GNSS Technology Promotion Activities at The University of Tokyo

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Center for Spatial Information Science, The University of Tokyo

Sixteenth Meeting of the International Committee on Global Navigation Satellite Systems (ICG)

Meeting of the Working Group C on Information Dissemination and Capacity Building

9 – 14 October 2022, Abu Dhabi, United Arab Emirates

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Overview

- Conduct GNSS Trainings, Workshops and Seminars
  - Basically in Asian countries
    - Indonesia, India, Laos, Malaysia, Myanmar, Nepal, Thailand, The Philippines, Singapore, Vietnam
  - Also, Some African Countries
    - Mozambique, Rwanda, Egypt
  - Conduct Trainings in Collaboration with ICG
- Conduct Joint Research and Pilot Projects
  - Low-Cost High-Accuracy GNSS Systems
  - Traffic Monitoring
  - Urban City Environment Monitoring
  - Illegal Fishing Monitoring
  - Any GNSS-based Application of your interest
- Installation of GNSS CORS
  - Install GNSS CORS in the Universities around the world for joint research, GNSS technology promotion and capacity building
- Develop Low-Cost Receiver Systems for
  - High-Accuracy based on
    - RTK: RTKDROID - RTK in Android
  - MADOCA PPP
    - MADROID: MADOCA-PPP in Android
    - MAD-WIN: MADOCA-PPP in Windows
    - MAD-PI: MADOCA-PPP in RaspberryPi Device
  - Space Weather Data Analysis
  - Dynamic Air Quality Monitoring
- RPD (Rapid Prototype Development) Challenge
  - Organize RPD Challenge as a part of MGA (Multi-GNSS Asia) activity
  - Encourage students and researchers to bring solutions and business values by solving real-life problems
- GNSS Summer School
  - Organized by TUMSAT (Tokyo University of Marine science and Technology)

Training on GNSS, Jointly Organized by UTokyo and ICG

Past Training in JAN 2021

CSIS The University of Tokyo
ICG International Committee on Global Navigation Satellite Systems

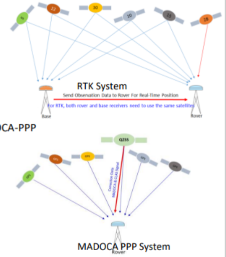
GNSS Data Processing for High-Accuracy Positioning using Low-Cost Receiver Systems

Online training program jointly organized by
Center for Spatial Information Science (CSIS) and International Committee on GNSS (ICG)
Date: 19 – 21 JANUARY 2021

This training program focuses on hands-on practices. After the training, the participants will be able to process GNSS Data for high-accuracy
- Use RTK and MADOCA PPP software to process GNSS data
- Use Low-Cost Receiver system data

Other Highlights:
- Learning and using RTKLIB, RTKDROID, MADROID and MAD-WIN software
- Understanding GNSS data types, GNSS errors, coordinate systems and applications
- Use of Android devices to log GNSS data for high-accuracy

Training Schedule
- Day 1: 19 JANUARY
  - Lectures: GNSS Introduction and Applications
  - GNSS Accuracy, Errors, Coordinate Systems
  - Sample Data, Data Processing Software
- Day 2: 20 JANUARY
  - GNSS Data Logging and Processing for RTK and MDOCA-PPP
  - Software: RTKLIB, RTKDROID, MADROID, MAD-WIN
- Day 3: 21 JANUARY
  - GNSS Data Processing by the Participants
  - Presentation of Data Analysis Results and Reports



Training Application Link:
GNSS Data Processing for High-Accuracy Positioning using Low-Cost Receiver Systems (office.com)
Application Deadline: 5th JANUARY 2021
Prerequisites : Knowledge of basic GNSS. If GNSS is new for you, please visit our past webinars and training materials and videos at :
https://home.csis.u-tokyo.ac.jp/~dinesh/WEBINAR.htm
2018: https://www.unoosa.org/oosa/en/ourwork/icg/activities/2018/ait-gnss.html
2019: https://www.unoosa.org/oosa/en/ourwork/icg/activities/2019/ait2019-gnss.html
2020: https://www.unoosa.org/oosa/en/ourwork/icg/activities/2020/ait2020-gnss.html
Number of participants will be limited to 250 persons.
The training will be conducted online from 06:00 – 11:00 UTC
CSIS and ICG reserve all rights for the selection of participants.

CSIS The University of Tokyo
ICG International Committee on Global Navigation Satellite Systems

GNSS for Policy and Decision Makers

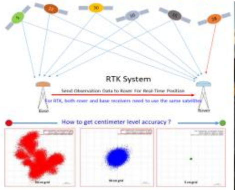
Online workshop jointly organized by
Center for Spatial Information Science (CSIS) and International Committee on GNSS (ICG)
Date: 28 JANUARY 2021

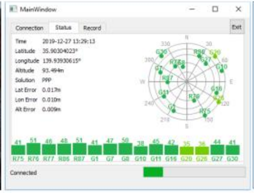
This workshop is designed to provide the following information:
General introduction of GNSS
- GNSS Applications and Its importance
- GNSS Accuracy, Errors, Coordinate Systems
- Required hardware and software for GNSS
  - Focusing standard and high-accuracy data processing
- Interpretation of GNSS specifications
- Low-Cost GNSS receiver systems
- Receiver selection guidelines

Reference to our past activities:
2018: https://www.unoosa.org/oosa/en/ourwork/icg/activities/2018/ait-gnss.html
2019: https://www.unoosa.org/oosa/en/ourwork/icg/activities/2019/ait2019-gnss.html
2020: https://www.unoosa.org/oosa/en/ourwork/icg/activities/2020/ait2020-gnss.html
https://home.csis.u-tokyo.ac.jp/~dinesh/WEBINAR.htm

Target Participants: People at policy and decision making level or who would like to pursue GNSS as a part of their career with working experiences
Training Application Link :
Global Navigation Satellite Systems (GNSS) for Policy and Decision Makers (office.com)
Application Deadline: 15 JANUARY 2021
Prerequisites : None
Please refer our past webinars and training materials for reference.
Number of participants will be limited to 250 persons
The training will be conducted online from 06:00 – 11:00 UTC

Sample GNSS data logged by base-stations, field receivers (both static and dynamic), GNSS data from Android devices etc. will be provided to explore data quality, accuracy and problems. Hands-on exercise with GNSS data using Google Earth and u-center software.





ICG Programme on GNSS Applications

Upcoming activities carried out in the framework of the ICG Workplan in 2022

International Workshop on Machine Learning for Space Weather: Fundamentals, Tools and Future Prospects, 7 - 11 November 2022, Buenos Aires, Argentina

Announcement (External Link): https://indico.ictp.it/event/9840/material/poster/0.pdf
Website (External link): https://indico.ictp.it/event/9840/

African Capacity Building Workshop on Space Weather Effects on GNSS, 3 - 14 October 2022, Trieste, Italy

Announcement (External Link): https://indico.ictp.it/event/9831/material/poster/0.pdf
Website (External link): https://indico.ictp.it/event/9831/

Technical Seminar on Reference Frames in Practice, 10 - 11 September 2022, Warsaw, Poland

Website (External link): https://www.fig.net/fig2022/rfip.htm

21st International Beacon Satellite Symposium 2022, 1 - 5 August 2022, Boston College, United States of America

Website (External link): https://www.bc.edu/content/bc-web/research/sites/institute-for-scientific-research/events-conferences/bss2022.html
Session 9: Ionospheric Effects on GNSS Augmentation Systems

(Hybrid Format) Regional Workshop on Global Navigation Satellite Systems (GNSS) and Space Weather, 9 - 13 May 2022, Rabat, Morocco, jointly organized with the Abdus Salam International Centre for Theoretical Physics (ICTP), the African Regional Centre for Space Science and Technology in French Language (CRASTE-LF), and Boston College

Announcement (External Link): http://indico.ictp.it/event/9778/material/poster/0.pdf
Website (External Link): http://indico.ictp.it/event/9778/
Presentations (External link): https://indico.ictp.it/event/9778/other-view?view=ictptimetable

Training Announcement in JAN 2022

Global Navigation Satellite Systems (GNSS) Training Programme, jointly organized by the Centre for Spatial Information Science (CSIS), The University of Tokyo (UTokyo), Japan and the International Committee on Global Navigation Satellite Systems (ICG)

Annoucement
Software and Dataset (External Website)

(Hybrid Format) GNSS Training Programme, 11 - 14 January 2022, Pokhara, Nepal

Programme
Presentations

(Online) Workshop on GNSS Applications for Policy and Decision Makers, 21 January 2022

Programme

Our Work

- Secretariat of COPUOS
- Programme on Space Applications
- UN-SPIDER
- International Committee on GNSS
  - Overview
  - Members
  - ICG Terms of Reference
  - Providers' Forum
  - Working Groups
  - ICG Annual Meetings
  - ICG Programme on GNSS Applications
    - Workshops
  - Resources
  - ICG Documents
  - Other Events
  - ICG Timeline
- UN-Space
- UNISPACE+50
- Space Law
- Benefits of Space
- Space4Health
- Access to Space for All
- Space for Persons with Disabilities
- Space4Youth
- Space4Water
- Space4Women
- World Space Forum
- Worldwide Space Agencies
- Capacity Building Activities

Summary of GNSS Trainings: Jointly Organized by CSIS and ICG/UNOOSA

Course A: GNSS Data Processing for High-Accuracy Positioning using Low-Cost Receiver Systems, 19 – 21 JAN
Course B: GNSS for Policy and Decision Makers, 28 JAN 2022

Training Mode / Location	**Hybrid-Training Venue: Nepal**		**Online GNSS Training**		**GNSS Trainings Venue: AIT, Thailand**		
Date and Duration	**11 – 14 Jan 2022 3 days**	**28 Jan 2022 1 day**	**19 – 21 Jan 2021 3 days**	**28 Jan 2021 1 day**	**JAN 2020 5 days**	**JAN 2019 5 days**	**JAN 2018 5 days**
Course Type	Course A	Course B	Course A	Course B	T-151	T-151/T-131	T-141
(A) ICG Funded International (travel only)	(5 awarded but Cancelled due to Corona Situation, attended online)	NA	NA	NA	19	23	14
(B) Other Funding (travel only)	NA	NA	NA	NA	X	4[E]	X
(C) Self Funded International	(3 but cancelled due to Corona Situation, attended online)	NA	NA	NA	34	40	11
(D) Self-Funded Domestic (Thailand or Nepal)	30 (On-site Nepal)	NA	NA	NA	18	27	42 (24 + 18)
(E) Online Participants	**45**	**25**					
Total (A + B + C + D + E)	**75**	**25**	**270**	**160**	**71**	**94**	**67**
Number of Applicants	**90**	**40**	360	190	160+	180+	80+
Number of Resource Persons	**13**	**3**	15	6	16 7 (Int) + 9 (GIC)	20 11 (Int) + 9 (GIC)	13 7 (Int) + 6 (GIC)
Number of Countries	**16**	**10**	70+	60+	15	15	15
Resource Persons' Countries	**7**	**2**	4	3	4	7	4

ICG / UTOKYO GNSS Training 2023 (Hybrid Format)

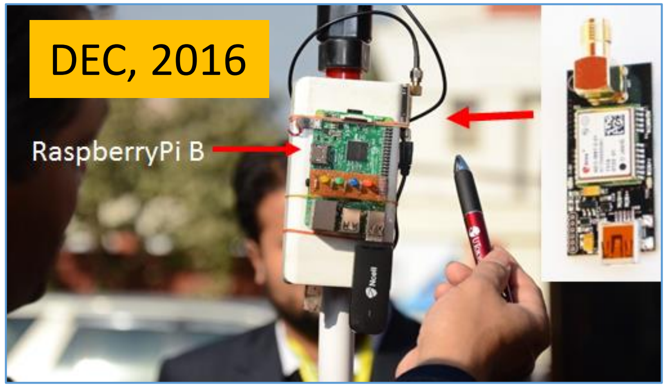
- Program – 1 : GNSS Training
- Program – 2 : Workshop on GNSS for Policy and Decision Makers
- Dates
  - Program 1: xx January 2023
  - Program 2: xx January 2023
- Venue
  - Onsite : Tribhuvan University, Pokhara, Nepal
  - Online
- Notice will be announced soon. Please check ICG's homepage.

On-Site participants during opening ceremony of ICG/UTOKYO GNSS Training in January 2022

Installation of Base-Stations in Universities for Capacity Building

Country	Place	University	Receiver Type
Indonesia	Jakarta	University of Indonesia	GNSS, GNSS + MADOCA
Japan	Tokyo-A	The University of Tokyo	GNSS, GNSS + MADOCA
Japan	Tokyo-B	Tokyo University of Marine Science & Tech.	GNSS, GNSS + MADOCA
Japan	Tokyo-C	KEIO University	GNSS
Laos	Vientiane	National University of Laos	GNSS
Malaysia	Kuala Lumpur	Malaysia Japan International Institute of Tech.	GNSS, GNSS + MADOCA
Myanmar	Yangon	Yangon Technological University	GNSS
Thailand	Bangkok	Chulalongkorn University	GNSS, GNSS + MADOCA
Thailand	Pathumthani	Asian Institute of Technology	GNSS
Thailand	Bangkok	Kasetsart University	GNSS
Thailand	Khon Kaen	Khon Kaen University	GNSS
Philippines	Manila	University of the Philippines	GNSS, GNSS + MADOCA
Vietnam	Ho Chi Minh City	International University Vietnam National University	GNSS
Vietnam	Hanoi	Will be installed early next year	GNSS + MADOCA
Mozambique*	Maputo	Universidade Eduardo Mondlane	GNSS
Singapore	Singapore	Nanyang Technological University	GNSS + MADOCA
Australia	Perth	Curtin University	GNSS + MADOCA

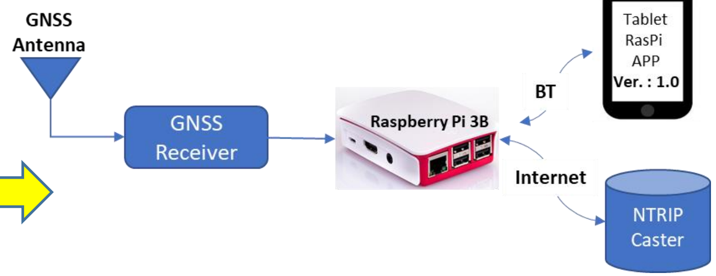
Low-Cost High-Accuracy Receiver system Development Cycle



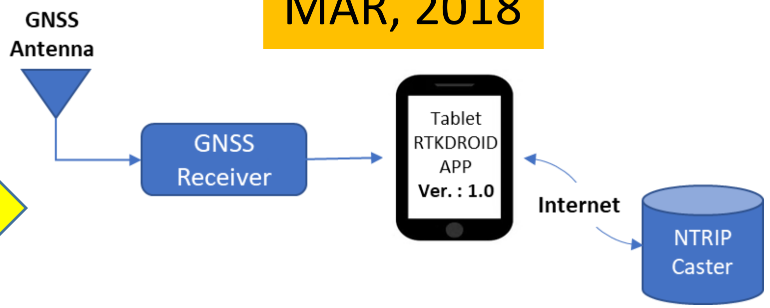
Demo during UN/Nepal GNSS workshop

MAY, 2017

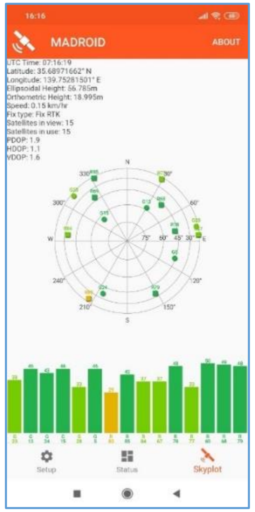
Low-Cost RTK

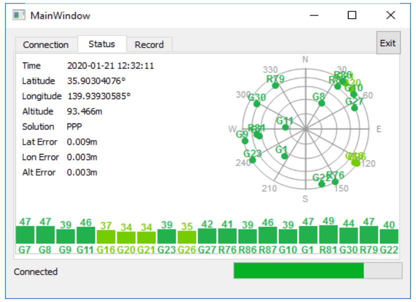


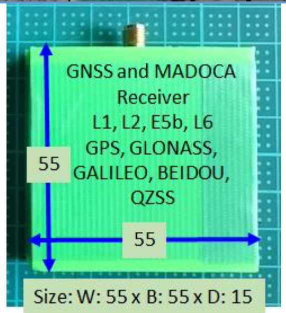
MAR, 2018



Low-Cost MADOCA







DEC, 2019

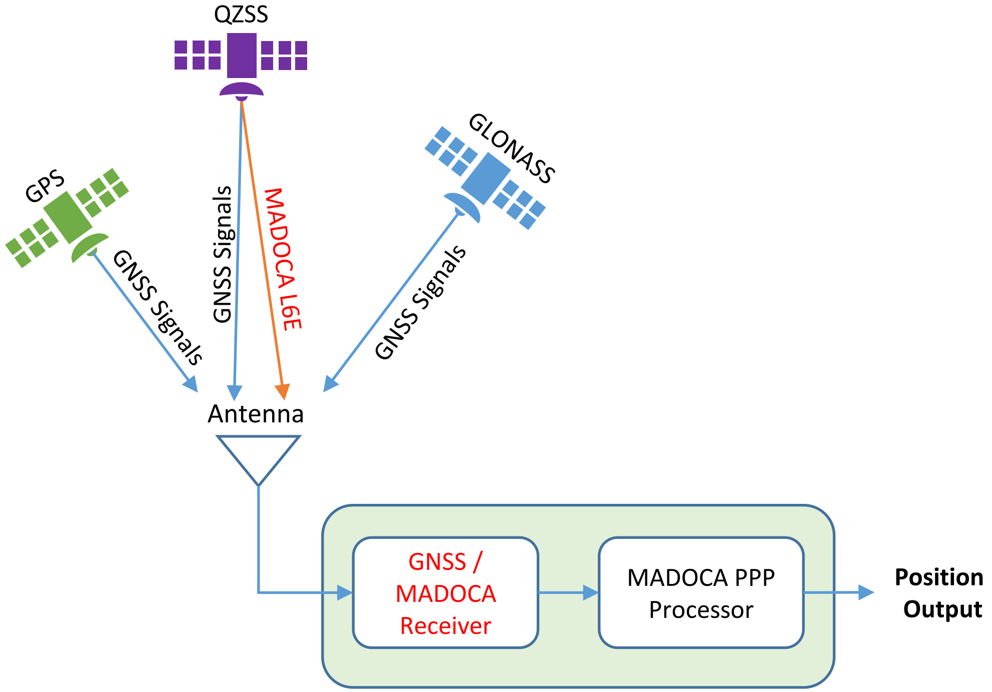
What Application or System Do you Want?

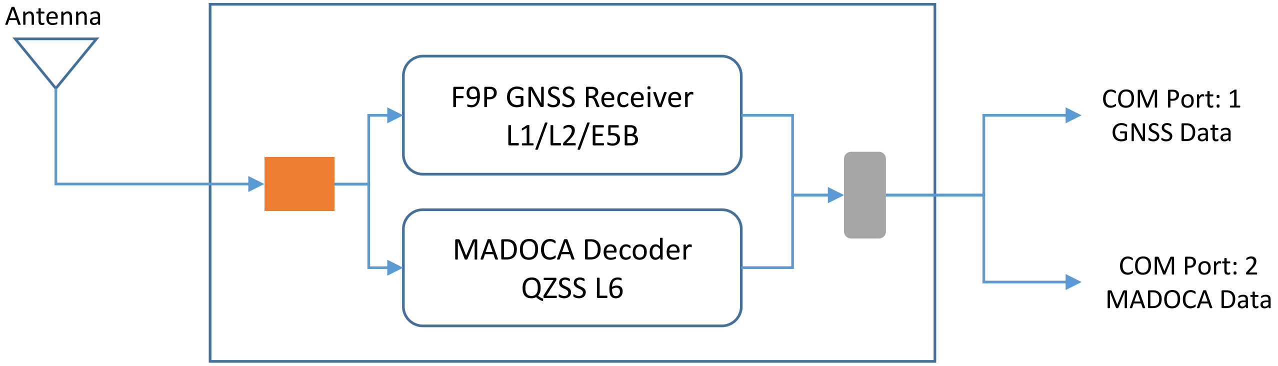
- Enhancement of MADOCA System 2022 / 2023
- Android Device based Applications RTK / MADOCA / EWS / SAR
- Space Weather Applications
- Dynamic Air Quality Monitoring System

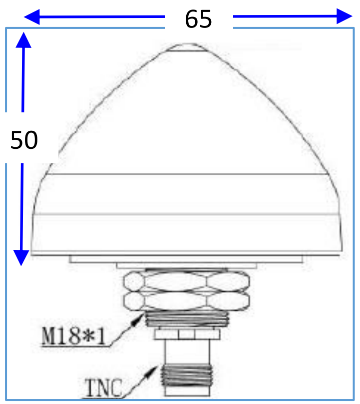
2022 - 2023

Low-Cost MADOCA Receiver System

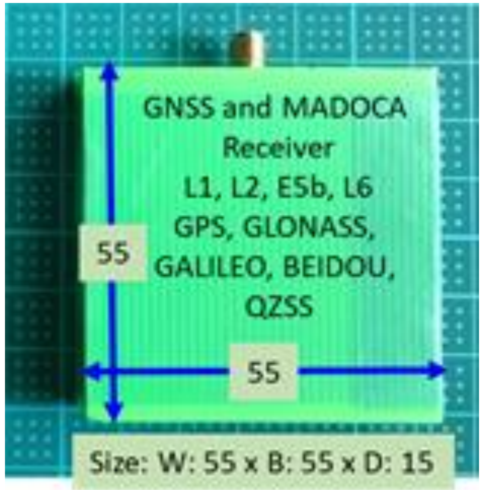
GNSS Receiver + MADOCA Decoder



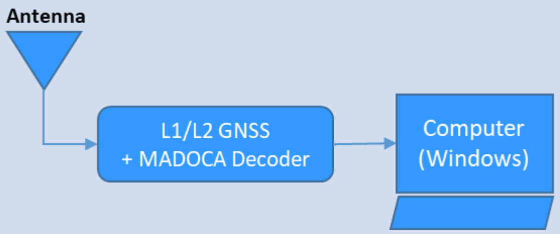
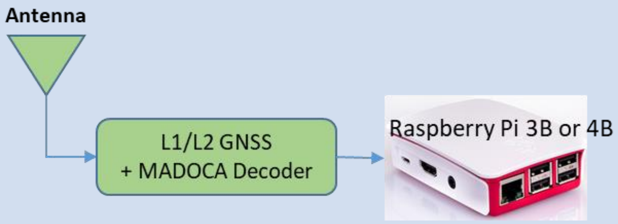
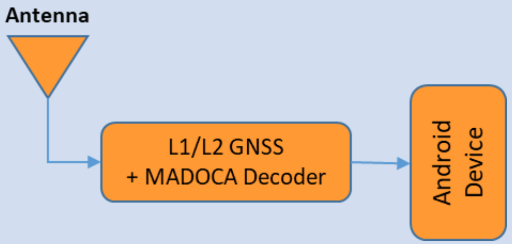




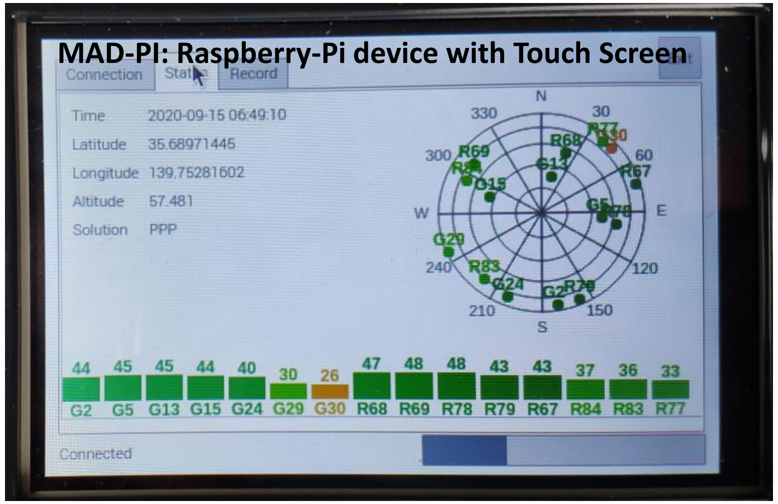
GNSS Antenna

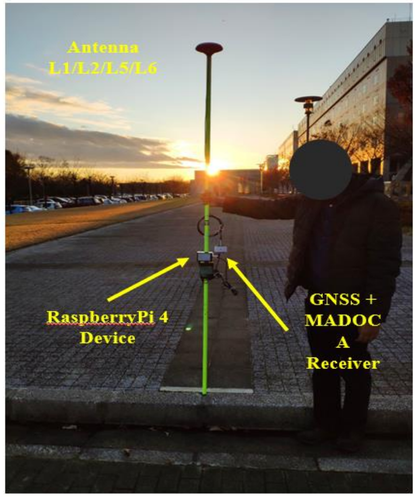


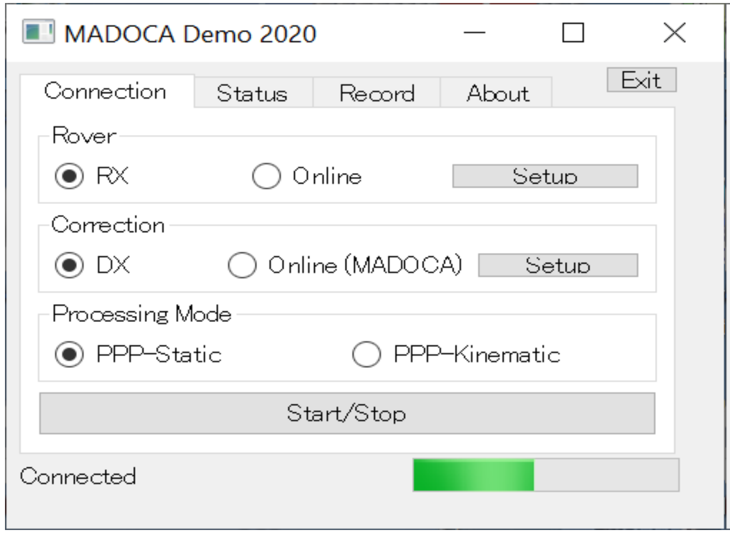
Low-Cost MADOCA Receiver Systems: Product Types

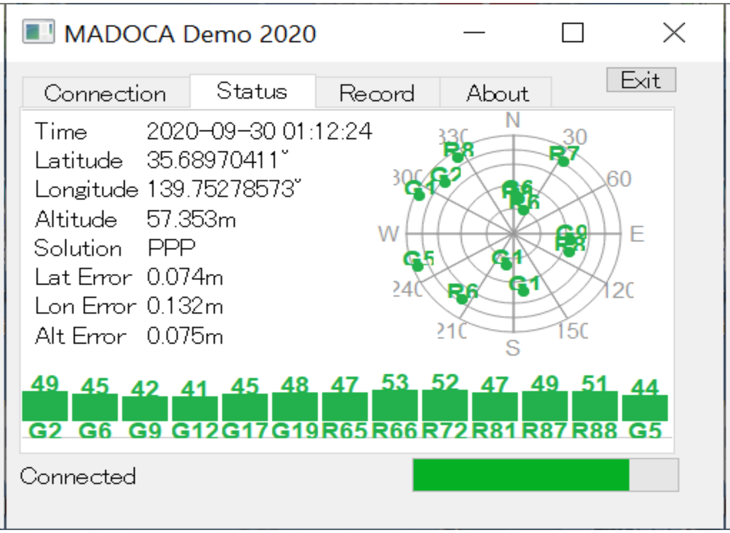
	MAD-WIN	MAD-π	MADROID
Platform / OS	Windows	RaspberryPi 3B or 4B	Android Device
GNSS Receiver	Default : u-blox F9P Other: Any dual-frequency Receiver	Default : u-blox F9P only	Default : u-blox F9P Other: Any dual-frequency Receiver
MADOCA Receiver	U-blox D9 only	U-blox D9 only	NA (MADOCA Online Correction Data only)
GNSS Receiver Data Format	UBX, SBF, RTCM3	UBX SBF, RTCM3 (For online GNSS data)	UBX
MADOCA Correction Data Format (Satellite)	UBX only	UBX only	UBX only
MADOCA Correction Data Format (Online)	Online Services from GPAS, UTokyo (Test Level) UBX or RTCM3	Online Services from GPAS, UTokyo (Test Level) Online Services UBX or RTCM3	GPAS Services, RTCM3 UTokyo Online Service in the next release
System Architecture			

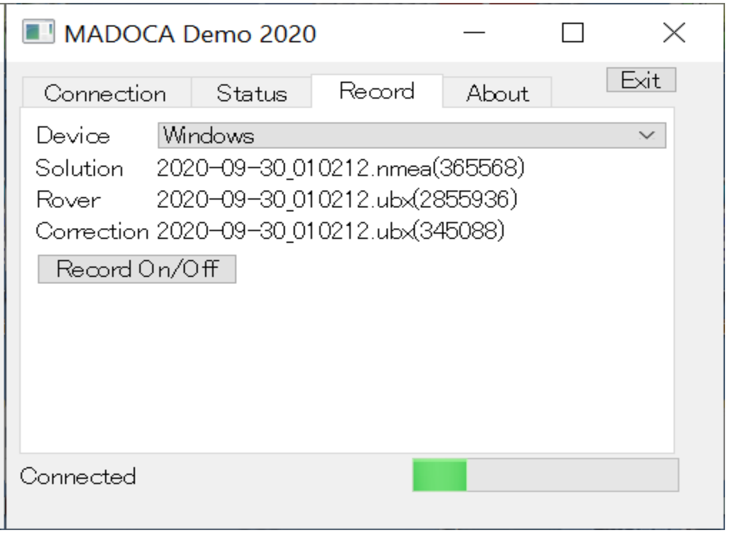
MAD-WIN and MAD-PI System and User Interface









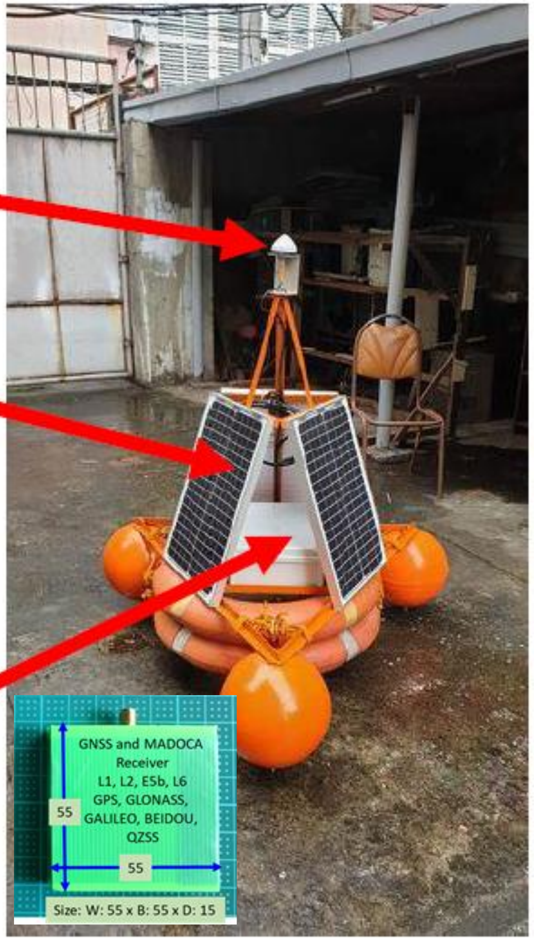


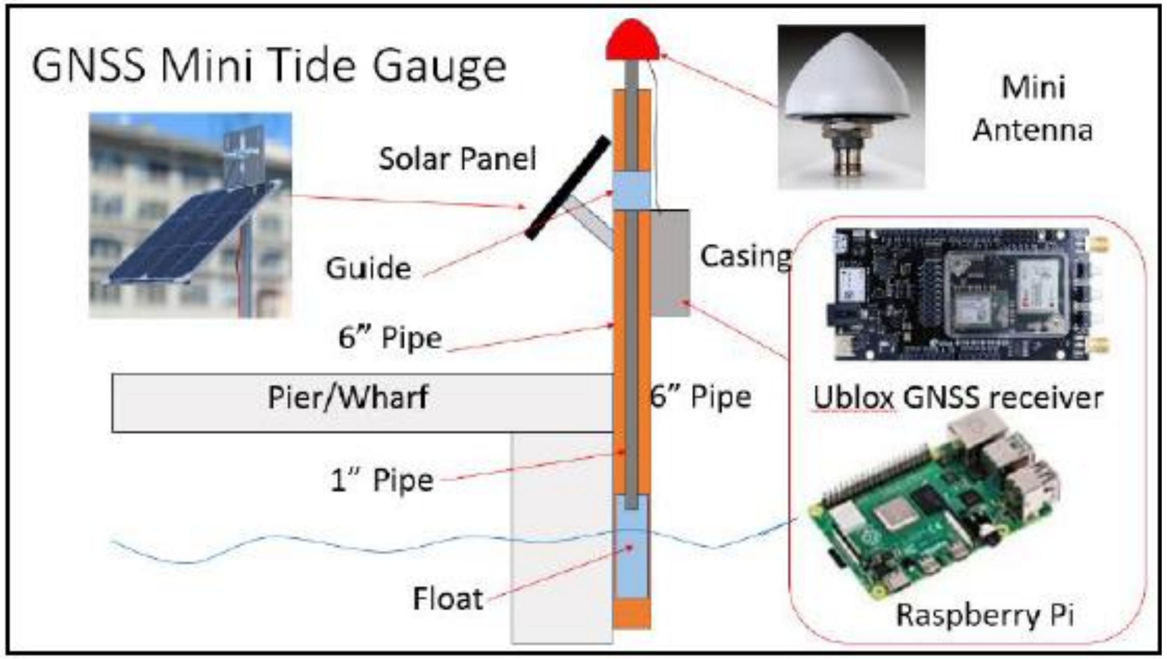
Low-Cost MADOCA Receiver for Sea-Level Rise Measurement

GNSS antenna

Solar power

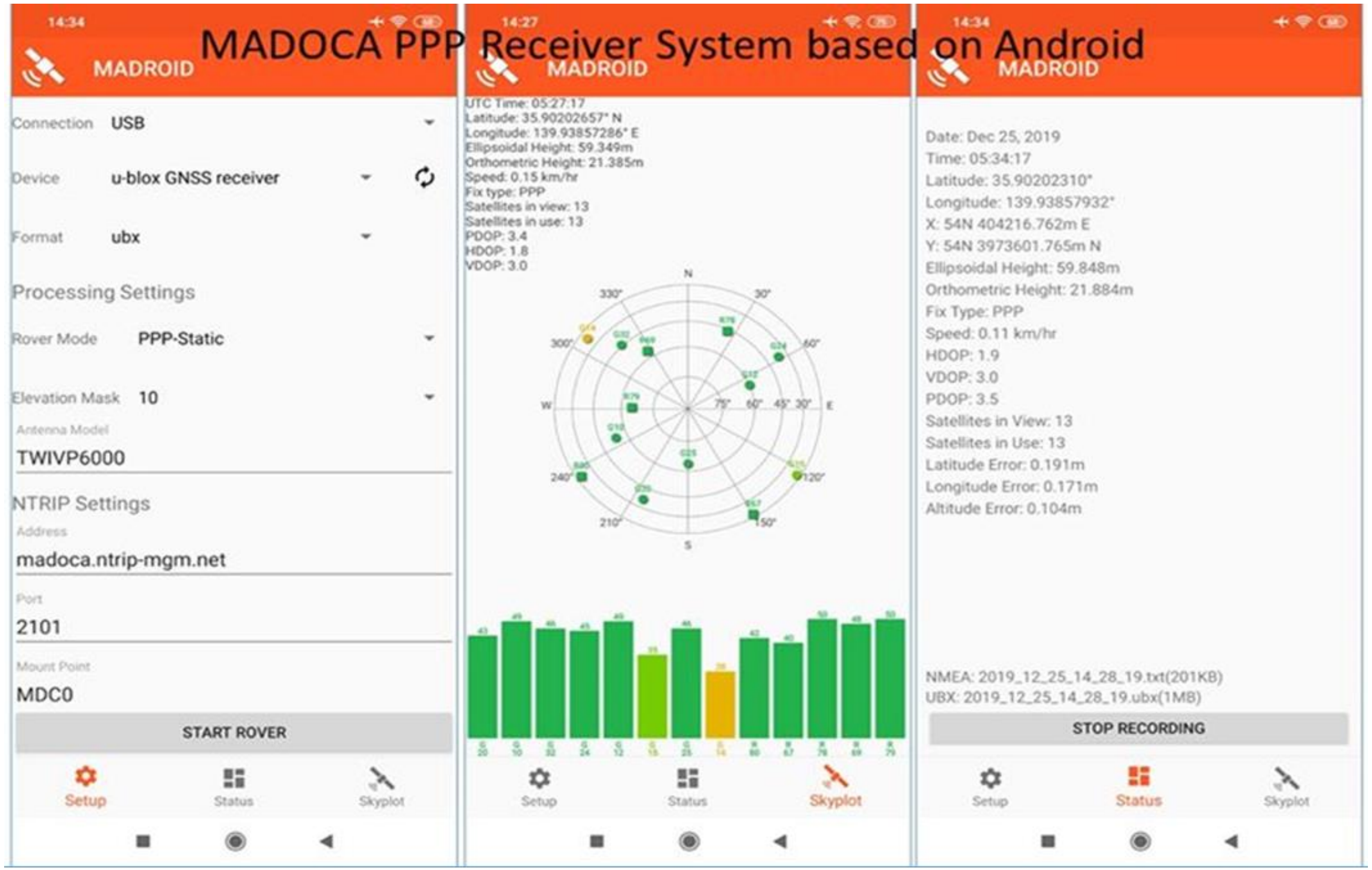
TiBox enclosure containing the battery, raspberry pi and Ublox and MADOCA decoder





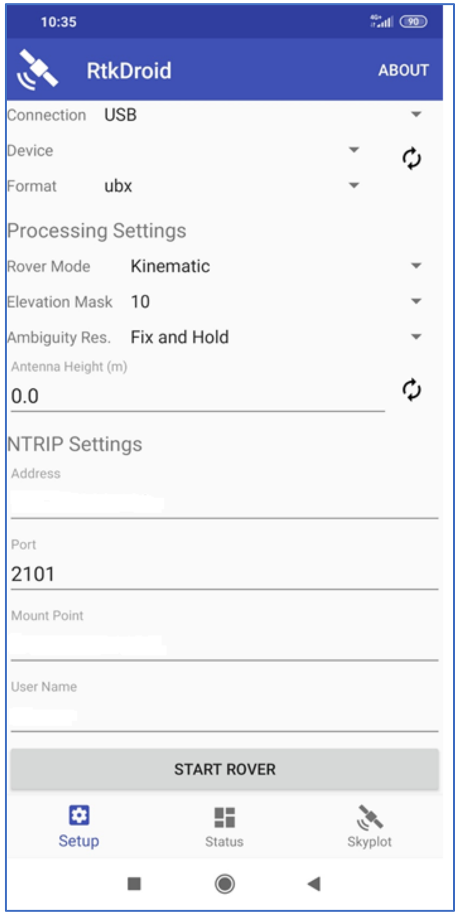
Source: Technical Report, GNSS/QZSS MADOCA PPP Data Acquisition for Sea Level Rise Measurement, DR. ROSALIE B. REYES, UP DGE and Project Leader, CLSR-Phil Project

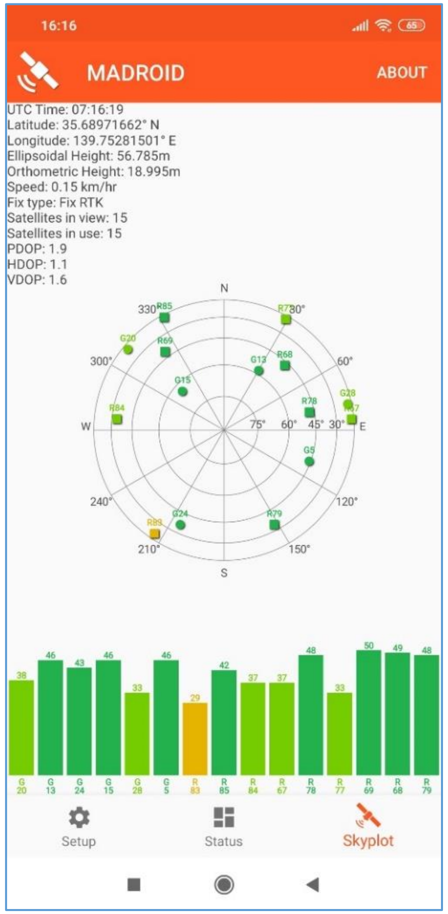
MADROID: MADOCA with Android Device



Android APPs for GNSS Data Logging & Processing

- RTKDROID
  - Real-Time RTK for Android devices
  - Based on RTKLIB
  - Already Released – Distribution by Request
    - Send e-mail to dinesh@csis.u-tokyo.ac.jp
- MADROID
  - Real-Time MADOCA-PPP based on MADOCA correction data
  - Based on u-blox F9P dual frequency receiver
  - Already Released – Distribution by Request
    - Send e-mail to dinesh@csis.u-tokyo.ac.jp

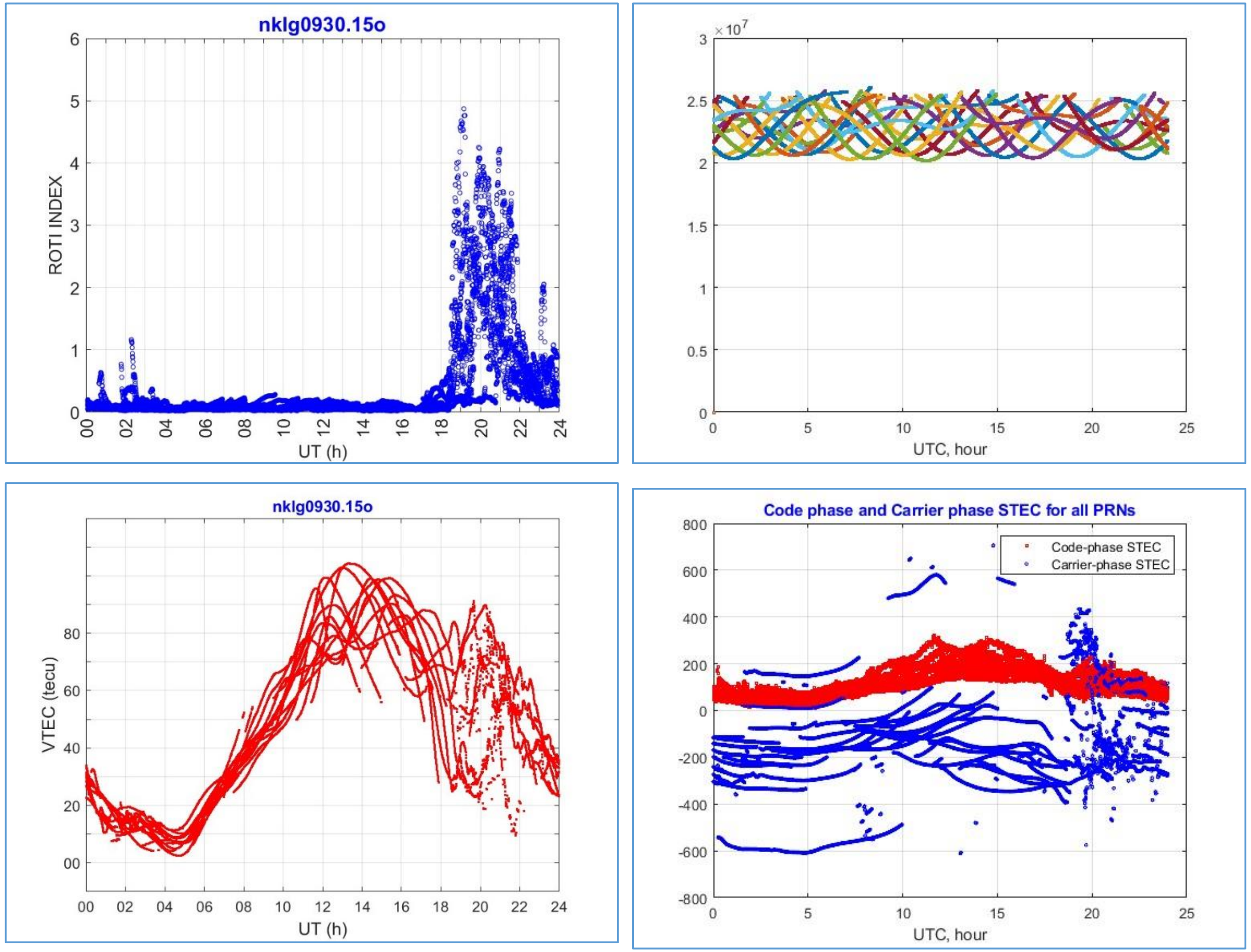




Low-Cost GNSS Receiver System for Space Weather Applications

- Explore Low-Cost GNSS Receivers that can be used to compute ionosphere related parameters TEC, S4 index etc.
- Explore software that can be used for processing data from low-cost GNSS receivers to compute TEC, S4 and other space weather related parameters.
- Develop prototype low-cost GNSS receiver system for remote unattended data logging.

Output of TEC computation from Matlab based software: FLEURY



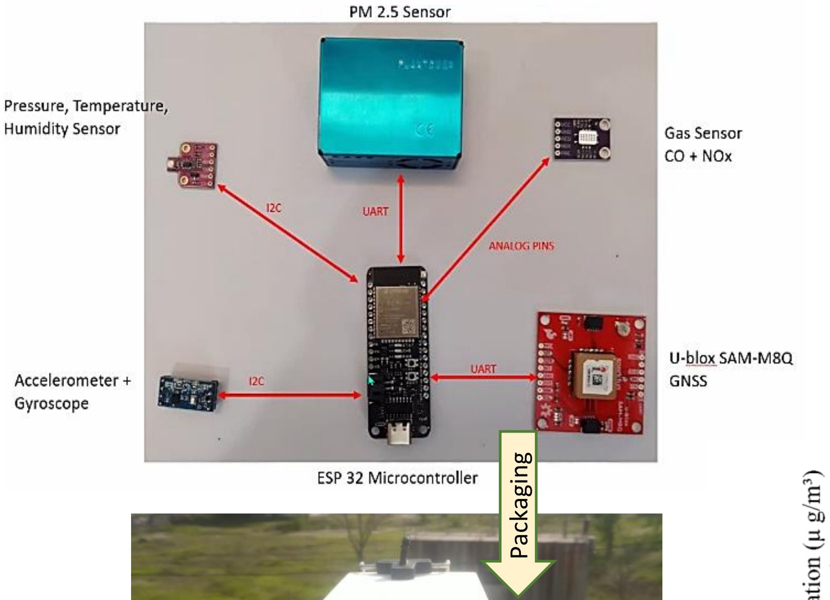
Matlab source files to compute TEC parameters are provided by Rolland Fleury
These outputs are from sample data provided by Fleury
We will modify the software to process data from low-cost GNSS receivers in different RINEX version.

Low-Cost Dynamic Air Quality Monitoring System

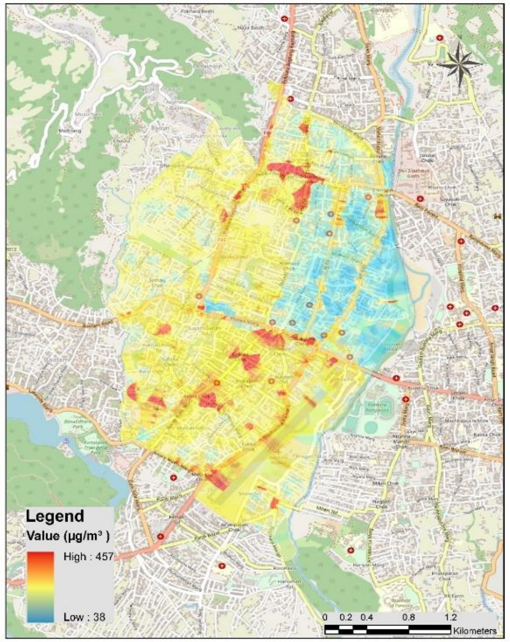
Pokhara City, Nepal
Top: During Corona Lockdown period
Bottom: During dusty and forest fire days

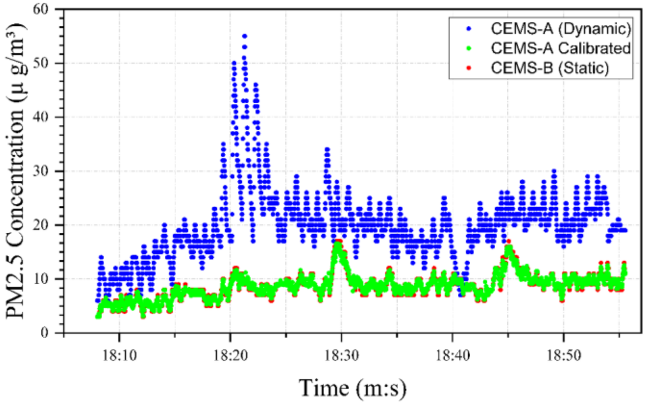
Source : RONB

- GPS, Accelerometer, Gyroscope
- PM1.0, 2.5, 10 sensor
- Pressure, Humidity, Temperature (PHT) Sensor
- Gas Sensor (CO and NOx)
- WiFi, BT and SD Micro Memory Card
- Total Device Cost: $200



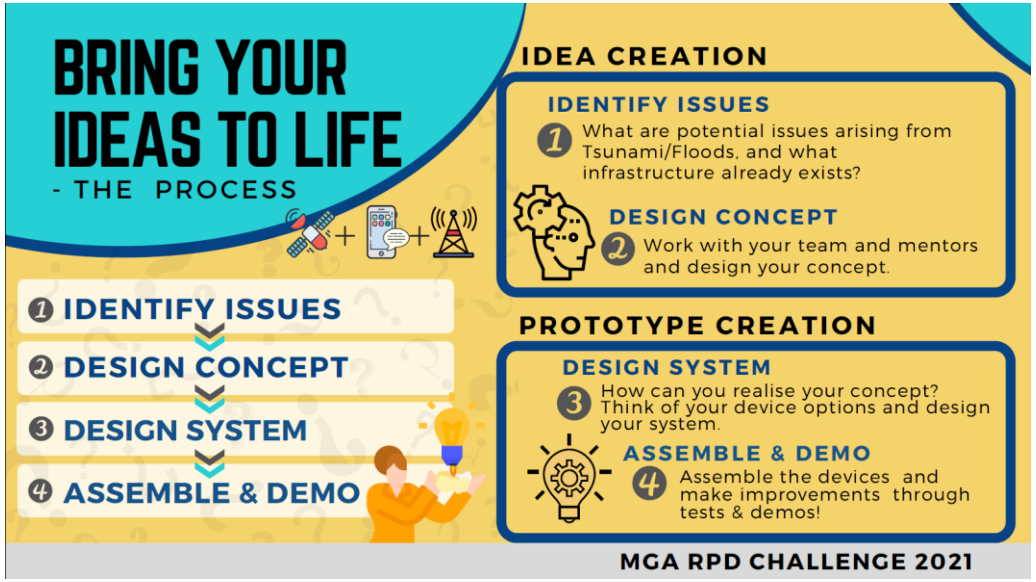
PM2.5 Concentration of Pokhara Valley





MGA (Multi-GNSS Asia) Activities: RPD Challenge

https://www.rpdchallenge.com/



IPNTJ

Tokyo University of Marine Science and Technology

GNSS Summer School 2022

MULTI GNSS ASIA

QZSS Services

Period : 2022/08/28- 09/01 (6-days)

Venue : On-line by Zoom

Organized by Institute of Positioning, Navigation and Timing of Japan (IPNTJ)

Co-organized by Faculty of Marine Technology,

Tokyo University of Marine Science and Technology (TUMSAT)

Supported by Septentrio, Komine Musen Denki and u-blox

小峰無線電機株式会社
KOMINE MUSEN DENKI CO.,LTD.

Applicants 2022/08

Country		Country		Country	
Afghanistan	5	India	26	Singapore	2
Austria	1	Indonesia	54	South Africa	2
Bangladesh	1	Iraq	6	Spain	5
Brazil	1	Italy	3	Sri Lanka	8
Cambodia	1	Japan	9	Switzerland	1
Cameroon	3	Kosova	1	Taiwan	1
Canada	1	Malaysia	8	Thailand	3
China	9	Mongolia	4	Turkey	5
Colombia	1	Morocco	4	Uganda	1
Ecuador	1	Nepal	21	Ukraine	1
Egypt	17	Nigeria	2	United Kingdom	3
Finland	5	Oman	1	United States	1
France	5	Pakistan	19	Vietnum	2
Germany	12	Philippines	15		
Hong Kong	2	Russia	2		
				total	275

Number of attendees did not exceed 100

Program Schedule

Virtual GNSS Summer School 2022 Organized by IPNTJ Co-organized by TUMSAT

	29-Aug	30-Aug	31-Aug	1-Sep
JST	Monday	Tuesday	Wednesday	Thursday
1200-1330	Introduction	B-1 Software for basic	Class C-1 SDR-Receiver	1200 Special Lecture 4
1330-1340	Break	Break	Break	1300-Special Lecture 5
1340-1510	Class A-1- Positioning with GNSS and satellite orbits	B-2 Software for basic positioning	Class C-2 SDR-Demo Break	1400 Special Lecture 6 Break
1510-1540	Break	Break	Special Lectures	D-1 Practice on SDR receiver with RTKLIB Part I, Part II.
1540-1710	Class A-2-GNSS Signals	B-3 Introduction of RTKLIB	1510 Special Lecture 1	
1710-1720	Break	Break		
1720-1850	Class A-3-Generic GNSS receiver theory	B-4 RTKLIB DEMO	1610 Special Lecture 2 1710 Special Lecture 3	Closing
	1 class=90 minutes			

Instructors		
	Introduction / Closing	Dr. Akio Yasuda / Dr. Nobuaki Kubo (TUMSAT)
	Class-A : Fundamentals	Dr. Ivan G. Petrovski (iP-Solutions)
	Class-B : Software	Dr. Tohru Takahashi, B-1,2 (ENRI)
		Mr. Tomoji Takasu , B-3,4 RTKLIB & Demo
	Class-C: Receiver	Dr. Taro Suzuki, C1,2, SDR-Demo (CIT)
	Class-D: SDR Practice	Dr. Ivan G. Petrovski (iP-Solutions.)

Special Lectures

- GNSS Satellite Products for Positioning : Dr. Urs Hugentobler (Technical University of Munich)
- Update of Galileo : Dr. Peter Buist (Galileo Reference Center, EUSPA)
- PPP Tropospheric Estimation : Dr. Gerard Lachapelle (The University of Calgary)
- Introduction of QZSS : Dr. Rui Hirokawa (Mitsubishi Electric)
- NavIC lecture : Dr. Anindya Bose (The University of Burdwan)
- GNSS Signal Security : Dr. Dinesh Manandhar (The University of Tokyo)

IPNTJ

TUMSAT Tokyo University of Marine Science and Technology

GNSS Summer School 2023

By TUMSAT and IPNTJ

Period : 2023/07/31- 08/05

Venue : TUMSAT, Tokyo, Japan

Invite about 20 from abroad

With a lot of Practices and Trainings

Organized by Faculty of Marine Technology,

Tokyo University of Marine Science and Technology (TUMSAT)

Co-organized by Institute of Positioning, Navigation and Timing of Japan (IPNTJ)

Supported by Sakura Science Project, JST

Link for Reference Materials

- Lab Home Page
  - https://www.csis.u-tokyo.ac.jp/en/
  - https://home.csis.u-tokyo.ac.jp/~dinesh/
- GNSS Training Materials, Data etc.
  - https://home.csis.u-tokyo.ac.jp/~dinesh/GNSS_Train.htm
- Low-Cost High-Accuracy Receiver Systems
  - https://home.csis.u-tokyo.ac.jp/~dinesh/LCHAR.htm
- GNSS Webinar
  - https://home.csis.u-tokyo.ac.jp/~dinesh/WEBINAR.htm
  - https://gnss.peatix.com
- Link to Documents, Software, Android APP etc.
  - https://home.csis.u-tokyo.ac.jp/~dinesh/Download.htm
- Facebook : https://www.facebook.com/gnss.lab (GNSS Related)
- Contact : dinesh@csis.u-tokyo.ac.jp