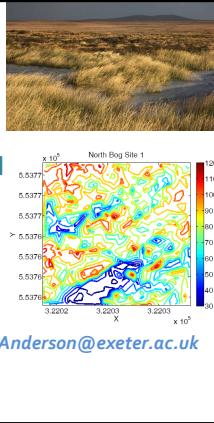


Early results from the first full waveform LiDAR survey over a lowland ombrotrophic peatland, and synthesis with hyperspectral Eagle-Hawk data

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Study site

- Wedholme Flow, Cumbria
- Ombrotrophic peatland
- Range of condition classes
 - Wet, intact, diverse *Sphagna*
 - Dry, degraded, cut over, shrub-dominated
- Good test bed for short-sward vegetation
- NERC-funded work on LiDAR DSMs and vegetation structure showed relevance of ALS technique Anderson, K. J. J. et al.

Anderson, K., J. J. Bennie, et al. (2010). "Combining LiDAR and IKONOS data for ecohydrological classification of a lowland ombrotrophic peatland." *Journal of Environmental Quality* 39: 1-14.

Anderson, K., J. J. Bennie, et al. (2009). "Laser scanning of fine-scale pattern along a hydrological gradient in a peatland ecosystem." *Landscaping Ecology* **25**: 477-492.

Aims of project

- Determine information content of FWL data
 - context of short sward vegetation
- Test the processing chain for FWL data
- Consider operational data processing and handling issues
 - Develop methods for processing
 - Feedback to ARSF-DAN
- Compare with existing LiDAR data from a well-instrumented site
 - Peatland site with demonstrated links between top of canopy structure and underlying hydrology / biodiversity

Relationship to NERC strategy

- Biodiversity resource
- Spatial data required for ecosystem service evaluation
- Hydrology, ecology and C sequestration linked
- “compost bomb” instability in peatlands under c.c.*
- Many relationships to NERC-banners including *climate system, biodiversity, technologies*

C. M. Luke et al. Soil carbon and climate change: from the Jenkinson effect to the compost-bomb instability. *European Journal of Soil Science* 2010, 61, 1–10.

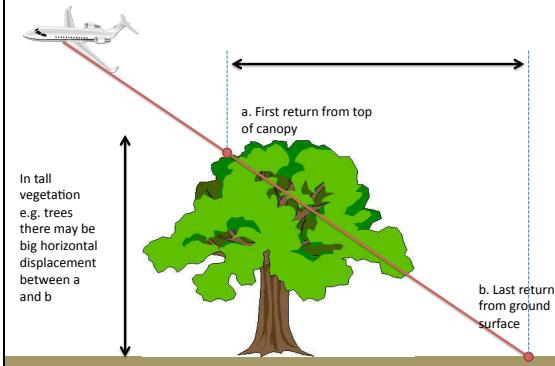
1. Data format

- Text file for every point on the land surface

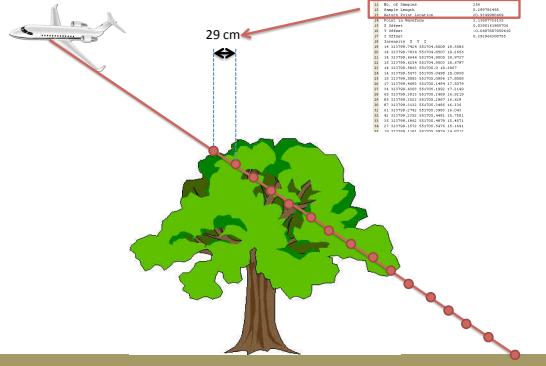
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What do the data mean? Standard ALS...



The full waveform dimension



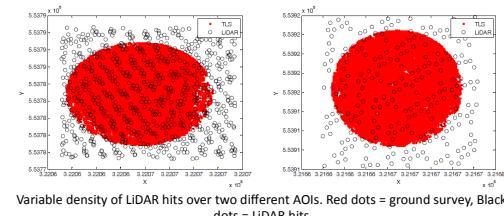
Data format

- X,Y,Z co-ordinate in header for the “point”

What is the header position and where is it located?

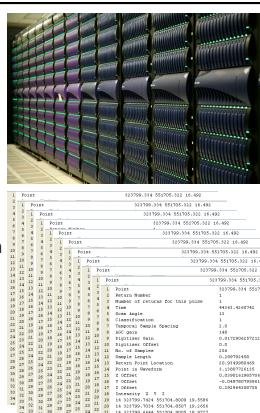
2. Density of points

- Note that density of LiDAR points will vary depending on data capture
- Flightline overlap regions will be denser



Data volumes

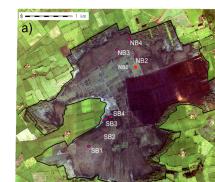
- Health warning
- 256 FW values per point (high redundancy)
- In 10×10 m AOI = up to 750 text files
- For entire peatland (5×7 km) = several million files
- Large data processing burden
- Raw text files not ready for use with standard IP software
- Requires coding capabilities (matlab, R, C etc.) to digest efficiently

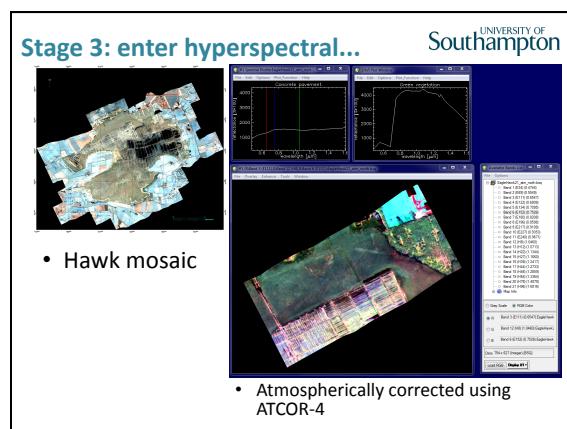
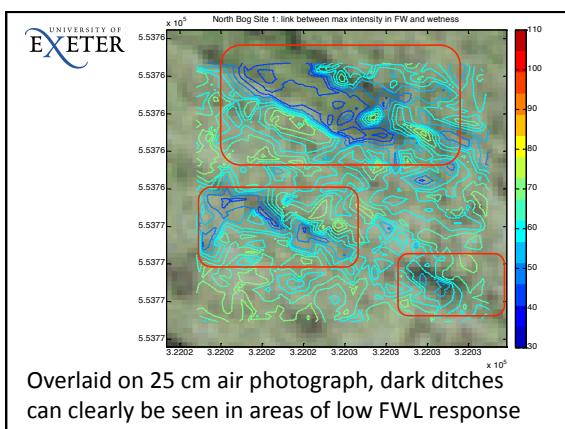
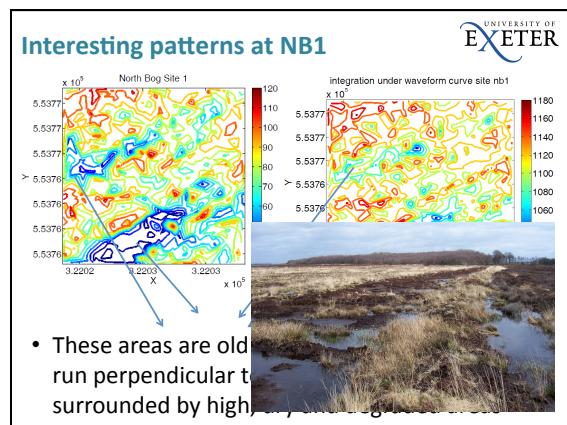
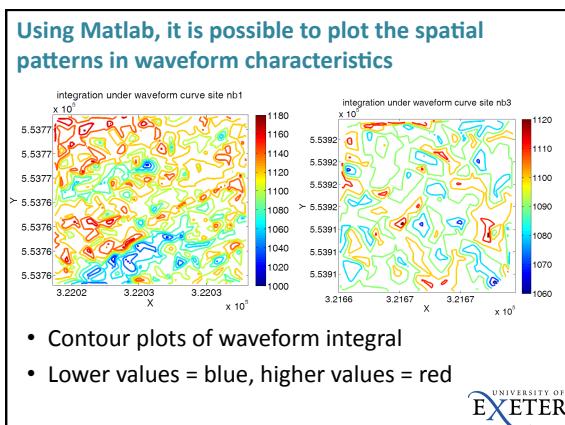
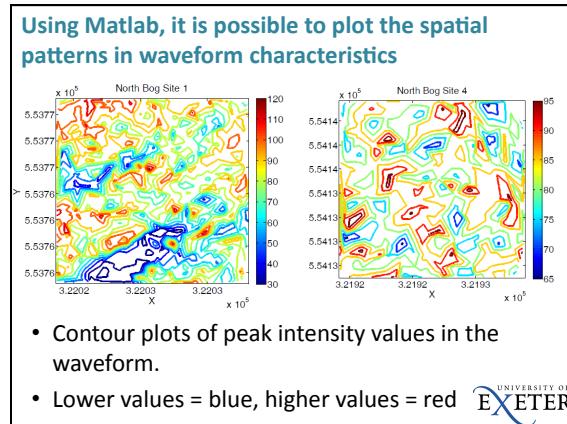
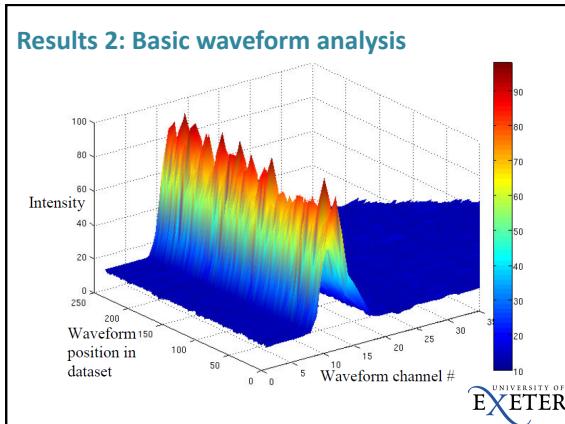


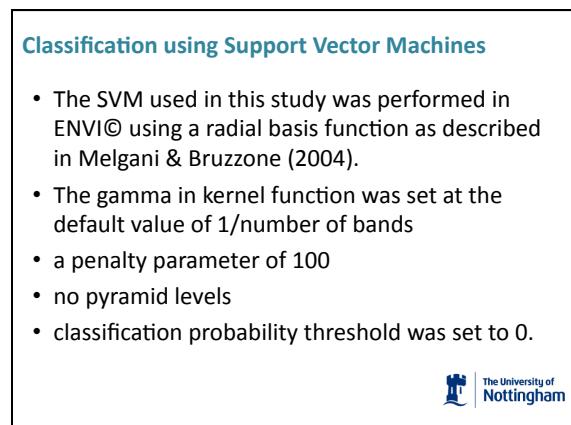
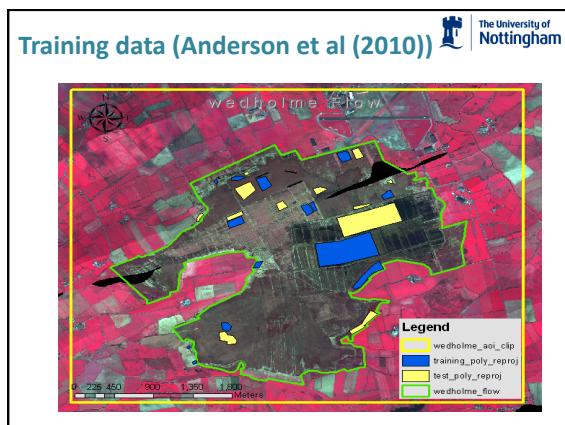
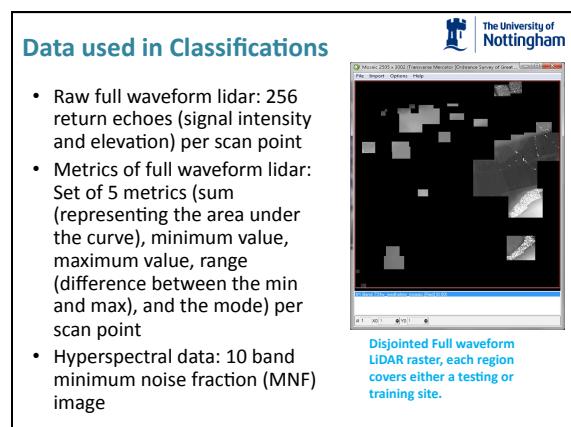
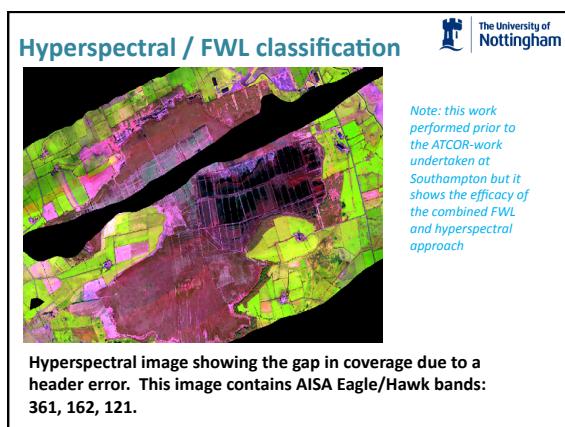
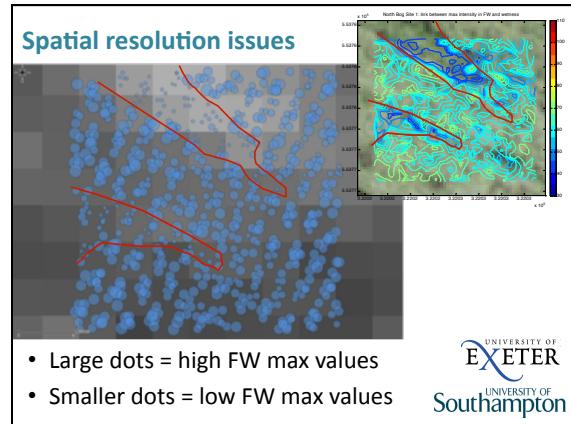
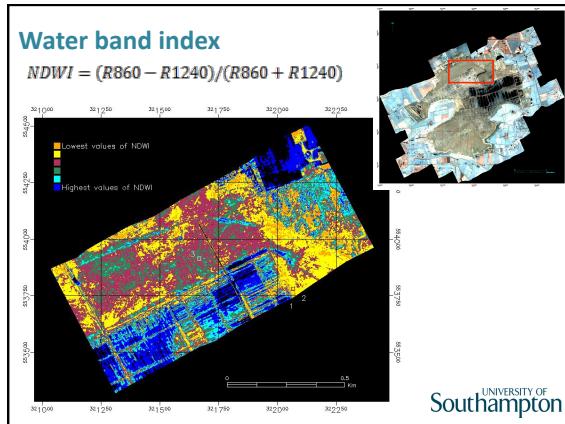
Results 1: header elevation value Validation against EA LiDAR

- N=25
- 8 sites distributed across peatland

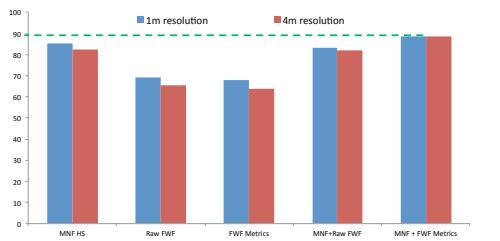
Site	Mean difference (m)
North bog 1	-0.04
North bog 2	0.08
North bog 3	-0.10
North bog 4	-0.02
South bog 1	-0.10
South bog 2	-0.14
South bog 3	-0.25
South bog 4	-0.11
Mean	-0.09







Overall Classification Accuracies (%)



Analysis per class (4m SVM classification)

	Optimal Dataset	Classification accuracy (%)
Active raised bog	MNF HS + FWF metrics	98.0
Active raised bog, degraded	MNF HS + Raw FWF	96.9
Drained and degraded (Calluna dominated)	Raw FWF	32.0
Drained and degraded (Erica dominated)	MNF HA + FWF metrics	25.0
Carr woodland	MNF HS + Raw FWF	98.7
Bracken	MNF HS + Raw FWF	35.3
Tussock grassland (Molinea dominated)	MNF HA + FWF metrics	63.8
Milled unvegetated peat	MNF + FWF metrics	92.6
Eriophorum bog	Raw FWF	97.0

In each case the optimal dataset for classification always includes a full waveform dataset, either in combination with the hyperspectral dataset or exclusively.



Conclusions

- Full waveform LiDAR data have high volume
 - Processing effort / requirement beyond standard RS
- We have presented results based on a few focused sites
 - Rolling this out over full extent is difficult
- Resolution difference between LiDAR point and hyperspectral data
- Initial results suggest that FWL intensity is proxy for near surface moisture

Recommendations to ARSF

- I would suggest that higher level product retrieval from FWL data could be an ARSF-DAN focus for the future
 - x,y,z product of maximum intensity
 - X,y,z product of waveform integral
 - X,y,z product describing waveform shape & extent
- For many users this would be the most efficient way of integrating this additional information into classifications etc.

Acknowledgements

- ARSF-DAN
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 - Mike Grant
- MSc students
 - Cheyne Hadley (Notts)
 - Chris Koster (Exeter)