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SEASONAL AND ANNUAL TRENDS OF SURFACE RADIO REFRACTIVE INDEX (RRI) OVER MAITRI STATION, ANTARCTICA (CONSIDERING ONLY DRY TERM)

1. India Meteorological Department is participating in Indian Antarctic Expeditions with one of its main objectives of study of Antarctic climate and its impact on global climate. Short period climatology of Maitri by Lal (2006), Meteorological studies over Maitri by Sreedharan and Sharma (1983) and by Hosalikar and Machnurkar (1998) and recent study of Short term characterization of wind and temperature over Maitri by Hosalikar *et al.* (2012) are some of the meteorological studies at Maitri. However no systematic studies are available on distribution of surface Radio Refractive Index (RRI) with reference to seasonal and annual variations. Radio refractive index (RRI) analysis in respect of Indian region have been carried by many researcher, Kulshrestha and Chatterjee, (1965) studies of radio climatology of India mentions about the importance of structure of the RRI in the lower layer of the troposphere for planning and design of microwave communication. So, an attempt has been made by the authors to study surface RRI over Maitri. Bean and Dutton (1968) equation is used here for RRI.

$$N = 77.6 \times (P/T) + 3.73 \times 10^5 (e/T^2) \tag{1}$$

where P - Surface pressure in hPa

T - Surface temperature in °K

e - Water vapour pressure in hPa

The (P/T) term is referred as dry term and (e/T²) as the wet term.

2. The accurate measurements of atmospheric humidity is problematic at continuously low temperature (mostly sub-zero) that prevails over Antarctica. Conventional wet and dry bulb psychrometer becomes increasingly inaccurate as temperature decreases, while solid state hygristors require special calibration for every low temperature operations (King and Anderson 1999). Atmosphere over Antarctica is very dry and low temperatures result in a very low absolute humidity. Due to this a continuous measurements of humidity at Maitri stations are not available. At Maitri, water vapour measurements (Jain, 2008) were attempted using Sun dependent instrument during summer. Considering these facts, RRI evaluation here is done by using the dry term only:

$$N = 77.6 \times (P/T) \tag{2}$$

3. *Data and analysis* : For computation of RRI (dry term) over Maitri, surface data from 1990 to 2004 is considered here, supplied by National Data Centre, Pune. Daily average values of RRI for 0000 and 1200 UTC are calculated for the entire period under consideration. The four seasons that generally prevail over Antarctica are summer (December to February), Autumn (March to May), Winter (June to August) and Spring (September to November). Table 1 shows maximum, minimum and average values of RRI in different seasons at Maitri.

4. *Results - 4.1. Annual variations* - From the Fig. 1 it is seen that average value of RRI for both 0000 and 1200 UTC shows marginal separation during summer and autumn with increasing tendency. During near-winter period these two curves almost coincide. This is due to the fact that there is not much variation in temperature and pressure during winter. As spring season approaches RRI value shows decreasing tendency. Lowest value of RRI is in the month of December-January and whereas highest value is in the month of July-August. It is observed that

TABLE 1

Maximum, minimum and average values of RRI in different seasons at Maitri

Seasons	Maximum RRI		Minimum RRI		Average RRI	
	0000 UTC	1200 UTC	0000 UTC	1200 UTC	0000 UTC	1200 UTC
Summer	279.76	276.75	278.04	274.35	278.69	275.71
Autumn	290.05	288.58	283.93	282.14	287.34	286.13
Winter	295.57	295.49	291.01	291.17	293.05	292.96
Spring	291.98	288.66	285.81	282.91	288.57	285.70

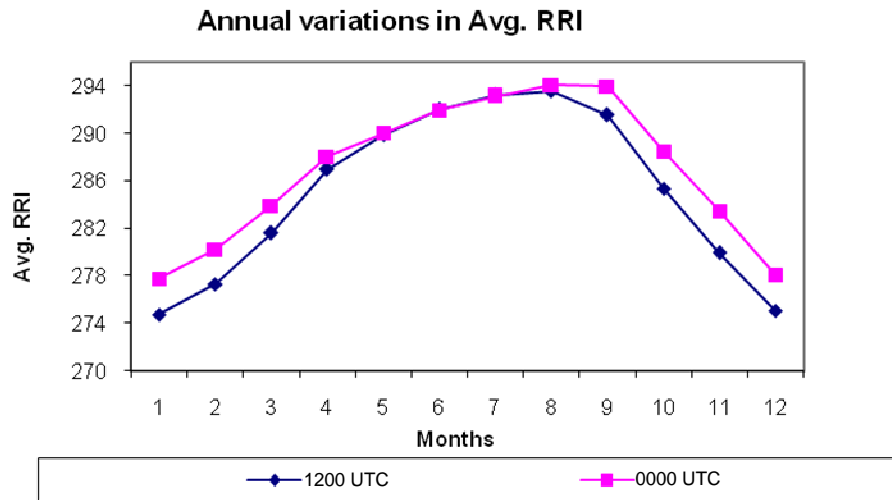


Fig. 1. Annual variation in RRI at Maitri

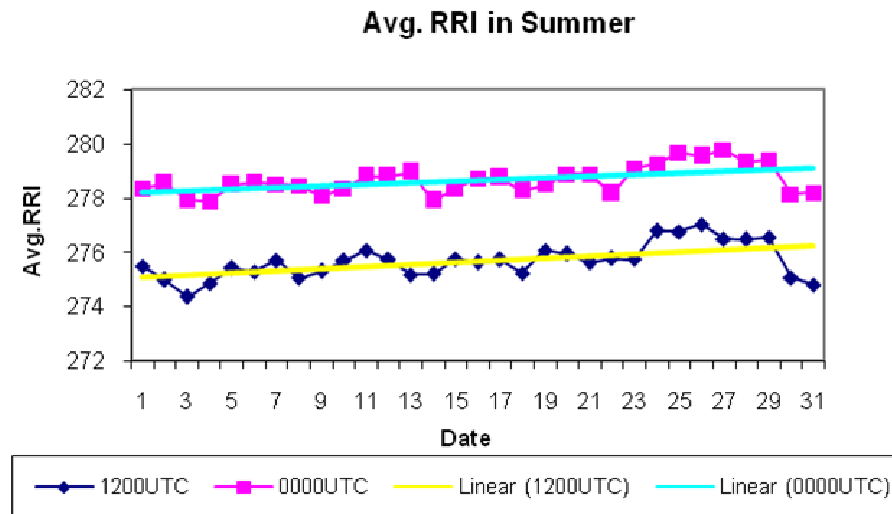


Fig. 2. RRI variation during summer season at Maitri

the values of RRI at 0000 UTC are relatively higher compared to that at 1200 UTC almost throughout the year, as also indicated in Table 1. The next section explains the seasonal variations in RRI at Maitri.

4.2. *Seasonal variations* - (a) *Summer season* - During the summer season at Maitri, sunlight is available throughout 24 hrs, (at Lat. 70° 45' S) resulting December

and January as warmest months in Antarctica. The daily average values of RRI do not exhibit much variation with slight increasing tendency for 1200 UTC profile as seen in Fig. 2.

(b) *Autumn season* - The season is characterized by sharp increasing tendency both for 0000 UTC and 1200 UTC RRI values (Fig. 3). The profiles being very close to

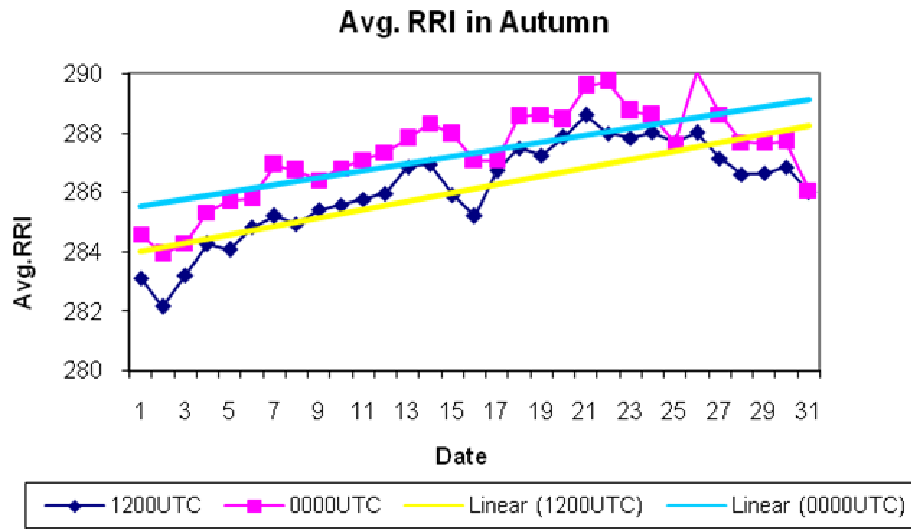


Fig. 3. RRI variation during autumn season at Maitri

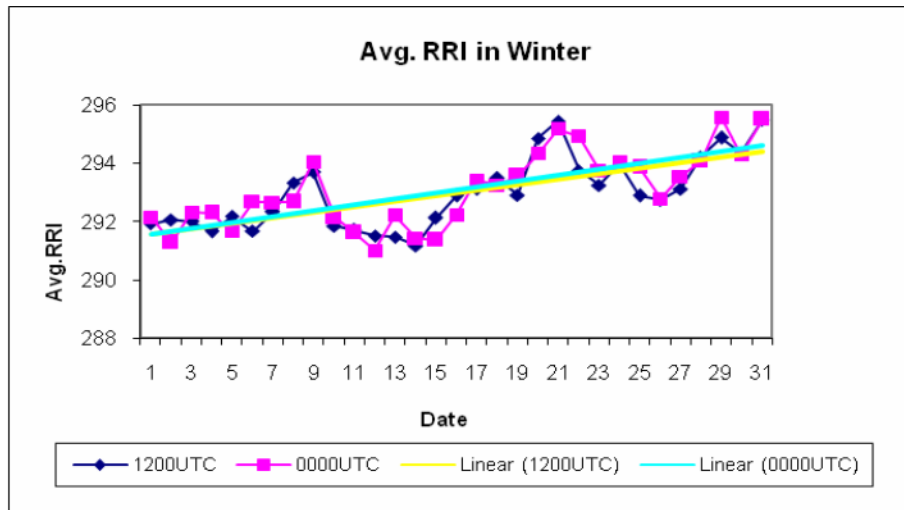


Fig. 4. RRI variation during winter season at Maitri

each other, indicates not much variation in RRI values for the entire day. A decreasing trend in RRI towards the end of the season is due to fall in pressure on account of occurrences of blizzards; the low pressure systems.

(c) *Winter season* - Typically both 0000 and 1200 UTC RRI profiles almost overlap throughout the season (Fig. 4). The average values of RRI show sharp fluctuations throughout the season with rising tendency in

RRI as season progress towards the Spring season at Maitri. The maximum and minimum RRI values are observed to be higher in this season.

(d) *Spring season* - It is characterized by sharp decreasing tendency both for 0000 UTC and 1200 UTC RRI values, with approach of summer season (Fig. 5). The fluctuations in the daily average values of RRI for spring season are not as marked as in Autumn or Winter.

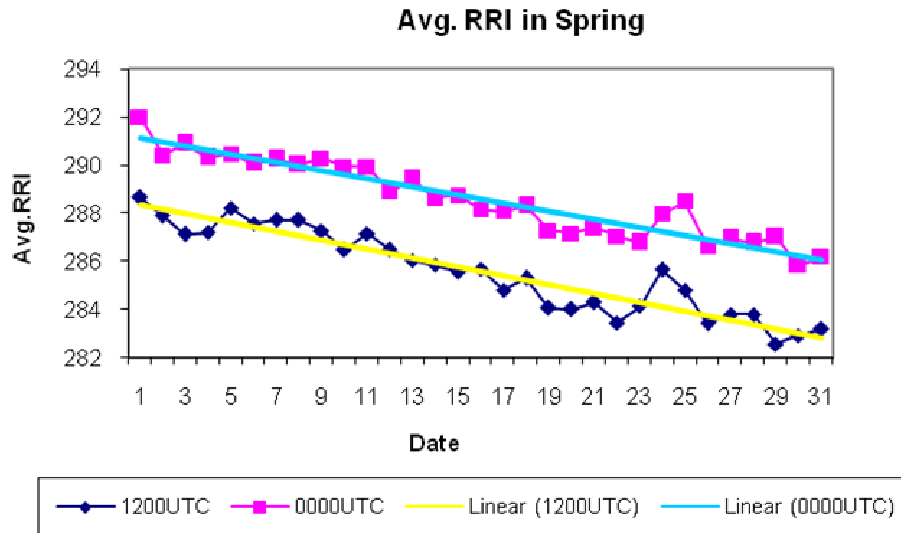


Fig. 5. RRI variation during spring season at Maitri

5. *Conclusions* - From the study annual and seasonal variation of RRI at Maitri, it is observed that RRI values show significant variations throughout the year, with maximum values in winter season and minimum during summer season. 0000 and 1200 UTC RRI shows almost in phase trend. During the blizzard conditions, there are significant changes in surface pressure as well as in temperatures, influencing RRI values. The contribution of wet term also needs to be investigated by having the long term measurements of humidity at the station. It is hoped that this preliminary study of RRI will provide a base for further analysis of RRI over Maitri and also will assist radio-physicists and radio-engineers in radio communication and allied investigation over Maitri.

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