Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MTT40-03 Room:203 Time:May 24 09:30-09:45

Attenuation curve of infrasound signal from a sounding rocket launch detected by multiple-sites arrayed sensors

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Infrasound and audible sound propagation in atmosphere is one of the open fields of the atmospheric science. Infrasound and atmospheric gravity waves propagating vertically up to the thermosphere is important in energy transportation way from the ground/ocean to the thermosphere. These waves can possibly be a seed of observable waves in upper atmosphere as many kinds of horizontal waves observed by optically or electromagnetically at each fixed altitude, suggesting they might be a key of atmospheric studies in vertical interactions. Many kinds of sources in naturally and artificially on ground, ocean, or troposphere like volcanic eruptions, earthquakes, tsunamis, artificial explosions, traffic of vehicles and planes can emit acoustic/infrasonic waves, however, experiments of direction finding by multiple-sites arrayed infrasound sensors in mesoscale region have been limited.

Determination of wave source coordinates of infrasonic waves was studied by using multiple eruptions of Sakurajima volcano and 3 sounding rocket launches from Uchinoura Space Center (USC), JAXA. In August 2012, we deployed 8 infrasound sensors at 4 sites as 2 triangles of 3-sensor arrays (Chaparral Model-2.5) and 2 independent sensors (Model-2) at 4 independent azimuths in separations within 14 km from the launch pad. During the experiment, JAXA's S-310-41 sounding rocket was launched at USC at 16:30 JST on Aug. 7, 2012. A clear infrasound pulse was detected at each 3 of 4 sites, however, not at 1 site. Based on the wind measurement on ground and by radiosondes, wind vector was ENE to WSW at the launch time. The observation site in negative result was located in SW azimuth and a high mountain was located between the launch pad and the site, implying the site was in the shadow region of the infrasound propagation at that time. According to the pulse signal at the other 3 sites and previous two rocket launches, attenuation curve by atmospheric viscosity was clearly observed between 1 km and 63 km, suggesting maximum propagation distance of about 40 km from the launch pad for S-310 and S-520 type sounding rockets.

The data were recorded as win-format files by Hakusan LS-8000WD and LS-8800 data loggers as well as SAYA 16 bit A/D boards with a PC at each site. Data viewer software directly from the win-format binary files was developed for the direction finding of wave source azimuth by each 3-sensor array. Using the software, infrasonic wave source coordinates by the Sakurajima eruptions and the rocket launches were successfully confirmed within a few km radius. In this paper, we will present a summary of direction finding experiments and introduce planned multiple-sites arrayed observation of infrasound in Kochi seacoast.

Keywords: infrasound, direction-finding, sensor array, sounding rocket, attenuation, atmospheric viscosity