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On the evaluation of the short-term variability of atmospheric tides and gravity waves based on ground-based measurements and reanalysis data of temperatures and horizontal winds

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The variability of the middle atmosphere is driven by a variety of waves covering different spatial and temporal scales, e.g., gravity waves (GWs), thermal tides and planetary waves. The temporal variability of thermal tides and GWs due to changes in the background atmosphere is diagnosed by an adaptive spectral filter taking into account the intermittency of tidal waves. We apply this diagnostic to temperature observations from a daylight-capable lidar at mid-latitudes (54°N, 12°E) as well as to reanalysis data of horizontal winds from MERRA-2. These data provide additional information on a global scale as well as winds in an altitude range, where wind measurements are typically not available. A comparison of the temperature and wind information affirms whether there is a fixed phase relation of the tidal waves in the temperature and the wind data. We found that in general the tidal signature is weaker in temperatures compared to the signature in winds. While the meridional wind tide is leading the zonal wind tide, the phase relation between the temperature and the wind tide is more complex. At certain altitudes the temperature tide follows the zonal wind tide. This knowledge will help to improve the interpretation of the seasonal variation of atmospheric waves from different observables. The findings presented here clearly show the importance of a measurement acquisition on a routine basis with high temporal and spatial resolution.