The ISB-52 Project - improving air quality forecasting

15 April 2003

NETCEN

The Project Team

- QinetiQ: *D Willetts, G Pearson & R Young*
- Met Office: *D Middleton*
- Salford University: *C Collier, F Davies & K Bozier*
- Essex University: *A Holt, G Upton & S Siemen*
- Client: *J Dixon*

Project Objective

- To achieve the ability to improve the accuracy of dispersion model forecasts
- by improved understanding of the flow dynamics in the urban environment
- rather than by incorporating lidar data directly into the model.

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Doppler Lidar Details

- 10 μm wavelength
- TEA laser
- Pulsed system
- 10 km range
- Complimentary to radar
- Gives Line of Sight measurements
- **Dual lidar combines measurements to determine unambiguous vector components**

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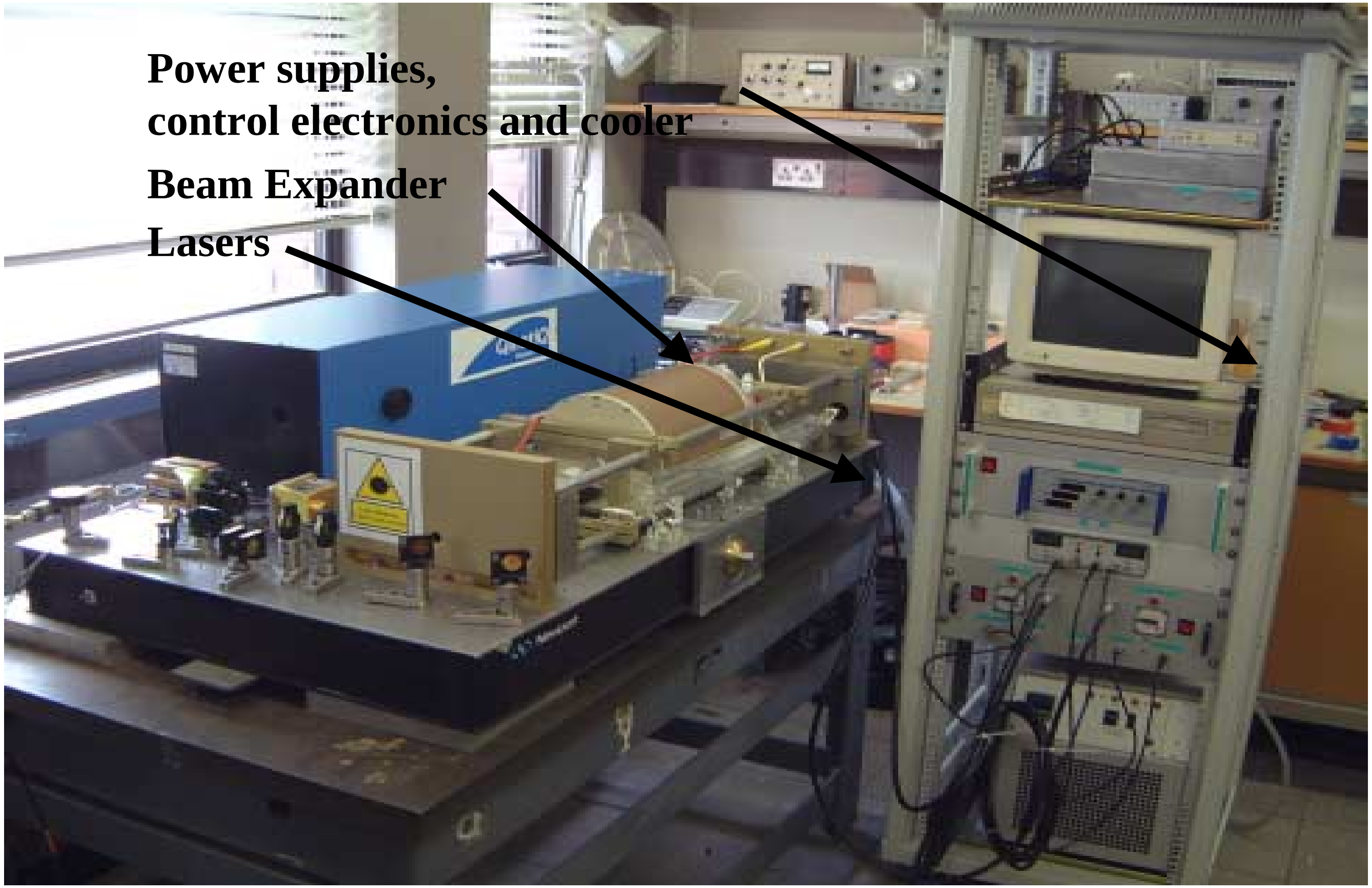
Doppler Lidar



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System Status

- Optical system now complete and tested
  - Delays in construction due to late delivery of TEA laser and faulty laser tube
- Data acquisition system configured for either real-time or raw mode
- Scanner control complete

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Identification of key dispersion model parameters and how to measure them with lidars.

- A lidar cannot monitor the complete wind field instantaneously
- Need to decide what features to observe
- Need to deduce the scale lengths of these features so the lidar sampling will be appropriate for **monitoring pollution dispersal mechanisms**

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- All current forecasting models for the urban environment were designed for the rural and then extended to cover the urban.
- All models extended to the urban environment contain *assumptions* that could be improved upon via the use of in-situ observations.

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Potential ways in which to improve the forecasting models

- The highest priority parameters to observe are the **turbulence** and **the structure of the Planetary Boundary Layer**.
- In particular it will be important to observe the diurnal changes in turbulence and mixing layer structure and depth for the rural and urban environments simultaneously.
- Monitor the same volume of space for long times, at least 600 s at frequencies in the order of Hz if possible.
- This implies a scan pattern which concentrates upon collecting temporal data at the expense of spatial.

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How to quantify the improvements in forecasting accuracy

- Cannot be assessed until data has been gathered, analysed and incorporated into the forecasting models.
  - Compare forecasts from models using assumptions to models that have been modified in light of ISB-52 findings
- Difficult to believe that replacement of assumptions will not improve forecasting accuracy

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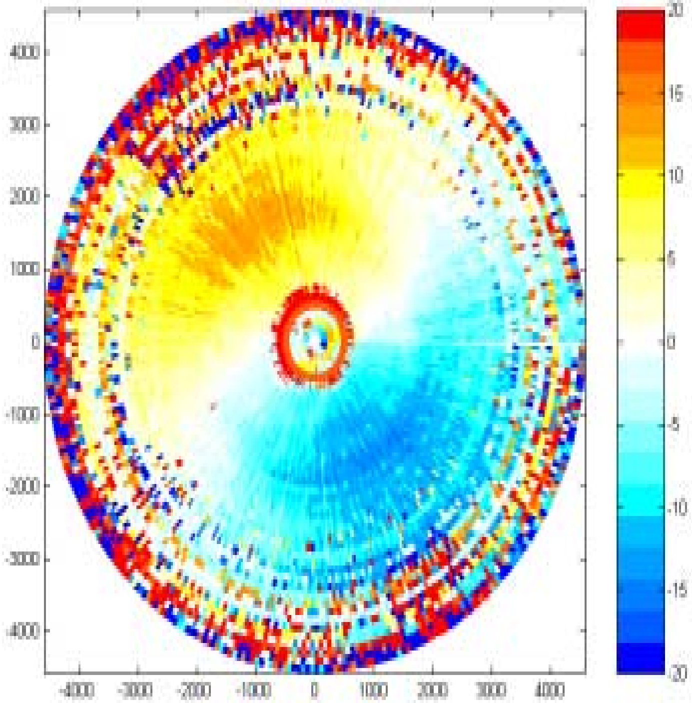
How to make the measurements: VAD



- Gives prevalent wind direct
- Useful to align beams to minimise cross talk
- and optimise observation of turbulence, at least for one lidar.

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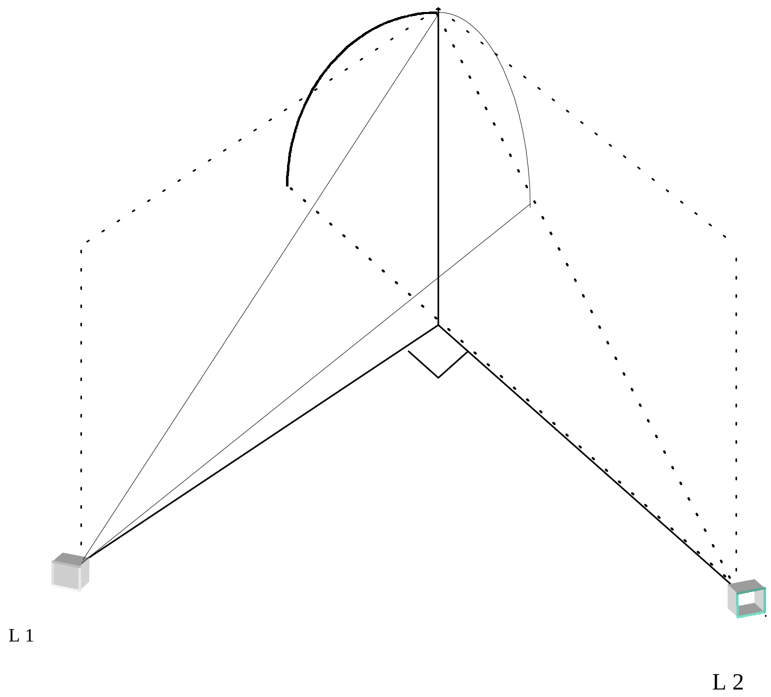
To gather unambiguous horizontal flow data at a column



- Small number of elevations chosen
- preference is for most of the measurements to be made at lower altitudes

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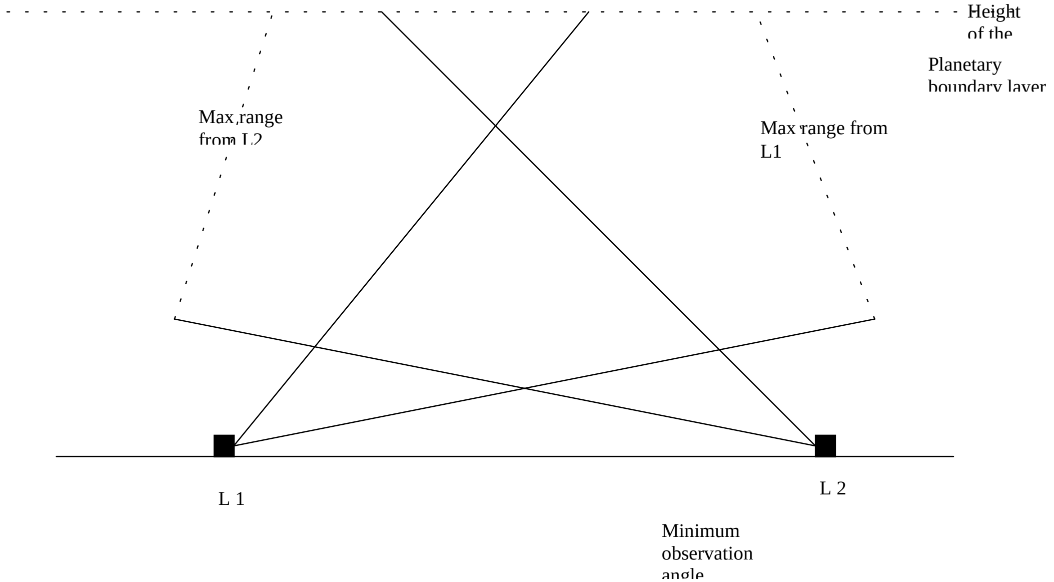
To obtain unambiguous vertical flow data in the plane of the lidars.



- Also gives unambiguous horizontal wind flow in the plane between the two lidars

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What the observations give us

- Unambiguous horizontal wind flow data at columns
- Unambiguous vertical wind flow data in the plane of the lidars
- ambiguous wind flow along line of sight
- PBL structural information
- BUT observations could be uncorrelated because of length of time to make these measurements

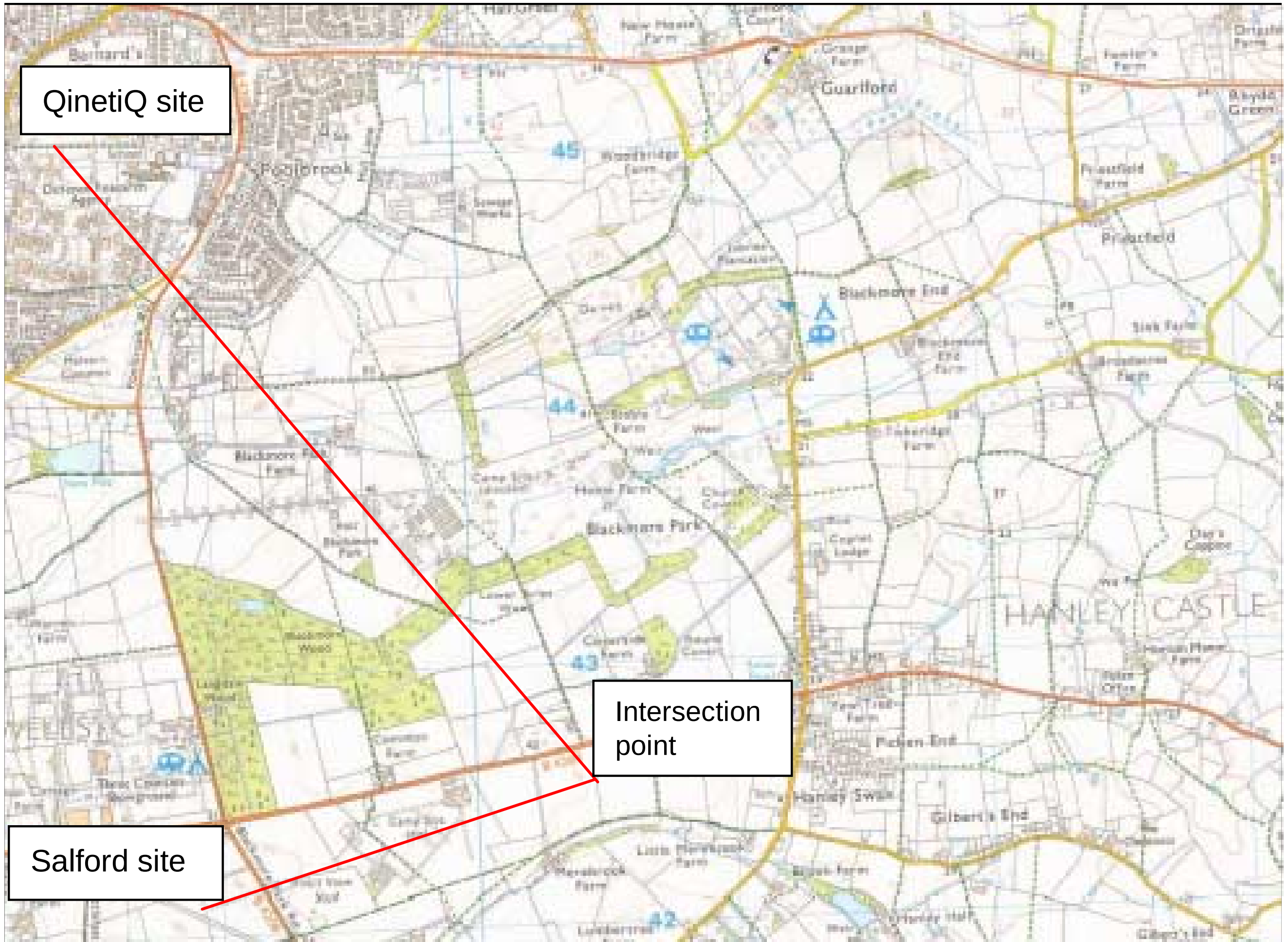
Key parameters to visualise

- Mean wind flow in terms of direction and strength
- Turbulence
- PBL
- To be presented in the following formats
  - Visualising rays of lidar data and wind vectors in 3D
  - Production of a 2D snap shot of a 3D display
  - Animations

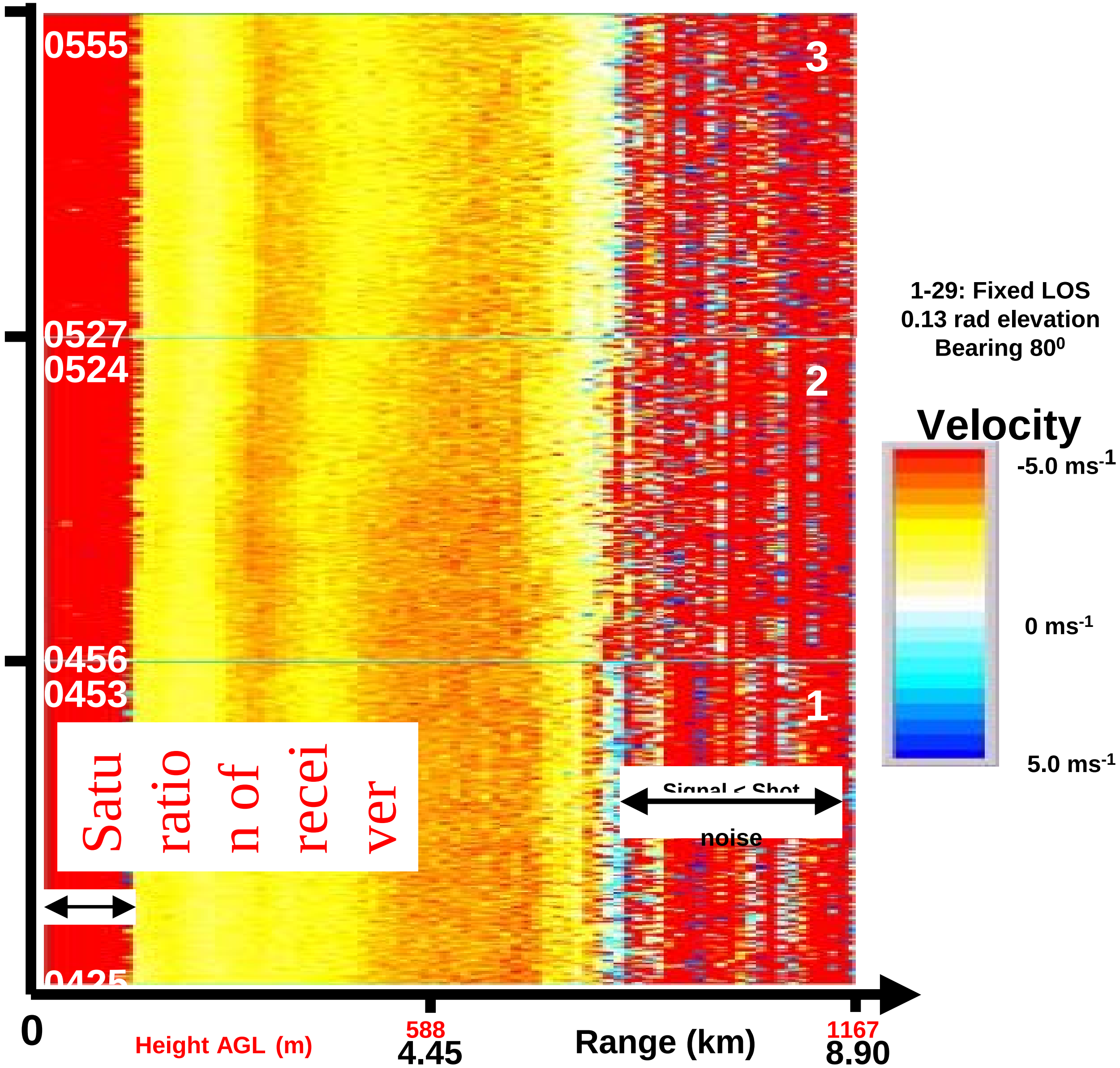
Requirements for the trial site

- Borders a *representative* urban rural boundary
- Base line of 1800 to 3000 m
- Excellent fields of view
- Vehicle security
- Ideally only one site

Malvern Local trial



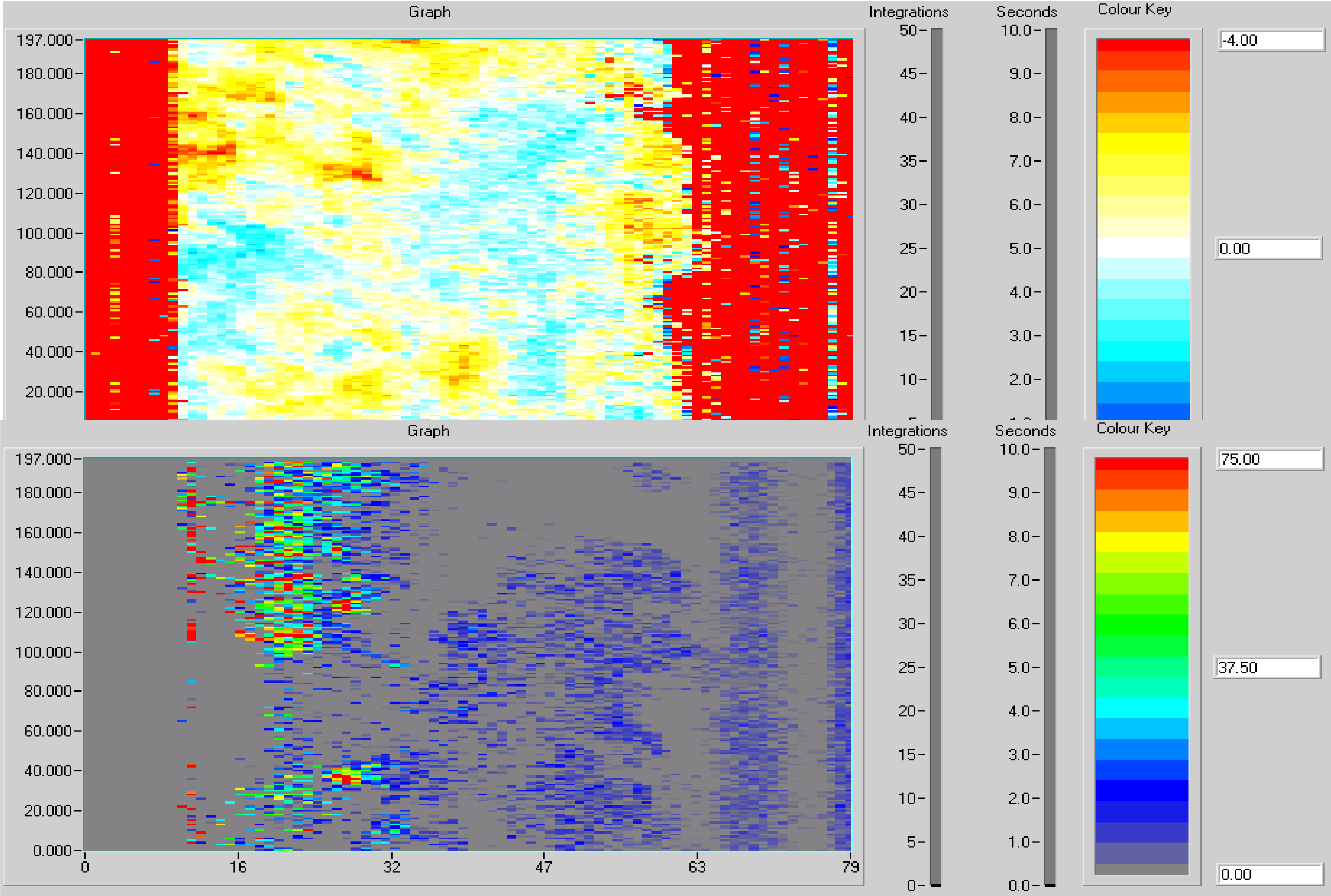
Preliminary results



- Observation of the PBL

Structure in backscatter profiles

- Curve fit signal power versus range
- Subtract function to leave fluctuations
- Applied to18th file of March data set
- Correlation of velocity structure with backscatter
- Pollution entrainment, boundary layer height



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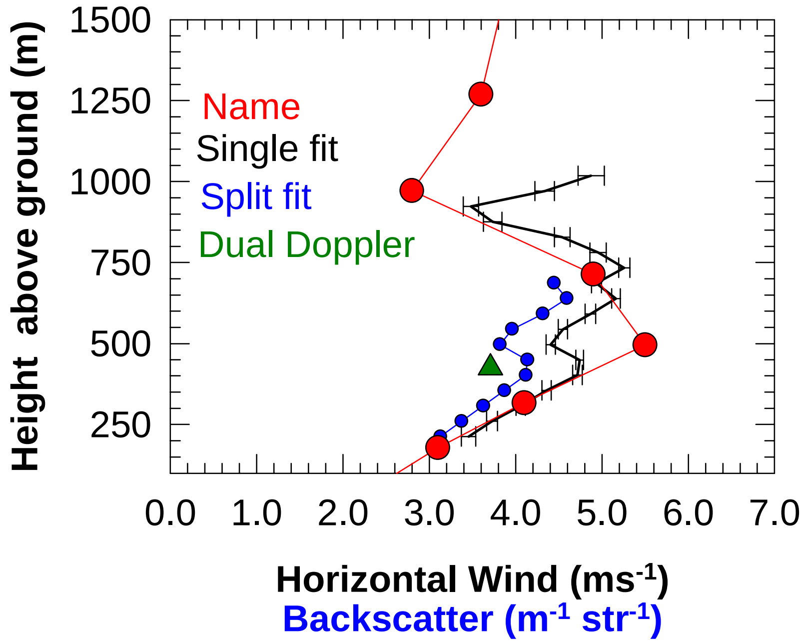

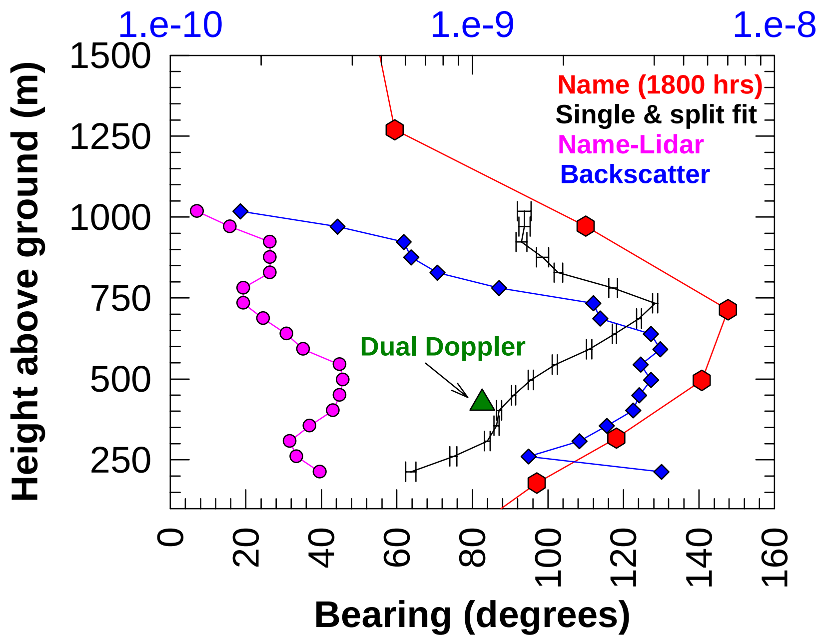

Preliminary comparison to NAME model observations

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Summary

- Project 19 months old
- Lidar performance has been enhanced to meet ISB-52 specifications
- Strategy for making observations devised
- Winter trial has taken place
- First dual Doppler lidar data is currently being analysed

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