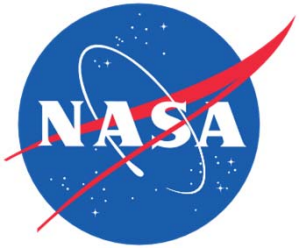
Jet Propulsion Laboratory
California Institute of Technology

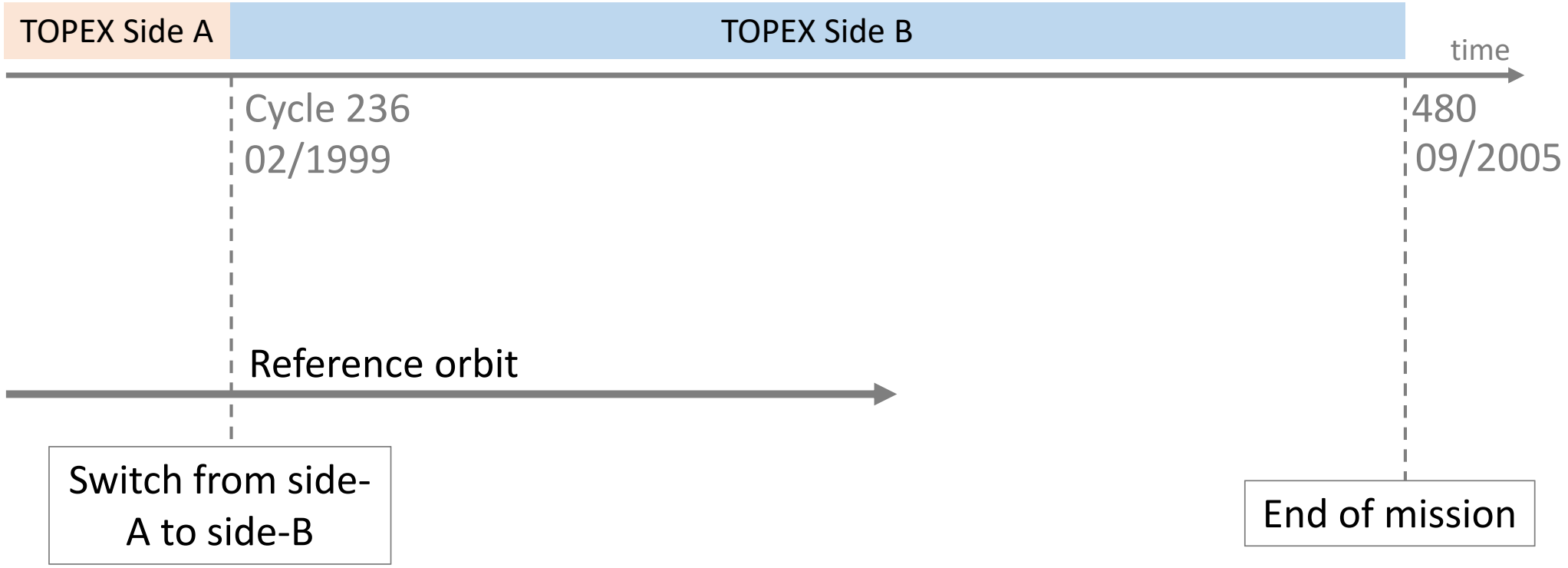


Global Calibration and Validation of Reprocessed TOPEX Side-B Data

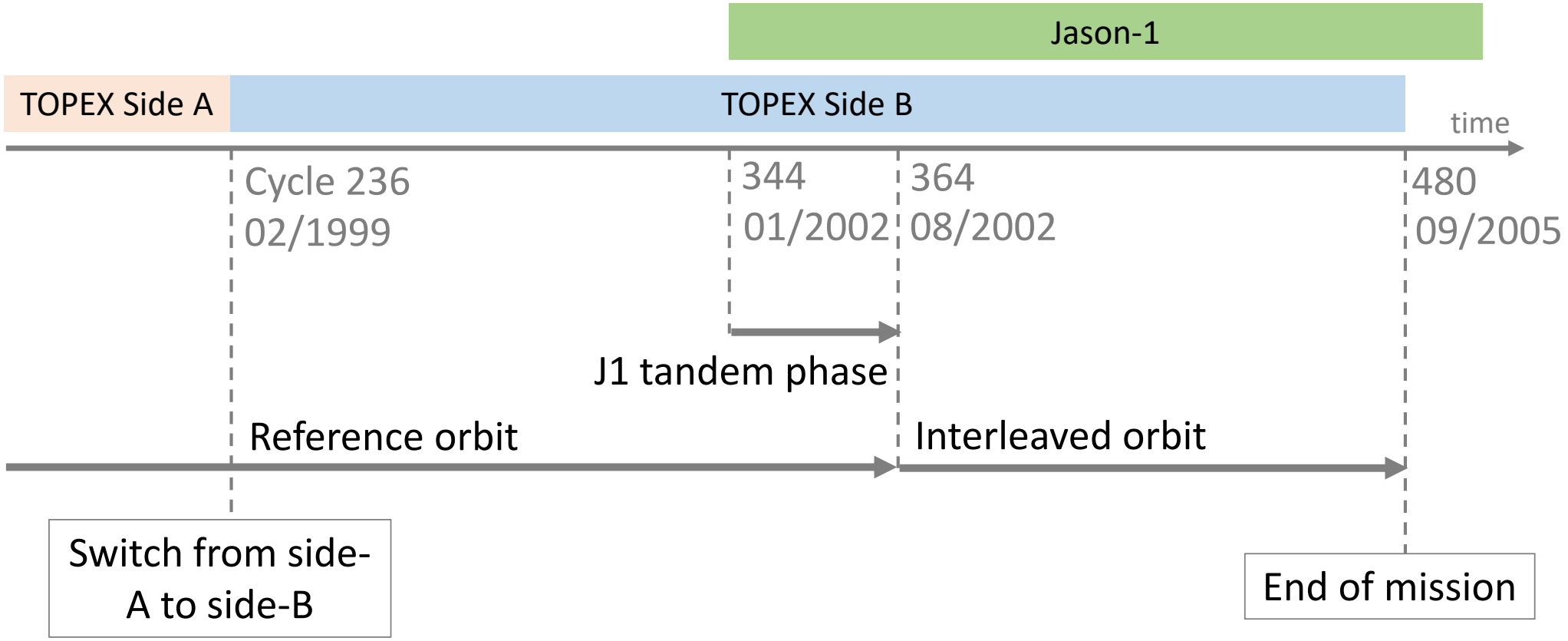
Jet Propulsion Laboratory, California Institute of Technology

Matthieu Talpe on behalf of JPL and CNES Cal/Val teams

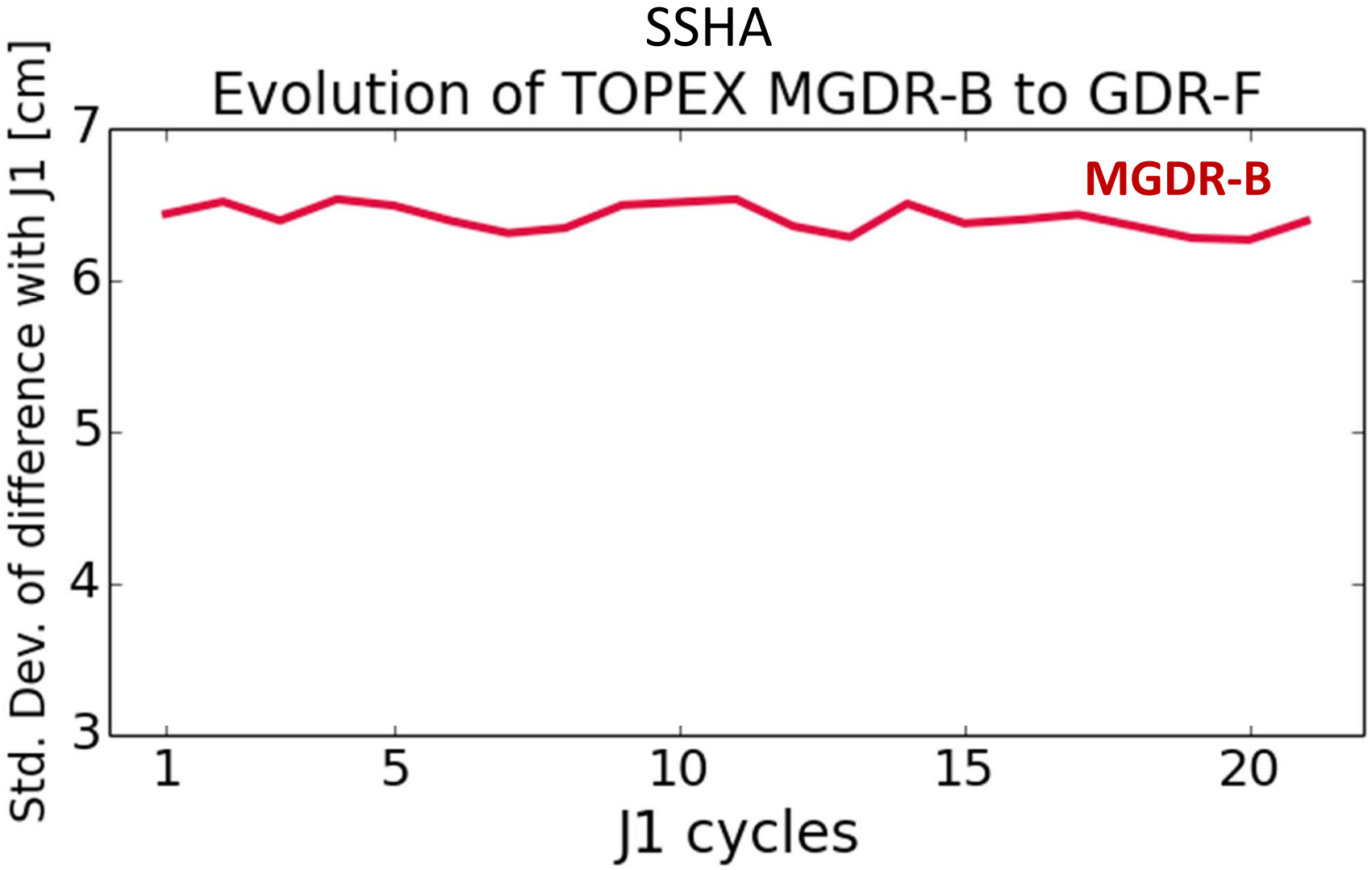
TOPEX side-B timeline

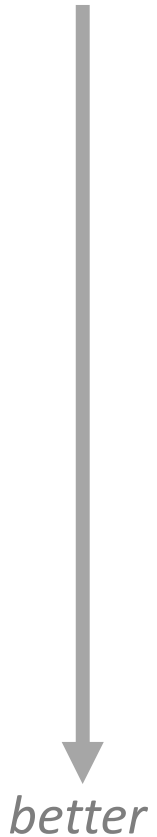


TOPEX side-B timeline



Improved consistency between TOPEX GDR-F and Jason-1 GDR-E





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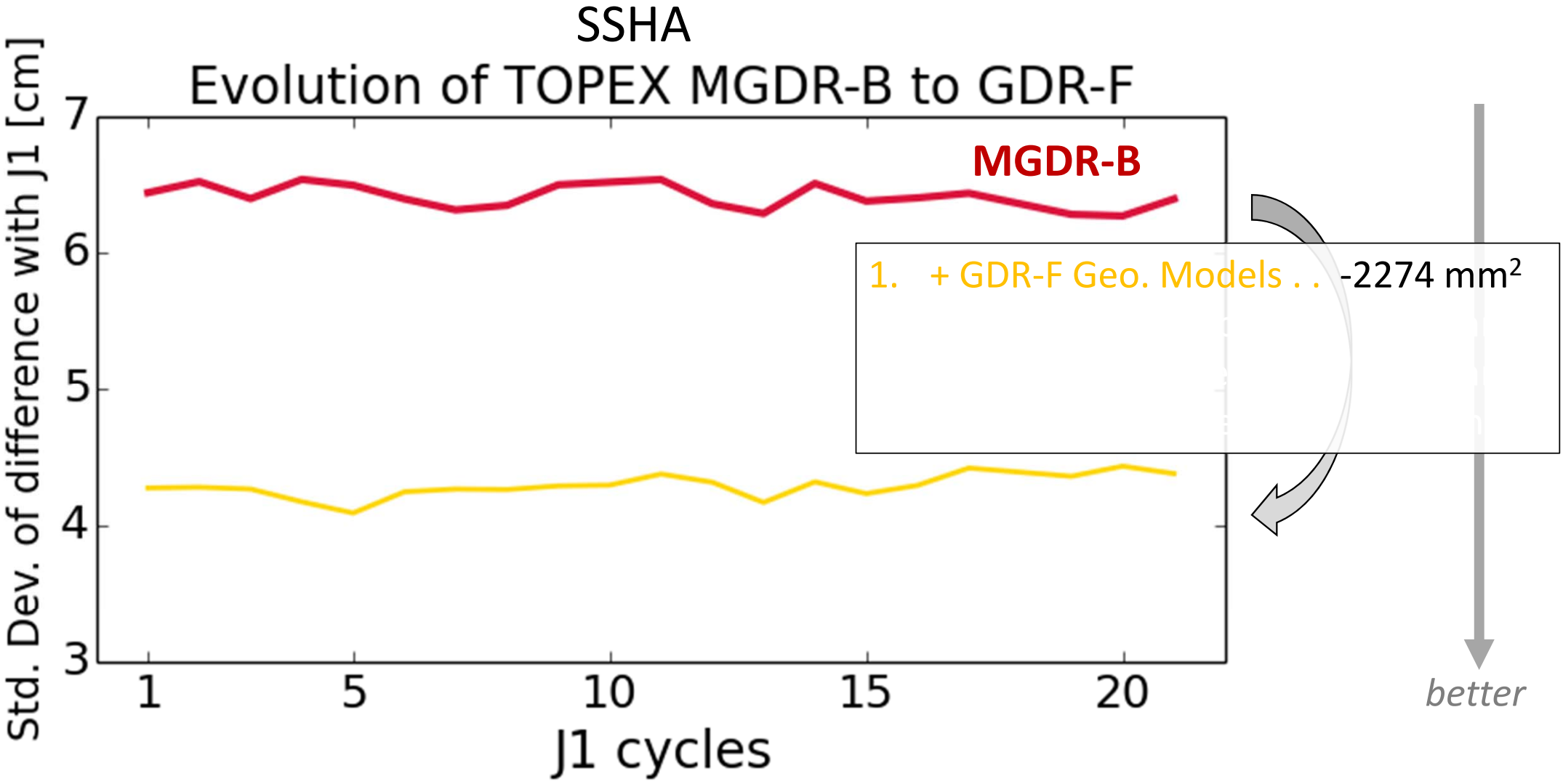

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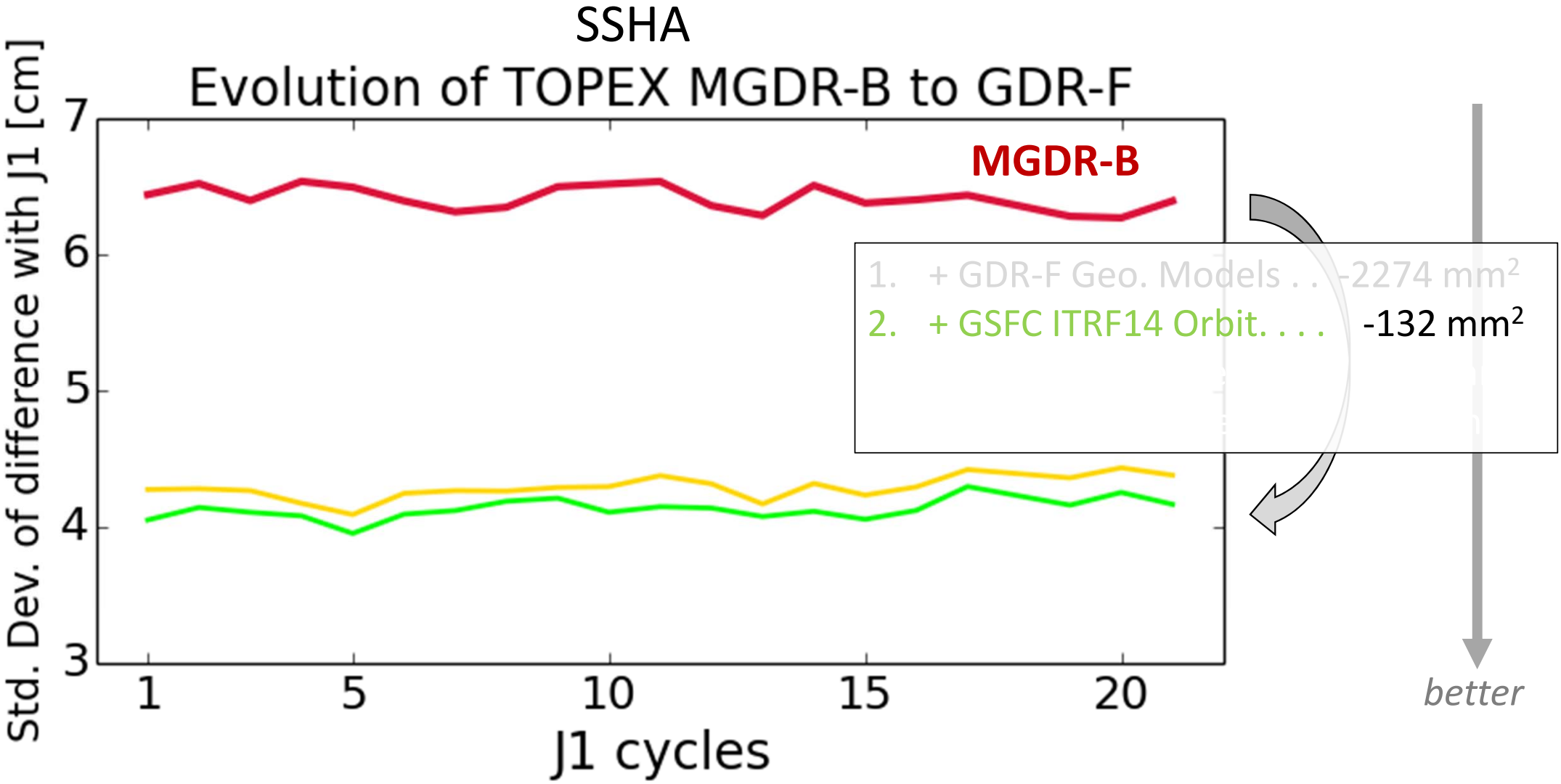

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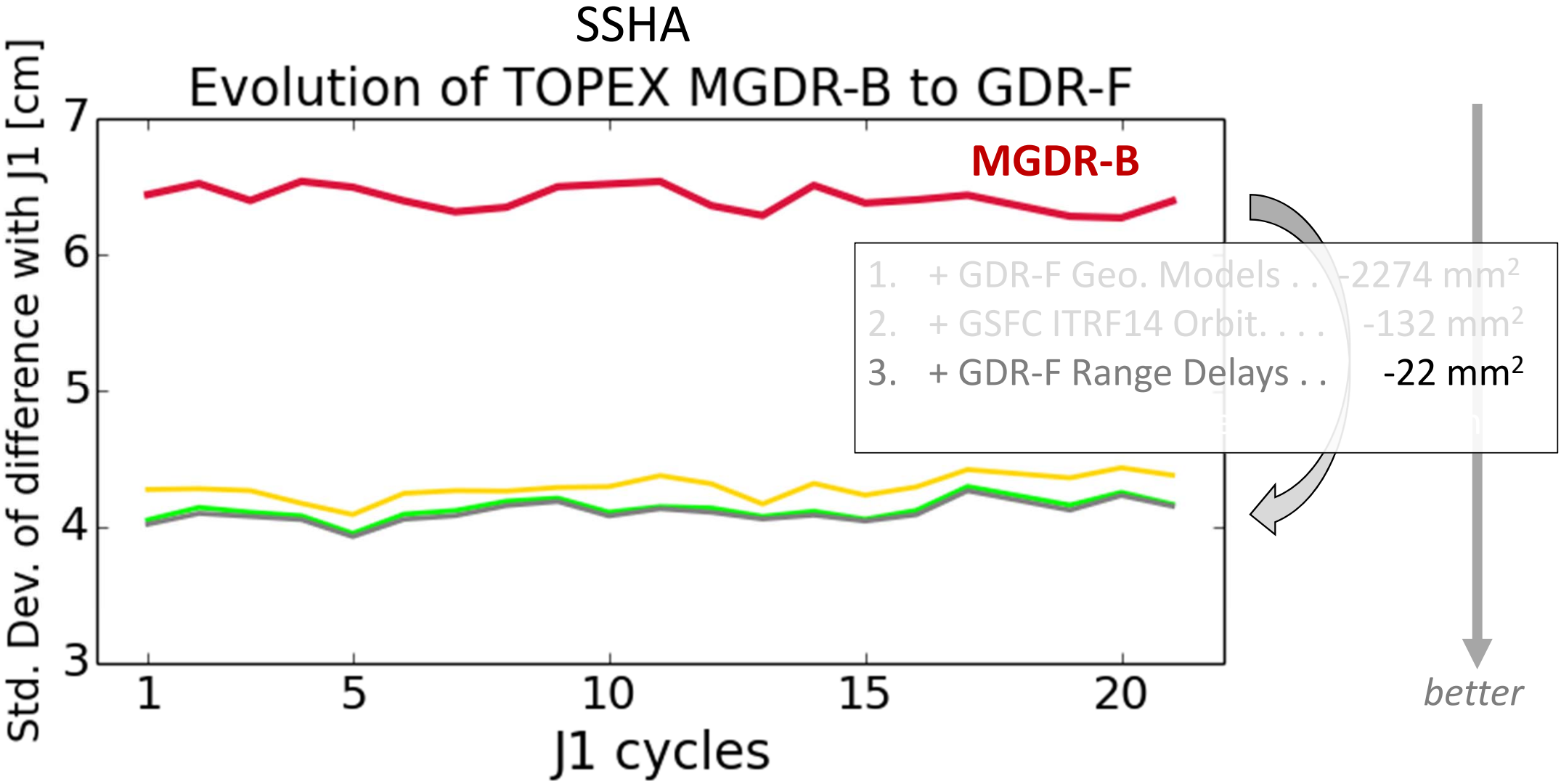

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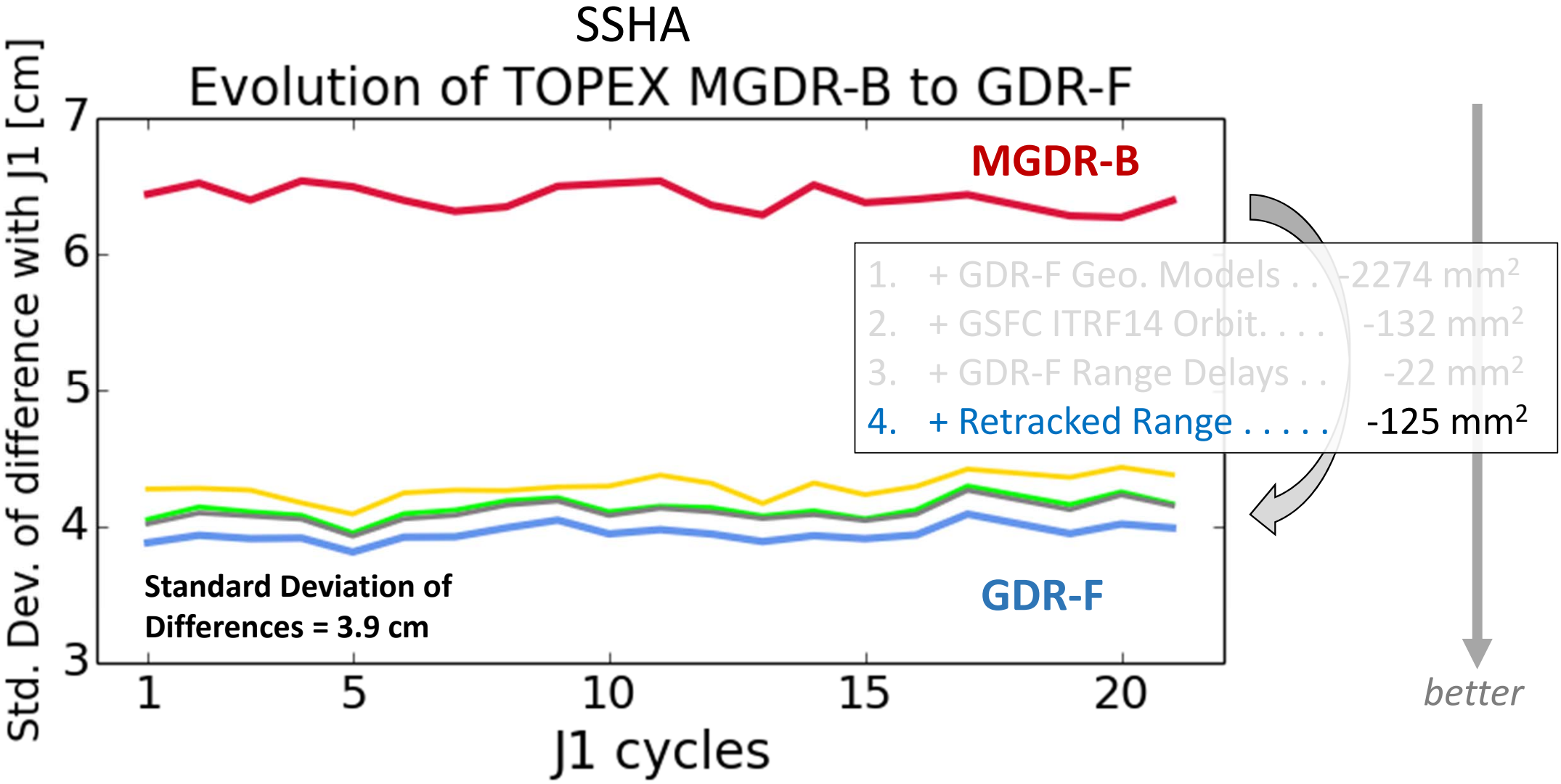

Updates in TOPEX products

	MGDR-B	GDR-F
Altimeter parameters	Onboard	Numerical Retracking
Range correction	Wallops Cal1	Numerical Retracking
Sigma0 correction	Wallops Climatological	Numerical Retracking
Radiometer Sigma0 attenuation	Uncalibrated	Calibrated
Radiometer wet path delay	Uncalibrated	Calibrated + coastal retrieval
Dry tropospheric correction	ECMWF Operational (no S1/S2)	ERA Interim + S1/S2
Model wet path delay	ECMWF Operational	ERA Interim
Sea State Bias	Parametric (Gaspar et al., 1994)	Non-Parametric (Vandemark and Feng, 2019)
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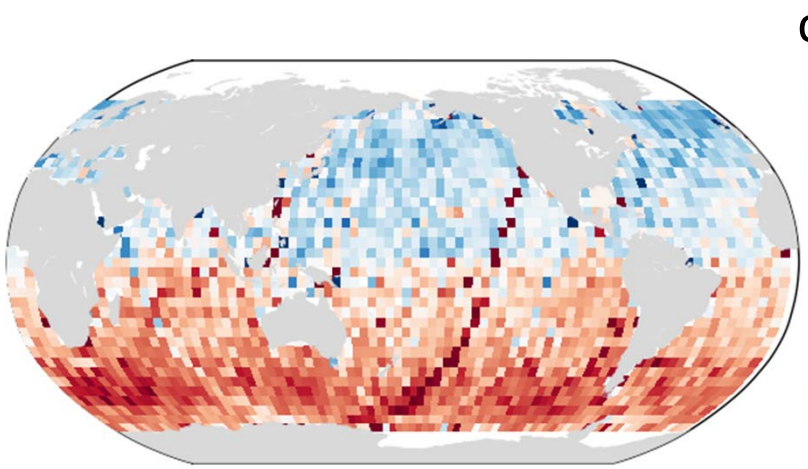
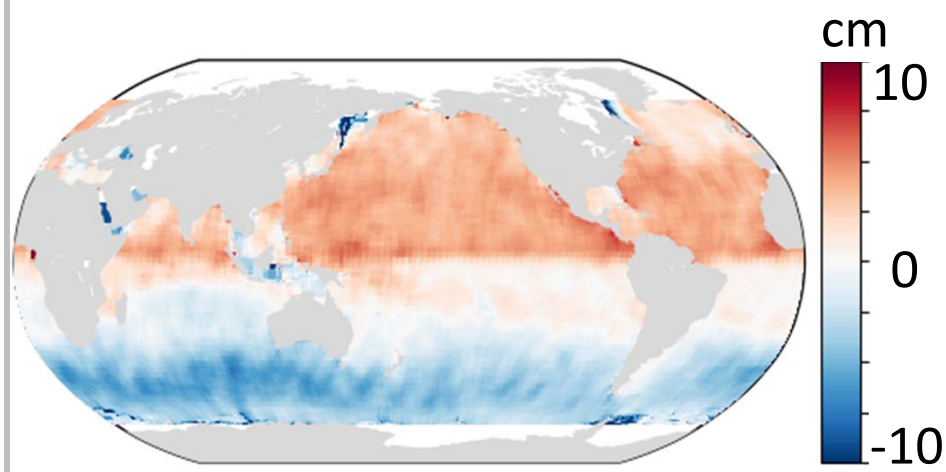
Hemispherical bias is attenuated

	SSHA crossovers	Ku SWH, TOPEX – J1, asc.
MGDR-B	 *Only the ranges are from MGDR-B*	
GDR-F		

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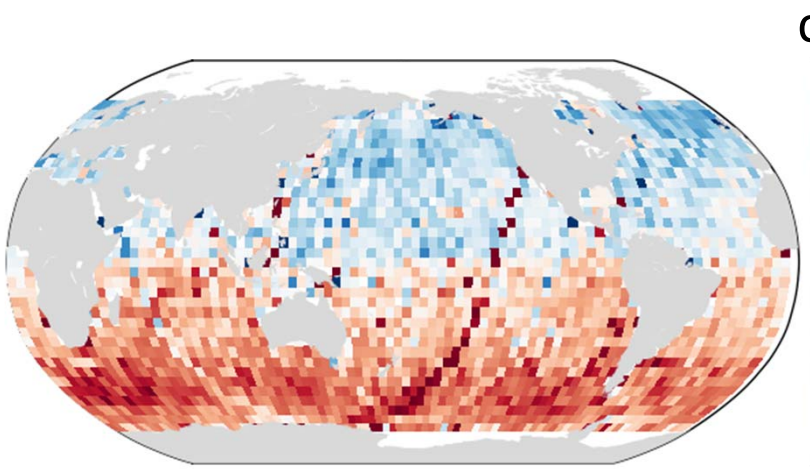
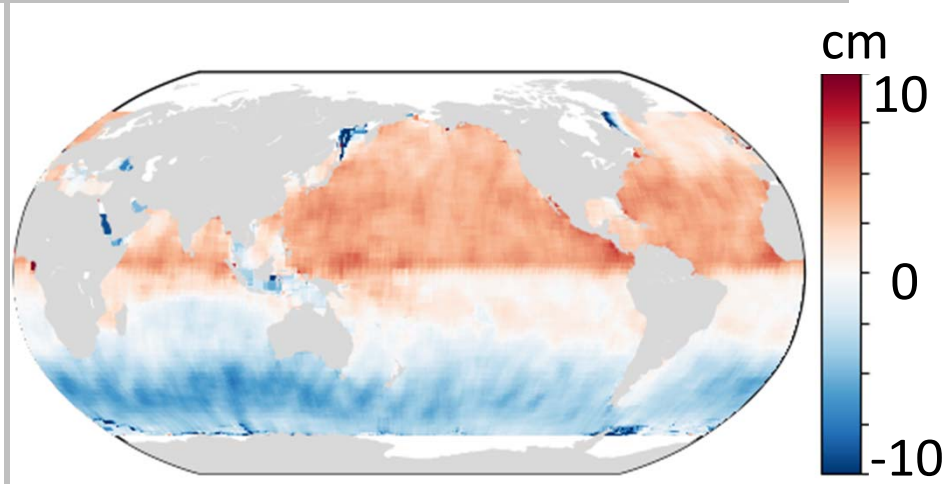
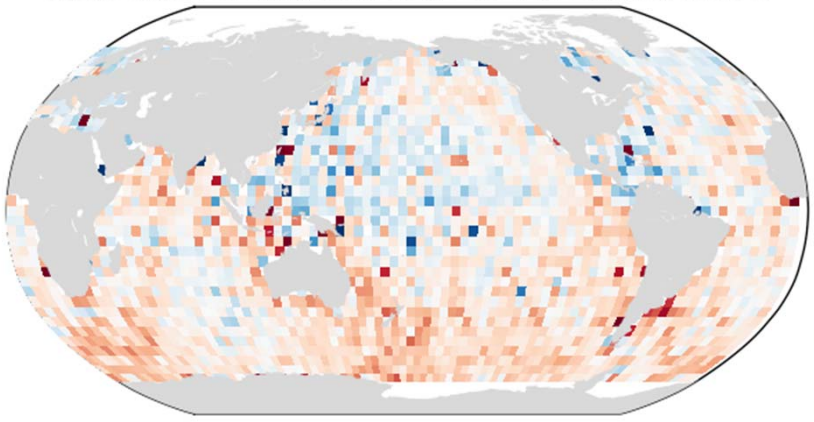
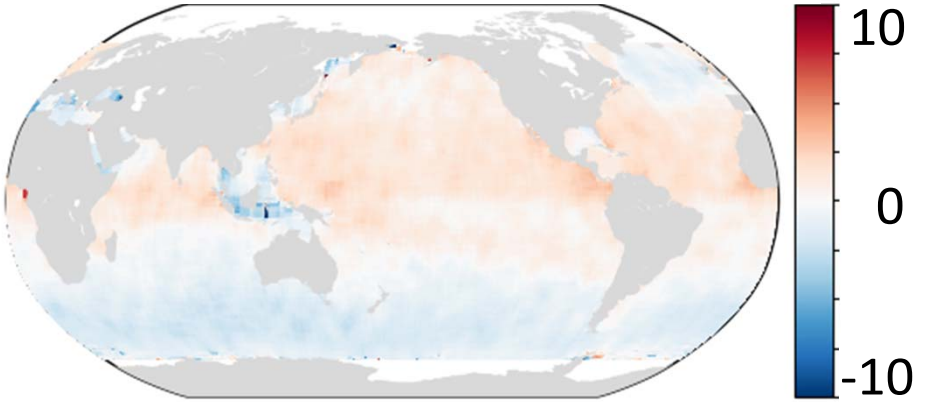
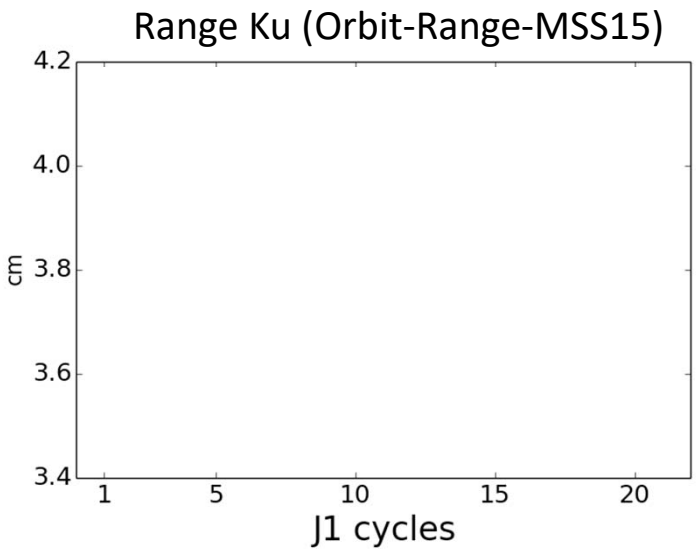
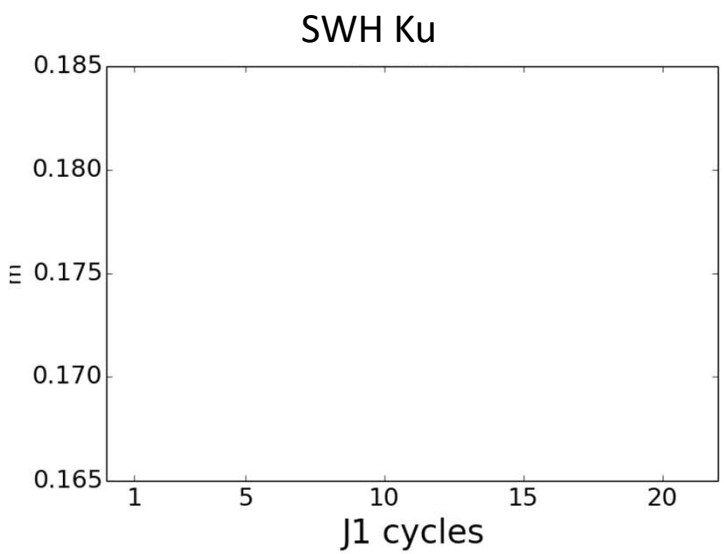
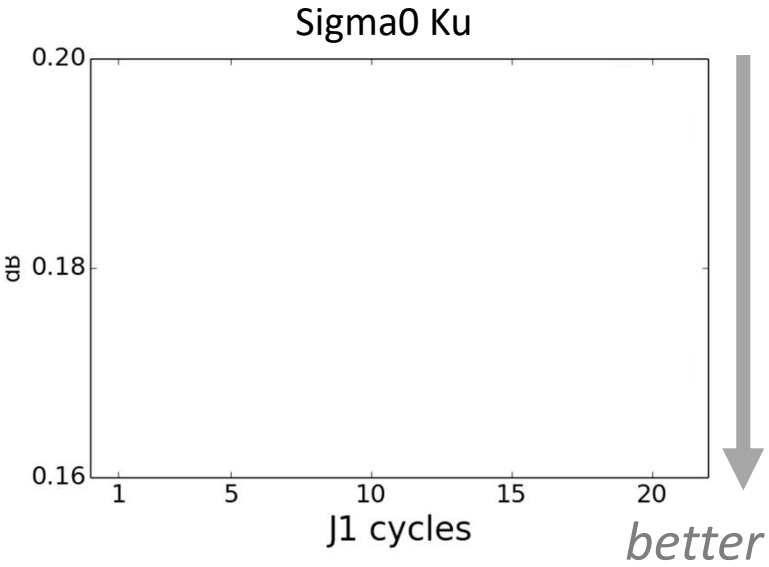
MGDR-B	 *Only the ranges are from MGDR-B*	
GDR-F		

Better consistency with Jason-1 for range, SWH, Sigma0

Standard Deviation, J1 and TOPEX Differences







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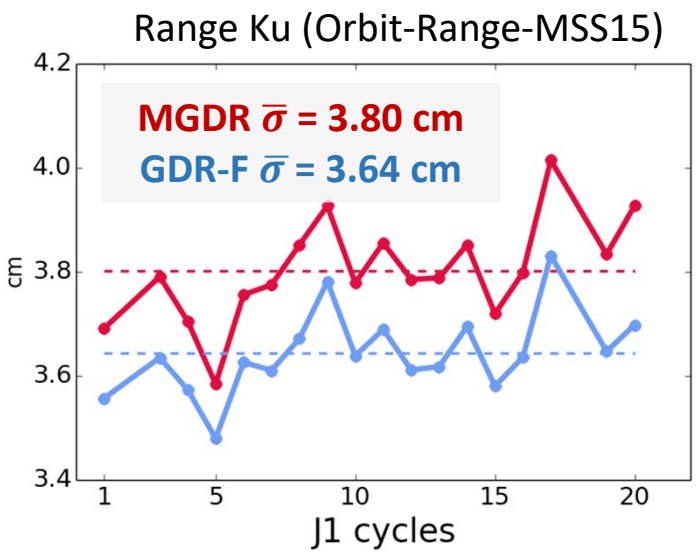
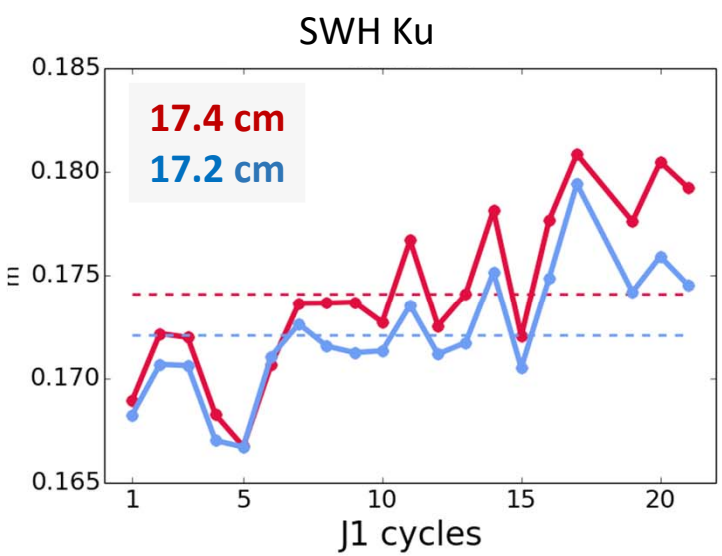
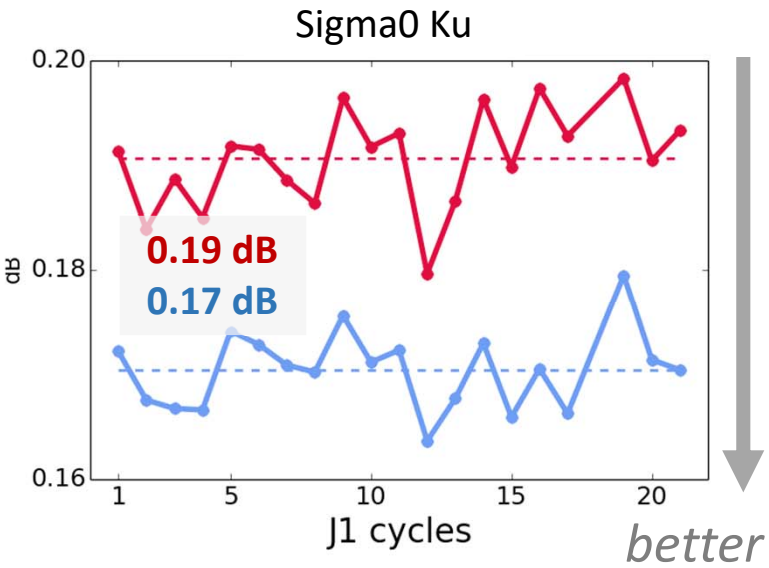
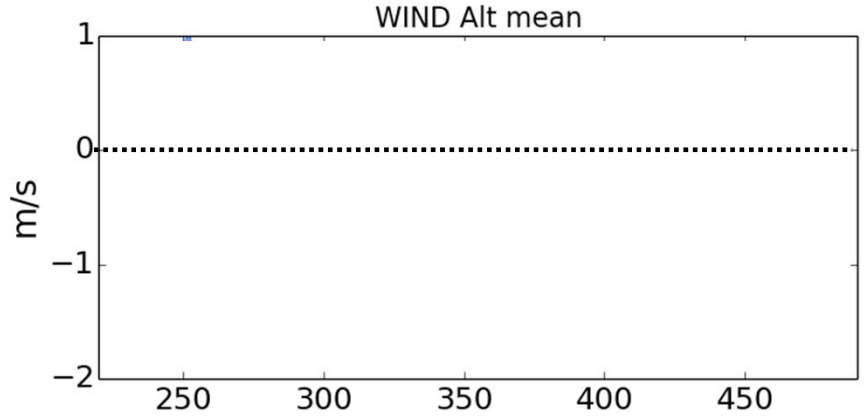
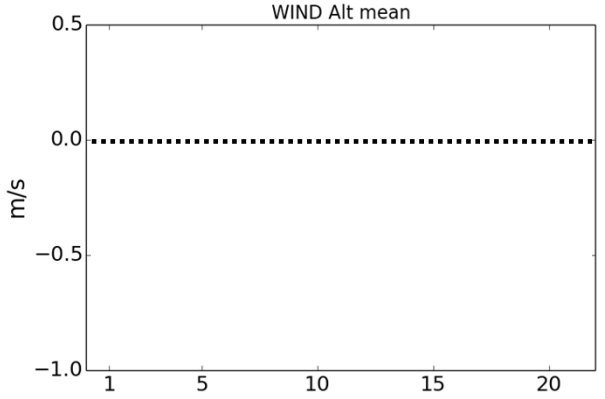
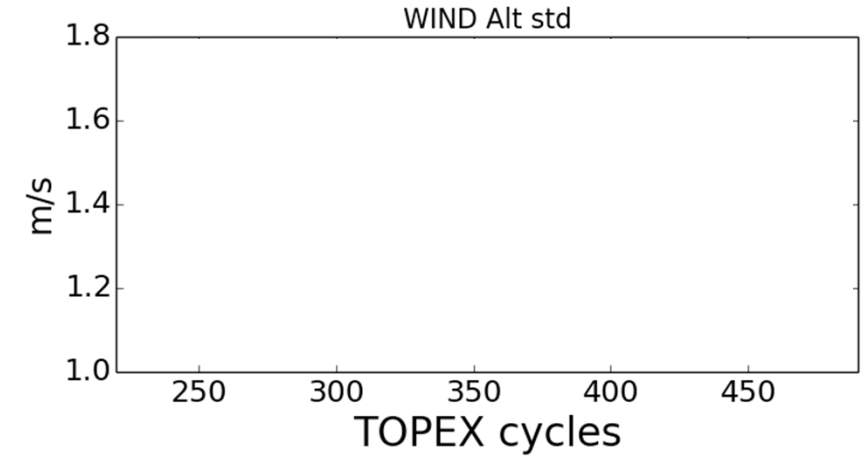
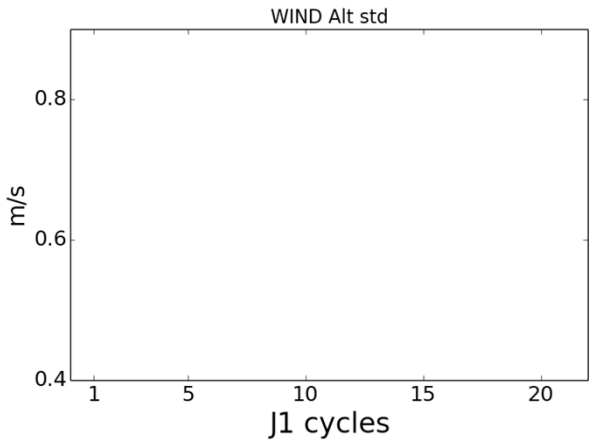






- **MLE4 retracking is consistently better than MGDR.**

Improvement in altimeter wind speed

	Difference with ERA Interim	Difference with J1
Mean		
Std Dev		

better

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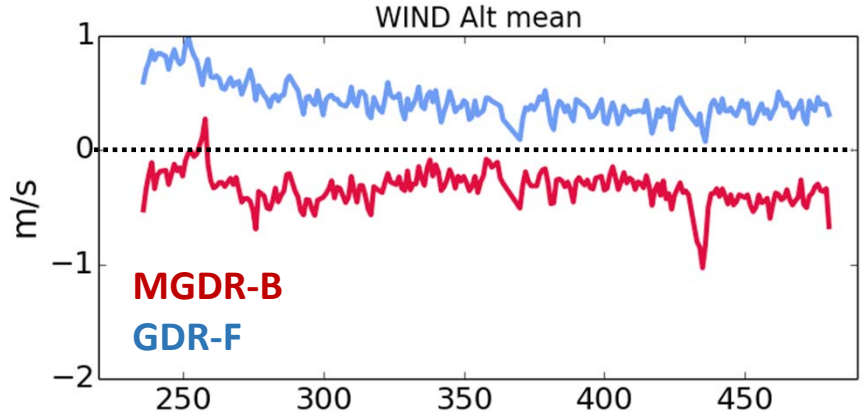
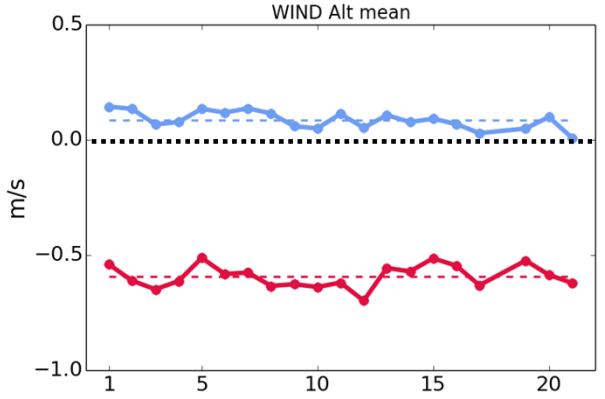
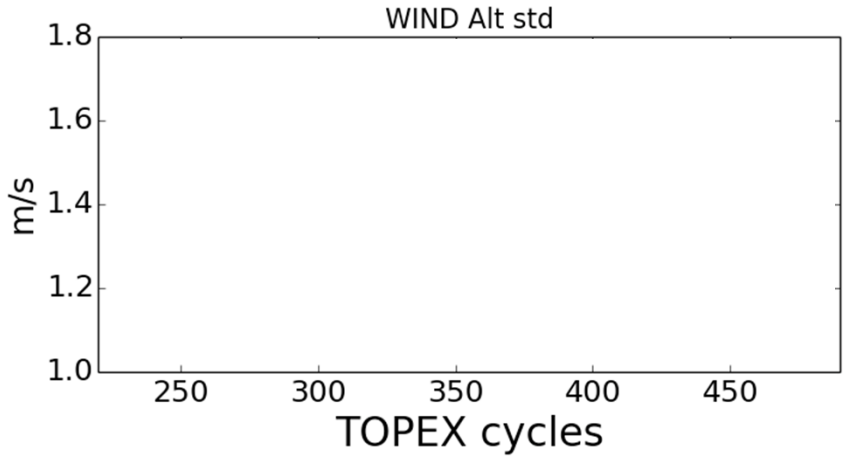
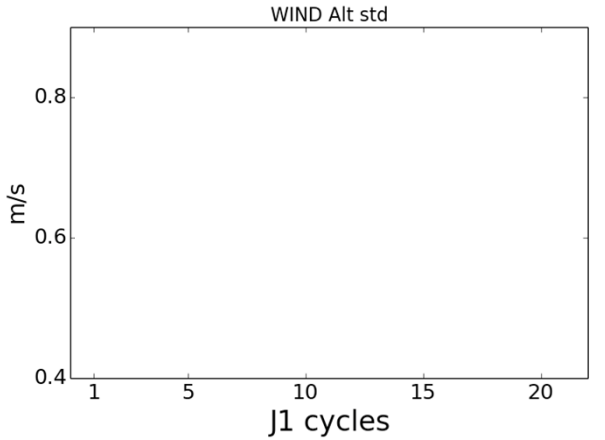
Mean		
Std Dev		

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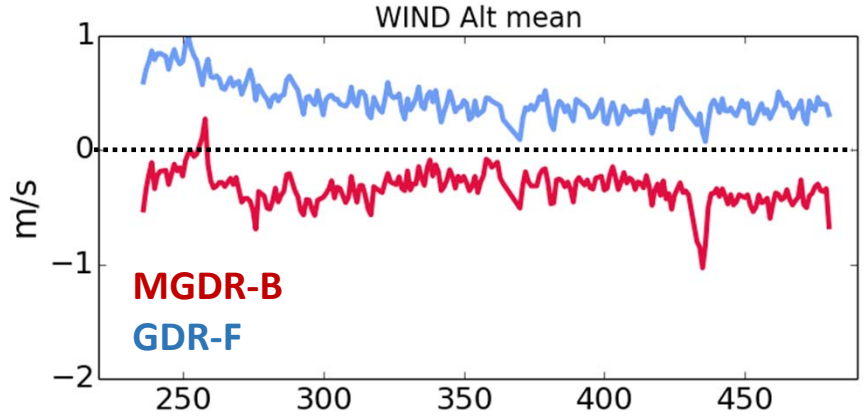
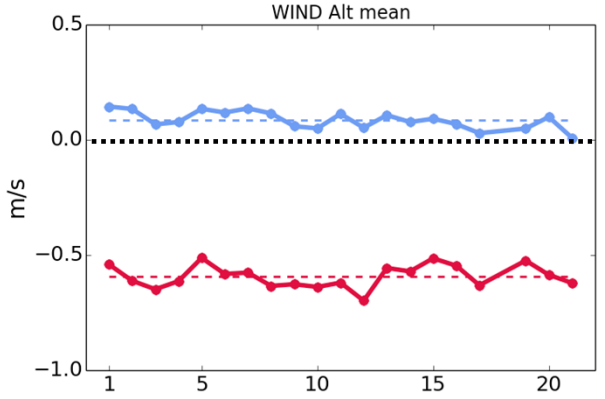
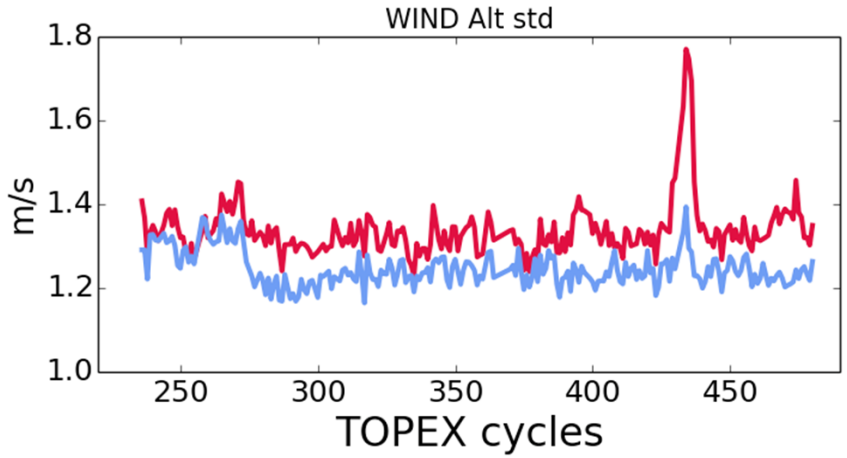
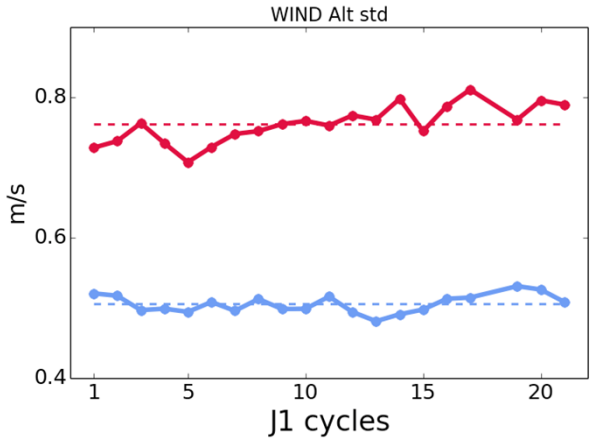
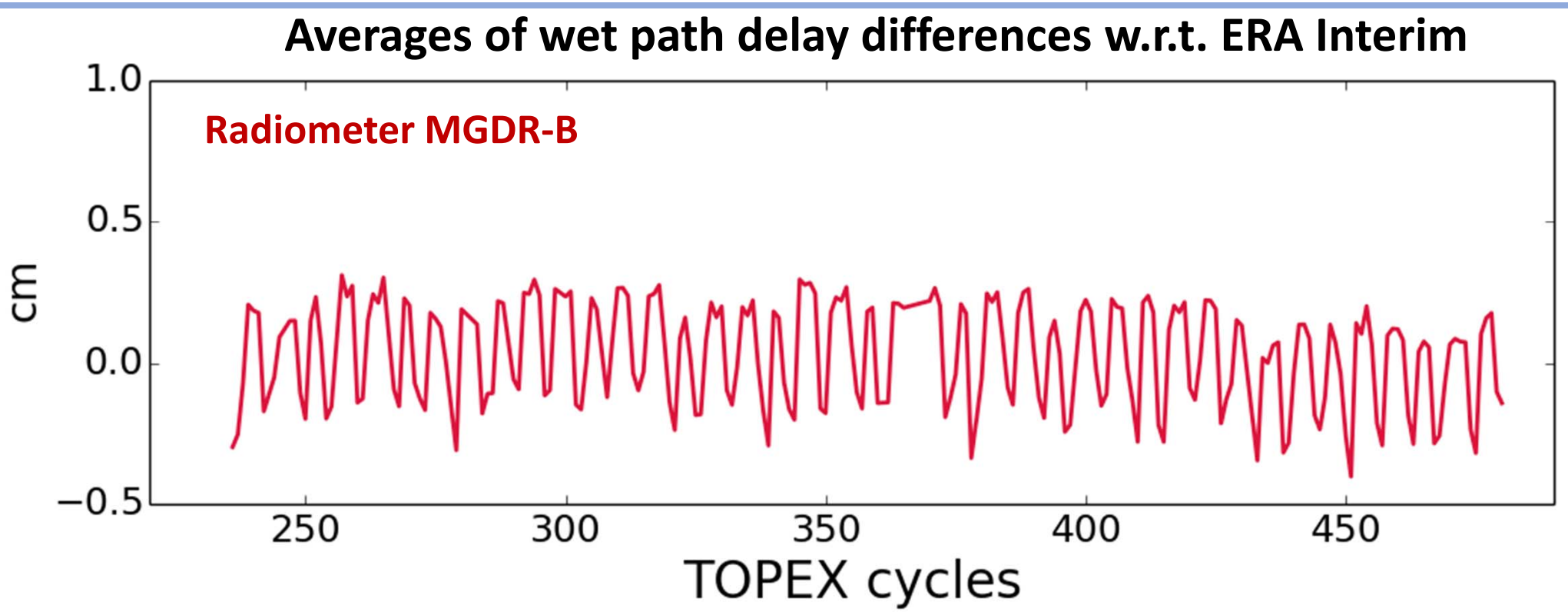
Mean		
Std Dev		

- The GDR-F wind speed instability early in side-B is traced back to sigma0 instability.
- The alt. wind speed is aligned to J1 based on sigma0 calibration during the J1 tandem phase.

Calibrated radiometer data significantly reduce (60-day) yaw state errors



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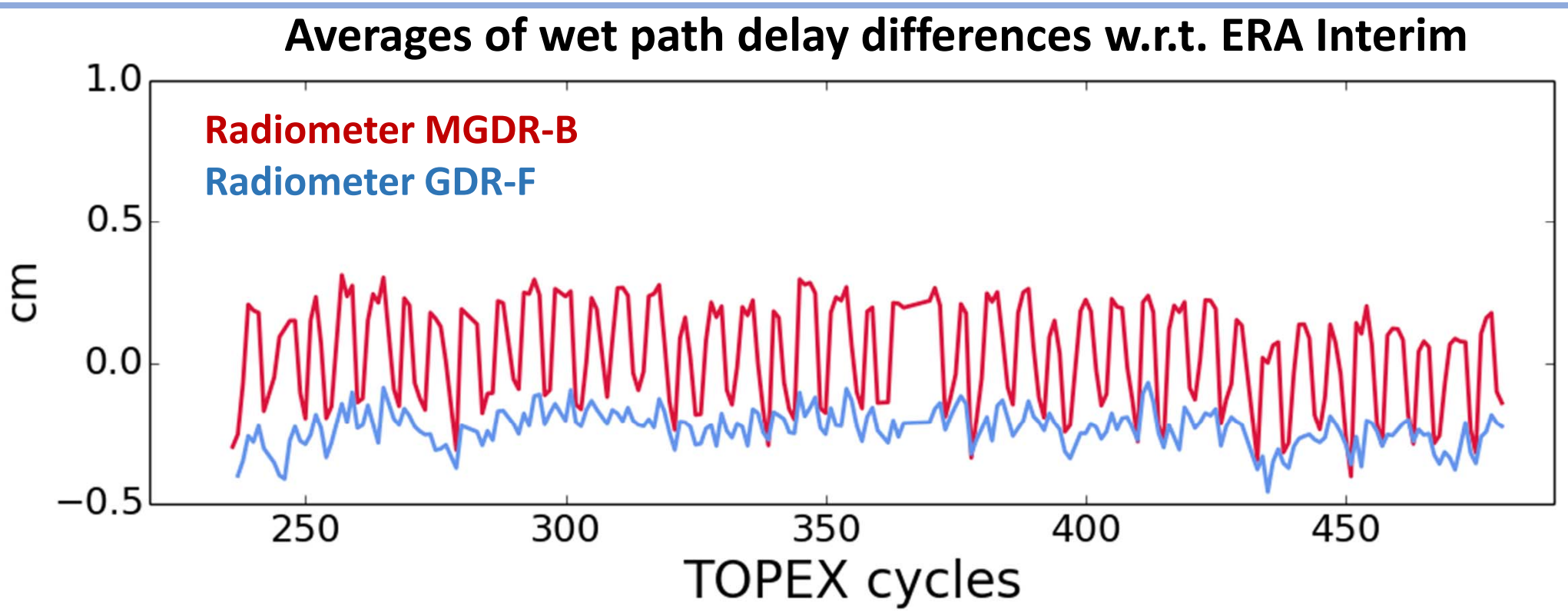

- The GDR-F radiometer path delay is more consistent with ERA Interim.
- The 4-mm, 60-day signal induced by yaw-state dependent thermal environment is attenuated by end-of-mission recalibration of radiometer.

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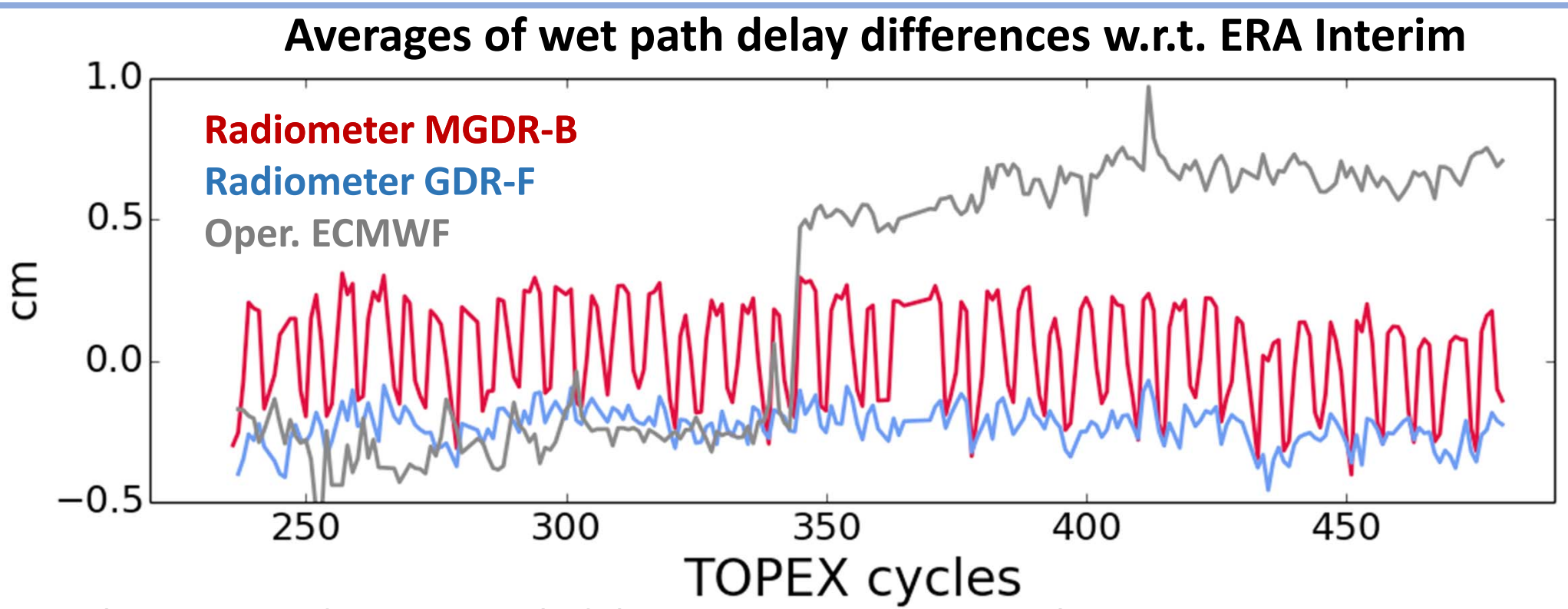

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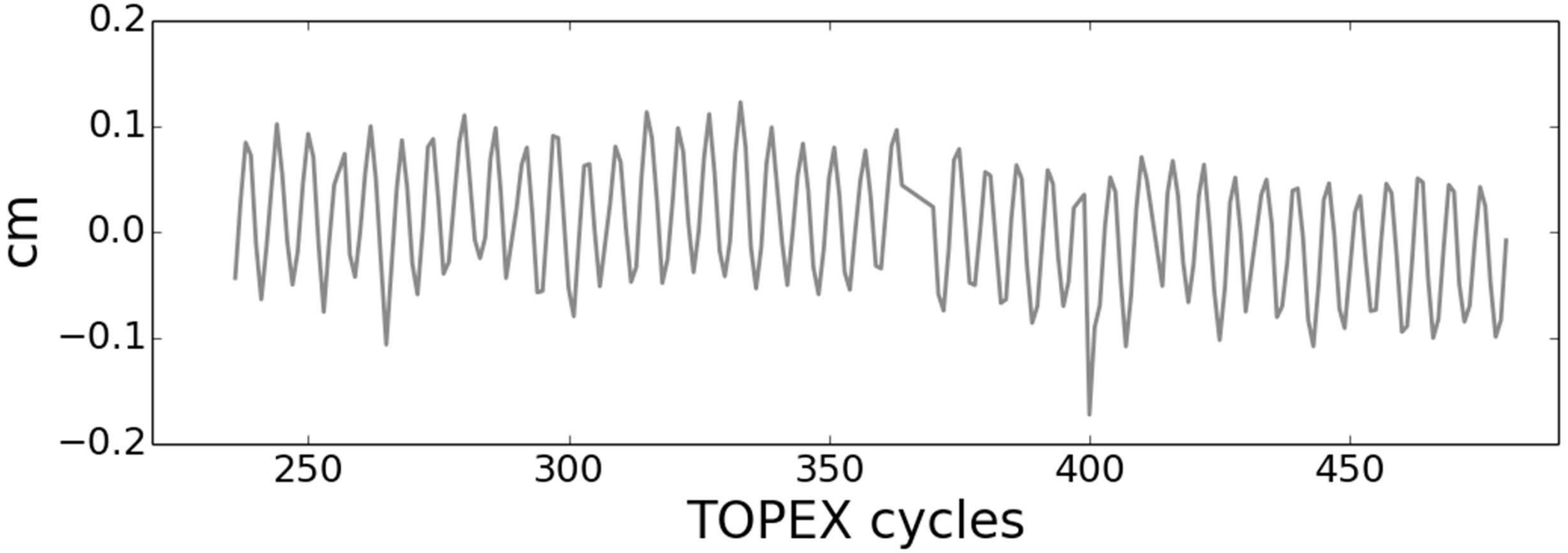
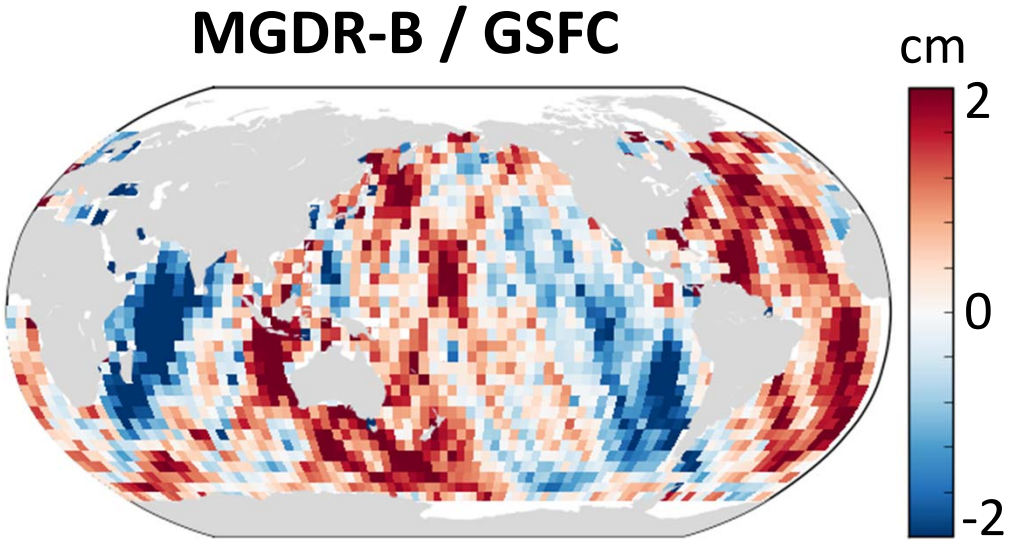
- The ERA model wet path delay provided in GDR-F eliminates “jumps” caused by model changes in ECMWF operational analysis in MGDR.

Averages of MGDR and GDR-F difference of dry troposphere correction



- The ~1.5-mm, 60-day difference signal is explained by the use of S1/S2 atmospheric tides in GDR-F.

SSHA crossovers using different orbits show significant reduction of geographically correlated errors



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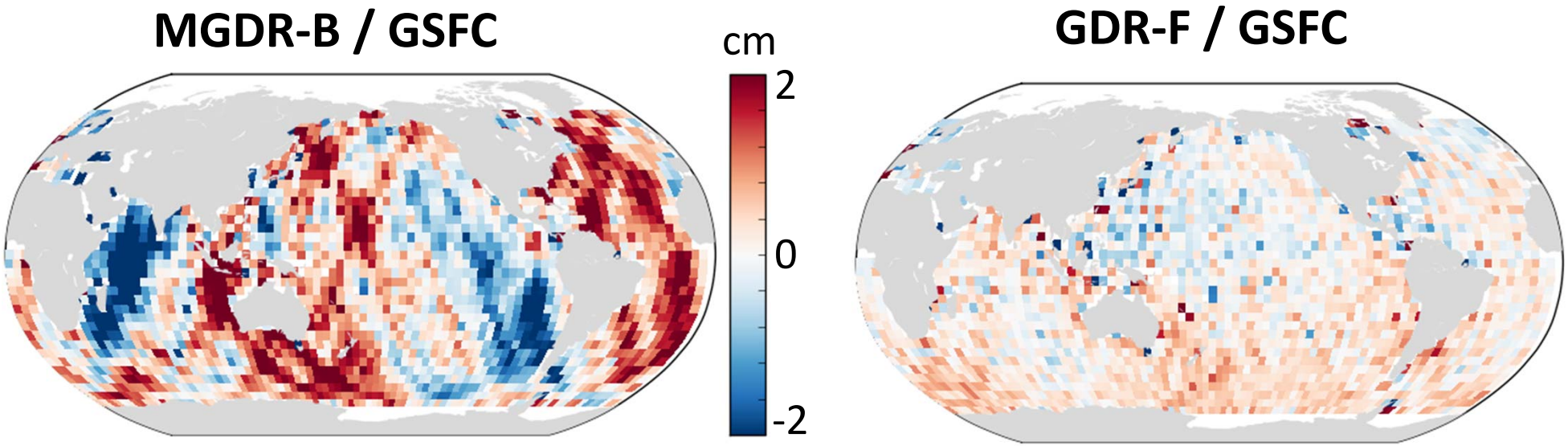

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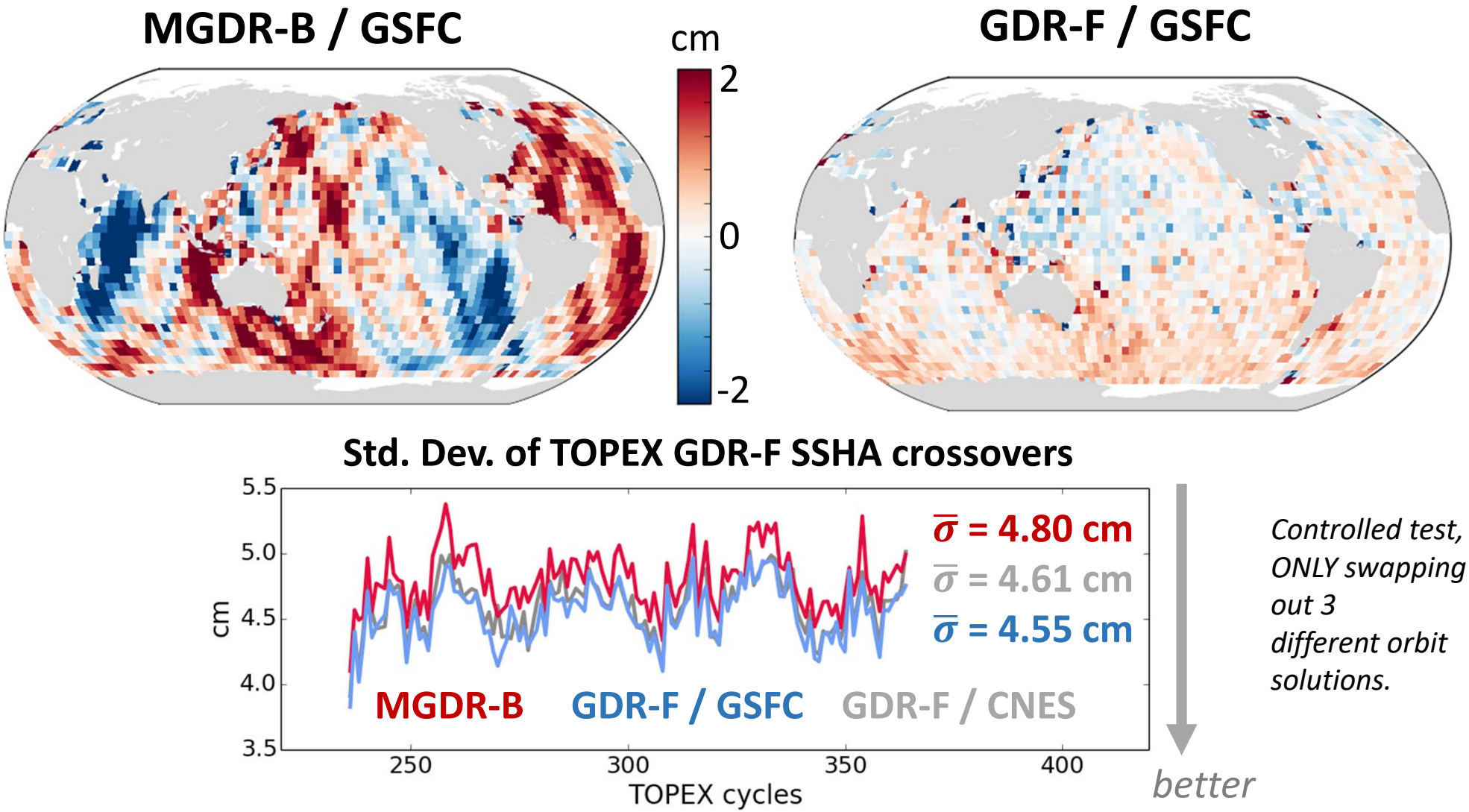
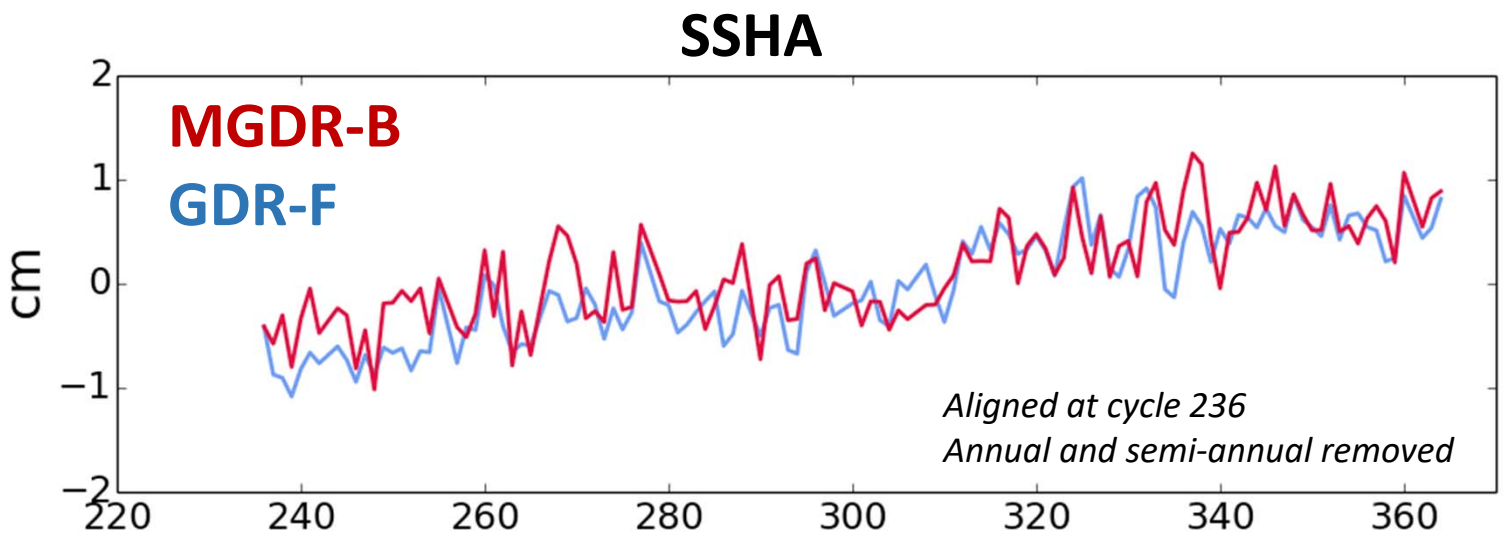


Controlled test, ONLY swapping out 3 different orbit solutions.

Changes in long-term evolution of SSHA are within 1 cm



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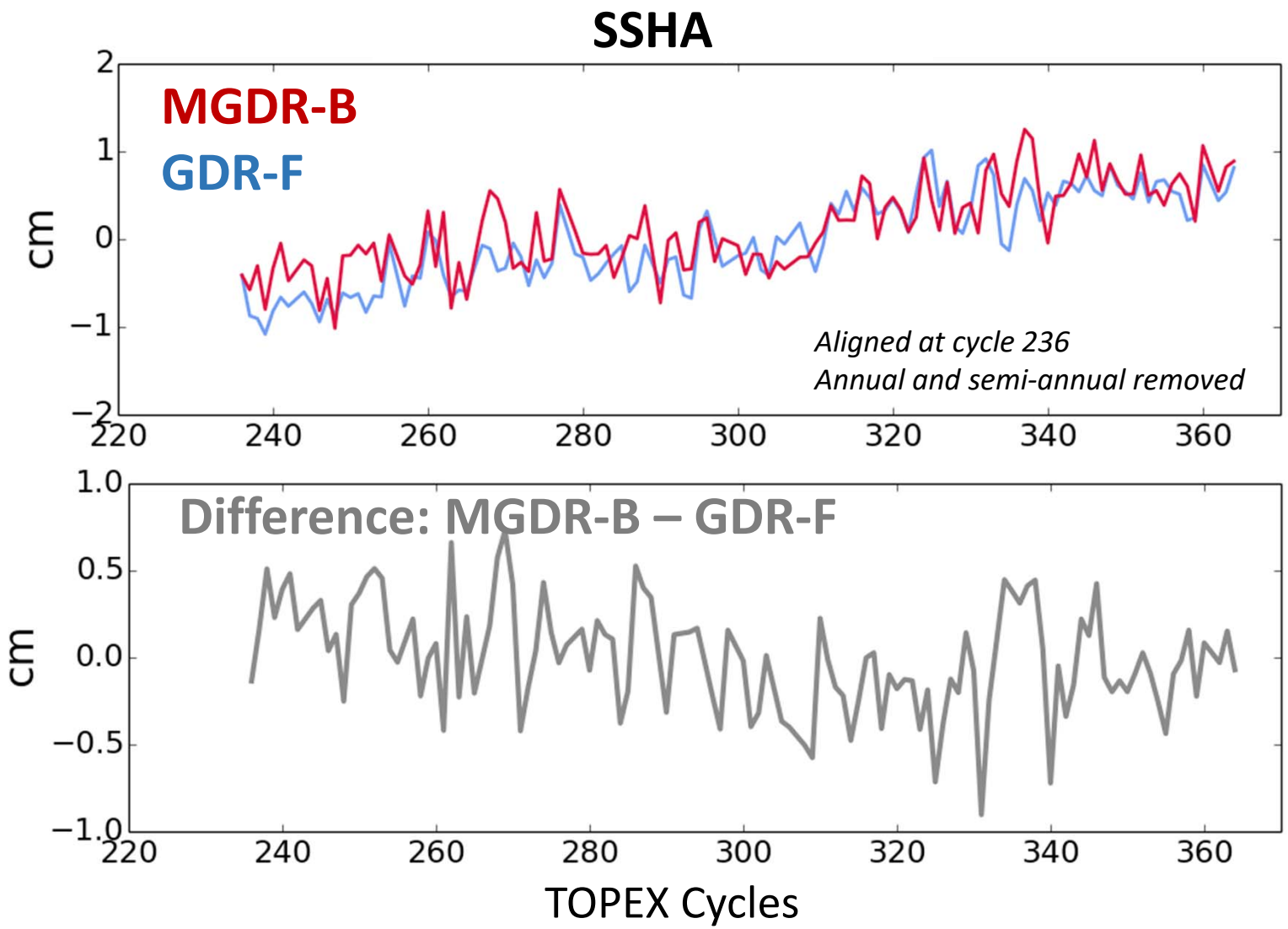

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  - **The performance of TOPEX GDR-F side-B meets Jason/S6 mission requirements.**
    - e.g., Standard deviation of SSH crossovers = 4.55 cm, implies RMS noise = 3.2 cm**.**
  - **MLE4 retracking mostly removes hemispherical biases in SSHA and SWH.**
  - GDR-F standards for geophysical models and ITRF14 orbit solutions facilitate consistency with the Jason time series.
    - Atmospheric path delays are more consistent with ERA interim.
    - New orbits improve SSHA crossovers variance and reduce geographically-correlated errors.
- Next steps:
  - Perform side-A calibration and validation.
  - Complete POSEIDON retracking and calibration/validation.
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- "**Assessment of the last TOPEX Side-B reprocessing**", Calval Session, Hélène Roinard et al., Thursday 24 October, poster CVL_010
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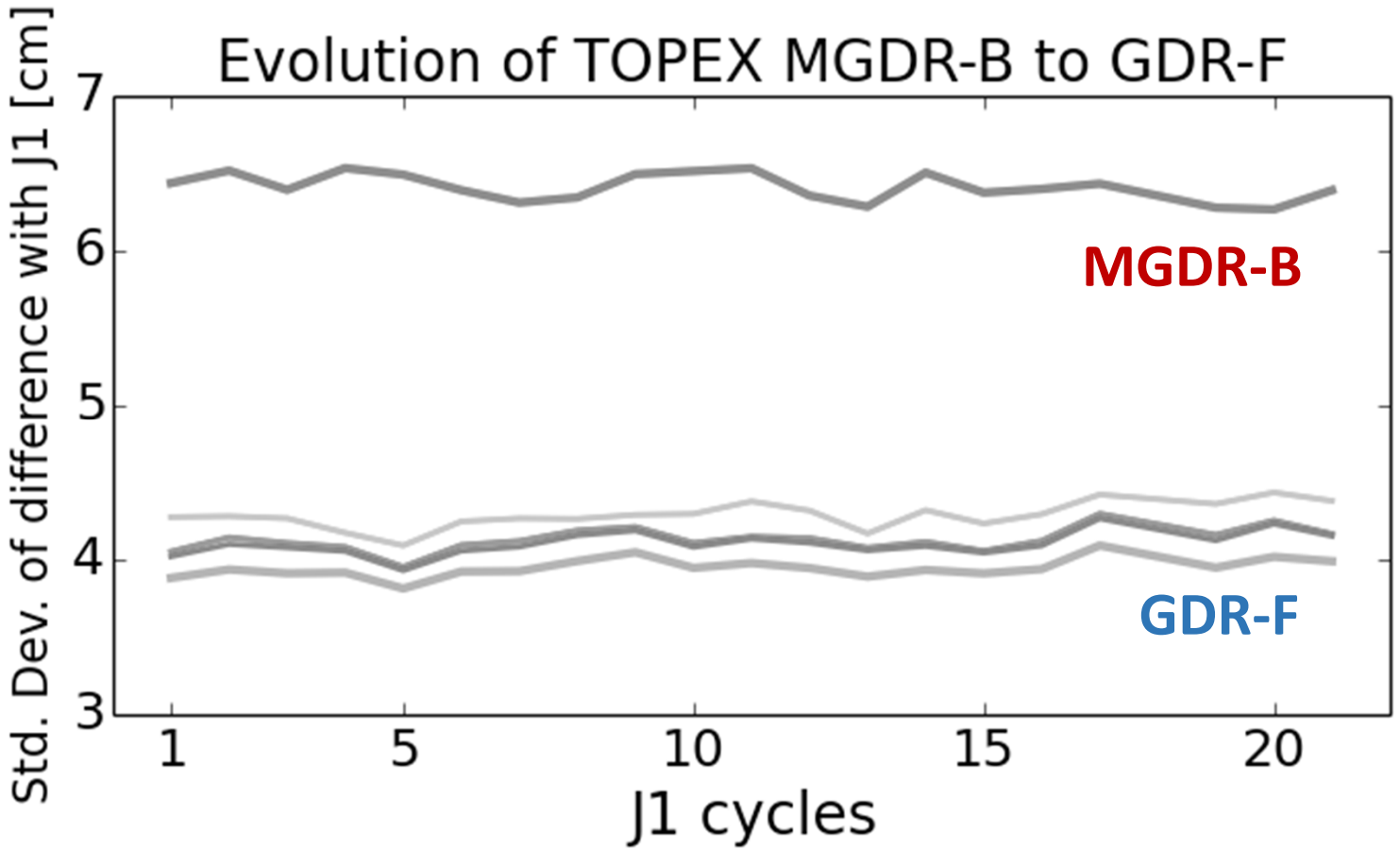
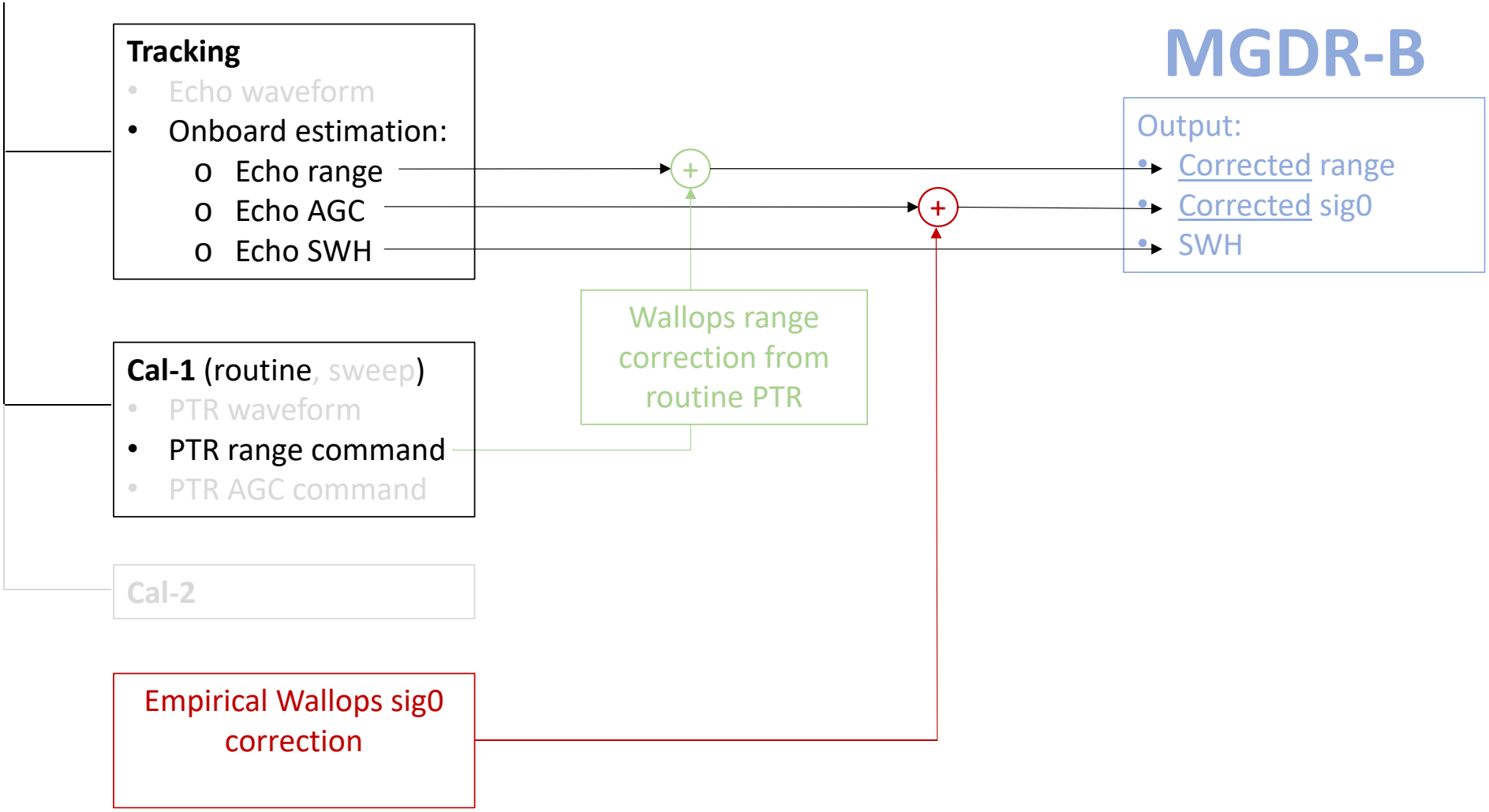
Questions?


Evolution of TOPEX MGDR-B to GDR-F
Std. Dev. of difference with J1 [cm]
7
6
5
4
3
1
5
10
15
20
J1 cycles
MGDR-B
GDR-F

Back-up

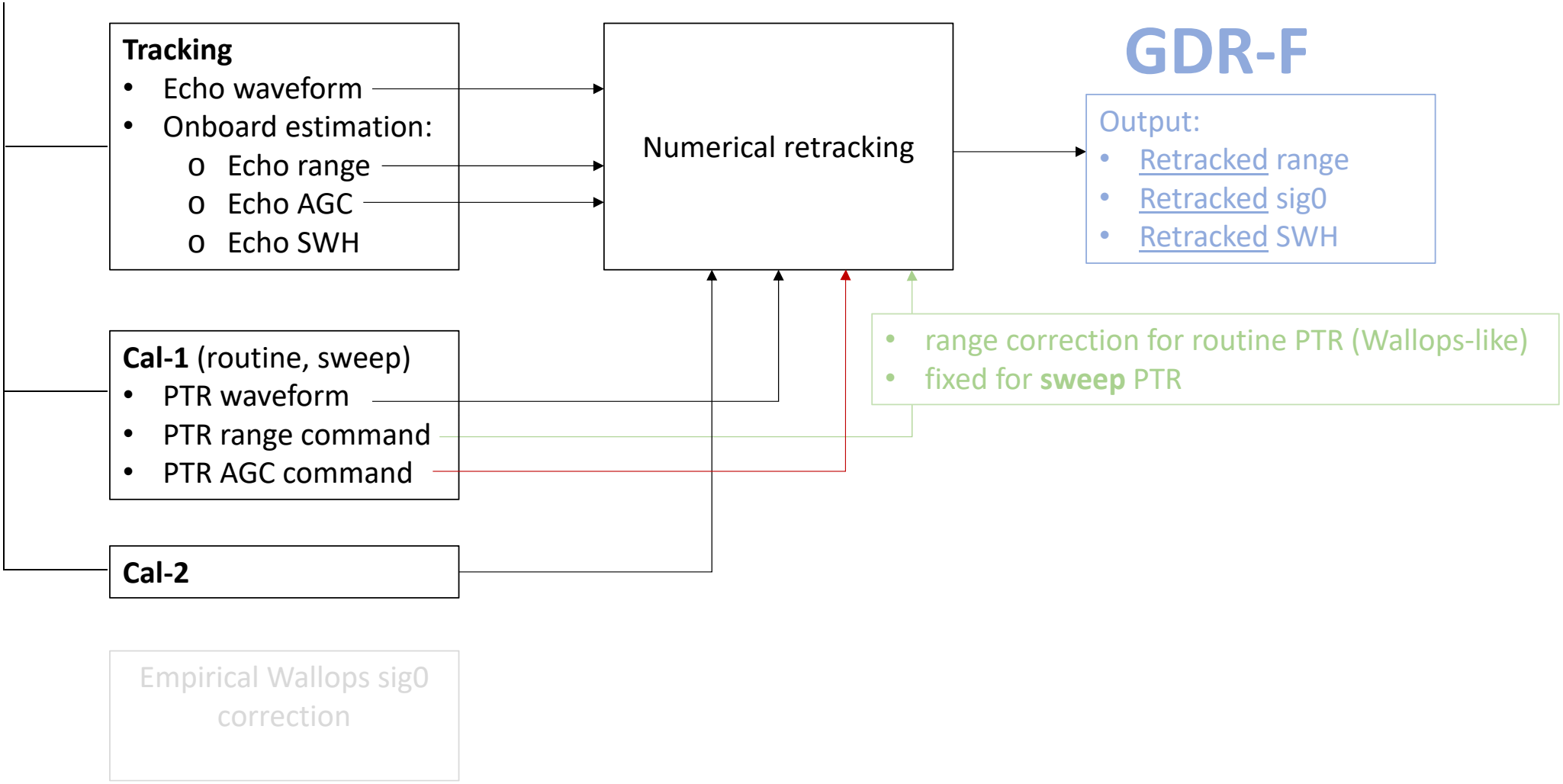
MGDR-B approach

Altimeter modes



GDR-F retracking approach

Altimeter modes

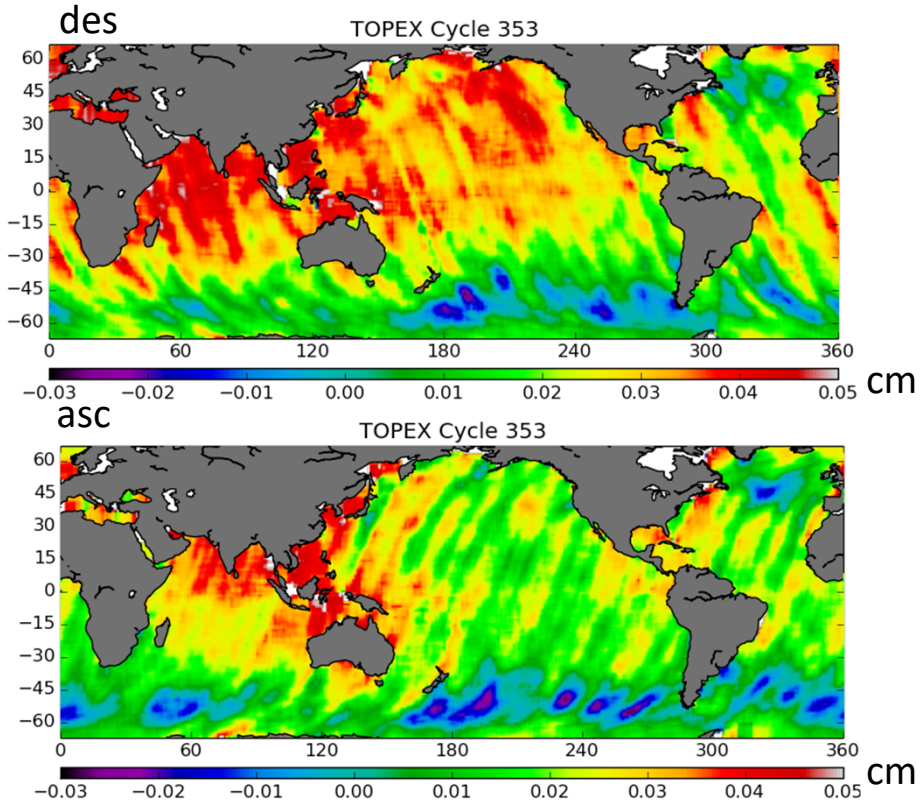


SSB from Vandemark compared to J1 SSB

Jason-1 minus TOPEX: Orbit – Range Ku – MSS – SSB, ascending and descending passes separated

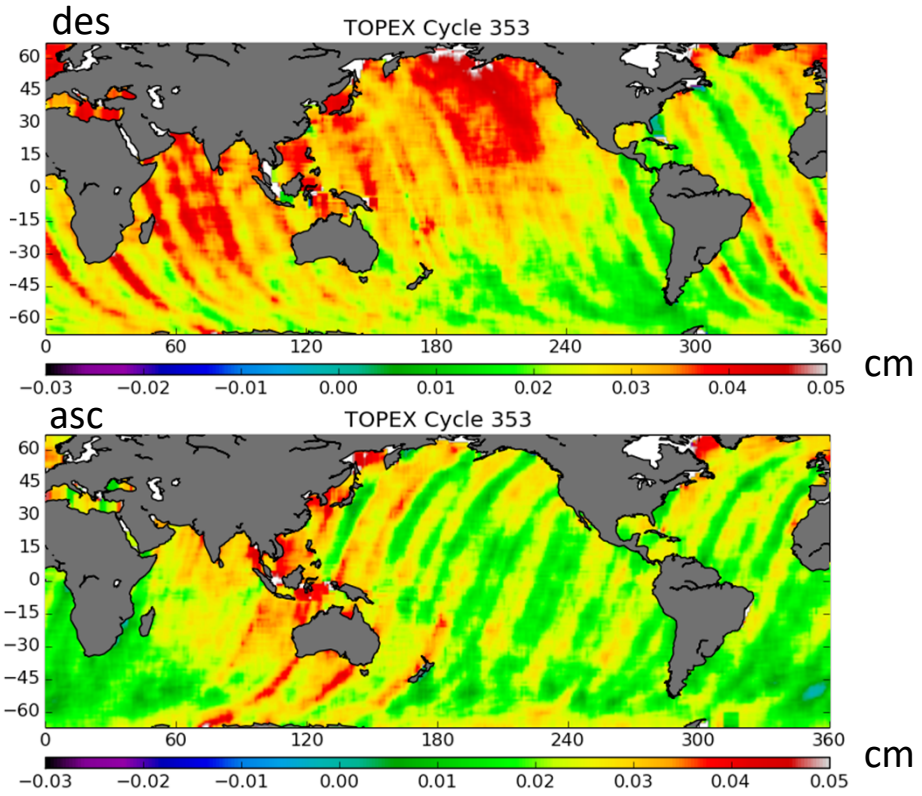
Before

	Orbit	Range	MSS	SSB
TOPEX	GSFC	MLE4	MSS 2015	J1 SSB
Jason-1	GDR-E	MLE4	MSS 2015	J1 SSB



After

	Orbit	Range	MSS	SSB
TOPEX	GSFC	MLE4	MSS 2015	UNH SSB
Jason-1	GDR-E	MLE4	MSS 2015	J1 SSB

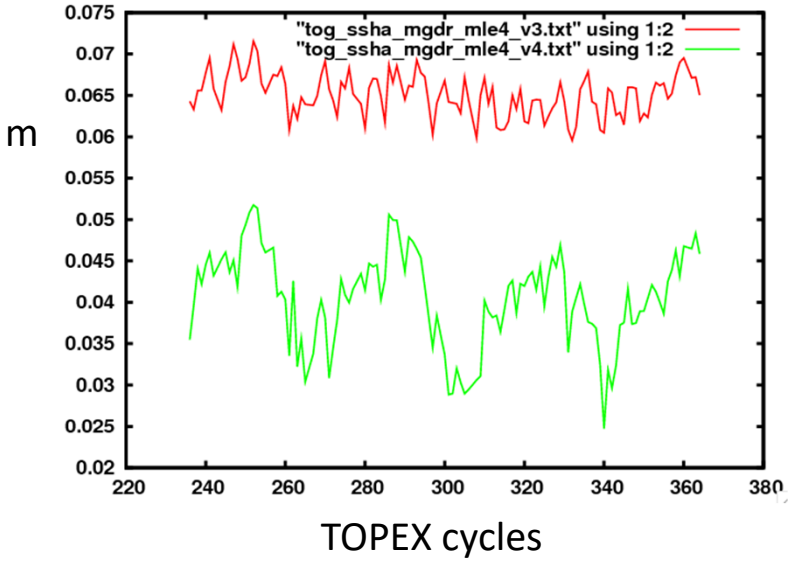


Inverse barometer correction is computed differently between GDR-F and MGDR-B standards

MGDR-B $H_{IB} = -9.948\ (P_{atm} - 1013.3)$

GDR-F $H_{IB} = -9.948\ (P_{atm} - \overline{P_{atm}})$

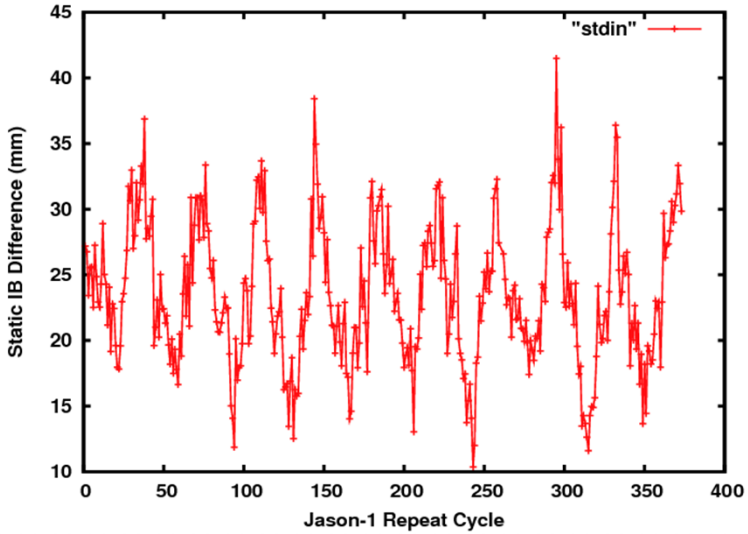
Mean of difference of SSHA wrt J1



Using ERA IB for MGDR-B

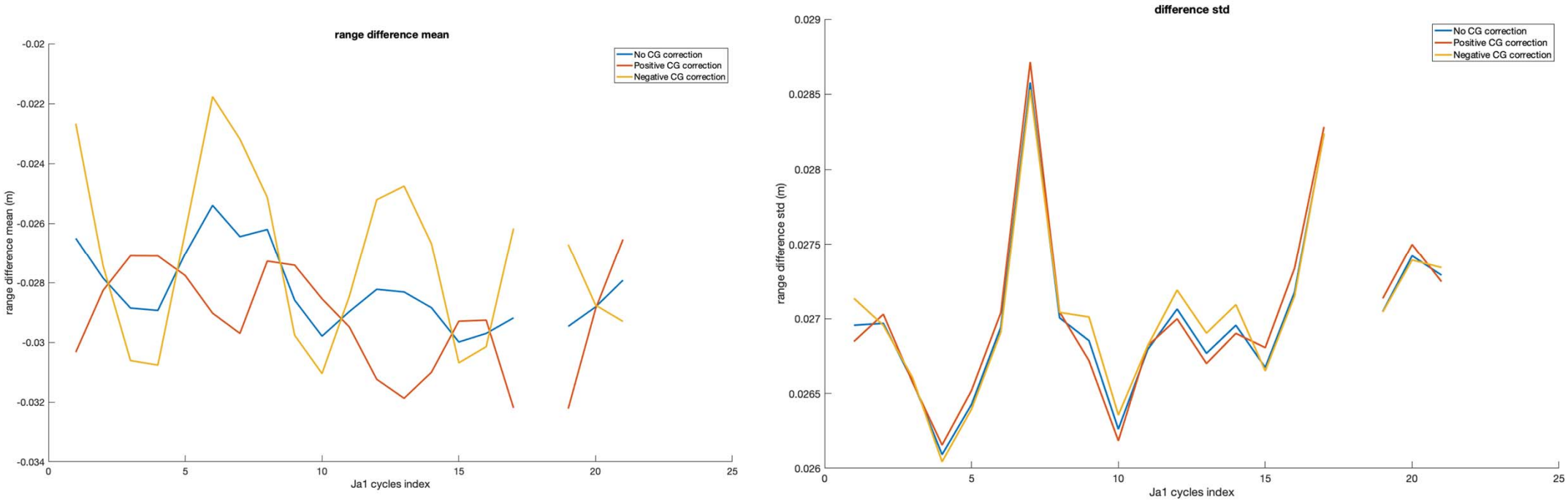
Using MGDR-B IB for MGDR-B

Difference between IB from J1 and MGDR-B-like IB for J1



Using prior IB computations leads to cm-level bias and seasonal signal.

Addition of CG correction to SSHA



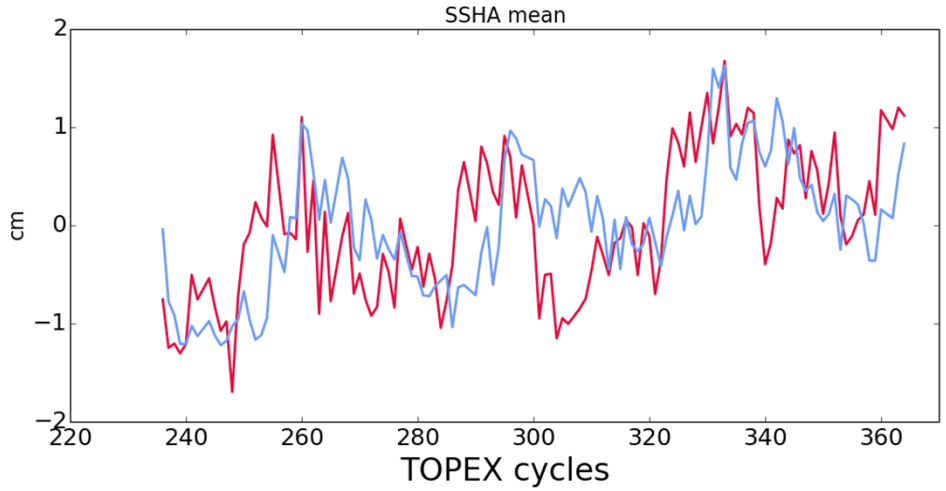
Credit: J-D Desjonquères

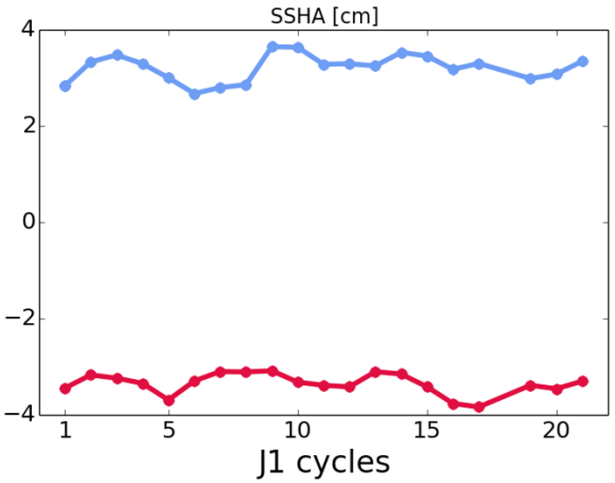
- Correction to SSHA from solar panel influence on satellite CG
- **Adding CG correction** (orange line) as opposed to subtracting (yellow) to SSHA (blue) reduces 60-day signal in SSHA difference to J1 SSHA

SSHA

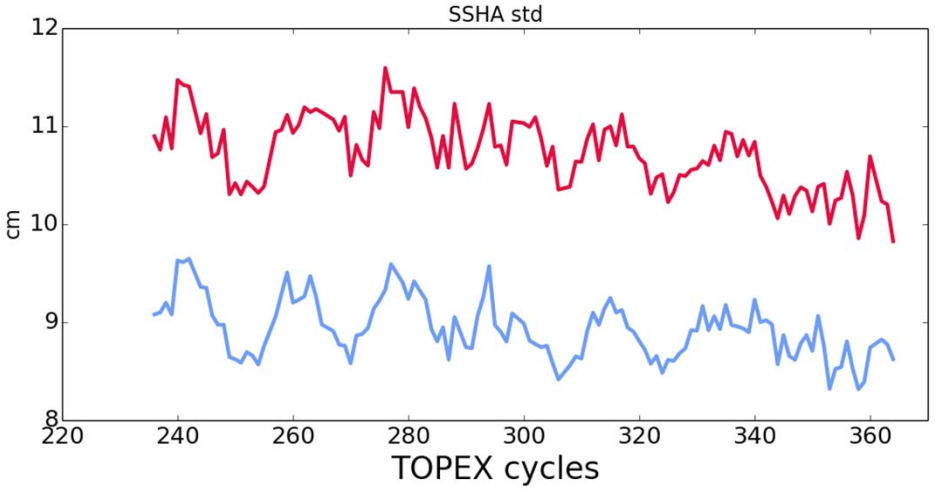
Differences with J1

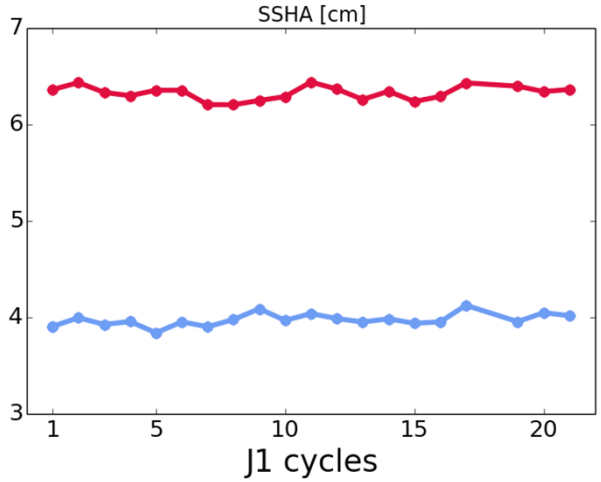
Mean



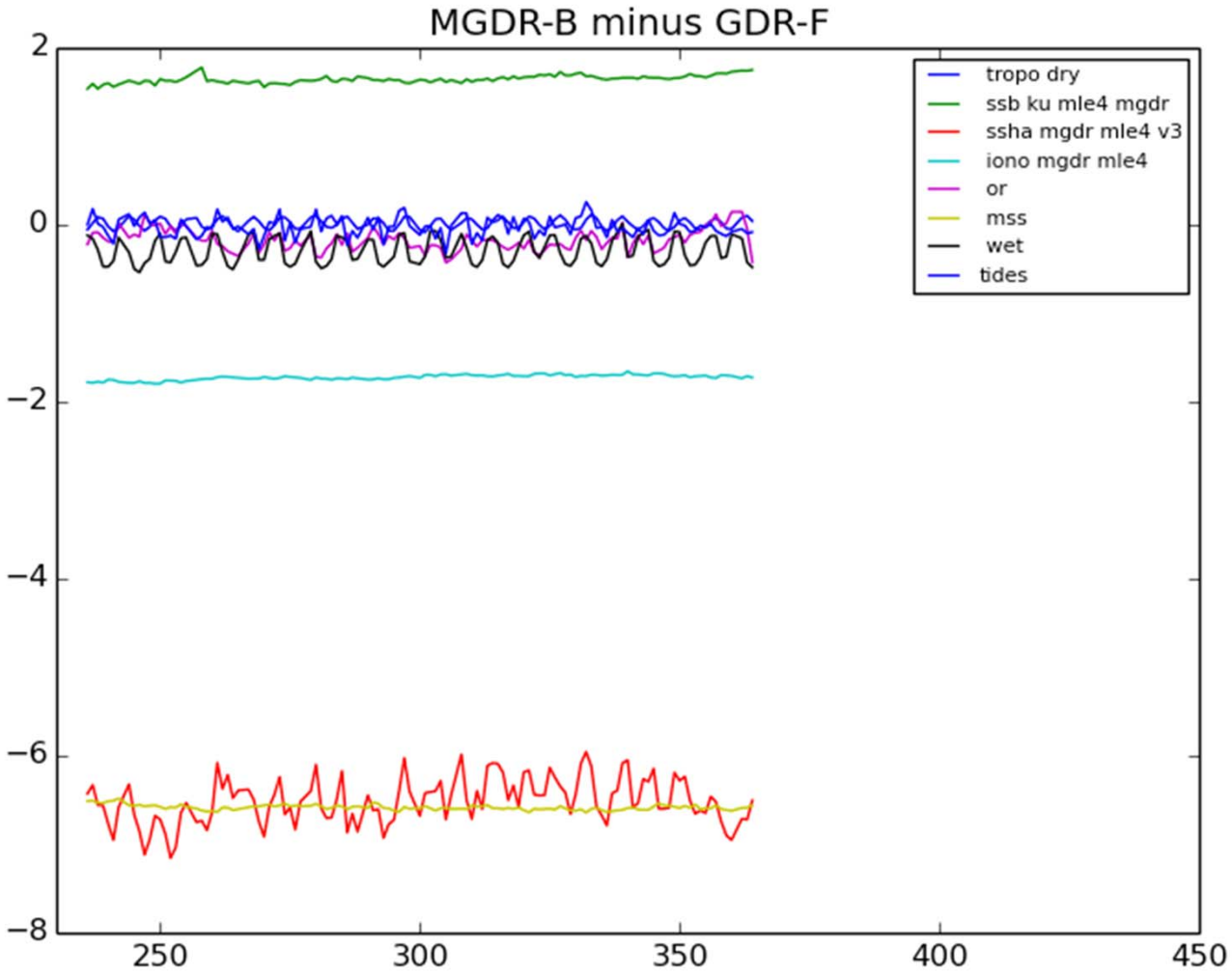


Std Dev





SSHA components of MGDR-B and GDR-F



Geophysical Models

	MGDR-B	GDR-F
MSS	OSUMSS95	MSS2015
IB	Op. ECMWF	ERA Interim
HF Fluctuations	NA	ERA Interim
Ocean tide	CSR 3.0.1, FES95.2.1	GOT4.10c, FES2014b
Internal tide	NA	Ray and Zaron (2015)
Solid earth tide	Cartwright and Edden (1973)	Cartright and Edden (1973)
Pole tide	Wahr (1985)	Desai et al. (2015)