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Mid-mesospheric radar echoes: recent observations with a novel MST-radar and implications for the scattering mechanism

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The novel Middle Atmosphere ALOMAR Radar System (MAARSY) has been used to study radar echoes from mid mesospheric altitudes, i.e., from $\sim$60 – 80 km. Compared to previously used radar systems, MAARSY possesses a much enhanced sensitivity for the detection of these echoes due to its large transmitted power of $\sim$800 kW and an antenna aperture of approximately 6300 m^2. Owing to this large sensitivity, echoes have been observed throughout the entire year but show a pronounced maximum of occurrence during winter months. The echoes further reveal a clear diurnal variation which is mainly driven by the diurnal variation of Ly-α ionization in this lowermost part of the ionosphere which is further modulated by geomagnetic activity. In addition, the diurnal occurrence pattern over altitude provides evidence for a relation of these echoes to tidal downward phase propagation. This is further scrutinized by comparison of the diurnal echo morphology to the corresponding morphology of tidal wind structures in the same altitude range as observed with collocated MF-radars. The same MF-radar observations are further used to investigate the frequency dependence of the observed echoes promising insight into the underlying scattering mechanism. This is important since the scattering mechanism is currently debated between two major hypotheses. One of these is invoking infrasound propagation and viscosity waves and the other is proposing neutral air turbulence as the main physical process creating these echoes. Finally, we also present some first multi-beam observations of these echoes which allow us to determine their horizontal structure and study their relation to horizontal wave propagation.