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Determination of seasonals using wavelets in terms of noise parameters changeability

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The reliable velocities of GNSS-derived observations are becoming of high importance nowadays. The fact on how we determine and subtract the seasonals may all cause the time series autocorrelation and affect uncertainties of linear parameters. The periodic changes in GNSS time series are commonly assumed as the sum of annual and semi-annual changes with amplitudes and phases being constant in time and the Least-Squares Estimation (LSE) is used in general to model these sine waves. However, not only seasonals' time-changeability, but also their higher harmonics should be considered. In this research, we focused on more than 230 globally distributed IGS stations that were processed at the Military University of Technology EPN Local Analysis Centre (MUT LAC) in Bernese 5.0 software. The network was divided into 7 different sub-networks with few of overlapping stations and processed separately with newest models. Here, we propose a wavelet-based trend and seasonals determination and removal of whole frequency spectrum between Chandler and quarter-annual periods from North, East and Up components and compare it with LSE-determined values. We used a Meyer symmetric, orthogonal wavelet and assumed nine levels of decomposition. The details from 6 up to 9 were analyzed here as periodic components with frequencies between 0.3-2.5 cpy. The characteristic oscillations for each of frequency band were pointed out. The details lower than 6 summed together with detrended approximation were considered as residua. The power spectral densities (PSDs) of original and decomposed data were stacked for North, East and Up components for each of sub-networks so as to show what power was removed with each of decomposition levels. Moreover, the noises that the certain frequency band follows (in terms of spectral indices of power-law dependencies) were estimated here using a spectral method and compared for all processed sub-networks. It seems, that lowest frequencies up to 0.7 cpy are characterized by lower spectral indices in comparison to higher ones being close to white noise. Basing on the fact, that decomposition levels overlap each other, the frequency-window choice becomes a main point in spectral index estimation. Our results were compared with those obtained by Maximum Likelihood Estimation (MLE) and possible differences as well as their impact on velocity uncertainties pointed out. The results show that the spectral indices estimated in time and frequency domains differ of 0.15 in maximum. Moreover, we compared the removed power basing on wavelet decomposition levels with the one subtracted with LSE, assuming the same periodicities. In comparison to LSE, the wavelet-based approach leaves the residua being closer to white noise with lower power-law amplitudes of them, what strictly reduces velocity uncertainties. The last approximation was analyzed here as long-term trend, being the non-linear and compared with LSE-determined linear one. It seems that these two trends differ at the level of 0.3 mm/yr in the most extreme case, what makes wavelet decomposition being useful for velocity determination.