VLBI-derived Earth Orientation Parameters generated at ESOC

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07/06/2018

10th IVS General Meeting (GM2018), Longyearbyen, Svalbard

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Overview

- Motivation

- Current status of VLBI implementation in NAPEOS

- Validation concept

- First VLBI analysis results

- Conclusions

- Next steps

Motivation

ESOC's Navigation Support Office has enhanced its processing capabilities for VLBI tracking data to

- complete ESOC's capabilities in generating independent Earth Orientation Parameters (EOPs)

- contribute to the IVS service as an analysis centre

- enhance ESOC's contribution to the IERS service with UT1-UTC and nutation products

- enable NAPEOS to combine all space-geodetic techniques at the observation level

Current implementation status allows estimation of EOPs

→ next slides will show first results

Status of VLBI implementation in NAPEOS

- Observation model fully implemented

- Data analysis based on NGS card files

  - Cable delay from NGS files used

  - Formal errors from NGS files used for observation weighting

  - Meteo data from NGS file used for modeling tropospheric dry zenith delay

- Partial derivatives for parameter estimation implemented

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Status of VLBI implementation in NAPEOS

Parameter estimation enabled			Parameterization	Interval	Constraints
EOP	Polar motion + rates	✓	offset + drift	24 h	45 mas
	dUT1	✓	constant	24 h	3 ms
	LOD	✓	constant	24 h	3 ms/d
	Nutation offsets	✗			
Source coordinates		✗			
Station coordinates		✓	constant	24 h	NNR /NNT
Station clocks		✓	piece-wise linear offset	6 h	100 ms
Tropo	Wet zenith delays	✓	piece-wise linear offset	30 min	1 m
	Gradients	✓	constant	24 h	1 m

How to validate VLBI processing of NAPEOS?
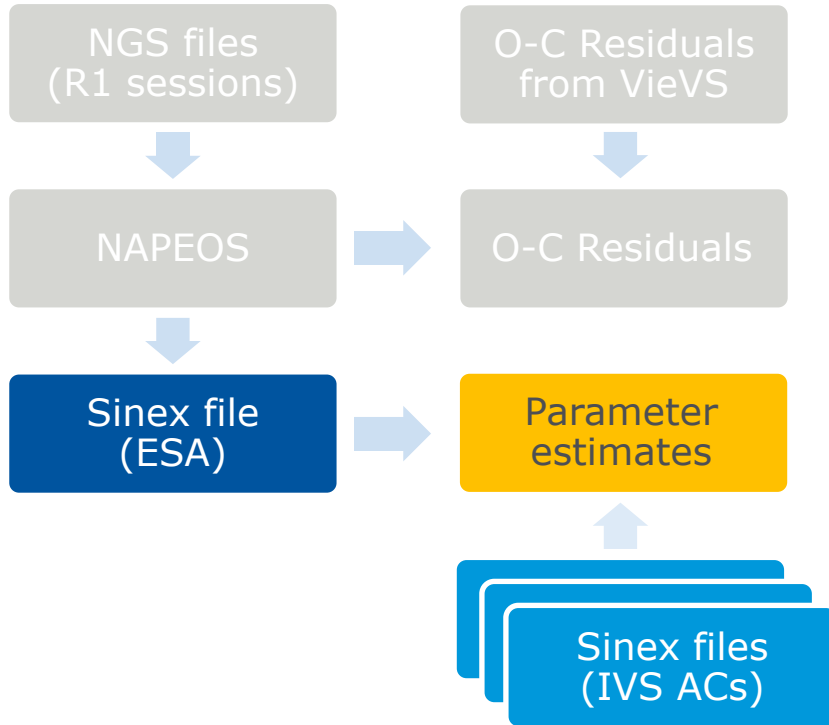
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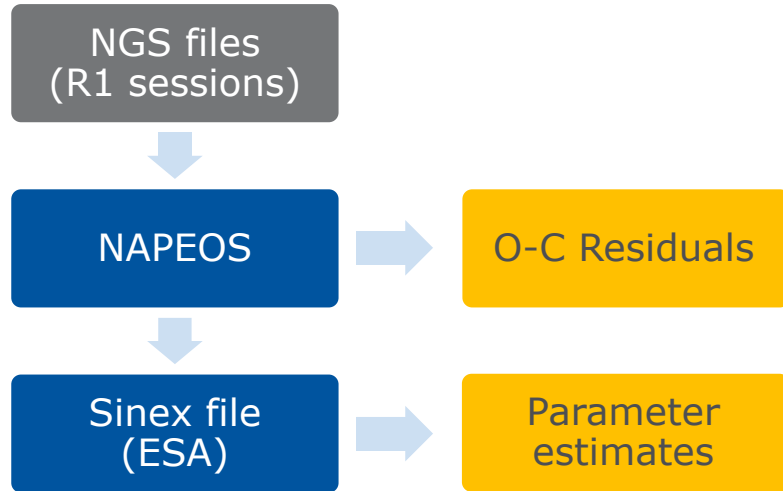
How to validate VLBI processing of NAPEOS?
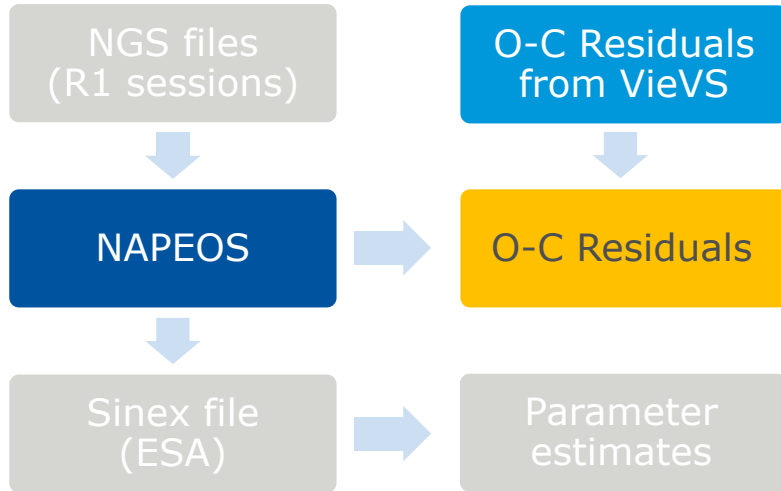
→ Compare residuals

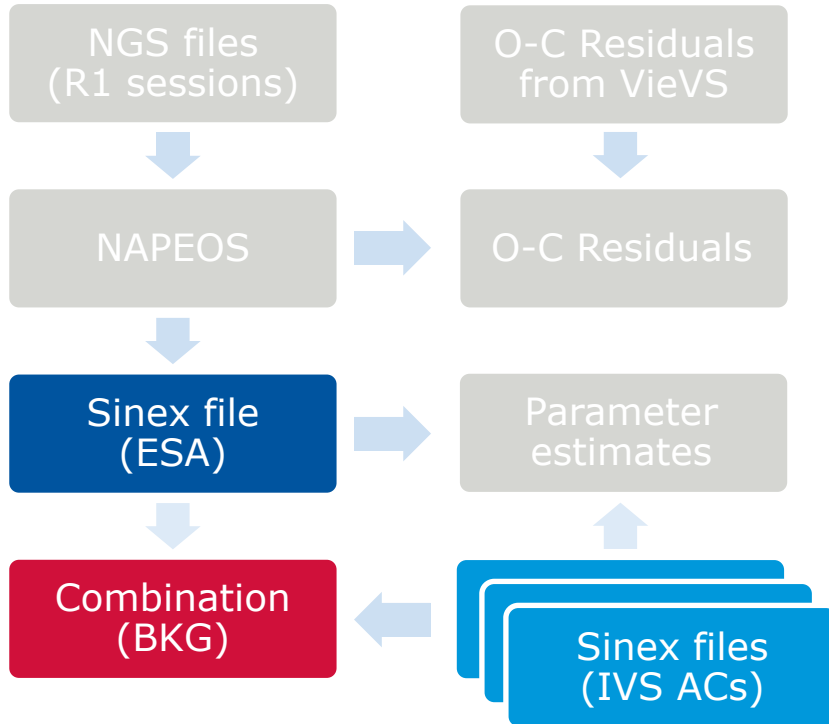# How to validate VLBI processing of NAPEOS?

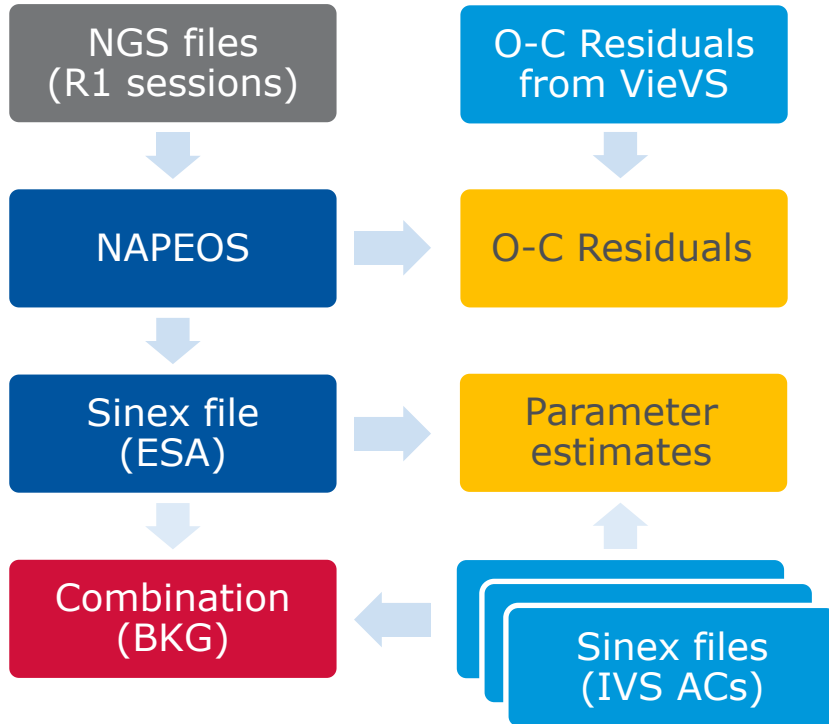→ Compare residuals

→ Compare parameter estimates

How to validate VLBI processing of NAPEOS?

→ Compare residuals

→ Compare parameter estimates

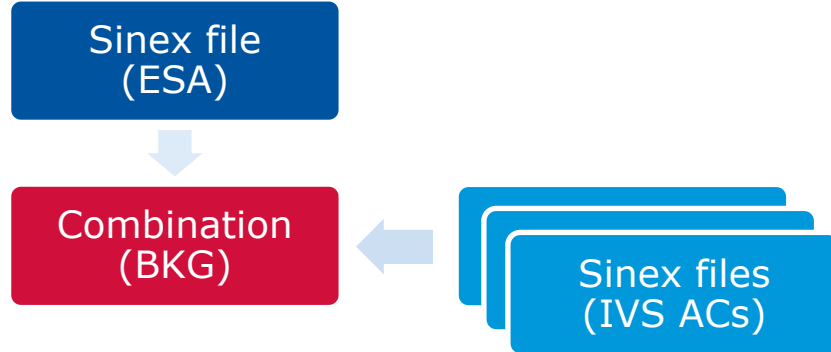→ Combination at NEQ level

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How to validate VLBI processing of NAPEOS?

→ Compare residuals

→ Compare parameter estimates

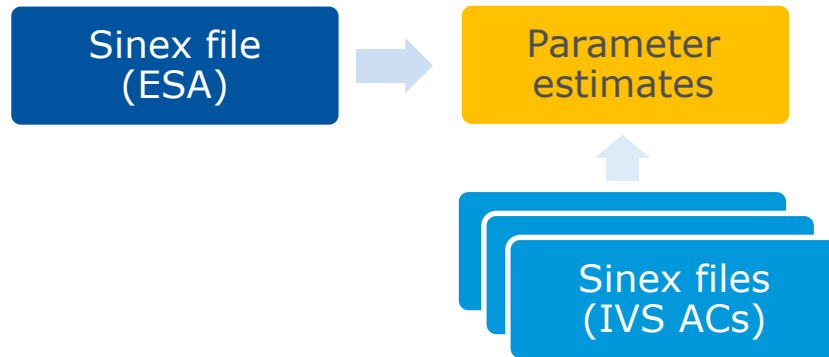→ Combination at NEQ level

To validate
- Observation model
- Partial derivatives
- Parameterization
- Constraints

→ Combination at NEQ level

- Sinex format ok (datum-free) 😎
- Combination only for some sessions possible 😕
- Several sessions could not be combined due to outliers in coordinate estimates 😕

Sinex file
(ESA)

↓

Combination
(BKG)

←

Sinex files
(IVS ACs)

→ Compare parameter estimates

→ Combination at NEQ level

Sinex file
(ESA)

→

Parameter
estimates

↑

Sinex files
(IVS ACs)

Estimated parameters … dUT1 (w.r.t. C04)
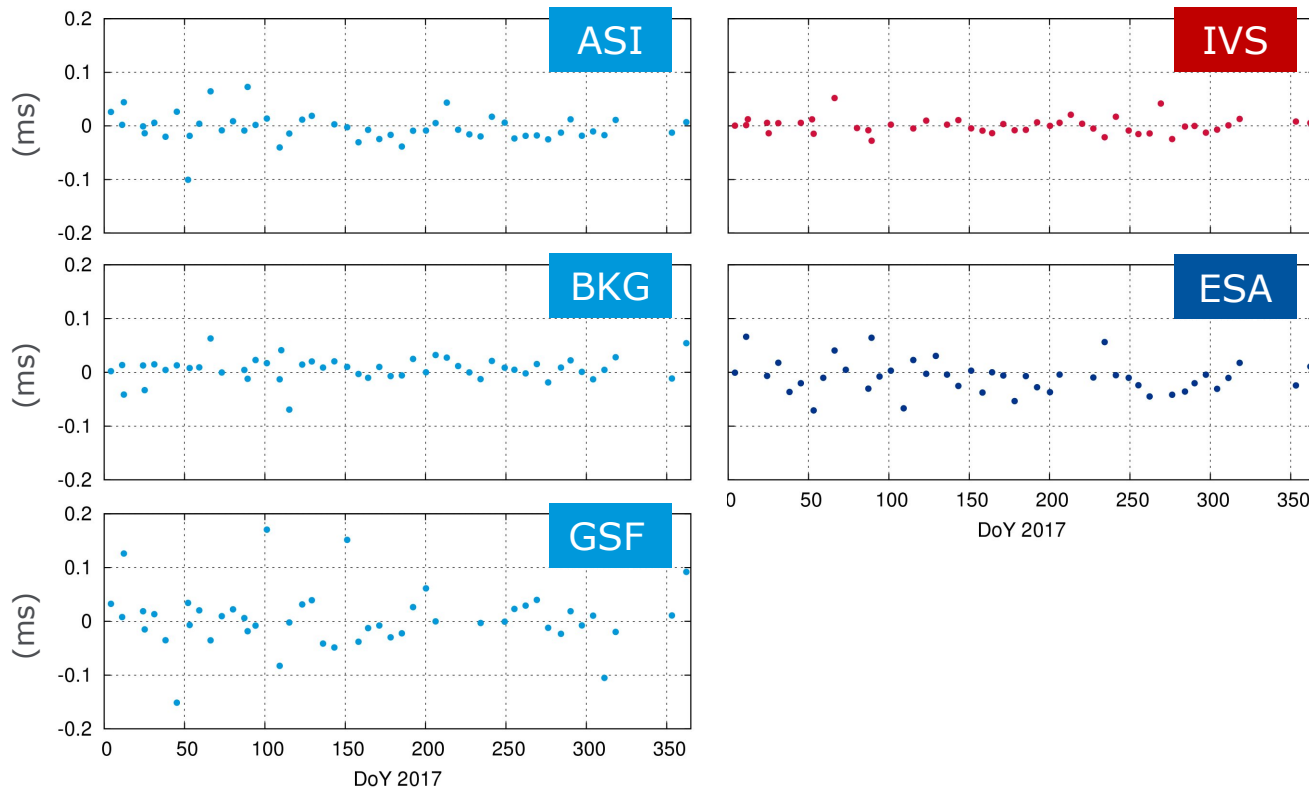
RMS (ms)

0.015   IVS

0.023   ASI

0.022   BKG

0.032   GSF

😎 0.030   ESA

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Estimated parameters … LOD (w.r.t. C04)
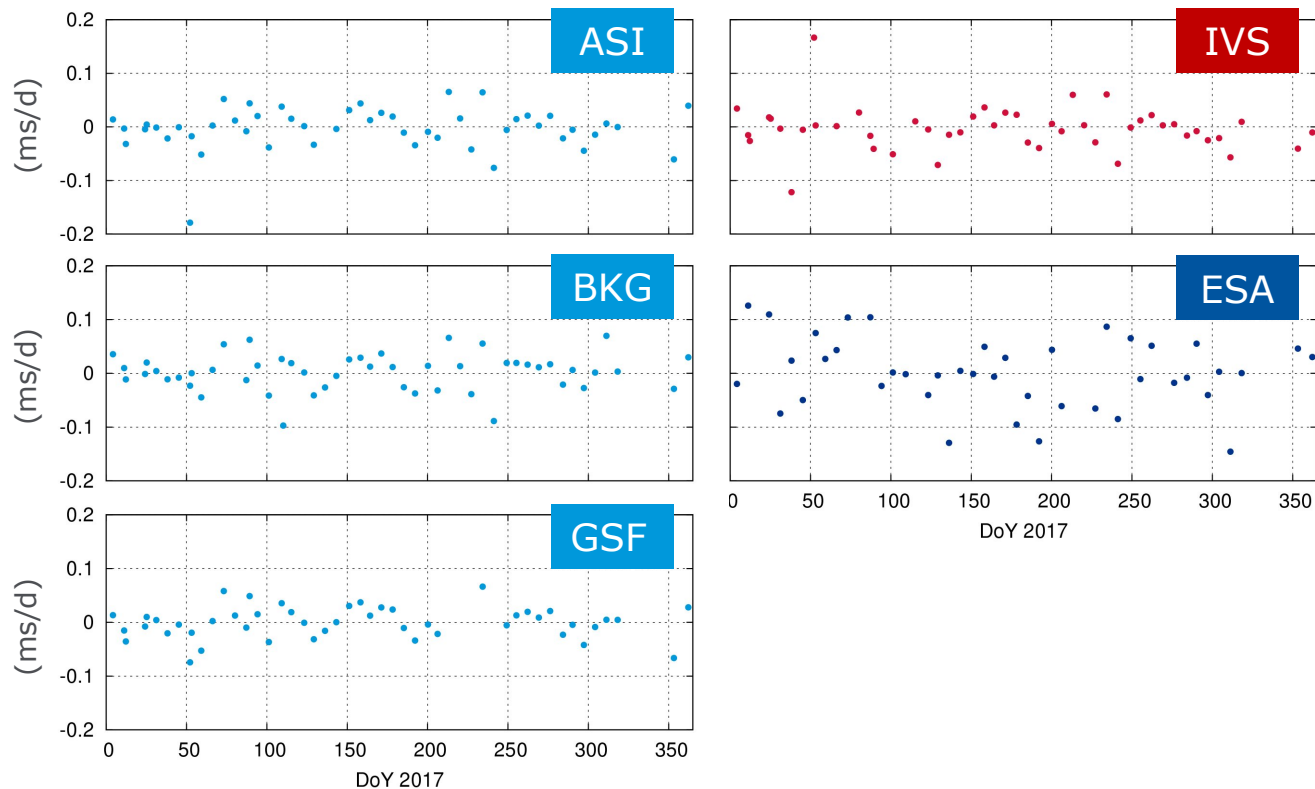
RMS (ms/d)

0.029	IVS
0.031	ASI
0.034	BKG
0.030	GSF
0.046	ESA

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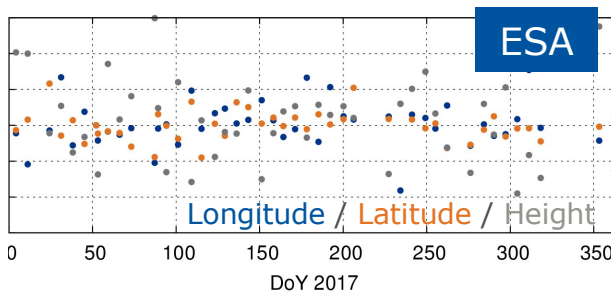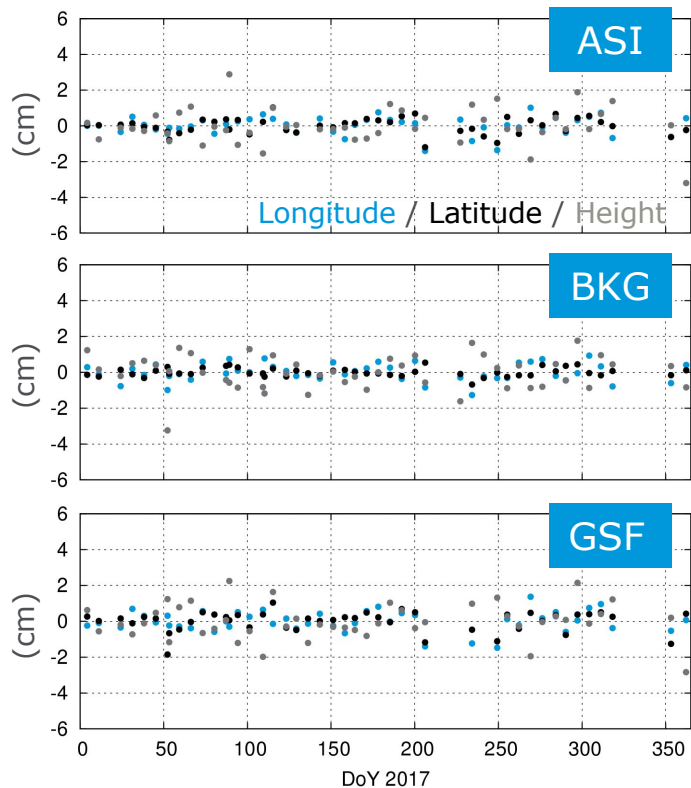# Estimated parameters … Polar motion (w.r.t. C04)
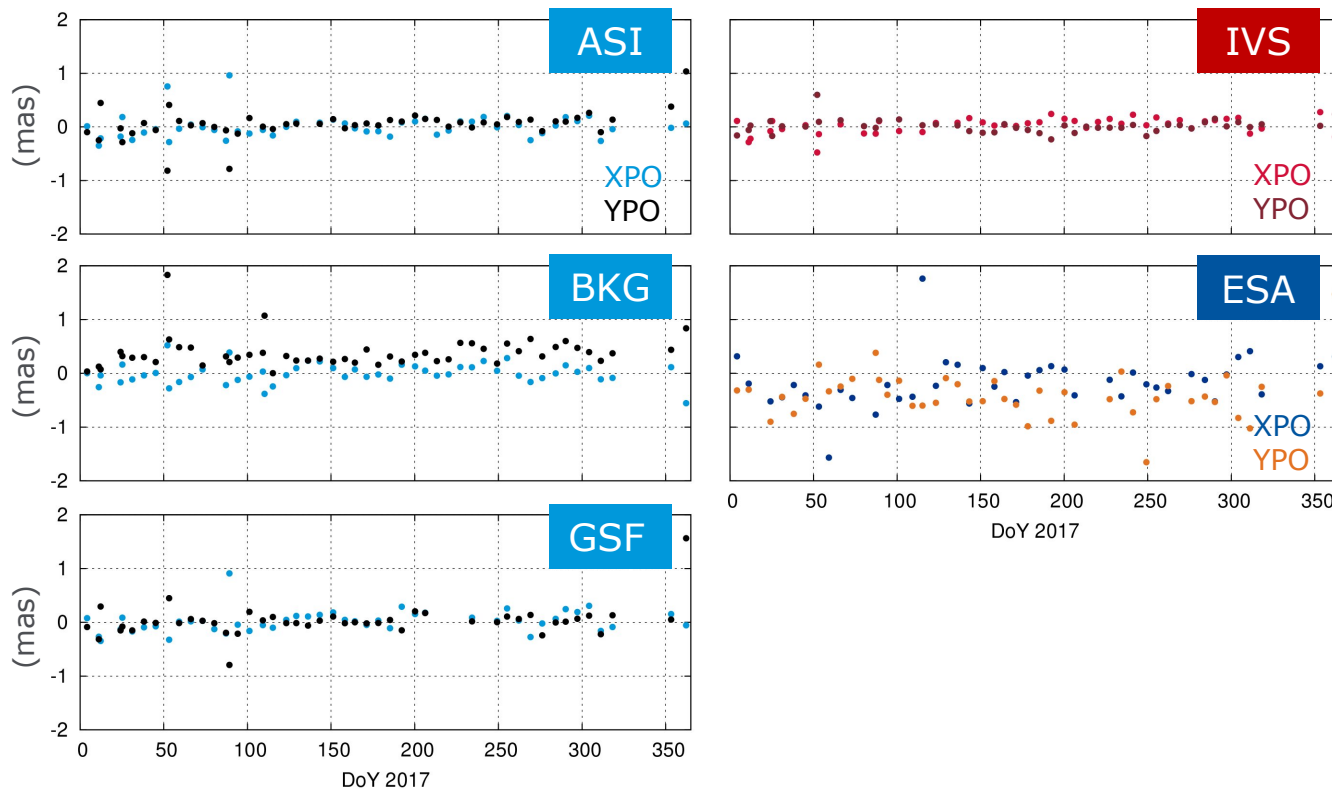
Estimated parameters ... Station coordinates WETTZELL

RMS (cm)

0.5 / 0.4 / 1.0   ASI

0.5 / 0.2 / 0.8   BKG

0.6 / 0.6 / 1.0   GSF

🙁 1.3 / 0.9 / 2.3   ESA

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Validation results … O-C Residuals

```
┌─────────────────────┐
│   O-C Residuals     │
│    from VieVS        │
└─────────────────────┘
           │
           ▼
┌─────────────┐      ┌─────────────────────┐
│   NAPEOS    │ ──▶  │    O-C Residuals    │
└─────────────┘      └─────────────────────┘
```
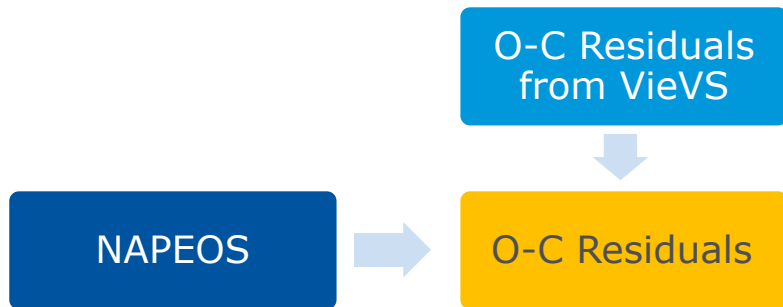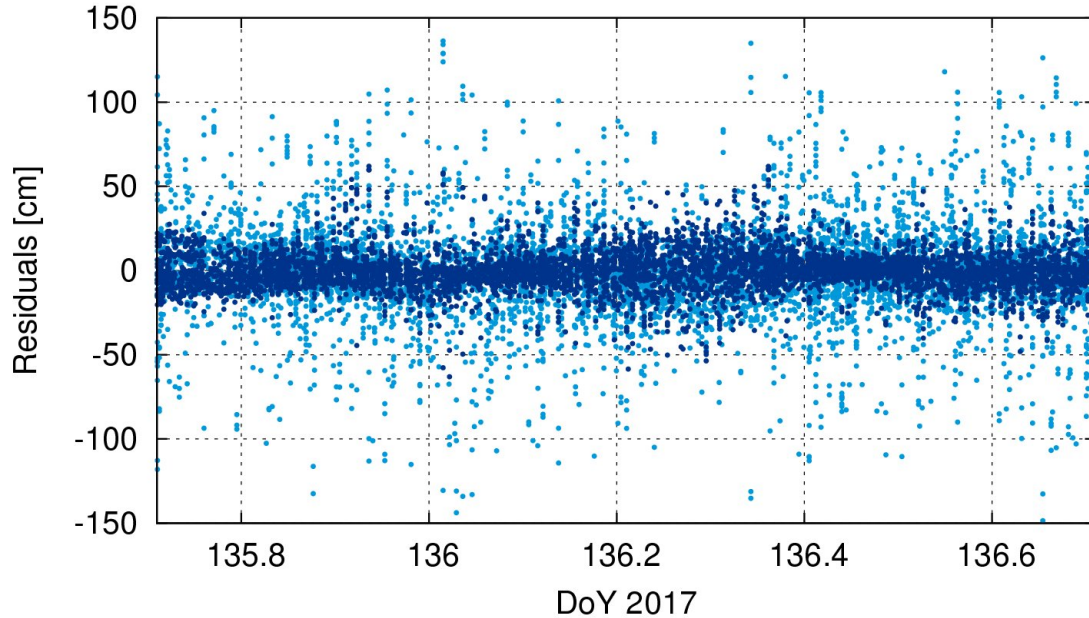
→ Compare residuals

→ Compare parameter estimates

→ Combination at NEQ level

- **Before** parameter estimation
  → to validate observation model

- **After** parameter estimation
  → to validate parameterization, constraints, partial derivatives

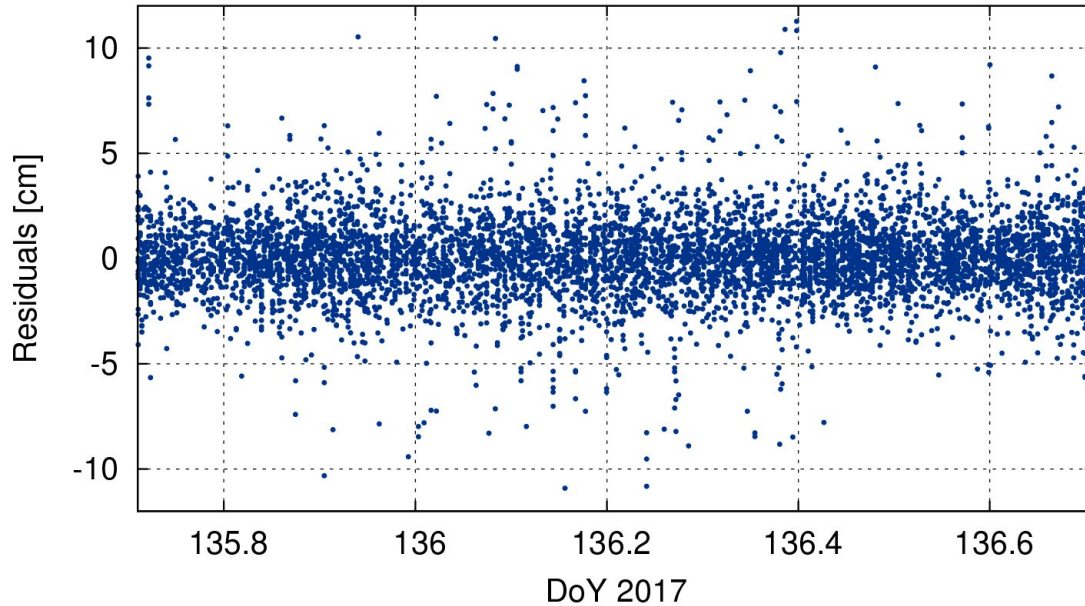# O-C Residuals … before parameter estimation

RMS (cm)

28.4	VieVS
😎 11.7	ESA

→ observation model ok

RMS (cm)

1.5   ESA

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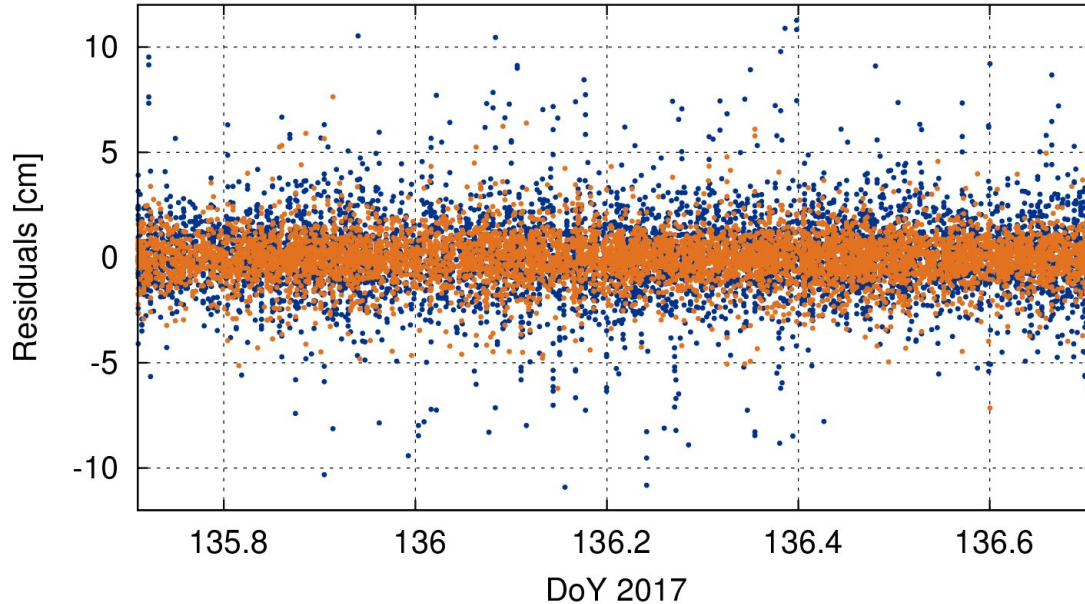
O-C Residuals … after parameter estimation

RMS (cm)

1.5   ESA

1.1   VieVS

→ different parameterizat.
→ different constraints

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O-C Residuals ... after parameter estimation
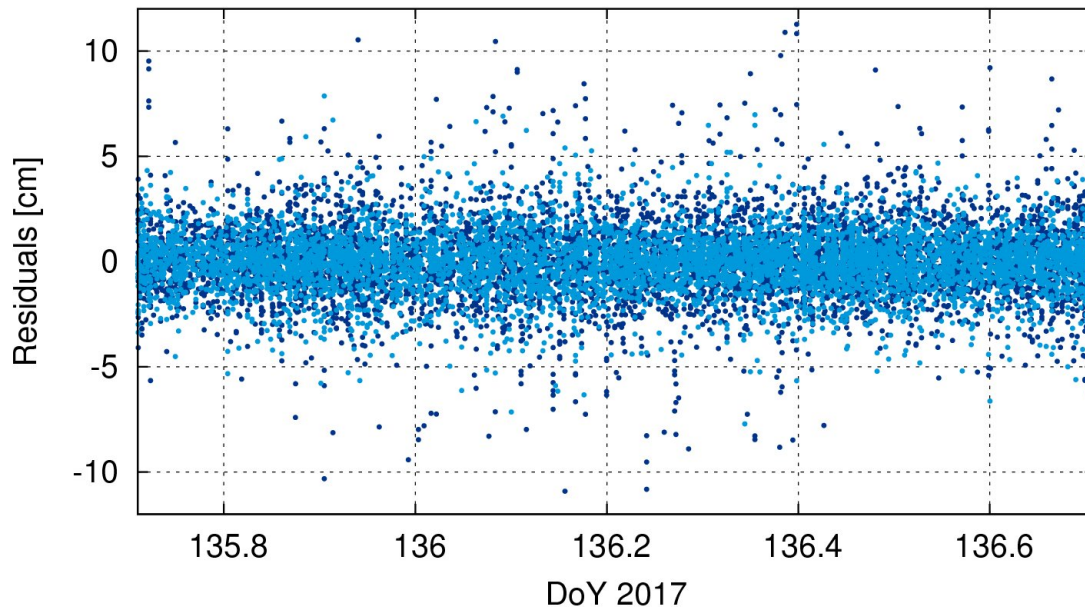
RMS (cm)

😎 1.5   ESA

1.4   VieVS (ESA par.)

→ similar parameterization
→ similar constraints

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Conclusion

😎 ESOC's Navigation Support Office has continued its efforts towards VLBI data analysis

- First parameter estimates based on VLBI observations could be generated

- Comparison of O-C residuals with VieVS proves implementation of observation model is ok

- ESA residuals are at 1.5 cm level (> 1 cm level of standard IVS solutions, but can be explained by parameterization differences)

😕 First attempt to combine ESA Sinex files at the IVS combination centre worked for some session, but not for all due to outliers in coordinate estimates

- Comparison of estimated parameters with other IVS ACs shows degraded repeatability for ESA solution

→ points to problem in partials?

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Next steps

- Continue discussing combination results with BKG

- Continue comparing parameter estimation on session-level with TU Vienna

- Check implementation of partials in NAPEOS

- We would like to consult with the IVS analysis groups to understand current issues in parameter estimation, and to avoid "the obvious", as e.g.

    → Do not use baseline WETTZELL-WETTZ13N

    → Read sign for quasar declination separately `[-00 01 50.4137]`

THANK YOU!

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