Changes in surface-wave phase velocities below the Greenland Ice Sheet measured from three-component ambient noise correlation method

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Basal conditions of the Greenland Ice Sheet (GrIS) are a key research topic in climate change studies. The recent construction of a seismic network has provided a new opportunity for direct, real-time, and continuous monitoring of the GrIS. In our previous research, we used ambient noise Rayleigh waveforms, extracted from vertical-component continuous seismograms from all over Greenland for a 4.5-year period, to detect changes in Rayleigh-wave phase velocity between seismic station pairs (Toyokuni et al., 2018, PEPI). We observed clear seasonal/long-term velocity changes for many pairs. Dominant factors driving the velocity changes might be seasonal and long-term pressurization/depressurization of the GrIS and shallow bedrock by air and ice mass loading/unloading. An interesting feature was that, even at adjacent two station pairs in the inland GrIS, one pair shows velocity decrease while another shows velocity increase as a response to the high air and snow pressure. The former pair might be located on a thawed bed that decreases velocity by increased meltwater due to pressure melting, whereas the latter pair might be located on a frozen bed that increases velocity by compaction of ice and shallow bedrock. The results suggested that surface waves are very sensitive to the GrIS basal conditions.

In this study, we extend our previous work for 5-year and three-component continuous seismograms from stations on GrIS, to yield none cross-correlograms (ZZ, ZR, ZT, RZ, RR, RT, TZ, TR, and TT, where Z, R, and T stand for the vertical, radial, and transverse components, respectively) between station pairs. Through these analyses, we have succeeded in retrieving Rayleigh waveforms (ZZ, ZR, RR, and RZ), Love waveforms (TT), and the coupling between Rayleigh and Love waves (ZT, RT, TZ, and TR). We find clear seasonal/long-term changes in both Rayleigh- and Love-wave phase velocities, whose characteristics are similar to those in our previous work using only ZZ copmponent. In this presentation, we mainly introduce the results for Love waves, which might be much sensitive to meltwater below the GrIS.

Reference:

Toyokuni, G., H. Takenaka, R. Takagi, M. Kanao, S. Tsuboi, Y. Tono, D. Childs, D. Zhao (2018) Changes in Greenland ice bed conditions inferred from seismology. Phys. Earth Planet. In. 277, 81-98. https://doi.org/10.1016/j.pepi.2017.10.010.

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