Total Electron Content Monitoring Complemented with Crowdsourced GNSS Observations

G. Kłopotek, B. Soja, M. Awadaljeed, L. Crocetti, M. Rothacher, L. See, R. Weinacker, T. Sturn, I. McCallum, and V. Navarro

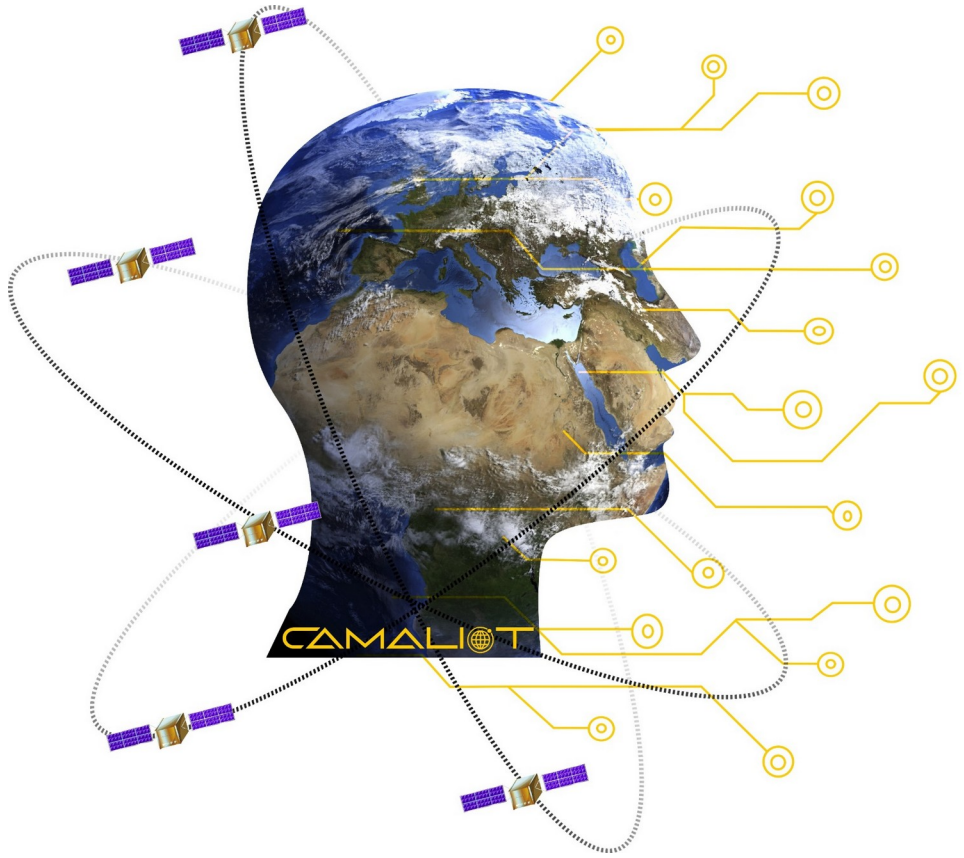
EGU General Assembly 2022
Vienna, Austria & Online | 24 May 2022

CAMALIOT

Application of **ma**chine **l**earning technology for GNSS **IoT** data fusion

(NAVISP-EL1-038 bis)

funded by ESA NAVISP Programme Element 1,
dedicated to innovation of the PNT technology



Camaliot - Goals

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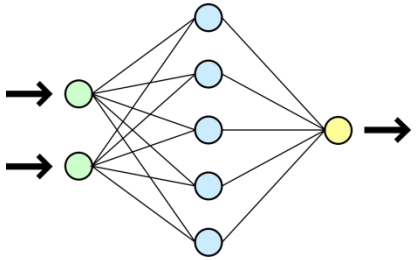
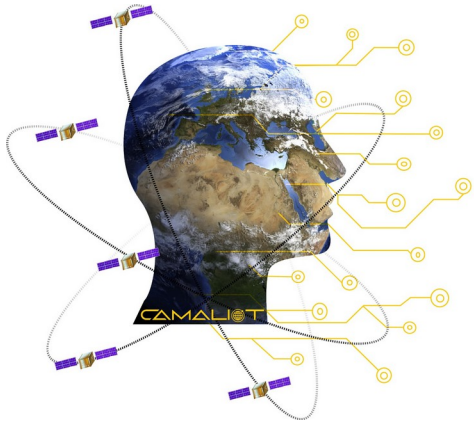
- GNSS IoT Data
  - Investigate alternative sources of GNSS observations
  - **Collection of GNSS community data**
- GNSS Big Data Processing
  - Framework for an automated, robust and scalable GNSS processing
  - Fusion of indices and models with huge and heterogeneous data sets of various quality
- Science Use Cases
  - Troposphere – Earth Weather
  - Ionosphere – Space Weather





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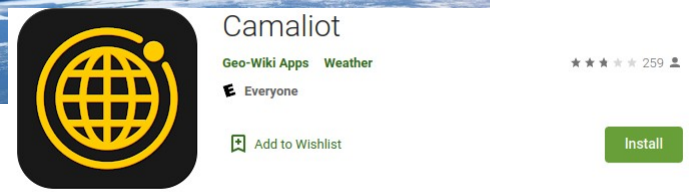
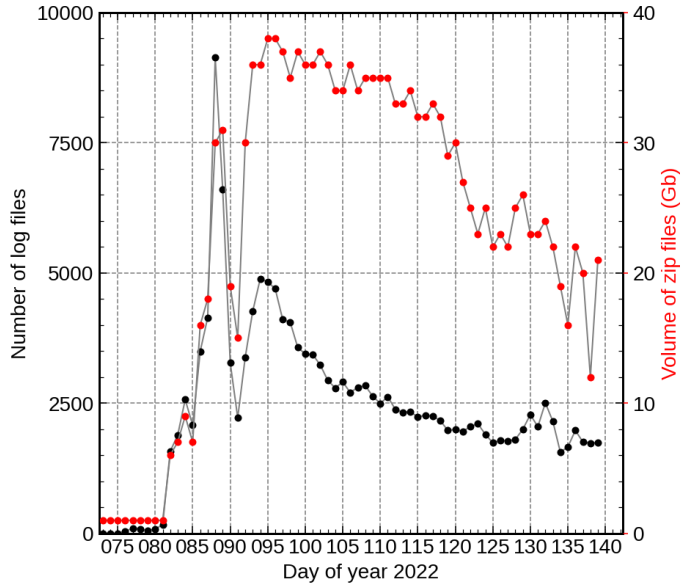
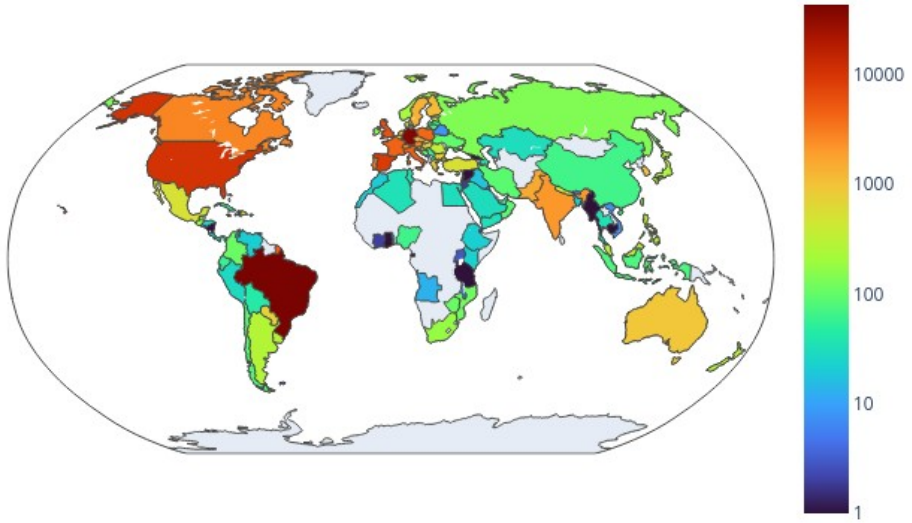
Camaliot - Crowdsourcing Campaign

- Started March 17, 2022
- Android app with 35k+ installations
- 11k+ registered users
- Over 55 billion GNSS observations collected so far





Size and number or received files expressed per day



Quantity of uploaded files per country (until May 21)

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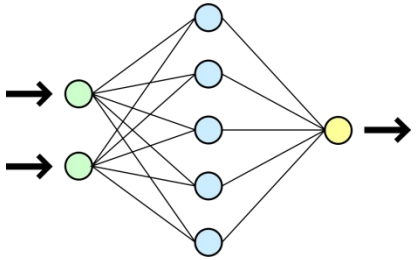

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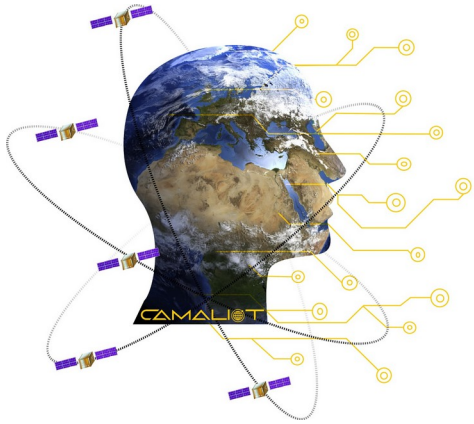

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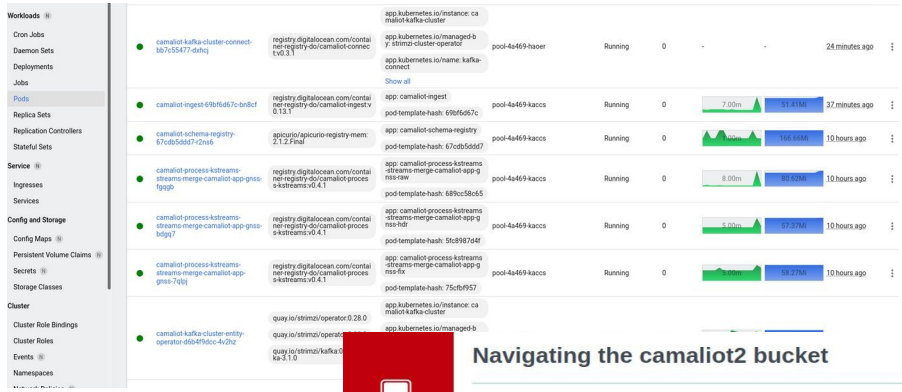
Camaliot Functional SW Architecture

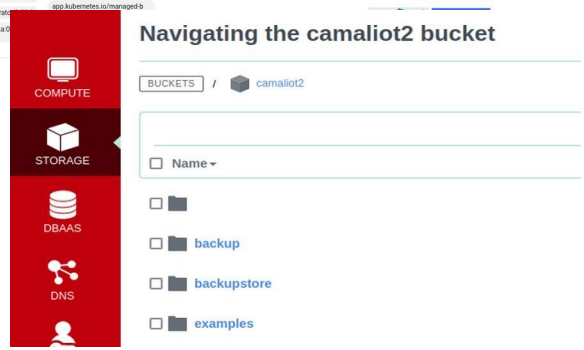
Development of a self-contained SW running on Kubernetes and communicating with GSSC

EXOSCALE

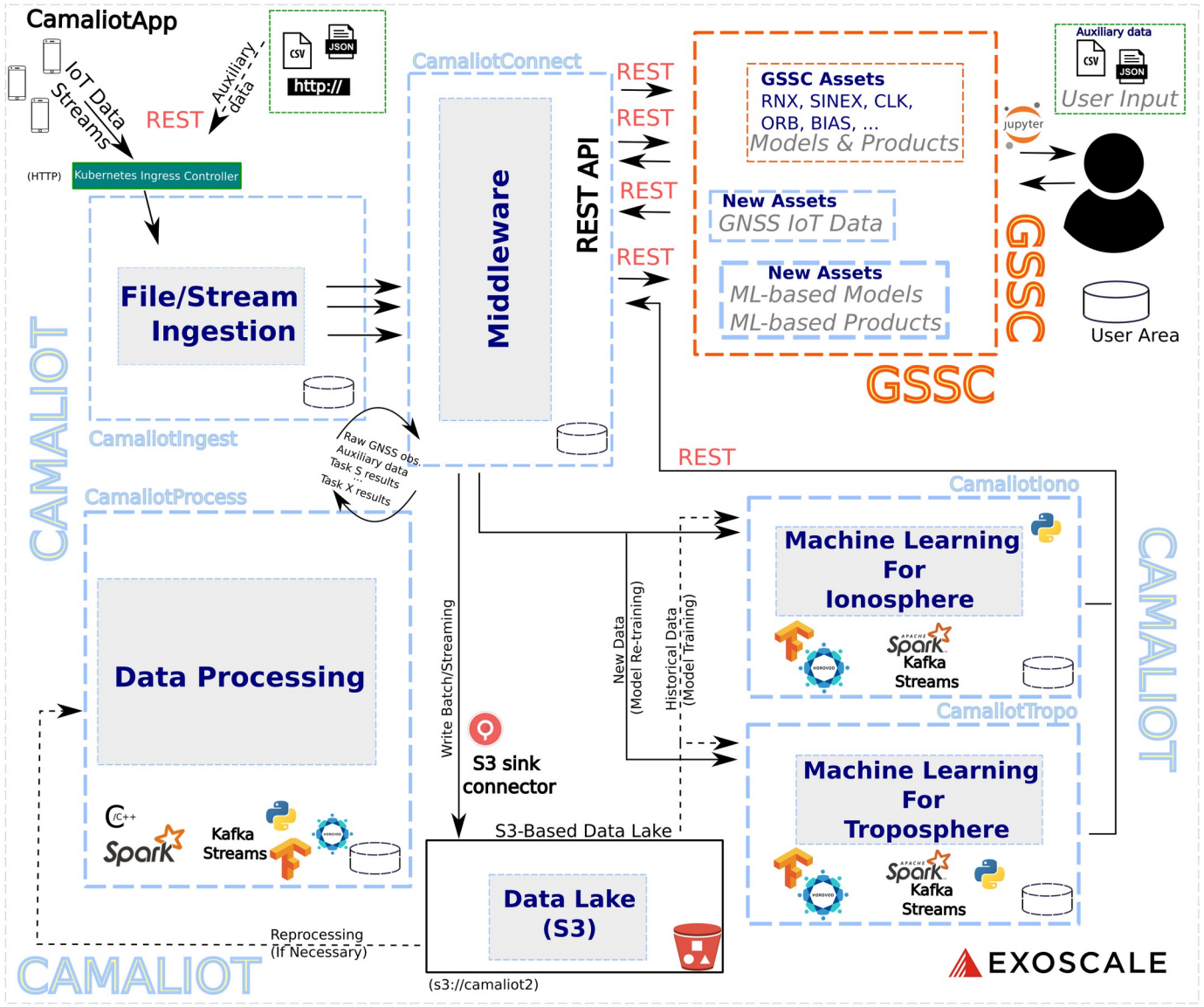
Kubernetes Cluster



Object Store



- File/Stream Ingestion
- Data/Stream Processing
- Real-time Data Enrichment
- Data offload/aggregation



ETH zürich IASA CAMALIOT esa

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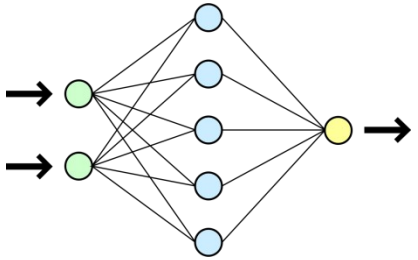

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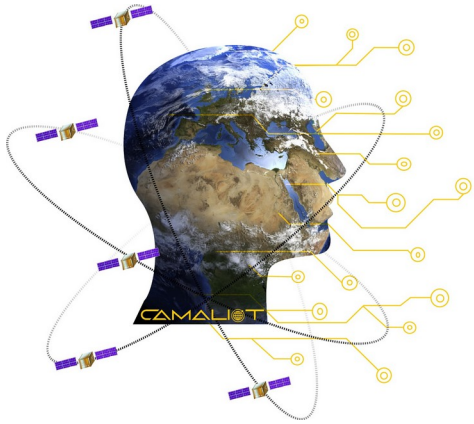

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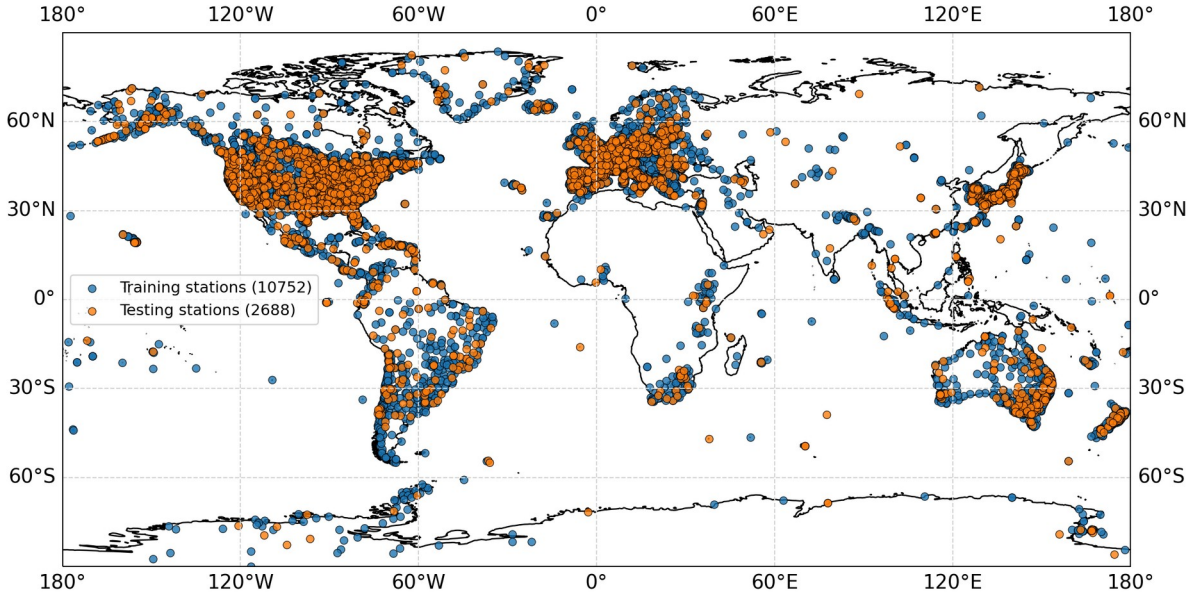
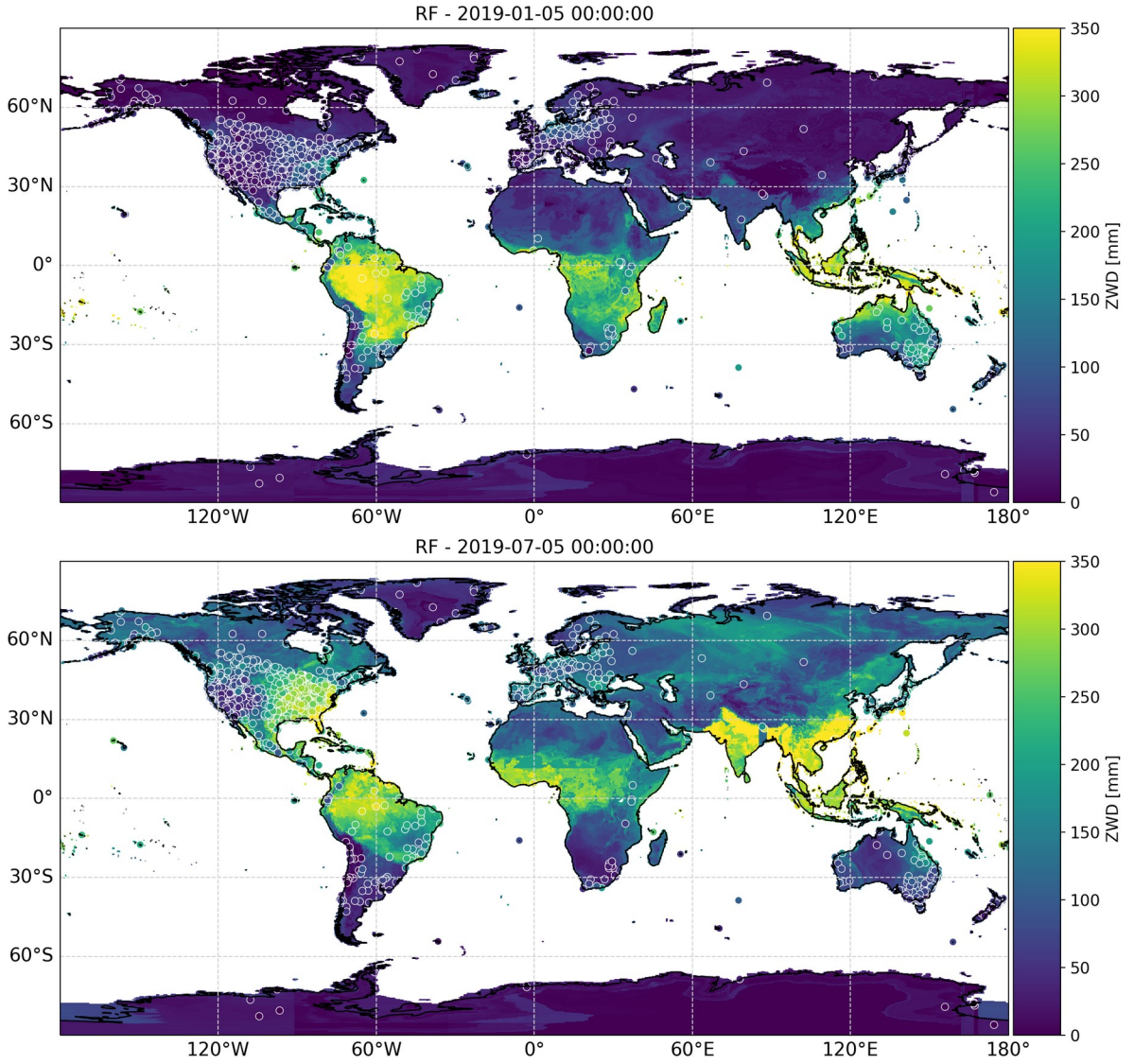
Machine Learning For Spatial Interpolation and Forecasting

Example: Data fusion for the spatial modelling of ZWD

Distribution of training and test stations for all available stations (2019)



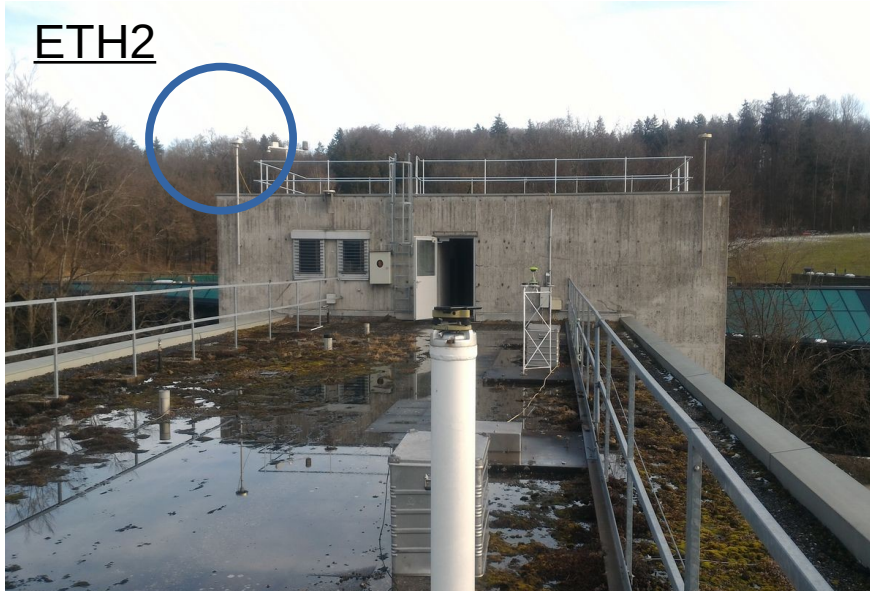


Talk by Laura Crocetti
G1.3: Fri, 27 May, 09:45

GNSS IoT Data Collection & Exploration

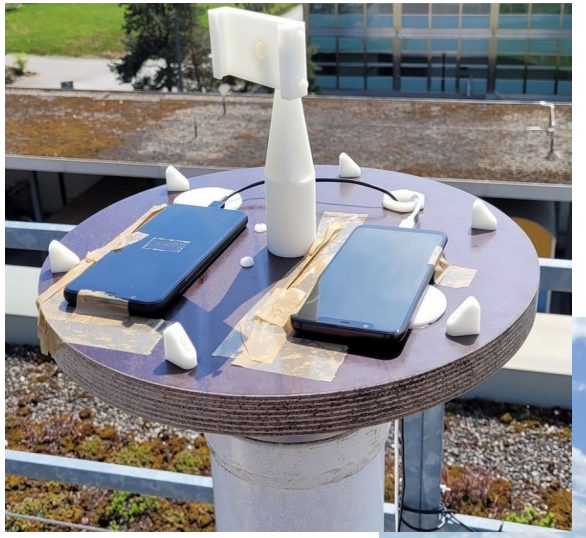
Exploring smartphone-based observations with dedicated measurement campaigns

ETH2

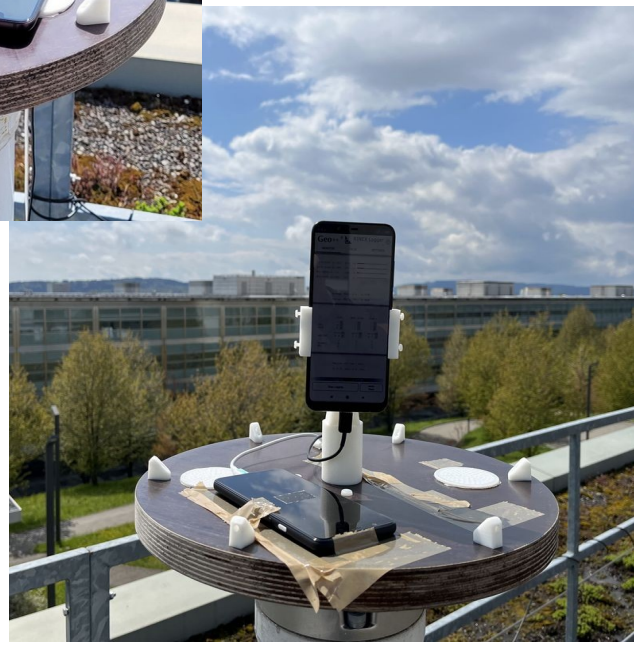


Platform for horizontal/vertical smartphone orientation during measurements

Pixel 4



Mi8



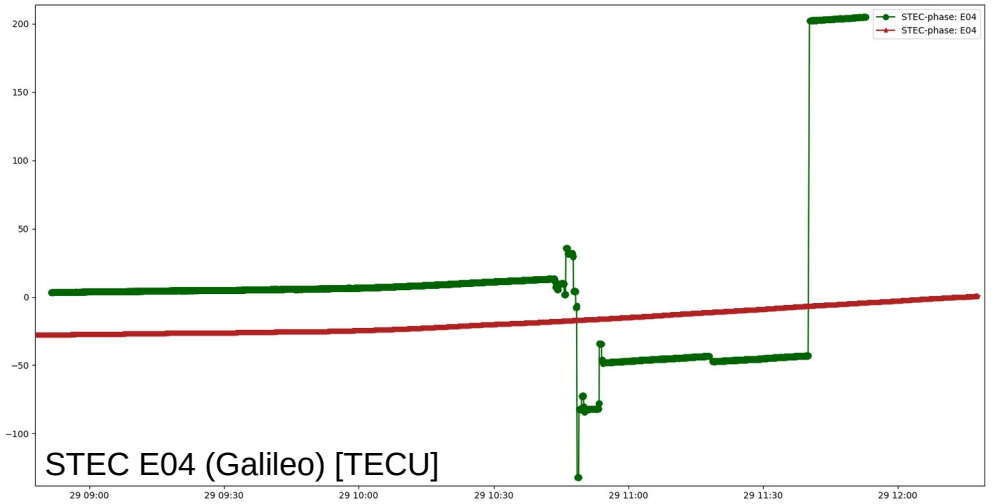
Smartphones for STEC:

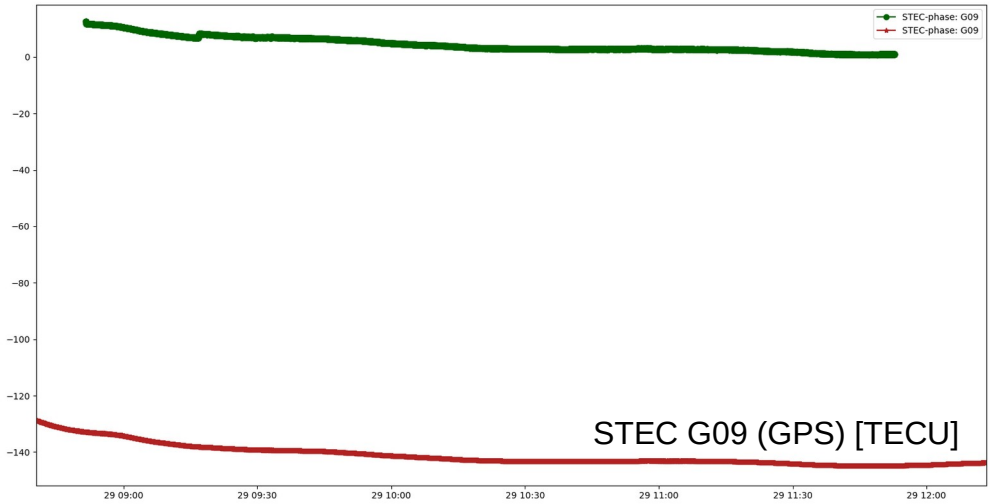
- Observations in the vicinity of the AGNES ETH2 station
- Geometry-free (L1/L5) combination for STEC
- Observations in the RINEX-3 format (Geo++ RINEX Logger)
- Investigating “raw” satellite-specific STEC time series for smartphones and ETH2

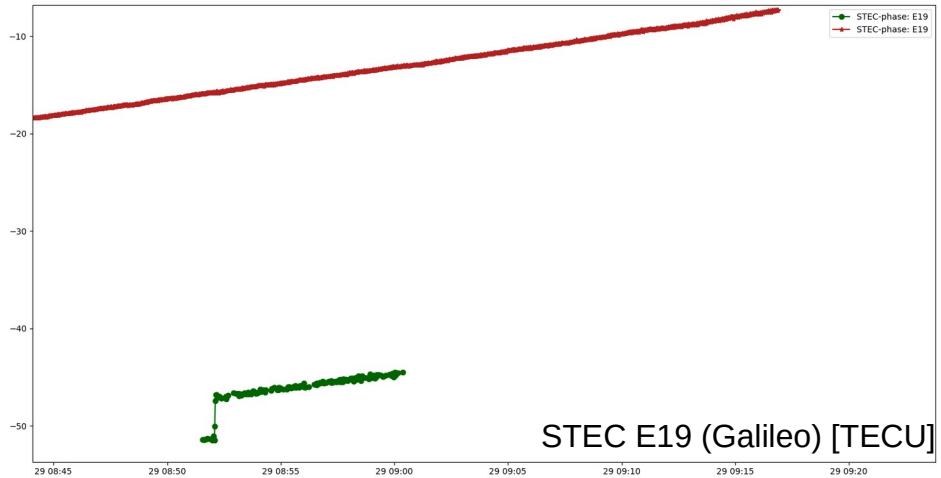
Mi8

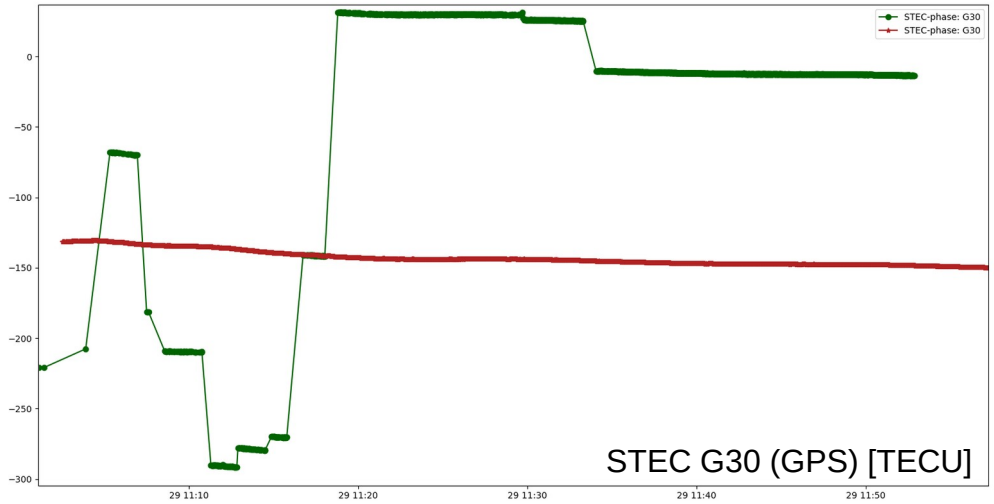
GNSS IoT Data Collection & Exploration

Examples of STEC time series from Xiaomi Mi8 (green) and ETH2 (red)









GNSS IoT Data Collection & Exploration

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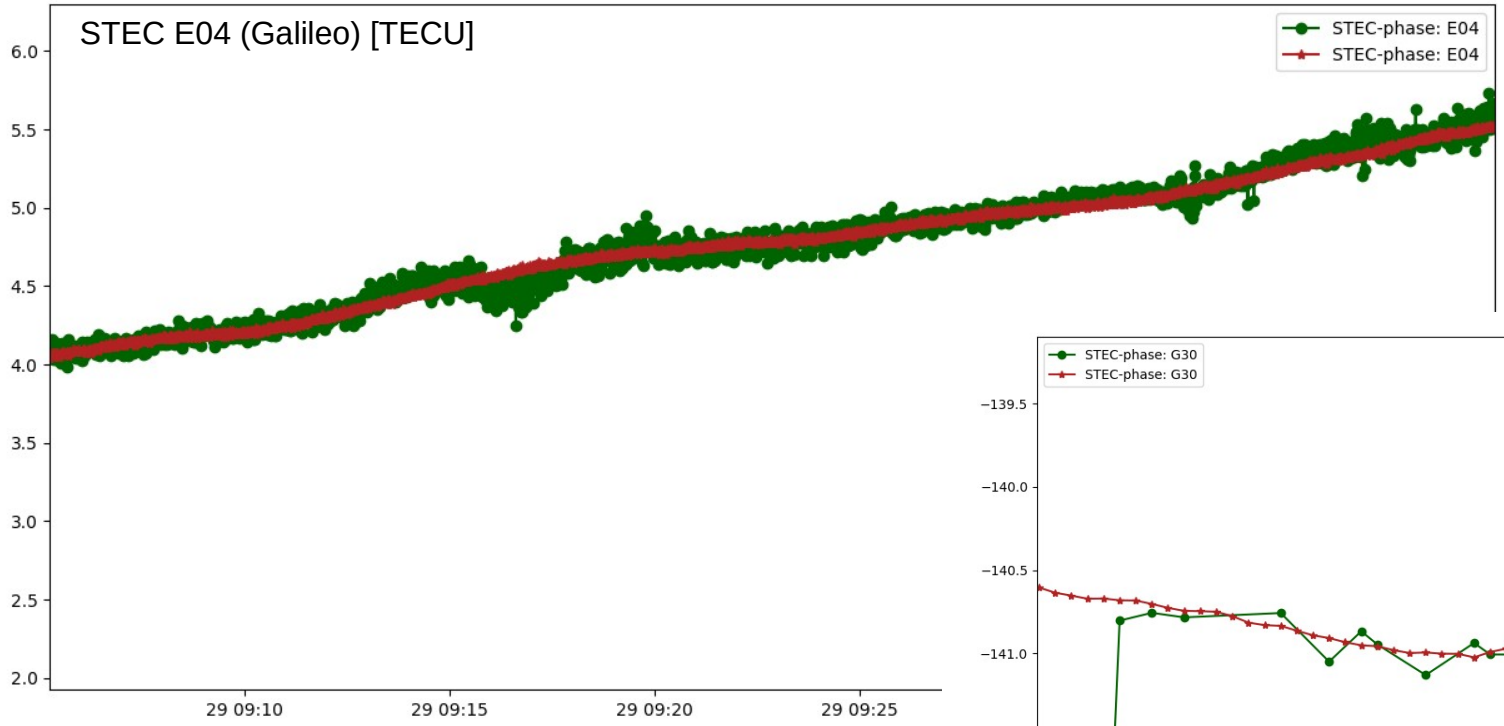
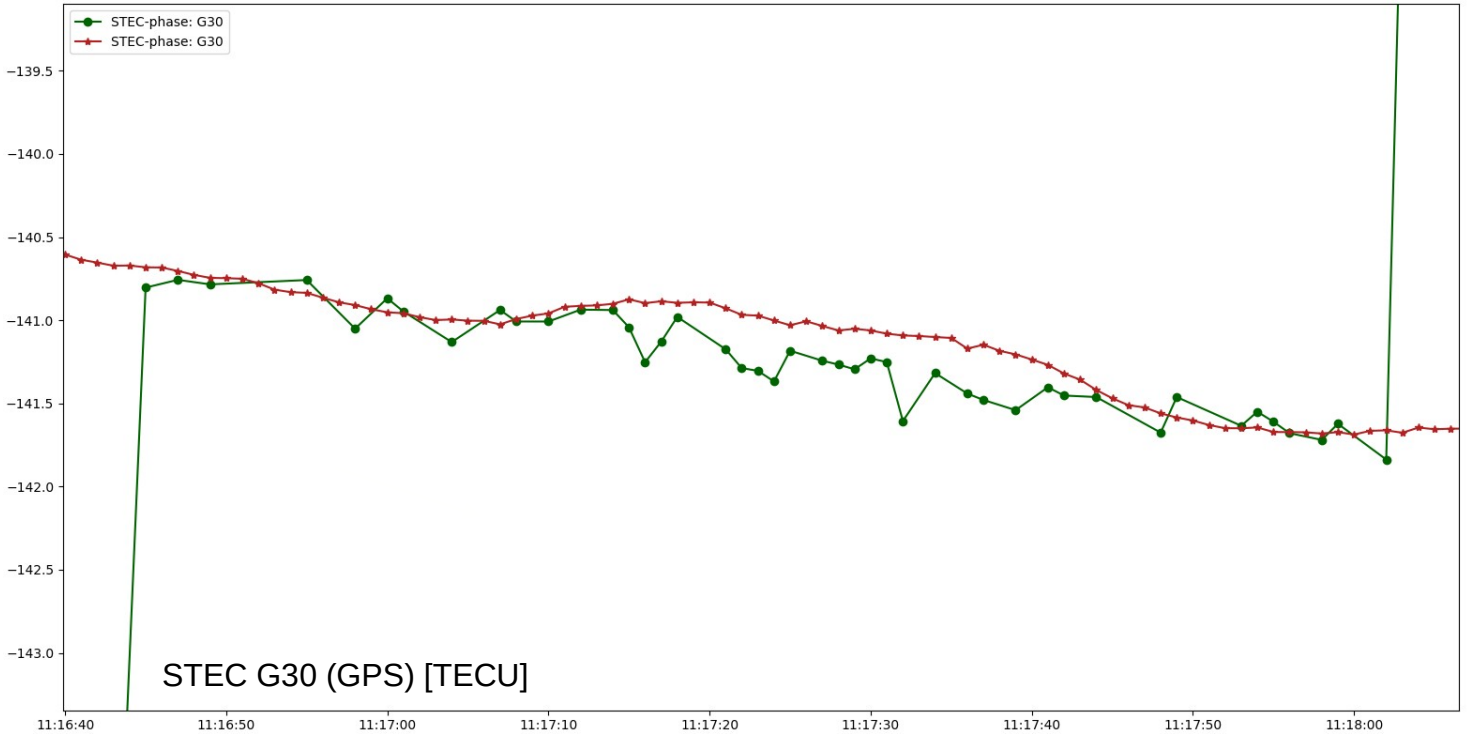


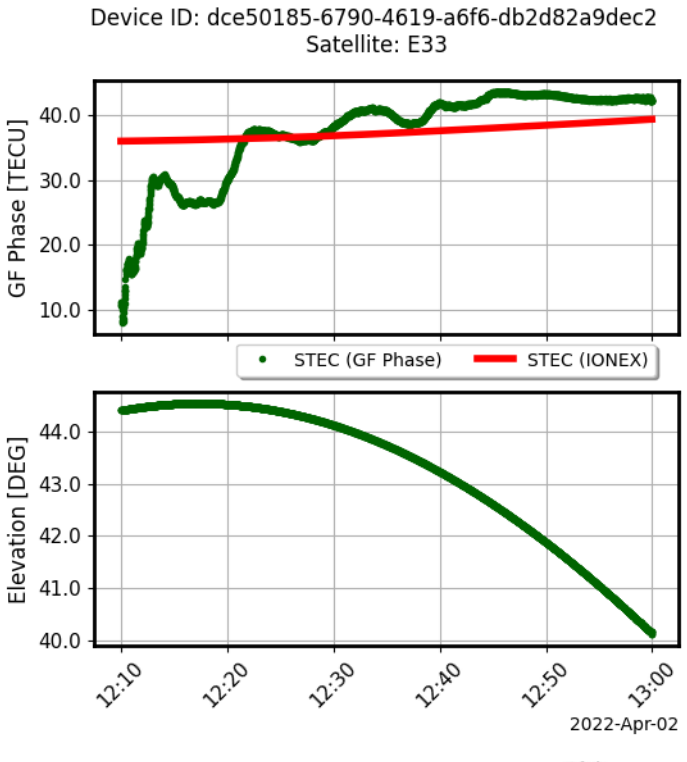
- STEC from Xiaomi Mi8 aligned (offset) manually to STEC from ETH2

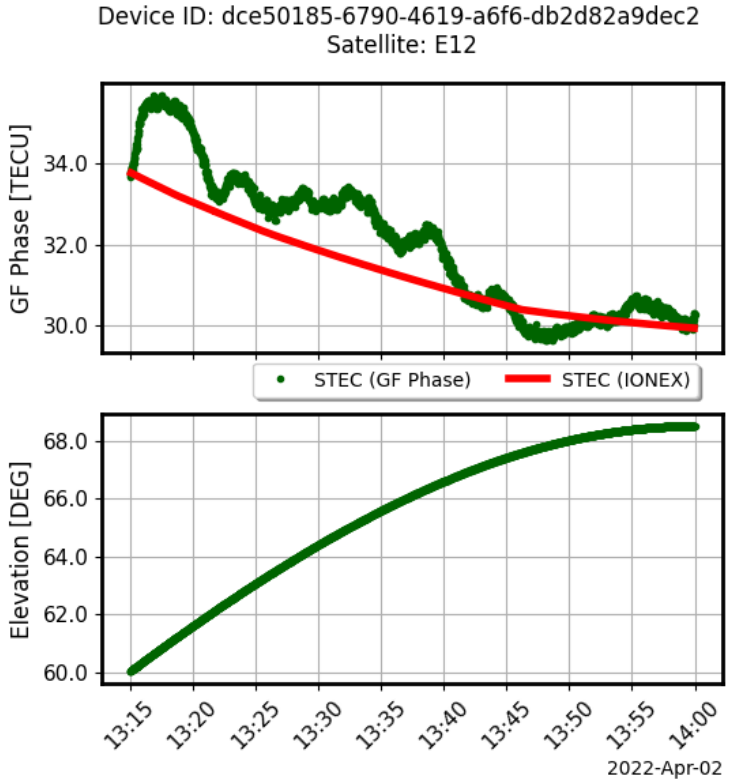


GNSS Community Data

Examples of STEC time series from crowdsourced observations (as acquired from the Camaliot app)

- Observations uploaded by the users
- Geometry-free (L1/L5) combination for STEC
- Observations in the RINEX-3 format (Camaliot RINEX Converter)
- Investigating “raw” satellite-specific STEC aligned to the IONEX-based STEC time series (GIM from IGS)





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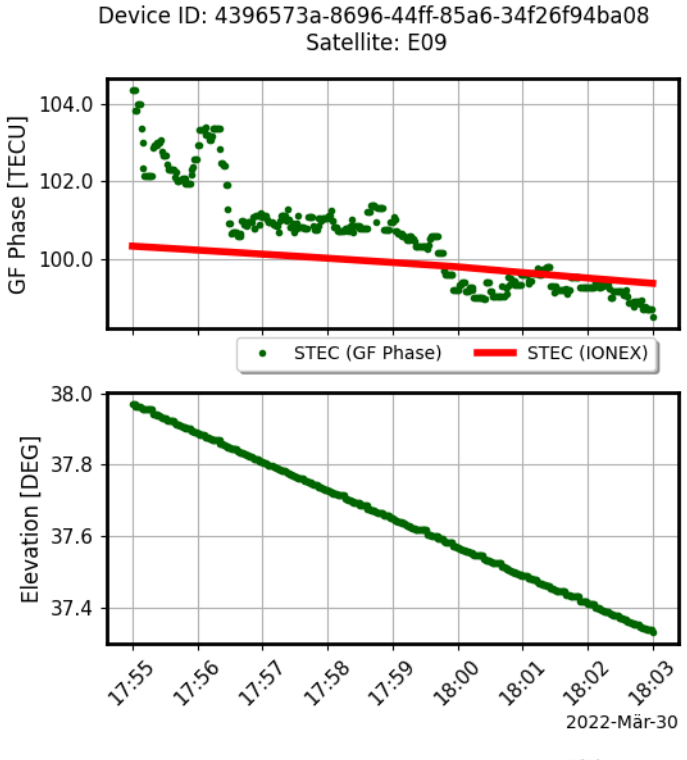

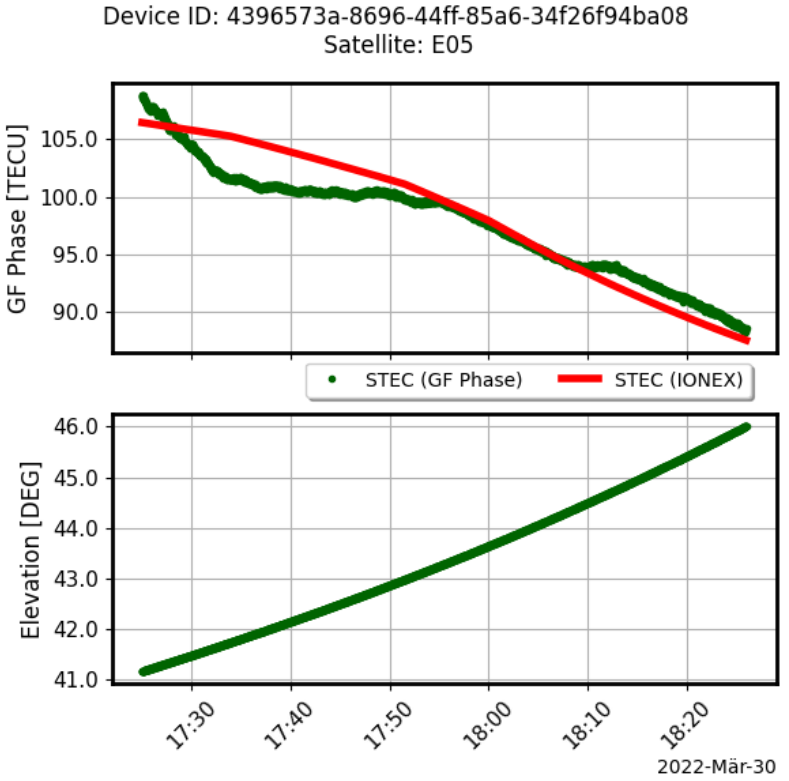

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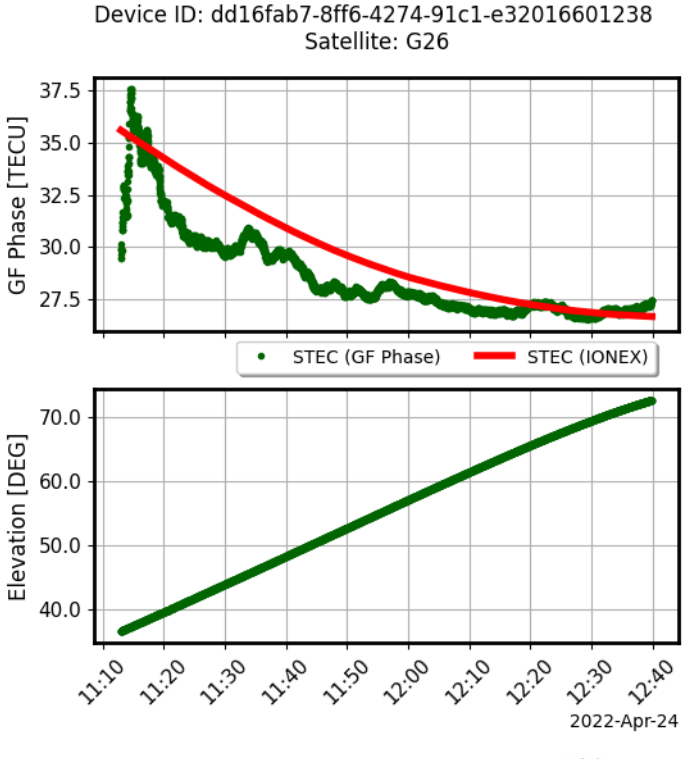

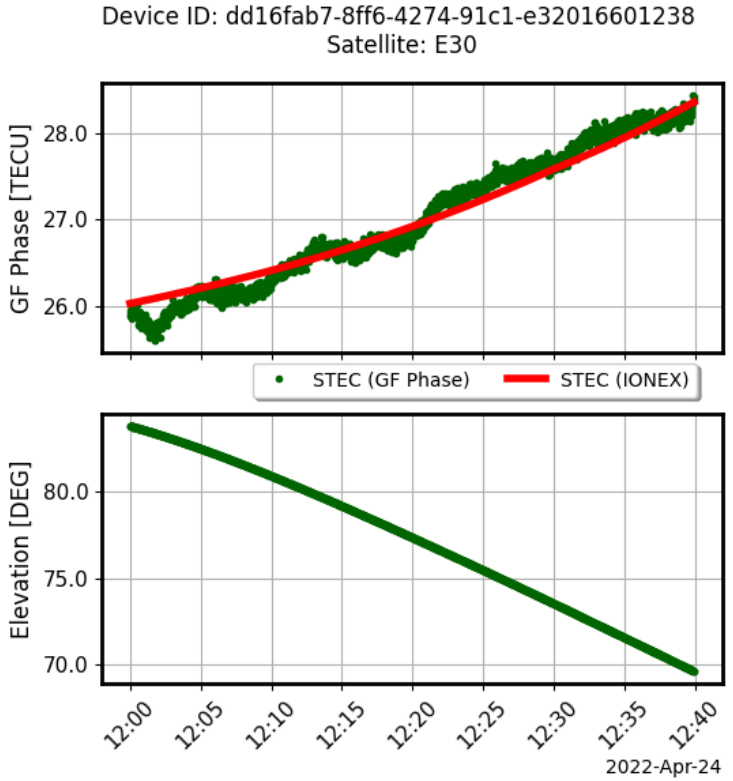

Summary

Camaliot Project:

- Collection of GNSS community data during the dedicated crowdsourcing campaign
- Development of the GNSS big data processing framework for the ML-based data fusion at scale

Smartphone-based GNSS observations:

- With the potential to be exploited for ionospheric monitoring (to a certain extent)
- Quality much lower compared to the conventional GNSS observations
- Frequent occurrence of observation gaps and cycle slips
- Dedicated screening and preprocessing stages needed to extract reliable ionospheric information

Visit www.camaliot.org for more!

Try out the Camaliot App today!

THANK YOU FOR YOUR ATTENTION!

klopotek@ethz.ch