EGU22-776
https://doi.org/10.5194/egusphere-egu22-776
EGU General Assembly 2022

Interannual variability of the 12-hour tide in the mesosphere and lower thermosphere in 15 years of meteor-radar observations above Rothera (68° S, 68° W)

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The wind field in the mesosphere and lower thermosphere (MLT), at heights between 80 and 100 km, is dominated by the global scale oscillations of the atmospheric tides. The tides are crucial to the dynamics of the middle and upper atmosphere and hence to understanding the coupling between the lower atmosphere and space. The tides are known to show considerable variability on timescales of days to years, with significant variability at interannual timescales. However, the nature and causes of this variability remain poorly understood. Here, we present measurements made over the interval 2005 to 2020 of the interannual variability of the 12-hour tide as measured at heights of 80 – 100 km by a meteor radar over the British Antarctic Survey base at Rothera (68°S, 68°W). We use a linear regression analysis to investigate correlations between the 12-hour tidal amplitudes and several climate indices, specifically the solar cycle (as measured by F10.7 solar flux), El Niño Southern Oscillation (ENSO), the Quasi-Biennial Oscillation (QBO) at 10 hPa and 30 hPa, the Southern Annular Mode (SAM) and time. Our observations reveal that the 12-hour tide has a large amplitude and a clearly defined seasonal cycle with monthly mean values as large as 35 ms^{-1}. We observe substantial interannual variability with monthly mean tidal amplitudes at 95 km exhibiting an interdecile range in spring of 17.2 ms^{-1}, 12.6 ms^{-1} in summer, 23.6 ms^{-1} in autumn and 9.0 ms^{-1} in winter. We find that F10.7, QBO10, QBO30, SAM and time all have significant correlations at the 95% level, whereas we detect very minimal correlation with ENSO. For example, there is a significant negative correlation between F10.7 solar flux and tidal amplitudes in summer, implying an increase in solar flux is related to a decrease in monthly mean tidal amplitudes in the MLT. These results suggest that the amplitude of the polar 12-hour tide is modulated by the solar cycle, QBO and SAM.