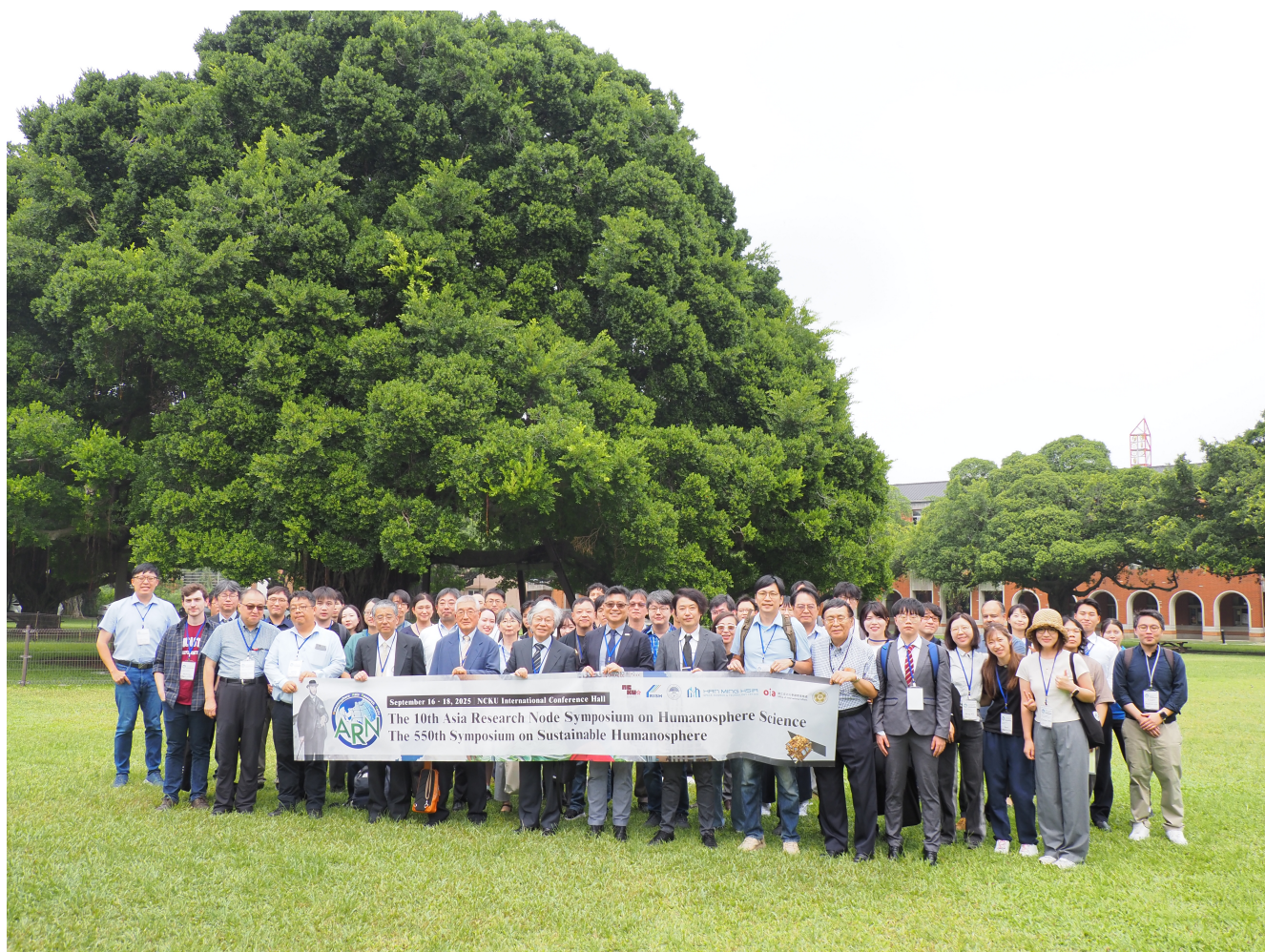


生存圏アジアリサーチノード活動報告

Humanosphere Asia Research Node Activity Report

ARN 2025



生存圏アジアリサーチノード
Humanosphere Asia Research Node

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Preface



Director of RISH
Mamoru Yamamoto

The rapidly changing environment, with its complex interconnections, poses a significant threat to sustainable development and human well-being. Consequently, there is a growing need for reliable future projections based on a thorough understanding of the current state of the Humanosphere, as well as for the development of effective solutions. To achieve a Sustainable Humanosphere, fostering international collaboration and expanding Humanosphere Science on a global scale are crucial.

In 2016, the Research Institute for Sustainable Humanosphere (RISH) launched the Humanosphere Asia Research Node (ARN) program. This initiative aims to strengthen international collaborative research hubs and cultivate talented individuals who can advance the field of Humanosphere Sciences globally. ARN consolidates RISH's diverse facilities and human networks across the ASEAN region and Japan to bolster international collaborative research focused on achieving a "Sustainable Humanosphere."

To promote this goal, we have organized a series of symposia (ARN Symposium) on Humanosphere Science: 1st ARN Symposium (2016) in Penang, Malaysia, in collaboration with Universiti Sains, Malaysia (USM); 2nd ARN Symposium (2017) in RISH, Kyoto U., Uji, Japan; 3rd ARN Symposium (2018) in Taichung, Taiwan, in collaboration with National Chung Hsing University (NCHU); 4th ARN Symposium (2019) in Nanjing, China, in collaboration with Nanjing Forestry University (NFU); 5th ARN Symposium (2020) held online due to the COVID-19 outbreak and travel restrictions; 6th ARN Symposium (2021) as a joint online program of "LAPAN-Kyoto University International Symposium for Equatorial Atmosphere"; 7th ARN Symposium (2022) held online with the Indonesian Research and Innovation Agency (BRIN); 8th ARN Symposium (2023) in Makassar, Indonesia, as a joint program with the 18th Southeast Asia Network Forum (18th SEA) and the 2nd International Conference on Environment and Sustainable Development (2nd ICESD) in collaboration with Kyoto University ASEAN Center, in collaboration with HAKU (the alumni association of former international students from Southeast Asia); and 9th ARN Symposium (2024) in RISH, Kyoto U., Uji, Japan as a joint program with the JASTIP WP3 Wrap-up Symposium, organized by the Kyoto University Japan-

ASEAN Science, Technology and Innovation Platform (JASTIP) Bioresources & Biodiversity (WP3) program.

This year, we successfully organized the 10th ARN Symposium at National Cheng Kung University (NCKU) in Tainan, Taiwan, from September 16–18, 2025. With generous support from the Kyoto University Foundation and NCKU, ARN provided travel support for 17 young researchers (postdoctoral, master's, and Ph.D. students) to attend the symposium from RISH and other Japanese institutions. A total of 94 participants, including 26 students from Japan and Taiwan, attended the symposium. We remain committed to actively expanding our educational and research activities in collaboration with the Humanosphere Science community. This effort aims to scientifically demonstrate the progress and milestones in humankind's path toward constructing a sustainable Humanosphere. We look forward to your valuable assistance, support, and continued participation.

October 2025

Director of RISH, Kyoto University

Mamoru Yamamoto

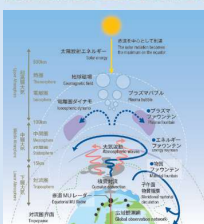
2. Humanosphere Asia Research Node



Humanosphere Asia Research Node



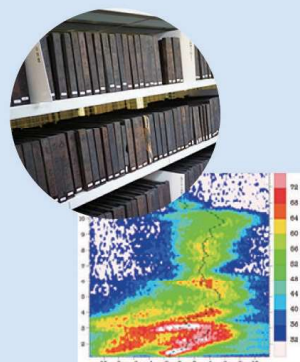
Cooperative Study of the “Equatorial Fountain”



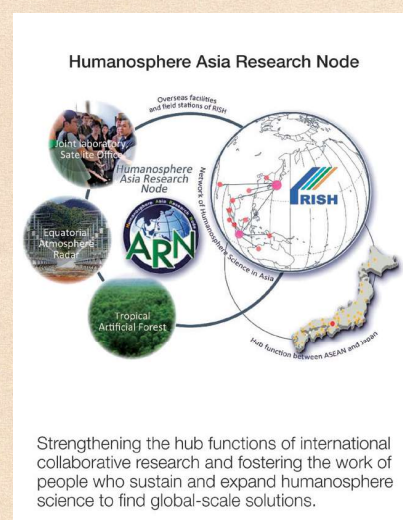
Cooperative Research on the Sustainable Production and Utilization of Tropical Biomass in Relation to Environmental Conservation



International Cooperative Studies Using the Database for Humanosphere Science



In 2016, RISH initiated a new program named “Humanosphere Asia Research Node (ARN)”, thereby strengthening the hub functions of international collaborative research and fostering innovation in Humanosphere Science with the ultimate goal of delivering solutions on a global scale. ARN’s achievements included the following: 1) an ARN joint laboratory at the Indonesian Institute of Sciences (LIPI) was founded jointly with the Japan-ASEAN Science, Technology and Innovation Platform (JASTIP) project; 2) a number of RISH Open Seminars were delivered and broadcast live via web conferencing to selected foreign research organizations; 3) a server mirroring system for the “Humanosphere Science Database” was installed in Indonesia; 4) and a lecture and practical training course on atmospheric science was offered. ARN also served as a co-organizer for the International Workshop on Bioresources and Biodiversity in Uji, Kyoto (with the JASTIP), and the “Humanosphere Science School” in Indonesia. ARN held the 1st Asia Research Node Symposium on Humanosphere Science in Penang, Malaysia in February 2017, and the 2nd Symposium in Uji, Kyoto in July 2017, at which more than 30 speakers from Japan and all over the world were invited. With these ARN activities, RISH is in a perfect position to pursue the integration of different research disciplines and to promote the internationalization of Humanosphere Science.



ARN & JASTIP Joint Laboratory

ARN serves as a network hub that connects research between ASEAN and Japan through joint laboratories in Indonesia and also provides an opportunity for various research institutes in Japan to access ARN’s overseas facilities. In addition, ARN highly encourages overseas researchers to conduct collaborative research using domestic facilities under the joint usage platform it promotes.



Capacity Building

ARN supports the career development of young researchers and engineers by offering opportunities for collaborative research and involvement in international schools in Indonesia and other Asian countries. With ARN’s support, these young scientists can grow into future leaders in various fields of Humanosphere Science.



Practical training on atmospheric science in Indonesia



The 1st ARN Symposium on Humanosphere Science (February 20-21, 2017/Penang, Malaysia)



The 2nd ARN Symposium on Humanosphere Science (July 19-21, 2017/Uji, Kyoto)



Humanosphere Science School 2017, The 7th International Symposium for Sustainable Humanosphere (November 1-2, 2017/Bogor, Indonesia)

URL

Humanosphere Asia Research Node

http://www.rish.kyoto-u.ac.jp/asiaresearchnodes_e/

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10th ARN Symposium
at National Cheng Kung University (NCKU)
in Tainan, Taiwan,
from September 16–18, 2025



Program

September 16 (Tuesday)

Venue: Hall #1, NCKU International Conference Hall (成功大學國際會議廳)

8:45 – 8:55	Opening Ceremony
8:55 – 9:15	NCKU–RISH MoU Signing Ceremony
9:15 – 10:35	Keynote Session I Chairs: Charles LIN (NCKU, Taiwan) and Tatsuhiro YOKOYAMA (RISH, Kyoto U., Japan)
9:15 – 9:20	Introduction by Chairs
9:20 – 9:45	[Keynote-I-1] Exploring Sustainable Humanosphere Science, Pioneering New Research Fields, Expanding Asia Research Node Mamoru YAMAMOTO (RISH, Kyoto U., Japan)
9:45 – 10:10	[Keynote-I-2] Between Legacy and Innovation: Spatial Development on the NCKU Campus Ping-Sheng WU (NCKU, Taiwan)
10:10 – 10:35	[Keynote-I-3] Atmospheric Coupling Processes in the Sun-Earth System Toshitaka TSUDA (RISH, Kyoto U., Japan)
10:35 – 10:45	Photo Session
10:45 – 10:55	Tea Break
10:55 – 12:35	Session I. Satellite Payload and Engineering Chairs: Alfred Bing-Chih CHEN (NCKU, Taiwan) and Hirotsugu KOJIMA (RISH, Kyoto U., Japan)
10:55 – 11:10	[O-I-1]: The Electron Temperature and Density Probe (TeNeP) Onboard FORMOSAT-8A and FORMOSAT-9A Missions Alfred Bing-Chih CHEN (NCKU, Taiwan)
11:10 – 11:30	[O-I-2] Energetic Electron Detector Onboard the IMPACT Mission Satoshi KASAHARA (U. Tokyo, Japan)
11:30 – 11:45	[O-I-3] Prospects of Maritime CubeSats and AIS Payloads Sheng-Long KAO (National Taiwan Ocean U., Taiwan)

- 11:45 – 12: 00 [O-I-4] The Deep Space Radiation Probe: Development and Results from a First Lunar Science Payload for Space Environment Studies and Capacity Building
Loren CHANG (National Central U., Taiwan)
- 12:00 – 12:15 [O-I-5] Gamma-ray Transients Monitor (GTM) onboard Formosat-8B
Chih-Hsun LIN (Academia Sinica, Taiwan)
- 12:15 – 12:35 [O-I-6] Miniaturization of onboard instruments dedicated to scientific satellites
Hirotugu KOJIMA (RISH, Kyoto U., Japan)
- 12:35 – 13:45 Lunch Break**
- 13:45 – 18:30 Excursion**
- 18:30 – 20:00 Banquet**
Venue: A SHA Tainan Main Restaurant (阿霞飯店)

September 17 (Wednesday)

Venue: Hall #2, NCKU International Conference Hall (成功大學國際會議廳)

- 8:45 – 10:25 Session II. Equatorial Aeronomy and Remote Sensing**
Chairs: Charles LIN (NCKU, Taiwan) and Tatsuhiro YOKOYAMA (RISH, Kyoto U., Japan)
- 8:45 – 9:05 [O-II-1] The use of Frequency Modulation Interrupted Continuous Wave (FMICW) High Frequency Surface Wave Radar for ionospheric Irregularity Observations
Yen-Hsyang CHU (National Central U., Taiwan)
- 9:05 – 9:25 [O-II-2] Three-Dimensional Electron Density Reconstruction Using Global Ionospheric Specification Extended (GIS-Extended)
Chi-Yen LIN (National Central U., Taiwan)
- 9:25 – 9:45 [O-II-3] Global Monitoring of Ionospheric Irregularities by Using FORMOSAT-7/COSMIC-2 Observations
P. K. RAJESH (NCKU, Taiwan)
- 9:45 – 10:05 [O-II-4] Investigating the Forecasting Potential of Equatorial Plasma Bubbles Based on Physical Drivers
Chun-Yen HUANG (RISH, Kyoto U., Japan)

10:05 – 10:25	[O-II-5] Automatic Ionogram Scaling in East and Southeast Asia Based on Machine Learning Peng LIU (RISH, Kyoto U., Japan)
10:25 – 10:40	Tea Break
10:40 – 12:20	Session III. Urban Pest and Management Chairs: Hou-Feng LI (National Chung Hsing U., Taiwan) and Wakako OHMURA (RISH, Kyoto U., Japan)
10:40 – 10:50	[O-III-1] Recent termite problems in Japan Wakako OHMURA (RISH, Kyoto U., Japan)
10:50 – 11:15	[O-III-2] Successive invasions of longhorned beetles into Japan: Threats for urban trees Etsuko KAGAYA (Forestry and Forest Products Research Institute, Japan)
11:15 – 11:35	[O-III-3] Cutting Edge of Termite Biological Research, Including Termite Problems in Taiwan Hou-Feng LI (National Chung Hsing U., Taiwan)
11:35 – 11:55	[O-III-4] Challenges in the Control of the Black Cocoa Ant: Ecological Insights and Management Strategies Shu-Ping TSENG (National Taiwan U., Taiwan)
11:55 – 12:20	[O-III-5] Insecticide Resistance and Behavioral Adaptation Drive Reduced Cockroach Gel Bait Performance Kok-Boon NEOH (National Chung Hsing U., Taiwan)
12:20 – 13:20	Lunch Break
13:20 – 15:00	Session IV. Wireless Systems – Semiconductor Devices and Wireless Power Transfer – Chairs: Yu-Te LIAO (National Yang Ming Chiao Tung U., Taiwan), Tsung-Heng TSAI (National Yang Ming Chiao Tung U., Taiwan), Tomohiko MITANI (RISH, Kyoto U., Japan)
13:20 – 13:40	[O-IV-1] Design of a Single Class-E Inverter for Multi-Frequency Wireless Power Transfer Heng-Ming HSU (National Chung Hsing U., Taiwan)
13:40 – 14:00	[O-IV-2] A 2.4 GHz, -19 dBm Sensitivity RF Energy Harvesting CMOS Chip with 51% Peak Efficiency and 24 dB Power Dynamic Range Yu-Te LIAO (National Yang Ming Chiao Tung U., Taiwan)
14:00 – 14:20	[O-IV-3] Electromagnetic Beam-Guiding Technology for Communication Enhancement Chia-Chan CHANG (National Chung-Cheng U., Taiwan)

- 14:20 – 14:40 [O-IV-4] Auto-Tracking Wireless Power Transfer technologies
Bo YANG (RISH, Kyoto U., Japan)
- 14:40 – 15:00 [O-IV-5] Recent Long-Range Wireless Power Transfer Projects in Japan
Tomohiko MITANI (RISH, Kyoto U., Japan)
- 15:00 – 15:15 Tea Break**
- 15:15 – 16:55 Session V. Architecture with Wood – Large-scale Structures with Timber Materials –**
Chairs: Yu-Lin CHUNG (NCKU, Taiwan) and Ai TOMITA (RISH, Kyoto U., Japan)
- 15:15 – 15:35 [O-V-1] Architecture with Wood – Large-scale Structures with Timber Materials –
Hiroshi ISODA (RISH, Kyoto U., Japan)
- 15:35 – 15:55 [O-V-2] Structural Performance of Timber-based Hybrid Structure System and Its Impact
on Achieving Low Embodied Carbon Built Environment
Meng-Ting TSAI (National Taiwan U. Science and Technology, Taiwan)
- 15:55 – 16:15 [O-V-3] Trends in Wood-based Mid-rise Buildings in Japan
Yasuhiro ARAKI (National Institute for Land and Infrastructure Management, Japan)
- 16:15 – 16:35 [O-V-4] Lightweight Seismic Retrofit for RC Frames Using Cold-Formed-Steel-Timber
Composite Walls
Bing-Syun LI (NCKU, Taiwan)
- 16:35 – 16:55 [O-V-5] Structural Performance and Numerical Analysis of 3 Story CLT Platform Type
Narrow Panel Structures
Min-chih HOU (KOZO KEIKAKU ENGINEERING Inc., Japan)
- 16:55 – 17:40 Poster Appeal Session**
Moderator: Tomohiko MITANI (RISH, Kyoto U., Japan)
- 17:40 – 19:10 Poster Session**
Venue: Multifunction room, NCKU International Conference Hall (成功大学國際會議廳)

September 18 (Thursday)

Venue: Hall #2, NCKU International Conference Hall (成功大学國際會議廳)

- 9:00 – 10:05 Keynote Session II**
Chairs: Chao-Li HUANG (NCKU, Taiwan) and Yuki TOBIMATSU (RISH, Kyoto U., Japan)

9:00 – 9:05	Introduction by Chairs
9:05 – 9:30	[Keynote-II-1] An Artificial Apomixis Inducing System is A Powerful Tool to Overcome Food Shortages Masaru OHME-TAKAGI (NCKU, Taiwan)
9:30 – 9:55	[Keynote-II-2] Bio-Reactor Development with AI in the Humanosphere Time Takashi GOJOBORI (NCKU, Taiwan)
9:55 – 10:10	Tea Break
10:10 – 11:50	Session VI. Biology and Biotechnology for a Sustainable Future Chairs: Chao-Li HUANG (NCKU, Taiwan) and Yuki TOBIMATSU (RISH, Kyoto U., Japan)
10:10 – 10:30	[O-VI-1] How Grasses Produce Cell Walls Distinct from Woody Plants: From Perspectives of Lignin Structure and Biosynthesis Yuki TOBIMATSU (RISH, Kyoto U., Japan)
10:30 – 10:50	[O-VI-2] Single-Cell and Spatial Multiomics Identifies Heterogeneous Xylem Development Driven by Mechanical Stress in Populus Ying-Chung Jimmy LIN (National Taiwan U., Taiwan)
10:50 – 11:10	[O-VI-3] Revisiting the Vulnerability and Resilience of Mountain Biota under Rapid Warming I-Ching CHEN (NCKU, Taiwan)
11:10 – 11:30	[O-VI-4] A Long-distance Signaling Peptide across Flowering Plants regulate Plant Growth and Immunity Ying-Lan CHEN (NCKU, Taiwan)
11:30 – 11:50	[O-VI-5] Association of Soil and Litter Microbiome with Fire Adaptive Strategies in Two Pinus Subgenera Chao-Li HUANG (NCKU, Taiwan)
11:50 – 13:00	Lunch Break
13:00 – 14:40	Session VII. Space Science and Space Weather Chairs: Charles LIN (NCKU, Taiwan) and Yusuke EBIHARA (RISH, Kyoto U., Japan)
13:00 – 13:20	[O-VII-1] Space Weather Research and Progresses in Taiwan Tiger J. Y. LIU (National Central U., Taiwan)
13:20 – 13:40	[O-VII-2] Reassessment of the Tsyganenko 1989 Model and Storm-time Applications Nicholas LARSEN (Nagoya U., Japan)

13:40 – 13:55	[O-VII-3] Energetic Electron Precipitation Induced by Nonlinear Interactions with Parallel and Oblique Chorus Waves Yikai HSIEH (RISH, Kyoto U., Japan)
13:55 – 14:10	[O-VII-4] Generation, propagation and consequence of field-aligned currents during auroral substorm Yusuke EBIHARA (RISH, Kyoto U., Japan)
14:10 – 14:25	[O-VII-5] Observations of the dynamics of plasma structure of storm-time ionosphere using FORMOSAT-7/COSMIC-2 Charles LIN (NCKU, Taiwan)
14:25 – 14:40	[O-VII-6] A 3D view of seismo-ionospheric coupling: integrating ground-based GNSS and space-borne F7/C2 observations of the 2024 Mw 7.4 Hualien earthquake Chia-Hung CHEN (NCKU, Taiwan)
14:40 – 15:00	Tea Break
15:00 – 16:40	Session VIII. Advanced Biomass-based Materials Chairs: Yi-Chun CHEN (National Chung Hsing U., Taiwan) and Yukiko ENOMOTO (U. Tokyo, Japan)
15:00 – 15:20	[O-VIII-1] Eco-friendly Polyurethane Materials from Natural Resources Yi-Chun CHEN (NCHU, Taiwan)
15:20 – 15:40	[O-VIII-2] Application of Biomass-Thermally-Modified Carbonated Hydroxyapatite for the Removal of Multiple Heavy Metal Pollutants Biqing LIANG (NCKU, Taiwan)
15:40 – 16:00	[O-VIII-3] Oxidation of Lignin Using an Electrolytic Mediator System: From Model Compounds to Biomass-Derived Lignins Bing XIE (Kyoto U., Japan)
16:00 – 16:20	[O-VIII-4] The Impact of Soil Carbon Sink on Net Zero Emissions and Mitigation of Climate Change Yu-Ting LIU (National Chung Hsing U., Taiwan)
16:20 – 16:40	[O-VIII-5] Ultra-high-performance biomass plastics derived from divanillin Yukiko ENOMOTO (U. Tokyo, Japan)
16:40 – 16:55	Closing Ceremony

Poster Session

Date: September 17 (Wednesday) 17:40 – 19:10

Venue: Multifunction room, NCKU International Conference Hall (成功大學國際會議廳)

- [P-01] In-situ Observations of Ionospheric Perturbations Triggered by the Launches of 2022 and 2023 South Korea Rockets
Jong-Min CHOI (Department of Earth Sciences, NCKU, Taiwan)
- [P-02] Mapping Surface Water by using TRITON GNSS-R.
Shih-Ping CHEN (Department of Earth Sciences, NCKU, Taiwan)
- [P-03] Automatic Detection of Spread F Using Machine Learning and Its Application
Kentaro HARUNA (RISH, Kyoto U., Japan)
- [P-04] Detection of Ionospheric Irregularities Using a Single-Frequency GPS Differencing Algorithm
Yin-Chen CHENG (Department of Earth Sciences, NCKU, Taiwan)
- [P-05] Ionospheric Skywave Propagation Experiment over Taiwan Area
Yen-Hsyang CHU (Center for Astronautical Physics and Engineering, National Central U., Taiwan)
- [P-06] The Thermosphere Density Variation During Geomagnetic Storm in Low-Earth Orbit
Ching-Hua SHEN (Department of Earth Sciences, NCKU, Taiwan)
- [P-07] The Influence of Large-Scale Natural Phenomena on the Ionosphere
I-Ling KAO (Department of Earth Sciences, NCKU, Taiwan)
- [P-08] Long-term Statistical Analysis of Shigaraki Ionosonde Observations Using Machine Learning Models
Mitsuru TERAUCHI (RISH, Kyoto U., Japan)
- [P-09] GNSS-reflectometry Measuring the Width of Rivers
Ho-Fang TSAI (Department of Earth Sciences, NCKU, Taiwan)
- [P-10] The Impact of SpaceX Starship Launches on the Ionosphere
Yu-Hao CHEN (Department of Earth Sciences, NCKU, Taiwan)
- [P-11] EIA Crest Variation During Solar Maximum
Ting Ya HU (Department of Earth Sciences, NCKU, Taiwan)
- [P-12] Electron Dynamics Driven by Chorus Emissions with MLT-Dependent wave properties
Hiraku TSUYAMA (RISH, Kyoto U., Japan)
- [P-13] Impact of Equatorial Plasma Bubbles on Radio Occultation Observations of Large-Scale Ionospheric Plasma Density
Shih-Ping CHEN (Department of Earth Sciences, NCKU, Taiwan)

- [P-14] A Real-Time Plasma Bubble Detection Method Combining Neural Networks and All-Sky Imaging
Hsiao TUNG YUAN (Nuclear Science and Technology Development Center, National Tsing Hua U., Taiwan)
- [P-15] Physics-guided Models of Forecasting the AE Geomagnetic Indices with the LightGBM Machine Learning Framework
Meng-Jung TSAI (Department of Space Science and Engineering, National Central U., Taiwan)
- [P-16] Spatio-temporal Evolution of Phase Space Density of Energetic Electrons in the Transition Region Between the Radiation Belt and Plasma Sheet During Substorm
Yuki OTA (RISH, Kyoto U., Japan)
- [P-17] In-House All-Sky Imager Observations of Airglow and Ionospheric Disturbances over Taiwan
Ching-Wei CHANG (Department of Earth Sciences, NCKU, Taiwan)
- [P-18] Artificial Intelligence for Space Science and Engineering
Cissi LIN (Department of Space Science and Engineering, National Central U., Taiwan)
- [P-19] Ionospheric Detection of Atmospheric Gravity Waves Triggered by Intense Precipitation
Pin-Yen CHIU (Department of Earth Sciences, NCKU, Taiwan)
- [P-20] Lateral Load Test of CLT Shear Wall Infilled Hybrid Steel Frames
Mizuki KOMORI (RISH, Kyoto U., Japan)
- [P-21] Soil Microbiome and Physiological Responses of Flint Corn to Swine Wastewater Irrigation.
Zong-Yi LIN (Institute of Tropical Plant Sciences and Microbiology, NCKU, Taiwan)
- [P-22] The Role of Dirigent Protein in Stereochemical Control of Neolignan Biosynthesis in Arabidopsis
Koji TAKAESU (RISH, Kyoto U., Japan)
- [P-23] Seismic Behavior of Four-Story Wood Frame Construction Method Frame with a Cross-Laminated-Timber Shear Wall in the First Story
Hiyu IWASAKI (RISH, Kyoto U., Japan)
- [P-24] Temporal Effects of Pomelo Branch Biochar on Soil and Fruit Quality under Sod Culture
Ying-Hsuan HUANG (Institute of Tropical Plant Sciences and Microbiology, NCKU, Taiwan)
- [P-25] Investigation on Improving the Sensitivity of a Water-Sensitive Sensor Using Radio Wave Attenuation Phenomena in the UHF Band
Kenta KOBAYASHI (RISH, Kyoto U., Japan)
- [P-26] Simplifying Grass Lignin Through Multiplex Bioengineering Targeting Grass-specific Lignin Decoration Units
Chunxu YOU (RISH, Kyoto U., Japan)

- [P-27] Chronosequence of Soil Microbial Communities and Their Interaction with Forest Recovery in Pine Forests with Different Fire Adaptation Traits Following Wildfire
Yen-Ju CHEN (Institute of Tropical Plant Sciences and Microbiology, NCKU, Taiwan)
- [P-28] Lignocellulose Supramolecular Assembly and Deconstruction Properties of Rice Transgenic and Mutant Lines with Altered Lignin and Ferulate Structure
Senri YAMAMOTO (RISH, Kyoto U., Japan)
- [P-29] Phenolic chemical production from lignin by pyrolysis-assisted catalytic hydrogenolysis
Jiaqi WANG (Graduate School of Agricultural and Life Sciences, U. Tokyo, Japan)
- [P-30] Profiling the Changes of Nitrogen-relative Soil Microbiomes Under the Excessive Fertilizer Input
Chu-Chun LIN (NCKU-AS Graduate-Program in Translational Agriculture Sciences, NCKU, Taiwan)
- [P-31] Enhancing the Utilization of “Kihada” (*Phellodendron amurense*): Distribution of Medicinal Alkaloids
Miyu FUJIMOTO (RISH, Kyoto U., Japan)
- [P-32] Relaxed Selection Constraints in Pulvinus-Expressed Genes Facilitate the Evolution of Rapid Movement in *Mimosa*
Yan-Han FANG (NCKU-AS Graduate-Program in Translational Agriculture Sciences, NCKU, Taiwan)
- [P-33] Full-Scale Shaking Table Tests for Evaluating Building Pounding Caused by Structural Collapse during Earthquakes in Densely Built Urban Areas
Koichiro NAKA (RISH, Kyoto U., Japan)
- [P-34] Colony-level Metabolism: King- and Queen-specific Degradation of Uric Acid Contributes to Reproduction in Termites
Takao KONISHI (Forestry and Forest Products Research Institute, Japan)
- [P-35] Study on the Optimization of Banana Pseudostem Fiber Extraction and Pretreatment Conditions
Yu-Jia LO (Department of Forestry, NCKU, Taiwan)
- [P-36] Bioactivities of Microwave Solvolysis Lignin from Woody Biomass
Yumi OKABE (RISH, Kyoto U., Japan)
- [P-37] Ionospheric Observations by Portable GNSS Receivers during the 2024 Solar Eclipse
Yi-Ting CHEN (Department of Space Science and Engineering, National Central U., Taiwan)

Keynote Sessions

[Keynote-I-1]

**Exploring Sustainable Humanosphere Science, Pioneering New Research Fields,
Expanding Asia Research Node**

Mamoru Yamamoto^{*}

1: Research Institute for Sustainable Humanosphere, Kyoto University

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Research Institute for Sustainable Humanosphere (RISH) is an institute affiliated with Kyoto University, established in 2004. It was launched through the merger of its predecessors: the Wood Research Institute and the Radio Science Center for Space and Atmosphere. RISH is also designated by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) as a “Joint Usage/Research Center for Humanosphere Science.” We promote the science for sustainable humanosphere and develop joint usage and research activities by establishing research themes aligned with our five missions. The standard of our research is internationally very high and wide-ranging. For many years, we have placed a strong emphasis on the Asian region in our international research activities. We named our initiative to expand research collaboration in Asia the “Asia Research Node” and hold a continuous series of international symposia. In 2022, RISH established the “Center for Future Pioneering Research on the Humanosphere.” This unique research center conducts its activities with a strong focus on societal output, based on a flexible philosophy that enables the pioneering of new fields and the building of diverse collaborations, including those beyond academia.

Keywords: Humanosphere Science, New Research, Asia Research Node

[Keynote-I-2]

Between Legacy and Innovation: Spatial Development on the NCKU Campus

Ping-Sheng Wu

Professor of Architectural History, Department of Architecture,
Senior Vice President for the museum, art, campus planning and branding affairs,
Director, NCKU Museum, National Cheng Kung University (NCKU), Taiwan

This keynote explores the spatial development of National Cheng Kung University (NCKU) as a site where institutional legacy and technological innovation intersect and interact. Situated in the historic city of Tainan, NCKU's campus embodies nearly a century of layered spatial transformation, from Japanese colonial-era architecture to the recent emergence of innovative and sustainable infrastructure. Rather than viewing heritage and innovation as opposing forces, this presentation frames them as co-constitutive elements in the evolution of the modern university.

Through selected case studies in campus planning and building adaptation, the keynote examines how spatial strategies have been employed not only to preserve material and symbolic traces of the past but also to articulate forward-looking visions aligned with research, education, and social responsibility. The NCKU campus thus serves as both a repository of historical continuity and a laboratory of institutional renewal.

By drawing on NCKU's experiences, this keynote contributes to a broader discussion on how universities in East Asia can integrate their unique historical trajectories with future-oriented development, positioning themselves as culturally grounded yet globally engaged academic environments.

[Keynote-I-3]

Atmospheric Coupling Processes in the Sun-Earth System

Toshitaka Tsuda
Professor Emeritus, Kyoto University
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The Earth's atmospheric environment is fundamentally formed by solar energy, which can be divided into two main categories: solar radiation and solar wind. We study coupling processes in the Sun-Earth system, aiming to characterize the solar energy inputs to the Earth, and the response of the atmosphere to that energy input. The basic structure of the middle atmosphere (10-100 km) is first formed by solar radiation, but it is known that the vertical coupling process caused by upward propagating atmospheric waves are essential to maintain the general circulation of the middle atmosphere. We utilize high resolution observations from the Middle and Upper atmosphere (MU) radar and the GNSS radio occultation mission onboard the FORMOSAT-3/COSMIC satellite. The MU radar measures wind velocity disturbances consisting of the superposition of various atmospheric waves and reveals the breaking (saturation) processes of atmospheric gravity waves, which act to decelerate the mean zonal winds through dynamical stress caused by turbulence generation. Accurate temperature profile measurements by GNSS-RO enables us to visualize the global distribution of the atmospheric gravity wave activity and study the wave excitation mechanisms.

Keywords: atmospheric gravity wave, wave breaking, the MU radar, Formosat-3/COSMIC, GNSS radio occultation (RO)

[Keynote-II-1]

An artificial apomixis inducing system is a powerful tool to overcome food shortages

Masaru Ohme-Takagi

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A growing population demands further increases in food production, but the available arable land is reducing. Therefore, improving yield per unit area is an urgent matter. F1 hybrid vigor is an effective method for increasing food production, demonstrating yield increases of more than 20%. However, it is only used for a limited number of grains, such as dioecious maize. Apomixis is a natural phenomenon in which seeds are produced without fertilization. However, it has not yet been observed in cultivated species. If apomixis could be artificially applied to crops, it would be possible to fix the F1 hybrid traits through the production of clone seeds and maintain high yields in the next generation without the need for crossbreeding, thereby increasing crop productivity by more than 20% on a global level. We are establishing complete apomixis inducing system, in which both embryo and endosperm apomictically developed without pollination using our chimeric repressor gene silencing technology (CRES-T), and identified transcription factors that could regulate apomixis both in embryo and endosperm. Here we present an attempt to produce rice without pollination.

Keywords: apomixis, F1 hybrid, chimeric repressor, transcription factor, *Oryza sativa*

Oral Sessions

[O-I-2]

Energetic electron detector onboard the IMPACT mission

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Radiation belts, a threat to scientific and engineering activities in space, are maintained by the balance between acceleration and loss of electrons. Despite substantial efforts to understand these physical processes, details are not sufficiently clarified to the level of quantitative predictions. A remaining key issue is the mechanism of rapid electron loss due to the pitch-angle scattering by electromagnetic waves. The leading candidate is the wave propagation through the density duct structure, resulting in the efficient scattering of electrons. However, the relationships between the density duct and the wave-induced scattering are not observationally established. IMPACT is a microsatellite project to clarify such wave-particle interactions occurring in the ducts. The 12U-sized CubeSat carries three scientific instruments: a small plasma wave detector (DPS), a small high-energy electron detector (LEON), and a small impedance probe (NEI). This instrument suite provides direct measurements of duct structures, waves propagating through the ducts, and radiation belt electrons scattered by these waves. Here we present details of the design of LEON. The emphasis is on the miniaturisation of the sensor, which broadens the possibility of future applications.

Keywords: energetic electron detector, CubeSat, radiation belts

[O-I-3]

Prospects of Maritime CubeSats and AIS Payloads

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The "Taiwan Maritime CubeSat" refers to the "Yushan Satellite" launched by Taiwan in 2021. It is a 1.5U cubic satellite whose mission is to receive Automatic Ship Identification System (AIS) signals emitted by ships and detect Automatic Packet Reporting System (APRS) signals emitted by ground vehicles to track maritime and land traffic dynamics and enhance maritime safety and national security monitoring. The Yushan satellite is equipped with an AIS receiver that can receive AIS signals from ships and track their navigation trajectories. The research team of National Taiwan Ocean University has successively developed mass-produced AIS and flight payloads. The AIS CubeSat can collect global maritime traffic data and Big Data on hydrometeorology. It also has innovative technologies such as satellite Starlink communication and artificial intelligence to develop deep learning mechanisms for dynamic and static ship data. It has high commercial value and carbon reduction functions for the global maritime industry. This study introduces its development and application to improve Taiwan's wind farms and global maritime traffic safety.

Keywords: Maritime CubeSat, AIS, Navigation Safety, Windfarm

[O-I-4]

The Deep Space Radiation Probe: Development and Results from a First Lunar Science Payload for Space Environment Studies and Capacity Building

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Regions outside of Low Earth Orbit (LEO, altitudes above approximately 1000 km) are classified as “deep space”, including Medium Earth Orbit (MEO), geostationary orbit (GEO), as well as cislunar and lunar space. The deep space environment poses many challenges for human and robotic exploration, including stronger ionizing radiation fluxes, more extreme temperature variations, as well as limited data downlink volume. With the growth of the rideshare and hosted payload model aboard government and commercial lunar missions, developing the capacity to design and implement payloads and other space avionics for this environment is of increased importance this decade. Utilizing one of the growing number of rideshare opportunities offered by commercial lunar mission providers, National Central University (NCU) has completed the rapid development of Taiwan’s first scientific payload for lunar lander use, which was launched aboard the Hakuto-R Mission 2 (M2) *Resilience* lander from ispace, inc. on January 15, 2025, immediately commencing operations following post launch checkout. This Deep Space Radiation Probe (DSRP) provided 5 months of measurements of radiation dose, dose rate, and single event upset (SEU) rate during two and a half lunar swing by orbits, the low energy lunar transfer transit, and in lunar orbit. DSRP was developed by a student team, in consultation with experienced engineers from the ispace lunar lander team. We report on the objectives, concept of operation, design, implementation, and results of the DSRP project. The radiation data provided by DSRP covers a period of high solar activity, with dose rates considerably higher than on missions during lower solar activity, including several solar particle events, geomagnetic storms, and transit through the Van Allen radiation belts. The data will be beneficial for the development of future deep space spacecraft avionics, as well as crewed missions, and has also served to build the capacity for deep space spacecraft and payload development at NCU. The payload itself is also being modified for future missions based on lessons learned from the Hakuto-R M2 flight.

Keywords: lunar payload, ionizing radiation, single event effects, deep space

[O-I-5]

Gamma-ray Transients Monitor (GTM) onboard Formosat-8B

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The Gamma-ray Transients Monitor (GTM) is a science payload of Formosat-8B (FS-8B) for monitoring Gamma Ray Bursts (GRBs) and other transients in the energy band from 50 keV to 2 MeV. GTM consists of two identical modules located on two opposite sides of FS-8B, a Taiwanese remote sensing satellite. Each module has four sensor units facing different directions to cover half of the sky. The two modules will then cover the whole sky, including the direction occulted by the Earth. Each sensor unit is composed of a GAGG scintillator array (50 mm × 50 mm × 8 mm) to be readout by SiPM with 16 channels. Based on different flux levels detected by different sensor units, the direction of the GRB event can be determined. GTM will enhance the sky coverage of contemporary missions and provide independent event localization measurement. Spectral analysis and polarization-state determination for bright GRBs can be conducted with GTM data. GTM is expected to detect about 50 GRBs per year. Its flight model was delivered to Taiwan Space Agency in September 2023. On-ground calibration is being conducted. The launch is expected in 2026.

Keywords: GAGG, Gamma Ray Bursts, GTM, FS-8B

[O-I-6]

Miniaturization of onboard instruments dedicated to scientific satellites

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Space missions always struggle with resource constraints in terms of mass and power. Resource limitations are particularly critical for small-satellite and CubeSat missions. The miniaturization of onboard instruments is crucial for these missions. ASIC devices enable the extreme downsizing of electronic circuits, because they are specially designed chips tailored to meet the objectives of specific instruments. Our research group is making extensive efforts to develop ASIC devices for use in onboard scientific instruments. This paper introduces a small plasma wave instrument, based on an ASIC device developed for targeting CubeSat in Japan's OHISAMA mission (OHISAMA; (ON-orbit experiment of High-precision beam control using small Satellite for MicrowAve power transmission)). The small plasma wave instrument covering the frequency range of 10 MHz is installed inside a space of one unit with a size of 10 cm × 10 cm × 10 cm. Although this is approximately one-third the size of conventional instruments, it is capable of collecting high-quality scientific data. We also touch on the ASIC devices developed in our group for use in other scientific instruments.

Keywords: ASIC, miniaturization, space plasma

[O-II-1]

The use of Frequency Modulation Interrupted Continuous Wave (FMICW) High Frequency Surface Wave Radar for ionospheric Irregularity Observations

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In this study, the ionospheric echoes detected by Pengjiayu FMICW high frequency surface wave radar (HFSWR) at Taiwan (25.63°N, 122.07°E) were employed to compare with the ionogram traces recorded by Chung-Li ionosonde (24.97°N, 121.20°E). After correcting the range aliasing effect of the FMICW radar echoes, the ranges of the radar-observed ionospheric specular echoes are consistent with those observed by the ionosonde. However, no one-to-one trace counterparts can be found in the ionograms for the diffuse type ionospheric radar returns. With the help of International Geomagnetic Reference Field (IGRF) model, we find that perpendicular distance of field-aligned irregularities (FAIs) associated with sporadic E (Es) layer are comparable to those of the HFSWR-observed diffuse type Es echoes, suggesting the targets responsible for the diffuse type ionospheric echoes are very likely the FAIs at decameter.

Keywords: FMICW radar, ionosonde, Es field-aligned irregularities

[O-II-2]

The Three-dimensional Electron Density Reconstruction by Using Global ionospheric Specification Extended (GIS-Extended)

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This study uses the data assimilation model of global ionospheric specification (GIS) to reconstruct the three-dimensional electron density structure of the ionosphere and plasmasphere. It employs a Gaussian-Markov Kalman filter to assimilate ground-based GNSS and FORMOSAT-7/COSMIC-2 radio occultation slant total electron content (TEC) observations. The study extends the model's altitude boundary from the ionosphere to the lower plasmasphere, ranging from 1,000 to 21,000 km. An observing system simulation experiment (OSSE) is conducted to verify the accuracy of the reconstructed electron density, with results showing that the model can effectively reconstruct both the ionosphere and plasmasphere. A significant geomagnetic storm occurred on Mother's Day of 2024 (May 10-12), with the Dst index dropping to -412 nT, the lowest value since November 2003. GIS electron density analysis indicates that this geomagnetic storm considerably impacted the ionosphere for about two days, while the plasmasphere experienced effects for over two days. Furthermore, after the geomagnetic storm's influence on the plasmasphere began, plasma density rose sharply for one day before experiencing a noticeable decline that lasted more than a day.

Keywords: Data Assimilation, GNSS-RO, Ionosphere, Geomagnetic storm

[O-II-3]

Global monitoring of ionospheric irregularities by using FORMOSAT-7/COSMIC-2 observations

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The FORMOSAT-7-COSMIC2 (F7/C2) constellation consisting of six satellites equipped with GNSS radio occultation (RO) payload, and in-situ ion density and velocity meters (IVM), constitute a unique observation suite for monitoring plasma irregularities worldwide. The IVM ion-density measurements detect plasma density variations from irregularities associated with equatorial plasma bubbles (EPBs), offering continuous observations over the low-latitudes. Such measurements by successive F7/C2 satellites are used to track the latitudinal expansion as well as zonal evolution of EPBs. With the elevated solar activity and frequent geomagnetic disturbances in recent years, the observations show increased occurrence of intense irregularities. Further, the complex ionospheric variations associated with disturbed conditions cause the irregularities to sustain much longer, even after sunrise. The IVM measurements are compared with the EPB observations by ground-based all sky imager, GOLD airglow images, and ground-based GNSS measurements. Besides, the hourly 3D global ionospheric specification (GIS) electron density derived from slant total electron content (TEC) measurements by F7/C2 RO as well as ground based GNSS network are used to understand the background ionospheric electron density variations that favor the generation of EPBs.

Keywords: Equatorial plasma bubble, FORMOSAT-7/COSMIC-2, ion-velocity meter, Global Ionosphere Specification, geomagnetic storm

[O-II-4]

Investigating the Forecasting Potential of Equatorial Plasma Bubbles Based on Physical Drivers

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Predicting equatorial plasma bubbles (EPBs) remains a critical challenge in space weather forecasting. The Rayleigh–Taylor (R-T) instability is recognized as the primary mechanism for EPB generation, and its growth rate is strongly modulated by the prereversal enhancement (PRE) of vertical plasma drift. Previous studies have shown that the climatology of PRE aligns closely with both the R-T instability growth rate and EPB occurrence probability, suggesting that PRE vertical drift serves as a key link connecting the two. In this study, we investigate the influence of solar activity on PRE, R-T growth rate, and EPB occurrence rate, with the goal of establishing an empirical relationship between growth rate and occurrence probability. The R-T growth rate is derived from the coupled Whole Atmosphere Model–Ionosphere Plasmasphere Electrodynamics (WAM-IPE) model using a new formulation expressed in Quasi-Dipole coordinates and modified electrodynamics equations. EPB occurrence rates are obtained from ROCSAT-1 and C/NOFS observations, while WAM-IPE simulated PRE vertical drifts are compared with satellite measurements to evaluate their consistency.

Keywords: Equatorial Plasma Bubbles, Rayleigh-Taylor Instability, Pre-reversal Enhancement

[O-II-5]

Automatic Ionogram Scaling in East and Southeast Asia Based on Machine Learning

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The Earth's ionosphere is a region where a part of the Earth's upper atmosphere is ionized into electrons and ions by sunlight. The most widely used ionospheric observation equipment in the world is the ionosonde. It transmits pulse signals ranging from low to high frequencies vertically, obtaining observation data called as ionogram. By scaling various parameters from ionogram, the electron density distribution in the ionosphere can be derived. However, considering the ionogram formats of different ionosondes differ, a general intelligent processing system for ionograms is in high demand. Leveraging the recent progresses in artificial intelligence, this research aims to develop a new method for intelligently scaling ionograms based on instance segmentation technology. The proposed method consists of five steps: 1) denoising the raw data; 2) creating labeled images and training the machine learning model; 3) automatically processing ionograms in east/southeast Asia by referencing the trained model; 4) restoring the coordinate system transformation from images to ionogramst; 5) statistically analyzing the ionospheric disturbance phenomena and improving the International Reference Ionosphere (IRI) model accuracy.

Keywords: Ionosphere, Ionogram Auto-scaling, Artificial Intelligence, Instance Segmentation

[O-III-1]

Recent termite problems in Japan

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This session will focus on the crucial issues posed by pests in urban areas. In Japan, invasive insects introduced through the international timber trade have emerged as a significant threat, causing extensive damage to both living trees and processed wood materials. Among wood-destroying species, the progressive spread of the established invasive termite *Incisitermes minor* has been well documented. In addition, the introduction of a new drywood termite, *Cryptotermes brevis*, has recently been reported, although fundamental strategies for the management of drywood termites remain undeveloped. Notably, in 2023, cases of structural damage to residential housing caused by the native subterranean termite *Reticulitermes speratus* were confirmed in Obihiro City, Hokkaido—a region previously considered unsuitable for this species due to its colder climate. To ensure the long-term durability and sustainable utilization of wooden structures, it is imperative to undertake comprehensive investigations into the physiology and ecology of wood-destroying organisms, including both termites and wood-decay fungi, and to develop evidence-based countermeasures informed by this knowledge.

Keywords: termites, invasive species, wood pest, drywood termites, global worming

[O-III-2]

Successive invasions of longhorned beetles into Japan: Threats for urban trees

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Over the past 15 years, urban trees in Japan have faced a new threat. Longhorned beetles, which spend most of their lives inside trees, can be unintentionally transported from their native habitats and become invasive species as wood is traded globally. Due to the repeated invasions of tree-killing longhorned beetles into Japan, broadleaf trees have suffered severe damage.

Invasions of the red-necked longhorned beetle *Aromia bungii* in 2011, the starry sky beetle *Anoplophora glabripennis* in 2020, and the rusty-spotted longhorned beetle *Apriona swainsoni* in 2021 have been detected, and their spread continues. Damage caused by these non-native longhorned beetles is particularly noticeable in urban and suburban natural areas.

The red-necked longhorned beetle attacks cherry, plum, and peach trees. It has now invaded 15 of Japan's 47 prefectures, affecting more than 10,000 trees. The starry sky beetle is known for its wide host range. It often damages street trees, and in some areas, all the horse chestnut or katsura trees have had to be cut down. The rusty-spotted longhorned beetle targets ornamental Fabaceae trees in Fukushima Prefecture.

Keywords: invasive species, pests, protection plan

[O-III-3]

Cutting edge of termite biological research, including termite problems in Taiwan

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Global warming, human population growth, and expanding wood harvests are intensifying termite-related economic losses, further exacerbated by invasive species. Taiwan, situated in the transitional zone between temperate and tropical climates, is particularly vulnerable to diverse termite pests, including subterranean, drywood, and fungus-growing termites. Genomic-scale analyses have refined termite classification, recognizing 13 families and 18 subfamilies within Termitidae, providing a robust evolutionary framework for biological research and taxonomy-based management. Advances in termite management now include field detection systems with IoT and wireless transmission, enabling continuous real-time monitoring of termite activity. Durable, weather-resistant baits support area-wide control, while gel-based baits make localized and above-ground treatments more practical. Despite the global increase in termite damage, expanding knowledge of termite biology is guiding the development of cost-effective, environmentally friendly, and sustainable tools. Because the scale of damage and control practices differ substantially from other urban pests, public education is especially critical. Artificial intelligence for pest identification and prediction, together with citizen science, offer practical means to enhance public engagement in termite management.

Keywords: global warming, invasive termite pest, area-wide management, termite baiting, environmentally friendly

[O-III-4]

Challenges in the control of the black cocoa ant: ecological insights and management strategies

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The black cocoa ant (*Dolichoderus thoracicus*) has emerged as both an agricultural and household pest in Taiwan. Genetic analyses indicate that invasive populations form a cryptic lineage distinct from native ones, and current infestation hotspots appear to be associated with the distribution of this lineage. These populations also exhibit supercolony formation, a trait that may facilitate their ecological success. Unlike many other ant species, *D. thoracicus* does not perform stomodeal trophallaxis, limiting the efficiency of conventional bait-based control. To address this challenge, we tested baits with different active ingredients in laboratory assays to evaluate worker mortality and the potential for horizontal transfer. These assays clarify which compounds remain effective in the absence of oral food sharing. In addition, alternative approaches such as manipulating microbial associates are being explored to disrupt colony function. Together, these findings provide new directions for managing this persistent pest.

Keywords: invasive ant, urban pest, supercolony, gut microbial, trophallaxis

[O-III-5]

Insecticide Resistance and Behavioral Adaptation Drive Reduced Cockroach Gel Bait Performance

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Insecticide resistance is a major challenge in managing German cockroach (*Blattella germanica*) infestations, with resistance reported to 43 active ingredients. Gel baits are widely used because of their fast action, long residual effect, safe application, and low environmental impact. However, increasing reports of poor bait consumption and reduced field efficacy highlight emerging concerns. Resistance development varied by insecticide and population: cockroaches with moderate to high fipronil resistance showed a sharp increase in resistance ratios after three generations of exposure to fipronil-containing bait, whereas resistance to imidacloprid and indoxacarb developed more slowly. Behavioral assays revealed that resistant cockroaches visited gel baits more frequently than susceptible strains, yet 80% of resistant males were not attracted to the bait. Transcriptome analysis identified two candidate olfactory genes with altered expression in resistant populations, suggesting impaired bait detection. These results emphasize the importance of routine resistance monitoring and integrated insecticide resistance management (IRM) strategies to preserve the efficacy of gel baits and ensure sustainable cockroach control.

Keywords: German cockroach, integrated pest management, glucose aversion behavior

[O-IV-1]

Design of a Single Class-E Inverter for Multi-Frequency Wireless Power Transfer

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Wireless power transfer (WPT) systems operating in the multi-megahertz (MHz) range commonly utilize the ISM bands at 6.78, 13.56, and 27.12 MHz. These frequency ranges are widely recognized as promising for mid-range WPT applications due to their balance of efficiency and practicality. This paper presents a novel multi-frequency class-E inverter design that employs a single transistor, thereby reducing hardware complexity and cost. The core innovation lies in modifying the conventional inverter topology to support dual-frequency operation by incorporating an impedance transformation circuit that effectively provides a shunt capacitor at multiple frequencies. The proposed circuit model and step-by-step design procedure are detailed to validate the concept. A prototype WPT system was implemented, consisting of a single class-E inverter, multi-frequency transmission coils, and two receivers. Experimental results show that the system achieves a peak efficiency of 71% with an output power of 17.7 W at 6.78 MHz, and a peak efficiency of 72% with an output power of 24.7 W at 13.56 MHz.

Keywords: multiple frequency class E design; multiple frequency coil; resonant wireless power transfer

[O-IV-2]

A 2.4 GHz, -19dBm Sensitivity RF Energy Harvesting CMOS Chip with 51% Peak Efficiency and 24 dB Power Dynamic Range

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This work proposes a 2.4 GHz wireless energy harvesting chip with a meander dipole antenna. The design was fabricated in a 180-nm standard CMOS process and occupies a chip area of 2.3×2.5 mm² while consisting of a reconfigurable rectifier, a bandgap reference, a maximum power point tracking controller, a 3× switched-capacitor charge pump, two regulators, and an ultra-low power diode. The design achieves a peak power efficiency of 51.9 % at -4 dBm and sensitivity of -19 dBm. The peak power efficiency of SCCP3× is 97.2 %, and the reverse leakage current of ULPD is less than 2 nA. The automatic maximum power tracking scheme extends the >20% power efficiency range to 24 dB.

Keywords: RF powering, energy harvesting, CMOS, wide dynamic range

[O-IV-3]

Electromagnetic Beam-Guiding Technology for Communication Enhancement

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This presentation details our team's research on Reconfigurable Intelligent Surfaces (RIS) as a transformative solution for enhancing Non-Line-of-Sight (NLOS) communication quality. We will showcase our developed RIS prototypes and explain their function in actively guiding electromagnetic waves to improve signal coverage and performance. The discussion will cover our different design methods, including both single-beam and multi-beam configurations for various communication scenarios. Field test results will be presented to validate the RIS's capability to effectively mitigate signal blind spots and demonstrate its practical use. The integration of EM sensing enables the RIS to autonomously detect an incoming wave's direction and polarization, leading to rapid, dynamic beam adjustments. Finally, we will discuss our ongoing efforts to achieve energy self-sufficiency and develop a new generation of sustainable intelligent surfaces.

Keywords: reconfigurable intelligent surface, non-line-of-sight, communication, EM sensing

[O-IV-4]

Auto-Tracking Wireless Power Transfer technologies

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This presentation shows the auto-tracking wireless power transfer technologies. It also demonstrated a tracking charging system for a free-moving smartphone, which utilized image recognition technology to locate the position of the smartphone, using a 5.75 GHz phased array system to shift the microwave beams toward the smartphone, then a microwave rectifier circuit converted microwave power into dc power to supply the Qi wireless charging circuit for charging the smartphone. The maximum transmission power of the phased array is 32W, and the radiation angle of the microwave beam is within $\pm 25^\circ$ when the smartphone is outside the radiation area the transmission power will be stopped. The transmission distance is within 50cm, and the smartphone can be automatically tracked and charged.

Keywords: microwave power transmission, phased arrays, rectifier circuits, microwave antennas, image recognition

[O-IV-5]

Recent Long-Range Wireless Power Transfer Projects in Japan

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Long-range microwave wireless power transfer (MWPT) projects are underway in Japan. One of the projects is a demonstration experiment of long-range MWPT using an aircraft. and has succeeded in beam forming and beam direction control with a transfer distance of more than 5 km in December 2024. Another project is a demonstration experiment of long-range MWPT using a satellite, which is currently being developed and will be launched in the near future. Japan Space Systems has played coordinating roles in both projects, and our research group contributes to numerical simulations and measurements of the transmitting antennas, which is phased array antennas at a 5.8-GHz band. In this presentation, the recent long-range MWPT projects are introduced. Technological developments in this long-range MWPT will lead to a future mission of a space solar power satellite.

Keywords: wireless power transfer, microwave, space solar power satellite

[O-V-1]

Architecture with Wood – Large-scale Structures with Timber Materials –

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In recent years, significant progress has been made worldwide in utilizing timber as a versatile and sustainable construction material. New possibilities for timber and timber-composite construction become available through updated design codes that allow for larger and taller buildings, as well as buildings under extreme and serviceability loading conditions. In Europe and the United States, buildings exceeding 20 stories have already been constructed using timber as a structural member. In Japan, 10-story buildings made entirely of timber have been constructed, and in Taiwan, new applications for timber are emerging. However, there are several challenges to using wood, including ensuring seismic performance and durability. This session will focus on the use of wood in buildings in Taiwan and Japan, and discuss the possibility.

Keywords: Timber Construction, Structural Performance, Carbon Impact

[O-V-2]

Structural Performance of Timber-based Hybrid Structure System and Its Impact on Achieving Low Embodied Carbon Built Environment

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Amid the global transition of the construction industry toward net-zero carbon emissions, reducing embodied and operational carbon has become a critical challenge for sustainable building development. This study focuses on Taiwan's unique context, where high seismic risk coexists with aggressive carbon reduction policies, and aims to establish an assessment method for embodied carbon in timber-based hybrid structural system and its impact on achieving built environment with low-embodied carbon. The evaluation framework integrates both structural performance and carbon reduction potential to address technical and policy demands arising from the construction sector's sustainable transition. The research investigates how timber-based hybrid structure system affect overall building weight, inter-story stiffness, and seismic behavior comparing with non-timber buildings. The study adopts the EN 15978 Life Cycle Assessment (LCA) framework to quantify embodied carbon in stages A1–A4 (raw material supply, manufacturing, and transport). The findings provide a valuable reference for mid- to high-rise timber design, early embodied carbon assessments, and potential revision of regulatory frameworks, supporting trajectory toward a safer and more sustainable built environment in Taiwan.

Keywords: timber-based hybrid structure system, structural performance, embodied carbon, life cycle assessment (LCA)

[O-V-3]

Trends in wood-based mid-rise buildings in Japan

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Since ancient times, Japan has constructed large wooden buildings, including shrines, temples, pagodas, and castles. However, many of these buildings were destroyed by fire during past earthquakes and World War II. This led to restrictions on wooden construction after the war. Recently, promoting the use of wood has gained attention as a solution to global warming. Since 2000, Japan has developed technologies for constructing fire-resistant wooden buildings, and mid-rise and large-scale wooden buildings are now being built. This presentation will introduce recent trends in mid-rise wooden buildings in Japan, focusing on four structural types. Additionally, examples of research related to mixed structures combining CLT with reinforced concrete or steel structures, as well as mixed structures combining CLT with the 2x4 construction method, will be presented.

Keywords: Wood-based mid-rise buildings in Japan, Mixed structures

[O-V-4]

Lightweight Seismic Retrofit for RC Frames Using Cold-Formed-Steel-Timber Composite Walls

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This study proposes an innovative seismic retrofitting technique employing a cold-formed-steel-timber composite (CFSTC) wall, consisting of a cold-formed steel (CFS) frame clad with thick glued-laminated timber (glulam) panels and inserted into an existing reinforced concrete (RC) frame. The “Light Retrofit” method adopts dry construction with modular units and lightweight members, thereby reducing falsework, finishing, and site disturbance. Cyclic lateral loading tests were conducted on two full-scale retrofitted RC frames to evaluate the effectiveness of this lightweight, labor-saving, and low-carbon retrofit strategy. One specimen utilized screw connections, while the other combined screws with adhesive. The results showed that the retrofitted frames exhibited substantial improvements in strength and deformation capacity compared to the non-retrofitted frame reported by Tu and Lian (2021). Because the composite walls were anchored to beams rather than columns, the failure mode of the RC frames remained unchanged. Nevertheless, the retrofitted walls delayed collapse by maintaining frame stability after column shear failure. Furthermore, the addition of adhesive enhanced the steel-timber interaction, increasing initial stiffness and, prior to adhesive failure, effectively preventing panel splitting and screw failure.

Keywords: Seismic Retrofit, Shear Wall, Timber, Cold-formed Steel, Composite.

[O-V-5]

Structural Performance and Numerical Analysis of 3 Story CLT Platform Type Narrow Panel Structures

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As Japan promulgated the structure design criteria for buildings using CLT (Notification No. 611), CLT has become a popular material for construction industry. To investigate the structural performance of the Japanese CLT panel construction method and validate the structure analysis method required for the practical design process, two full-scale CLT structures were tested under cyclic loading test. The structures were designed as 3 stories staked walls, the CLT panels utilized in the experiments were in accordance with Japanese Agriculture standard JAS 3079, and the joints and connections were designed strictly followed the *Japanese CLT Manual*. Cyclic and monotonic lateral loading tests were performed, and the deformations of the structures were traced. After the tests, numerical validations were conducted. The comparisons between test and numerical results showed good agreement, verifying the accuracy and reliability of the proposed numerical approach and highlighting its potential for simplified seismic design applications.

Keywords: Cross-laminated timber, structural performance, numerical analysis

[O-VI-1]

How Grasses Produce Cell Walls Distinct from Woody Plants: From Perspectives of Lignin Structure and Biosynthesis

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Monocotyledonous grasses have evolved unique cell wall structures distinctively different from those of typical wood species, i.e., softwoods (gymnosperms) and hardwoods (eudicots). As a prime example, grasses produce lignins highly decorated by hydroxycinnamates and flavonoid tricetin units by incorporating γ -acylated monolignols and tricetin alongside canonical (non-acylated) monolignols for cell wall lignification. To understand the biosynthesis of grass-specific lignin units and their impact on cell wall function and biomass utility, our group has been investigating grass lignin biosynthesis and bioengineering using rice as a model. In this presentation, I will summarize our recent findings on the biosynthesis of these grass-specific lignin monomers and the cell wall properties of transgenic and mutant rice plants with altered lignin decoration units. I will also introduce a potent bioengineering strategy that manipulates grass lignin's aromatic composition by simultaneously targeting both canonical and grass-specific lignin pathways. Our research provides a deeper understanding of cell wall biosynthesis and evolution, which can ultimately inform the biotechnological upgrading of lignocellulosic biomass.

Keywords: bioengineering, cell walls, grasses, lignin, lignocellulose

[O-VI-2]

Single-cell and spatial multiomics identifies heterogeneous xylem development driven by mechanical stress in *Populus*

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Xylem, the predominant tissue for structural support, forms tension wood with G-layer-rich fibers under mechanical stress. Despite being recognized over a century ago, three key biological questions remained unclear: (1) Are fibers in normal and tension wood distinct cells due to morphological differences? (2) Do tension wood fibers arise from different lineages? (3) What are the key genes controlling tension wood formation? We conducted single-cell RNA-seq on normal, tension and opposite xylem. Fibers in normal and tension wood belong to the same cell type and lineage. Differential developmental speed and cell-type ratio in tension and opposite xylem were further validated by spatial transcriptomics and metabolomics. Phosphoproteomics showed mechanical sensing mechanisms conserved between stems and roots across angiosperms. We identified a group of genes involved in the cell fate transition in tension wood. The knowledge on the heterogeneity of cell development offers insights for optimizing biomass production and bioenergy yield.

Keywords: Xylem Development, Mechanical Stress, Tension Wood, Single-Cell Transcriptomics, Spatial Transcriptomics and Metabolomics

[O-VI-3]

Revisiting the Vulnerability and Resilience of Mountain Biota under Rapid Warming

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Mountain ranges harbor concentrations of endemism and serve as climate refugia for lowland biotas. Yet whether montane biota are intrinsically vulnerable or resilient under rapid warming remains contested. In this talk, I synthesize new estimates of vertical climate velocity derived from satellite-based and moist-adiabatic lapse rates with global records of historical and modern elevational limits for more than 2,000 species. High-velocity regions—spanning dry mountains and some wet ranges with shallow lapse rates—impose acute tracking demands, and several taxa closely track isotherms where velocities are low; nonetheless many species lag, implying persistent disequilibria even with emissions mitigation. Conversely, evidence for a generalized “escalator to extinction” is limited once geometric constraints are considered: mountaintop losses appear delayed, while both narrow-range and lowland species often expand upslope, indicating thermal niche underfilling and contributing to biotic homogenization. I evaluate when vulnerability (extinction debt, range-shift gaps) dominates and when resilience (upslope expansion, persistence in microrefugia) emerges, and outline conservation levers—maintaining elevational connectivity, safeguarding cool refugia, and improving monitoring—to manage biodiversity redistribution in mountains.

Keywords: biotic homogenization, climate velocity, elevational range shifts, isotherm tracking

[O-VI-4]

A Long-distance Signaling Peptide across Flowering Plants regulate Plant Growth and Immunity

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Signaling peptides act as hormones to deliver intercellular signals governing complex developmental processes. However, very few peptides have been identified and evolutionarily characterized *in vivo*, particularly long-distance signaling peptides. Recently, we developed a highly sensitive targeted MS method for detecting peptides, which enabled the identification of known locally acting peptides as long-distance mobile peptides. To discover more mobile peptides, we applied peptidomic approach to reveal sap peptidomic datasets of six plant species from all major evolutionary clades of angiosperms, including monocots, magnoliids, rosoid eudicots, and asterid eudicots. A novel sap peptide, identical across all six species, was identified and named Angiosperm sap peptide (ASAP), making it the most conserved peptide discovered so far. Phosphoproteomic analysis revealed that ASAP rapidly induces a series of protein phosphorylation events involved in a signaling cascade previously reported to regulate plant growth and plant immunity. Phenomic and metabolomic analyses were conducted to demonstrate the functions of ASAP. This study provides insights into the conservation and functional significance of long-distance signaling peptides in plants, offering potential applications in crop improvement and disease control strategies.

Keywords: long-distance signaling, vascular sap peptides, peptidome, multi-omics analysis, phosphoproteome

[O-VI-5]

Association of Soil and Litter Microbiome with Fire Adaptive Strategies in Two *Pinus* Subgenera

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Pines are pioneer species that rely on fire to maintain their unique subclimax phase. They are categorized into two subgenera with different fire adaptations: the fire-tolerant *Pinus*, which uses fallen needles as fuel, and the fire-avoiding *Strobus*, which coexists with other plants. We hypothesized that facilitated needle decomposition could reduce fuel loads, and we explored the microbial communities responsible for this process. We studied the microbial communities involved in needle decomposition in three compartments—fresh needles, needle litter, and humus—at three sites of the fire-tolerant *Pinus taiwanensis* and one site of the fire-avoiding *Pinus morrisonicola* in Taiwan. We found that *P. morrisonicola* habitats are more favorable for decomposition. A reciprocal litter decomposition experiment showed that *P. morrisonicola* litter decomposed faster, primarily influenced by the litter species. Fungi were the dominant decomposers on pine litter, and those specialized in *P. morrisonicola* harbored abundant genes for lignocellulolytic enzymes, linking decomposition rates to the composition of fungal communities. Our findings provide valuable insights into the long-term effects of fire and can inform forest management.

Keywords: *Pinus*, litter decomposition, shotgun metagenomics, fire adaptation, microbiome

[O-VII-1]

Space Weather Research and Progresses in Taiwan

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This presentation will discuss the recent progress of the space weather research activity of Taiwan with emphases on the ionosphere forecast/nowcast using FORMOSAT-7/COSMIC-2 (F7/C2) and university built CubeSats. With 30 mins time latency of the ionosphere observations taken from F7/C2 radio occultation observations of the ionosphere electron density profiles, it is possible to perform data assimilation of the ionosphere model for forecast and nowcast. Additional observations of in-situ plasma density are also available from AIP (advanced ionospheric probe) of FORMOSAT-5 and IVM (ion velocity meter) of F7/C2 for better understanding of the ionosphere responses to space weather events. Additionally, ionosphere perturbations driven by the earthquake activities are also well studied by the abundant of the ionosphere observations provided by FORMOSATs. In recent years, university based CubeSats are also built to demonstrate the capability of space weather related payloads and these progresses will also be discussed in the presentation.

Keywords: Space Weather, Ionosphere Disturbances, FORMOSAT, Seismo-Ionosphere Disturbances, CubeSat

[O-VII-2]

Reassessment of the Tsyganenko 1989 Model and Storm-time Applications

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The Tsyganenko 1989 model (TSY89) is a semi-empirical description of the Earth's magnetospheric contribution to the total magnetic field. It was parameterized with spacecraft data sorted by Kp index bins (0–5+). Due to limited observations, TSY89 best represents quiet to moderately disturbed conditions. Its speed, simplicity, and reliance on only the Kp index make it a popular magnetospheric model. To extend TSY89 into storm-time conditions, Boberg et al. (1995) introduced a linear relation between the model's ring current amplitude parameter and the Dst index, allowing application during periods of Kp > 5. This Boberg extension remains a common tool for examining historical storms where data for later Tsyganenko models are unavailable. However, TSY89 was last refitted in 1996, and the Boberg extension still relies on the original TSY89 fit. In this work, we reparameterize both TSY89 and the Boberg extension using the extensive modern data set offered by recent space missions. The updated fits are further tested through geomagnetic cutoff computations for extreme geomagnetic storms and compared with earlier versions.

Keywords: Magnetosphere, Tsyganenko, Modelling, Cutoff Rigidity, Space Climate

[O-VII-3]

Energetic Electron Precipitation Induced by Nonlinear Interactions with Parallel and Oblique Chorus Waves

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Nonlinear wave-particle interaction with whistler-mode chorus waves is one of the processes that drive energetic electron precipitation in the Earth's inner magnetosphere. We investigate the precipitation rates of electrons interacting with both parallel and oblique lower-band chorus emissions around the outer radiation belt by numerical simulations. We analyze both short-term effects (within a single emission) and long-term evolution (~tens of minutes) of electron precipitation. Our results confirm that oblique chorus waves induce more efficient pitch angle scattering and higher precipitation rates than purely parallel waves, particularly for electrons in the tens of keV to a few hundred keV range. This enhanced scattering is attributed to the additional contributions of Landau and higher harmonic cyclotron resonances in oblique wave-particle interactions, which are absent in purely parallel cases. Moreover, we find that very oblique chorus waves can scatter electrons with initial equatorial pitch angles (α) exceeding 45° , whereas other waves primarily affect electrons with $\alpha < 30^\circ$. Additionally, we derive pitch angle scattering rates which provide valuable insights for improving the prediction of space weather phenomena such as pulsating auroras and microbursts.

Keywords: chorus waves, nonlinear wave-particle interaction, energetic electron precipitation

[O-VII-4]

Generation, propagation and consequence of field-aligned currents during auroral substorm

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A substorm is one of the most drastic phenomena in the near-Earth space. When the substorm occurs, aurorae suddenly brighten and electrojets intensify in the polar region. A large amount of energy exceeding 10^{11} W is consumed in the polar ionosphere through Joule heating, which is driven by electric currents flowing along magnetic field lines. Upward field-aligned currents (FACs) are closely related to the bright aurorae. Thus, the abrupt intensification of FACs is a key to understanding substorms. Our global magnetohydrodynamics (MHD) simulation provided the following results. When magnetic reconnection occurs in the near-Earth tail region, plasma is rapidly transported toward and away from the Earth. As the earthward moving plasma approaches the Earth, the fast plasma flow is decelerated, compressing both plasma and magnetic field. This compression causes the plasma flow to split into eastward and westward directions. The azimuthal flows excite FACs, propagating toward the polar region. These processes offer a reasonable explanation for the reasons why FACs are abruptly intensified, and they are confined to a narrow region located well equatorward of the footprints of reconnection site.

Keywords: substorm, aurora, magnetosphere, simulation

[O-VII-5]

Observations of the dynamics of plasma structure of storm-time ionosphere using FORMOSAT-7/COSMIC-2

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This presentation will show the electron density structures of the global ionosphere during magnetic storms of 2022-2024. For the severe storms occurred in 2024, May and October storms, we observe low latitude plasma were transported to mid-latitudes and later became the drainage plumes to high latitude regions. The Global Ionosphere Specifications (GIS) built based on Gauss-Markov Kalman filter assimilation of the ground-based slant TEC and FORMOSAT-7/COSMIC-2 radio occultation TEC provides the three dimensional ionospheric plasma structure in 2.5 by 2.5 and 5 km resolution in longitude, latitude and altitude. GIS outputs for the two storm events could capture the vertical structure of these plasma transport and shows the field-aligned nature of the storm enhanced density (SED) of the low and mid-latitude ionosphere plasma. With the altitude information of the SED drainage plume, it could help better understandings of the dynamics of the low to mid- and high-latitude ionosphere connections during severe storm events. The coupling processes from the low- and mid-latitude region to the high latitude convection regions are also investigated by superposition of the SED structure in the ionosphere to the high latitude convection patterns. Additionally, we will also present the case study of 1 December 2023 storm event that drove the long lasting post midnight equatorial plasma bubble (EPB). Using GIS and ground based GNSS network, we could explore the driver of the long lasting storm driven effects.

Keywords: FORMOSAT-7/COSMIC-2, Ionospheric Storm, Equatorial Plasma Bubble, Global Ionosphere Specification

[O-VII-6]

A 3D view of seismo-ionospheric coupling: integrating ground-based GNSS and space-borne F7/C2 observations of the 2024 Mw 7.4 Hualien earthquake

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The three-dimensional (3D) structure of seismically induced ionospheric waves is poorly understood, particularly in low latitudes. We investigate the 2024 Mw 7.4 Hualien earthquake by synergistically integrating high-rate ground-based GNSS-TEC with space-borne FORMOSAT-7/COSMIC-2 (F7/C2) radio occultation (RO) data. A semi-variance analysis optimized the sub-ionospheric point altitude to 280 km, enhancing mapping resolution. Our study presents the first observation in this region of distinct, concentric acoustic-gravity waves originating northeast of the epicenter. These waves propagated with an initial acoustic-mode velocity of ~800 m/s before transitioning to a slower gravity-wave mode. The F7/C2 RO profiles constrained the vertical wavelength to 30-50 km at 100-250 km altitude. This detailed 3D characterization provides unprecedented observational constraints to validate seismo-ionospheric coupling models. Our findings illuminate the energy propagation pathway through the atmosphere-ionosphere system and demonstrate the power of combining ground and space-based observations for comprehensive monitoring.

Keywords: TEC perturbations, Acoustic-Gravity Waves, GNSS TEC, FORMOSAT-7/COSMIC-2 RO

[O-VIII-1]

Eco-friendly Polyurethane Materials from Natural Resources

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Biomass, a renewable resource rich in hydrocarbons, can be converted into industrial raw materials to replace petroleum-based products. This study focuses on developing bio-based chemicals from sustainable feedstocks through simple and green methods for polymeric materials. Polyurethane (PU), formed by isocyanates and polyols, reached a global market value of USD 78.07 billion in 2023. Natural resources can serve as feedstocks for bio-based PU products, with solvent-free and atmospheric processes enabling PU foams to substitute formaldehyde-based adhesives in lignocellulosic composites. Conventional solvent-based PU releases volatile organic compounds (VOCs), while waterborne PU disperses in water, reducing VOC emissions. Bio-based waterborne PU resins are non-toxic and applicable in wood coatings, with manufacturing routes avoiding harmful by-products. Considering that buildings account for 37% of global carbon emissions, reducing emissions from construction materials is critical. The integration of green chemistry with biomass-based production demonstrates that bio-based PU offers an environmentally friendly pathway for sustainable composite materials and carbon reduction in the building materials.

Keywords: Adhesive, bio-based, coating, foam, polyurethane.

[O-VIII-2]

Application of Biomass-Thermally-Modified Carbonated Hydroxyapatite for the Removal of Multiple Heavy Metal Pollutants

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Long-term field experiments on unburnt hydroxyapatite (HAp) derived from biological bone revealed detailed pathways of natural decomposition, dissolution, and recrystallization, demonstrating its potential as a sustainable material for phosphorus management and providing new insights into the geochemical retention of phosphorus. Building on this foundation, we developed a temperature-gradient thermal modification process to produce bone char (BC), which is mainly Biomass-Thermally-Modified Carbonated Hydroxyapatite (CHAp), identifying the critical temperature window that maximizes carbonation and optimizes its physicochemical properties and dissolution behavior for targeted environmental applications. When applied to the remediation of Cd, Sb, and As pollution, CHAp exhibited superior and durable removal performance. Mechanistic investigations demonstrated that, beyond conventional adsorption and one-dimensional ion exchange, three-dimensional ion exchange and lattice-level substitution within the BC structure dominate the long-term sequestration of heavy metals. This work establishes a robust scientific basis for integrating waste-derived BC modification with advanced strategies for pollutant remediation and carbon–phosphorus resource sustainability.

Keywords: Bone Char; Carbonated Hydroxyapatite; Heavy Metal; Removal; Resource Sustainability

[O-VIII-3]

Oxidation of Lignin Using an Electrolytic Mediator System: From Model Compounds to Biomass-Derived Lignins

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Lignin, a major component of lignocellulosic biomass, is the most abundant aromatic polymer on Earth, and the development of effective degradation technologies is a key factor in the success of biorefineries. However, achieving efficient lignin depolymerization under mild conditions remains a challenge. In nature, white-rot fungi utilize low-molecular-weight metabolites as mediators to enhance enzymatic oxidation, enabling efficient lignin degradation. Inspired by this mechanism, electrochemical mediator system (EMS) have emerged as an environmentally friendly approach to lignin degradation.

We investigated EMS oxidation of lignin model compounds, synthetic polymers, and native lignins isolated from cedar (softwood) and eucalyptus (hardwood). The mediators ABTS, LA/HBT, and Fe(bpy)₃ exhibited distinct selectivities, affecting both linkage cleavage and overall reactivity across plant sources. For example, ABTS showed selectivity toward β–O–4–type linkages, while also enhancing depolymerization and oxidation in guaiacyl-rich cedar lignin, whereas Fe(bpy)₃ exhibited broader reactivity across multiple linkage types and induced stronger oxidative effects in syringyl-rich eucalyptus lignin. Such complementary selectivities indicate that EMS can be tailored to both structural motifs and plant origin, enabling more controlled and efficient lignin transformation.

Keywords: Lignin depolymerization, Electrochemical mediator systems (EMS), Biorefinery, Selective reactivity

[O-VIII-4]

The Impact of Soil Carbon Sink on Net Zero Emissions and Mitigation of Climate Change

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In the context of climate change, nature-based solutions are increasingly recognized as key to achieving net-zero goals. Plants continuously fix atmospheric CO₂ through photosynthesis, transferring carbon into soil, which holds about 2500 Pg of organic carbon, 4.5 times the global biomass pool, making it the largest terrestrial carbon reservoir. Converting CO₂ into biomass and subsequently into soil organic carbon (SOC) is thus a promising negative-carbon strategy. Policies highlight soil's role as a carbon sink, promoting biochar from agricultural residues and practices such as cover cropping, irrigation adjustments, and microbial applications to enhance SOC. Yet, local studies on soil suitability and SOC saturation remain limited. Since SOC is eventually mineralized to CO₂, its stability is critical. Recent research stresses differentiating particulate organic matter (POM) from mineral-associated organic matter (MAOM): POM decomposes readily, while MAOM is stabilized by minerals. Current management often favors POM, which has no limit, over MAOM, which does. This underscores the need for strategies enhancing both POM and MAOM accumulation, considering mineral composition, pH, nitrogen, and saturation in effective soil carbon management.

Keywords: soil carbon sink, soil carbon stabilization, particulate organic matter, mineral-associated organic matter

[O-VIII-5]

Ultra-high-performance biomass plastics derived from divanillin

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Because of concerns regarding resource depletion and environmental problems, the synthesis of bio-based monomers or polymers from renewable resources has recently been extensively studied to enable the development of alternatives to petroleum-based materials. However, for ultra-high-performance plastics with excellent properties such as extraordinary high temperature resistance, high strength, and high durability, which are required for automotive and electrical equipment applications, no bio-based alternative materials are commercially available so far. Aromatic ring units are essential in biopolymer backbones to endow high mechanical strength, and heat or chemical resistance. Vanillin is one of the most promising bio-based aromatic compounds derived from lignin. In our recent study, divanillin (DVA) was synthesized by enzymatic dimerization of vanillin and a wide variety of DVA-based biomass polymers were synthesized with an aim to develop novel bio-based ultra-high-performance plastics, such as polyamides and polyketones (Figure 1). The polyamides and polyketones exhibited a glass transition temperature (T_g) of ca. 200–300 °C, which indicated high heat resistance and thermal stability. The maximum tensile strength of the thermos-pressed films of DVA-polyamides was ca. 60-70 MPa.

Keywords: Lignin, vanillin, divanillin, high-performance biomass plastic

Poster Sessions

P-01

In-situ observations of ionospheric perturbations triggered by the launches of 2022 and 2023 South Korea rockets

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We investigated in-situ ionospheric plasma density perturbations triggered by the South Korea KSLV-2 rocket launches on June 21, 2022, and May 25, 2023, by combining ground-based GNSS total electron content (TEC) observations with in-situ measurements from the FORMOSAT-7/COSMIC-2 Ion Velocity Meter (IVM). GNSS data revealed that localized ionospheric holes developed within minutes of each launch and persisted for approximately four hours near the rocket trajectories. In-situ F7/C2 IVM observations confirmed plasma depletion as well as elevated ion temperatures (by several hundred kelvins) and distinct plasma flows, marking the first direct measurement of ion density perturbations associated with rocket-generated shock-acoustic waves. Interestingly, the temperature and velocity changes began prior to the minimum density point, suggesting that both exhaust-plume chemistry and shock wave dynamics contribute to the overall depletion process. Our results indicate that ionospheric holes arise from chemical recombination facilitated by rocket exhaust, coupled with pressure bulge-driven neutral wind flows that carry plasma away from the disturbed region. These findings are consistent with both empirical evidence and numerical simulations (e.g., Lin et al., 2017a), providing new insights into how moderate-sized launch vehicles can generate significant and long-lasting ionospheric perturbations at altitudes near 550 km.

Keywords: Rocket-Induced Ionospheric Perturbations, First in-situ shock-acoustic observations, F7/C2 IVM In-situ Measurements

P-02

Mapping Surface Water by using TRITON GNSS-R

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GNSS reflectometry (GNSS-R) is widely used to observe sea surface winds, inland water bodies, and soil moisture by receiving GNSS signals reflected from the Earth's surface. The TRITON satellite (FORMOSAT-7R), Taiwan's first independently designed and developed remote sensing satellite, was launched on October 9, 2023. It began providing data one month after launch and has since accumulated nearly two years of observations. By capturing reflected GNSS signals influenced by surface roughness at the specular point, TRITON's primary mission is to demonstrate and validate the application of GNSS-R for ocean surface wind retrieval. To further extend its utility, this presentation introduces preliminary results of global surface water distribution derived from TRITON's Delay-Doppler Maps (DDMs) using machine learning classification. These findings highlight the versatility of TRITON data and demonstrate its potential contribution to global surface water monitoring.

Keywords: Triton mission, GNSS-R, Surface water, Machine Learnin

P-03

Automatic detection of spread F using machine learning and its application

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The ionosphere exists at altitudes ranging from 50–60 km to 1,000 km, where molecules and atoms in the atmosphere are partially ionized by solar radiation and exist as plasma, giving it the property of reflecting radio waves. The maximum reflected frequency foF2 is determined by the peak electron density in the ionospheric F region. Its automatic reading system for the ionosonde at Shigaraki MU observatory has been developed, but it is difficult to apply the system during spread F events when ionospheric echoes are blurred or scattered. In this study, we trained a machine learning model, Mask R-CNN, using ionograms during spread F events to detect spread F. We achieved a detection accuracy of over 90% for Shigaraki ionosonde data. Based on this, we compared and analyzed the results with methods already in use and applied the same method to the ionosonde in Chiang Mai, Thailand. We achieved a certain level of detection accuracy for the Chiang Mai ionograms. Additionally, we conducted long-term data verification to evaluate the applicability under different seasons and solar activity conditions.

Keywords: Ionosphere, ionogram, machine learning

P-04

Detection of Ionospheric Irregularities Using a Single-Frequency GPS Differencing Algorithm

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Ionospheric irregularities cause rapid fluctuations in electron density, resulting in signal scintillation, phase cycle slips, and degraded positioning accuracy in Global Navigation Satellite Systems (GNSS), particularly affecting the weaker L2 frequency. This study implements a single-frequency GPS differencing algorithm based on the L1 carrier phase to estimate ionospheric delay variations. The estimated delay is used to identify ionospheric irregularities signatures and correct ionospheric errors in GNSS positioning solutions. Compared to conventional dual-frequency approaches, this technique ensures better continuity and robustness under disturbed ionospheric conditions, making it highly suitable for regional ionospheric monitoring. Furthermore, the single-frequency first-difference ionospheric delay is incorporated into the DGPS positioning method, demonstrating partial improvement in positioning accuracy compared to uncorrected solutions.

Keywords: Plasma bubble, GNSS, Ionospheric delay, Single-frequency algorithm

P-05

Ionospheric Skywave Propagation Experiment over Taiwan Area

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An ionospheric over-the-horizon propagation experiment was carried out in Taiwan to investigate ionospheric skywave propagation at frequencies 4-12 MHz. The reflection heights and incident angles of the reflected skywaves are estimated in accordance with transmission curve equation. The peak-to-peak amplitude variations in the incident angles during daytime are in a range of 4°--5°, and those for virtual heights are 40-70 km. These parameters are validated by comparing true horizontal distance with those deduced from transmission curve equation, and the results show that mean relative errors are smaller than 0.8% and relative uncertainties are in a range of 1.17%-3.6%. One intriguing transient phenomenon occurred at around sunrise that virtual height and incident angle both change dramatically with respective peak descending rate of about 83 km/hr and maximum increasing rate of about 9° per hour are especially noted and discussed in this article.

Keywords: skywave, incident angle, reflection height, transmission curve.

P-06

The Thermosphere Density Variation During Geomagnetic Storm in Low-Earth Orbit

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To investigate the impact of geomagnetic storms on the global thermosphere-ionosphere system, we employ the NCAR Thermosphere-Ionosphere-Electrodynamics General Circulation Model (TIEGCM), a first-principles model that simulates the coupled neutral and plasma environment. To ensure physical realism, we incorporate time-dependent geophysical drivers, including the interplanetary magnetic field (IMF) and the F10.7 solar flux index.

To respond dynamically to observed storm-time conditions, the theory-guided TIEGCM is assimilated with ground-based Global Navigation Satellite System total electron content (GPSTEC) observations and radio occultation (RO) ionospheric profiles from the FORMOSAT-7/COSMIC-2 mission, using the Ensemble Kalman Filter (EnKF) within the Data Assimilation Research Testbed (DART).

Neutral density estimations are validated against space-based observations from satellites such as Swarm and GRACE. Our goal is to develop an efficient method for estimating storm-induced neutral density enhancements.

Keywords: TIEGCM, neutral density

P-07

The influence of large-scale natural phenomena on the ionosphere

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In recent years, the Pacific Ring of Fire has experienced frequent seismic and volcanic activity. On July 30, 2025, a powerful earthquake with a magnitude of 8.8 struck the Russian Far East, generating a tsunami with wave heights reaching up to five meters and affecting regions across the Pacific, including Japan and the United States. These two regions are characterized by dense networks of ground-based GNSS stations, which provide valuable opportunities to investigate the ionospheric disturbances induced by the earthquake-generated shock waves, as well as the subsequent signatures of tsunami-driven Lamb waves in the ionosphere. Comparative analyses can then be conducted against similar ionospheric responses observed during the 2022 Tonga volcanic eruption and its associated tsunami.

Keywords: ionosphere, gnsstec, earthquake, tsunami

P-08

Long-term Statistical Analysis of Shigaraki Ionosonde Observations Using Machine Learning Models

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The ionosphere, spanning 50–60 km to 1000 km altitude, forms when solar ultraviolet radiation ionizes atmospheric particles, producing plasma. It reflects radio waves, with reflection frequency and height determined by electron density distribution, making long-term monitoring crucial for communication technologies. One of the observation methods is the incoherent scatter (IS) radar, and the MU radar installed in Shigaraki, Japan, also has this function. However, absolute electron density cannot be directly measured from MU radar data, requiring calibration with ionosonde-derived parameters. The Shigaraki MU Observatory also operates an ionosonde, but manual reading of ionospheric parameters is impractical given the vast historical dataset.

To overcome this, the study developed an automatic ionosonde reading system using a machine learning model to extract the F2-layer critical frequency (f_oF_2). The extracted values were validated against Kokubunji ionosonde data, demonstrating accuracy. Furthermore, comparisons with the International Reference Ionosphere (IRI) model provided insights into the long-term statistical behavior of the ionosphere over Shigaraki, confirming the system's effectiveness for large-scale data analysis.

Keywords: Ionosphere, Ionosonde, MU Radar, IRI, Machine Learning

P-09

GNSS-reflectometry measuring the width of rivers

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GNSS-reflectometry (GNSS-R) is a remote sensing technique that analyzes radio signals transmitted by Global Navigation Satellite Systems (GNSS) and reflected from the Earth surface. The reflected ray paths sweep over the ground and the sea surface between satellites and receivers for collecting information from inland, ocean, sea ice, and even surface wind speeds and soil moisture. In this study, the Cyclone Global Navigation Satellite System (CYGNSS) raw Intermediate Frequency (IF) calibrated data products are used to estimate the width of rivers, which is a valuable hydrology metric for river discharge monitoring and water resources management, especially in Taiwan. Taiwan's rivers are experiencing both depletion and flooding, which influenced by heavy rainfall, uneven rainfall distribution and dry seasons, etc.

Keywords: GNSS-R, river widths, CYGNSS, raw IF

P-10

The Impact of SpaceX Starship Launches on the Ionosphere

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This study assesses the regional ionospheric disturbances caused by seven SpaceX Starship launch missions. We use single-station, single-channel GPS receiver data to perform a time-series analysis of the ionospheric Total Electron Content (TEC) before and after each launch. We will first apply filtering techniques to isolate the short-term disturbance signals induced by the rocket's exhaust plume from background variations. A key focus is to analyze the disturbance patterns for each launch, including the onset time, peak amplitude, and the periodicity of the disturbance and its recovery. Our goal is to establish a clear correlation between the launch events and the observed ionospheric disturbance modes. This work aims to provide a deeper understanding of the dynamic behavior of these artificial disturbances and their impact on Earth's environment.

Keywords: ionosphere, TEC

P-11

EIA Crest Variation During Solar Maximum

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This study focuses on the characteristics of electron density distribution in the Equatorial Ionospheric Anomaly (EIA) region during the solar maximum period. Using three-dimensional electron density data provided by FORMOSAT-7/COSMIC-2 missions, and assimilated global ionospheric specification (GIS) models, we analyze the vertical drift properties of the $E \times B$ plasma transport. The analysis involves vertical cross-sections, peak latitude variations, and temporal evolution to compare electron density trends and to examine whether they correspond to the typical $E \times B$ drift mechanisms (such as the PRE phenomenon). Results indicate that, at certain times, X-type electron density structures may arise from short-term east–west electric field variations, which cannot be fully explained by the PRE mechanism alone. In summary, this study demonstrates the advantages and potential of three-dimensional electron density data in capturing variations driven by electric fields and their associated dynamics.

Keywords: Electron density, Equatorial Ionospheric Anomaly (EIA), Global Ionospheric Specification (GIS), $E \times B$ vertical drift, FORMOSAT-7/COSMIC-2

P-12

Electron Dynamics Driven by Chorus Emissions with MLT-Dependent wave properties

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The Earth's outer radiation belt hosts energetic electrons whose dynamics are strongly influenced by interactions with whistler-mode chorus waves. Chorus emissions, observed predominantly in the dawn sector, show magnetic local time (MLT)-dependent variations that significantly affect electron acceleration and loss. Traditional Green's function and convolution integral methods are effective for tracing long-term evolution of wave–particle interactions, but existing models do not consider MLT dependence. In this study, we develop a multiple-wave model that incorporates MLT-dependent wave variations and validate it against an existing Green's function database. We further construct chorus wave models from observational data and apply the Green's function method, based on test particle simulations, to examine electron interactions with different wave populations. We track the temporal evolution of kinetic energy and equatorial pitch angle distributions, finding that our new model more accurately represents electron acceleration and precipitation than previous approaches. Results show that relativistic turning and ultra-relativistic acceleration strongly shape electron populations, with implications for space weather effects, satellite protection, and improved radiation belt modeling.

Keywords: radiation belt, chorus emissions,

P-13

Impact of Equatorial Plasma Bubbles on Radio Occultation Observations of Large-Scale Ionospheric Plasma Density

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The FORMOSAT-7/COSMIC-2 (F7C2) constellation, consisting of six small satellites, provides high temporal and spatial resolution ionospheric observations at mid- and low-latitudes using radio occultation (RO) technology. While the dense coverage of RO-derived electron density profiles (EDPs) benefits applications such as data assimilation and ionospheric monitoring, ensuring data quality remains critical. Fluctuations in EDPs caused by small-scale structures, such as equatorial plasma bubbles (EPBs), can affect parts of the RO line-of-sight, leading to uncertainties like underestimations or variations in the retrieved electron density (Ne) and consequently impacting applications such as data assimilation. In this study, we statistically examine how EPBs induce fluctuations in GNSS signals and degrade the quality of large-scale ionospheric structure observations obtained via RO. These findings underscore the influence of EPBs on space weather monitoring.

Keywords: FORMOSAT-7/COSMIC-2, Radio Occultation, Equatorial Plasma Bubbles, Machine Learning

P-14

A Real-Time Plasma Bubble Detection Method Combining Neural Networks and All-Sky Imaging

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We develop a convolutional neural network (CNN) trained on deviation images generated from 630.0 nm airglow data collected by a ground-based all-sky imager (ASI). The network is designed to distinguish plasma bubble structures from background emissions, enabling pixel-level identification without manual labeling or post-processing. A dataset of labeled EPB events was constructed for training and validation, incorporating various nighttime conditions and geophysical environments to ensure generalizability. Unlike previous studies that relied on handcrafted features, thresholding, or offline pipelines, our method enables high-speed inference directly on processed ASI data streams. Evaluation at a low-latitude ASI observatory shows that the model achieves high precision and recall in detecting EPBs, with average inference time suitable for real-time applications. The system provides not only binary detection but also spatial localization of EPB regions, offering a valuable tool for integration into future space weather nowcasting and alert systems.

This work represents an important advancement toward operational, automated EPB monitoring using optical remote sensing and deep learning techniques. It also lays the foundation for expanding into multi-instrument integration for improved situational awareness of ionospheric conditions affecting communication reliability.

Keywords: plasma bubble, equatorial ionosphere, all-sky imager, convolutional neural network, space weather

P-15

Physics-guided Models of Forecasting the *AE* Geomagnetic Indices with the LightGBM Machine Learning Framework

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Predicting the Auroral Electrojet (*AE*) indices is essential for space weather monitoring and substorm forecasting. This study introduces a physics-guided Light Gradient Boosting Machine (LightGBM) model that predicts the *AE* indices by incorporating physical solar wind-magnetosphere coupling functions, including solar wind energy input, magnetopause shape parameters, magnetic reconnection rate (R_{cs}), and polar cap index (*PC*). These functions represent the key physical processes hidden in the solar wind energy transport and coupling with the magnetosphere, making them far more effective predictors than the basic solar wind parameters. Additionally, the time parameters (day of year and hour) account for seasonal and daily variations. Using 24 years of data (1996-2019), we trained two models: Model_L, which utilizes lagged features to capture temporal dependencies, and Model_N, which directly uses coupling functions with optimized lead times derived from Model_L's importance analysis. Our results demonstrate excellent performance with correlation coefficients of 0.93 for hourly predictions and 0.89 for minutely predictions. Feature importance analysis reveals that the *PC* and R_{cs} are the most critical predictors. Noteworthy, R_{cs} can be used to replace *PC* for real-time applications.

Keywords: *AE* indices, solar wind-magnetosphere-ionosphere coupling, Machine Learning, Magnetopause, Magnetic Reconnection

P-16

Spatio-temporal evolution of phase space density of energetic electrons in the transition region between the radiation belt and plasma sheet during substorm

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The radiation belts are harmful to human activities in space. To understand their variations, it is essential to investigate the spatio-temporal evolution of phase space density (PSD) of electrons. In particular, the PSD of electrons in the radiation belt-plasma sheet transition region is of great importance, as these electrons serve as the source population for the heart of the radiation belt. However, tracing the trajectories of these electrons poses a major challenge due to the large computational cost. To overcome this, we pre-assigned global magnetohydrodynamics (MHD) simulation data onto a regularly spaced Cartesian grids. We then focused on a substorm, and reconstructed the PSD by tracing the trajectories backward in time in the magnetic and electric fields obtained by the MHD simulation. The PSD of the electrons with energy lower than 60 keV gradually increase. In addition, the PSD of the electrons with energy about 100 keV appears to increase in a longitudinally limited region near midnight. Multistep acceleration mechanisms could have occurred in the plasma sheet. We will discuss in detail the overall evolution of electron's PSD.

Keywords: magnetosphere, energetic particles, simulation

P-17

In-House All-Sky Imager Observations of Airglow and Ionospheric Disturbances over Taiwan

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Using an in-house all-sky imager (ASI) deployed at Lulin and the Tainan Astronomical Education Area (TAEA), together with ground-based Global Positioning System (GPS) receivers, we investigate F-region airglow morphology, accompanying plasma bubbles, and ionospheric disturbances over Taiwan. The ASI records simultaneous broadband and 630-nm band-pass images. Star-field matching is used to photogrammetrically calibrate images and project them into geographic coordinates. Co-located GPS receivers provide total electron content (TEC) and the rate of TEC index (ROTI). Overlays of ROTI on ASI maps show that bright/dark airglow bands correspond to increases/decreases in ROTI, respectively. Broadband images capture traveling ionospheric disturbances (TIDs), whereas the 630-nm channel does not; conversely, the 630-nm channel renders two-dimensional airglow depletion/enhancement with higher contrast. Accordingly, we prioritize 630-nm imaging for springtime airglow studies and broadband imaging during the summer TID season, supplementing ASI with GPS when clouds or limited fields of view preclude optical observations. The experiment is expected to quantify the seasonal and diurnal occurrence, scale, propagation speed, altitude, and location of plasma bubbles and assess their interactions with TIDs.

Keywords: all-sky imager, airglow, plasma bubbles, GPS TEC, traveling ionospheric disturbances (TIDs)

P-18

Artificial Intelligence for Space Science and Engineering

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Artificial intelligence (AI) is reshaping space science and engineering by offering new solutions to long-standing challenges in space science and engineering. This study presents two complementary applications to tackle: ionospheric total electron content (TEC) for space weather forecasting and real-time GPS orbit correction for satellite navigation. The ionosphere's TEC, a key parameter influencing radio propagation, varies due to complex geophysical forcing that is often difficult to foresee with physics-based models alone. To address this, we employ Transformer architectures for sequence-to-sequence TEC prediction. Our 12-layer, 128-hidden-unit model achieves global 48-hour forecasts with an overall root-mean-square error (RMSE) of ~1.8 TECU, demonstrating that deep learning can effectively complement traditional models in space weather applications. In parallel, we develop a lightweight Long Short-Term Memory (LSTM) network to enhance GPS orbit accuracy. Broadcast ephemeris, the standard for real-time positioning, typically deviates by ~2 m from precise orbits. Our model, only ~830 kB and operating at ~0.01 sec per satellite, predicts correction terms that reduce orbit errors to ~1 m for 95% of the time. Together, these results highlight AI's transformative potential to improve real-time navigation reliability and space environment monitoring.

Keywords: Deep Learning, Ionospheric Total Electron Content, GNSS Orbit Correction

P-19

Ionospheric Detection of Atmospheric Gravity Waves Triggered by Intense Precipitation

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Deep convection has been shown to induce atmospheric gravity waves (AGWs), which can be observed in the ionosphere. This study examines a case from July 28 to August 2, 2025. During that period, the maximum cumulative rainfall recorded was approximately 2,800 mm. The rainfall was mainly concentrated in the southwestern part of Taiwan and caused severe flooding. Moisture for this extreme rainfall was supplied by an atmospheric river and was advected toward Taiwan by the typhoon's circulation. As the atmospheric river traversed the region, its interaction with Taiwan's complex topography intensified precipitation along its path, leading to exceptionally heavy rainfall over southwestern Taiwan that far exceeded typical amounts. Persistent convection over the same region generated AGWs that radiated outward from the heavy-rainfall core. GNSS total electron content (TEC) measurements are used to observe the effects of AGWs in the ionosphere. These observations enable an examination of how deep convection manifests in the ionosphere under different background atmospheric conditions.

Keywords: Atmospheric Gravity Waves, atmospheric river, GNSS TEC

P-20

Lateral Load Test of CLT Shear Wall Infilled Hybrid Steel Frames

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As timber is a sustainable material, its use in building construction has been promoted. However, increasing the proportion of timber construction in middle-to-high-rise buildings, where timber utilization remains limited, is still a challenge. Cross Laminated Timber (CLT) is a panel material that consists of multiple layers cross-laminated, and it is considered a suitable material for middle-to-high-rise buildings, taking advantage of its stable in-plane shear performance. Nevertheless, in timber frames infilled with CLT walls, when lateral loads are applied to the frame, the timber beams may fail before the CLT walls can fully engage their shear capacity. Consequently, many researchers are studying the possibility of hybridizing CLT with steel-framed structures, which are stronger than timber, to increase the performance of buildings utilizing CLT. This research aims to investigate hybrid structures with CLT walls infilled in steel frames through static lateral load tests, as well as to develop more efficient joints. The test results showed that the CLT mainly failed in shear, indicating that its shear resistance was sufficiently utilized in this frame.

Keywords: Cross Laminated Timber (CLT), Steel, Hybrid Structure, In-Plane Shear Performance

P-21

Soil Microbiome and Physiological Responses of Flint Corn to Swine Wastewater Irrigation

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Swine wastewater is a nitrogen-rich resource that can replace chemical fertilizers and promote sustainable agriculture. Nitrogen supports both plant growth and microbial metabolism, but improper use of wastewater may cause soil salinization and plant stress. In this study, swine wastewater was applied as a substitute for traditional topdressing in flint corn. Treatments included three concentrations diluted with underground water: low (25%, SWL), normal (50%, SWC), and high (100%, SWH), compared with a control (CT) without wastewater. These treatments were compared to assess differences in flint corn phenotype, soil properties, and rhizosphere microbial community composition. Results showed that increasing wastewater application enhanced corn fresh weight, dry weight, and plant height. However, elevated malondialdehyde (MDA) and carotenoid levels in corn leaves under high application indicated nutrient overloading and “over-fertilization stress.” Analysis of the soil microbial community revealed *Pseudomonadota* as the dominant phylum, while NMDS results demonstrated significant shifts in microbial composition after wastewater application. Overall, moderate application promoted corn growth, while excessive use posed stress risks and altered soil microbial communities.

Keywords: *Swine wastewater, flint corn phenotype, microbial community*

P-22

The Role of Dirigent Protein in Stereochemical Control of Neolignan Biosynthesis in Arabidopsis

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As major classes of specialized plant metabolites involved in chemical defense, lignans and neolignans are biosynthesized by the regio- and enantioselective radical coupling of phenylpropanoid monomers, a process thought to be mediated by dirigent protein (DIR). While DIRs involved in lignan biosynthesis have been extensively studied, reports on those involved in neolignan biosynthesis are scarce. Recently, a gene encoding a DIR protein (AtDIR12) was identified as being involved in the biosynthesis of *erythro*-SC(4-O-8)G, a sinapoylcholine (SC)-conjugated neolignan that accumulates in Arabidopsis seeds. Nevertheless, the specific biochemical function of AtDIR12, particularly its role in the stereochemical control of *erythro*-SC(4-O-8)G, remained elusive. To address this, we firstly investigated the enantiomeric composition and absolute configurations of *erythro*-SC(4-O-8)G isolated from Arabidopsis seeds. We are also conducting heterologous expression and biochemical characterization of recombinant AtDIR12.

Keywords: *Arabidopsis thaliana*, dirigent protein, neolignan, phenylpropanoid, stereochemical control

P-23

Seismic Behavior of Four-Story Wood Frame Construction Method Frame with a Cross-Laminated-Timber Shear Wall in the First Story

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To mitigate global warming, reducing CO₂ emissions in the construction sector is essential. Timber use in buildings contributes through carbon sequestration, reduced energy in construction, and promotion of forest management. Therefore, expanding timber use in mid- to high-rise buildings, where timber utilization remains limited, is still a challenge. Mid-rise buildings of around four to six stories are relatively suitable for timber construction, and they are often realized by using reinforced concrete (RC) only for the first story, which requires the highest seismic performance, while using the wood frame construction method for the upper stories. As an alternative, the use of Cross-Laminated-Timber (CLT), which provides superior strength compared with plywood and other conventional timber materials, may provide sufficient seismic performance while reducing CO₂ emissions, construction periods, and labor. The authors propose a composite system with CLT at the first story and the wood frame construction method for upper stories. Static loading test on a four-story frame confirmed that the CLT story had sufficient strength. Numerical analyses further showed that the lateral resistance behavior of the CLT could be appropriately reproduced.

Keywords: CLT, Static test, Pushover Analysis, Wood frame construction method, Mid-rise wooden building

P-24

Temporal Effects of Pomelo Branch Biochar on Soil and Fruit Quality under Sod Culture

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To support Taiwan's 2050 Net-zero target, this study evaluated biochar made from pomelo branches. With biochar's long half-life, it can sequester carbon in soil, thus contributing to carbon storage. Its high surface area, abundant functional groups, and porous structure improve soil aeration and provide habitats for microorganisms. These characteristics enhance soil quality and microbial diversity, which in turn increase plant resistance, promote growth, and improve crop yields. Furthermore, biochar's physical, chemical, and microbiological properties help reduce greenhouse gas emissions from the soil.

Pomelo is a major cash crop in Tainan. Producing biochar from pomelo branches and applying it to pomelo orchards is a sustainable strategy that not only recycles agricultural waste but also supports Taiwan's net-zero targets.

In this study, we investigated the effects of biochar application on orchard soil. We compared the physical, chemical, and microbiological properties of soils in orchards under sod culture and clean tillage management at different time points. We also confirmed that the application of biochar did not negatively affect fruit quality or yield.

Keywords: biochar, 2050 Net-zero target, sod culture, pomelo

P-25

Investigation on Improving the Sensitivity of a Water-Sensitive Sensor Using Radio Wave Attenuation Phenomena in the UHF Band

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Water-sensitive papers are often used in orchards to estimate the amount of pesticide deposition on fruit trees. However, they require visual observation, which prevents real-time monitoring and demands considerable labor. As a potential solution, water-sensitive sensors utilizing Radio Frequency Identification (RFID) systems have been proposed, taking advantage of the property that water strongly attenuates radio waves in the UHF band.

In this study, we aimed to enhance the sensitivity of water-sensitive sensors by modifying their dielectric properties through the addition of NaCl to the paper surface. Papers were immersed in distilled water and NaCl solutions at different concentrations, followed by drying. These samples were then subjected to radio wave attenuation tests.

The results demonstrated that papers impregnated with NaCl significantly reduced the received signal strength. Compared with previous tests using untreated paper, the NaCl-impregnated papers exhibited markedly higher sensitivity, demonstrating a clear improvement in sensor performance. These findings indicate that NaCl-impregnated papers, when integrated into an RFID system, are expected to function similarly to conventional water-sensitive papers, while enabling non-contact, real-time data acquisition without the need for visual inspection.

Keywords: RFID, cellulose, paper, dielectric property

P-26

Simplifying Grass Lignin Through Multiplex Bioengineering Targeting Grass-specific Lignin Decoration Units

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Grass biomass represents a sustainable resource for lignocellulose-derived biochemicals. However, the complex structure of grass lignin, which stems from its incorporation of a wide array of lignin monomers, poses a challenge for converting grass lignocellulose into valuable chemicals. In this study, we developed new rice mutant and transgenic lines with simplified lignin through multiplex bioengineering targeting grass-specific lignin biosynthetic pathways. Following our earlier identification of the rice genes responsible for the biosynthesis of grass-specific lignin units, namely, *p*-coumarate and tricetin units, we used multiplex genome editing to create a quadruple mutant that completely lacks both units. Using this mutant as a background, we then generated additional rice lines that produce lignins dominated by guaiacyl (G) or syringyl (S) units by knocking out or overexpressing the CONIFERALDEHYDE 5-HYDROXYLASE (Cald5H) gene. We are currently conducting in-depth lignin structural analyses and assessing the biomass utilization properties of these lignin-simplified rice lines.

Keywords: grass, lignin, rice, genome editing

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Chronosequence of Soil Microbial Communities and Their Interaction with Forest Recovery in Pine Forests with Different Fire Adaptation Traits Following Wildfire

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Pines interact with wildfire through two distinct adaptive strategies: fire tolerance, as observed in *Pinus taiwanensis* (subgenus *Pinus*), and fire avoidance, as seen in *Pinus morrisonicola* (subgenus *Strobus*). As wildfire frequency increases under climate change, understanding soil microbial resilience associated with these strategies becomes increasingly important. We assessed soil properties and microbial communities across a postfire chronosequence to investigate recovery dynamics. Wildfire induced immediate shifts in soil conditions, including elevated pH, reduced in carbon and nitrogen, and electrical conductivity, followed by gradual recovery in three years. Microbial communities exhibited distinct taxonomic and functional succession, particularly in carbon metabolism. Microorganisms enriched one-year postfire revealed traits for degrading thermally altered polycyclic aromatic hydrocarbons, indicating microbial adaptation to fire-altered substrates. In *Strobus* sites, carbohydrate and amino acid metabolism pathways were significantly enriched, indicating rapid responses to organic matter release. This resource-driven recovery contrasts with *Pinus* sites, where declines in energy and lipid metabolism pathways indicate greater physiological stress on microbial communities. These findings highlight contrasting postfire trajectories shaped by fire-adaptive strategies, with *Pinus* exhibiting more pronounced shifts in soil microbiomes and functional capacity.

Keywords: Wildfire, *Pinus*, Shotgun Metagenomics, Soil bacteria

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Lignocellulose Supramolecular Assembly and Deconstruction Properties of Rice Transgenic and Mutant Lines with Altered Lignin and Ferulate Structure

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The chemical structure of lignocellulose in cell walls varies among plant species, tissues, and cell types, which in turn impacts its supramolecular arrangement in cell walls. However, the relationship between the chemical structure of lignocellulose and its supramolecular assembly, as well as its utility as biomass, remains unclear. To close this gap, we conducted comparative analyses of lignocellulose supramolecular structure in a series of rice transgenic and mutant lines with altered lignin aromatic structure (H/G/S unit ratio) and cell wall cross-linking ferulate (FA) units. Using solid-state NMR and X-ray approaches, we demonstrated that reductions in FA levels led to disorganized lignocellulose assembly, evidenced by decreased cellulose crystallinity, increased cellulose molecular mobility, and occasionally disordered cellulose fiber packing within the cell walls. Conversely, alterations in lignin aromatic composition had minimal impacts on the examined lignocellulose assembly parameters. Furthermore, the disorganized lignocellulose molecular assembly in the FA-reduced rice mutants correlated with enhanced cell wall saccharification efficiency. These findings highlight the importance of cell wall cross-linking FA over the aromatic composition of lignin in shaping grass cell wall architecture and enhancing biomass utility.

Keywords: Lignocellulose, Supramolecular assembly, Grass, Lignin, Ferulate

Phenolic chemical production from lignin by pyrolysis-assisted catalytic hydrogenolysis

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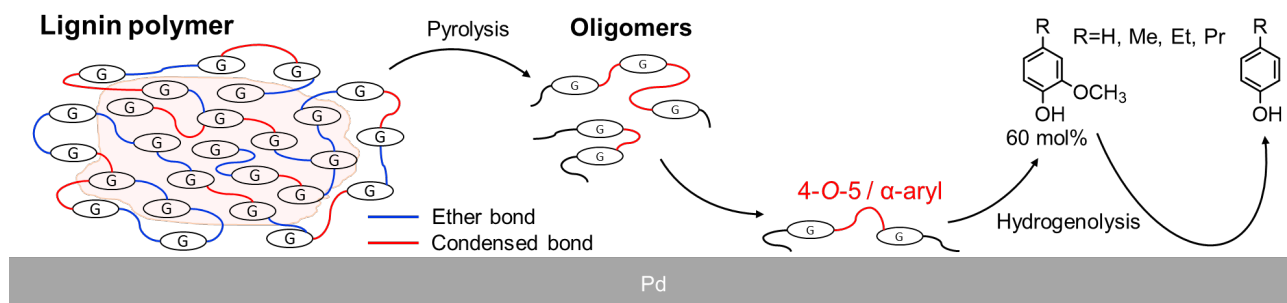
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Transitioning from petroleum-based to biomass-derived chemicals is essential for a low-carbon future. Lignin, the most abundant natural aromatic polymer in woody biomass, offers great potential for producing phenolic compounds through depolymerization. However, recalcitrant C–C bonds limit monomer yields, and the structural diversity of guaiacyl (G), syringyl (S), and p-hydroxyphenyl (H) units complicates selective monomer production due to differences in methoxyl substitution.

Here, we report a pyrolysis-assisted catalytic hydrogenolysis strategy for softwood lignin (G-type >95%). Rapid pyrolysis generates fragments that undergo efficient catalytic reaction, enabling cleavage of 4-O-5 ether bonds and condensed C–C linkages, while simultaneously reducing C4 side chains. This combined approach achieves up to 60 mol% monomer yield—about threefold higher than conventional methods—mainly as alkyl-guaiacols and alkyl-phenols. Furthermore, solvent tuning promotes demethoxylation, affording phenol-type monomers with relatively low boiling points. These can be readily separated by distillation and serve as promising precursors for phenolic resin synthesis.

Overall, this work demonstrates an efficient route for valorizing lignin into uniform, well-defined building blocks, offering strong potential for developing bio-based plastics and advancing sustainable chemical production.



Keywords: lignin depolymerization, pyrolysis, hydrogenolysis, demethoxylation, phenol production.

P-30

Profiling the changes of nitrogen-relative soil microbiomes under the excessive fertilizer input

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Soil microbial communities, which play roles in nutrient cycling, are significantly influenced by excessive fertilizer application. However, a comprehensive understanding of the perturbation impacts the functional dynamics of soil microbiomes remains limited. This study investigates the effects of varying nitrogen (N) fertilizer inputs on soil microbiomes in three flint corn fields. Three treatment levels were established: (i) rational fertilization (control, CT): 206 kgN/ha; (ii) low fertilization (LF): 124 kgN/ha; (iii) high fertilization (HF): 248 kgN/ha, and collected the soil samples at four-time points: before planting (D0), 28 (D28), 75 (D75), and 150 (D150) days after planting. Shotgun metagenomic sequencing is employed to characterize the soil microbiomes and identify functional genes, primarily those involved in nitrogen cycling, including genes related to nitrogen fixation, nitrification, and denitrification. Our findings indicate that bacteria participating in various stages of the soil nitrogen cycle exhibit distinct trends in response to differing fertilization regimes. Moreover, excessive fertilization disturbs the stability of soil microbial communities.

Keywords: Excessive fertilization, soil nitrogen cycle, soil microbial community, shotgun metagenomic sequencing

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Enhancing the Utilization of “Kihada” (*Phellodendron amurense*): Distribution of Medicinal Alkaloids

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Kihada (*Phellodendron amurense*), also known as Ōubaku (黄柏), is one of Japan's oldest and widely used traditional herbal medicines. Its yellow inner bark has been valued both for medicinal purposes and as a natural dye, maintaining an important role in Kampo medicine. With rising demand for berberine supplements and a growing market, resource sustainability is increasingly important. However, the inner bark—currently the main source of berberine—accounts for only about 2% of the total tree mass. In this study, we investigated the distribution of berberine and palmatine in various parts of the tree. Fluorescence microscopy visualized the localization of these alkaloids, and their abundance was quantified using Fourier Transform Mass Spectrometry (FTMS). While berberine was most abundant in the inner bark, the sapwood contained approximately one-third the concentration found in the inner bark. Given that sapwood comprises more than ten times the volume of the inner bark, its overall contribution is substantial. These findings suggest that extracting berberine from both inner bark and sapwood could significantly enhance the economic value of Kihada. This approach supports the integrated use of forest biomass, promoting more efficient, sustainable utilization of resources and greater harmony between natural ecosystems and human activities.

Keywords: Berberine, Medicinal Alkaloid, FT-ICR-MS, biomass valorization

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Relaxed selection constraints in pulvinus-expressed genes facilitate the evolution of rapid movement in *Mimosa*

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Mimosa, a genus in the Fabaceae, is renowned for its ability to perform seismonastic movements of varying sensitivity across species. These rapid movements are driven by the pulvinus, where asymmetrical volume changes in motor cells are thought to be regulated by various ion channels. This movement is effective for defense against herbivores, though the evolutionary footprints underlying this adaptation remain to be further elucidated. In this study, we conducted comparative analyses on the pulvini of nine *Mimosa* species, each demonstrating different sensitivities in their leaf movements. Core pulvinus-expressed genes were identified and classified based on their evolutionary origins, with those emerging after *Mimosa* divergence showing high K_s values, likely reflecting relaxation of purifying selection. *M. pudica*, known for its extraordinary sensitivity, showed the highest rate of positive selection in recently duplicated genes, suggesting that positive selection was potentially enhancing seismonastic sensitivity, particularly via ion channel proteins involved in the regulation of rapid movement. Our findings suggested the rapid movement displayed by *M. pudica*, representing a functional innovation, likely relies on the recently duplicated genes of its lineage.

Keywords: *Mimosa*, pulvinus, rapid movement, comparative genomics, selection

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Full-Scale Shaking Table Tests for Evaluating Building Pounding Caused by Structural Collapse during Earthquakes in Densely Built Urban Areas.

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In Japan, many districts remain densely occupied by old wooden houses, and Kyoto is no exception. Such districts are characterized by narrow separations between houses and restricted street widths. In particular, Kyoto has been spared large-scale disasters, which has preserved its historic urban fabric. At the same time, many districts densely built with old wooden houses from earlier periods still remain. Consequently, earthquake-induced collapses may block narrow streets, obstructing evacuation and rescue activities. Although seismic retrofitting of existing wooden houses has been promoted as a solution, its implementation remains insufficient. Therefore, improving the seismic performance of adjacent houses and introducing protective measures against street blockage are being considered. This study conducted a full-scale shaking table test to evaluate the seismic performance of such measures. The test objective was to quantify shear forces acting on these measures when a two-story wooden frame collapses. The test results confirmed pounding between the wooden frame and the measures, imposing shear forces up to about 3.5 times the total weight of the wooden frame.

Keywords: Pounding, Narrow Streets, Street Blockage, Full-scale Shaking Table Test, Wooden Houses

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Colony-level metabolism: king- and queen-specific degradation of uric acid contributes to reproduction in termites

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Caste-based reproductive division of labor in social insects is built on asymmetries in resource distribution within colonies. Kings and queens dominantly consume limited resources for reproduction, while non-reproductive castes such as workers and soldiers help reproductive castes. Studying the regulation of such asymmetries in resource distribution is crucial for understanding the maintenance of social systems in insects, although the molecular background is poorly understood. We focused on nitrogen compounds, the key to reproduction requiring protein synthesis. Here, we show that king- and queen-specific degradation of uric acid (a major product of nitrogen metabolism) contributes to reproduction in the subterranean termite *Reticulitermes speratus*. The urate oxidase gene, which catalyzes the uric acid degradation, was highly expressed in mature kings and queens. Suppression of uric acid degradation decreased the number of eggs laid per queen. Uric acid was shown to be provided by workers to reproductive castes. Our results indicate that king- and queen-limited capability to use certain compounds enables colony resources to concentrate in reproductive castes.

Keywords: nitrogen metabolism, social insect, termite, urate oxidase, uric acid

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Study on the optimization of banana pseudostem fiber extraction and pretreatment conditions

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This study focuses on optimizing fiber extraction and pretreatment conditions for banana pseudostems in Taiwan. Banana harvesting produces a large amount of pseudostems, approximately four times the weight of the fruit, which are a high-value agricultural residue. The extracted fibers have potential applications in sanitary products, textiles, and bank-note papers. This study evaluates thermal, alkaline, and mechanical pretreatment methods for their effects on fiber yield and appearance. The results indicate that mechanical process alone can yield high-quality fibers without the need for thermal or chemical treatment. The optimal condition, using 1 hr of soaking and 10 min of disintegration, achieved a high yield with reduced processing time. Compared to traditional thermo-alkaline methods, the optimized mechanical method reduced carbon emissions by 93.6%, contributing to low-carbon and sustainable development goals. This research confirms the potential of banana pseudostems as a valuable fiber source and demonstrates that mechanical pretreatment is both efficient and environmentally friendly.

Keywords: banana pseudostem, fiber extraction, mechanical pretreatment, sustainable materials, agricultural residue, carbon reduction.

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Bioactivities of microwave solvolysis lignin from woody biomass

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Development of variety of applications from lignocellulose is essential to foster biorefinery. Lignin, which is a component of lignocellulose in plant cell wall, plays important role as provider of aromatic resources for this sustainable system. So far, fuels, chemicals, plastics, and other applications are produced from lignocellulose and lignin. In this context, in order to create more feasible biorefinery with potential of lignin, we focus on producing bioactive substances. In this study, we have employed woody biomass as resources, and degraded it in solution via microwave reaction. The products were fractionated, and several fractions were obtained and analyzed in bioactive assays and structural analysis. Bioactivities related with bacteria, viruses, and animal cells were evaluated, and anti-multidrug resistant *Streptococcus pneumoniae* activity, anti-SARS-CoV-2 activity, and immunomodulatory activity were observed. Structural analysis, such as gel permeation chromatography (GPC), nuclear magnetic resonance (NMR), and pyrolysis gas chromatography–mass spectrometry (py–GC–MS) revealed that the bioactive fractions derived from microwave degraded woody biomass were mainly composed of structurally modified lignin. Our study indicates the potential of lignin for production of various bioactive substances.

Keywords: lignin, bioactivity

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Ionospheric Observations by Portable GNSS Receivers during the 2024 Solar Eclipse

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On April 8, 2024, during the North American total solar eclipse, we operated low-cost portable GNSS receivers at the University of Texas at Arlington (UTA) and the University of Texas at Dallas (UTD) for five consecutive days; a Septentrio receiver at UTD provided co-located data. Using GNSS RINEX files, we computed total electron content (TEC) to examine eclipse-driven ionospheric changes. Totality occurred at 13:41 CDT (UTA) and 13:42 CDT (UTD). As totality approached, GPS-derived vertical TEC (VTEC) differences turned negative and propagated from southwest to northeast, consistent with the eclipse track. Afterward, TEC from satellite G06 recovered but remained below normal-day levels. Comparing UTA and UTD, we resolved the onset-time offset of the depletion between sites. These results demonstrate that our inexpensive, field-deployable GNSS systems are robust and reliable tools for ionospheric monitoring during rapid, large-scale disturbances.

Keywords: Total solar eclipse, GNSS receiver, Ionospheric Observations

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