ICESat Attitude Data Description for Day 196 to Day 226 (2010)

Summary

ICESat was de-orbited with a series of maneuvers that took place over the period from end of June to July 14, 2010. This document gives a description of the resulting attitude data and the data used to generate the attitude products. On July 14 (Day of Year 195), all remaining fuel was expended with the de-orbit maneuvers.

Attitude Product Description

The attitude information is given as quaternions, which are commonly used to describe spacecraft attitude. The methodology used to generate the quaternions can be found in the ICESat Precision Attitude Determination Algorithm Theoretical Basis Document (Bae and Schutz, 2002; Chapter 2 and Appendix A) and the basic reference book of Spacecraft Attitude Determination and Control, Ed. Wertz (1978; Chapter 12 and Appendix D).

The ICESat attitude files provide quaternions for the spacecraft attitude for each day during the specified period and the file naming convention includes the day of year (e.g., ICESAT_ATTITUDE_2010xxx.txt, where xxx represents the three-digit Day of Year). The file content is illustrated in Table 1.

The ICESat attitude was generated using the Bus Star Tracker 2 (BST-2), which is one of two Ball CT-602 trackers on spacecraft bus with an 8º field of view, and a Litton HRG gyro, also known as SIRU. Another star tracker, BST-1 could not observe stars for long period of time (around 1000 seconds) every orbit during the time of ICESat de-orbit due to the periodic proximity of the Sun to its field of view (FOV). This sun-blinding on BST-1 made the quality of attitude information degraded substantially comparing to the attitude based on BST-2 data.

During the time periods given in Table 2, problems were encountered with the ability to transmit the BST and SIRU data to the ground. As a consequence, the attitude was generated using a model created from the attitude results in other time periods with similar attitude. For all times not given in Table 2, the attitude was based on BST and SIRU data. The methodology used to generate the attitude quaternions for all time except those shown in Table 1 was based on an Extended Kalman Filter (EKF), as described by Bae and Schutz (2002), using the BST and SIRU data. During the periods when BST and SIRU data were available, the resulting attitude is estimated to have an accuracy of better than 10 arcsec. During the periods shown in Table 2 when the attitude was modeled because of missing BST and SIRU data, the resulting attitude is estimated to have an accuracy of approximately 500 arcsec.

Table 1. Example Attitude data (start of day 197). Note that the time tags are given in GPS-Time, which differed from UTC in this time period by 15 seconds.

	GPS time from 00:00	q1	q2	q3	q4
Day 197	0.030976	0.206184417	0.546357852	-0.342133587	0.736156024
	0.130881	0.206204467	0.546401515	-0.342120861	0.736123915
	0.231158	0.206224737	0.546442783	-0.342110658	0.736092345
	0.330959	0.206245044	0.546485771	-0.342097833	0.736060701
	0.431117	0.206265405	0.54652913	-0.342085824	0.736028384
	0.530731	0.206285715	0.546571774	-0.342073972	0.735996534
	0.630968	0.20630586	0.546614164	-0.342062594	0.735964693
	0.730674	0.206325542	0.546657738	-0.342049625	0.735932838
	0.830984	0.206345348	0.546701495	-0.342037818	0.735900267
	0.930745	0.206365906	0.546744449	-0.342024715	0.73586868

Table 2. Time spans for missing BST and SIRU data.

	GPS time from 00:00	
	Start	End
day 196	4668.934338	5761.134571
day 218	21608.84144	37789.94034

References:

Bae, S., and B. Schutz, *ICESat Precision Attitude Determination Algorithm Theoretical Basis Document*, 2002 (updated version 2012, in preparation). Available at http://www.csr.utexas.edu/glas/atbd.html as pdf file.

Wertz, J. R. (Ed.), *Spacecraft Attitude Determination and Control*, Kluwer Academic Publishers, Dordrecht, 1978.