My project during the 3 months at ERI was to pursue the collaboration with Shingo Watada on the search for the horizontal motion of the seismic mode 0S0. This fundamental radial seismic mode is called the "breathing mode" of the Earth with a period of 20.5 min. In a spherically symmetric Earth model, 0S0 surface amplitude is the same everywhere on the Earth's surface and can be observed only on vertical components. However, in a more realistic three-dimensional heterogeneous rotating elliptic Earth model, our past computation has shown that the amplitude of 0S0 should be present also on horizontal components by coupling effects with other seismic modes through lateral heterogeneities of the Earth. In order to search for this small amplitude effect, we have to consider low noise sites and stack horizontal seismograms. Since horizontal seismograms are known to be noisier than vertical components, particularly because of the atmospheric tilt-induced noise, we had to try to reduce this noise as much as possible. So the title of my project was:

Reduction of atmospheric pressure noise on horizontal seismograms of F-net stations in the long-period seismic band

We have considered 9 F-net stations which are equipped with a barometer. By computing a transfer function between horizontal accelerations and local pressure changes and its Hilbert transform, we can estimate some barometric admittance that are then used to correct horizontal accelerations from the atmospheric effect. The use of the Hilbert transform of the pressure changes enables to correct the tilt-effect induced by travelling waves in the atmosphere. Such noise reduction was efficient for most of the 9 sites. Particularly the signal to noise ratio of the seismic modes below 1 mHz, that were excited after the largest past recent earthquakes (for instance M_w9.0 2011 Tohoku and M_w8.8 2010 Maule-Chile earthquakes), is improved by this atmospheric reduction. In order to try to further reduce the noise level of horizontal seismograms, we have checked the contribution of a regional barometric network on the seismometer horizontal noise. For that we have collected barometric data from the Japan Meteorological Agency and from barometers installed by Pr. Imanishi around Matsushiro seismometer site (cf map below of the barometer, F-net and Matsushiro sites). Unluckily the contribution of the regional barometer to the atmospheric pressure reduction turned out to be less than 2% of the variance reduction. So only the local barometric reduction was efficient to reduce the noise level of horizontal components. Since the horizontal motion of 0S0 could not be detected by stacking the atmospheric-reduced F-net seismic records, we have to consider another method to try to detect this small signal.