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Radio refractivity over Bay of Bengal during monsoon season from Monex-79 data*

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सार – मॉनेक्स 1979 कार्यक्रम के अन्तर्गत जुलाई 1979 में बंगाल की खाड़ी में रूसी शोध पोतों एवं भारतीय जलयानों द्वारा अभिलेखित उपरितन वायु के आंकड़ों से भू, 850, 700, 500 मि० बार के तलों के लिए वैध रेडियो अपवर्तनांक (आर० आर० आई०) की गणना की गई है। इसमें समय और आकाशी विचरण का वर्णन किया गया है। तटीय स्टेशन एवं उसी अक्षांश पर मध्य समुद्र में जलयान के प्रेक्षणों से निकाले गए रेडियो अपवर्तनांकों के मानों की तुलना रोचक है।

ABSTRACT. From the upper air data recorded by the Russian research vessels and the Indian ships in the Bay of Bengal during July 1979 under Monex-79 programme, the radio refractive indices (RRI) valid for surface, 850, 700 and 500 mb were calculated. The time and space variations have been discussed. The comparison of RRI values from observations at a coastal station and from a ship in the mid seas at the same latitude is interesting.

1. Introduction

Radio refractivity over the sea areas is of vital importance in the study of propagation problems and planning of telecommunication links between mainland, sea islands and ocean going vessels. Radio refractive index is a function of the three meteorological parameters, *viz.*, pressure, temperature and humidity. Kulshrestha and Chatterjee (1966, 1967) have given the radio climatology for India and Kulshrestha (1975) has done the same for sea areas adjoining Indian subcontinent.

Onset of monsoon over India and Indian seas brings about a drastic change in the airmass characteristics. Even during the season, the activity can vary from weak phase to rigorous phase and accordingly the meteorological parameters also will be influenced. Hence an analysis of radio refractivity with real time data may be more interesting.

Recently Sivaramakrishnan (1981) has given the RRI profile for equatorial seas and south Arabian Sea using Monex-79 data and studied the changes due to monsoon arrival over Arabian Sea. The RRIs valid for Bay of Bengal were evaluated from the ships' observations during the Monex-79 period and the results are presented here.

2. Data

During 11 to 23 July 1979, four Russian research vessles *Priliv* (EREC), *Priboy* (EREH), *Academic Shirshov* (UMAY) and *Academic Korolov* (UHQS) were stationed at the corners of a stationary polygon position and they recorded both surface and upper air observations. For about a week from 16 July INS *Deepak*, stationed at Lat. 7.5° N/Long. 89° E in south Bay of Bengal recorded observations. Similarly INS *Darshak* and research vessel *Gaveshini* were also in south Bay during the period. The position of the ships and the period of observations are shown in Fig. 1.

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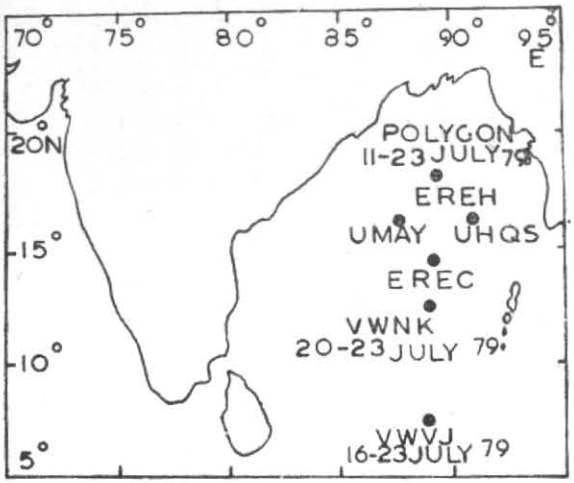

Fig. 1

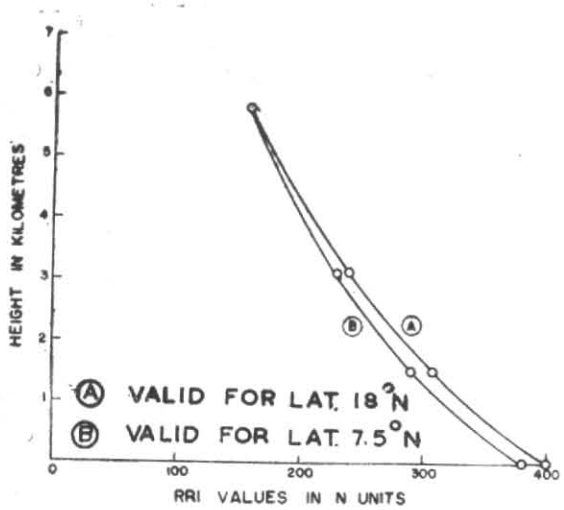

Fig. 2. Vertical profile of RRI

3. Method

The radio refractivity is computed using the equation $N=(n-1)\times10^6=77.6\ P/T+3.73\times10^5 e/T^2$ where P is pressure in mb, T is temperature in Kelvin scale and e is the water vapour pressure in mb. Surface refractivity was calculated for all the four observations 00, 06, 12 and 18 GMT in a day. Likewise the N values for 850, 700 and 500 mb were also computed.

4. Results and discussion

4.1. *Time variation*

The first point observed was that there was no diurnal variation in the RRI values computed for each ship. Hence, one typical value for each day can be arrived at. Table 1 presents the RRI values from the observations of ship *Priliv*. It can be seen that the value was practically steady during the period of the 13 days (11 to 23 July). The statement is true for the RRIs computed for 850, 700 and 500 mb also. Similar tendency was observed for the values computed for all the ships mentioned. During this period, the monsoon was mostly moderate in the central Bay and at a few occasions moderate to strong. In south Bay the activity was varying from weak to moderate on certain days to generally moderate on certain other days. Hence under the conditions of no large scale variation in monsoon activity, no time variations in RRI values was noticed in the Bay either at surface or at higher levels.

TABLE 1

RRI values from observations by ship *Priliv* (14.4°N, 89.5°E)

Date (Jul '79)	Surface	RRI at levels (mb)		
		850	700	500
11	399	308	241	162
12	398	305	234	163
13	395	310	236	163
14	394	307	235	160
15	396	313	239	161
16	395	308	233	162
17	394	298	233	161
18	396	303	235	164
19	392	302	238	162
20	392	305	238	161
21	394	308	240	161
22	395	309	242	161
23	392	305	239	159
Average	395	307	237	161

TABLE 2

RRI values

Level	Vizag.	(18°N, 89° E)
Surface	388	397
850 mb (1.5 km asl)	302	307
700 mb (3.1 km asl)	235	237

4.2. *Space variations*

Along the latitude of 16.2°N two ships were stationed at Long. 87.7°E and Long. 91.1°E. The RRI values for these two ships were examined to explore the presence of any longitudinal variation. The surface values were 395 and 394 and at 850 mb they were 304 and 302 while at 700 mb both were 237. Thus within a distance of about 4 degrees in longitude (roughly 400 km) no difference in RRI was observed.

However, since observations from south Bay were available latitudinal variation could be examined in a better manner. INS *Deepak* was at Lat. 7.5°N and INS *Darshak* was at 12° N both along Long. 89°E with *Priliv* at Lat. 18° N/Long. 89.5° E. The data from these three ships can very well serve the purpose. Fig. 2 gives the vertical RRI profile valid for Lats. 7.5°N and 18° N.

It can be seen that the values are more at 18°N. The values at 12° N (*Darshak*) were 386 (surface), 301 (850 mb), 237 (700 mb), and 160 (500 mb). The RRI values thus increase as we go from south Bay to central Bay. The tendency is pronounced in surface and low levels and disappears as we go up. The comparison of the values arrived at with the climatological values is interesting. The Bay has been divided into squares of 5° × 5° in latitude and longitude and the RRI values for each block have been given monthwise by Kulshrestha (1975). The comparison for surface level is as follows :

Location	*Value as per this work*	*Climatologcal value*
Lat. 18°N	397	392
Lat. 12°N	386	389
Lat. 7.5°N	381	386

Our values are within ± 5 from the climatological values. Climatological values for 850 and 700 mb were not available for these locations valid for July and hence comparison was not attempted for those levels.

4.3. *Comparison with coastal station values*

To see the effect of land and sea the radio refractivity from coastal stations at the same latitude was compared. Table 2 gives the values at Vizagapatnam and those at Lat. 18° N/Long. 89° E. It is seen that the values at surface and 850 mb are more for the sea than for the coast. This can be understood as follows :

The relative humidity on all days was more than 82 per cent and reached 100 per cent on some days at high sea, whereas at Vizag R. H. went down upto 54 per cent and was less than that at the seas. Similarly the temperature at sea was less than that at land on all days. With the temperature in degrees Kelvin in the denominator in the equation

the value at sea is expected to be more than at land. A comparison between the values for Madras and a ship along the same latitude in the Bay also confirmed a similar tendency.

5. Conclusions

(*i*) There is no diurnal variation in RRI at any level in lower troposphere over the Bay. There was no day to day variation in RRI at surface, 850 and 700 mb levels over Bay of Bengal during the fortnight considered.

(*ii*) There is a latitudinal variation of RRI over the Bay. The values increase as we go from south Bay to central Bay upto about Lat. 20°N.

(*iii*) The comparison of surface RRI values at a coastal station and a ship in the midst of high seas at the same latitude showed that the RRI at the sea is always more than at the coastal station.

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