GFO RADAR ALTIMETER PERFORMANCE

July 2000

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NASA GSFC/Wallops Flight Facility, Code 972

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Wallops GFO Altimeter Role

- ¥ NASA representative for Radar Altimeter Performance
- ¥ Member of GFO Cal-Val Team
- ¥ Data distribution to members of CAL-VAL Team
- ¥ Validate Radar Altimeter instrument related corrections
- ¥ Provide correction for instrument changes to NAVY by monitoring internal calibration mode and altimeter performance.

Wallops Involvement (To Date) with GFO Processing

- ¥ Pre-Launch Testing
- ¥ Cal-Val
- ¥ Provided Improved Temperature Correction for AGC
- ¥ Analysis of Effects from Loss of OnBoard Software Patch
- ¥ Analysis of Record-to-Record Timing Problems
- ¥ Analysis of Processing for Apparent Range Drift
- ¥ Detected Tropospheric Correction Problem at Greenwich Longitude Crossings
- ¥ Noted Bad Data Apparently Resulting from Telemetry Download Problems

NAVY - Wallops Data Flow

Daily

RA Data (without waveforms)

RA Cal Data (with waveforms)

ENG Data (engineering)

WVR Data (water vapor)

Sensor Data Records (SDR)

As Soon As Available

Navy Geophysical Data Records (NGDR)

OODD (orbit)

Wallops - Cal/Val Team Data Flow

SDR

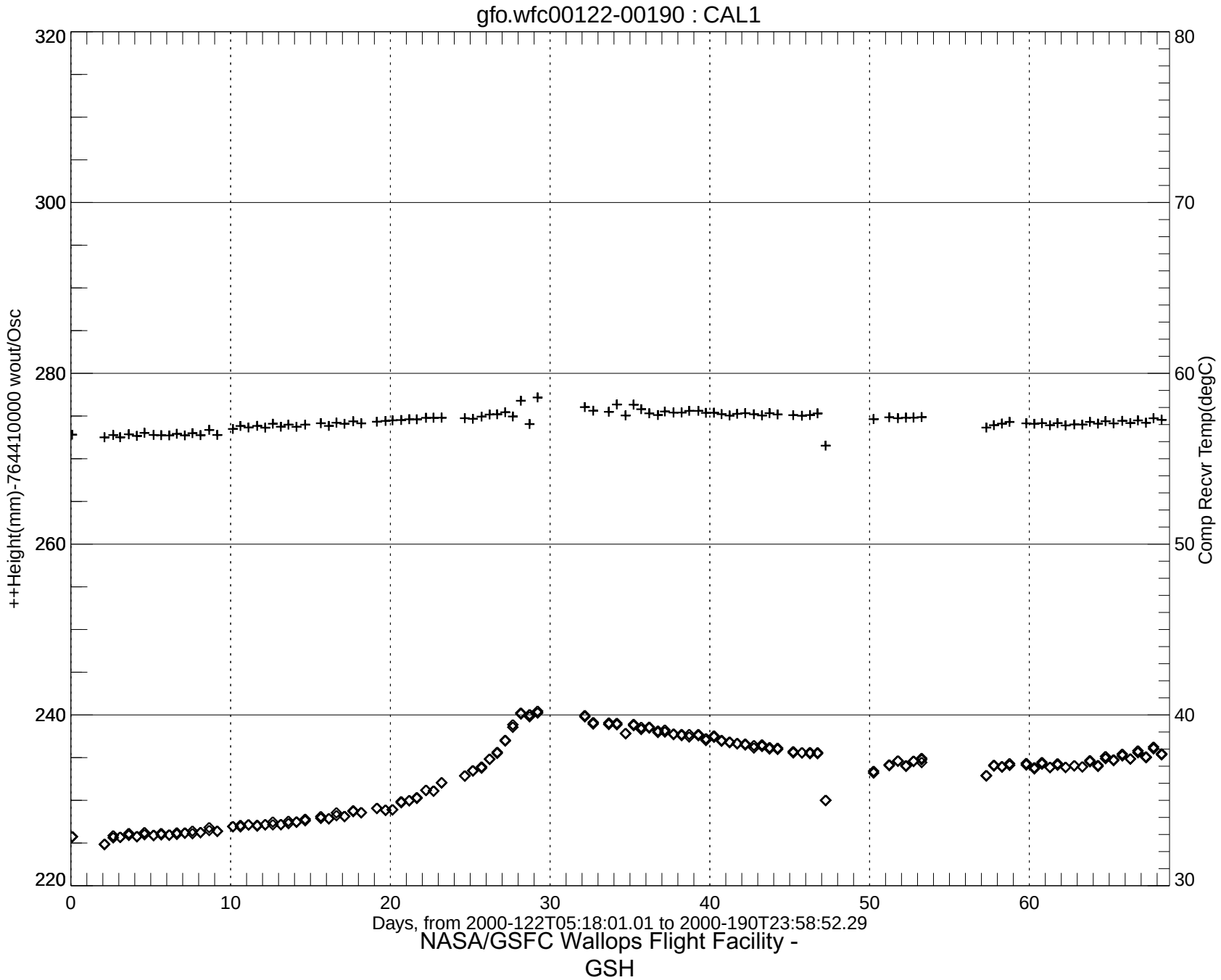
RA Cal Data

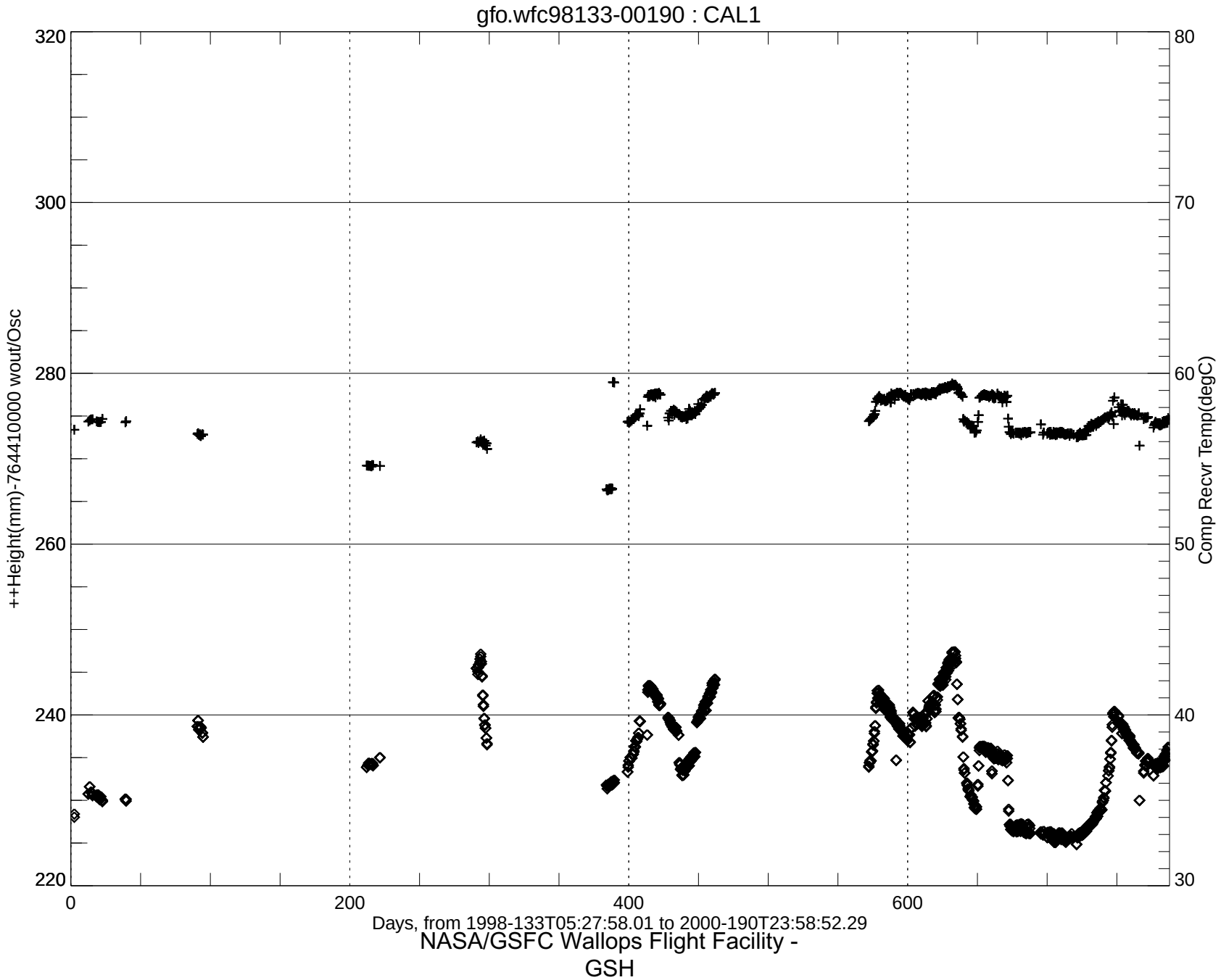
OODD

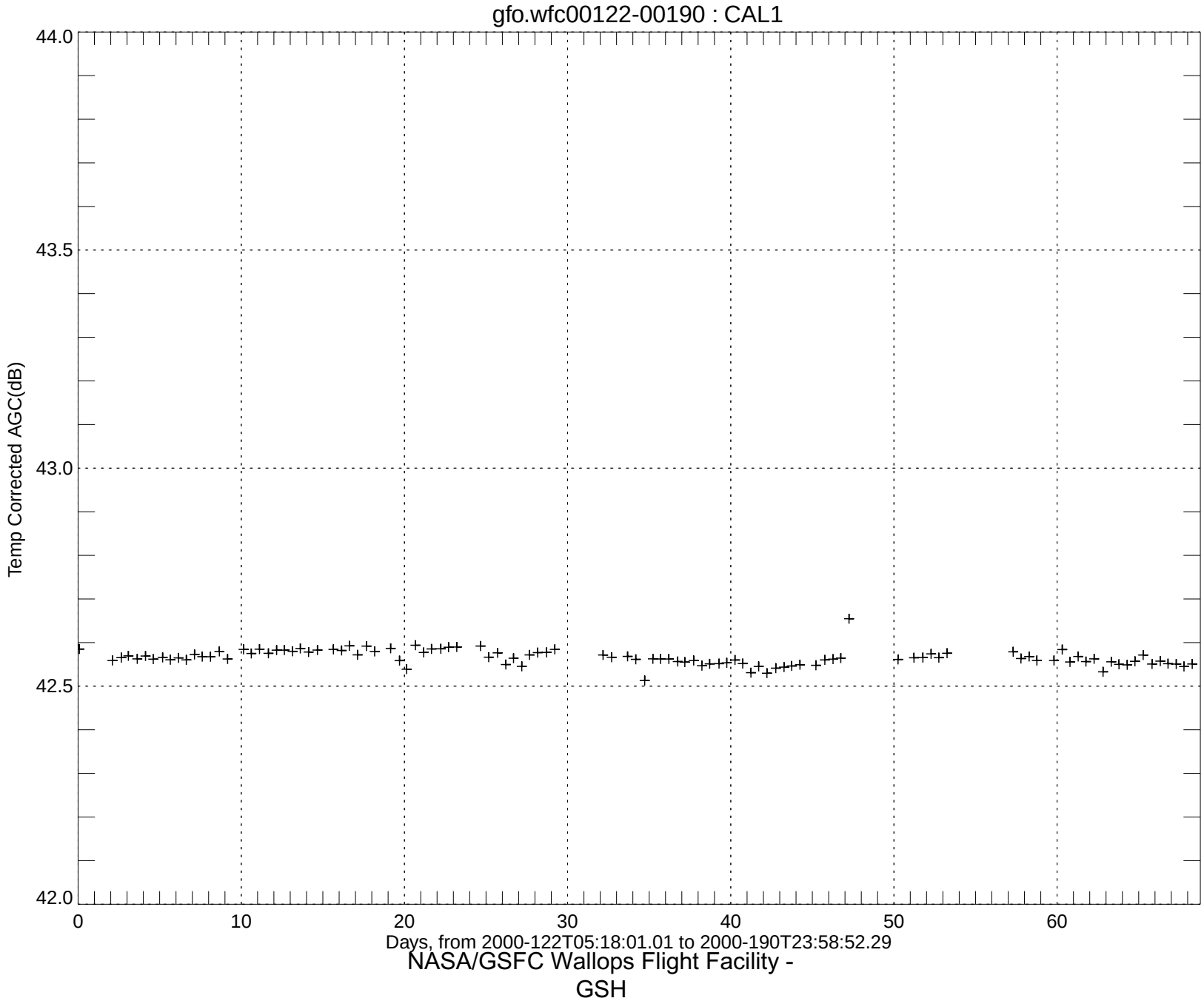
Wallops-Recommended Editing Criteria
Quality Word #1

- ¥ Record is zero filled (bit 2)
- ¥ RA not in fine track (bit 3)
- ¥ No smoothed VATT(bit 7)
- ¥ SWH bounds error (bit 10)
- ¥ Off Nadir error (bit 18)
- ¥ SWH STD error (bit 19)
- ¥ RA data frame missing (bits 22-31) (greater than 5 missing)

Note: Also be sensitive to the bad value fill data.


gfo.wfc00122-00190 : CAL1
++Height(mm)-764410000 wout/Osc
Comp Recvr Temp(degC)
320
300
280
260
240
220
80
70
60
50
40
30
0
10
20
30
40
50
60
Days, from 2000-122T05:18:01.01 to 2000-190T23:58:52.29
NASA/GSFC Wallops Flight Facility -
GSH


gfo.wfc98133-00190 : CAL1
++Height(mm)-764410000 wout/Osc
Comp Recvr Temp(degC)
320
300
280
260
240
220
80
70
60
50
40
30
0
200
400
600
Days, from 1998-133T05:27:58.01 to 2000-190T23:58:52.29
NASA/GSFC Wallops Flight Facility -
GSH


gfo.wfc00122-00190 : CAL1
Temp Corrected AGC(dB)
44.0
43.5
43.0
42.5
42.0
0
10
20
30
40
50
60
Days, from 2000-122T05:18:01.01 to 2000-190T23:58:52.29
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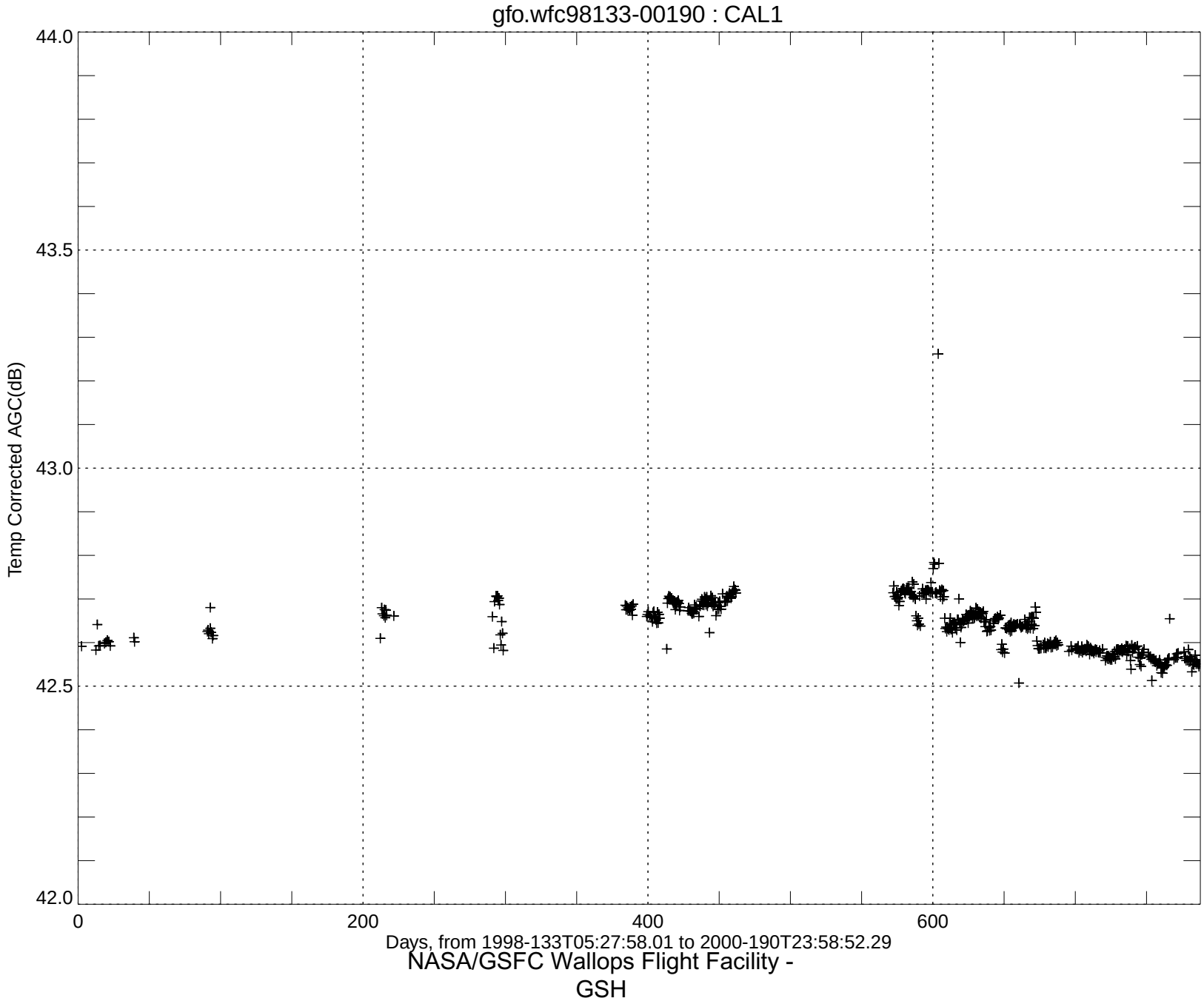
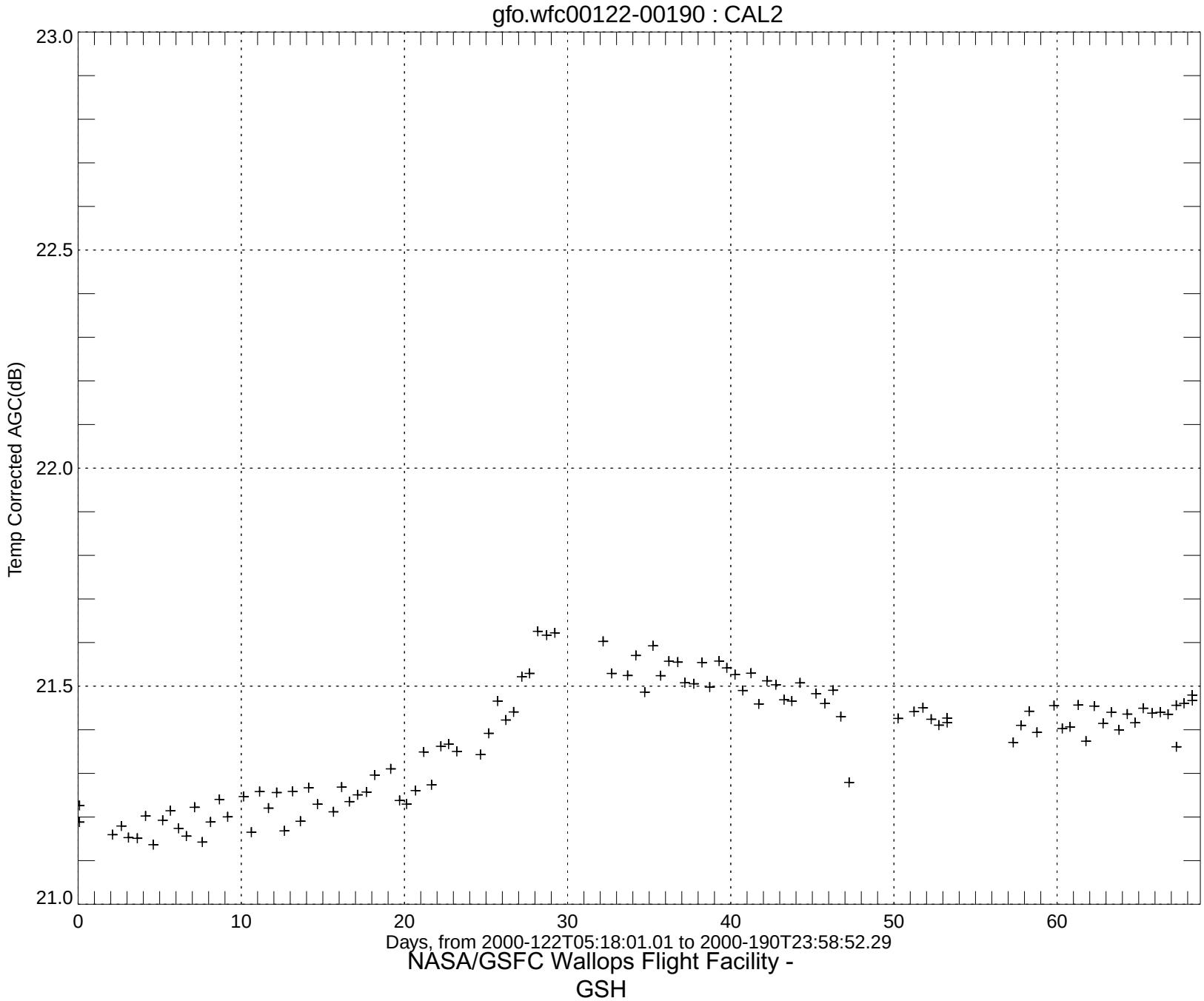
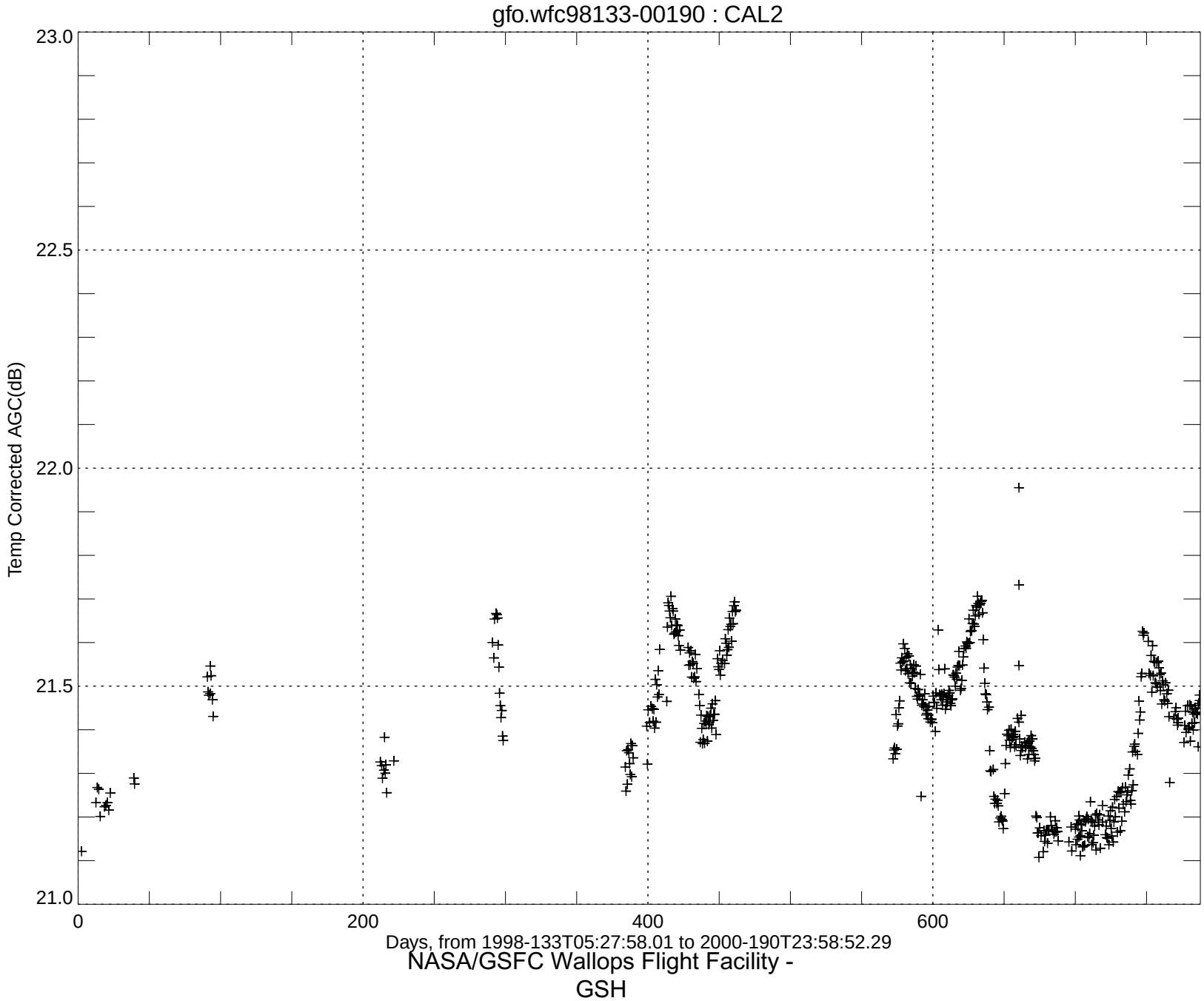
GSH


gfo.wfc98133-00190 : CAL1
44.0
43.5
43.0
42.5
42.0
Temp Corrected AGC(dB)
0
200
400
600
Days, from 1998-133T05:27:58.01 to 2000-190T23:58:52.29
NASA/GSFC Wallops Flight Facility -
GSH


gfo.wfc00122-00190 : CAL2
Temp Corrected AGC(dB)
23.0
22.5
22.0
21.5
21.0
0
10
20
30
40
50
60
Days, from 2000-122T05:18:01.01 to 2000-190T23:58:52.29
NASA/GSFC Wallops Flight Facility -
GSH


gfo.wfc98133-00190 : CAL2
Temp Corrected AGC(dB)
23.0
22.5
22.0
21.5
21.0
0
200
400
600
Days, from 1998-133T05:27:58.01 to 2000-190T23:58:52.29
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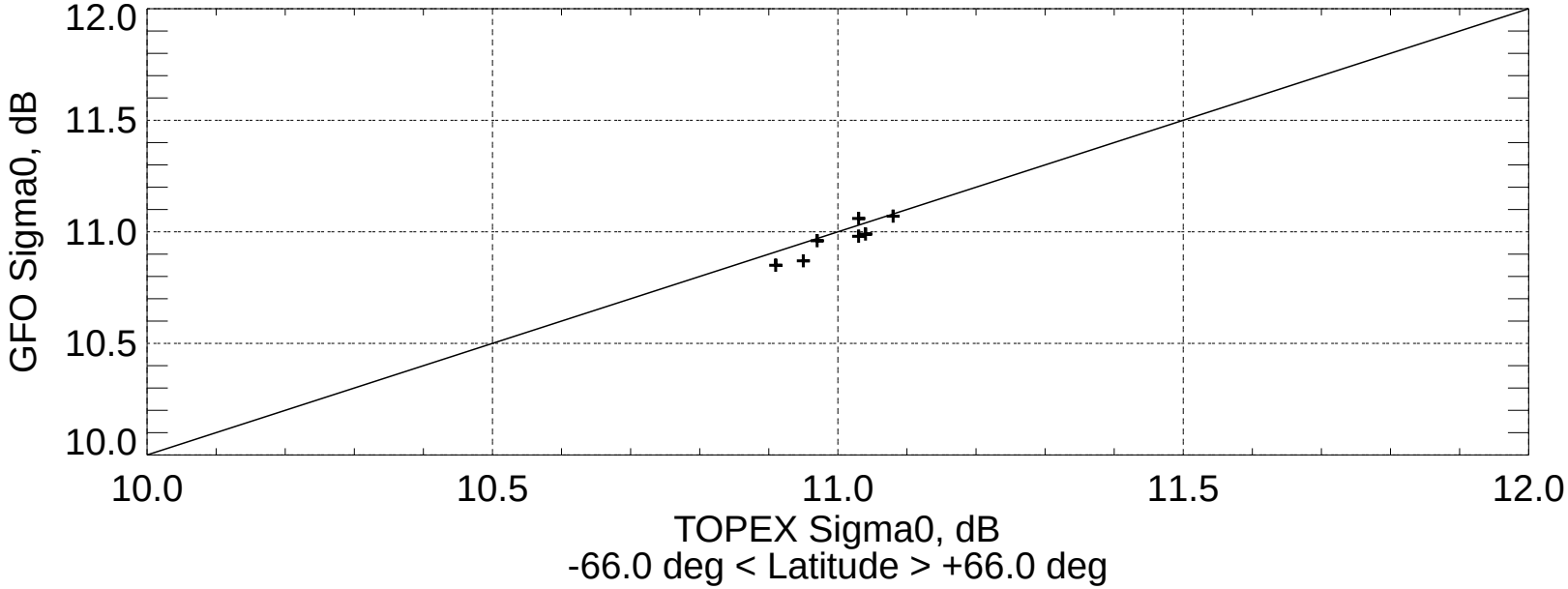
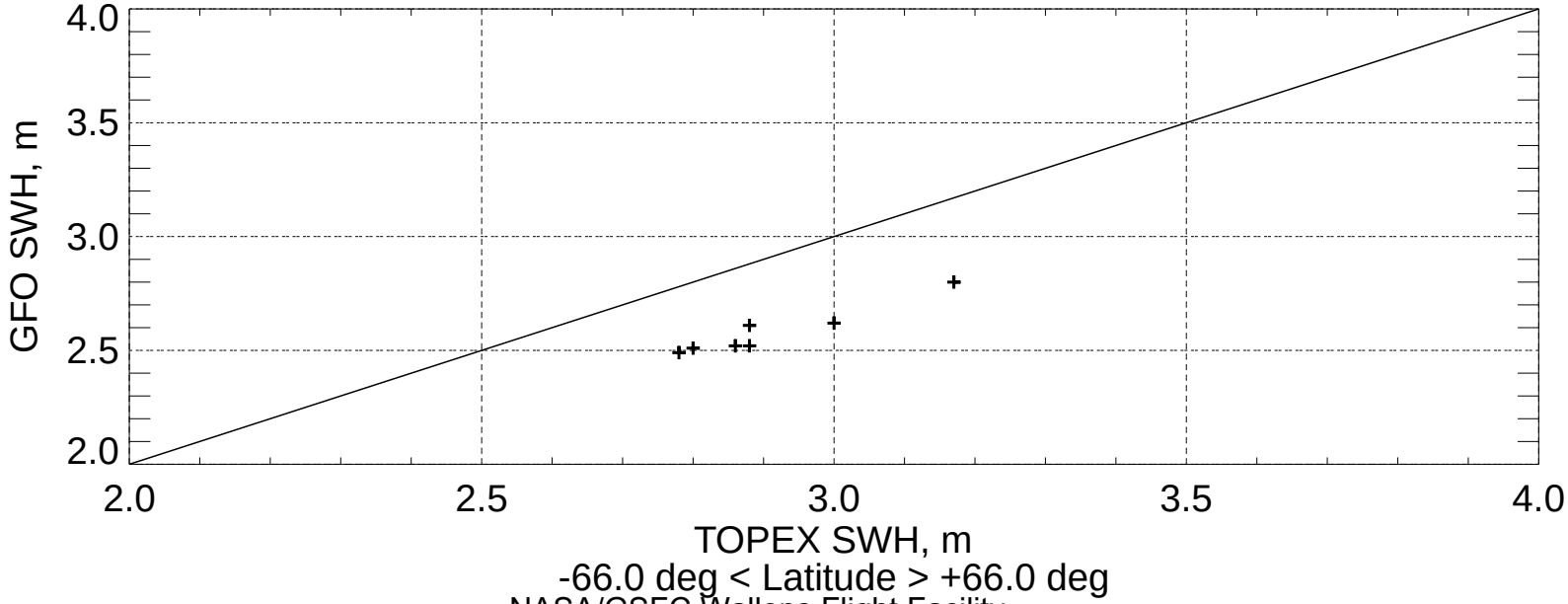
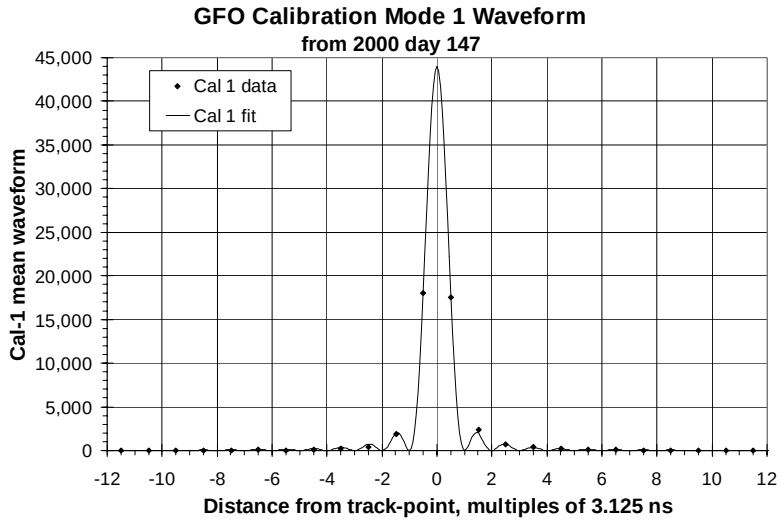
Comparison of GFO and TOPEX for 10-Day TOPEX Cycles

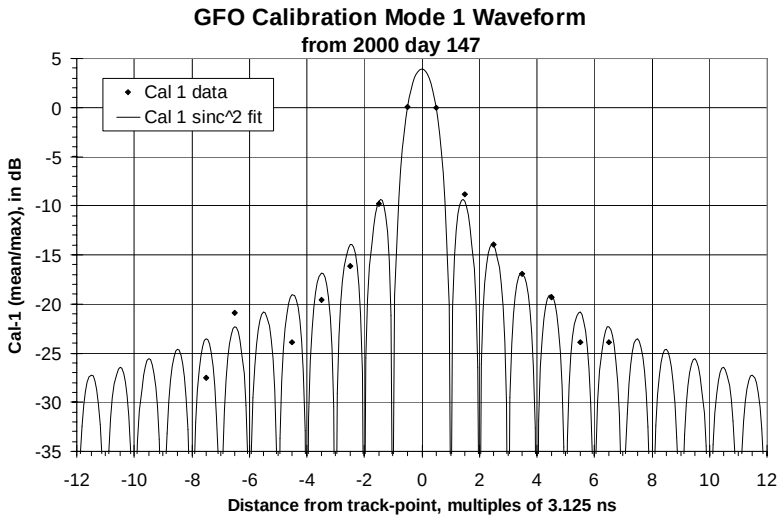




NASA/GSFC Wallops Flight Facility - GSH

GFO Waveform Data from Calibration Mode 1
Fitted to Ideal Sinc^2 with 3.125 ns Width





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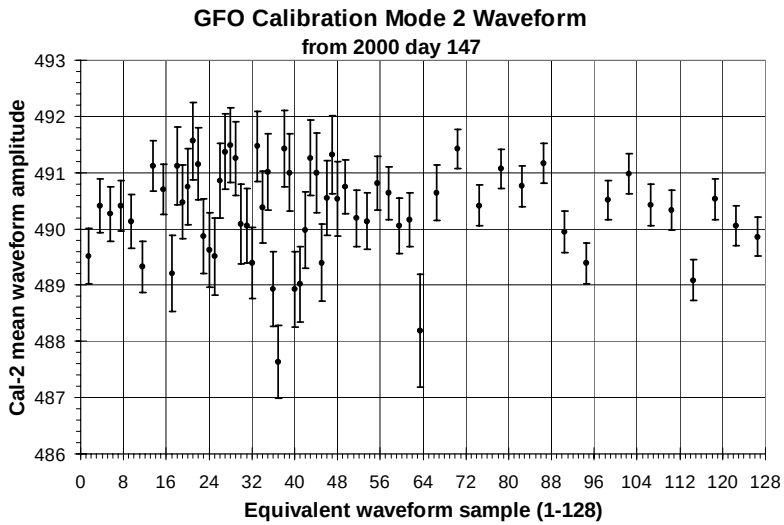
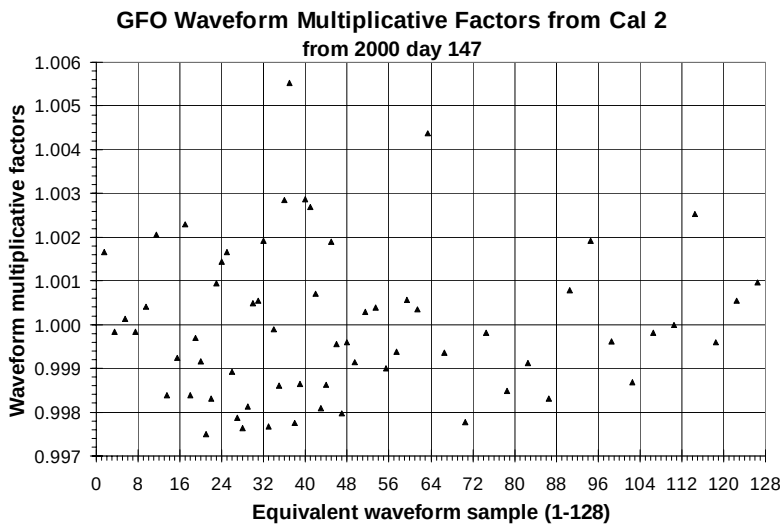
GSH

GFO Waveform Data from Calibration Mode 2





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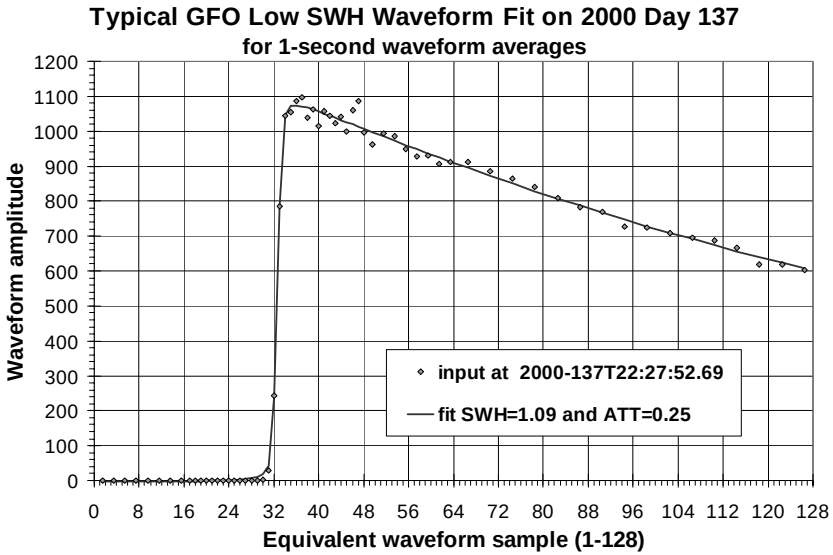
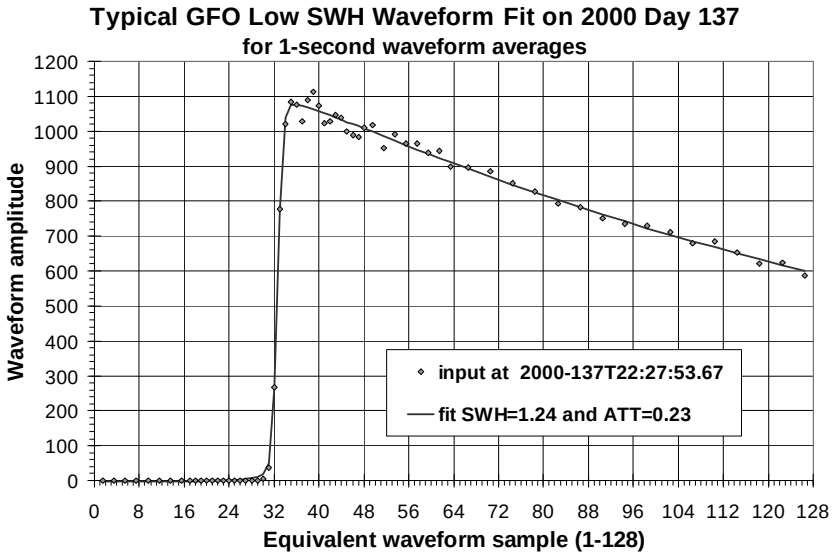
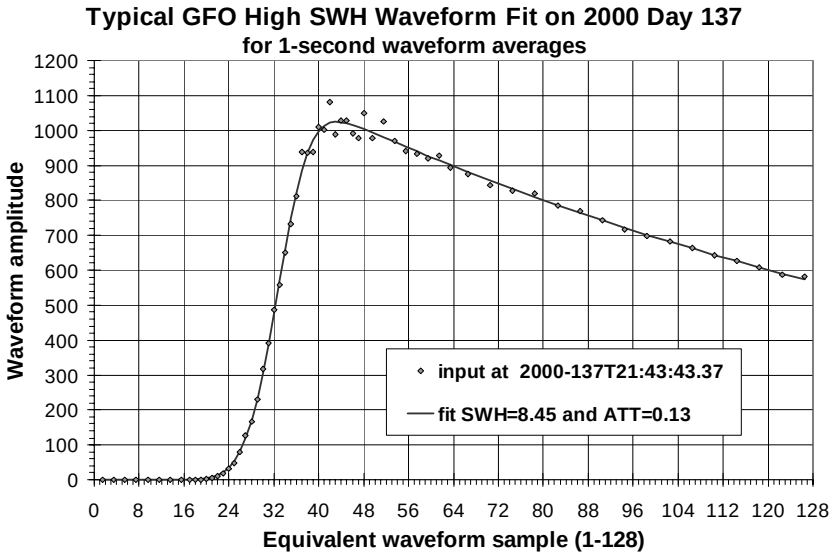
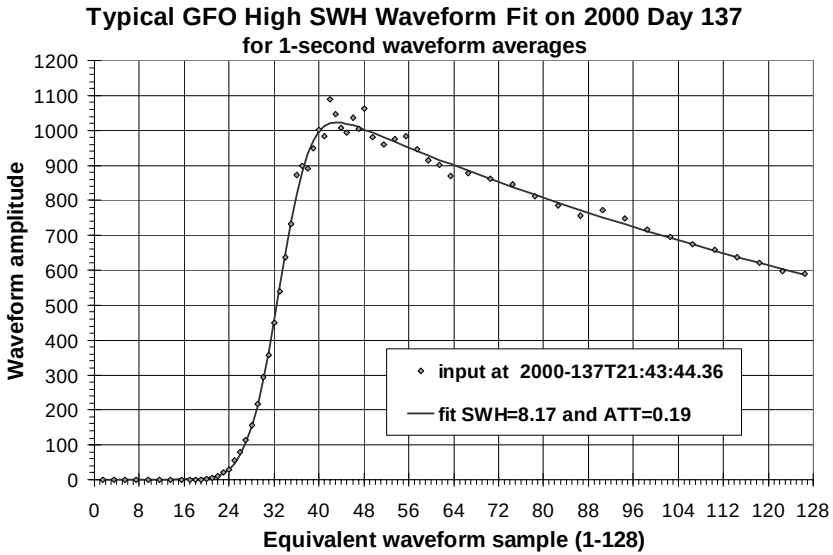
GFO Waveform Sample Data and Model Waveform Fits

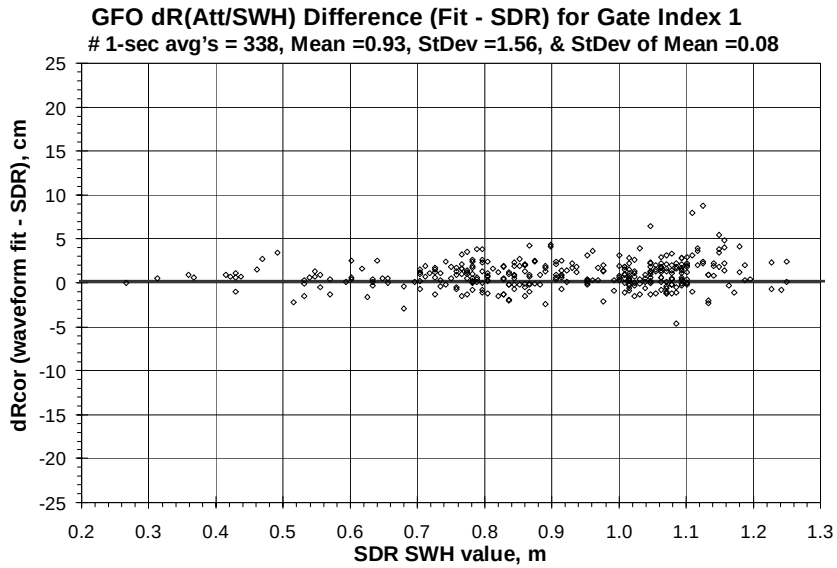


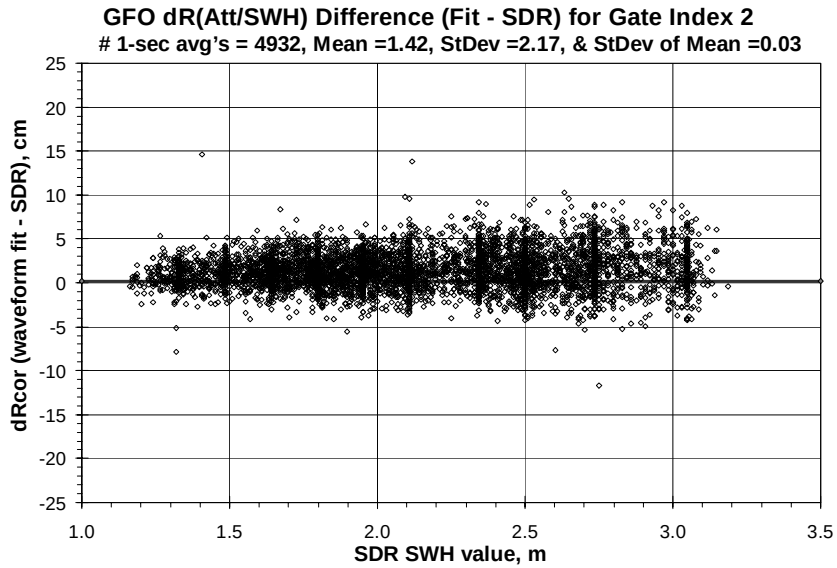


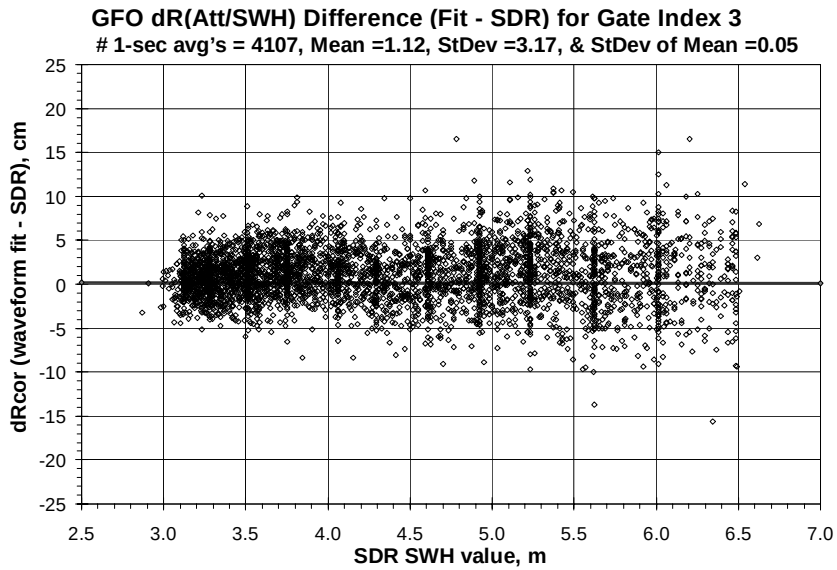


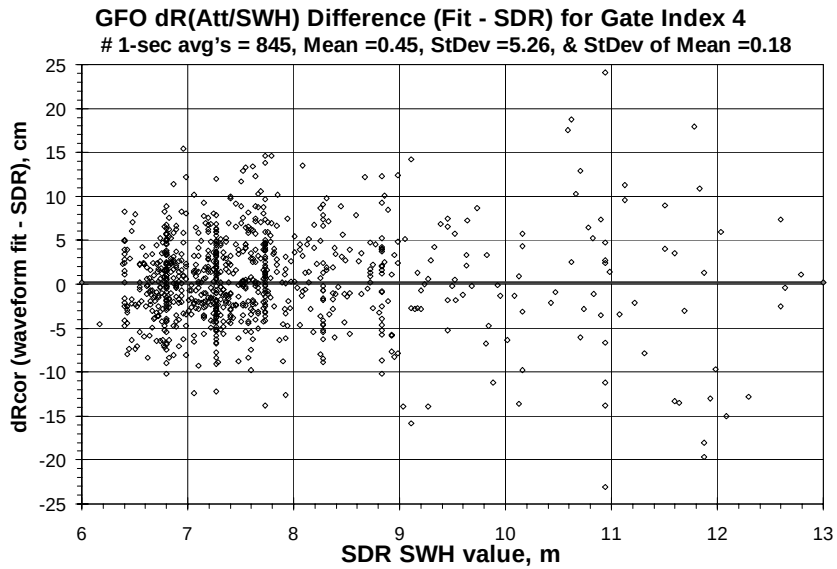


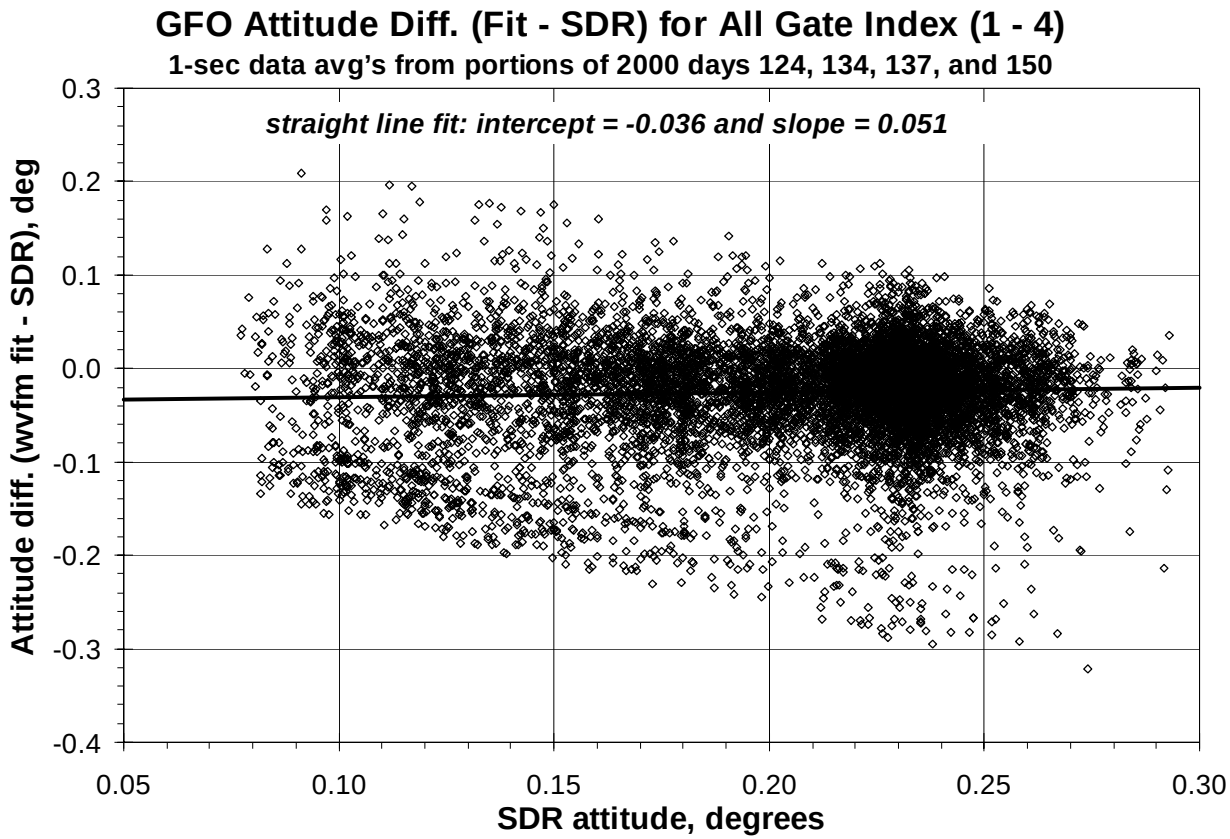
GFO Waveform Fit Comparisons of Attitude/SWH Correction to Range



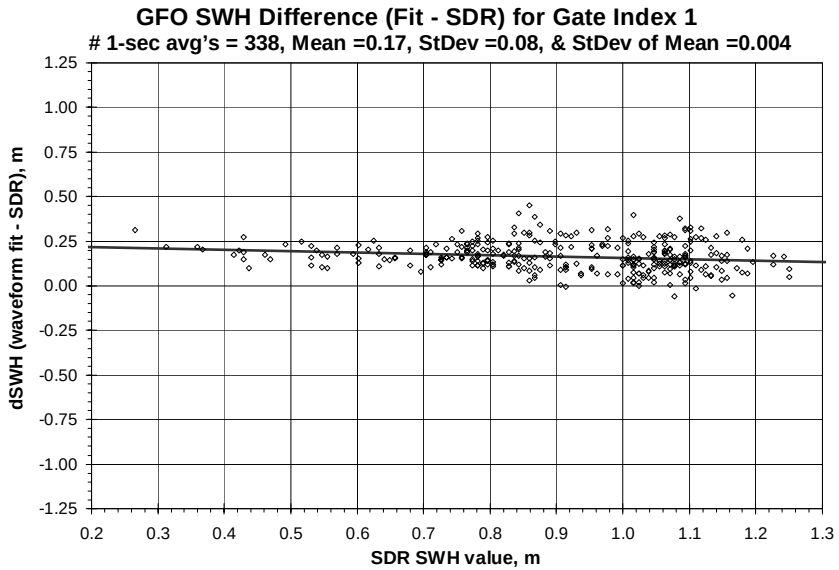


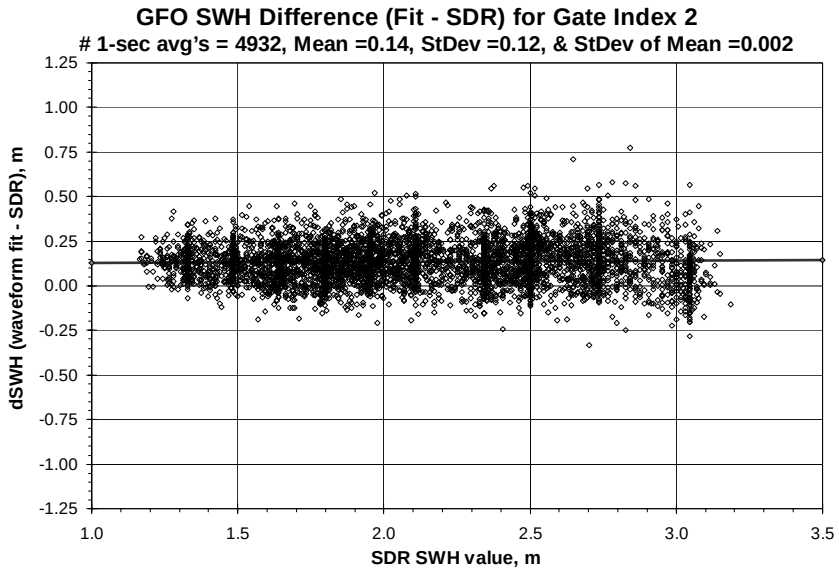


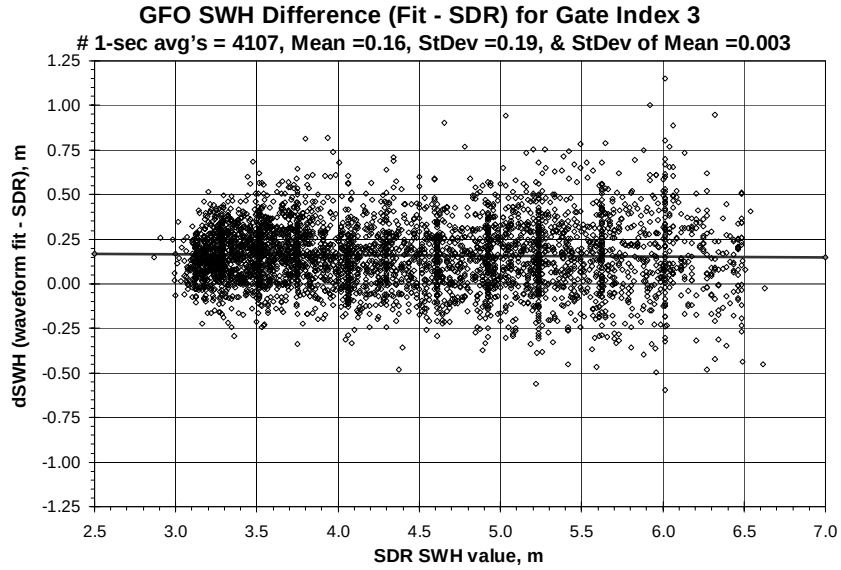


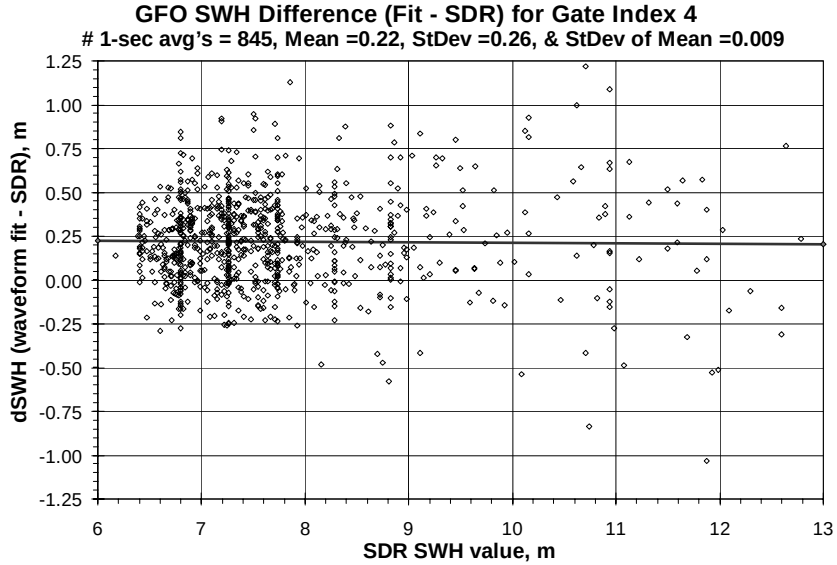

GFO Attitude Diff. (Fit - SDR) for All Gate Index (1 - 4)
1-sec data avg's from portions of 2000 days 124, 134, 137, and 150
straight line fit: intercept = -0.036 and slope = 0.051
Attitude diff. (wvfm fit - SDR), deg
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
0.05
0.10
0.15
0.20
0.25
0.30
SDR attitude, degrees

GFO Waveform Fit Comparisons of SWH Estimates



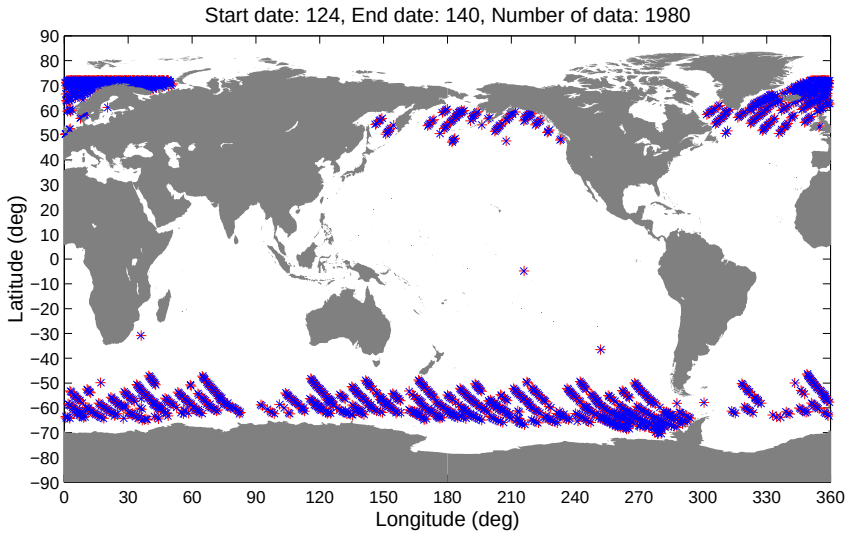


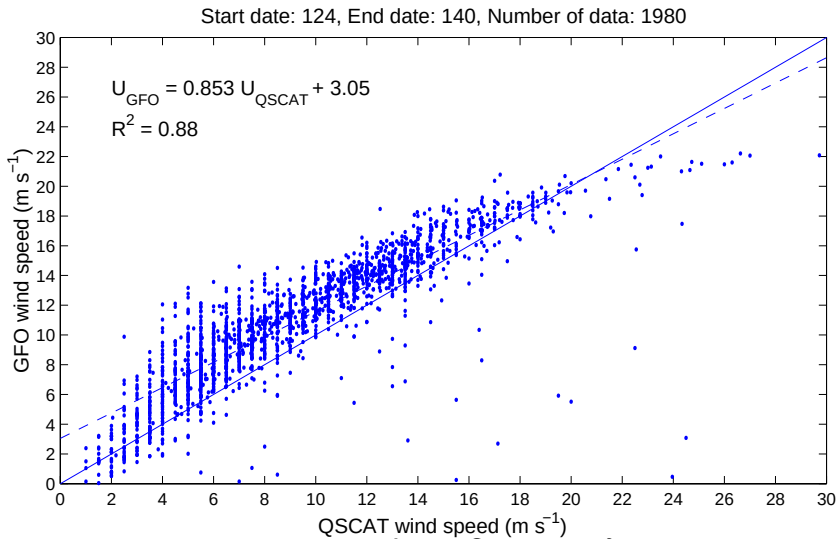




Comparison of GFO-Derived Windspeed with QUIKSCAT (GFO 17-DAY CYCLES)

(Analysis by N. Tran, Raytheon ITSS)





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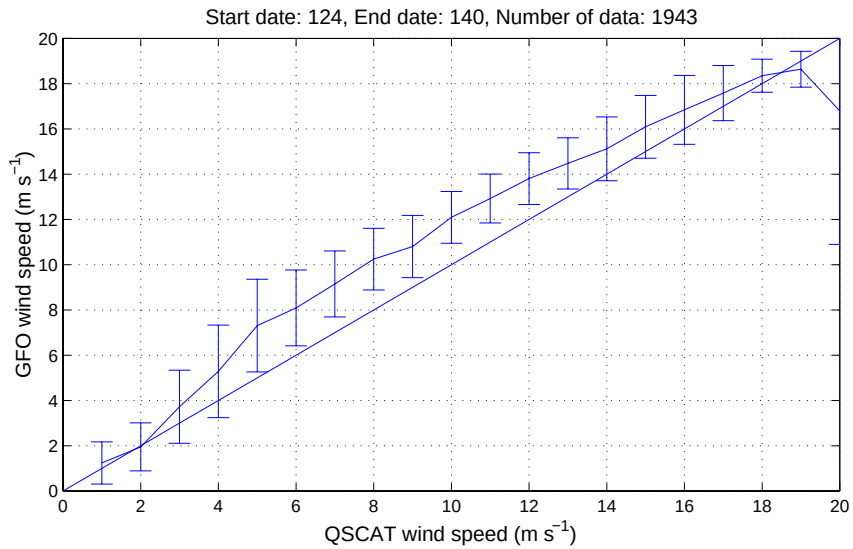
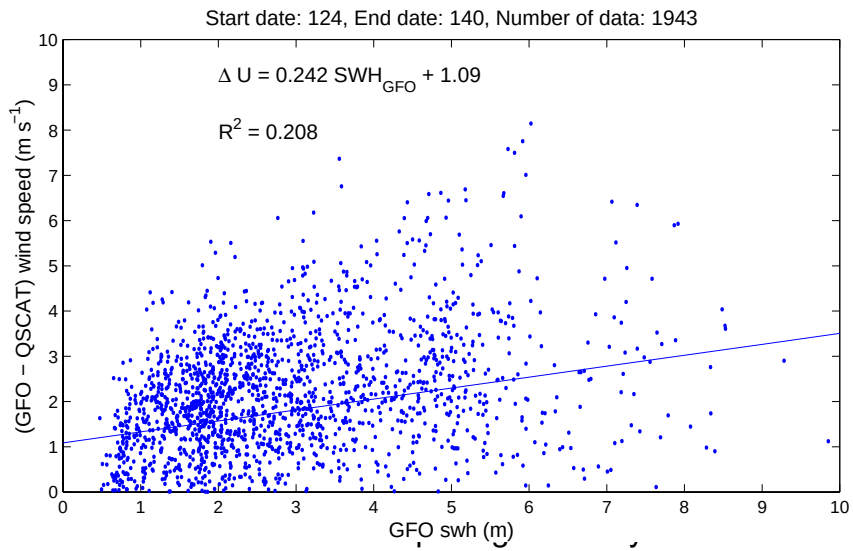
Comparison of GFO-Derived Windspeed with QUIKSCAT (GFO 17-DAY CYCLES)

(Analysis by N. Tran, Raytheon ITSS)





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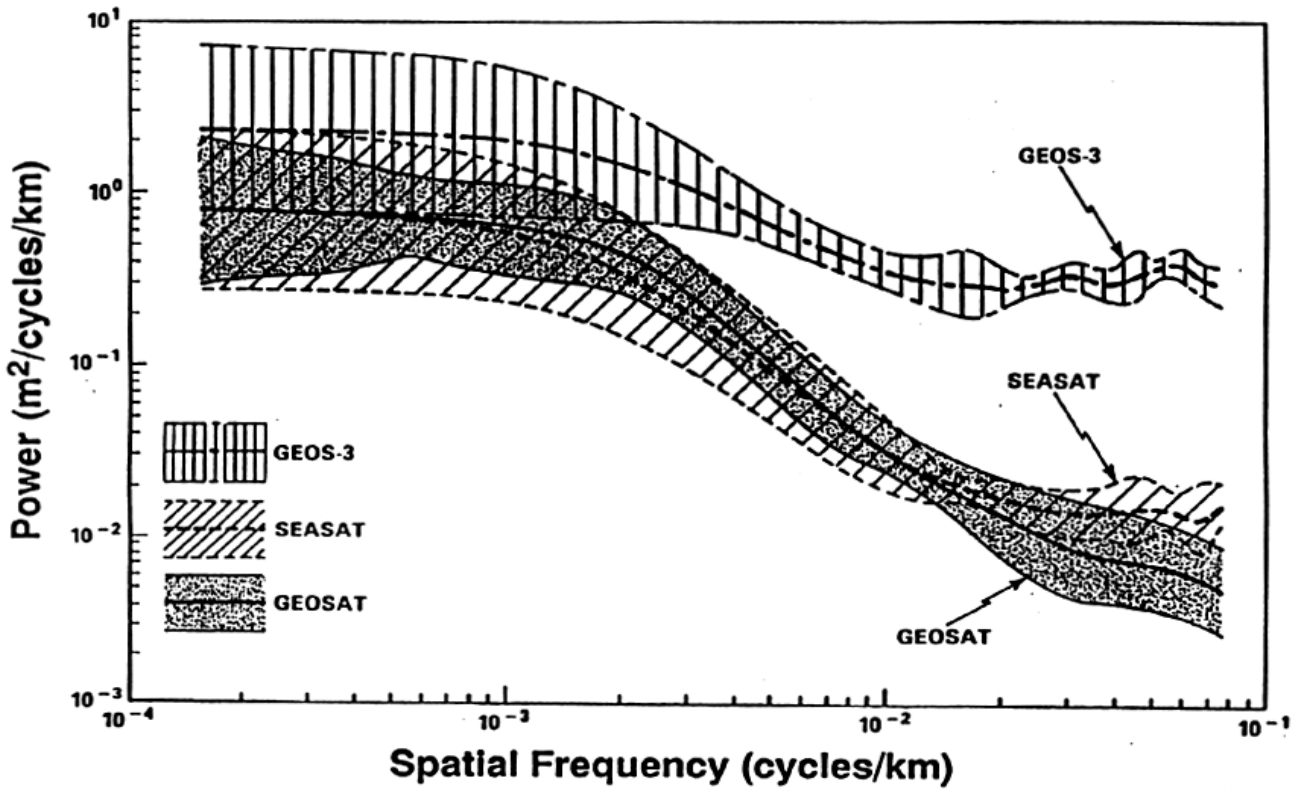
Conventional Method to Determine Noise Level

(Driscoll & Sailor - TASC - 17 July 2000)

- **Has been applied to all altimeter missions**
- **Based on observing the noisy time series obtained by differencing repeat tracks to cancel out the geoid**
- **Spectral estimation applied to the difference time series shows colored noise due to oceanography plus a white noise floor due to the altimeter instrument noise**
- **RMS white noise level is obtained by integrating the noise under the noise floor. Bandwidth is usually 1-Hz (integrate from -0.5 to +0.5 Hz).**

Noise in Altimetry —Spectra Derived by Differencing Repeat Tracks

(Driscoll & Sailor - TASC - 17 July 2000)



Noise spectra show oceanographic noise plus a white noise floor visible at high frequencies (f > ~0.02 cy/km)
RMS white noise power over 0.5 Hz bandwidth is 23 cm for GEOS-3, 5 cm for Seasat, and 3 cm for Geosat.

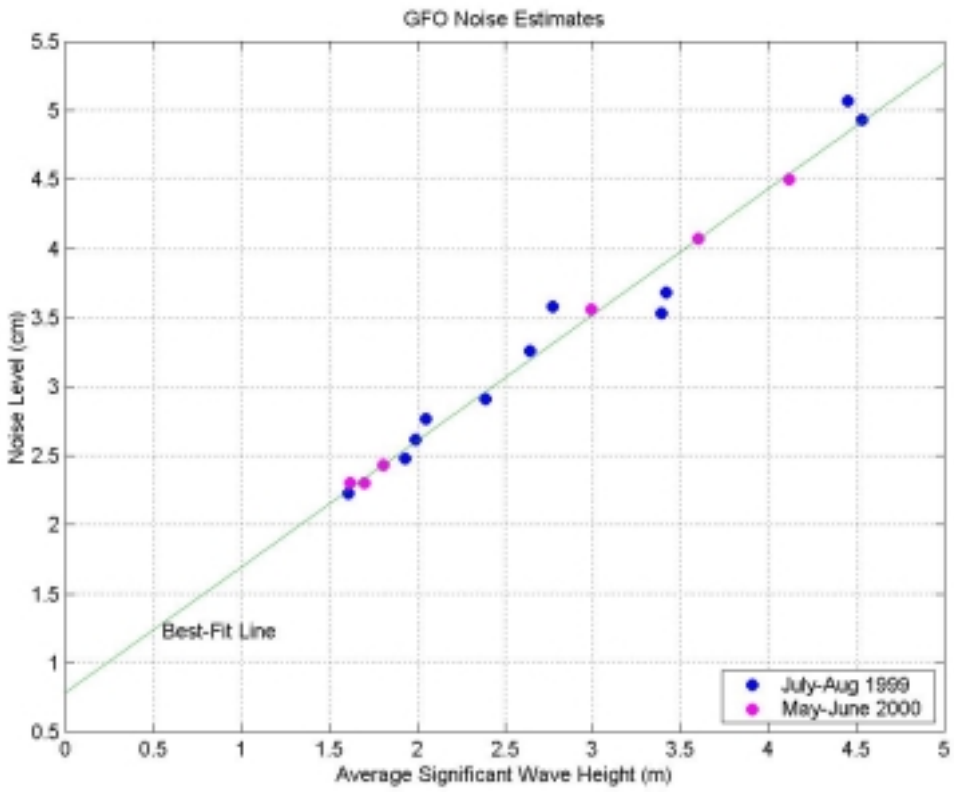
Noise Determination for GFO

(Driscoll & Sailor - TASC - 17 July 2000)

- **GDR data collected during July-August 1999, and May-June 2000 were analyzed**
- **Data were edited to remove spikes (only a few per arc)**
- **Repeat tracks were differenced; noise power spectral density (PSD) determined using parametric state-space modeling (similar to autoregressive or Maximum Entropy spectral estimation)**
- **Noise level is determined by integrating the power beneath the white noise floor**
- **Results plotted vs average SWH along the tracks**

GFO Noise Level

(Driscoll & Sailor - TASC - 17 July 2000)

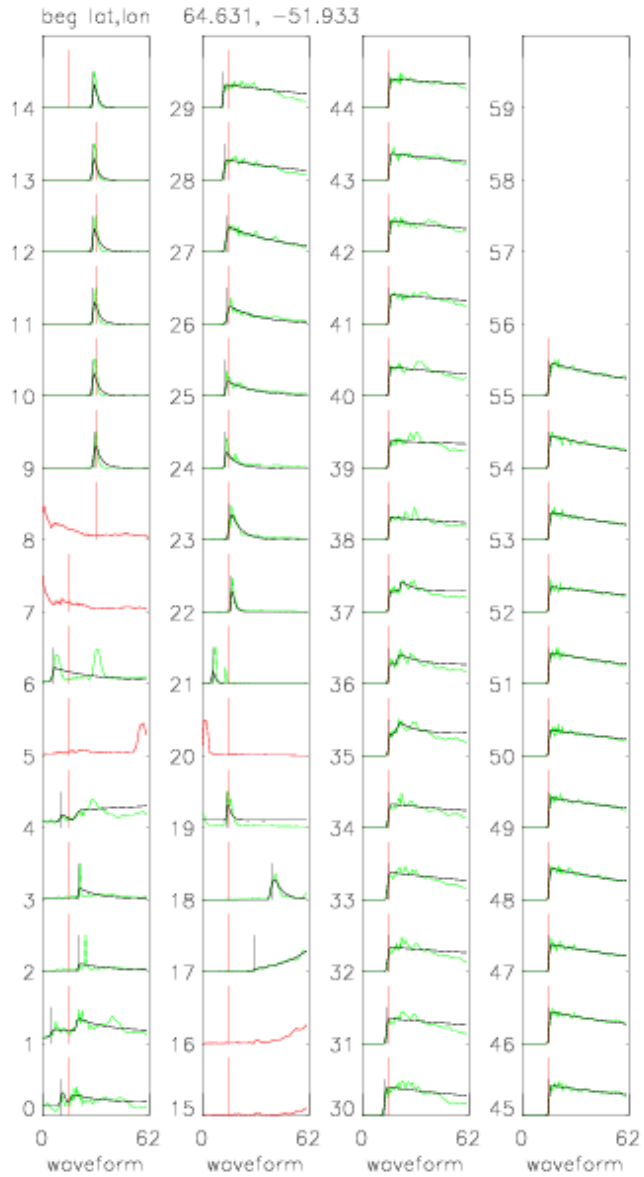


Noise level estimates from 17 pairs of repeat tracks plotted versus the average significant wave height (SWH)

Noise level is less than 2.6 cm for average SWH less than 2 meters

GFO Individual Waveforms, Greenland-to-Ocean

(A. Brenner - Raytheon ITSS)



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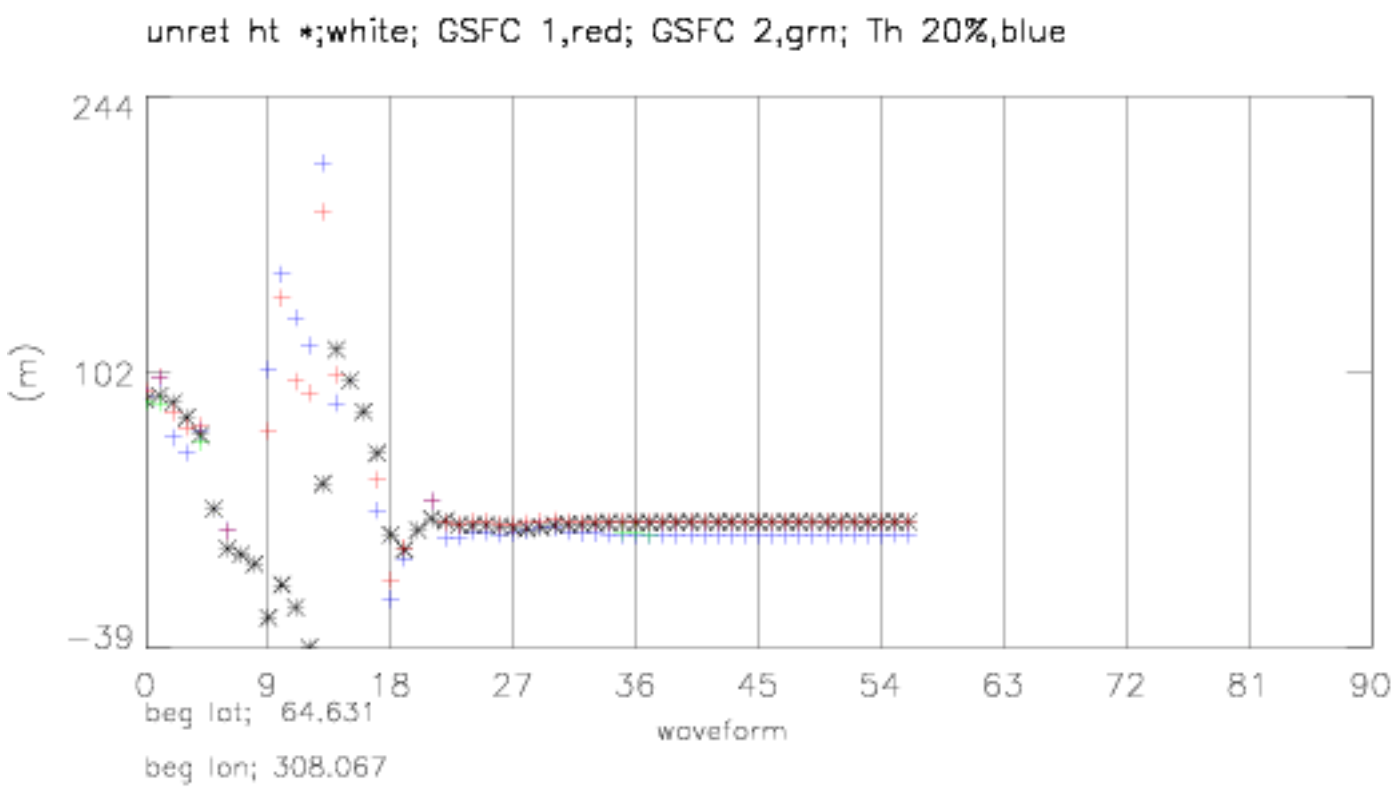
GFO Height Estimates, Greenland-to-Ocean

(A. Brenner - Raytheon ITSS)



GFO Altimeter Data Errors

- ¥ **2000 Day 147 bad down link caused segments of ocean data to appear bad**
- ¥ **200 Day 150 bad Sea Surface Height from apparently misaligned data**
- ¥ **Implies need to improve automated quality assurance on nGDR. Wallops can help develop recommendations.**

Open Issues

- ¥ Time Tag assigned in presence of bad data- (Ball has fix)
- ¥ Tropospheric correction problem at 0 deg Longitude
- ¥ SDR/nGDR data misalignment
- ¥ nGDR quality assurance
- ¥ Possible Sigma Naught/AGC calibration correction needed
- ¥ Windspeed bias (Possible offset or model)
- ¥ SWH Bias (Possible)

Conclusion

- ¥ **The GFO Radar Altimeter (Configuration 1) is performing well, instrument specifications have been met**
- ¥ **Recommend workshop to resolve open issues (Wallops and others)**
- ¥ **Recommend the GFO data flow be open to the Altimeter user community after open issues closed**