

Working Group C: Information Dissemination and Capacity Building

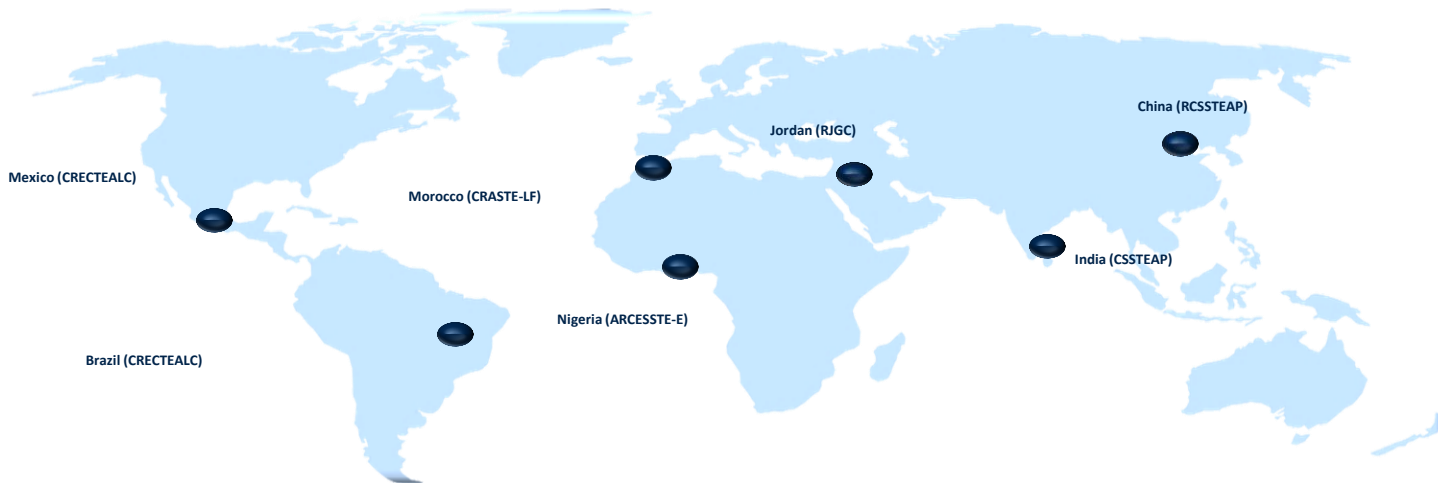
Space Weather monitoring using low-cost GNSS receiver systems (WG C)

- ❑ Exploring low-cost GNSS receivers (*any receiver that is capable to output raw data, dual frequency receiver, cost*) that satisfies space weather needs both in terms of scintillation and total electron content
- ❑ Exploring software that could be used to process data from low-cost GNSS receivers in order to compute TEC
- ❑ Design a prototype low-cost GNSS receiver for space weather related applications
 - (ICTP) Performance in estimating TEC is *comparable to those of geodetic/scientific grade receivers and can therefore be used to monitor the ionosphere*
 - (The University of Tokyo) *Data formats and processing algorithms shall be standardized for uniform results*
 - (Boston College) *Space weather monitoring implies TEC and scintillation (both phase and intensity), and the preliminary results are promising. Full analysis of performance including tracking and other characteristics are in progress*

https://www.unoosa.org/oosa/en/ourwork/psa/schedule/2023/2023-iswi-workshop_presentations.html

Information Dissemination and Capacity Building

- ❑ **Regional Workshops/Training Courses** to provide updated knowledge of how GNSS operate and their applications, to describe the science of space weather and how to perform ionospheric and space weather research with GNSS data
 - ❑ Workshop on ISWI, 26 – 30 June 2023, Vienna
 - ❑ *Germany (June, 2024), Nigeria (2025) and Republic of Korea (2026)*
 - ❑ Workshop on the applications of GNSS, 23 – 26 October 2023, Finland
 - ❑ *Spain (March, 2024), Philippines (April, 2024)*



Information Dissemination and Capacity Building

Eastern Africa Capacity Building Workshop on Space Weather and Low-latitude Ionosphere

3 - 12 October 2023
Luigi Broglio - Malindi Space Centre, Kenya

Cooperation ICG, ICTP and Boston College: *Provide training courses: focusing on the use of SW instruments for scientific research and for SW effects*



FIG WORKING WEEK 2023
28 May - 1 June, 2023, Orlando, Florida, USA



Protecting Our World, Conquering New Frontiers

The Technical Seminar on Reference Frames in Practice: on reference frames in general with a specific focus on UN initiatives, global and regional frames as well selected national case studies

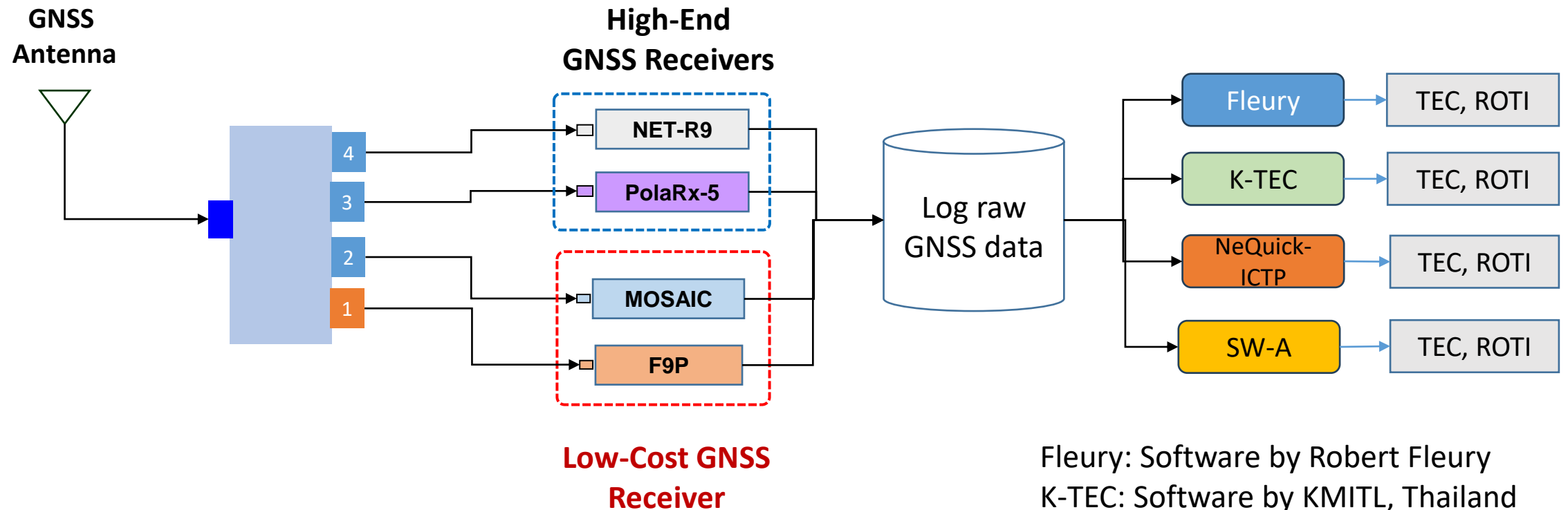
Training programme on GNSS focuses on GNSS data types, GNSS errors, coordinate systems and applications, and low-cost receiver system data. **Workshop on GNSS Applications for Policy and Decision Makers** focuses on basic introduction to GNSS and how GNSS can be used in various applications. *Cooperation UNOOSA and The University of Tokyo*



In 2022, humanity crossed a symbolic milestone as the world's population reached 8 billion. Science has been among the main drivers of this growth, gradually increasing the human lifespan thanks to advances in public health, water, sanitation and hygiene, and nutrition, among many others. There are 8 billion stories, minds, bright ideas and new perspectives, all waiting to leave their mark in improving life on our cosmic spaceship - planet Earth (UNOOSA-EUSPA).

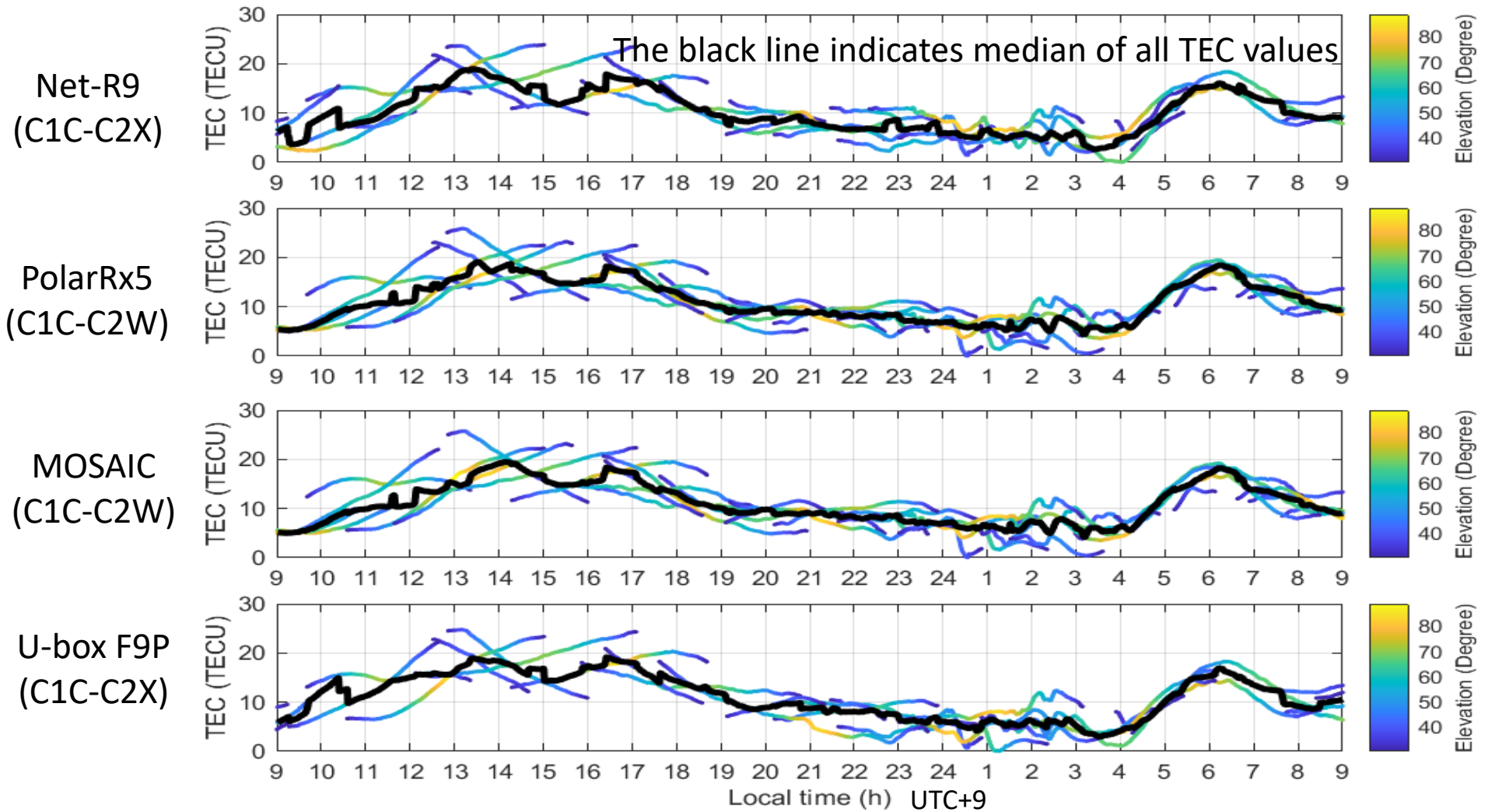
https://www.unoosa.org/res/oosadoc/data/documents/2023/stspace/stspace85_0_html/st_space_085E.pdf

Data Observation Method



Fleury: Software by Robert Fleury
 K-TEC: Software by KMITL, Thailand
 NeQuick ICTP: Software by B. Nava, ICTP

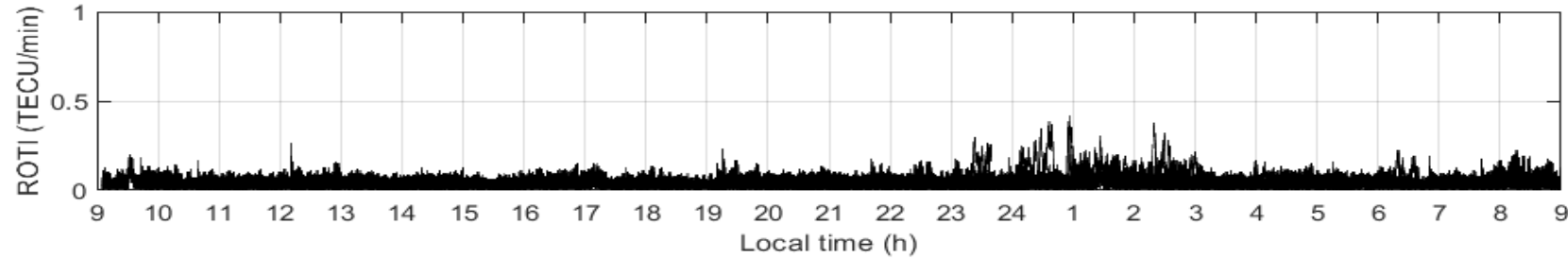
VTEC Results



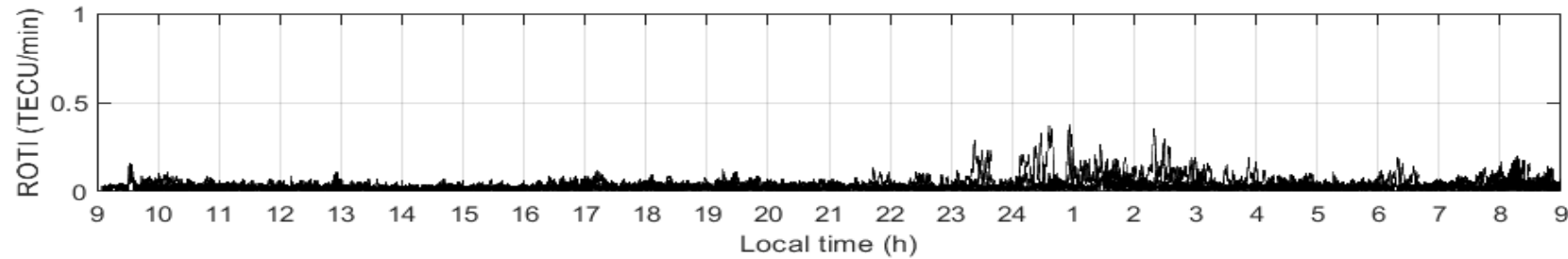
Since the same antenna is used, the VTEC from all receivers has similar trends and levels.

ROTI Results

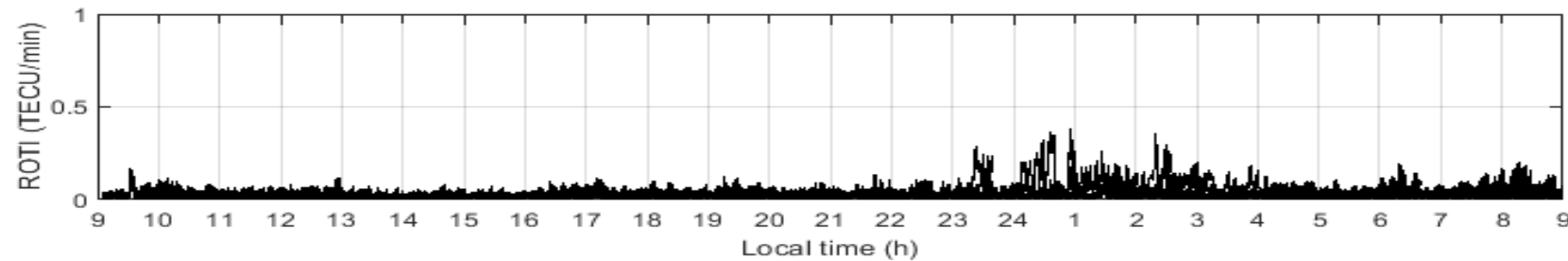
Net-R9
(C1C-C2X)



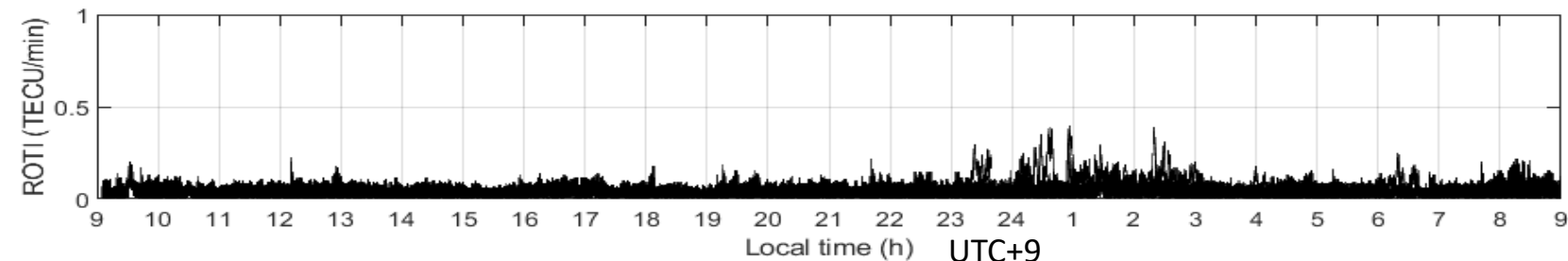
PolarRx5
(C1C-C2W)



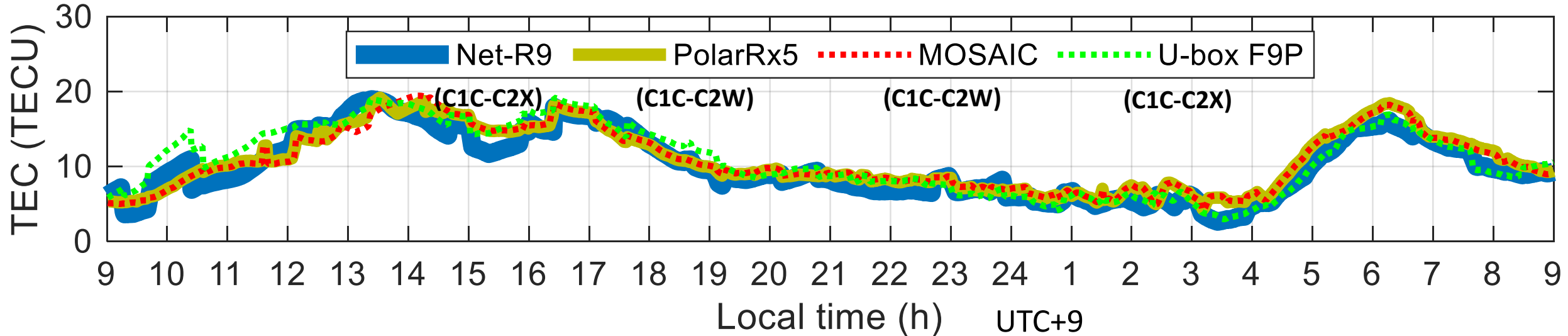
MOSAIC
(C1C-C2W)



U-box F9P
(C1C-C2X)

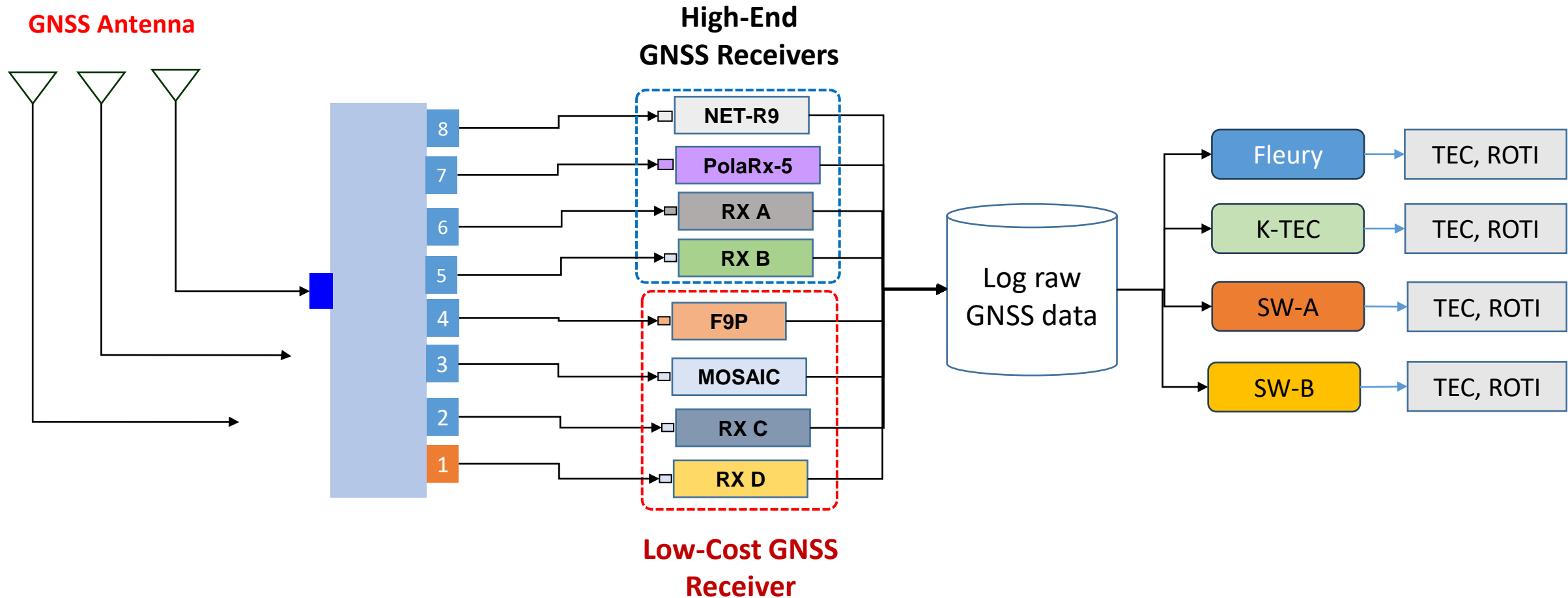


Comparison of VTEC Results



- The low-cost receiver VTEC values have similar results to the high-end receiver VTEC values.
- MOSAIC receiver VTEC values are equivalent to PolarRx5 receiver VTEC values.

- Future Works:
- (a) Test more receiver types
 - (b) Test more antenna types
 - (c) Compute using different software

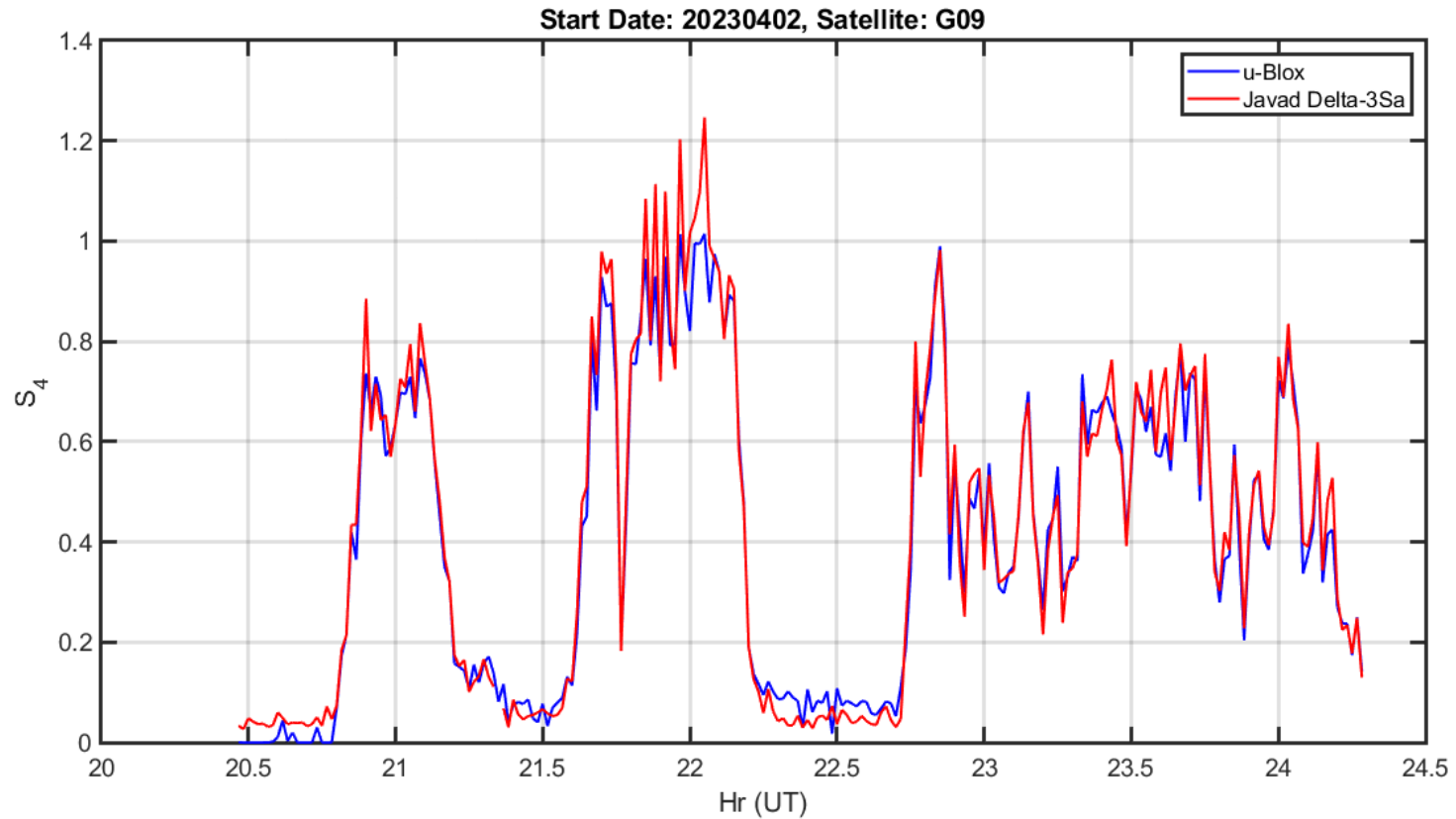


Overview

- Conduct GNSS Training, Workshops and Seminars
 - Mainly in Asia
 - Indonesia, Thailand, Vietnam, Philippines, Singapore, Malaysia, India, Nepal
 - Conduct Training in Collaboration with ICG
- Conduct Joint Research and Pilot Projects
 - Low-cost High-Accuracy GNSS Systems
 - Any GNSS-based Application
- JIS (Jamming, Interference and Spoofing) Test
 - Conduct JIS test and demo
 - Create awareness of spoofing attacks
- Installation of GNSS CORS
 - Install GNSS CORS in Universities for joint research, GNSS technology promotion and capacity-building
- Develop Low-Cost Receiver Systems for
 - High-Accuracy based on RTK and MADOCA PPP
 - Space Weather Data Analysis
 - Dynamic Air Quality Monitoring
- RPD (Rapid Prototype Development) Challenge
 - Organize RPD Challenge as a part of the 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)

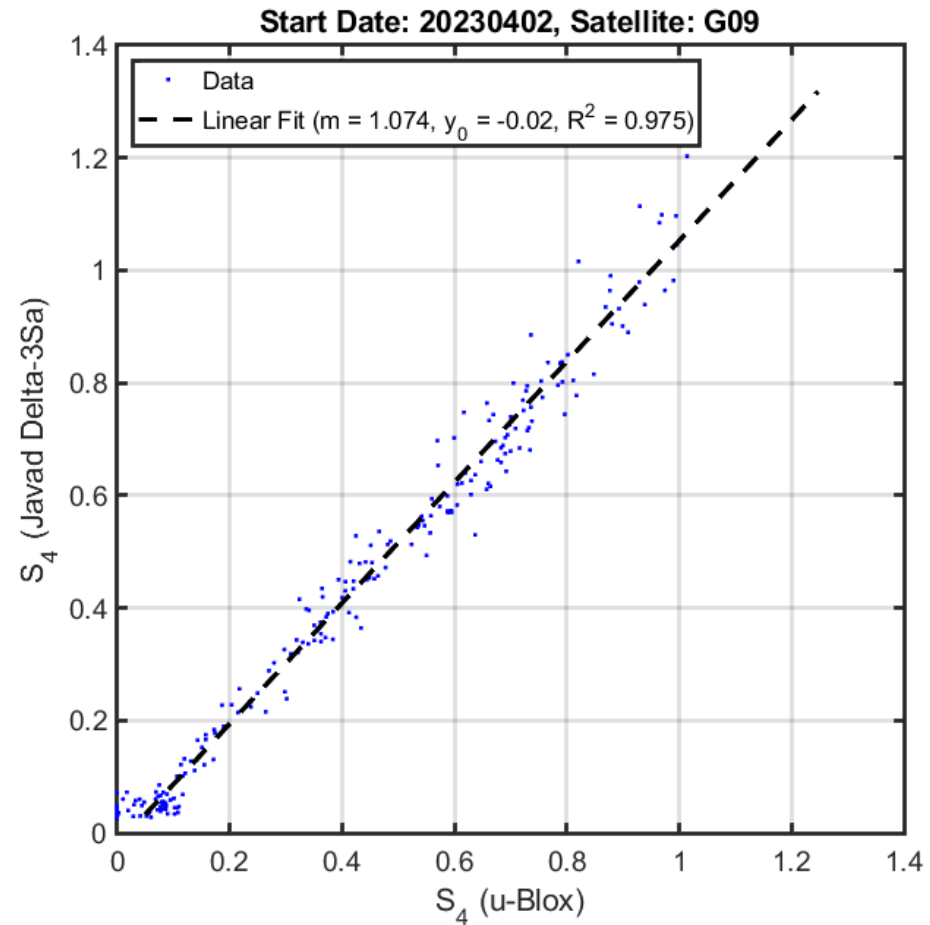


S4 Comparisons: GPS PRN09 – Javad vs. U-Blox



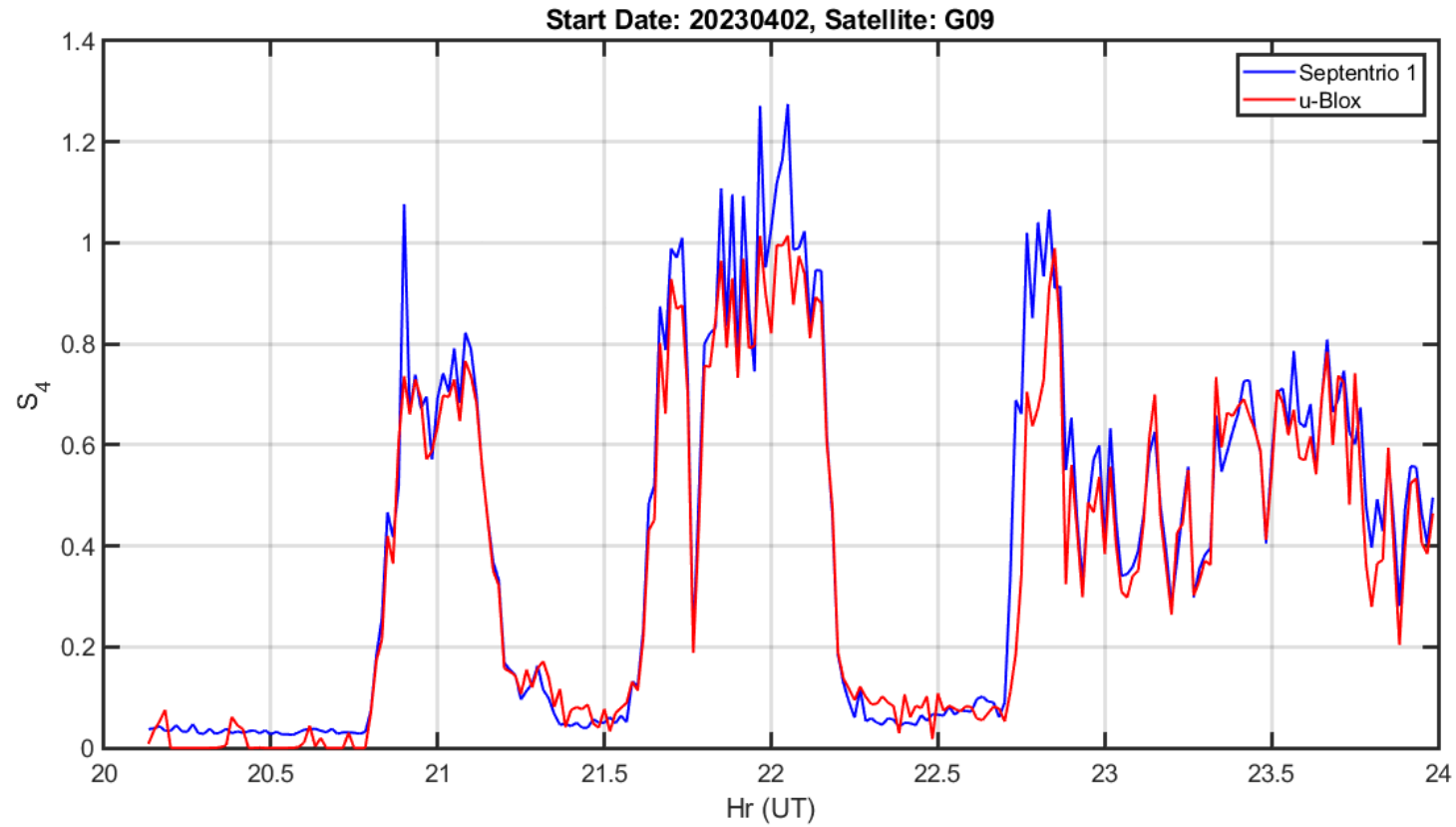


GPS PRN09 – Javad vs. U-Blox Fit



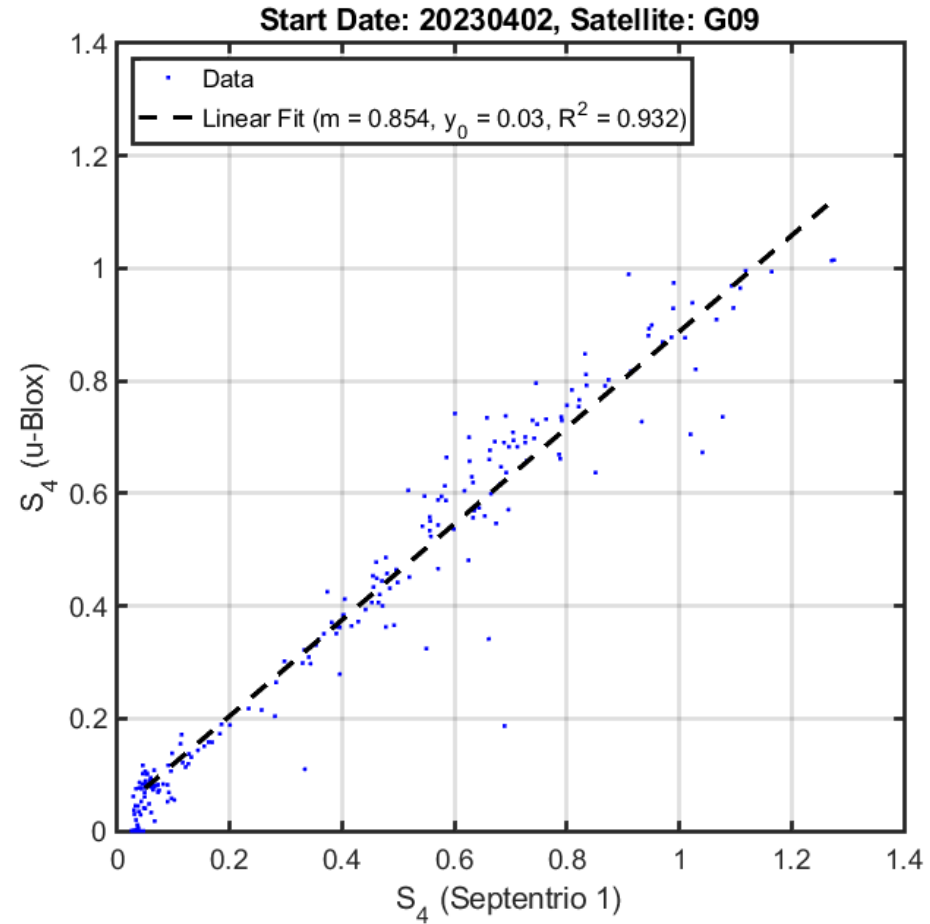


GPS PRN09 – Septentrio vs. U-Blox



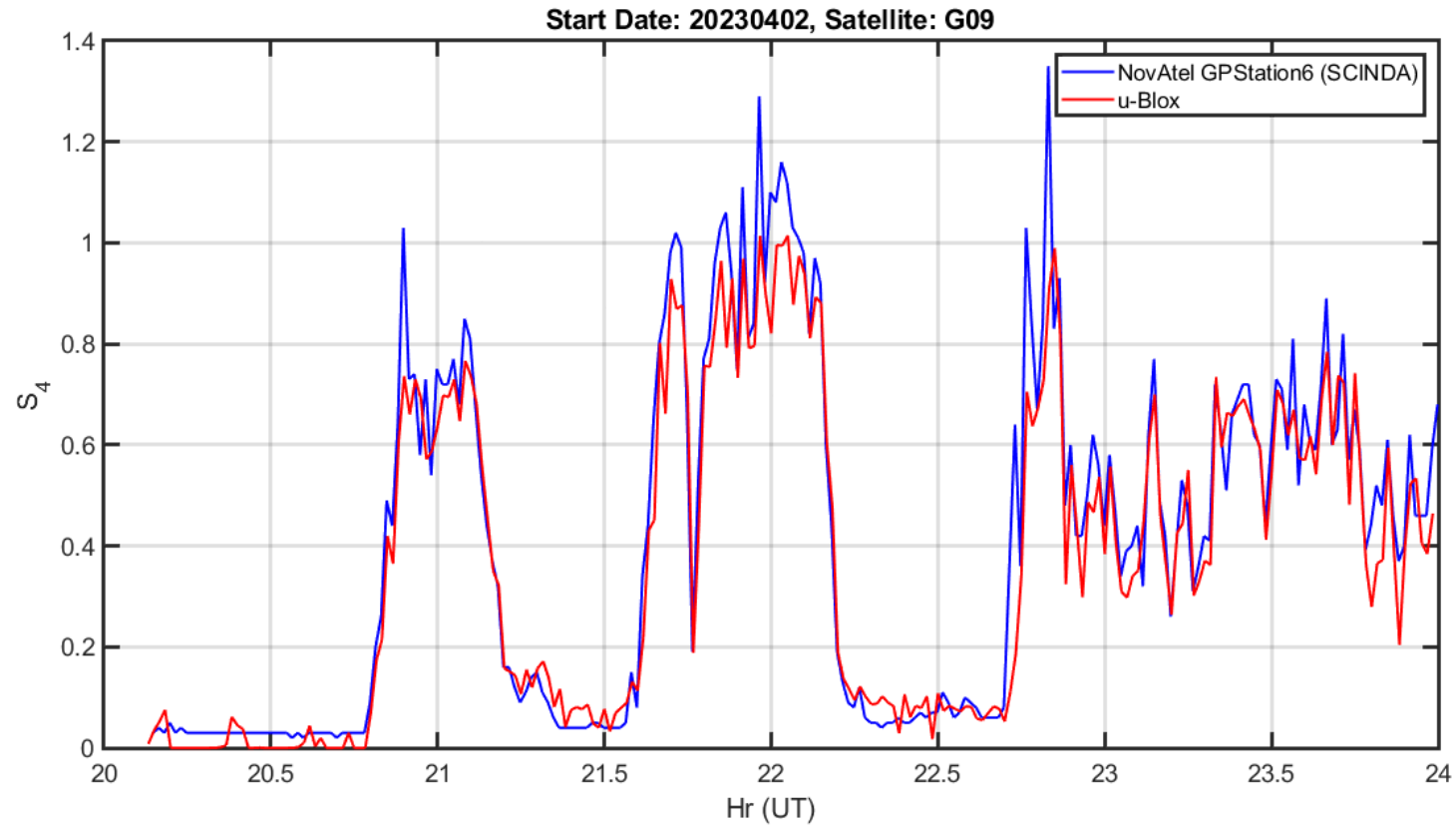


GPS PRN09 – Septentrio vs. U-Blox



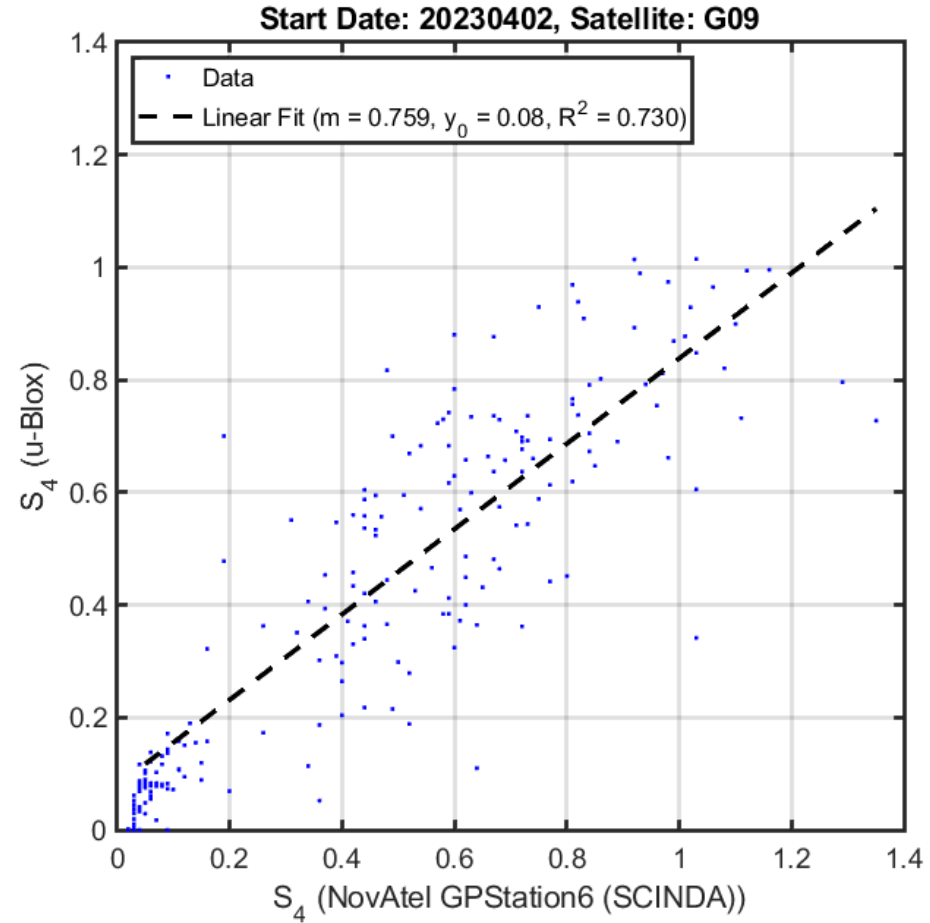


GPS PRN09 – NovAtel-6 vs. U-Blox



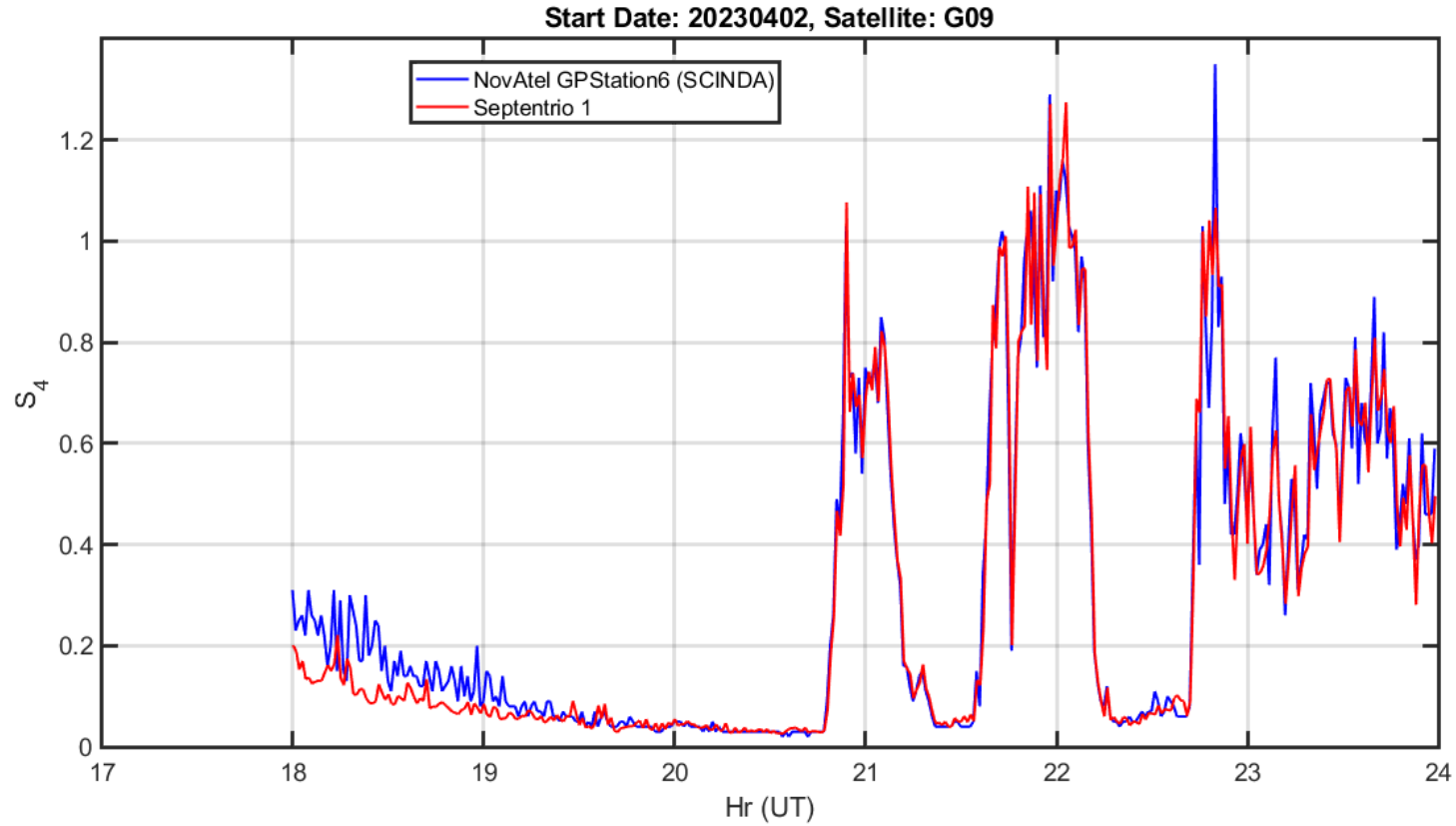


GPS PRN09 – NovAtel-6 (N6) vs. U-Blox





GPS PRN09 – Corrected Septentrio vs. N6





GPS PRN09 – Septentrio vs. N6

