International Committee on Global Navigation Satellite Systems

United Nations/Azerbaijan Workshop on ISWI
31 October – 4 November 2022, Baku

Sharafat Gadimova
Office for Outer Space Affairs

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International Committee on GNSS (ICG)

- UNOOSA serves as the executive secretariat of ICG

- Established in 2005, ICG provides a mechanism for multilateral discussion and coordination on GNSS issues of concern

- Encourages **coordination** among GNSS providers

- **Promotes** the introduction and utilization of GNSS services in developing countries

- **Assists** GNSS users with their development plans and applications

- Assure GNSS **interoperability and compatibility** among providers and users globally for enhanced services and applications

WWW.UNOOSA.ORG

WWW.UNOOSA.ORG/OOSA/EN/OURWORK/ICG/ICG.HTML

ICG: Working Groups

▪**Systems, Signals and Services (*United States & Russian Federation*):** Compatibility and spectrum protection; interoperability and service standards; system-of-system operations

▪**Enhancement of GNSS Performance, New Services and Capabilities (*India, China & ESA*):** Future & novel integrity solutions; implementation of interoperable GNSS Space Service Volume (SSV) and its evolution; *examination of performance of atmospheric models, establish dialogue with space weather/RS community*

▪**Information Dissemination and Capacity Building (*UNOOSA*):** Focused on education and training programmes, *promoting GNSS for scientific exploration (incl., space weather and its effects on GNSS*)

▪**Reference Frames, Timing and Applications (*IAG, IGS & FIG*):** Focused on monitoring and reference station networks

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Working Group on Information Dissemination and Capacity Building

Wildlife Conservation

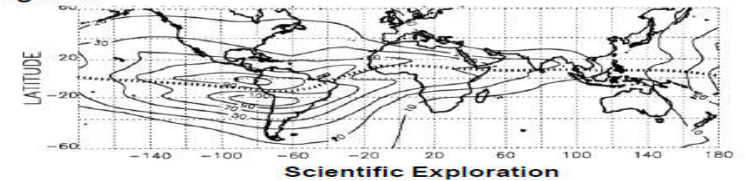Land Navigation

Precision Farming

Air Navigation

Water Navigation

Disaster Relief

Scientific Exploration

Regional Workshops/training courses on the use and applications of GNSS:

- To reinforce the exchange of information between countries and scale up the capacities in the regions for pursuing the application of GNSS solutions

- To provide updated knowledge of how GNSS operate and their applications; to describe the science of SW; and how to perform ionospheric and SW research with GNSS data

Interoperable GNSS Space Service Volume

- All providers have agreed on the information presented in this booklet, and on several recommendations to continue development, support, and expansion of the multi-GNSS SSV concept.
- This publication, and the work of WGB, show the significant value of GNSS SSV for a much wider scope of future space exploration activities for countries all over the world.
- GNSS SSV and its potential augmentations can enable ambitious future missions and activities in the context of space exploration going beyond low-Earth orbit to the Moon, Mars and other celestial bodies.

https://www.unoosa.org/res/oosadoc/data/documents/2021/stspace/stspace75rev_1_0_html/st_space_75rev01E.pdf

(1) Explore Low-Cost GNSS Receivers for Space Weather Applications

We will explore at least two types of receivers
- u-blox F9P
- Septentrio (MOSAIC)

Criteria for Receiver Selection
- Any receiver that is capable to output raw data
- Dual frequency receiver
- Price less than $1,000

	U-Blox F9P	Septentrio MOSAIC	Other Brand (To be Explored)
GNSS	GPS, GLONASS, Galileo, BeiDou, QZSS, SBAS	GPS, GLONASS, Galileo, BeiDou, QZSS, SBAS	
Frequency Bands	L1, L2, E5b	L1, L2, L5	
Raw Data	Code Phase, Carrier Phase, Doppler, Signal quality related data	Code Phase, Carrier Phase, Doppler, Signal quality related data	
Navigation Frame Data	Yes including data bits	Yes including data bits	
Output Rate	Max 20Hz	Upto 100 Hz for Measurement 50Hz for RTK	
RTK / PPP Capable	Yes	Yes	
TEC Computation	Yes (To be checked)	Yes (To be checked)	
S4 Computation	To be explored	To be explored	
Price (USD)	300	700	

https://shop.septentrio.com/en/shop/mosaic-go-gnss-module-receiver-evaluation-kit

https://content.u-blox.com/sites/default/files/ZED-F9P_ProductSummary_UBX-17005151.pdf

Note: We have no preferences of whatsoever on any brand or name. The receivers are selected based on our selection criteria. Any suggestions on receiver types are highly appreciated.

(2) Explore Software to Compute Space Weather Parameters

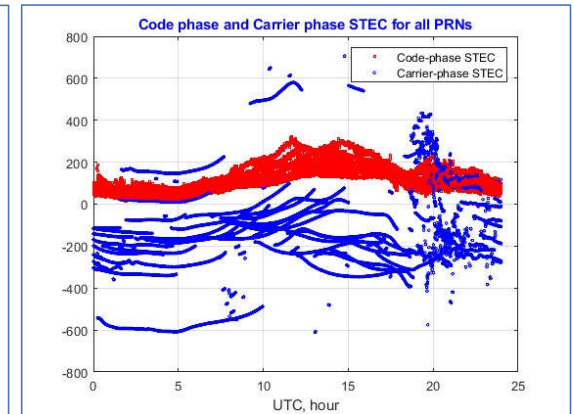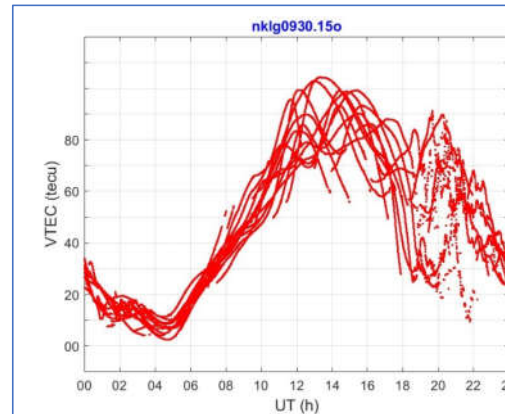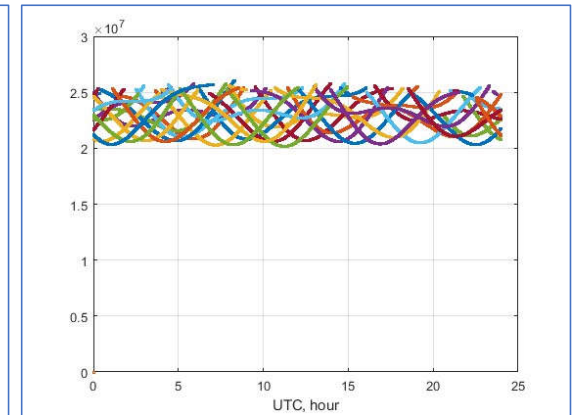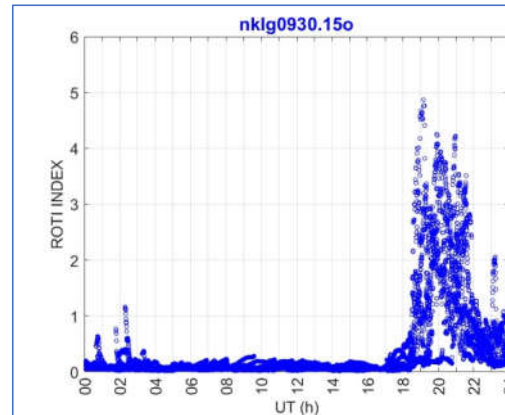Output of TEC computation from Matlab based software: FLEURY

- Explore software that can be used for processing data from low-cost GNSS receivers to compute TEC, S4 and other space weather related parameters.
  - FLEURY
    - Available with source code
  - GOPI
    - Only Binary executable program
  - NeQuick
    - Source available with registration

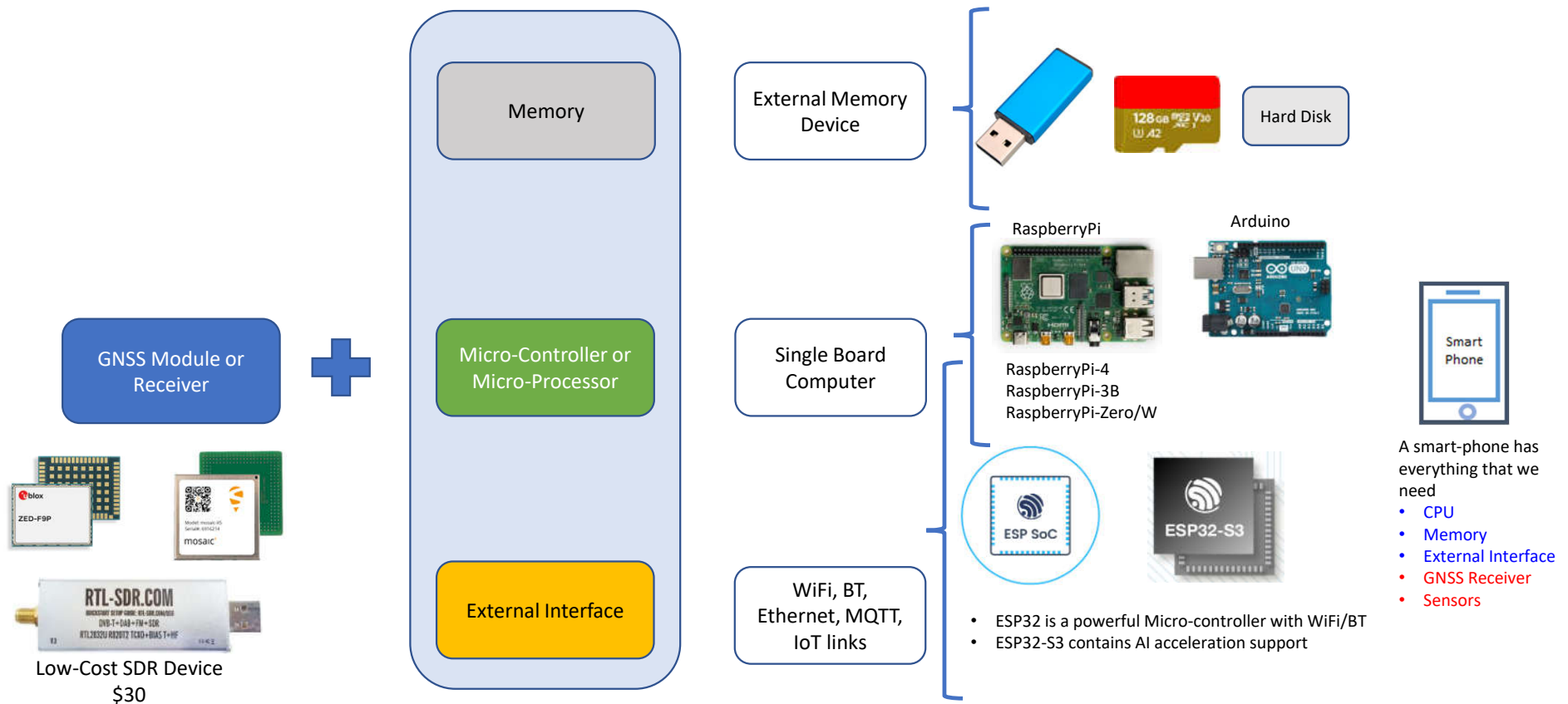*Matlab source files to compute TEC parameters are provided by Rolland Fleury*
These outputs are from sample data provided by Fleury
*We will modify the software to process data from low-cost GNSS receivers*

How to Make a Low-Cost GNSS Receiver System?

GNSS Module or Receiver **+**

Low-Cost SDR Device $30

Memory
→ **External Memory Device**

Hard Disk

Micro-Controller or Micro-Processor
→ **Single Board Computer**

RaspberryPi

Arduino

RaspberryPi-4
RaspberryPi-3B
RaspberryPi-Zero/W

External Interface
→ **WiFi, BT, Ethernet, MQTT, IoT links**

ESP SoC

ESP32-S3

- ESP32 is a powerful Micro-controller with WiFi/BT
- ESP32-S3 contains AI acceleration support

Smart Phone

A smart-phone has everything that we need
- CPU
- Memory
- External Interface
- GNSS Receiver
- Sensors

- Note: We use these modules for high accuracy positioning system based on RTK and MADOCA PPP or other GNSS/QZSS special applications.
- There are many other GNSS modules as well. We have no intention of any purpose to name some of the makers here.

(3) Design Low-Cost GNSS Receiver System for Data Logging

- Design low-cost GNSS receiver system for unattended data logging
  - Integrate receiver module with RaspberryPi device or ESP32 module or single board computer
  - Log GNSS data automatically to a local memory device
  - Connect the device to a remote server via internet

- Explore different types of configurations
  - Type – A
  - Type – B
  - Type – C

- Requirements
  - The system shall be able to Log raw data when power is connected.
  - Recover all setups including network information when the receiver is rest or power supply is turned off and on.
  - Connect remote server or NTRIP caster automatically.
  - Log raw data locally in a SD Card.

Type - A

U-blox F9P

Type - B

U-blox F9P

Type - C
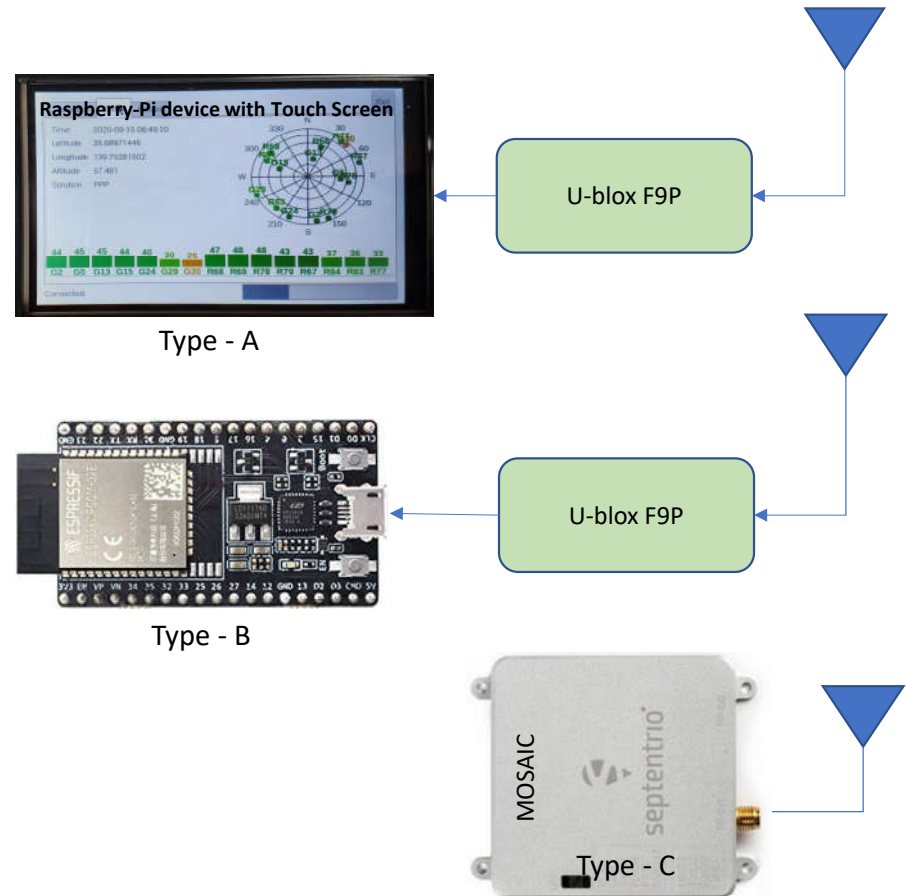
THANK YOU

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