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Long-term changes in mesospheric wind and wave estimates based on radar observations in both hemispheres

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Several studies (Banerjee et al. (2020) and before that Sun et al. (2014)) found a trend reversal between winter and summer circulation in the southern hemisphere around 2000 in the middle atmosphere. One may argue that the negative trend after 2000 is due to the CO_2-induced change in stratospheric dynamics. However, Ramesh et al. (2020), using the newest WACCM6 simulation and a multiple linear regression model, confirmed that the negative trend in the stratosphere after 2000 can be attributed to ozone recovery. Here we investigate how stratospheric trends relate to trends in the mesosphere and lower thermosphere (MLT) dynamics. Using the adaptive spectral filtering (ASF) method (Stober et al., 2021), we study long-term changes in mesospheric wind and planetary and gravity wave estimates of meteor radar stations in the northern (NH: Collm, Kiruna, Sodankyla, CMOR) and southern (SH: Rio Grande, Davis, Rothera) hemisphere, respectively, for the altitude range of 80–100 km. Linear trends have been estimated (from monthly means calculated from the preprocessed original data using ASF) by the Theil–Sen estimator (Theil, 1950; Sen, 1968). The robustness of our fitting method is assessed in terms of spurious trends due to, e.g., high autocorrelation of relatively short time series. The long-term changes are validated in two whole-atmosphere models, namely, GAIA and WACCMX-SD (both nudged in the stratosphere). While both models reveal issues reproducing basic climatology in the mesosphere, GAIA fairly reproduces the trends captured by the meteor radars. Finally, we conclude that the ozone recovery effects in the SH stratosphere influence the dynamics in MLT via gravity wave coupling.