Seismo-electromagnetic phenomena, electron-density perturbation in the ionosphere, satellite communications, ski-sliding resistance measurement, and manufacturing education

Ichiro TOMIZAWA Laboratory

Summary of Research

Applying the Advanced Electromagnetic Wave Observation Technologies Developed for Geophysical Phenomena Research

At our laboratory, we pursue two major research topics: the electromagnetic phenomena associated with earthquakes and ionospheric perturbations. To tackle these two research topics effectively, we have developed electromagnetic wave observation technologies spanning a wide range of bands from extremely low frequency (ELF) to ultrahigh frequency (UHF).

Various momentary changes in the electromagnetic field are constantly being triggered around the Earth by earthquakes and the atmosphere, ionosphere, magnetosphere, and the sun. Detailed study requires advanced electromagnetic observation technologies.

Our laboratory applies the advanced technologies accumulated over the years through studies involving weak electromagnetic field measurements, signal reception from positioning satellites, signal processing, and remote observation systems.

Studies of Seismo-Electromagnetic Phenomena

Earthquakes pose life-threatening potential. Since 1980, we have studied the relationship between electromagnetic phenomena and earthquakes and presented several reports on electrical noise enhancement phenomena. At the Nojima fault, the hypocenter of the Hanshin-Awaji (Kobe) earthquake, we performed an underground electromagnetic wave propagation experiment, successfully detecting signal transmissions from a depth of 500 meters; the results imply a strong connection to seismicity. We are currently engaged in experiments involving electromagnetic wave propagation from even deeper areas with the goal of deepening our current understanding of seismo-electromagnetic phenomena.

Studies of Ionospheric Perturbations

Ionospheric perturbations represent another major research focus at our laboratory. Atoms and molecules in the ionosphere, a layer of the atmosphere located 100-1000 km above the surface of the Earth, occur in an ionized state due to solar UV radiation and X rays. The ionosphere acts as a mirror that reflects numerous geophysical phenomena, from atmospheric variations such as solar variations and typhoons to magnetospheric variations such as auroras. The ionosphere is a crucial region of the atmosphere in terms of geophysics. Additionally, data from observations of the ionosphere can be applied to studies of the Sun and terrestrial phenomena.

Advantages

Advanced Observation Technologies and Geophysical Research

Our laboratory transmits highly stable shortwave radio waves from our Chofu campus and continuously monitors the reflected radio waves, Doppler shift, and variations in direction of arrival from nine observation points within Japan, including Sugadaira. These observation points also acquire data around the clock on the UHF radiowave intensities of signals transmitted from positioning satellites such as GPS and JAXA’s ETS-VIII satellite. This project models ionospheric variations and makes this information available to the public in real-time.

The salient characteristics of our laboratory include geophysical research based on the advanced electromagnetic wave observation technologies and knowhow accumulated through our research and observations and the grand scale of our observation target—the Earth.
Sugadaira Space Radio Observatory: A Splendid Research Environment and Facilities

Among our greatest advantages is full access to the dedicated research facilities of the Sugadaira Space Radio Observatory in Nagano prefecture. The observatory offers two 3.6-meter parabolic receiving antennas for UHF satellite tracking, as well as various receiving antennas for satellite radio signals and satellite tracking systems. We host a summer program on space communication engineering at the Sugadaira observatory, in which students are given the opportunity to operate artificial satellites using this satellite tracking system.

We are also pursuing studies of ski-sliding resistance measurement at Sugadaira, an area where ample snowfall provides the ideal environment for such research. Involving another laboratory research partner, this joint research project seeks to develop a friction measuring system. Our laboratory contributes knowhow in measurement technologies as part of efforts to study the correlation between ski-sliding resistance and the physical properties of the snow surface.

The Sugadaira Space Radio Observatory is open not just to researchers at the University of Electro-Communications, but to individuals affiliated with educational institutions. We highly recommend that anyone interested take the time to visit and actually see the entire facility.

Future Prospects

Focusing on Advance Technology Education and Promoting Joint Research with Corporate Partners

In addition to research, advanced technology education is another area in which we take a keen interest.

Our laboratory builds nearly all the instruments used in our research, and we believe that the actual work of designing, building, and manufacturing is vital to nurturing the scientific mindset. Regardless of field of study, students with the skills needed to conceive, design, and build the instruments tailored to the needs of their experiments will be capable of independent and original research.

Geophysics, an area in which our laboratory pursues research, does not present the direct potential for the development of commercial technologies. However, through our research process, our laboratory has produced students of science capable of independent thinking, thorough and independent investigation of a problem, and the skills needed to create the necessary instruments. We believe these students hold significant potential for contributing in the corporate world.

Through our study of the fascinating phenomena that occur on the grand scales of the Earth’s interior, the Sun, and space, we hope to nurture students equipped with understanding and practical skills across a wide range of fields and prepared to tackle any challenge the corporate environment might present.