Applicability of Empirical Orthogonal Function in Crustal Deformation Analysis: A Review

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With the rapid increase and availability of dense continuous GPS network data, an automatic, transparent and regular way of crustal deformation analysis is highly desirable in many seismically active large geographical regions. In this study, we provide a review of empirical orthogonal function (EOF) with a focus to the applicability in crustal deformation analysis. For this, (i) we provide a mathematical description of EOF that utilizes both time-series and spatial patterns of data, (ii) we highlight the advantages and limitations of EOF in comparison to the method of principal component analysis (PCA), (iii) we discuss numerous applications of EOF technique in co-seismic deformation analysis in Taiwan, reconstruction of gappy coordinates of continuous GPS stations, modeling of ionospheric total electron content over South Korea and African regions, and gravity changes due to large earthquakes detected in GRACE satellite data. The EOF-based coherent spatio-temporal analysis is observed to be an appropriate method to eliminate GPS common mode error that comprises environmental and technique-dependent systematic errors. The EOF approach is not only superior to the ordinary least-squares estimation of solution vector in overdetermined system, but also encourages innovative data-summarization techniques in crustal deformation analysis. Towards the end, we provide some prospective EOF applications that can be intertwined to the conventional notions of geophysics and associated fields.

Keywords: Empirical orthogonal function, GPS, common-mode error

