VARIATIONS OF THE SEMI-DIURNAL TIDAL WIND IN THE METEOR REGION WITH PERIODS OF ABOUT 27 AND 13.5 DAYS

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Daily values of sunspot number and solar radio emission at 10.7 cm wavelength show a well known strong modulation with a period of 27 days, the sun's rotation period. Recent satellite measurements revealed the same modulation of the U.V. irradiance at wavelength below 300 nm (ROTTMANN 1983, LONDON et al., 1984). These U.V. variations, though relatively weak (a few percents), can influence the thermal heating of the ozone layer by altering the chemical composition (LONDON et al., 1984). Therefore, one can also expect a corresponding variation in the middle atmosphere of the semi-diurnal tide, which is thermally excited essentially by absorption of U.V. between 200 and 370 nm in the upper ozone layer.

We used results of radar meteor wind measurements at Kühlungsborn which were, for the most part, continuous since 1976. In order to detect a presumably very weak 27-day modulation within the natural and artificial noise of the daily values of the semi-diurnal wind amplitude (V_2) we chose the summer period with relatively steady conditions and the maximum amplitudes during the year (August, September). Further, by using the Bartels Rotation of the sun with a period of 27 days we applied the method of superposed epochs (or synchronization method). The result of this procedure by using the daily V_2 values of all Bartels Rotation periods in July, August and September from 1976 to 1983 for the zonal and meridional component, respectively, give a surprisingly distinct variation with dominant periods of about 27 and 13.5 days and a minimum to maximum change of about 20%. As was to be expected from the physics of the atmospheric tide, both components show a very similar behavior.

To test the significance of these results we investigated various subsets of the whole amount of data, for instance solar minimum and maximum years of every second year from the eight years 1976-1983. No essential differences of the amplitudes and phases of the 27 day- and 13.5 day-harmonics were found for the various data sets. That means that, especially, the deep minimum around the day 18 of Bertels Rotation is a persistent feature in the long-term mean behavior.

To remove the remaining doubts about the reality of this unexpectedly strong influence of the sun's rotation, a quantitative statistical test is necessary. For this purpose one can apply the "shaking test" after Bartels. This test gives the result that we have found a systematic 27-day variation at a confidence level of 95%. For other seasons than summer we haven't found any significant variation. This may be, above all, due to the noise introduced by natural wave processes in the same range of periods especially in winter.

Concerning a similar investigation for individual years, only the summer data of 1982 and 1983 were suitable because of only small gaps and

the high statistical significance of the data. Again, the already known picture from the many years average appears for these individual years but with a larger minimum change: about 50%. The "shaking test" shows the significance of this 27-day variation. There are some indications of an anticorrelation between solar activity and the amplitude of the semidiurnal tidal wind as was already found by GREISIGER et al., (this issue) for the 11-year solar cycle.

We have found a clear modulation of the semi-diurnal tidal wind amplitude in summer by the rotation of the sun. This amplitude variation exists for individual summer periods, but is present also in the average of several years (up to eight) with relatively persistent maxima and minima. We may speculate that on the sun a longitudinal activity variation exists which is persistent for several years. But a corresponding solar radiation modulation of this kind is not known up to now.

The modulation of the tidal amplitude was unexpectedly strong and seems to be in anticorrelation with solar activity. As for the 11-year solar cycle dependence of the tidal amplitude, the strength and the anticorrelation with solar activity of this 27-day variation also cannot be explained with current models of the semi-diurnal tide; the mechanism of this modulation has to be found yet.

References

1. J. London, G. G. Bjarnason and G. J. Rottmann, 1984, 18 Months of U.V. Irradiance Observations From the Solar Mesosphere Explorer Geophys. Res. Lett. 11, pp. 54-56.

2. G. J. Rottmann, 1983, 27-day Variations Observed in Solar U.V. (120-300 nm) Irradiance Plan. Space Sci. 31, pp. 1001-1007.