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Understanding of crustal activity based on spatiotemporal relationships between various geophysical measures (4)

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For comprehensive understanding of crustal activities, which are expected to be accompanied by their time variations prior to large inland earthquakes, it is important to develop a monitoring index / indices which are useful for monitoring of crustal activities. With the aim of developing monitoring indices well featuring crustal activities, we have focused on the spatiotemporal relationships between any two of geophysical measures, at least one of which must be time-variable. For smooth comparisons between geophysical measures, we have created a database with spatially and temporally gridded formats from geophysical datasets such as seismicity, GPS, gravity anomaly, and geothermal gradient, which reflect crustal activities with different time scales. As a further step to create a monitoring index / indices, we developed a statistical validation system which evaluates the association of the relationship between geophysical measures with the occurrence times of large inland earthquakes. Furthermore, we have improved the system by adding a statistical evaluation process based on error diagram (Molchan diagram). This leads to more improved and informative statistical evaluation than the previous one, which was based on only probability gains of true positive ratio (prediction rate) and hit rate (alarm rate) calculated from a contingency table. The improved validation system requires the input of a pair of geophysical measures, various adjusted parameters such as a grid interval of gridded data used, and definition of a monitoring index, and leads to the output of the result of the statistical evaluation based on probability gains of true positive ratio and hit rate and error diagram. We applied the improved system to four pairs of seismic and geodetic measures (seismic energy, the number of earthquakes, dilatation rate, and maximum shear strain rate) over inland Japan with designated spatially and temporally gridded data formats, which were obtained from the JMA hypocenter catalog and the GSI GEONET data, respectively. In this application, we defined the same monitoring indices for the four pairs as in Kawamura *et al.* (2010). With the improved system, the monitoring index created based on the relationship between dilatation rate and seismic energy turned out to statistically most reflect the temporal changes in crustal activities prior to large ($M >= 6.0$) inland mainshocks. This was consistent with the result based on only probability gains of true positive ratio and hit rate in Kawamura *et al.* (2010). This result needs to be validated by updating the database to which the improved validation system is further applied.

Keywords: Seismicity, Strain rate, Spatiotemporal relationship, Crustal activity, Probability gain, Error diagram