

**University of Texas
Center for Space Research**

**ICESAT/GLAS
CSR SCF Release Notes
for
Orbit and Attitude Determination**

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CSR SCF Release Notes for Orbit and Attitude Determination

- Notes for ANC04, ANC08, and ANC09 ancillary files reported by UTCSR
- Includes descriptions of each ANC file type for each ANC release of each campaign
- Includes calibration level numbers used to determine the Y-code in the release naming convention for the elevation products GLA06 and GLA12-15. (See also *YXX Release Number Convention* document.)

General Notes

ANC04: ICRF to ITRF Transformation File

The transformation between the International Celestial Reference Frame (ICRF) and the International Terrestrial Reference Frame (ITRF) depends on Earth orientation parameters provided by the International Earth Rotation Service (IERS). It is critical that the same values used in ICESat precision orbit determination (POD) are used in the geolocation algorithm. Thus, UTCSR typically provides one product with the rapid POD products, generated during the laser operations campaign, and a second one with the final POD products, generated during data reprocessing after the completion of the campaign.

ANC08: Precision Orbit Determination (POD) Ephemeris File

The differences between the ICESat rapid and final POD products are entirely related to the inputs from external sources. The most significant of these are the orbits of the GPS satellites, as determined by the International GPS Service (IGS), which provides its own rapid and final solutions. To generate the ICESat rapid POD products (*POD calibration level 1*), UTCSR uses the IGS rapid orbit solutions, along with preliminary IERS Earth orientation parameters (mentioned above), and rapid estimates of solar flux and geomagnetic indices obtained from the National Oceanic and Atmospheric Administration (NOAA) Space Environment Center. Unless otherwise noted, final POD products (*POD calibration level 2*) are generated using the final IGS orbit solutions for the GPS satellites, the final IERS Earth orientation parameters, and final estimates of solar flux and geomagnetic indices provided by the National Geophysical Data Center.

ANC09: Precision Attitude Determination (PAD) File

During the course of the ICESat mission, the determination of the laser-pointing direction for each transmitted pulse has evolved significantly. As a result, however, there have been, and continue to be, multiple releases of these precision attitude determination (PAD) solutions for each campaign (comprising *PAD calibration levels 1 to 4*). In general, during a laser campaign, UTCSR computes instrument attitude solutions using an Extended Kalman Filter (EKF) to process gyro and uncorrected instrument star-tracker (IST) data, and then applies fixed laser biases to obtain the laser pointing directions. After a campaign concludes, UTCSR applies calibration corrections to account for IST and laser motion with respect to the instrument. For different campaigns, these corrections have been based on: (1) direct observations made in the on-board Laser Reference Sensor

(LRS); (2) models using limited LRS data; (3) differencing of the EKF and batch-derived attitude solutions; and (4) ocean and around-the-world scan maneuvers. New campaigns will likely be limited to the rapid solutions described above (*PAD calibration level 1*), and the fully calibrated solutions (*PAD calibration level 4*), which combine the last two corrections.

Laser 1a

I-SIPS Product Release(s)	Start Date (DOY)	Stop Date (DOY)	UTCSR ANC04 Release	UTCSR ANC08 Release/ Level	UTCSR ANC09 Release/ Level	Elevation Product Y-code
18	20-Feb-2003 (051)	21-Mar-2003 (080)	2	2/2	11/3	3
17	05-Mar-2003 (064)	21-Mar-2003 (080)	2	2/2	8/2	2
11-13	20-Feb-2003 (051)	21-Mar-2003 (080)	2	2/2	2/1	1
8-10	20-Feb-2003 (051)	21-Mar-2003 (080)	10*	10*/1	10*/1	1

* UTCSR Release 10 was incorrectly used to label products that were actually Release 1.

ANC04

Release 2

- Generated during final POD solutions
- Added RELEASE keyword to standard header
- Added USEBEG and USEEND keywords to file-specific header

Release 10 (see footnote in table above)

- Generated during rapid POD solutions

ANC08

Release 2 (*POD calibration level 2*)

- Final POD solutions
- Added RELEASE keyword to standard header

Release 10 (see footnote in table above) (*POD calibration level 1*)

- Rapid POD solutions

ANC09

Release 11 (*PAD calibration level 3*)

- Applied 50-ms correction to gyro time tags and implemented gyro time-tag interpolation algorithm
- Added Laser Profiling Array (LPA) centroid (X,Y) and pulse orientation with respect to LPA X-axis at 40-Hz
- Applied Release 8 laser biases

Release 8 (*PAD calibration level 2*)

- Applied modeled LRS corrections to compensate for IST motion with respect to the instrument
- Updated and applied laser biases to pre-launch alignment

Release 2 (*PAD calibration level 1*)

- Tuned EKF parameters
- Changed LPA orientation to be measured with respect to topocentric North
- Added RELEASE keyword to standard header
- Added USEBEG and USEEND keywords to file-specific header
- Added DEGRADE_INDEX_START and DEGRADE_INDEX_STOP keywords to file-specific header
- Applied additional laser biases to pre-launch alignment based on range-residual analysis of ocean scans

Release 10 (see footnote in table above) (*PAD calibration level 1*)

- Used pre-launch estimate of laser alignment (no additional biases)

Laser 1b

I-SIPS Product Release(s)	Start Date (DOY)	Stop Date (DOY)	UTCSR ANC04 Release	UTCSR ANC08 Release/ Level	UTCSR ANC09 Release/ Level	Elevation Product Y-code
8-10	21-Mar-2003 (080)	29-Mar-2003 (088)	10*	10*/1	10*/1	1

* UTCSR Release 10 was incorrectly used to label products that were actually Release 1.

ANC04

Release 10 (see footnote in table above)

- Generated during rapid POD solutions

ANC08

Release 10 (see footnote in table above) (*POD calibration level 1*)

- Rapid POD solutions

ANC09

Release 10 (see footnote in table above) (*PAD calibration level 1*)

- Used pre-launch estimate of laser alignment (no additional biases)

Laser 2a

I-SIPS Product Release(s)	Start Date (DOY)	Stop Date (DOY)	UTCSR ANC04 Release	UTCSR ANC08 Release/ Level	UTCSR ANC09 Release/ Level	Elevation Product Y-code
26	25-Sep-2003 (268)	18-Nov-2003 (322)	2 (v2)	4/2	25/4	4
21,24	25-Sep-2003 (268)	18-Nov-2003 (322)	2 (v2)	4/2	15/4	4
19	25-Sep-2003 (268)	18-Nov-2003 (322)	2 (v2)	4/2	13/3	3
18	25-Sep-2003 (268)	18-Nov-2003 (322)	2 (v2)	4/2	9/3	3
14,17	25-Sep-2003 (268)	18-Nov-2003 (322)	2 (v1)	3/1	6/2	2
12	25-Sep-2003 (268)	18-Nov-2003 (322)	2 (v1)	3/1	2/1	1

ANC04

Release 2 (v2)

- Generated during final POD solutions
- Maintained release number, but incremented version to 2

Release 2 (v1)

- Generated during rapid POD solutions
- Added RELEASE keyword to standard header
- Added USEBEG and USEEND keywords to file-specific header

ANC08

Release 4 (*POD calibration level 2*)

- Final POD solutions
- Changed gravity field from GRACE31 to GGM01C

Release 3 (*POD calibration level 1*)

- Rapid POD solutions
- Changed gravity field from GRACE31 to GGM01C

ANC09

Release 25 (*PAD calibration level 4*)

- Updated Laser Profiling Array (LPA) spot characteristics to reflect $1/e^2$, rather than fixed, cutoff in intensity values

Release 15 (*PAD calibration level 4*)

- Applied scan-maneuver calibrations
- Removed pre-launch laser alignment and subsequent biases

Release 13 (*PAD calibration level 3*)

- Applied de-distortion map (L2a Version 1) to IST data
- Applied Release 6 laser biases

Release 9 (*PAD calibration level 3*)

- Applied 50-ms correction to gyro time tags and implemented gyro time-tag interpolation algorithm
- Added LPA centroid (X,Y) and pulse orientation with respect to LPA X-axis to each 40-Hz record
- Applied Release 6 laser biases

Release 6 (*PAD calibration level 2*)

- Applied direct LRS corrections to compensate for IST motion with respect to the instrument
- Corrected star catalog precession error
- Updated and applied laser biases to pre-launch alignment
- Removed incorrect adjustment of laser biases to account for velocity aberration

Release 2 (*PAD calibration level 1*)

- Tuned EKF parameters
- Changed LPA orientation to be measured with respect to topocentric North
- Added RELEASE keyword to standard header
- Added USEBEG and USEEND keywords to file-specific header
- Added DEGRADE_INDEX_START and DEGRADE_INDEX_STOP keywords to file-specific header
- Applied Laser 1 Release 2 laser biases

Laser 2b

I-SIPS Product Release(s)	Start Date (DOY)	Stop Date (DOY)	UTCSR ANC04 Release	UTCSR ANC08 Release/ Level	UTCSR ANC09 Release/ Level	Elevation Product Y-code
26	17-Feb-2004 (048)	21-Mar-2004 (081)	2 (v2)	6/2	23/4	4
22	17-Feb-2004 (048)	21-Mar-2004 (081)	2 (v2)	6/2	20/3	3
15-17	17-Feb-2004 (048)	21-Mar-2004 (081)	2 (v1)	3/1	6/1	1

ANC04

Release 2 (v2)

- Generated during final POD solutions
- Maintained release number, but incremented version to 2

Release 2 (v1)

- Generated during rapid POD solutions
- Added RELEASE keyword to standard header
- Added USEBEG and USEEND keywords to file-specific header

ANC08

Release 6 (*POD calibration level 2*)

- Final POD solutions
- Changed zenith delay parameter estimation strategy for short passes

Release 3 (*POD calibration level 1*)

- Rapid POD solutions
- Changed gravity field from GRACE31 to GGM01C

ANC09

Release 23 (*PAD calibration level 4*)

- Applied scan-maneuver calibrations
- Removed pre-launch laser alignment and subsequent biases
- Updated LPA spot characteristics to reflect $1/e^2$, rather than fixed, cutoff in intensity values

Release 20 (*PAD calibration level 3*)

- Replaced direct LRS corrections with batch-EKF corrections to compensate for IST motion with respect to the instrument
- Applied de-distortion map (L2a Version 1) to IST data
- Updated and applied laser biases to pre-launch alignment

Release 6 (*PAD calibration level 1*)

- Applied direct LRS corrections to compensate for IST motion with respect to the instrument
- Corrected star catalog precession error
- Applied Laser 2a Release 6 laser biases
- Removed incorrect adjustment of laser biases to account for velocity aberration

Laser 2c

I-SIPS Product Release(s)	Start Date (DOY)	Stop Date (DOY)	UTCSR ANC04 Release	UTCSR ANC08 Release/ Level	UTCSR ANC09 Release/ Level	Elevation Product Y-code
17	18-May-2004 (139)	21-Jun-2004 (173)	2 (v1)	3/1	7/1	1

ANC04

Release 2 (v1)

- Generated during rapid POD solutions
- Added RELEASE keyword to standard header
- Added USEBEG and USEEND keywords to file-specific header

ANC08

Release 3 (*POD calibration level 1*)

- Rapid POD solutions
- Changed gravity field from GRACE31 to GGM01C

ANC09

Release 7 (*PAD calibration level 1*)

- Applied Laser 2b Release 6 laser biases

Laser 3a

I-SIPS Product Release(s)	Start Date (DOY)	Stop Date (DOY)	UTCSR ANC04 Release	UTCSR ANC08 Release/ Level	UTCSR ANC09 Release/ Level	Elevation Product Y-code
23	03-Oct-2004 (277)	08-Nov-2004 (313)	2 (v2)	6/2	19/4	4
22	03-Oct-2004 (277)	08-Nov-2004 (313)	2 (v2)	6/2	17/3	3
18	03-Oct-2004 (277)	08-Nov-2004 (313)	2 (v1)	5/1	12/1	1

ANC04

Release 2 (v2)

- Generated during final POD solutions
- Maintained release number, but incremented version to 2

Release 2 (v1)

- Generated during rapid POD solutions
- Added RELEASE keyword to standard header
- Added USEBEG and USEEND keywords to file-specific header

ANC08

Release 6 (*POD calibration level 2*)

- Final POD solutions
- Changed zenith delay parameter estimation strategy for short passes

Release 5 (*POD calibration level 1*)

- Rapid POD solutions
- Changed zenith delay parameter estimation strategy for short passes

ANC09

Release 19 (*PAD calibration level 4*)

- Applied scan-maneuver calibrations
- Removed pre-launch laser alignment and subsequent biases

Release 17 (*PAD calibration level 3*)

- Applied batch-EKF corrections to compensate for IST motion with respect to the instrument
- Applied de-distortion map (L3a Version 1) to IST data
- Updated and applied laser biases to pre-launch alignment

Release 12 (*PAD calibration level 1*)

- Applied additional laser biases to pre-launch alignment based on range-residual analysis of ocean and around-the-world scans

Laser 3b

I-SIPS Product Release(s)	Start Date (DOY)	Stop Date (DOY)	UTCSR ANC04 Release	UTCSR ANC08 Release/ Level	UTCSR ANC09 Release/ Level	Elevation Product Y-code
Y28	17-Feb-2005 (048)	24-Mar-2005 (083)	2 (v2)	8/2	28/4	4
19	17-Feb-2005 (048)	24-Mar-2005 (083)	2 (v1)	5/1	16/1	1

ANC04

Release 2 (v2)

- Generated during final POD solutions
- Maintained release number, but incremented version to 2

Release 2 (v1)

- Generated during rapid POD solutions
- Added RELEASE keyword to standard header
- Added USEBEG and USEEND keywords to file-specific header

ANC08

Release 8 (*POD calibration level 2*)

- Final POD solutions
- Corrected geomagnetic computation for low solar-flux periods

Release 5 (*POD calibration level 1*)

- Rapid POD solutions
- Changed zenith delay parameter estimation strategy for short passes

ANC09

Release 28 (*PAD calibration level 4*)

- Applied batch-EKF corrections to compensate for IST motion with respect to the instrument
- Applied scan-maneuver calibrations
- Removed pre-launch laser alignment and subsequent biases
- Updated LPA spot characteristics to reflect $1/e^2$, rather than fixed, cutoff in intensity values

Release 16 (*PAD calibration level 1*)

- Applied de-distortion map (L3a Version 1) to IST data
- Applied additional laser biases to pre-launch alignment based on range-residual analysis of ocean and around-the-world scans

Laser 3c

I-SIPS Product Release(s)	Start Date (DOY)	Stop Date (DOY)	UTCSR ANC04 Release	UTCSR ANC08 Release/ Level	UTCSR ANC09 Release/ Level	Elevation Product Y-code
22	20-May-2005 (140)	22-Jun-2005 (173)	2 (v1)	5/1	18/1	1

ANC04

Release 2 (v1)

- Generated during rapid POD solutions
- Added RELEASE keyword to standard header
- Added USEBEG and USEEND keywords to file-specific header

ANC08

Release 5 (*POD calibration level 1*)

- Rapid POD solutions
- Changed zenith delay parameter estimation strategy for short passes

ANC09

Release 18 (*PAD calibration level 1*)

- Applied de-distortion map (L3a Version 1) to IST data
- Applied additional laser biases to pre-launch alignment based on range-residual analysis of ocean and around-the-world scans

Laser 3d

I-SIPS Product Release(s)	Start Date (DOY)	Stop Date (DOY)	UTCSR ANC04 Release	UTCSR ANC08 Release/ Level	UTCSR ANC09 Release/ Level	Elevation Product Y-code
26	21-Oct-2005 (294)	24-Nov-2005 (328)	2 (v2)	6/2	22/4	4
25	21-Oct-2005 (294)	24-Nov-2005 (328)	2 (v1)	5/1	21/1	1

ANC04

Release 2 (v2)

- Generated during final POD solutions
- Maintained release number, but incremented version to 2

Release 2 (v1)

- Generated during rapid POD solutions
- Added RELEASE keyword to standard header
- Added USEBEG and USEEND keywords to file-specific header

ANC08

Release 6 (*POD calibration level 2*)

- Final POD solutions
- Changed zenith delay parameter estimation strategy for short passes
- Used preliminary solar flux and geomagnetic index data

Release 5 (*POD calibration level 1*)

- Rapid POD solutions
- Changed zenith delay parameter estimation strategy for short passes

ANC09

Release 22 (*PAD calibration level 4*)

- Applied batch-EKF corrections to compensate for IST motion with respect to the instrument
- Applied scan-maneuver calibrations
- Removed pre-launch laser alignment and subsequent biases
- Updated LPA spot characteristics to reflect $1/e^2$, rather than fixed, cutoff in intensity values

Release 21 (*PAD calibration level 1*)

- Applied arctangent correction to GLA04 IST data
- Applied additional laser biases to pre-launch alignment based on range-residual analysis of ocean and around-the-world scans

Laser 3e

I-SIPS Product Release(s)	Start Date (DOY)	Stop Date (DOY)	UTCSR ANC04 Release	UTCSR ANC08 Release/ Level	UTCSR ANC09 Release/ Level	Elevation Product Y-code
27, Y28	22-Feb-2006 (053)	28-Mar-2006 (087)	2 (v2)	8/2	27/4	4
26	22-Feb-2006 (053)	28-Mar-2006 (087)	2 (v1)	5/1	24/1	1

ANC04

Release 2 (v2)

- Generated during final POD solutions
- Maintained release number, but incremented version to 2

Release 2 (v1)

- Generated during rapid POD solutions
- Added RELEASE keyword to standard header
- Added USEBEG and USEEND keywords to file-specific header

ANC08

Release 8 (*POD calibration level 2*)

- Final POD solutions
- Corrected geomagnetic computation for low solar-flux periods

Release 5 (*POD calibration level 1*)

- Rapid POD solutions
- Changed zenith delay parameter estimation strategy for short passes

ANC09

Release 27 (*PAD calibration level 4*)

- Applied batch-EKF corrections to compensate for IST motion with respect to the instrument
- Applied scan-maneuver calibrations
- Removed pre-launch laser alignment and subsequent biases
- Updated LPA spot characteristics to reflect $1/e^2$, rather than fixed, cutoff in intensity values

Release 24 (*PAD calibration level 1*)

- Applied arctangent correction to GLA04 IST data
- Applied additional laser biases to pre-launch alignment based on range-residual analysis of ocean and around-the-world scans
- Updated LPA spot characteristics to reflect $1/e^2$, rather than fixed, cutoff in intensity values

Laser 3f

I-SIPS Product Release(s)	Start Date (DOY)	Stop Date (DOY)	UTCSR ANC04 Release	UTCSR ANC08 Release/ Level	UTCSR ANC09 Release/ Level	Elevation Product Y-code
26	24-May-2006 (144)	26-Jun-2006 (177)	2 (v1)	7/1	26/1	1

ANC04

Release 2 (v1)

- Generated during rapid POD solutions
- Added RELEASE keyword to standard header
- Added USEBEG and USEEND keywords to file-specific header

ANC08

Release 8 (*POD calibration level 1*)

- Rapid POD solutions
- Corrected geomagnetic computation for low solar-flux periods

ANC09

Release 26 (*PAD calibration level 1*)

- Applied arctangent correction to GLA04 IST data
- Applied additional laser biases to pre-launch alignment based on range-residual analysis of ocean and around-the-world scans
- Updated LPA spot characteristics to reflect $1/e^2$, rather than fixed, cutoff in intensity values