

SOLAR PROMINENCES IN THE YEARS 1967-1985

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**ABSTRACT.** The preliminary results of the solar prominences for the years 1967-1985 are presented, based on the Lomnický Štít coronal station observations and processed by the PDP computer at the Department of Astronomy and National Observatory (DANO), Sofia.

1. The number of prominences and their areas are functions of time and vary similarly to the Wolf's number.

2. A large decrease in the number and the area of prominences was observed in 1971, and a local maximum in 1975, one year prior to the beginning of the new cycle 21.

3. A similar phase shift was observed between the polar zones of the two hemispheres in cycle 21 as in cycle 20. The north polar zone reached the pole in 1980, the southern one year later.

4. Preferred longitudes were observed in the polar and equatorial prominence zones in some years, (1977-1979).

5. Maximum frequency of observed height + 20", width: 1° - 3°, area: 20 - 40 units.

**СОЛНЕЧНЫЕ ПРОТУБЕРАНЦЫ В 1967-1985 г.:** Приводятся предварительные результаты наблюдений протуберанцев в 1967-1985 г. на внеатмосферном коронографе Ломницкий Пик, которые были обработаны на вычислительной машине ПДП 6 ДАНО в Софии.

1. Количество и площадь протуберанцев является функцией времени в согласии с числом Вольфа.

2. В 1971 г. наблюдается резкое понижение этих характеристик, а в 1975 г. за один год до начала цикла № 21, локальный максимум.

3. В течение цикла № 21 наблюдается асимметрия в развитии и дрефте поляр-

ных зон на отдельных полушариях похоже как в цикле № 20. На северном полушарии эта зона достигает полксь в максимуме цикла, в 1980 г., на южном полушарии на год позже.

4. В экватореальной и полярной зонах наблюдаются яркие зоны преферованных долгот протуберанцев, напр. в 1977-1979 г..

5. Максимальные фреквенции наблюдаемых высот-20", широт -  $1^{\circ}$ - $3^{\circ}$  и площадей 20-40 единиц.

SLNEČNÉ PROTUBERANCIE V ROKOCH 1967-1985: Na základe fotografických pozorovaní protuberancií pomocou 20 cm koronografu na koronálnej stanici Lomnický Štít a po ich spracovaní na počítači PDP v DANO v Sofii, uvádzame niektoré predbežné výsledky ich analýzy za roky 1967-1985.

1. Počet protuberancií a ich plocha je funkciou času a má podobný priebeh ako priebeh Wolfovho čísla.

2. V roku 1971 sa pozoruje náhly pokles oboch charakteristík, a v roku 1975, rok pred začiatkom nového cyklu, lokálne maximum.

3. V 21. cykle sa pozoruje podobný vývoj polárnych zón ako v cykle 20. Polárna zóna protuberancií dosahuje pól v roku 1980, južná o rok neskôr.

4. Preferované dĺžky sa pozorujú ako v polárnej tak aj v rovníkovej zóne, napr. v 1977 - 1979.

5. Maximálne frekvencie výskytu: pozorovanej výšky - 20", šírky  $1^{\circ}$ - $3^{\circ}$ , plochy 20 - 40 jednotiek.

## 1. INTRODUCTION

Prominences are cool clouds in the hot solar corona which "form in the line of demarcation between photospheric fields of opposite polarity", for example, Babcock and Babcock (1955). Their occurrence at the limb or in the chromosphere (filaments) over long periods of time provide abundant information about the large-scale topology of the Sun's magnetic field. They can also be compared with other features of solar activity.

Earlier papers, for example Secchi (1972), d'Azambuja and d'Azambuja (1948), Waldmeier (1973), Hansen and Hansen (1975), Makarov et al. (1983), unambiguously showed their variation with the solar cycles, for example, the occurrence of prominence zones, their poleward migration, etc. Several results can be found in the relation between prominences and other features of solar activity, for example Kiepenheuer (1953), Hanssen (1974), Waldmeier (1978). However, many questions remain unanswered (equatorward migration, preferred longitudes, interaction between prominences and corona, stability, etc.).

The purpose of this paper is to continue in the effort of earlier papers, mainly for the cycle 21.

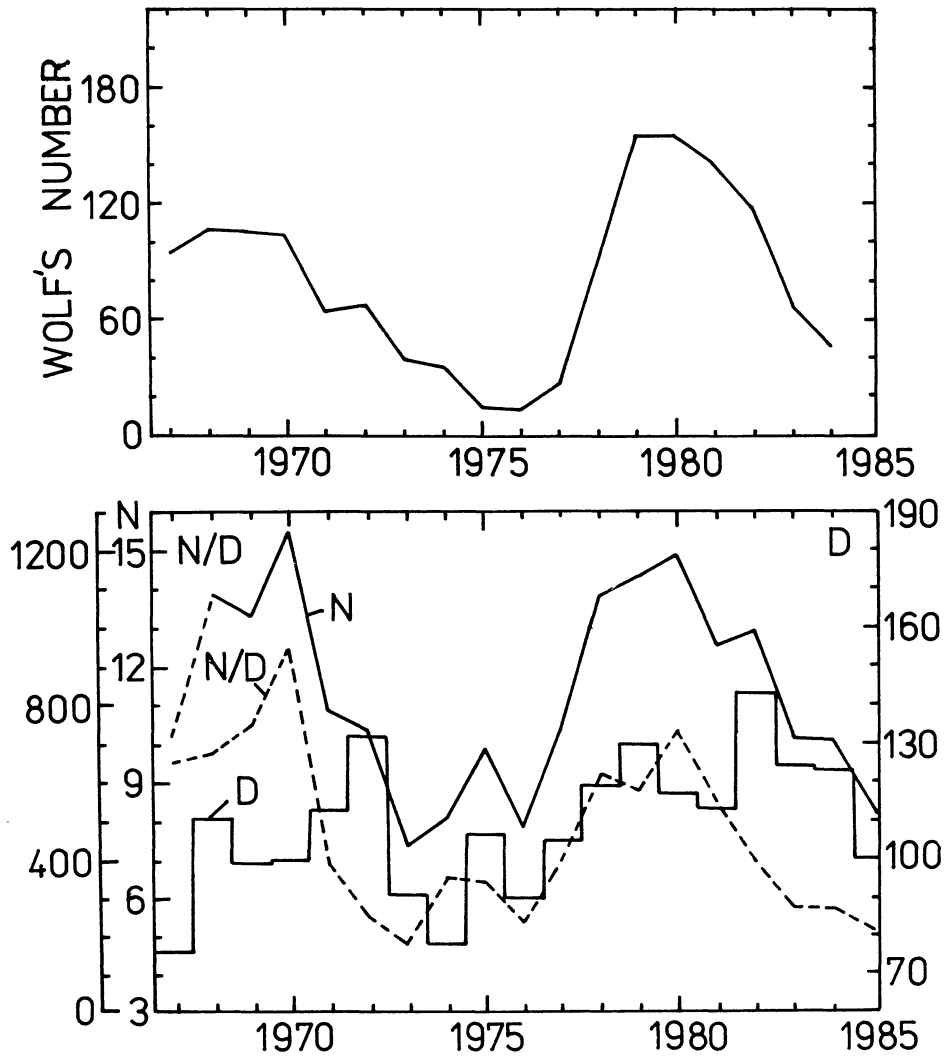


Fig. 1: Number of prominences (N), days of observation (D) and the average number of prominences observed daily (ND). Wolf's number in the upper part.

## 2. OBSERVATIONS AND PRELIMINARY RESULTS

Since May 1967, regular limb observations of solar prominences have been carried out at the Lomnický Štít coronal station with the 20 cm coronagraph. Over the period 1967-1985, a great number of prominences have been observed, covering the maximum and descending phase of cycle 20, and the whole current cycle 21.

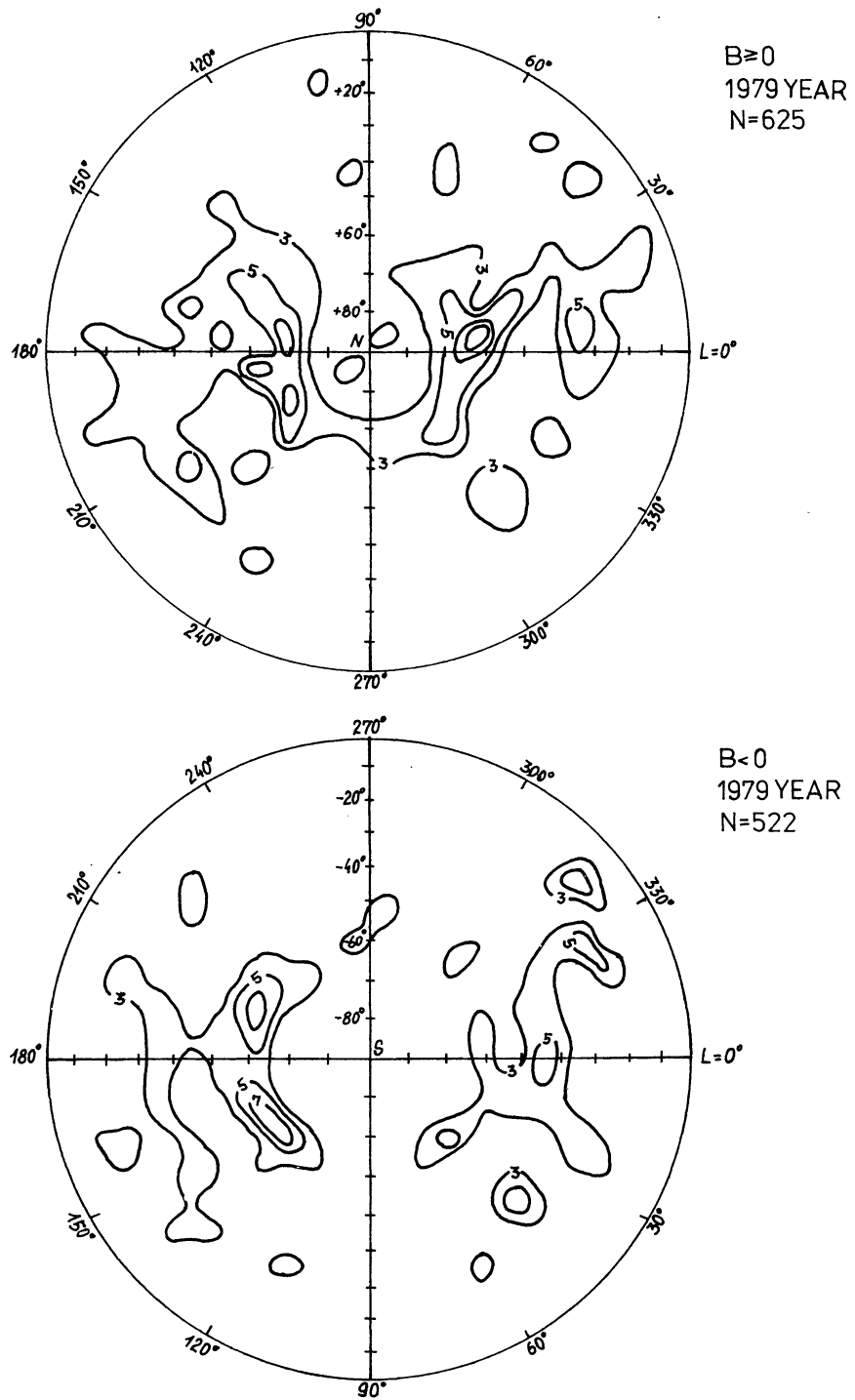


Fig. 2: Lambert's projection of prominences for 1979.

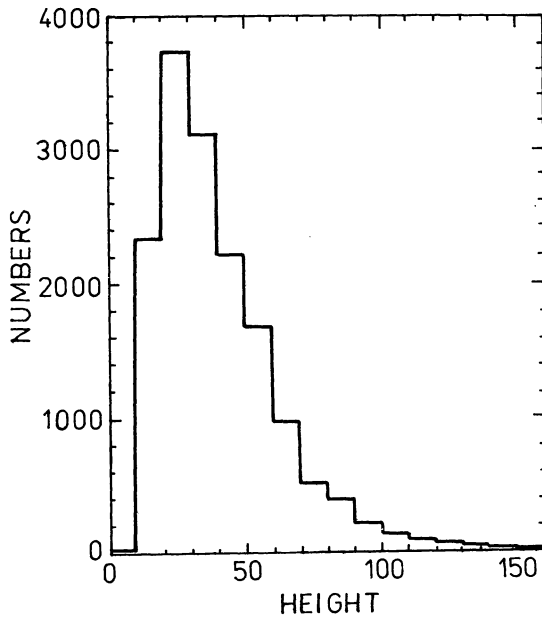


Fig. 3: Distribution of prominences by height.

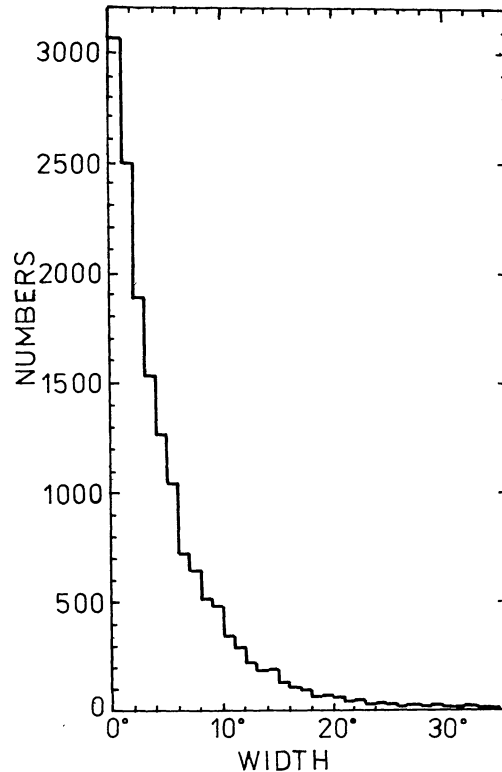


Fig. 4: Distribution of prominences by width.

The observational material was processed regularly at the Lomnický Štít observatory (the area of limb prominences is measured in terms of a "rectangular" surface,  $1^\circ$  heliocentric longitude and  $10''$  geocentric height, heliographic latitude, height, width and brightness).

Recently a catalogue of solar prominences in the EBSDI codes was presented on 9-track tape of density 800 bpi, BLOCKSIZE = 4800 bytes, RECORDSIZE = 48 bytes, NUMBER OF RECORDS = 15 819, by DANO, Sofia.

On the basis of this catalogue we studied the distribution of the prominences with heliographic latitude and longitude, their temporal development as well as frequency distribution of their principal morphological characteristics. The following are the preliminary results:

A. Figure 1 shows the average annual number of prominences ( $N$ ), the number of days on which observations were made throughout each individual year ( $D$ ), and the average number of prominences observed daily ( $ND$ ) as a function of time. As this figure indicates, the prominence activity (expressed by  $ND$ ) generally adopts the pattern of sunspot activity given in the upper part of this figure. Yet, it must be noted that in 1971 it decreased rapidly, and re-

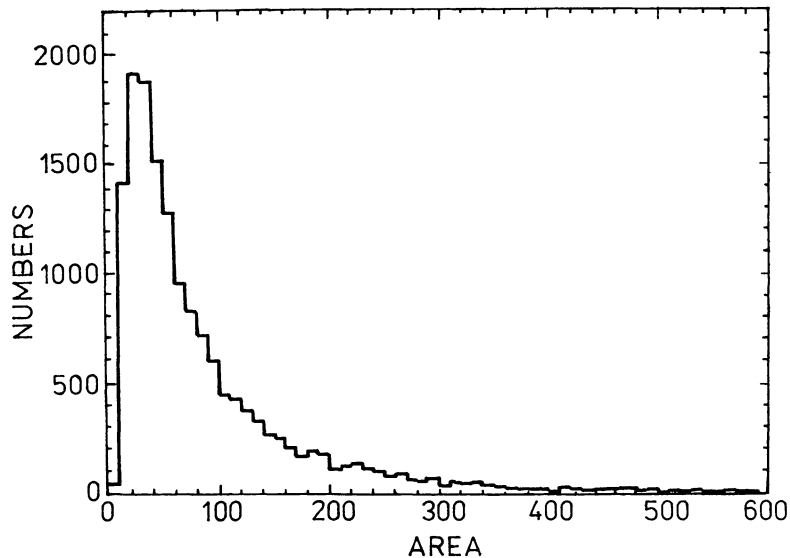


Fig. 5: Distribution of prominences by area.

ached a local maximum in 1975, one year prior to the next cycle, 21. This is most clearly manifested for the northern hemisphere. The study of prominences, arranged into groups according to their heights, has shown that the maximum for 60" h 80" is very pronounced.

B. The prominence distribution with heliographic latitude and longitude, and the phase of sunspot activity cycle was investigated using contour maps, plotted in equivalent azimuthal projection (Lambert's projection). A sample of these maps for 1979 is given in Fig. 2. In the whole observational interval two activity zones can be distinguished well, one at low heliographic latitudes, and the other near to poles, divided by a zone of lower activity, which agrees with the results cited earlier for similar studies. The preferred longitudes are well manifested in some years (1979-1979) in both zones and both hemispheres.

C. The analysis of the consecutive contour maps leads to the following conclusions: 1. clearly manifested asymmetry is present in the prominence distribution in the northern and southern hemispheres both with regard to the activity level and the development of the two zones of activity. The north polar zone reached the north pole in cycle 20 in 1969 and in cycle 21 in 1980; for the southern hemisphere this occurred in 1970 and 1981 respectively. 2. A well manifested polar zone was observed in the years of sunspot maximum, shorter in duration for cycle 21. 3. The polar zone exhibits a fine structure expressed by formation of one to two preferred longitudes. 4: In 1975, year of relatively high activity in the minimum, four active longitudes were formed in the northern hemisphere at about  $50^{\circ}$ .

D. The morphological prominence characteristics - limb height, width and area-were studied by means of the empirical distribution function. As seen in Figures 3, 4, 5, the most frequently observed height is: 20" - 30", width  $1^{\circ}$  -  $3^{\circ}$ , area 20 - 40 units.

The purpose of this paper is to introduce the Catalogue and make known a number of important preliminary results, mainly for cycle 21. The results of the on-going statistic at studies will be published elsewhere.

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#### DISCUSSION

Г.В. Куклин

Пробовали ли Вы сопоставлять Ваши картины распределения встречаемости протуберанцев с картами положения линии раздела полярностей фоновых магнитных полей по данным о волокнах составляемых В.И. Макаровым с сотрудниками ?

V. Dermendjiev

Нет, но мы намерены это сделать.