

## Relationship between infrasonic and seismic waves as an example of multi-sphere interaction

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Infrasound is known as lower frequency pressure waves than the hearable sound by human ears, thus the frequency range is below 20 Hz. The pressure waves can usually be generated by moving surfaces in the atmosphere with a kind of *resonance* situation with a huge moving membrane. In the earth's atmosphere, it can be realized by moving massive geophysical surfaces such as landslides, earthquakes, and tsunamis, for example. Thus, the infrasonic wave is one of the important waves in nature to be continuously and carefully monitored, if we intend to develop disaster prevention system with any kinds of sensor networks. The infrasound can be understood generally being coupled with long scale seismic waves as well as sea waves, atmospheric gravity waves, and planetary scale tidal waves.

The pressure waves can propagate in the atmosphere not only for horizontal direction but also for vertical orientations. When the waves propagate upward from the ground, the waves can enhance their amplitude as the background atmospheric pressure comes to rarefied situation in upper atmosphere, decreasing with "scale height" basis. Thus, such pressure waves with a fixed frequency can collapse themselves in a fixed atmospheric density level, thus at a fixed altitude. At an altitude of collapsing waves, the energy can be released into the molecules there and the remained energy can be thought as a source of another waves. In the mesosphere and thermosphere, many kinds of wave patterns have been found as many remote-sensing methodologies, those are, imaging of airglows and mapping of total electron contents (TEC) by analyzing the GNSS satellites receiving waves, for example.

On the other hand, at a time of meteorites encountering into the earth's atmosphere, the hypersonic entry from the outer space can generate intense pressure waves as shock waves and then propagates vertically to the ground. At the special case of Hayabusa's artificial reentry in 2010, we conducted an experiment on ground to expand many seismic and infrasonic sensors in the desert area of Australia, measuring precise infrasonic waves and its coupling into the ground motion. Such coupling phenomena can usually be detected by seismometers and sea waves monitoring stations on/near the ocean. Coupling between the infrasound in the atmosphere and the seismic waves on ground, sea waves in the ocean, or the sea ice motion on the polar sea, is usually understood as the both directing interaction as the inter-sphere couplings. Here we will introduce some interesting case studies for the inter-sphere coupling processes, showing possibilities to conduct a new disaster prevention technique for tsunami and any other geophysical destructive events and/or a new monitoring proxy for the global warming.

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