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Synthesis of wind-affected long-period seismoacoustic waves

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We developed a method of seismoacoustic waveform calculation using a normal mode summation, in which we used a million of acoustic normal mode eigenfunctions that are calculated for an earth model including both atmospheric and solid parts by the method developed by Kobayashi (2007), with period longer than 10 s. As a performance test of the method, we calculated infrasounds generated by the 2008 Iwate-Miyagi Nairiku Earthquake, Japan since an infrasound monitoring station IS30 operated by CTBTO recorded clearly air pressure variations excited by the earthquake. The observed and calculated infrasonic waveforms in a period range longer than 30 s are in good match. However the arrival time of calculated acoustic wave packets are slightly different from observed ones by about 5 s. One of the causes of this discrepancy is the effect of winds on the propagation of acoustic waves in the atmosphere. To see this effect, we extend the normal mode calculation method to the case with zonal winds. In the case of degree one pattern of wind distributions, the simultaneous differential equations with respect to the radius can be decomposed into equations including only a single pair of azimuthal order (m) and angular degree (l). Assuming this simple situation, we calculated eigenfunction of $_0S_{29}$ which is the normal mode of solid earth and of which eigenfrequency is beside that of the acoustic normal mode $_0P_{29}$. We used CIRA86 model to calculate the degree one structure of zonal winds in the calculation. The vertical eigenfunctions of $_0S_{29}$ with m=-29 and +29 are slightly different in the atmosphere although their eigenfrequencies are very close to each other. This result implies the importance of winds on the property of acoustic modes. To understand it deeply, we use a simpler model of winds with linearly increasing or decreasing vertical profile, and discuss the effect of winds on wave propagations. Finally we will discuss about calculation of acoustic waves that propagates against winds and following winds using a more realistic wind profile for the 2008 Iwate-Miyagi Nairiku Earthquake.

Keywords: normal mode, waveform calculation, seismoacoustic, zonal wind, splitting, coupling