

**On the Evaluation of the
GEOSAT Follow-On (GFO) Altimeter**

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The NAVY GFO Satellite was launched on February 10, 1998. The spacecraft system and the onboard GPS Instrument have experienced a number of problems that have delayed the mission from entering normal operations. However, the GFO Radar Altimeter has been turned on a number of times since launch and does appear to be performing well. We have been approved to assist in the monitoring of the long term trends in the altimeter, similar to the functions we have been performing for the TOPEX Radar Altimeter.

The pre-launch testing we were involved with occurred during the instrument performance test and the thermal vacuum testing. Figure 1 shows the height noise rms during testing as a function of significant waveheight (SWH). The GFO Performance was very comparable to previous satellite radar altimeters. We observed that there was a small change with temperature in the calibration mode 2 waveform shape: the extreme case of this is shown in Figure 2. Onboard scaling was implemented to make the waveform flat at the nominal expected flight temperatures. Our model errors show that, if the system is maintained within the few degrees expected, the induced height errors are better than 1 cm. The observed in-flight operating temperatures have been slightly less than nominal, but very consistent (Figure 3). The resulting cal mode 2 waveform, shown in Figure 4, is not quite flat but is very repeatable. Tracker corrections have been placed in the GFO data processing based on the in-flight calibration.

Additionally, Figures 5, 6a and 6b, show that cal mode height and AGC are very stable. The last set of calibrations shows some change in AGC, but this could be due to an error in the temperature corrections. Figure 7 shows that the altimeter performance over a variety of waveheights is very similar to previous radar altimeters. Lastly, Figure 8 is a time series of several output parameters, to provide an indication that the GFO altimeter provides quality data over a range of conditions. Similar to the TOPEX radar altimeter, the GFO altimeter performance is affected by sigma naught blooms; this is seen at approximately 11 and 30 minutes on Figure 8.

Pre-Launch Summary

- Radar Altimeter performance met specifications
- Waveform sample gain variation with temperature detected
- Modeling over expected flight temperature variations indicated sub-centimeter residual

In-Flight Summary

¥ Performance appears to be excellent

¥ Calibration Mode is very stable

¥ Temperatures are below the nominal values defined for ground testing

¥ Temperature while operating in track has been maintained to about 5 degrees

Calibration Mode Summary

- Cal Mode 1 is used for monitoring active mode changes
 - In-Flight heights show repeatability to better than 1 cm
- Cal Mode 2 is used primarily for noise characteristic monitoring
 - Noise character is very stable
 - Below nominal preflight testing; therefore, waveform is not flat
- Cal Modes cannot easily compare to Pre-Launch since it has been processed slightly different
- Calibration Mode AGC very repeatable
 - Both Cal 1 and 2 show similar performance
 - Suspect 0.5 dB between datasets is due to a temperature calibration problem
 - No recent calibration mode data available to verify

GFO Events and Data History at WFF

Oct. 1996	E-Systems testing
Mar. 1997	Ball Thermal Vacuum testing
Feb. 10, 1998	Launch
May 13 (Day 133)	First altimeter data through distribution
May 25 - Jun. 4 (Day 145 - 155)	Normal operation with cal modes
Jun. 21 (Day 172)	Operation with cal modes
Jul. 16, 1998	First GFO CalVal Meeting
Aug. 11 - Aug. 15 (Day 223 - 227)	Normal operation with cal modes
Nov. 21 - Nov. 28 (Day 325 - 332)	Track Mode data no cal modes through distribution

Figure 1. GFO Pre-Flight Height Noise Performance

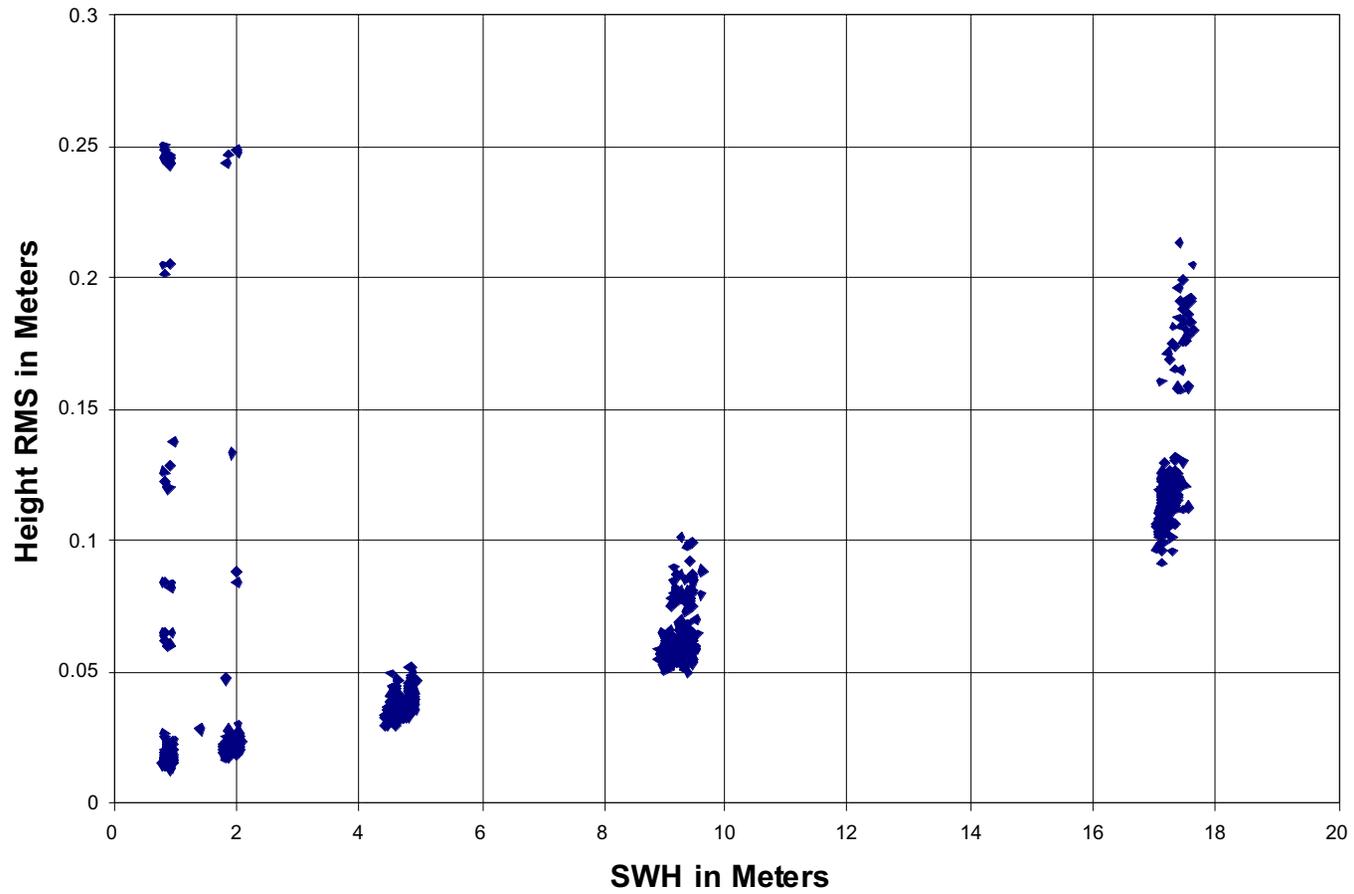


Figure 2. GFO Pre-Flight Test Config 1 Cal Mode 2

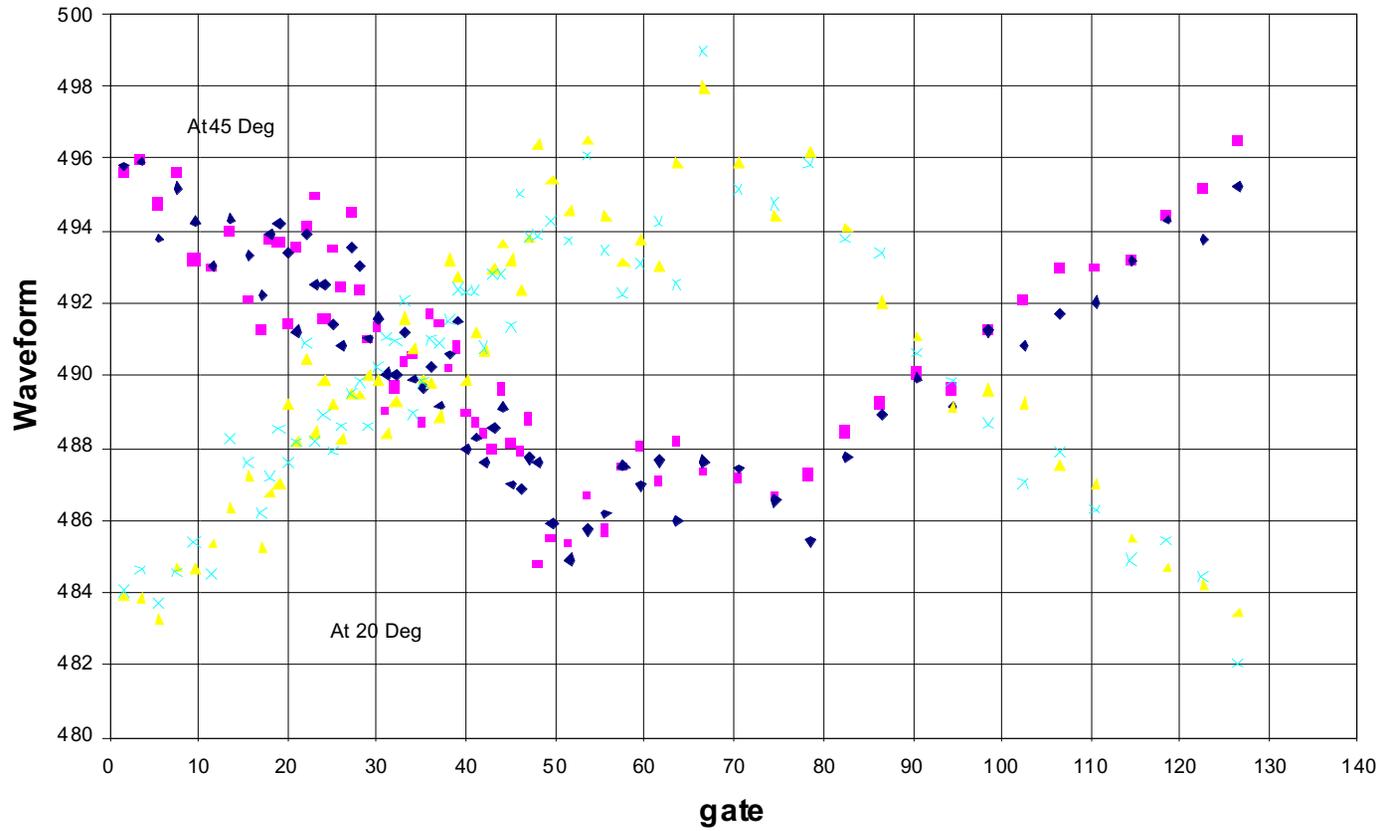


Figure 3. GFO Composite Receiver Temperature

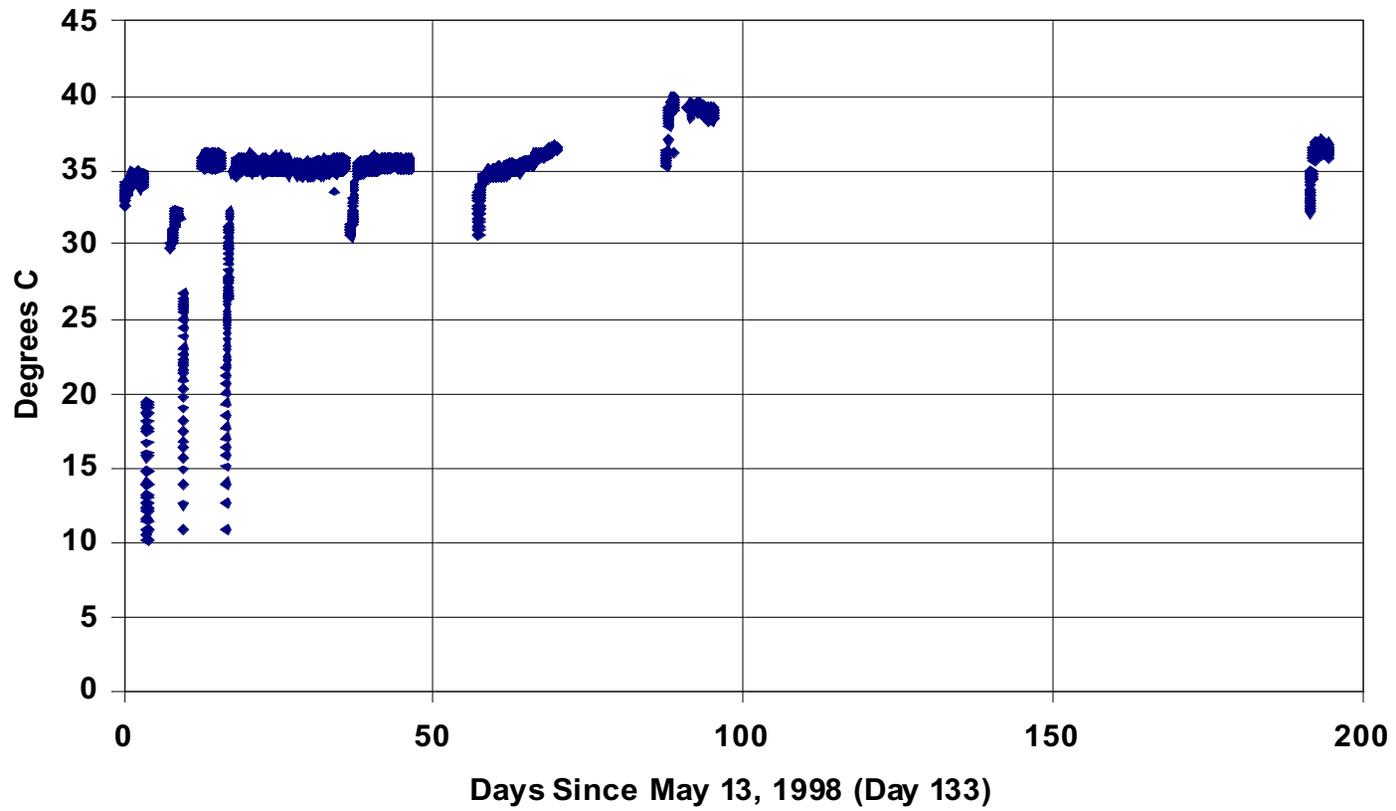
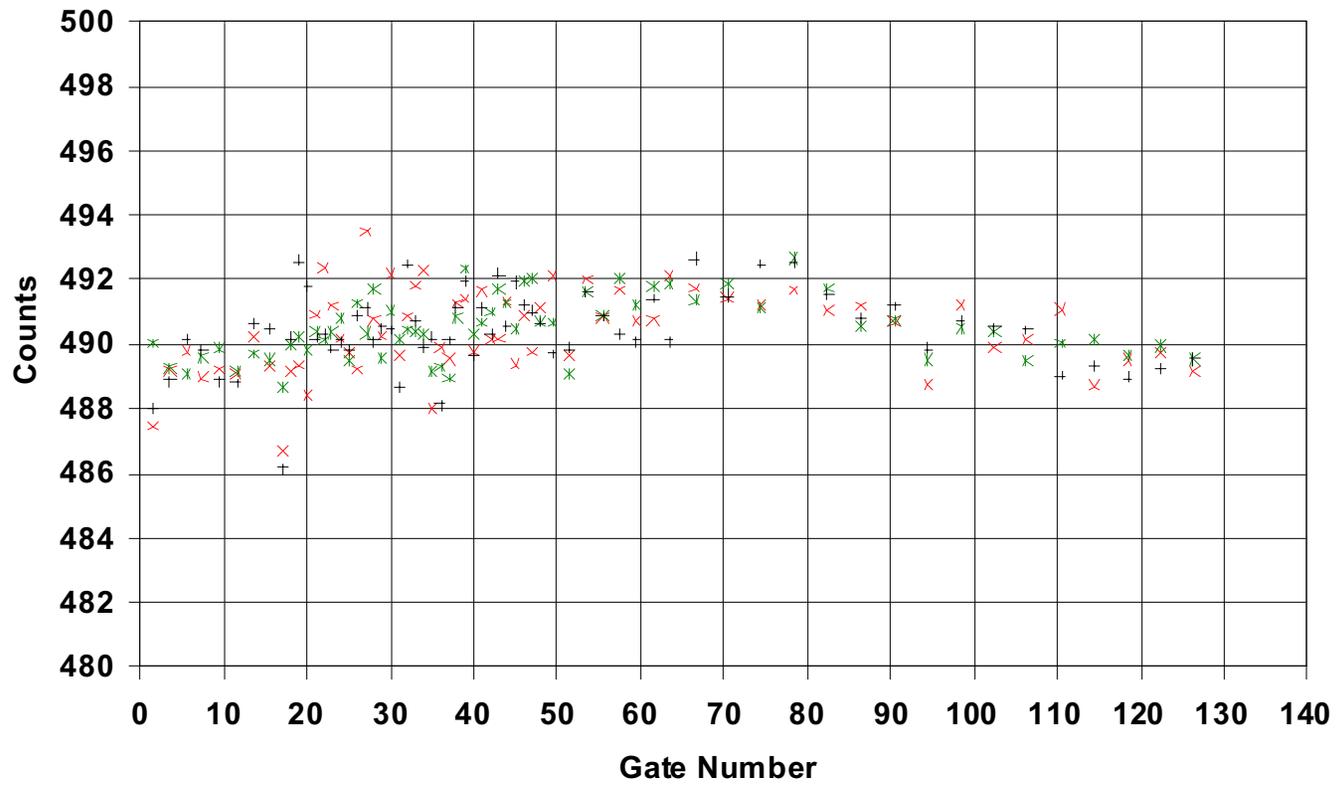


Figure 4. GFO Cal 2 In-Flight Waveforms Selected to 7/13/98



**Figure 5. GFO In-Flight Cal Mode Height
(relative to a fixed offset)**

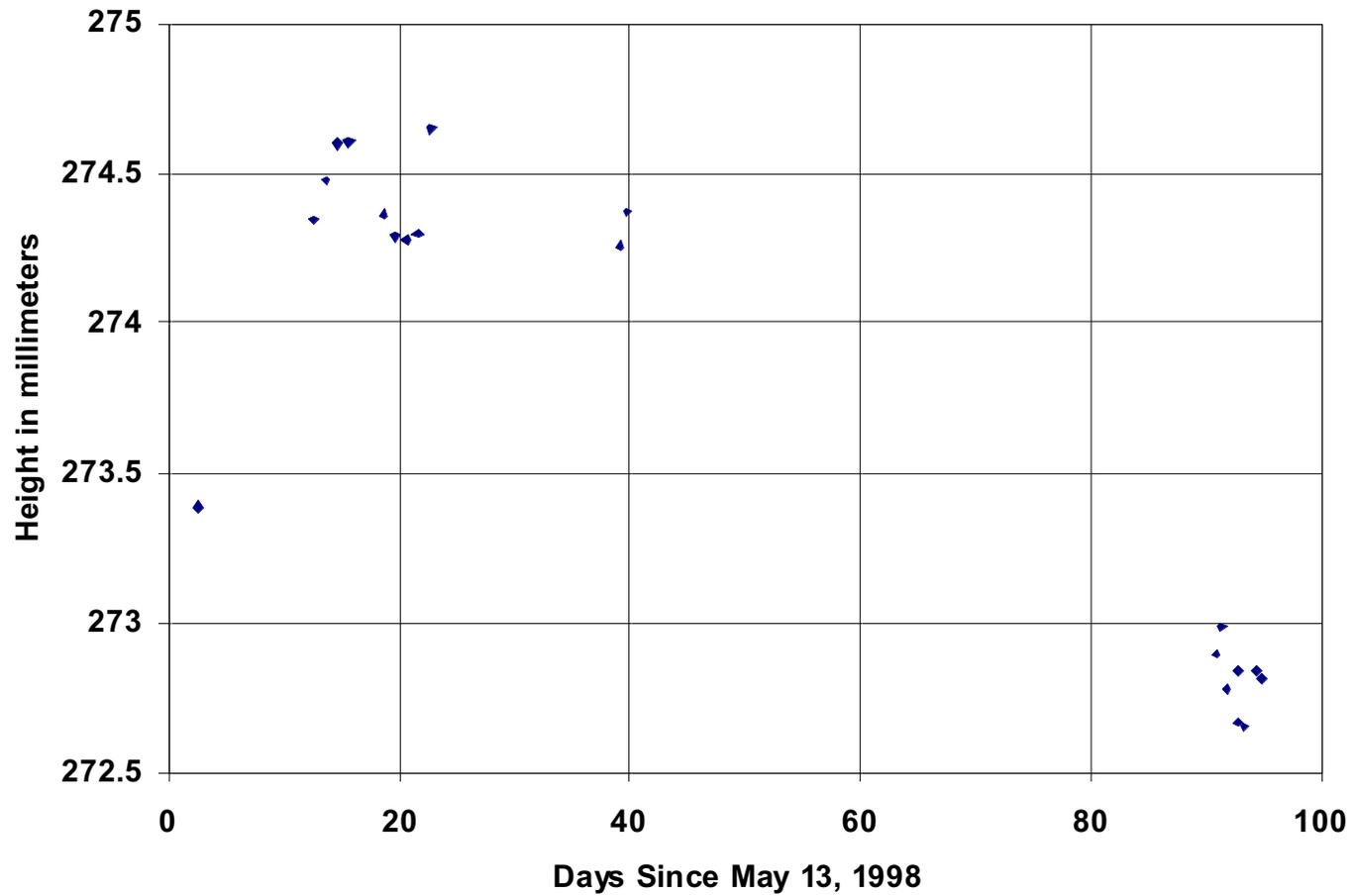


Figure 6a . GFO In-Flight Cal Mode 1 AGC

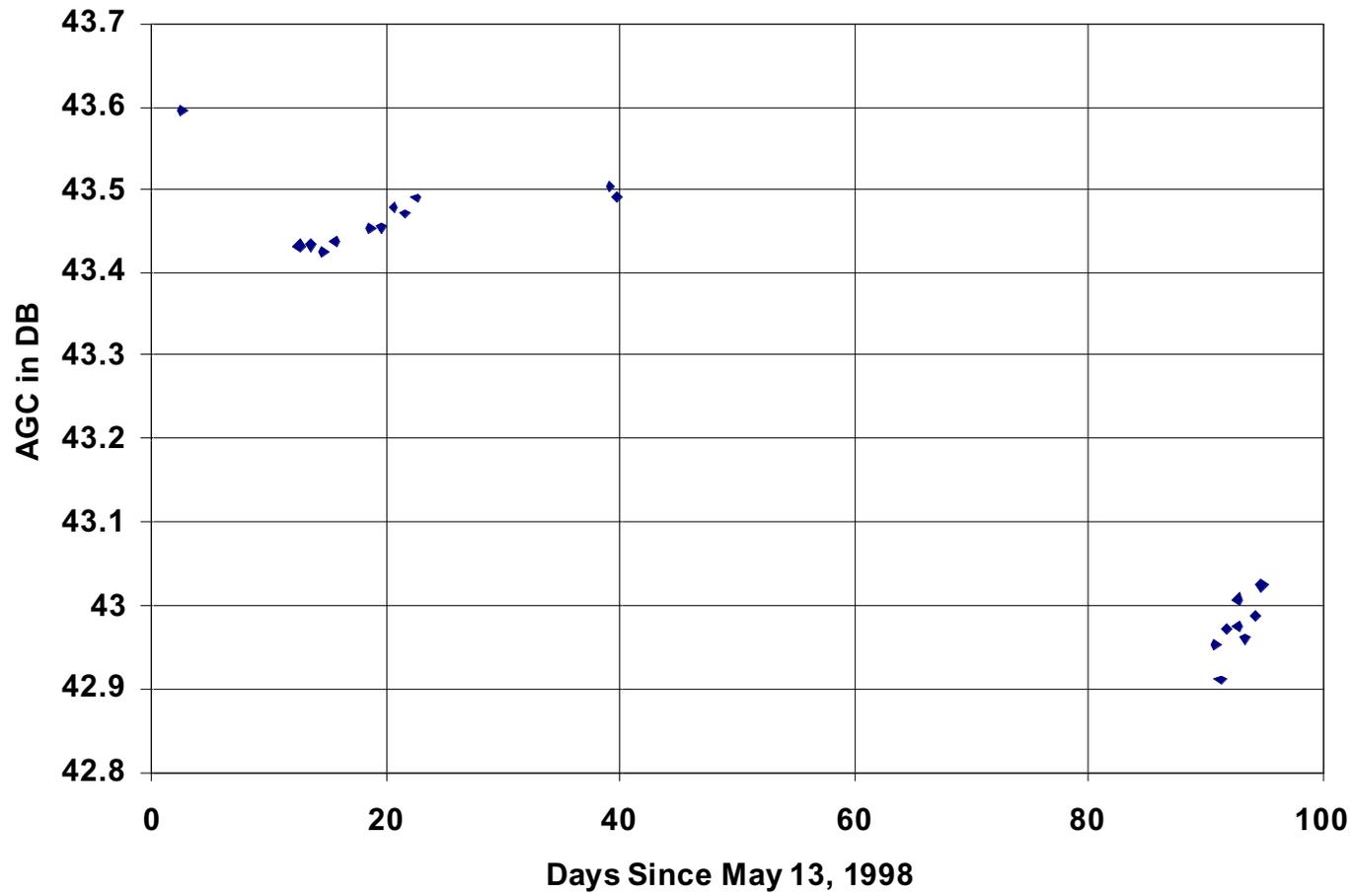
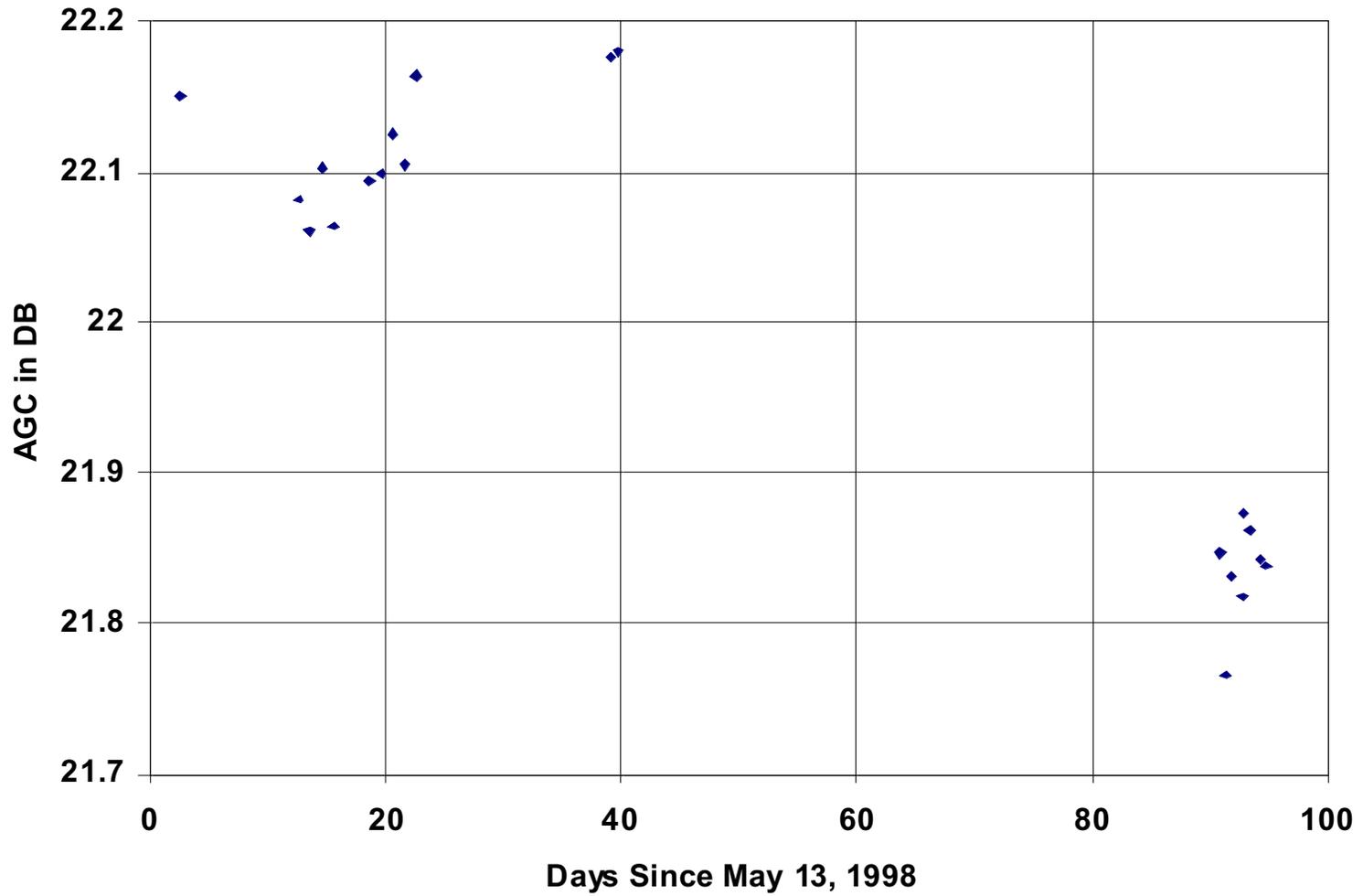


Figure 6b. GFO In-Flight Cal Mode 2 AGC



**Figure 7. Day 227 1998
02:20 to 02:45**

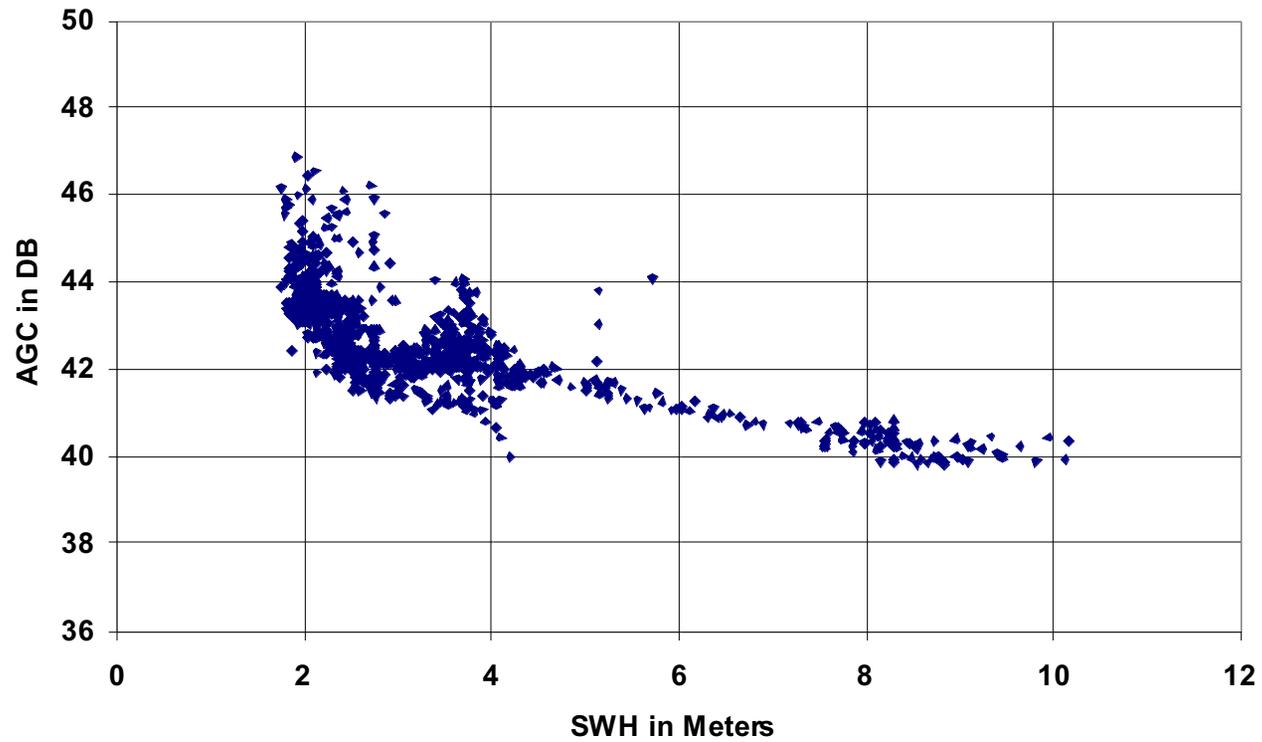
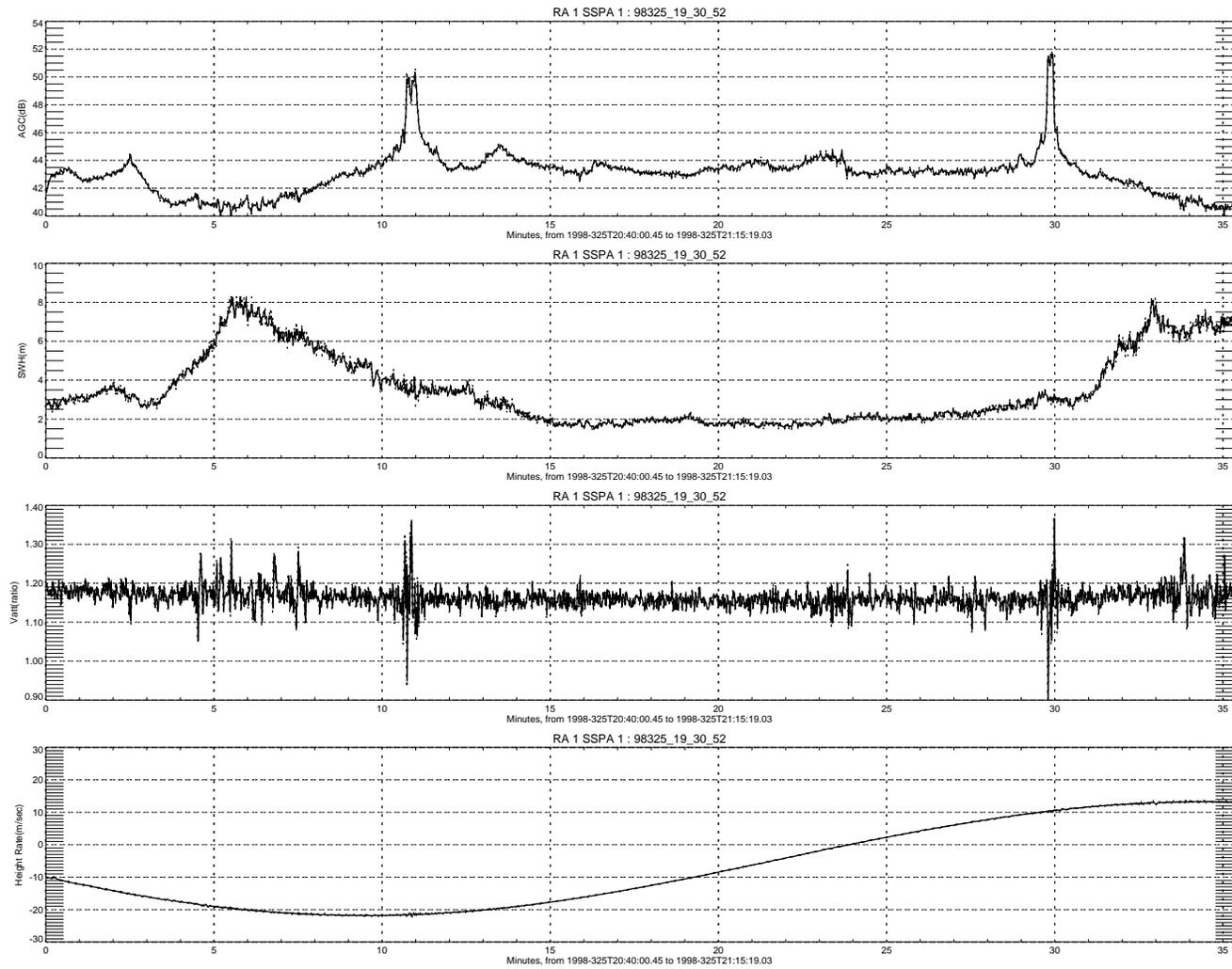


Figure 8. GFO Track Parameter Plot



GFO Program Status

- Altimeter performance very good
- Spacecraft problems with processor reset
 - Modified Software did not resolve problem
 - Switching Processors did not resolve problem
 - New software to be tested very soon
- GPS
 - All four GPS have problems receiving sufficient levels of signal to establish lock to provide time tag and position data.
 - Appears to be an amplifier problem
 - Possible GPS software fix to overcome
 - JPL developing GPS flight software modification
- Time tag
 - Design for GPS to supply time tag
 - Processor resets make difficult time tagging on the ground
 - A ground station timing unit has been developed and is being installed
 - Time tag system to be tested very soon
- Normal operations with Cal Mode is expected to start soon

See: <http://gfo.bmpcoe.org/gfo/>

See: <http://gfo.wff.nasa.gov>