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The 2019 July Stromboli volcano paroxysm event: contribution of infrasound to the Volcanic Ash Advisory Centers

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The Event:

On July, 3rd, 2019, at 14:45:43, a VEI3 (GDACS) paroxysmal explosion occurred at Stromboli volcano, in Southern Italy. The eruptive cloud injected ash up to several km in the atmosphere.



Despite activity was monitored in real time and Civil Protection activity started locally immediately.

VAA to aviation was issued only at 17:00 UTC, 2 hours after event occurrence.

STROMBOLI - 2019-07-03 17:00 utc

VA ADVISORY

DTG: 20190703/1700Z

VAAC: TOULOUSE

VOLCANO: STROMBOLI 211040

PSN: N3847 E01512

AREA: ITALY

SUMMIT ELEV: 924M

ADVISORY NR: 2019/01

INFO SOURCE: INGV WEBCAM, SAT IMAGERY

AVIATION COLOUR CODE: NIL

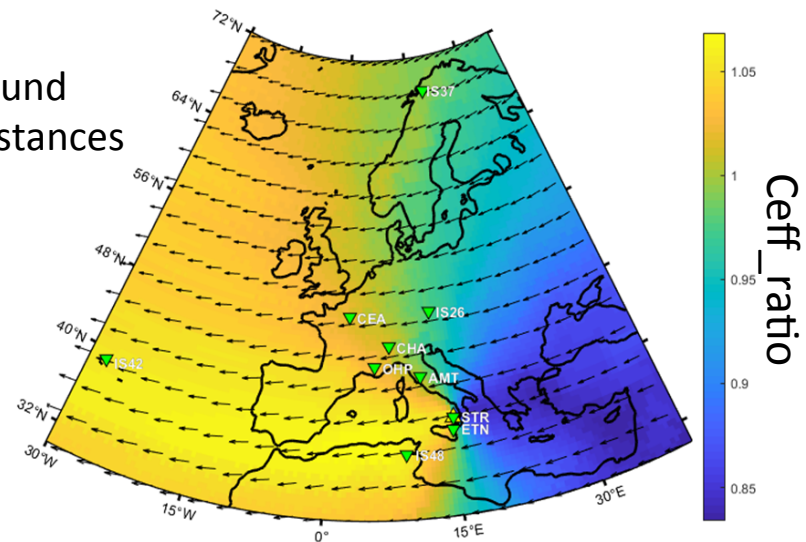
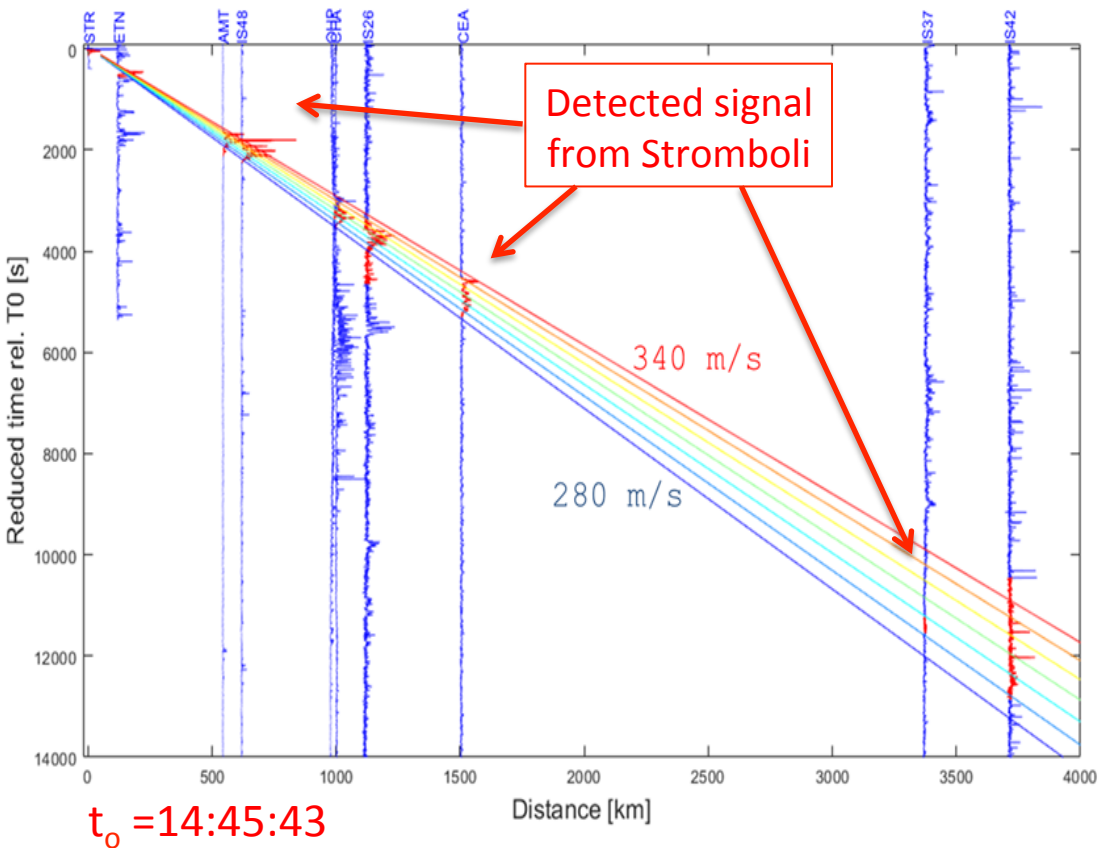
ERUPTION DETAILS: EXPLOSIVE ERUPTION OCCURED AT 1448Z

OBS VA DTG: 03/1700Z ...

Volcanic Ash Advisory

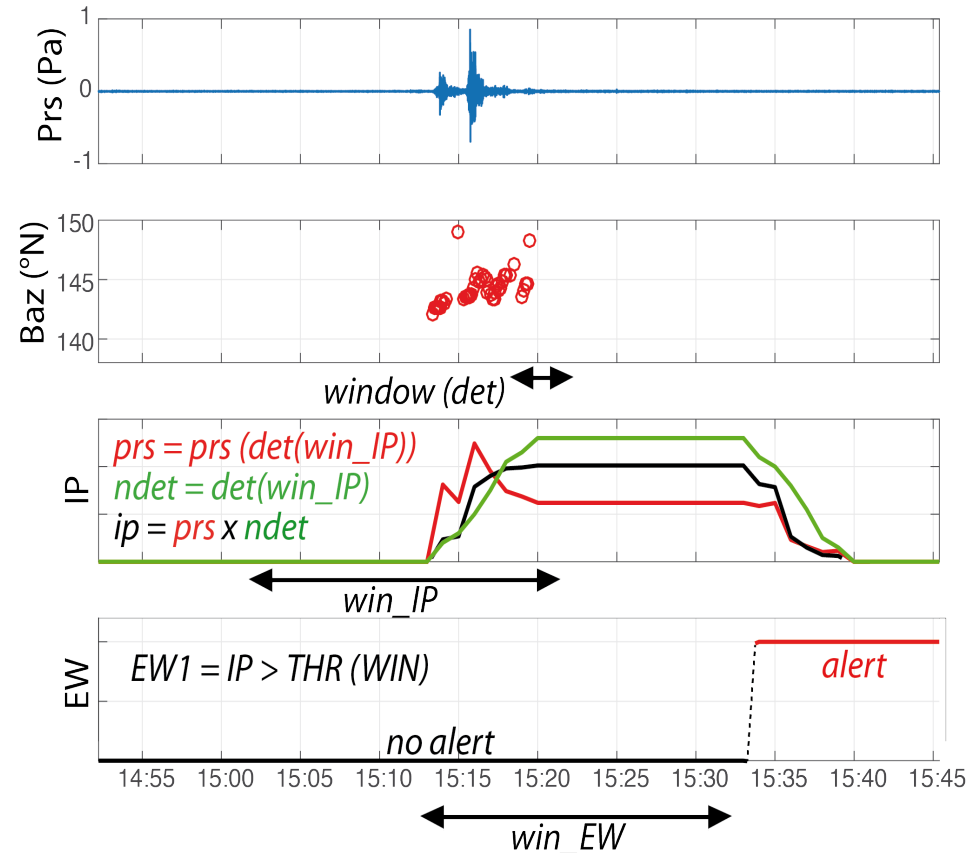
Infrasound Observations

We consider infrasound recorded by 10 permanent infrasound arrays (CTBTO+National) deployed at source-to-receiver distances spanning from 120 to 3700 km from Stromboli volcano.



Station	Dist (Km)	Baz (°N)	Ceff_ratio
ETN	127	7.4	0.96
AMT	543	145.3	1.12
I48TN	617	55.7	1.12
OHP	970	122	1.14
CHA	995	135	1.11
ILG	1039	140.7	1.10
I26DE	1124	173.3	1.05
ADFR	1507	131.5	1.10
I37NO	3373	185.2	1.01
IC1	3627	123	1-06
I42PT	3702	76.4	1.14

Long range infrasound detections were used to calculate the IP (Infrasound Parameters) reflecting signal amplitude and persistency.



Step 1: Detections (win_det) from the azimuth of the volcano are selected.

Step 2: Number of detections and max pressure in a given time window (win_IP) are extracted and IP calculated.

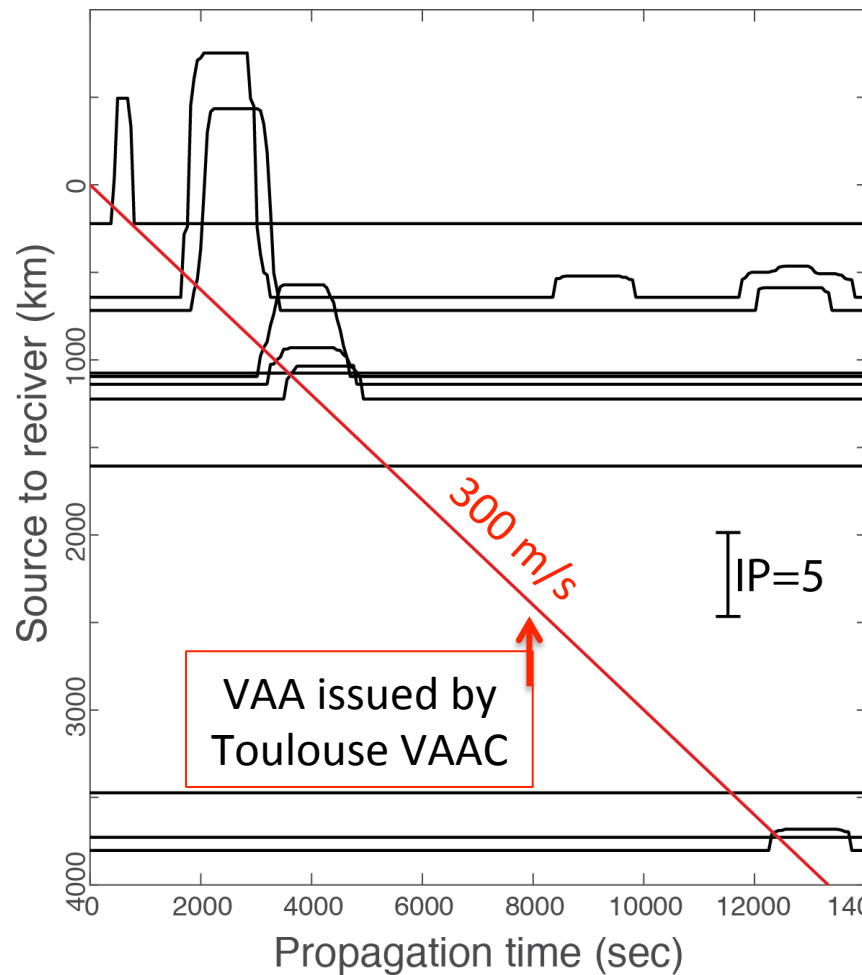
Step 3: Reduced pressure at the source is calculated considering real propagation conditions.

Step 1: IP is normalized according to range-dependent parameters.

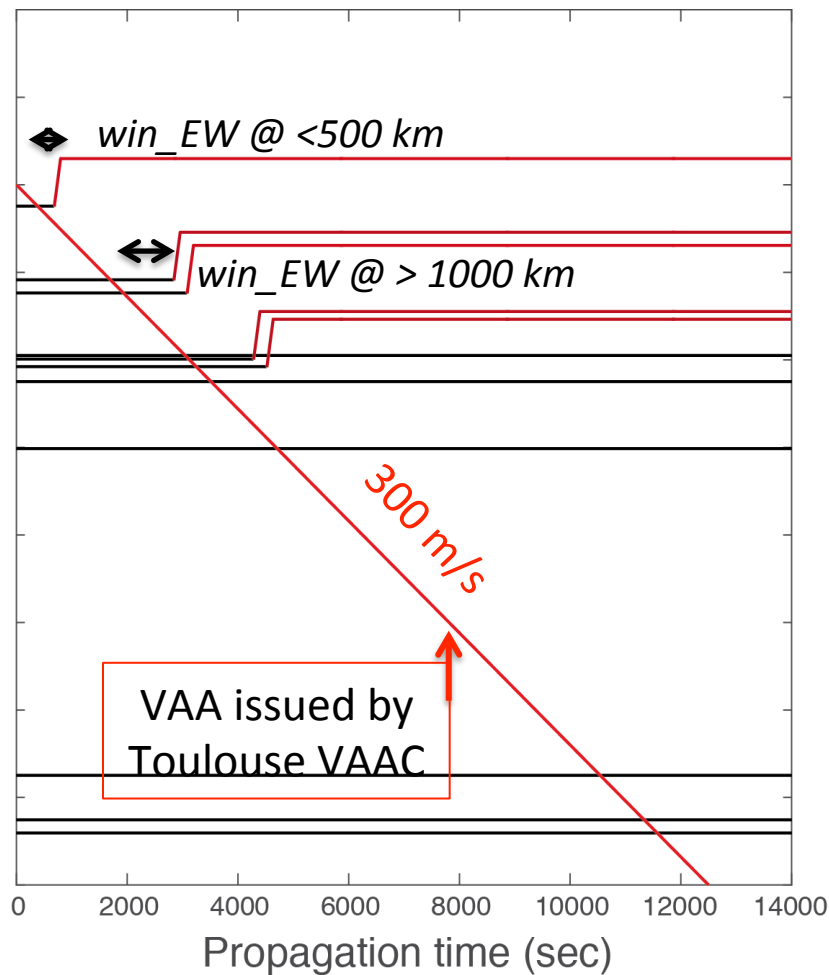
Step 5: Early Warning (EW) is provided if the range corrected IP exceeds a fixed threshold (60) for a given time window (win_EW).

	D < 500 km	D < 1000 km	D > 1000 km
win_det	5 sec	30 sec	60 sec
win_IP	5 min	20 min	20 min
win_EW	5 min	20 min	20 min

Infrasound Parameter



Range-corrected Early Warning



Conclusions: a long range EW system

- 1) Infrasound from the July 2019 paroxysmal explosion at Stromboli volcano is detected by several arrays up to 3700 km.
- 2) The Infrasound Parameter (IP) is calculated (signal amplitude and persistency)
- 3) The IP is range corrected, considering reduced infrasound pressure and range dependent correction parameters.
- 4) The Early Warning (EW) procedure is applied on the IP considering threshold values fixed a-priori.
- 5) Automatic notification would have been anticipated the VAA by 1-2 hours.

Results suggest that, considering real propagation effects, infrasound at source to receiver distances <1500 km can be used efficiently to notify automatically the occurrence of “small-scale” volcanic eruption by applying threshold values that can be fixed a-priori without a real tuning is required [Marchetti et al., SciRep, 2019].

VAA, 17:00 UT ←

Stz	Notification (UT)	Dist (Km)
ETN	14:57	127
AMT	15:33	543
I48TN	15:37	617
OHP	No alert	970
CHA	15:57	995
ILG	16:02	1039
I26DE	16:05	1124
ADFR	No alert	1507
I37NO	No alert	3373
IC1	No alert	3627
I42PT	No alert	3702