SOME SIGNIFICANT RESEARCH FINDINGS FROM POLAR REGIONS

Even though India is an equatorial country, it has its presence in both the Polar Regions. IIG is actively involved in Antarctic research since 1981, and has recently taken up Arctic studies. Antarctic geomagnetism has special importance for India since Maitri and Dakshin Gangotri (both located at about 70^o S, 12^o E geographic) are the only locations where India can carry out research on high-latitude geomagnetism. Direct deposition of solar wind energy occurs at latitudes exceeding 60^o geomagnetic latitude. The lower latitudes, where India is located, however, are shielded from such direct energy deposition by the closed magnetic field line configuration. Most of the developed countries directly witness this solar-terrestrial energy transfer by virtue of their geographic location. The Indian Polar venture has given a rare opportunity to study this phenomenon *in situ*.

IIG has been in leadership positions in many of the national scientific missions to Antarctica and has set up a number of experiments related to global electric circuit (GEC), geomagnetic field variation, crustal movement and cosmic radio noise absorption at its permanent station Maitri. In addition, triangulation experiments to calculate the velocity of mobile small scale auroral currents were carried out. This experiment is necessarily carried out during austral summers. Though such experiments are carried out on a regular basis in northern hemisphere and arctic region, India is the first country to carry out such experiments in Antarctica.

Maitri occupies a unique subauroral location during geomagnetic quiet condition and records the signatures of southern limb of Sq current system. With increasing magnetic activity, the auroral zone expands equatorwards and encompasses Maitri. During such periods, Maitri is influenced by auroral currents. This movement of shifting in and out of auroral zone makes Maitri an ideal location for studies of Space weather.

The Schumann resonances (SR) are a set of spectrum peaks in the extremely low frequency (ELF) portion of the Earth's electromagnetic field spectrum. Schumann resonances are global electromagnetic resonances, generated and excited by lightning discharges in the cavity formed by the Earth's surface and the ionosphere. Lightning channels behave like huge antennas that radiate electromagnetic energy at frequencies below about 100 kHz. These signals are very weak at large distances from the lightning source, but the Earth–ionosphere waveguide behaves like a resonator at ELF frequencies and amplifies the spectral signals from lightning at the resonance frequencies.

Determining the spatial lightning distribution from Schumann resonance records is a complex problem which can be circumvented by placing the receiver at the North or South Pole. These remain approximately equidistant from the main thunderstorm centers during the day. These studies will help monitor global temperature and the contribution of different atmospheric components to climate change.

Based on the observations of Earth's total magnetic field using Proton Precession Magnetometer (PPM) at Dakshin Gangotri/Maitri, it was concluded that the field was rapidly declining at this location, at the rate of more than 110 nT per year. The global average decrease is 40 nT per year. These observations are of importance in the light of modeling works at the Earth's core-mantle boundary.

The cosmic radio noise monitored at 30 MHz and corroborating the data with geomagnetic field variations as well as interplanetary conditions during high geomagnetic activity, it was concluded that apart from southward interplanetary magnetic field (IMF) and high solar wind (SW) velocity, high ion density and high SW dynamic pressure play a role in causing pronounced magnetic disturbances at the subauroral location.

During high geomagnetic activity the velocity of mobile auroral ionospheric current systems over Maitri was monitored using three fluxgate magnetometers at the vertices of a triangle. The dependence of extent of westward electrojet during a substorm on the interplanetary By was examined and it was concluded that IMF might play a role in controlling the longitudinal extent of substorm.

Using the data from a network of GPS stations (21 sites) during 2003-04, the characteristics of Schirmarcher glacier in Antarctica was studied and estimate of glacier velocity as well as strain field was obtained. Horizontal velocities of the glacier sites lie between 1.89±0.01 and 10.88±0.01 m a^{-1} to the north-northeast, with an average velocity of 6.21±0.01 m a^{-1}.

Magnetic anomaly map for the new Antarctic station Bharati promontory, Larsmann Hills, East Antarctica was successfully prepared. The studies show a very prominent high magnetic ridge with values of ~5000 nT higher than the surrounding values.

GEC parameters at Maitri are monitored with the help of various instruments such as long wire antenna, electric field meter, wire antenna and passive antenna. Electric Field Meter (EFM-100) and wire antenna were used to measure atmospheric electric field and conduction current under any weather conditions like snow fall and strong blizzard etc. The measured electric field from the passive antenna and EFM-100 matched very well.

Using Maxwell current density and conduction current density the displacement current density could be separated out. The studies also revealed that the electric field decreases to zero or negative values 2-3 hr before the onset of blizzards. The deviation of the diurnal pattern of potential gradient and current density on fair-weather condition at Maitri from the standard Carnegie curve was attributed to the global thunderstorm activity.

Using magnetic data from the third Indian Antarctic station Bharati, in conjunction with IMAGE chain data, substorms were found to have onset latitudes beyond the standard auroral oval towards the pole. Because of this they cannot be detected by normal auroral indices. However, typical low latitude substorm features such as positive bay and Pi2 burst on the nightside are distinctly evident.

With the advent of imaging riometer at Maitri, it is being examined how energetic particles precipitate down to D-region ionosphere during geomagnetic disturbances and cause enhancement in cosmic noise absorption. This aspect of polar research has direct bearing on space weather.

Secular variation (SV) refers to the variation of the main field of the Earth on time scales of the order of tens of years and longer. Studies to understand characteristics of SV in total F at Antarctica for the interval 1960 to 1995 were carried to determine average dipole, quadrapole and octapole fields and their contribution to the total field variation.

The Antarctic region shows an absence of westward drift (WD), which is a prominent feature of SV at some locations. A region of peak decrease in total F in the Antarctic region is seen to be stationary. The rate of decrease of this feature is to the tune of ~100 nT/year and the magnitude of this decrease is itself falling since 1980. The dipole field variation contributes less than 40% to this feature and the quadrupole and octapole fields are inferred to contribute to increasing field. This implies large contribution comes from within the Antarctic region. Recent studies of SV at the core-mantle boundary have postulated that flux expulsion, resulting from fluid upwellings, may be the likely cause of SV features in the high latitude regions of southern hemisphere. The northern hemisphere also has a long-lived region of decreasing total magnetic field, but this is located at the mid latitudes.

A wealth of magnetometer/riometer data in both analog and digital forms exists with the Institute for the study of a wide spectrum of polar geomagnetic issues. The Institute is also utilizing the set-up at Antarctica to measure air-Earth Maxwell currents and atmospheric electric fields, which require very clean atmospheric conditions that are free from anthropogenic pollution. This will help to shed light on the global electrical circuit, thereby extending the understanding of the magnetosphere-ionosphere electrical coupling to the troposphere, an area most important because of its relevance to solar-weather relations.