AOB Seminar

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講演題目: Coseismic velocity changes caused by large crustal earthquakes in Japan - Comparison and depth estimation

Using Passive Image Interferometry, i.e. by cross-correlating ambient seismic noise recorded by Hi-net sensors, we measured coseismic and postseismic velocity changes for several earthquakes (Mw > 6.5) which occurred in Japan (Fukuoka 2005, Noto Hanto 2007, Iwate-Miyagi Nairiku 2008, three earthquakes in Niigata prefecture 2004, 2007 and 2011). For each of these earthquakes, we cross-correlated ambient seismic noise recordings of several years in four different frequency ranges between 0.125 and 2.0 Hz. Using a simple tomography algorithm, the observations of the different station pairs can be reprojected onto the actual station locations. For the analyzed earthquakes, the observed coseismic velocity changes are systematically larger at higher frequency. As the analyzed seismic noise is mainly composed of surface waves, these findings suggest that the coseismic velocity changes are concentrated in the shallow layers of the ground structure.
The cross-correlation analysis fails at higher frequencies, as the distance of a station pair becomes too large for well-correlated signals. Auto-correlations of the signals at a single sensor might work better at higher frequencies, but they are prone to changes in the seismic noise field or human activities. We can overcome these problems by correlating the different components of a single sensor (self-correlation). In this way, the frequency range of velocity variations can be increased to about 4 Hz.

Using the coseismic velocity changes at different frequencies, the actual depth distribution of the coseismic velocity changes can be modeled. Starting from a reference shear and pressure wave velocity profile, the corresponding Rayleigh wave dispersion curve is modified according to the measured velocity changes in the different frequency ranges. By changing the original velocity profile in a simple way (constant percental velocity change between given depths), the depth distribution of the coseismic velocity changes can be constrained. Using this modeling, we find that for stations close to the epicenter of the Iwate-Miyagi Nairiku earthquake, the coseismic velocity change is most likely to be of the order of - 3 % to - 5 % and to be concentrated in the shallowest several hundred meters, whereas a station at the southern end of the fault zone shows a more complicated damage which is most likely to reach several kilometers of depth.