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Recent DORIS-related activities at GFZ

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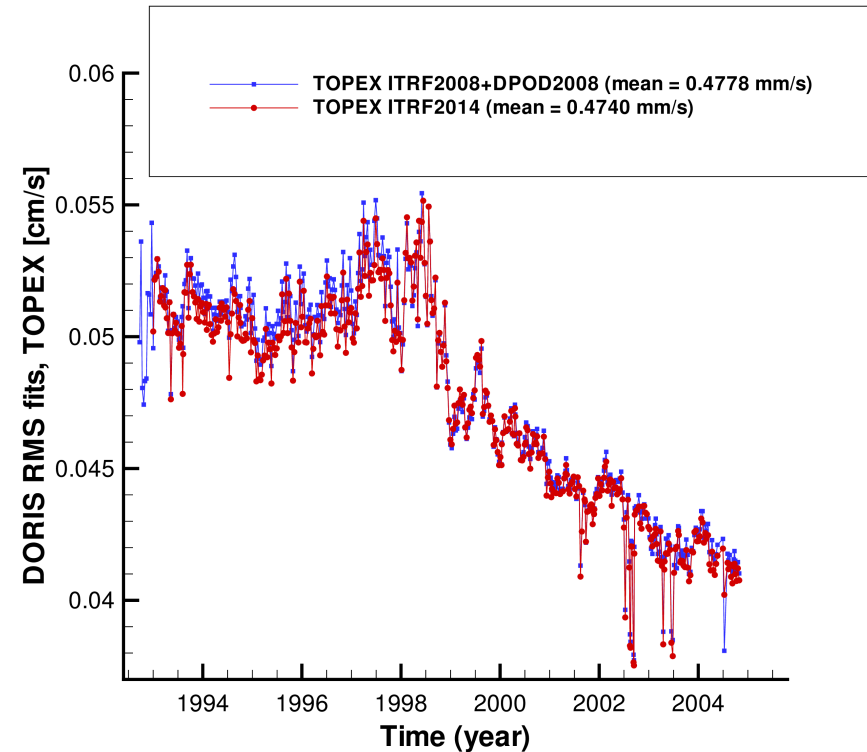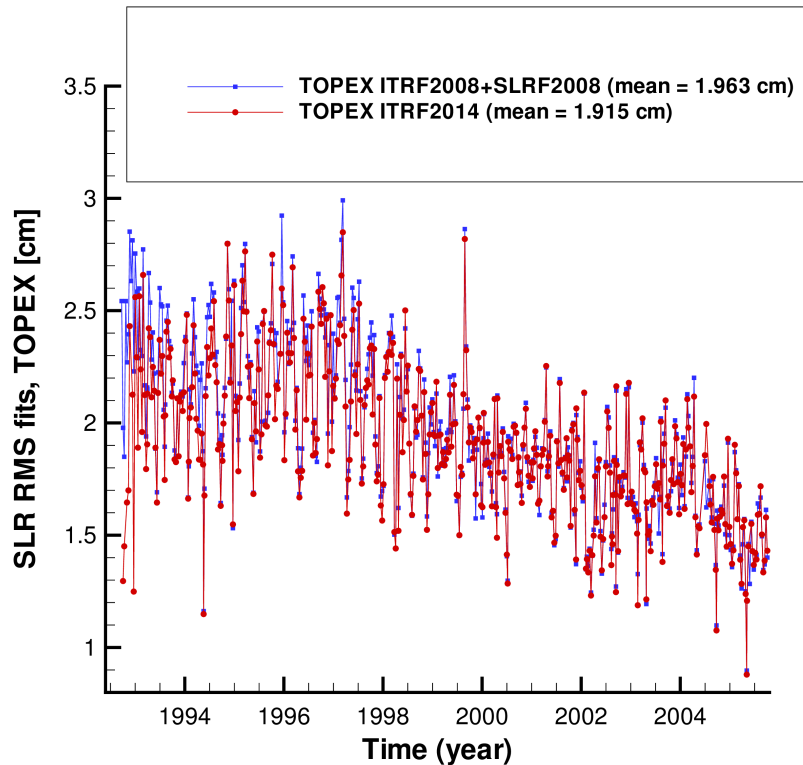GFZ German Research Centre for Geosciences,
Potsdam, Germany

Outline

- **Tests of ITRF2014 for precise orbit determination (POD) for TOPEX/Poseidon and Envisat**

- **A study on the truncation degree of drift terms of EIGEN-6S4 geopotential model for Envisat POD**

Preliminary results of TOPEX/Poseidon precise orbit determination using ITRF2014 versus ITRF2008+SLRF2008+DPOD2008
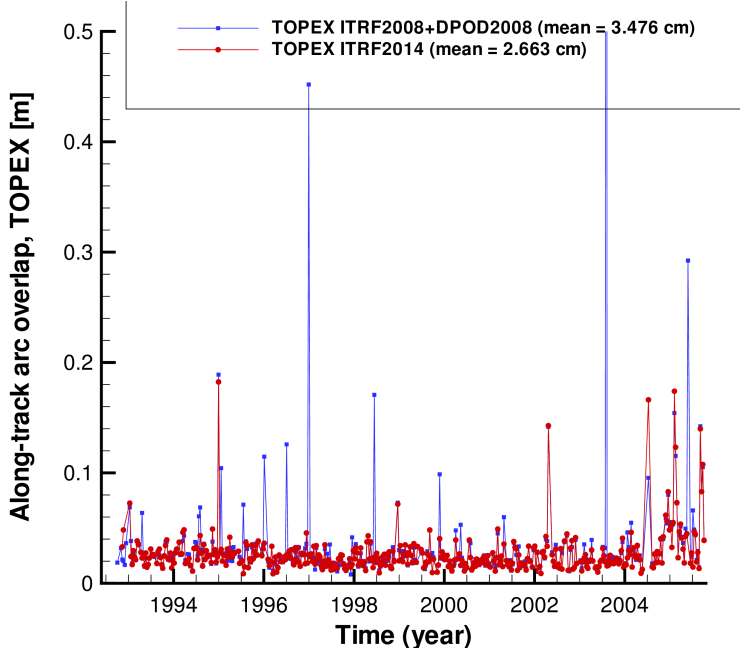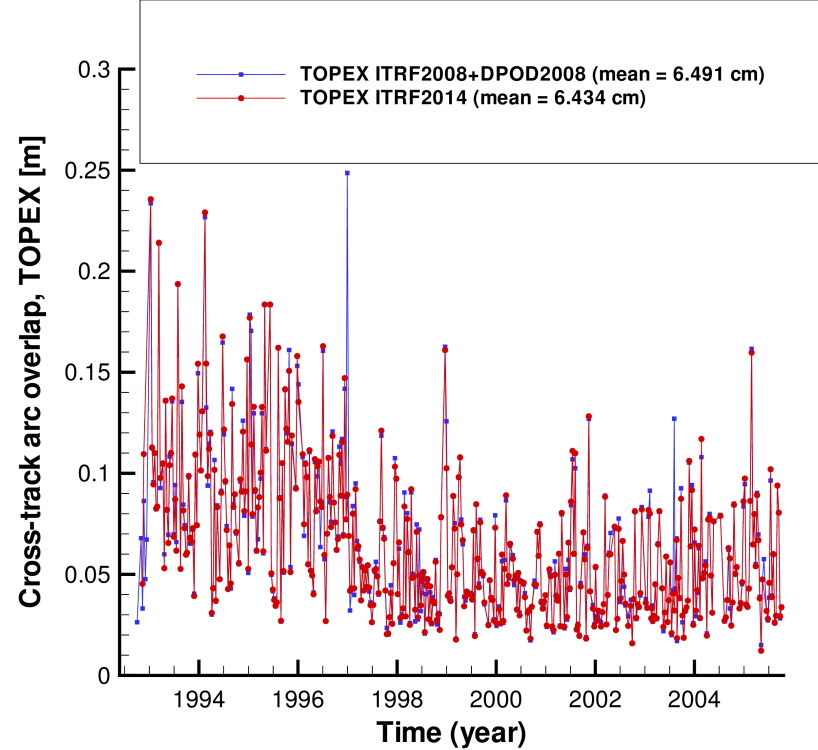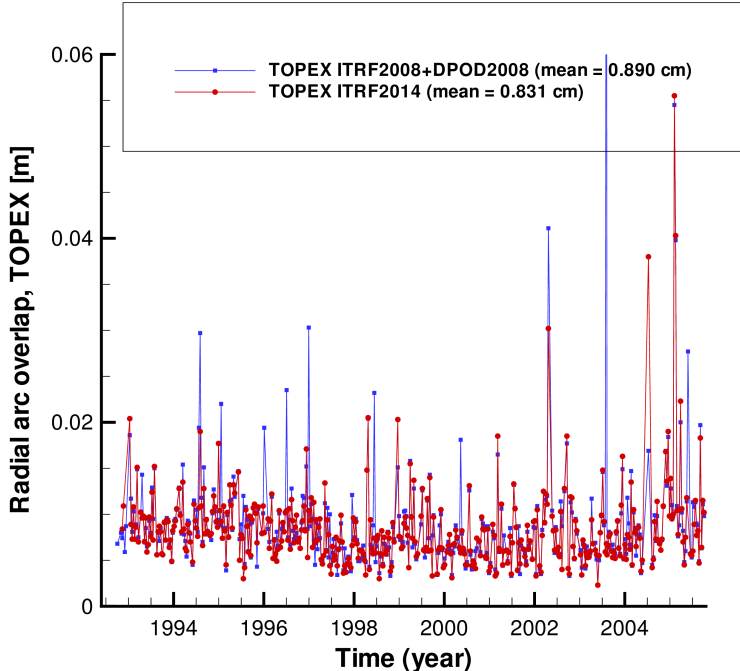
RMS fits of observations for TOPEX/Poseidon orbits (September 1992 – October 2005) derived using ITRF2014 versus ITRF2008+SLRF2008+DPOD2008

- The mean value of the TOPEX/Poseidon SLR RMS fits reduced from 1.963 to 1.915 cm, i.e. by 0.048 cm (about 2.5%), when using ITRF2014 instead of ITRF2008; the most significant improvements for years 1992-1998.
- The mean value of the TOPEX/Poseidon DORIS RMS fits reduced from 0.4778 mm/s to 0.4740 mm/s, i.e. by 0.0038 mm/s (about 0.8%), when using ITRF2014 instead of ITRF2008, especially for years 1992-1998.

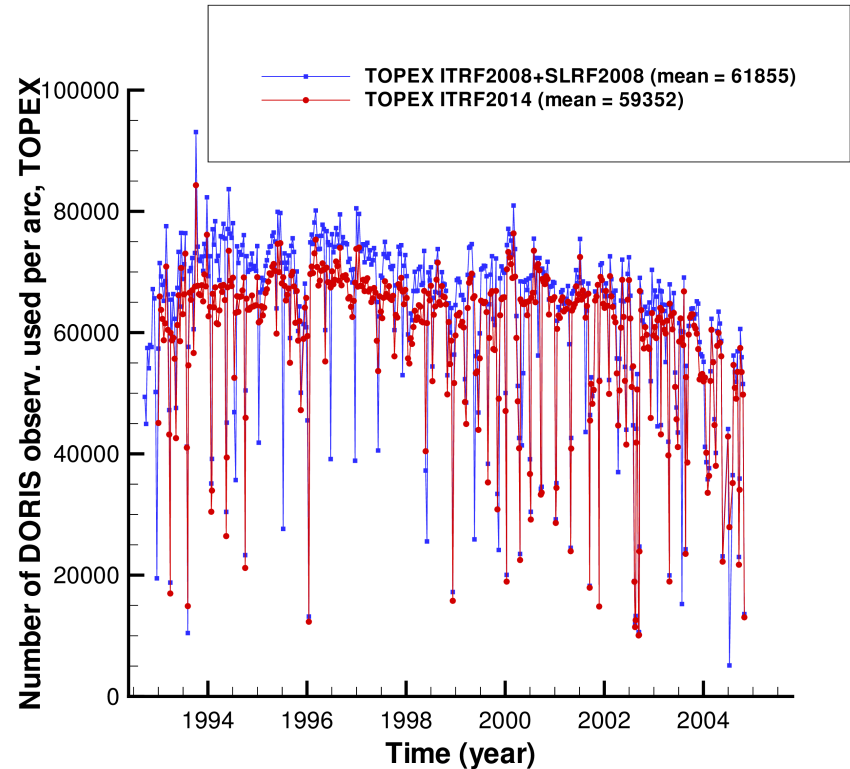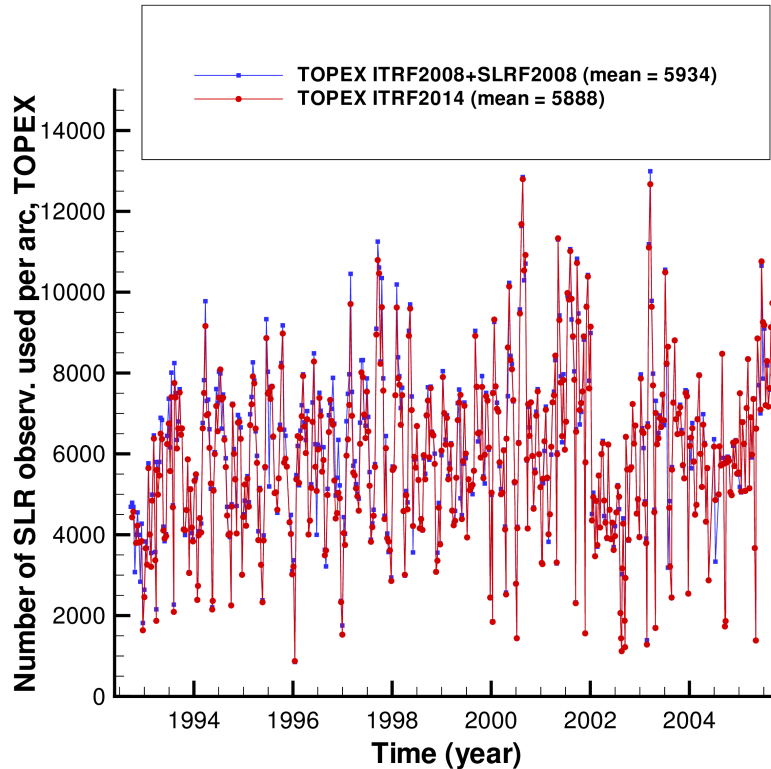# Two-day arc overlaps for TOPEX orbits: ITRF2014 versus ITRF2008

TOPEX arc overlap improvements using ITRF2014, as compared to ITRF2008:
- radial: from 0.89 to 0.83 cm, i.e. by 0.06 cm (~7.1%),
- cross-track: from 6.49 to 6.43 cm, i.e. by 0.06 cm (~0.9%),
- along-track: from 3.48 to 2.66 cm, i.e. by 0.82 cm (~30.8%).
Many outliers disappeared or became smaller.

The number of SLR and DORIS observations used for TOPEX POD (September 1992 – October 2005) per 12-day arc: ITRF2014 versus ITRF2008+SLRF2008+DPOD2008
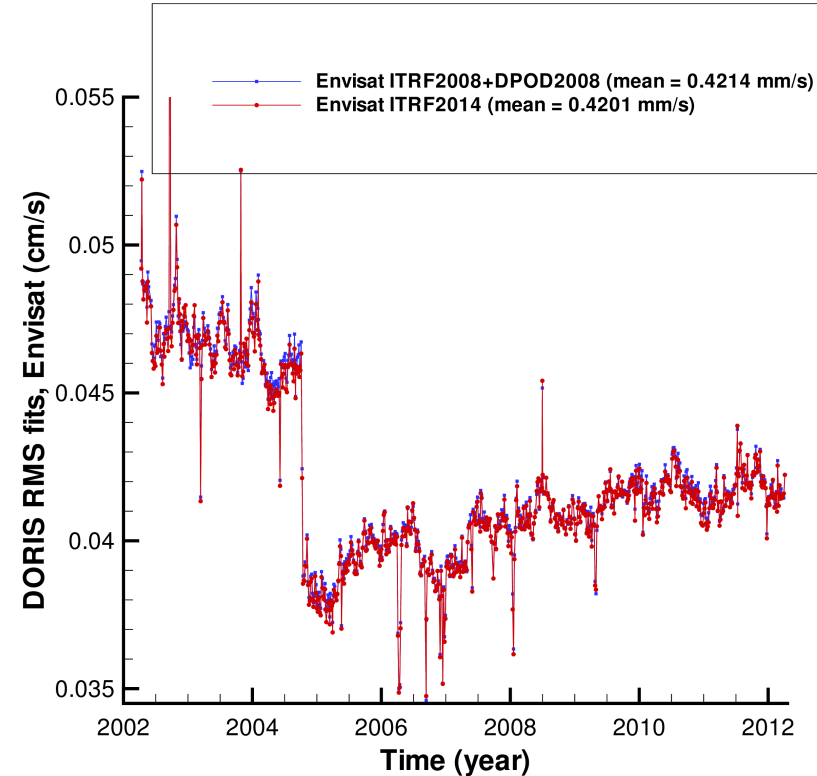

- The mean number of SLR observations used for TOPEX POD per 12-day arc is about 0.8% less, when using ITRF2014, as compared to using ITRF2008+SLRF2008;
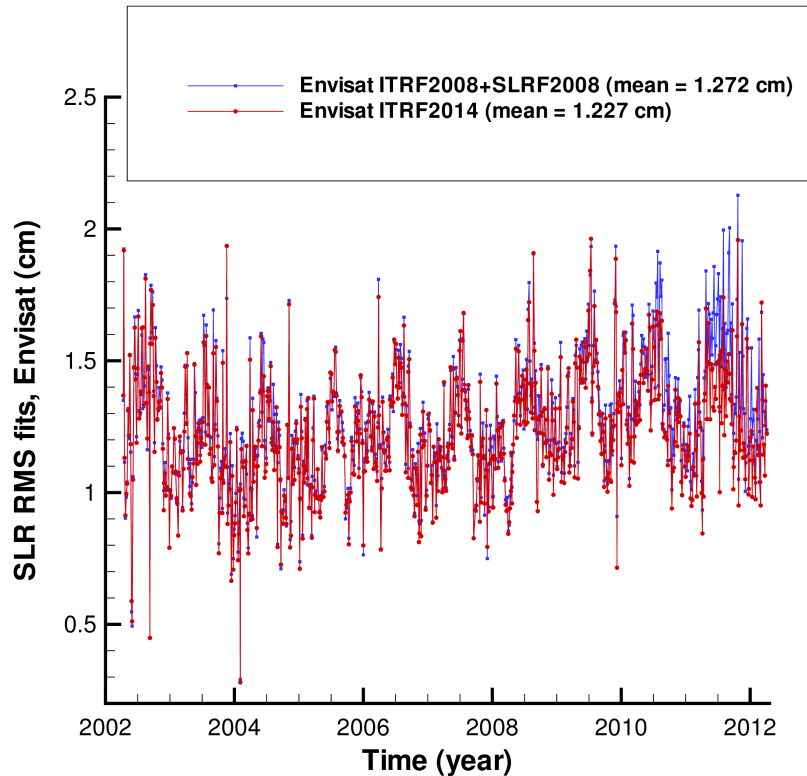- The mean number of DORIS observations used for TOPEX POD per 12-day arc is about 4.2% less, when using ITRF2014, as compared to using ITRF2008+DPOD2008.
- There is a need in the creation of SLRF2014 and DPOD2014 by adding SLR and DORIS stations missing in the ITRF2014.

Preliminary results of Envisat precise orbit determination
using ITRF2014
versus ITRF2008+SLRF2008+DPOD2008
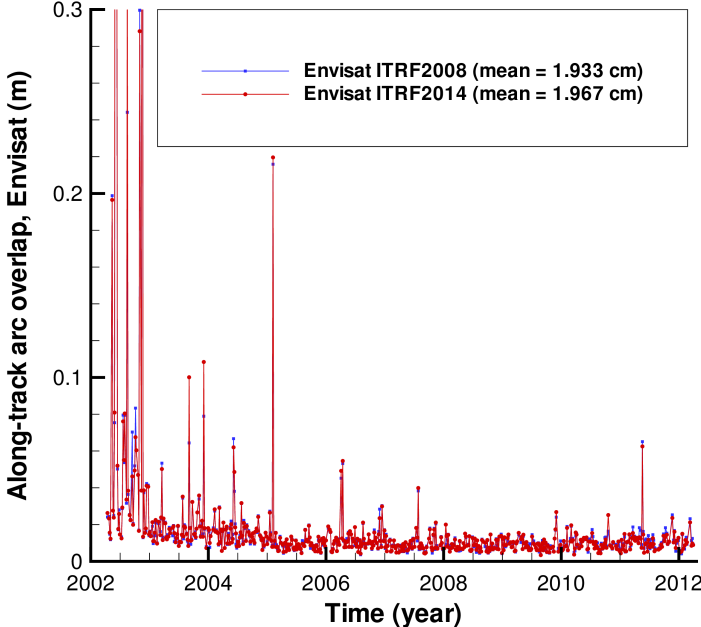
RMS fits of observations for Envisat orbits (April 2002 – April 2012) derived using ITRF2014 versus ITRF2008+SLRF2008+DPOD2008

- The mean value of the SLR RMS fits reduced from 1.272 to 1.227 cm, i.e. by 0.05 cm (about 3.6%), when using ITRF2014 instead of ITRF2008; the most significant improvements for years 2010-2012.
- The mean value of the DORIS RMS fits reduced from 0.4214 mm/s to 0.4201 mm/s, i.e. by 0.0013 mm/s (about 0.3%), when using ITRF2014 instead of ITRF2008.

Two-day arc overlaps for Envisat orbits: ITRF2014 versus ITRF2008

Minor impact on the arc overlaps. However, cross-track arc overlaps improved for years 2010-2012.

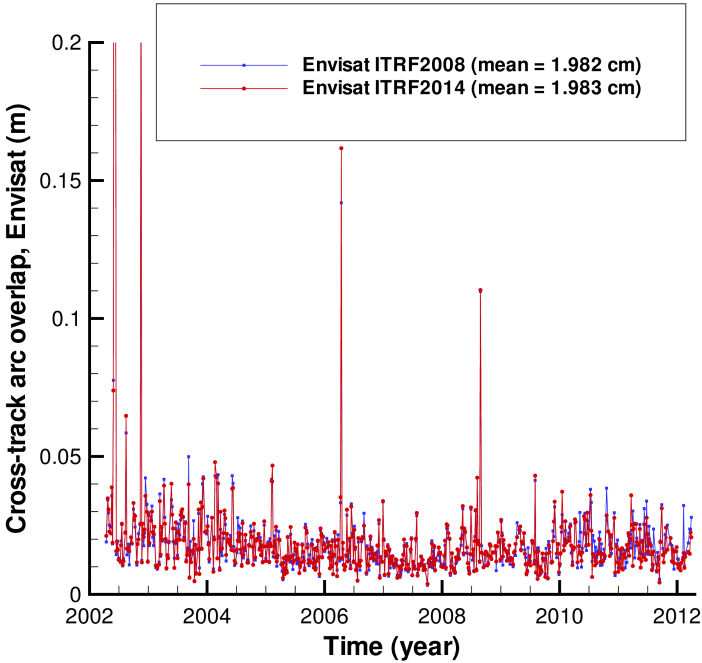# The number of SLR and DORIS observations used for Envisat POD (April 2002 – April 2012) per 7-day arc: ITRF2014 versus ITRF2008+SLRF2008+DPOD2008

- The mean number of SLR observations used for Envisat POD per 7-day arc is about 0.7% less, when using ITRF2014, as compared to using ITRF2008+SLRF2008;
- The mean number of DORIS observations used for Envisat POD per 7-day arc is about 2.3% less, when using ITRF2014, as compared to using ITRF2008+DPOD2008.
- There is a need in the creation of SLRF2014 and DPOD2014 by adding SLR and DORIS stations missing in the ITRF2014.

Conclusions on the tests of ITRF2014
for TOPEX/Poseidon and Envisat POD,
as compared to using ITRF2008+SLRF2008+DPOD2008

- The mean values of the SLR RMS fits improved by 2.5-3.6% for these satellites.

- The mean values of DORIS RMS fits improved by 0.3-0.8% for these satellites.

- The most significant reduction of SLR and DORIS RMS fits obtained for years 1992-1998 for TOPEX/Poseidon and 2010-2012 for Envisat. That is, most probably, related to the improved values of station velocities in ITRF2014, as compared to ITRF2008+SLRF2008+DPOD2008.

- Significant improvement of 2-day orbital arc overlaps obtained for TOPEX/Poseidon orbits, when using ITRF2014 instead of ITRF2008+SLRF2008+DPOD2008: 7.1, 0.9 and 30.8% in radial, cross-track and along-track directions, respectively. Many outliers disappeared or descreased.

- The number of used SLR and DORIS observations is 0.7-0.8% and 2.3-4.2% less, when using ITRF2014 instead of ITRF2008+SLRF2008+DPOD2008. That means, there is a need in the generation of SLRF2014 and DPOD2014 by the inclusion of SLR and DORIS stations missing in the ITRF2014.

A study on the truncation degree
of drift terms of the EIGEN-6S4
geopotential model for Envisat POD

Study setup

EIGEN-6S4 time variable geopotential model (maximum n and m is 300).
Gravity field coefficient representation:
$C(n,m)(t) = C(n,m)(0) + C(n,m)dot \; \Delta t +$
$+ \; C(n,m)(sinA) \; sin(2\pi\Delta t) + C(n,m)(cosA) \; cos(2\pi\Delta t) +$
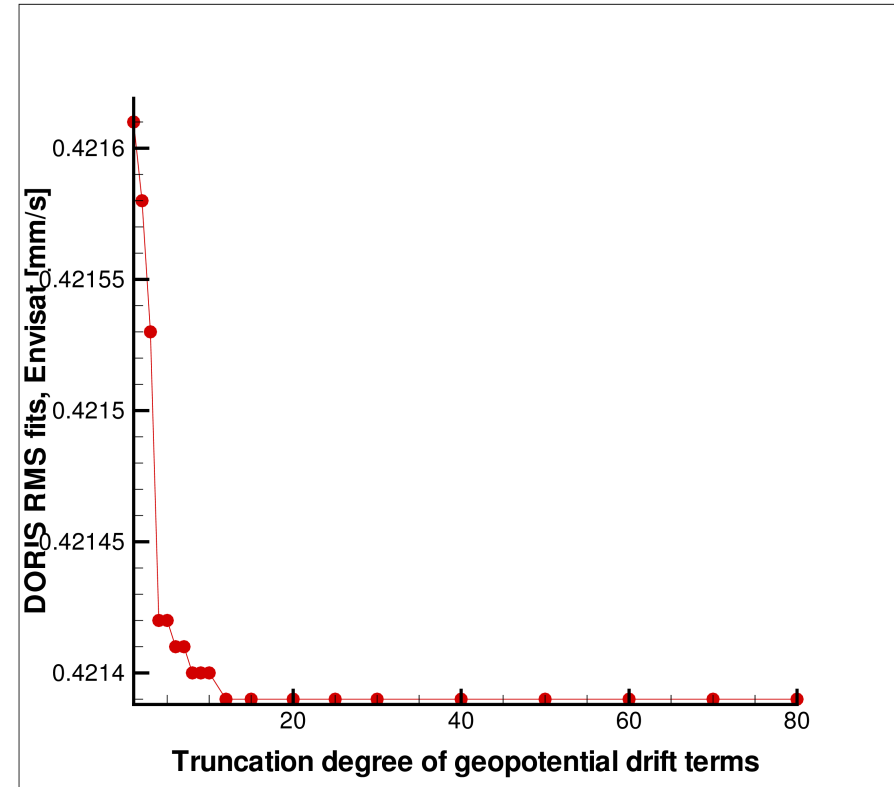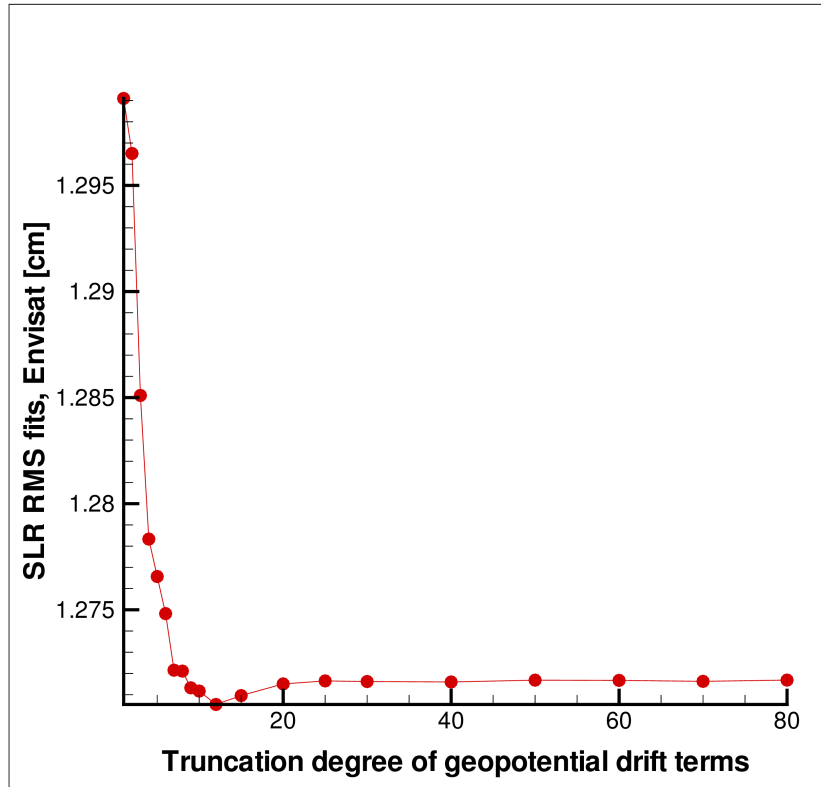$+ \; C(n,m)(sinS) \; sin(4\pi\Delta t) + C(n,m)(cosS) \; cos(4\pi\Delta t),$
where $C(n,m)$, $C(n,m)(sinA)$, $C(n,m)(cosA)$, $C(n,m)(sinS)$, $C(n,m)(cosS)$
are given as an yearly time series.
Drift terms $C(n,m)dot$ and $S(n,m)dot$ of degree 1-80 are estimated from
GRACE data from 15.08.2002 until 15.06.2014 and set to zero after that
date.

Tests for Envisat precise orbit determination from April 2002 till April 2012
(763 seven-day orbital arcs with two-day arc overlaps) were performed. The
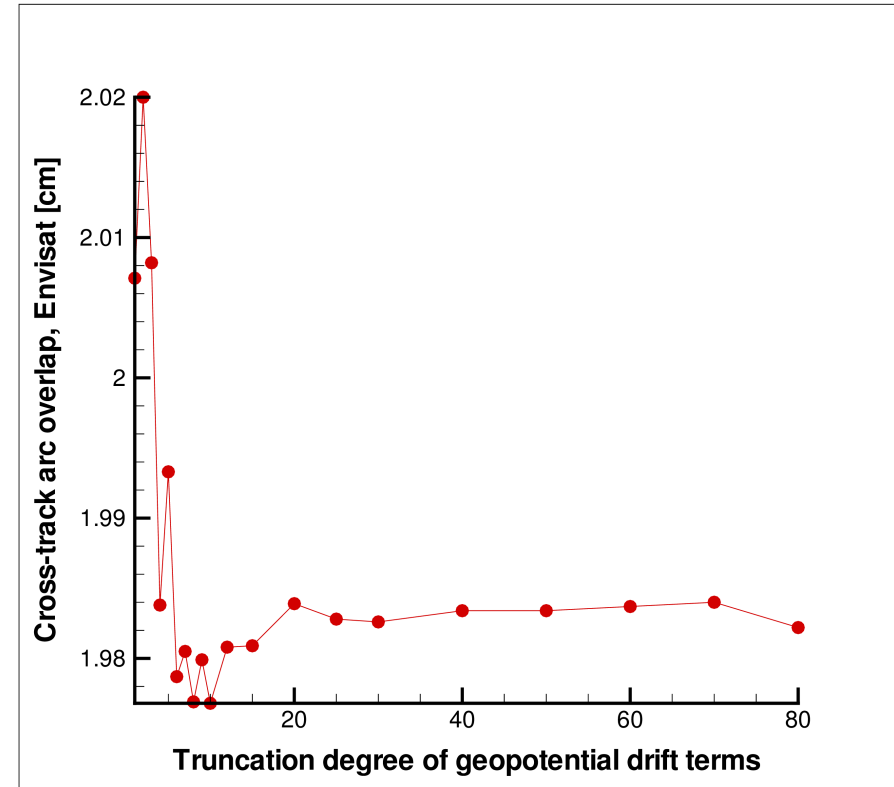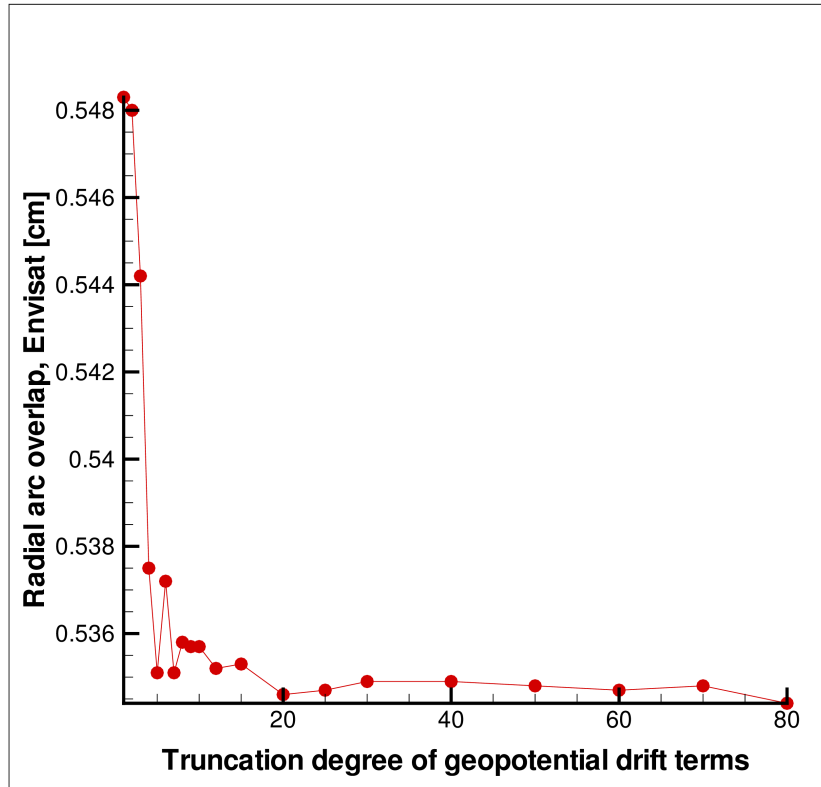truncation degree of the static geopotential terms is 90 for all test cases.

Truncation degree of drift geopotential terms $C(n,m)dot$ and $S(n,m)dot$:
80, 70, 60, 50, 40, 30, 25, 20, 15, 12, 10, 9, 8, 7, 6, 5, 4, 3, 2, 1.

Impact of the truncation degree of the geopotential drift terms on the RMS fits of SLR and DORIS observations for Envisat (2002-2012)
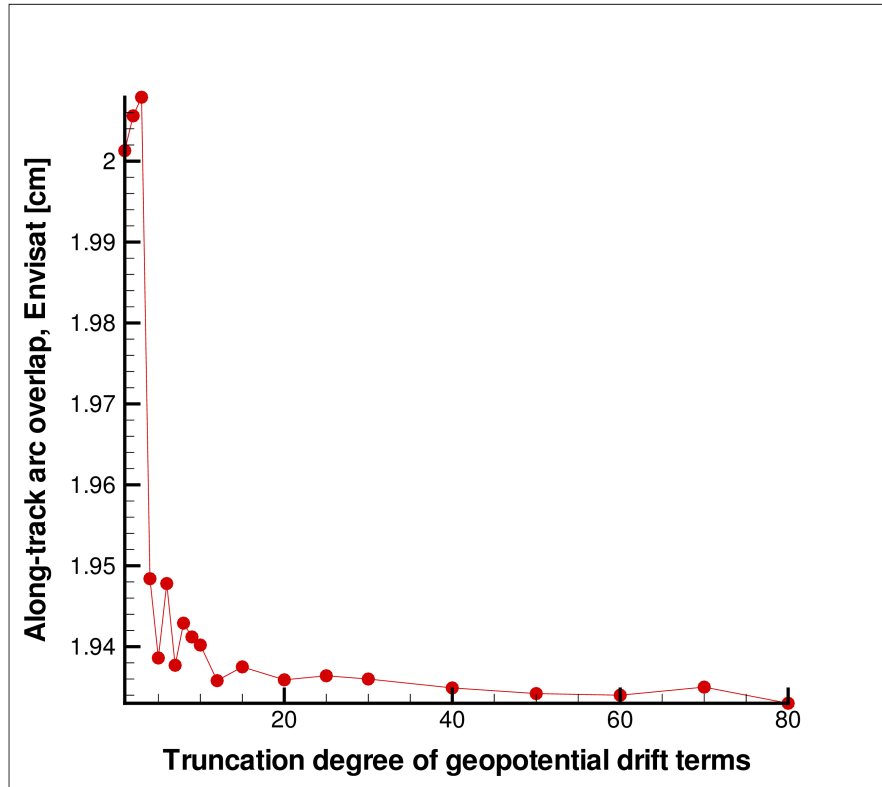

- Minimum SLR RMS fits is reached at the truncation degree of geopotential drift terms equal to 12;
- Minimum DORIS RMS fits is reached at the truncation degree of geopotential drift terms equal to 12. No additional impact of the drift terms of higher degree on DORIS RMS fits

Impact of the truncation degree of the geopotential drift terms on the radial and cross-track 2-day orbit arc overlaps for Envisat (2002-2012)

- Minimum radial arc overlaps are reached at the truncation degree of geopotential drift terms equal to 20, 60 and 80;
- Minimum cross-track arc overlaps are reached at the truncation degree of geopotential drift terms equal to 8 and 10.

Impact of the truncation degree of the geopotential drift terms on the along-track 2-day orbit arc overlaps for Envisat (2002-2012)

- Minimum along-track arc overlaps are reached at the truncation degree of geopotential drift terms equal to 80.

Conclusions
on the study on the truncation degree of drift terms
of the EIGEN-6S4 geopotential model for Envisat POD

- The major contribution of the geopotential drift terms to the Envisat orbit quality is given by low degree terms up to degree 12

- However, to reach the best orbit quality in the radial (what is important for altimetry applications) and along-track directions the geopotential drift terms up to degree and order 80 should be used

- Slightly increase of the cross-track orbit error, when using EIGEN-6S4 geopotential drift terms for degree larger than 20

Acknowledgements

Thank you for your attention!