Direct measurement of low frequency sound / audible sound propagation characteristics in middle and upper atmosphere using MOMO3 sounding rocket

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Variations in atmospheric pressure, temperature, density, wind, and composition (especially the ratio of water vapor as humidity) in the Earth’ s atmosphere and their profiles are the most important parameters for understanding and have been investigated. In this study, the sound wave propagation characteristics in middle and upper atmosphere are studied, where the sound wave propagation path is compared with the atmospheric model and verified with in-situ observation by using a sounding rocket operated by a private company.

The MOMO3 sounding rocket experiment took place in May 4 2019 at Taiki, Hokkaido. Using the sound of fireworks launched for experiments and the audible and infrasound sounds generated when launching the rocket itself as sound sources, sound propagation characteristics in the middle to upper atmosphere was investigated by comparisons between ground observations and direct measurement data from on-board equipment. In addition, for the purpose to compare and verify the sound wave propagation path with the atmospheric model, experimental data were analyzed.

During telemetry communication between the MOMO3 payload and the ground station was successfully performed for 282.5 seconds after the launch data at an altitude range from 0km to 113km in upleg and to103km in downleg was acquired by onboard infrasound sensor of INF03D. Figure 1 shoes the data acquired by INF03D.
Since MOMO3 payload data shoes a drastic change, it is possible that some impulsive sound events were successfully detected in the middle and upper atmosphere. During the first 120 seconds from the launch, the sensor measured the sound of the rocket’ s combustion, and during some periods the value showed completely saturated. The value of the sensor was fluctuated vigorously until T+120 second, (T is the time of launch) followed by subsequent T+200 second, and gradually changed to be small values. For characteristic signal were captured after T+200 second.

In the MOMO3 experiment, there is a possibility that the shock wave was continuously measured until about T + 200 seconds, and the four waveforms after T + 200 seconds show that the temperature (wind) There is a possibility that the sound was refracted by a change of temperature and/or wind profile and the sound was measured by sensors.
In this study, we tried to clarify the sound propagation characteristics. We conclude that the method used for analysis is effective for sound source prediction. However, the applied temperature and wind information required for analysis is an average value, not exact parameter for each altitude when the rocket was launched. In one rocket experiment data, the sound source could be predicted but could not perfectly be identified, thus we will verify the issue by comparing MOMO5 rocket experiment.

Keywords: Rocket, Infrastructure Sound, Atmosphere

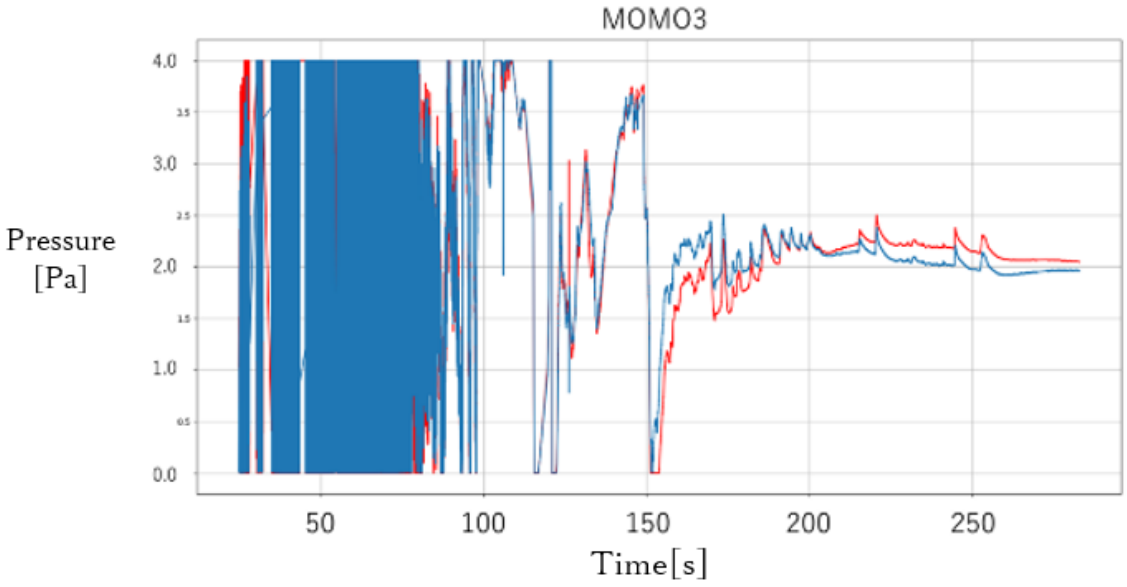

Figure 1 MOMO3 payload data (INF03D)

