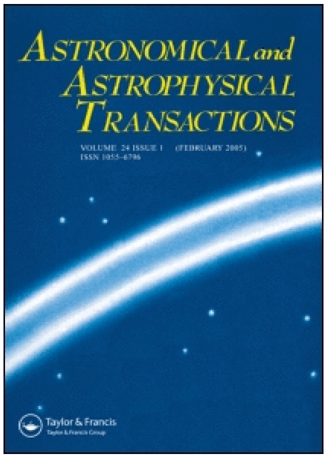

Astronomical & Astrophysical Transactions
The Journal of the Eurasian Astronomical Society
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713453505

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Online Publication Date: 01 January 1998
To cite this Article: Dmitrieva, I. V., Zaborova, E. P. and Obridko, V. N. (1998) 'Natural disasters and solar activity (based on chronicles and annals)', Astronomical & Astrophysical Transactions, 17:1, 29 - 33
To link to this article: DOI: 10.1080/10556799808235421
URL: http://dx.doi.org/10.1080/10556799808235421

Astronomical and Astrophysical Transactions, 1998,
Vol. 17, pp. 29–33
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NATURAL DISASTERS AND SOLAR ACTIVITY (BASED ON CHRONICLES AND ANNALS)

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(Received August 12, 1997)

The chronicle data on natural phenomena observed in Europe and in Russia from the year 0 to 1600 were analysed. We compared droughts, cold-spells, epidemics, epizootics and famines with solar activity data (sunspots visible to the naked eye). As shown by the analysis, the maximum occurrence of droughts, epidemics and epizootics either coincides with the sunspot maximum or is observed in the growth phase of solar activity. For very cold winters the correlation with solar activity was not so pronounced. As to famines, they do not reveal noticeable correlation with any natural factors.

KEY WORDS Chronicle data, climate, cold, drought, famine, solar activity

1 INTRODUCTION

The question of whether variations in solar activity exert any effect on climate has been under investigation since long ago. In a number of recent works (e.g., Lebedeva, 1979; Girskaya, Sazonov *et al.* 1981; Efanova, 1981; Iasamanov, 1991) the authors tried to establish a relation between natural disasters and solar activity. As a result, it was shown that the solar activity/climate coupling is very complicated and its mechanism is not clear. The works cited above are based on the analysis of either too-long (several millennia), or too-short (several decades) time series. Long series are usually composed of the data from diverse sources, whereas short series are insufficient for reliable rating of the significance of natural phenomena.

We can overcome this difficulty by using the chronicles. On the one hand, these records (at least in some regions of the world) are long enough to satisfy the requirements to the data series to be analysed. They report a variety of events, including the weather and climatic phenomena, such as droughts, cold-spells, floods, etc., and the evidence of solar activity, such as sunspots, observed by the naked eye. On the other hand, these data are relatively homogeneous. Of course, the human eye is an imperfect instrument. It can hardly provide objective criteria for appraising the observed climatic phenomena. However the human assessments themselves have not changed much over two millennia before the advent of the technological epoch. The quantity of records did change, but this trend is noticeable and can be eliminated.

2 DATA AND METHODS

The chronicle data on natural phenomena observed in Europe and in Russia from the year 0 to 1600 were collected and published by Borisenkov and Pasezky (1988). This paper presents the data for Europe from the beginning of our era up to 1600 and the data for Russia from 900 up to 1900. The list of phenomena comprises severe droughts and floods, too mild or too severe winters, cold and early springs, earthquakes, epidemics and epizootics, pest invasions, thunderstorms, fires, famines, etc.

The chronicles report frequent droughts, severe winters, rainy summers and early cold-spells in the first millennium of our era. In the first century, severe droughts in Western Europe were only reported twice. There were also many years without droughts in the second century. This was the epoch of a deep solar minimum (150–250). The famines in that epoch were more connected with severe winters, than with droughts.

Many cold winters, followed by droughts were recorded in the fourth century. At the end of the fourth and at the beginning of the fifth century, the winters in Europe were so cold that the Black Sea froze up. It was also the epoch of a solar minimum – 450.

In the sixth century, severe winters were followed by cool and rainy summers, after which came the period of droughts. The same situation at the beginning of the seventh century brought hunger. Severe winters and droughts in the eight century again resulted in hunger and epidemics. Periods of deep solar minima were recorded in the seventh and eight centuries. The period of the eight to the tenth centuries was the time of a small climatic optimum in Europe, whereas the Oort's solar minimum was recorded in the tenth and eleventh centuries.

Seventeen types of events are reported for the European part of Russia and ten types of events for Europe. Of course, the types of data do not always coincide, because Europe and Russia are different climatic zones and thus the importance of various natural phenomena received different appraisals.

Taking into account the discrepancies in the data for Europe and Russia, we could only analyse the time interval from the beginning of our era to 1600, and considered only similar characteristics. Thus, we treated combinations of droughts and cold-spells as exclusive climatic parameters and for comparison, epidemics, episootics, and famines were treated as the parameters characterizing climate, population, and even social effects. Since the major events, like those reported in the chronicles, are quite rare in history, we summarized the number of such events for every 50 years.

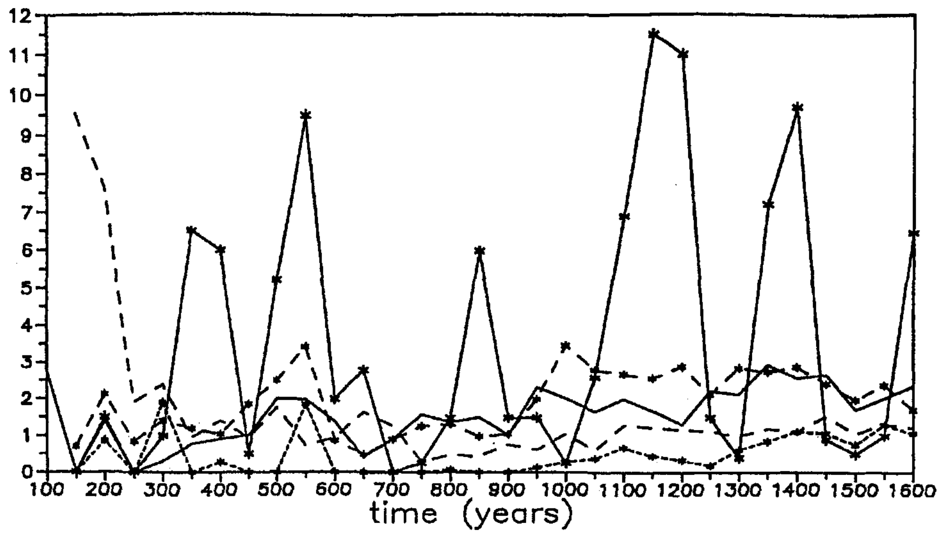

Figure 1 Data versus time: —*— sunspots, - -*- - droughts, . . . *. . . epidemics and epizootics, —— cold-spells, - - - - - famines

With the progress of civilization, there was an increase in the number of cultural centres, where people were keeping records of natural phenomena, and as a result, the number of fixed phenomena increased. So, we have normalized the annalistic data to the information trend (i.e. we approximated the data series by a polynomial and isolated the linear part). In the further analysis these normalized data were used. Solar activity data are the data on sunspots visible to the naked eye. They were reconstructed from Chinese and European chronicles of observations of the Sun (Leftus 1986). These data were not normalized.

3 RESULTS AND DISCUSSION

We have compared the data on droughts and on sunspot numbers. As shown by the analysis, the maximum occurrence of droughts either coincides with the sunspot maximum or is observed in the growth phase of solar activity (see Figure 1), which is corroborated by Girskaya, Sazonov *et al.* (1981). The same study was carried out for very cold winters. However the correlation with solar activity was not as pronounced as in the previous case (see Figure 1). One can only state that the greatest number of severe winters is usually recorded in the years close to the maximum or minimum of solar activity.

Comparison of periodograms of the series under investigation obtained by the Fourier method also yields interesting results. The data of solar activity and droughts clearly reveals a 250-year period, which is less pronounced in the data

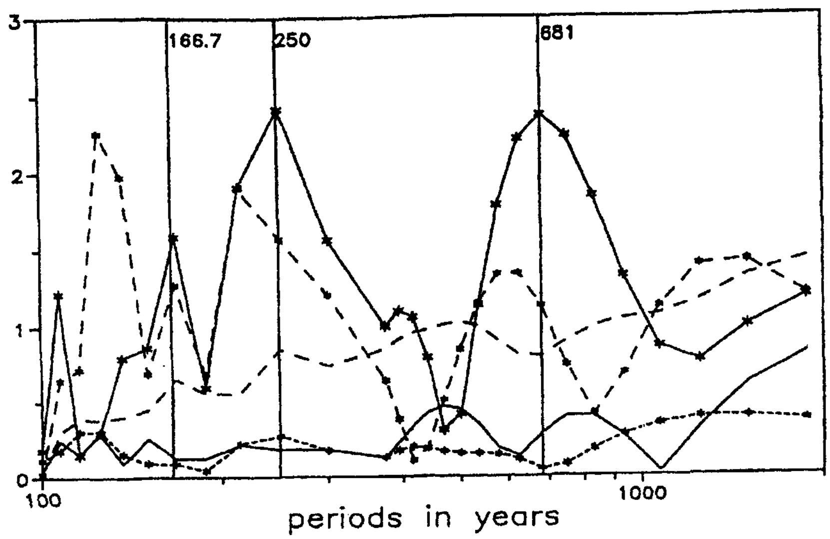

Figure 2 Periodograms: —*— sunspots, – –*– – droughts, ...*...epidemics and epizootics, —— cold-spells, – – – – – famines

for epidemics and epizootics, and is practically absent in the data for famines and cold winters (see Figure 2).

As shown by Serdyuk and Kotlar (1981) and by Sazonov and Scheremetova (1985), the principal role among the factors triggering droughts belongs to anticyclonic circulation. So long as a certain dependence exists between the atmospheric circulation and the solar activity, the latter should manifest itself in the occurrence of droughts (Molodych, 1985), whereas its relation to cold winters is not as direct. The periodicity of epizootics is more determined by droughts than directly by solar activity. As to famines, they do not reveal noticeable correlation with any natural factors, either in then dynamics or in then spectrum. Their cause should be most likely sought in the social and political spheres.

Acknowledgments

This paper was supported by the Russian Federal "Astronomy" Program (Grant No. 7–148). The authors are also grateful to G. V. Kuklin for annalistic data placed at our disposal, and for help in processing the data.

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