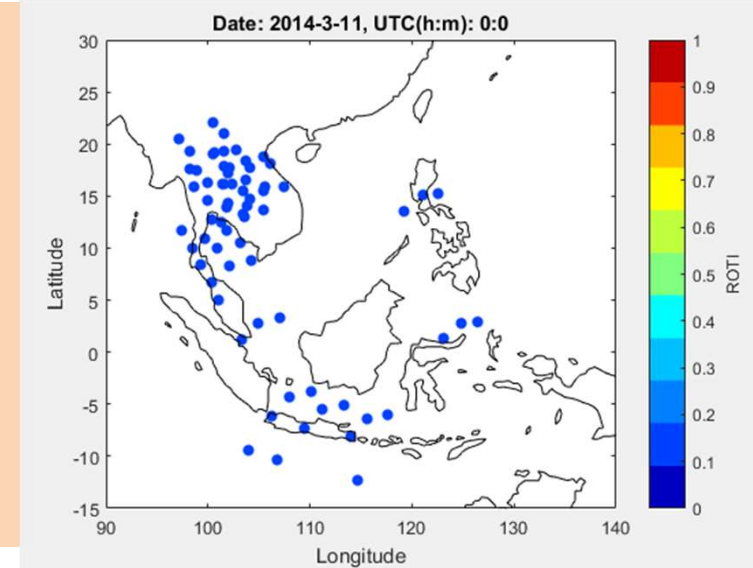


Project Title: Research and development for precise positioning with Artificial Intelligence (AI) during ionospheric disturbances in low-latitude region in ASEAN

Background :

Ionospheric irregularities such as **equatorial plasma bubbles (EPB)** in low-latitude regions in ASEAN countries often lead to degradation in **precise positioning and navigation**. To detect irregularity various sensors and data are typically utilized such as ionosonde, GNSS receivers, VHF (Very High Frequency) radar and LEO (Low Earth Orbit) satellite data. In addition, forecasting and mitigation of EPB effects on modern technology is needed for society at large. Importantly, as Solar cycle 25 is ongoing and will reach the solar maximum in 2024 or 2025, it is imperative to acquire more data and develop the warning capability.



Target :

1. To analyze the EPB statistics during the solar maximum and mitigate the EPB effects
2. To develop forecasting models for EPB occurrences
3. To demo RTK technology at local stations and utilize for various applications

Speaker: Prof. Pornchai Supnithi

School of Engineering & Excellence Center in GNSS and Space Weather
KMUTL, Thailand



Project Title: Research and development for precise positioning with Artificial Intelligence (AI) during ionospheric disturbances in low-latitude region in ASEAN

Project Members : (9 institutes)

(KMITL, Thailand) P. Supnithi, P. Jamjureegulgarn, P. Kenpankho, K. Sepsirisuk , Lin Min Min Myint, Jirapoom Budho, S. Sophan, T. Thankulketsarat, N. Tongkasem,
(CMU, Thailand) Tharadol Komolmis, Witsarut Achariyaviriya, Prayoonsak Praychan
(KMUTT, Thailand) Alisa Kongthon
(NUOLS, Laos) Phosy Phanthongsy, Phimmasone Thammavongsy, Tick Sengthipphany, Phouthong Southisombath
(IGP, Vietnam) Le Truong Thanh, Dung Nguyen Thanh, Mai Thi Nguyen, Thanh Ha Nguyen
(LQDTU, Vietnam) Hoang Van Phuc, Nguyen Van Trung
(ITC, Cambodia) Sainglong Kaing
(CADT, Cambodia) Phutphalla Kong, Soklay Heng
(NICT, Japan) Michi Nishioka, Takuya Tsugawa, Septi Perwitasari

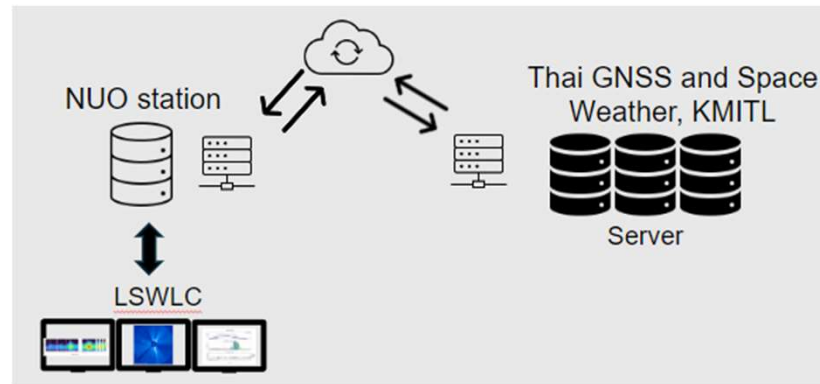
Project Duration : 24 months + 12 months extension (1st April 2023 - 31st March 2026)

Project Activities: **NUOL Space Weather**

Dr. Donekeo Lakachan (NUOL, Laos)

LSWLC has been approved on **January 8th, 2024** under the ASEAN-IVO project

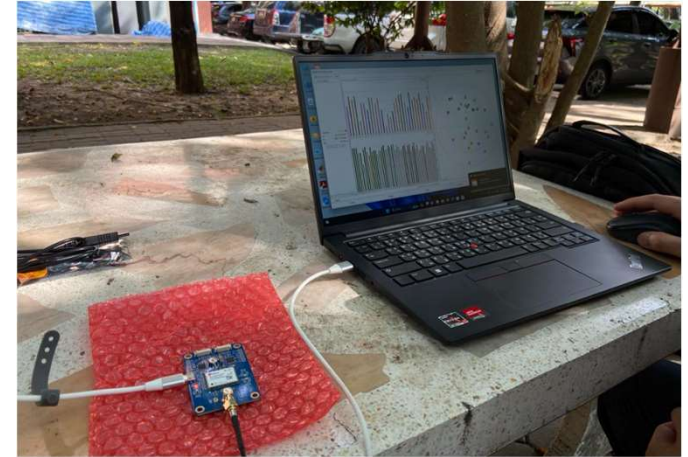
- 1.To enhance awareness and prevention of space impacts to society and industry
- 2.To develop observational center of Space Weather in Laos
- 3.To open space research gate in Laos



Project Activities: **RTK Training at KMITL**

**Dr. Lin MM Myint, Dr. Jirapoom Budtho
(KMITL, Thailand) - October 4th, 2024**

- Training on the basics of GNSS receiver
- Training on the use of RTK system



Project Activities: **AOSWA 2024 Workshop**

Asia-Oceania Space Weather Alliance (AOSWA)

Oct. 8-11, 2024 in Bangkok, Thailand

ASEAN IVO Members (8)

(KMITL, Thailand) P. Supnithi, L. M.M.Myint,
J.Budho, P. Jamjareegulgarn, P.Kenpankho
(CADT, Cambodia) Dr. Cheab Sovuthy
(IGP, Vietnam) Dr. Minh Le Huy
(NICT, Japan) S. Perwitasari, T. Tsugawa



Project Activities: **ASEAN IVO Progress/Closing Meeting**

16-17 October, 2025



Workshop: 17 October, 2025

ICONSiam, Thailand

Morning:

Panel on “Research Leadership and Ecosystem In GNSS and Space Weather – Opportunities and Challenges

Afternoon:

International Proposal Development Workshop

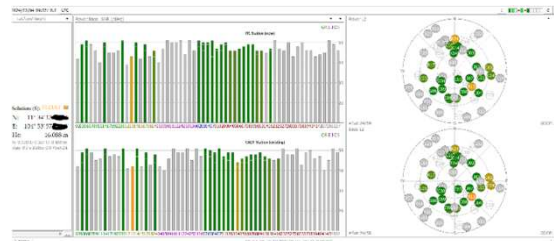


R&D results: GNSS installation and training at ITC (Cambodia)

Mr. Sainglong Kaing (ITC, Cambodia)

- tested the new GNSS receiver (1-2 February, 2024)

RTK Training at ITC



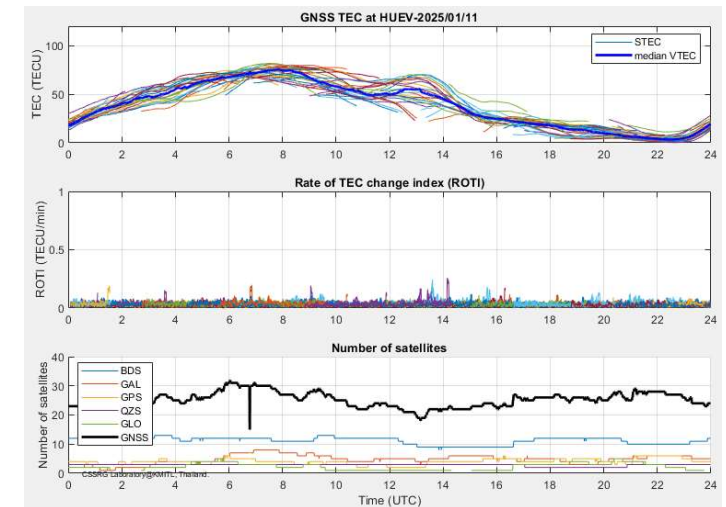
R&D results: GNSS installation at IGP (Vietnam)

Dr. Thanh Dung Nguyễn, Dr. Ha Thanh Nguyen, Dr. Le Truong thanh (IGP, Vietnam)

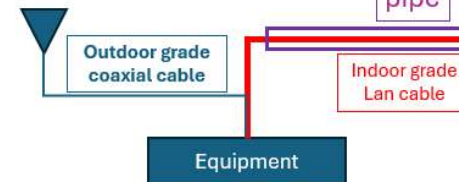
- installed the GNSS receivers at IGP's seismic station, Hue, Vietnam **in January 2025**

Multi-frequency, multi-constellation GNSS receiver system set

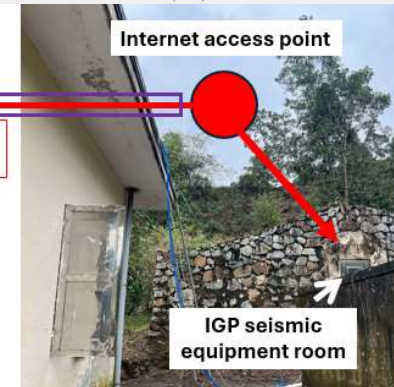
1. NovAtel PwrPak7 GNSS Receiver
2. NovAtel GNSS-850 GNSS Antenna



Antenna

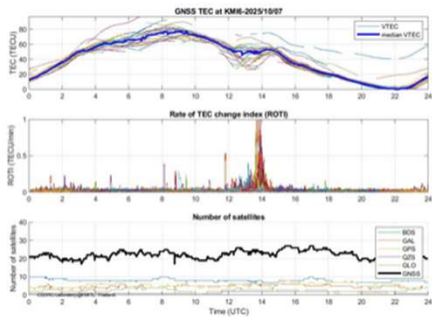


Name: HUEV
Reverse tunnel: 161.246.18.204:8062
Router IP: 192.168.7.1

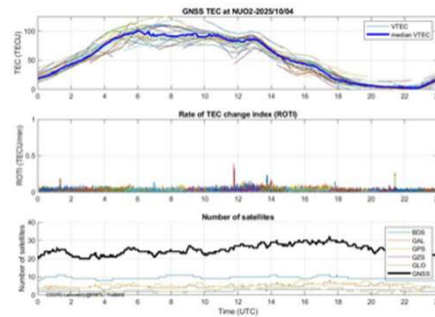


R&D results: IONOSPHERIC MONITORING SYSTEM

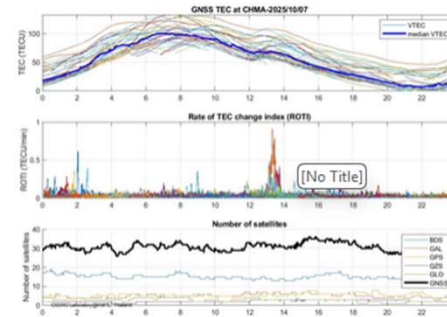
**KMI6 station
(Bangkok, Thailand)**



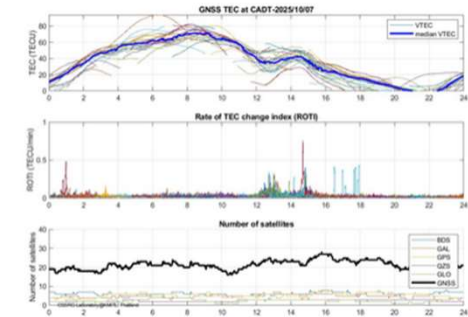
**NUO station
(Vientiane, Laos)**



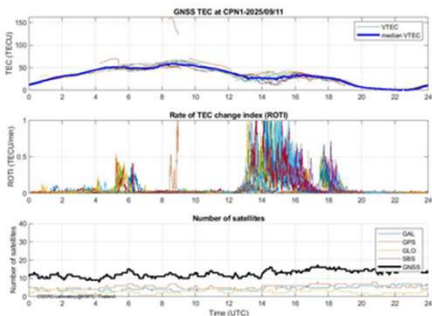
**CHMA station
(Chiangmai, Thailand)**



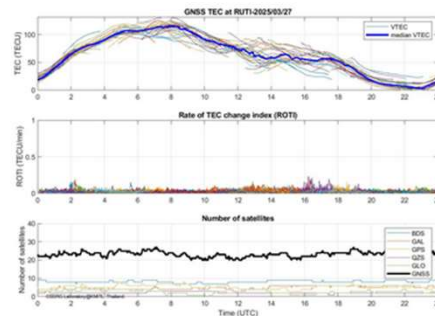
**CADT station
(Phnom Penh, Cambodia)**



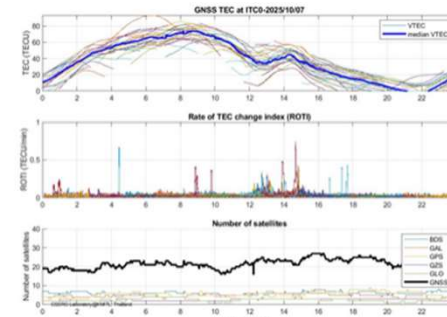
**CPN station
(Chumphon, Thailand)**



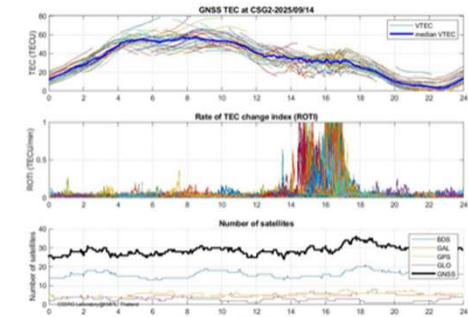
**RUTI station
(Nakhon Ratchasima, Thailand)**



**ITC0 station
Phnom Penh, Cambodia**



**CSG2 station
(KMITL, Thailand)**

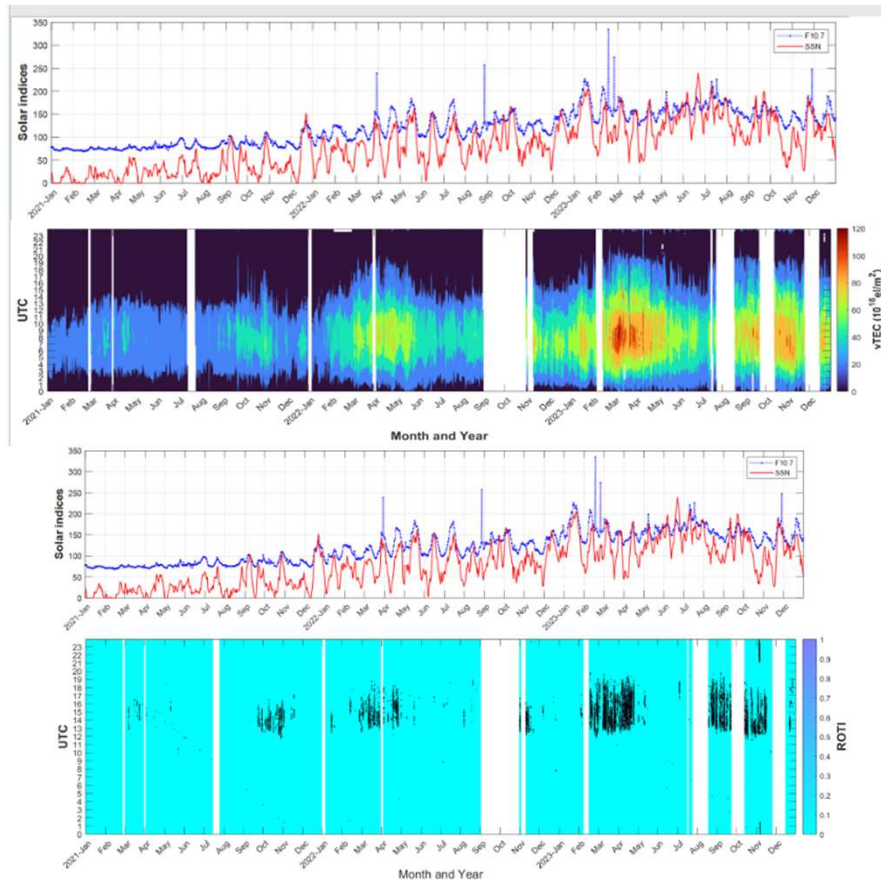


The daily TEC and ROTI plots from the HUEV station from IGP Hue, Vietnam will be added soon.

R&D results: VTEC analysis (NUOL)

P. Thammavongsy, P. Panthongsy, D. Lakanchanh

Results: Observed VTEC at NUO station from 2021 to 2023



Thammavongsy et al.
Earth, Planets and Space (2023) 75:118
<https://doi.org/10.1186/s40623-023-01868-7>

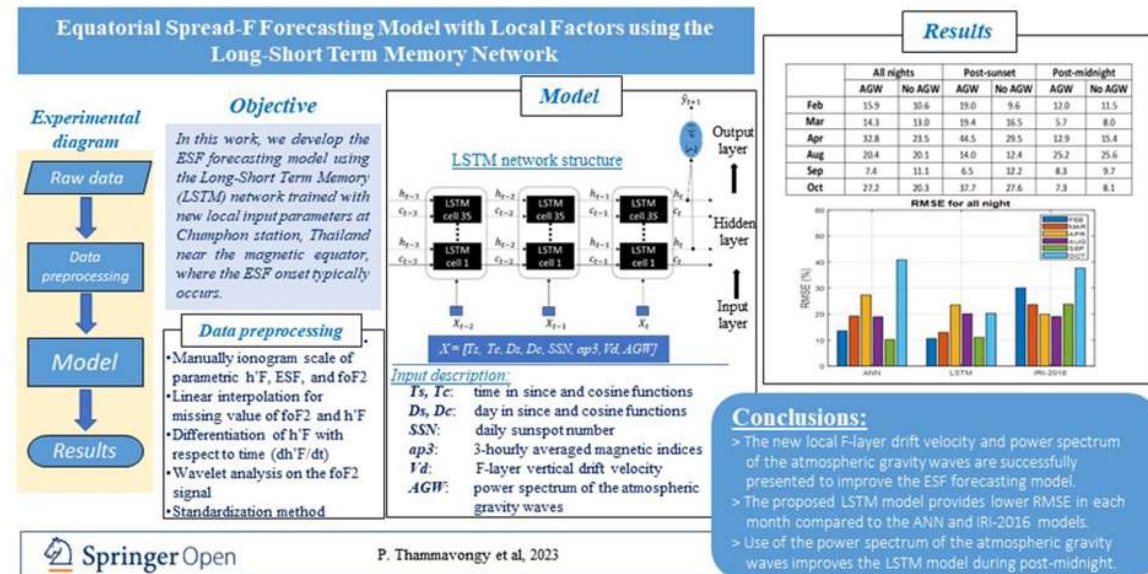
Earth, Planets and Space

FULL PAPER

Open Access

Equatorial spread-F forecasting model with local factors using the long short-term memory network

Phimmasone Thammavongsy¹, Pornchai Supnithi^{1*}, Lin Min Min Myint¹, Kornyanat Hozumi² and Donekeo Lakanchanh³

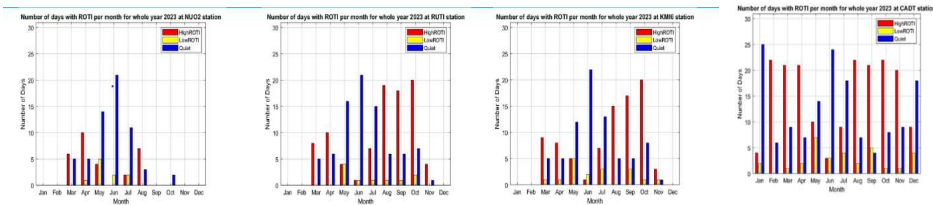


R&D results: VTEC analysis in ASEAN (2023-2025)

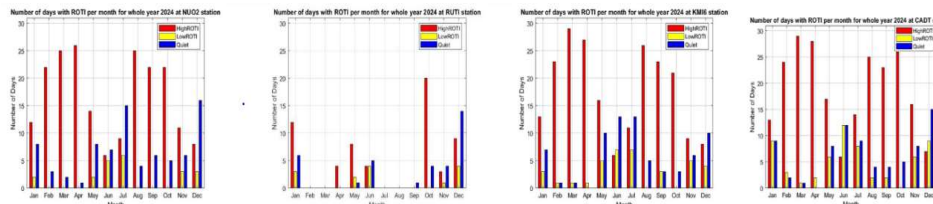
Nut Kunthy, L.M.M Myint, J. Budtho, P. Supnithi, P. Phanthongsy, P. Kong, S. Kaing, Thanh Truong Le, M. Nishioka, S. Perwitasari

Submitted **AOSWA 2025 Workshop, Hainan, China**

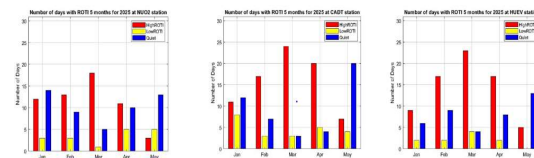
2023



2024



2025



Thanakulketsarat et al.
Earth, Planets and Space (2023) 75:161
<https://doi.org/10.1186/s40623-023-01903-7>

Earth, Planets and Space

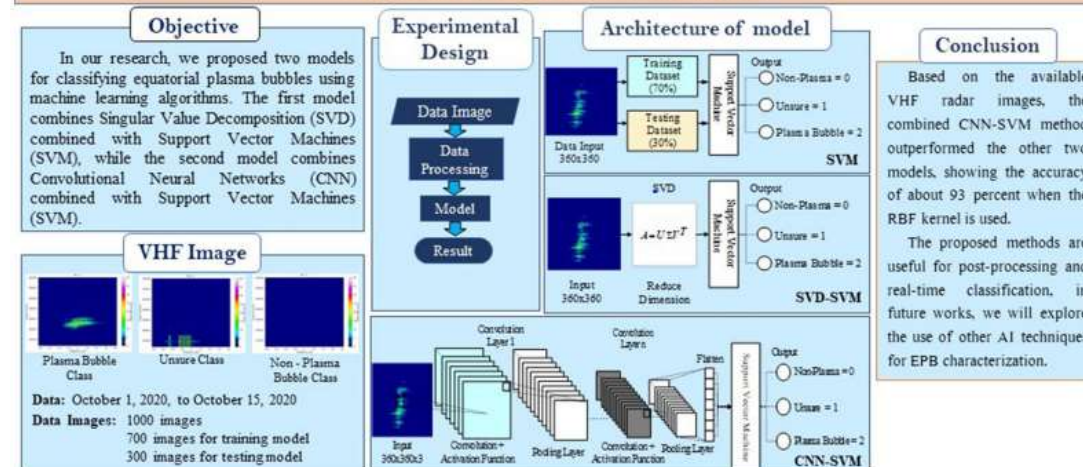
FULL PAPER

Open Access

Classification of the equatorial plasma bubbles using convolutional neural network and support vector machine techniques

Thananphat Thanakulketsarat¹, Pornchai Supnithi^{1*}, Lin Min Min Myint¹, Kornyanat Hozumi² and Michi Nishioka²

Classification of the Equatorial Plasma Bubbles Using Convolutional Neural Network and Support Vector Machine Techniques



R&D results: RTK utilization in agriculture (NUOL)

Dr. Phosy Phanthongsy
Dr. Donkeo Lakachanh

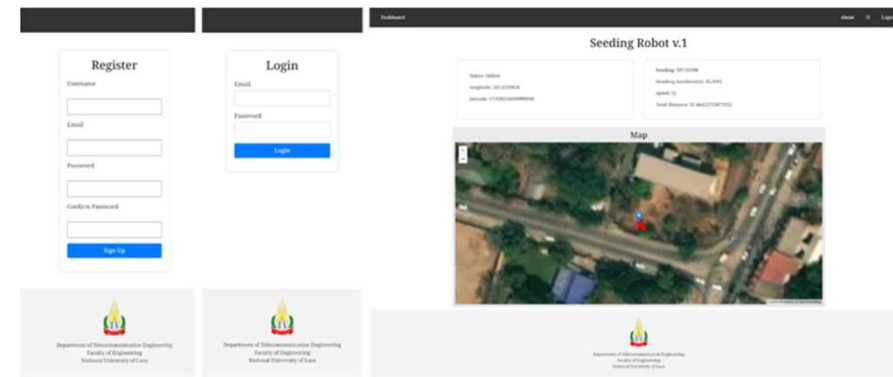
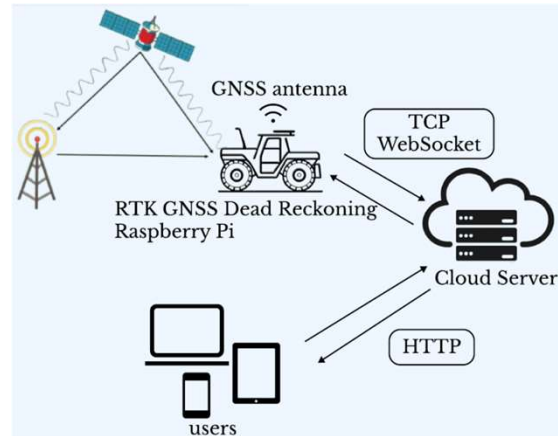


Figure 7 User interface for RTK positioning and monitoring

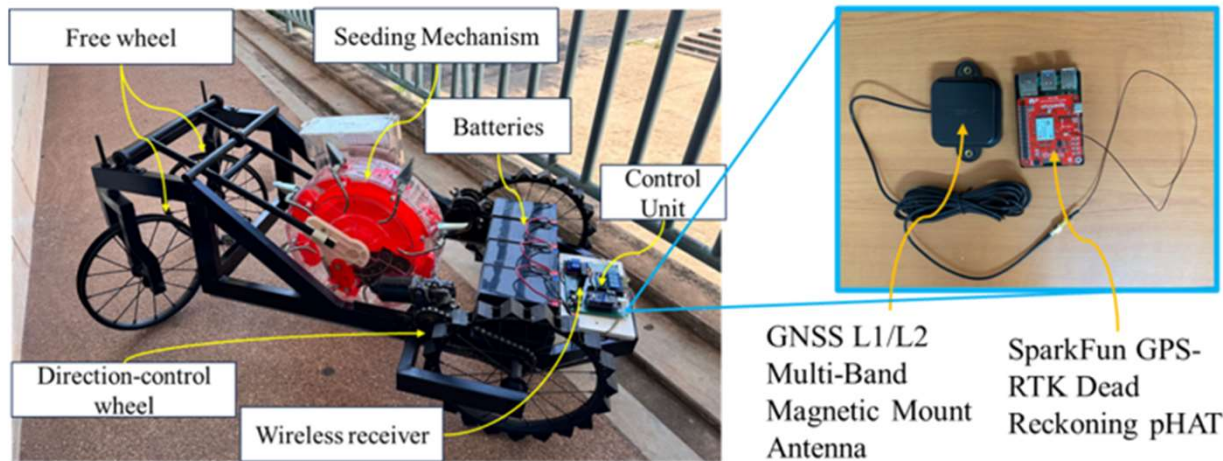
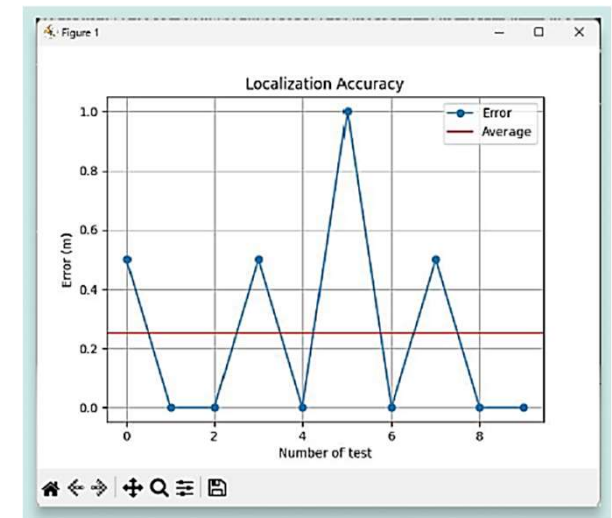


Figure 8 Seeding Robot with RTK positioning module



Scientific Contribution:

Presentations at International Conferences:

No	Paper title	Author names	Affiliation	Conference	Dates	Venue
1	Statistics of the Equatorial Plasma Bubbles in February, March and May 2023 at CPN station, Thailand, and NUOL station, Laos	P. Thammvongsy, P. Supnithi, L. M.M. Myint, D. Larkanchanh, P. Phanthongsy, P. Southisombath and M. Nishioka	NUOLS (Laos), KMITL (Thailand), NICT(Japan)	AOSWA 2023 Workshop	9-11/10/2023	Kuala Lumpur, Malaysia
2	The network of continuous GPS observation in Vietnam and adjacent region and evaluation of the ionospheric quasi-biennial oscillation (QBO) of TEC amplitude of equatorial ionization anomaly (EIA)	D. Thanh	IGP (Vietnam)	AOSWA 2023 Workshop	9-11/10/2023	Kuala Lumpur, Malaysia
3	Ground Subsystem Error Contribution of a Multi-Constellation GBAS Based on a CORS Network in the Vicinity of Airport Areas	M. Cuetas, J.Budtho, P.Supnithi, S. Saito	KMITL (Thailand) ENRI (Japan)	ION-GNSS+ 2024	15-20/9/2024	Baltimore, USA
4	Artificial Intelligence Applications in Ionospheric Irregularities: A Bibliometric Analysis	A. Kongthon, P. Supnithi	KMUTT (Thailand) KMITL (Thailand)	PICMET	4-8/8/2024	Portland, Oregon
5	Identification of Equatorial Ionospheric Irregularities using Clustering Techniques on ROTI Keogram Images	G.Mutasov, P. Supnithi, L. M.M. Myint, J.Budtho, N. Tongkasem, M.Nishioka	KMITL (Thailand) NICT (Japan)	AOSWA 2024 Workshop	5-8/10/2024	Bangkok, Thailand
6	The classification of Spread – F using Machine learning with Data from VHF radar and Ionosonde at Chumphon station, Thailand	T. Thanakulketsarat, P. Supnithi, L. M.M. Myint, J.Budtho, N. Tongkasem, M.Nishioka, S. Perwitasari	KMITL (Thailand) NICT (Japan)	AOSWA 2024 Workshop	5-8/10/2024	Bangkok, Thailand
7	Seasonal Characteristics of Ionospheric Plasma Densities in 2021 to 2023 at Vientiane Station, Laos	P. Thammavongsy, P. Phanthongsy, D. Larkanchanh, P. Supnithi, L.M.M. Myint, P. Septi, M. Nishioka	NUOL (Laos) KMITL(Thailand) NICT(Japan)	AOSWA 2024 Workshop	5-8/10/2024	Bangkok, Thailand
8	Monitoring Ionospheric Irregularities and TEC Variations During High solar activity in 2024	N. Tongkasem, P. Supnithi, L. M.M. Myint, M.Nishioka	KMITL(Thailand) NICT(Japan)	AOSWA 2024 Workshop	5-8/10/2024	Bangkok, Thailand
9	Continuous GNSS network and some study results on time variation of the Equatorial Ionization Anomaly in the Vietnam and adjacent region	M. Le Huy	IGP (Vietnam)	AOSWA 2024 Workshop	5-8/10/2024	Bangkok, Thailand



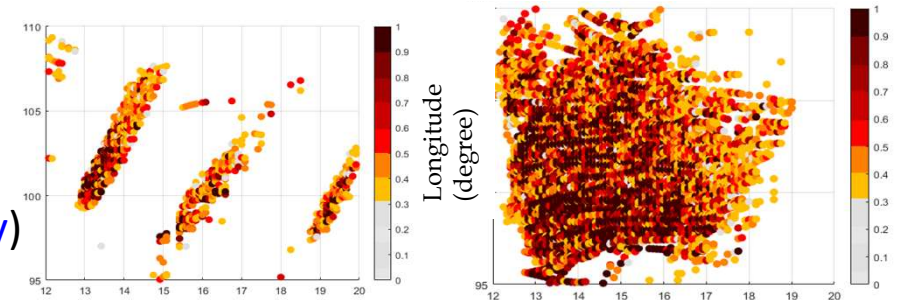
Scientific Contribution:

No	Paper title	Author names	Affiliation	Conference	Dates	Venue
10	Effects of Geomagnetic Storms on Equatorial Ionization Anomaly and Equatorial Ionospheric Plasma over Thailand	L.M.M. Myint, P. Supnithi, J. Budtho, P. Septi, M. Nishioka	KMITL(Thailand) NICT(Japan)	AOSWA 2024 Workshop	5-8/2024	Bangkok, Thailand
11	Enhanced Ionospheric Delay Gradient Estimation Using a Dynamic Time-Step Method with GNSS IGSO Satellites	J. Budtho, P. Supnithi, L. M. M. Myint	KMITL(Thailand)	AOSWA 2024 Workshop	5-8/2024	Bangkok, Thailand
12	Analysis of Ionospheric Variations Using GNSS Stations in the Northern ASEAN Region	K. Nut , L.M.M Myint, J. Budtho, P. Supnithi, P. Phanthongsy, P. Kong, S. Kaing, Thanh Truong Le, M. Nishioka, S. Perwitasari	NICT (Japan) KMITL (Thailand) CADT, ITC (Cambodia) NUOLS (Laos)	AOSWA 2025 Workshop	10-12/11/2025	Hainan, China
12	Comparative Analysis of Deep Learning Models for Daily Solar Indices Forecasting in Solar Cycle 25	L.M.M.Myint, G. Mutasov, P. Supnithi, J. Budtho,	KMITL(Thailand)	ITC-CSCC 2025,	1-5/7/2025	Seoul, Korea
13	Predicting Equatorial Ionospheric Total Electron Content Using the Transformer-based Model with Observations From Ground GNSS Receivers and COSMIC-2 Satellites	G. Mutasov, P. Supnithi, J. Budtho,S. Perwitasari, M. Nishioka, L.M.M.Myint,	KMITL(Thailand) NICT (Japan)	ITC-CSCC 2025,	1-5/7/2025	Seoul, Korea
No	Paper title	Author names	Affiliation	Journals	Publisher	Details
1	Equatorial spread-F forecasting model with local factors using the long short-term memory network	P. Thammavongsy, P. Supnithi ,L. Myint, K. Hozumi and D. Lakanchanh	NUOL (Laos) KMITL (Thailand) NICT (Japan)	Earth, Planets and Space (Q1 level, SJR)	Springer Open	Vol 75, No. 118, 04 August 2023 https://doi.org/10.1186/s40623-023-01868-7
2	Classification of the equatorial plasma bubbles using convolutional neural network and support vector machine techniques	T. Thanakulketsarat, P. Supnithi ,L. Myint, K. Hozumi and M.Nishioka,	KMITL (Thailand) NICT (Japan)	Earth, Planets and Space (Q1 level, SJR)	Springer Open	Vol 75, No. 161, 16 October 2023 https://doi.org/10.1186/s40623-023-01903-7
3	Classification of Equatorial Ionospheric Irregularities Using Unsupervised Machine Learning Based on Spatiotemporal ROTI Keograms	G. Mutasov, P. Supnithi, J. Budtho, N. Tongkasem, M. Nishoka, S. Perwitasari, L. Myint	KMITL (Thailand) NICT (Japan)	IEEE Journal of Sel Top in Applied Earth Obs and Remote Sensing	IEEE	vol. 18, pp. 21769-21782, August, 2025, https://doi.org/10.1109/JSTARS.2025.3600477

Societal Impact:

- Research on AI for TEC and ROTI maps
 - ➔ TEC map and ROTI map aid EPB detection and prediction
 - ➔ Used by positioning, navigation agencies
 - ➔ Aerothai, ICAO, Meteorology Dept. – [Earthquake study](#))
- Low-cost RTK receivers and applications in space weather, agriculture, etc.
 - ➔ Educational, Agriculture, Space Weather area
- Control Room/Learning Center benefits the educational aspect and visibility
 - ➔ Capacity-building, education, research at NUOLS, ITC, and CADT

(Example) ROTI Keogram



Conclusion:

- **Trainings:**
 - ITC (Cambodia) on RTK setup and performance evaluation
 - KMITL(Thailand) on RTK setup and performance evaluation
- **GNSS receiver installation:**
 - ITC - Cambodia, IGP – Vietnam
- **Research results:**
 - (NUOL) set up Space Weather Learning Center, analyze TEC at NUOL, assemble RTK system for agriculture
 - (ITC, CADT) analyze TEC and ROTI parameters
 - (KMITL) AI clustering on ROTI keograms and VHF radar images, ROTI map construction, VHF radar analyses
- **Publications:**
 - 13 conference papers/abstracts, 3 Journal articles

Future Works:

- **Research topics and grant support**

- Near-real time EPB detection and prediction using multi-instrument (EPBAIert)
- (NICT) Validation of EPB prediction
- (NICT) Effects of EPB on GNSS and tech and how to quantify the effects
- Development of RTK applications in survey, aviation, mobility
- EPB effect mitigation methods
- Jamming detection project
-
- NBTC project on 'Jamming detection' devices
- PMU-B proposal in Earth-Space Technology
 - EPB prediction
 - GNSS for Aviation
- Develop joint proposal together → E-Asia, Asia-Pacific Telecommunity, ASEAN IVO, EU-Horizon, PMU-B

- **Academic exchange/Training**

- Encourage more staff and student exchanges (NICT, KMITL)
- Any opportunities from others?
- Training → AOSWA Workshop
- Scholarships
-

- **Conferences/Publications:**

- (Asia-Oceania) AOSWA - Asia-Oceania Space Weather Alliance) Workshop
- (Japan) JpGU
- (AOGS) conveners, students
- Cospar, ursi, iaga, iri
- (Cambodia) ACET by CADT
- (Thailand) ECTI-CON conference (Support for ASEAN researchers)
- Siam Physics Conference – not free

AOSWA 2025 Workshop

10 – 12 November, 2025, Hainan China



Session/Conveners	Description
1. Thermosphere, Ionosphere, and Magnetosphere Dynamics and Interactions	Dr. Zahra Bouya Dr. Pornchai Supnithi Dr. Noraset Wichaipanich
2. Monitoring and Simulation of Solar Activity and Space Radiation	Prof. David Ruffolo Dr. Jingjing Wang
3. Space Weather Observations and Collaborations between AOSWA, IMCP, and Other Communities	Dr. Bingxian Luo Dr. Septi Perwitasari Prof. Mardina Abdullah Dr. Nurul Shazana Abdul Hamid
4. Space Weather Awareness and Public Outreach	Dr. Suwicha Wannawichian
5.. AI and New Techniques of Space Weather Forecasting	Dr. Lin Min Min Myint Dr. Naoto Nishizuka Dr. Anan Kruesubthaworn
6. General Topics on Space Weather	Dr. Takuya Tsugawa Dr. Zahra Bouya Dr. Sittiporn Channumsin Dr. Kichang Yoon
7. Space Weather Impact and Mitigation	Dr. Takuya Tsugawa Dr. Jirapoom Budho Dr. Venkat Ratnam

Discussion: Future forward (2)

- **Academic exchange/Training**
 - Encourage more staff and student exchanges (NICT, KMITL)
 - **Any opportunities from others?**
 - Training → AOSWA Workshop
 - Scholarships
 -
- **Conferences/Publications:**
 - (Asia-Oceania) AOSWA - Asia-Oceania Space Weather Alliance) Workshop
 - (Japan) JpGU
 - (AOGS) conveners, students
 - Cospar, ursi, iaga, iri
 - (Cambodia) ACET by CADT
 - (Thailand) ECTI-CON conference (Support for ASEAN researchers)
 - Siam Physics Conference – **not free**
- **Joint committee/organization**
 - AOSWA National Committee
 - ECTI ASEAN committee and International Steering committee
 - IAGA (No representative from Cambodia, Laos)
 - ISWI (No representative from Vietnam)
 -
- **Other items**
 - Communication mode? **Thru AOSWA?**