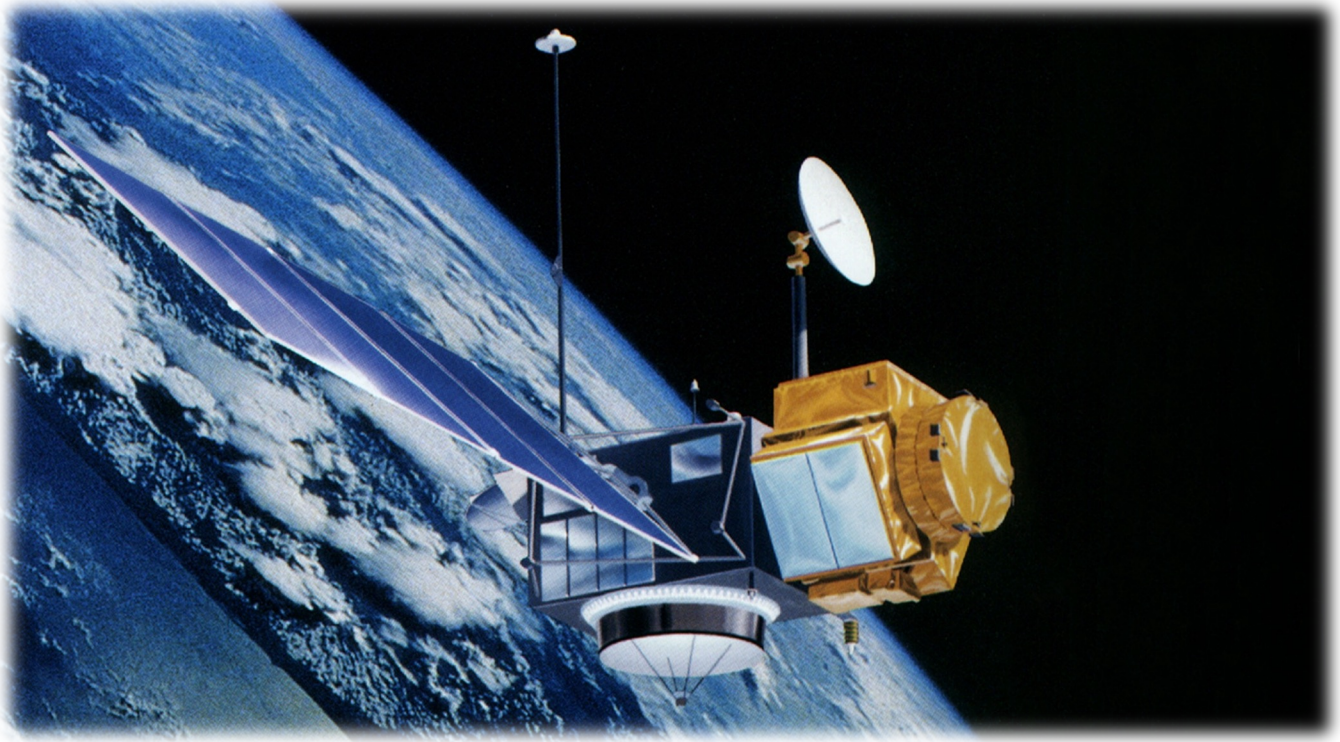
# TOPEX Altimeter Data Reprocessing



Jean-Damien Desjonquères[1], Francois Bignalet-Cazalet[2], Philip Callahan[1], Shailen Desai[1], Linda Forster[1], Adrien Guerou[3], Bruce Haines[1], Nicolas Picot[2], Helene Roinard[3], Matthieu Talpe[1,4], Josh Willis[1]

(1) Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA / (2) Centre National d'Etudes Spatiales, Toulouse, France

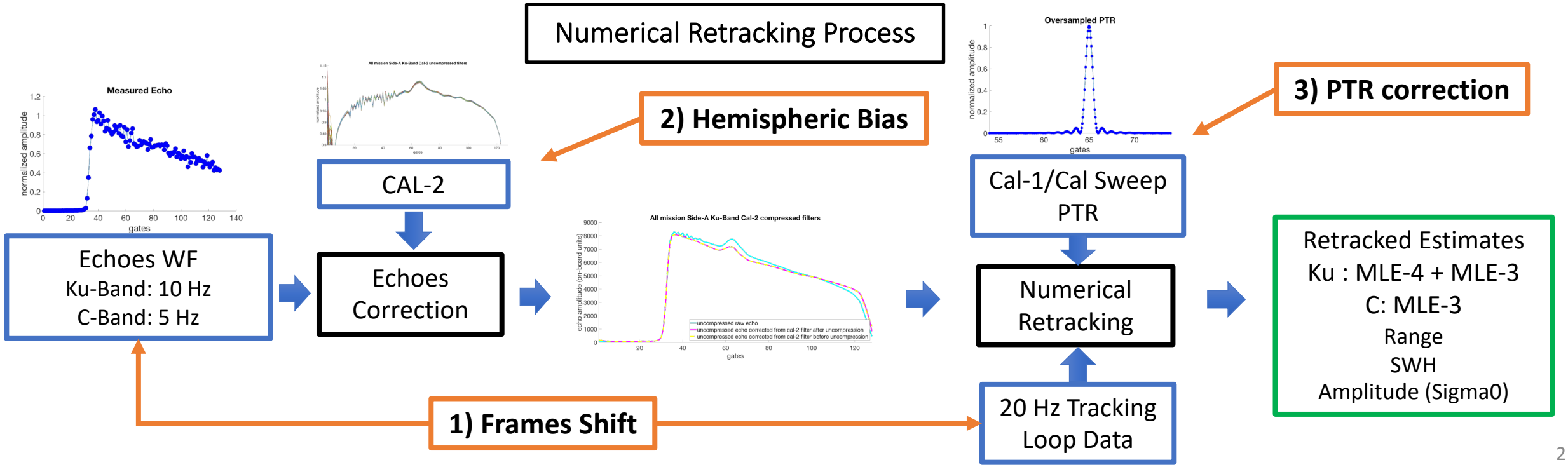
(3) Collecte Localisation Satellites, Toulouse, France / (4) Now at Spire, Luxembourg.



OSTST Venice, 2022

# Main Results … from 2019

1. **Frames shift: improve performance** (See back-up and OSTST 2018 CalVal poster)
2. **Hemispheric Bias:** new Cal-2 filter correction of echoes (based on altitude rate) resulting in a strong reduction of the ascending vs descending hemispheric differences
3. **PTR corrections:** How Cal-1 PTR are impacting the altimeter estimations
   a) Explains Wallops Range Correction… and more
   b) Reduces side-A SWH evolution
   c) Provides direct correction for Sigma0

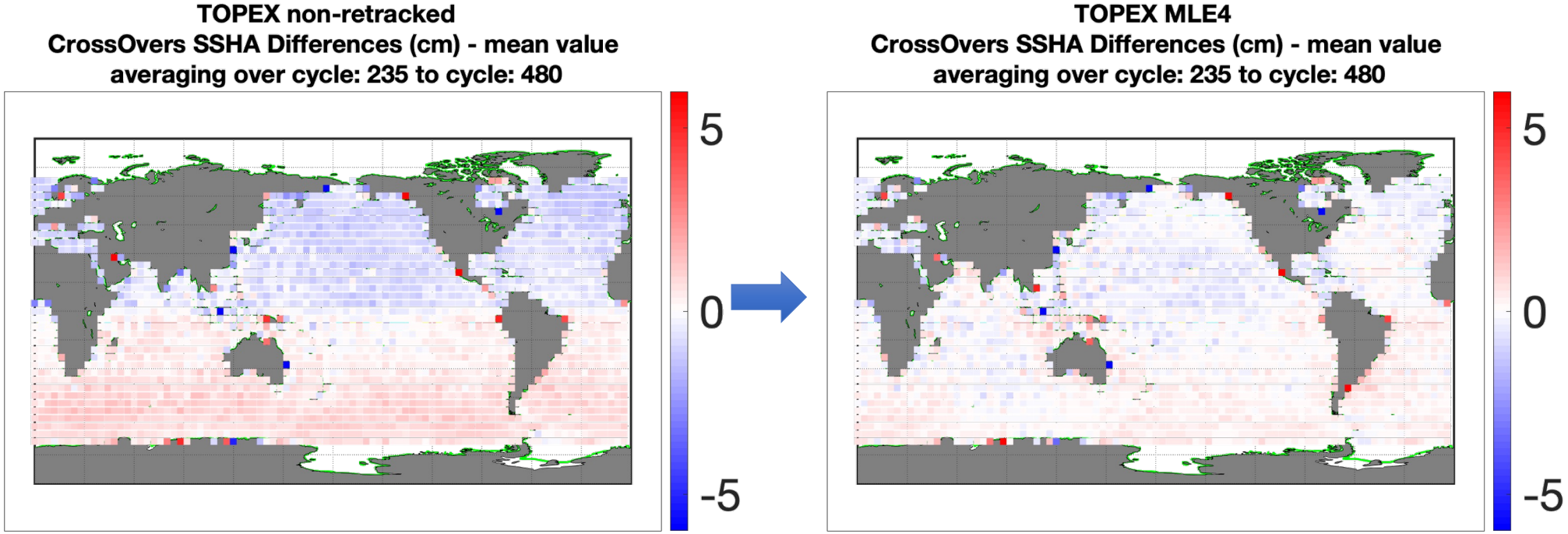


# 2. Hemispheric Bias (from Cal2 filter)

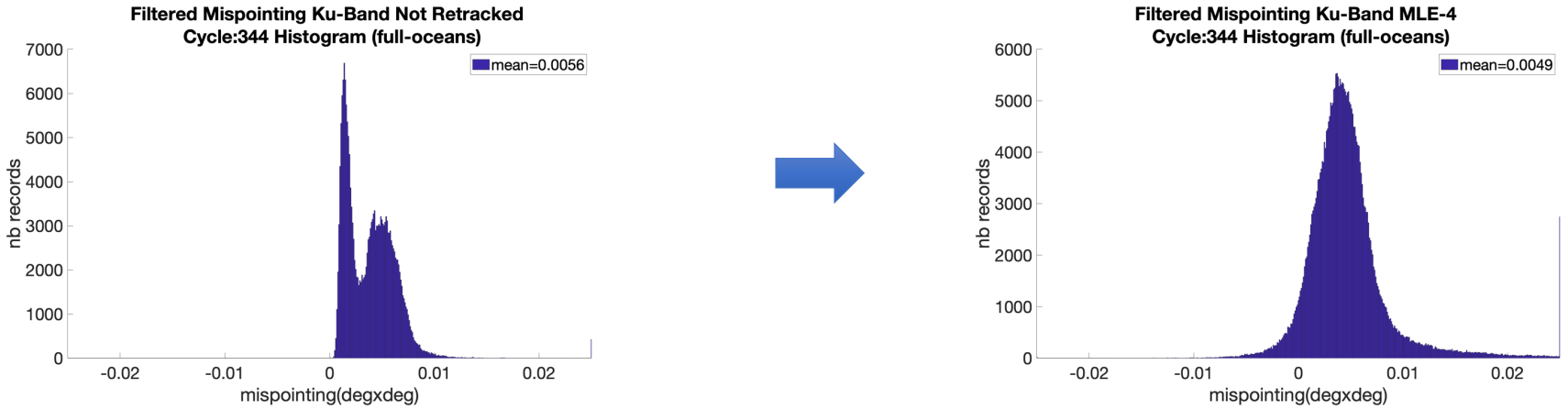
Hemispheric signal observed in TOPEX M/GDR Data

MLE4 Retracking Results

SSH Crossovers North/South signal

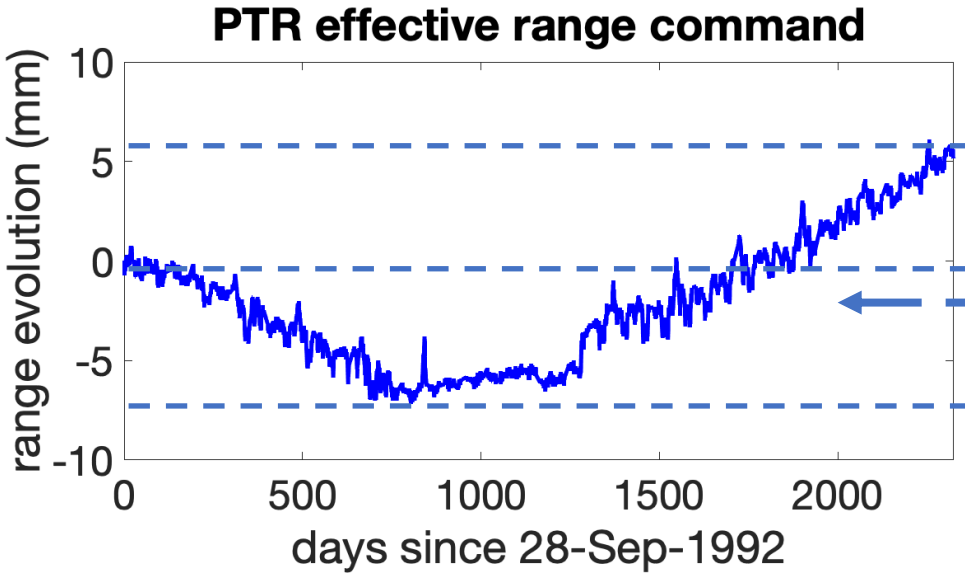



Non-homogeneity in Mispointing estimates

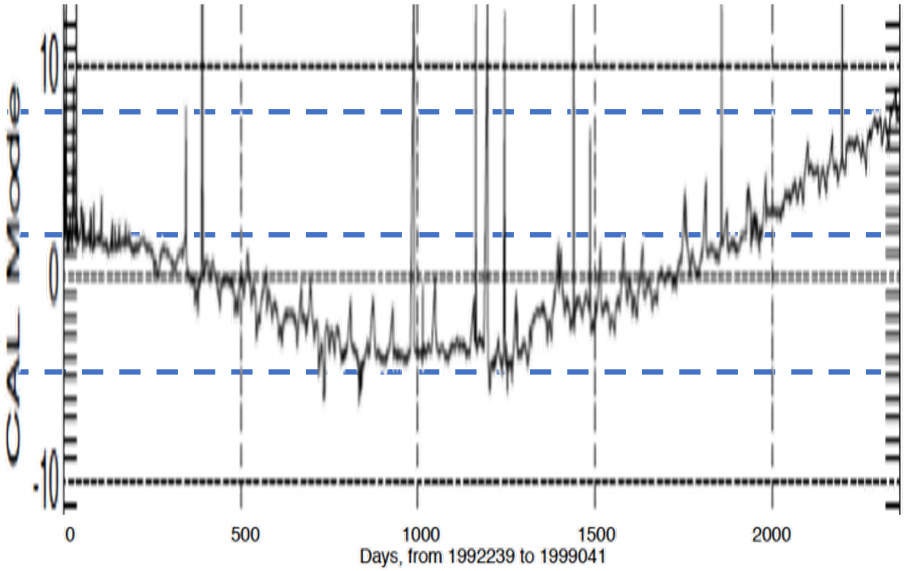


# 3. Wallops Range Correction is explained

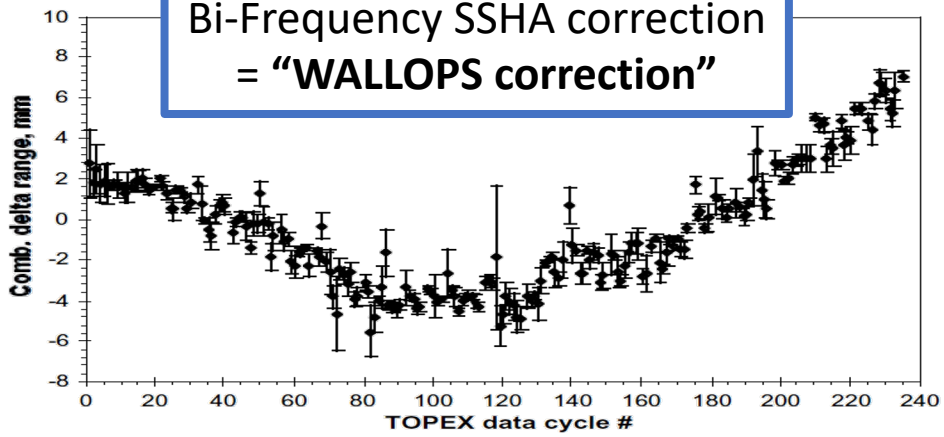
Processed Ku PTR range command (for Att=5)
**from new algorithm to process Cal1**




Reported Ku PTR range command (for Att=5)
**from TOPEX Radar Altimeter Engineering Assessment Report**




Bi-Frequency SSHA correction
= **"WALLOPS correction"**




1. New algorithm is able to reproduce the range command as reported in the TOPEX Radar Altimeter Engineering Assessment Report (February 10, 1999)

2. The derived bi-frequency range correction is the so-called "Wallops Range Correction"

# New for 2022 version

Changes on Side-A processing only

1) Use of +1 point on each side of the main lobe of PTR waveforms from Cal-1 to reconstruct oversampled PTR waveforms time-series

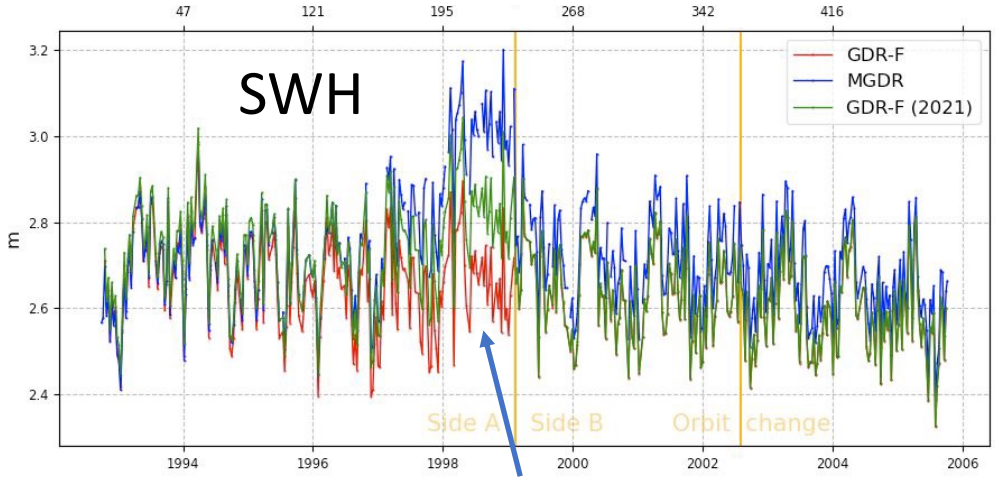
- Improve stability of SWH and Sigma0
- Signal detected in SSB-3D corrections (highlighted by UNH, very sensitive to SWH evolution)

2) Remove contribution of Cal-1 Range correction from retracking estimates

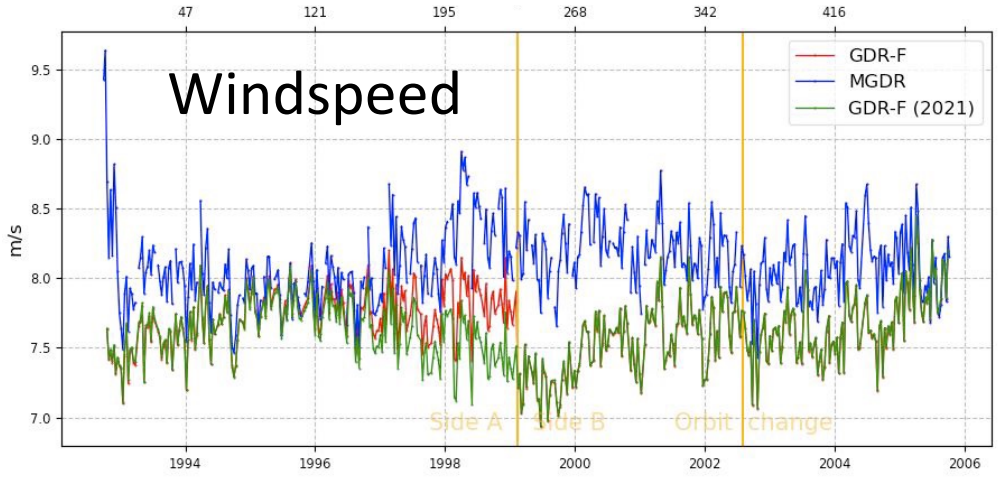
- First step: Retracking estimates first computed using Cal-1 waveforms and tracker.
- **New Second Step: Remove contribution of Cal-1 range correction from estimates.**
- Anomaly detected with Cal-2
- External validation suggests range correction from cal-1 actually degrades measurements

3) Recommendation:  Side-A timeseries split into Side-A1 / Side-A2.

# 1) Adding 1 point from left and right lobes Cal-1 PTR in oversampled PTR reconstruction -> improves SWH and Sigma0 (Windspeed) stability



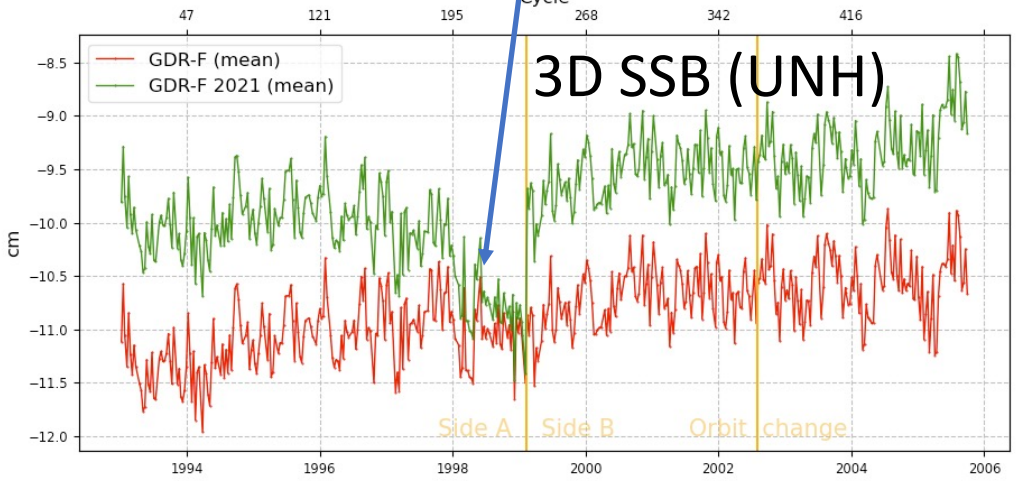

Previous version was slightly under correcting SWH evolution at the end of side-A time series vs New version




Windspeed time series is more stable with New version vs Previous version (sig0 stability has improved)

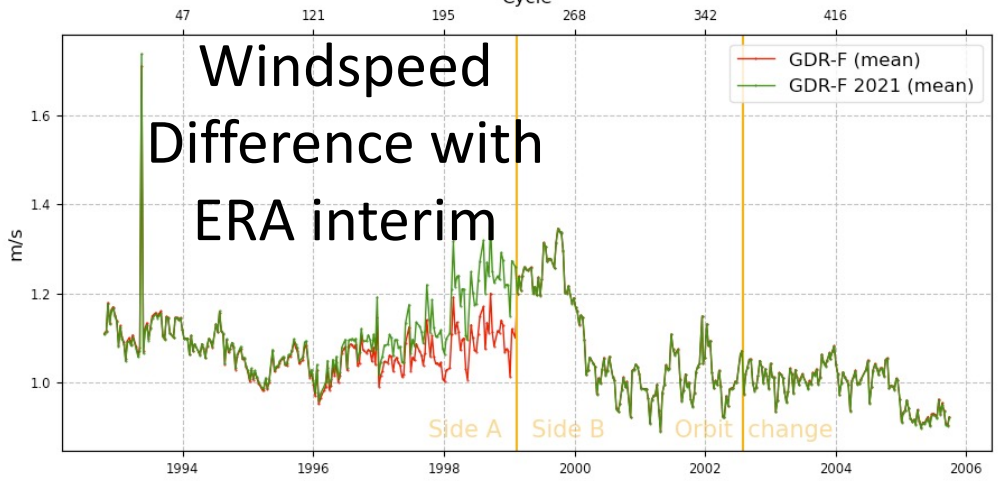
**Along-track SSB 3D (with selection by threshold)**
**Mean**

| | nbr | min | mean | med | max | std |
|---|---|---|---|---|---|---|
| GDR-F (mean) | 436 | -11.96 | -10.85 | -10.85 | -9.871 | 0.3828 |
| GDR-F 2021 (mean) | 436 | -11.48 | -9.755 | -9.726 | -8.419 | 0.5046 |

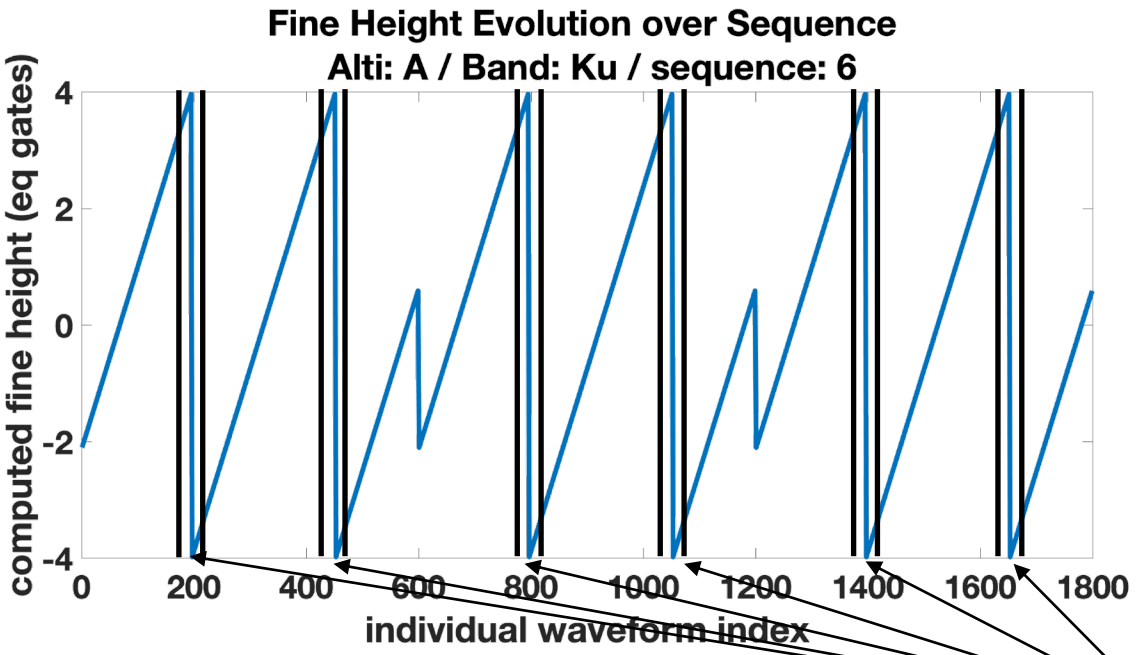


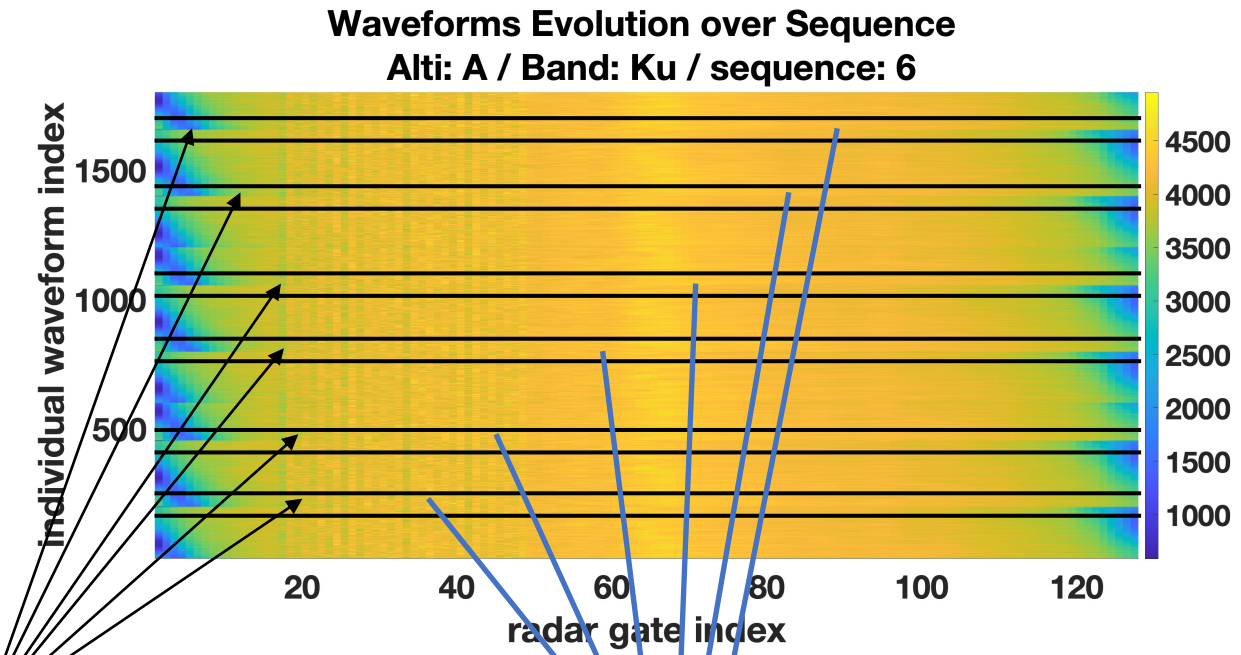

**Along-track d_wind**
**Mean**

| | nbr | min | mean | med | max | std |
|---|---|---|---|---|---|---|
| GDR-F (mean) | 444 | 0.891 | 1.054 | 1.042 | 1.71 | 0.08665 |
| GDR-F 2021 (mean) | 444 | 0.8889 | 1.068 | 1.052 | 1.738 | 0.099 |

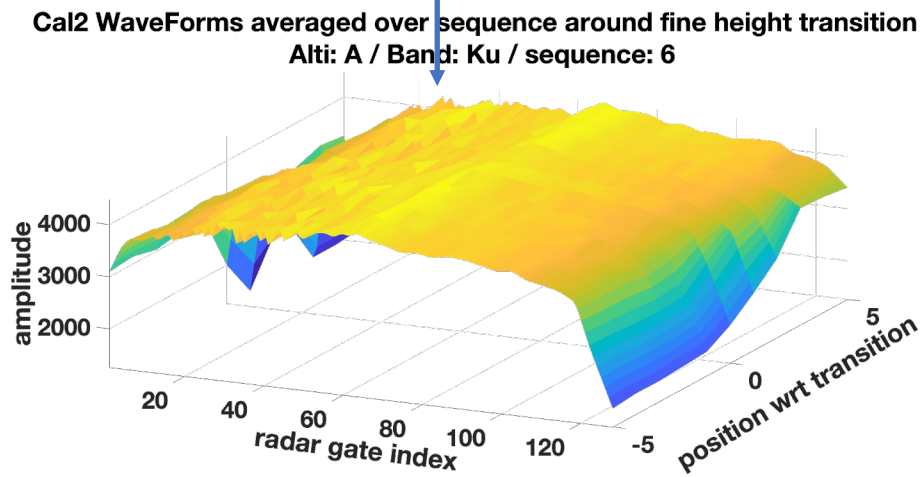


# 2) Un-correcting the corrected range….



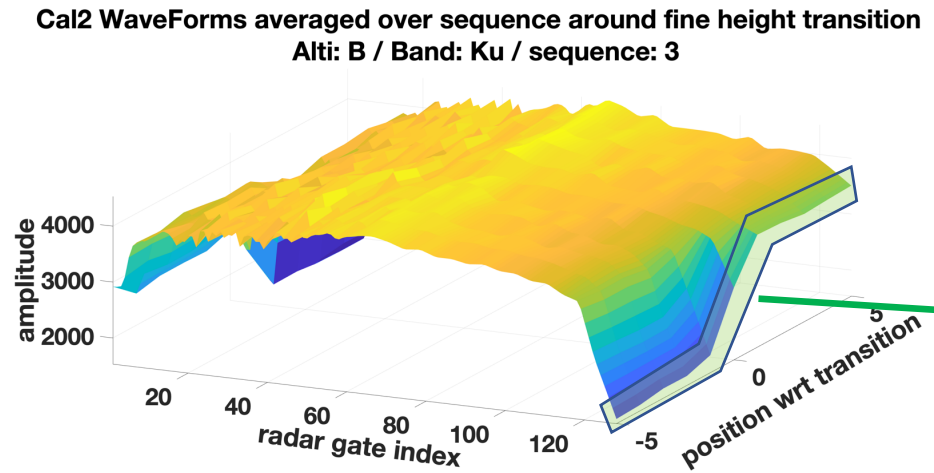




Fine Height transitions (max to min)

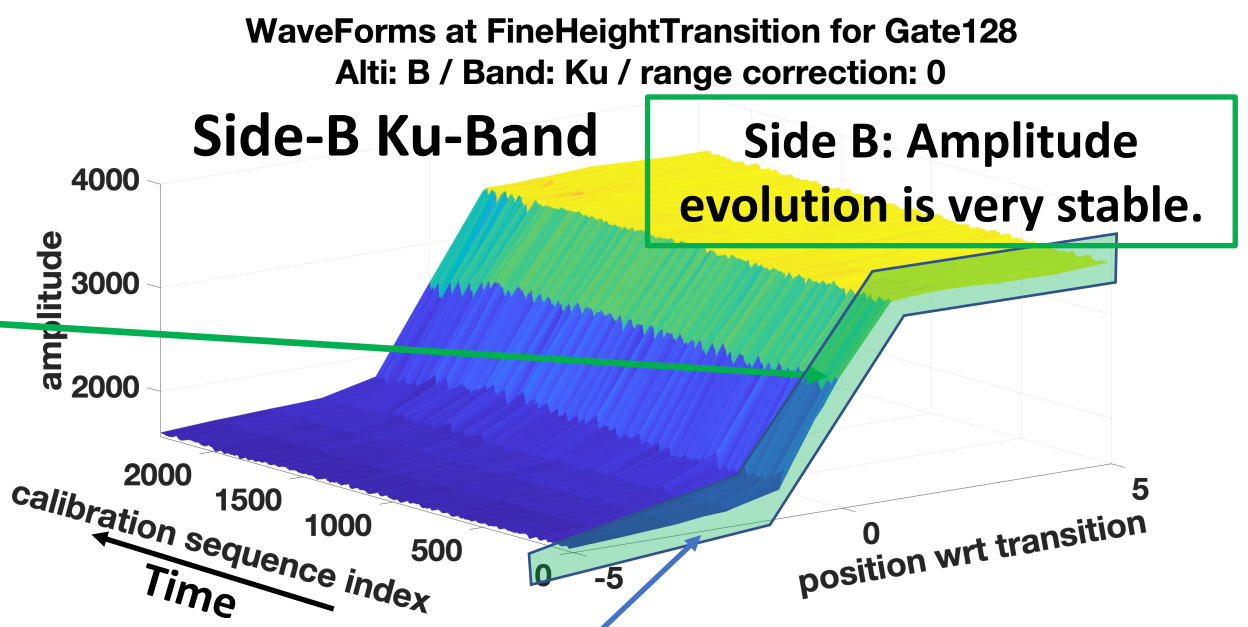



Investigations from Cal-2 sequences

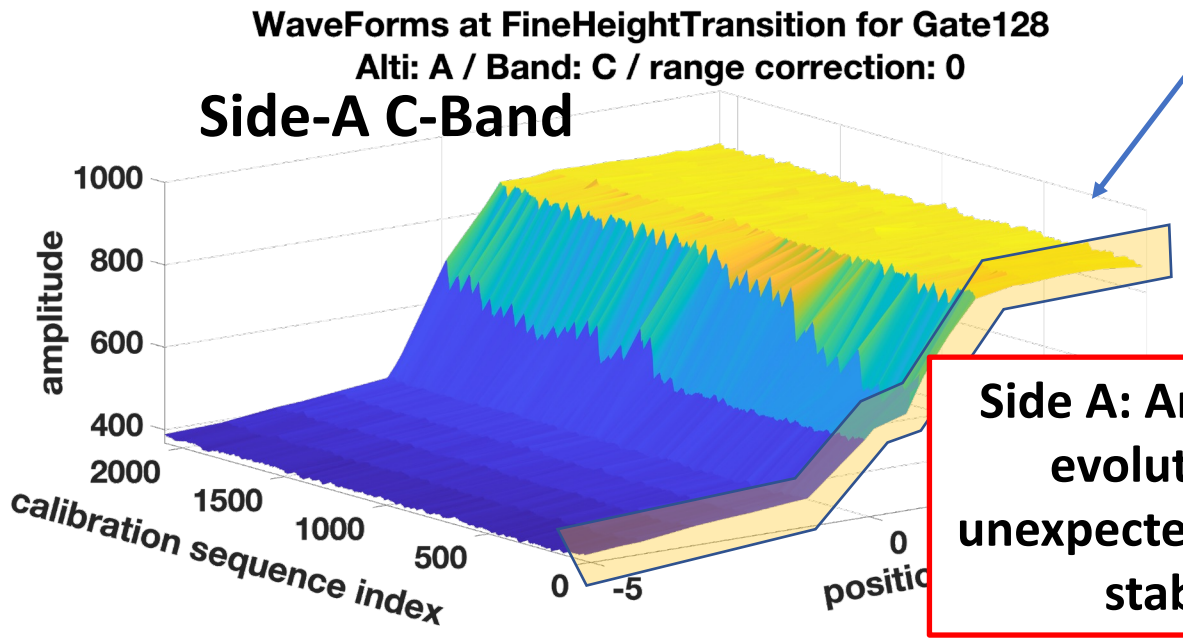
Waveforms averaged over all transitions for the current sequence



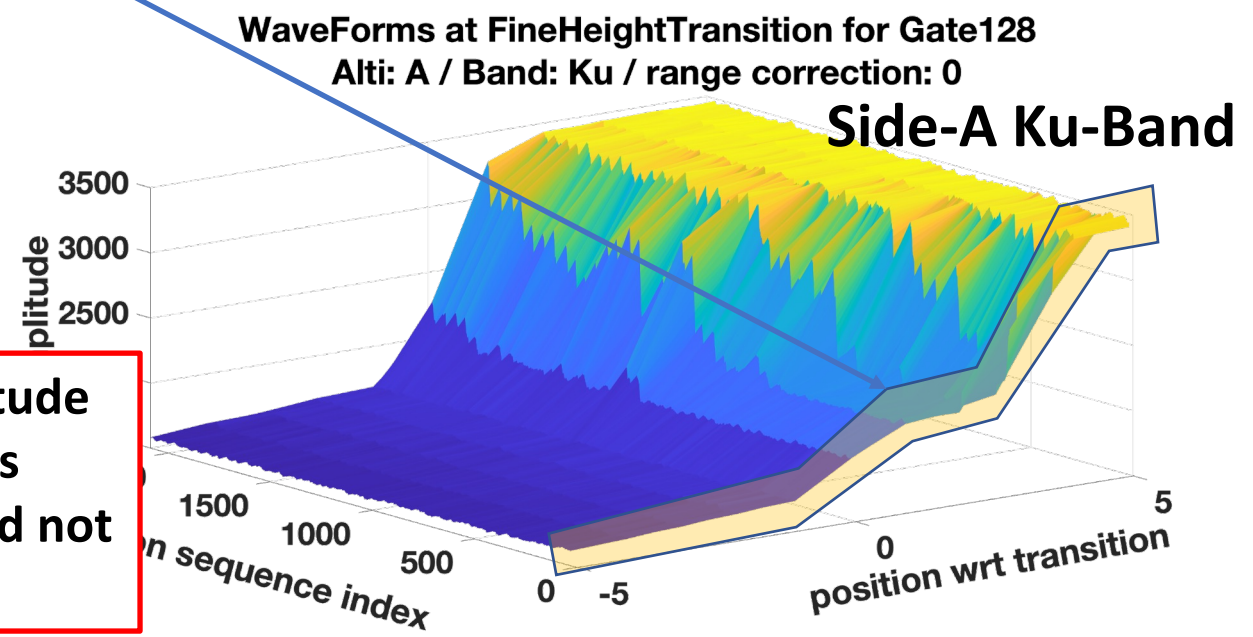

Waveforms at transition for one cal-2 sequence




Timeseries of amplitude of gate 128

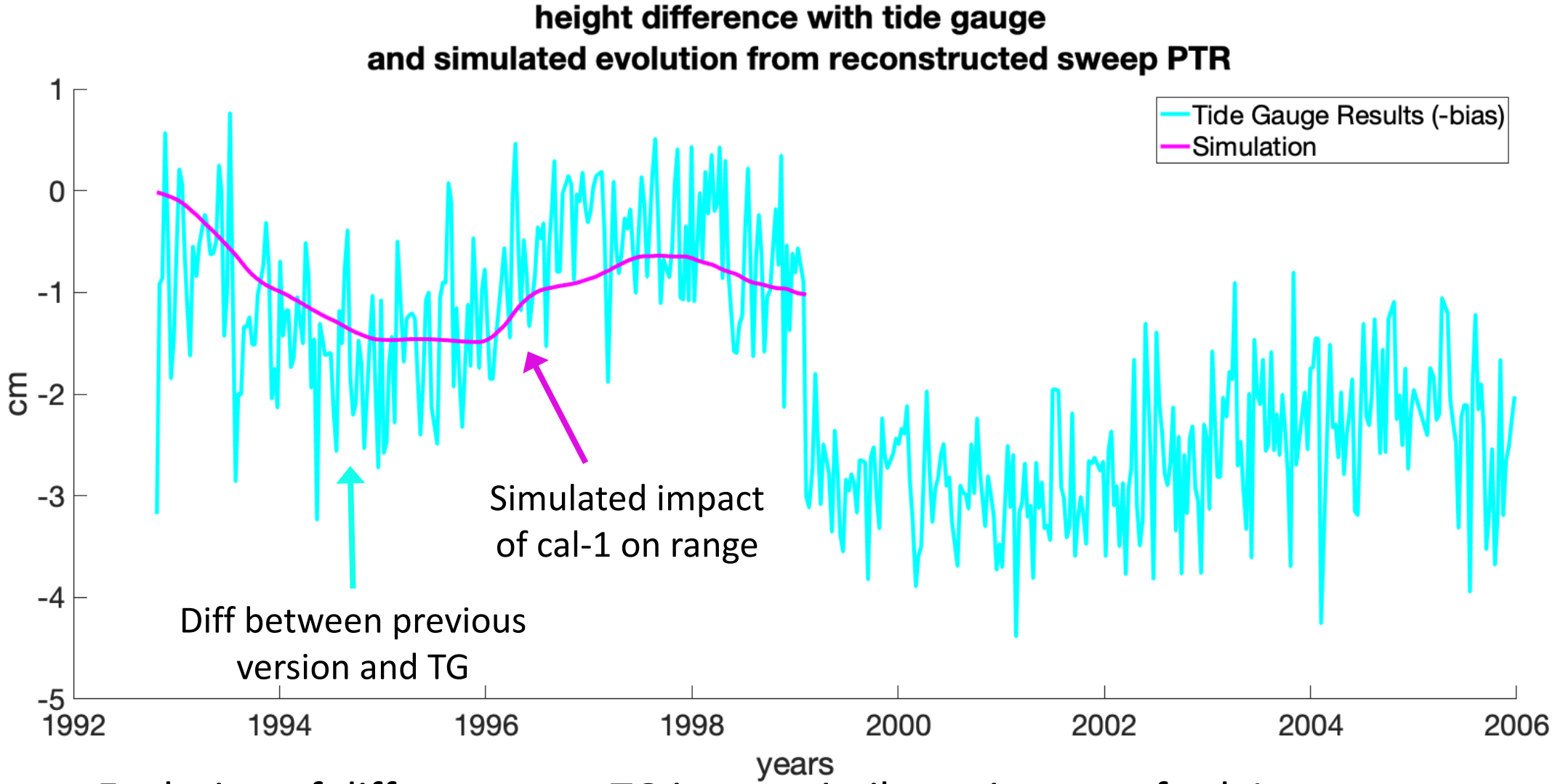



Side A: Amplitude evolution is unexpected and not stable.



# Validation using Tide Gauges data

(Tide Gauge data courtesy of Brian Beckley and Gary Mitchum)



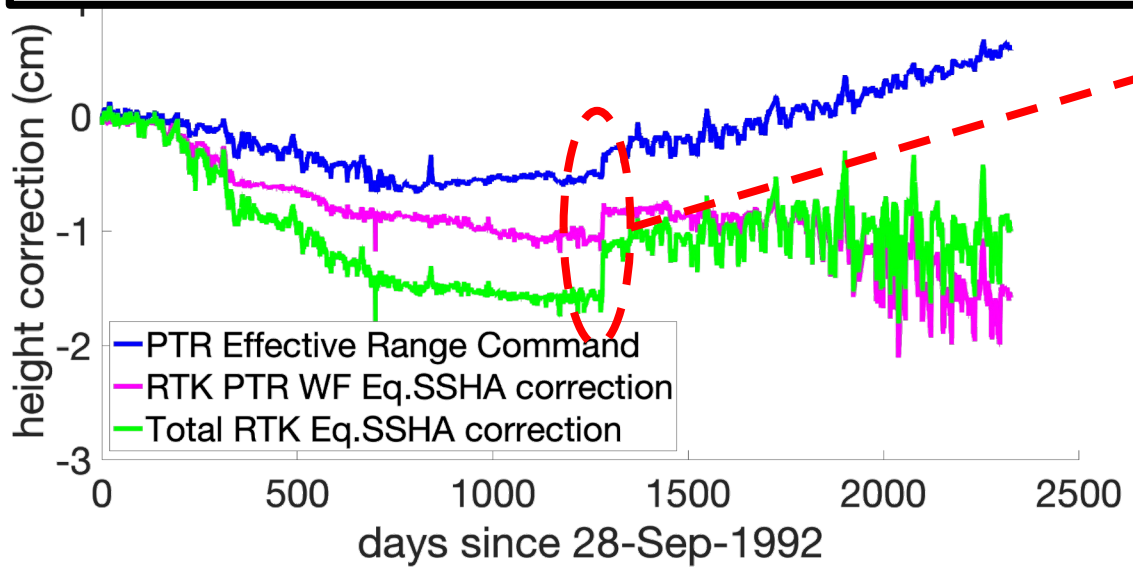

Evolution of difference wrt TG is very similar to impact of cal-1 on range

-> confirms cal-1 generates discrepancy on range

**Decision to remove contribution of Cal-1 range correction from retracking estimates**

# Need for separating Side-A1 and Side-A2

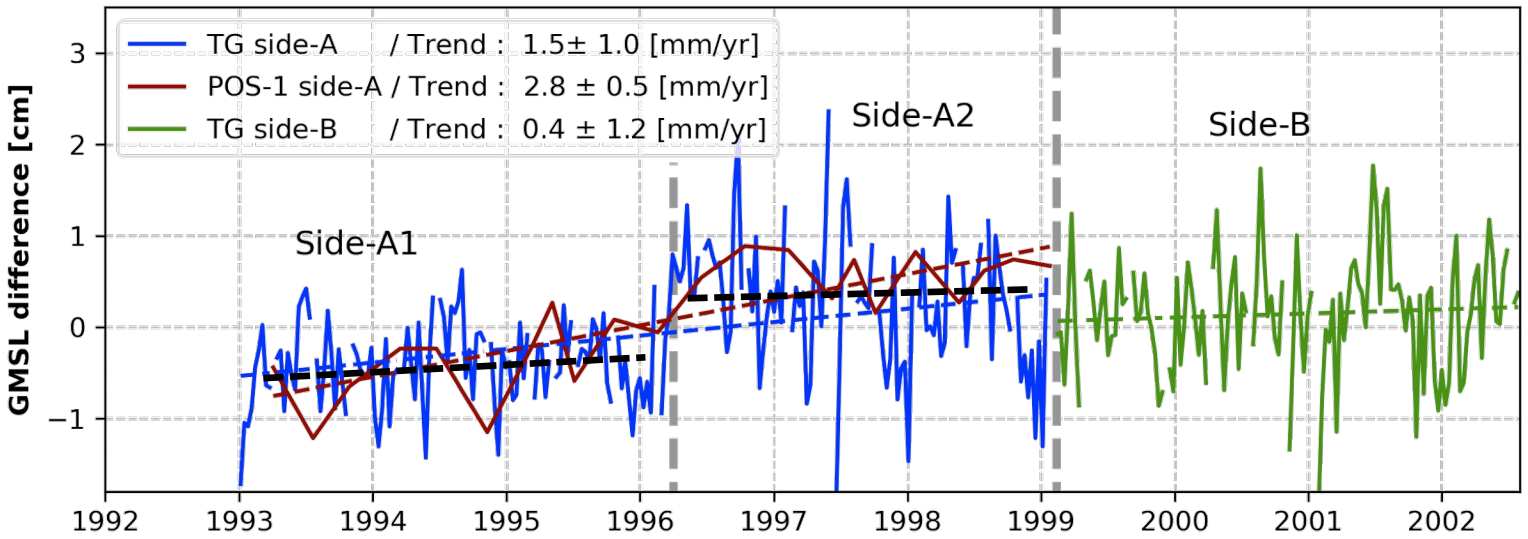
## Simulated Cal-1 impact on SSH




PTR jump occurred during cycle 130

Cal-1 data -> a jump in the time series (Apr 1st, 1996) reflecting a change in the behavior of the altimeter.

**-> Recommendation to separate Side-A1 (up to cycle 130 pass 185) and Side-A2 (after cycle 130 pass 186) time series.**




Comparisons to tide gauge and Poseidon:
-> suggest a jump in side-A around cycle 130
(See Adrien Guerou's poster "Cal/Val stability assessment of TopexGDR-F reprocessing")

Courtesy Adrien Guerou (CLS)

# Conclusion

- From Side-A Cal-2 analysis, unexpected behavior and not stable over time
  -> The basic relation between waveforms and range command seems violated
  -> This principle is used to correct range based on calibration-1 data (both for wallops and numerical retracking)

-> Cal-1 not reliable to correct Side-A range

-> We have decided to remove contribution of Cal-1 Range correction from retracking estimates

1) pseudo wallops correction (from cal-1 tracker)

2) impact on waveform with numerical retracker

As a results the range is not corrected for altimeter range drifts

External validation provides better agreement with uncorrected data.

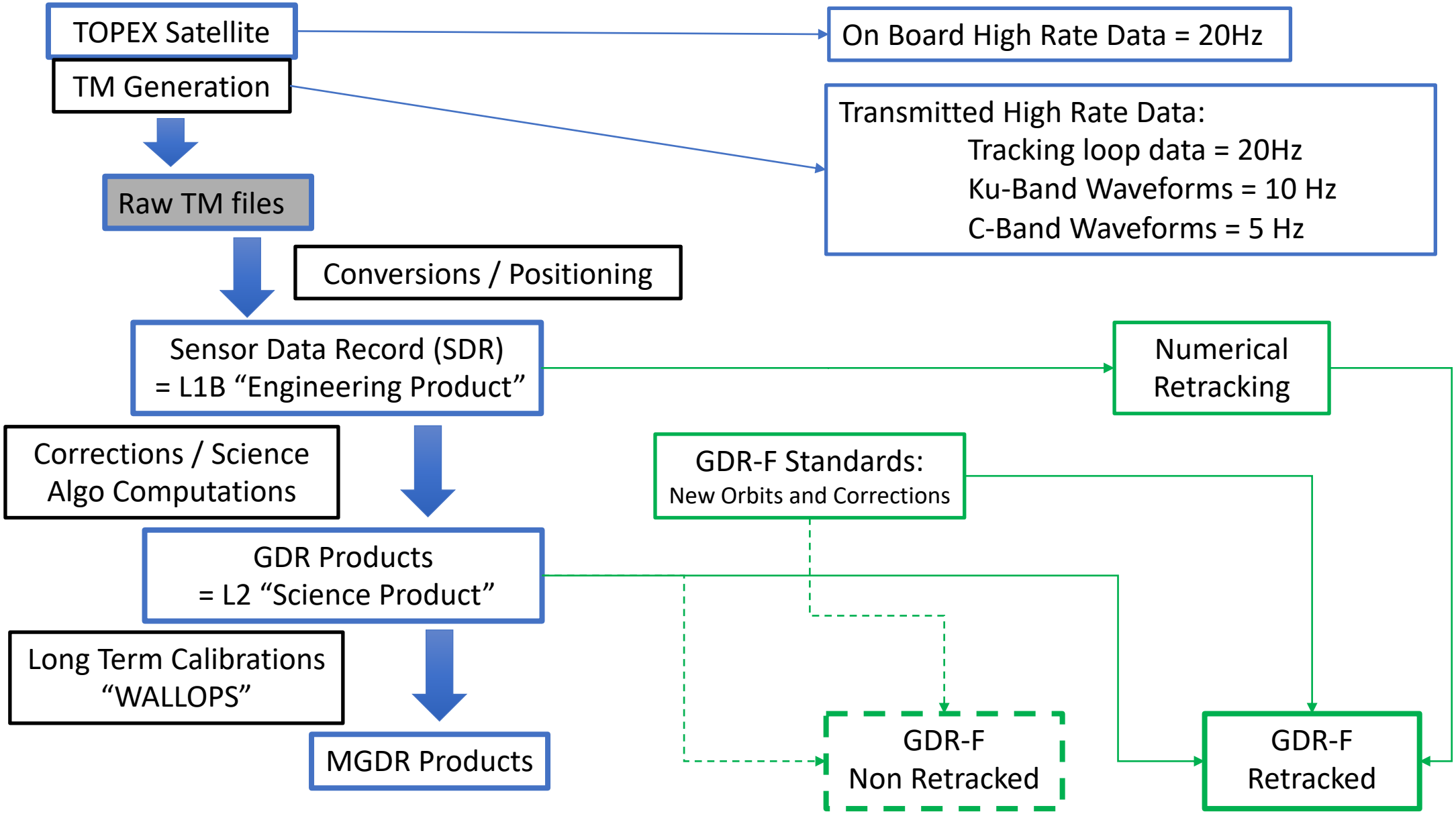
Consistent with Beckley et al., 2017.

- The cal-1 waveforms are used to correct SWH and Sig0 evolution (with positive impact in stability of SSB)

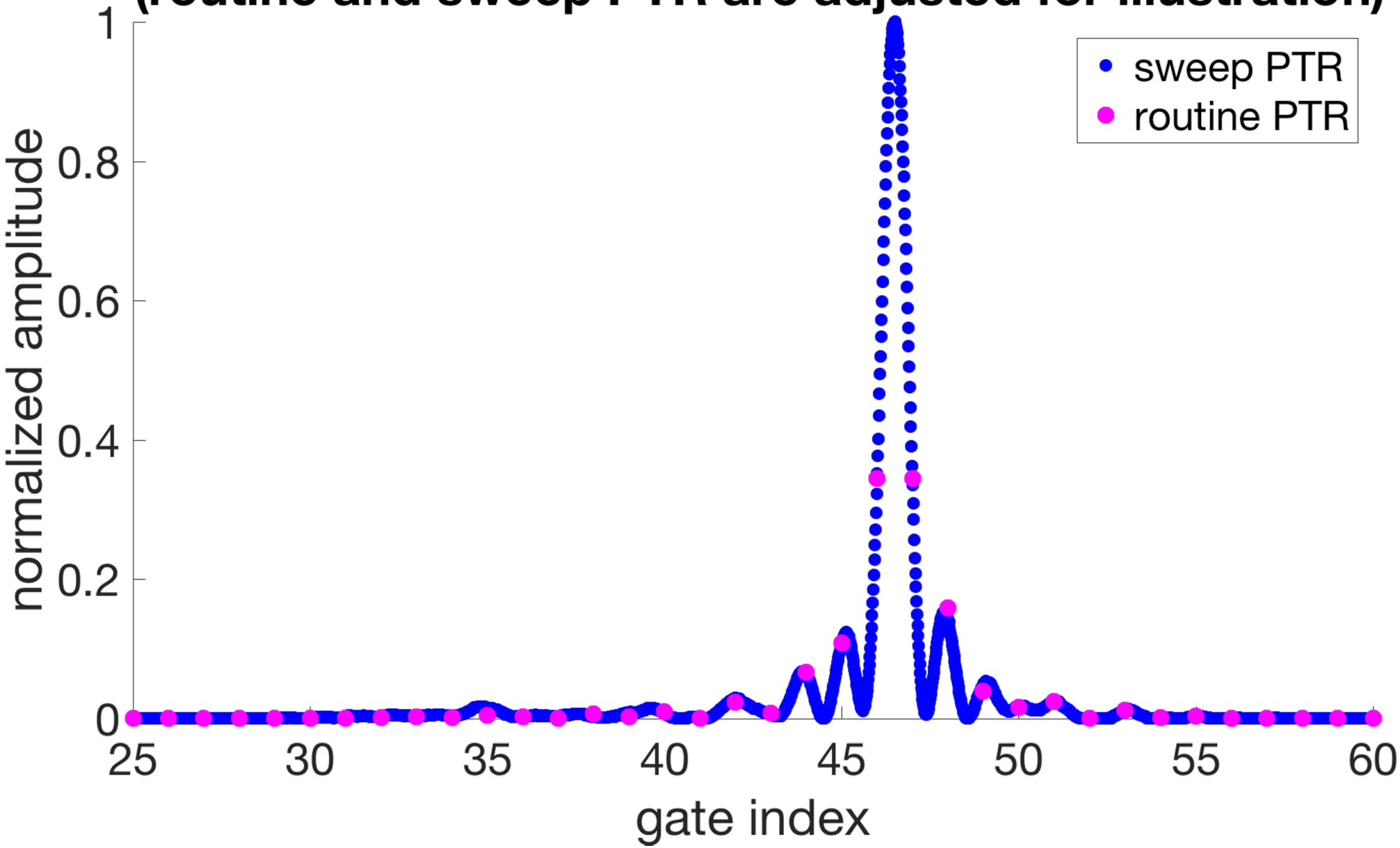
- Recommendation to split Side-A into 2 time series (split on April 1st 1996, cycle 130 )

# Back-up slides

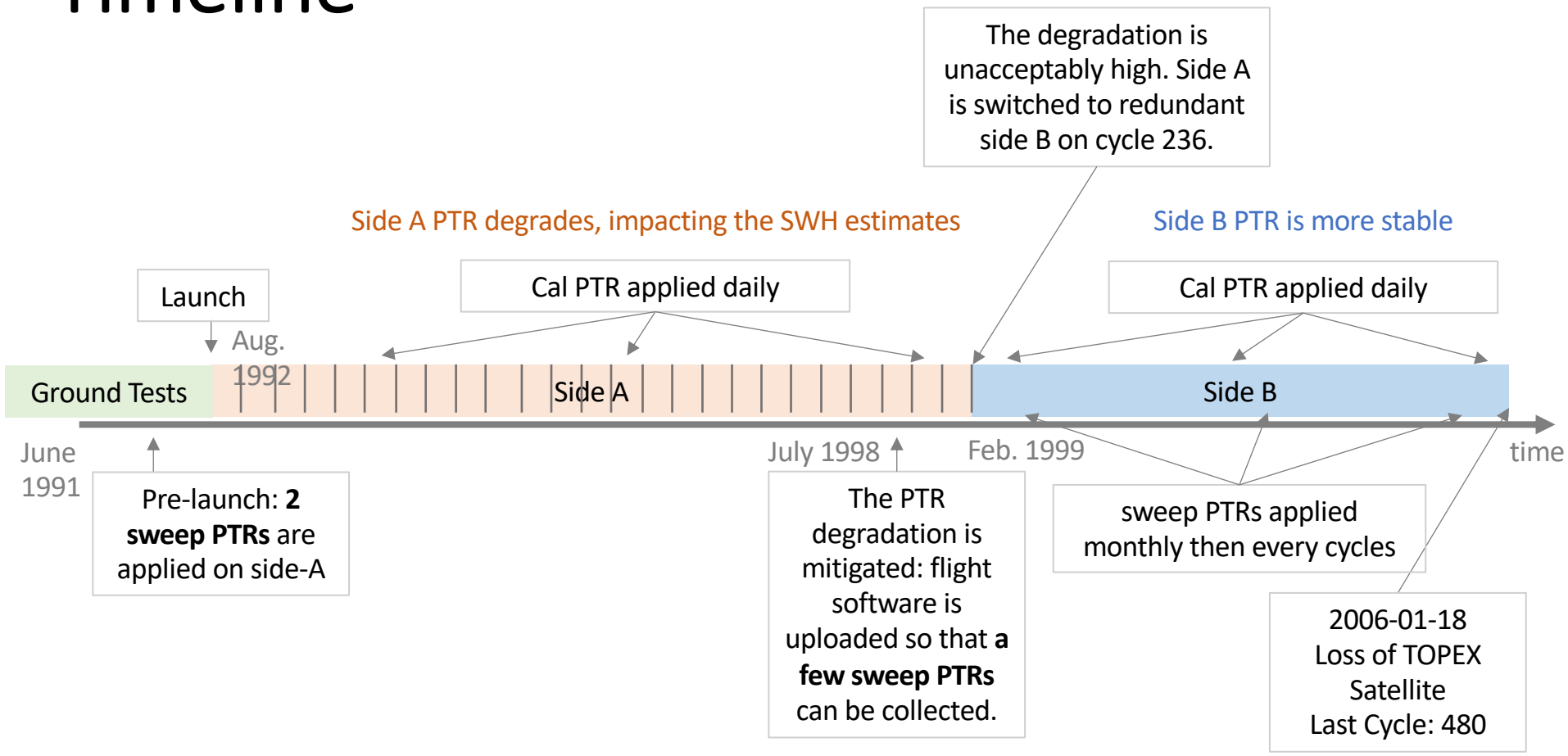
# TOPEX Data and Products



# Side-A Ku-Band PTR Comparison
# (routine and sweep PTR are adjusted for illustration)



# Timeline


The degradation is unacceptably high. Side A is switched to redundant side B on cycle 236.
Side A PTR degrades, impacting the SWH estimates
Side B PTR is more stable
Launch
Cal PTR applied daily
Cal PTR applied daily
Aug. 1992
Ground Tests
Side A
Side B
June 1991
July 1998
Feb. 1999
time
Pre-launch: 2 sweep PTRs are applied on side-A
The PTR degradation is mitigated: flight software is uploaded so that a few sweep PTRs can be collected.
sweep PTRs applied monthly then every cycles
2006-01-18
Loss of TOPEX Satellite
Last Cycle: 480