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InSAR analysis on inland crustal activities induced by the 2011 off the Pacific coast of Tohoku earthquake

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We detected local crustal deformations induced by the 2011 off the Pacific coast of Tohoku earthquake on March 11 (Mw9.0) by interferometric synthetic aperture radar (InSAR) analysis. We used ALOS/PALSAR images acquired before and after the earthquake and processed with the GAMMA software suite. We used the digital elevation models of the Geospatial Information Authority of Japan and hole-filled SRTM to remove topographic fringes.

First of all, we created interferograms in which large wavelength phase changes are dominant by far. To detect local signals, next, we determined coefficients of the bi-quadratic function, which well represents the large wavelength phase change, and subtract the modeled phase change from observed phase change. With this procedure, we succeeded in detecting many local signals induced by this large earthquake.

Some of the detected local signals clearly correspond to large and shallow inland earthquakes: an earthquake at northern Nagano pref. on March 12 (M6.7) and April 12 (M5.8), at eastern Shizuoka pref. on March 15 (M6.4), etc. Among all, we detected large phase changes due to large normal fault earthquakes along the Pacific coast in the northern Ibaraki and the southern Fukushima prefectures. In this region, the local fringes match the local topographic expression (active faults, steep slopes, rivers, etc.) implying that the normal fault motions have been accumulating over geologic time scale. Seemingly, reported earthquake hypocenters and mechanisms in this region cannot explain the detected phase changes.

Local crustal deformations are likely to be induced in and around the volcanic and/or geothermal area. We found signals in Mt. Fuji, Mt. Azuma, near the Naruko caldera, Nikko area, etc. However, we should be careful of atmospheric phase delay because the amplitude of the detected signals is not large.

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