Studies of High Latitude D-Region Using VLF Observations

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INTRODUCTION

Measurements of phase variation of 12 9 kHz signals from OMEGA, Argentina (43^0S 65 2^0W) were made at the Indian Antarctic Base Camp (70^0S, 11^0E) during the IInd Indian Antarctica Expedition. The path was 5060 km long and traversed mainly mid-high latitudes. The length of the path was enough for only the 1st order mode $n = 1$ (Wait and Spies, 1964) to be predominant during daytime. The phase recording was made with TRACOR 599K VLF receiver and 1 m^2 loop antenna, the reference being Rubidium frequency standard. The period of measurement was 17.1.1983 to 16.2.1983.

RESULTS

In the present paper we discuss two features of the phase measurements in light of the processes taking place in the high latitude D-region.

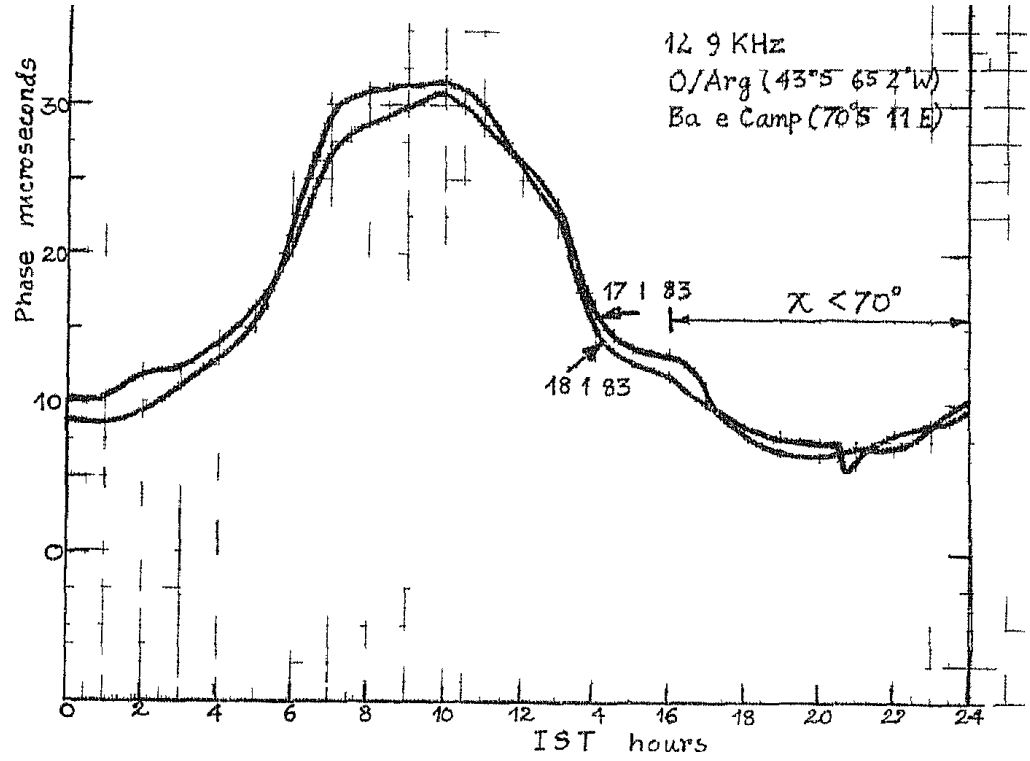
Quiet-time solar control of the D-region

In our previous study during the 1st Indian Antarctic Expedition it was concluded (Sen Gupta, 1983) that the solar zenith angle control of the D-region lonisation during daytime is identical at low and high latitudes. This conclusion was based on VLF phase variation data obtained from a trans equational path Goa-ReUnion and a high latitude path Antarctic base-Omega Argentina, during the 1st Indian Expedition. In the present work the above conclusion has been reconfirmed using the data obtained over the Antarctic base-Argentina path.

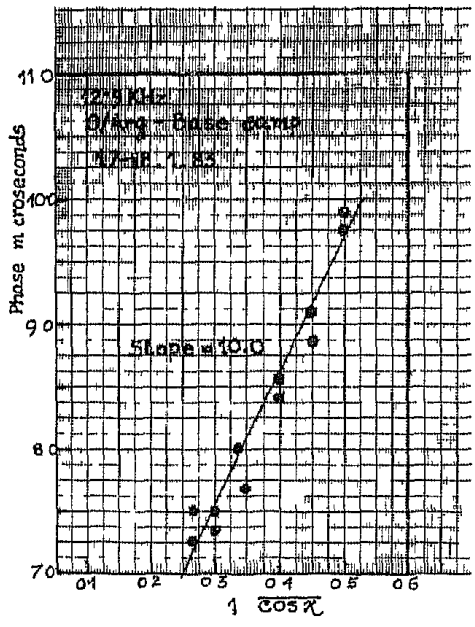
In Fig 1 we show an illustrative example of diurnal phase variation for two successive days in January '83. This period is roughly same as that during the 1st expedition enabling a comparison Fig 2 shows the relationship between the daytime phase in Fig 1 and the parameter $(I - \overline{\cos x})$ where x is the solar zenith angle and the bar indicates an average over the propagation path. The relation between phase and $(1 - \overline{\cos x})$ in Fig 2 is a straight line whose slope is found to be 100. This is in good agreement with the earlier result (Sen Gupta 1983) which showed values of slope around 11. We thus reconfirm our earlier conclusion that the D-region electron density varies linearly with $(1 - \overline{\cos x})$ and the slope of this variation is identical at equatorial and high latitudes region during daytime.

Storm time behaviour

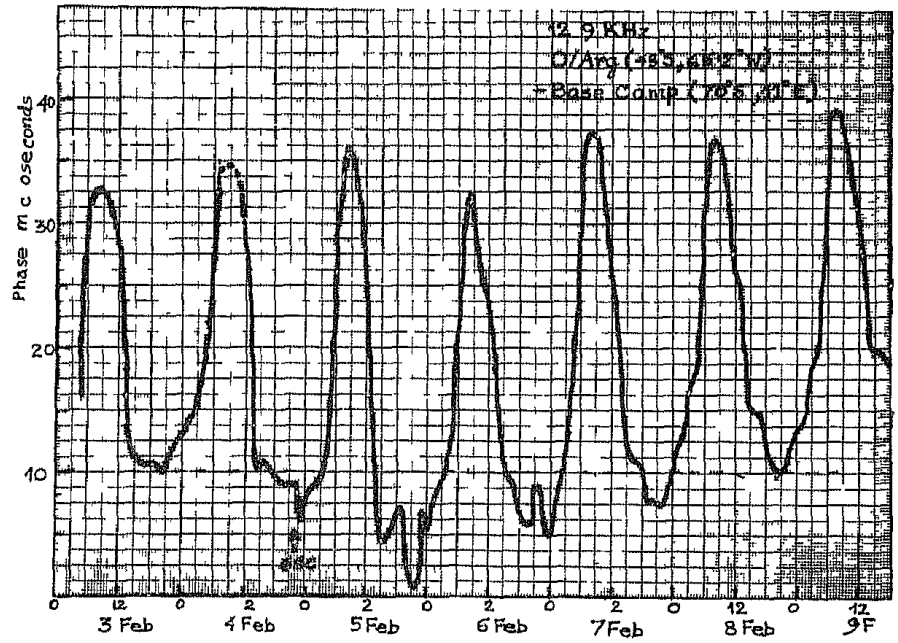
Fig 3 shows a sequence of phase variations on six days, 3 8 February, 1983. During this period there was an enhanced geomagnetic activity as discussed by Rangarajan *et al* (1984) 3rd February was a magnetically quiet day and so the phase variation on this day are considered to be normal quiet time behaviour. On 4th February at 2145 IST there was a Storm Sudden Commencement (SSC) following which there was severe geomagnetic activity on 5th, 6th and 7th February, 1983. This was recorded by the total field magnetometer set up at the base camp by the II G group (Rangarajan, Private Communication). On examining Fig 3 we find that following the SSC there is a sudden phase anomaly (SPA) with a slow and gradual recovery On the following day 5th February the daytime



I g. 1 D rnal pha e v a on t 2 9 kHz over t e Base Can p 70 S 11 E O/A b (43°S 65 2 W) path



I g 2 Re t nsh p betwee day me h se and $(1 - \overline{\cos x})$ at 12 9 kHz ov Base Camp A gentin i patl



I g. 3 I hase v r a ons over the B se C p A g l s x days 3 8 February 1983

phase value is considerably lower than the normal and is undergoing large changes The lower phase reading indicates enhancement of the D region electron demsty This 1 confirmed by the simultaneous Riometer Observations also (Saha *etal* 1984) as excess absorption event Preliminary

computations based on the mode theory of Wait and Spies (1964) indicate an effective lowering of the D region height by 4 km The undulations of the daytime phase on 5th and 6th are somewhat similar to changes in the absorption events recorded by the Riometer (Saha Private Communication) The lower values of daytime phase are also persistent on 6th and 7th February becoming normal on 8th February with decrease of magnetic activity It is noted in Fig 3 that the night time phase values are not depressed during the magnetically disturbed period Westerlund *et al* (1969) have studied Polar Cap Absorption (PCA) events using the VLF propagation data in the Arctic region Their results indicated considerable lowering of both the day and night time phase values which persist for several days The PCA events are usually a consequence of intense charged particle precipitation in the polar region Particle precipitation data in the present case are being obtained from World Data Centre for a more detailed investigation of the present event

It is interesting to note that during the storm event of 6th to 7th February there was a total blackout of the shortwave communication being tried between the Antarctic base camp and India

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