

A Comparison of Occurrences of Geomagnetic Pulsations *pc* and Ionospheric Sporadic Echoes of Type *h*

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(With 4 figures)

Summary

On the basis of data from 1966, a report is given on the results of a comparison of occurrences of geomagnetic pulsations *pc* observed at M'bour (Senegal) and Dourbes (Belgium) with that of ionospheric sporadic echoes of type *h* observed at Dakar-Cambérène (Senegal) and Dourbes. According to the limited amount of data, there might exist a tendency for smaller occurrences of *pc* (3—4) when larger occurrences of *Es-h* are observed. This observation may be useful in the study of effects of the lower ionosphere on the transmission of electromagnetic disturbances.

Zusammenfassung

Unter Benutzung von Daten aus dem Jahr 1966 wird ein Bericht gegeben über die Ergebnisse eines Vergleichs zum Auftreten geomagnetischer Pulsationen *pc*, beobachtet in M'bour (Senegal) und Dourbes (Belgien), mit denen ionosphärischer sporadischer Reflexionen des Typs *h*, beobachtet in Dakar-Cambérène (Senegal) und Dourbes. Entsprechend dem begrenzten Beobachtungsmaterial scheint eine Tendenz für ein geringeres Auftreten von *pc* 3—4 zu bestehen, wenn ein häufigeres Auftreten von *Es-h* beobachtet wird. Diese Beobachtung ist nützlich für die Untersuchung der Einwirkungen der unteren Ionosphäre auf die Ausbreitung elektromagnetischer Störungen.

When examining ionograms from vertical ionospheric sounding stations, sometimes a particular type of sporadic echoes called *Es-h* (*h* = high) may be observed. A preliminary crude comparison of such observations made at the ionospheric sounding station of Dakar-Cambérène (Senegal)¹ with the occurrence of geomagnetic pulsations *pc* 3—4 recorded at the geomagnetic observatory of M'bour (Senegal)² 70 km to the SE of Cambérène revealed that a tendency seemed to exist for *Es-h* to occur on days when *pc*-activity was low at this particular site.

In order to obtain a better idea on this phenomenon, occurrences of *Es-h* (hourly soundings) were compared with occurrences of *pc* 3—4, for the year 1966.

Es-h is a type of daytime sporadic echo of variable occurrence over the year at this station, according to the observations made in 1966. The corresponding results — in percent of monthly occurrence, with a lower contour limit of 30% — are represented in Fig. 1. All sub-types of *Es-h* have been used for construction of this graph, pure *h* types as well as combined ones as *lh*, *l²h*, or *ch²* for example.

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¹) Dakar-Cambérène: $\varphi = 14^{\circ}46' N$; $\lambda = 17^{\circ}25' W$; $\Phi = 21.7^{\circ} N$, $A = 54.3^{\circ} E$

²) M'bour: $\varphi = 14^{\circ}23' N$; $\lambda = 16^{\circ}57' W$; $\Phi = 21.3^{\circ} N$, $A = 55.0^{\circ} E$.

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Collection de Référence

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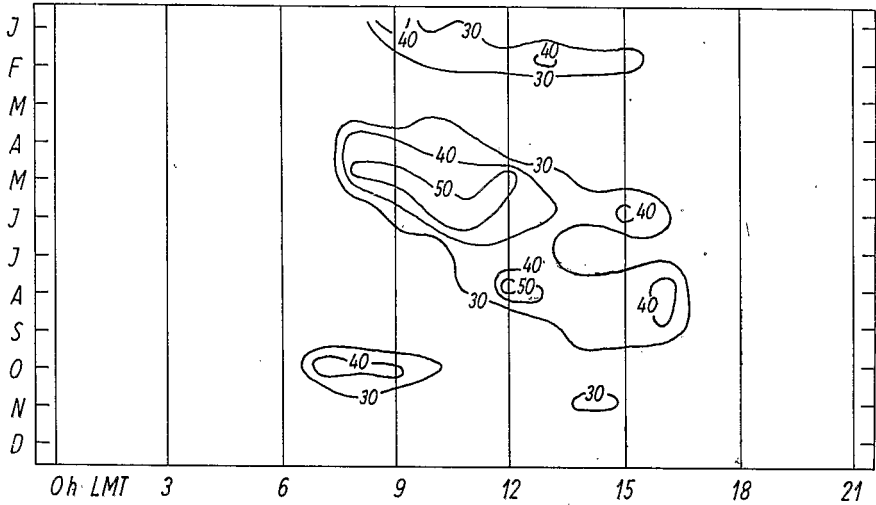


Fig. 1. Monthly percentage of observed occurrences of sporadic ionospheric echoes of type *h* at Dakar-Cambérène at the instants of soundings

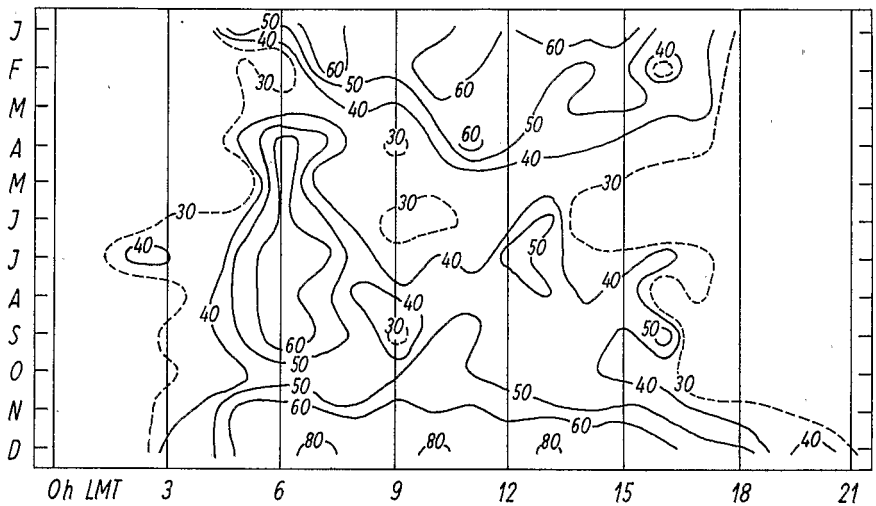


Fig. 2. Monthly percentage of observed occurrences of *pc* 3-4 at instants of ionospheric soundings at the geomagnetic observatory of M'Bour

Critical frequencies or virtual height of *E*s have not been used because they do not reflect the existence of *h* types (due to scaling techniques).

A similar graph (Fig. 2) of *pc* occurrence (*pc* 3-4) in 1966 for the station of M'Bour was constructed, but as we may think that sporadic echoes may change rapidly in time, only observations made at the instant of ionospheric soundings \pm about 2 minutes were used.

From each graph we may see that in (1966)

- i) *Es-h* occurred mostly in summer, with maximum occurrence shifting from morning and noon hours in May/June to noon and later hours in August; smaller maxima of occurrence being observed from morning to noon in January/February and in morning hours in October;
- ii) at the instants of ionospheric soundings, *pc* 3—4 showed an important maximum of occurrence around sunrise, except in February and March, and a broader, less well-defined one around local noon, in accordance with the results of a previous study on *pc* occurrence at M'Bour (BARSCZUS [2]). M'Bour belongs to the low-latitude group of observatories which display as a rule two maxima in *pc* occurrence (ROMAÑA [11]; BARSCZUS [1]).

Comparing both graphs, we may see that high *Es-h* occurrences from April to approximately September correspond to relatively low *pc* occurrences at the instants of ionospheric soundings, or observation of *Es-h*, as well as probably in the case of the October *Es-h* maximum occurring in the morning. In June, *pc* occurrences at the instants of soundings drop off very sharply after noon and a secondary *Es-h* occurrence maximum is observed. Such a pattern, however, will not be observed clearly in January and February, even if such indication exists. In November and December 1966, *Es-h* occurrence was very low and *pc* occurrence at the instants of ionospheric soundings was exceptionally high.

This rather crude method of comparison is not fully satisfactory for different reasons, especially because

1. of mixing of *pc* 3 and 4;
2. of the relative scarcity of *Es-h* data (only results of hourly soundings as performed routinely at Cambérène were available) compared with the continuous recording of *pc*;
3. the distance (about 70 km between Dakar-Cambérène and M'Bour) seems rather important, especially if we assume small dimensions of the *Es-h* responsible patterns, changing rapidly with time and of unknown displacement direction.

For these reasons we have tried to check this observation made at a low-latitude station by use of observational results (concerning 1966 as well) from another station, but located at middle latitudes and where both types of observations are made at the same plane. The results obtained at the Centre de Physique du Globe of Dourbes¹⁾ (Belgium) as published in the usual observatory bulletins (cf. [5], [6]) were easily available and have been used.

A similar graph of *Es-h* occurrence was constructed (Fig. 3). In winter (January/February and December), there is a maximum of *Es-h* occurrence before noon, and a strong morning maximum exists in April/May, together with a secondary maximum in the late afternoon in April. The graph of *pc* occurrence (Fig. 4) shows maxima occurring in the forenoon and noon hours in equinoctial months.

Comparison of both graphs for Dourbes leads to similar conclusions as in the case of Dakar-Cambérène: *Es-h* will be observed chiefly when *pc* activity is low, with exception of the months of April and December 1966.

¹⁾ Dourbes: $\varphi = 50^{\circ}06' \text{ N}$, $\lambda = 4^{\circ}36' \text{ E}$; $\Phi = 52.0^{\circ} \text{ N}$, $A = 87.7^{\circ} \text{ E}$.

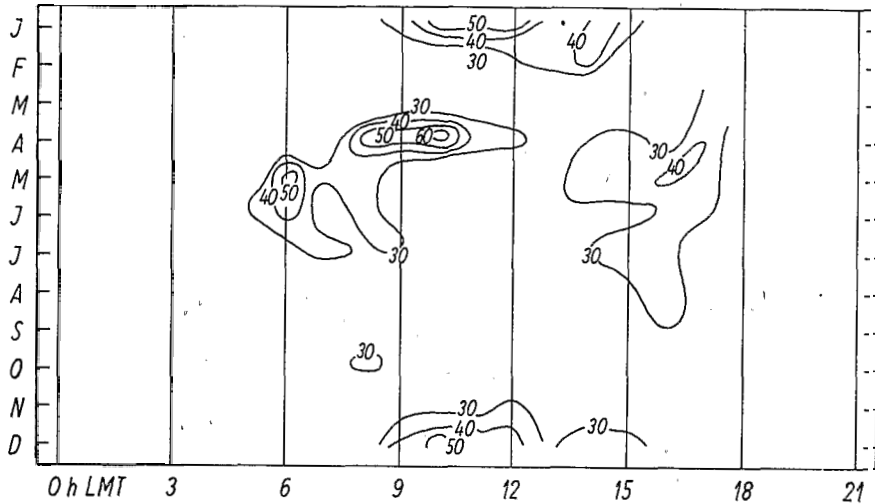


Fig. 3. Monthly percentage of observed occurrences of sporadic ionospheric echoes of type *h* at Dourbes at the instants of soundings

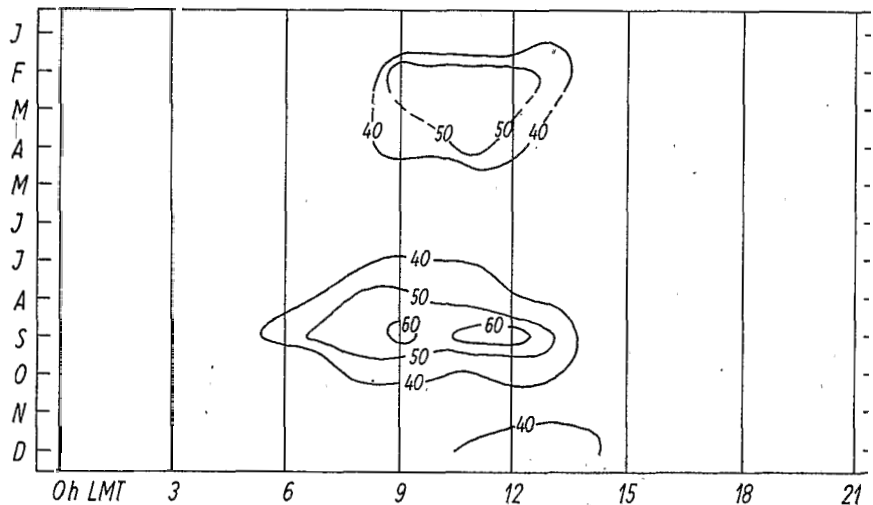


Fig. 4. Monthly percentage of observed occurrences of *pc* 3 at approximately the instants of ionospheric soundings at the geomagnetic observatory of Dourbes

Dourbes belongs to the one-maximum of *pc* occurrence stations. Moreover we should like to point out that only *pc* 3 have been observed in 1966 at Dourbes, so that the objection of mixing *pc* 3 and 4 does not hold; in this case, however, the (Dourbes) graphs were obtained by using bulletins only, whereas in the case of M'Bour the *pc* graph was obtained by scaling the actual records for *pc* occurrence at the instants of ionospheric soundings.

At this stage, it is uneasy to decide if the above observation will be significant, as only a small number of observations (1 year) made at just two stations are avail-

able. It could be interesting to repeat such observations over a longer period at some other stations where both types are performed at the same place (the Dakar-M'Bour stations might be too distant from each other), and using essentially sounding data obtained at a quicker rate (15 minutes soundings).

Such observations will be interesting for studying possible local influences of the ionosphere on *pc*. Occurrence of sporadic echoes of this type with virtual heights ranking up to 200 km and more might change the electron-density profiles and so alter the resonance and/or transmission characteristics of the local ionosphere: It might be possible to observe eventually an attenuation of *pc* amplitudes and/or shifts of observed *pc* mean-periods which could be correlated with the behaviour of sporadic echoes.

To some degree similar observations have been reported by HRUŠKOVÁ [9]: It seems probable that at higher critical frequencies $f_0 E_s$ the amplitude of *pc* 3 is lower than at small $f_0 E_s$; as well as by MORGAN [10]: *pc* occurrence seems to be smaller if $f_0 E_s$ exceeds some typical threshold level.

It has been mentioned by BOCHNÍČEK [3] that the effects of the lower ionosphere should not be neglected when considering the transmission of *pc* through the ionosphere, as in the type of work initiated for example by GREIFINGER and GREIFINGER [8] and by FIELD and GREIFINGER [7]. The same author concludes later (BOCHNÍČEK [4]) that with increasing period of the electromagnetic disturbance the effect of the sporadic layer on the behaviour of this disturbance should decrease, and that possibly the sporadic layer is not the immediate cause of the vanishing of micropulsations *pc* 1 to *pc* 3, during the occurrence of the sporadic layer this phenomenon being probably due to "filtering" effects.

In connection with these studies, may be that the observations we reported on will initiate some more detailed experimental study on the behaviour of E_s types with respect to geomagnetic pulsations *pc*.

References

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