Task Objectives for Year 1 (original proposal)

- Develop and validate systematic PTR fitting and retracking procedures.
- Begin investigation of 59-day variation.
- Begin development of data product in consultation with OSTST.
- Begin retracking of TOPEX data.
- Set up quality assurance procedures for retracked data.

Task Objectives for Year 2 (original proposal)

- Complete retracking of TOPEX; retrack selected Jason-1, Jason-2 data.
- Complete investigation, correction of 59-day variation.
- Develop software for fitting for SSB.
- Begin SSB fitting.
- Develop error estimates for inclusion in data products.
- Complete definition of common netCDF data format.

Progress During Reporting Period

As indicated in the Financial section, progress during the early part of this period was less than planned because of personnel not being able to spend the planned amount of time on the task. However, during the last two months significantly more time has been available. Progress continues to be consistent with expenditures.

Because of previous shortfalls in both personnel and funding, the project has been extended for a year. We are currently finishing the tasks of the first year and working on those of the second year.

- Develop and validate systematic PTR fitting procedures – PTR estimation from data.

As described in the previous report, we implemented a closed form expression for PTR changes that result from a phase imbalance between the I/Q channels of the SSB mixer, as originally
proposed by R. Jensen of APL. The resulting expression produces a PTR whose shape varies not only with the phase imbalance, but also with the waveform sample number at which it is centered. In other words, a point target centered at one particular waveform bin would spread energy into the other bins differently than a point target centered at some other bin. This model produces many of the general features seen in the CalSweep data, but it does not fit the CalSweep well enough to allow a time variable phase difference to produce usable PTRs for processing.

During this period we investigated the full range of PTR bin centers between those used in calibrations – CalSweep (47-48), Cal-1 (46-47) – and the nominal track point (32-33). An I/Q phase error of about 18 degrees reproduces the late stage CalSweep PTR fairly well. The Cal-1 data are not left-right symmetric, and this feature is produced periodically as the center of the PTR is shifted. Comparing these results to the available calibration data show that +/-7 or fewer of the Cal-1 off-center points (i.e., 16 of 64) are usable for generating PTRs for retrack (Cal-1 data are available for each cycle up to 425 of 485.). Previous results and new runs of the retrack software show that +/-30 points are needed for stable retrack. The proposed method to createPTRs for retrack is to use the theoretical sinc-squared scaled to the outer sidelobe levels. The asymmetry noted in the real data and the simulations will be used in this scaling.

While studying the Cal-1 data, it was found that there are jumps in the data associated with temperature changes in the altimeter. In the next period, these temperature changes will be correlated with satellite events in an effort to understand whether they are peculiar to the Cal-1 measurements or are representative of the whole cycle. In the former case, the unusual data will not be used, and Cal-1 data and the derived PTRs from adjacent cycles will be substituted.

The other piece of instrument information that is needed for retrack is “weights” to adjust waveform samples for small (~ +/-5%) variations in gain. Different weights were used in the 2009 version of retrack that produced results rather different than previous attempts. The 2009 weights were derived from very limited ocean data fitting. The retrack software has been run with the pre-2009 weights and the 2009 systematic PTR fitting procedure (which needs revision as outlined above). Small but systematic differences between these new runs and the 2009 ones are observed that seem to confirm that the 2009 weights are not valid. Thus, our proposed retrack will use the original weights supplied by the instrument team and a PTR generation procedure related to that of 2009 but with the modifications outlined above.

- Develop Quality Assurance Procedures for Retracked Data.

In order to systematically evaluate different choices of PTRs and weights software that will be suitable for doing quality assurance on the final data products has been developed. The software could also be extended to produce the Sea State Bias (SSB) fit needed for the final data product; but, as noted below, we will probably rely on outside expertise for this fit.

The main features investigated are waveform residuals, which indicate the quality of the retrack fits, and the variation of the residual sea surface height (the final quantity of interest) with wave height and wind speed (i.e., SSB). It is desirable that the SSB structure more closely
resemble that of Jason-1/2 data and that it be stable with time, particularly for Alt-A as the PTR changes. Height and wave height trends over oceans and lakes/seas as well as along-track spectra of retracted parameters are also employed to assess the quality of the retracted data.

- **Begin retracking of TOPEX data.**

The full machinery of the retracking software has been set up on our development machine. Scripting to automatically run through multiple cycles of data, including importing needed files from the external long-term archive, has been exercised to run various test sets of data for analysis. The final output in netCDF format, along with final implementation of quality flags is yet to be developed.

The data processing that has been done indicates that it takes about 1 CPU core day to process 1 cycle. The development machine can use 7 cores for processing. Thus it would take about 65 calendar days to process the approximately 450 cycles of data. However, the Jason project has offered CPU resources to assist with processing, so that we should be able to cut this time to about 2 weeks. The processing set up will be ported to the Jason machines in the next two months for testing.

- **Begin Development of Data Product in Consultation with the OSTST**

We participated in the October OSTST meeting where an update to the Jason altimeter products was discussed. We have interacted with JPL and CNES system engineers to insure that compatible inputs exist to update the TOPEX data product to the same standards. The schedule for the release of initial (before Sea State Bias correction) TOPEX products is consistent with the Jason schedule.

- **Develop Software for Sea State Bias Fitting**

At the October OSTST meeting we discussed Sea State Bias approaches with Doug Vandemark who has become the leading expert on this correction. He and collaborators have developed an extensive software system for generating and comparing SSB solutions from the altimeter data. He agreed to apply this software to the TOPEX data as it becomes available. This will result in a substantial time savings for this project as well as insuring compatibility with Jason products.