



# Which datation method for DORIS-RINEX data ?

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# RINEX-DORIS / Context and history (1/3)

- **Since 2008, a new format of DORIS data** has been available at IDS data Centers for all satellites equipped with DGXX and DGXX-S DORIS receivers: the “**RINEX-DORIS**” format.
- **RINEX-DORIS format /main characteristics: RINEX\_S**
  - Very close to RINEX-GPS ( pseudo-range , phase measurements)
  - Very close to raw data, no satellite correction needed
  - Easy to use, used for the POE & MOE at CNES since **2008**
  - Provider: SPARINEX (SSALTO tool) → **RINEX\_S** (S for SPARINEX)
  - Time tagging : coming from DIODE (DORIS on board navigator), accurate time tagging but slightly unstable (Kalman filter)
- **Missions: Jason2, Cryosat2, Hy-2A, SARAL, Jason3, Sentinel-3A \***  
(\* ) only format available → IDS ACs have to use this new format

# RINEX-DORIS/ Context and history (2/3)

- **2012 New SSALTO tool : PANDOR** for DORIS system expertise : characterize the behavior of USOs of the DORIS system (onboard and ground beacons).
- **PANDOR objectives/characteristics:**
  - time-tag all DORIS data in a common time reference, then convert in the TAI scale
  - gives time information of all the DORIS network beacons
  - Global solution: multi-satellite and multi-beacons
  - least squares method → accurate and stable time-tagging
  - PANDOR can provide RINEX files with improved time-tagging
- → **2015: switch to RINEX-DORIS provided by PANDOR: RINEX\_P** (P for PANDOR) instead of SPARINEX
  - → To benefit from a more stable time-tagging
  - → reprocessing of all missions and dissemination of all RINEX\_P files to IDS DATA Centers

# RINEX\_S / RINEX\_P Pros/cons

characteristics	RINEX_S (Sparinex)	RINEX_P (Pandor)
<b>Delivery frequency</b>	every 24h / file 24h of data	every 24h / file 24h of data
<b>latency</b>	1 day	3 to 5 days
<b>time-tagging</b>	Diode (unstable $\sim 1\mu s$ )	Pandor stable
<b>re-processing</b>	each mission separately	all missions together
<b>Impact Mission interruption of X days</b>	data gap of X days	loss of X+2 days
<b>maintenance/operational cost</b>		+
<b>Orbit &amp; positioning performances</b>	?	?

# STUDY

- Which datation for the RINEX-DORIS data?
  - Impact of the time-tagging (stability/accuracy) on the orbit determination and the positioning performance?
- ➔ Analyses and comparisons performed by 2 ACs (GRG and GFC)
- Single satellite Jason 2, 2008 and 2015 data
  - Presented to the DORIS Performance Group on September 28, at CNES, in Toulouse



# GRG DORIS RINEX data processing

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# DORIS data processing

## Test processing of Doris2.2 and RINEX formats on Jason-2

□ **Test data** : 6 months from March, 27 2016 to September, 3 2016

- **Doris2.2 (V2)** [ftp://cddis.gsfc.nasa.gov/doris/data/ja2/ja2data\\${cycle}](ftp://cddis.gsfc.nasa.gov/doris/data/ja2/ja2data${cycle})

- **RINEX PANDOR (RINEX\_P)** <ftp://cddis.gsfc.nasa.gov/doris/data/ja2/2016>

the correction on the RINEX PANDOR software was made from **June 2 2016**

- **RINEX SPARINEX (Diode time-tagging) (RINEX\_S)** [ftp://avisorp.cnes.fr/AVISO/pub/doris/jason-2/doris\\_rinex/](ftp://avisorp.cnes.fr/AVISO/pub/doris/jason-2/doris_rinex/)

□ **Evaluation SLR+DORIS POD and single satellite positioning**

- DORIS RMS residuals and measurements number
- Independent SLR RMS residuals evaluation
- Orbit comparison
- Comparison of the Jason-2 single satellite solution to DPOD2008

# Jason-2 DORIS residuals

## DORIS data:

DORIS2.2 (V2)

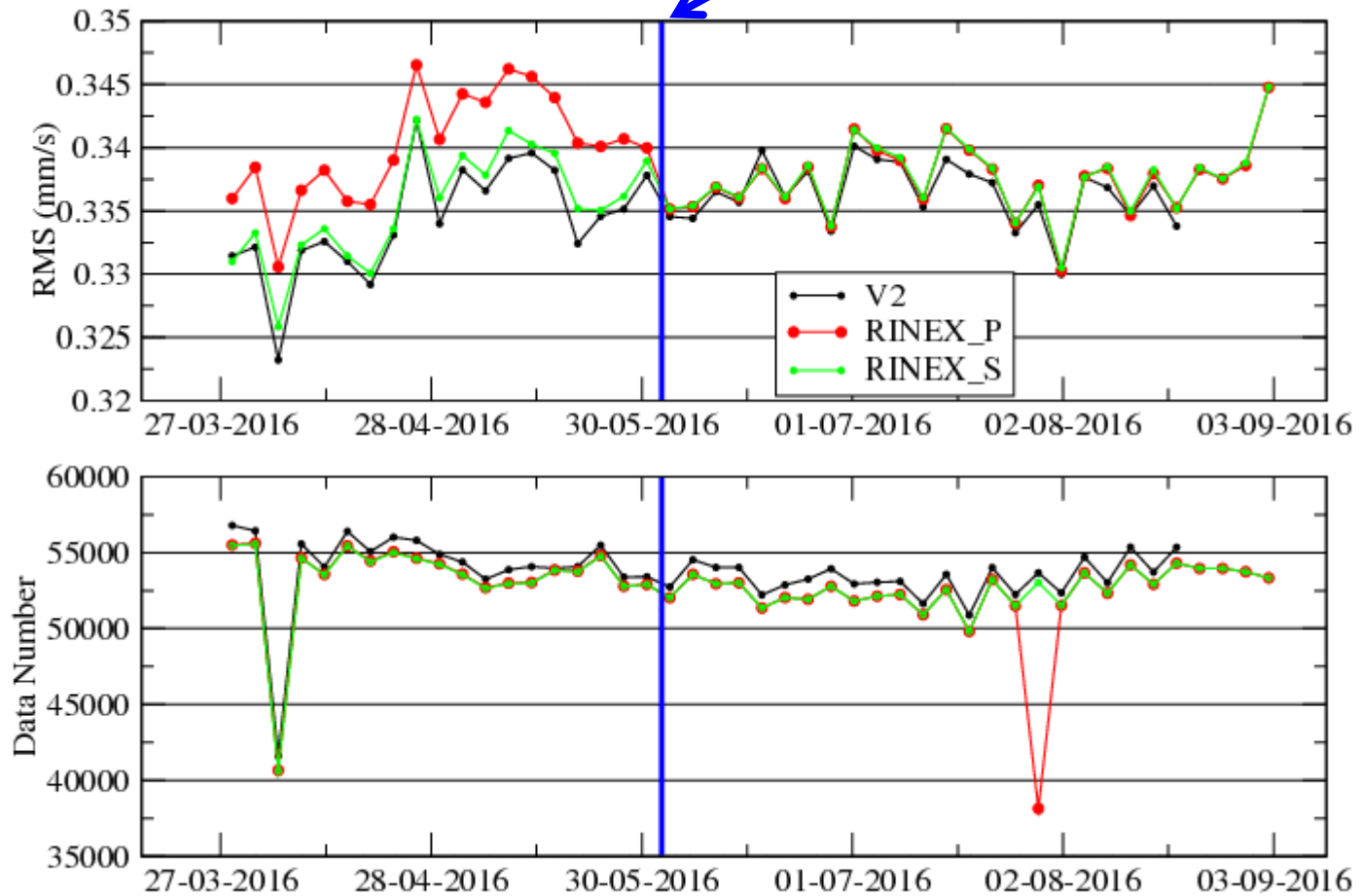
RINEX files from PANDOR (RINEX\_P)

RINEX files from SPARINEX (RINEX\_S)(DIODE time-tagging)

## Time span processing:

March 2016 to September 2016

Correction in the RINEX PANDOR file applied





# Jason-2 DORIS-only orbit independent SLR residuals

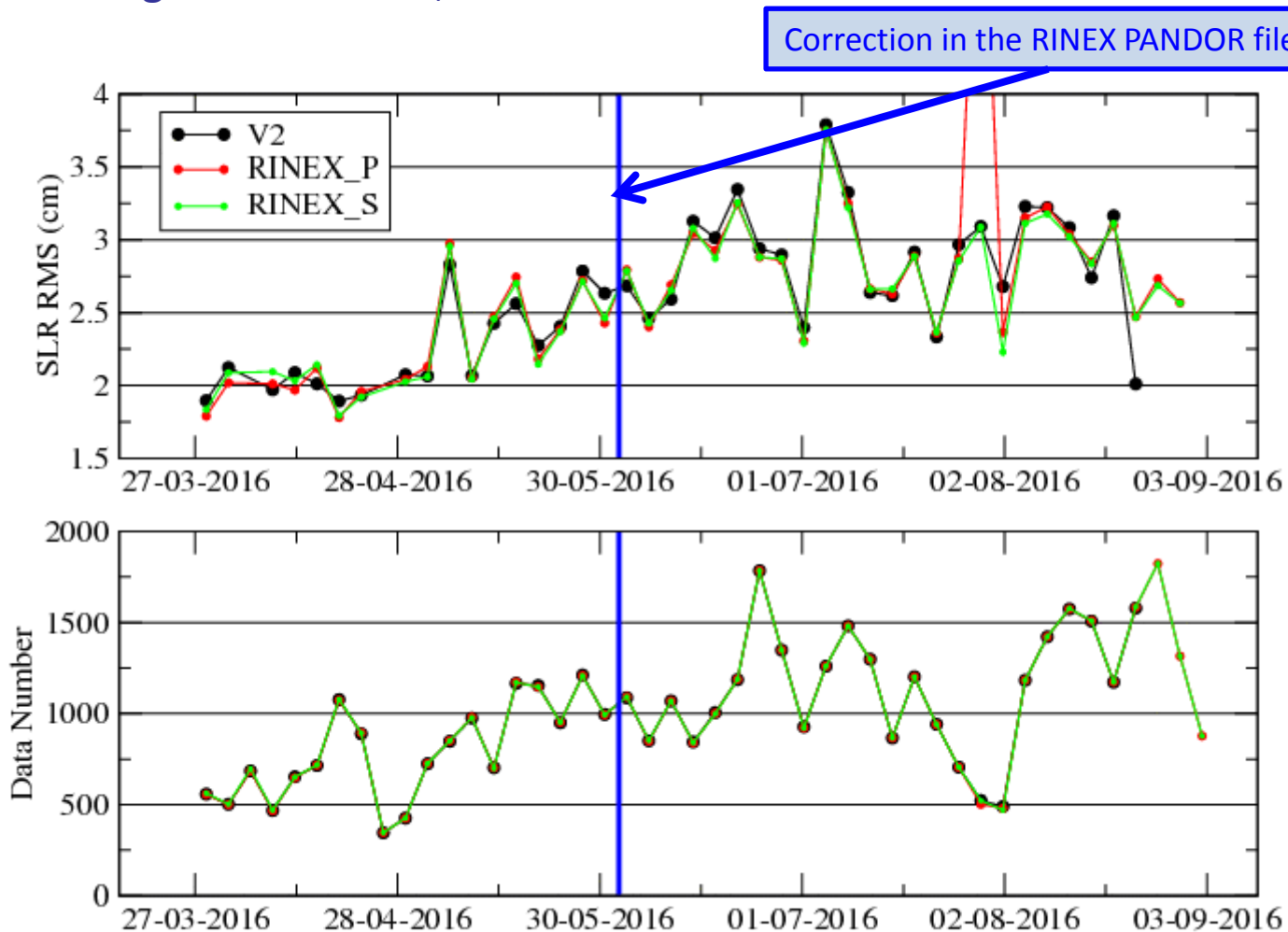
## DORIS-only orbit:

From DORIS2.2 (V2)

From RINEX files from PANDOR (RINEX\_P)

From RINEX files from SPARINEX (RINEX\_S)(DIODE time-tagging)

Time span processing: March 2016 to September 2016



# Jason-2 DORIS-only orbit independent High Elevation SLR residuals

## DORIS-only orbit:

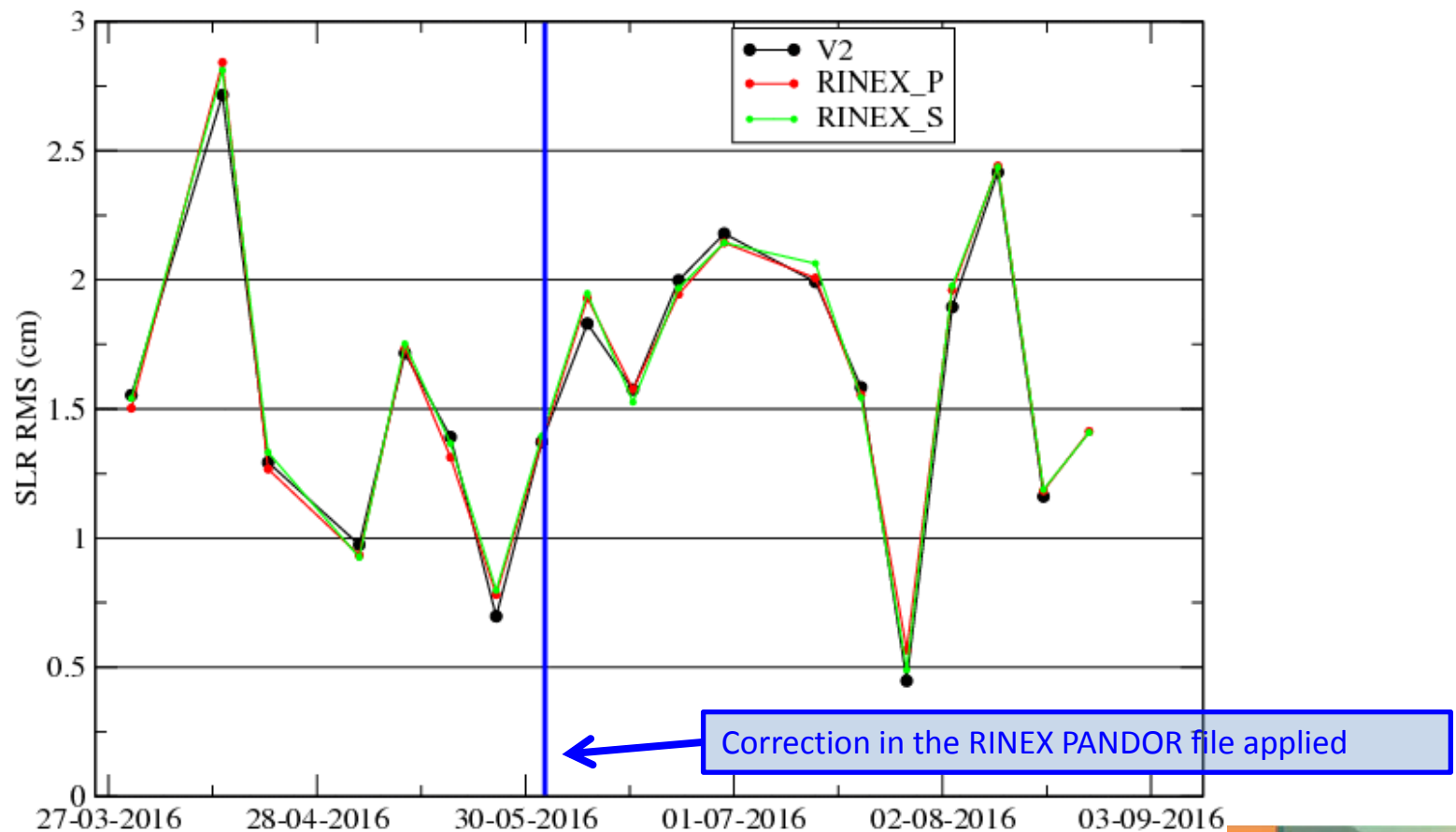
From DORIS2.2 (V2)

From RINEX files from PANDOR (RINEX\_P)

From RINEX files from SPARINEX (RINEX\_S)(DIODE time-tagging)

**Time span processing:** March 2016 to September 2016

**SLR RMS for data from Core Network and with high elevation ( $> 70^\circ$ )**



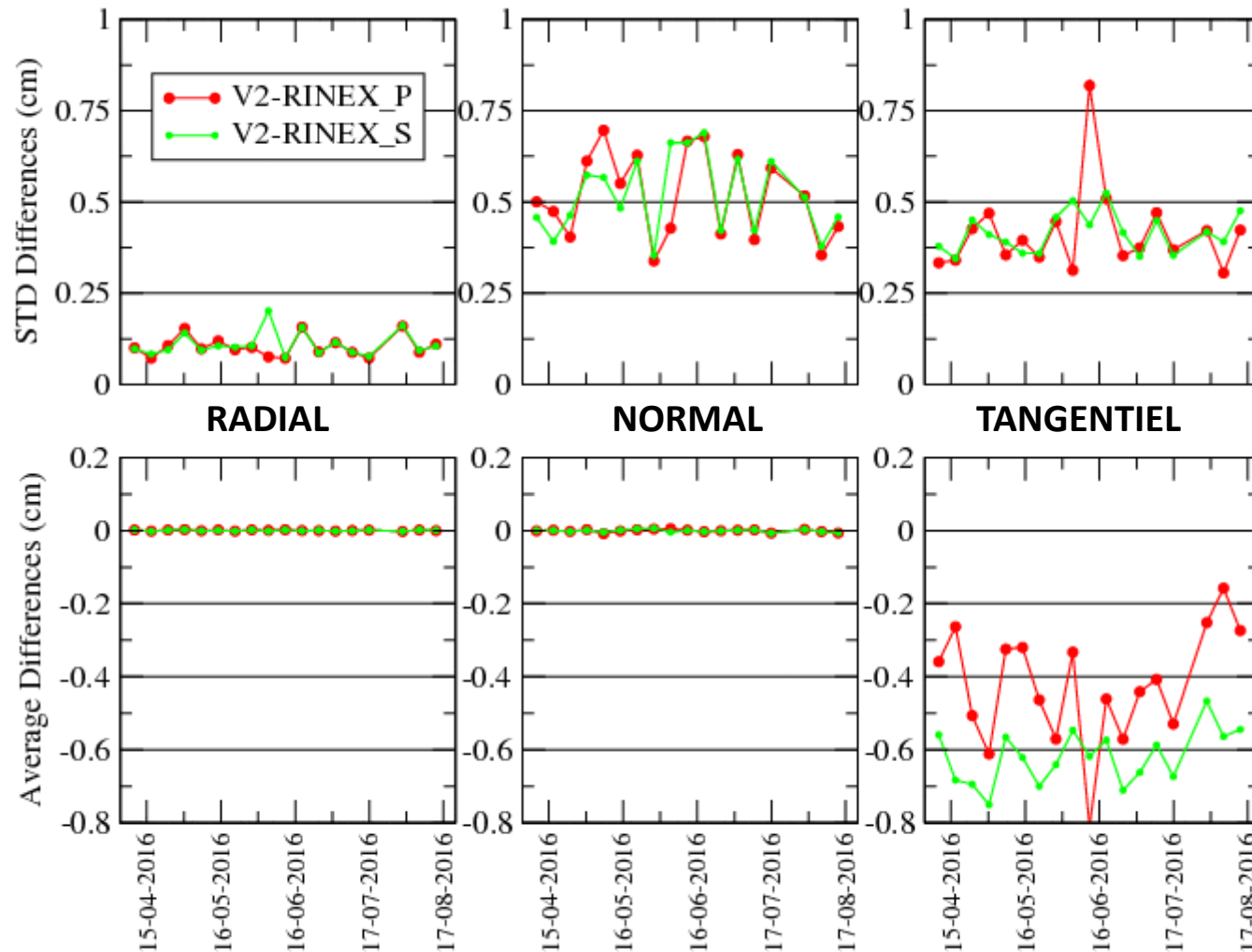
# Jason-2 orbit comparison

Jason-2 DORIS-only orbit differences **V2-RINEX Differences**

Time span processing: March 2016 to September 2016

V2-RINEX files from PANDOR (**RINEX\_P**)

V2-RINEX files from SPARINEX (**RINEX\_S**)(DIODE time-tagging)



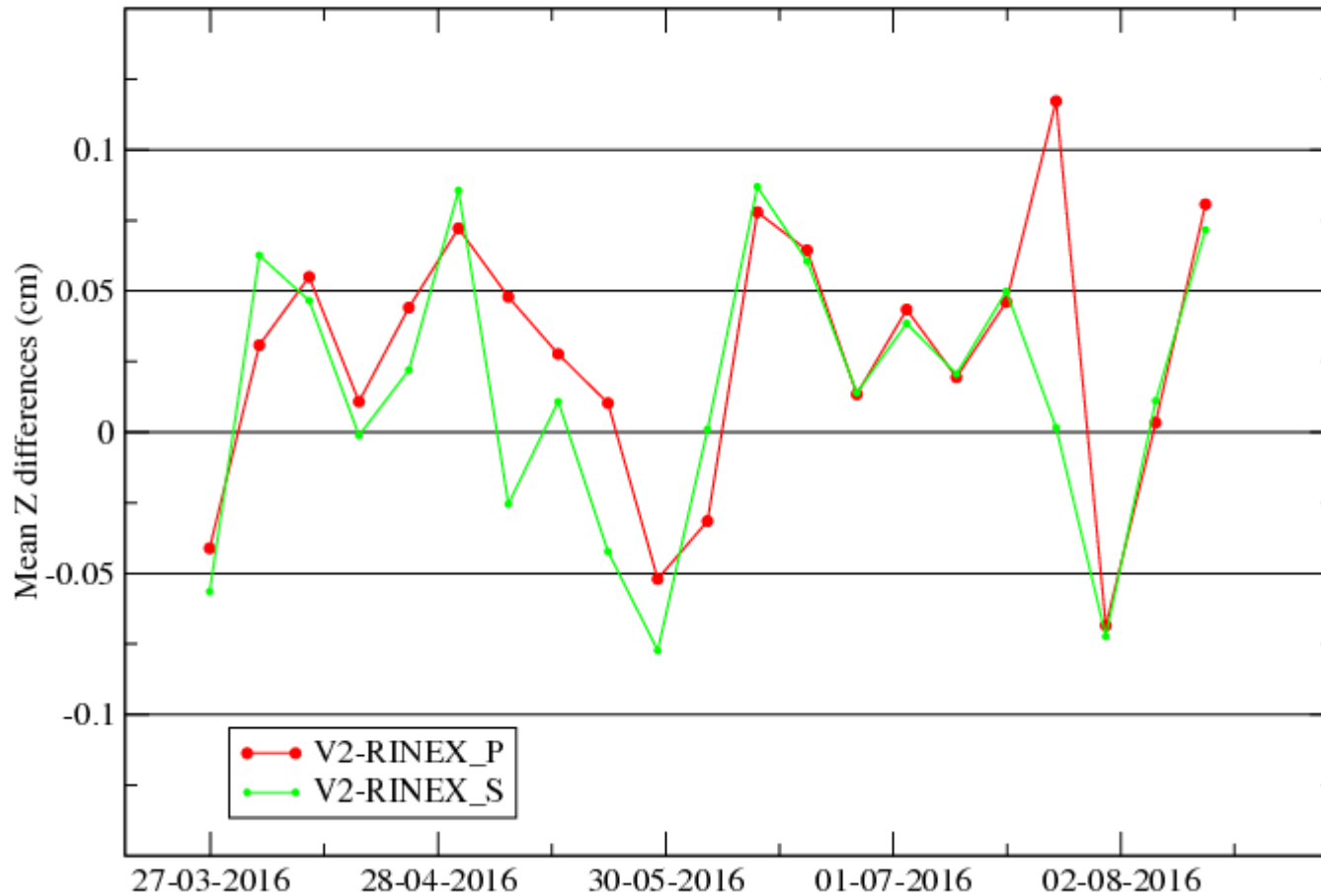
# Jason-2 orbit comparison

Jason-2 DORIS-only orbit differences **V2-RINEX Differences along the Z axis**

Time span processing: March 2016 to September 2016

V2-RINEX files from PANDOR (**RINEX\_P**)

V2-RINEX files from SPARINEX (**RINEX\_S**)(DIODE time-tagging)



# Jason-2 Single satellite station network solution

Comparison to DPOD2008 computed by CATREF

Time span processing: June 2016 to September 2016

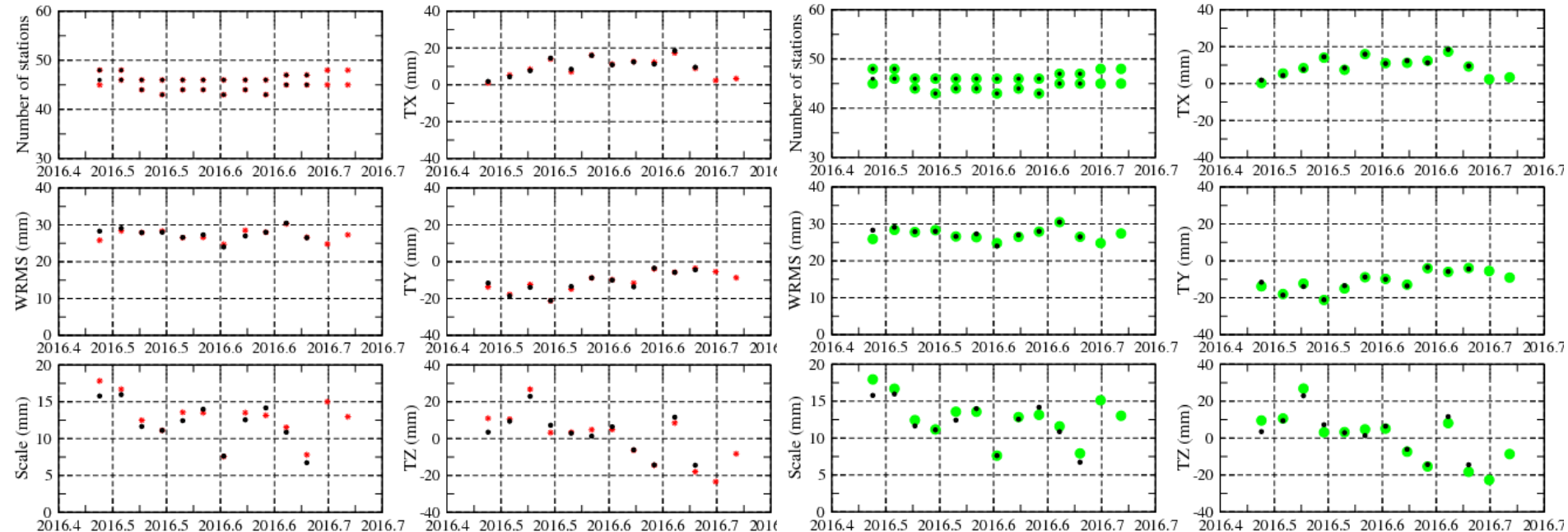
Helmert parameters: Scale and Geocenter

in black from DORIS2.2 V2

in red from DORIS RINEX PANDOR

in black from DORIS2.2 V2

in green from DORIS RINEX DIODE



# Jason-2 Single satellite station network solution

Comparison to DPOD2008 computed by CATREF

Time span processing: June 2016 to September 2016

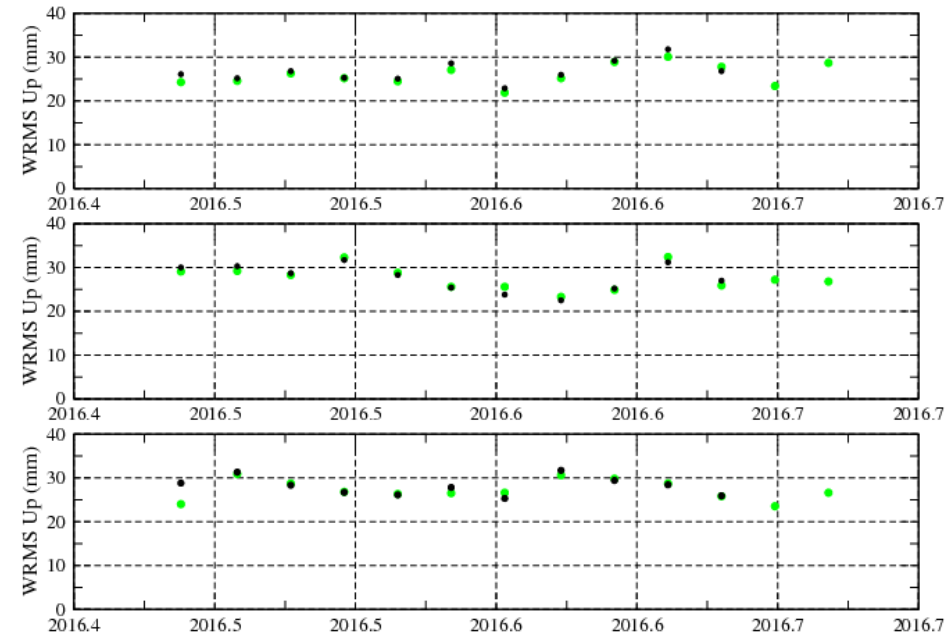
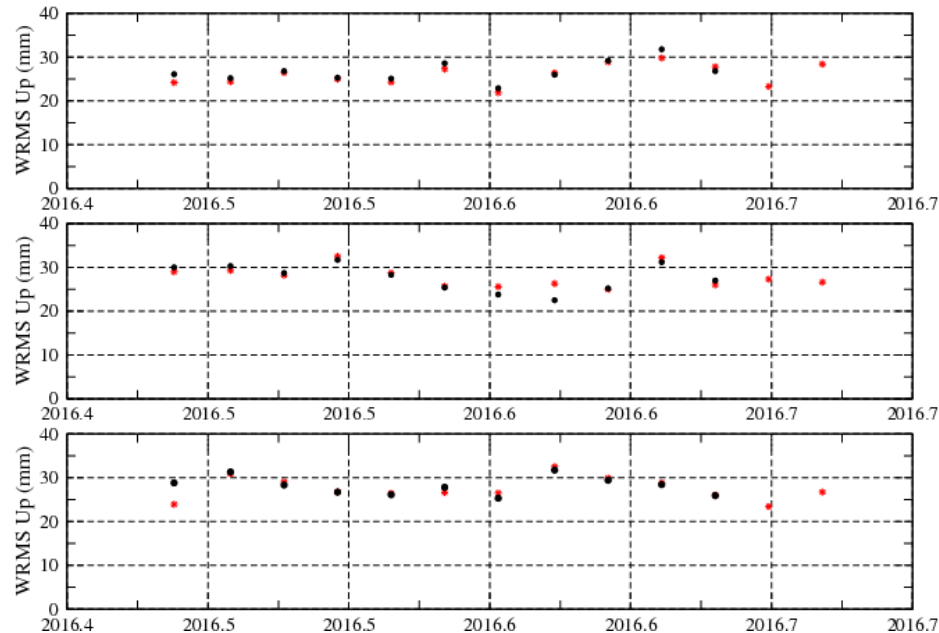
WRMS by component (Up North East)

in black from DORIS2.2 V2

in red from DORIS RINEX PANDOR

in black from DORIS2.2 V2

in green from DORIS RINEX DIODE



# CONCLUSIONS

## Jason-2 residuals (DORIS and SLR)

- Since the correction made in the PANDOR software in June 2016 the DORIS RMS residuals are at the same level for DORIS2.2 (V2) data and the two sets of RINEX data (PANDOR and SPARINEX)
- The Jason-2 DORIS-only orbit independent SLR RMS residuals are at the same level for the 3 sets of data

## Jason-2 orbit comparison (RINEX data compared to DORIS2.2 data)

- The orbits are very close but:
  - Radial orbit differences have a STD < 0.2 cm
  - There is an offset of 0.4 cm in the Along-track orbit differences for RINEX PANDOR
  - There is an offset of 0.6 cm in the Along-track orbit differences for RINEX SPA

## Jason- 2 single satellite positioning results

- As shown at the AWG in Toulouse in May the quality with DORIS RINEX data is at the same level as with DORIS2.2 data

**For GRG AC, the POD and the station position estimation obtained from RINEX PANDOR and SPARINEX (DIODE time-tagging) are of the same quality**



# GSC ANALYSIS

- **POD evaluation of DORIS data at GSFC / NASA GSFC POD Team**  
(*N.P. Zelensky, F.G. Lemoine*), Sept. 20, 2016
- DORIS data flavors (SLR+DORIS POD tests)
  - **V2** range-rate (CDDIS)
- Rinex **Pandor: RINEX\_P** (CDDIS import in mid-2016)
  - 2008 data (080712 - 090106)
  - 2016 data (160108 - 160813)
- Rinex **Old: RINEX\_S** (AVISO import in mid-2016)
- Rinex **2015: RINEX\_P** (CDDIS import in early-2015)



# GSC results

- Jason-2 DORIS data performance is evaluated over 2008 and 2016 with SLR+DORIS POD using the latest GSFC standards.
- USO 2016 frequency corrections differ by 1.6 mm/s on average between the Pandor (RINEX\_P) and Old Rinex data (RINEX\_S).
- Pandor data show the largest residuals, typically about 0.03 mm/s larger than V2 for 2008 and for 2016 - up to June.
- Starting June 2016 Pandor (RINEX\_P) residuals are reduced, relative to V2, to about 0.02 mm differences, and are identical with the Rinex Old (RINEX\_S)
- Starting June 2016 the V2 edited data begin to exceed the Rinex
- RINEX orbits differ radially from V2 by 1-2 mm and are near of the same accuracy, judging by SLR residuals.

# CONCLUSION / DECISION

## DORIS PERFORMANCE GROUP RECOMMENDATIONS:

### ❑ REC1

The studies show that the time-tagging provided by PANDOR in the RINEX files does not improve perceptibly the quality of orbits nor positioning

➔ the Group recommends to come back to the baseline: RINEX-DORIS provided by SPARINEX (with DIODE time-tagging) to IDS Data Centers.

### ❑ REC 2

The REC1 only concerns the use of PANDOR for providing RINEX files

The Group wishes to emphasize that PANDOR is very valuable for the DORIS system monitoring by its relevance wrt different time scales in the Doris system.

➔ **In November: dissemination of RINEX\_S data for all missions.**

And all DORIS-RINEX available on IDS data Centers will be again RINEX\_S data from the beginning of all missions: Announcement by DORISMAIL