ICESat-2/ATLAS: Instrument Status and Projected Performance

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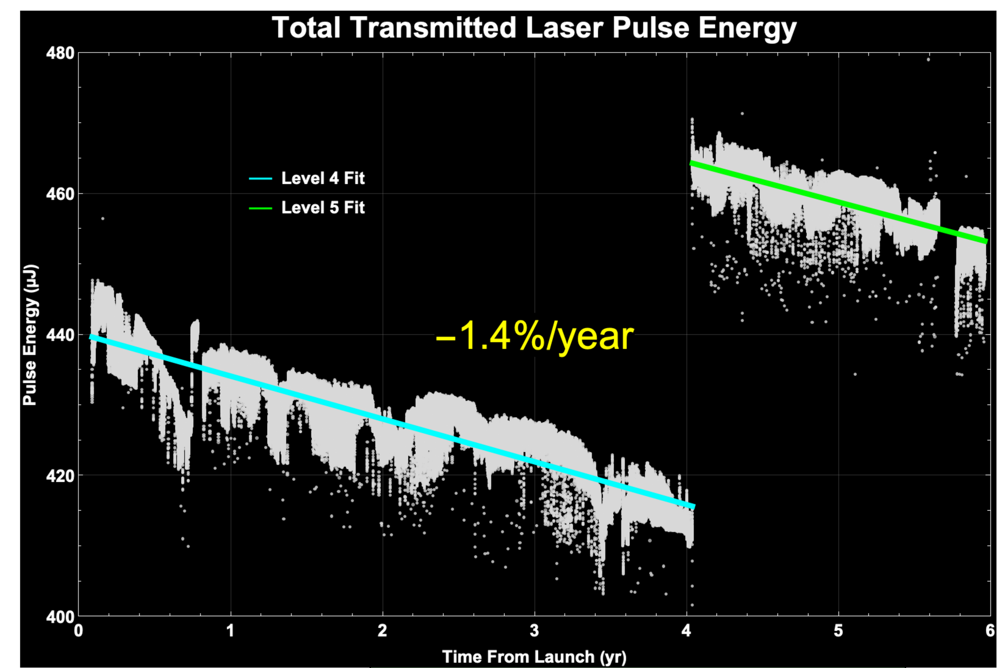
After six years in orbit, the Advanced Topographic Laser Altimeter System (ATLAS) on NASA's ICESat-2 mission continues to provide high-precision range measurements with a high sample density along its ground tracks, meeting or exceeding its lifetime and performance requirements.

We present performance measurements and trends for several instrument parameters, including:

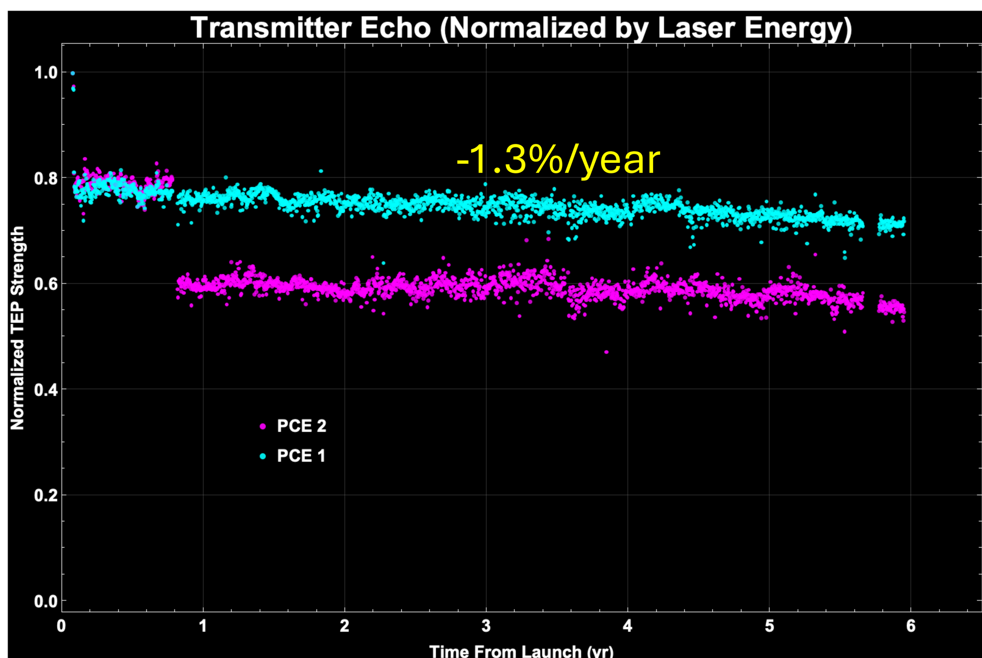
- Laser pulse energy, gauged by an on-board monitor, showed a decline between 1% and 2% per year at a constant power setting from October 2018 to September 2022. In September 2022, the power setting was increased by one increment; since then, the pulse energy has shown a trend similar to that before the increase.
- Receiver sensitivity, gauged by solar background levels, return strength, and strength of an on-board calibration pulse, has declined at a rate similar to that of the pulse energy.
- Transmitter/receiver misalignment varies in a cyclic manner over orbital and seasonal time scales. The active alignment control system corrects for these variations, keeping the instrument's throughput near its maximum value at all times.
- Oscillator frequency is very stable, requiring infrequent, small adjustments to the value used in computing time of flight.
- Other instrument properties that contribute to vertical and horizontal precision have been stable over the mission.
- Temperatures of instrument components vary on orbital and seasonal time scales within a small subset of the range over which they were tested. Small adjustments to temperature set points are occasionally required.

We have recently concluded a major update of the instrument's calibration parameters for time-of-flight components, radiometry, alignment, and range bias. We have used on-orbit data where possible to supplement or replace pre-launch data. This has resulted in a reduction in artifacts and a small reduction in measurement noise.

The observed rates of change in laser energy and receiver sensitivity project to ATLAS maintaining its early-mission return strength into the mid-2030s.



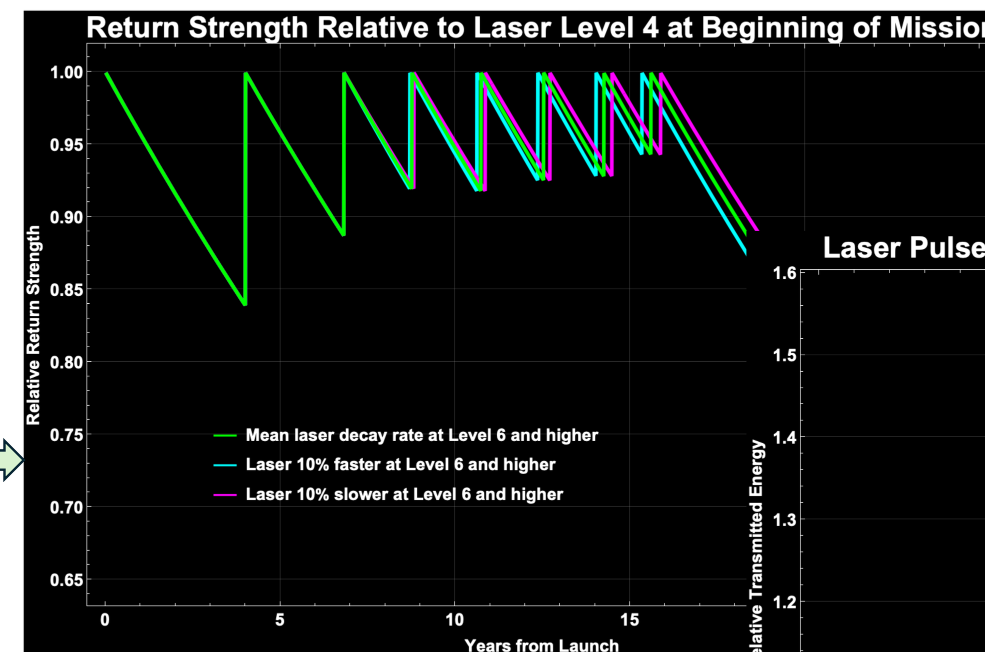
After two years at Level 5, the slope of laser pulse energy appears nearly identical to the slope observed at Level 4.



Strength of the two Transmitter Echo pulses per unit of transmitted laser energy

- PCE 1 shows a steady linear decline at about -1.3%/year
- PCE 2 shows a discontinuity after the first safehold period, then slower decline than PCE 1
- Serves as a probe of PMTs, fiber optics and detector optics

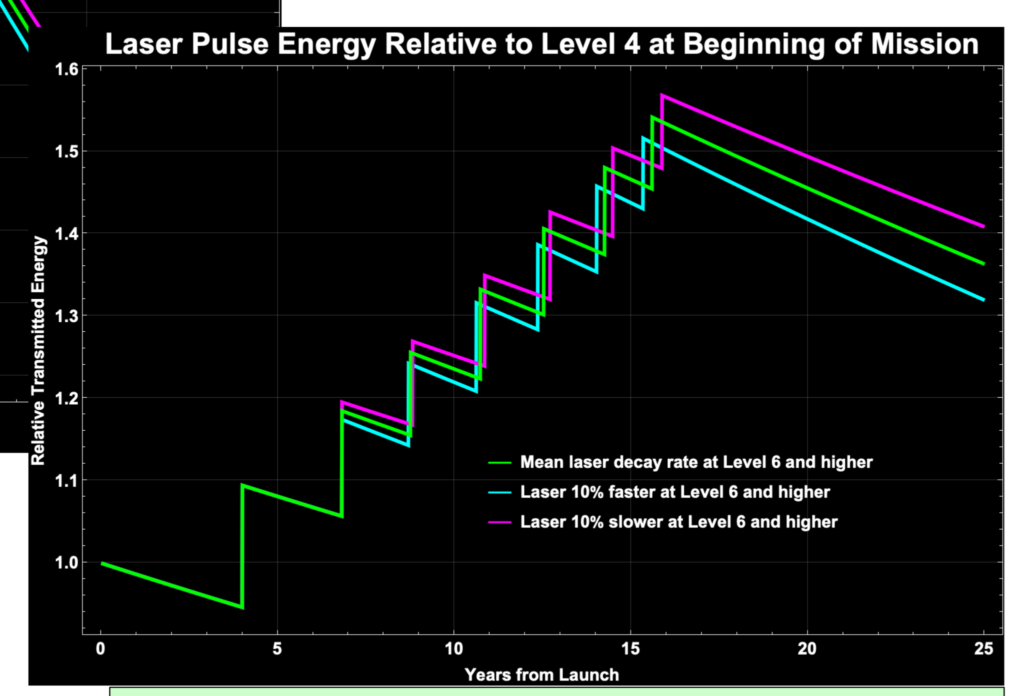
Observations and estimates of transmitter and receiver decline rates feed into models of instrument lifetime.



Projected return strength relative to early-mission value, assuming

- receiver decline at 3%/year
- various assumptions about laser decline rate
- pulse energy setting increased by 1 whenever that would theoretically recover the return strength to its early-mission value

Greater estimated receiver decline rate results in slightly shorter life than in previous predictions.



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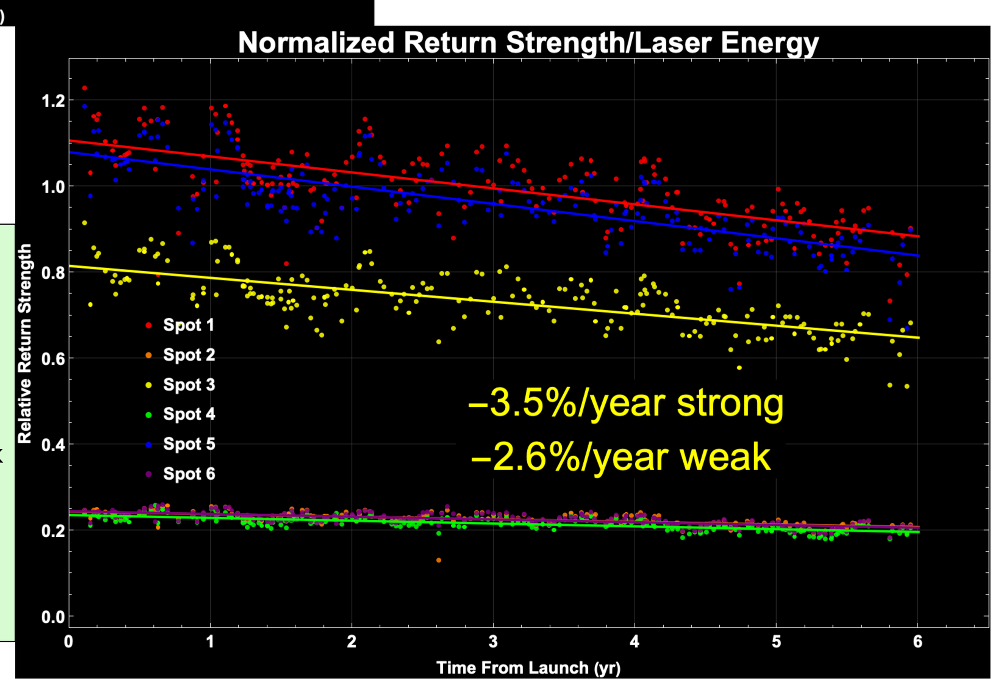
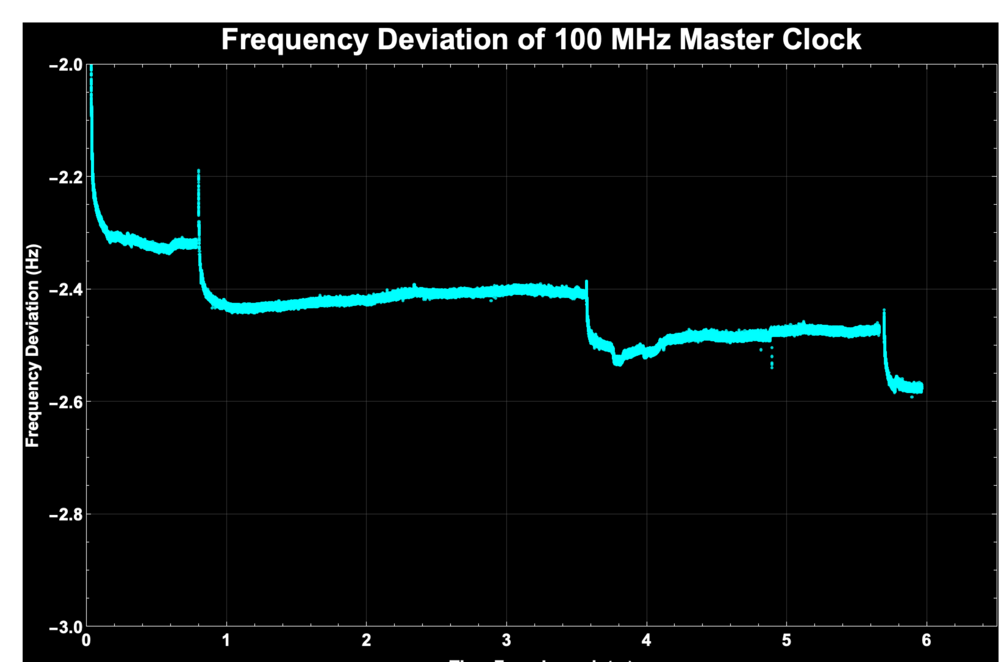


Return strength per unit of transmitted laser energy from selected cloud-free Antarctic interior areas

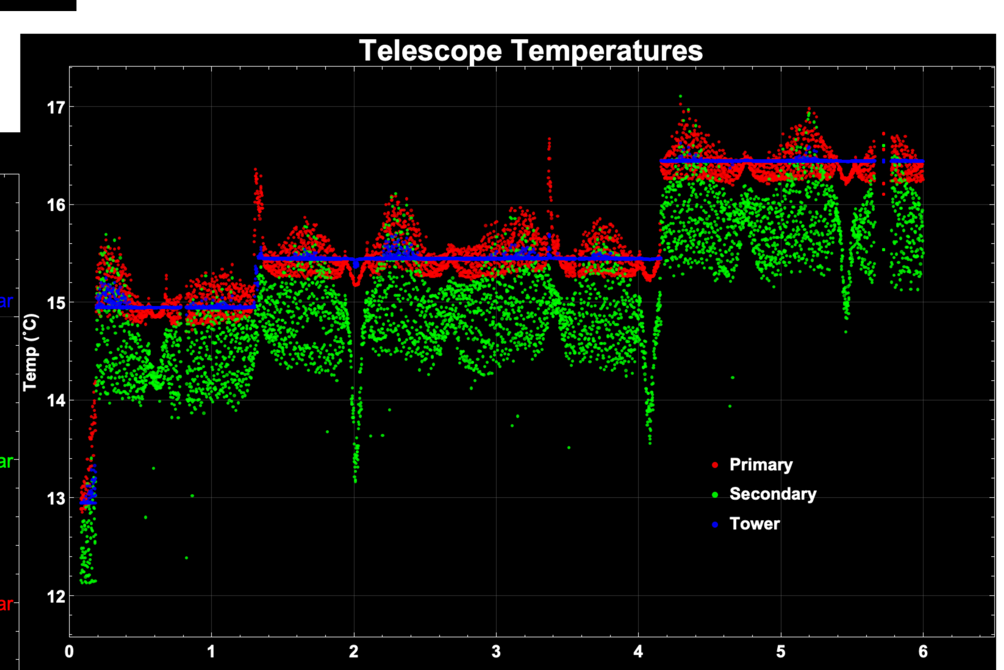
- Background subtracted, dead-time correction applied
- Probes the telescope as well as the components probed by the Transmitter Echo
- Difference between decline rates for strong and weak spots is being investigated

For more details, see the poster by Aimée Gibbons

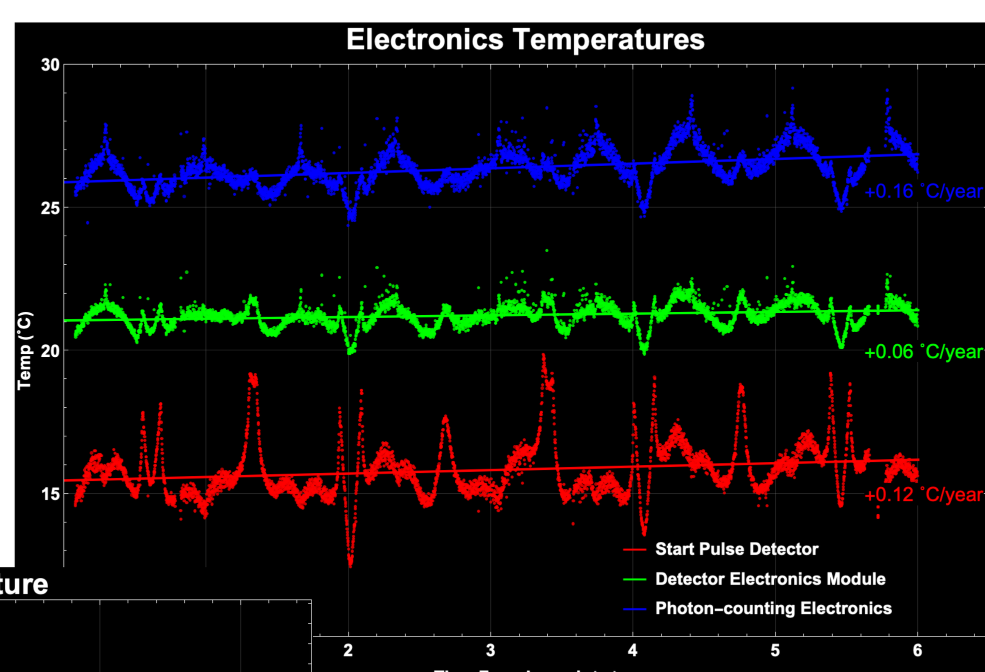


Each time the instrument has been power-cycled, the clock frequency has stabilized at a different value.

- well within requirements
- value used in data reduction is updated whenever the measured value changes by 0.01 Hz

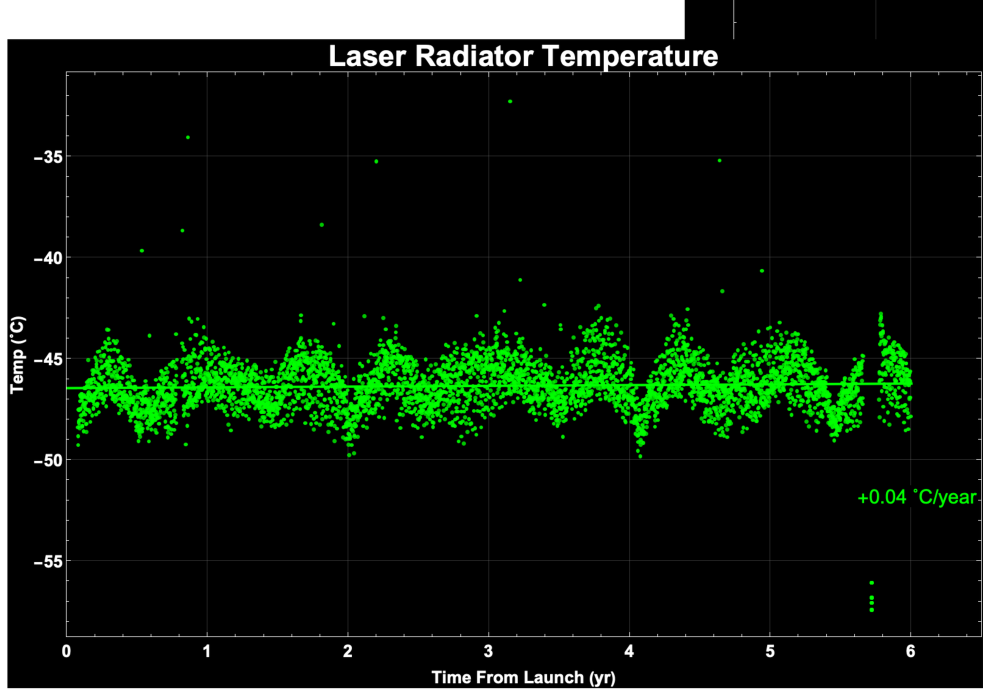


The setpoint for the telescope tower temperature has been adjusted during the mission to maintain control authority, preventing undesirable gradients.



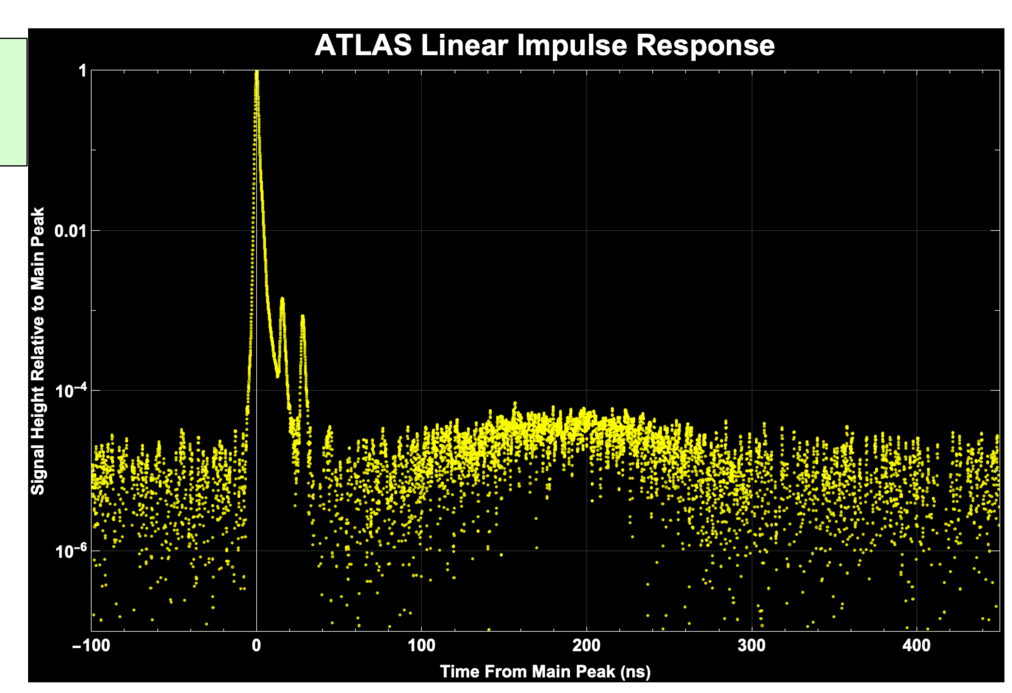
ATLAS monitors temperatures at numerous points. A few representative temperatures are shown.

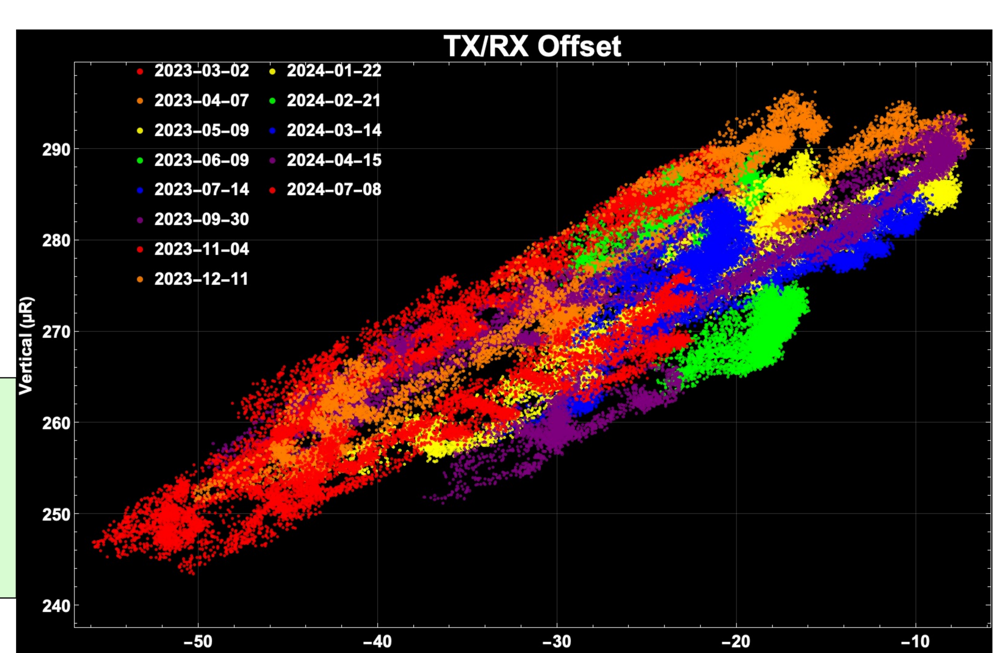
Many component temperatures have shown very slow rising trends over the mission. All are staying well within the operating range.



Estimates of the linear impulse response have been improved.

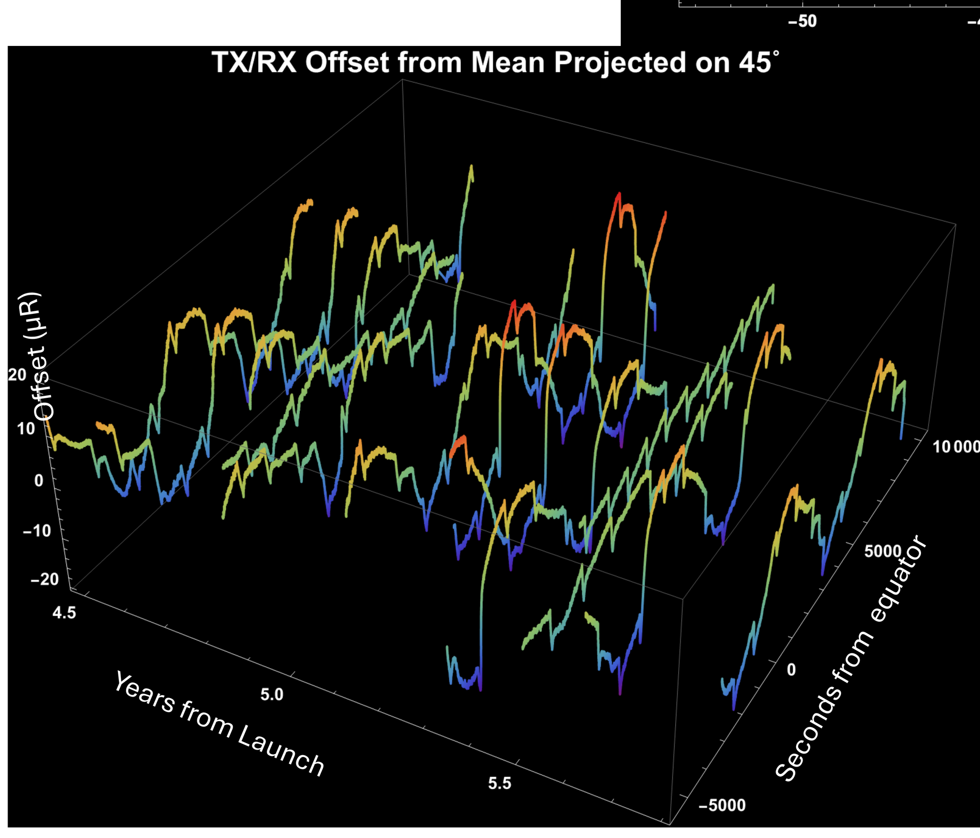
For more details, see the poster by Almut Pingel.





Motion of the transmit/receive pointing offset when the Beam Steering Mechanism is held in a fixed position

- Orientation of motion is nearly constant along a 45˚ line
- Center and amplitude change seasonally

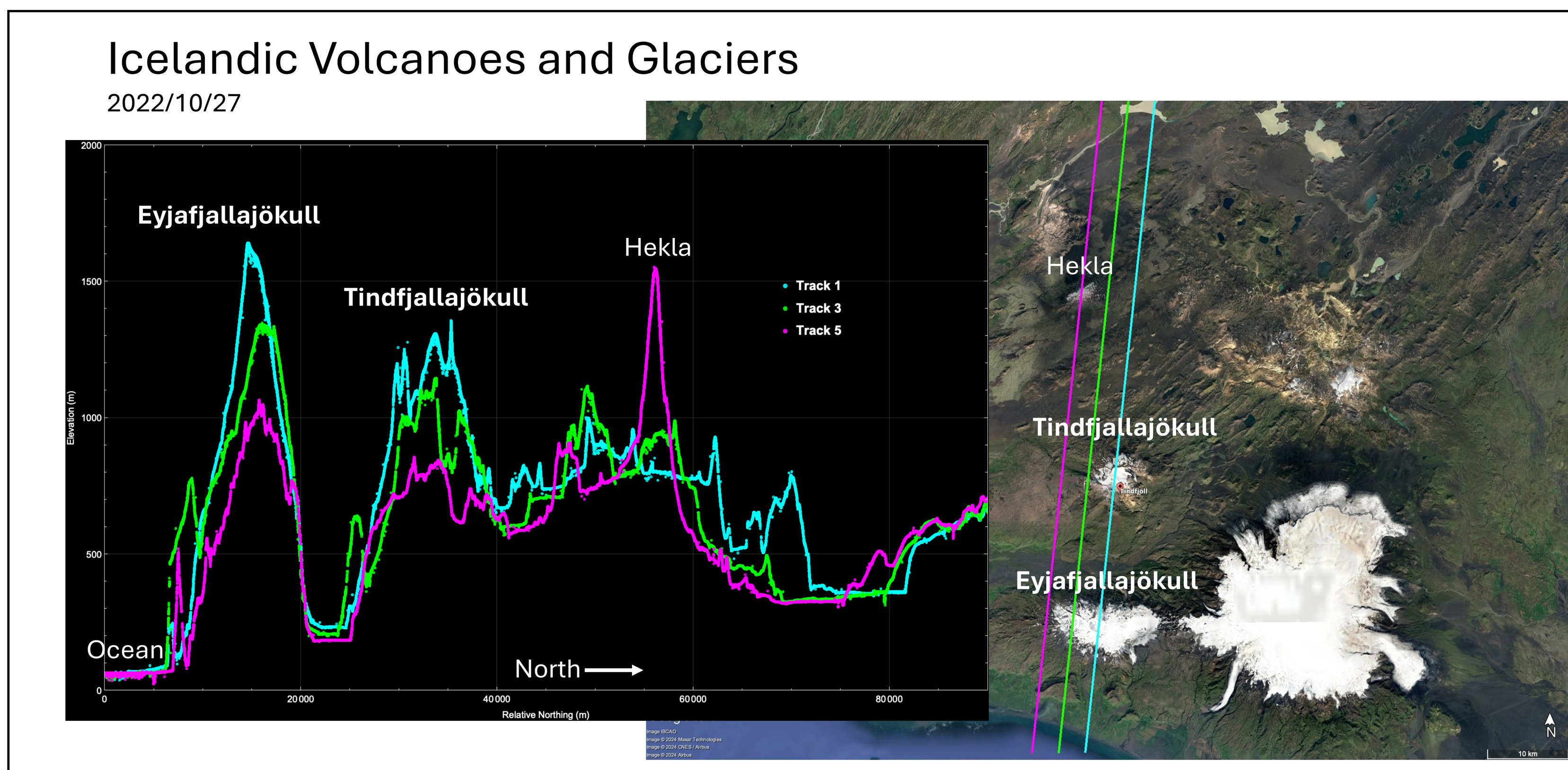


Two main components of uncontrolled motion of transmit/receive offset

- orbital-frequency due to moving in/out of shadow up to 20 μR amplitude
- higher-frequency due to heater cycling about 5 μR amplitude

When ICESat-2 is in sunlight through the whole orbit, only the heater cycling effect is visible.

Control loop maintains offset at commanded value to < 3 μR.



Acknowledgements

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