T1.1-O7 Recording of internal gravity waves and infrasound waves from the warm and cold fronts in Moscow region

Elena Golikova, Sergey Kulichkov, Igor Chunchuzov, Oleg Popov, Vitaliy Perepelkin

A.M. Oboukhov Institute of Atmospheric Physics RAS

Object

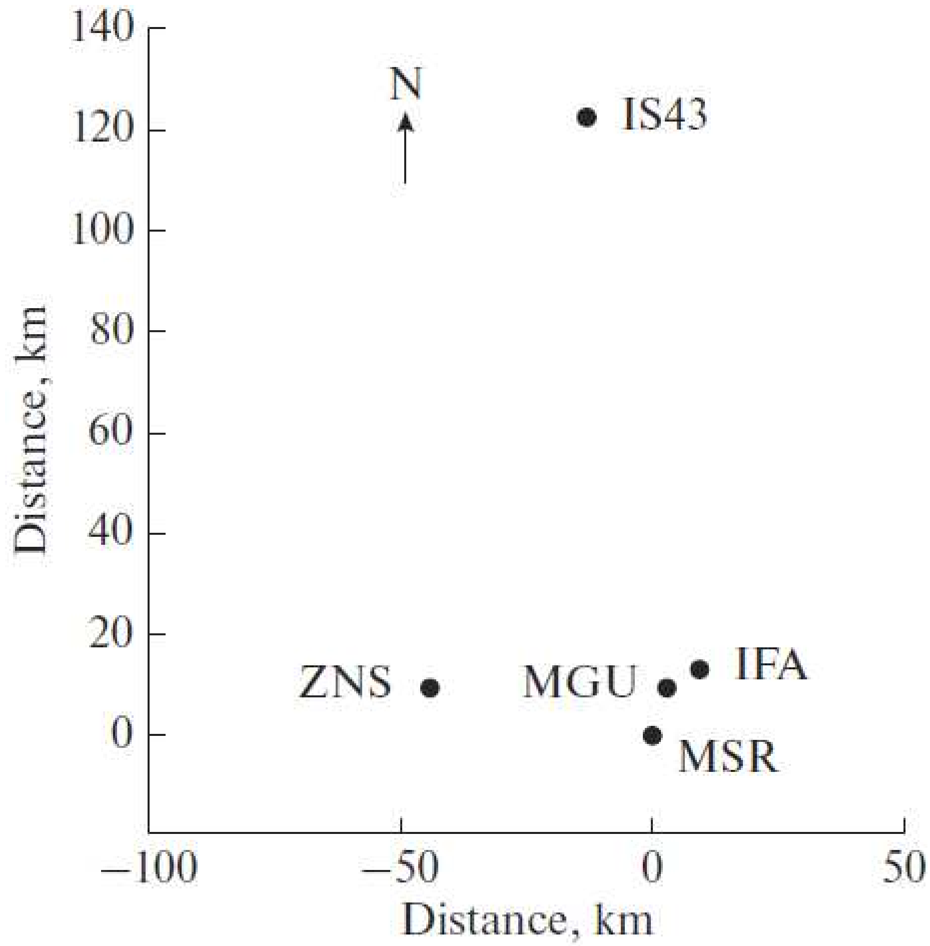
♦ Registration of IGWs from atmospheric fronts and their classification according to the probability of occurrence of dangerous phenomena: thunderstorms, squalls, tornadoes, based on the characteristics of the received signal.

♦ It is important to make the detection of IGWs and their classification in advance, a few hours before the occurrence of dangerous phenomena associated with the meteorological front.

♦ An important problem is the organization of a system for continuous monitoring of IGWs in the atmosphere.

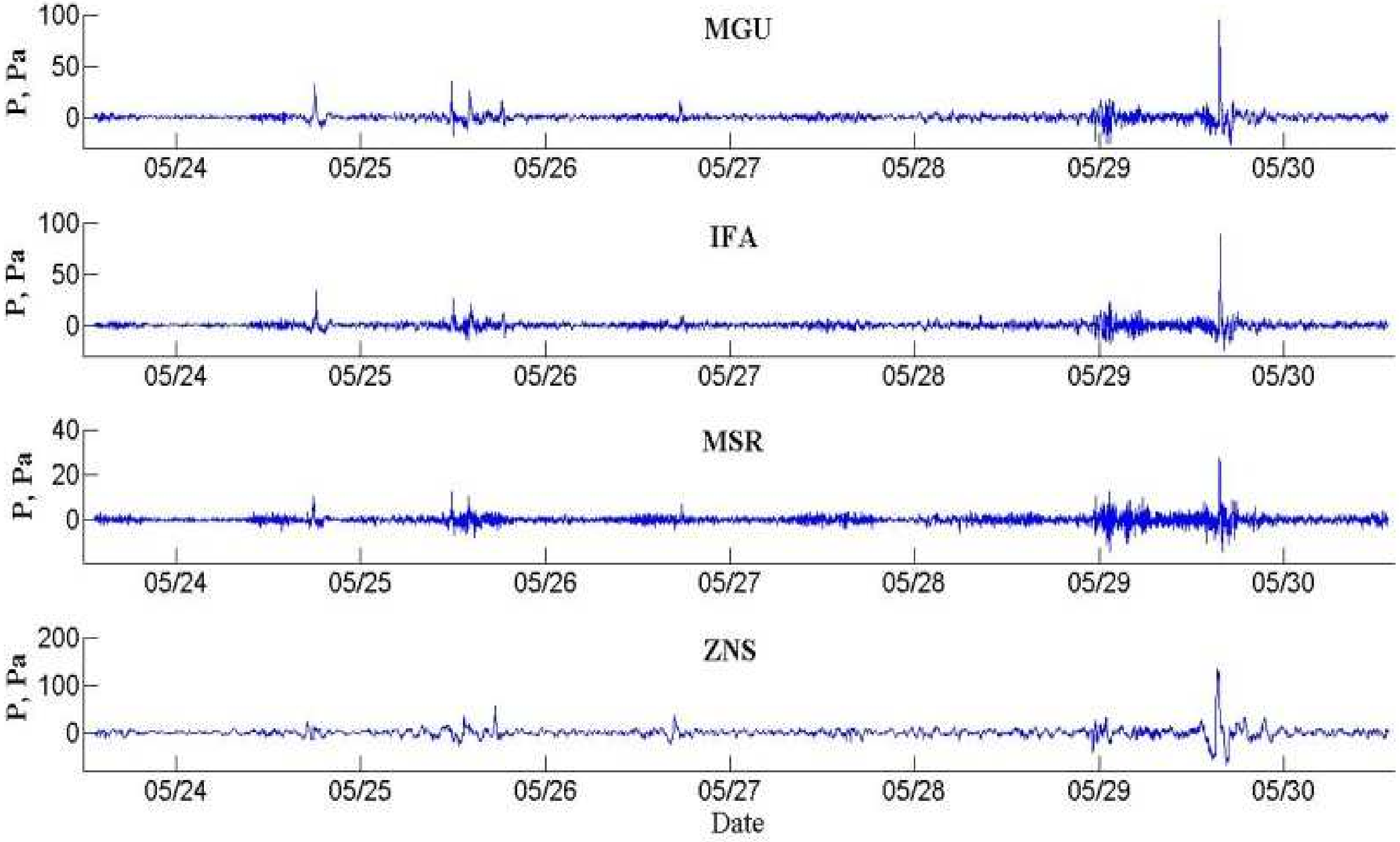
♦ An unique complex has been developed in Moscow and its region in order to continuously record internal and infrasound waves. This complex makes it possible to record wave disturbances of different scales in the field of atmospheric pressure (using a network of microbarographs and infrasonic receivers).

Location of the IFA, MGU, MSR and ZNS microbarographs and the IS43 infrasonic station



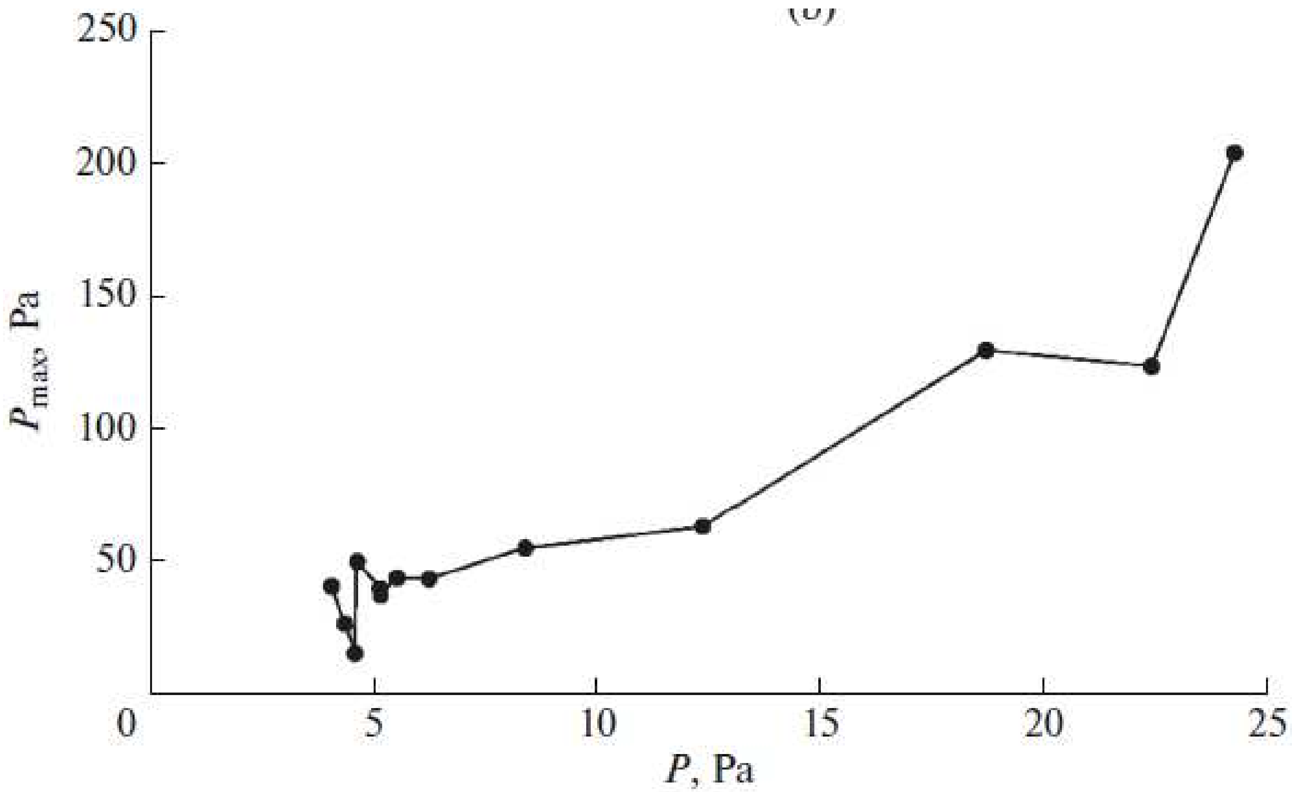
- The measuring complex includes a network of four microbarographs to measure wave atmospheric-pressure disturbances within a frequency range of infrasounds and IGWs (0.0003–3 Hz).
- The distance between the microbarographs is from 7 to 54 km.
- The IS43 infrasonic station (Dubna) using six infrasonic receivers.

Atmospheric-pressure variations recorded from 23 to 30, May 2017, at the network of the MGU-IFA-MSR-ZNS microbarographs



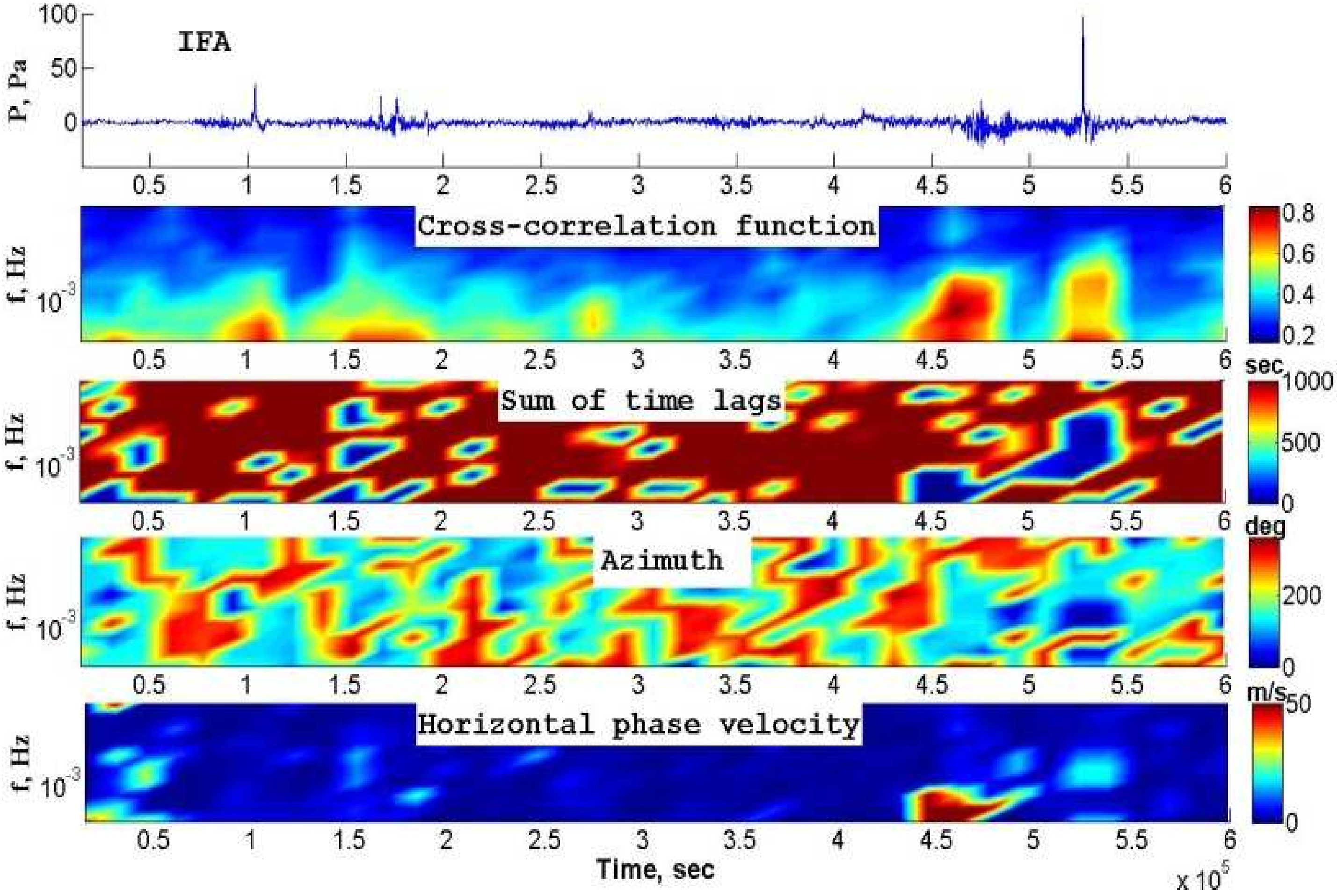
- The fluctuation intensity increases on the night of May 29 and the pressure rapidly jumps before the passage of the storm on May 29.
- The weaker (in amplitude) pressure jumps were observed on the previous days (May 24 and 25), which were associated with the passage of atmospheric fronts on these days.

Dependence of the amplitudes of pressure jumps (*P* max) before the atmospheric fronts on the amplitudes of pressure (*P*) variations in the wave precursors of the front arrival



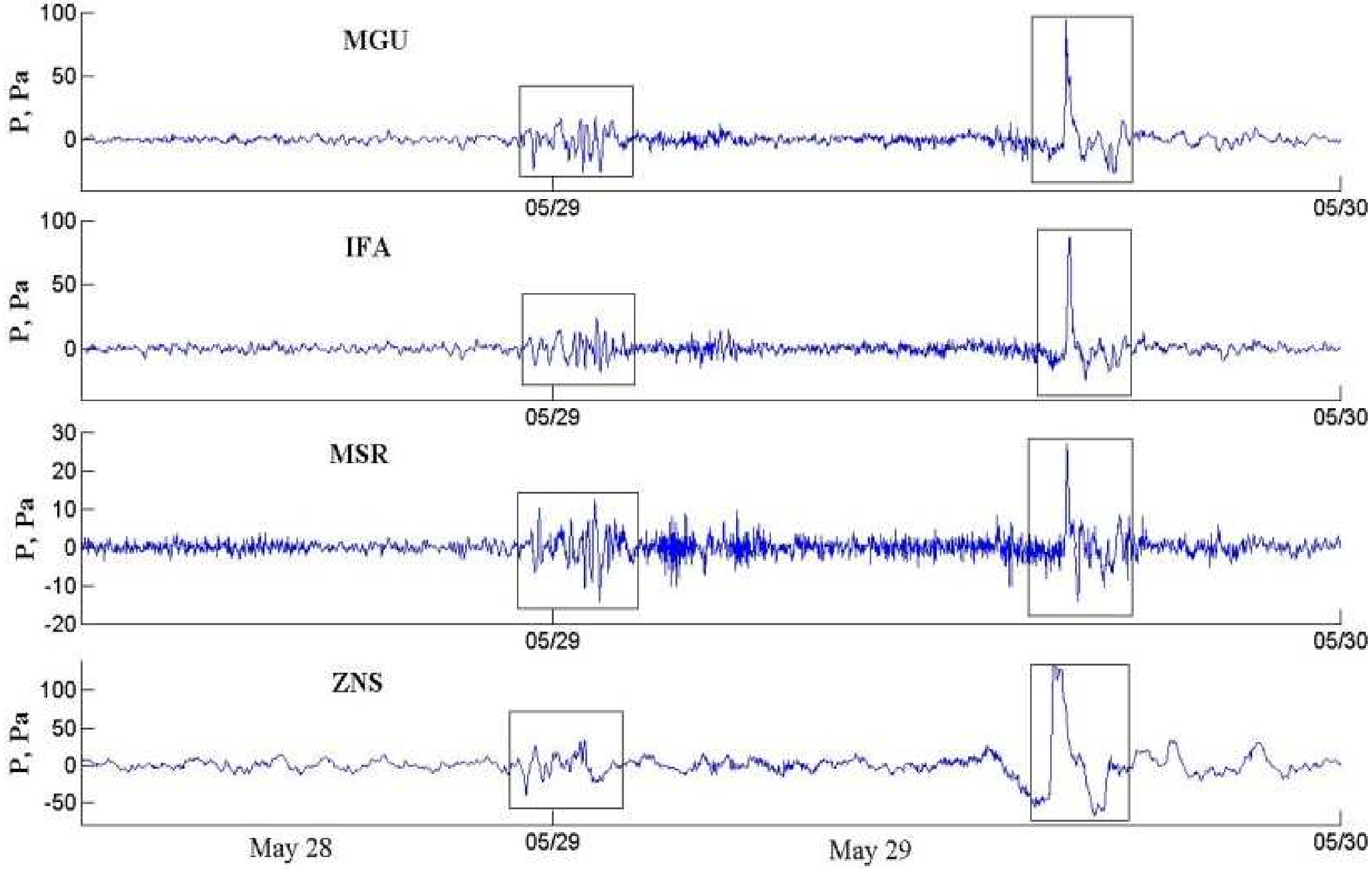
- The curve is plotted using 12 fronts.
- The tendency for an increase in *P* max with increasing *P* is clearly seen.

Results of the correlation analysis of atmospheric-pressure fluctuations from 23 to 30, May 2017



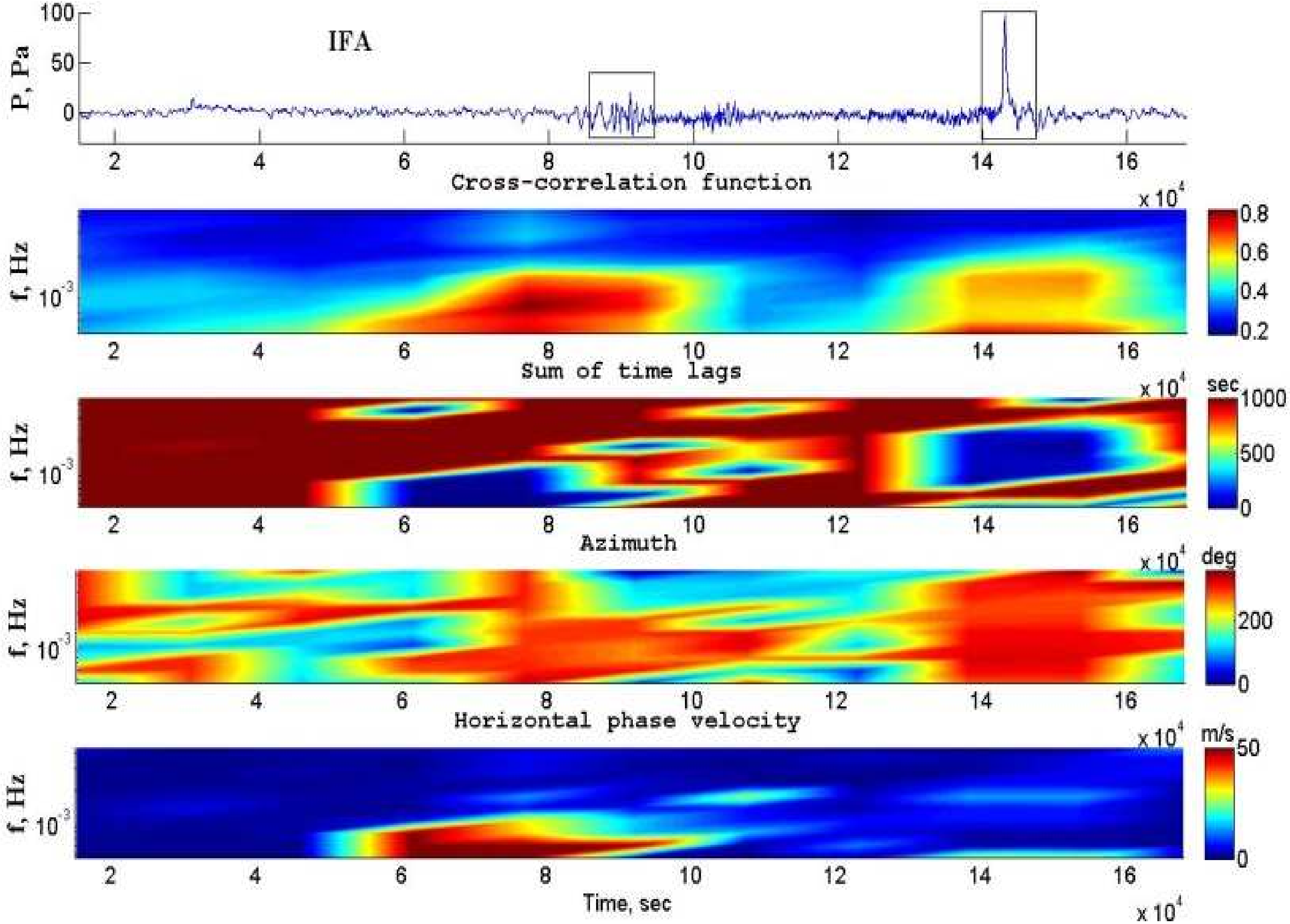
- With the passage of atmospheric fronts through receivers, as a result, the horizontal speed and signal intensity increase.
- The clearly pronounced time intervals, within which the sum of time lags is close to zero when the correlation function averaged over the three points tends to unity.
- Within these intervals, one can see the stable (in time) azimuths of the arrivals of waves and their horizontal phase velocities.

Signal precursors of the atmospheric storm on the night of May 29, 2017, and the main IGW arrival with a rapid change in the signal intensity approximately at 15:30 MSK

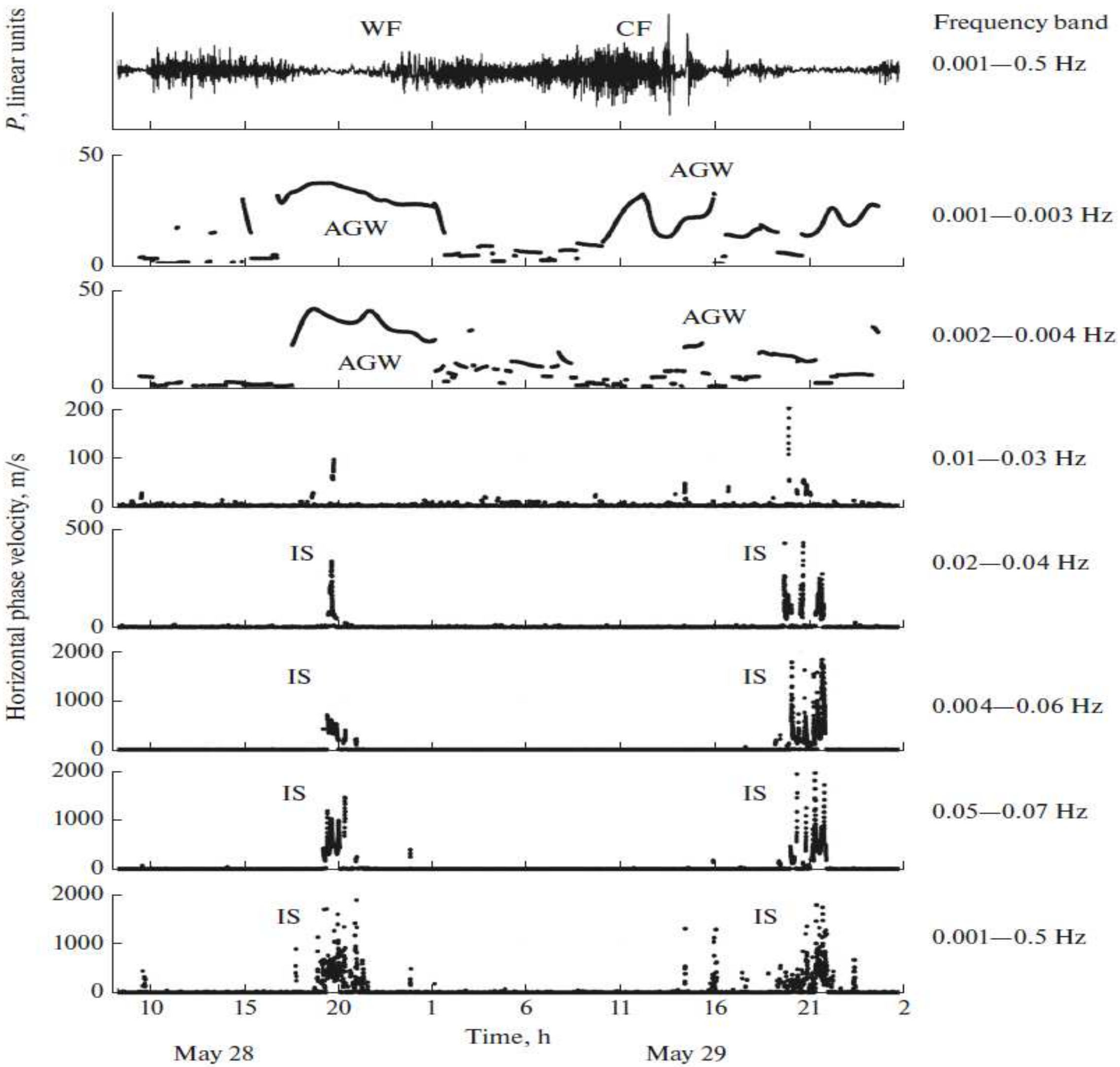


The long train of waves within (the left rectangles) are caused by the warm front arrived at the observation points over 15 h before the arrival of the train of IGWs and the rapid pressure jump associated with the cold front and the atmospheric storm of May 29 (the right rectangles). The signal frequency band is 0.0001–0.0015 Hz.

Results of the correlation analysis of atmospheric-pressure fluctuations



- The mean direction of the signal arrival during the passage of the cold front of the atmospheric storm was about 307°, i.e., the signal arrived from the northwestern direction.
- The horizontal phase velocities of propagation of these waves exceeded wind velocities and reached 50 m/s.
- This provided the possibility of using IGW precursors in forecasting the passage of atmospheric fronts in advance (a few hours before their passage) in real time.



Top: Signal recorded by one for the receivers at the IS43 station (in Dubna).

Below: Time dependences of the horizontal phase velocities of atmospheric gravity waves (AGWs) and infrasounds (IS) from the warm (WF) and cold (CF) fronts within different frequency ranges. MSK (Moscow time).

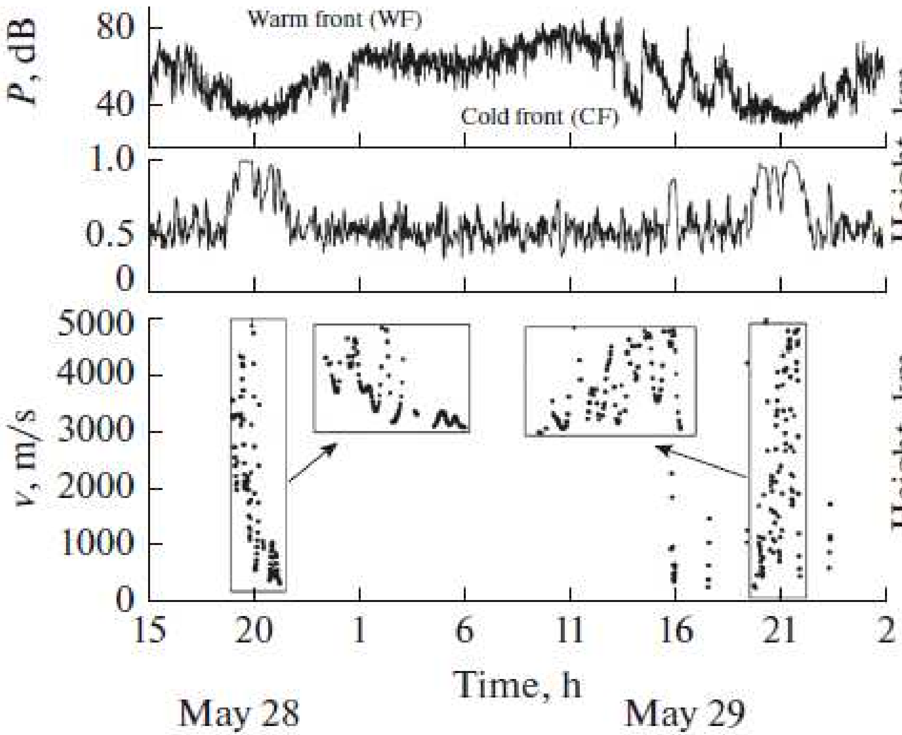
Within low-frequency ranges (corresponding periods are over 5 min) the horizontal phase velocities of wave disturbances do not exceed 50 m/s; i.e., they are characteristic of IGWs

(panel 2–3).

Within high-frequency ranges

over 0.01 Hz (corresponding periods are shorter than 100 s) the horizontal phase velocities of wave disturbances rapidly increase and reach 1000 m/s

(panels 4–8).



Top: IS level for one of the receivers at the IS43 station within a frequency range of 0.05–0.1 Hz during the passage of the warm and cold fronts on May 28 and 29. Below: the cross-correlation function for the pair of IS43 receivers and the horizontal phase velocity corresponding to correlation maxima.

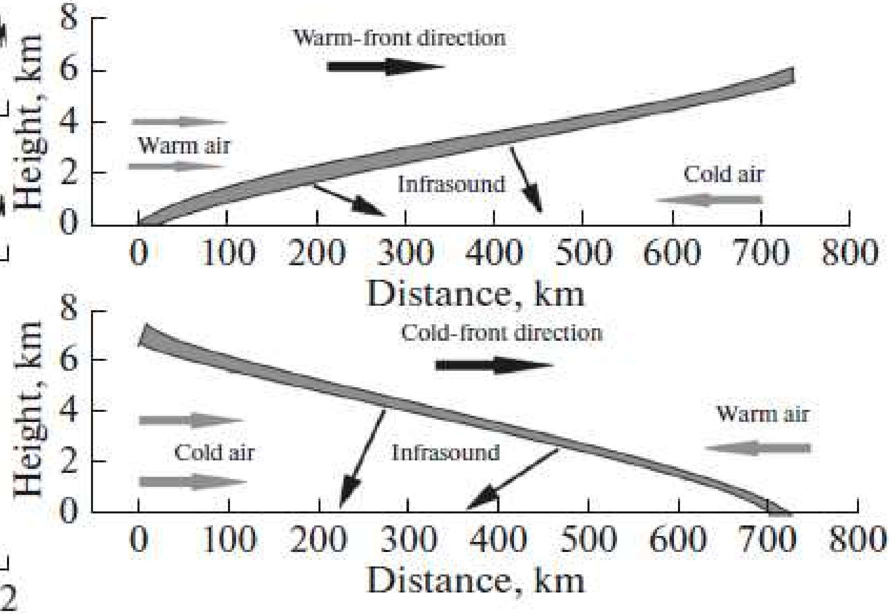
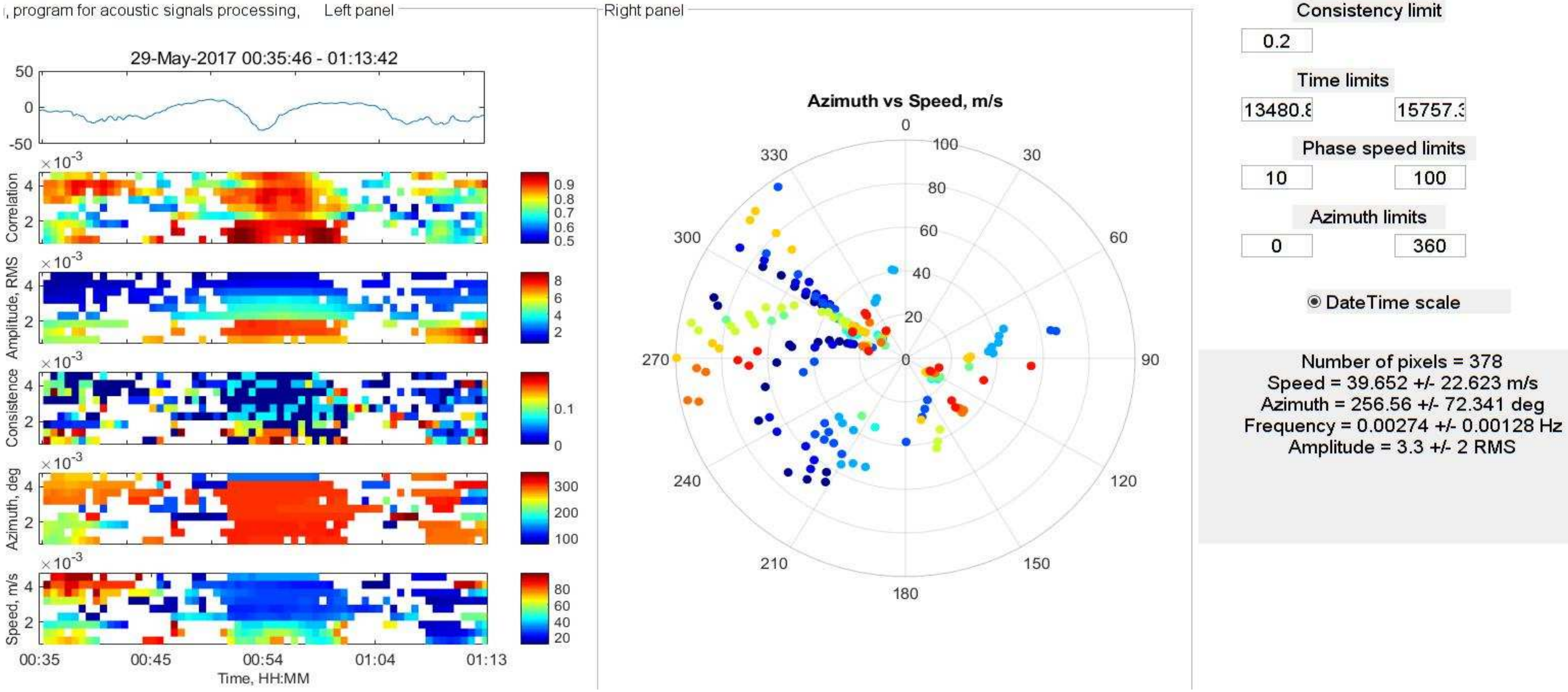


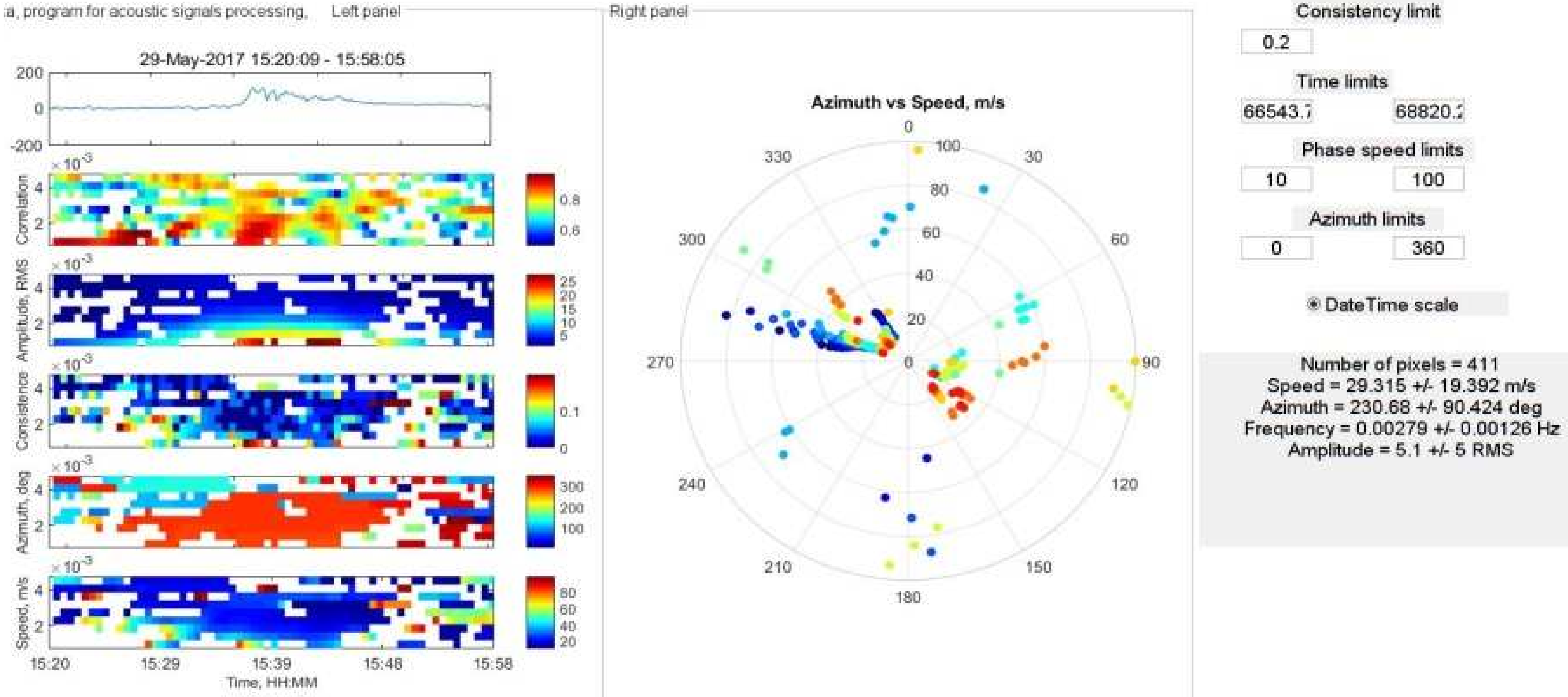
Diagram of warm and cold fronts.

Inclined arrows conventionally denote infrasound radiations by the fronts.

Processing the records of atmospheric-pressure fluctuations during the passage of a warm front for the period of time May 29, 2017 from 00:35:46 to 01:13:42 MSK (upper left panel): The left panel shows (top to bottom): correlation, amplitude, mean square delay, azimuth and phase velocity. The right panel shows the azimuth of the signal arrival and the phase velocity.



Processing the records of atmospheric-pressure fluctuations during the passage of a cold front for the period of time May 29, 2017 from 15:20:09 to 15:58:05 MSK (upper left panel): The left panel shows (top to bottom): correlation, amplitude, mean square delay, azimuth and phase velocity. The right panel shows the azimuth of the signal arrival and the phase velocity.



Conclusion

- Data on internal gravity and infrasound waves recorded during the passage of both warm and cold fronts throughout Moscow, which are associated with the atmospheric storm of May 29, 2017, are given.
- The structure and sizes of the measuring complex have made it possible to reliably determine the characteristics (coherence, azimuths, and propagation velocities) of the basic arrivals of IGWs from the atmospheric fronts within a wavelength range of a few to hundreds of kilometers.
- There are prospects for creating a system of warning about atmospheric fronts approaching Moscow region and estimating their power on the basis of data obtained with the four (IFA, MGU, MSR, ZNS) microbarographs located in Moscow and Moscow region.

Conclusion

- The analysis of data obtained with this measuring complex and from infrasonic measurements in the town of Dubna has made it possible to observe the transition from IGWs to the acoustic dispersive branch of acoustic-gravity waves generated by the fronts.

- A rapid change in the phase velocity of waves with increasing frequency was revealed, as was the IGW-induced modulation of the phase velocity of infrasound waves.


THANK YOU