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CENTRE NATIONAL D'ÉTUDES SPATIALES

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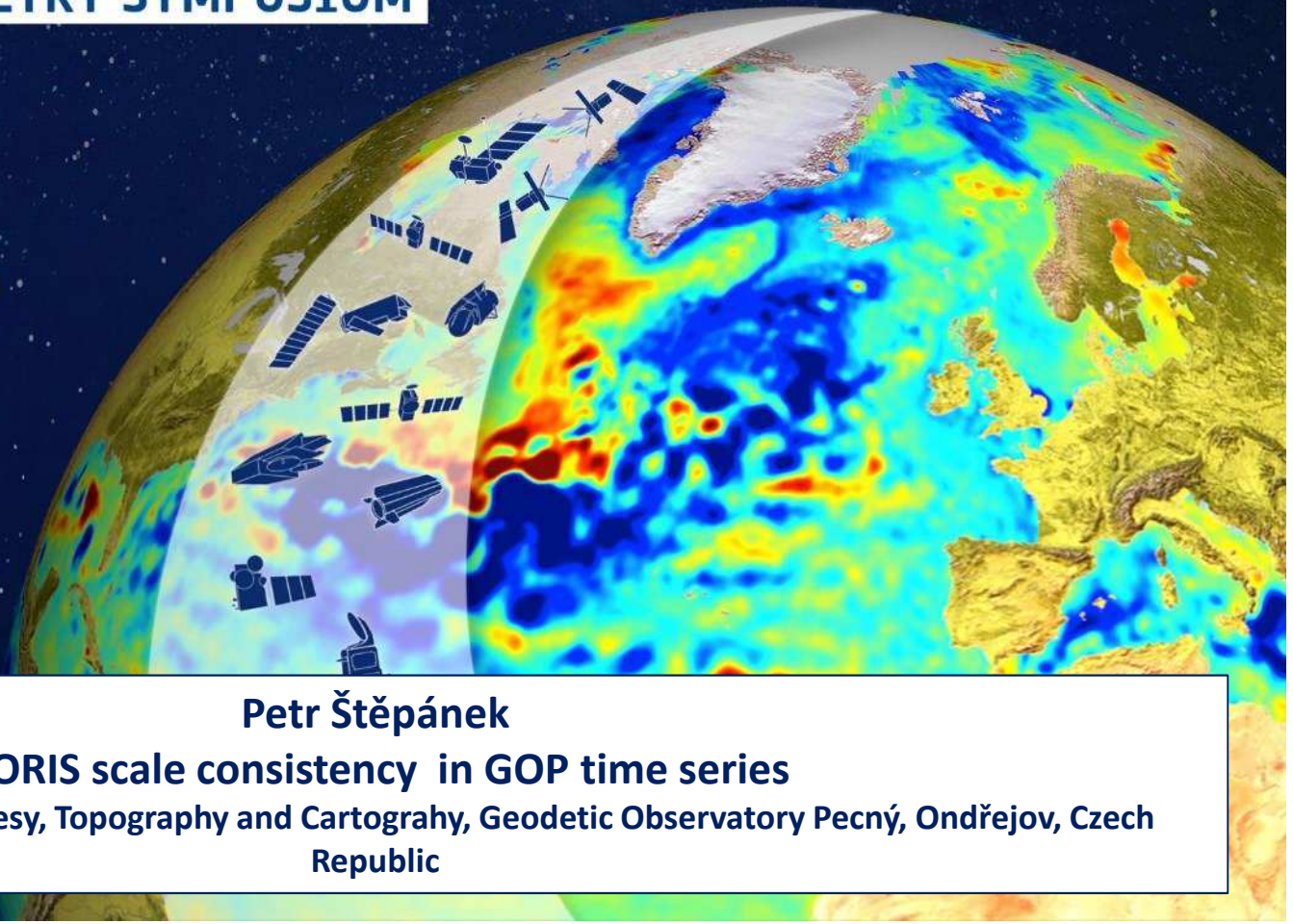
European Space Agency

→ 25 YEARS OF PROGRESS IN RADAR ALTIMETRY SYMPOSIUM

IDS WORKSHOP

24–29 September 2018
Ponta Delgada, São Miguel Island
Azores Archipelago, Portugal



Petr Štěpánek

DORIS scale consistency in GOP time series

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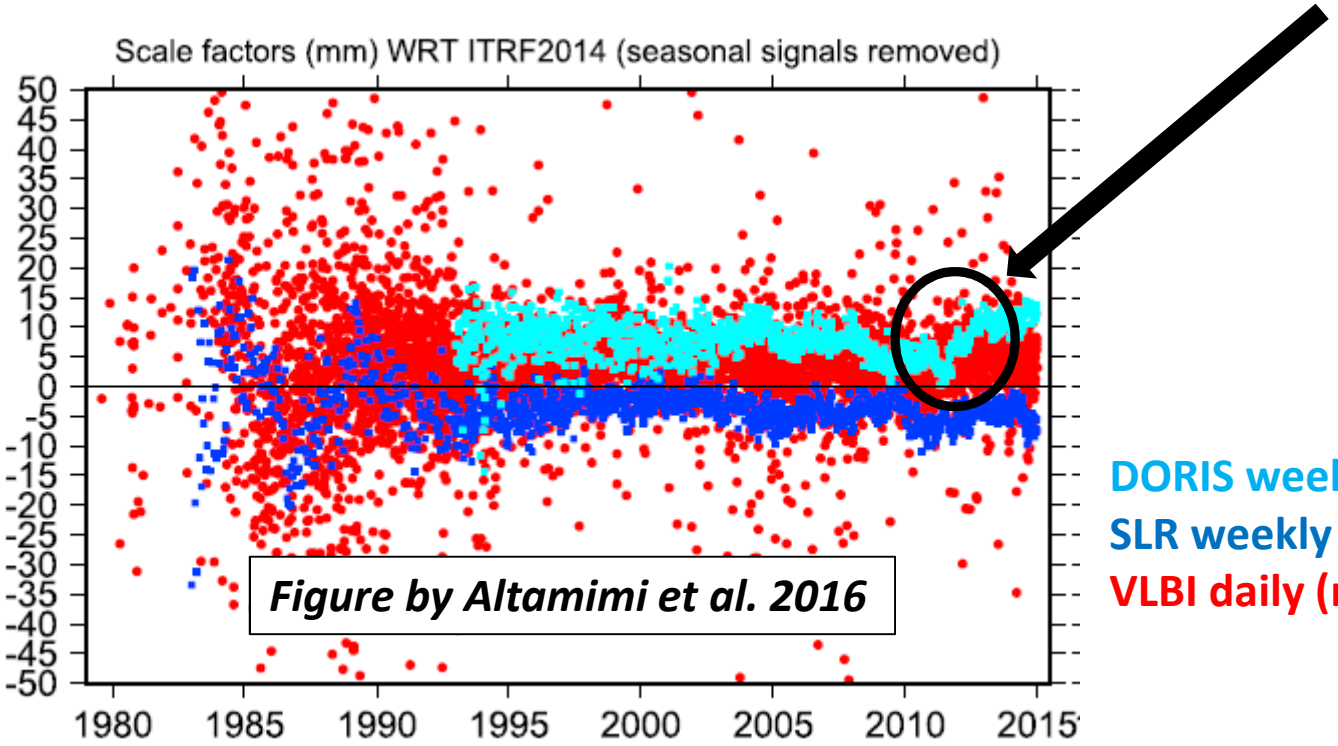
DORIS and ITRF scale

❑ Participated in ITRF2014, but not for the Scale definition



DORIS weekly (cyan)
SLR weekly (blue)
VLBI daily (red)

DORIS – derived TRF scale issue

- Satellite-specific bias
  - phase center vector, attitude modeling
  - ratio of low elevation observations (altitude, instrument generation)
- Scale increment in 2012 and in 2015
  - not fully explained by changes in the Satellite constellation
  - not the same size for all the individual analysis center solutions
  - 2012 scale increment in DORIS series for ITRF2014
  - 2015 scale increment in IDS operational series
- systematic effect of data elevation cut off and downweighting

Scale increment in 2012

- ❑ Scale factor increment more than 10 mm in IDS-solution, up to 20 mm for individual AC solutions
- ❑ Possible effect of data quality indicator application (Capdeville et al. 2017)
- ❑ Jason-2, Cryosat-2
- ❑Changes in CNES POD standards

Scale increment in 2015

- ❑ Scale factor increment around 5 mm in IDS-solution, up to 10 mm for individual AC solutions
- ❑ Affects significantly 3 of 5 individual AC solutions
- ❑ Could relate to another change in CNES POD standards (Moreaux 2017)

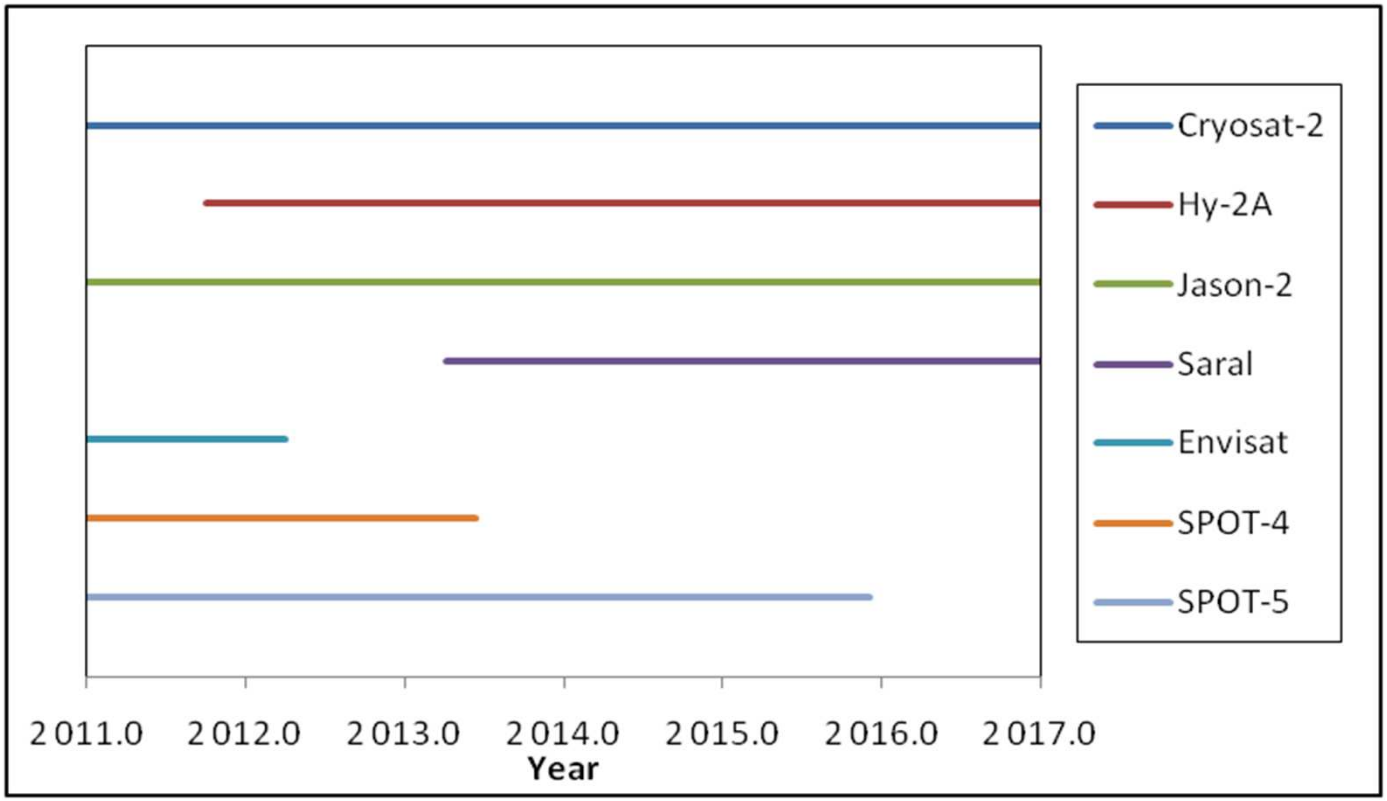
Testing Campaign

- 2011.0 – 2017.0
- Multi-satellite and all single-satellite solutions
- DORIS Doppler (2.2) data
- Consistent series of one AC (Geodetic Observatory Pecny – GOP)
- 2012 and 2015 scale issues
- DPOD2014 (version 1) as a reference
- 4 solutions (V1-V4)
  - V2-V1 difference = downweighting
  - V3-V2 difference = Validity indicator
  - V4-V3 difference = CoM correction
  - elevation cut off 10 deg for all

ITRF2014 GOP reprocessing standard

Solution	Observation weight	Validity indicator from data file	CoM correction from data file
V1	1	Yes	Yes
V2	$\mathrm{Sin}^2 E$	Yes	Yes
V3	$\mathrm{Sin}^2 E$	No	Yes
V4	$\mathrm{Sin}^2 E$	No	No

Satellite constellation

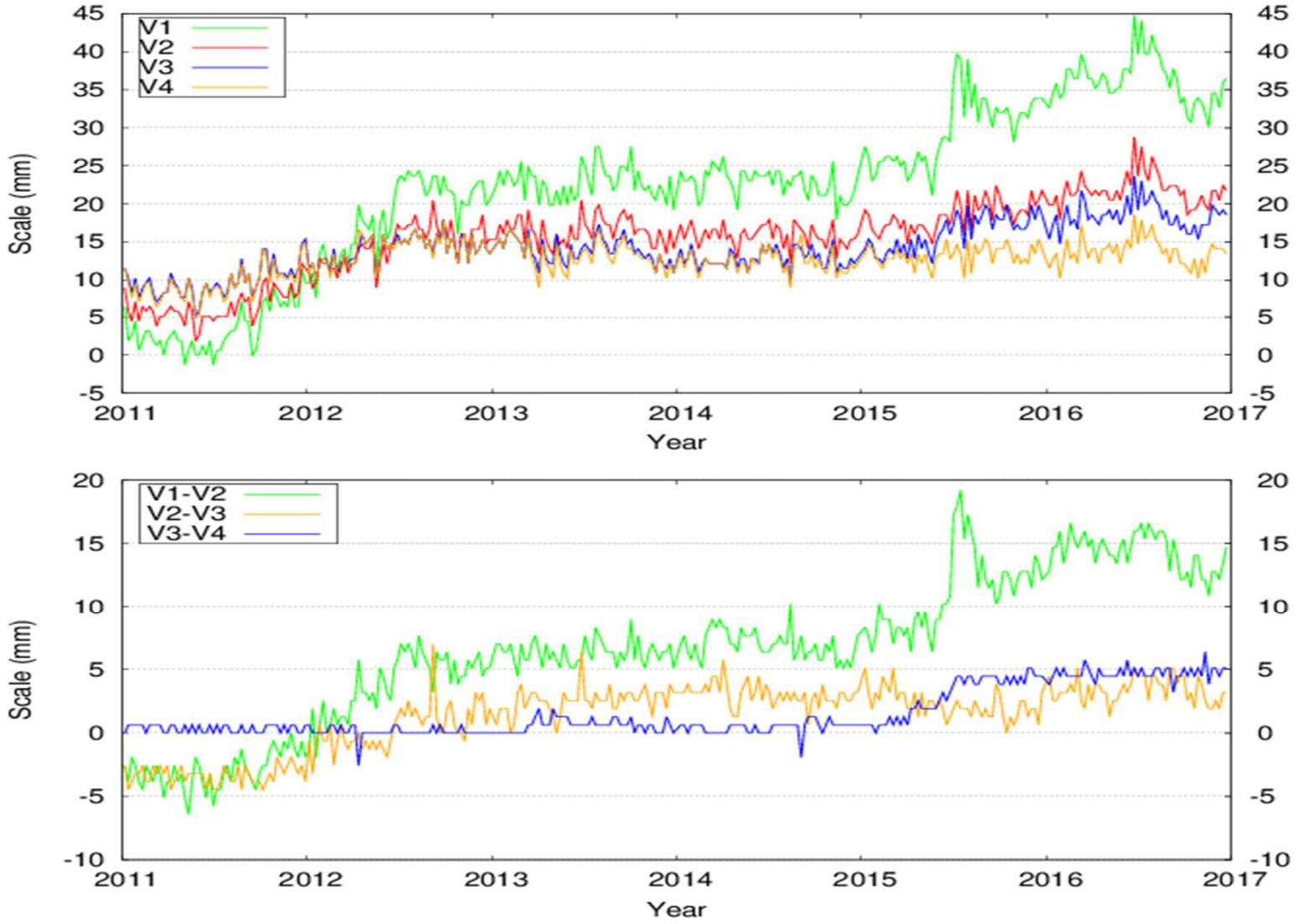


Campaign Summary

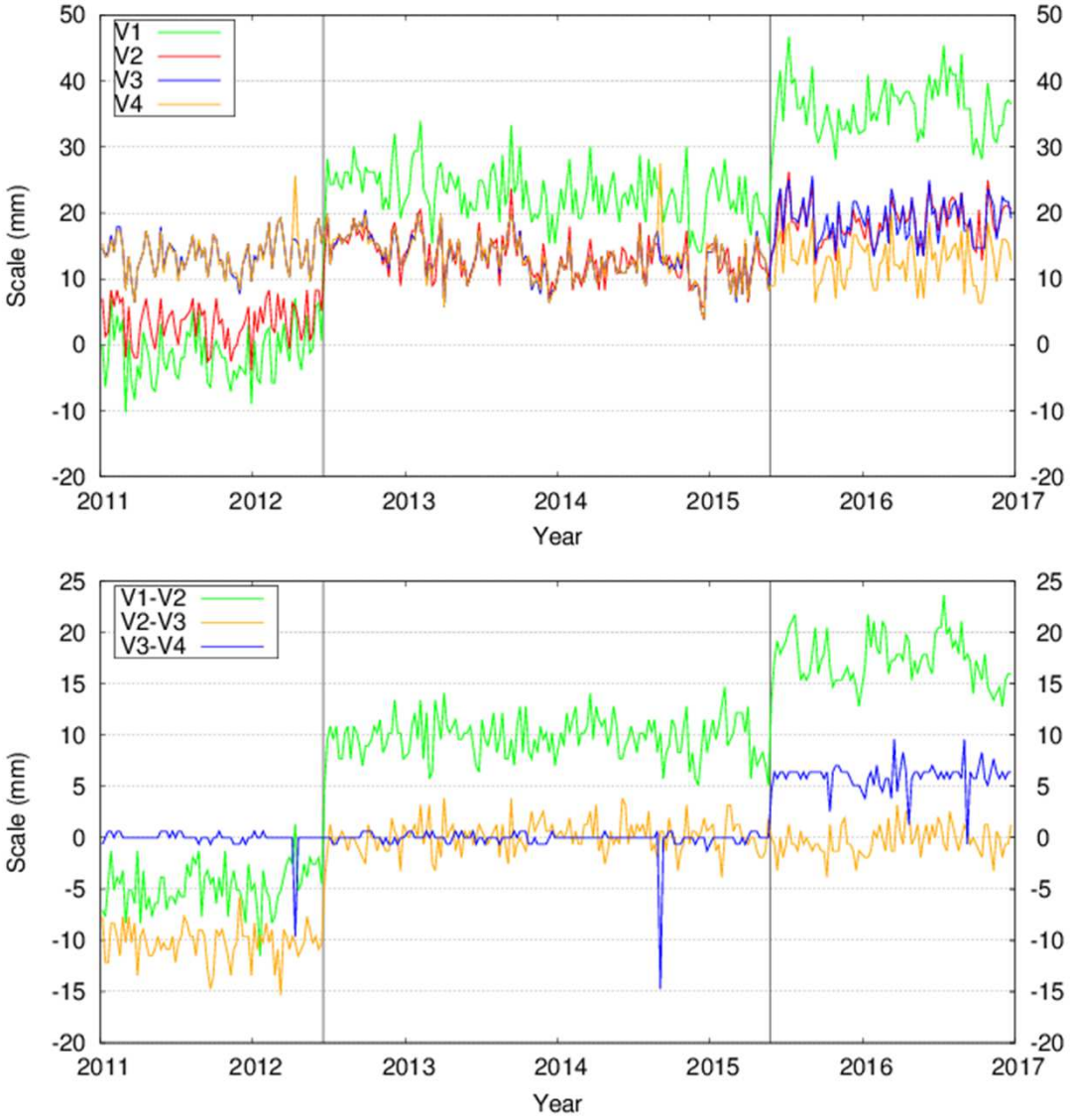
- ❑ for complete time span 2011.0 – 2017.0
- ❑ only minor improvement (if any) for SPOT-4, SPOT-5 and Envisat
- ❑ Inconsistency in the periods of CNES POD standard changes (eliminated in V4)
- ❑ ITRF2014 reprocessing strategy V1, recommended strategy V4
- ❑ Bias w.r.t. DPOD2014(1) reduced from 22.1 mm to 12.7 mm
- ❑ RMS reduced from 10.7 mm to 2.3 mm
- ❑ when applying Hy-2A new antenna phase center offset , another improvement is expected (possibly Mean < 10 mm, RMS < 2 mm)

Sat/Sol	V1 (mm)	V2 (mm)	V3 (mm)	V4 (mm)
Saral	27.4±7.6	16.9±4.0	11.5±4.4	6.8±2.6
Hy-2A	39.2±3.6	28.9±2.9	24.6±2.6	24.8±2.6
Cryosat-2	21.9±13.7	16.9±6.8	12.8±5.2	10.2±3.6
Jason-2	20.4±14.1	12.2±6.3	14.7±4.0	13.4±3.3
SPOT-5	10.9±3.5	10.4±2.6	12.4±2.8	12.4±2.8
SPOT-4	5.5±6.3	2.7±4.5	3.4±5.8	3.5±5.7
Envisat	-2.1±2.9	1.0±2.8	1.2±2.9	0.0±2.9
Combination	**22.1±10.7**	**15.5±5.1**	**14.2±3.3**	**12.7±2.3**

Combination



Jason-2



- CNES POD standards changes – vertical lines
- Data downweighting reduced the effect
- 2012 – validity indicators
- 2015 – CoM corrections

Low elevation data

Omitting the accessory information from DORIS Dopler 2.2 data files and applying the data downweighting, we reached the goal (consistent scale time series for period 2011.0 – 2017.0 and reduction of the offset w.r.t. ITRF 2014). It is clear that the data quality indicator and center of mass corrections from the data file are not consistent, when inconsistencies relates to the period of CNES POD standards

However, the systematic effect on the estimated scale when applying the data downweighting or elevation cut off is not explained.

- ❑ Real improvement?
- ❑ Relevant also for RINEX data
- ❑ New experiments needed
  - ❖ Effect of downweighting/elevation cut off for solution without application of data accessory information
  - ❖ Residual analysis (ascending and descending elevation)

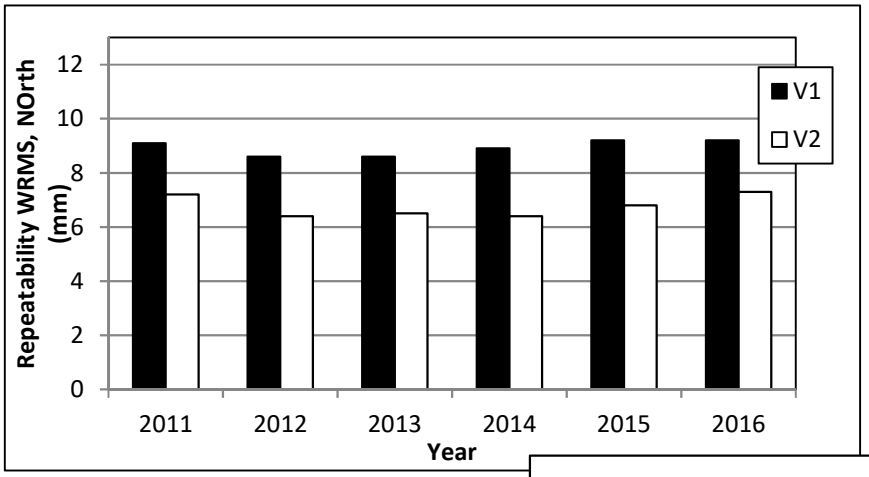
Comparison to SSALTO orbits

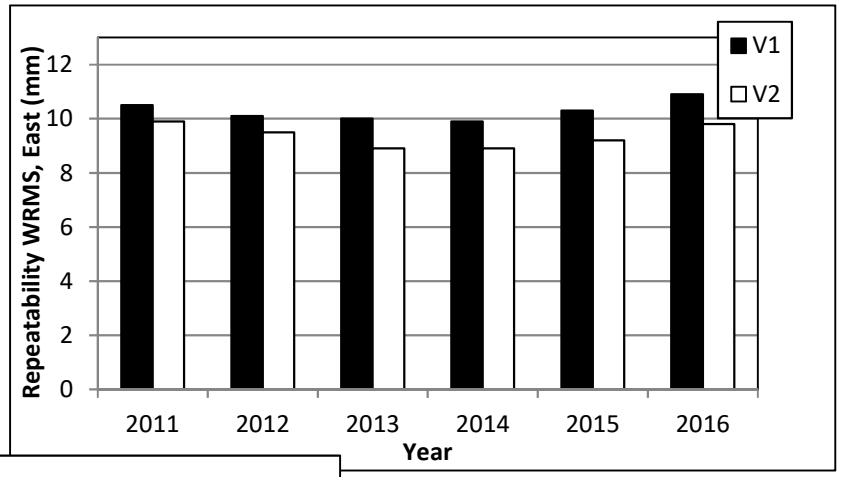
- ❑ Improvement in radial RMS for all satellites (V2 vs V1)
- ❑ Radial RMS decreased by 3-15 mm

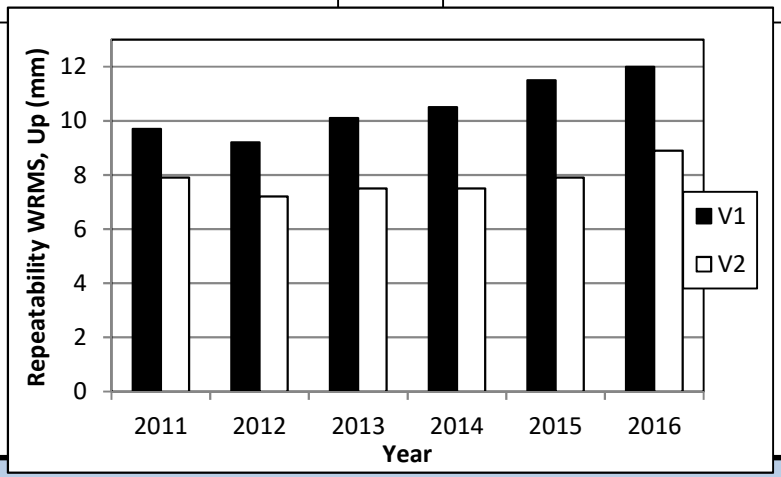
Sat/Sol	Radial Mean (mm)				Radial RMS (mm)			
	V1	V2	V3	V4	V1	V2	V3	V4
Saral	-0.2	-0.2	0.0	0.5	9.5	8.0	8.2	8.2
Hy-2A	0.0	0.6	0.7	0.7	8.5	8.1	8.1	8.1
Cryosat-2	0.4	0.3	0.4	0.4	9.6	8.3	8.4	8.5
Jason-2	-0.5	-0.4	-0.4	-0.4	9.1	8.8	8.8	8.8
SPOT-5	0.1	-0.1	-0.2	-0.2	12.7	11.7	11.7	11.8
SPOT-4	0.4	0.5	0.5	0.4	14.1	13.2	14.8	14.8
Envisat	0.4	0.2	0.0	0.1	8.5	8.0	8.3	8.3

weekly reatability RMS

- Improvement in all components (V2 vs V1)
- Repeatability WRMS reduction of 24% in North, 9% in East and 26% in height







Summary and Conclusions

- Scale „jumps“ in the last ITRF re-processing and IDS operational series are clearly explained by inconsistencies in the accessory informations from Doppler data files
- Avoiding this information or using RINEX data files, the problem is fixed
- Satellite Hy-2A – participation on the scale estimation?
- Systematic effects of low elevation observations needs explanation
  - Elevation dependent data downweighting (this experiment)
  - Elevation cut off (Capdeville et al. 2017)
- Make all these issues clear before the next ITRF data re-processing

For detailed results : Štěpánek, P.; Filler, V., 2018. **Cause of scale inconsistencies in DORIS time series**, *STUDIA GEOPHYSICA ET GEODAETICA*, in press

References

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https://ids-doris.org/ids/reports-mails/meeting-presentations.html

Thanks for your attention …