Remote infrasound in SE-Asia: A case study of the 2014 Kelud eruption and minimum detection threshold through space and time

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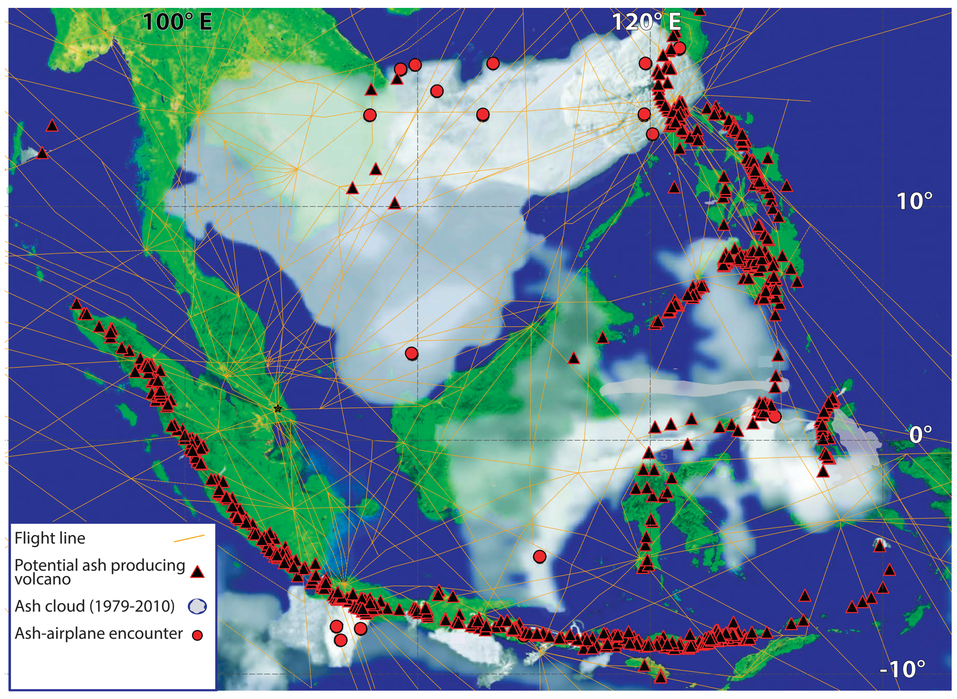
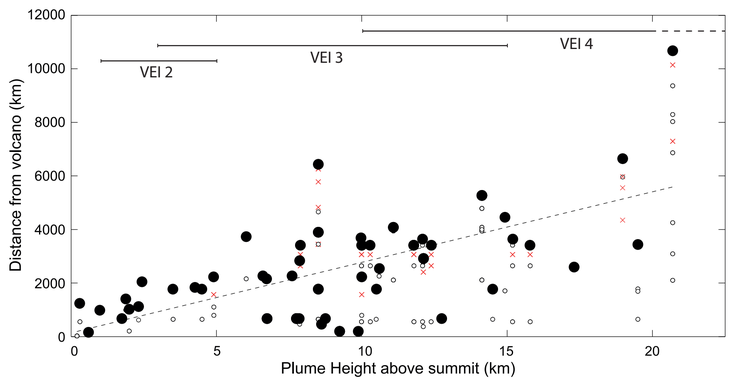
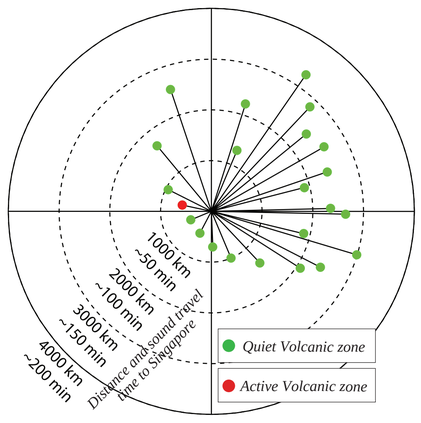
Volcanic Ash and Air Traffic



Ash cloud image after A. Tupper, Australia Bureau of Meteorology [2002]



Detections (circles) and non-detections (crosses) of volcanic infrasound from 110 eruptions occurring at 39 globally distributed volcanoes. The most distant detection is highlighted by filled black circles. The dashed lines represent the linear best-fit line to the maximum detected distances only. From Dabrowa et al. [2012], EPSL. Horizontal lines represents the plume elevation for VEI 2, 3 and 4.



Polar plot highlighting azimuth and distance of each volcanic zones with respect to Singapore.

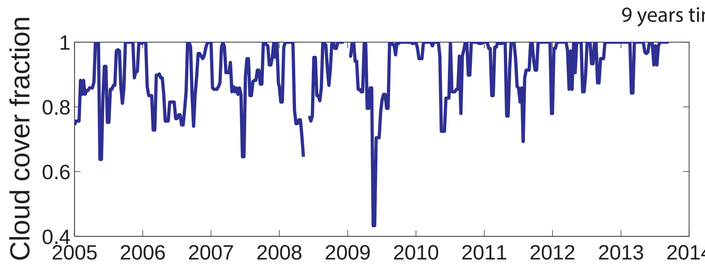
The proposed study will allow an automated detection of strong volcanic activity, and trigger a set of ash dispersal simulations that will be refined as information is collected.

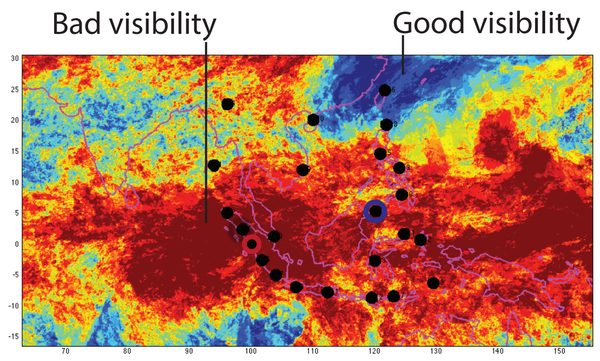
When are we blind when are we deaf ?

Review on the detection capability of two remote sensing techniques: Satellite and Infrasound.
We focus our analysis on South East Asia where climatic conditions are challenging both techniques.

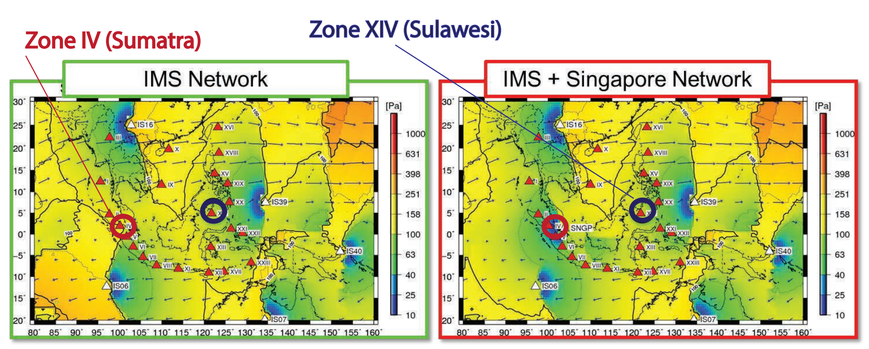
Satellite

Infrasound

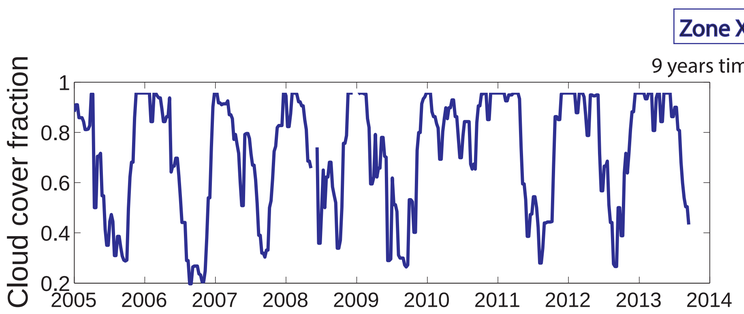




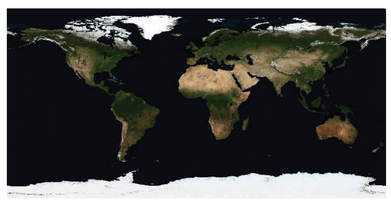
8 days average cloud cover over South East Asia in June 2014 (ranging between 0 (no clouds) and 1 (fully covered)).
Black dots are different volcanic zones.
Source: http://neo.sci.gsfc.nasa.gov/ (Modis product)



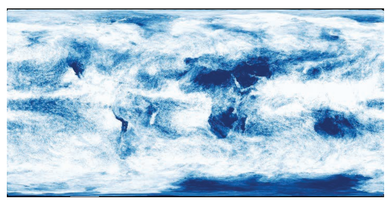
Simulations of the minimum pressure detectable by one array of the IMS infrasound network complemented or not by Singapore Network. Maps are calculated for the same day with/without Singapore station for zone 4 (above) and 14 (below)



'Ideal' situation
Source:
http://neo.sci.gsfc.nasa.gov/

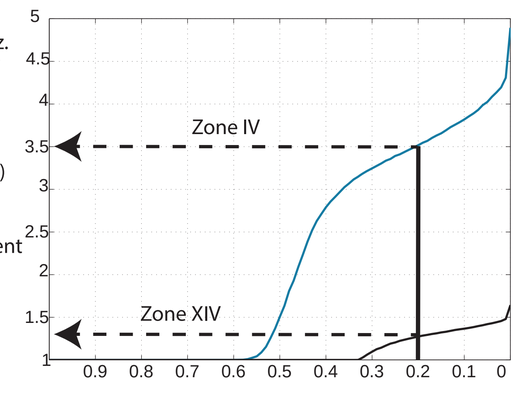


Most frequent situation
Source:
http://neo.sci.gsfc.nasa.gov/

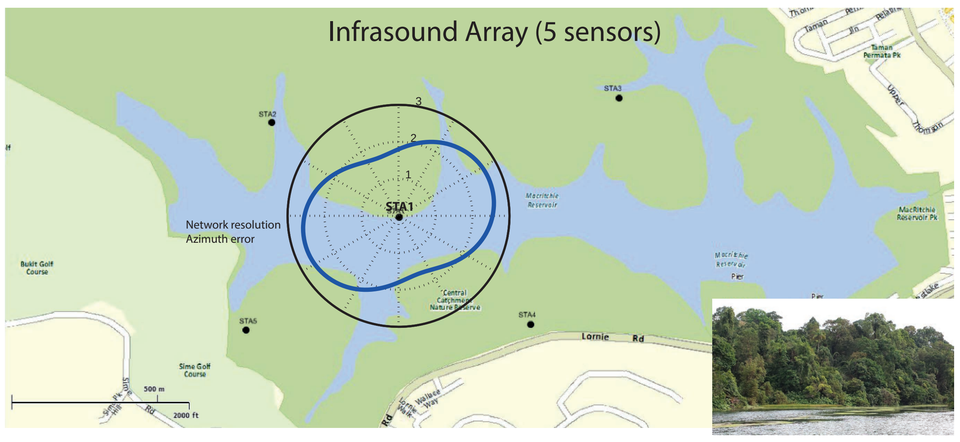


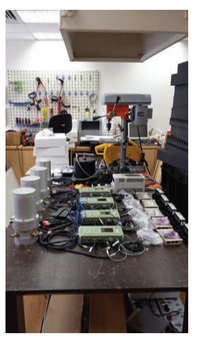
Detection tresholds at 0.4 Hz. for a Signal to Noise Ratio of 0.1
Factor of improvement achieved by adding Singapore to IMS for zone IV (blue) and zone XIV (black)

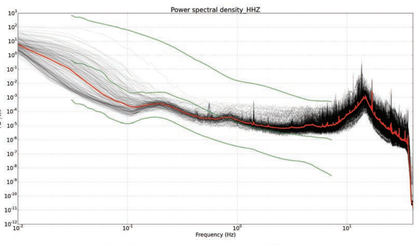
20 % of the time, improvement treshold of:
- 3.5 in zone IV
- 1.25 in zone XIV



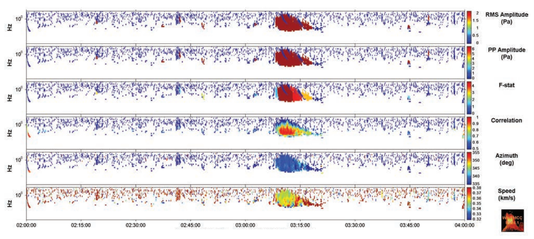
Infrasound array in Singapore





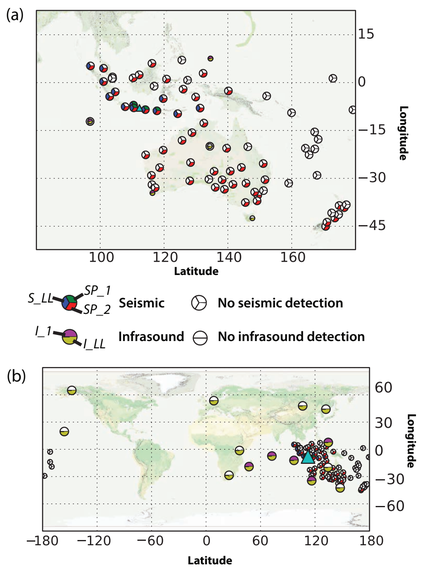


10 days of PSDs recorded at STA1 between 1-10 August 2015 (green curves: noise models / red curve: median of the 1-hr curves displayed in black)

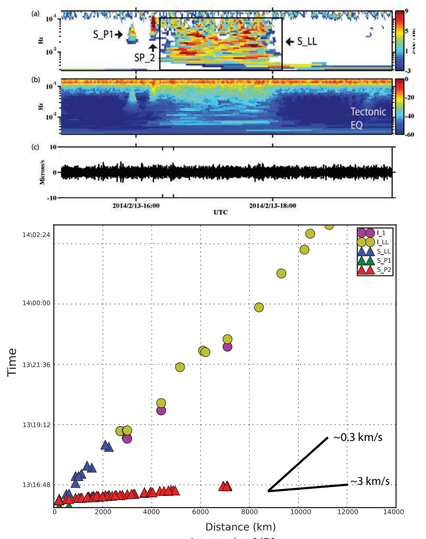


Results of preliminary PMCC analysis for the Thai bolide recorded in Singapore on 7 September 2015 (time is in UTC and origin time ~01:45 UTC)

On the use of remote infrasound and seismic stations to detect volcanic eruptions
Case study: 2014 Kelud eruption

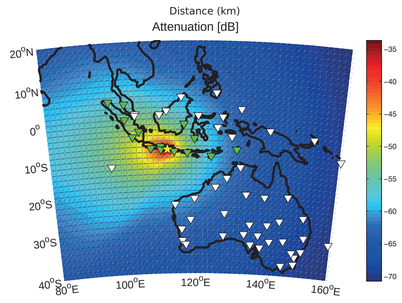


Kelud volcano (Central Java, Indonesia, cyan triangle on (a) and (b)). (a) Seismic detections: the pies are divided in three and correspond to the broadband sensors detections (IRIS and GEOFON networks) used in this study. Infrasound detections: the half pies are the infrasound stations (IMS network). White colors correspond to a non detection, green to the detection of S_P1, blue of S_LL, red of S_P2, magenta of I_1 and yellow of I_LL. (a) zoom on the region of interest (b) global detections.



Signal recorded at GE-UGM (Yogyakarta, Central Java, Indonesia, 198 km from Kelud volcano). (a) Spectrogram of signals having a high Signal to Noise Ratio (SNR, in dB, where the noise is considered as the energy averaged over the record at each frequency band) (b) raw spectrogram (c) corresponding seismogram. (a) and (b) are computed using 6th octave bands and 1/f window scaling with a 75% overlap (dB re 1 micron/s). A tectonic earthquake (EQ) is indicated on the plot (b).

The different arrivals altogether as a function of the distance with respect to Kelud volcano.



Predicted attenuation map of the acoustic signal (central frequency of 0.06 Hz and using European Centre for Medium-Range Weather Forecasts (ECMWF) wind conditions) using parabolic equation numericalmodelling [Le Pichon et al., 2012]

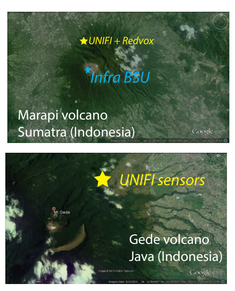
Caudron, C., Taisne, B., Garcés, M., Le Pichon, A., & Mialle, P. (2015). On the use of remote infrasound and seismic stations to constrain the eruptive sequence and intensity for the 2014 Kelud eruption. Geophysical Research Letters, 42(16), 6614-6621.

Future perspectives for next year

Installation
Singapore: Redvox array

Marapi (Sumatra, Indonesia):
3 different technologies experiment:
Redvox (ISLA, Hawai'i)
Unifi (Firenze University)
Infra BSU (Boise University)

Gede (Java, Indonesia):
5 sensors array



Redvox Inc: A project from M.A. Garces, ISLA

REDVOX INFRASOUND RECORDER
In App Store

http://www.redvoxsound.com/