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L E T T E R S

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MEASUREMENT AND ANALYSIS OF RADIO REFRACTIVE INDEX OVER DELHI WITH RESPECT TO ITS DIURNAL AND SEASONAL CHARACTERISTICS

1. Radio wave transmission from a station is received at a distant point through tropospheric mode of propagation. The transmitted radio wave follows the curved path, due to refraction and the degree of curvature is controlled by the refractive index of the atmosphere, which leads to signal de-focussing (Kukushkin and Sinistin 1983). Thus, it is important to map the radio refractive index of a particular station taking the seasonal and diurnal classifications separately. Profiles of Radio Refracive Index (RRI) of different stations have been received earlier (Bayonton 1965; Majumdar *et al*., 1976; Kulshrestra 1987 and Sukla Dattagupta 2008). A model for calculating such gradients from ground based data is developed over Guwahati (Sharma *et al*., 1995).

The refractivity of the troposphere is a function of atmospheric pressure, temperature and water vapor pressure as derived by Bean and Dutton (1968).

The total refractivity is given as

$$N = N_{dry} + N_{wet} \quad (1)$$

A model for the dry and wet refractivity is given by

$$N_{dry} = 77.6 * P/T \quad (2)$$

and

$$N_{wet} = 3.73 * 10\ 5 * e/T^2 \quad (3)$$

Where P is atmospheric pressure in hPa, T is absolute temperature and e is the water vapor pressure in hPa.

$$T = t + 273 \quad (4)$$

t = temperature in degree C (°C) and

$$e = 6.1078 * \exp\ [5417.1*(1/273-1/T_d)] \quad (5)$$

Where T_d is dew point temperature in degree Kelvin.

TABLE 1

Diurnal and seasonal variations and ranges

Season and level		Average value of RRI 0000 (UTC)	Average value of RRI 1200 (UTC)	Variations in RRI 0000 (UTC)	Variations in RRI 1200 (UTC)
Winter	At Surface	315.0	314.6	304 to 325	309 to 320
	At 1.5 km	258.5	260.5	251 to 268.5	252.5 to 273.5
	% variation from surface to 1.5 km	Falls by 17.3 %	Falls by 17.8 %		
Summer	At Surface	328.2	321.4	317.1 to 340.8	312.3 to 331.9
	At 1.5 km	269.3	272.5	255.7 to 287.4	259.9 to 285.1
	% variation from surface to 1.5 km	Falls by 17.9 %	Falls by 15.2 %		
Monsoon	At Surface	384.8	374.3	375 to 402	367 to 383
	At 1.5 km	311.2	312.2	304 to 317.5	305.5 to 322
	% variation from surface to 1.5 km	Falls by 19.1 %	Falls by 16.5 %		

Hence, the total refractivity comes out to be

$$N = 77.6\ P/T + 3.73 * 10\ 5 * e/T^2 \quad (6)$$

For model calculations of refractivity over Delhi, the atmospheric pressure, temperature and dew point temperature are examined at 0000 UTC and 1200 UTC from radiosonde observations throughout the eleven years study (1997 to 2007). The refractivity for twice a day is calculated for two heights using Equation (6) above. The surface refractivity is determined at ground level and the elevated refractivity at a little above planetary boundary layer, around 1.5 km (above the mean sea level) height are computed. Data for 1st January for the years 1997 to 2007 have been studied and the average value is determined. Similarly the values have been calculated for each date of the month of January from the above mentioned eleven year period. In this manner, exercise has been completed for the month of April to cover summer season and for July as representative month for monsoon.

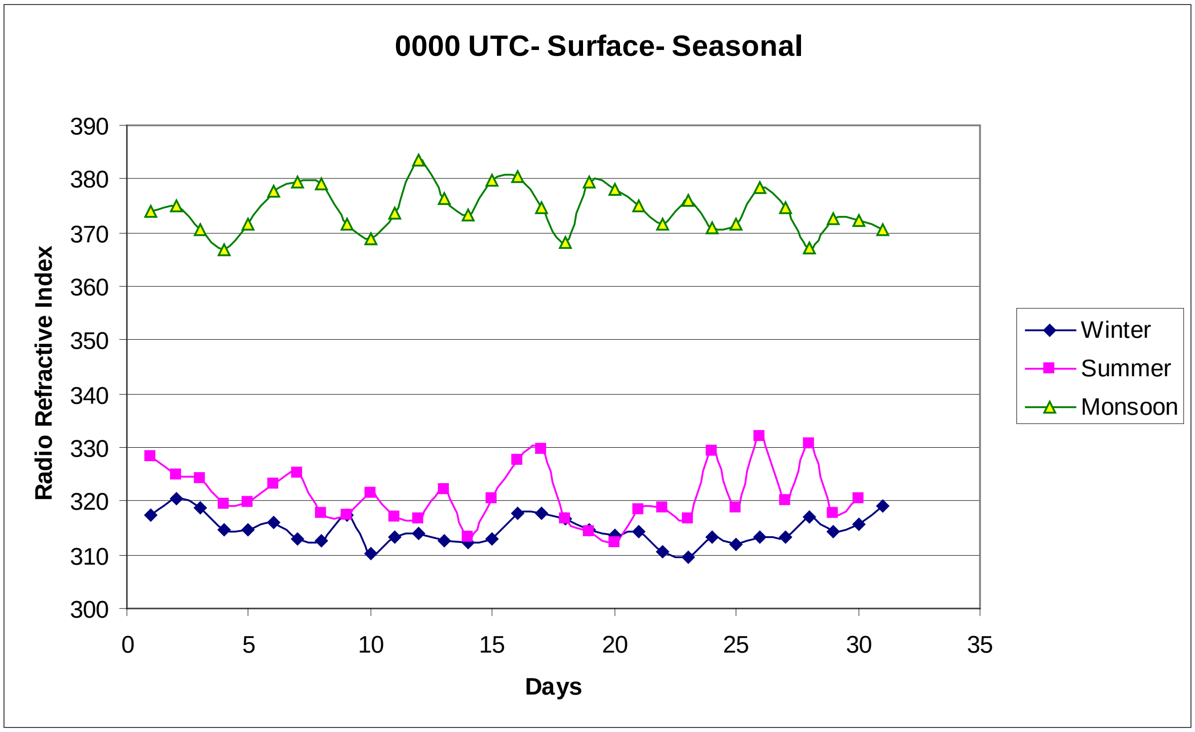

Fig. 1. Seasonal RRI profile at surface at 0000 UTC

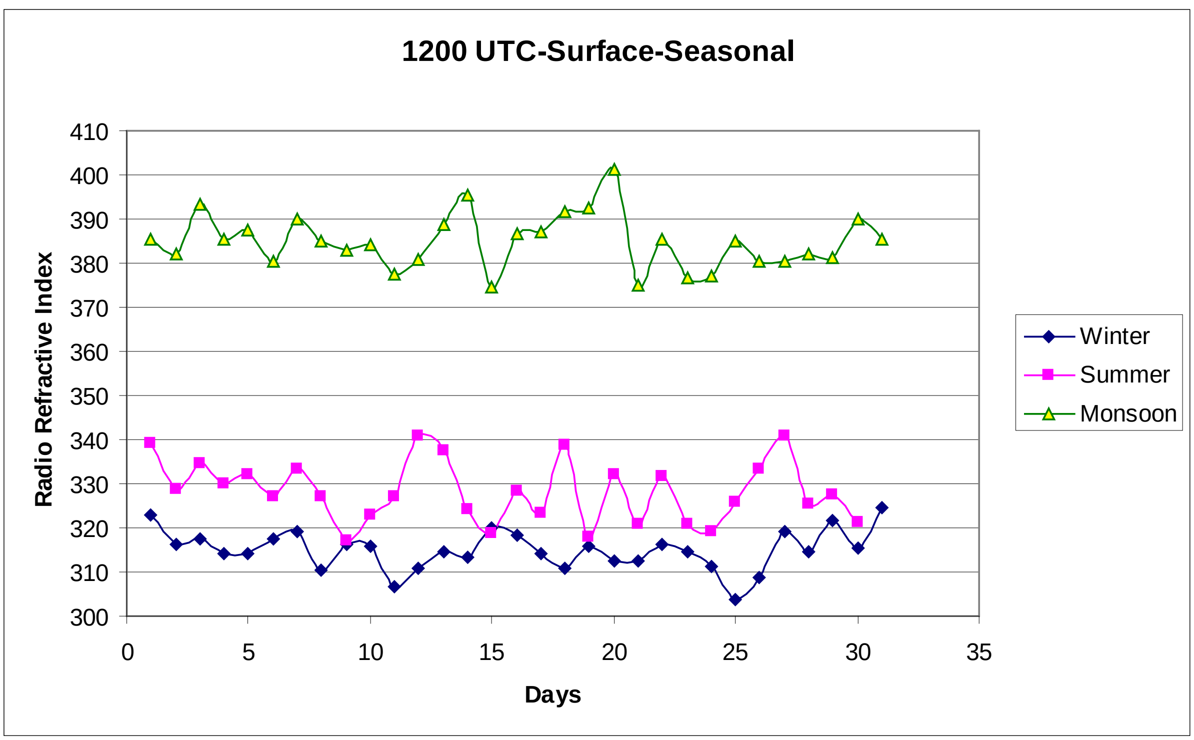

Fig. 2. Seasonal RRI profile at surface at 1200 UTC

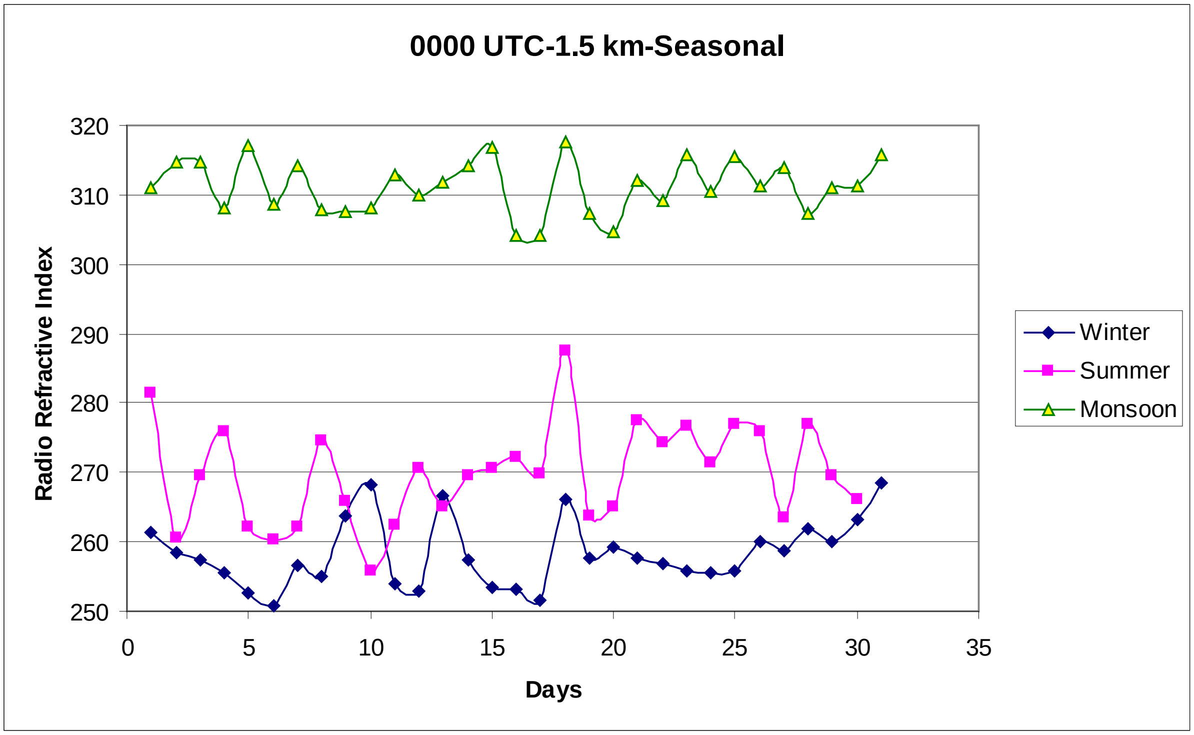

Fig. 3. Seasonal RRI profile at 1.5 km at 0000 UTC

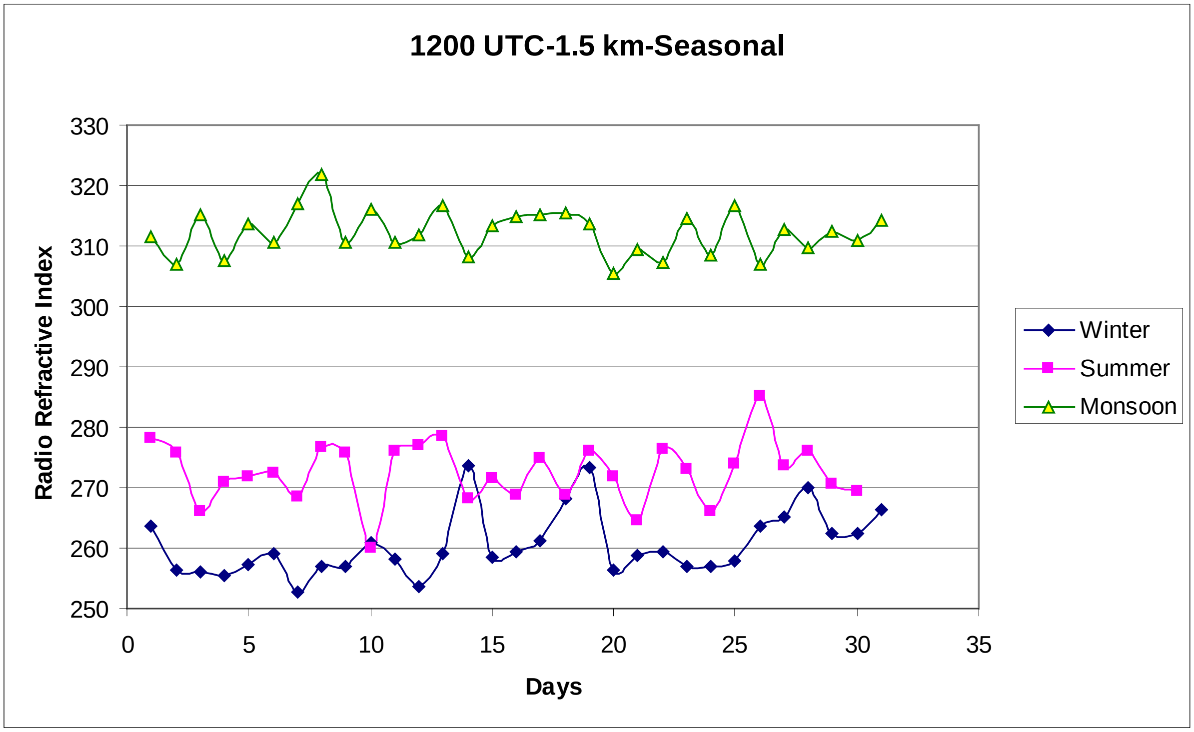

Fig. 4. Seasonal RRI profile at 1.5 km at 1200 UTC

2. *Diurnal analysis* – The average values of RRIs and their diurnal and seasonal variation during 0000 UTC and 1200 UTC hours are summarized in Table 1.

3. *Seasonal analysis*

(*i*) For early morning hours observing period at the ground level, RRI has more or less same values in summer and monsoon months, but winter season has a much lower value (Fig. 1).

(*ii*) In the evening hours at the surface level, the RRI in winter has much lower values in comparison to that of monsoon values. The computed values for summer season lie between the two (Fig. 2). The difference in mean values of RRI of summer/monsoon with that of winter remains almost equal in morning as well as late after noon observed values.

(*iii*) At 1.5 km above in the troposphere in the morning hours the monsoon and summer months have almost same RRI and monsoon values are much higher (Fig. 3).

(*iv*) At 1.5 km above in the troposphere in the evening hours, the calculated values of RRI have been found in analogous that of the lower level (Fig. 4).

4. It has been observed that the values of refractivity at an altitude of 1.5 km always have higher values in the evening hours compared those of morning hours. In contrast, the values of RRI at the surface are higher in the morning and lower in the evening. The probability of the presence of atmospheric boundary layer that forms due to vertical diffusion of moisture and heat attributes to the above fact (Schiavone 1982). This atmospheric boundary layer gets distorted itself only after sunset.

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