Tidal wind mapping from observations of a meteor radar chain

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We propose a technique to map the tidal winds in the mesosphere and lower thermosphere (MLT) region from the observations of a four-station meteor radar chain located at middle- and low-latitudes along the 120°E meridian in the Northern Hemisphere. The horizontal winds in the altitude range of 70–110 km is observed by the meteor radar chain (including Mohe, Beijing Wuhan and Sanya station). We first decompose the tidal winds into mean, diurnal, semidiurnal, and terdiurnal components for each station. It is found that the diurnal/semidiurnal components dominate at the low-latitude/midlatitude stations. Their amplitudes increase at lower altitudes and then decrease at higher altitudes after reaching a peak in the MLT region. Pronounced semiannual oscillation (SAO) is presented in the diurnal component. While latitude-depended seasonal variation is found in the semidiurnal and terdiurnal components. At the low/mid- latitude stations, the semiannual/annual oscillation is relatively stronger. Hough functions of the classical tidal theory are then used to fit the latitudinal distribution of each decomposed component. The diurnal component is found to be dominated by the first symmetric (1, 1) mode. Yet for the semidiurnal and terdiurnal components, the corresponding dominant modes are the second symmetric modes (2, 4) and (3, 5), and considerable contributions are also from the first antisymmetric modes (2, 3), (3, 4) and second antisymmetric modes (2, 5), (3, 6). Apparent SAO is observed in the dominant (1, 1) mode; (2, 4) mode is strong in the autumn and winter months (after the Sep. equinox). Based on the decomposed results, we further map the horizontal winds in the domains of latitude, altitude and local time. The mapped horizontal winds successfully reproduce the local time versus altitudinal distributions of the original observations at the four stations. Additionally, the mapped results are finally compared with the corresponding values observed by TIDI/TIMED and modeled from GSWM. Each mapped tidal component agrees well with corresponding TIDI observation in the seasonal variation. Meanwhile, coincidences are found in the seasonal dependency of the diurnal component between the mapped values and the modeled results from GSWM, while difference between them exists in that of the semidiurnal one. Thus, we conclude that the meteor radar chain is useful to monitor and study the regional characteristics of the tidal winds in the MLT region.