Horizontal Motion Vectors from Cross-Correlation

First Application to Eye-safe Aerosol Lidar Data from CHATS

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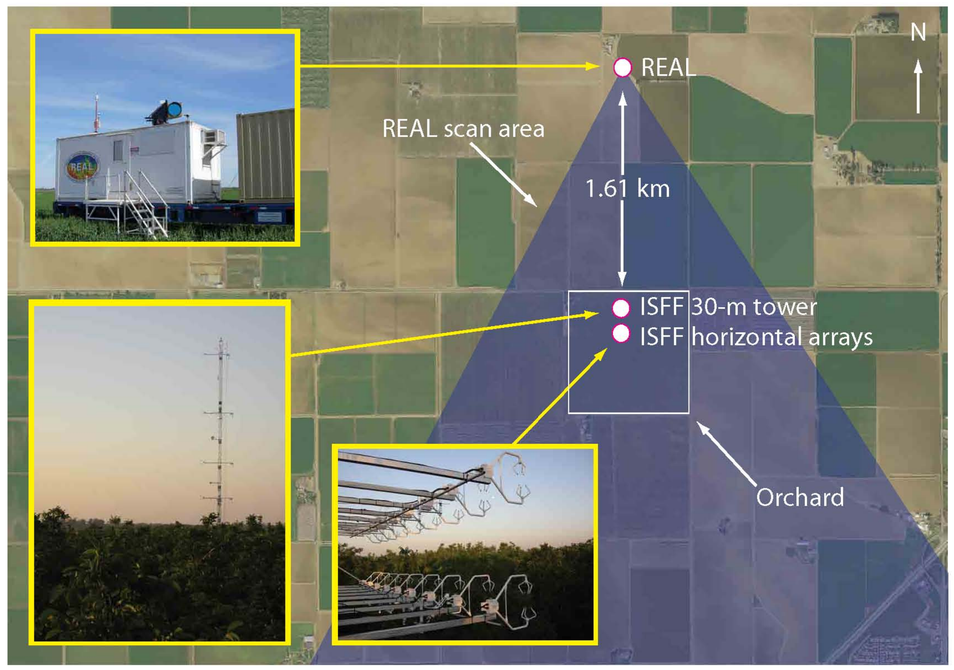
Experiment

The REAL was located 1.61 km north of a micro-meteorological tower. PPI scans intersected the tower at 12 m AGL. A sonic ane-mometer at that level provides a reference wind measurement for comparison with the lidar derived velocities.



Algorithm

SCANS

In this example, a series of PPI scans are used, each resulting from about 150 laser pulses. The radial arrays have been high- and low-pass median filtered and interpolated to a Cartesian grid with 10 m resolution.

BLOCKS

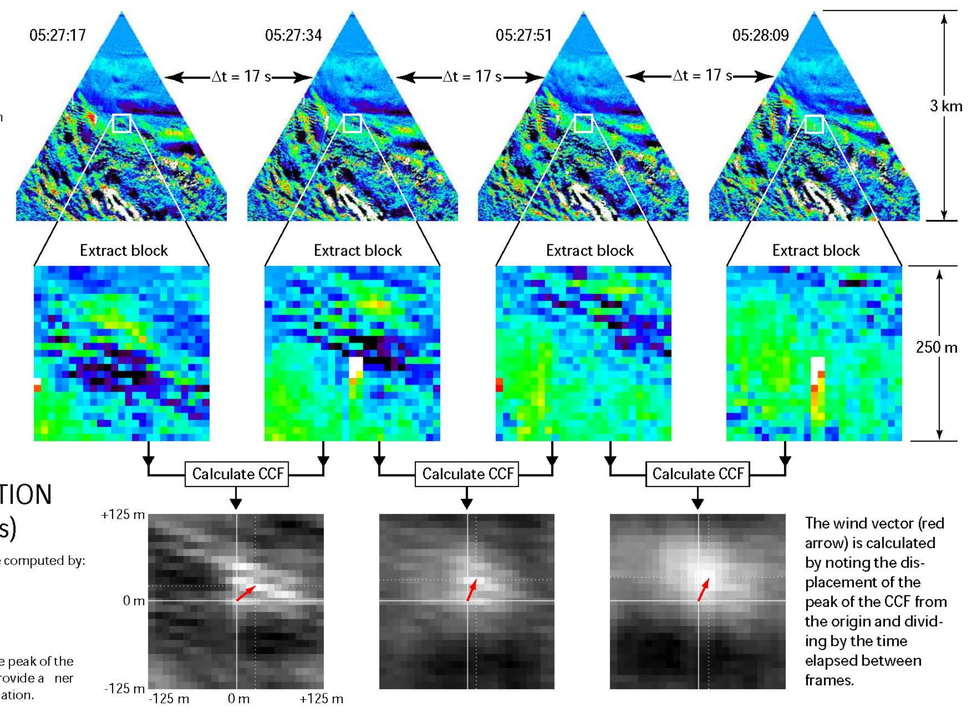
A block can be extracted from anywhere in a gridded scan. In this example, they are taken from a location centered on the tower.

CROSS-CORRELATION FUNCTIONS (CCFs)

The cross-correlation functions are computed by:

F1 = FFT(block1,-1)
F2 = FFT(block2,-1)
CCF = FFT(F1 * Conj (F2), 1)

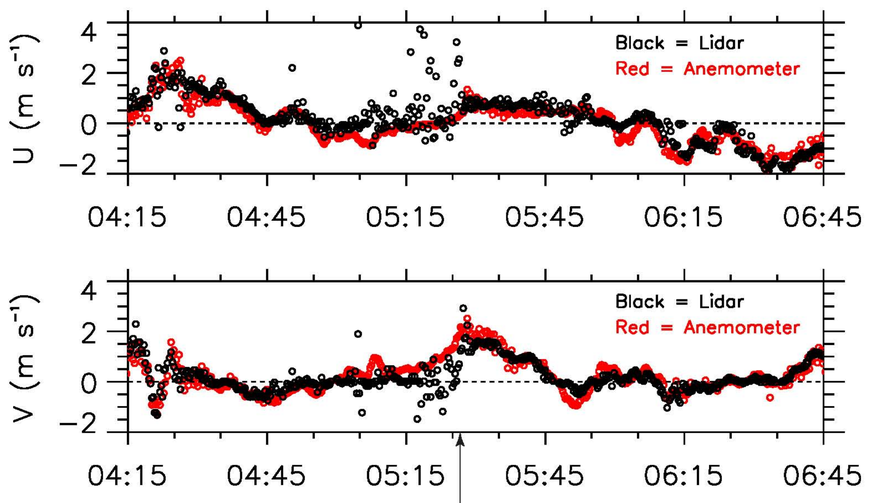
The 9x9 point area surrounding the peak of the CCF is fit with a bicubic spline to provide a finer resolution estimate of the peak location.



The wind vector (red arrow) is calculated by noting the displacement of the peak of the CCF from the origin and dividing by the time elapsed between frames.

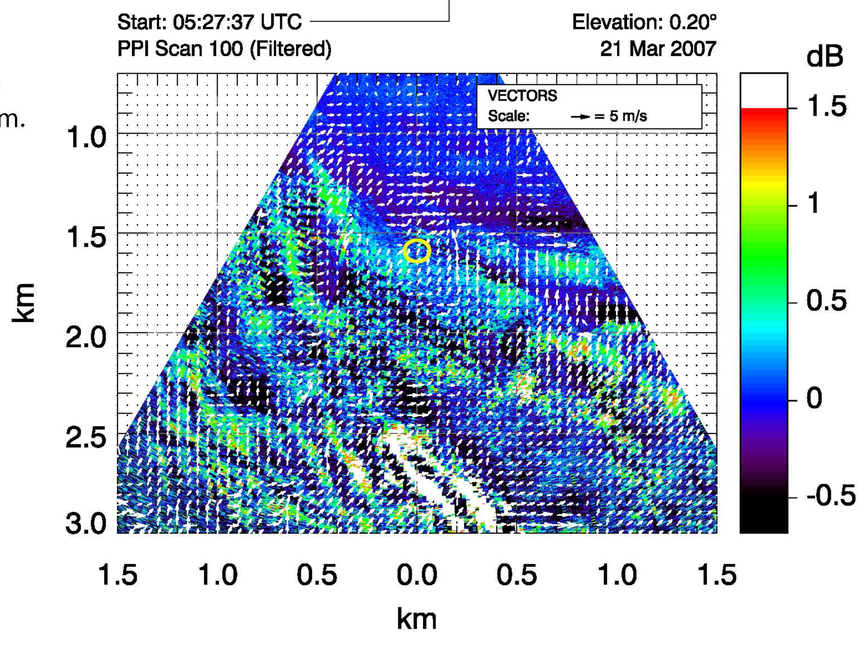
Case 1: Weakly stable, nearly-quiescent evening

21 March 2007
One scan per 17 s
250m x 250m block
Weakly stable
Wind speeds: < 2.5 m/s



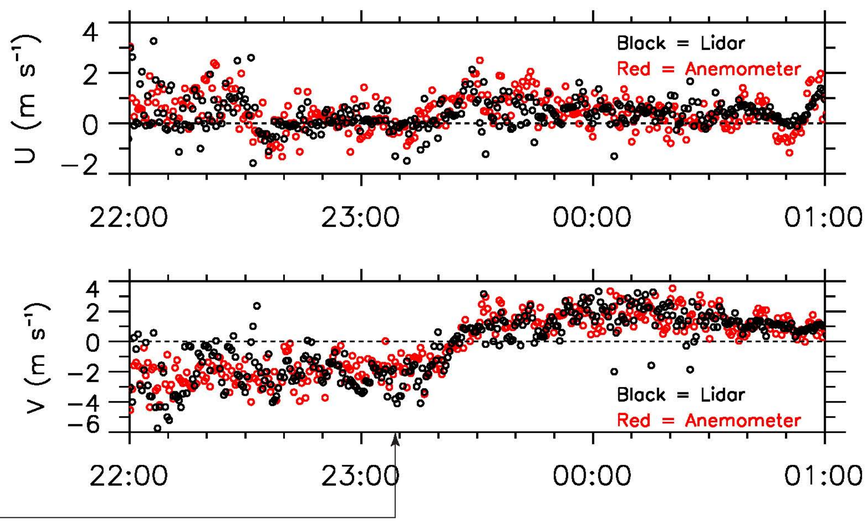
Vectors from 250 m x 250 m blocks are plotted every 50 m.

Vectors plotted:
CCF Peak > 0.1
Speed > 0.2 m/s



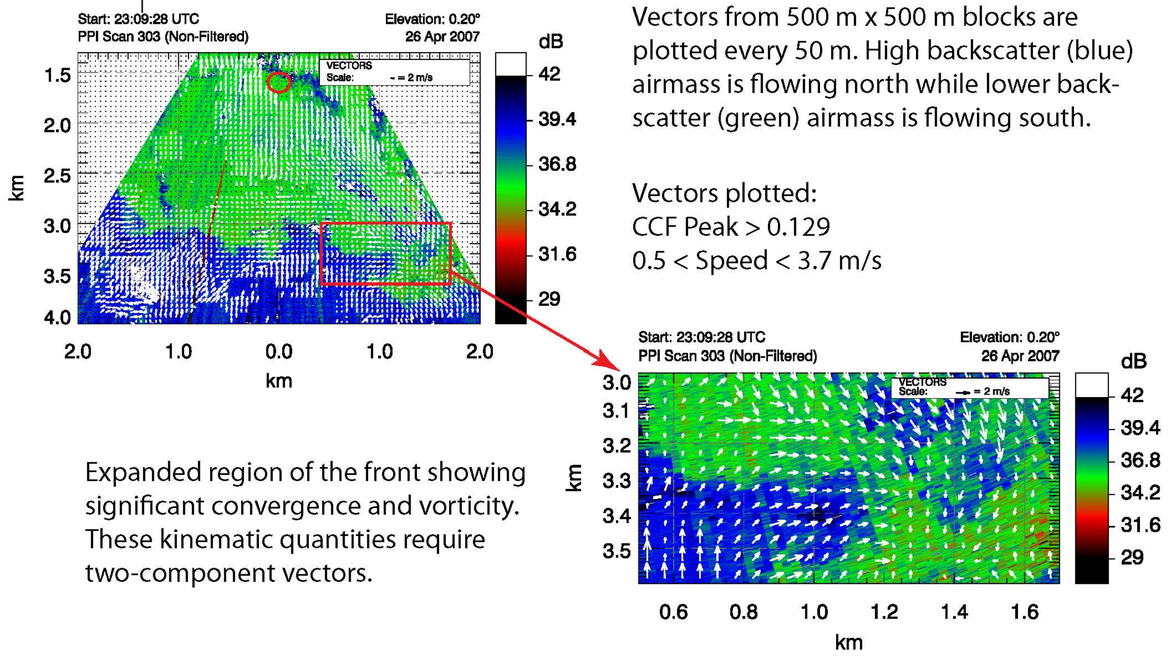
Case 2: Turbulent afternoon with frontal passage

26 April 2007
One scan per 30 s
500m x 500m block
Unstable, turbulent
Wind speeds: < 5 m/s



Vectors from 500 m x 500 m blocks are plotted every 50 m. High backscatter (blue) airmass is flowing north while lower backscatter (green) airmass is flowing south.

Vectors plotted:
CCF Peak > 0.129
0.5 < Speed < 3.7 m/s



Expanded region of the front showing significant convergence and vorticity. These kinematic quantities require two-component vectors.

Conclusions

Turbulence (or the absence of it) has a significant impact on the comparisons. A more comprehensive evaluation of the measurements is forthcoming.

Acknowledgements

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