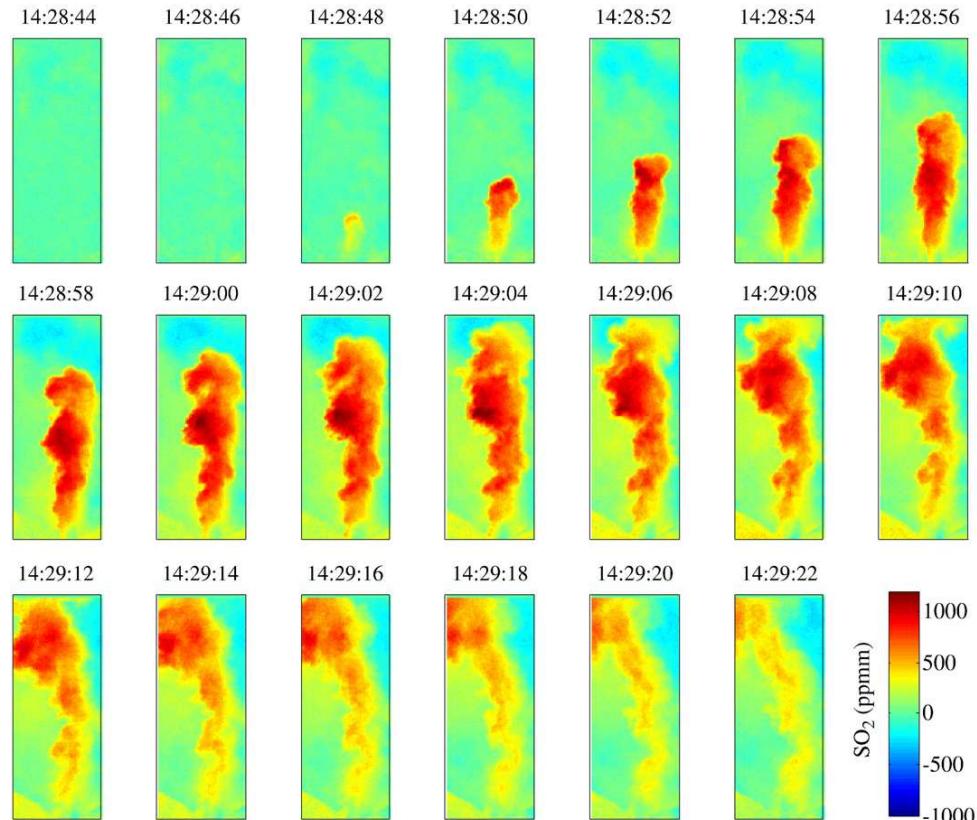
Universität Hamburg

Mori and Burton (2006)



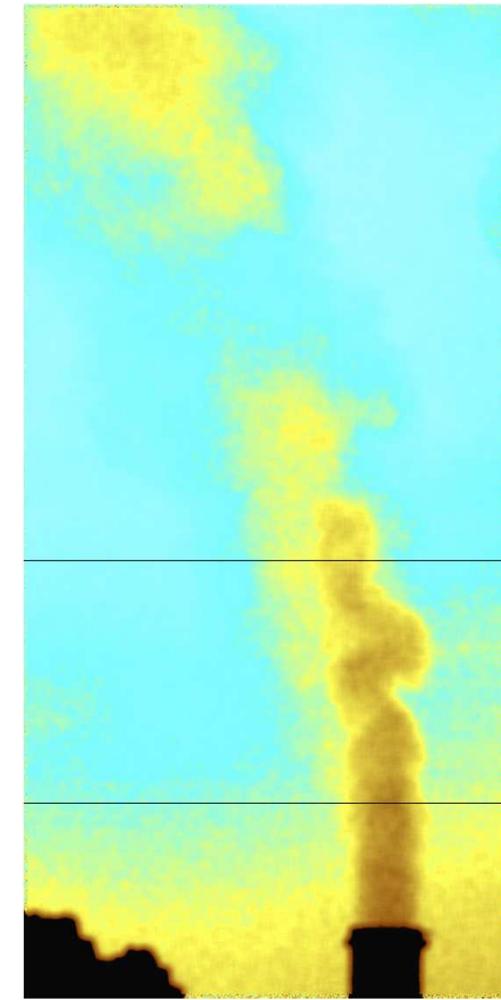
Mori and coworkers

SO₂ measurements



Time-sequence of SO₂ column amount images of a single hornito eruption that occurred at 14:28:48. Images were collected every 2 s starting at 14:28:44. Each pixel has an equivalent size at the distance to the explosive plume (~650 m) of 0.5 m×0.5 m. The images are 75 m×190 m at the plume.

Mori and Burton (2009)



F. Prata (2010, from his Webpage)

Radar observations

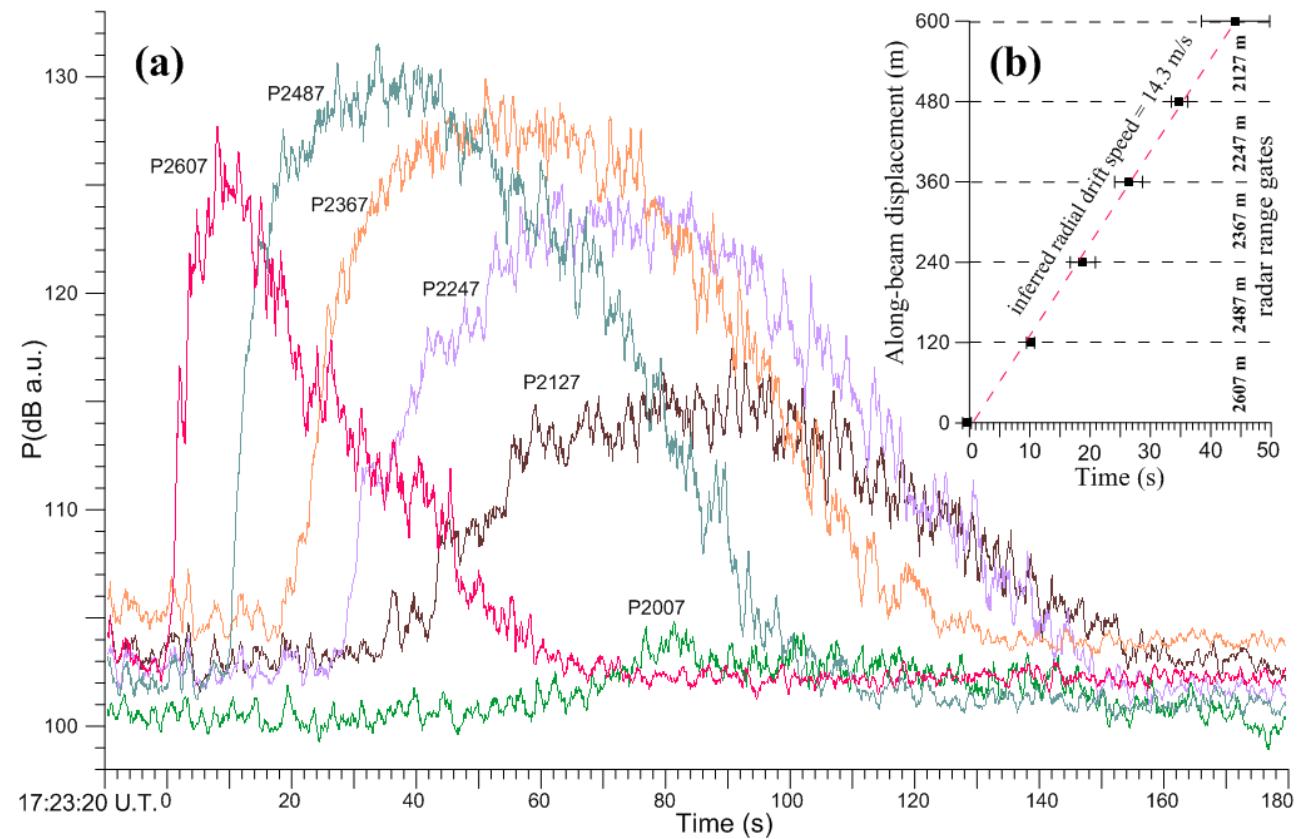
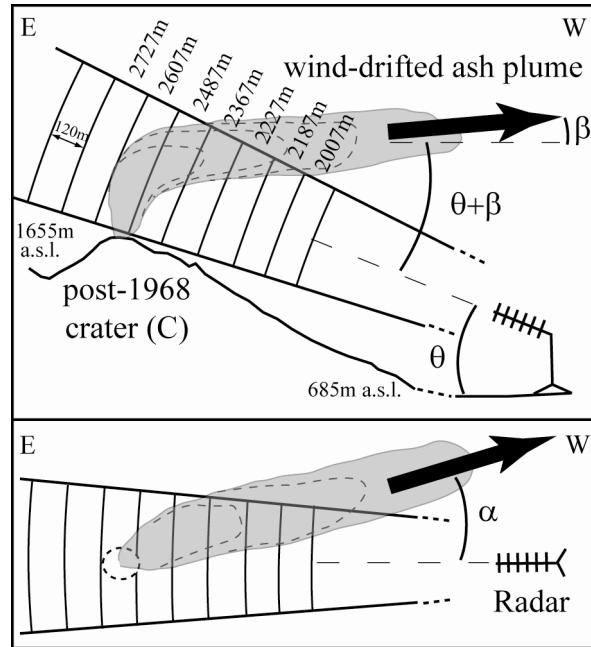


Pulsed system
High power consumption
Large opening angle
Far reach



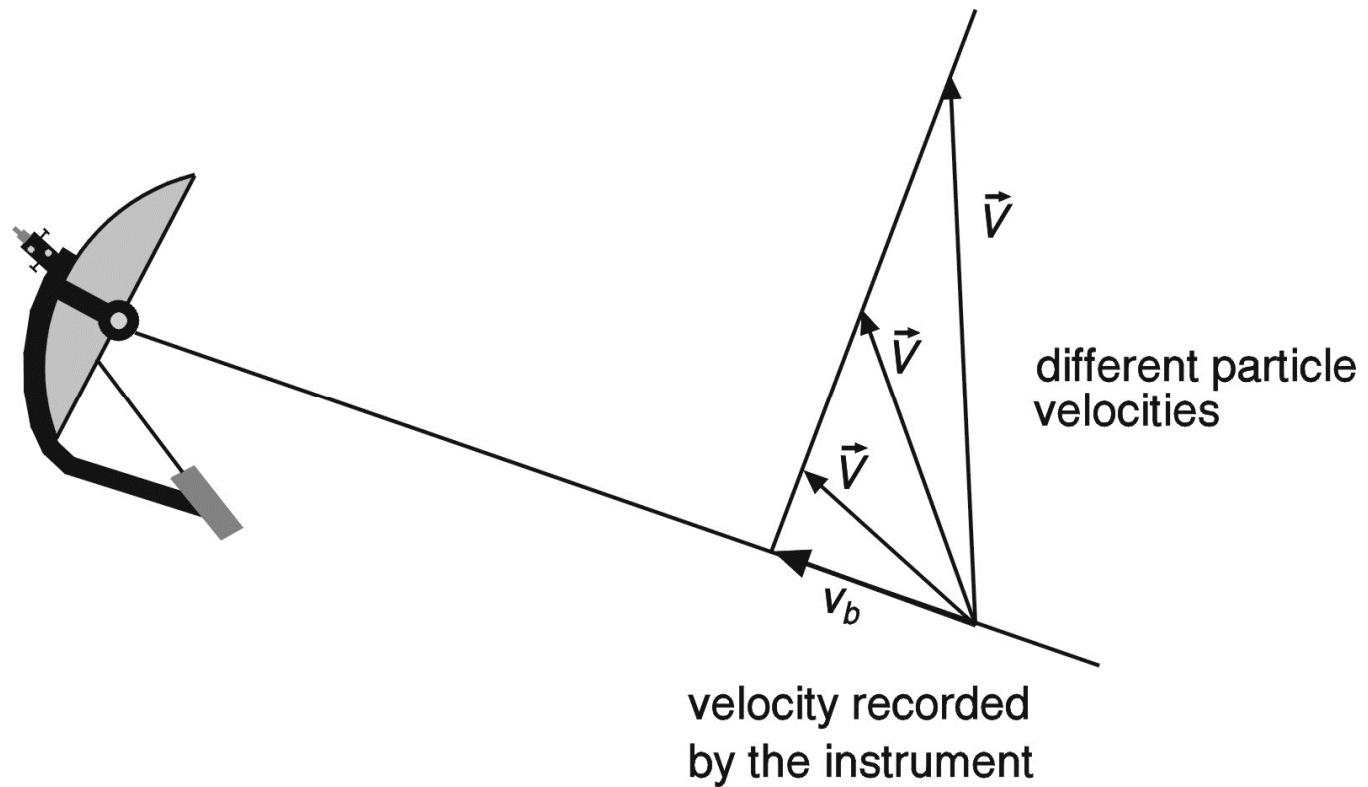
FMCW system
Low power consumption
small opening angle
Up to 6km reach

Pulsed radar observations



Donnadieu et al. (2011)

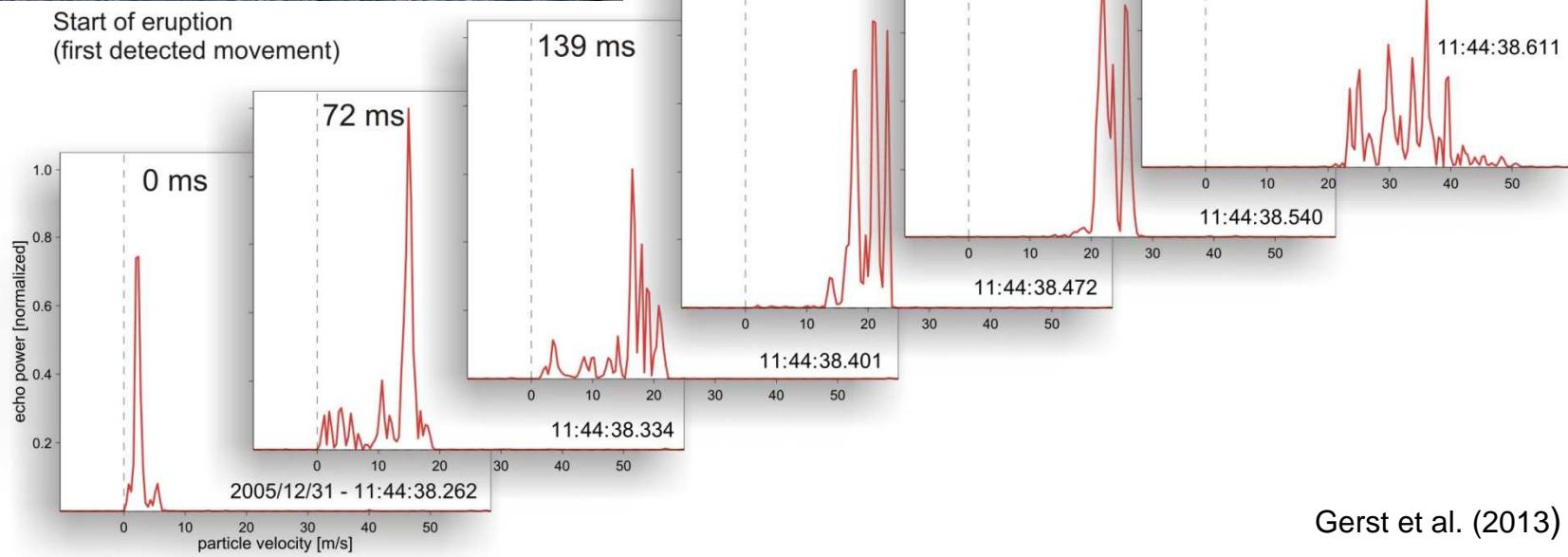
Typical Doppler radar signals



Strombolian eruptions: Single bubble bursts

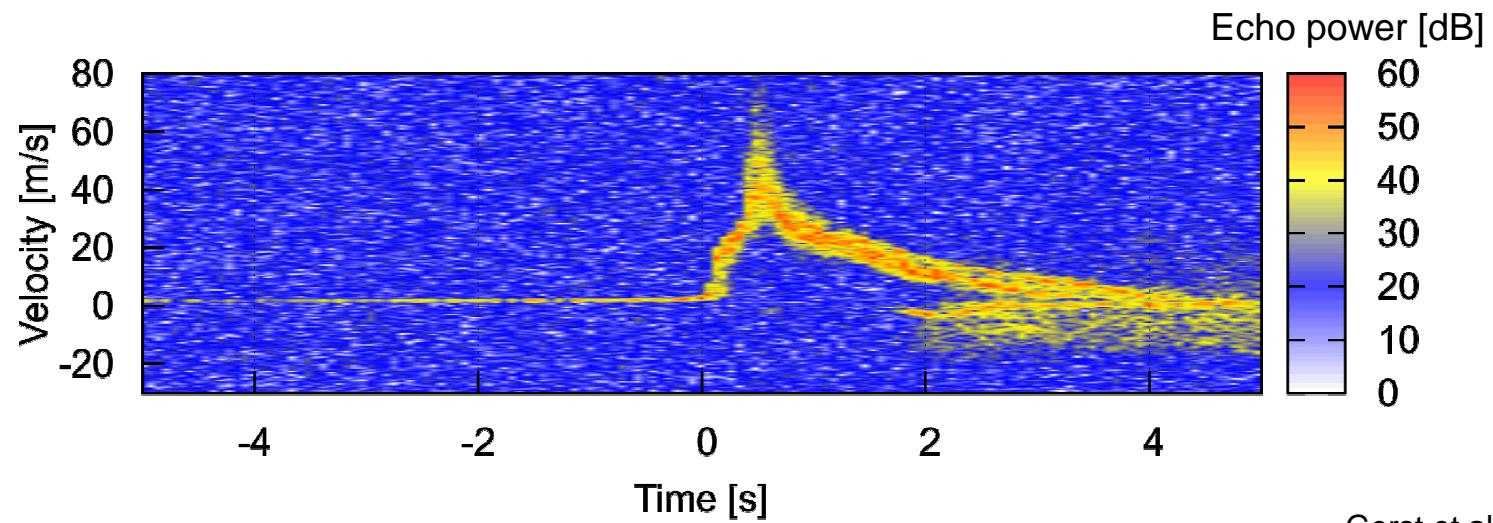
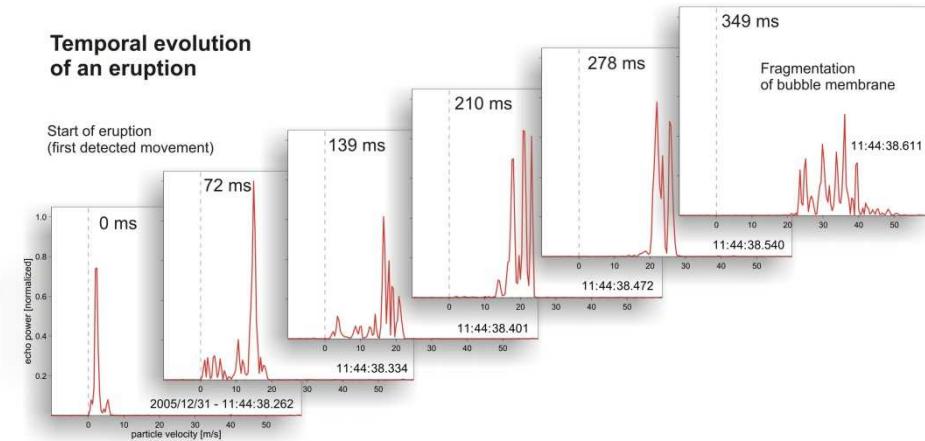


Onset of an eruption: Mt. Erebus, Antarctica



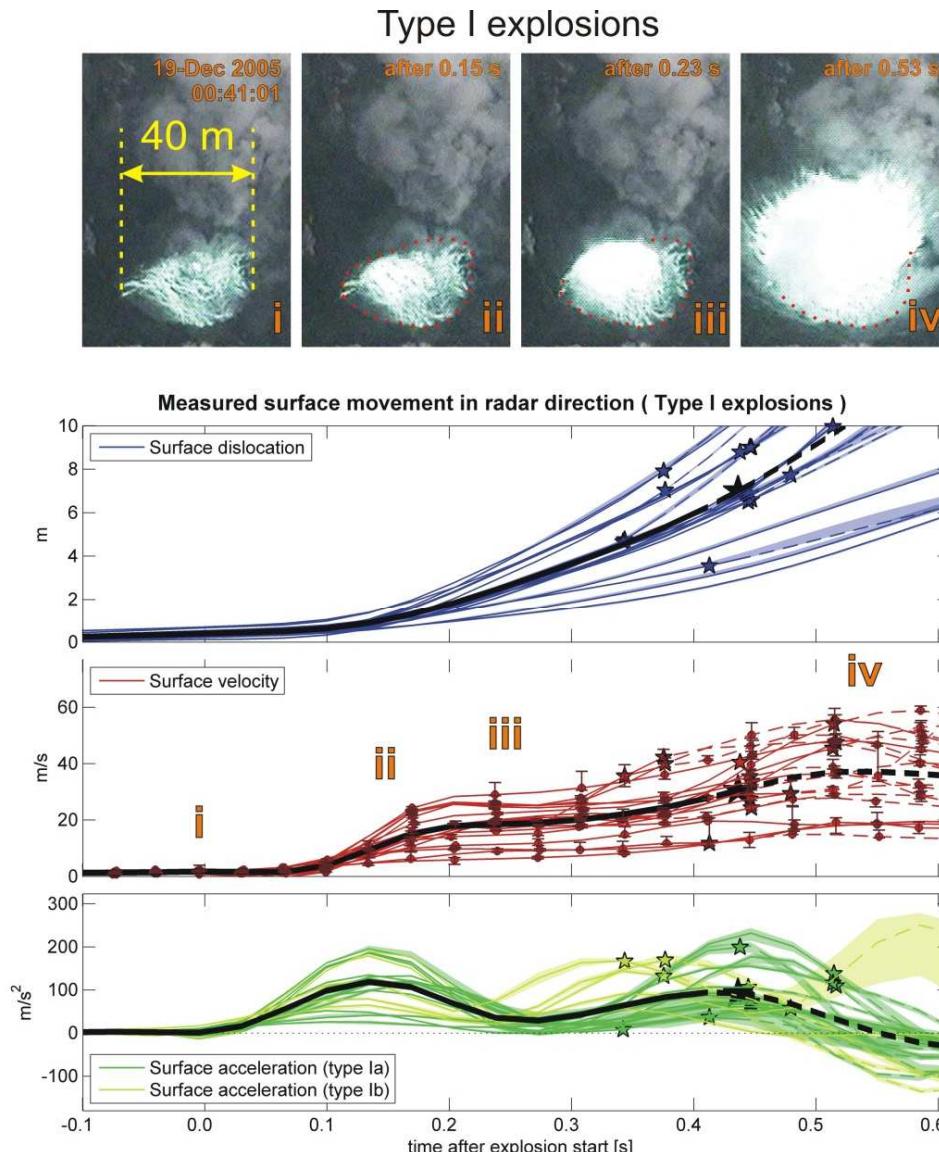
Gerst et al. (2013)

Temporal evolution of a bubble burst as seen by the Radar

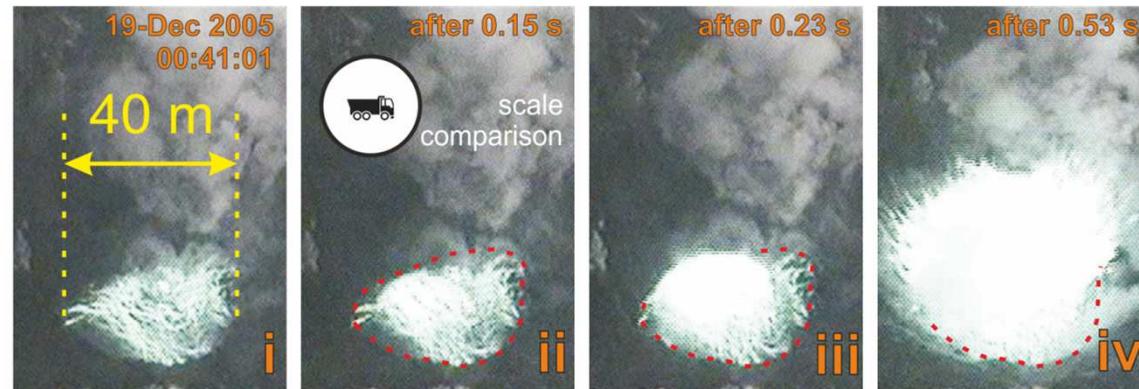


Gerst et al. (2013)

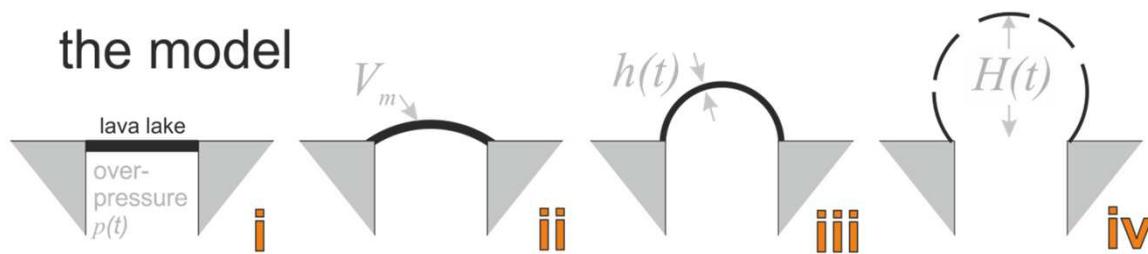
Detailed analysis of eruption with regard to pressures and energies



Bubble burst model

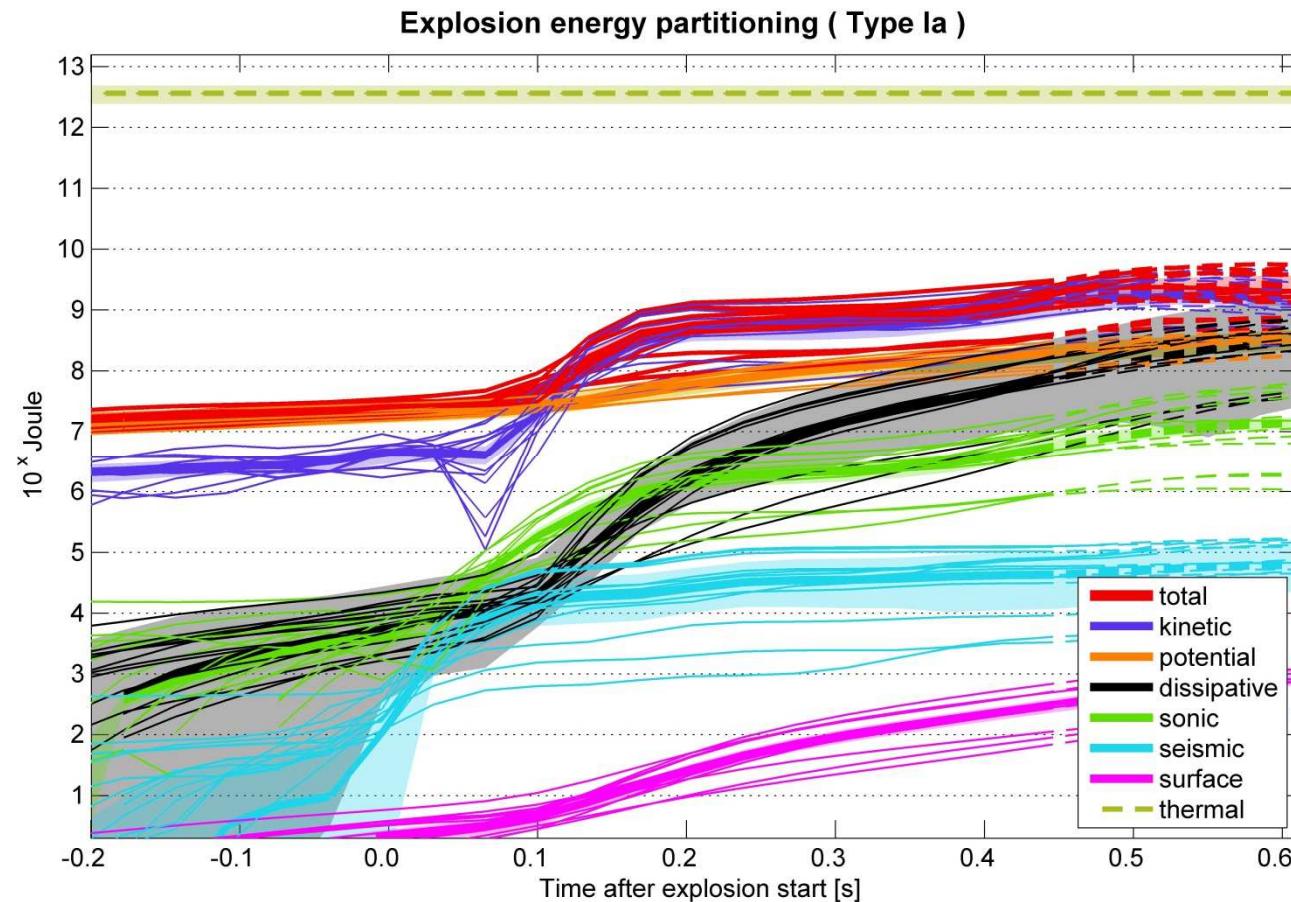


the model



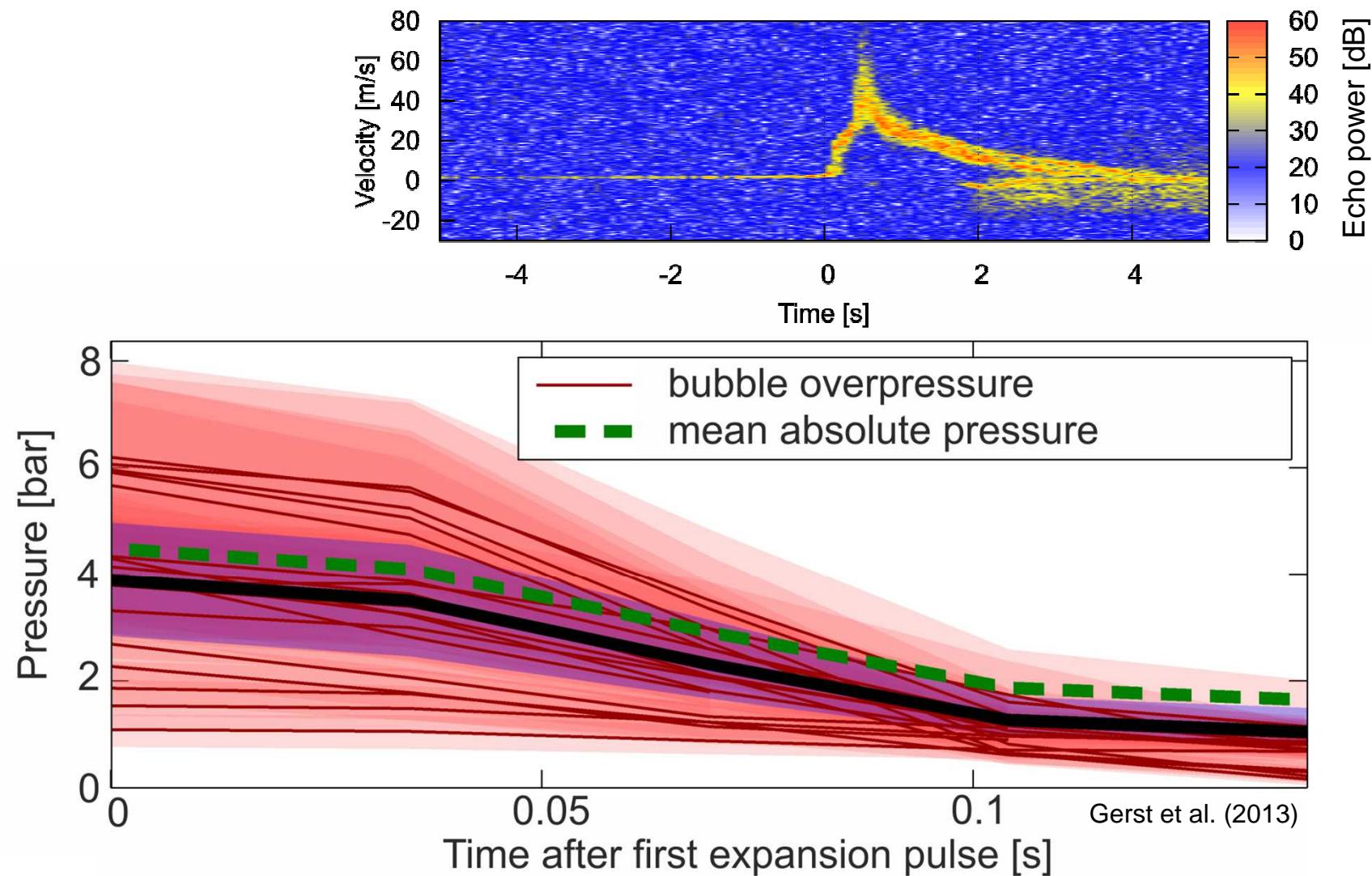
Gerst et al. (2013)

Complete Energy balance

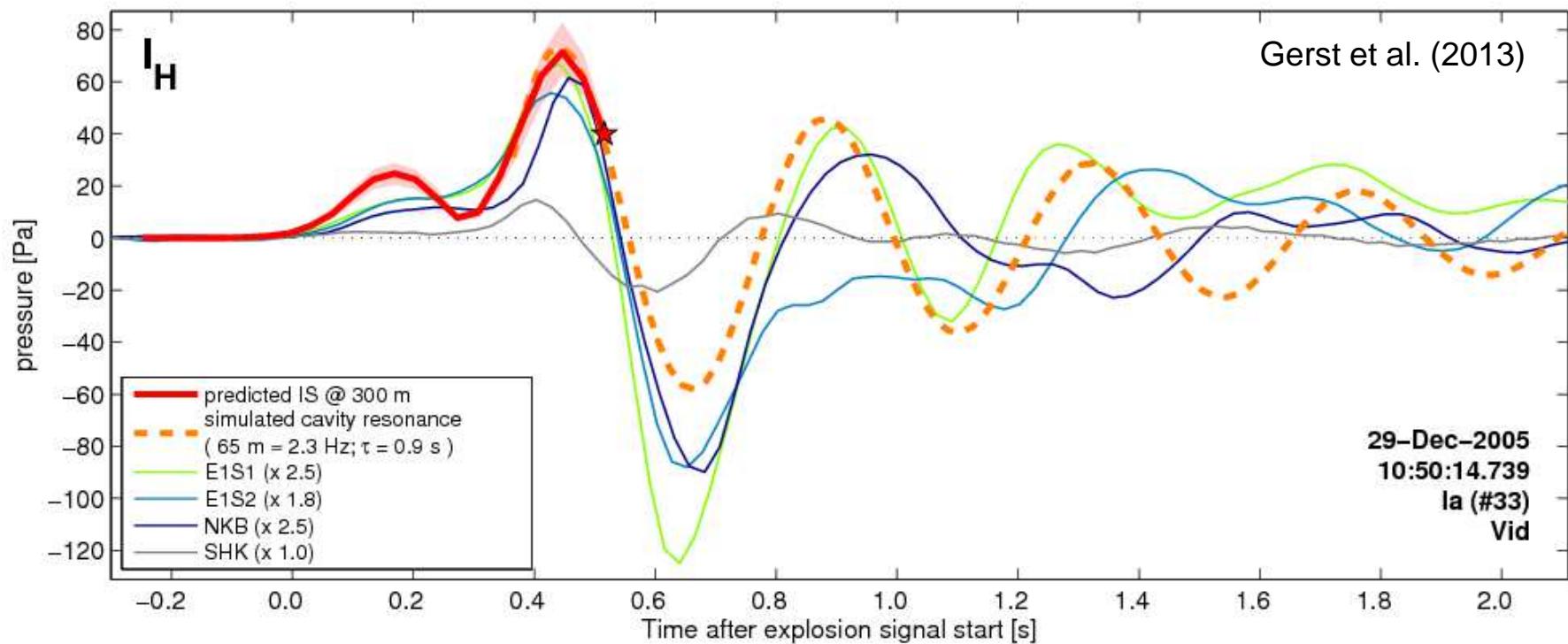
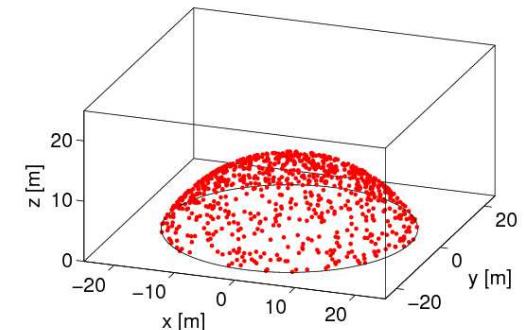


Gerst et al. (2013)

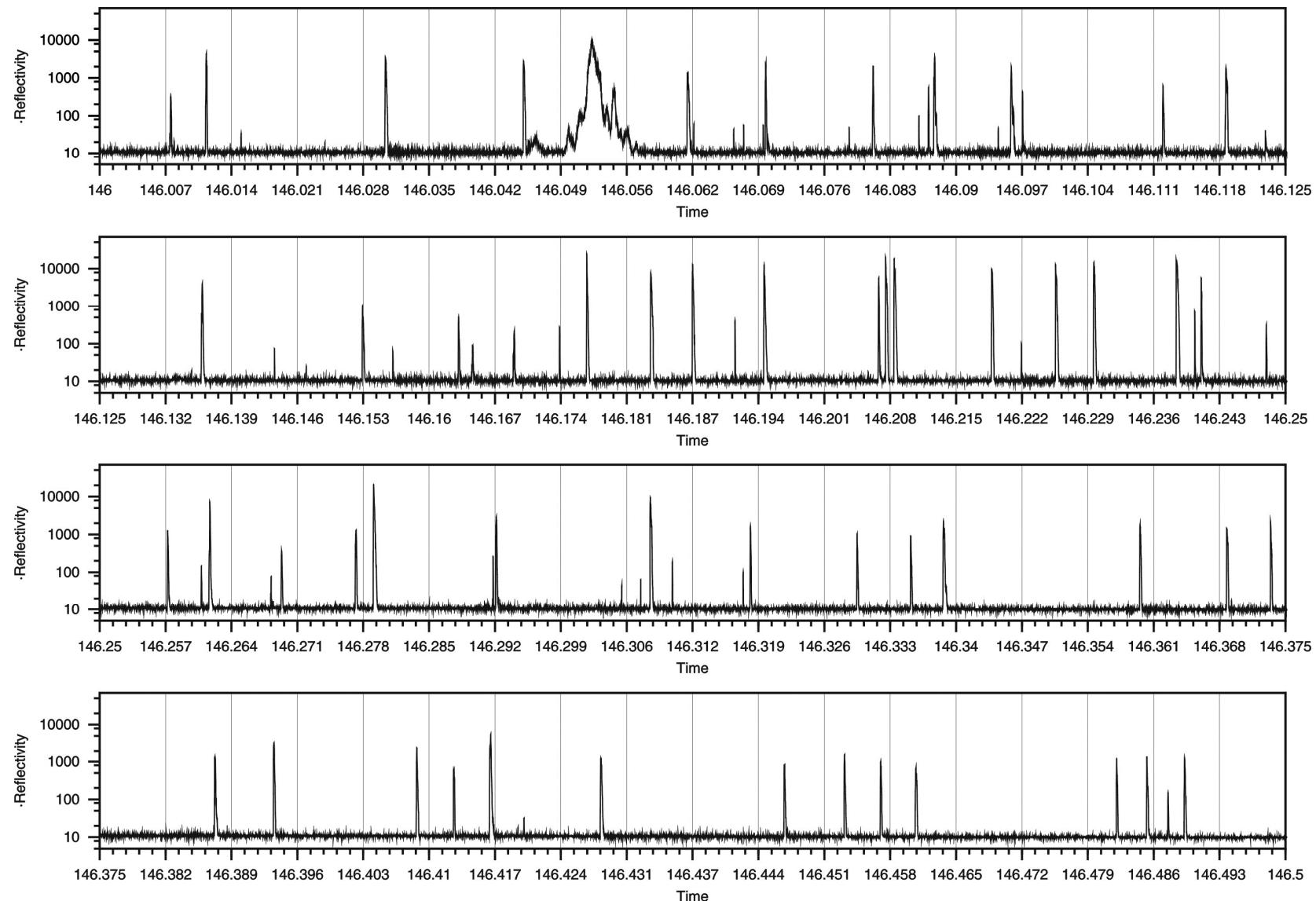
Bubble overpressures



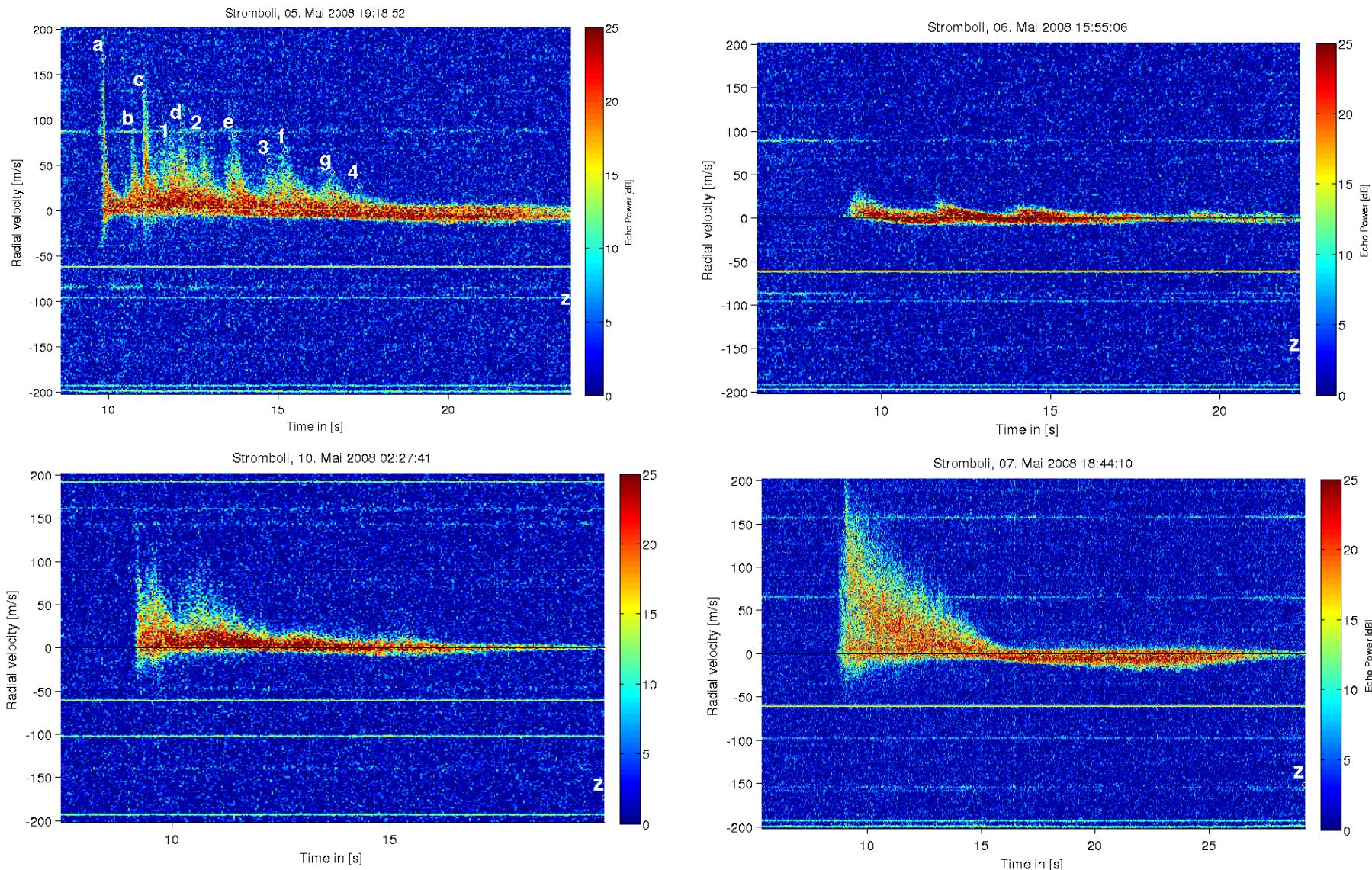
Modelling infrasound



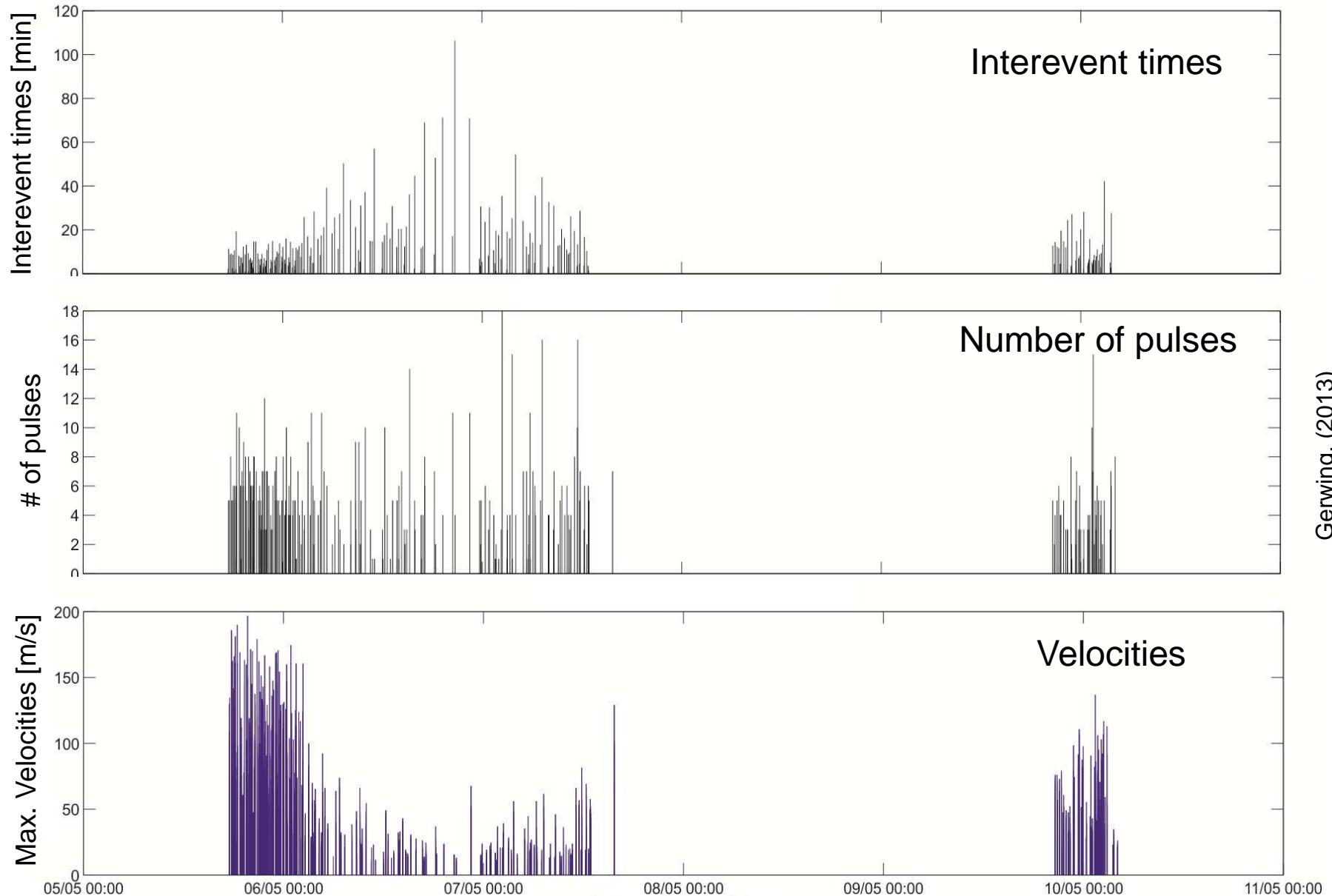
Continuous strombolian activity: SWC Stromboli



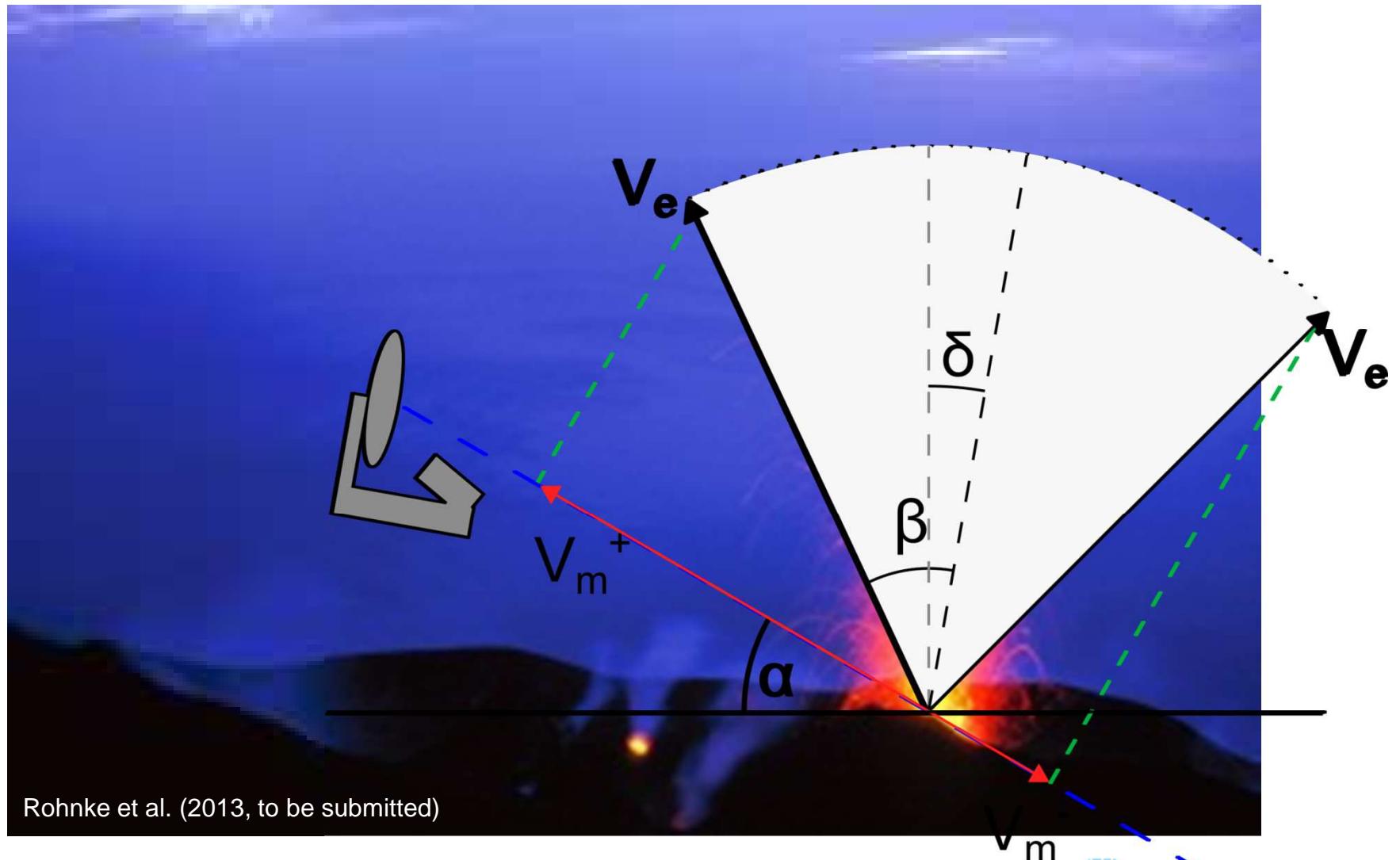
Pulsations of the eruption column



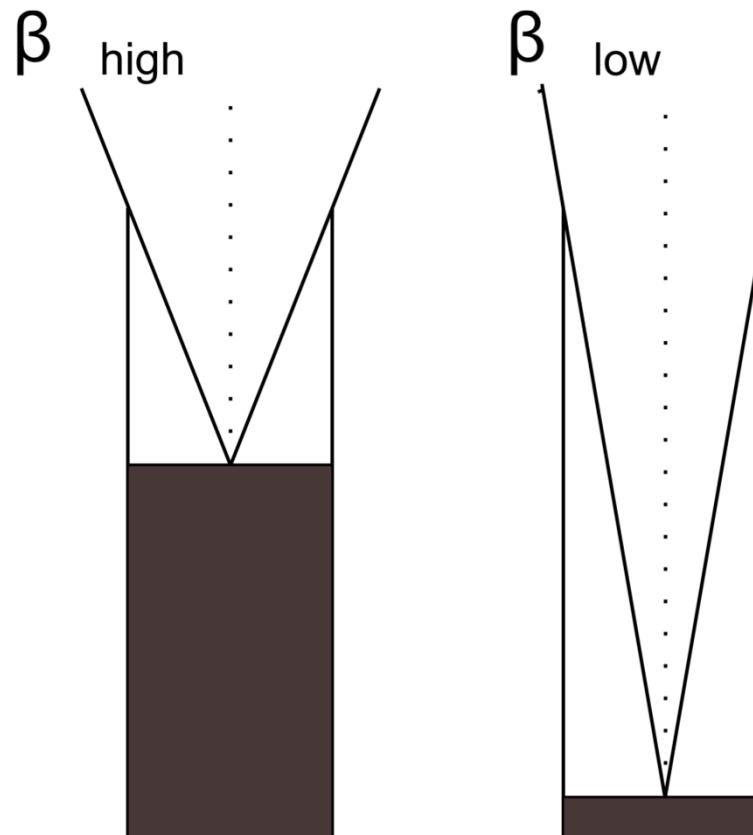
Pulsations of the eruption column



Simplified geometry of a strombolian eruption

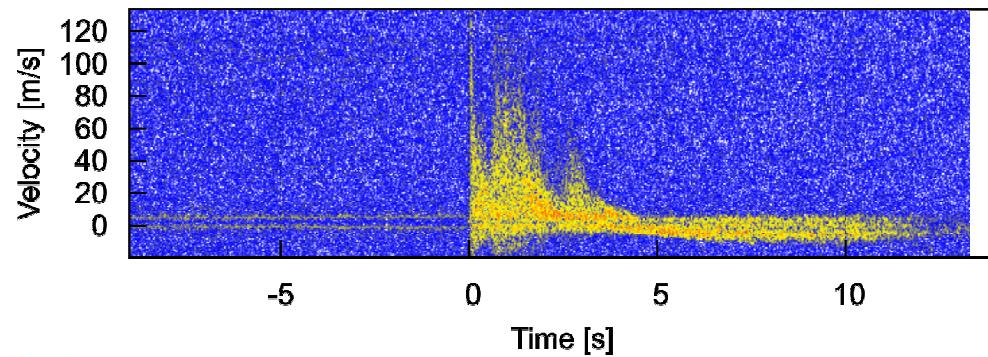
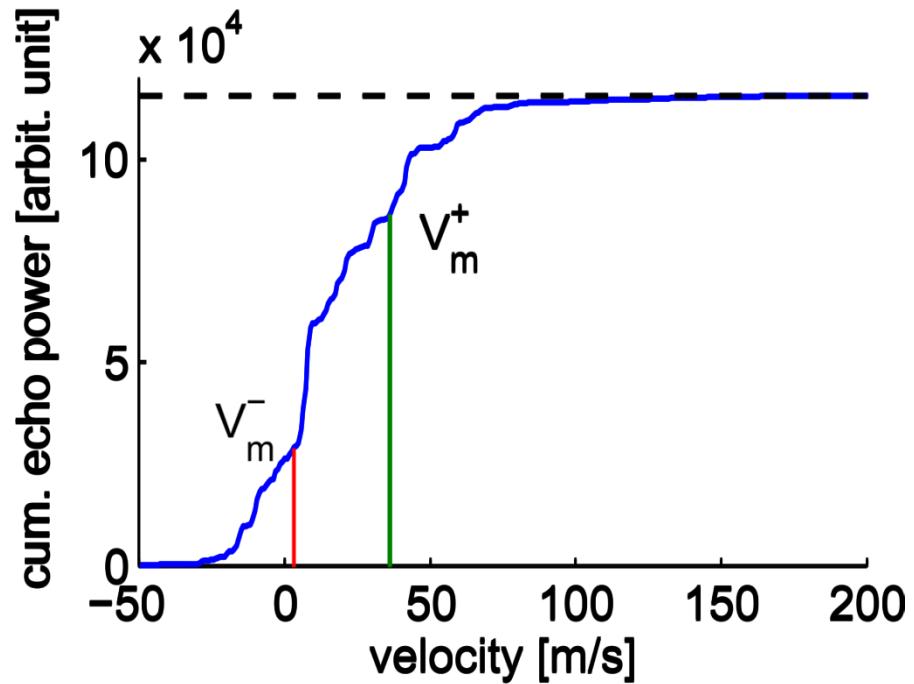
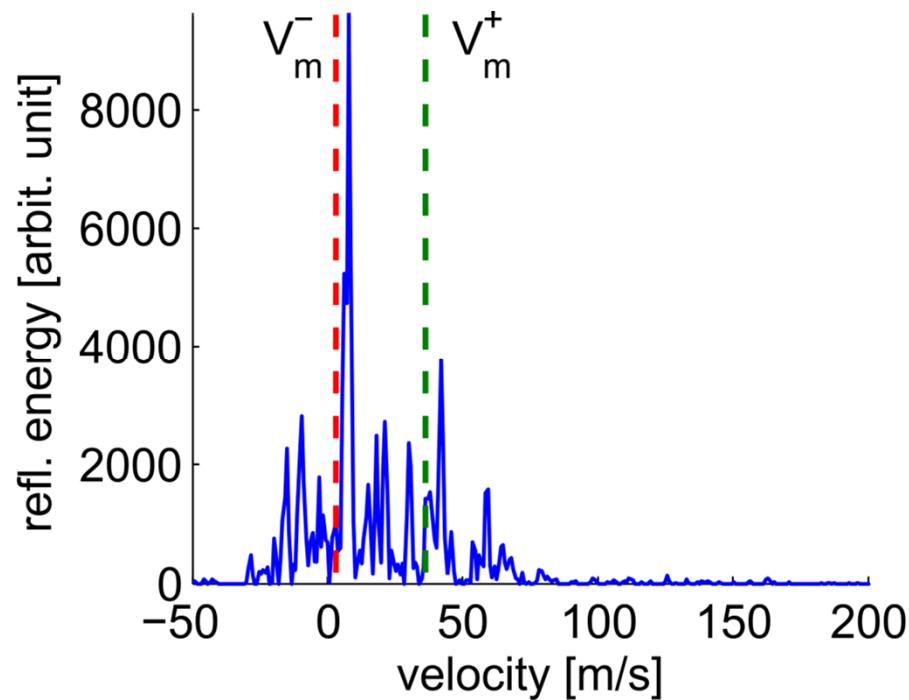


Where is the magma?



Rohnke et al. (2013, to be submitted)

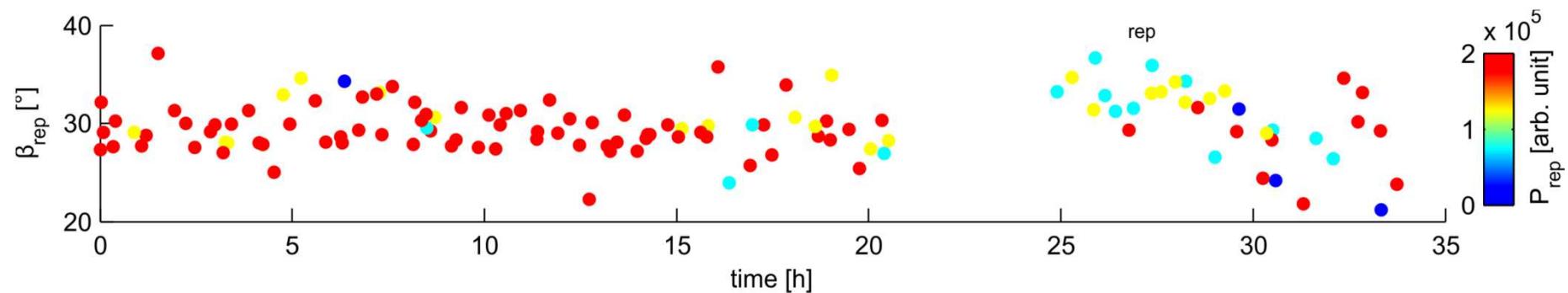
Snapshot of Velocity distribution during an eruption



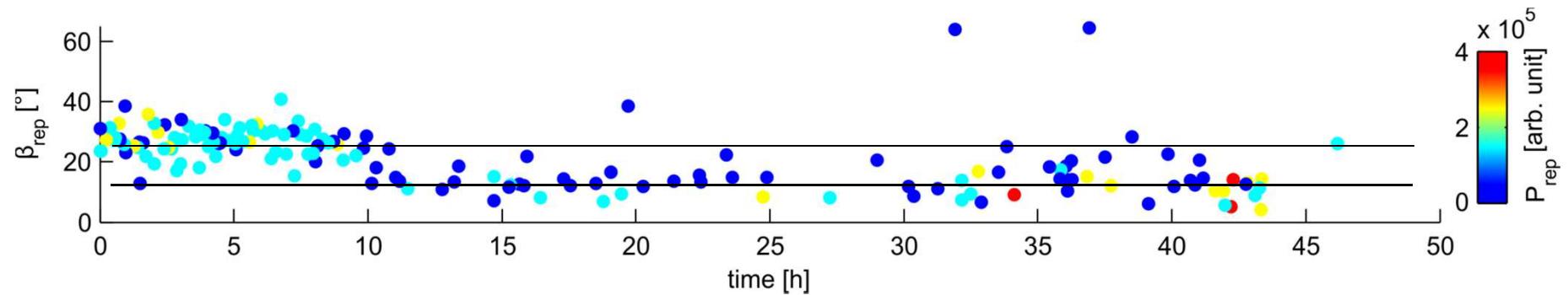
Rohnke et al. (2013, to be submitted)

Variation of opening angle with time

Stromboli SW crater

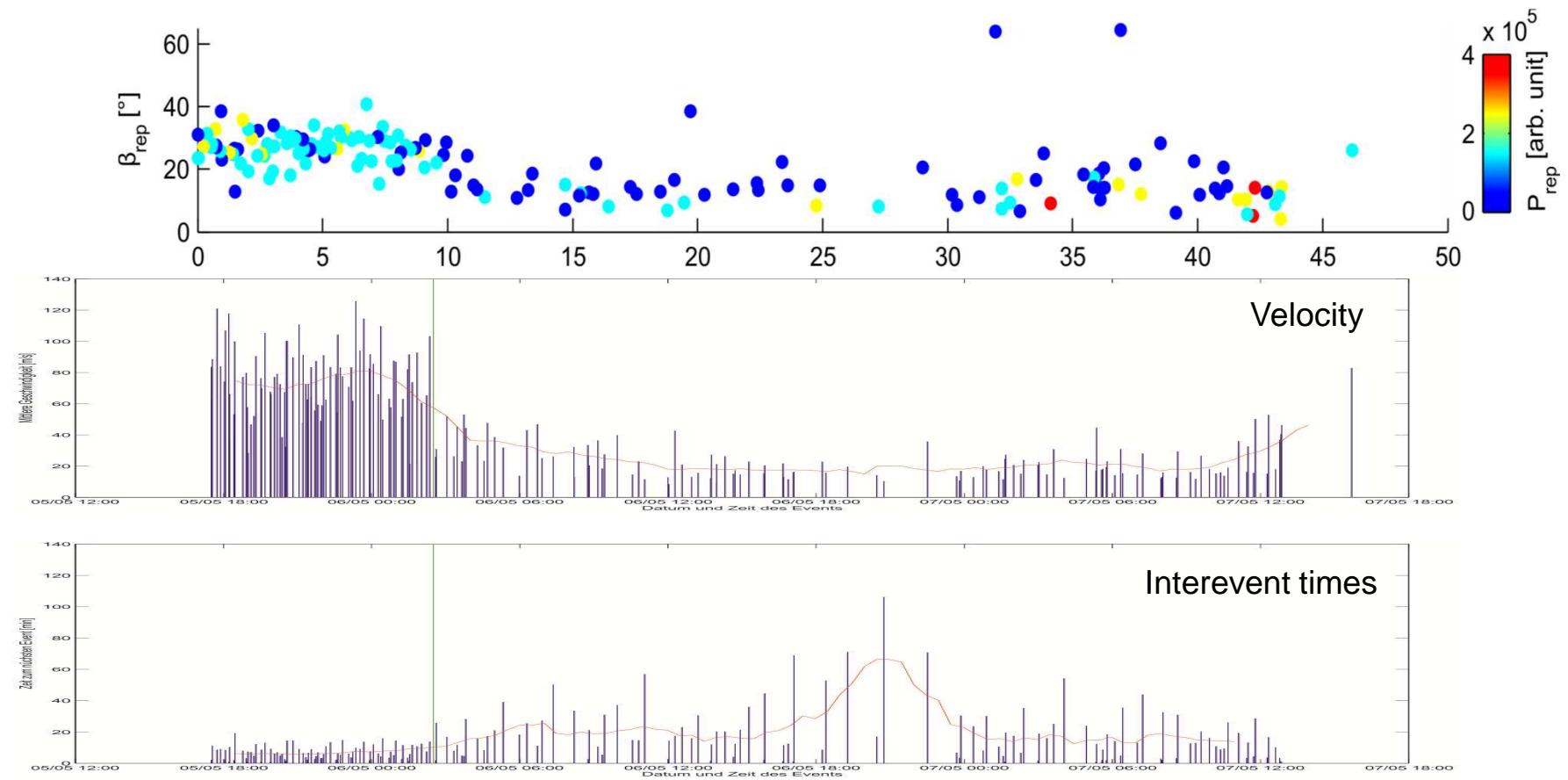


Stromboli NE crater



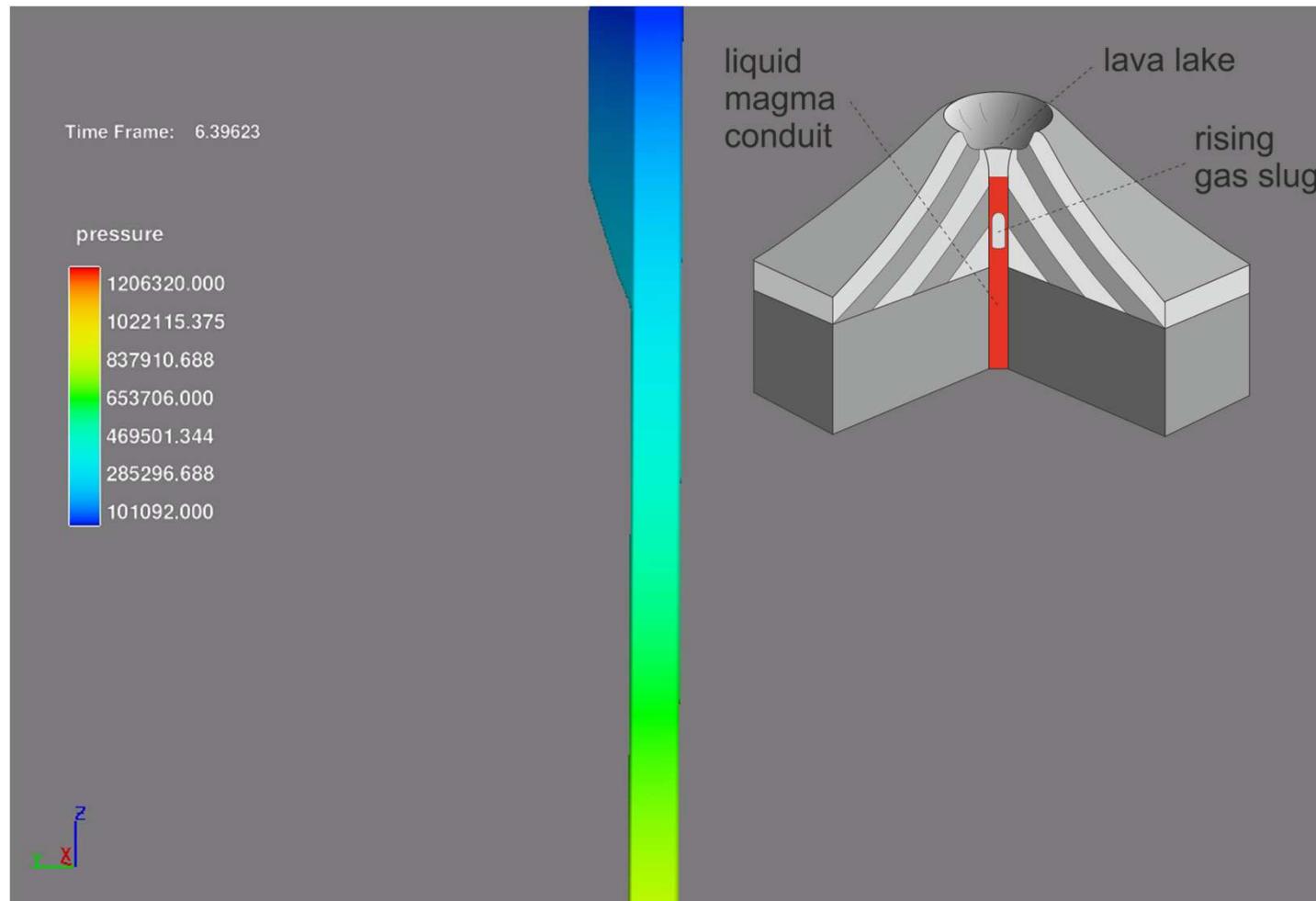
Rohnke et al, 2013 (to be submitted)

Variation of opening angle with time

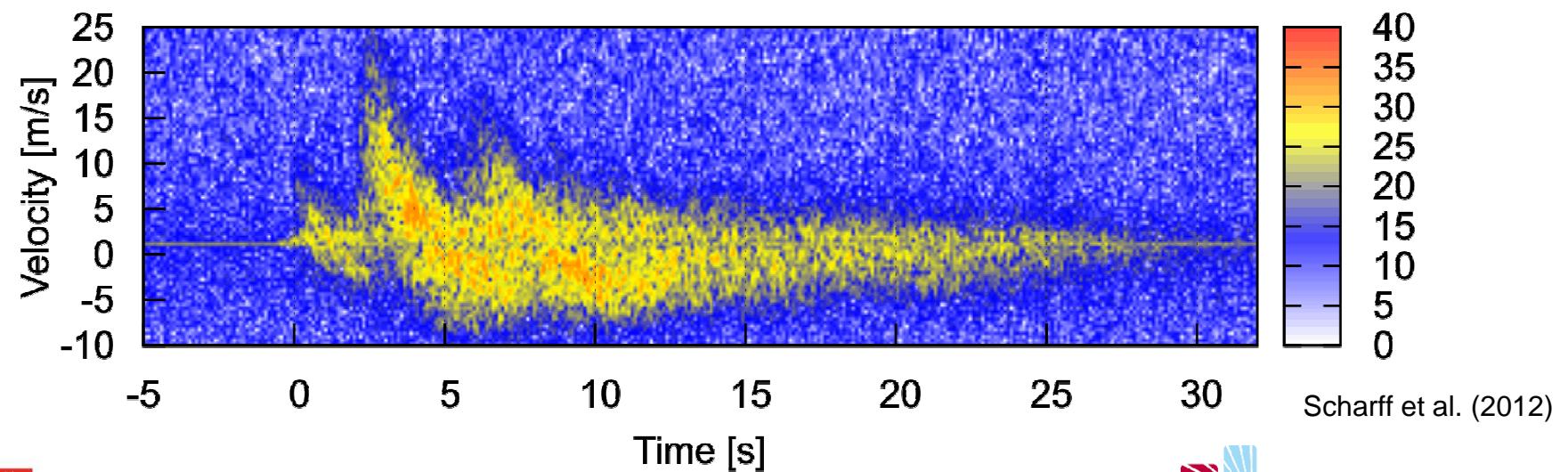
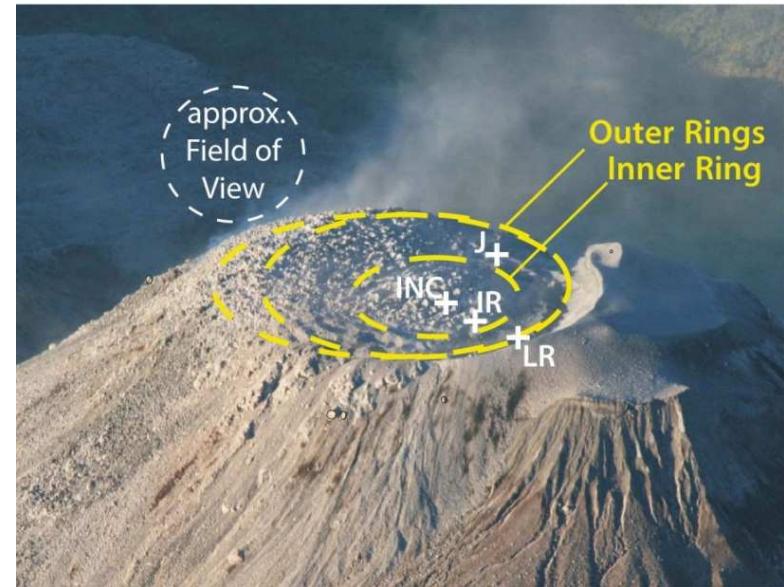


Gerwing, (2013)

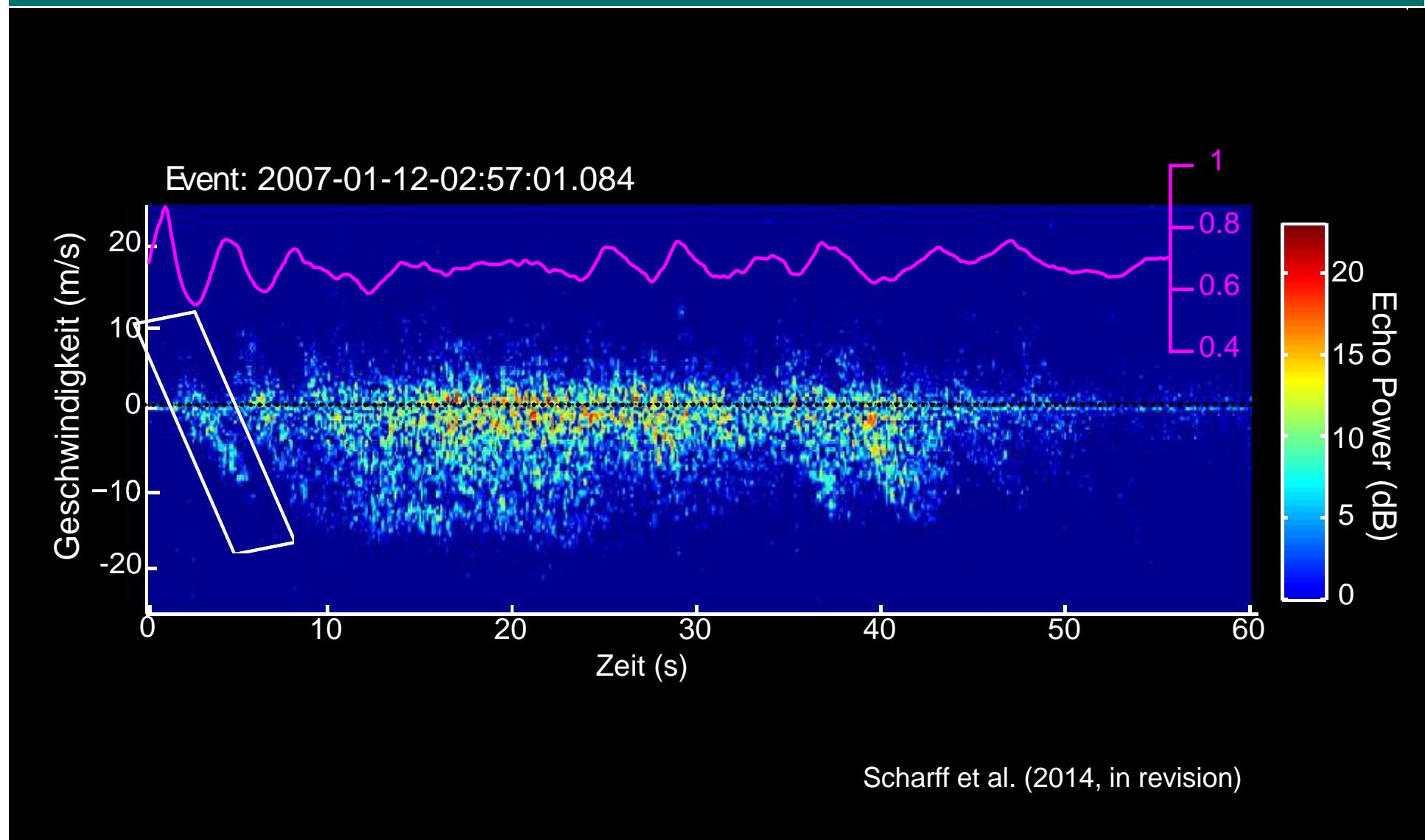
Simple explanation for pulsed behaviour in low viscosity systems



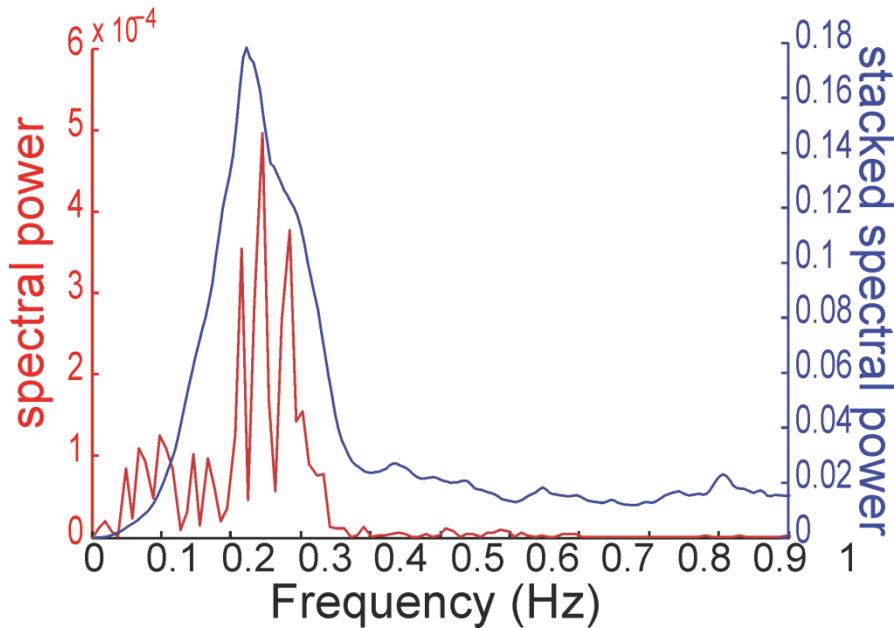
Dome building volcanoes: Santiaguito volcano, Guatemala



Searching pulses



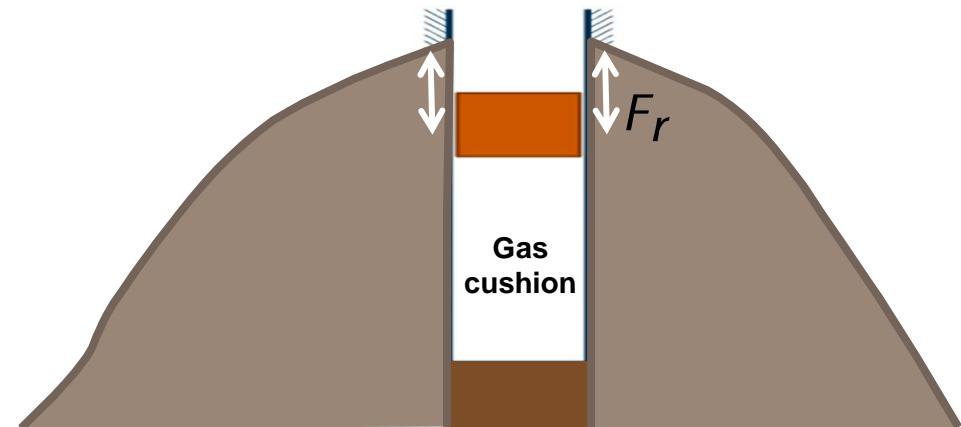
Model for pulsed gas release



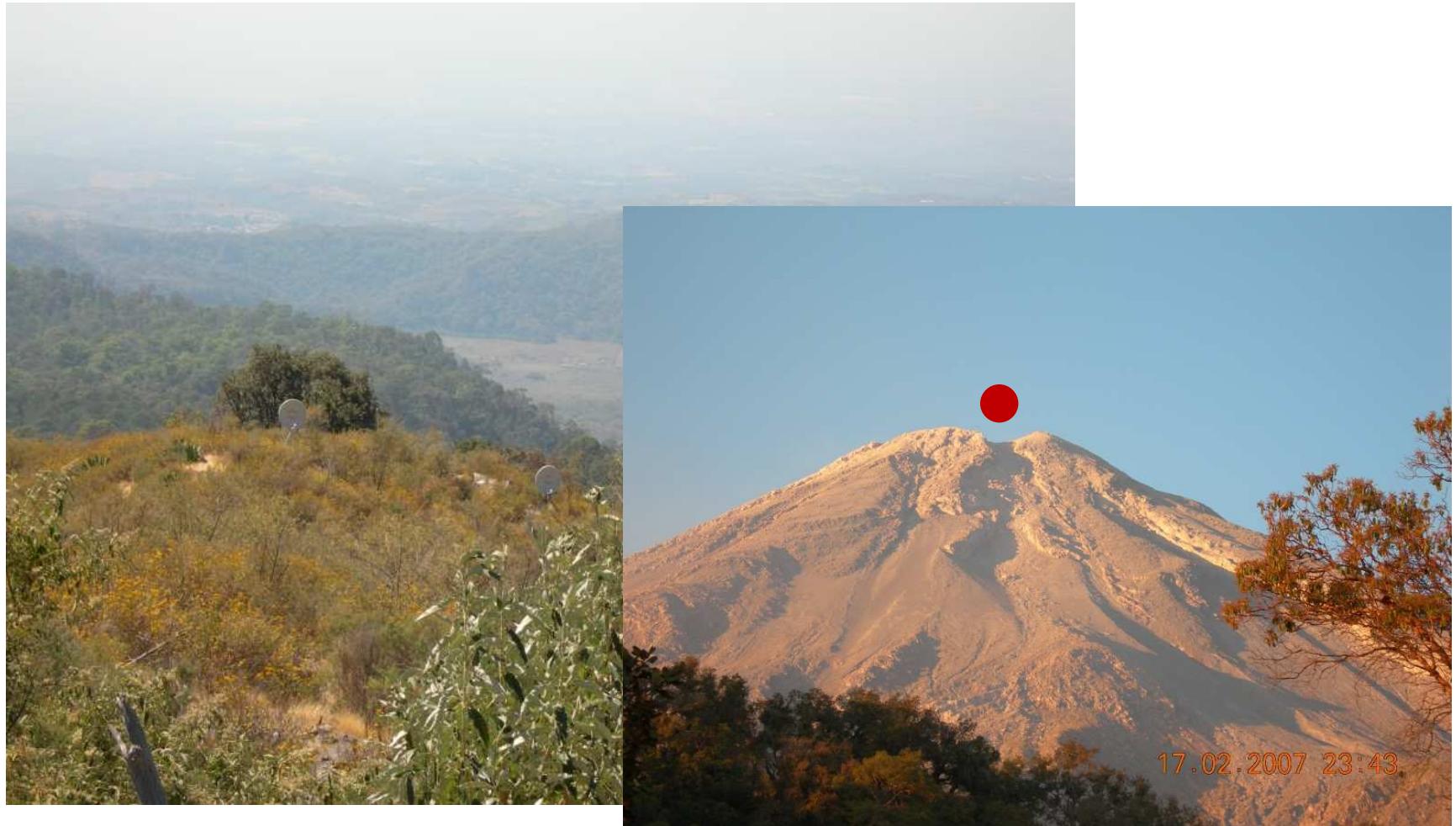
Scharff et al. (2014, in revision)

Model includes:

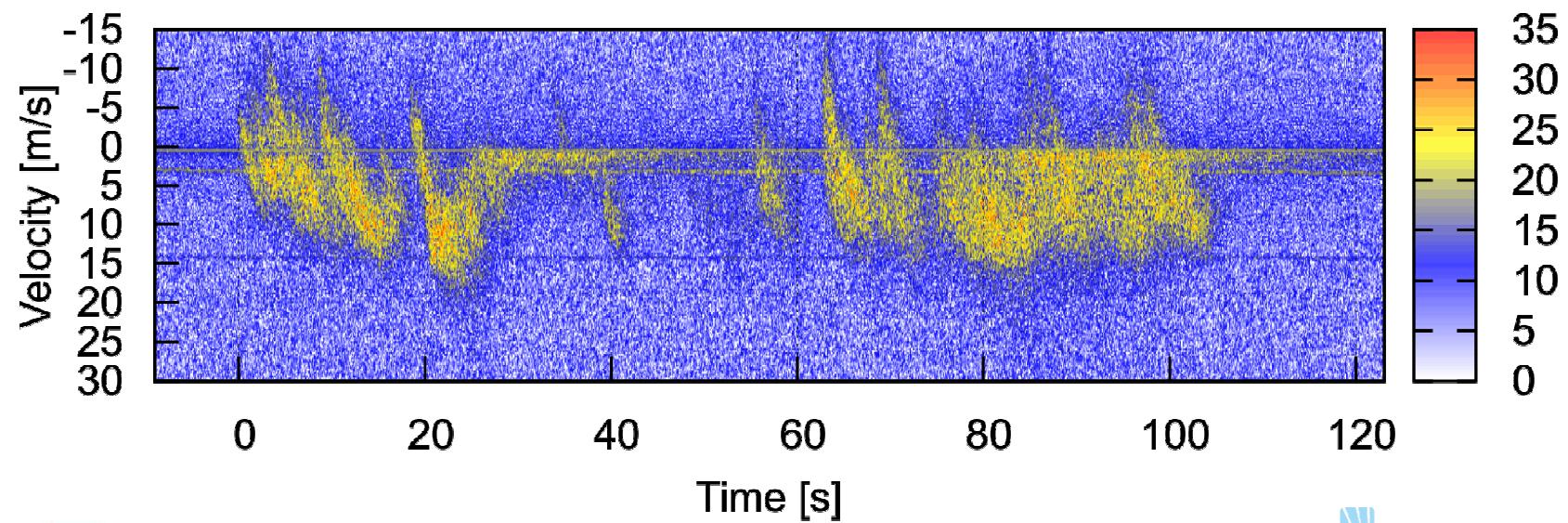
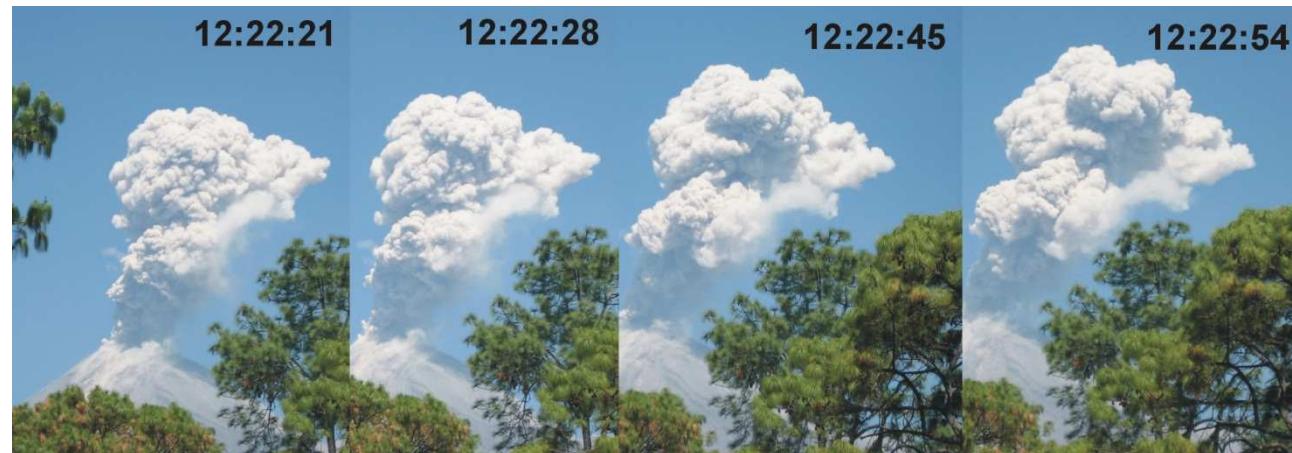
- Damping due to viscous friction
- Release of gas using Darcy flow and var. permeability



What about other dome building volcanoes: Colima volcano, Mexico

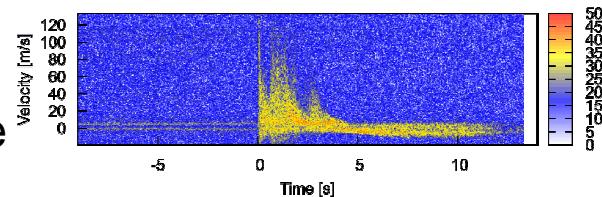


Pulsed eruption at Colima volcano

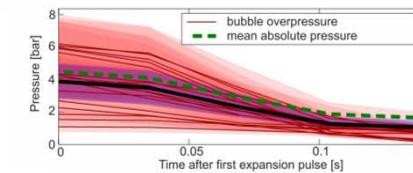


Take home points

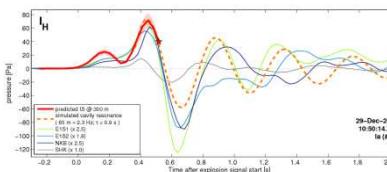
Mass flux at the vent is probably often non continuous
Eruption dynamics are probably controlled by near surface conduit geometry



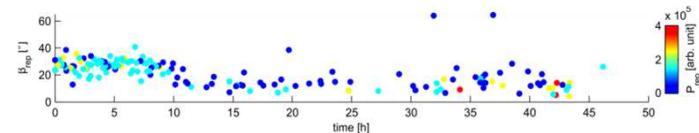
Bubble overpressures are on the order of bicycle tire pressures



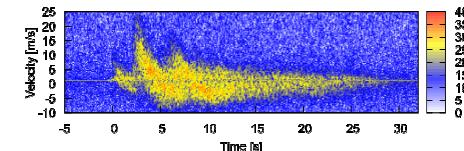
Acoustic signals are generated at the magma air interface



Magma levels in the conduit are likely to change



Dome building systems appear to oscillate giving rise to pulsed gas release



Thank you for your attention

