



UNITED NATIONS
Office for Outer Space Affairs



UN/ARGENTINA WORKSHOP ON THE APPLICATIONS OF GNSS

**Falda Del Carmen, Argentina,
19 – 23 March 2018**

Initiative for concerted international co-operation on
collection of GNSS Positioning
Environment Data using Low-cost Sensors Networks

(Reported by **Nenad Sikirica**, Dean, University College of
Applied Sciences Hrvatsko Zagorje Krapina, Krapina, Croatia)

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- Satellite navigation as a component of national infrastructure, and a public goods.
- Non-navigation applications has overtaken navigation ones in GNSS utilisation



Illustration sources: <http://bit.ly/2H64UFK>, and <http://bit.ly/2FKZtFN>.

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- Deterioration of GNSS PNT services quality has direct impact on GNSS-based applications -> **identification, detection and mitigation of disruptive GNSS conditions and effects** <- research subject throughout the world

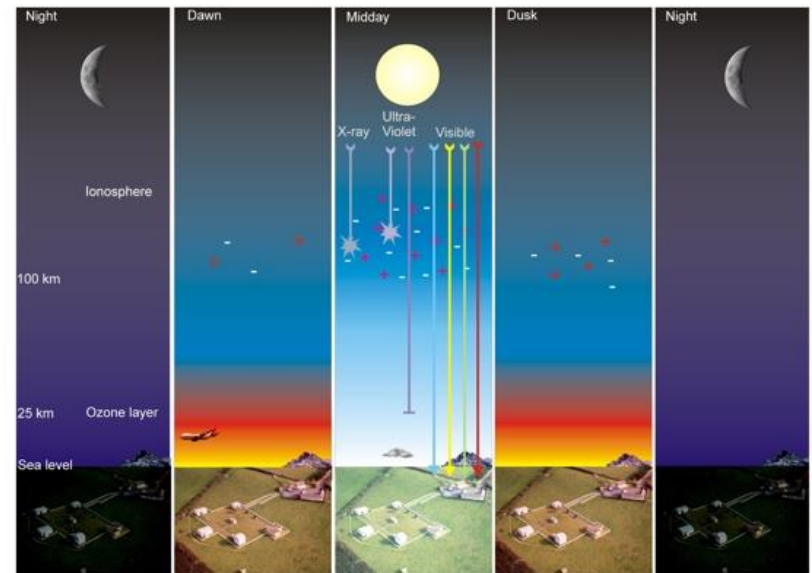


Illustration sources: <http://bit.ly/2td1Fdi>, and <http://bit.ly/2A6aOXU>

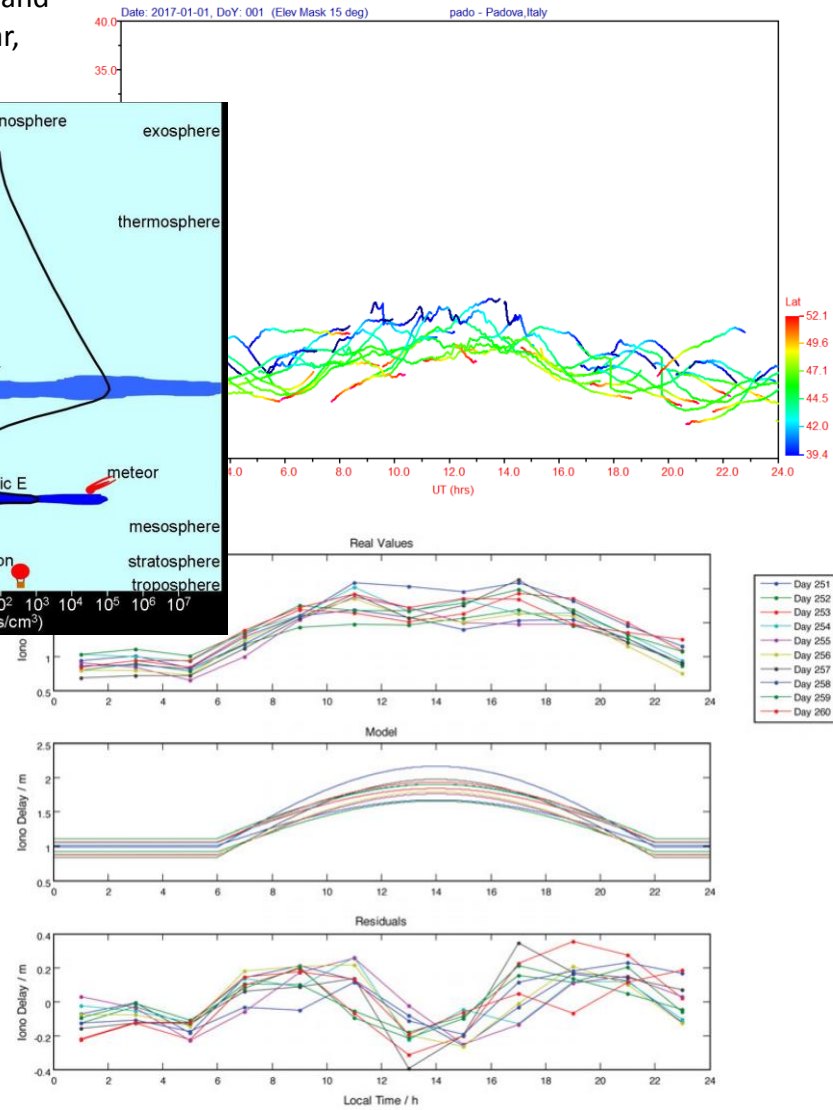
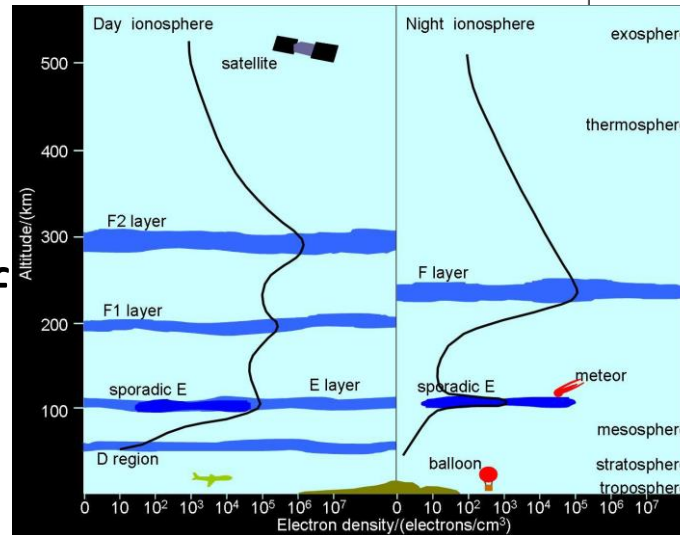
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- Space weather and ionospheric effects as the principal single cause of GNSS PNT quality deterioration
- Understanding developed on analysis of numerous case-studies

Sources: <http://bit.ly/2FhG5pV>, and publications by Prof Renato Filjar, PhD FRIN



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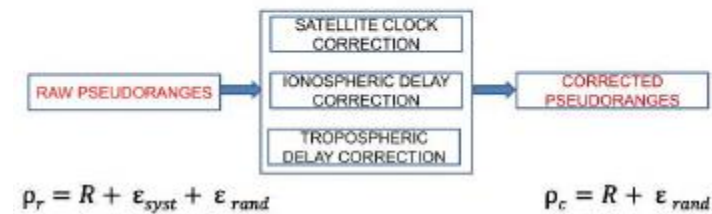
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- Software-Defined Radio (SDR) renders GNSS position estimation process transparent.
- It supports development and utilisation of bespoke error correction models on raw GNSS observations.
- Collection of raw GNSS pseudorange observations recently enabled for Android smartphones.



Figure 1 The GNSS position estimation procedure extends over three essential domains

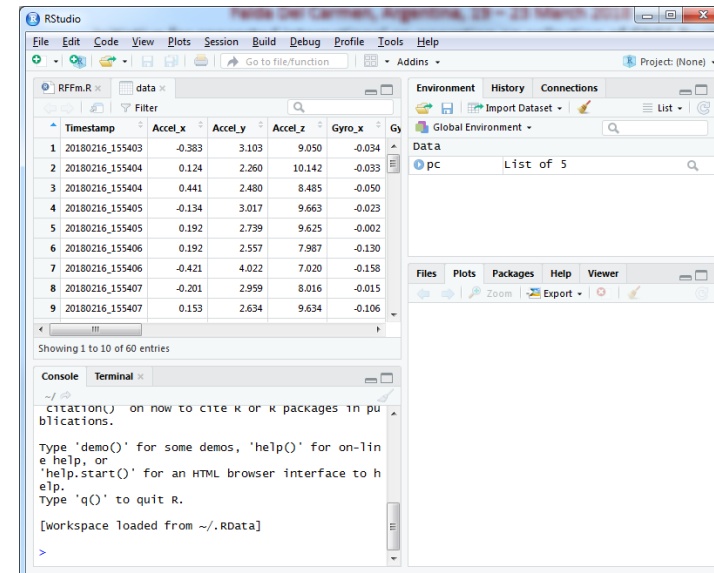
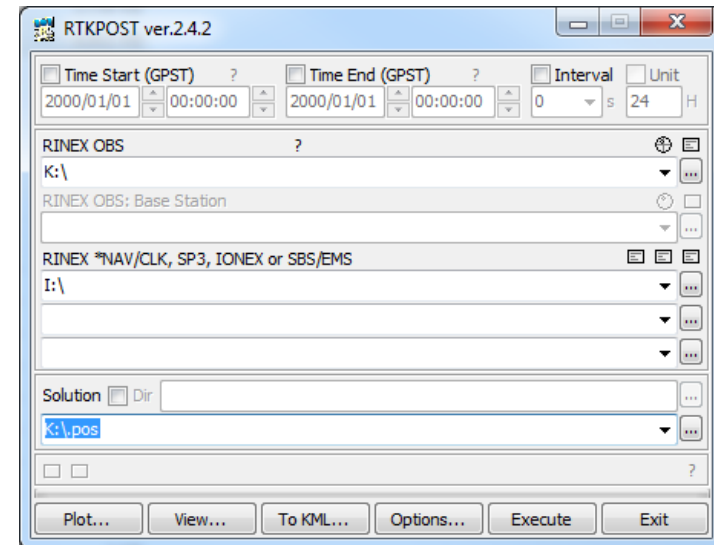


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- A research team in Croatia has developed the GNSS positioning performance assessment methodology and framework, based on utilisation of **RTKLIB GNSS SDR**, and proprietary analysis and assessment software, developed in the R environment for statistical computing.
- The framework allows for assessment of GNSS PNT quality, as well as for error correction model development and validation.
- All categories of GNSS positioning environments and the related effects can be examined.



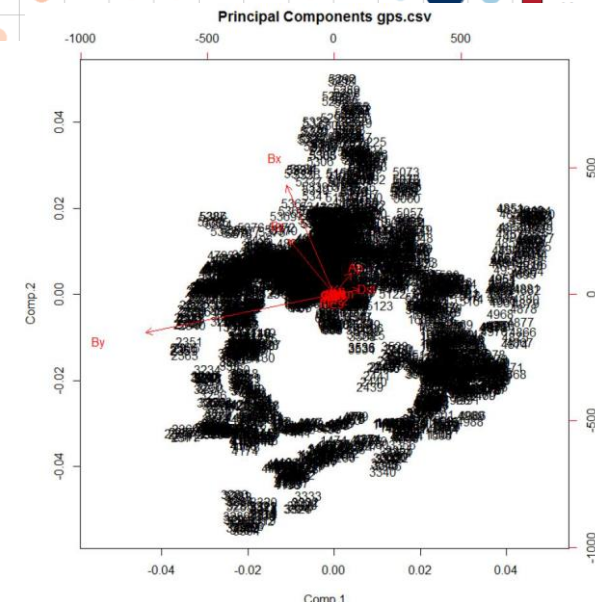
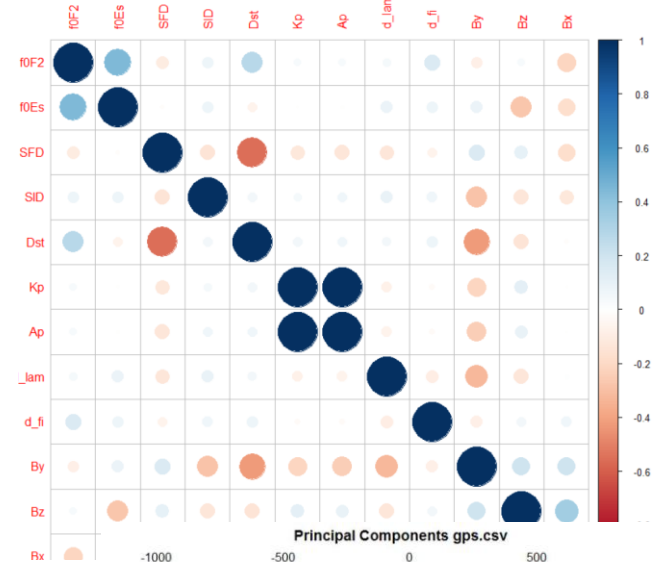
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Correlation gps.csv using Spearman

- Machine learning-based approach has led to recent developments in modelling space weather/ionospheric-GNSS performance coupling (case-study of quiet space weather), accomplished by the team from Faculty of Engineering, University of Rijeka, Croatia (list of references at the end of presentation)



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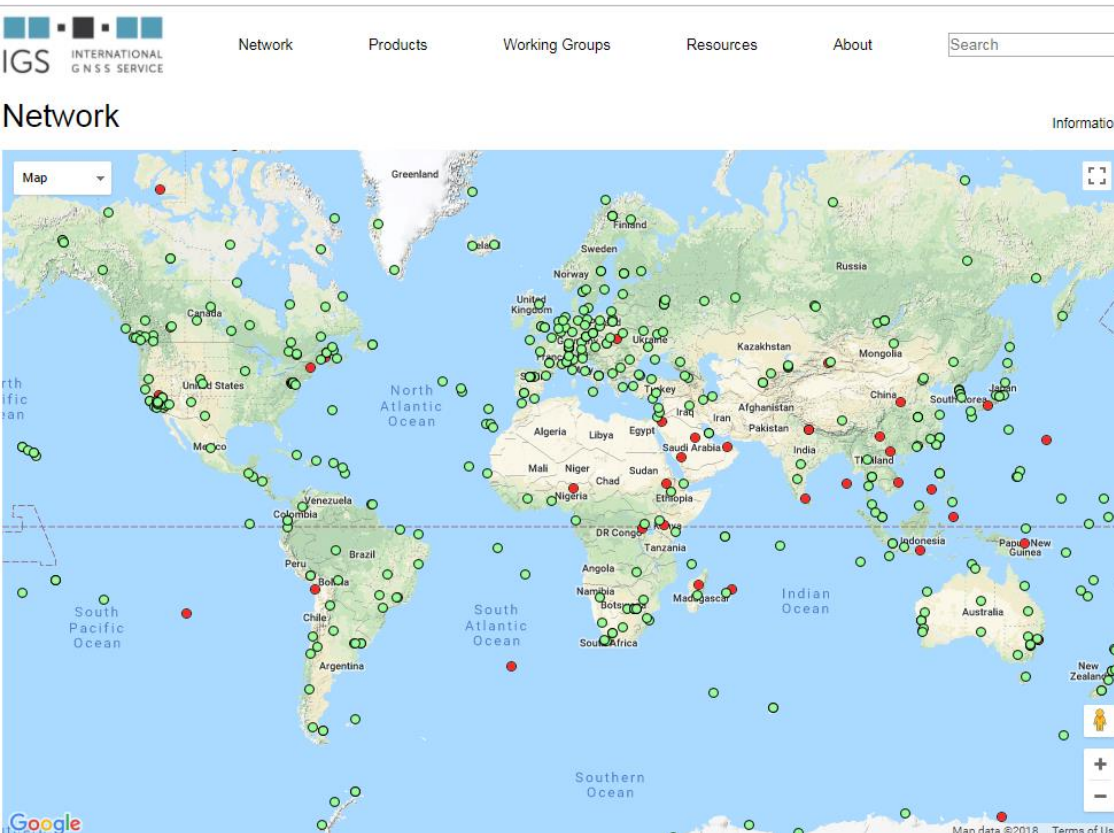
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- We are hungry for GNSS data and case-scenarios!

Source: <http://www.igs.org/network>

Source: <http://www.gnsscalendar.com/>



GNSS CALENDAR AND UTILITY

Sunday, January 1, 2017 (UTC)

Julian Day Number: 2457754.5 Day of Year: 1
GPS Week: 1930 GPS Week Number: 19300
GPS Final Orbits (IGS): [igs19300.sp3.Z](#)
GIONASS Final Orbits (CDDIS): [igl19300.sp3.Z](#)
BRDC GPS Broadcast Orbits (BRDC): [brdc0010.17n.Z](#)
IGS Clock file 30 s (IGS): [igs19300.clk_30s.Z](#)
AIUB ION file: [COD19300.ION.Z](#)
AIUB SNX file: [COD19300.SNX.Z](#)
SNX file for Week: [COD19307.SNX.Z](#)
P1C1 DCB: [P1C11701.DCB.Z](#)
P1P2 DCB: [P1P21701.DCB.Z](#)

JANUARY 2017							FEBRUARY 2017							MARCH 2017							APRIL 2017						
Su	M	Tu	W	Th	F	Sa	Su	M	Tu	W	Th	F	Sa	Su	M	Tu	W	Th	F	Sa	Su	M	Tu	W	Th	F	Sa
1	2	3	4	5	6	7				1	2	3	4								1	2	3	4			
8	9	10	11	12	13	14	5	6	7	8	9	10	11	5	6	7	8	9	10	11	2	3	4	5	6	7	8
15	16	17	18	19	20	21	12	13	14	15	16	17	18	12	13	14	15	16	17	18	9	10	11	12	13	14	15
22	23	24	25	26	27	28	19	20	21	22	23	24	25	19	20	21	22	23	24	25	16	17	18	19	20	21	22
29	30	31					26	27	28					26	27	28	29	30	31		23	24	25	26	27	28	29
																						30					

MAY 2017							JUNE 2017							JULY 2017							AUGUST 2017						
Su	M	Tu	W	Th	F	Sa	Su	M	Tu	W	Th	F	Sa	Su	M	Tu	W	Th	F	Sa	Su	M	Tu	W	Th	F	Sa
	1	2	3	4	5	6					1	2	3								1	2	3	4	5		
7	8	9	10	11	12	13	4	5	6	7	8	9	10	2	3	4	5	6	7	8	6	7	8	9	10	11	12
14	15	16	17	18	19	20	11	12	13	14	15	16	17	9	10	11	12	13	14	15	13	14	15	16	17	18	19
21	22	23	24	25	26	27	18	19	20	21	22	23	24	16	17	18	19	20	21	22	20	21	22	23	24	25	26
28	29	30	31				25	26	27	28	29	30									27	28	29	30	31		
																						30	31				

SEPTEMBER 2017							OCTOBER 2017							NOVEMBER 2017							DECEMBER 2017							
Su	M	Tu	W	Th	F	Sa	Su	M	Tu	W	Th	F	Sa	Su	M	Tu	W	Th	F	Sa	Su	M	Tu	W	Th	F	Sa	
							1	2	1	2	3	4	5	6	7							1	2	3	4			
3	4	5	6	7	8	9	8	9	10	11	12	13	14	5	6	7	8	9	10	11	3	4	5	6	7	8	9	
10	11	12	13	14	15	16	15	16	17	18	19	20	21	12	13	14	15	16	17	18	10	11	12	13	14	15	16	
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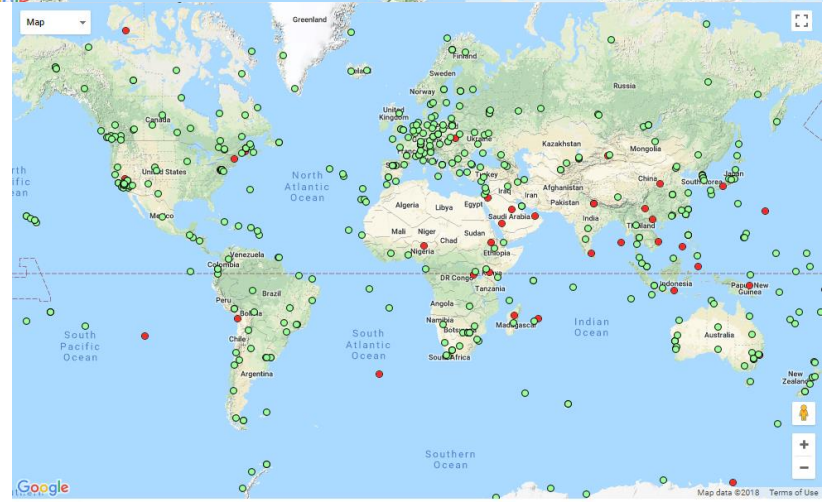
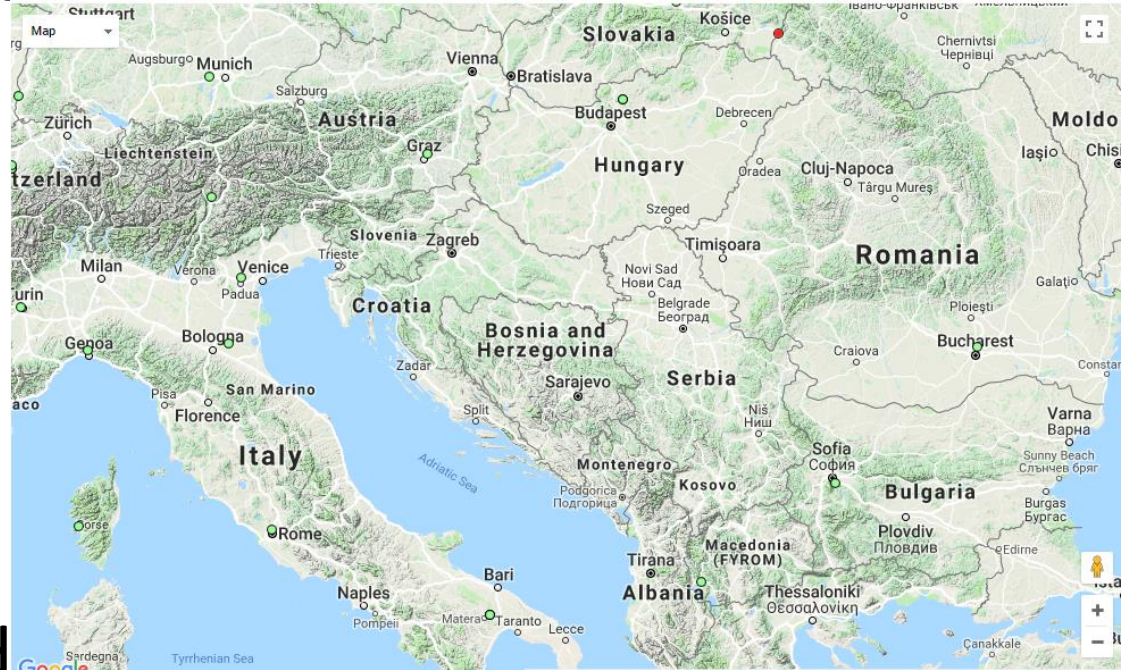
1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018			

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- GNSS observations are still sparse in spatio-temporal domain.
- Major events and case-scenarios are not always covered appropriately -> missing data on GNSS-critical events



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- Low-cost sensors are ubiquitous and affordable

R-based (open source) signal and information processing, and analysis and modelling

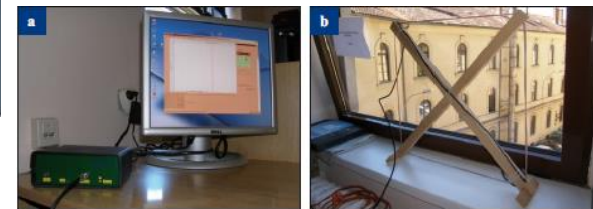
GNSS pseudoranges from smartphones



Timestamp	Accel_x	Accel_y	Accel_z	Gyro_x	Gyro_y
20180216_155403	-0.383	3.103	9.050	-0.034	
20180216_155404	0.124	2.260	10.142	-0.033	
20180216_155404	0.441	2.480	8.485	-0.050	
20180216_155405	-0.134	3.017	9.663	-0.023	
20180216_155405	0.192	2.739	9.625	-0.002	
20180216_155406	0.192	2.557	7.987	-0.130	
20180216_155406	-0.421	4.022	7.020	-0.158	
20180216_155407	-0.201	2.959	8.016	-0.015	
20180216_155407	0.153	2.634	9.634	-0.106	

Internet archives

SID/AWESOME monitors of ionospheric activity



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- Recommendations for international collaboration on:
 - Data ontology development (specification of related space weather, ionospheric, GNSS performance indices)
 - Data collection methodology and standard development
 - ICT infrastructure for data aggregation, storage and access

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- Recommendations for international co-operation on (cont.):
 - New approaches in data utilisation for modelling and forecasting of space weather and ionospheric effects on GNSS PNT from base-band (signal processing) and navigation (application) perspectives
 - GNSS PNT quality assessment in various positioning environment conditions
 - Academic and professional education in new and emerging disciplines

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THANK YOU FOR YOUR ATTENTION !

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With the invitation to **12th Annual Baška GNSS Conference,**
Baška, Krk Island, Croatia, 6 – 9 May, 2018

Details at: <http://www.rin.org.uk/events/5066/12th-Annual-Ba%C5%A1ka-GNSS-Conference>

