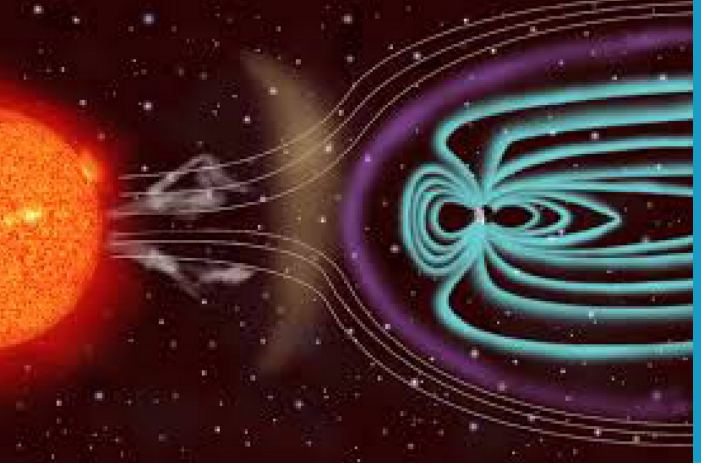

Analysis of electromagnetic radiation during Shiveluch and Bezymyanniy volcano eruptions from 2017 to 2023

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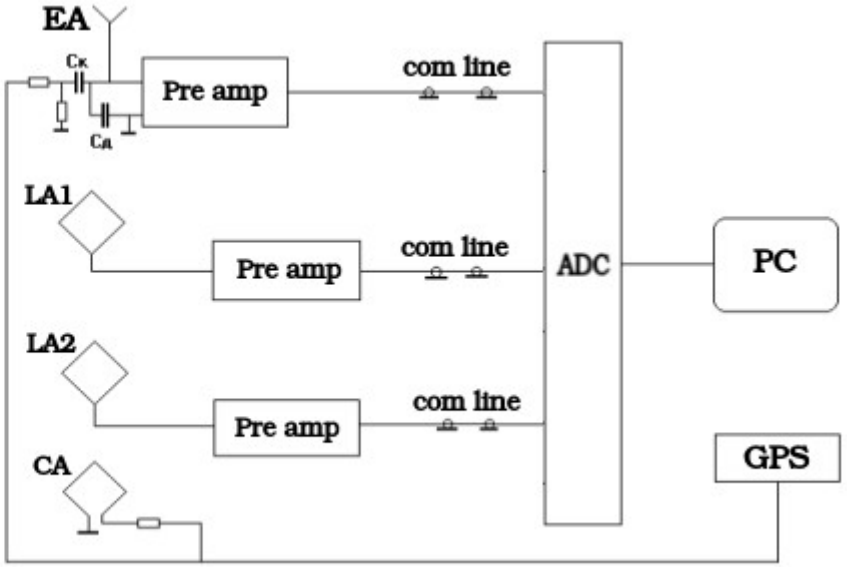
Volcanic lightning.

Lightning captured during the eruption of Taal Volcano, Philippines.

Explosive eruption of Shiveluch volcano with the formation of a pyroclastic flow on December 3, 2013 (Photo by A.V. Shevchenko)

Equipment



A direction finder of very low frequencies (VLF direction finder, f ≈ 0.5 − 60 kHz) is used to record pulse electromagnetic radiation (PER) at the Institute of Cosmophysical Research and Radio Wave Propagation (IKIR) FEB RAS (Karymshina). The hardware-software complex for PER recording is described in the paper

Volcanic explosion

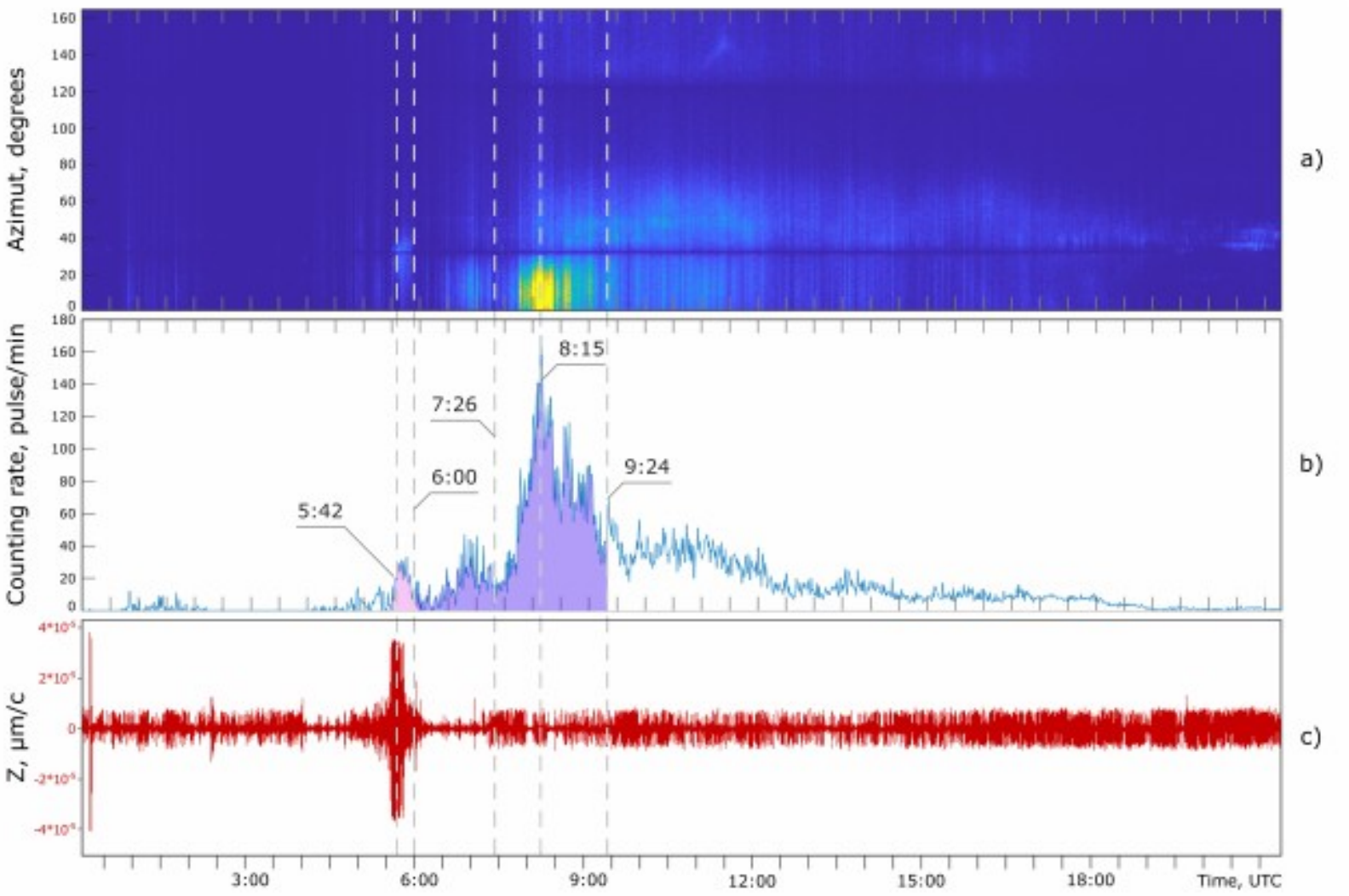
Parameters of the three most vivid events during the Shiveluch volcano eruptions.

date	time	time 1 phase, mim	max counting rate, pulse/min	pulse number pulse	time 2 phase, min	max counting rate, pulse/min	pulse number pulse	WWLLN
11.05.2017	18:24	4	16	47	28	14	183	4
23.07.2017	17:43	4	3	10	26	18	205	0
21.10.2019	12:17	5	18	45	–	–	–	0

Parameters of the three most vivid events during the Bezymianniy volcano eruptions.

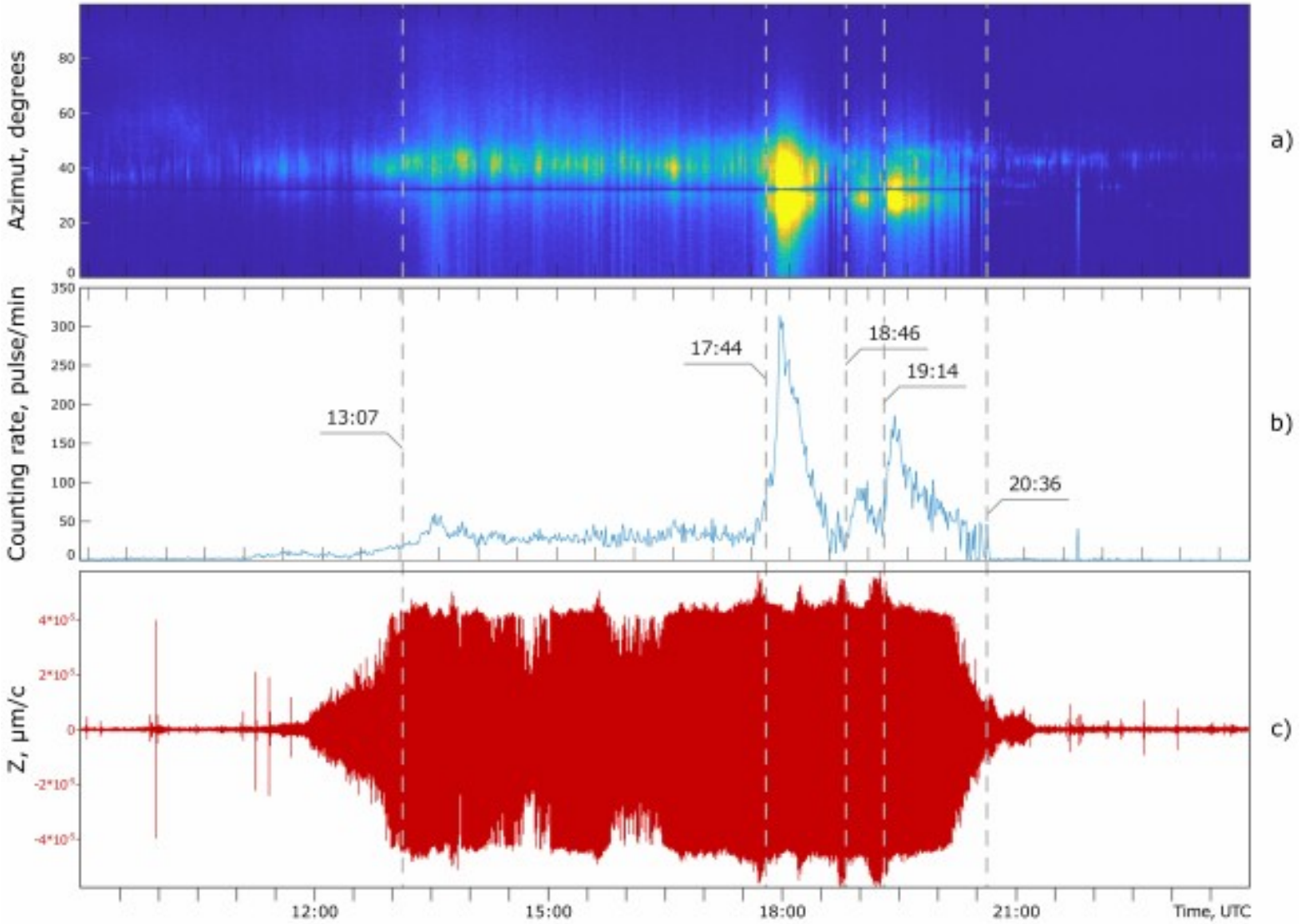
date	time	time 1 phase, mim	max counting rate, pulse/min	pulse number pulse	time 2 phase, min	max counting rate, pulse/min	pulse number pulse	WWLLN
20.12.2017	03:39	3	5	9	54	37	781	7
15.03.2019	12:17	–	–	–	40	83	1138	11
15.03.2022	18:24	4	11	32	50	21	159	4

Volcanic explosion



Azimuthal distribution of PER direction finding in the range of 0°-60°(a). The counting rate of PER, azimuthally arrived from Bezymianniy volcano direction, during the eruptions (b). Record of explosive earthquakes at BZM seismic station during Bezymianniy volcano eruption on 7 April 2023 (c)

Volcanic explosion



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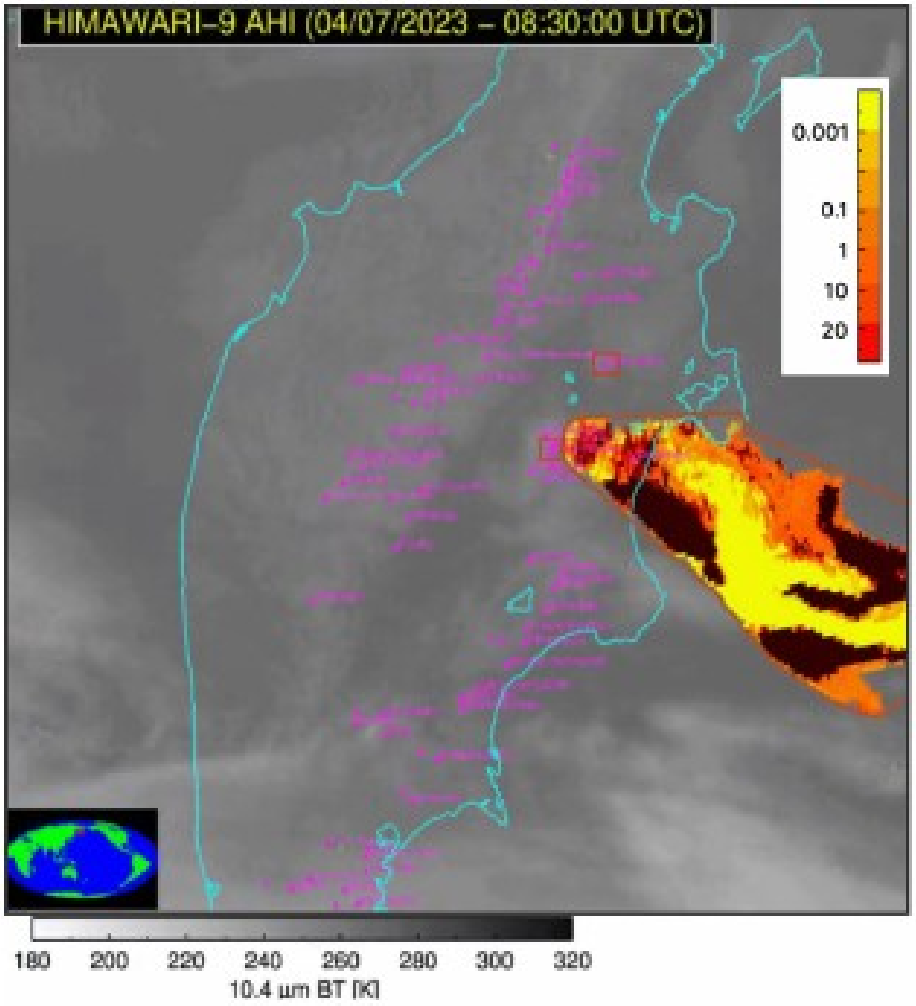
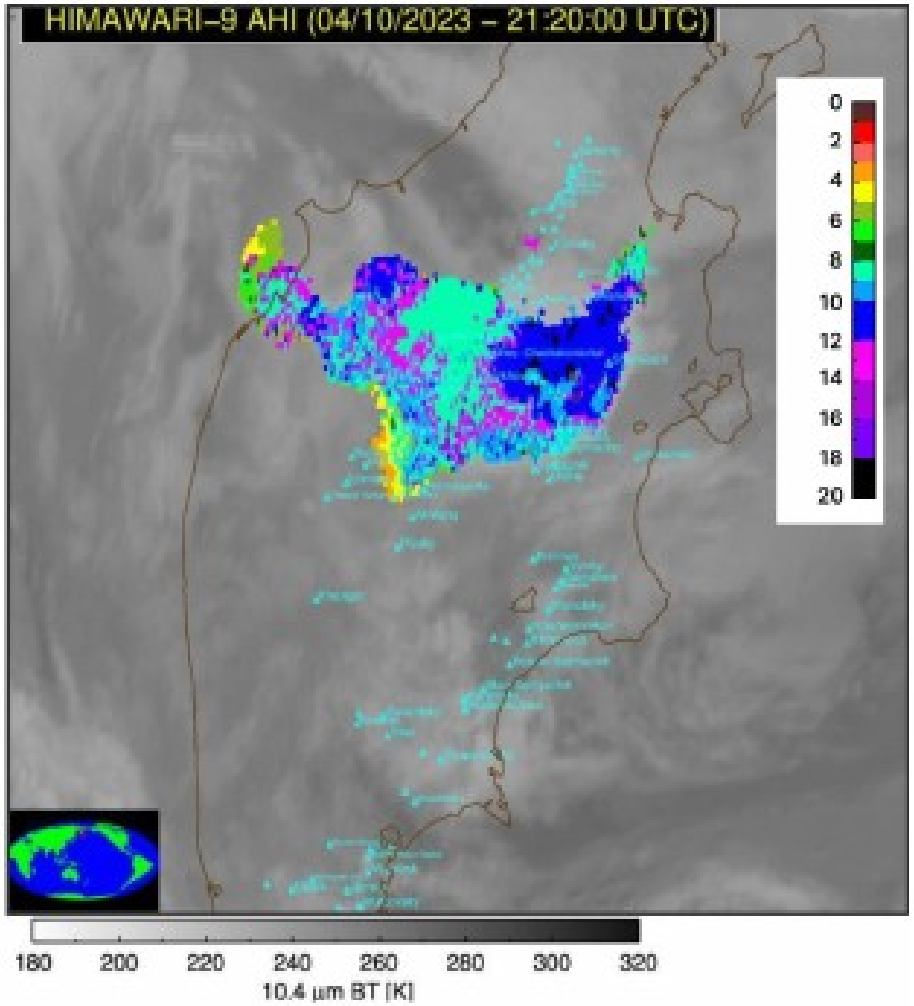
Volcanic explosion



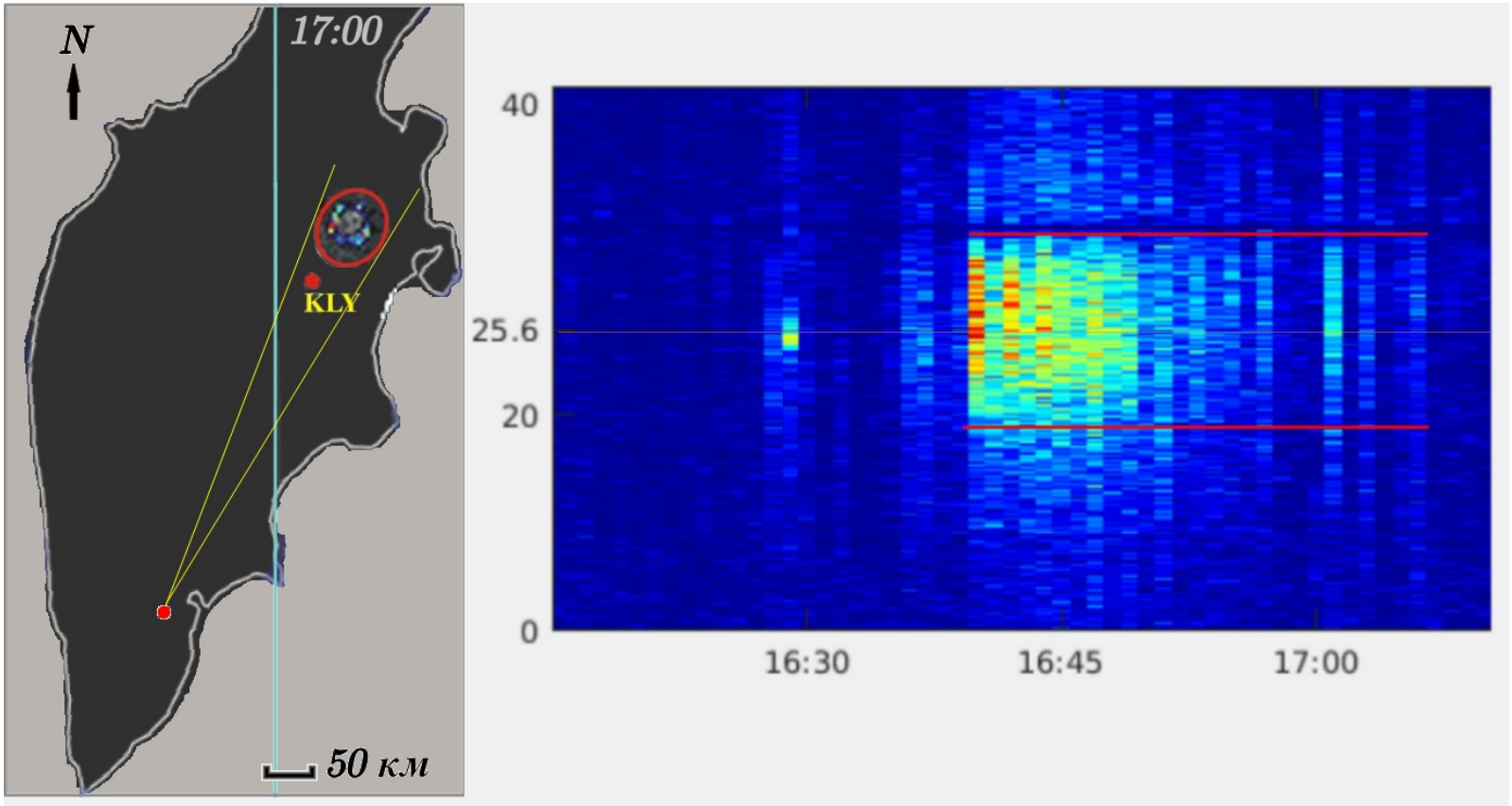
a)



b)

Propagation of the eruptive cloud from Bezymianniy volcano eruption on 7 April 2023 (a) and from Shiveluch volcano eruption on 10 April 2023 (b) based on the HIMAWARI-9 satellite image data

Volcanic explosion



According to satellite images (http://rammb.cira.colostate.edu/), the angular size of the eruptive cloud is ~ 10°, which is confirmed by the azimuthal distribution of EMR.

Conclusions

The Kamchatka volcano group is located near international aviation routes. Due to that fact, eruptions are a serious threat for air communication safety. In order to decrease the risks, online systems for eruption detection are required. Remote observation methods, such as tracing of accompanying thunderstorm sources, make it possible to receive the information at the stages of formation and fragmentation of eruptive clouds when electrification processes develop the most intensively. Lightning strokes give the information on eruptive plume formation and trace its motion during the eruption initial period.

Thank you for your attention