ICESat/GLAS Laser 1 Summary

April 2011

Tim Urban[1], Urban@csr.utexas.edu
David Handcock[2], David.W.Hancock@nasa.gov
Bob Schutz[1], Schutz@csr.utexas.edu

[1]Center for Space Research, The University of Texas at Austin
[2]Wallops Flight Facility, NASA

The laser 1 campaign was a unique period of the ICESat mission. Laser 1 was turned on 20 February 2003 and failed on 29 March 2003 (operating from day of year 051 to 088). This first campaign provided a commissioning and a calibration/validation phase of the spacecraft, instrument, and operations. Issues met during these 38 days included many of the complexities of operations and data product generation that were encountered during the subsequent seven years of operation by lasers 2 and 3.

Laser 1 data underwent extensive analysis during 2003, and again at the end of the "2011 Reprocessing" of all the ICESat science data. The ICESat PAD/POD team (Precision Attitude Determination and Precision Orbit Determination) applied methods that were tested and refined over the previous eight years to provide the best quality laser 1 data. Hence, to the best of our knowledge, laser 1 data meet all requirements of elevation precision and accuracy. However, to ensure that the end user is fully informed, details concerning the unique nature of the laser 1 period are summarized below.

- The entire laser 1 campaign is officially designated L1a, although unofficially the airplane mode has been referred to as L1b.
- The spacecraft was in an 8-day repeat orbit for calibration/validation and completed four and half cycles (one 8-day cycle=119 orbit revolutions), from cycle-track number 001-72 to 006-23.
- During the first two days of laser 1 operation, the Laser Profile Array (LPA) coordinates were updated to optimize the LPA spot location in the detector.
- Over the course of laser 1 operations, the laser footprint (or spot) became non-elliptical and developed a "side lobe", effectively increasing the major axis of the footprint from 130 m to 160 m.
- To mitigate frequent upsets of the Laser Reference System (LRS) during Laser 1 operations, the LRS was turned off in daylight.
- The minimum gain was set to 4 from initial laser operation until 8 March 2003 (day of year 67) when it was changed to a minimum gain of 13. The elevation saturation correction does not provide a proper correction when the gain is below 13.

- The spacecraft orientation was changed from sailboat mode (-Y direction) to airplane mode (+X direction) while the laser was in operation on 21 March 2003 (day of year 080) at 17:20 UTC.
- The spacecraft entered Sun Acquisition Mode on 26 March 2003 at 11:41 UTC (day of year 085), causing a subsequent science data gap of about 13 hours.
- The temperature of laser 1 was lowered twice on 27 March 2003 (day of year 086) at 12:05 UTC and 17:04 UTC.
- Laser 1 failed on 29 March 2003 (day of year 088) at 14:57 UTC.

During the "2011 Reprocessing" activity, and given the unique nature of laser 1, the PAD team calculated three different candidate solutions for laser spot geolocations using slightly different algorithms. Analysis of statistics from ocean mean sea surface and ice sheet crossover computations allowed the team to select the geolocation solutions that appeared to perform the best in each of three distinct time periods.

The following list describes the time periods, gives the name of solution process, and the reasoning behind the adoption of each correction for the Release 633 elevation products for L1a. For details of the solution process, see the document "ICESat-1 pointing cal/val and obatt file correction summary".

- 20 February to 21 March yaw flip (day of year 051 to 080)
  - Corrv1c
  - Analysis of statistics from ocean mean sea surface and ice sheet crossover computations indicates that Correction 1 elevation accuracy and stability are consistent internally and are similar to statistics from laser 2 and 3 campaigns.

- 21 March yaw flip to 26 March safe hold (day of year 080 to 085)
  - Corrv1b corr3
  - Analysis of statistics from ocean mean sea surface (ascending-descending difference) computations indicates the best performance from Correction 3.

- 27 March to 29 March (day of year 086 to 088)
  - Corrv1b corr2
  - Analysis of statistics from ocean mean sea surface (bias and ascending-descending difference) and ice sheet crossover computations indicates the best performance from Correction 2.