Amplitude Variations of VLF Signal of NWC Transmitter (19.8 khz) Propagating Over the Earthquake Epicentre

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Abstract. Lower ionosphere perturbations accompanying earthquakes can be investigated by VLF signals of radio stations. Amplitude variations of VLF signal of NWC transmitter (19.8 kHz) are considered during registration in Yakutsk from August 21 to September 15, 2018 to detect lower ionosphere disturbances as a result of the earthquake (magnitude is 6.6, depth is 35 km) on Hokkaido Island (42.686 ° N 141.929 ° E) on September 5, 2018. On the day of the earthquake the effect manifested as the amplitude increase of the radio signal.

1. Introduction

Very low frequency (VLF: 3-30 kHz) radio signals can travel long distances with a small attenuation of ~ 0.3 dB / 1000 km in the waveguide. The lower boundary of the waveguide is water or the earth's surface (Earth), and the upper boundary is the lower ionosphere (region D: height 65-80 km in the daytime, region E: 90-110 km at night) [1].

The lithosphere and ionosphere are interrelated and seismic activity has a significant impact on the lower ionosphere [2]. The amplitude and phase of VLF signals from radio stations changes during propagation in the Earth-Ionosphere waveguide [3]. These changes are used to monitor ionospheric disturbances of the lower ionosphere [4].

2. Data and measurement techniques

To register in Yakutsk (62.02 ° N, 129.70 ° E) VLF signals from the Australian radio navigation station NWC (19.8 kHz, 21.82 ° S 114.17 ° E), a recording complex was used. This complex consisted of a whip antenna, a preamplifier, an ADC, and a laptop with a regular recording program. The signals were 4 seconds long. Signals were recorded with an interval of 126 seconds. A highly stable sampling rate is created using a frequency divider and a GPS clock [5].

3. Results

A strong earthquake occurred on September 5, 2018. The epicenter was on Hokkaido Island in Japan (42.686 ° N 141.929 ° E), M = 6.6, the depth of the source is 35 km.

In figure 1 shows the variations of the signal amplitude of the NWC radio station according to measurements at 03-05 UT (mid-day on the propagation path) and 15-17 UT (mid-night) during registration from August 21 to September 15, 2018 in Yakutsk. Vertical bars crossing the amplitude

line indicate the spread in amplitude values. The blue line indicates the median value of the amplitude for all days during these hours.

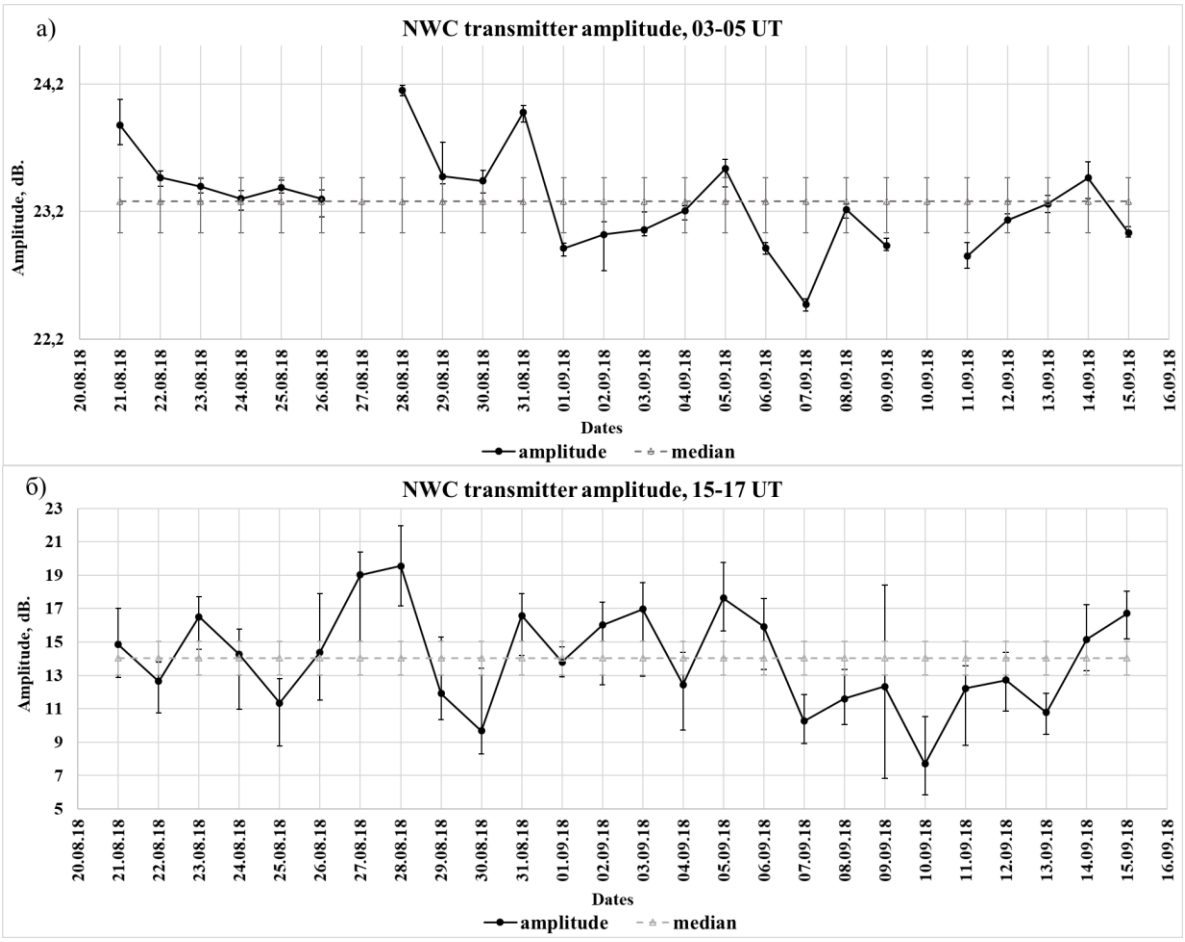

Figure 1. The amplitude variations of VLF signals from radio station NWC a) 03-05 UT and b) 15-17 UT.

An analysis of variations in the VLF radio station amplitude shows a strong deviation from the median value on August 28, September 5, September 7, and September 10.

Naturally, geomagnetic disturbances can have an impact on the lower ionosphere.

Variations in the signal amplitude before September 1 can be explained by a strong magnetic storm on August 26 with Kp = 7 and Dst-index up to 180 nT, which caused ionospheric disturbances (Figure 2).

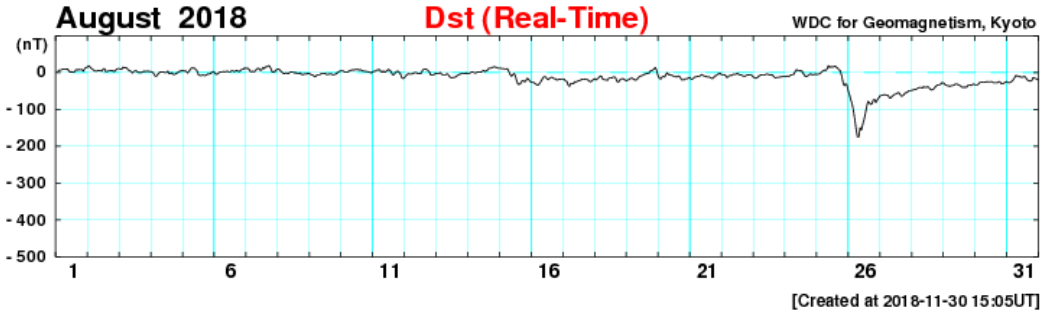

Figure 2. Dst-index in August 2018.

Geomagnetic disturbances were weak during the indicated period in September. Only on September 10-11, the Dst-index variations exceeded 50 nT (Figure 3). Which explains the deviation from the median amplitude on September 10.

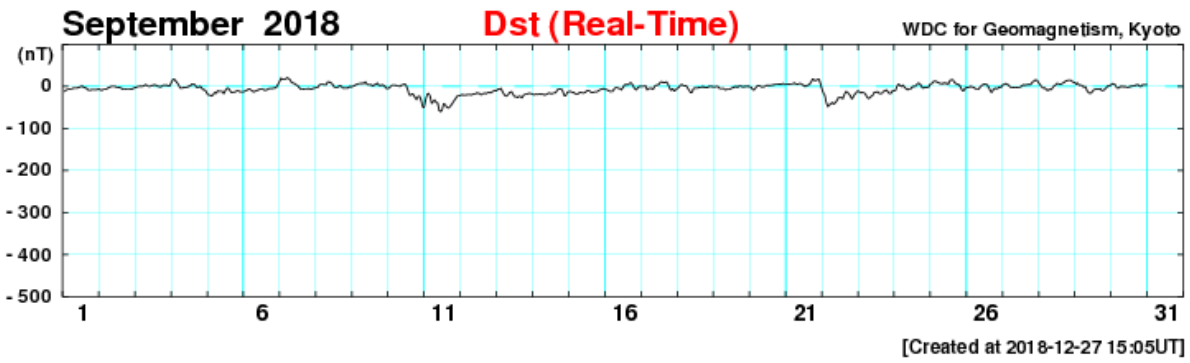

Figure 3. Variations of average amplitude of atmospherics, passing over the epicenter of the earthquake in Baikal on 27.08.08.

In the absence of geomagnetic disturbances, the amplitude variations on September 5 can be explained by the influence of lithospheric disturbances on the parameters of the lower ionosphere.

4. Conclusion

Seismic disturbances in the lower ionosphere are investigated using signals from a low-frequency radio station. The effects of an earthquake can be expressed as an amplification of the signal amplitude of the NWC radio station per day or within 5 days after the event. Possible precursors of an earthquake are also manifested in an increase in the amplitude of atmospherics several days before the events.

5. References

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