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Diagnosing the zonal wavenumber of tidal variants through a phase differencing technique

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A propagating wave induces coherent oscillations everywhere on the wave's path but typically in different phases. This phase difference provides a possibility to diagnose the wavenumber with a limited number of detectors. The possibility was realized, for example, on the observations from the Magnetospheric quadruple-spacecraft mission Cluster. The current study consolidates the technique to a framework and further implement the framework to mesospheric zonal wind observations from a configuration of two midlatitude meteor radars, located in Germany and China, respectively. Our case study of 2013 SSW demonstrates that the periodicities of 11.6 and 12.4 hours are characterized by m=3 and m=2, respectively. Besides dominated by the m=2 mode, the 12.4 hours periodicity also comprises a weak mode m=1. These results suggest (1) the semidiurnal spectral sidebands extracted from ground-based observations and the qSW1/qSW3 (the quasi-semidiurnal westward-propagating modes with zonal wavenumber =1 and 3) enhancements observed by satellites are signatures of identical phenomena but observed from different perspectives, and (2) the zonal structure of the 12.4 hours periodicity fits the suspected nominal mode of semidiurnal lunar tide.