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SCIENTIFIC REPORT ON VERY LOW FREQUENCY (VLF) PHENOMENA AT MAITRI DURING THE SUMMER PERIOD OF XVII INDIAN ANTARCTIC EXPEDITION

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Project Summary

Under the above-proposed project, we have recorded whistlers with the help of analog system. Whistlers are very low frequency (VLF) electromagnetic waves generated by lighting discharges which propagate along the magnetic field lines of the earth, get dispersed due to the field aligned irregularities and are heard as descending tones with higher frequencies coming first and lower frequencies arriving subsequently falling tone. During the last four decades, significant progress has been made in elucidating the solar wind- magnetosphere - ionosphere-coupling processes at high latitudes between (50-70 degree geomagnetic latitudes) using the propagation path of whistlers.

The study of VLF propagation acquires its importance because of its ability to allow atmospheric scientific community to understand the electron density variation in 500-1200 km region derived from the dispersion characteristics of simultaneously observed whistlers at different suitable stations as well as the effect of solar wind - magnetospheric interaction on the propagation of whistlers along the field aligned irregularities. In XVII Indian Antarctic Expedition 1997-98 whistler recording has been done with the analog system. Data analysis is going on related to the whistler phenomena, details of the theory has also been developed on basis of non-linear wave-wave interaction and work has been ready for publication.

Introduction

Whistler, at high and mid latitudes, propagates in ducted mode along the geomagnetic field lines whereas at low latitudes, whistler propagation is interpreted in terms of ducted/non-ducted mode of propagation. The direction finding measurements at Japanese stations are interpreted in terms of field aligned propagation either in surface mode or in whistler gallery mode. Whistler at low latitude travel large distances in the plasmasphere and brings back variable information about the plasma and geomagnetic field parameters such as electron density in the equatorial plasmasphere duct localization and large-scale maganetospheric electric field. However, to determine these parameters, their propagation paths must be known. At middle and high latitudes, propagation paths of whistlers are determined easily from their nose characteristics or by applying nose approximation methods. Unfortunately, this is not possible in case of low latitude whistler. The direction finding polarization measurement of low latitude whistlers are used to locate their exit points from the ionosphere. These techniques have found worldwide recognition on account of their versatility, accuracy and sensitiveness.

The downward exit region of the whistler from the ionosphere after field-aligned propagation in the inner plasmasphere is widely distributed due to its electromagnetic scattering. By proper spectral analysis and direction finding techniques, it should then be possible not only to identify and locate the whistler monitored simultaneously at the two places but also to distinguish the sources of whistler that could have possibly been monitored simultaneously at the two stations, if they were different. Further, to train manpower and expand research activity, it is meaningful to involve and manage competent researchers.

Under All India Coordinated Programmes on Ionosphere and Thermosphere Study (AICPITS), simultaneous observations of whistler were carried out in a chain of four stations (Bhopal, Varanasi, J & K and Agra). These stations are equipped with Analog and Digital recording facilities of whistler and they have observed and analyzed whistler for a period of three years.

The radial electric field in the plasmsphere/magnetosphere produces ExB drift of flux-tubes. The flux-tubes interchange gives rise to enhancements and depressions in the electron plasma density. The magnitude of this electric field (assuming E is perpendicular to B) is given by $E = 2.07 \times 10^{-2}$ d/dt ($fn^{2/3}$) V/m, where fn is measured in Hz. If fn increases with time, then electric field is directed from east to west and in the reverse case it is directed from west to east. E can determined with a precision of typically 0.1 mV/m.

Objective

To Study the Very Low Frequency (VLF) Phenomena from ground based technique at Maitri (70.7° S, 11.7° E 120m ASL):
The Antarctic atmosphere is unique due to its geographical location for the observation of VLF Phenomena. Special interest of VLF phenomena is to observe whistler emissions and their propagation in ducted and non-ducted mode along the magnetic field lines of the Earth. They are being observed during day and night hours at high latitudes. This study will be divided into two parts during XVII Indian Antarctic Expedition.

(i) Continuous recording of Whistler at Antarctic with the help of Analog System

(ii) Multistation recording of Whistler (Bhopal, Agra, Varanasi, and Jammu) for Coordinated Study of Very Low Frequency (VLF) Phenomena

Technical Details

VLF wave and associated phenomena can be moniterd with the help of T-type Antenna along with pre and main amplifiers to record the signal on magnetic tape recorder (Philips Radio Cassettes Recording AW 7550) since the frequency is in audible range. Later we have analysed the data on Sonogram and few of the fine structure analyses are being carried out by AVDAS system, which translate the magnetic tape data into frequency-time spectrum. Interpretation of f-t spectrum we have studied the variation of

electron density and electric field in the region from where these VLF phenomena is generating the sourse of origin of VLF emission.

Achievements

As per programme of the proposal, recording of whistler, a Very Low Frequency (VLF) emission with the analog system has been completed. Data is partly analysed. The results are being interpreted and completed in the form of research paper.

VLF study has been coordinated on multistation observations, Bhopal, Agra, Varanasi and Jammu. This study is; yet to be analysed. The study of whistler at Jammu has already been done and published (1). Theoretical studies on the generation of whistler wave has been completed and published (2)

List of Publications

1. Role of field aligned current and parallel electric field on the generation of whistler mode instability in the Earth's magneto sphere, Harsha Maru, Sushil Kumar and A. K. Gwal, Ind. J. Radio & Space Phys., 28, p95, 1999.

2. Extremely small dispersion whistler and VLF emission recorded during day time at Jammu, Lalmani, Madhu Kaul Babu, Rajou Kumar, Rajesh Singh and A. K. Gwal, Ind. J. Radio & Space Phys. 28, p216, 1999.

Workshop Held

Looking at the importance of VLF phenomena occurring globally, an International Workshop on Coordinated Study of Very Low Frequency (VLF) Phenomena: Global Approach had . been origanised during 25-27 November, 1999 at Barkatullah University, Bhopal under the sponsorship of Department Of Ocean Development, Government of India, New Delhi.