

Solar & Terrestrial Section Initiative

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Geospace



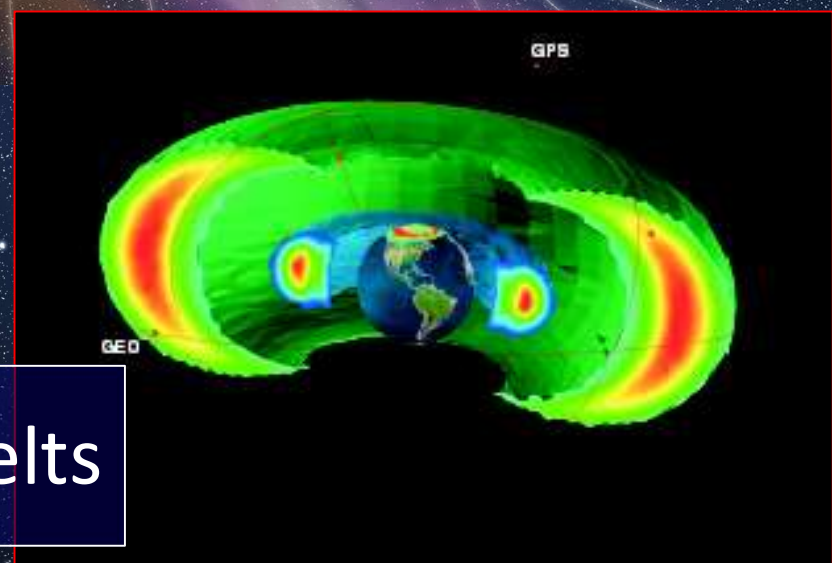
Solar Wind
➔

Magnetosphere

Plasmasphere

Ring Current

Plasma Sheet



Radiation Belts



Aurora observed from International Space Station

Regional Cooperation Programs For Early Career Scientists in China

1. National Natural Science Foundation of China (NSFC)



- **Research Fund for International Young Scientists**

How to Apply

Applicants with foreign citizenship should directly apply for the Fund from NSFC through their host institutions in China.

Eligibility

Applicants with foreign citizenship should meet the following qualifications:

- (1) Less than 40 years old
- (2) Have a Ph.D. degree.
- (3) Have experience of conducting basic research projects or postdoctoral research.
- (4) Guarantee of full-time work at the host institutions during the project implementation.
- (5) Abide by Chinese laws and NSFC's relevant rules and regulations while doing research in China.

Project Duration: One year or two years

Award size: RMB 200,000 Yuan per project for one year or RMB 400,000 Yuan per project for two years, and the award is direct cost.

1. National Natural Science Foundation of China (NSFC)



- **Other Funds for both young and senior scientists**

NSFC has already established international cooperation and exchange relationship with 94 science funding organizations and research institutions in 49 countries and regions including USA/NSF, Germany/DFG, Japan/JST, Korea/NRF, Canada/NSERC, etc.

(http://www.nsfc.gov.cn/english/site_1/international/D2/2018/01-25/87.html). Funding schemes include international academic conferences held in China and international (regional) exchange programs.

(i) **Joint Research Projects**

(ii) **Major International (Regional) Joint Research Projects**

2. Chinese Academy of Sciences (CAS)



- **PRESIDENT'S INTERNATIONAL FELLOWSHIP INITIATIVE (PIFI)**

PIFI is a funding program to attract talented foreigners to CAS for scientific exchanges and research cooperation. It is open to scientific research personnel from around the globe, of seven types including Visiting Scientists, Postdoctoral Scientists, Young Staff, etc.

(<http://international-talent.cas.cn/front/pc.html#/bicsite/pifiIntroduce/pifi>)

2. Academic Universities (e.g., PKU, USTC, NJU, etc.)

- **Peking University (PKU)**

- (i) Exchange Scholar Program
- (ii) Exchange Faculty Program

How to apply

- (1) Apply to your home institution
- (2) Get nominated by your home institution
- (3) Contact the host institution.

Stipend specified by the relevant agreement between the home and host institutions



- **University of Science and Technology of China (USTC)**

Visiting Scholar Program

- **Nanjing University (NJU)**

Visiting Scholar Program



- **Wuhan University (WHU)**

Visiting Scholar Program



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Space science projects in Taiwan



- Operations
 - FORMOSAT-5 (2017-): Advanced Ionospheric Probe (AIP).
 - FORMOSAT-7/COSMIC-2 (2019-): Tri-GNSS Radio Occultation System (TGRS), Ion Velocity Meter (IVM), and Radio Frequency Beacon (RFB).
- In the future
 - INSPIRESat-1 CubeSat (2021-): Compact Ionospheric Probe (CIP).
 - INSPIRESat-2/IDEASSat CubeSat (2021-): Compact Ionospheric Probe (CIP).
 - INSPIRESat-4/ARCADE CubeSat (2022-): Compact Ionospheric Probe (CIP).
 - INSPIRESat-6/SCION-X CubeSat (2023-): Compact Ionospheric Probe (CIP).
 - FORMOSAT-8A (2023-): Dual-band Imager of Atmospheric Transient (DIAT) and Electron Temperature and Density Probe (TeNeP).
 - FORMOSAT-8B (2024-): Gamma-ray Transients Monitor (GTM).
 - FORMOSAT-8C (2025-), 8D (2026-), 8E (2027-), and 8F (2028-): P/L TBD.

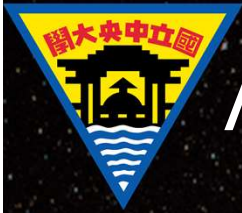


FORMOSAT-5 satellite



FORMOSAT-5 (FS-5) is a **remote sensing satellite** and was launched by SpaceX at **2:51 2017/8/25 CST**. FS-5 flies in a **98.28°** inclination **sun-synchronous circular orbit** at **720 km** altitude in the **1030/2230 LT** sectors and has a **2-day** revisiting time. Primary payload is **Remote Sensing Instrument (RSI)** conducted by NSPO. A secondary payload, **Advanced Ionospheric Probe (AIP)**, is developed by National Central University for **space weather/climate** and **earthquake precursor** research.

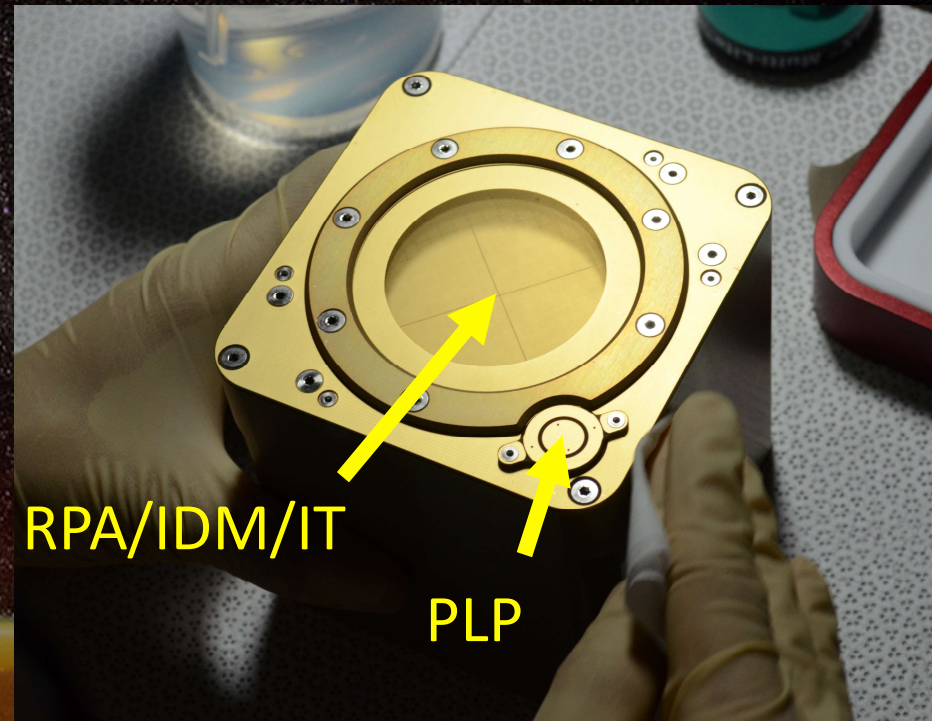




Advanced Ionospheric Probe



Advanced Ionospheric Probe (AIP) is an **all-in-one thermal plasma sensor** that measures ionospheric plasma concentrations (N_i), velocities (V_i), and temperatures (T_i and T_e) in a time sharing way to play Ion Trap (IT), Ion Drift Meter (IDM), Retarding Potential Analyzer (RPA), and Planar Langmuir Probe (PLP).



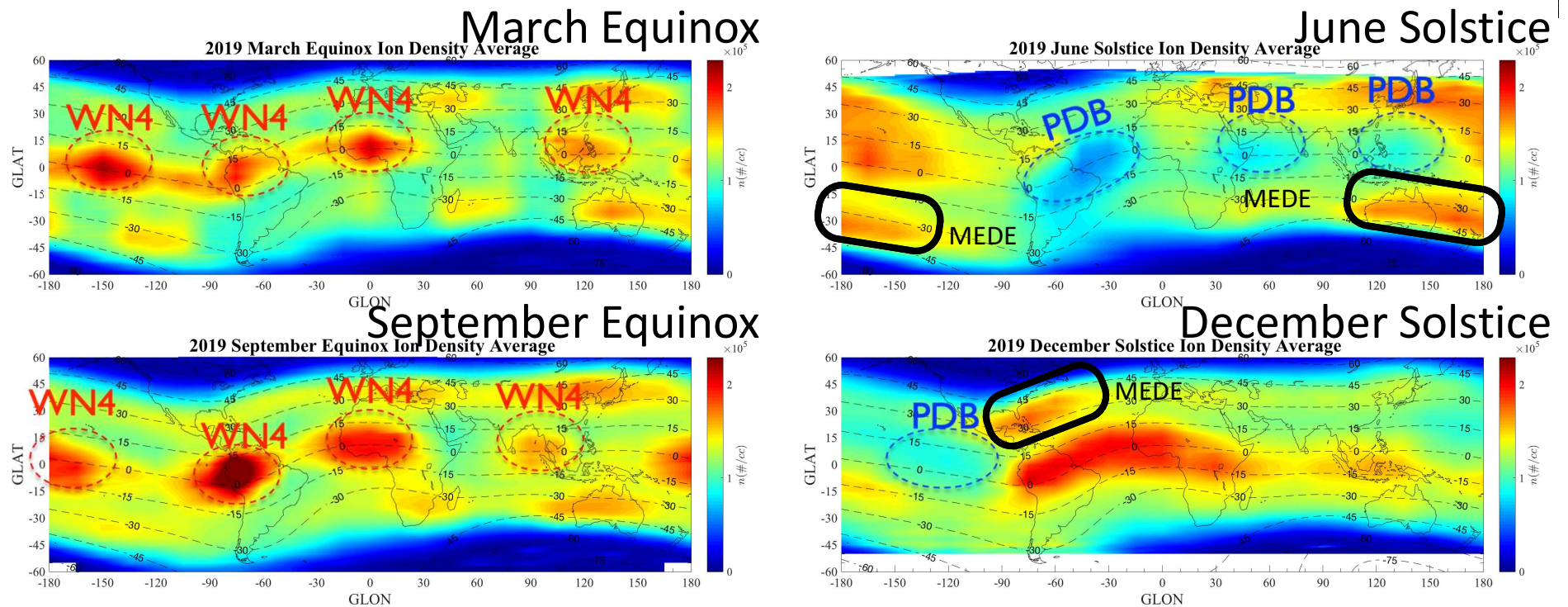
AIP is capable of measuring **ionospheric plasma irregularities** at a sampling rate up to **8,192 Hz**. Electro-formed gold grids used in the AIP can reduce hysteresis phenomenon in I-V curves and approximate ideal electrical potential surfaces for accurate geophysical parameters.



FS-5/AIP observation



- To study Plasma Depletion Bay (PDB), Non-migrating tides of wave-number-4 (WN4), and Mid-latitude Electron Density Enhancement (MEDE) in the nighttime topside ionosphere.



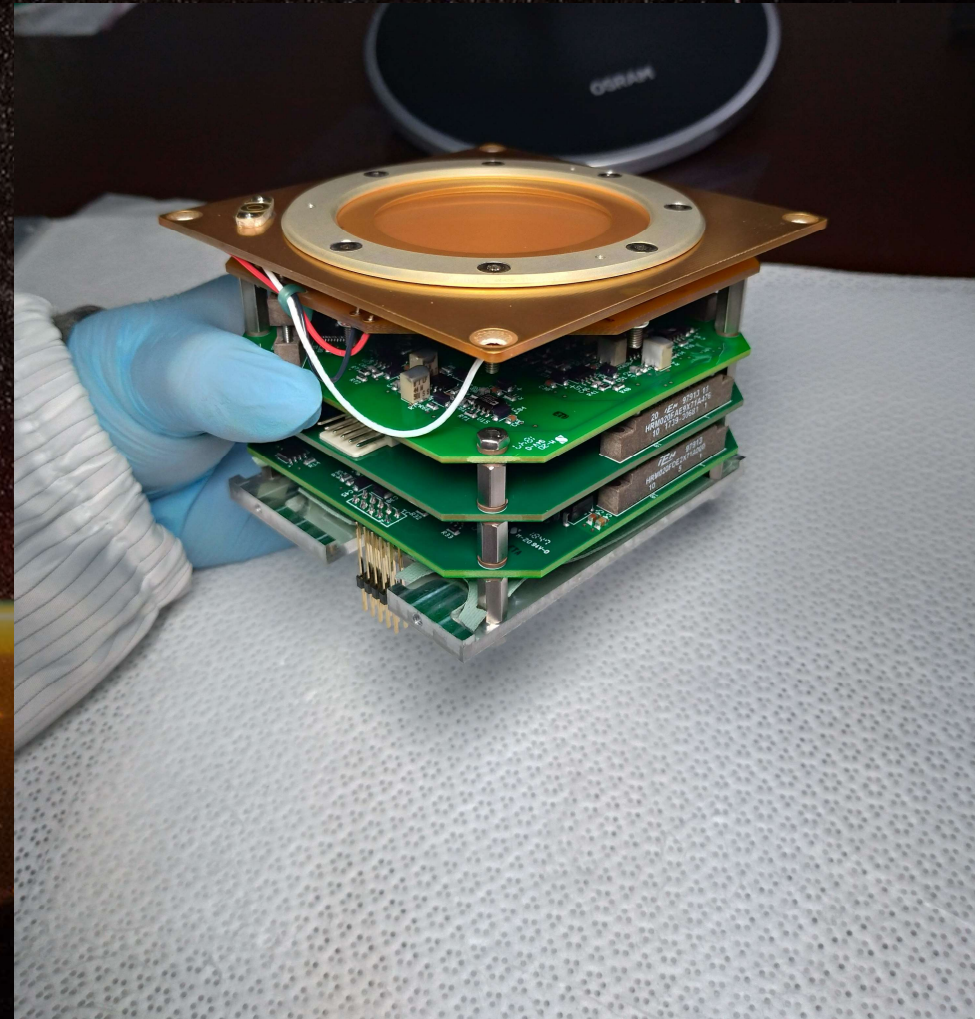


Compact Ionospheric Probe



Compact Ionospheric Probe

(**CIP**) is a miniature model (0.7U) of Advanced Ionospheric Probe (AIP) for CubeSat missions and is also an all-in-one thermal plasma sensor to measure ionospheric plasma concentrations (N_i), velocities (V_i), and temperatures (T_i and T_e). It is capable of measuring ionospheric plasma irregularities at a sampling rate up to 1,024 Hz.



Ionosphere Exploration using FORMOSAT-7/COSMIC-2

Contact: Prof. Charles Lin

Department of Earth Sciences, National Cheng Kung University

FORMOSAT-7/COSMIC-2
LASC & SWL lab

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NCKU

IONOSPHERE DATA OF FORMOSAT-7/COSMIC-2

A platform providing ionosphere data products of FORMOSAT-7/COSMIC-2 for research

Model display

<http://formosat7.earth.ncku.edu.tw>

Cubesat Program - for exploration of upper atmosphere

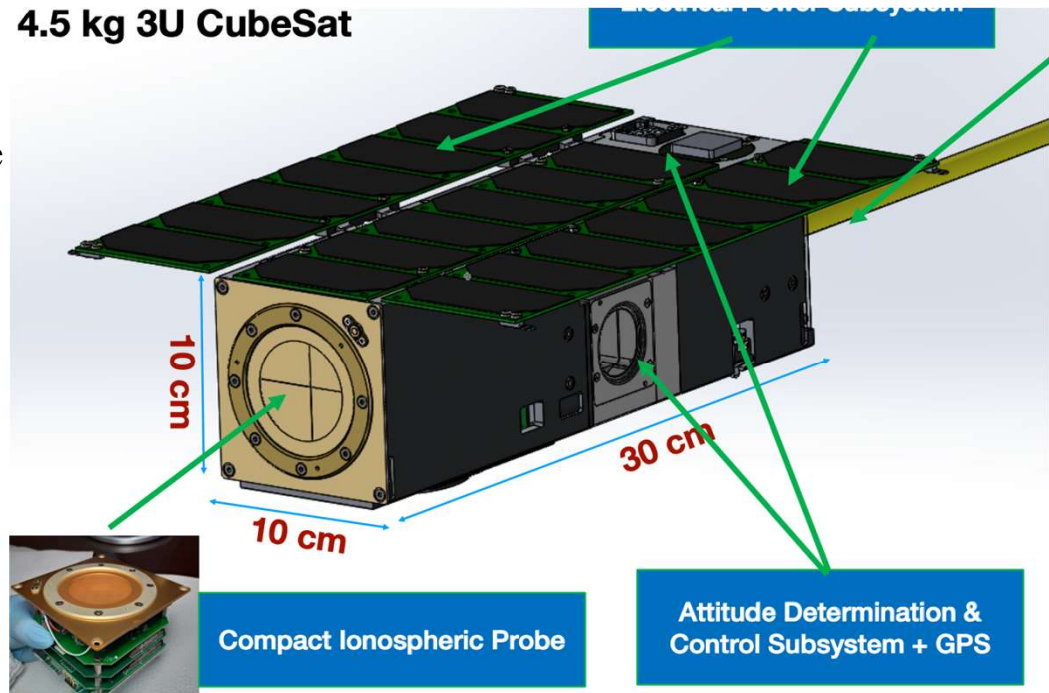
Contact: Profs. Loren Chang, Chi-Kuang, Chao, Tiger Liu and Cheng-Ling Kuo
Department of Space Science and Engineering National Central University, Taiwan



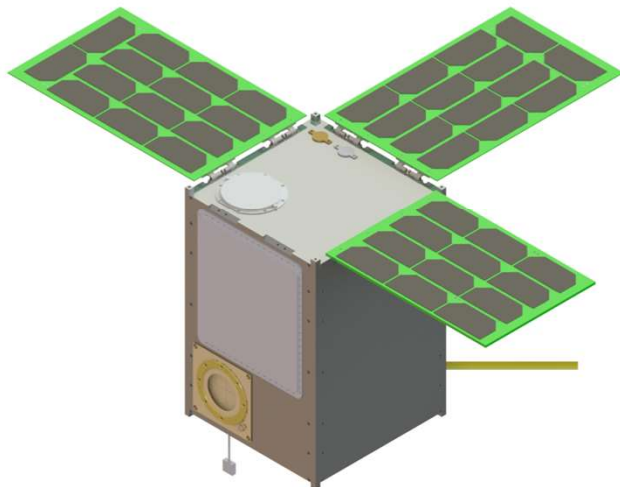
7 spacecraft funded under participating PIs from member institutions.

- **Ionospheric Dynamics Explorer and Attitude Subsystem Satellite (IDEASSat).**
- 3U CubeSat carrying Compact Ionospheric Probe (in- situ plasma sensor):
- Observations of global ionospheric structure, low latitude irregularities.
- Development of spaceflight capacity, hands on student learning, ground support facilities.
- Development, Fabrication, Test: 2017 – 2020.
- Launch: January 21, 2021. SpaceX Falcon 9 to 525 km high inclination orbit.

Contact: Prof. Loren Chang



SCION-X / INSPIRESat-6



- **Scintillation and Ionosphere Extended.**
- Spacecraft Funding:
 - Taiwan Ministry of Science and Technology (2019/2 – 2024/2)
 - Taiwan Ministry of Education (2018/1 – 2022/12)
- Objectives:
 - GNSS-RO & R observations for precipitation forecast.
 - Ionospheric observations for satellite communications quality assurance.
 - Solar EUV measurements.
 - Hyperspectral calibration spectra for aerosol identification.
- 2021: Preliminary Design Phase.

Hyperspectral Imager :

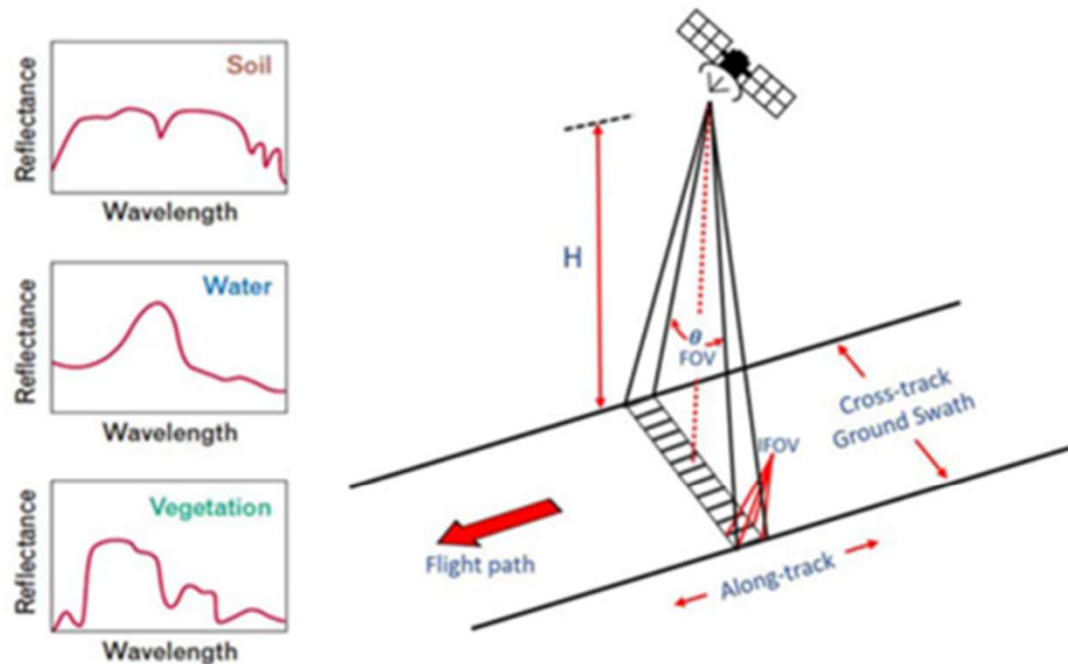
Applications for future space mission for

- Remote sensing
- Airglow imager with intensified CMOS sensor
- Meteor composition analyzer for spectrometer

Contact: Prof. Cheng-Ling Kuo



Hyper-SCAN(Spectral Camera ANalyzer) is an engineer model of hyperspectral Imager with weight <3 kg and ~4U size for CubeSat



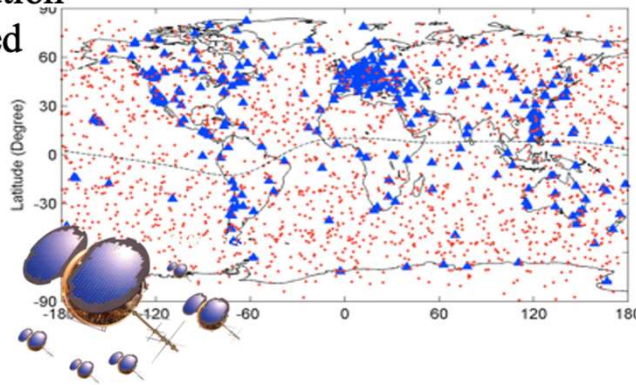
Development of Ionosphere Data Assimilation Model for Forecast

Contact: Prof. Koichi Chen

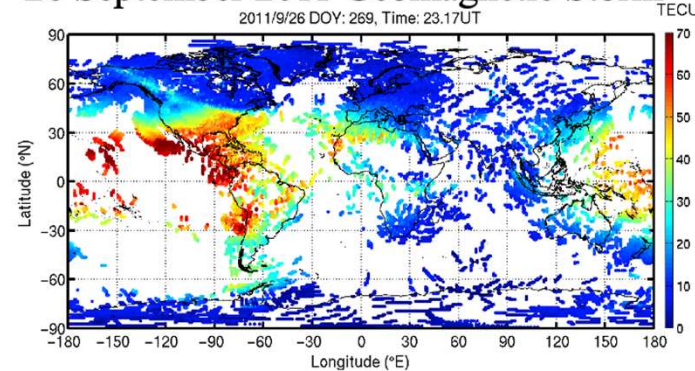
Department of Earth Sciences, National Cheng Kung University

Ionosphere Data Assimilation Model

Global distribution of ground-based GNSS and FORMOSAT-3/COSMIC



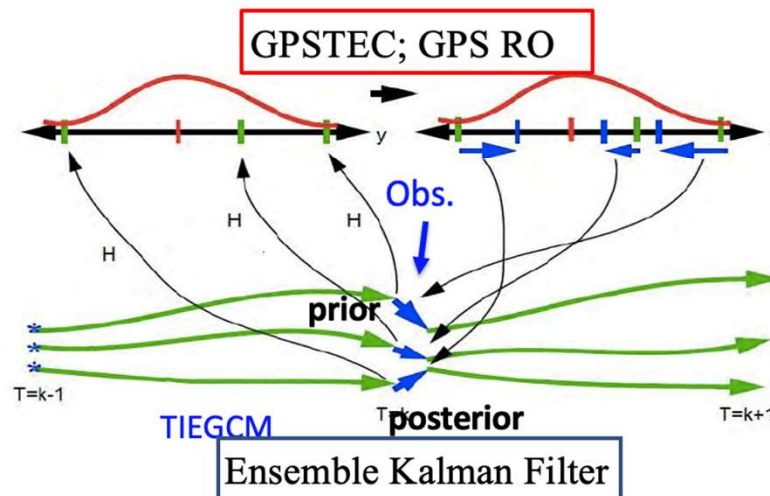
26 September 2011 Geomagnetic Storm



Lacks sufficient global coverage

Data Assimilation

DART-TIEGCM:
90 theoretical ensemble model runs:
solar flux (F10.7),
cross-tail potential
hemispheric power (K_p)



State variables:
Neutral temperature (TN),
Oxygen density (O),
Neutral zonal wind (U),
Meridional wind (V),
[O⁺] ion density

SNIPE

SNIPE (Small scale magNetospheric and Ionospheric Plasma Experiment) is going to be launched in 2021 into a polar orbit at an altitude of 500 km with an orbital high-inclination of (97.7°). The scientific goal of SNIPE is to identify temporal and spatial variations of small-scale plasma structures in ionosphere and magnetosphere. SNIPE consists of four 6U-nanosatellites (~10 kg for each spacecraft).

KASI (Korea Astronomy & Space Science Institute)



GNSS-TEC database in Japan

Global Navigation Satellite System - Total Electron Content

NICT (National Institute of Information and Communications Technology) and Nagoya University collect GNSS-TEC data and provide them for users. There have been many collaborations with international researchers.

<https://aer-nc-web.nict.go.jp/GPS/DRAWING-TEC/>

<http://stdb2.isee.nagoya-u.ac.jp/GPS/GPS-TEC/>

GAlA model

Ground-to-topside model of Atmosphere and Ionosphere for Aeronomy

A global atmosphere-ionosphere coupled model that has been developed by Japanese researchers. It is becoming well known in the community.

The long-term database is provided as a reference for comparison with various observations.

https://gaia-web.nict.go.jp/index_e.html

Geospace Exploration Satellite: Arase (2016-)



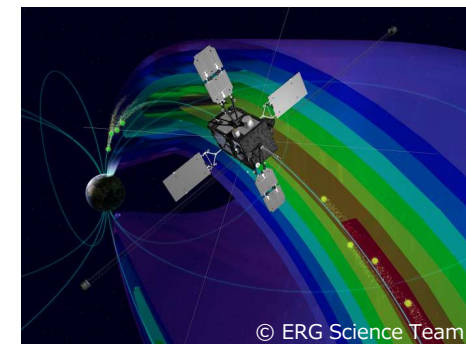
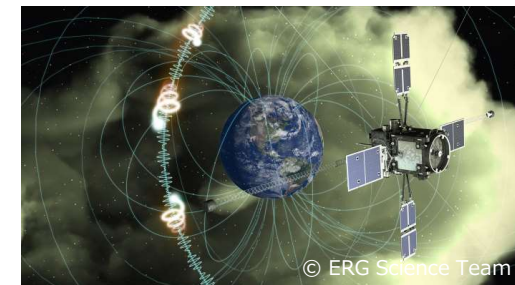
■ Comprehensive plasma/particle and field/wave observations

Eight instruments developed in Japan and Taiwan are installed in the Arase satellite.

- **Data /Analysis Tools:** ERG Science Center Webpage (<https://ergsc.isee.nagoya-u.ac.jp>)
Data from Arase and related ground-based observations are available.

Many new findings are coming from the ERG/Arase project

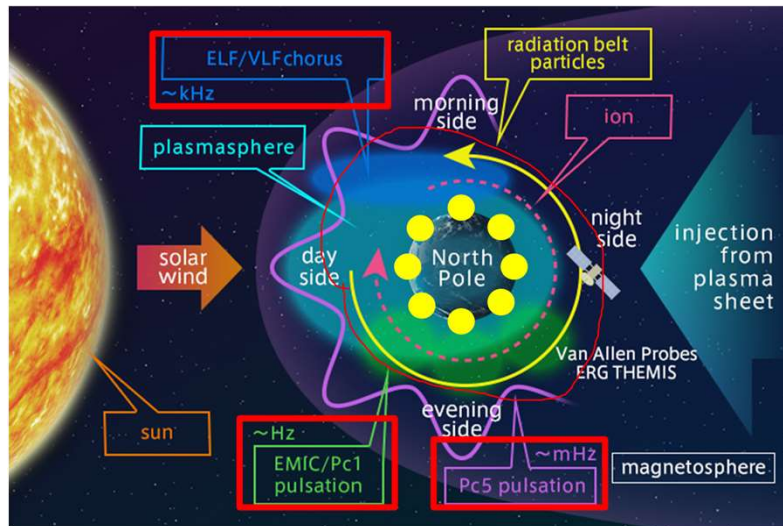
- **Direct evidence of electron acceleration by plasma waves**
Rapid deformation of electron distribution function
- **Origin of pulsating aurora:**
Direct evidence of loss cone filling by chorus waves and correspondence of pulsating aurora.
- **Discovery of high-altitude aurora acceleration region**
Field-aligned accelerated electrons at ~30,000 km altitudes are discovered by the LEP-e instrument(Taiwan/ASIAA&NCKU).
- **Relationship between plasma waves and ambient cold plasma**
Identification of enhancement of electrostatic waves and ambient plasma
- **Molecular ions (O_2^+ / NO^+ / N_2^+) in the inner magnetosphere**
Storm and solar wind dependence of molecular ions from the ionosphere



PWING Project (2016-2021)

The **PWING project** (2016-2020) operates **eight longitudinal sites** at **subauroral latitudes** (~60 MLAT). **More than 140 papers** have been published since 2016.

(<http://www.isee.nagoya-u.ac.jp/dimr/PWING>)

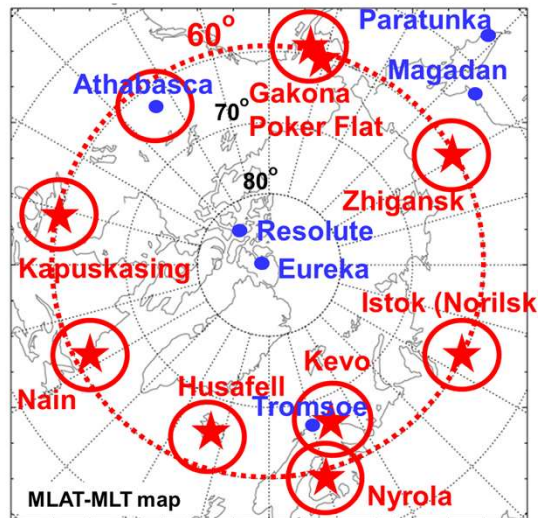


Particles longitudinally round the earth, while waves are localized in particular local time.

These instruments at eight stations measure ELF/VLF and EMIC waves as well as auroral and energetic particle precipitation.

Shiokawa et al. (EPS, 2017,10.1186/s40623-017-0745-9)

• Existing sites ★ New sites



Ground-based stations of the PWING Project

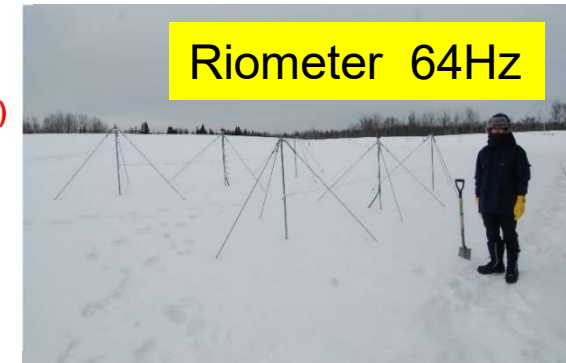
Induction magnetometer 64Hz



VLF antenna 40kHz



Riometer 64Hz

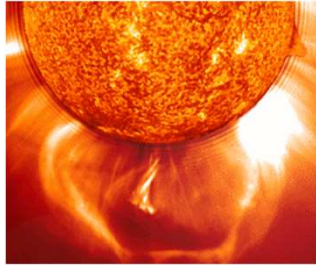


EMCCD (100Hz)
(ATH, GAK, KEV)

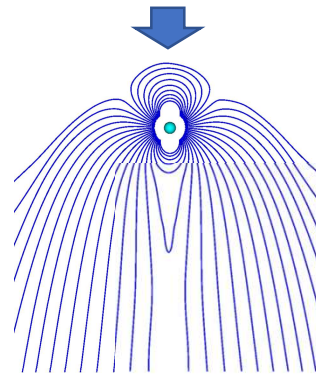


all-sky camera 1.5min

From Sun to Japan: Geomagnetically Induced Current in Japan



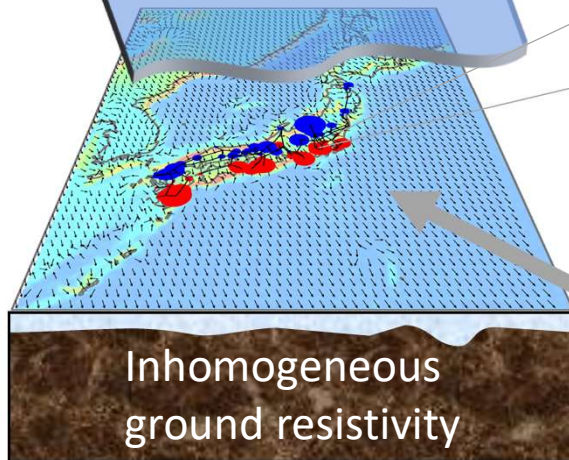
Solar eruption



Magnetospheric and ionospheric currents



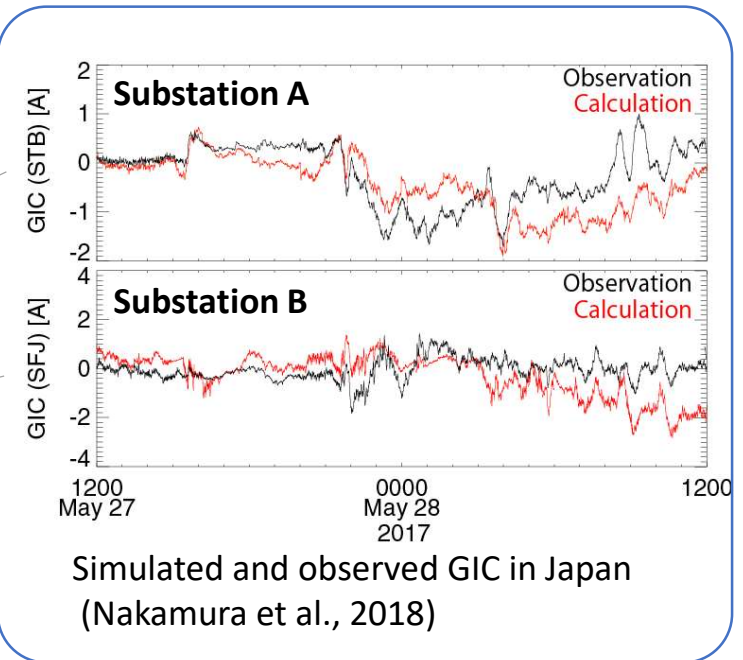
Magnetic and electric waves



Inhomogeneous ground resistivity

Distribution of geoelectric field (color plane) and geomagnetically induced current (filled circles) obtained by simulation.

We have developed 3D FDTD simulation to obtain 3D geoelectric field, and calculated GIC flowing in the Japanese power grid (Nakamura et al., 2018).



Research Priorities in India

Indian Institute of Geomagnetism, Mumbai

Space Physics Laboratory, Thiruvananthapuram

National Geophysical Research Institute, Hyderabad

- Studies on Atmosphere-Ionosphere Coupled system
- Space Plasmas: Observations, Theory and Simulations
- Dynamical and Electro-dynamical Coupling of Equatorial Atmosphere
- Middle Atmospheric Dynamics, Energetics and Coupling to other regions
- Ionospheric phenomena and Irregularities
- Dynamics of the Lithosphere-Atmosphere-Ionosphere-Magnetosphere mechanisms
- Design and development of scientific payloads/instruments for space missions to probe mechanisms of magnetic field of Earth and other planets

Projects related to Cosmic Rays and Space Science in the US

- Acceleration and transport of solar energetic particles in the inner Heliosphere
- Using energetic electrons to probe the solar wind magnetic field configuration
- ACR Proton Acceleration via Reconnection Processes near the Heliospheric Termination Shock
- The propagation of CMEs and its effect on Space Weather
- Boltzmann-Fokker-Planck kinetic solver with adaptive mesh in phase space

Often in the US **graduate students** and **fresh postdocs** get involved in a **space science related project** either through their own institutions (see a list of them below), or through some **summer schools** that have different topics and which are sponsored by **National Science Foundation**. Interested students/postdocs should contact individual advisers at different institutions for further information.

Some institutions that have space science programs in the US include:

Catholic University of America
Rice University
University of California, Berkeley
University of Colorado, Boulder
University of Hawaii
University of New Hampshire
University of Michigan
Boston University
Virginia Tech
Cornell University
University of Texas, Dallas

New Mexico State University
Univ. of Alabama in Huntsville
University of California, Los Angeles
University of Delaware,
University of Minnesota
West Virginia University
Dartmouth College
Boston College
University of Illinois Urbana Champaign
University of Texas, Arlington
New Jersey Institute of Technology

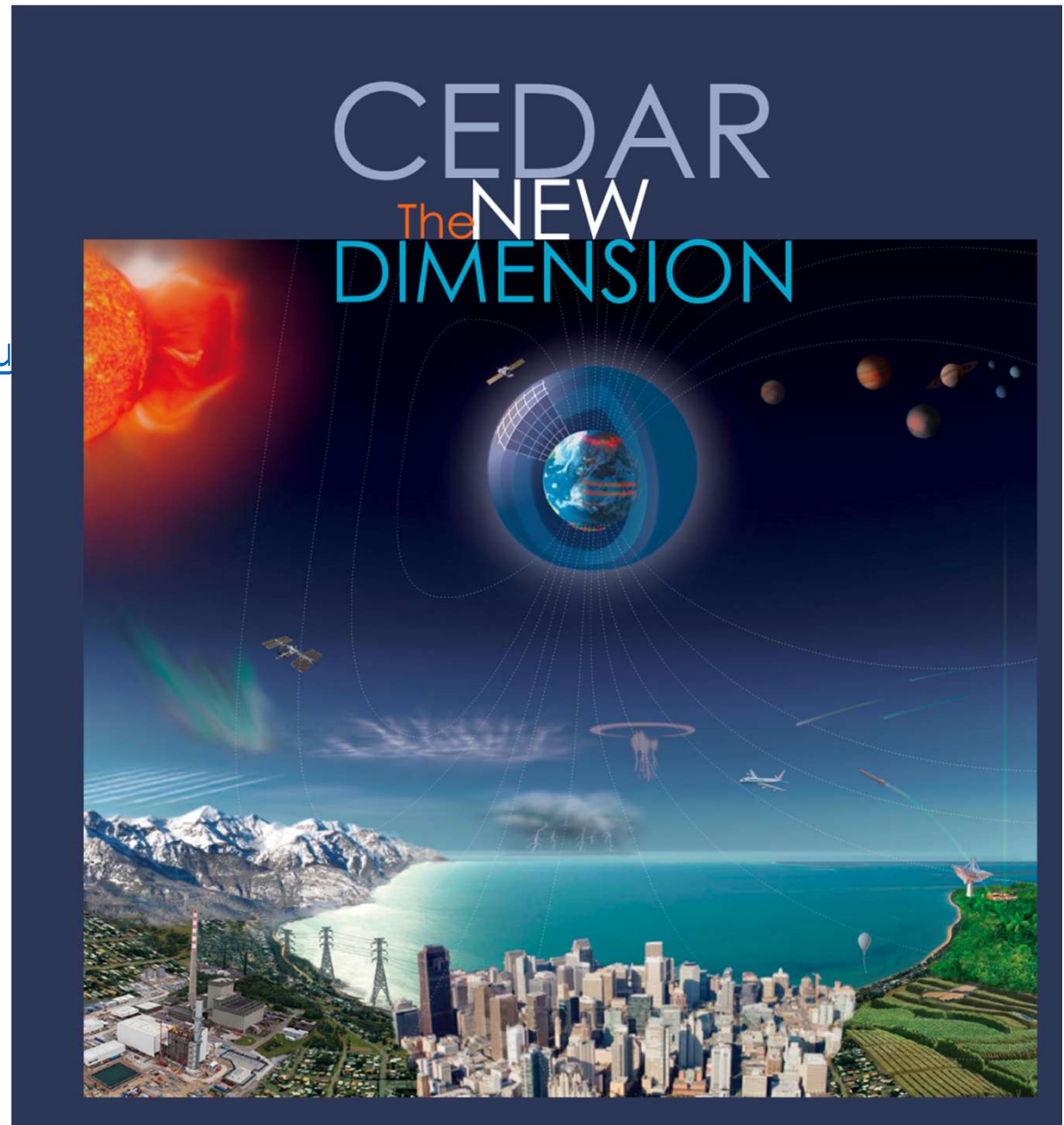
AGU Space Physics & Aeronomy (SPA)



- The Space Physics and Aeronomy Section is united by its interest in the Sun, the heliosphere, and the upper atmospheres and magnetospheres of solar system planets and small bodies.
 - Concerns of the *Aeronomy (SA)* subsection include the Earth's ionosphere, thermosphere, and mesosphere, auroras and airglow, lightning, and planetary atmospheres and ionospheres.
 - Researchers affiliated with the *Solar and Heliospheric physics (SH)* subsection study the solar wind, coronal heating, flares, coronal mass ejections, magnetic reconnection, collisionless shocks, and helioseismology.
 - The *Magnetospheric physics (SM)* subsection's focus is on geomagnetic storms, magnetospheric substorms, the magnetic fields and currents of the magnetosphere, the magnetopause, and the magnetospheres of planets and small bodies in the solar system.
 - *SPA section awards dedicated to international community: Sunanda and Santimay Basu Early Career Award for Research Excellence in Sun-Earth Systems Science (International)*

CEDAR Workshop

- Coupling, Energetics and Dynamics of Atmospheric Regions (CEDAR) is sponsored by the [National Science Foundation](https://www.nsf.gov/) (NSF).
- https://cedarweb.vsp.ucar.edu/wiki/index.php/Main_Page
- Annual workshop in the summer
- Some support available for international student participation



GEM Workshop

- Geospace Environment Modeling (GEM) is a broad-based, community-initiated research program on the physics of the Earth's magnetosphere and the coupling of the magnetosphere to the atmosphere and to the solar wind.
- https://gem.epss.ucla.edu/mediawiki/index.php/Main_Page
- Annual workshop in the summer
- Some support available for international student participation



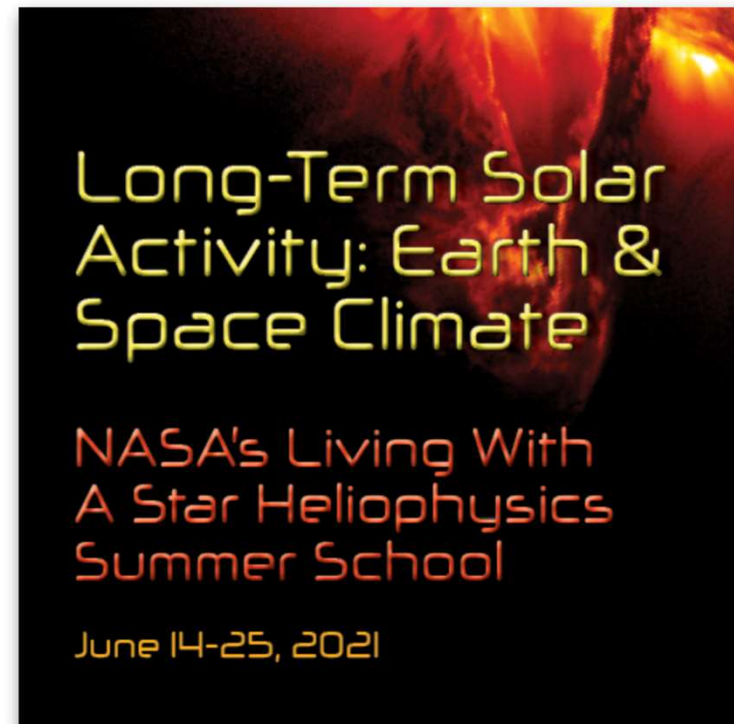
Heliophysics Summer School

- <https://cpaess.ucar.edu/heliophysics/summer-school>
- ***Application Deadline: 22 January, 2021***

Heliophysics Summer School Overview

The Heliophysics Summer School focuses on the physics of space weather events that start at the Sun and influence atmospheres, ionospheres and magnetospheres throughout the solar system. The solar system offers a wide variety of conditions under which the interaction of bodies with a plasma environment can be studied: there are planets with and without large-scale magnetic fields and associated magnetospheres;

planetary atmospheres display a variety of thicknesses and compositions; satellites of the giant planets reveal how interactions occur with subsonic and sub-Alfvénic flows whereas the solar wind interacts with supersonic and super-Alfvénic impacts.



Incoherent Scatter Radar Summer School

<https://amisr.com/school/v2/about>

The deadline for application submission is 5 March 2021.

Notice of acceptance will be sent to participants by 26 March 2021.

THE ISR SUMMER SCHOOL

[About](#)



2021 Incoherent Scatter Radar Virtual Summer School July 19 - 24, 2021

[Apply Now](#)



The 2021 Incoherent Scatter (IS) Radar Summer School will be held virtually on July 19-24. The school provides students with experience in designing and running experiments at IS Radar facilities. IS Radars are large facilities used to study the ionosphere and provide measurements of altitude profiles of electron density, electron and ion temperatures, and ion plasma drift. There are several active IS Radars located in equatorial, mid-latitude, and high-latitude regions.

International School on Equatorial and Low-latitude Ionosphere (ISELION 2018) Bandung, Indonesia on 5-9 March 2018



International School for Space Simulations (ISSS)

