

## Changes in TOPEX Side B Cal Mode Range Trend Starting at Cycle 364

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### Introduction

The TOPEX altimeter contains an internal calibration mode (Cal-1, hereafter) which tracks a time-delayed portion of the transmitted pulse. There are Cal-1 ranges for both the TOPEX Ku- and C-band altimeters, and we have been monitoring the Cal-1-derived combined delta ranges for the entire TOPEX lifetime. "Combined" refers to that weighted sum of Ku- and C-band results which eliminates path delays due to the ionospheric electron content, and "delta range" refers to the Cal-1 range after subtraction of an arbitrary but constant reference value. More calibration mode details are given by "TOPEX Altimeter Range Stability Estimates from Calibration Mode Data", by G.S. Hayne, D.W. Hancock III, and C.L. Purdy, in TOPEX/POSEIDON Research News, JPL 410-42, Issue 3, pp. 18-22, October 1994 (available at <http://topex.wff.nasa.gov/docs/RangeStabEst.pdf>). TOPEX cycle-averages of the combined delta ranges are reported in "TOPEX Altimeter Range Stability Estimate Update," G.S. Hayne (available at <http://topex.wff.nasa.gov/docs/RangeStabUpdate.html>, updated about once per month throughout the life of the TOPEX mission).

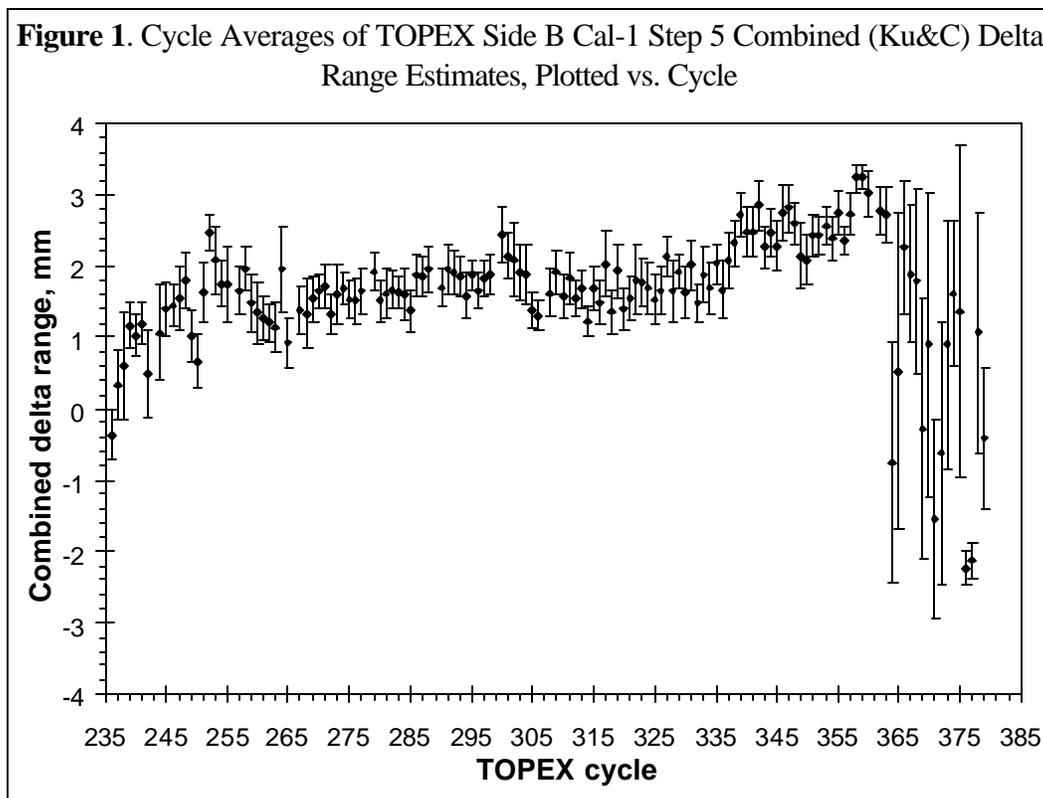
In August 2002 we described an apparent drift observed in the TOPEX altimeter's internal calibration mode's range measurement in the brief report "Discussion of TOPEX Side B Cal Mode Range Drift in Cycle 364", G. S. Hayne and D. W. Hancock III, August 15, 2002 (available at <http://topex.wff.nasa.gov/docs/calldht.pdf>). We reported then that the calibration mode combined (Ku & C) delta range had made a relatively sudden downward step of about 5 mm in the first half of cycle 364 and then was continuing at the new apparently stable lower value. The combined delta range change was almost entirely due to a change in the Ku-band Cal-1 delta range. Some three weeks after the August report, we saw that the Cal-1 combined delta range had not stayed at the 5 mm low value but had returned almost to the vicinity of its values prior to cycle 364, and we described this possible stability in another brief report "Discussion of TOPEX Side B Cal Mode Range Drift from Cycles 364 to 366," G. S. Hayne and D. W. Hancock III, September 6, 2002 (available at [http://topex.wff.nasa.gov/docs/sept\\_calldht.pdf](http://topex.wff.nasa.gov/docs/sept_calldht.pdf)).

Even the September report was too optimistic. Since then the delta range has continued to meander in a way that we do not understand. Today's report is only to try to characterize the odd history of the delta range in recent months; this report supersedes those of August and September 2002. Our Figures will

concentrate on the combined (Ku & C) Cal-1 range change, because it is the combined range that is of interest to the end user of the TOPEX data; however, the recent Cal-1 combined range change is almost entirely due to a change in the Cal-1 Ku-band range, and the Cal-1 C-band range has very little if any change over the time of the Ku-band change.

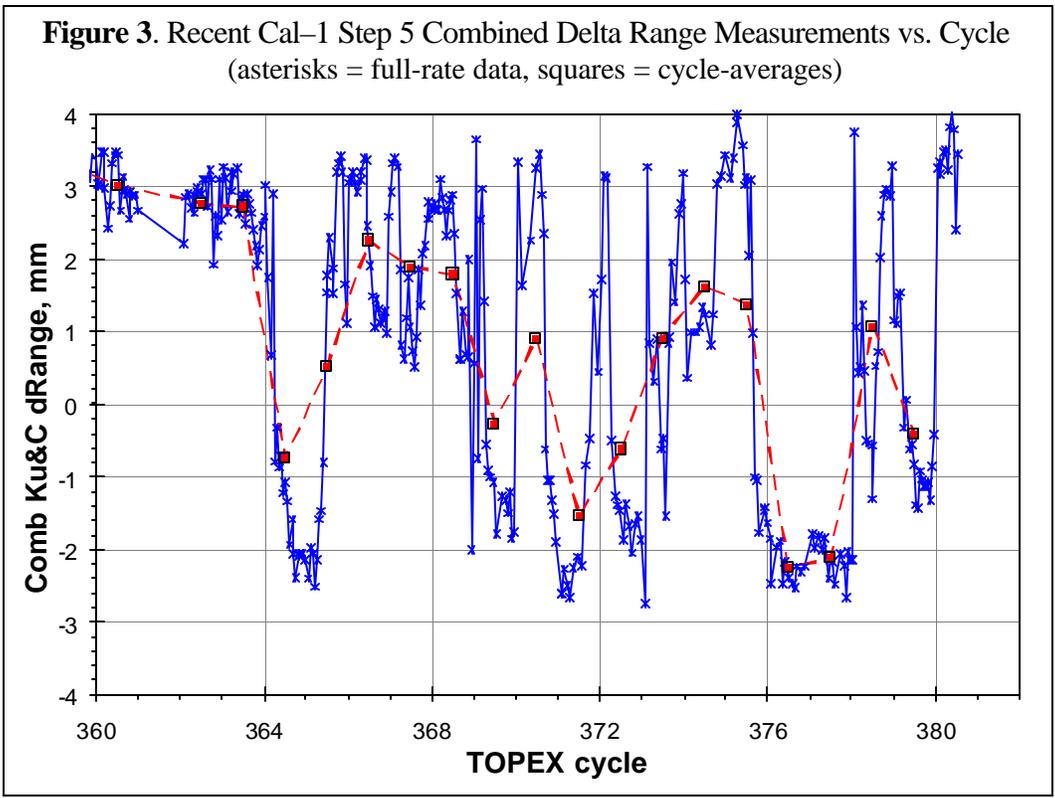
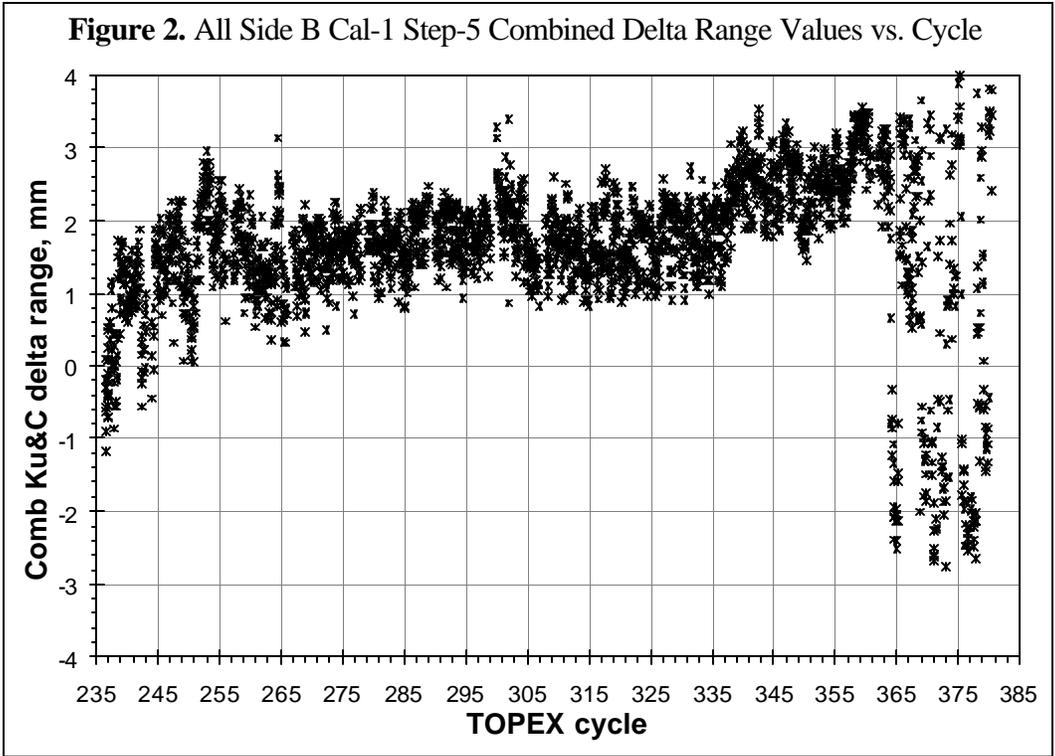
### Cal-1 Delta Range Results

Figure 1 presents the TOPEX cycle averages of the Cal-1-derived delta ranges for the combined Ku- and C-band result. The last complete data cycle in Figure 1 is number 379. There are about 20 individual Cal-1 results in each of the cycle averages in Figure 1, and the error bars indicate the



standard deviations in the averages. Figure 1 shows clearly that the Cal Mode delta range behavior changed at cycle 364.

To look at all the data from which the Figure 1 cycle averages were derived, Figure 2 presents the full-rate Cal Mode combined delta ranges for data from 2002 day 001 through 2003 day 012. Then Figure 3 uses an expanded horizontal scale to show the Cal Mode combined delta range data starting at cycle 360. Both the full-rate data and the cycle averages are plotted in Figure 3.



We repeat that, while this report has concentrated on the combined (Ku & C) Cal-1 range change, this Cal-1 combined range change is almost entirely due to a change in the Cal-1 Ku-band range. The Cal-1 C-band delta range has little if any change over the time of the Ku-band change and, unlike the Ku-band, there is no change in the Cal-1 C-band delta range characteristics before and after cycle 364.

### **Other investigations**

We have seen no significant changes in the altimeter's point target response (PTR). The PTR is in effect the transmitted pulse shape as observed by the receiver, and through all of Side B operation the PTR has been monitored by execution of a special calibration sweep (Cal Sweep) mode approximately once per month. After the appearance of the Cal-1 range change in cycle 364, the frequency of the Cal Sweeps was increased and a Cal Sweep is now executed once every 10-day data cycle. We have examined the data from all Cal Sweeps and we have found no significant changes in any recent Cal Sweep's PTR compared to the PTRs from any of the earlier Side B Cal Sweeps.

A Cal Sweep starts as a regular Cal Mode, and the first four AGC steps proceed normally with about 10 seconds of data in each step. About 3-4 seconds into the fifth AGC step the altimeter's normal Cal Mode tracking is interrupted and the fine height is stepped through its entire range several times in a procedure lasting several minutes. From the first several seconds of Cal-1 Step 5 there is a normal Cal-range available. We have always deleted that Cal-1 range from our Cal-1 range data sets because all other Cal-1 ranges are based on about 10 seconds of data while the Cal-1 range from a Cal Sweep is based only on three seconds or so of data. Therefore Figures 1 - 3 do not include the Cal-1 Step 5 results from any Cal Sweeps.

As indicated in our August 2002 report, we have searched in all the temperatures, voltages, currents, and powers which are monitored in the TOPEX engineering mode data, and have not found any parameters which were correlated with the Cal-1 range changes reported here. In September 2002 we thought that perhaps the +15 volt monitor had a very weak correlation with the Cal-1 range changes, but this has not been supported by the additional data since September.

### **Conclusion**

We note that the magnitude of the recent Cal-1 range change is only half a centimeter so it is the rate of the change, not the magnitude, which we find puzzling. The recent Cal-1 range changes (since cycle 363) are qualitatively unlike anything seen in the previous TOPEX Side B history. For now we can only wait and continue to monitor closely the altimeter data.