https://ntrs.nasa.gov/search.jsp?R=19850012156 2020-03-22T18:37:27+00:00Z

D16

N85-20466

SPRING CHANGEOVER OF THE MIDDLE ATMOSPHERE CIRCULATION COMPARED WITH ROCKET WIND DATA UP TO 80 KM

G. Entzian[1], D. A. Tarasenko[2], and E. A. Lauter[1]

1 - Academy of Sciences of the GDR
Central Institute of Solar-Terrestrial Physics
Observatory of Ionosphere Research
DDR-2565 Kuhlungsborn, GDR

2 - USSR State Committee of Hydrology and Control of Natural Environment
Central Aerological Observatory
Dolgoprudny, Moscow Region, USSR

The middle atmosphere circulation is governed by two seasonal basic states in winter and summer, twice a year separated by relatively shortlived reversal periods. In this paper we will deal with these seasonal basic states of circulation and the spring changeover period between them.

Figure 1 gives the height profile of the mean zonal wind in winter (December/January) and summer (June/July) as measured by rockets at Volgograd (USSR) completed by ionospheric wind measurements in about 95 km height (Kuhlungsborn and Colm, GDR; SPRENGER et al., 1974). In winter a uniform westwind system exists from the stratosphere up to the lower thermosphere. The maximum wind velocity of 70 m/s is attained at the height of 50 km. In summer there is an eastwind system from the stratosphere up to the upper mesosphere. A maximum of wind velocity of 55 m/s is attained in 70 km, but above 85 km again westwind is established. For comparison, Figure 1 shows also results of CIRA 72 for 50°N. In this reference atmosphere the the winter wind maximum is indeed placed at the correct height, but with 100 m/s it is much too intense. Because CIRA for winter months uses only values of Europe and western Asia a longitude effect should be negligible. Nevertheless, in order to estimate a possible longitude effect the single values at 40 and 50 km height indicate the mean zonal wind (circles) and the mean zonal wind plus the contribution of planetary waves (k=1 and 2; stars) to the zonal wind at the longitude of Volgograd, derived from a harmonic analysis of US-satellite data (NASA) for December/January 1974/75 and 1975/76. From the mean of these two winters only, the actually measured zonal wind is already well represented. Also this result emphasizes that these CIRA values are too high.

During summer, the stratospheric zonal wind is well reflected by CIRA, but the mesospheric wind maximum after CIRA is too low by about 7 km and too weak by about 15 m/s. The lower thermospheric wind values are again relatively well represented by CIRA.

The basic states of geopotential height at 30 mb and their change from one into the other can be seen in Figure 2 for 50°N (latitude mean) and the North Pole. Lower heights at the North Pole than in medium latitudes, as in winter, indicate westwind, higher heights, as in summer, indicate eastwind. The changeover from one state to the other is defined by the crossover of both curves. Its time is determinable with an accuracy of one day, not only in the case of this 13-year mean (1967-1979) but in general also for actual single years. Figure 3 shows the reversal dates defined in this way of the 30 mb level since 1958. The mean reversal date of these 25 years is April 7 with a relatively high variability of ±17.5 days.

An effect of the quasi biennial oscillation can obviously be seen from the alternation of early and late reversals between 1958 and 1967 and again after

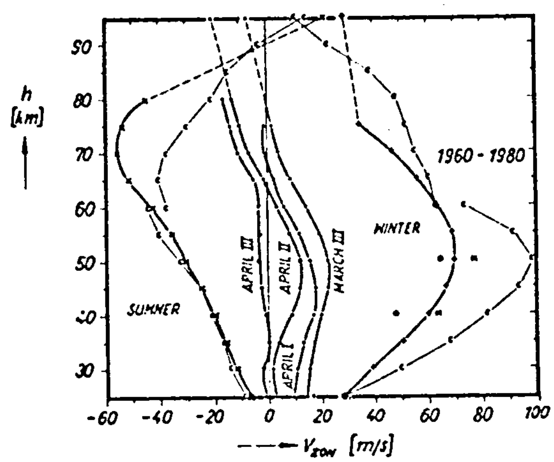

Figure 1. Mean zonal wind from Volgograd rocket data (48.7°N; 44.4 °E) during the seasonal basic states: + winter (Dec., Jan.), x summer (June, July) in comparison with CIRA 72 values (c) and US satellite data (o mean zonal wind; * mean zonal wind plus contribution by planetary waves to zonal wind; and during the spring changeover period (·). The experimental data at 95 km are from ionospheric drift measurements at the observatories Kuhlungsborn (54.1°N; 11.8°E) and Collm (51.3°N; 13.0°E).

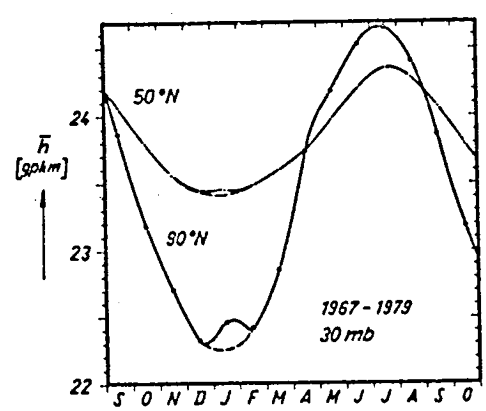

Figure 2. Seasonal variation of the height of the 30 mb level at 50°N zonal average and at the North Pole. Monthly mean values from 13 years (1967-1979). The dashed parts are extrapolations of the autumn and spring branches of the curves, as an estimated behaviour without stratospheric warming effects.

1977. The difference of reversal dates of consecutive years can attain more than one month! Since 1958 a secular trend to earlier reversal dates D (= day-number)

$$D = -0.52\,Y + 132.8$$

(Y = the last two digits of the year) can be observed. Of course this trend can only be the expression of a long-time climatic variation, and at some time the trend will end or even change the direction. Between 1958 and 1980 the above regression is statistically significant by more than 95 per cent, but when including the late reversals of 1981 and 1982 the trend is no longer significant

The small rectangles in Figure 3 indicate periods of late-winter zonal wind reversals. It can be recognized, that in general a late winter zonal wind reversal is followed by a delayed final reversal. For 13 winters without wind reversals, the mean final reversal date is March 29, whereas for 12 winters with wind reversals, the mean final reversal date is April 15. That means the occurrence of a late-winter zonal wind reversal tends to delay the final spring changeover by an average of 17 days in the 30 mb level.

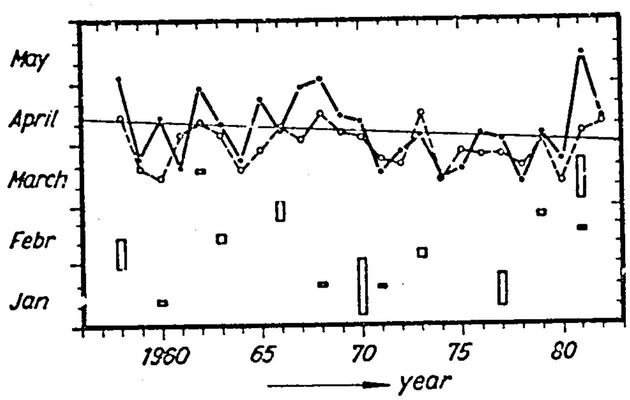

Figure 3. Spring reversal dates of the 30 mb level (·) and the occurrence times of the spring ionization minimum in the lower ionosphere (o). The rectangles indicate periods of late winter zonal wind reversals.

Figure 1 also shows the mean zonal wind height profiles for the last March decade and the three April decades (centered at 25th March, 5th, 15th and 25th April). At the end of March the seasonal changeover begins in the mesopause region and within the next 20-30 days it comes down to the middle stratosphere. With the position of the observing points mentioned above, this result refers to the longitude sector of central and east Europe and to a latitude of about 50°N. Around the middle of April the lower thermospheric east wind attains its most intense value. After that time it breaks down and changes again to westwind, which is then maintained during summer.

Figure 4 investigates if the classification of "early" or "late" spring changeover in the 30 mb level is valid for the whole height profile. For this purpose the mean of zonal wind profiles were evaluated for 4 "early" years (1974, 75, 78, 80) and for 4 "late" years (1967, 68, 69, 70). In the 4 years of

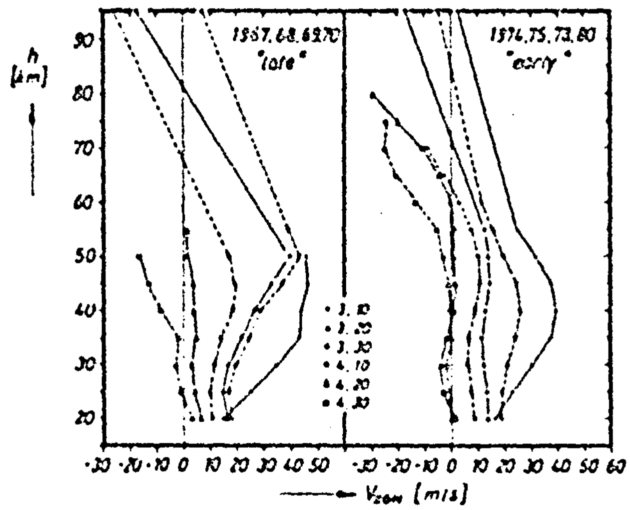

Figure 4. Mean zonal wind profiles (mean of 20 days in each year centered to the given date) over Volgograd, completed by ionospheric drift measurements at 95 km from Kuhlungsborn and Collm, in the cases of 4 years with late and 4 years with early spring changeover in the zonal average of the 30 mb level (see Figure 3).

"early" case the mean changeover date of the 30 mb level (as given in Figure 3) is March 17, and in the "late" case it is April 21, i.e. a difference of about one month. After Volgograd rocket data these reversals at the height of 23 km (about 30 mb) take place on April 17 and May 2, respectively, i.e. a difference of only 15 days. This smaller difference may be an effect of the longitude of Volgograd, but in spite of this smaller effect in the data of Volgograd the "early" and "late" cases can be recovered in almost all heights up to the lower thermosphere and can be identified already about one month before the actual reversal from west- to eastwind in the stratosphere by westwind velocities being smaller in the early case than in the late case.

Because the spring reversal processes are relatively uniform from the stratosphere up to the heights of the lower ionosphere an influence on the ionospheric plasma should be expected. From ground-based absorption and phase height measurements it is known that the electron density passes through a distinct minimum during spring (LAUTER and ENTZIAN, 1983). The occurrence time of this minimum suggests comparison with the reversal dates. The results can be seen in Figure 3. Both parameters are significantly (> 99.9 per cent) correlated with a correlation coefficient of $r = 0.6$. Like in the case of final wind reversals the occurrence times of the ionization minima are also delayed in cases of preceding late winter wind reversals: In the mean of the 13 cases without wind reversals the ionization minimum occurs at March 24, in the mean of the 12 cases with wind reversals it occurs at April 5, i.e. 12 days later.

The results confirm the statement made earlier (LAUTER et al., 1976) that during winter a dynamical coupling between different layers exists in the middle atmosphere from the stratosphere up to the lower thermosphere, and that this coupling continues till the final spring reversal.

REFERENCES

CIRA (1972), COSPAR International Reference Atmosphere 1972, Akademie-Verlag, Berlin.

Lauter, E. A. and G. Entzian (1983), Phys. Solariterr. Potsdam, 19, 118.

Lauter, E. A., J. Taubenheim, G. Entzian, J. Bremer, G. v. Cossart and G. Klein (1976), HHI-STP Report No. 7, Central Institute of Solar-Terrestrial Physics, Berlin-Adlershof, GDR

NASA, Synoptic analyses 5-, 2-, and 0.4 mb surfaces for July 1974 through June 1976, NASA Reference publication, 1023.

Sprenger, K., R. Schminder, K. M. Greisiger, D. Kurschner and B. Schaning (1974), HHI-STP Report No. 2, Central Institute of Solar-Terrestrial Physics, Berlin-Adlershof, GDR.

The rocket data were taken from: Bulletin of Atmospheric Rocket Sounding Results, Central Aerological Observatory. Gidrometeoisdat Moscow.

The 30 mb data were taken from: Meteorologische Adhandlungen Tagliche Hohenkarten der 30 mb Flache, Institute fur Meteorologie der Freien Universitat Berlin-West.