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Determining the origin of tidal-like neutral wind modulations in the ionospheric transition region with EISCAT

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The ionospheric dynamo region marks the transition from a collision dominated plasma below ~ 90 km to a nearly collisionless plasma above ~ 150 km. Processes at these altitudes can be forced either from above or below. Placing their origin could help understanding the complex coupling of solar and terrestrial influences.
Tidal-like oscillations of the neutral wind velocity can be used to identify these impacts. Limitations of other ground based instruments to altitudes below ~ 110 km leaves Incoherent Scatter Radars (ISR) as only instrument to measure plasma parameters across the whole transition region. Neutral wind velocities can be extracted following the method described in e.g. [1] utilizing the steady state ion mobility equation. The beam swinging mode of the ISRs operated by EISCAT allows to retrieve three dimensional ion velocity vectors from line of sight measurements. The ion-neutral collision frequency ν_{in} as central coupling parameter can either be calculated from models or directly measured due to the multifrequency capability of EISCAT, as demonstrated in [2].
The classical picture of tidal-like modulations in the ionosphere has semidiurnal atmospheric tides propagating upwards and diurnal variations being forced by the plasma convection pattern over the polar cap. The transition from predominantly semidiurnal to diurnal oscillations takes place somewhere around 120 km altitude, though 12h oscillations can be detected at higher altitudes (~ 250 km) as well [3]. A 22 day long EISCAT UHF campaign conducted in September 2005 confirmed the validity of this concept up to an altitude of 120 km [1].
In this paper, data from the same measurement campaign is evaluated up to an altitude of 140 km. The change of predominant oscillation period at or slightly below 120 km, as found in [1], has been confirmed. A transition back to stronger 12h variations has been detected at altitudes 130 km. The EISCAT measurements are validated and complemented by other instruments (e.g. meteor radars) and compared to global circulation models (GAIA and WACCM-X SD). Experimental and model data both show an upper band of strong semidiurnal oscillations above $\sim$130 km. The use of Adaptive Spectral Filtering (ASF) technique [4] allows to investigate day-to-day variability and phase progression of tidal-like oscillations. Also, the ASF technique takes into account the uncertainty of the input neutral wind data. The retrieved amplitudes therefore remain reliable at high altitudes where the uncertainty is increased. From phase progression analysis, propagating and *in situ* generated modulations can be distinguished. The phase information from global model data suggests the upper 12h oscillation band to be an *in situ* generated, sun-synchronous semidiurnal westward propagating wavenumber-2 (SW2) tidal mode undergoing a transition around equinox which can also be seen in the EISCAT data.
The capability of ISRs to cover a large altitude range is central for transition region studies. The additional uncertainty from the collision models at higher altitudes [1] can be avoided using the multifrequency capability of EISCAT [2]. This can be used to further improve the understanding of coupling processes in the transition region.

References

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