OIB campaigns status for ATM

a concise update

- Spring 2016/ P3 NOAA43:
  - QA completed, data delivered
- Summer 2016 part1/ Falcon NASA524:
  - Barrow processing complete, QA nearly complete, delivery imminent
- Summer 2016 part2:
  - Kangerlussuaq processing complete, QA underway
- Fall 2016/ DC8 NASA817:
  - preliminary processing complete, bias/parameter estimation underway
- Spring 2017/ P3 NASA426:
  - installation in progress this week
  - ATM6-T6 wide scan with new 1.3ns, 10kHz laser
  - ATM5-T5 narrow scan with old 6ns, 3kHz laser
- Summer 2017/ Falcon NASA524: ...
- Fall 2017/ P3 NASA426: McMurdo

OIB campaigns status for ATM

Challenges met and (mostly) overcome:

(*reminiscent of June OIB meeting)*

- Spring 2016: ~cm perturbations due to oil on window
- Summer 2016:
  - dropouts due to clouds...
  - maneuvering at high altitude reduced overlap with old data & resulting dH coverage
- Fall 2016:
  - new laser failed in testing before deployment.
  - old lasers exceeded operational life: degraded power, reduced operation
  - Applanix reliability: failures in all 3 systems. at least one system OK for any one flight
- Spring 2017:
  - lasers refreshed
    - Repaired 10kHz green laser shipped this week (1/23)
    - Both refurbished 3kHz lasers will ship soon. One is re-rated at 1.5mJ/pulse (down from 2mJ) until doubler crystal (back-ordered) can be replaced following deployment
    - Dual-frequency 10kHz laser due at end of January
  - Applanix retested
    - Two 610 units were retested at manufacturer- no problems found- returning to WFF this week
    - Will fly two 610 units, one 510 unit (DMS), and Novatel IMU's.

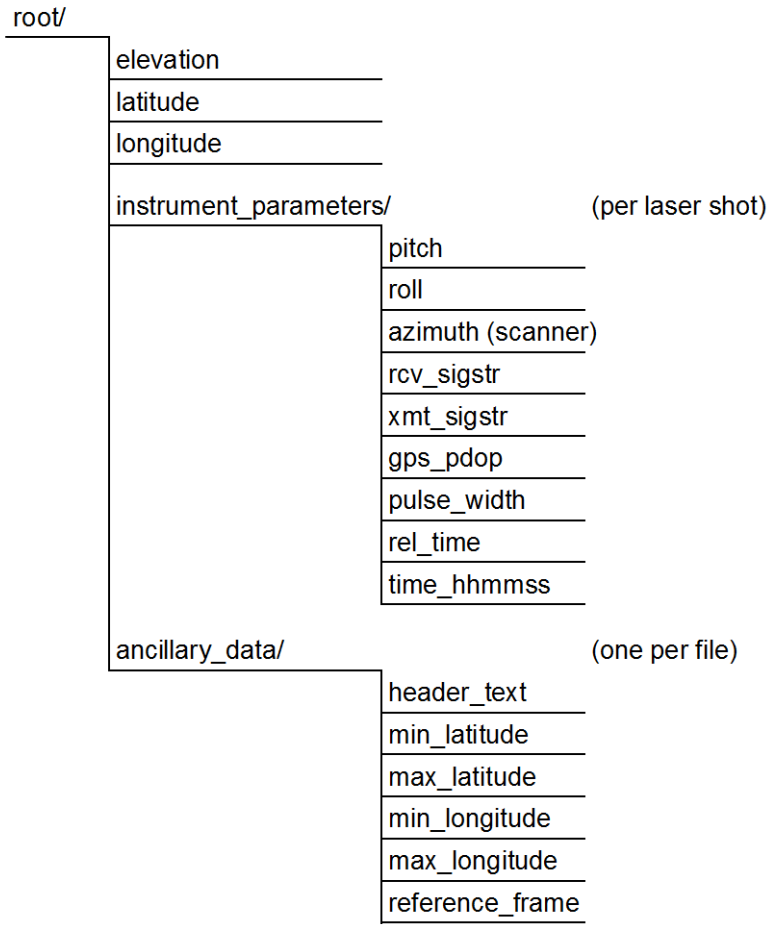
OIB campaigns status for ATM

Innovations, novelties, and freshies:

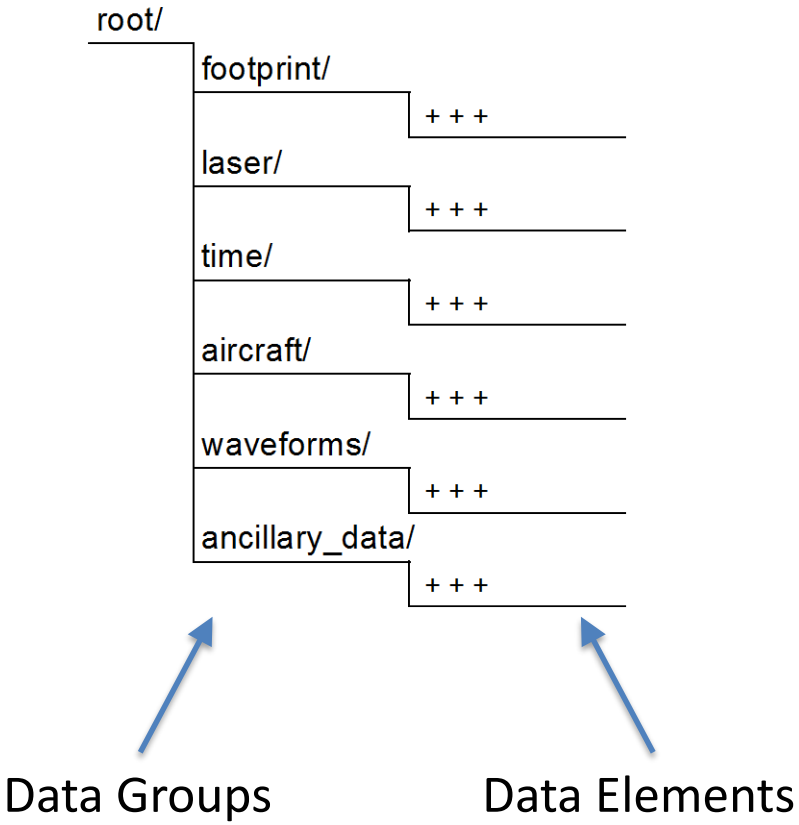
- Flew first campaign of new FLIR (model 655sc) - Summer 2016
- Flew first campaign of revamped Cambot - Summer 2016 part2
- Experimental installation of HeadWall imaging spectrometer for Spring 2017
- FLIR data product: We're working in collaboration with the project science office to finalize an official processing algorithm to generate a standardized product for use in the wider scientific community
- prototype waveform format in development/testing (in addition to standard delivery formats) starting with 2016 Barrow. User feedback is invited!

ATM data format – HDF5

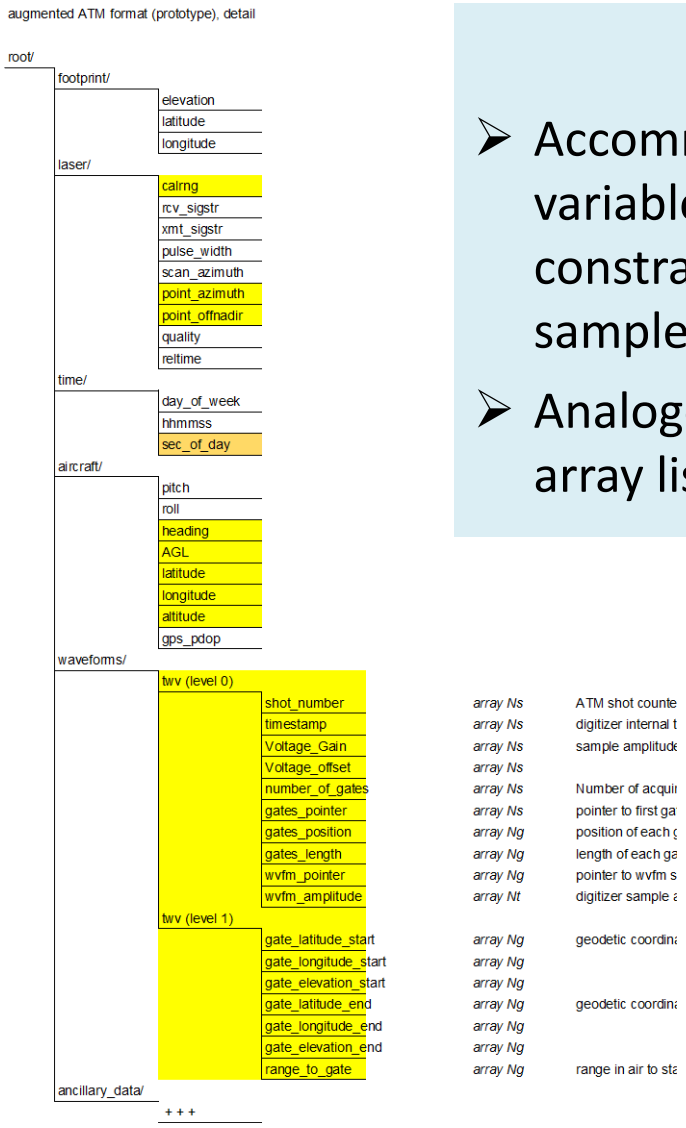
Current ATM format (ILATM1B v2)



Augmented ATM format prototype



Proposed ATM augmented format



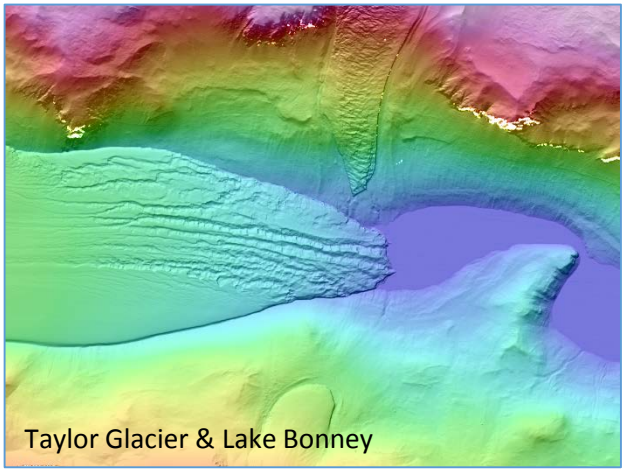
Waveforms

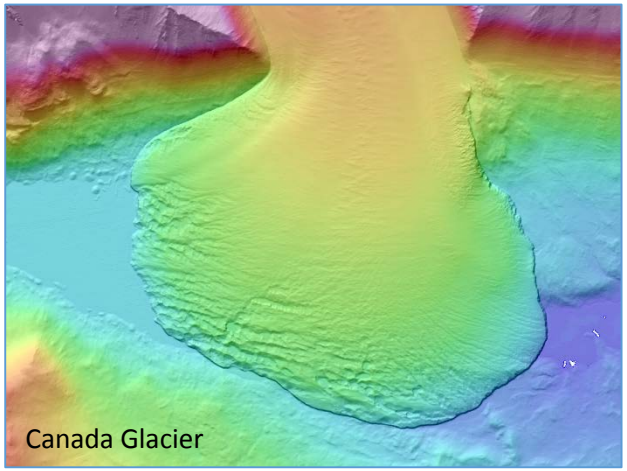
- Accommodates multiple waveform segments of variable lengths for each laser shot within HDF5 constraints: using pointers into array of waveform samples
- Analogous to ICESat-2 data format: Using pointers into array list of detected photons

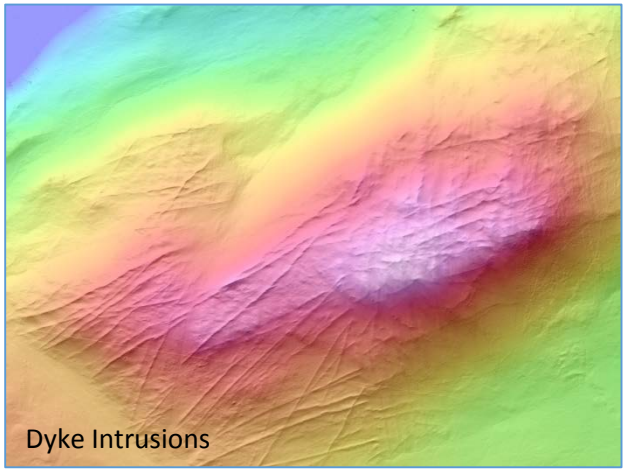
- Organized by HDF5 subgroups.
- New fields: heading, AGL, pointing azimuth and vertical angle, aircraft position, waveforms, etc.
- Improved precision for time

Airborne Topographic Mapper

Instrument Developments in Preparation for
ICESat-2 support and the post-IceBridge Era

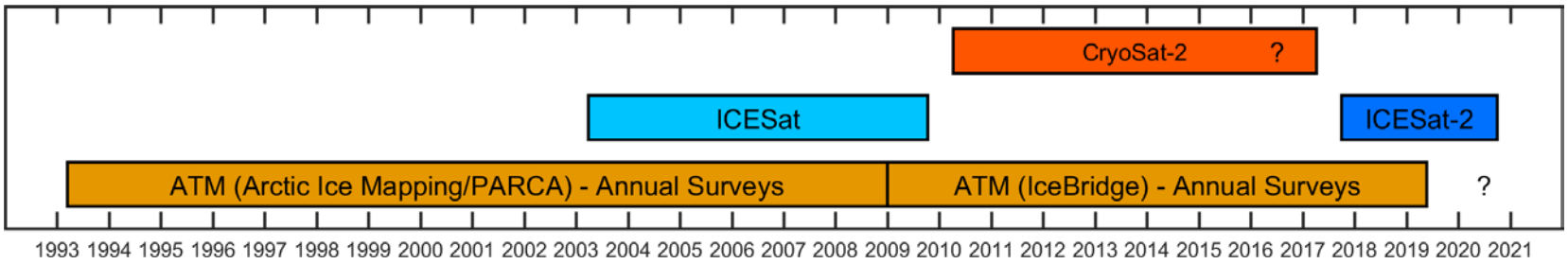

Taylor Glacier & Lake Bonney


Canada Glacier


Dyke Intrusions

ATM data from 2001/02 - Transantarctic Mountains & Dry Valleys McMurdo, Antarctica

Long-term Consistency: ATM Elevation Time Series



- existing and planned ATM measurements are the only data set that overlaps with all past, current, and currently planned space-borne altimeter missions
- this puts ATM in a unique position to create a consistent cross-calibrated time series of ice-surface elevation change involving both, radar altimeters and space-borne laser altimeters using different wavelengths (532 and 1064 nm)
- it is critical to have a **single consistent baseline data set** with which all other data sets can be compared
- a continuation of 25 years of ATM measurements will provide the necessary long-term consistency and baseline

The accuracy, consistency, spatial coverage, and length of time series make ATM the best available baseline data set to build a cross-calibrated and validated time series of elevation measurements

ATM Instrument Developments

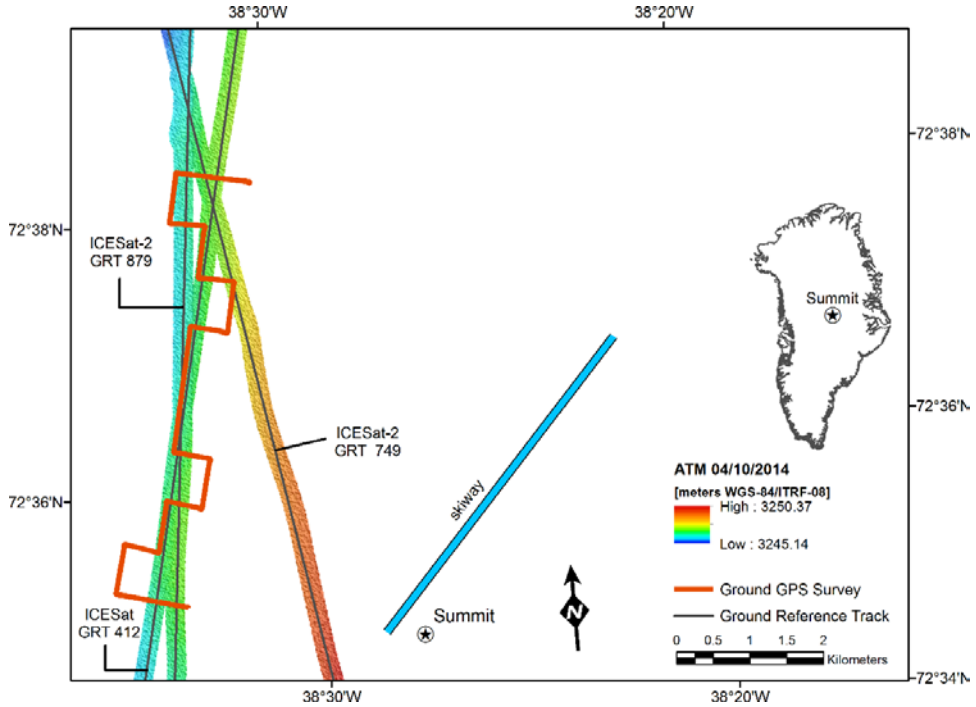
Demands for accuracy and instrument capabilities have increased over the course of IceBridge

ATM has begun addressing these new demands and preparing for upcoming ICESat-2 support and the post-IceBridge era by:

- **upgrading instruments**: scanner assembly, lasers, etc.
- **increasing DGPS accuracy** by developing new processing capabilities und upgrading GPS receivers
- **developing new data products** to fully utilize ATM data for new research applications and areas of research

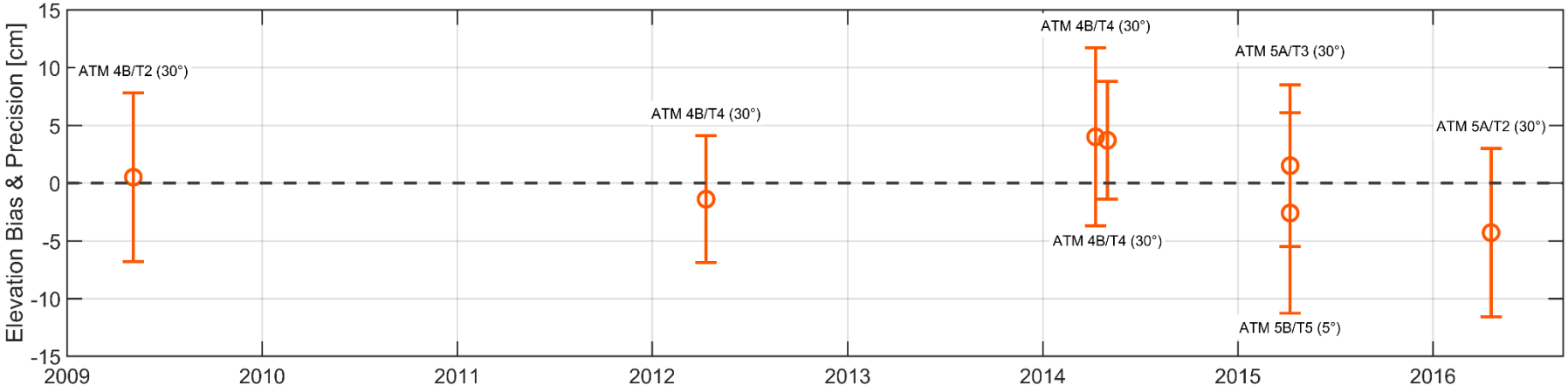
Priority is to **maintain stable, operational capability**.
Use necessary system replacements to upgrade and improve capabilities.

Instrument upgrades are done with careful consideration to long-term data consistency and accuracy



Assessment of ATM's absolute accuracy and long-term consistency of four generations of ATM instruments at Summit Station, Greenland

Brunt, K., *et al.*: Assessment of NASA airborne laser altimetry data using groundbased GPS data near Summit Station, Greenland, *The Cryosphere Discussions*, doi:10.5194/tc-2016-214, in review, 2016.



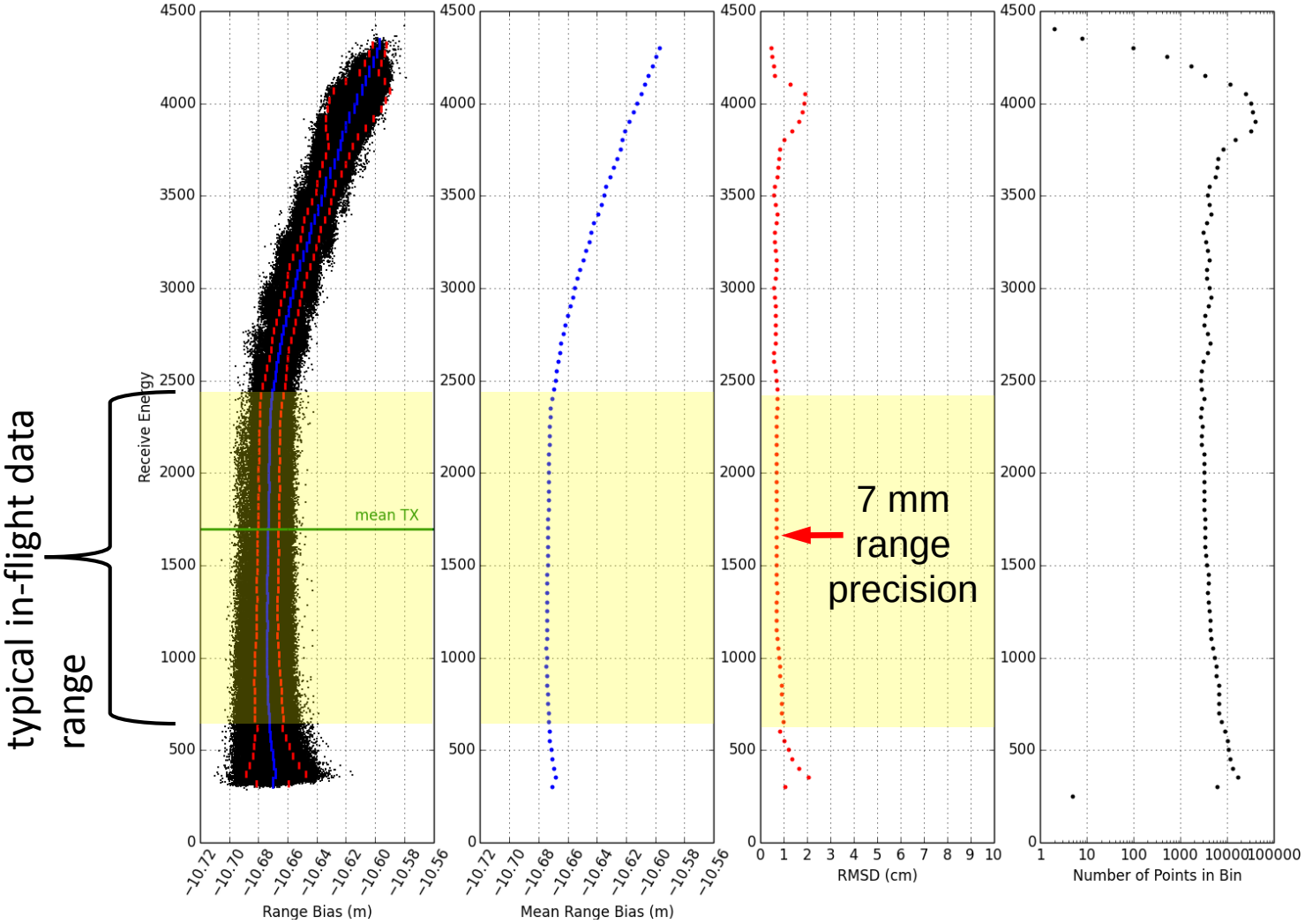
Instrument Upgrades

	Current Configuration	Planned Configuration
ATM-T5 (narrow)	2.5° off-nadir angle	2.5° off-nadir angle
	532 nm wavelength	532 & 1064 nm
	6 ns pulse width	1.3 ns pulse width
	3 kHz PRF	10 kHz PRF
ATM-T6 (wide)	15° off-nadir angle	15° off-nadir angle
	532 nm wavelength	532 nm wavelength
	6 ns pulse width	1.3 ns pulse width
	3 kHz PRF	10 kHz PRF

- new ATM T6 transceiver with increased scan-azimuth accuracy through increased mechanical rigidity and improved scan-angle measurements
- new ATM data collection system with 4 Giga samples digitization rate at 10 kHz laser PRF. Working on further increasing digitization rate for waveform studies

➢ already seeing improvements in range precision (ground test data)

Range bias calibration of new 10 kHz/1.3 ns laser system



previous 2 GHz/6 ns system: 3 cm range precision

Timeline for Instrument Upgrades

Upgrade	Initial Plan/Status	Adjusted Plan/Status
new 4 Giga sample digitizer and data system	Antarctica 2016 (done)	system has been deployed (at 2 Gs) and is operational
new 10 kHz/1.3 ns NG Hybrid Fiber Laser (532 nm single color)	Antarctica (2016) new laser showed beam issue hours before shipping	**Arctic 2017 (NASA P-3)** laser expected to be back from repair this week
new 10 kHz/1.3 ns NG Hybrid Fiber Laser (532 nm & 1064 nm)	Arctic 2017 Delivery of laser delayed from Oct/Nov 2017 to Jan 2017	**Antarctica 2017 (P-3)** experimental deployment, possible engineering data in Summer 2017

- beam issue with new 10 kHz/1.3 ns laser shortly before Punta Arenas deployment and lengthy repair, together with delay in delivery of new dual-color laser shifts implementation schedule to the right by at least one deployment
- transitioning to a highly accurate, dual-frequency LiDAR system will not be accomplished in a single step or a single deployment
- it will require a dedicated series of engineering efforts that ATM attempts to incorporate (without impacting present data quality) into the IceBridge program

Position Improvements and Attitude Determination

- determination of aircraft antenna phase center since 2012 with further improvements in 2014
- addition of GLONASS capability to ATM GNSS recording and differential processing in 2012 to improve periods of weak Position Dilution of Precision (PDOP) in GPS coverage
- since 2016: fully integrated GLONASS processing should result in minor accuracy improvements
- January 2017: procurement of Galileo-capable ground stations as first step towards fully Galileo-capable ATM GNSS recording and differential processing capability

➢ anticipated outcome will be increased accuracy of GNSS-derived aircraft trajectories and spot-elevation measurements for ICESat-2 cal/val

Attitude determination: ATM is depending on commercially available systems and is using the best available IMU on the market: Applanix 610

Potential New Science Applications

- sea-ice melt ponds
- supraglacial lakes
- co-located dual-color laser altimetry and imaging spectrometer in the future
- wave mapping in marginal ice zone
- wave mapping (ATM history) and other oceanographic applications
- multi-color lidar based surface classification

New ATM Website

http://atm.wff.nasa.gov

Interested in user feedback:

- contents
- ease of use
- errors
- anything else

we want this site to be useful for existing ATM users and potential new customers