Pre-Launch Calibration Efforts for the ATLAS Instrument on ICESat-2

C.M. Gosmeyer, T.D. Cole, C.T. Field, A.J. Martino, J.L. Saba
NASA Goddard Space Flight Center

AGU 10 Dec 2018

Abstract
C13C-1169

catherine.gosmeyer@nasa.gov

What is ATLAS?

- Advanced Topographic Laser Altimeter System
- Sole science instrument on NASA's ICESat-2 mission
- 532-nm laser, 10,000 pulses/second, split into six beams
- Measures times of flight along six tracks on Earth's surface, which are converted to elevations with cm-level vertical precision
- See poster **C13C-1170** by A.J. Martino for ATLAS characteristics

Calibration Summary

- Elevation measurements at cm-level precision requires measuring photon times of flight to **100 picosecond-level** precision
- 35 calibration products; 10 can be rederived from on-orbit data
- Only two of the 10 are expected to be updated regularly and all 10 will be monitored for changes
- **Most calibrations were final at launch**

What is ICESat-2?

- NASA's Ice, Cloud, and Elevation Satellite 2
- Launched 15 Sept 2018
- Three-year nominal mission
- Near-polar orbit, with repeat ground tracks every 91 days
- Specialized data products for sea ice, land ice, inland water, vegetation, ocean, and clouds

Pre-Launch Calibration

Measurements

- Primarily obtained during instrument-level tests at Goddard Space Flight Center winter 2017-2018
- Three general flavors: radiometry, timing, and alignment
- **Radiometric** measurements characterize the energy leaving the lasers and returning to the detectors for each of the six laser beams; measurements include
  - Beam energy, profile, and polarization
  - Receiver sensitivity to temperature, wavelength, and voltage
- **Timing** measurements characterize the timing of the photons leaving the laser and hitting the receiver, and the signal traveling through the electronics; measurements include
  - Travel time differences among start channels and receiver channels
- **Alignment** measurements characterize the geometry of the optics; measurements include
  - Misalignment of transmit-to-receive laser beam, and exiting beams' angle and polarization

Methods

- Close coordination with integration test team to obtain required measurements
- Test data pushed through suite of calibration scripts written primarily in Python
- Results reviewed by calibration team
- Products determined to be acceptable are forwarded to the ATLAS Science Algorithm Software group to be applied to the science data products

Products

- CSV format product files and PDF format product descriptions
- Available from
  1. National Snow and Ice Data Center (see Resources 2)
  2. Within the ATL02 (level 2b) science data product

Acronyms
PCE – Photon Counting Electronics
SPD – Start Pulse Detector
TEP – Transmit Echo Pulse
USO – Ultra Stable Oscillator
WTEM – Wavelength Tracking Electronics Module

Post-Launch Updates

What can be Updated

- 10 of the 35 calibration products can be rederived from on-orbit data; see table below
- Regular updates expected for only two
- Most updates will be a function of mission elapsed time and/or temperature shifts
- Users can sign up for notifications from NSIDC

Impact of Updates on Data

- Calibrations with scheduled updates take effect in data processing immediately
- Calibrations with "as needed" updates will be incorporated into next version of data release
- Goal for scheduled updates is to update while changes are so small that they do not introduce a significant step in the science data product

Calibrations that can be Rederived from On-Orbit Data	Affects	Update
Dead Time – interval between consecutive events recorded on a receiver channel	Timing	As needed
Nominal Receiver Sensitivity – adjusts counts relative to nominal optical power for each return laser beam	Radiometry	As needed
PCE Effective Cell Delay – adjusts fine count as function of temperature, voltage, channel, PCE card, and event edge	Timing	As needed
Receiver Channel Skews – aligns returns from different per-beam receiver channels	Timing	As needed
Receiver Sensitivity vs WTEM – adjusts receiver sensitivity as function of either WTEM signals or SPD energy monitor signals	Radiometry	As needed
Start Timing Skews – aligns signal start time among all start pulse timing channels	Timing	As needed
System Impulse Response – adjusts SIR relative to pre-launch baseline	Timing	As needed
USO Frequency vs Temperature – adjusts USO frequency relative to temperature shifts	Timing	As needed
USO Frequency Deviation – adjusts USO frequency relative to nominal 100 MHz	Timing	1/week
Zero Range – provides origin coordinates against which range timing measurements for each laser beam are referenced	Timing	1/TEP observation

Acknowledgements

We thank the ATLAS and ICESat-2 team members who supported calibration efforts, especially Meg Bock, Victor (John) Chambers, Alan Gostin, Jake Hageman, Phil Luers, and Luis Ramos-Izquierdo. We also thank past calibration team members, Phil Dabney and Daniel DaSilva.

Resources

1. **ICESat-2 public website:** https://icesat-2.gsfc.nasa.gov/
2. **Calibration products:** Will be posted at NSIDC, https://nsidc.org/
3. **Data archive:** https://nsidc.org/
4. **Technical video:** https://www.youtube.com/watch?v=aYRqkdYJRr0