

Jet Propulsion Laboratory
California Institute of Technology

Date: 2012/03/22

From: Philip S. Callahan

Subject: NOAA Climate Data Records Program – Generation of Altimeter Climate Data Records Using Retracking and Updated Corrections – Progress Report

NOAA Identification: Announcement: NOAA-NESDIS-NESDISPO-2011-2002566

JPL Identification: Task Order No.: NMO716236. Task Plan: 82-16240

Report Period: 2011 September 23 to 2012 March 21

Task Objectives for Year 1

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

Progress During Reporting Period

As indicated in the Financial section, progress is somewhat less than planned because of difficulty in finding suitable personnel during part of the reporting period. Nonetheless, significant progress has been made, a new person to assist with the analysis has been identified, and it is expected to be on plan by September.

- **Develop and validate systematic PTR fitting and retracking procedures.**

Existing documentation on altimeter performance and waveform features was revisited to determine effects that have been neglected in the retracking efforts of 2007 and 2009. Some useful details on both waveform features and point target response (PTR) degradation were found.

A simulation of waveforms and retracking was developed to incorporate the information found in the literature review in order to understand how small variations in these features will affect the retracking. The simulations reproduce features found in simpler simulations such as sensitivity to noise and also allow investigation of such effects as sea surface skewness. Statistics from numerous runs of the simulator including varying noise, skewness, and levels of waveform leakages are being evaluated.

The key outcome from the simulations will be an approach to a time dependent model separating the PTR from the waveform weights. The waveform weights are thought to be the problem with the 2009 retracking. Having a specific model for the time dependence of the PTR will allow more freedom in adjusting the weights.

The onboard altimeter calibration data (Cal-1) were reviewed including special measurements called Cal Sweeps in which the PTR is sampled at much higher resolution than in the regular once per cycle (10 days) Cal-1. Discrepancies between Cal Sweep information that had been used previously to check PTRs obtained from Cal-1 and the original Cal Sweep data were found. These differences are currently under investigation.

- **Begin investigation of 59-day variation.**

Work on 59-day variations for the Ocean Surface Topography Science Team (OSTST) was reviewed. It was realized that an additional variable that could affect the variations was the spacecraft clock calibration that is used in the Oscillator Drift Correction to adjust the altimeter range. The clock calibration data were obtained and an initial analysis showed a 59-day variation. The details of the affect on the altimeter range are currently under investigation.

- **Begin development of data product in consultation with OSTST.**

During a fortuitous trip to Toulouse in January, a meeting was held with CNES and CLS (CNES support contractor) on providing assistance with retracking studies and geophysical corrections for final products. CNES has agreed to provide updated meteorological data consistent with that used on Jason series altimeters when the data are needed. CLS has agreed to perform retracking studies to validate approaches developed in this effort. Initial information on waveforms and calibration data has been provided to CNES/CLS.

Financial Status

Total Funds Allocated: \$345,429

Estimated Funds Exhaustion Date: 2012/09/30

Total Funds Expended: through 2012/03/13, \$32,580

Financial Analysis:

This task is currently underspent relative to original plans due to difficulties in finding suitable personnel to assist the PI. The person who began work in November decided to leave JPL and only recently was a replacement found. The new person is ramping up now and will provide full support by mid-April.

We expect to spend at a higher rate through the rest of the fiscal year to meet technical goals. We currently estimate that the originally estimated date of funds exhaustion still holds.

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JPL Identification: Task Order No.: NMO716236. Task Plan: 82-16240

Report Period: 2012 March 22 to 2012 September 22

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.

Progress During Reporting Period

As indicated in the Financial section, progress is somewhat less than planned because of personnel not being able to spend the planned amount of time on the task. Nonetheless, significant progress has been made, and the new person assisting with the analysis has been providing excellent support. Progress continues to be consistent with expenditures.

- **Presentations were prepared for**
 - NOAA CDR Conference, July
 - 20 years of Progress in Ocean Altimetry and OSTST, September. The poster from this meeting is provided separately.
- **Develop and validate systematic PTR fitting and retracking procedures.**

Evaluation of the effects of waveform “leakages” continued during this period. The leakages are spurious signals that found their way into the signal path. The simulation developed during the first reporting period was found to breakdown in most cases with leakages, although it performed adequately for normal waveforms. Thus, the statistics that were initially developed were not usable. This work did contribute by showing the limit of standard search methods for finding retracking solutions. If a method other than the current semi-analytical one is to be developed, it will require significantly more effort than is currently planned.

A simulation derived from the current retracking method was found in the collection of existing code and was put into use. The simulations show two important results:

- The effects of leakages are larger than expected, 1-2 cm in range at 2 m SWH (Significant Wave Height) to 5-8 cm at 6 m SWH and about 0.05 m in SWH at 2 m SWH to 0.3 m at 6 m SWH, with little effect on the RMS deviation of the solutions. The strong variation with SWH is very bad for the accuracy of the global data set because of the systematic variation of average SWH geographically and seasonally. The effect of leakages probably also explains a long-standing question about why the TOPEX sea state bias (SSB) is significantly different than that of Jason.
- Solving for skewness increases the RMS of range by about 50%.

The latter is a very important result as previously solving for skewness was the approach to accounting for the leakages. The simulations suggest that not solving for skewness and accounting for leakages with corrections from simulations may be a more accurate method. Some additional simulation evaluation will be done to test this idea. To use it in practice would require the development of a smoothed model as a function of retrieved parameters (at least SWH and attitude) to apply uniformly during processing. These results also help to confirm that the bad results from the 2009 retracking effort that tried to adjust for the leakages introduced errors from using too little data in the correction process.

Based on point 1 above, a test of the effectiveness of the correction approach will be finding that the SSB solution based on retracked data is much more similar to that of Jason than previously. This can serve as a global quality metric for the new data set. It could be evaluated initially when about 2 years of data have been processed.

Discrepancies between Cal Sweep information that had been used to check PTRs (Point Target Response) obtained from Cal-1 found in the previous period were investigated, but final conclusions have not been reached. When the Cal Sweep data are validated they will be provided to CNES/CLS for numerical retracking studies to support this investigation.

An evaluation of the method for fitting the Gaussians used in the semi-analytic retracking method to the once per 10-day Cal-1 PTR measurements was begun. Initial results showed that care must be taken to keep the total “power” in the PTR consistent as the number of terms is varied. Investigation of the number of terms needed to produce stable results for the PTR and in simulations is continuing.

- **Begin investigation of 59-day variation.**

No work on 59-day variations (spacecraft clock calibration/Oscillator Drift Correction) was done during this period.

- **Begin development of data product in consultation with OSTST.**

New updates to the Jason data were discussed with CNES. These will require revisions to the final production software.

Financial Status

Total Funds Allocated: \$345,429 + \$25,000

Estimated Funds Exhaustion Date: 2013/06/30

Total Funds Expended: through 2012/09/01, \$168,580

Financial Analysis:

This task is currently underspent relative to original plans due to personnel (including PI) not being able to devote the planned amount of effort due to other oceanographic projects. We expect to spend at a slightly higher rate during the next period in order to approach technical goals, but also consistent with reduced funding. The above funds exhaustion date is based on this somewhat slower plan and the availability of funds.