Physical dispersion with a reference frequency of 2 Hz: Bridging between short- and long-period S travel times

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The P to S velocity ratio carries important information about the composition and state of the mantle. Comparison of the existing P and S tomography models, however, may not be always justified because of large differences in their accuracy and resolution. Our plan is to start from short-period S wave tomography consistent with P travel time tomography. At the present stage, we confirmed the validity of our method to measure S travel time with an unexpected finding about the reference frequency of the physical dispersion.

Picking an arrival time of S wave is in general difficult, and waveform correlation is a method to solve this problem. With an assumption of a point source model, P and S waveforms at the source are identical, and so S waveform can be synthesized from observed P waveform by correcting attenuation effect. We take into account the physical dispersion which is characterized by two parameters t* and f0. The reference frequency f0 is conventionally set to 1 Hz. A search is made for the value of t* that gives the maximum cross-correlation for the first half cycle of waveform. Then S-P differential travel time is measured by cross-correlating synthetic and observed S waves. The measured S-P times have an advantage of being little affected by the uncertainty of the origin time. Our method is justified for the consistency of measured travel times and those of AK135 (Kennett et al.,[1995]).

To examine more detail, our cross-correlation method was checked against about 100 hand-picked S-P times. If the onset frequency were 1 Hz as conventionally regarded, the measured S-P with a reference frequency of 1 Hz and the hand-picked S-P should be close. We, however, found a systematic discrepancy of about 0.5 s between these two S-P times. This indicates a higher value for the reference frequency that is consistent with the onset frequency of short-period body waves. The 0.5 s discrepancy disappears when the reference frequency is taken to be 2 Hz.

This result should be of great significance in bridging between long- and shot-period S travel times. The body wave models and associated travel time curves such as JB, IASP91 and AK135 should be those at a reference frequency of 2 Hz, not 1 Hz. If one wishes to combine these body wave models with those derived from normal mode data by taking physical dispersion into account, some correction is required for the Q model.