MATLAS
Selected slides From David Harding SDT presentation (to be updated)

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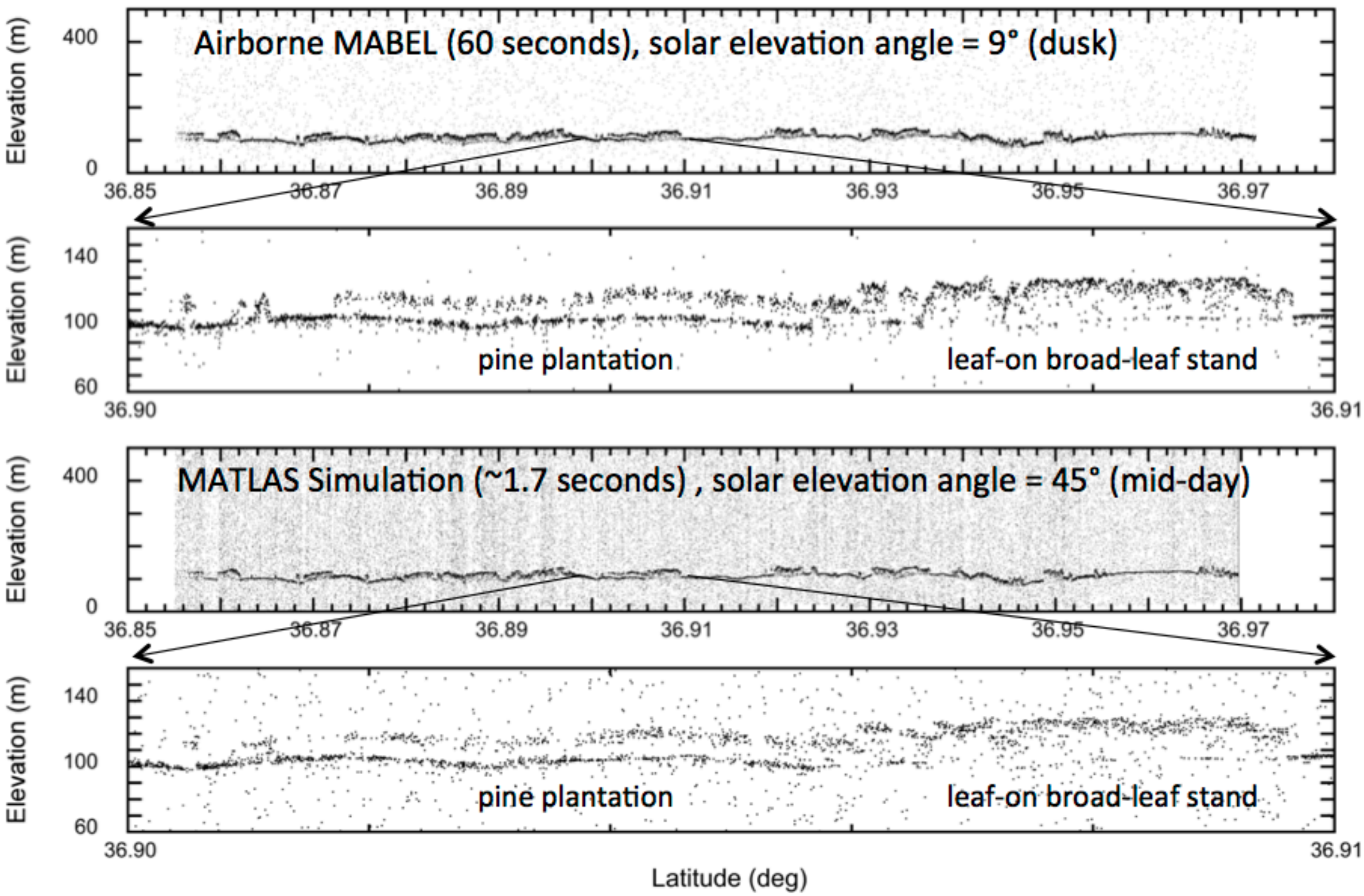
MATLAS Objectives

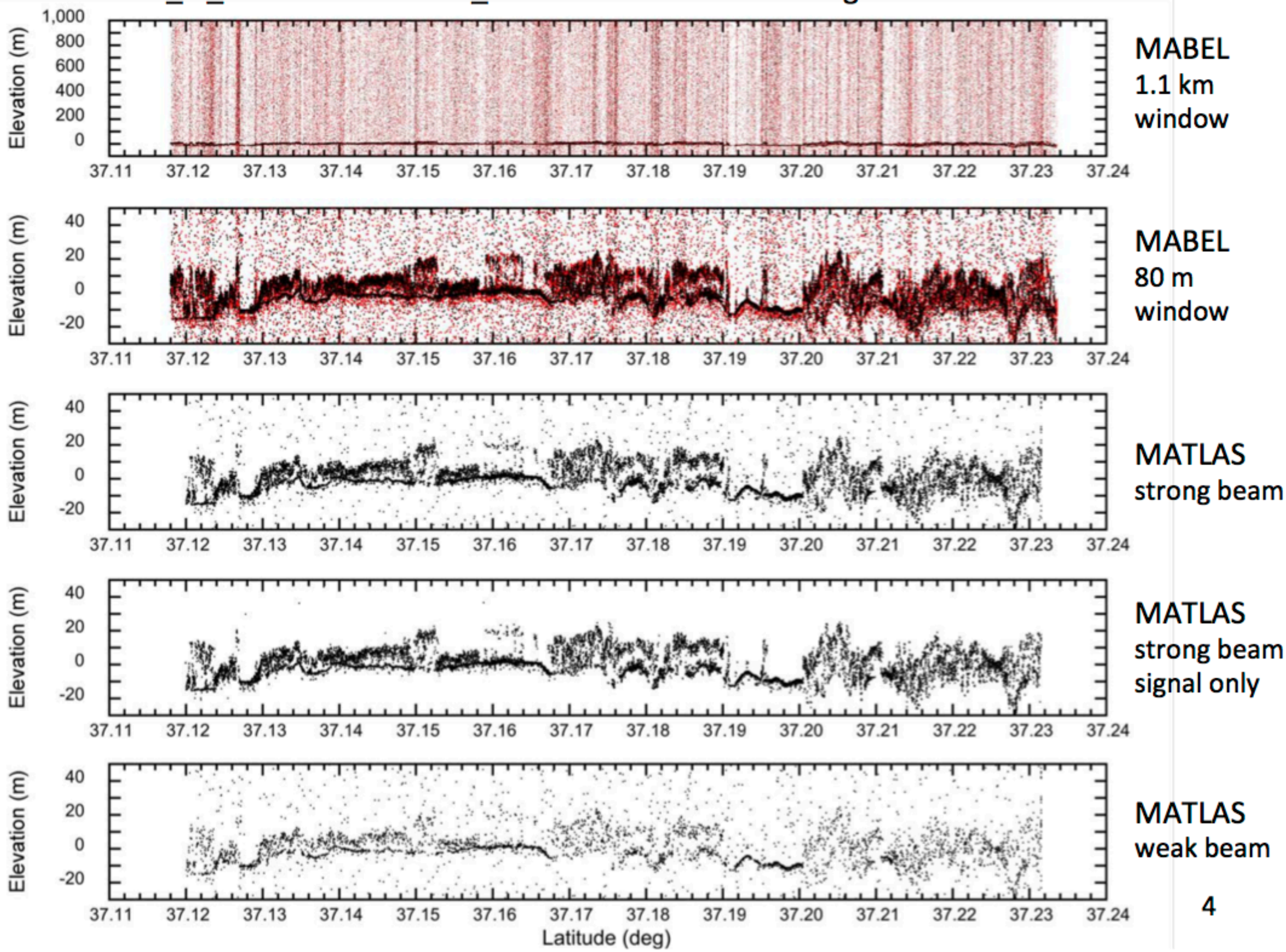
- Use MABEL data to simulate expected ATLAS photon point clouds
- Use ATLAS Design Cases (DC) for expected performance
  - Land ice
  - Sea ice and leads (issue remains on how to do sims with ice and leads both present)
  - Vegetation
  - Water (cases are only for open ocean calibration scans at 5° off-nadir)
- Match signal and noise rates predicted by Tony Martino DC modeling
  - noise rate can be adjusted to any solar elevation angle (using Lambertian model)
  - surface can be "brute force" modified (reflectance and fractional vegetation cover)
- Preserve spatial variation of MABEL signal and solar noise photons
  - Signal counts a function of surface retro-reflectance and atmosphere optical depth
  - Solar noise counts a function of surface bi-directional reflectance, atmosphere optical depth and shadows cast by clouds
  - In the absence of clouds the signal vs noise counts provides two measurements of the bi-directional reflectance distribution function (BRDF) sensitive to surface properties
- Reduce spatial resolution: 2 m MABEL to any ATLAS footprint size (14 m default)
  - Along-track: sample photons in 14 m segments spaced every 0.7 m
  - **Cross-track: combine "adjacent" channels, but interpretation complex**

Use MABEL data to simulate expected ATLAS photon point clouds

- signal, solar noise and instrument noise levels appropriate for a Design Case
- observed spatial variation of signal and solar noise preserved
- spatial resolution reduced due to larger footprint size and spacing

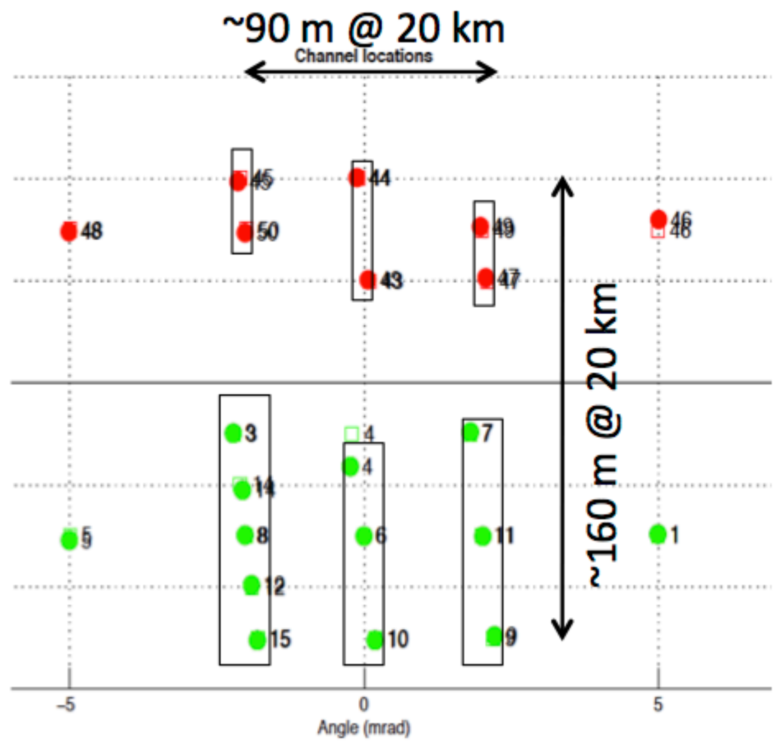


matlas_l2_20120921T222500_s1.h5 5° sun elevation angle channel 44 channel 43



Combining Adjacent Channels to Form "Larger" Footprints

Left, Center and Right Channel Groups: MABEL 2012 Geometry



Left Center Right

- MABEL design was so that adjacent channels could be grouped to form larger "ATLAS-like" footprints.
  2 m MABEL footprint x 5 = 10 m ATLAS footprint (design goal at time MABEL was developed)
- But angular divergence in flight direction to separate spots causes out-of-phase cross-track separation due to small aircraft rolls (e.g. 0.1°)
- **MATLAS v2 provides individual channel simulations and a combined channel group simulation to aid in interpretation of "larger " footprints**

- matlas_l2_20120419t110900_009_1_4_1edit.h5
  - METADATA
  - ancillary_data
  - novatel_ins
  - photon

METADATA and novatel_ins folders copied from MABEL granule

ancillary_data folder contains basic data about the MABEL granule and a matlas folder

- ancillary_data
  - control
  - data_end_gpssow
  - data_end_gpsweek
  - data_end_utc
  - data_start_gpssow
  - data_start_gpsweek
  - data_start_utc
  - end_latitude
  - end_longitude
  - granule_end_utc
  - granule_gps_epoch
  - granule_start_utc
  - release
  - start_latitude
  - start_longitude
  - version
  - matlas

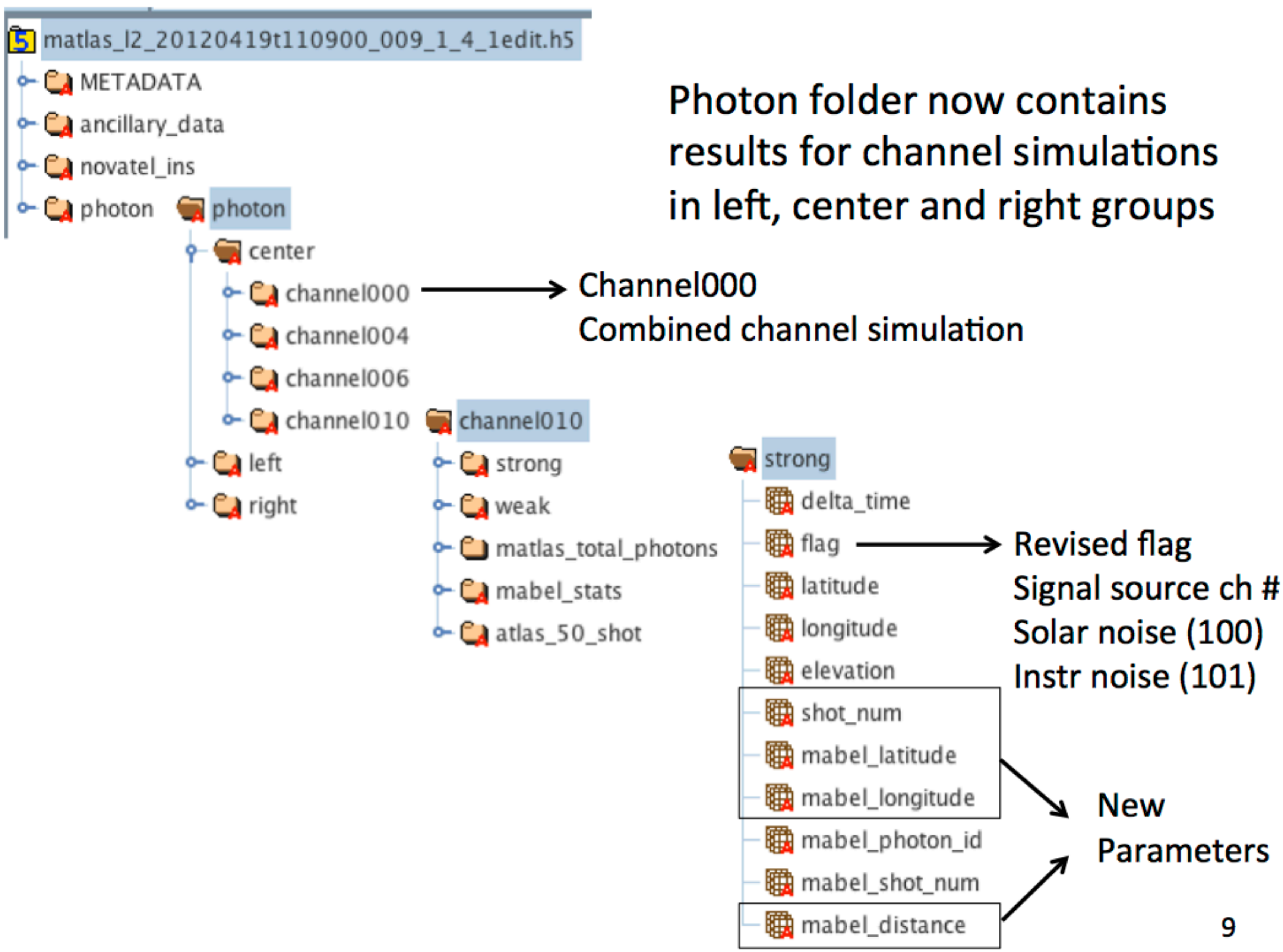
matlas folder contains input parameters defining simulation and derived processing parameters

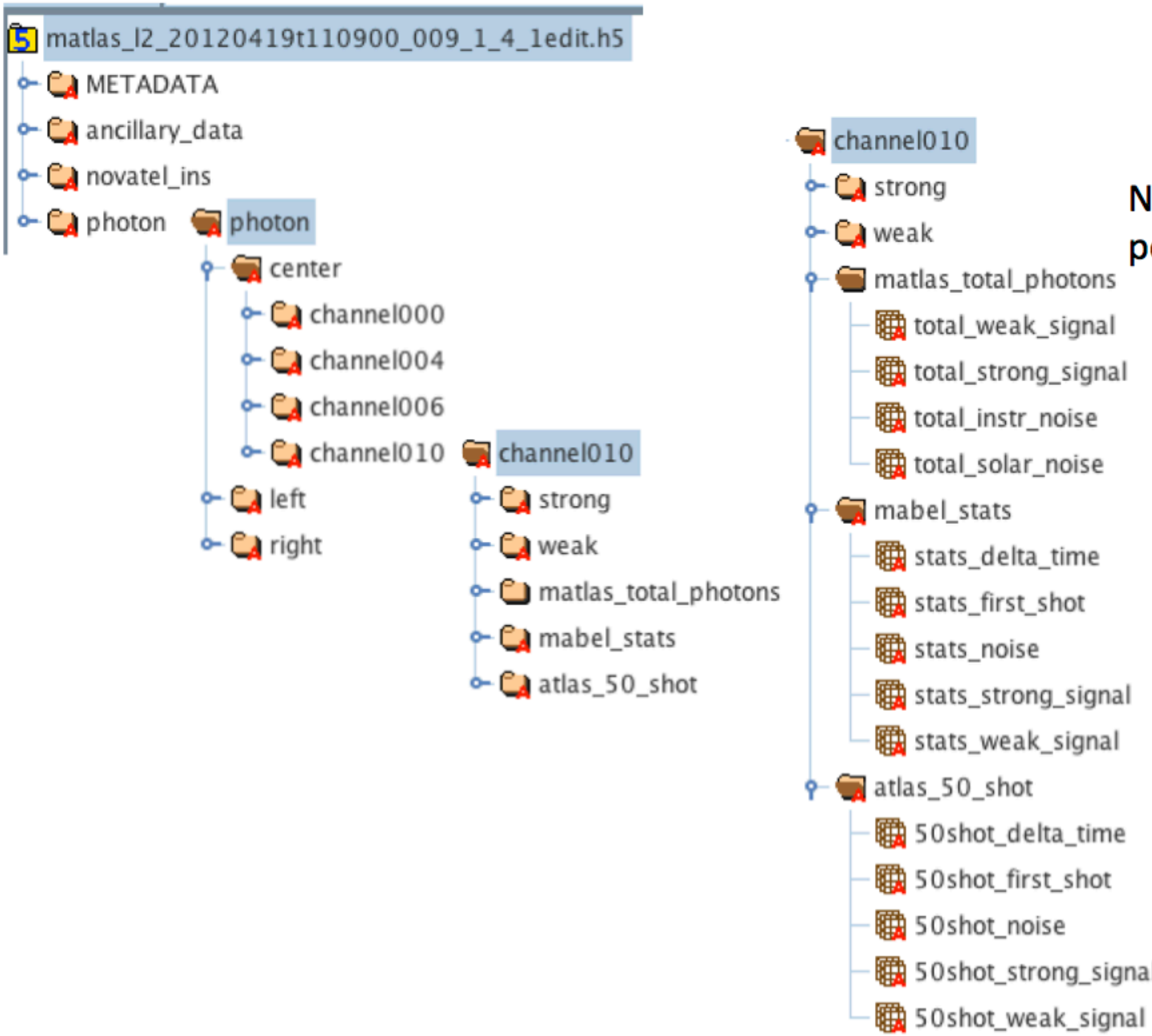
- matlas
  - al2a_aea
  - al2a_alt_ngroup
  - al2a_back_region_offset_bot
  - al2a_back_region_offset_top
  - al2a_backregion_offset
  - al2a_bin_back_multiplier
  - al2a_bthres_fact
  - al2a_case_solar_elevation_angle
  - al2a_cylinder_height_range_bot
  - al2a_cylinder_height_range_top
  - al2a_cylinderheight_range
  - al2a_delta_ms2as
  - al2a_delta_time_boundaries
  - al2a_delta_time_boundaries_a
  - al2a_delta_time_boundaries_end
  - al2a_gnd_off_bot
  - al2a_gnd_off_top
  - al2a_gs_binsize
  - al2a_hist_off_bot
  - al2a_hist_off_top
  - al2a_i_channel_noise_rate_c
  - al2a_i_channel_noise_rate_l
  - al2a_i_channel_noise_rate_r
  - al2a_i_select_channels_c
  - al2a_i_select_channels_l
  - al2a_i_select_channels_r
  - al2a_m_gs
  - al2a_mab_stat_diameter
  - al2a_mabel_laser_rate
  - al2a_max_photons_in_fp
  - al2a_ms2as
  - al2a_mt_fov
  - al2a_mt_fp_d
  - al2a_n_select_channels
  - al2a_n_select_channels_c
  - al2a_n_select_channels_l
  - al2a_n_select_channels_r
  - al2a_seed
  - al2a_sol_off_bot
  - al2a_sol_off_top
  - al2a_spot_separation
  - al2a_surf_binsize
  - al2a_track_end_latitude
  - al2a_track_end_longitude
  - al2a_track_start_latitude
  - al2a_track_start_longitude
  - al2a_vertical_bin_size

Average solar elevation and azimuth angles during MABEL collection also to be added

New Parameters

Photon folder now contains results for channel simulations in left, center and right groups





New Parameters per Channel

MATLAS photon counts in granule

MABEL photon counts in MATLAS track stats segments

MATLAS photon counts in 2 km ATLAS search window (scalable to any size window)

MATLAS v2 Simulation Methodology (1)

- MABEL photons projected perpendicularly to a straight ATLAS track
  - done separately for left, center and right channel groups to represent wider footprints
  - track is linear fit to all photons in the channels used for a group
  - MABEL granule should be a “straight” flight line (not big turns or cal maneuvers)
- MABEL photons classified as signal and noise photons
  - Done in elevation vs distance statistics bins (defaults are 2 m x 14 m)
  - Signal photons are the number in a bin exceeding expected background noise photons determined from below ground statistics and employing a Poisson distribution
- Noise photons then classified as solar background or instrument noise
  - Constant MABEL noise rate determined from nighttime data, per channel
  - Subtracted from total noise population leaving solar background

MATLAS v2 Simulation Methodology (2)

- Simulations are done per ATLAS 10 kHz laser fire with 0.7 m footprint spacing
- MATLAS signal photons are sub-sampled from the MABEL signal photons
  - MABEL channel has to have substantially more signal photons in order to subsample
  - Sampling factor is used so total number of photons is that expected for a design case
    - modified as appropriate for surface reflectance and veg cover changes
  - Along-track spatial variation seen in MABEL statistics bins is preserved
  - Separate populations for strong and weak beam cases are generated
- MATLAS noise photons are generated
  - Not subsampled because noise will often be higher than observed in MABEL data
  - Instrument noise at constant rate equal to current best estimate for ATLAS
  - Total number of solar noise photons is that expected for a design case
    - modified as appropriate for solar elevation angle
  - Along-track spatial variation in solar noise seen in MABEL statistics bins is preserved
  - Same populations are reported for the strong and weak beam cases

Things not done in MATLAS v2

- MABEL photon elevations are not changed
  - First-photon bias is not simulated; that would require knowing:
    - how to remove it from the MABEL data (where is it present and at what magnitude)
    - how to represent it properly in the simulation
  - Green penetration bias is not simulated; that would require knowing:
    - how to remove it from the MABEL data (where is it present and at what magnitude)
    - how to represent it properly in the simulation
- Laser after-pulse photons, producing a surface "echo" about 1.5 m below the true surface, are not removed
  - this is a rather strong echo at 1064 nm
  - it is reduced in strength substantially at 532 nm (by the process of frequency doubling) but a weak echo is often still present