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Radio climatology of Rajasthan

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सार — सतही वायुमंडलीय दाब, तापमान व वाष्पदाब मानों के तीस वर्षों के माध्य पर आधारित राजस्थान राज्य व उसके निकटवर्ती 18 स्टेशनों के, जो अन्तर्राष्ट्रीय सीमा रेखा के निकट व अन्दर स्थित हैं, रेडियो अपवर्तनांकों का अभिकलन किया गया है। प्राप्त आंकड़ों से इस क्षेत्र में रेडियो अपवर्तनांकों के मासिक व वार्षिक वितरण का प्रातः व सायं दो बार, वर्णन तथा विचार किया गया है जो रेडियो तरंग संचरण में उपयोगी हो सकता है।

ABSTRACT. Based on 30-year averages of the values of atmospheric pressure, temperature and vapour pressure near the ground surface, values of radio refractive indices for 18 stations of Rajasthan State and adjoining area near and within international border line, have been computed. Using these data, monthly and annual distributions of radio refractive indices over the area for both morning and evening have been described and discussed which may be useful in radiowave propagation in the area.

Key Words — RRI, Climatology

1. Introduction

It has been established that change in atmospheric refractivity from place to place, from morning to evening and its seasonal/diurnal variation is an important factor being considered by radio-physicists/engineers in radio measurements, propagation studies, frequency planning and allied applications, while putting a point to point radio-communication/microwave link. Meteorological parameters influencing radiowave propagation, signal strength and trapping of radiowaves in a certain region are pressure, temperature and humidity. It is seen by radio-scientists (Singh and Singh 1989) that every unit change in the surface refractive index causes a change of 0.2 dB in signal strength in the frequency range of 30 to 300 MHz.

Radio-climatological data for India have been derived by Kulshrestha and Chatterjee (1966) whereas local variations in radio-climatology for Delhi have been studied by Deshpande (1974), for Bombay by Dayakishan and Pradhan (1977) and for Patiala by Singh and Singh (1989). The present study has been confined to Rajasthan State and its adjoining area near and within international border line, in view of importance of the region.

2. Climatology of Rajasthan State

The Rajasthan State lies roughly between 23°N and 30°N latitudes and 69°E and 78°E longitudes.

The State has a very dry climate which is primarily influenced by the Aravali range dividing the State into two parts. Western part, forming 'great desert' extends from Rann of Kutch to near Delhi, features frequent duststorms and scanty rainfall. Its eastern side is 'little desert' consisting of rocky land cut off by lime stone ridges which to some extent protect it from the desert's sandy climate as determined by Aravali range.

West Rajasthan has tropical desert, arid and hot climate with temperature varying appreciably from morning to evening, whereas the remaining part has tropical steppe, semi-arid and hot climate. The State has four seasons — winter season from November to March, pre-monsoon season from April to June, south-west monsoon season from July to middle of September and post monsoon season from latter half of September to October (*Climate of Rajasthan State*, India Met. Dep., 1988). The annual rainfall in the State varies from 15 cm in the west to 75 – 100 cm in the east, whereas temperature varies from —4°C during winter to 50°C during summer.

3. Radio refractive index

The refractive index of radiowaves in a medium, a ratio of velocity of radiowaves in free space to that in the medium, is almost the same for dry air as in case of light waves. But in the presence of water vapour, at microwave frequencies, the index of refraction n is (Smith and Weintraub 1953) :

$$N = (n-1) \times 10^6 = 77.6\ (P/T) + 373000\ (e/T^2)$$

where, P = Barometric pressure in hPa,
e = Partial pressure of vapour (water) in hPa,
T = Temperature in degree Kelvin.

The parameter $N = (n-1) \times 10^6$ is the "Scaled up" index of refraction and is called the refractivity.

The difference between optical and microwave refraction is that the water vapour has a negligible effect

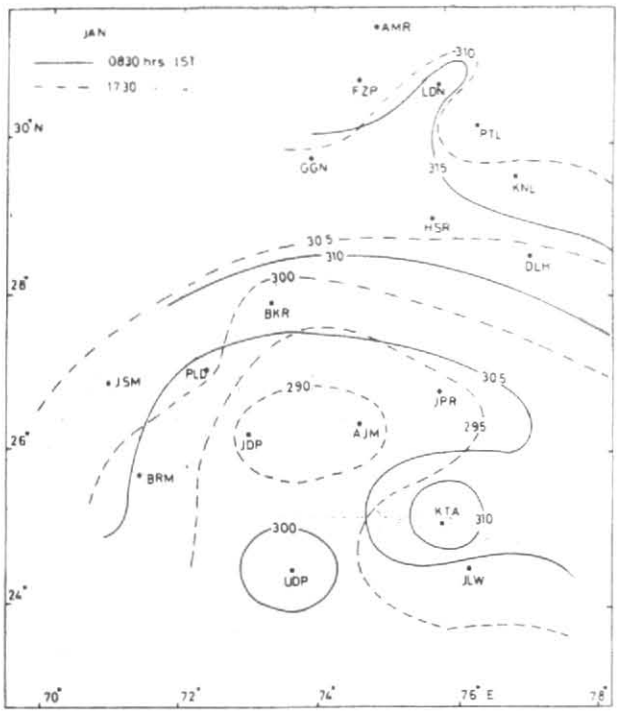

Fig. 1. Mean monthly radio refractive index of Rajasthan for the month of January

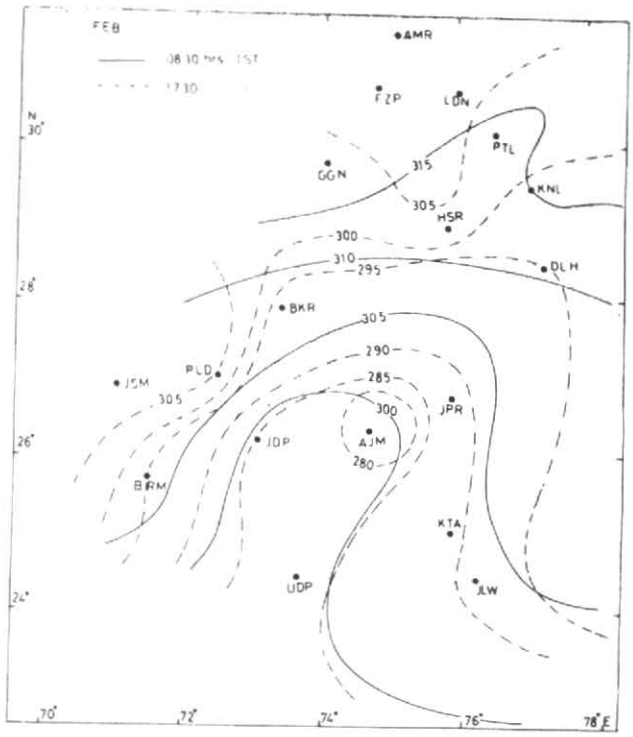

Fig. 2. Mean monthly radio refractive index of Rajasthan for the month of February

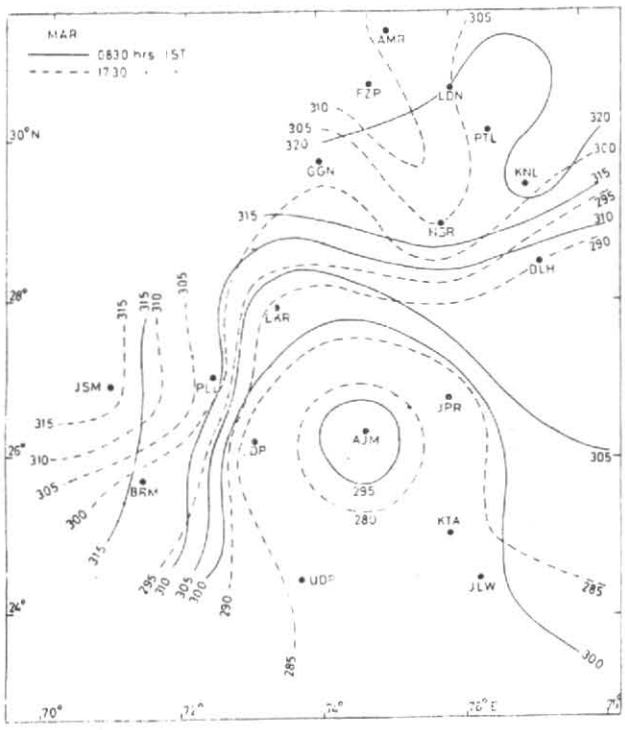

Fig. 3. Mean monthly radio refractive index of Rajasthan for the month of March

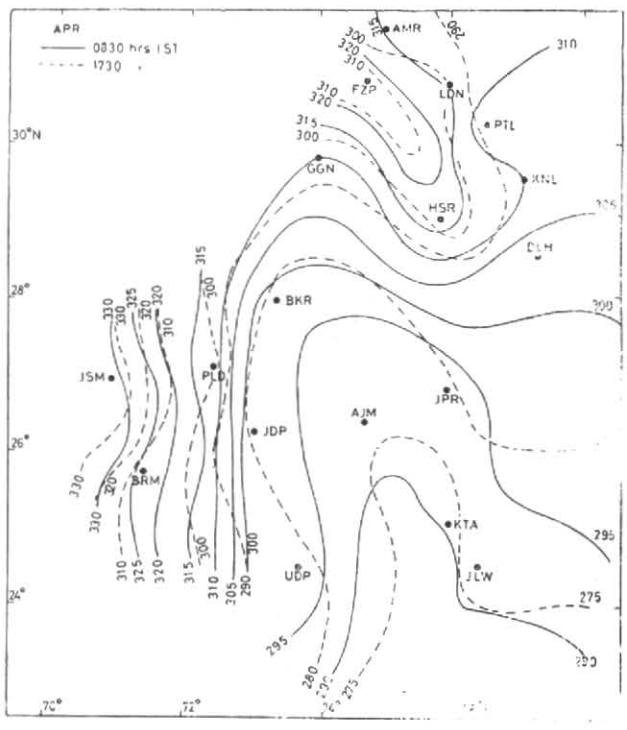

Fig. 4. Mean monthly radio refractive index of Rajasthan for the month of April

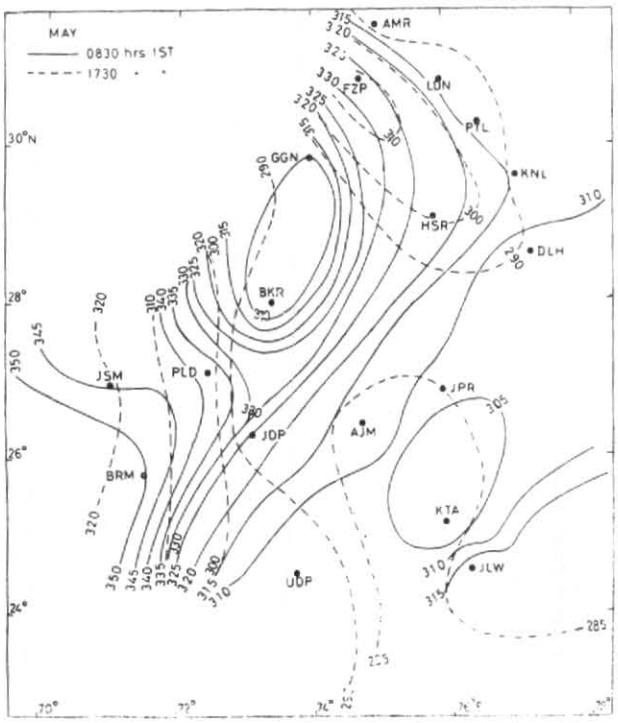

Fig. 5. Mean monthly radio refractive index of Rajasthan for the month of May

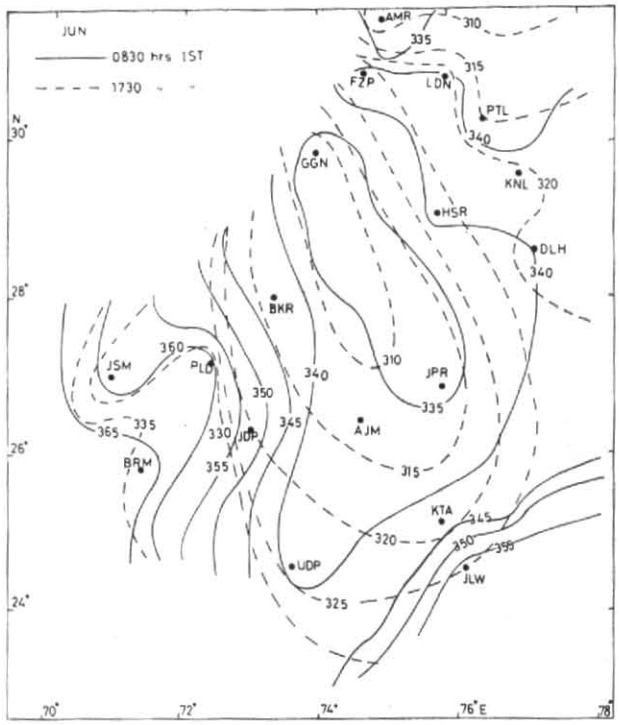

Fig. 6. Mean monthly radio refractive index of Rajasthan for the month of June

on the former; consequently the second term of the above equation can be neglected at optical frequencies. At microwave frequencies the first term which is a 'dry term' has a small variation compared to second term, a 'wet term'.

4. Data used

As the climatological data vary significantly in different months, the radio refractive index of a place which is a function of pressure, absolute temperature and humidity also varies accordingly. To find out the radio refractive index (RRI) the climatological data of 18 stations of Rajasthan State and its adjoining area near and within international border line have been considered for two times a day, *i.e.,* for 0830 IST and 1730 IST, to enable study the variations in RRI from morning to evening while studying the mean monthly variations in RRI of these stations.

The basic climatological data has been taken from '*Climatological Tables of Observatories in India*' by India Met. Dep., for the period from 1931 to 1960. The period may be a very good approximation for the computation of mean monthly values of radio refractive index for these stations for morning (0830 IST) and evening (1730 IST). Using the basic climatological data, RRI for different stations for different months have been computed from the above equation and its monthly variations studied by drawing lines of equal RRIs over the area. Variations of RRI values over the entire area during the month have also been studied.

Figs. 1-12 show the mean monthly variations of these stations and Fig. 13 shows the variation in annual mean values of RRI. In these figures, continuous lines show the lines of equal RRI at 0830 IST whereas broken lines show the lines of equal RRI at 1730 IST.

5. Discussion and conclusions

Analysing the variations of radio refractive index from these figures (Figs. 1-13) we interestingly find that the lowest values of RRI, round the year and throughout the day, are around Ajmer and the highest values of RRI are around Jaiselmer in the west and around Amritsar in the north.

The variation of RRI values over the area during monsoon period, *i.e.,* during July, August and September is less than that in other months. During monsoon period, values of RRI over a particular area are higher than values in other months; particularly in August when the values of RRI are the highest, both in the morning and evening.

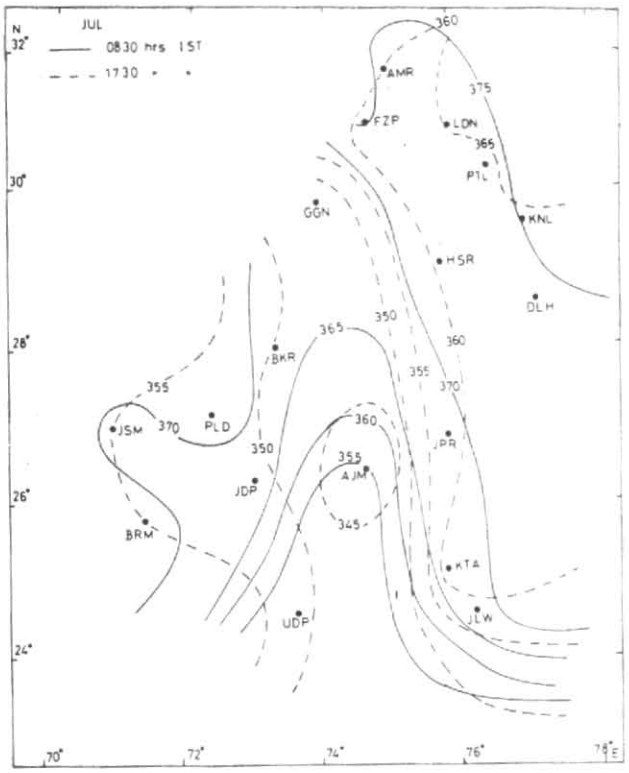

Fig. 7. Mean monthly radio refractive index of Rajasthan for the month of July

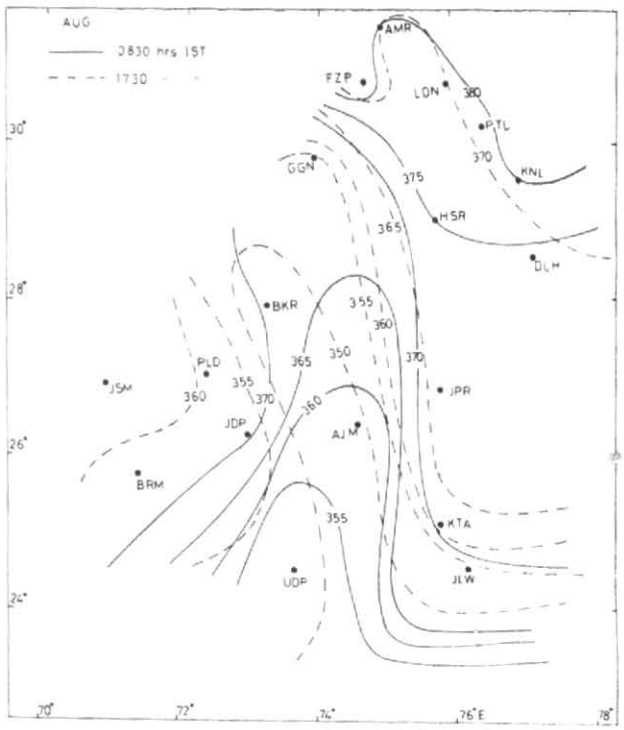

Fig. 8. Mean monthly radio refractive index of Rajasthan for the month of August

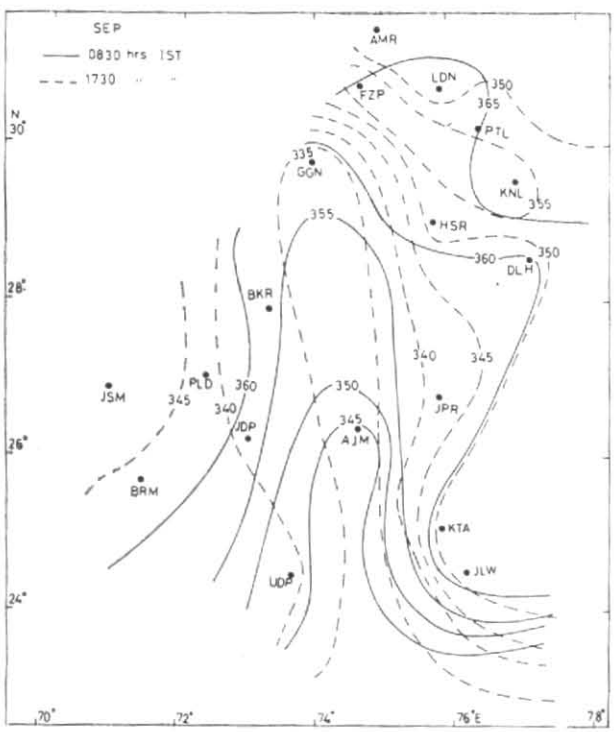

Fig. 9. Mean monthly radio refractive index of Rajasthan for the month of September

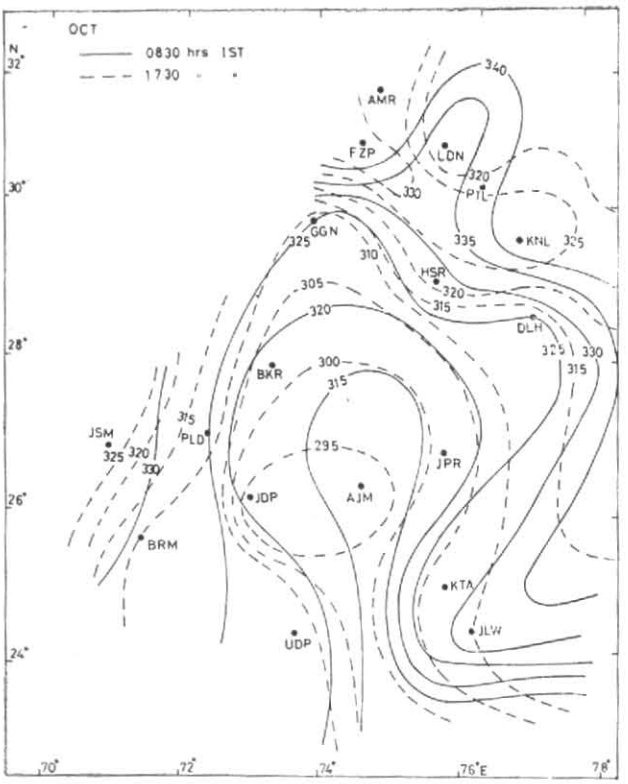

Fig. 10. Mean monthly radio refractive index of Rajasthan for the month of October

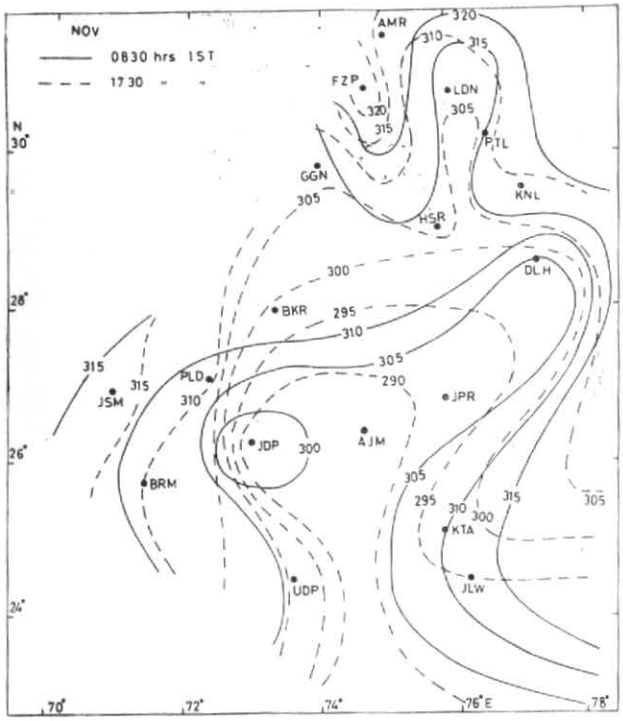

Fig. 11. Mean monthly radio refractive index of Rajasthan for the month of November

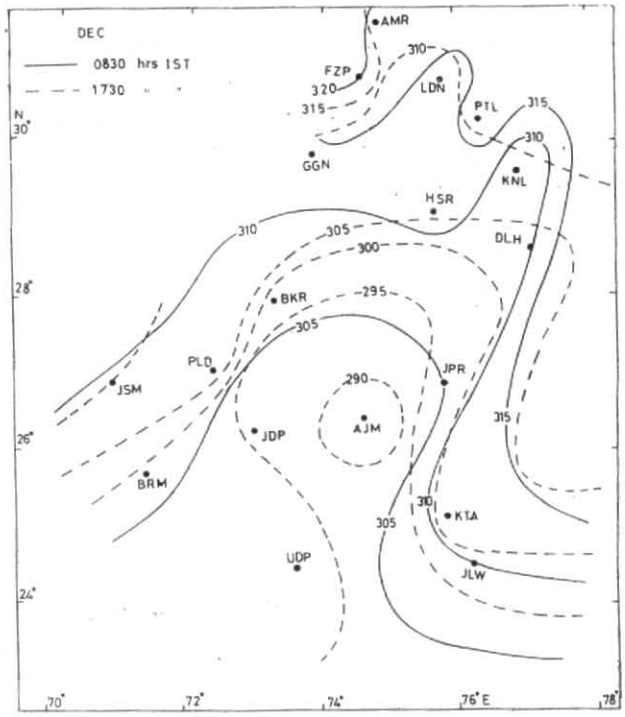

Fig. 12. Mean monthly radio refractive index of Rajasthan for the month of December

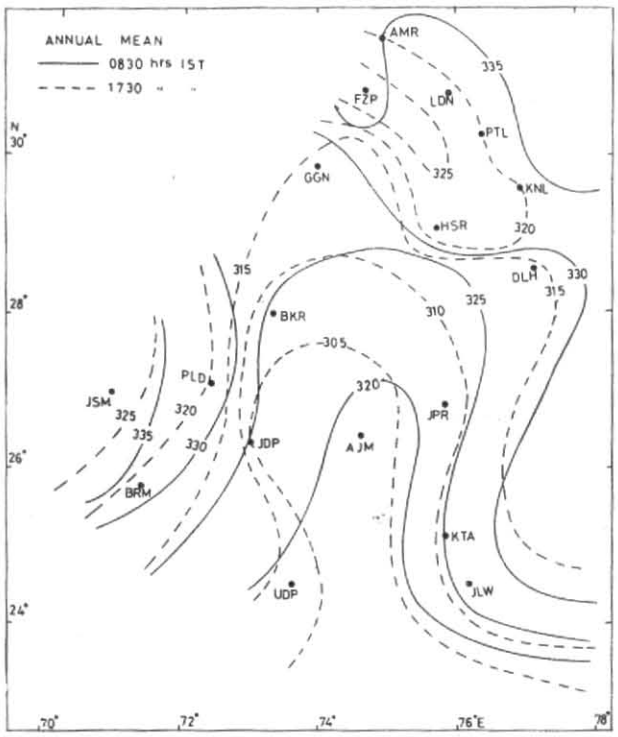

Fig. 13. Mean annual radio refractive index of Rajasthan

During winter season (September-January), the values of RRI around Ludhiana, in the morning, are lesser than those in the adjoining area, thus making a steep gradient around Ludhiana. In the evening, the values of RRI around Ferozepur are higher than those in its adjoining area.

We, thus, find that the values of RRI around Ajmer are the lowest. Ajmer has been almost at a dividing point between 'green land' and 'desert' as it is located on Aravali range. The values of RRI at and around Jaiselmer which is 'great desert' and also around Amritsar which is sufficiently 'green' are the highest. So, while considering the radiowave propagation in the desert area the radio-scientists have to take care of the fact that the RRI values are the highest either in the green area or in the desert area whereas these are the lowest at places which divide 'desert' from the 'green'.

We also find that the values of RRI along and within international border line are almost the highest and very stable, particularly in the morning. Also, morning values of RRI at a particular place, over the entire area, are higher than those corresponding RRI values in the evening. These facts must also be incorporated by radio-scientists studying or establishing radiowave propagation in the above area.

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