STATISTICAL STUDY OF EQUATORIAL SCINTILLATIONSAT ANCON, PERU

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Introduction

The 136 MHz interferometric system at the past NASA Satellite Tracking Station in Ancón, Perú, consists of two orthogonal baselines aligned along the North-South and East-West directions.

A sizable number of interferometric records intended for operational tracking was spoiled by large amplitude and phase fluctuations. Irregularities in the ionosphere, those associated with the spread-F phenomena, are the cause of these fluctuations (scintillations)[1].

In most of the distorted records the North-South baseline interferometer shows only a slight distortion from the expected satellite graph while in the East-West interferometer the distortions are severe. This clearly shows the anisotropy of the irregularities and that they are elongated and aligned the magnetic field lines[2] as have been found by other authors. The absence of North-South phase distortions when East-West distortions are present facilitates the detection of weak scintillations against the background noise.

For the purpose of this report the East-West baseline interferometric distortion was taken as an indication of scintillations. As an indfcation of intensity, we define a phase scintillation index as follows:

$$\text{Phase scintillation index} \; \overline{|\emptyset - \emptyset_o|} \times \frac{100}{2\pi}$$

where

$\emptyset$ is the East-Weste phase in radians

$\emptyset_o$ is the average East-West phase

The bar indicates average over the duration of the pass.

To study the time variation of scintillations, satellite passes during 1966 and 1968 were used.

Occurrence of Scintillations

Figures 1 and 2 show the number of passes distorted by scintillations for the years 1966 and 1968, respectively. An average of 25 passes per day during 1966 and 20 passes per day during 1968 were studied. These two figures show that the scintillation occurrence reaches a maximum about the months of October and March, and a minimum about the months of January and May. Also, it can be seen that the percentage of occurrence decreases with increasing solar activity (the peak of the solar cycle occurred in 1968). This conforms with the findings that spread-F is anticorrelated with solar activity[1]. It is in disagreement with Koster /Aarons' review[3]/.

The data collected can be expressed in a different way as shown in figures 3 and 4. In these figures the occurrence of 50 to 100% phase scintillation indexes has been plotted as a percentage of the total number of passes in a month.

Diurnal and Seasonal Variations

To study the diurnal and seasonal variations of scintillations the observation period from November 1967 to November 1968 has been divided in four quarters centered around equinoxes and soltices, and the occurrence of different degree of scintillation intensities against the time of the day has been plotted in figures 5 to 8.

The figures show that throughout the year strong scintillations are a nighttime phenomenon with maximum occurence before midnight, at approximately 21 hours. This deviates from the findings of Koster[4] in Ghana where he finds a peak about midnight, but in agreement with later findings of the same author reported in Aarons' review[3].

Figures 5 to 8 also whow that scintillations, though very weak ones, may occur during the day. We believe they are due to electrojet irregularities since no F-region irregularities have been detected during the day using other techniques, and because they peak at times when the electrojet is strongest.

These figures also whow that strong scintillations are more frequent during the equinoxes than during the soltices, in agreement with findings by Golden[5] and Bandyopadhyay et al.[6].

References

1. Herman, J. R., Spread F and ionospheric F-region irregularities, Rev. Geophys., 4, 255-299, May 1969.

2. Cohen, R. and K. L. Bowles, On the nature of equatorial spread F., J. Geophys. Res., 66, 1081-1106, April 1961.

3. Aarons, J., A brief review of equatorial scintillations; Radio Astronomy Branch, Ionospheric Physics Laboratory, Air Force Cambridge Research Laboratories, July 1969.

4. Koster, J. R., Ionospheric studies using the tracking beacon on the "Early Bird" synchronous satellite, Ann. Geophys., 22, 3, 57-59, 1965.

5. Golden, T., Ionospheric distortion of minitrack signals in South America; NASA. Goddard Space Flight Center, Greenbelt, Maryland, Feb. 1968, Rept. No. X-525-68-56.

6. Bandyopadhyay, P., J. P. Mullen and J. Aarons, Equatorial scintillation observations, In: Proceedings of the Third International Symposium on Equatorial Aeronomy, Ahmedabad, India, February 3-8, 1969; Physical Research Laboratory, Ahmedabad, India, 1969; pp. 303-308.

Figure Captions

Fig. 1. Satellite passes recorded during 1966 at the NASA Satellite Tracking Station in Ancón, Perú. Horizontal lines indicate the monthly average number of passes recorded per day. The dark vertical lines indicate the number of passes in a day, distorted by strong scintillations.

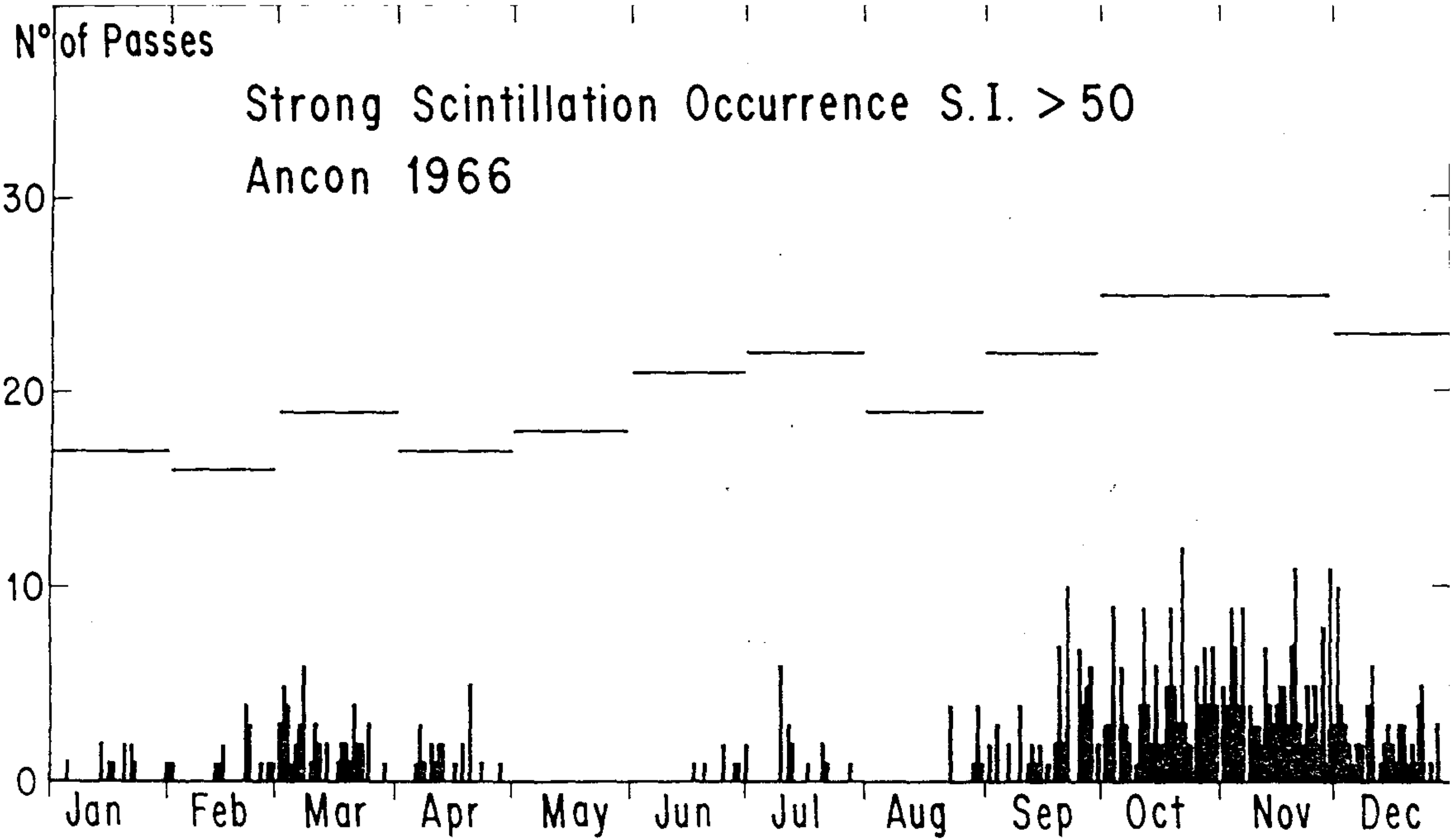
Fig. 2. Satellite passes recorded during 1968 at the NASA Satellite Tracking Station in Ancón, Perú. Horizontal lines indicate the monthly average number of passes recorded per day. The dark vertical lines indicate the number of passes in a day, distorted by strong scintillations.

Fig. 3. Occurrence of strong scintillations, 50 to 100% phase scintillation index, as a percentage of the total number of passes; year 1966.

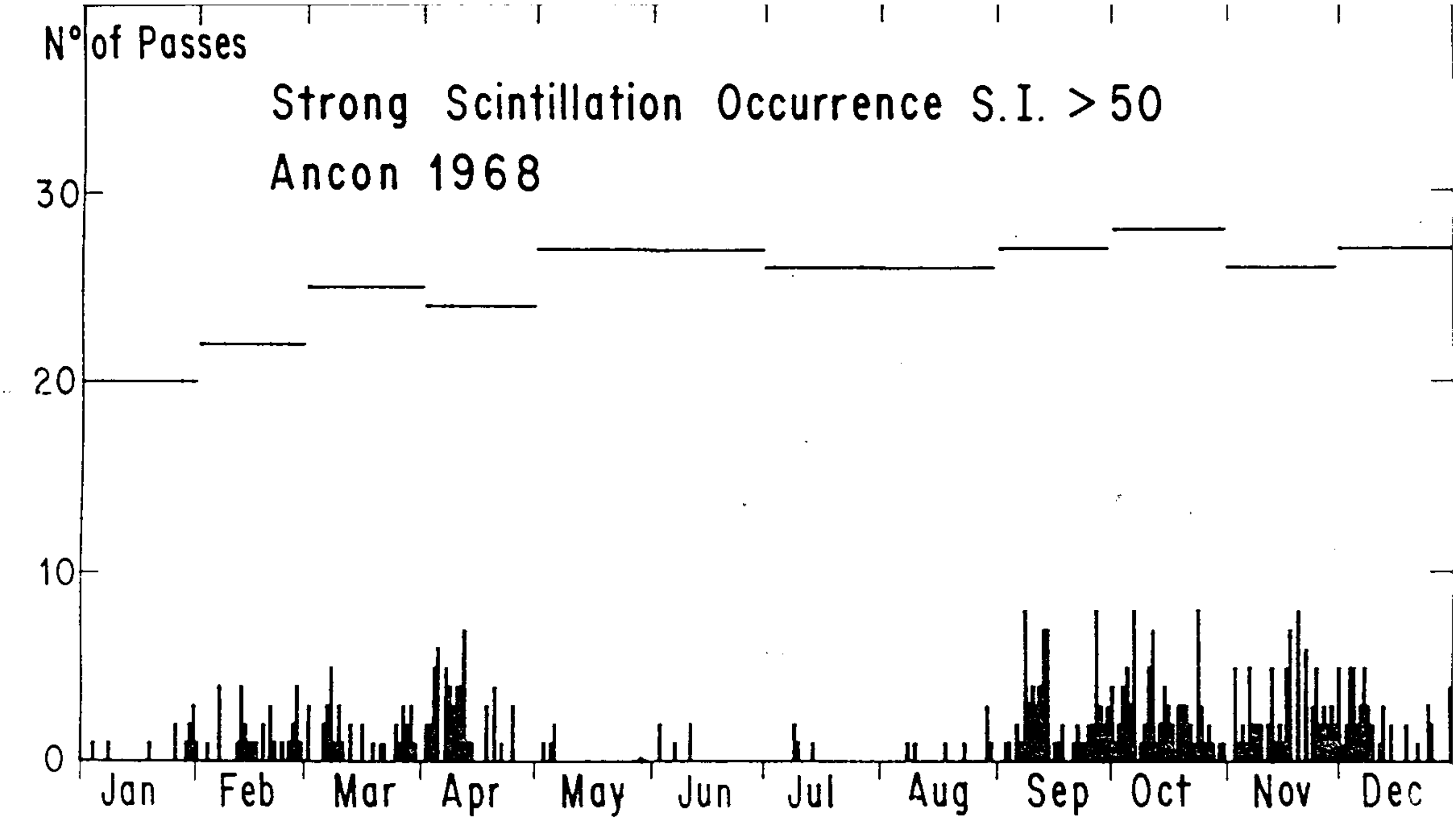
Fig. 4. Occurrence of strong scintillations, 50 to 100% phase scintillation index, as a percentage of the total number of passes; year 1968.

Fig. 5. Diurnal variation of occurrence of different scintillation indexes from November 9, 1967 to February 4, 1968 solstice period.

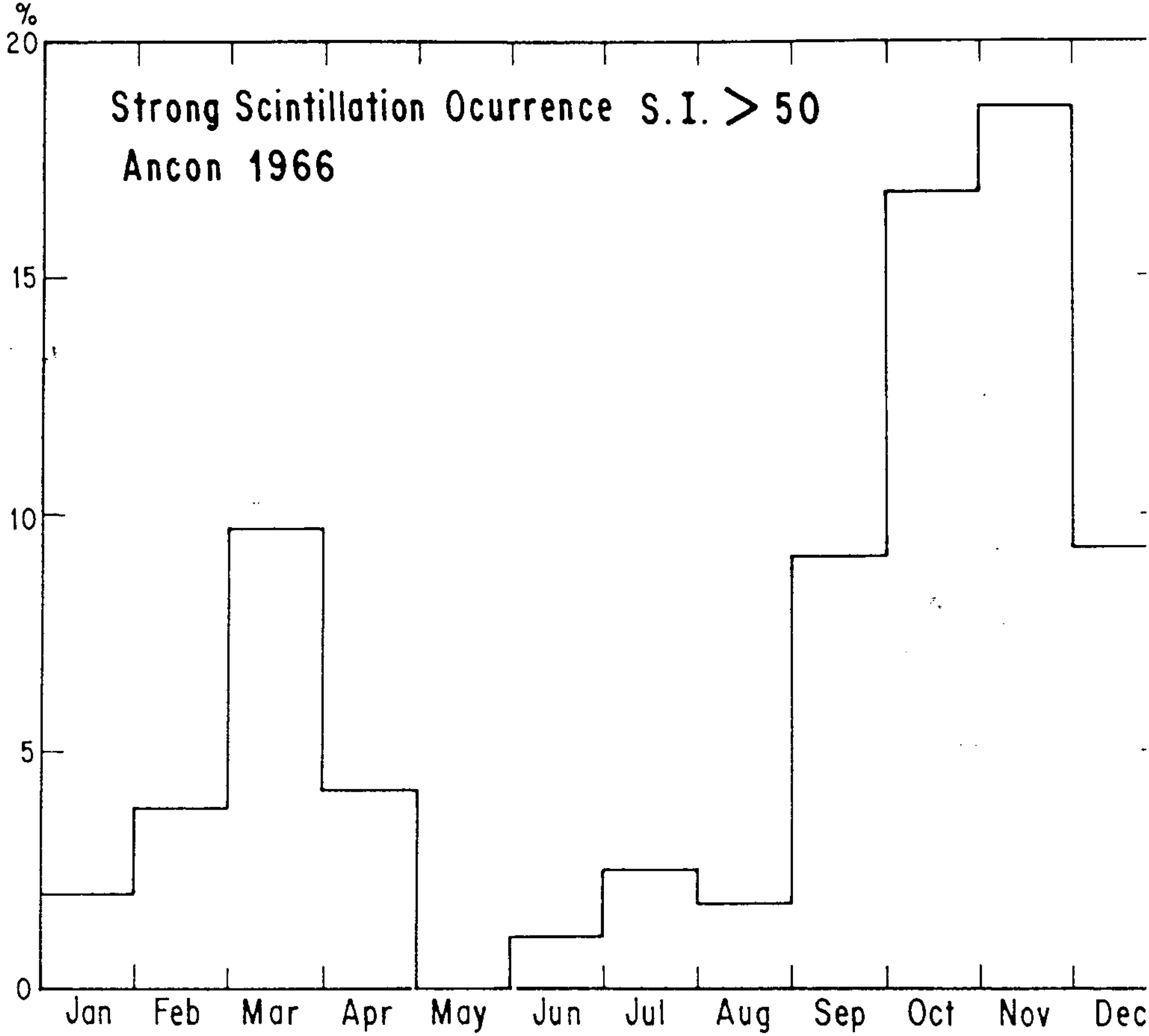
Fig. 6-8 Diurnal variation of occurrence of different scintillation indexes from February 5 to May 6, 1968 equinox; from May 7 to August 8, 1968 solstice; and from August 9 to November 8, 1968 equinox.



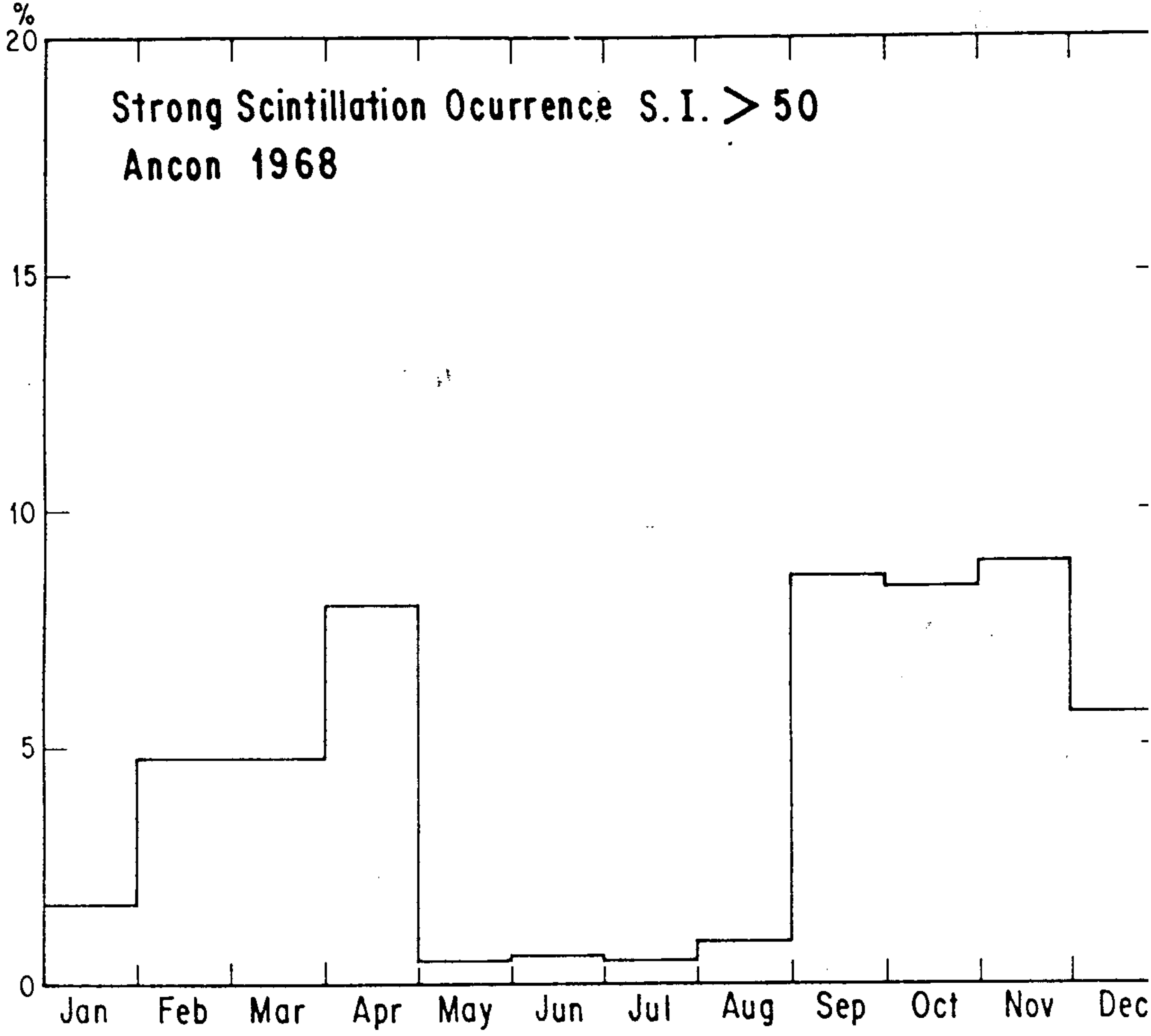
N° of Passes
Strong Scintillation Occurrence S.I. > 50
Ancon 1966
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec



N° of Passes
Strong Scintillation Occurrence S.I. > 50
Ancon 1968
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec



Strong Scintillation Ocurrence S.I. > 50
Ancon 1966
%
20
15
10
5
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Strong Scintillation Ocurrence S.I. > 50
Ancon 1968
%
20
15
10
5
0
Jan
Feb
Mar
Apr
May
Jun
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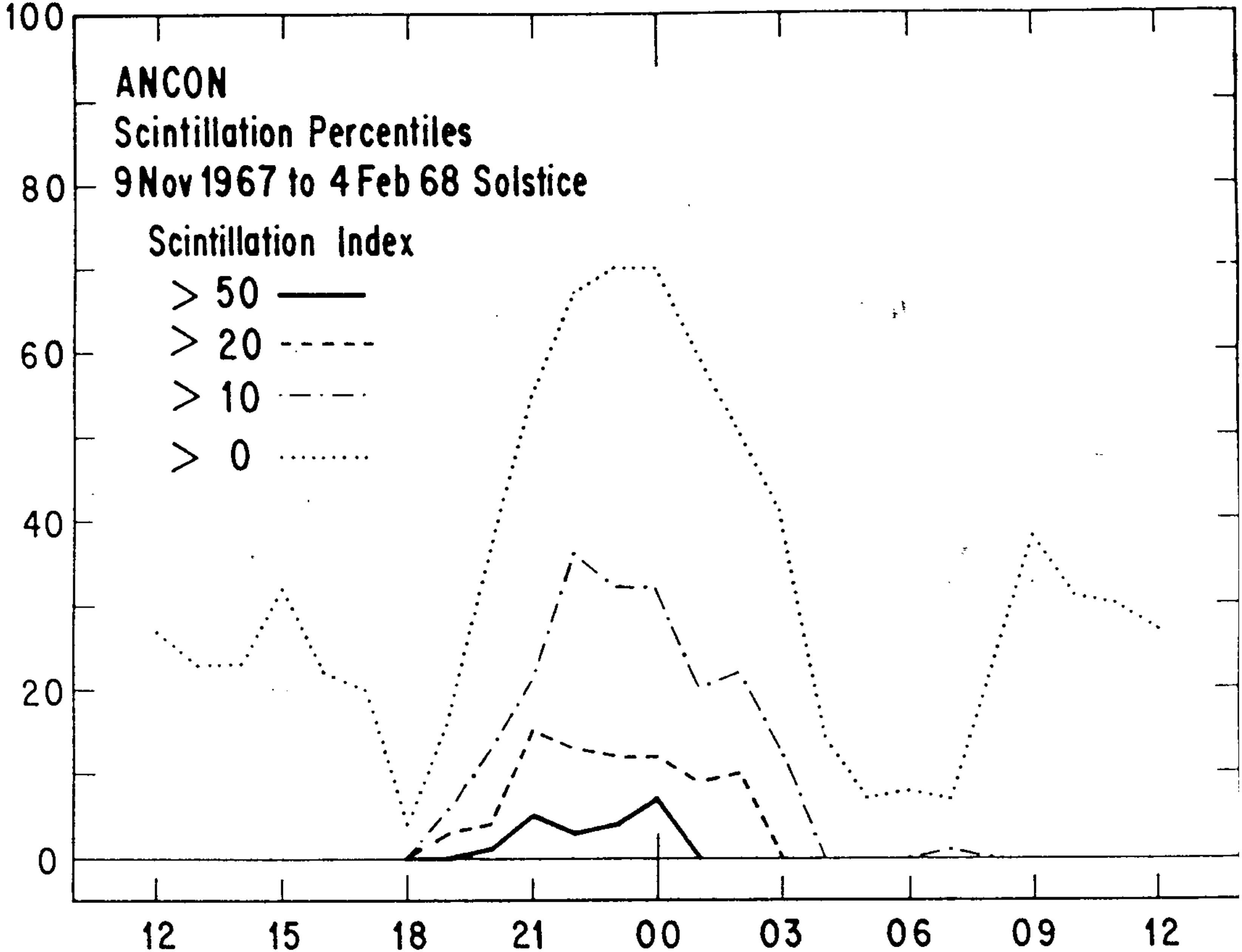
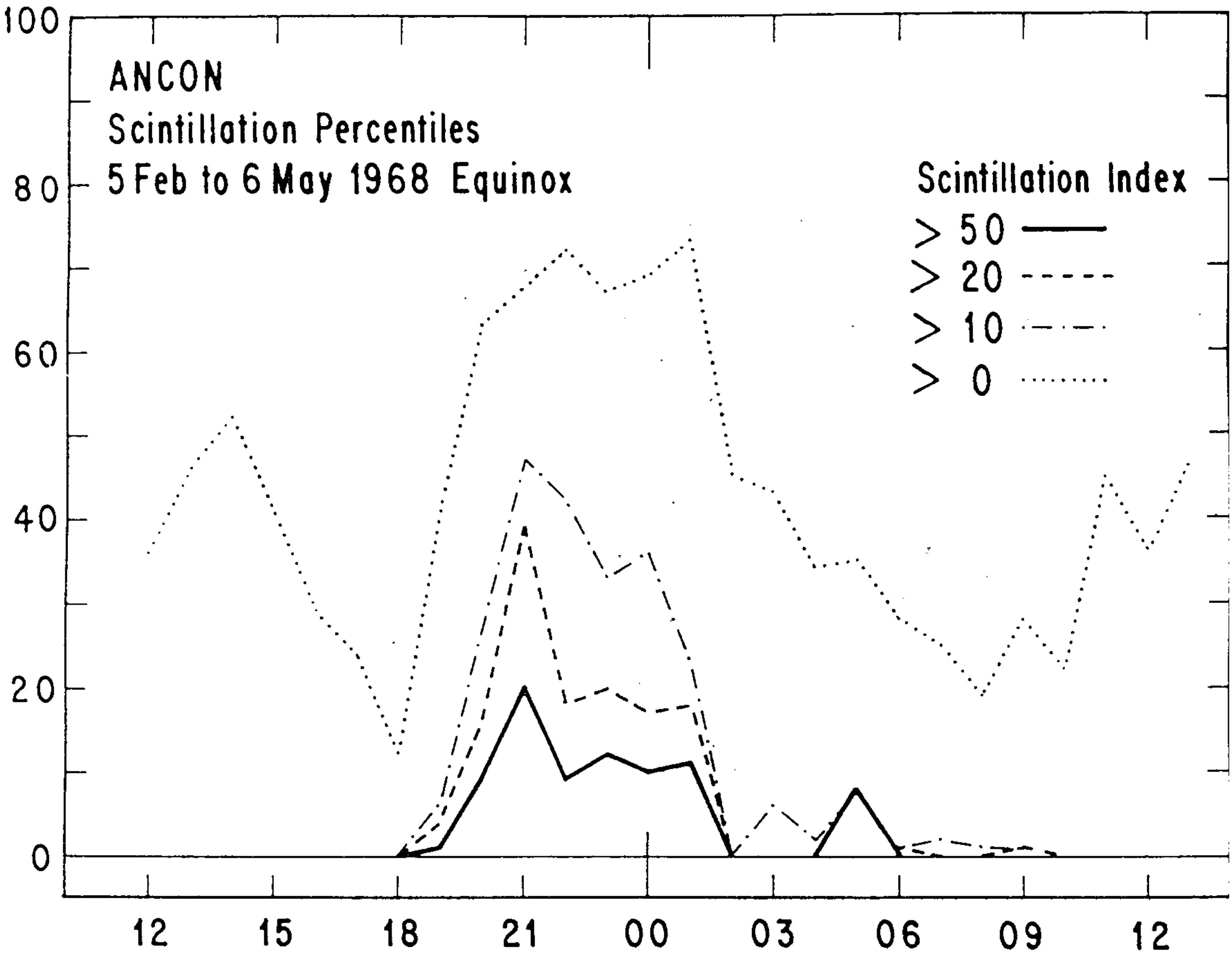
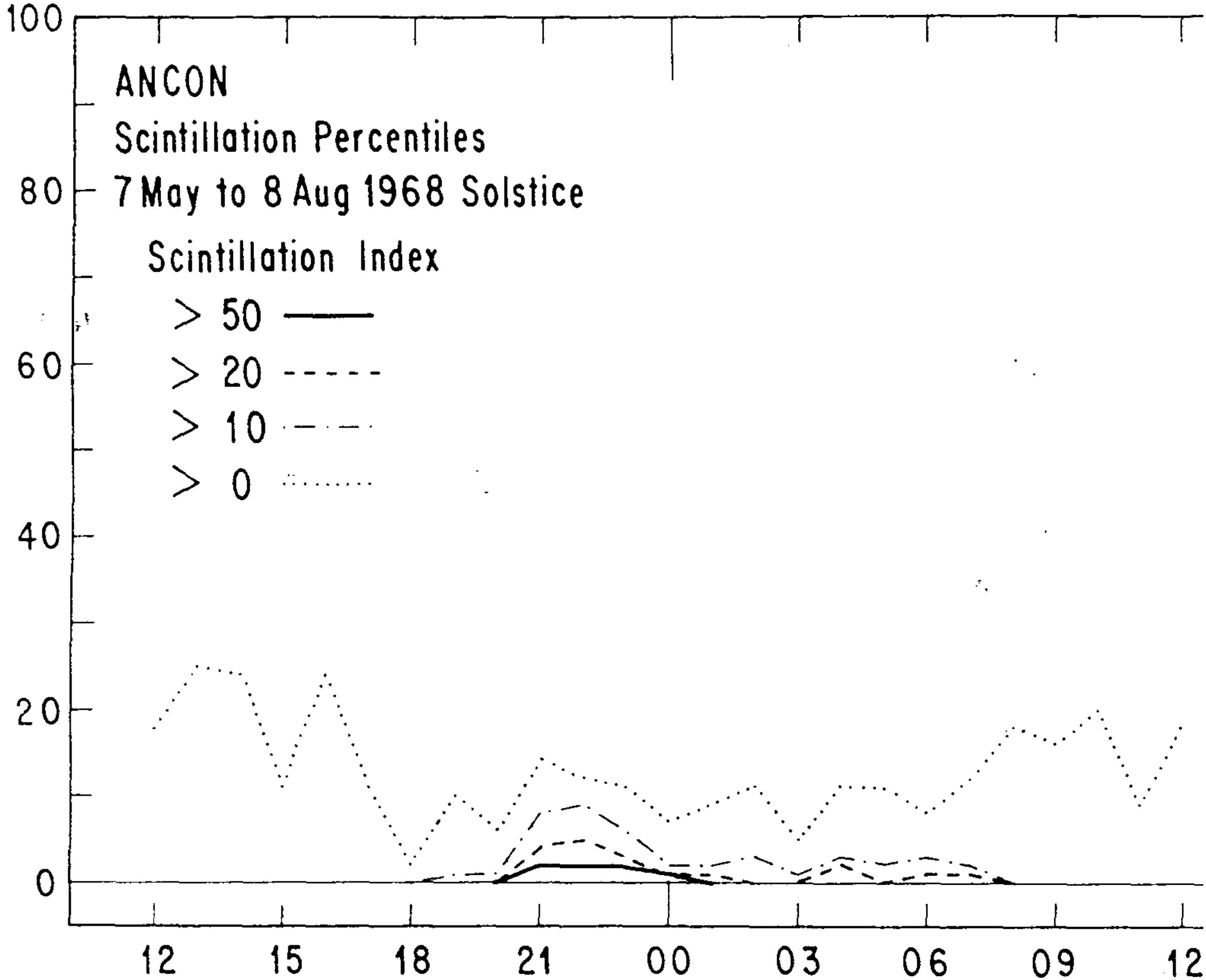
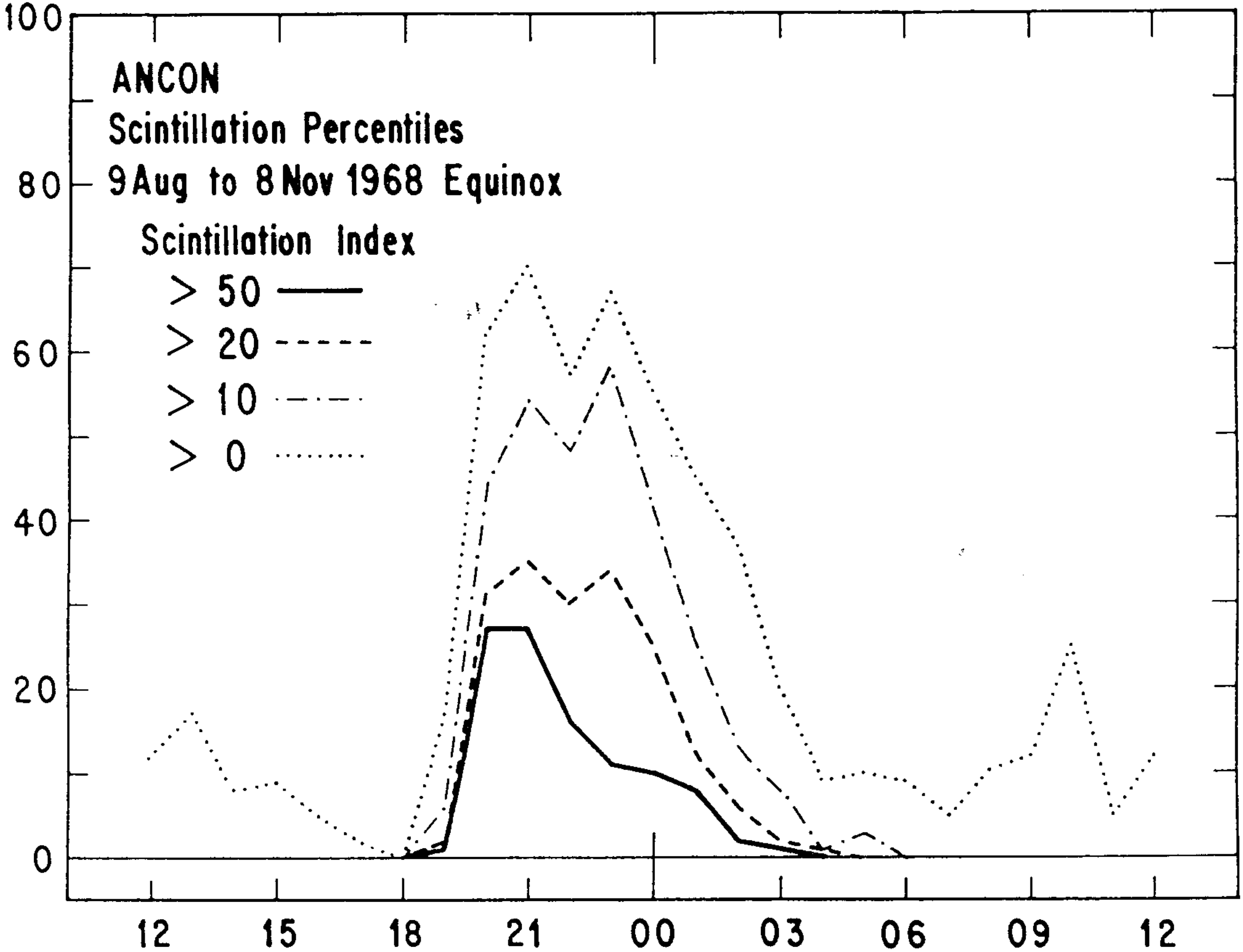
Aug
Sep
Oct
Nov
Dec


ANCON
Scintillation Percentiles
9 Nov 1967 to 4 Feb 68 Solstice
Scintillation Index
> 50
> 20
> 10
> 0
100
80
60
40
20
0
12
15
18
21
00
03
06
09
12


ANCON
Scintillation Percentiles
5 Feb to 6 May 1968 Equinox
Scintillation Index
> 50
> 20
> 10
> 0
100
80
60
40
20
0
12
15
18
21
00
03
06
09
12


ANCON
Scintillation Percentiles
7 May to 8 Aug 1968 Solstice
Scintillation Index
> 50
> 20
> 10
> 0
100
80
60
40
20
0
12
15
18
21
00
03
06
09
12


ANCON
Scintillation Percentiles
9 Aug to 8 Nov 1968 Equinox
Scintillation Index
> 50
> 20
> 10
> 0
100
80
60
40
20
0
12
15
18
21
00
03
06
09
12