Mausam, (1993), **44**, 1, 99-114

Letters to the Editor

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RADIO CLIMATOLOGY OF MADHYA PRADESH

1. The atmospheric influence on the propagation of UHF and microwave frequencies through space is known since very long. The radio horizon and signal strength at a given point as well as the fading and formation of ducts and anomalous propagation of the microwaves are significantly dependent on the meteorological conditions in the lower troposphere. The three meteorological parameters, *viz.*, surface pressure, temperature and humidity, which influence the radio propagation in the microwave region, are utilized in the computation of atmospheric radio refractive index (RRI). It has been observed by CYCIR study group that for 30 to 300 MHz communication, every unit change of surface RRI causes a change of 0.2 dB in signal strength.

2. Variations of RRI for the whole India have been studied by Kulshrestha and Chatterjee (1966), for Rajasthan State by Kulshrestha and Bhatia (1991). Similar studies for Delhi, Patiala and RRI profile over Indian seas are done by Deshpande (1974), Singh and Singh (1989) and Sivaramakrishnan (1981 & 1989) respectively. The present study is for Madhya Pradesh which has a very good network of meteorological observatories.

3. The refractive index of the medium for radiowave is almost same as for light waves for dry air. But for moist air, it is different and is defined as modified radio refractive index (N) given by :

$$N = (n-1) \times 10^6$$

$$= 77.6\,(p/T) + 3.73 \times 10^5 \left(\frac{e}{T^2} \right)$$

where, p is barometric pressure in hPa, e is partial vapour pressure in hPa, T is temperature in °K, n is refractive index, and N is modified refractive index.

4. For the present study, the climatological data of 26 stations in M.P. for 0830 IST and 1730 IST have been taken from "*Climatological Tables of Observatories in India*" published by India Meteorological Department for the period 1931-60. From the above data, RRI for different stations for different months for 0830 IST and 1730 IST have been computed. Monthly, annual and seasonal variations and changes in maximum and minimum values of RRIs for different stations have been analysed. Moreover, RRIs over the entire State have been studied with reference to its variations within a month, sectorwise and seasonwise.

(*i*) The monthly mean values of surface RRI (N_s) for 0830 & 1730 IST for all the 26 stations are given in Tables 1 and 2 respectively.

(*ii*) For each of the stations the annual maximum and annual minimum values of N_s as well as the values of annual range of variations are also given in Tables 1 & 2.

(*iii*) The mean annual values of RRIs have been analysed and shown in Fig. 5 which depicts the annual surface distribution of RRI over M.P. for 0830 IST and 1730 IST.

(*iv*) The mean seasonal values of N_s for all the 26 stations are plotted and isopleths of seasonal means of N_s have been drawn in Figs. 1-4.

5. It is observed from the Tables 1 and 2 that the minimum values of RRI during the year is at Panchmari, a hill station with altitude more than 1 km. This being the place of highest altitude in M.P. the observed minimum value of RRIs over this station is quiet obvious. The maximum RRI, however, is seen to be over south and southeast M.P. almost throughout the year. Apart from Panchmari the other minimum value of RRI in planes is observed at Sagar and Chhindwara area during most of the year.

(*i*) *Seasonal distribution of RRI over M.P.*— It may be seen from the Figs. 1-4 that the seasonal distribution pattern for summer season is similar to that of the post monsoon pattern in many respects. The pattern for winter is also similar in some respect with that of summer and post monsoon. However, the seasonal distribution pattern for monsoon is quite different from that of these three seasons. The lowest seasonal value of 'N_s' generally occurs over Panchmari and Nimach area while the highest value occurs over southeast M.P. area.

The winter pattern reveals that the lowest value of N_s occurs over Nimach in west M.P. whereas highest value occurs over southeast M.P., thus exhibiting steep gradient of N_s values between these two areas with a difference of 35 N_s. There is also a feeble gradient parallel to this but in opposite direction with a high forming over Nowgaon-Satna and a low over Pendra with a difference of 10 N_s. During the summer season, there is a general increase in the gradient with the pattern more or less similar to the winter. Lowest value of N_s occurs over Panchmari whereas highest is again over southeast M.P. area. During the monsoon season, the contour pattern changes considerably. The high has shifted slightly northward to Raigarh and

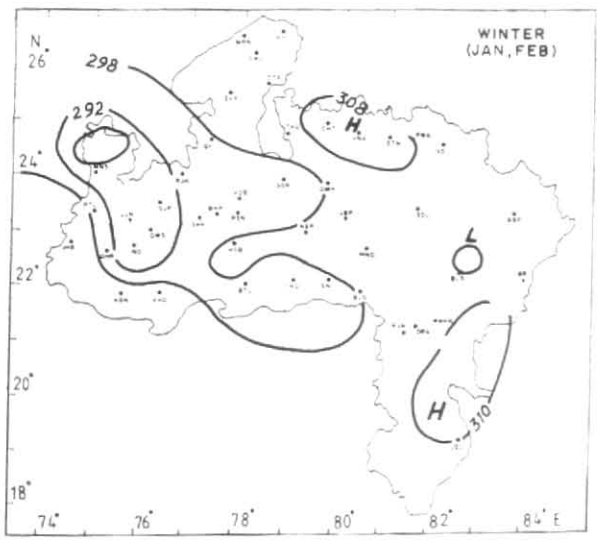

Fig. 1

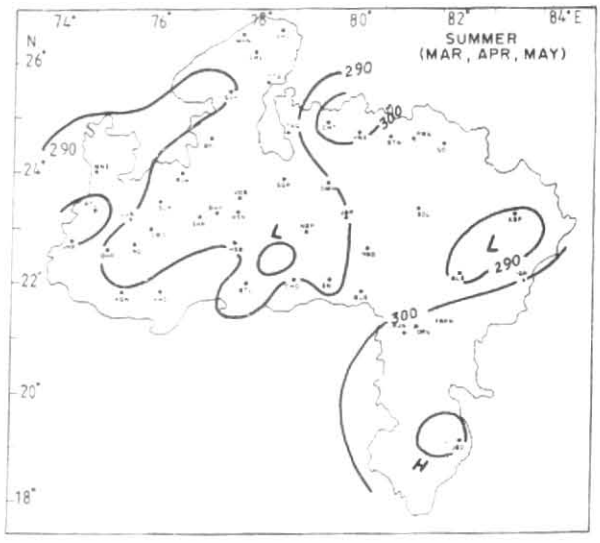

Fig. 2

TABLE 1

Mean monthly radio refractive index at various stations

Station	Sector	For 00 UTC												Annual			
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	Max	Min	Range
Nimach	NW	298	292	288	292	321	349	360	359	353	317	296	297	320	360	288	72
Guna	NW	305	301	296	288	299	336	362	364	358	341	308	305	323	364	288	76
Sheopur	NW	316	308	307	296	302	345	375	381	371	341	316	315	332	381	296	85
Gwalior	NW	312	307	300	289	298	331	373	377	368	332	311	311	326	377	289	88
Sagar	NW	300	294	286	283	294	338	368	364	357	324	298	296	317	368	286	82
Nowgaon	NW	319	317	297	305	323	348	376	378	373	344	322	319	337	378	297	81
Satna	NE	315	313	306	302	307	343	372	373	370	337	317	313	332	373	302	71
Jabalpur	SE	313	311	304	297	297	340	366	365	363	340	316	313	328	366	297	69
Mandla	SE	318	315	312	309	307	347	368	366	363	343	321	317	333	368	307	61
Pendra	SE	305	301	293	289	298	333	356	357	354	331	307	303	319	357	289	68
Ambikapur	SE	310	306	300	294	304	337	358	360	357	340	316	310	325	360	294	66
Champa	SE	320	316	311	311	319	351	376	377	376	359	329	323	339	377	317	66
Raigarh	SE	322	316	315	318	327	357	377	380	378	359	328	322	342	380	315	65
Raipur	SE	317	315	309	311	317	350	370	372	371	353	327	317	336	372	309	63
Kanker	SE	320	321	319	325	329	349	362	363	364	351	330	321	338	364	319	45
Jagdalpur	SE	315	316	315	325	332	347	355	357	356	346	326	317	334	357	315	42
Umaria	SE	311	310	304	296	301	339	365	365	361	338	314	309	326	365	296	69
Seoni	SW	304	300	294	294	299	337	355	354	350	326	306	306	319	355	294	61
Chhindwara	SW	302	295	289	291	296	336	353	351	348	327	303	301	317	353	289	64
Panchmari	SW	289	283	275	273	282	319	334	333	329	304	291	289	300	334	273	61
Batul	SW	303	292	287	288	306	343	353	352	351	329	305	303	318	353	287	66
Hoshangabad	SW	313	307	300	294	305	348	370	370	367	341	318	313	329	370	294	76
Bhopal	SW	301	296	288	288	301	344	360	360	356	328	307	303	320	360	288	72
Indore	SW	302	293	287	293	319	354	359	354	352	324	307	302	321	359	287	72
Ratlam	SW	304	297	300	302	336	362	364	363	357	326	306	304	328	364	297	67
Khandwa	SW	308	301	294	299	323	354	365	363	362	336	316	310	328	365	294	71

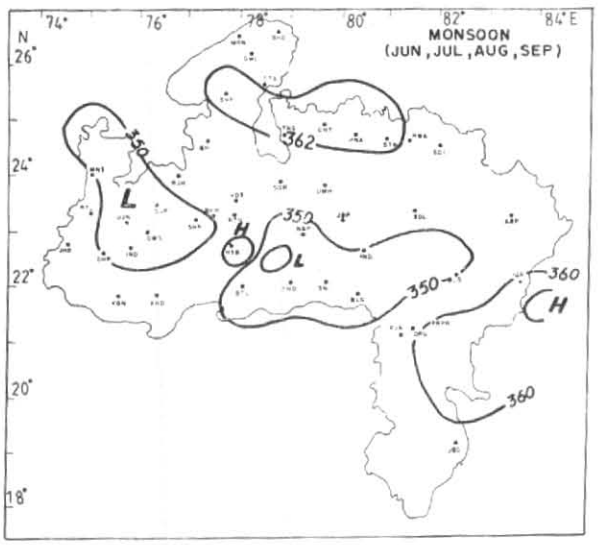

Fig. 3

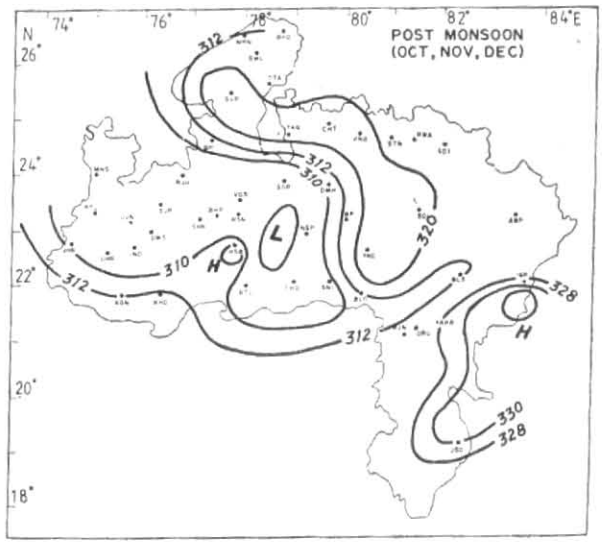

Fig. 4

TABLE 2

Mean monthly radio refractive index at various stations

Station	Sector	For 12 UTC												Annual			
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	Max	Min	Range
Nimach	NW	287	278	276	277	292	322	351	354	343	298	284	286	304	354	276	78
Guna	NW	293	284	278	272	279	318	359	363	352	309	297	295	308	363	272	91
Sheopur	NW	303	289	284	279	283	322	367	376	365	332	311	309	318	376	279	97
Gwalior	NW	301	292	279	271	276	315	367	375	363	324	303	304	314	375	271	104
Sagar	NW	293	283	274	274	282	329	365	359	352	315	294	293	309	365	274	91
Nowgaon	NW	304	294	288	291	300	336	374	376	365	329	310	306	323	376	288	88
Satna	NE	307	300	290	289	291	330	371	372	364	331	308	308.	320	372	289	83
Jabalpur	SE	306	295	284	280	279	327	365	365	359	329	311	308	317	365	279	86
Mandla	SE	303	290	284	286	287	339	364	265	358	334	309	305	318	364	265	99
Pendra	SE	299	291	283	278	283	326	357	358	353	327	303	298	313	358	278	80
Ambikapur	SE	299	287	280	275	280	325	356	360	354	333	308	302	313	360	275	85
Champa	SE	309	294	290	287	291	334	371	375	371	351	318	314	325	375	287	88
Raigarh	SE	309	299	294	292	297	338	373	376	376	351	320	313	328	376	292	84
Raipur	SE	308	298	290	289	294	335	368	369	366	345	319	310	324	369	289	80
Kanker	SE	308	305	301	305	307	342	364	364	363	344	321	313	328	364	301	63
Jagdalpur	SE	301	296	288	297	309	338	355	356	356	342	322	307	322	356	288	68
Umaria	SE	306	295	288	282	285	326	365	366	361	335	313	309	319	366	282	84
Seoni	SW	295	289	283	284	286	329	354	353	345	315	298	294	310	354	283	71
Chhindwara	SW	290	277	273	280	284	327	348	348	341	312	291	288	305	348	273	75
Panchmari	SW	287	276	266	264	271	311	335	335	330	302	289	285	295	335	264	91
Batul	SW	290	276	272	274	282	326	349	351	345	320	298	295	306	351	272	79
Hoshangabad	SW	302	289	278	275	283	326	367	368	361	331	309	304	316	368	275	93
Bhopal	SW	291	281	270	272	272	319	353	356	347	309	293	292	304	356	270	86
Indore	SW	288	275	274	271	280	322	349	351	342	308	291	288	311	351	271	80
Ratlam	SW	298	292	292	291	303	338	359	358	348	316	300	296	316	359	291	68
Khandwa	SW	296	289	279	281	288	330	360	361	354	317	303	299	312	361	279	82

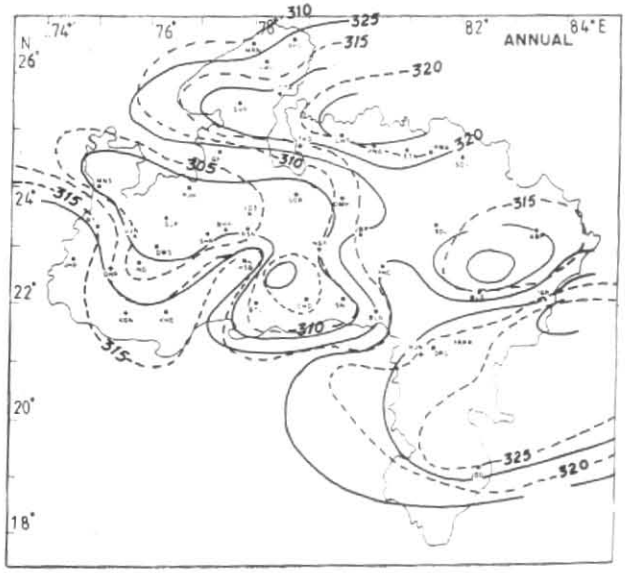

Fig. 5

other high is over central M.P. The low is more or less at same place, *i.e.*, Panchmari. Orientation of gradients has also changed. The pattern during post monsoon season is similar to that for summer but the gradients are more uniformly distributed. The highest value of N_s is more or less at the same place, *i.e.*, over Raigarh and the lowest over Panchmari.

(*ii*) *Annual maximum and minimum values of* N_s *over M.P. for 0530 IST* — It is observed from Tables 1 & 2 that the highest values of annual maxima are over southeast M.P. at Raigarh (380 N_s) and Sheopur in northwest M.P. (381 N_s) whereas lowest value of annual maxima of RRI occurs at hill station Panchmari (334 N_s) and after it, in planes, at Betul (353 N_s) and Chhindwara (353 N_s). Maximum value of annual minima is also at southeast M.P. at Kanker (319N_s) having gradient towards northern M.P. The minimum value of annual minimum RRI is at Panchmari (273 N_s) after that at Sagar over northwest and central M.P.

By comparing the monthly mean RRI values of Indore, it is observed that the RRI values are, in general, agreement with values seen in radio climatology (1966).

Tables 1 and 2 also show that RRI of a particular place is maximum in the morning and minimum in the evening which agrees with the diurnal variation of surface pressure at a particular place.

6. This study has brought out the following observational facts :

(*i*) RRI around Panchmari is found to be minimum.

(*ii*) Next minimum of RRI is at Chhindwara and Sagar situated on the Satpura plateau and Vindhyachal ranges having elevation around 650 m and 550 m.

(*iii*) The RRI values are high at Raigarh and Kanker region probably due to dense forests.

(*iv*) During monsoon, values of RRI over particular area are higher than the values in other months particularly in July and August.

(*v*) RRI values at a particular place seems to exhibit diurnal variations as maximum value is observed in the morning and minimum in the evening.

7. The author is grateful to Shri S.C. Gupta, Director, Meteorological Centre, Bhopal for his valuable suggestions during preparation of manuscript and to S/Shri A.L. Chimote, N. K. Chanchlani and M.S. Nimaje for computation and typing.

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23 May 1991, Modified 28 April 1992