Project Title: GNSS and Ionospheric Data Products for Disaster Prevention and Aviation in Magnetic Low-Latitude Regions

Background :

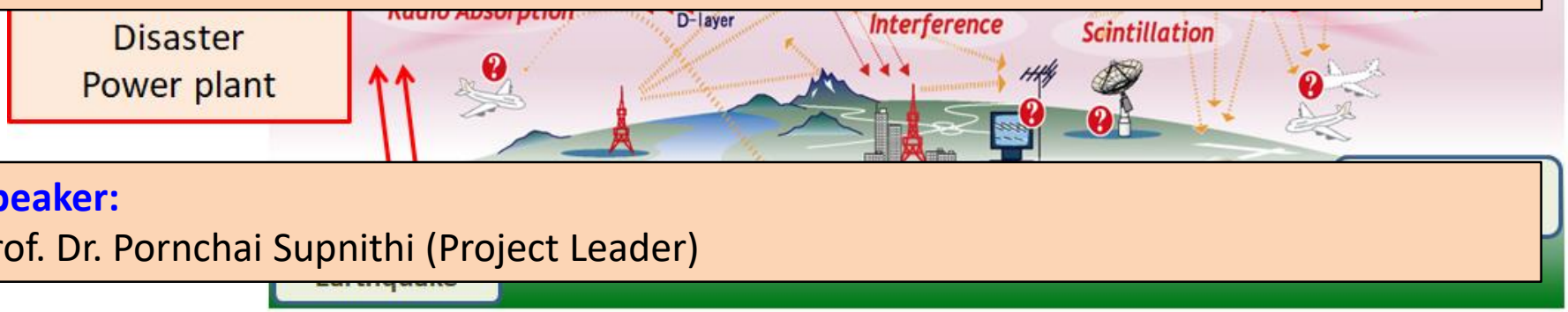
Ionospheric irregularity such as plasma bubble

➔ typically occurs after sunset due to the bottomside instability

➔ degrades HF communication, precise positioning and aeronautical navigation.

Targets:

1. Expand GNSS and ionospheric monitoring system in neighboring countries
2. Daily GNSS data products for disaster prevention and aviation
3. Ionospheric data products and disturbance prediction models for disaster prevention and aviation
4. Support the Installation of a new VHF radar station at Chumphon campus, Thailand



Speaker:

Prof. Dr. Pornchai Supnithi (Project Leader)

Project Title: GNSS and Ionospheric Data Products for Disaster Prevention and Aviation in Magnetic Low-Latitude Regions

Project Members :

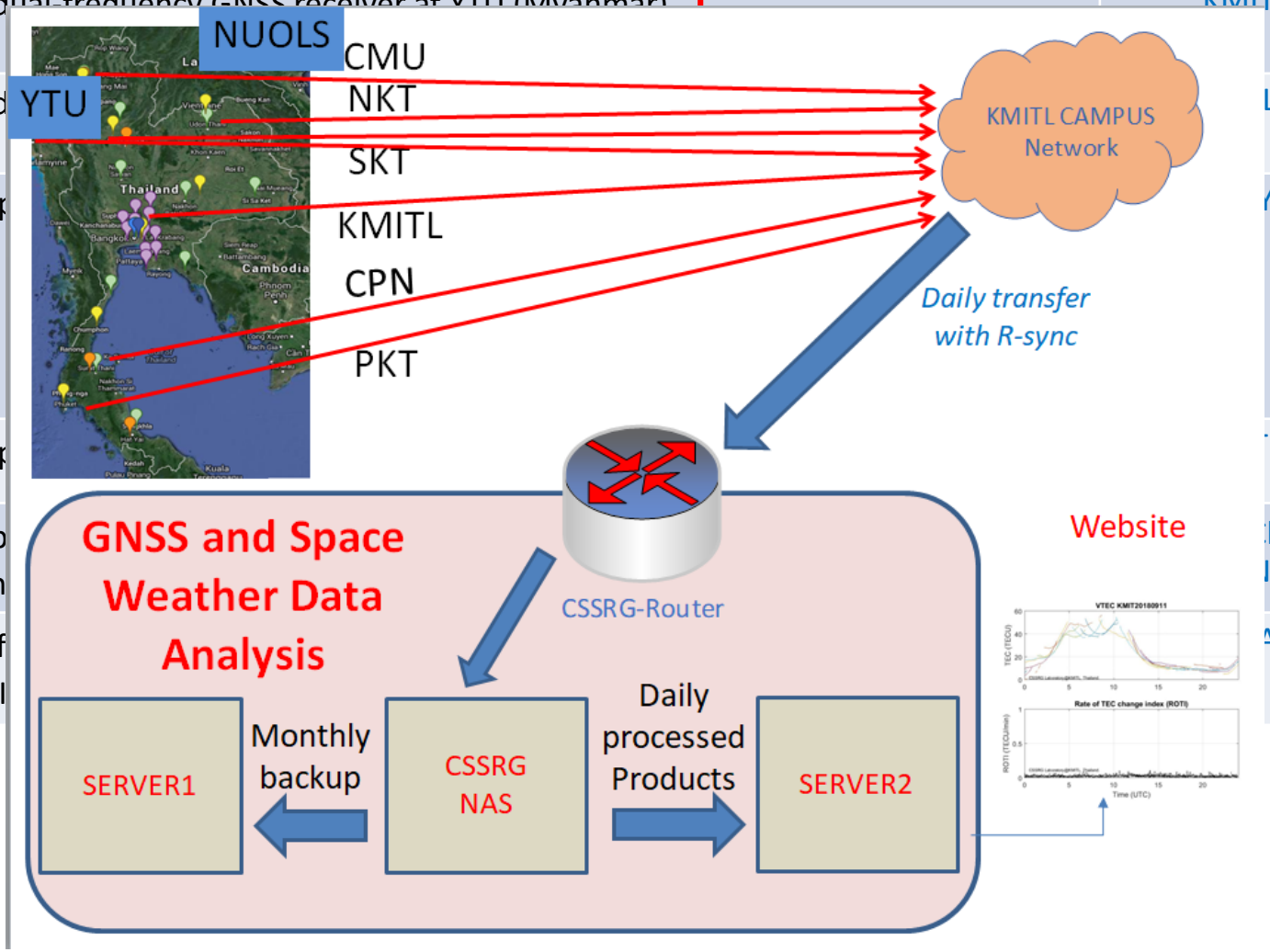
Name	Institution	Country
Prof. Pornchai Supnithi	KMITL	Thailand
Dr. Win Zaw	YTU	Myanmar
Asst.Prof. Donekeo Lakanchan	NUOL	Laos
Assoc.Prof. Punyawi Jamjureekulkarn	KMITL (Chumphon)	Thailand
Asst.Prof. Watid Phakphisut	KMITL	Thailand
Assoc.Prof. Tharadol Komolmis	Chiangmai Univ.	Thailand
Dr. Takuya Tsugawa (NICT)	NICT (Space Environment Laboratory)	Japan
Dr. Kornyanat Hozumi	NICT (Space Environment Laboratory)	Japan

Possible added members from Cambodia, Vietnam

Project Duration : 2 Years

Project Activities:

Project Activites	Responsible members
1. Install dual-frequency GNSS receiver at YTU (Myanmar) Collect	KMITL, YTU
2. Install d Collect	L, NUOL
3. Develop • • • •	YTU, NUOL
4. Develop	L, CMU
5. To supp Thailan	humphon), IICT
6. Kick-off ASEAN I	ALL



Project Activities: Kick-off Meeting

19th June, 2019

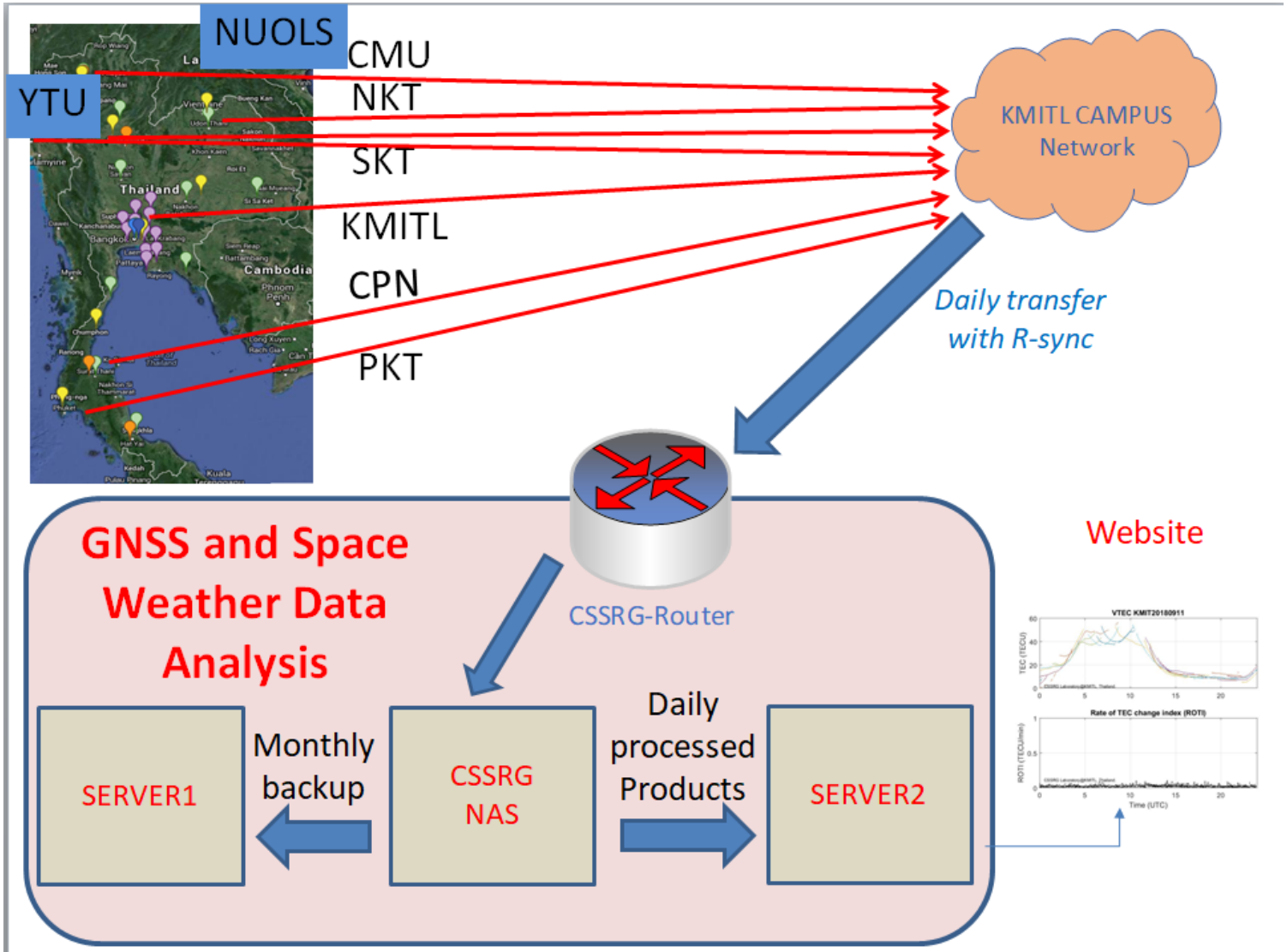
King Mongkut's Institute of Technology Ladkrabang (KMITL), Thailand

R&D results (1): 1. Data network and Analysis

GNSS & space Weather Website: http://iono-gnss.kmitl.ac.th/?page_id=807

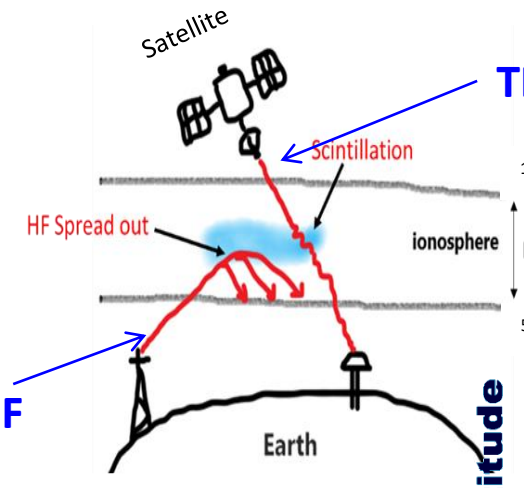
GNSS receiver

Ionosonde system



R&D results (2): 2. GNSS and Iono data analysis for disaster and aviation (KMITL, CMU)

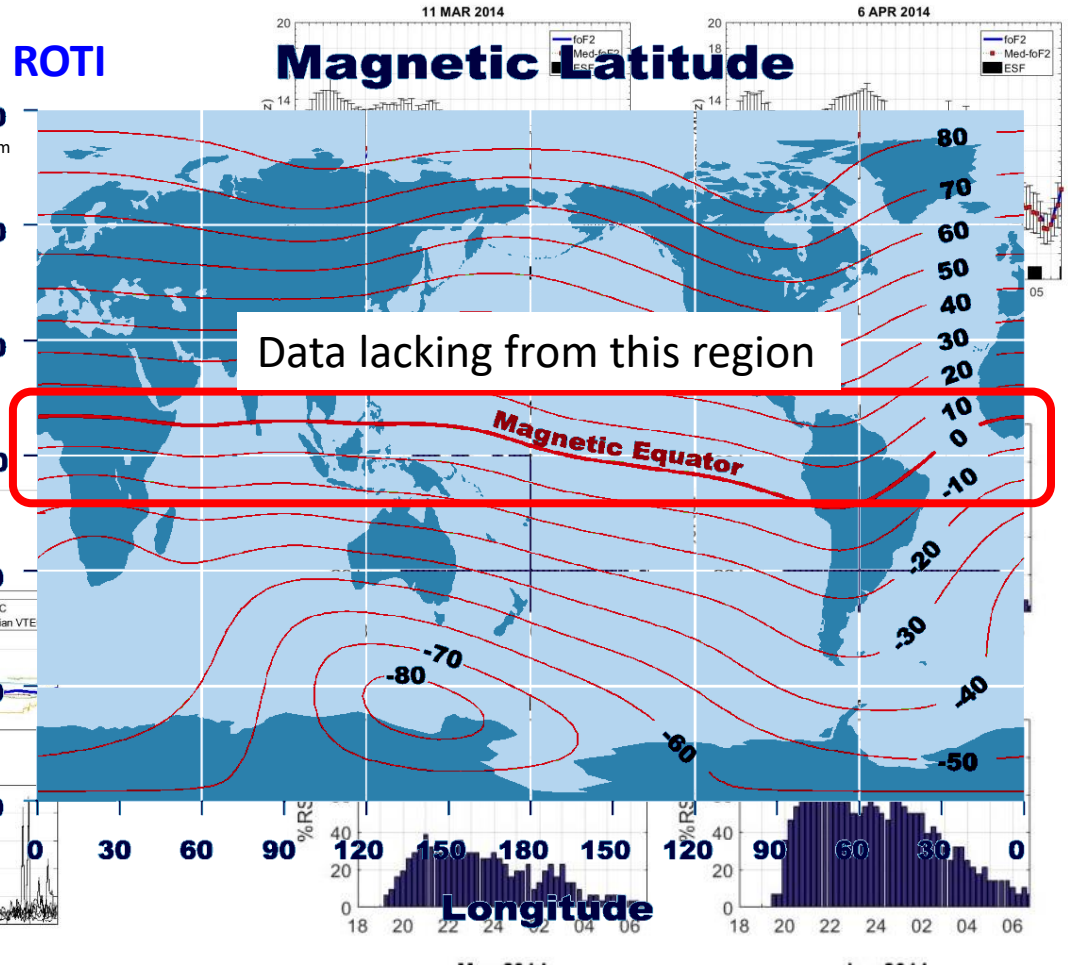
Equatorial Spread-F impacts on radio wave propagation at night-time



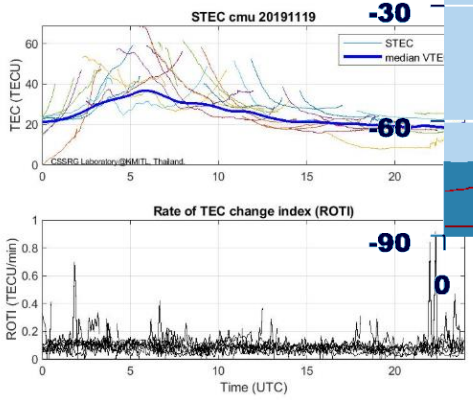
TEC, ROTI

foF2, Spread F

Critical frequency values (foF2)



TEC



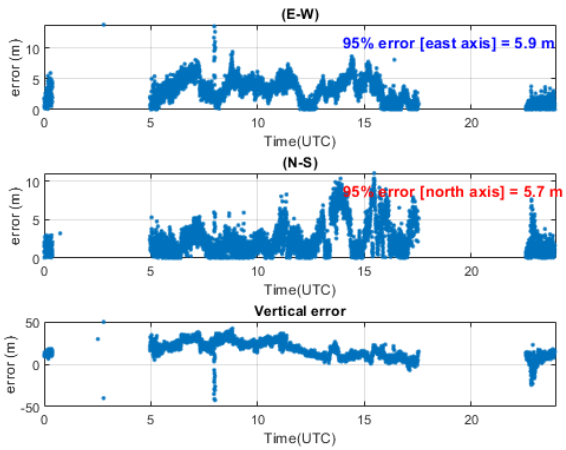
Chiangmai (CMU)

R&D results (3): 3. GNSS positioning accuracy at Chiangmai Station during disturbed days *(Single positioning)*

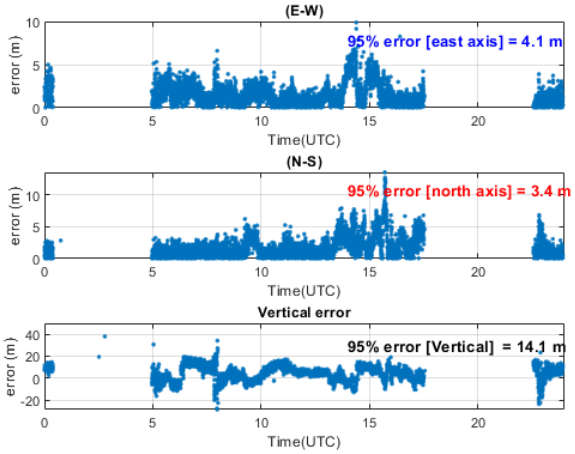
11 March 2018

Chiangmai

No correction



STEC correction

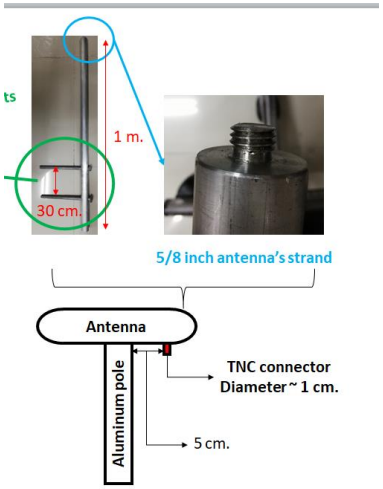


	No Corr.	STEC Correction	Correction (%)
Horizontal	5.7 m	3.8 m	**33.33 %**
North	5.7 m	3.4 m	**40.35 %**
East	5.9 m	4.1 m	**30.51 %**
Vertical	31.9 m	14.1 m	**55.80 %**
Mean			**40.00 %**

R&D results (4):

Expanded GNSS and ionospheric monitoring system (NUOL, YTU)

1. GNSS station at NUOL: Site survey ➔ NUOL

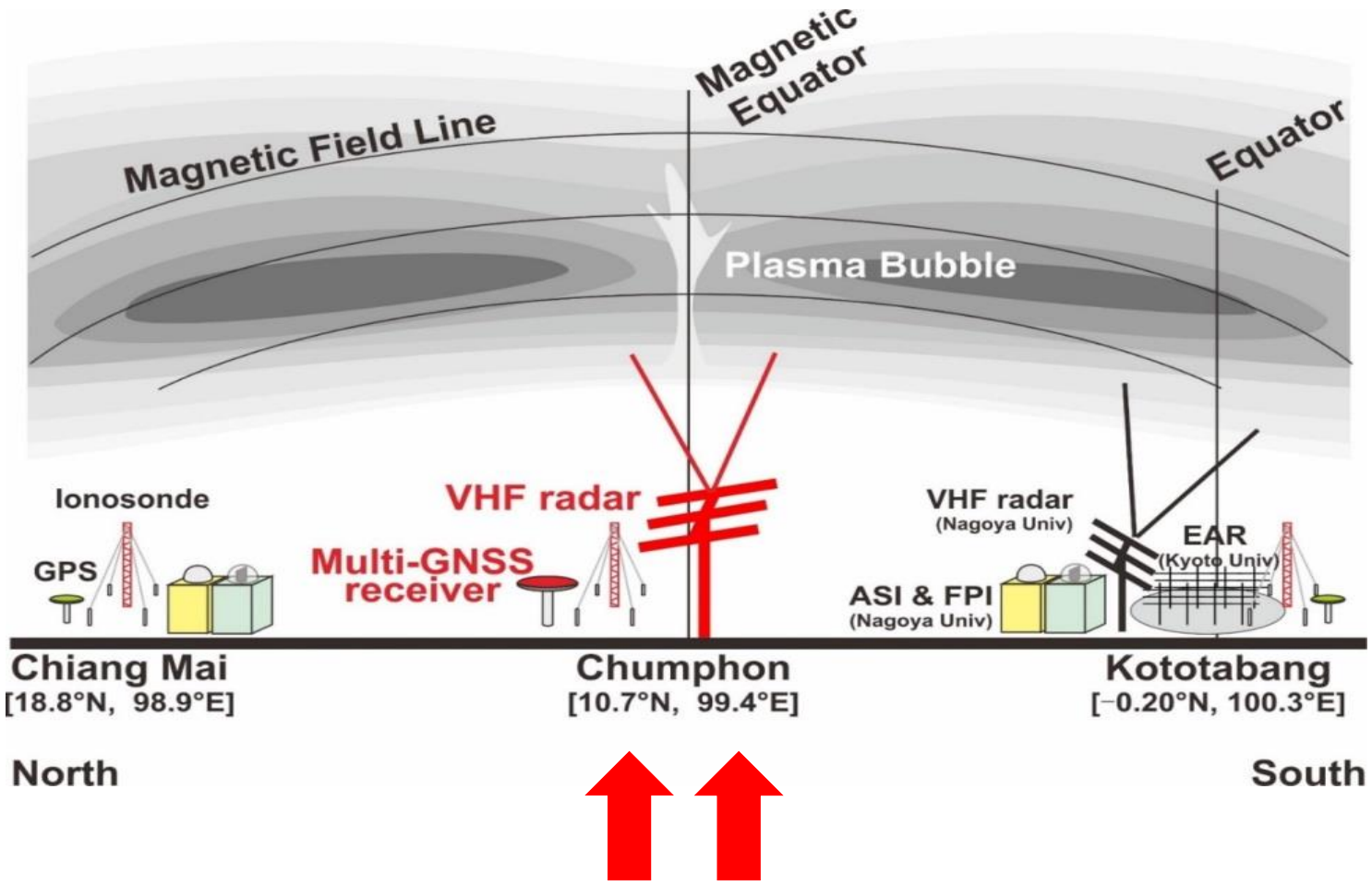


2. GNSS station at YTU (Mynamar): Site survey ➔ YTU

R&D results (5): Chumphon International Radar Station:

Press release : 26 November, 2019

Opening: 17 January 2019



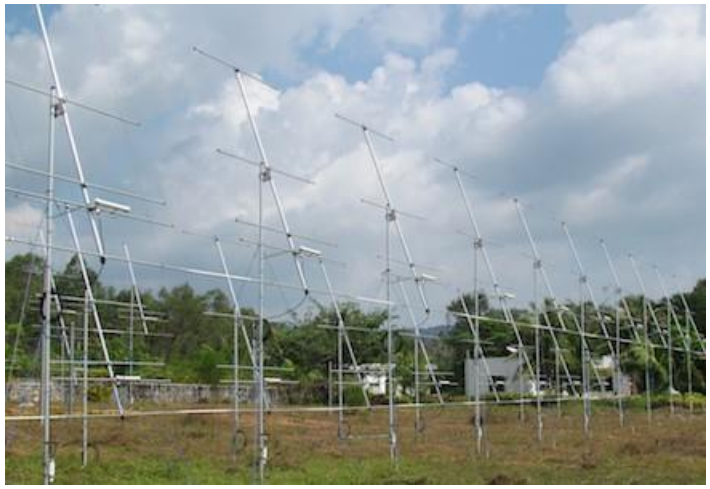
R&D results (5): Chumphon International Radar Station:

NOW

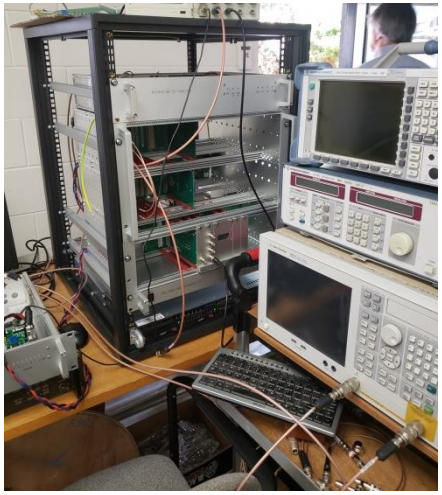
NOW

NOW

SOON



SOON



Scientific Contribution:

Presentations at **International Journals/Conferences/Exhibition:**

No:	Paper title:	Author names	Affiliation	Conference name:	The date	Venue
	Conferences					
1	Study of topside scale height based on NeQuick topside formulation and their comparison with ionogram-derived scale height in 2014 at Ascension Island	P. Jamjareegulgarn, P. Supnithi, T. Tsugawa, K. Hozumi	KMITL, NICT	International Reference Ionosphere 2019 (IRI 2019) Workshop	9-13 Sept. 2019	Nicosia, Cyprus
2	Comparison of Spread-F probability and the IRI-2016 model during descending solar cycle in 2016 at the equatorial Chumphon station, Thailand	P. Thammavongsy, P. Supnithi, P. Kenpankho, K. Hozumi, T. Tsugawa	KMITL	International Reference Ionosphere 2019 (IRI 2019) Workshop	9-13 Sept. 2019	Nicosia, Cyprus
3	The Statistics of Equatorial Spread-F and Effects on Critical Frequency at Chumphon, Thailand	P. Thammavongsy, P. Supnithi, W. Phakphisut, K. Hozumi, T. Tsugawa	NUOL, KMITL, NICT	Sriwijaya International Conference International Conference of Information Technology and its Applications (SICONIAN 2019)	15-16 Nov, 2019	Palembang, Indonesia
	Exhibitions					
4	Space Weather Knowledge			Nationa Science and Technology Fair 2019		

Societal Impact:

- Enhance **better understanding of ionospheric disturbance** **in magnetic equator and low-latitude region**, particularly, ASEAN region.
- Useful ionospheric disturbance detection for **aviation and HF communications**, prevalent, in aviation and communications in disaster situation, especially, along the coastal areas.
- Better disturbance characterization is required to determine performance of **high-accuracy GNSS system** used in other industries such as precisioned agriculture and autonomous driving.
- **Regional data collection** is important for long-term study and useful to **global model improvement** (such as IRI model and IGS model).

(Examples) Space Weather Advisory
➔ For airlines

SWX ADVISORY	
DTG:	20161108/0100Z
SWXC:	(to be determined)
SWX EFFECT:	GNSS MOD AND HF COM MOD
ADVISORY NR:	2016/2
REPLACES ADVISORY NR:	REPLACES NR: 2016/1
OBS SWX:	20161108/0100Z HNH HSH E18000 – W18000
FCST SWX +6 HR:	20121108/0700Z HNH HSH E18000 – W18000
FCST SWX +12 HR:	20161108/1300Z HNH HSH E18000 – W18000
FCST SWX +18 HR:	20161108/1900Z HNH HSH E18000 – W18000
FCST SWX +24 HR:	20161109/0100Z NO SWX EXP
RMK:	LOW-LEVEL GEOMAGNETIC STORMING IS CAUSING INCREASED AURORAL ACTIVITY AND SUBSEQUENT MOD DEGRADATION OF GNSS ACCURACY AND HF COM AVAILABILITY IN THE AURORAL ZONE. THIS STORMING IS EXPECTED TO SUBSIDE IN THE FORECAST PERIOD. SEE WWW.SPACEWEATHERPROVIDER.WEB
NXT ADVISORY:	NO FURTHER ADVISORIES

SWX ADVISORY	
DTG:	20161108/0100Z
SWXC:	(to be determined)
SWX EFFECT:	HF COM SEV
ADVISORY NR:	2016/1
OBS SWX:	20161108/0100Z DAYLIGHT SIDE
FCST SWX +6 HR:	20121108/0700Z DAYLIGHT SIDE
FCST SWX +12 HR:	20161108/1300Z DAYLIGHT SIDE
FCST SWX +18 HR:	20161108/1900Z DAYLIGHT SIDE
FCST SWX +24 HR:	20161109/0100Z DAYLIGHT SIDE
RMK:	PERIODIC HF COM ABSORPTION HAS BEEN OBSERVED AND IS LIKELY TO CONTINUE IN THE NEAR TERM. COMPLETE AND PERIODIC LOSS OF HF ON THE SUNLIT SIDE OF THE EARTH EXPECTED. CONTINUED HF COM DEGRADATION LIKELY OVER THE NEXT 7 DAYS. SEE WWW.SPACEWEATHERPROVIDER.WEB
NXT ADVISORY:	20161108/0700Z

3 Global forecasting centers

Start operation in November 2019

➔ Need local, regional data for validation

Conclusion:

- We have prepared the additional GNSS station installtion in Laos and Myanmar
  ➔ Site surveys and equipment purchase/allocation are completed

- We have analyzed the iono disturbance based on Ionosonde station
  ➔ foF2 statistics
  ➔ Spread F statistics

HF Communication data products

- We have analyzed the iono disturbance and create the ROTI map
  ➔ ROTI maps are accessible at http://iono-gnss.kmitl.ac.th

Aviation data products

- GNSS positioning analysis at Chumphon station, Chiangmai station
  ➔ quiet days, disturbed days

Positioning,Navigation data products

- Preparation for the new VHF radar station at Chumphon

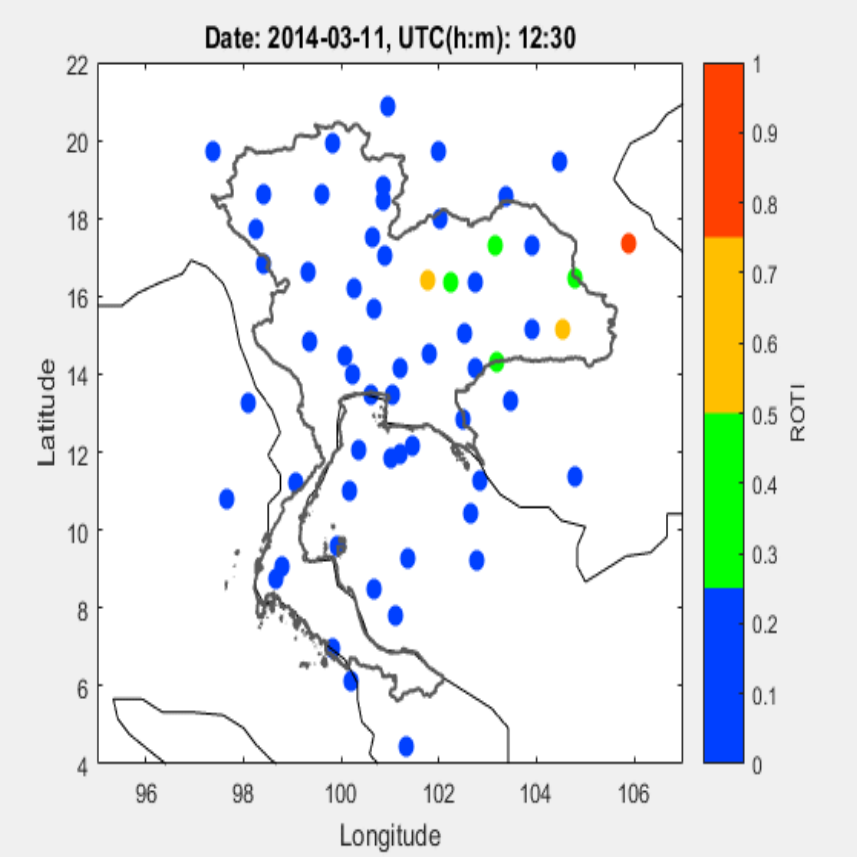
Future works:

Project Activites	Responsible members
1. Install dual-frequency GNSS receiver in Myanmar: **10-13 January, 2019** Collect observational data for further analysis	KMITL, YTU
2. Install dual-frequency GNSS receivers in Laos: **23-25 December, 2019** Collect observational data for further analysis	KMITL, NUOL
3. Develop daily GNSS data products for disaster and Aviation • Study the Space Weather (SW) Data Format for Aviation • Develop daily SW data with emphasis on GNSS data: **2-D TEC map, ROTI data products** • Analyze the **loss-of-lock statistics** and scintillation at various GNSS stations • **Prediction model** for iono parameters, GNSS parameters – **NN, SVM**	KMITL, YTU, NUOL
4. Develop daily ionospheric data products: **foF2, Spread F over more years**	KMITL, CMU
5. To support the new installation of VHF Radar Station at Chumphon, Thailand: **Operational opening – 17-19 Jan. 2020**	KMITL (Chumphon), NICT
6. ASEAN IVO Workshop on "**GNSS and total electron content (TEC) analysis for Positioning and Aviation**" 17 – 19 January, 2019 Chumphon campus, Thailand	ALL
7. Seminar/Workshop on GNSS data products for Aviation and Disaster **(Airlines, Government Agencies, GNSS industry, Marines)**	YTU KMITL

Examples of 2-D map

- disturbance, delay values, positioning accuracy?

Thailand



ASEAN