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IDC events related to volcanic activity at Kamchatka Peninsula

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ABSTRACT

International Monitoring System (IMS) is designed to detect and locate nuclear test explosions as part of Comprehensive Nuclear Test-Ban Treaty (CTBT) verification regime. This network can be also used for civil applications, such as the remote monitoring of volcanic activity.

Events related to volcanic eruptions, which are listed in the International Data Centre (IDC) bulletins, are typically detected by infrasound stations of the IMS network. Infrasound station IS44 and primary seismic station PS36 are situated in Kamchatka, Russian Federation, in the vicinity of several active volcanoes. These two stations recorded seismo-acoustic events generated by volcanic eruptions. In addition to atmospheric events, the IMS network has the potential of detecting underwater volcanic activity. Under favourable conditions, the hydroacoustic stations located in the Pacific Ocean and PS36 may detect underwater events close to the shore of Kamchatka Peninsula.

The aim of this presentation is to show examples of volcanic eruptions at Kamchatka Peninsula recorded by the IMS network. Supplementary information obtained by other observing networks can be found in reports issued by Kamchatkan Volcanic Eruption Response Team (KVERT) or Tokyo Volcanic Ash Advisory Center (VAAC). Such information can be compared with events listed in IDC bulletins.

International Monitoring System (IMS) has been designed to detect large release of energy, e.g. nuclear test explosions. When completed it will comprise 170 seismic, 11 hydroacoustic and 60 infrasound stations. Figure below shows the infrasound network of IMS stations. The map is centered on Kamchatka.

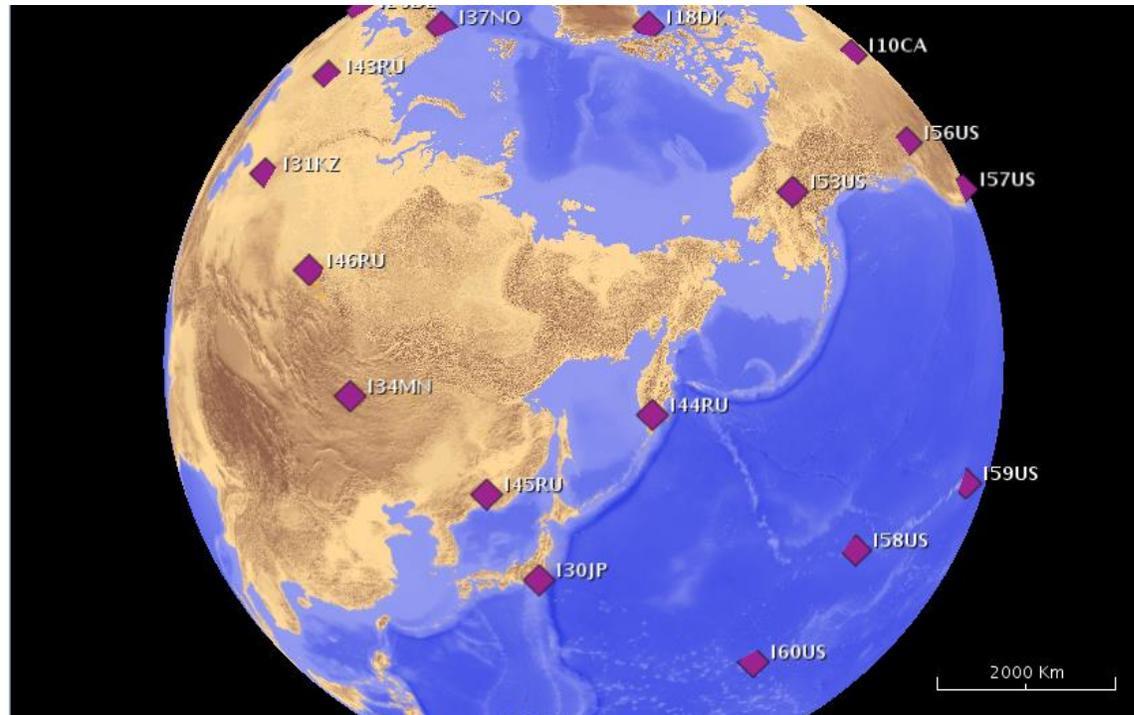


Fig.1. Infrasound network of the IMS in the vicinity of Kamchatka



Fig.2. Volcanoes in the Kamchatka area and two collocated stations IS44 and PS36

Kamchatka peninsula has one of the highest concentration of active volcanoes in the world.

Many of them are in a remote and difficult to access area. Remote monitoring methods, i.e. satellite observation are necessary.

Infrasound may be provide additional information about volcano eruption.

The most active volcano Karymsky is located at a distance of about 100 km from IS44 and PS36. Signal is observed from back azimuth of 50 deg.

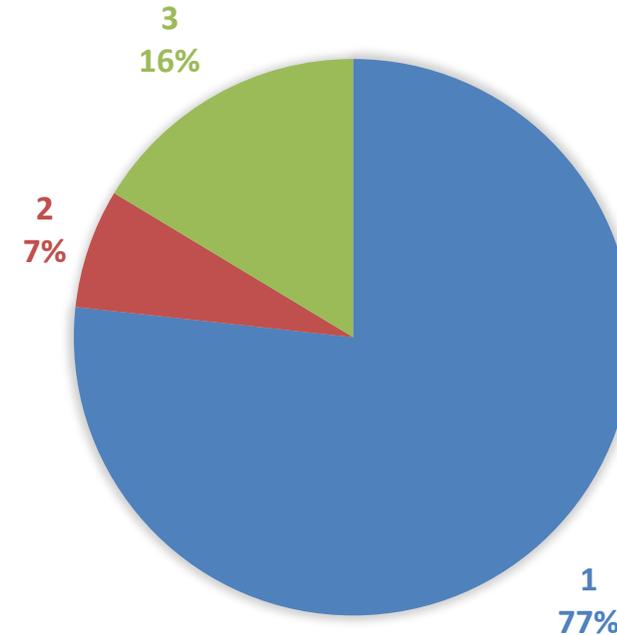
Other volcanoes (Kliuchevskoi and Bezymianny) mentioned in this presentation are 350 km away from IS44 and close to each other. Signal is observed from back azimuth of 28 deg.

Since February 2010 IDC analysts started reviewing events with infrasound associations. Events and associations considered as correct were included in the Late Event Bulletin (LEB). Events which met event definition criteria (i.e. detected at minimum three infrasound stations) were included in the Reviewed Event Bulletin (REB). REB contains seismic, hydroacoustic, infrasound or seismo-acoustic events. Only REB events are distributed to the Member States.

This diagram shows the distribution of more than 200 infrasound events related to volcanic activity recorded at Kamchatka Peninsula:

- 1 - events recorded at 2 infrasound stations
- 2 - events recorded at more than 2 infrasound stations
- 3 - events recorded at 2 infrasound stations and PS36

More than 75% of valid events related to volcanic activity in Kamchatka are not included in the REB. Volcanic activity is often observed at only one station, IS44 in case of Kamchatka volcanoes.



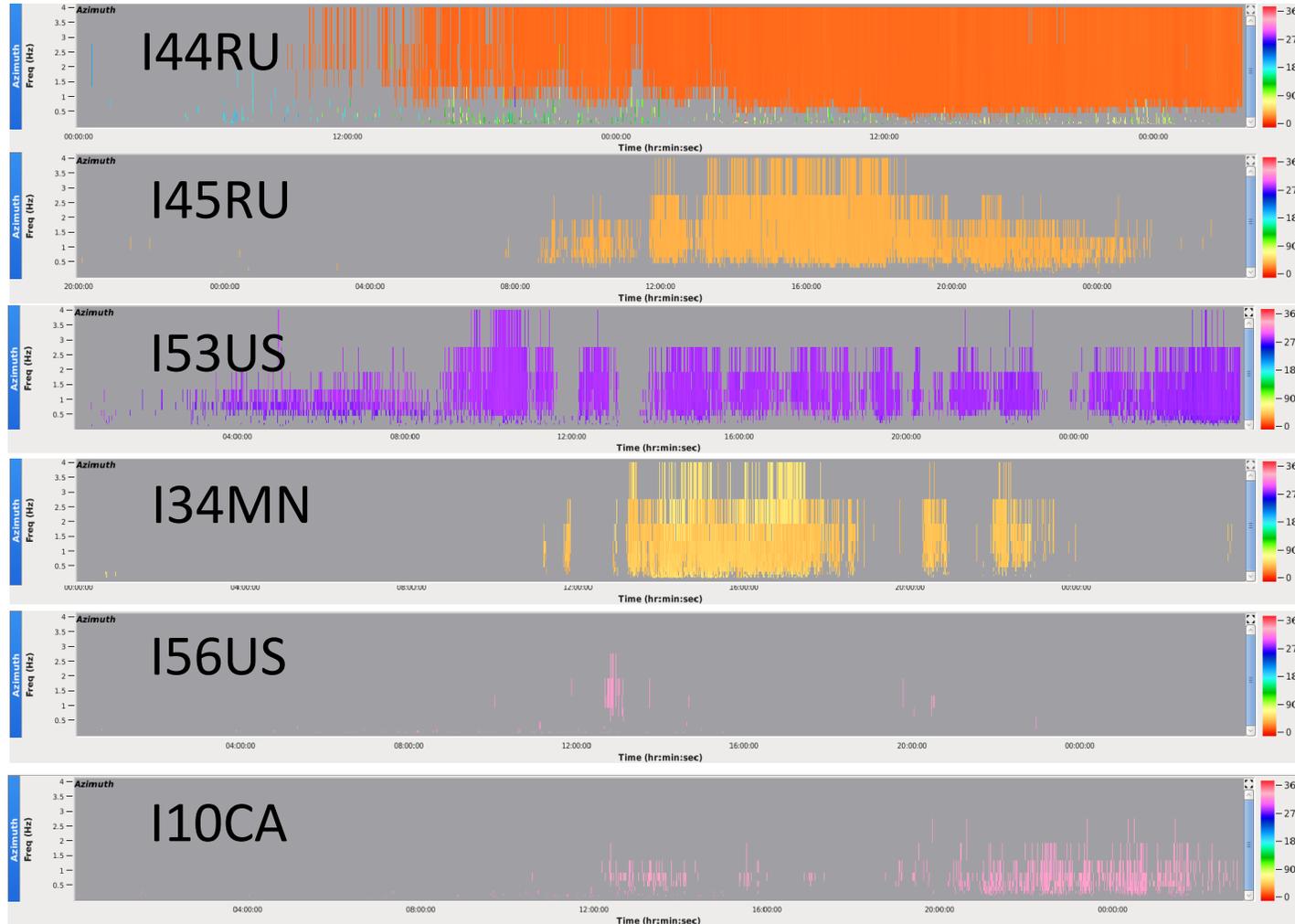


Fig.3. Overview of daily detections related to Kliuchevskoi eruption on 18/10/2013

On 18/10/2013 I44RU recorded continuous infrasound signal generated by Kliuchevskoi eruption. Other stations detected several intervals of signal related to Kliuchevskoi activity. Event which has been included in the REB was combined from detections within activity recorded at associated stations. Kliuchevskoi eruption which took place in October 2013 is an example of long duration activity. REB event shows that volcano was erupting but by no means describes the complexity of signals recorded by each station.

Despite unknown eruption time event location may be quite accurate. In this example Kliuchevskoi is within 90% confidence ellipse, 20 km from the REB location. This event was formed purely from observations at IMS infrasound stations and was not recorded at any IMS seismic station

Information from KVERT:
 Eruption between 17-19/10/2013
 Ash plume up to 8-9km altitude

Event took place in winter conditions in the Northern Hemisphere therefore most distant stations are to the east from the volcano – direction of the altitude winds.

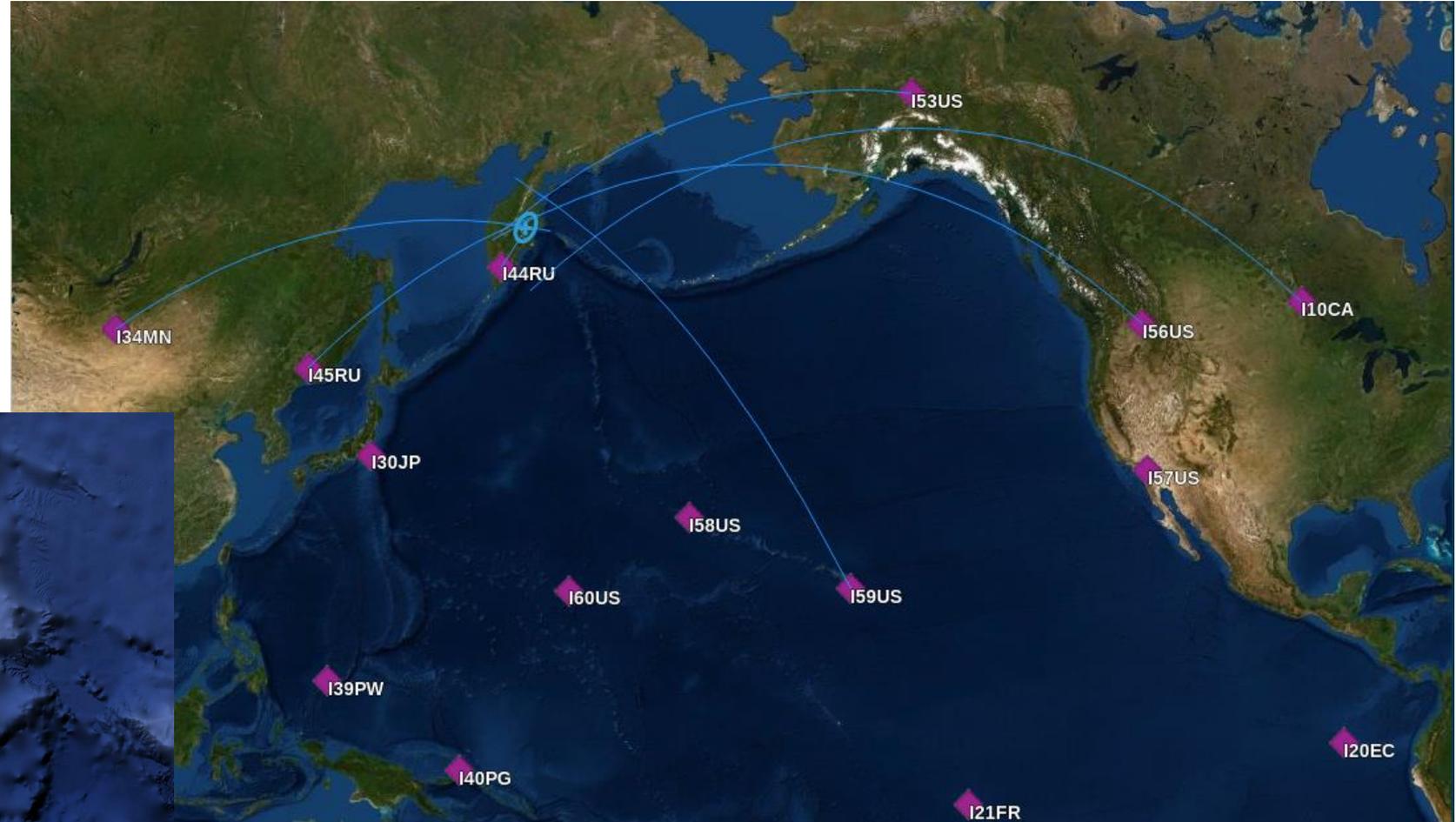


Fig.4. Network of IMS infrasound stations which recorded this event; blue lines show back azimuth measured at detecting stations.

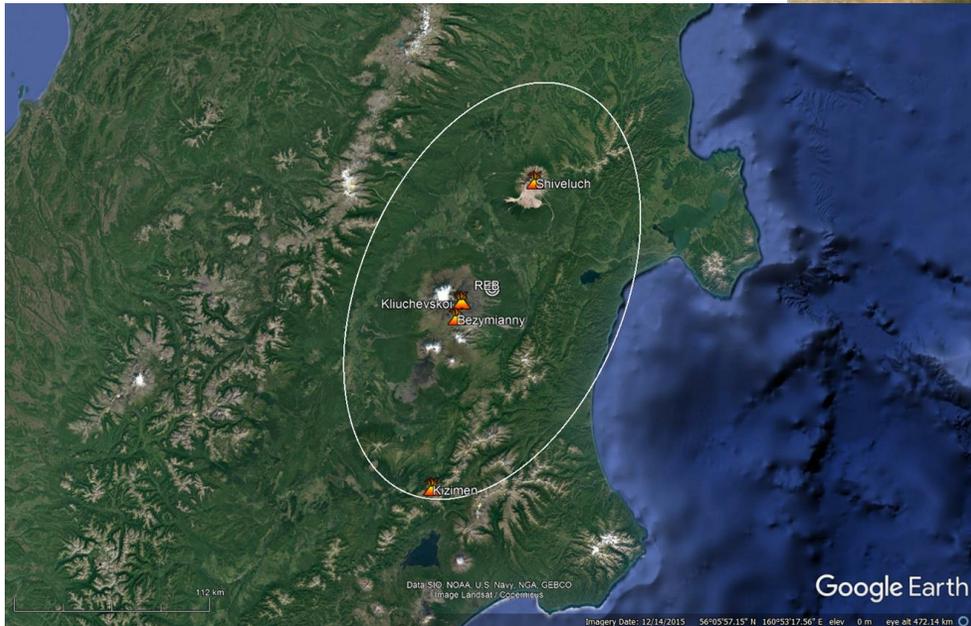


Fig.5. IDC location of the event

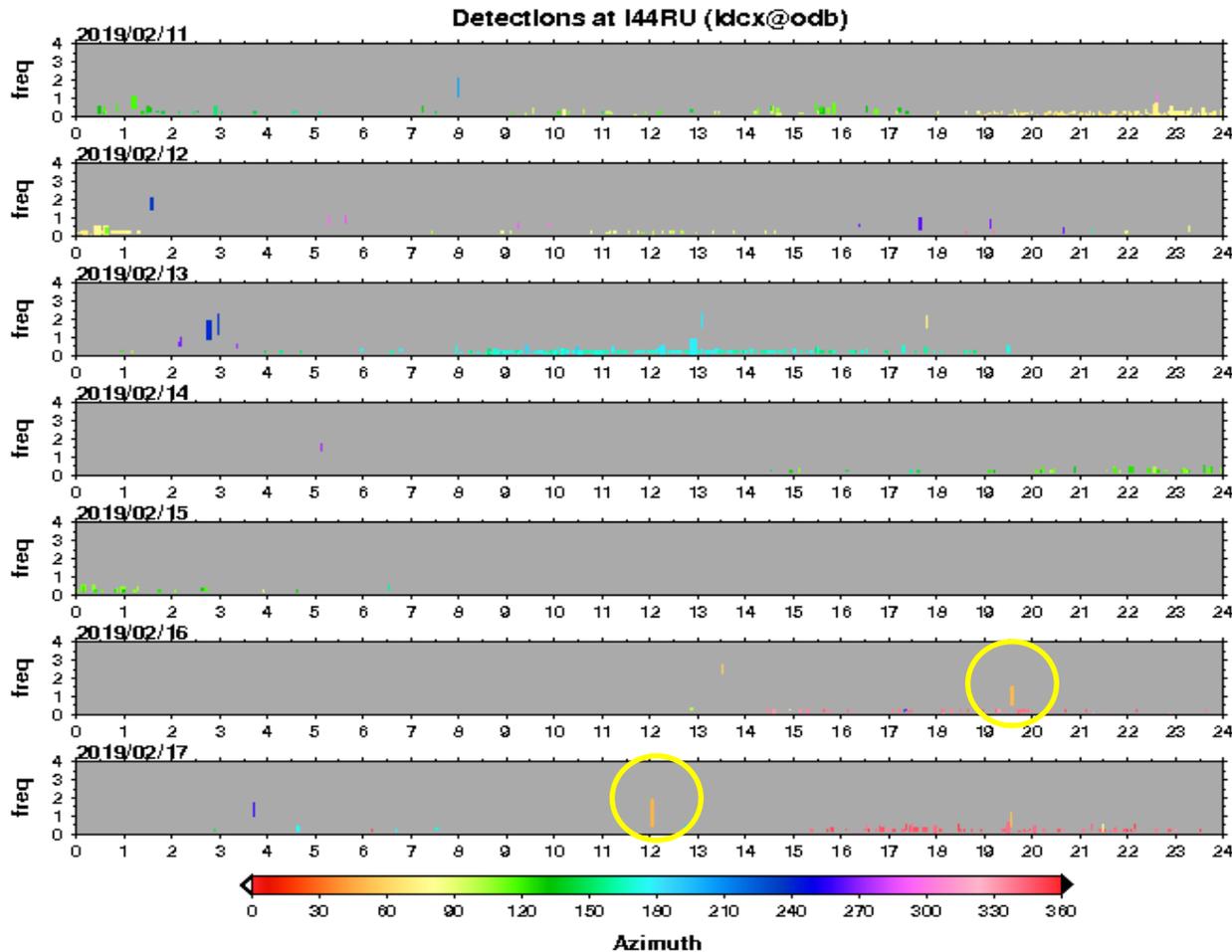


Fig.6. Overview of daily detections during the week 11/02 – 17/02;
Two events recorded at IS44 related to Karymsky activity marked in yellow

Some volcanic activity can be recorded as a sequence of short duration, impulsive eruptions. As they occur at a certain time it is easier to include them in the IDC bulletins as long as they are detected by at least two IMS stations. One of longest recorded sequences was Karymsky eruption which lasted a few weeks starting from 16 February. On 16 and 17 February 2 events were located based on detections observed at IS44 and IS53 (Alaska). Both locations coincide with Karymsky. KVERT did not report on times of individual episodes therefore it was not possible to compare times of events recorded in the IDC and actual eruption time.

KVERT:
Karymsky volcano remained quiet until 15/02

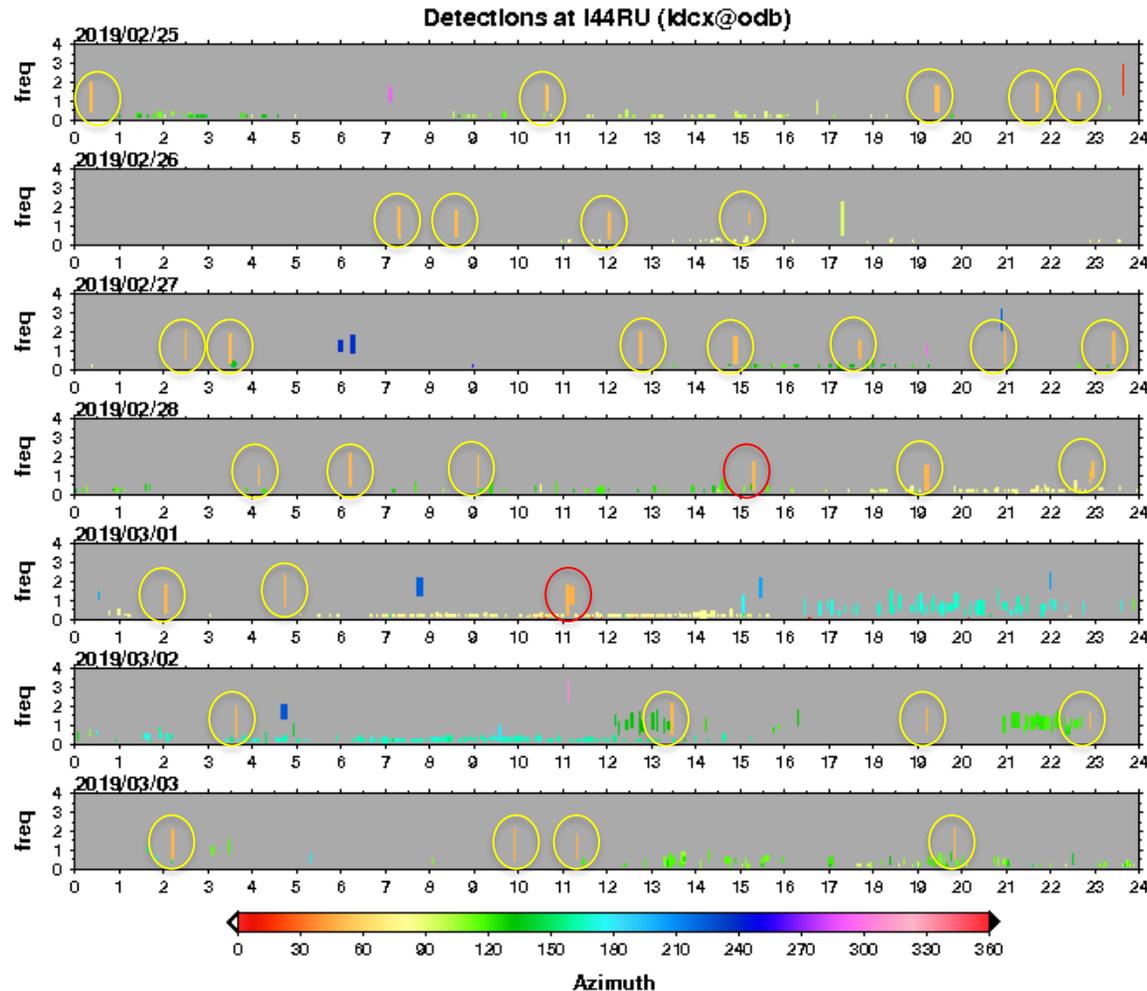


Fig.7. Overview of daily detections during the week 11/02 – 17/02;

Detections recorded at IS44 related to Karymsky activity are marked in yellow, detections marked in red contributed to REB events.

Activity at Karymsky continued for the next few weeks. Several related detections were seen at IS44. Fig.7. shows plots of daily activity at this station recorded in the week 25 February – 3 March. Despite many detections which parameters pointed to the Karymsky episodes only two events were included in the REB. One event was reported on 28 February, the other on 01 March. These events were detected by at least two other IMS stations.

Karymsky activity lasted until the beginning of March. Starting from 13 March it was reported as quiet. On 15 March another volcano – Bezymianny erupted sending ash up to 15 km. This eruption was well recorded by the IMS network, 3 events could be located, ones was included in the REB.

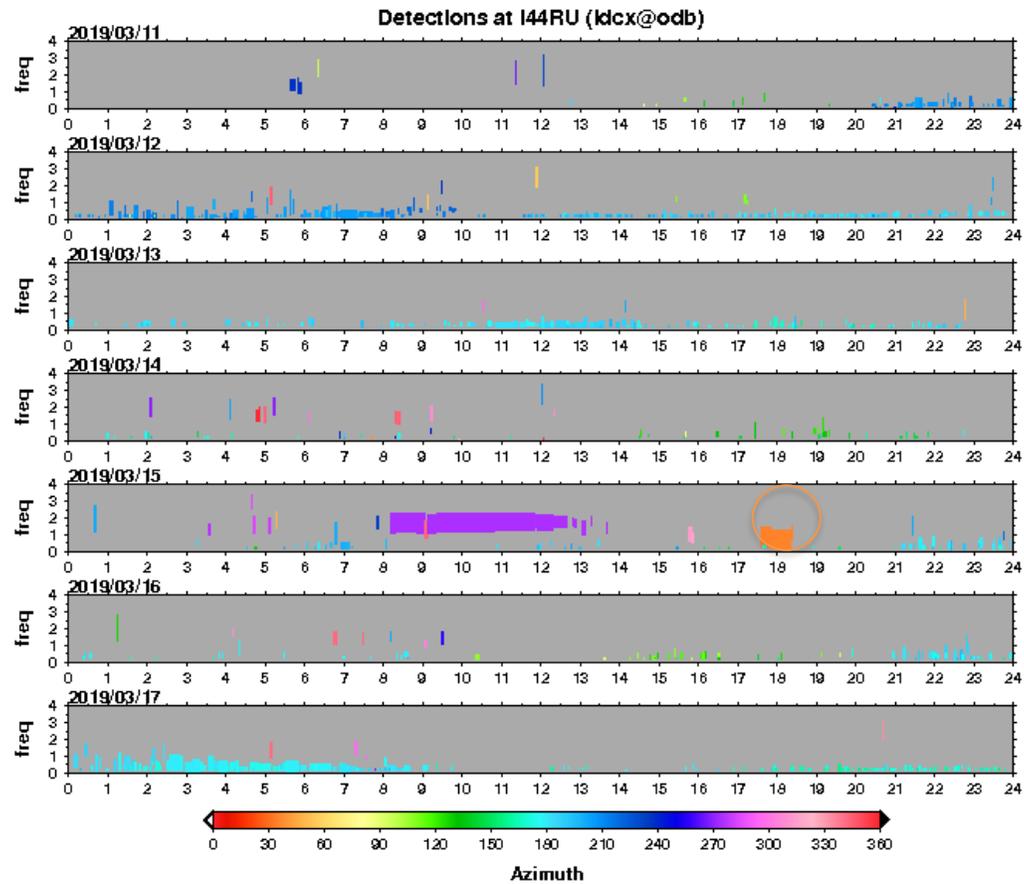


Fig.8. Overview of daily detections (week 11/03 – 17/03); detections marked in orange are related to Bezymianny eruption on 15/03/2010

KVERT: Strong explosions sent ash up to 15 km at 17:30 UTC, REB event at 17:21:48

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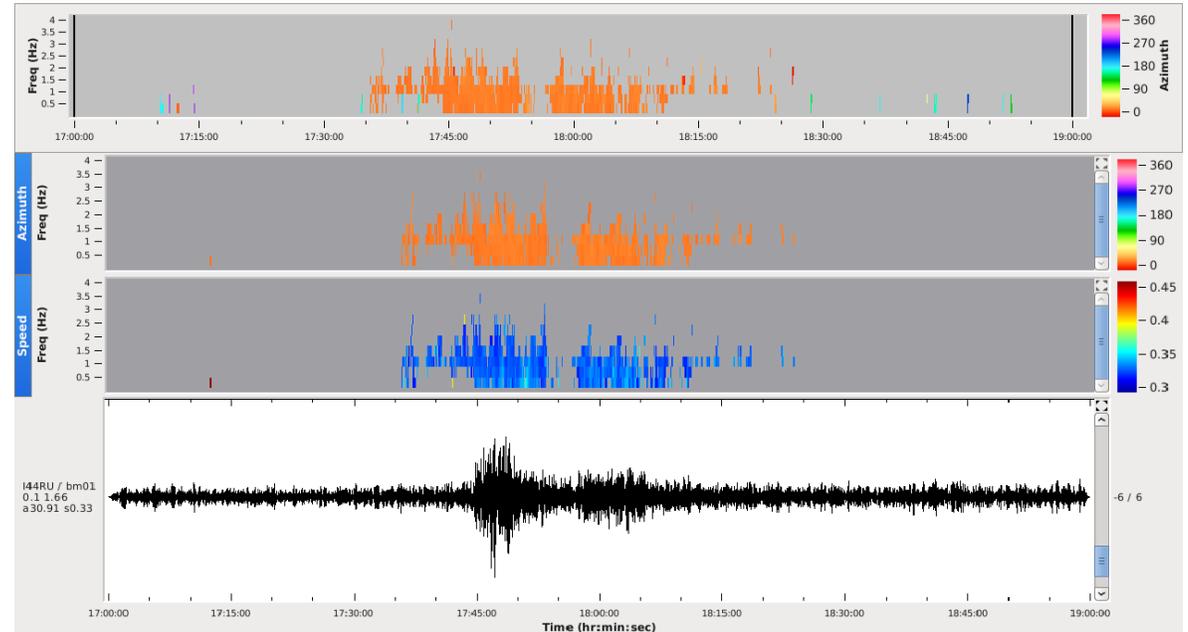


Fig.9. Signal recorded at IS44 related to Bezymianny eruption on 15/03/2010



Fig.10. Location of the IDC event related to Bezymianny eruption on 15/03/2010

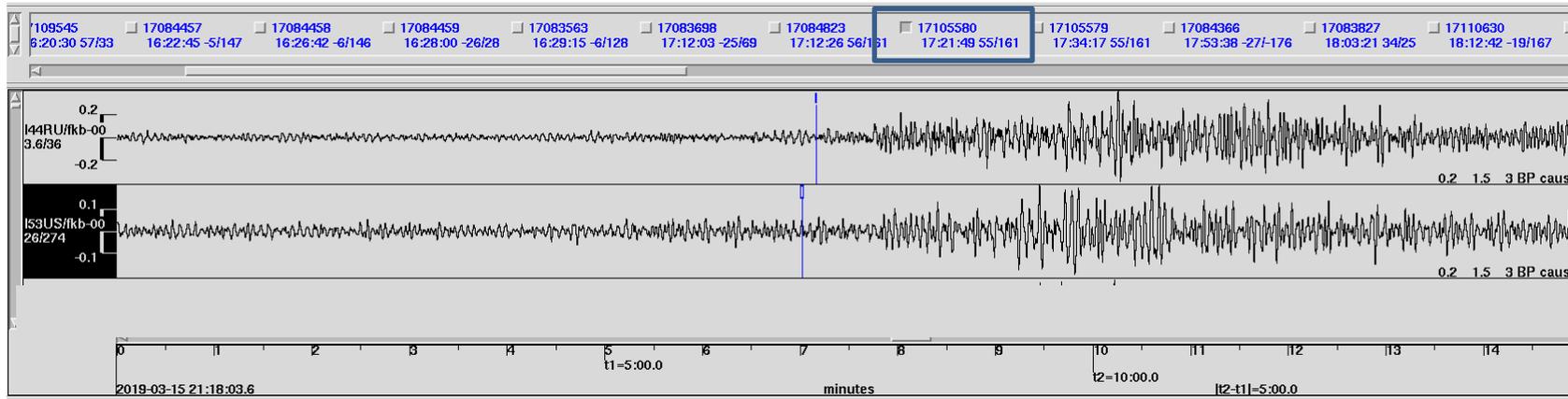


Fig.11. Onset of signals detected at IS44 and IS53 associated to the IDC event at 17:21:48 on 15/03/2010

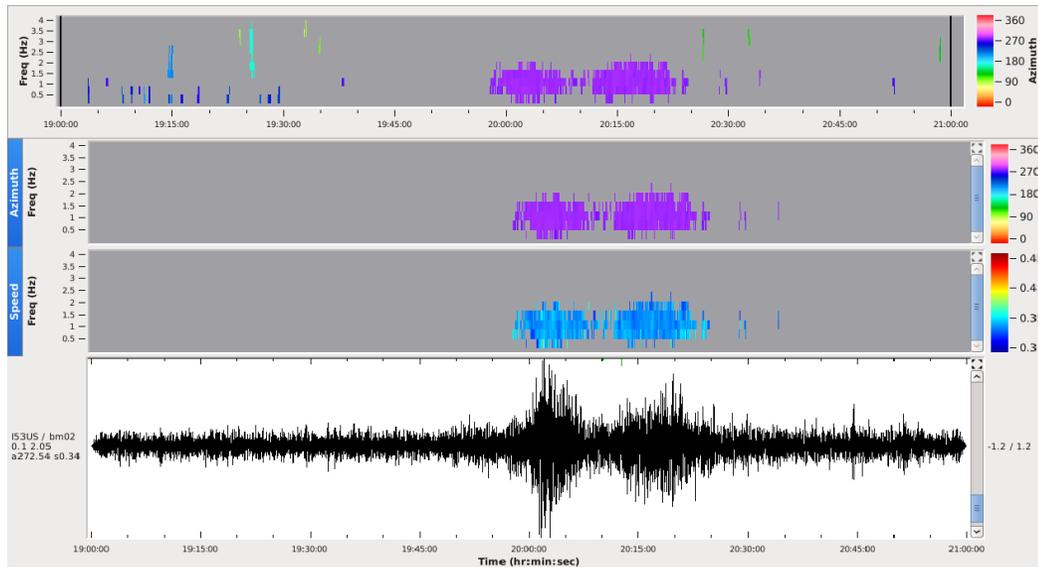


Fig.12. Signal recorded at IS53 related to Bezymianny eruption on 15/03/2010

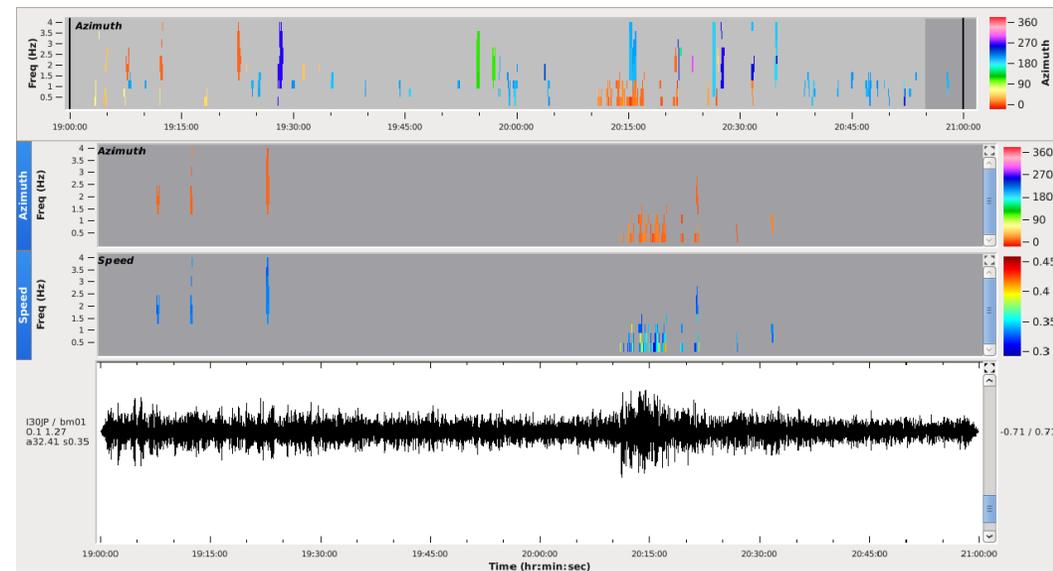


Fig.13. Signal recorded at IS30 related to Bezymianny eruption on 15/03/2010

Largest volcanic eruption at Kamchatka Peninsula was recorded by 7 IMS stations – a small number if compared to large seismic events

Sequence of volcanic events may be well observed at I44RU but only a small number of events will be included in the REB

In case of powerful eruptions and favorable propagation conditions time and location of events recorded at the IDC is coincidental with observations provided by volcano observation agencies