#### Forecast of Real-time Multi GNSS Positioning Accuracy

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#### Presentation plan

- Aim and motivation
- Ø Methodology
- Results
- Conclusions

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<mark>Aim</mark> Motivation

### The aim of work

Services that provide needed products for precise positioning are still developed. Our aim was to check if launching of GLONASS real time service enhances the PPP positioning.

Aim Motivatior

# IGS RTS products availability



The current availability of precise IGS RTS products for GPS and GLONASS (DOY 109-122 2015)

	GPS	GLONASS
Clocks	91.3	18.1
Orbits	91.3	41.2



Procedure scheme Final and RTS IGS product comparison ESA files degradation

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### Procedure scheme



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# Transformation differences to inertial frame

$$\begin{bmatrix} \Delta R \\ \Delta A \\ \Delta C \end{bmatrix} = E^{-1} \begin{bmatrix} \Delta X \\ \Delta Y \\ \Delta Z \end{bmatrix}$$

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#### where

$$E = \begin{bmatrix} e_r & e_a & e_c \end{bmatrix}$$
$$e_a = \frac{\dot{r}}{|\dot{r}|} \qquad e_c = \frac{r \times \dot{r}}{|r \times \dot{r}|} \qquad e_r = e_a \times e_c$$

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### Comparison results



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## Range

Setting the ranges of each component on the basis of differences between final and real-time products for GPS satellites

 $\begin{array}{l} \mathsf{R} = <{-}0.06 \ 0.03{>} \\ \mathsf{A} = <{-}0.09 \ 0.08{>} \\ \mathsf{C} = <{-}0.07 \ 0.06{>} \\ \mathsf{t} = <{-}4.83 \ {-}4.14{>} \end{array}$ 



Components differences ranges

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### Genearation noise

Deltas of R, A, C, t were generated for all GLONASS satellites on the basis of previously determined values ranges and peaks numbers ranges.

$$R = \langle 103, 192 \rangle$$
  

$$A = \langle 128, 210 \rangle$$
  

$$C = \langle 118, 189 \rangle$$
  

$$t = \langle 224, 287 \rangle$$



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#### Generated noise - example



### Results



Juxtaposition of coordinates residues from GNSS-WARP software (upper - |GS, |ower - |G|G)

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### Results comparison

#### Standard deviation of coordinates residues for DOY 113-117

	Static			Kinematic		
	N	E	U	N	Е	U
IGIG	0.027	0.029	0.031	0.087	0.144	0.141
IGS03	0.014	0.023	0.017	0.067	0.091	0.107





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## Conclusions

- currently not acceptable level of IGS RTS products availability for GLONASS
- no improvement of positioning accuracy after applying additional GLONASS clocks and orbits
- unsatisfying results caused probably by final ESA products accuracy degradation OR unsatisfying accuracy level of final ESA products destined for GLONASS
- insufficient quality of GLONASS products for PPP application, a demand for further improvement

# Thank you for your attention!

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