UN ICG Experts Meeting: GNSS Services

Vienna, Austria, 14 – 18 December, 2015

Citizen Science for GNSS Performance Monitoring and Assessment

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- **Introduction and motivation**
- Growing need for GNSS performance assessment in various environments of potential GNSS-based applications
- Laymen and expert community with prospects for and interest in collection of valuable experimental data
- Availability of tools and systems for data science (data statistics and analytics)
- Wide-spread novel ICT that allows for collection, aggregation, storage and access to large data sets (cloud services - computing, cloud storage, parallel computing, Internet of Things – IoT, mobile internet etc.)

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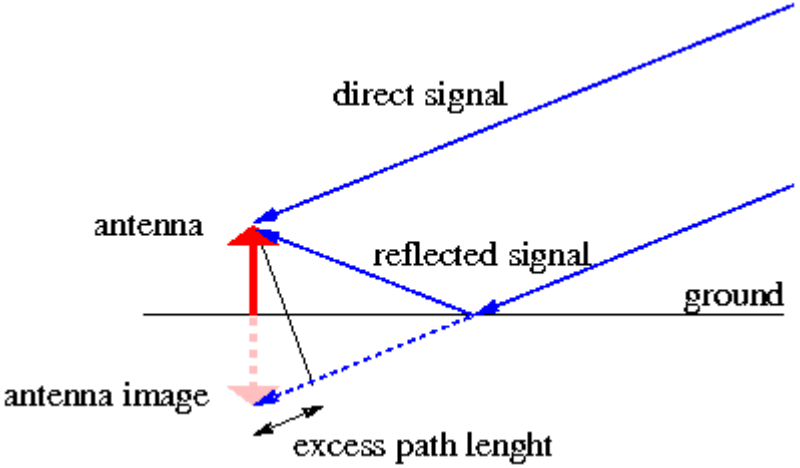

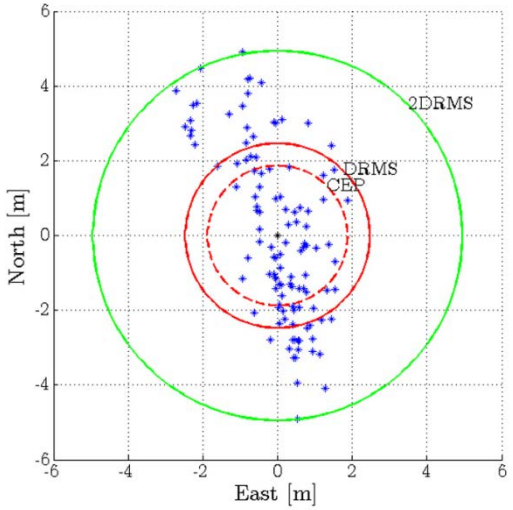

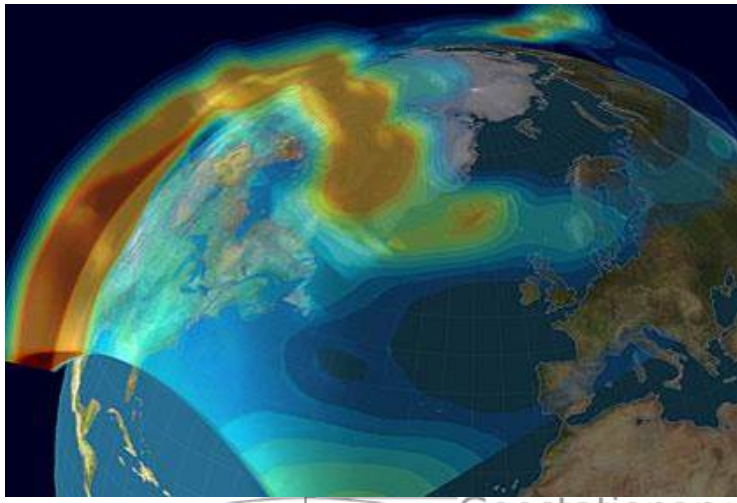

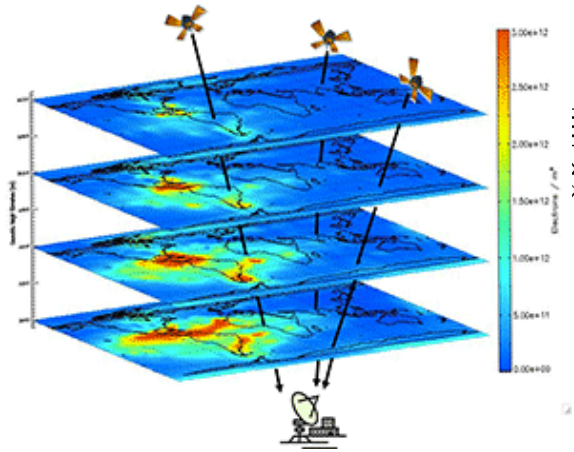

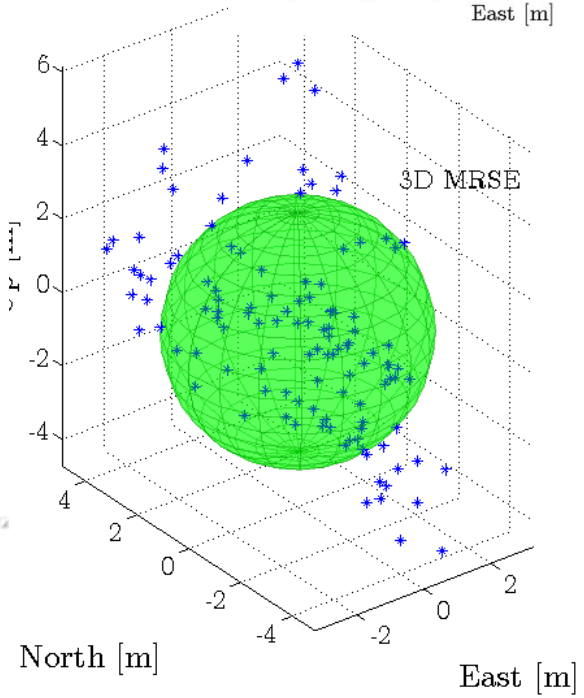

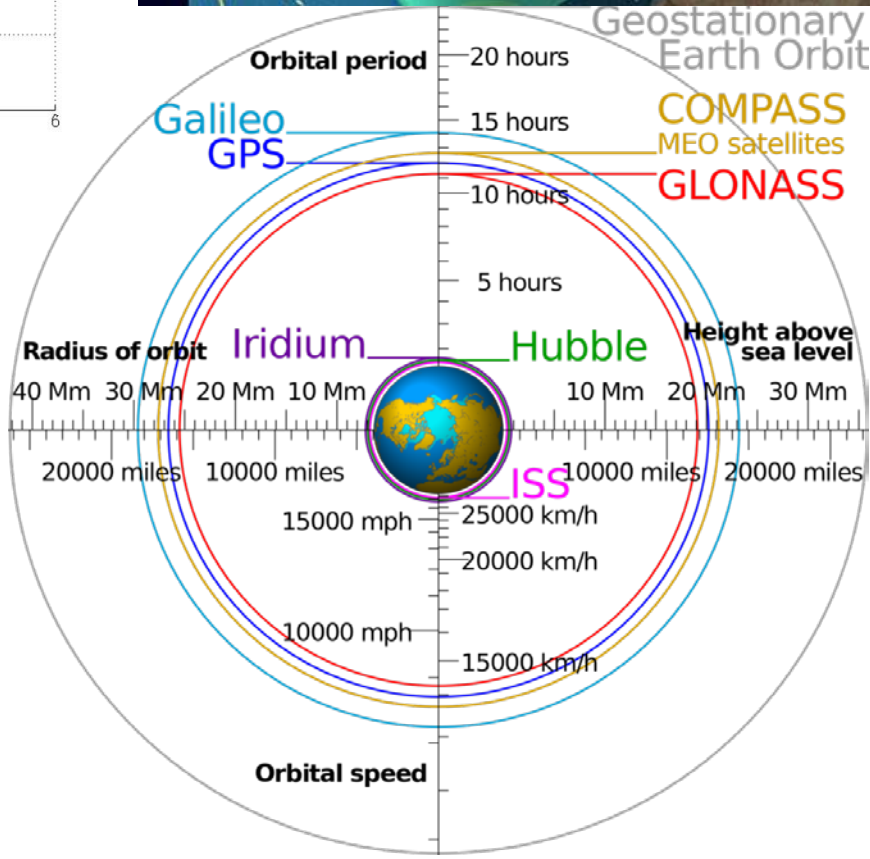

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- **Introduction and motivation**

- Citizen Science (CS) concept
- There are laymen and professionals around with (more or less):
  - Spare time and personal motivation
  - Access to technology
  - A certain level of domain understanding
  - Analytic skills
- How to organise them to deliver something useful?

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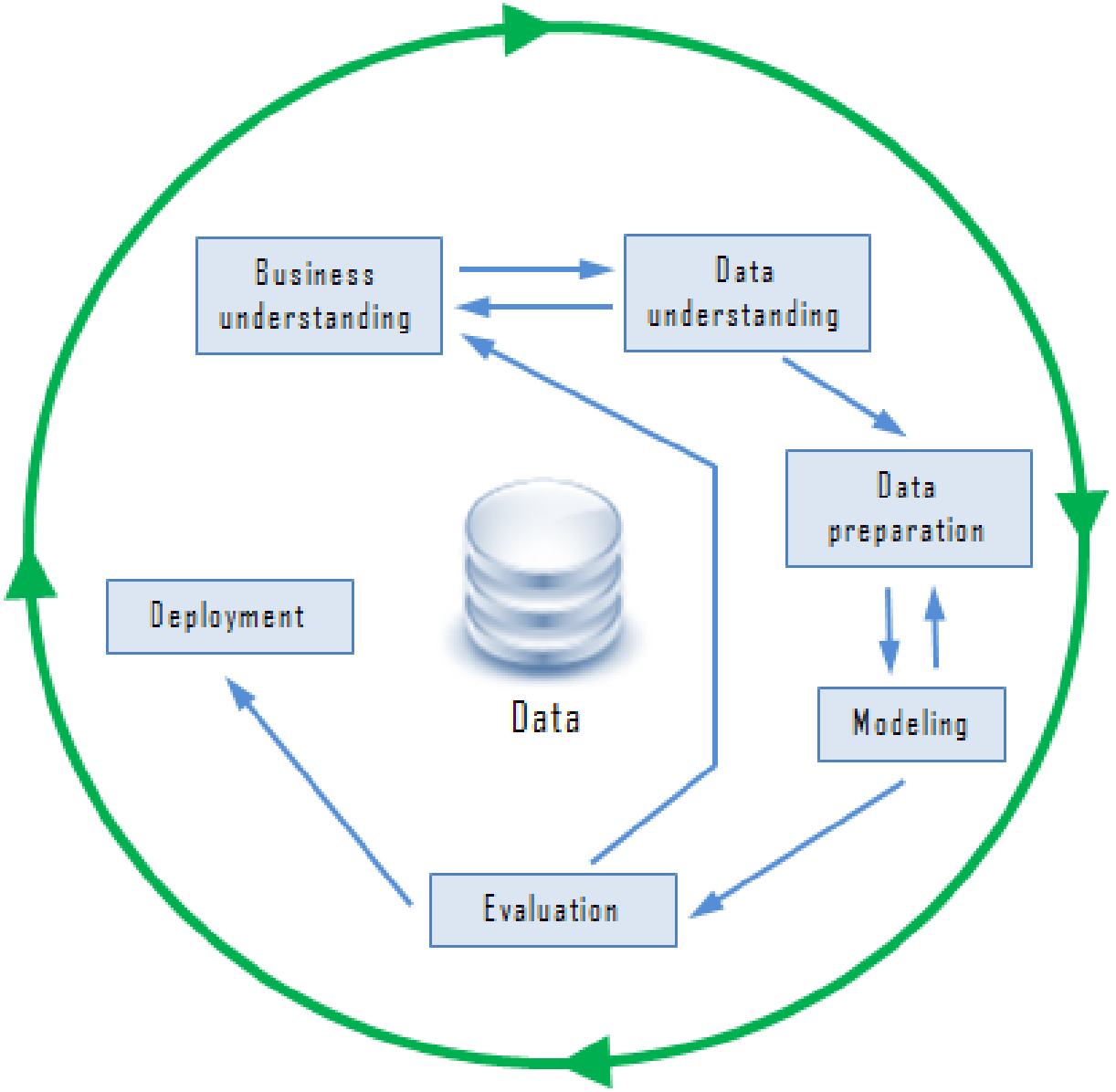
- **Data science**

- Statistics and statistical learning methods, techniques and tools applied to on large data sets in order to extract non-apparent patterns, relationships and knowledge about observed process in general



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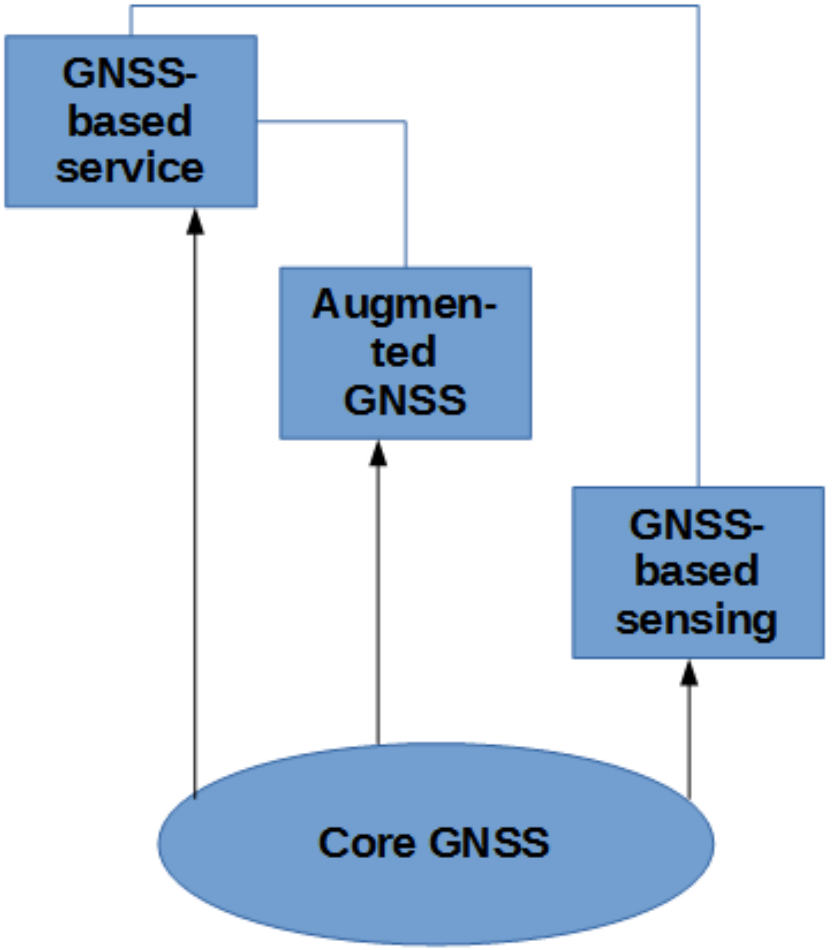
- **GNSS application development process**

- Requirements
- Users/stakeholders
- Technology
- Quality of service
- Result of the service



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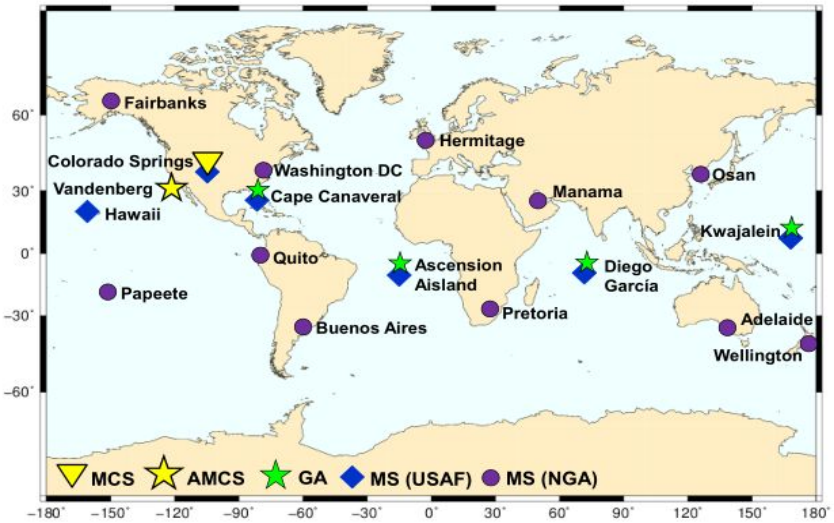
- **The problem: Lack of the experimental data**
- Lack of geographically well-distributed GNSS observations taken in different positioning environments and for different use-case scenarios
- Analogy with the weather forecasting data problem
- Large variations of QoS requirements for GNSS applications (especially for those of mobile nature)
- Noise and interference problem
- Well-populated low-cost sensors vs sparse and expensive high-quality sensors – which one brings the value?



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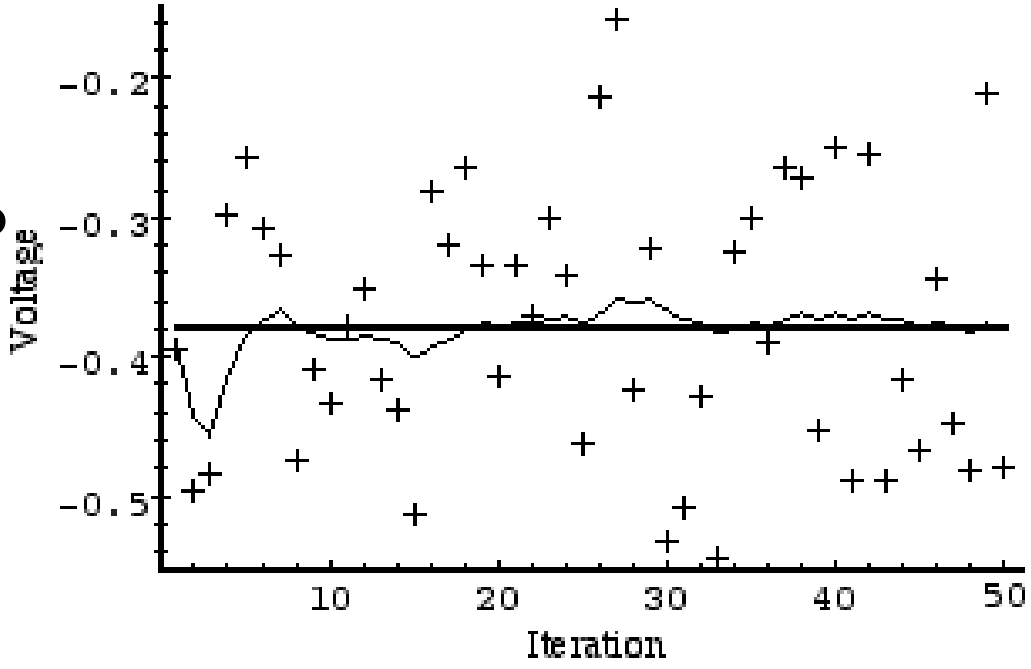
- **The problem: Lack of of the experimental data**

- Citizen science concept successful in many scientific disciplines, providing:
  - Low-cost sensors operation
  - Improved geographical distribution
  - Continuous monitoring

- Can we do this for GNSS?



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- **Good practices**

- International GNSS Service (IGS) (http://www.igs.org/)
- Intermagnet (http://www.intermagnet.org/data-donnee/download-eng.php)
- Space weather & ionospheric data:
  - SPIDR (NOAA, US): http://spidr.ngdc.noaa.gov/spidr/
  - ESA SSA Space Weather Co-ordination Centre: http://swe.ssa.esa.int/web/guest/service-centre
  - Royal Observatory of Belgium, GNSS Research Group: http://www.gnss.be/Atmospheric_Maps/ionospheric_maps.php

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- **Citizen Science for GNSS performance monitoring and assessment**

- GNSS observables collection by volunteers (both laymen and professionals) in compliance with the minimum standards for experimental design, (commercial-grade) equipment utilisation, and quality of collected data
- Data sets collection, aggregation, cleaning, sorting and storing in standrdised formats, with the open access to scientists, engineers, and technology-, strategy-, policy-, and business-developers

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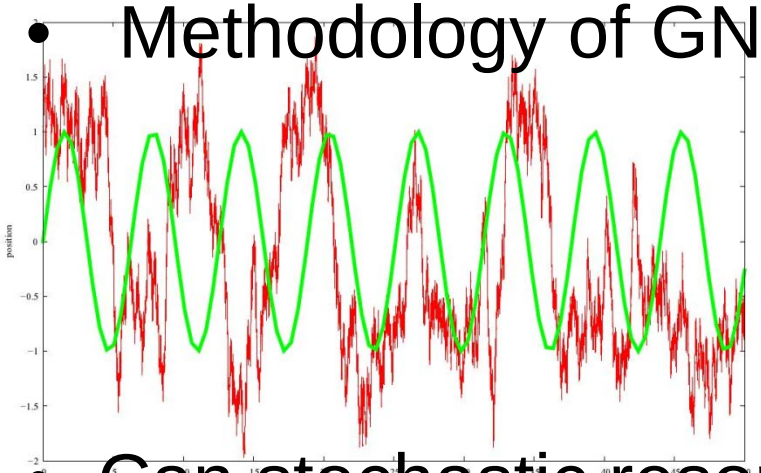
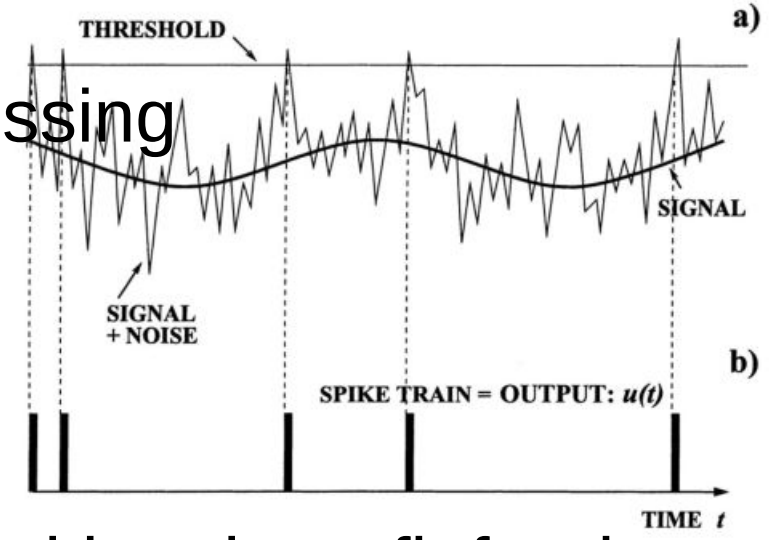
- **Citizen Science for GNSS performance monitoring and assessment**

- Error correction and modelling
- Assessment of the effect of PNT environment (effects of the ionosphere, multipath etc.) – identification of systematic effects
- Methodology of GNSS data processing





- Can stochastic resonance be turned into benefit for the GNSS performance assessment?

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- **Recommendations (1)**

- Establishment of the observation standards for Citizen Science-based GNSS performance monitoring and assessment
- Establishment of a catalogue/database of use-cases per targeted classes of applications (navigation: air, maritime, road, personal; non-navigation: ITS, LBS, timing and synchronisation, emergency services, agronomy and forestry etc.)
- Setting standards for data collection based on best practices (IGS) and characteristics of commercial-grade equipment

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- **Recommendations (2)**

- Setting standards for data storage, organise it, and operate it with the open-access principle deployed
- Setting standards for data access (incl. common data formats, data and system protection)
- Setting standard procedures for data cleaning and error correction (where required)
- Advising on and recommending the GNSS data processing methodology
- Fostering international co-operation and data analysis results exchange

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- **Challenges**

- Technology and organisational challenges
- Data and services hosting
- GNSS data collection
- GNSS data cleaning and normalisation
- GNSS data storage
- GNSS data access
- GNSS data processing
- Error corrections, modelling and processing
- Data and system protection
- Means of co-operation

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- **Conclusion and future work**
- GNSS operation and GNSS-based services increasingly requires knowledge of GNSS PNT performance in various deployment environments and conditions
- An initiative to establish a scientific & engineering – grade database of citizen science experimental observations to be used for GNSS PNT performance assessment in various conditions and environments, thus facilitating responsible, elegant and QoS-guaranteed GNSS-based applications development
- The initiative as an international co-operation effort that yields the system and reliable data accessible openly

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- **Tools and the other resources**

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- **Traceability**

This lecture is based on the paper presented at the 9th Annual Baska GNSS Conference (Baska, Krk Island, Croatia), a meeting point for scientists, engineers, strategists, advisors, policy-makers, technology- and business-developers, regulators, end-users and the other interesting parties.

The Annual Baska GNSS Conference addresses the latest developments in:

- GNSS core and advanced PNT,
- development of resilient GNSS (especially against space weather, ionospheric and jamming effects),
- signal processing for GNSS receiver design,
- GNSS alternatives, and
- GNSS PNT navigation and non-navigation applications (incl. intelligent transport systems, GNSS-R, location-based services, space weather and ionospheric monitoring, timing and synchronisation applications, forestry, and agriculture).

Invitation to 10th Annual Baska GNSS Conference to be held in Baska, Krk Island, Croatia
8 – 10 May, 2016

THANK YOU FOR YOUR ATTENTION !

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