Horizontal deformation in NE Japan from triangulation, trilateration, and GPS from 1890 to 2010

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Crustal deformation has been transformed in past decades by the availability of continuous GPS data. Time series analysis of GPS data often assumes strain accumulation at a steady rate. In the case of NE Japan, analysis of horizontal GPS data from 1996-2010 revealed crustal accelerations in the decade prior to the 2011 Tohoku-oki earthquake (Mavrommatis et al., 2014). Whether this represented precursory activity before the 2011 Tohoku-oki earthquake is open to debate. The limited duration of the observations makes it difficult to assess how these transients relate to the full interseismic period.

Historical geodetic data are available in Japan since the end of the 19th century. The data consist of two triangulation surveys (1890-1912; 1948-1968) and two trilateration campaigns in the latter half of the 20 th century (1973-1985; 1977-1994). Examination of historical data in combination with the GPS data can provide a way to evaluate the velocity and strain distributions in the last 100 years and elucidate whether the acceleration observed prior to the 2011 Tohoku-oki earthquake represents a short-term transient deformation or not. Thus, we analyze horizontal deformation in NE Japan utilizing all the geodetic sets available.

We estimate horizontal displacement fields in NE Japan for the historical geodetic data using the method developed by Yu and Segall (1996). In this, a denuisancing procedure is performed so that the dependency of the data on station coordinates is projected out of the system of equations and the horizontal displacement fields can be estimated directly. These results are transformed into average velocities by assuming steady deformation over the survey period. The null space inherent in trilateration and triangulation data is constrained by GPS velocities in either the early GPS (1996-2000) period or the period prior to the 2011 Tohoku-oki earthquake (2009-2010).

In this presentation, we will present the horizontal displacement fields for Northeast Japan in the last 100 years. We will offer a comparison of the historical data with the contemporaneous GPS data, as well as an evaluation of the strain state in NE Japan.

Keywords: Crustal deformation, Geodetic data, Interseismic period, Transient deformation