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Assessments of higher-order ionospheric effects on GPS coordinate time series: A case study of CMONOC with longer time series

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Higher-order ionospheric (HIO) corrections are proposed to become a standard part for precise GPS data analysis. For this study, we deeply investigate the impacts of the HIO corrections on the coordinate time series by implementing re-processing of the GPS data from Crustal Movement Observation Network of China (CMONOC). Nearly 13 year data are used in our three processing runs: (a) run NO, without HOI corrections, (b) run IG, both second- and third-order corrections are modeled using the International Geomagnetic Reference Field 11 (IGRF11) to model the magnetic field, (c) run ID, the same with IG but dipole magnetic model are applied. Both spectral analysis and noise analysis are adopted to investigate these effects. Results show that for CMONOC stations, HIO corrections are found to have brought an overall improvement. After the corrections are applied, the noise amplitudes decrease, with the white noise amplitudes showing a more remarkable variation. Low-latitude sites are more affected. For different coordinate components, the impacts vary. The results of an analysis of stacked periodograms show that there is a good match between the seasonal amplitudes and the HOI corrections, and the observed variations in the coordinate time series are related to HOI effects. HOI delays partially explain the seasonal amplitudes in the coordinate time series, especially for the U component. The annual amplitudes for all components are decreased for over one-half of the selected CMONOC sites. Additionally, the semi-annual amplitudes for the sites are much more strongly affected by the corrections. However, when diplole model is used, the results are not as optimistic as IGRF model. Analysis of dipole model indicate that HIO delay lead to the increase of noise amplitudes, and that HIO delays with dipole model can generate false periodic signals. When dipole model are used in modeling HIO terms, larger residual and noise are brought in rather than the effective improvements.