

PML

Plymouth Marine
Laboratory

Listen to the ocean

NERC-ARF Data Analysis Node

Aser Mata, Plymouth Marine Laboratory

2nd May 2018

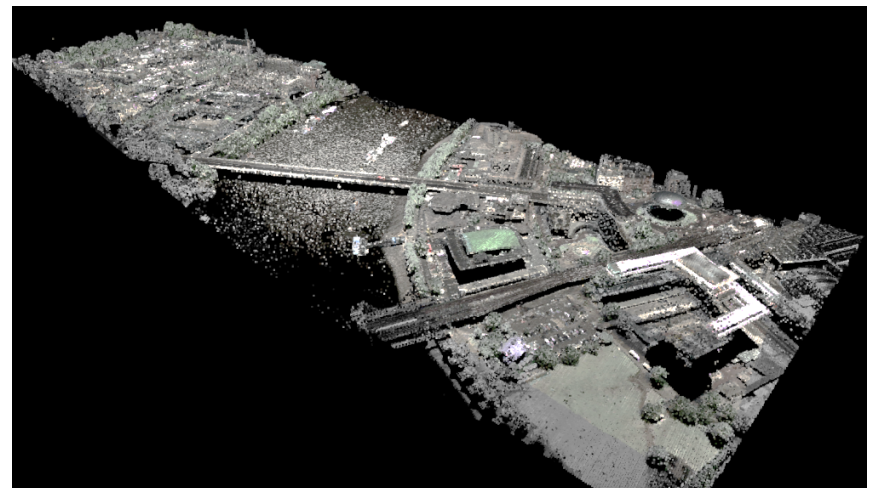
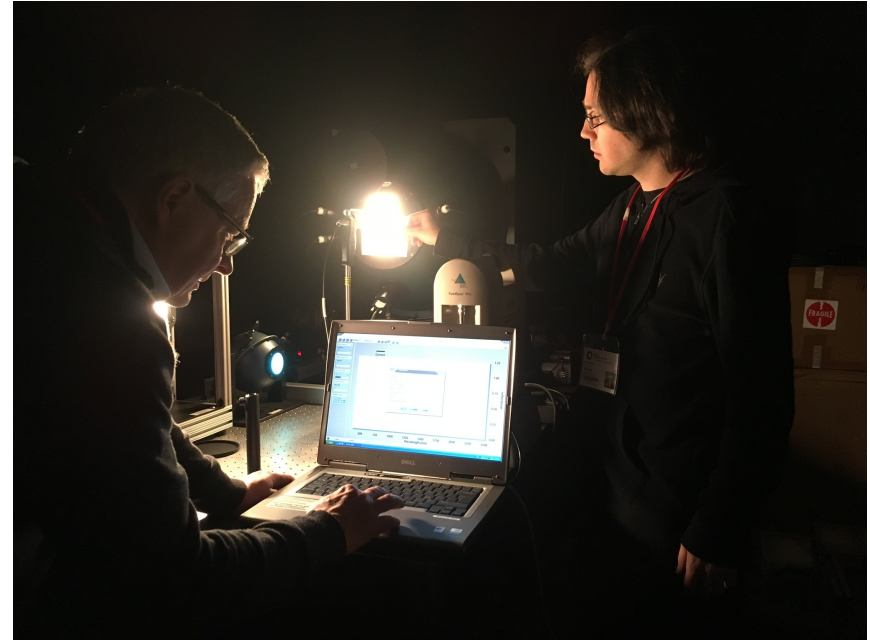


@NERC_ARF_DAN



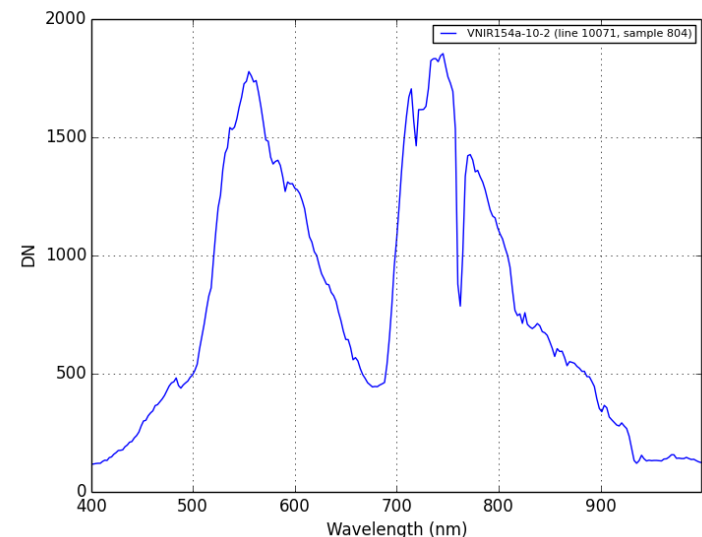
NERC Airborne Research Facility Data Analysis Node

- Process data for NERC-ARF
 - Builds on existing expertise of operational processing at PML (e.g.: NEODAAS)
- Focused on scientific use of data
 - Open and well documented processing chain
 - Research into sensor characterisation in collaboration with NERC-FSF
 - Assist Operations team
- Help desk
 - Help with all aspects of data processing
 - Centralised expertise



Airborne collection

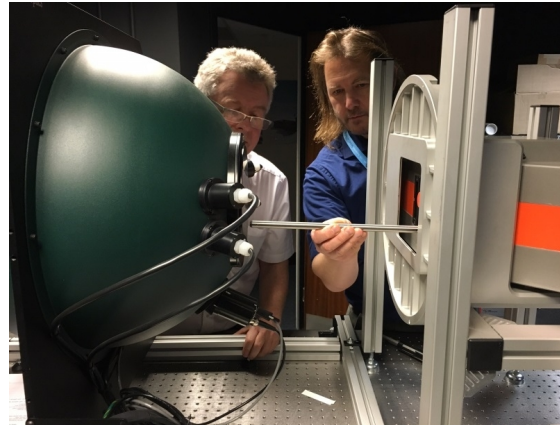
- Raw images are acquisition lines containing all scans in units of digital number:
 - Can't match with what is on the ground or other data
 - Often lots of distortions
 - A digital number isn't a physical quantity!
- Apart for specialist applications raw data isn't that useful!
 - Processing is needed before analysis



Calibration

- Bench calibration at BAS includes:
 - Wavelength calibration procedure
 - Radiometric calibration procedure
 - Bad pixel Mapping

-A new Data Quality Report is tailored with each calibration



Data Quality Report - 2016

Hyperspectral

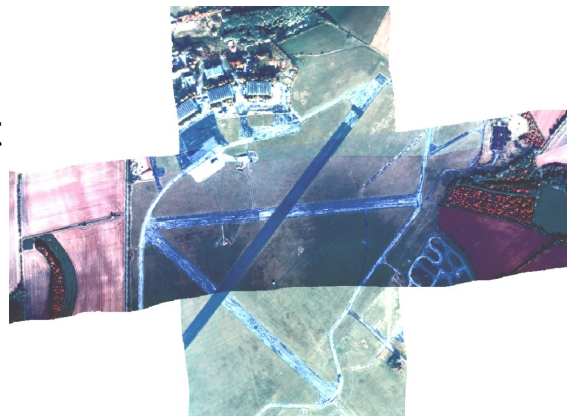
ARSF - Data Analysis Node

Updated on: February 22, 2016

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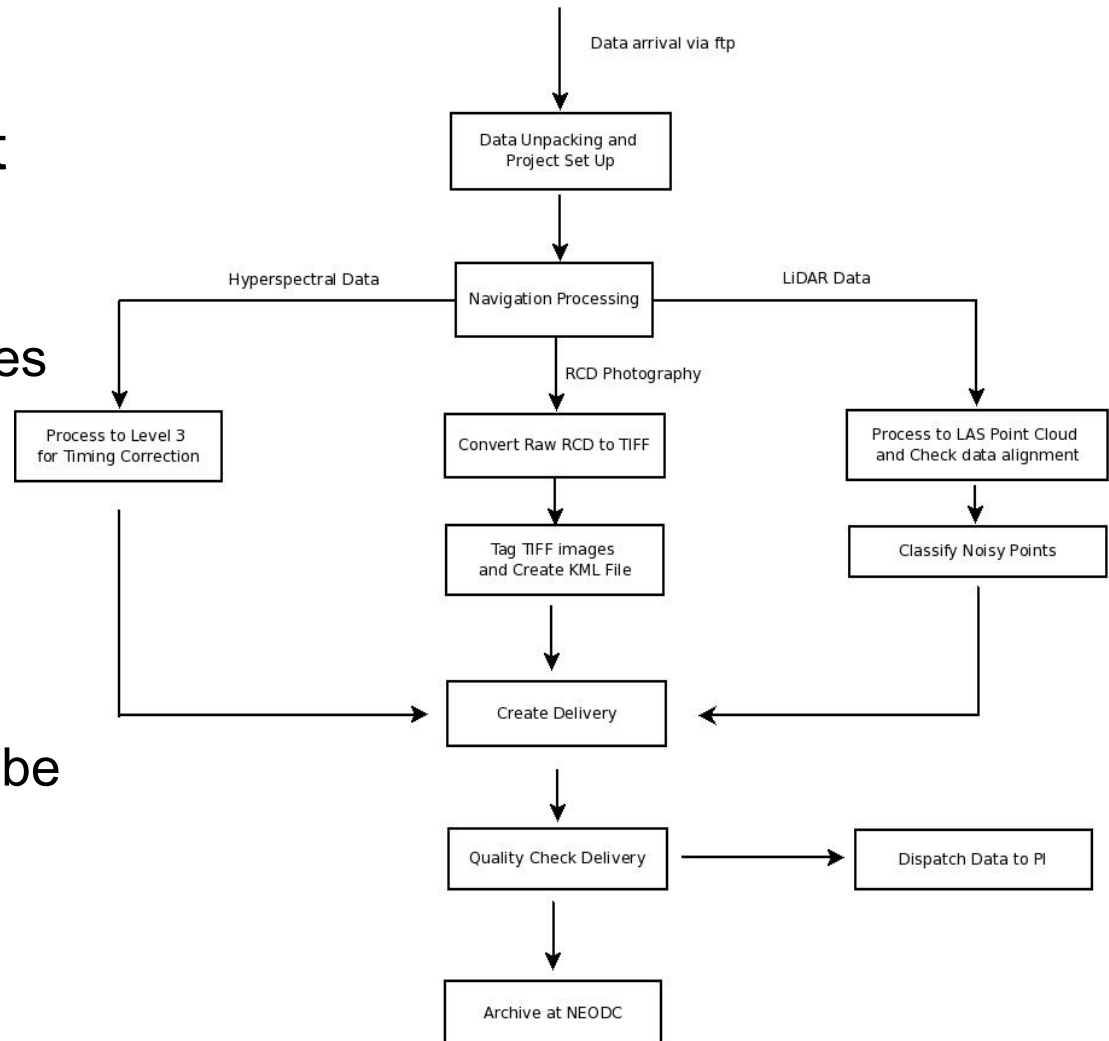
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- Boresight Calibration Flight:
 - To precisely determine sensor orientation with respect to the aircraft (pitch, roll and heading offsets)



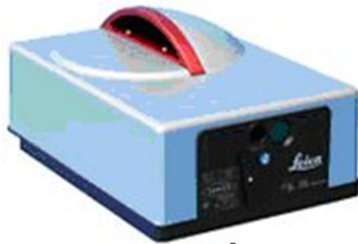
Processing Overview

- Data transferred to NERC ARF-DAN
- PI Notified and ticket opened on wiki
 - Ticket used to record internal processing notes
 - Visible to PI
 - PI page to view raw images and flight KML
- Data dispatched on hard drive
 - Different sensors may be sent separately
- Aim to process data within a month



Sensors

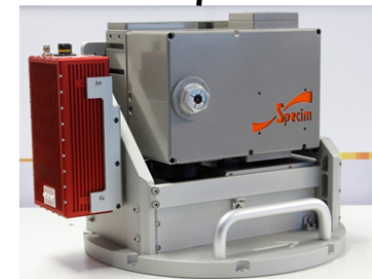
Leica ALS50-II LiDAR



AISA Fenix Hyperspectral



Leica RCD105 Digital Camera



AISA Owl Thermal

Data Products: Digital Camera

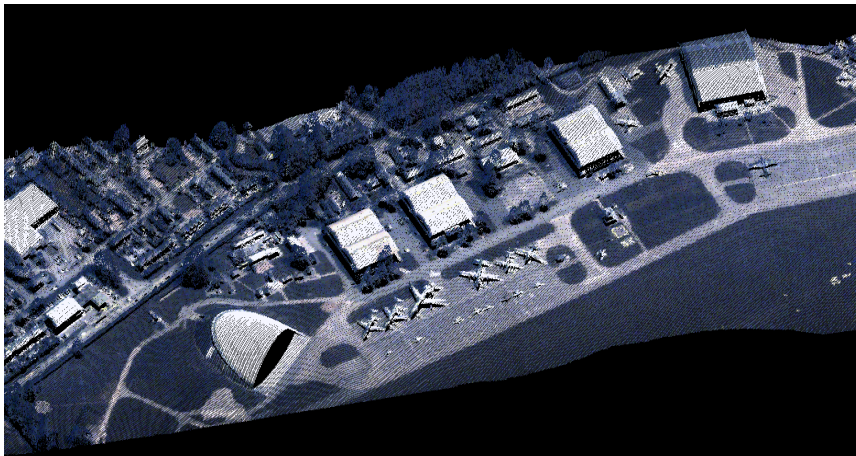
- **Phase One 100 MP (2016 onwards)**
(Better than 20cm of accuracy flying at 2km of altitude)
- Leica RCD105 pre 2016
(Medium format (39 MP @ 7216 x 5412))



- TIFF image tagged with location
- KML file for viewing in Google Earth

Data Products: Full Waveform Lidar

- **Leica ALS50-II (from 2010 to 2017)**
- Point cloud of data in LAS format (and ASCII format)
 - Discrete data as LAS 1.2, full waveform as LAS 1.3
- Digital Elevation Model (ENVI format) patched with ASTER data



Duxford airfield point cloud

London
Digital
Surface
Model
(2010)

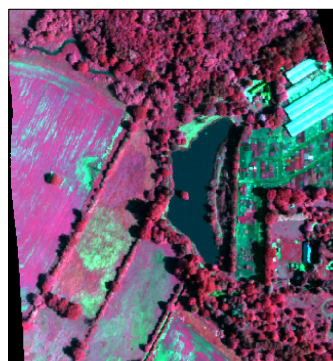


Data Products: Hyperspectral (VNIR-SWIR)

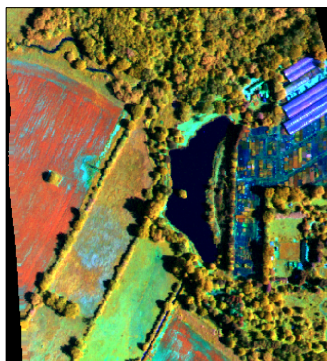
- **Specim Aisa FENIX (since 2014)**
 - 400 nm – 2500 nm
 - 622 spectral bands
- (previously AisaEAGLE (VNIR) and AisaHAWK (SWIR))
- Provide both level 1b (radiometrically calibrated) and level 3 (mapped) ENVI BIL files
- Data are at-sensor radiance (can be atmospherically corrected. PML has a license for ATCOR)



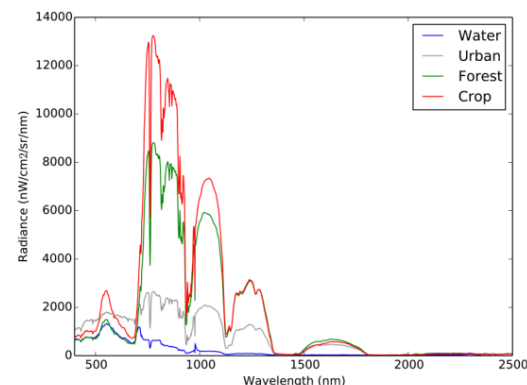
a) True colour
(650, 550, 450 nm)



b) NIR false colour
750, 650, 550 nm



c) NIR/SWIR false colour
750, 1700, 650 nm



Data Products: Hyperspectral (LWIR)

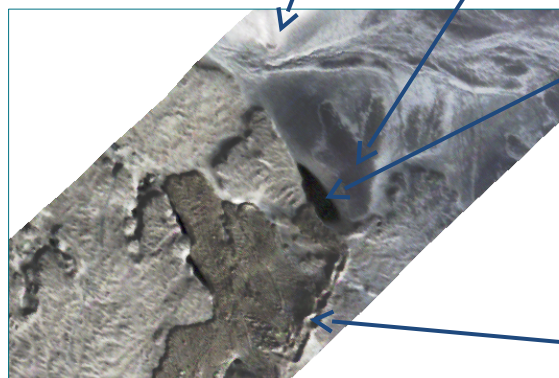
- **Specim AisaOWL (since 2014)**

- 7.6 μm – 12.6 μm
- 102 spectral bands

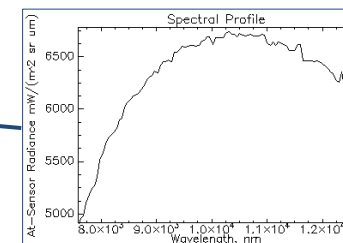
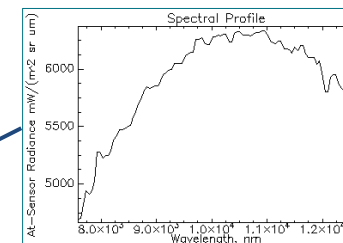
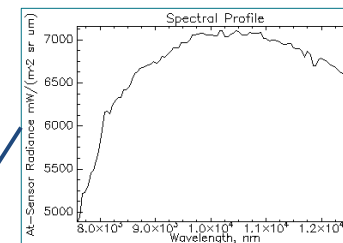
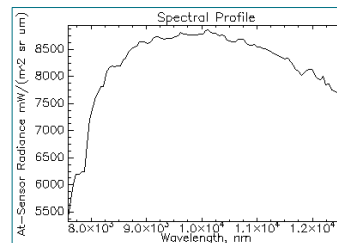
- Level 1b and mapped
- Slightly smaller swath width



AisaFENIX



AisaOWL



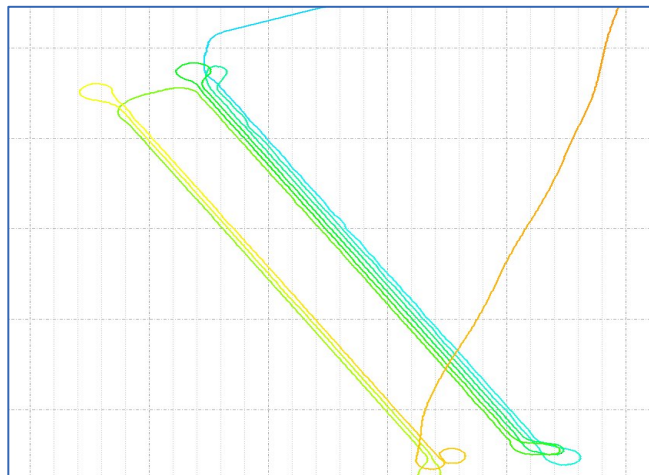
Processing Chain: Navigation

1. Base station verification

- Use Ordnance Survey RINEX network of base stations in UK
- Deploy own (or use PI's) base station outside of UK

2. Post process GPS data

- Differential GPS
- Need current level arms



Processing Chain: Digital Camera

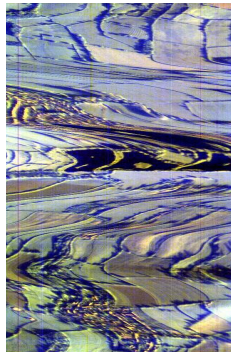
1. Convert Raw data to TIFF images
 - Using manufacturer supplied calibration file
2. Tag images with location using EXIF standards
3. Generate KML file
4. Create delivery

ExifTool Version Number	: 9.76
File Name	: RCD105-BGS11_01-2012236a-00001.tif
GPS Altitude	: 2561.786982 m
GPS Time Stamp	: 09:34:58.563013
GPS Map Datum	: WGS84
GPS Dest Bearing Ref	: True North
GPS Dest Bearing	: 119.040319
GPS Date Stamp	: 2012:08:23
Unique Camera Model	: Leica RCD105
CH39 digital camera	
Camera Serial Number	: 21
GPS Date/Time	: 2012:08:23
09:34:58.56301268Z	
GPS Latitude	: 72 deg 24' 16.66" N
GPS Longitude	: 22 deg 53' 20.36" W
Image Size	: 7212x5408



Processing Chain: Hyperspectral

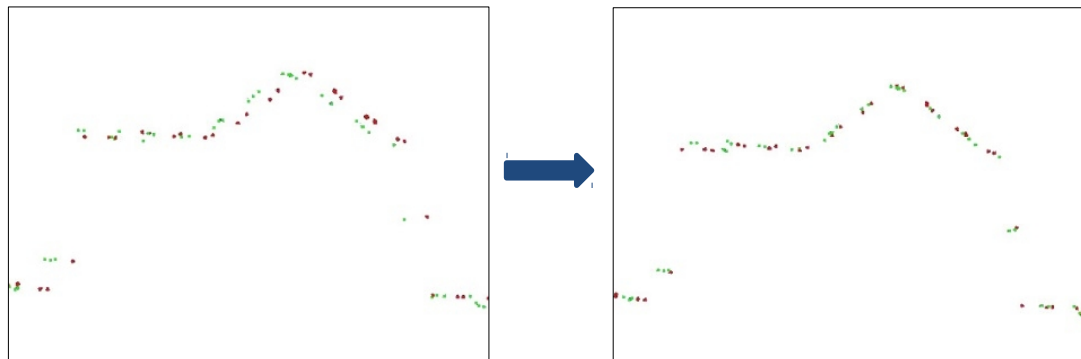
1. Calibrate raw data to at-sensor radiance (level 1b)
 - Use the Airborne Processing Library (APL) developed in-house (Currently use Specim's Preprocessing tool for AisaOWL data)
 - Mask out bad pixels
2. Geometrically correct the data using APL
 - Transform from the sensor orientation to a real world projection.



3. Create delivery
 - Including project documentation and data quality reports.

Processing Chain: Lidar (1)

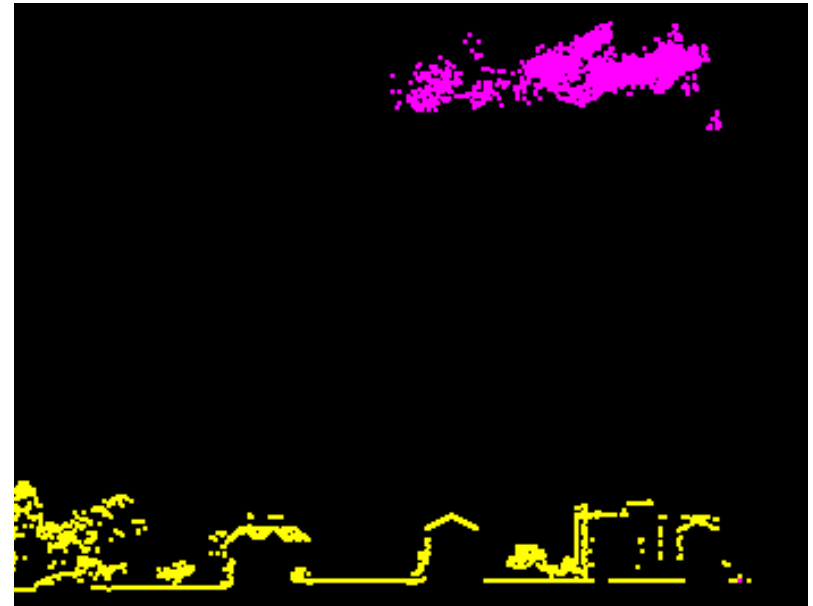
1. Convert data to georeferenced point cloud.
 - Use ALSPP (Leica software)
2. Determine and correct pitch and roll errors between overlapping flight lines.
 1. Use the Lidar Analysis Graphical User Interface (LAG) to view data
 2. Locate useful features (e.g. pitched roofs)
 3. Estimate error in roll (from across track shift)
 4. Estimate error in pitch (from along track shift)
 5. Reprocess to generate new flight lines



Processing Chain: Lidar (2)

3. Classify noisy points

- Includes cloud, haze and false returns
- Set to LAS class 7 (noise)
- Manual to achieve highest quality

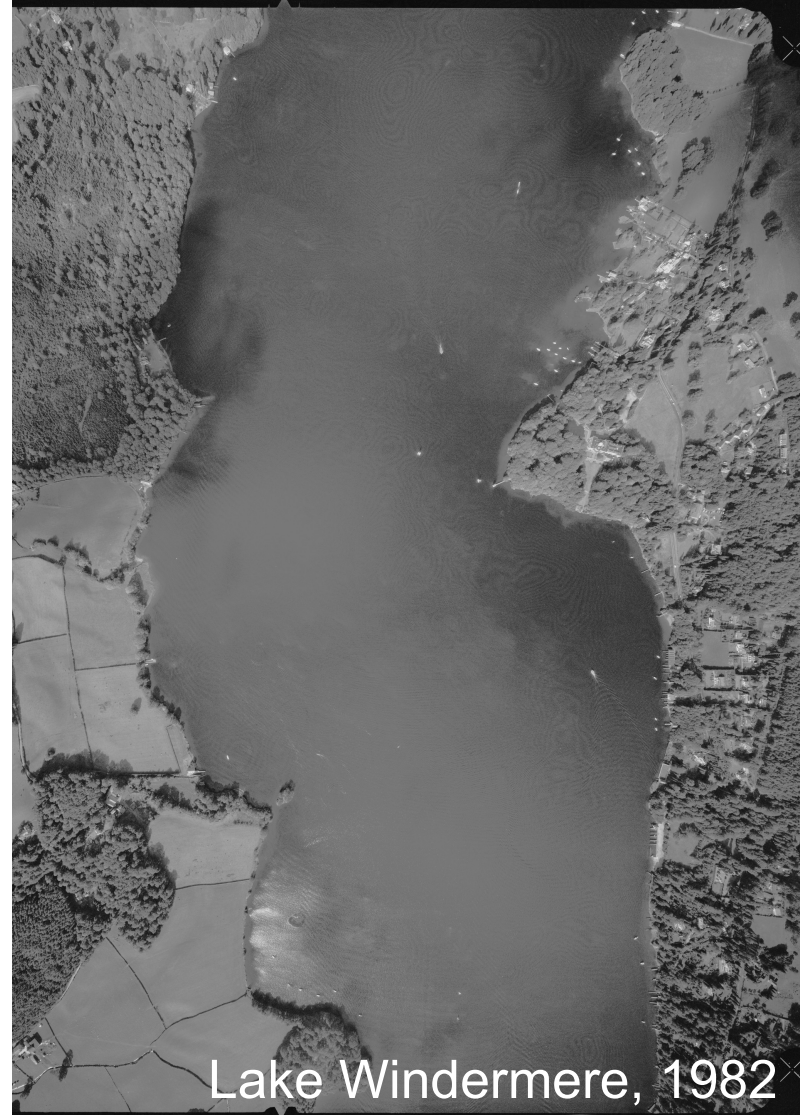


4. Create delivery

- Discrete data in LAS 1.2 (and ASCII)
- Full waveform in LAS 1.3
- Project documentation
- Data quality reports
- DEM patched with ASTER data

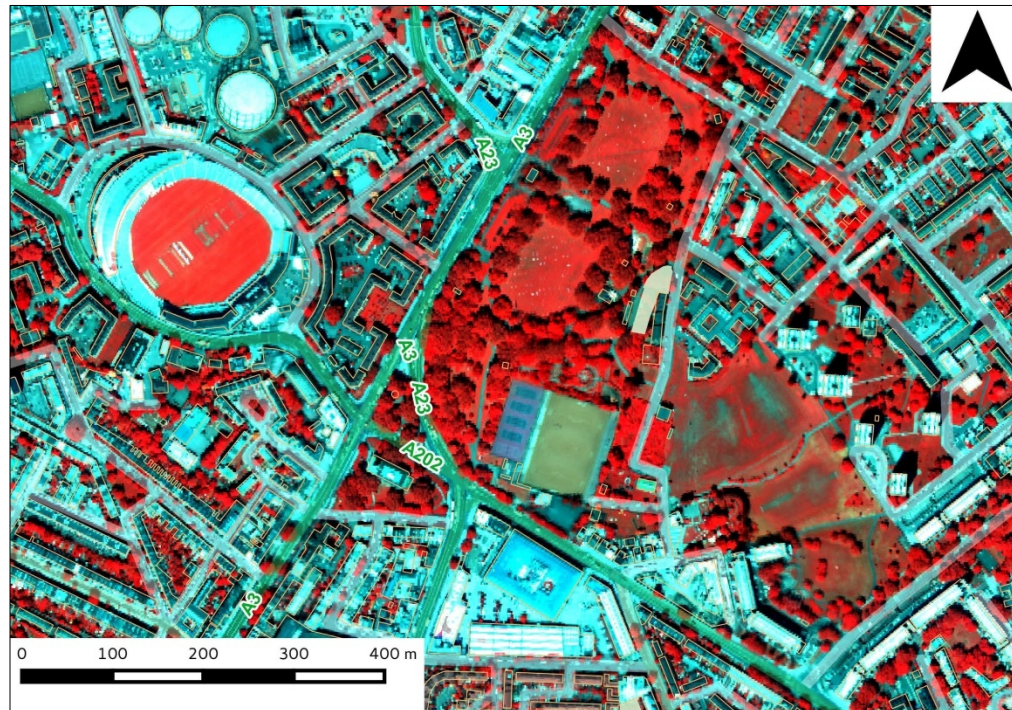
NERC Airborne Research Facility Archive

- NERC Centre for Environmental Data Analysis (CEDA)
- Have data going back to the 1980s
 - Survey camera – still usable for SfM
- From 2007 onwards generally better quality
- Can contact NERC-ARF for guidance
 - Some reprocessing might be required for older data formats



Lake Windermere, 1982

Examples from recent developments Available open source tools & Additional Services



Tools for LiDAR processing

ARSF DEM Scripts

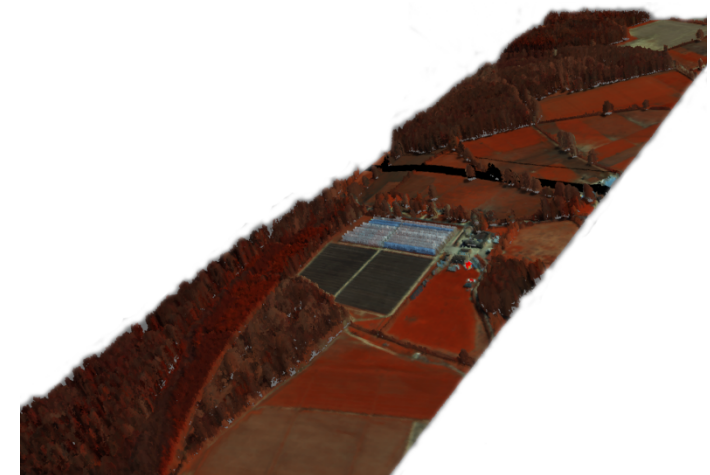
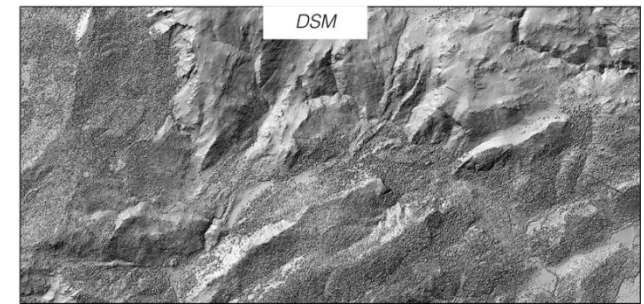
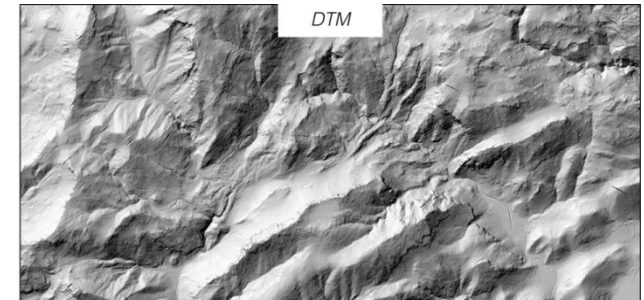
- https://github.com/pmlrsg/arsf_dem_scripts
- Open source Python library for generating DTMs and DSMs from LiDAR point clouds.

SPDLib

- <https://bitbucket.org/petebunting/spdlib>
- Added support for LAS 1.3 waveform data using LASlib
- Utilities to generate LiDAR metrics (e.g., canopy cover, number of returns for height range)

DASOS

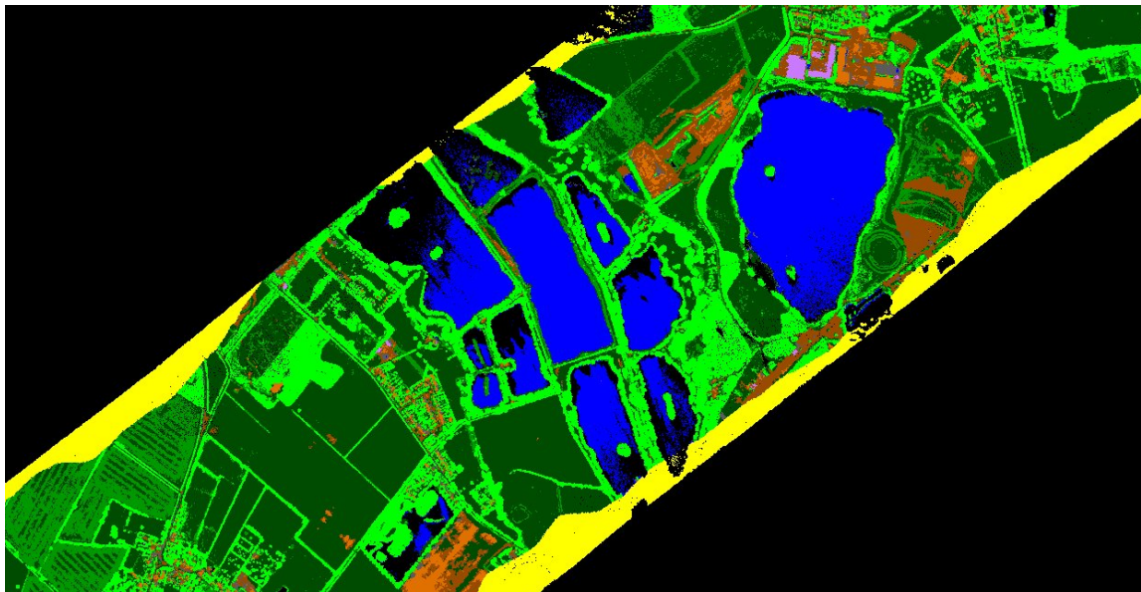
- LiDAR visualization tool (can use full waveform for detailed 3D visualization)
- Polygonises the point cloud



FW LiDAR 3D visualization using DASOS

LiDAR classification based on hyperspectral data

- Use the hyperspectral data to classify the LiDAR data
 - Data from same flight / same time
 - Uses simple classification routines to generate a classification mask from the hyperspectral data
 - Updates the LiDAR classification based on this mask

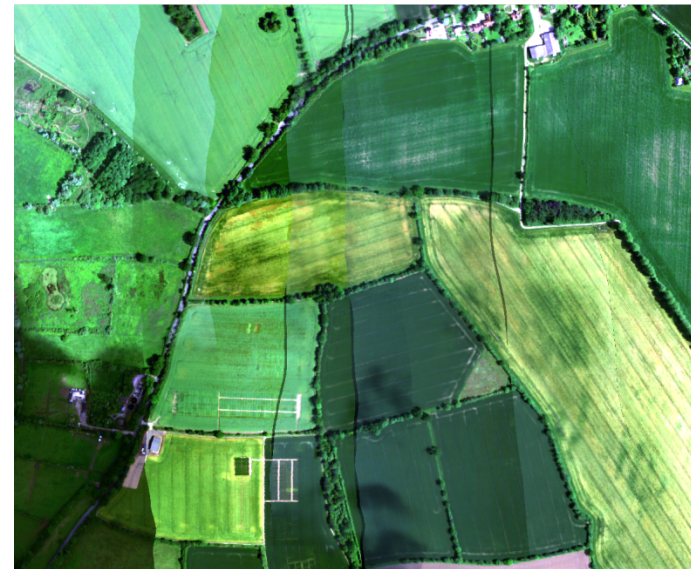


HYLIGHT project tools: <http://eufar.net/cms/development-hylight-tools/>

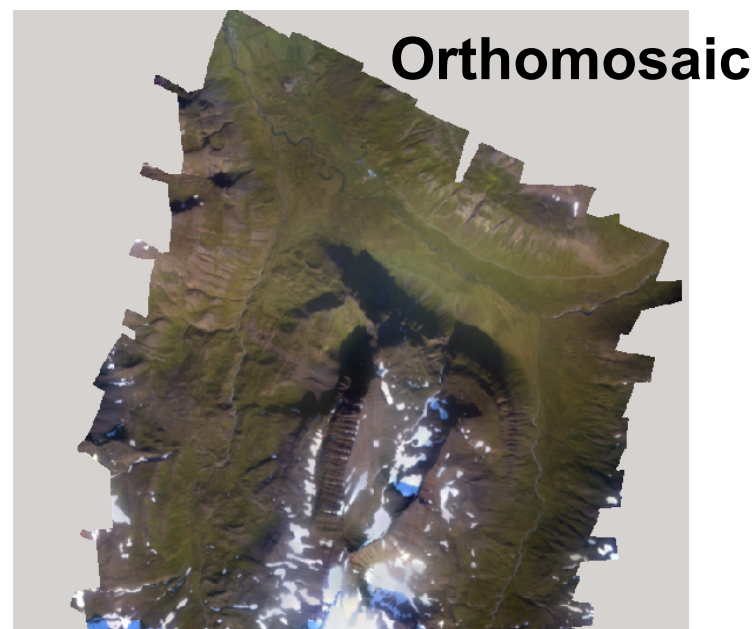
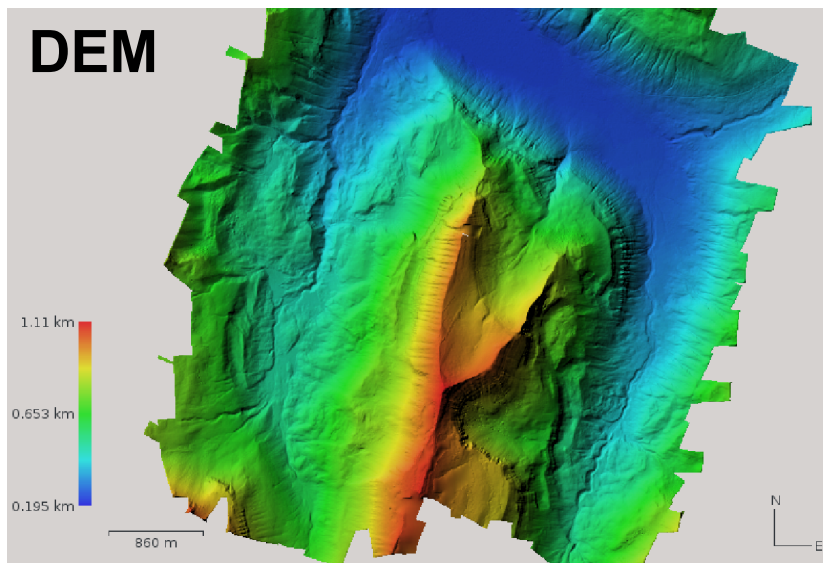
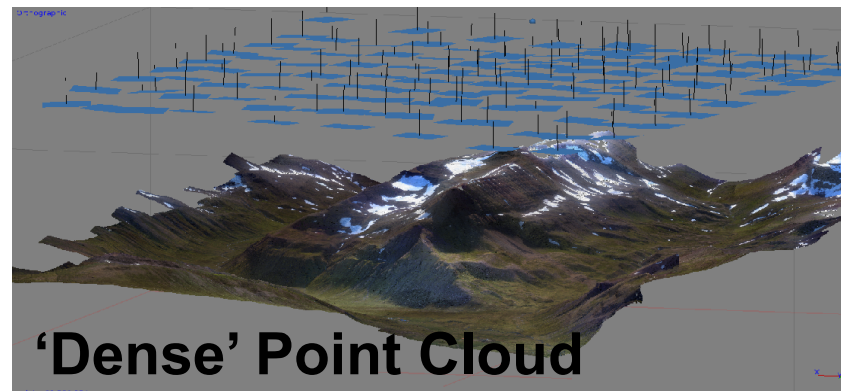
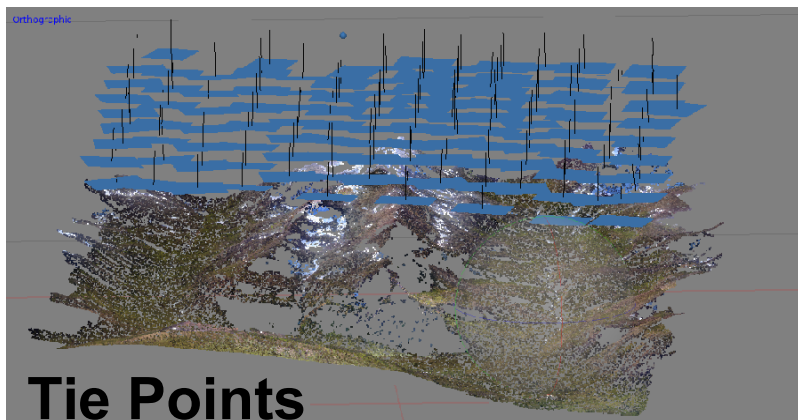
Atmospheric Correction

- Atmospheric parameters must be estimated.
- Highly dependent on good ground data – calibration targets!
- BRDF correction is an additional step.
- Cloud shadow still a problem.
- NERC-ARF-DAN has a license for ATCOR4

At-sensor radiance → Reflectance



DEM and Orthomosaics from Digital Camera



Help Desk Activities

- Supporting users is a key role – we want to help you get publications out!
- Very broad scope
 - Help with analysis, e.g. LiDAR intensity normalisation.
 - Answer questions on instruments – perform experiments to help with this (such as sensor characterisation).
 - Software generation and support.
 - DTM / DSM generation from LiDAR.
 - Patching NERC-ARF LiDAR with EA LiDAR for hyperspectral processing.
- Host annual workshop.
 - Streaming option will be available.
 - Last one held on March 2018

Thank you

