Introduction
The tectonic movement of the northeastern margin of the Tibetan Plateau has been very strong since the new tectonic period, which is very important in terms of geotectonic position. In this paper, two types of geodetic measurements, GRACE and GPS, are combined to study the vertical crustal deformation on this area, for obtaining more information of the crustal tectonic deformation field there.

GRACE and GPS Data
The GRACE Level-2 monthly data used here were obtained from the GSM Release-05 products provided by the Center for Space Research (CSR), University of Texas, for the period between March 2002 and November 2014 up to degree 60.

The GPS measurements used in this paper are provided by the Crustal Movement Observation Network of China (CMONOC) and were collected by 40 continuous GPS stations along the margin of the Tibetan Plateau.

The GPS data can be divided into two groups: Period I includes 4 long occupational sites – DLHA, DXIN, XNIN and YANC – with approximately 15 years of observations, and period II includes stations with nearly 4 years of observations.

Results
Both GRACE and GPS vertical time series show significant seasonal variations.

To further analyze the correlation between these two time series, we simultaneously fit the mean, trend, annual and semiannual signals using the following equation:

\[ y = a + b \cdot t + A_\sigma \cos(\omega(t - \Phi)) + \Delta A_\sigma \cos(2\omega(t - \Phi)) \]

The two geodetic data sets are highly consistent in terms of the amplitudes and phases of the annual signals.

Conclusions
This result suggests that increasing the length of the observation period eliminates the influences of some nonlinear factors in the GPS signals and is beneficial for extracting seasonal effects from GPS time series.

The correlations between GRACE-derived vertical deformation due to seasonal hydrological loading and GPS-observed seasonal position variations are very high for most of the 40 stations.

In addition, we found that approximately 73% of the GPS vertical time series featured a significant WRMS reduction of approximately 40%. This reduction reaches 60% by subtracting the corresponding seasonal components derived from GRACE measurements.

The estimated secular trends decreases by 46% in the vertical direction, indicating that the seasonal effect in campaign GPS stations can be modified well by GRACE data.