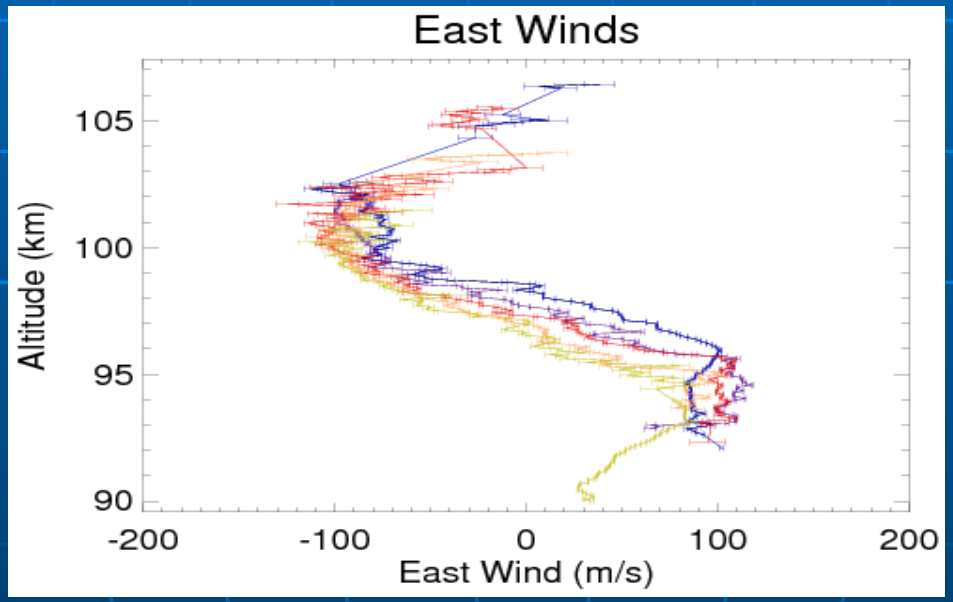
An Update on Non-Specular Trail Meteor Winds: Validation and Techniques

Meers Oppenheim[1], Glenn Sugar[1], Nick Slowey[1], Elizabeth Bass[1], Steven Arredondo[1], Jorge Chau[2], and Sigrid Close[3]

[1]Boston University, [2]Radio Observatorio de Jicamarca, [3]Los Alamos National Laboratory



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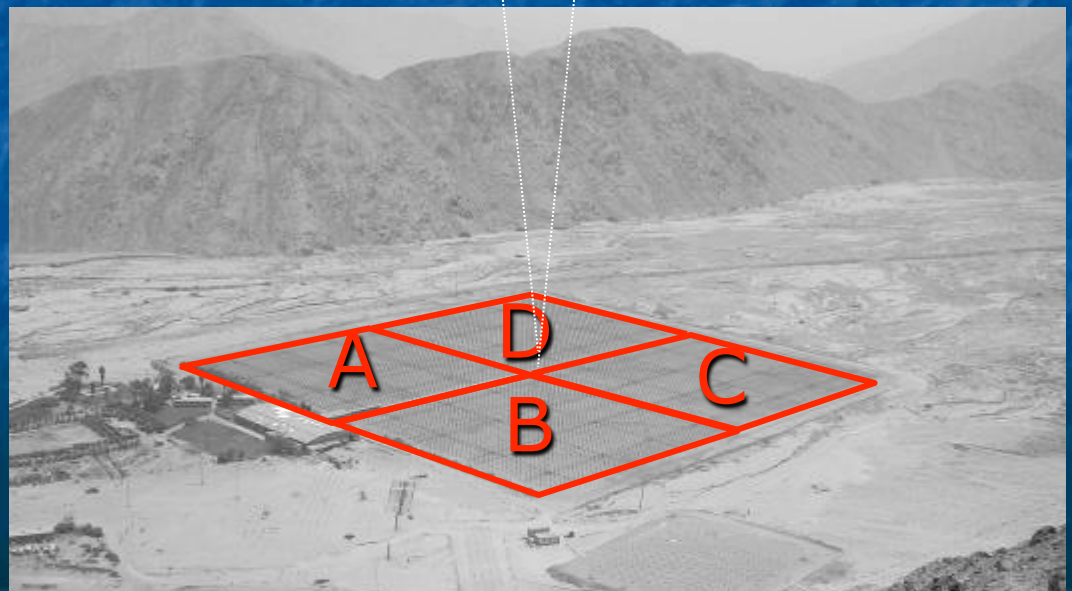
BOSTON UNIVERSITY

CEDAR Workshop 2011

JRO 50MHz Radar Observations

- Antenna:
  - 300m x 300m
  - 18,432 dipoles
  - Peak power: 2 MW
  - Frequency: 50 MHz
- *A truely High-Power Large-Aperture Radar (HPLA)*
- **Interferometer**

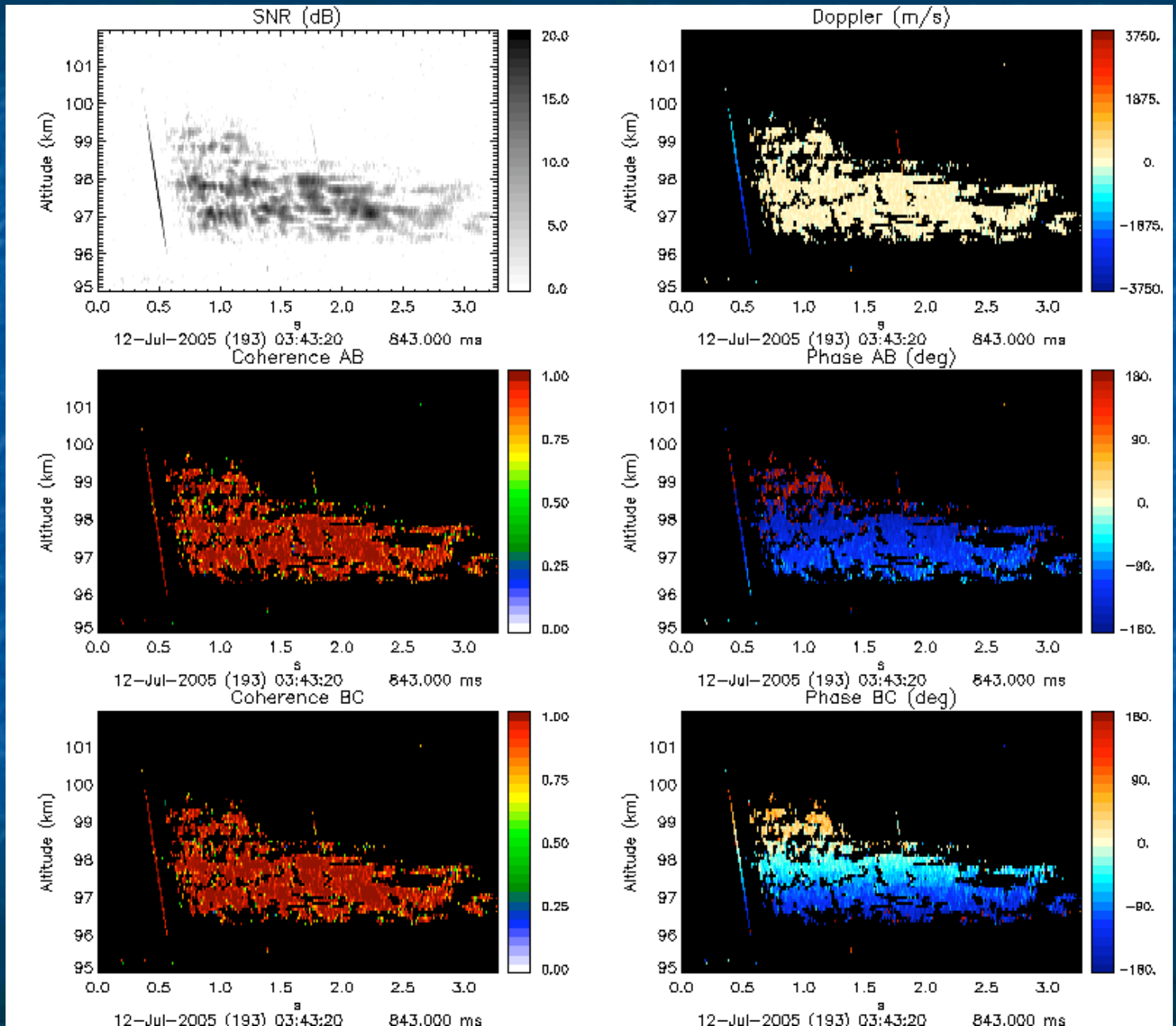


•130 km

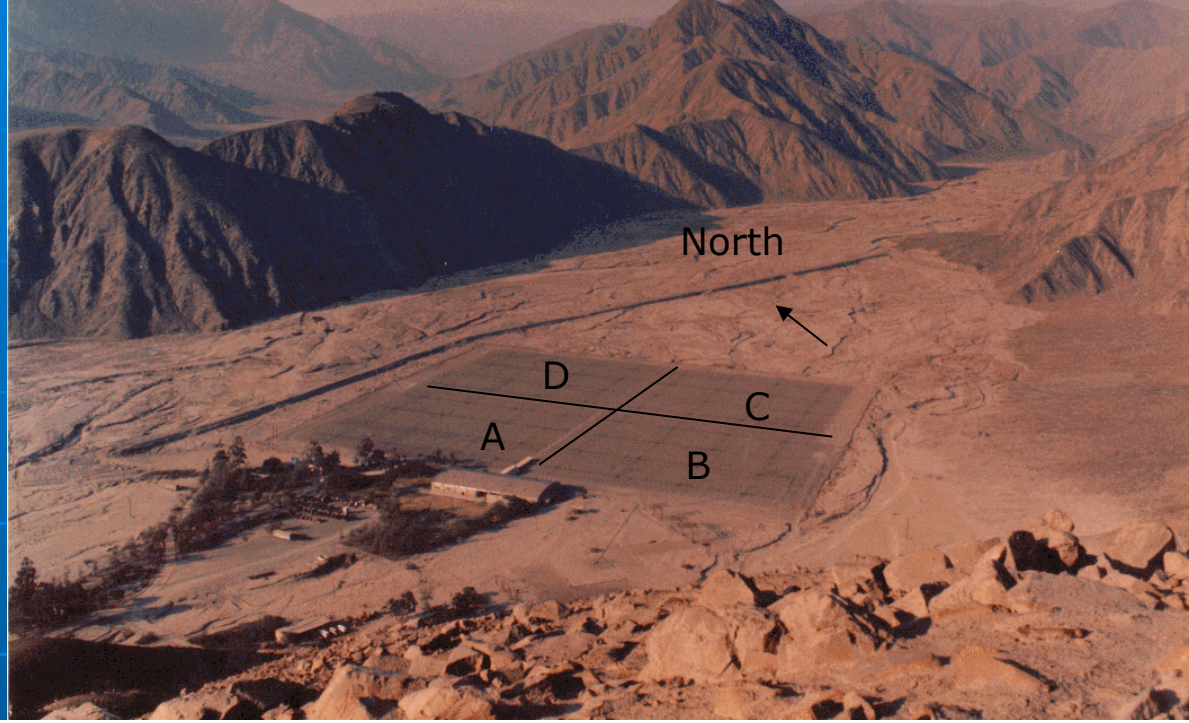
•80 km

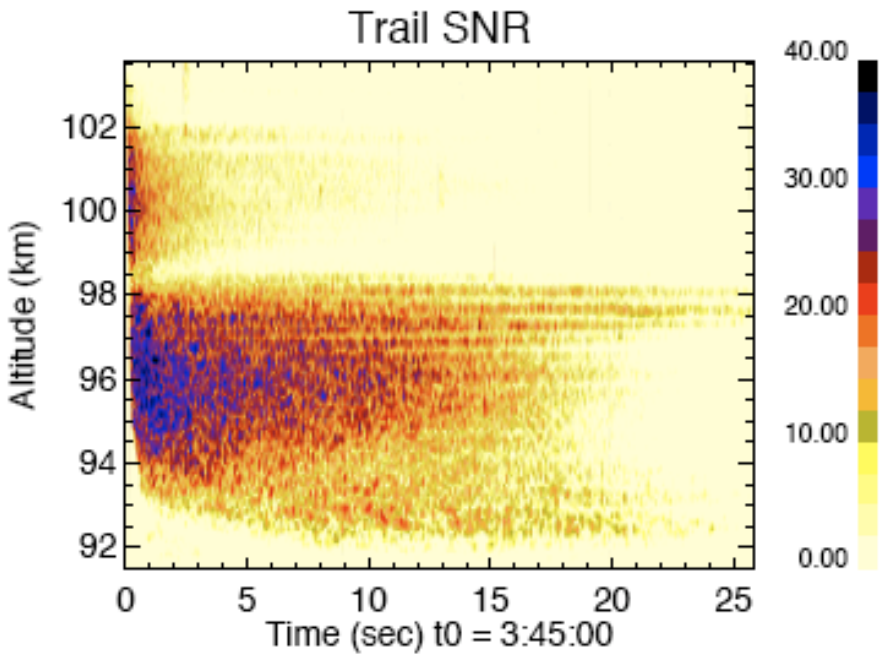
•Not to scale

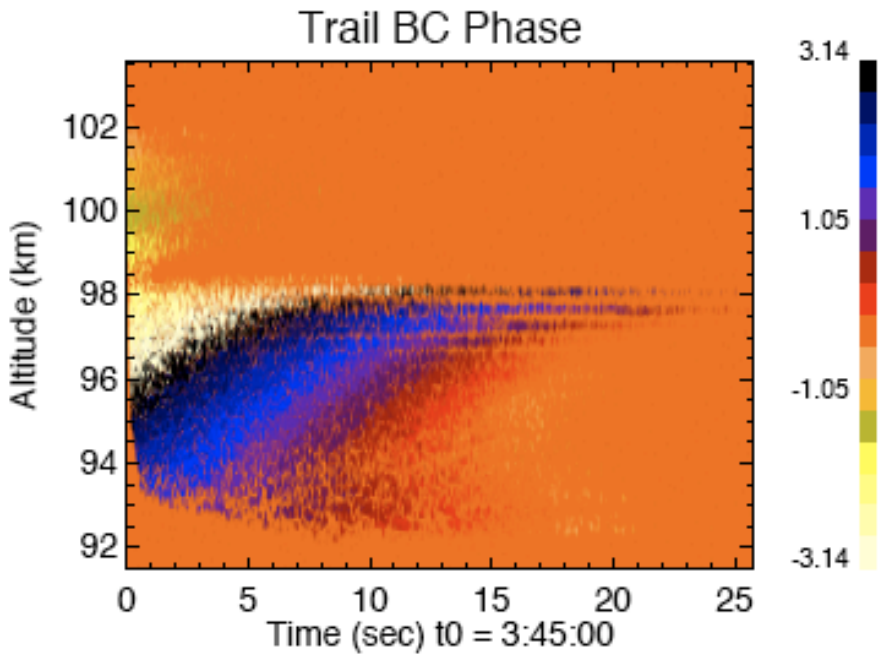
SNR, Doppler, and Phase



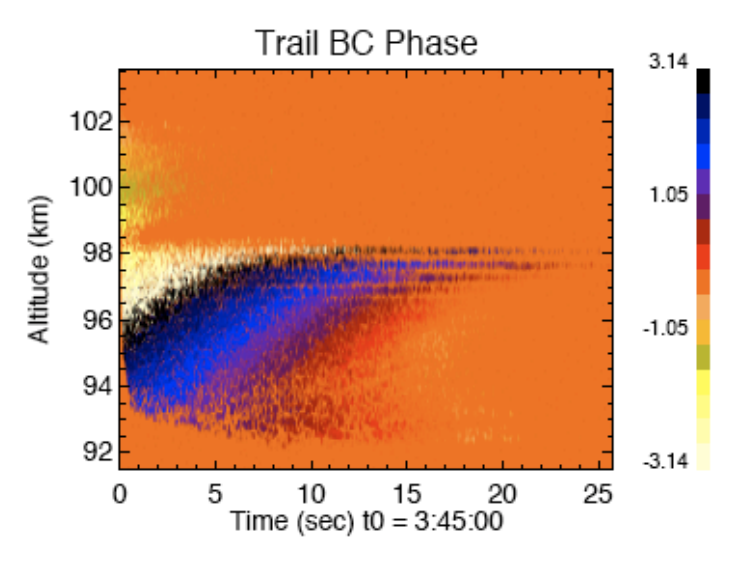
Jicamarca Trail Interferometry

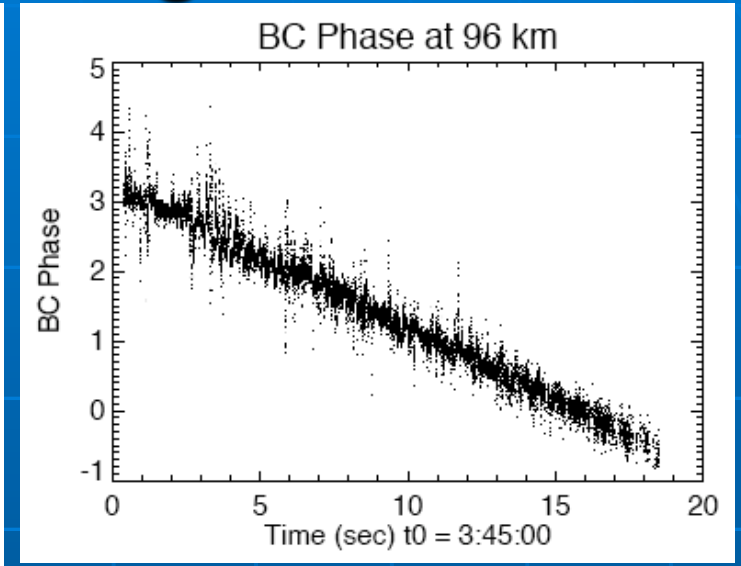




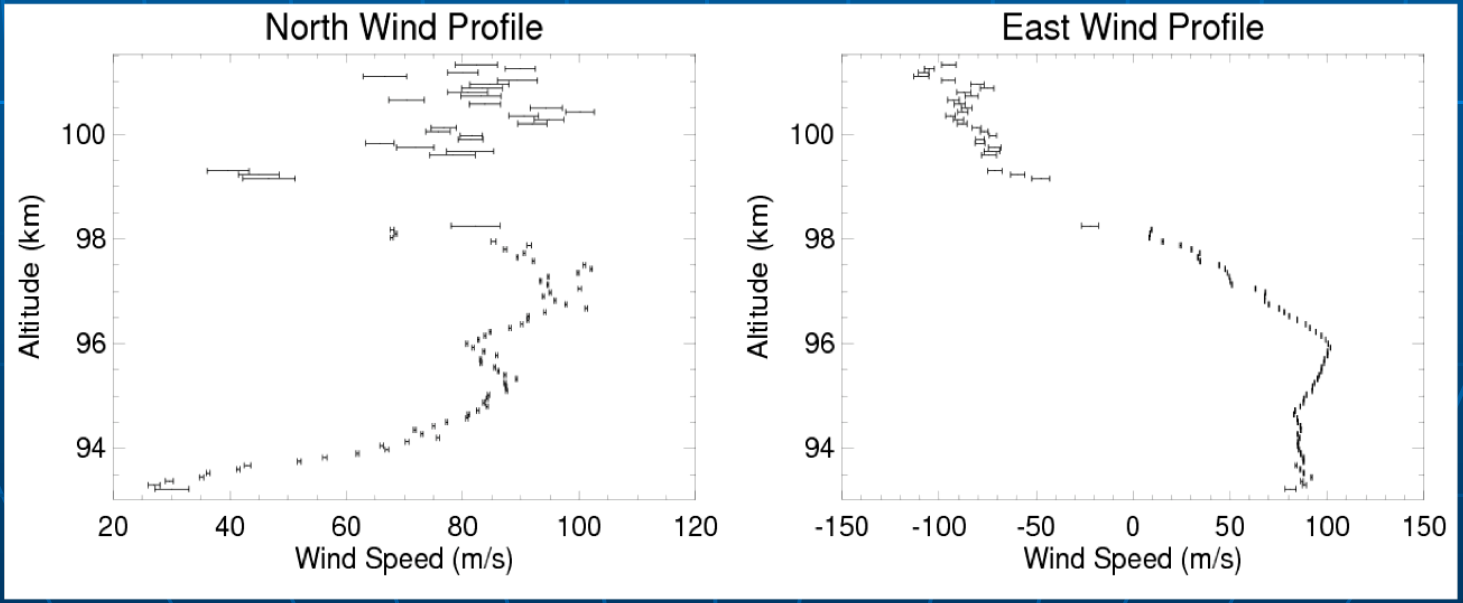


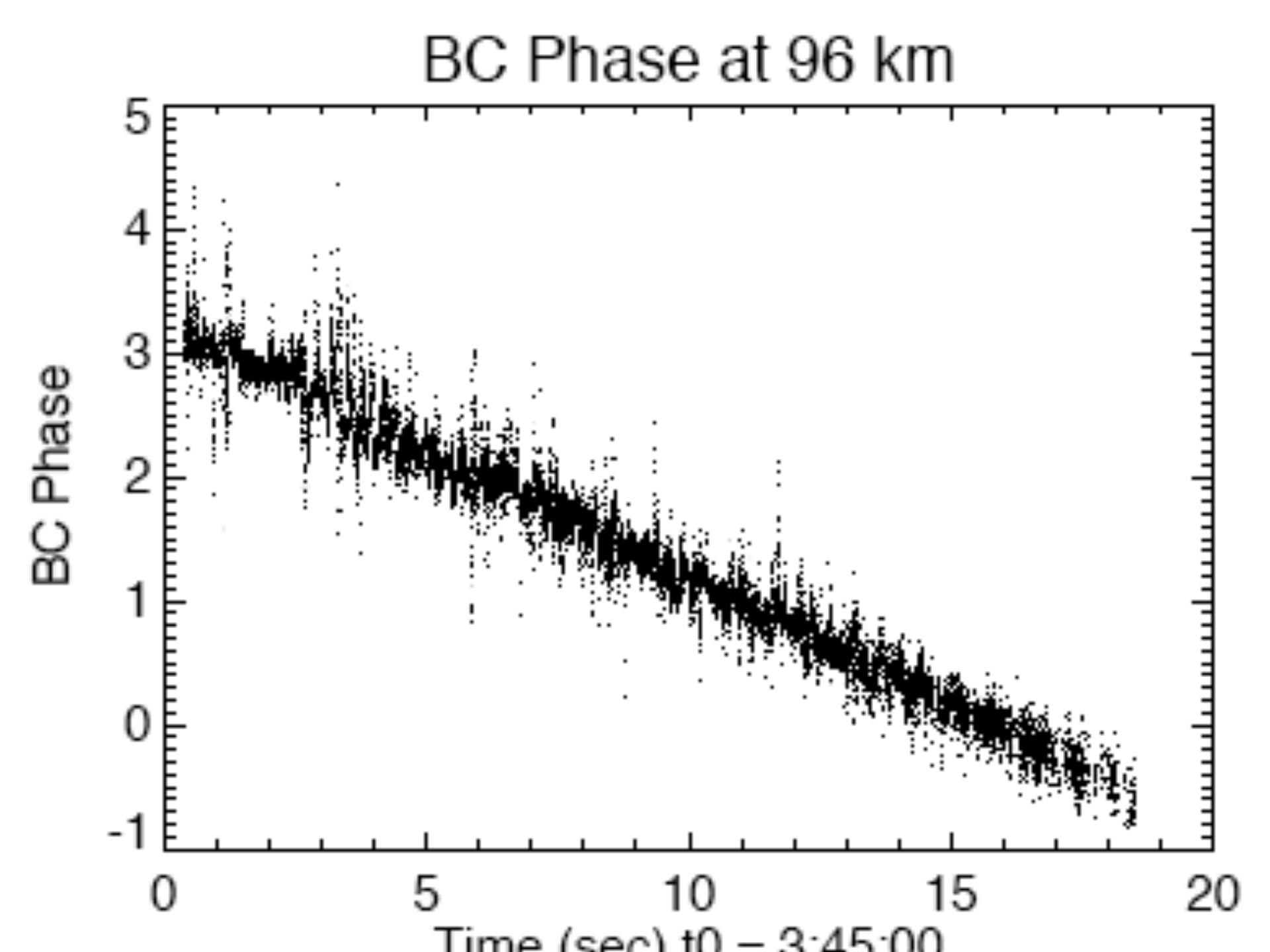
Trail Phase at Single Altitude



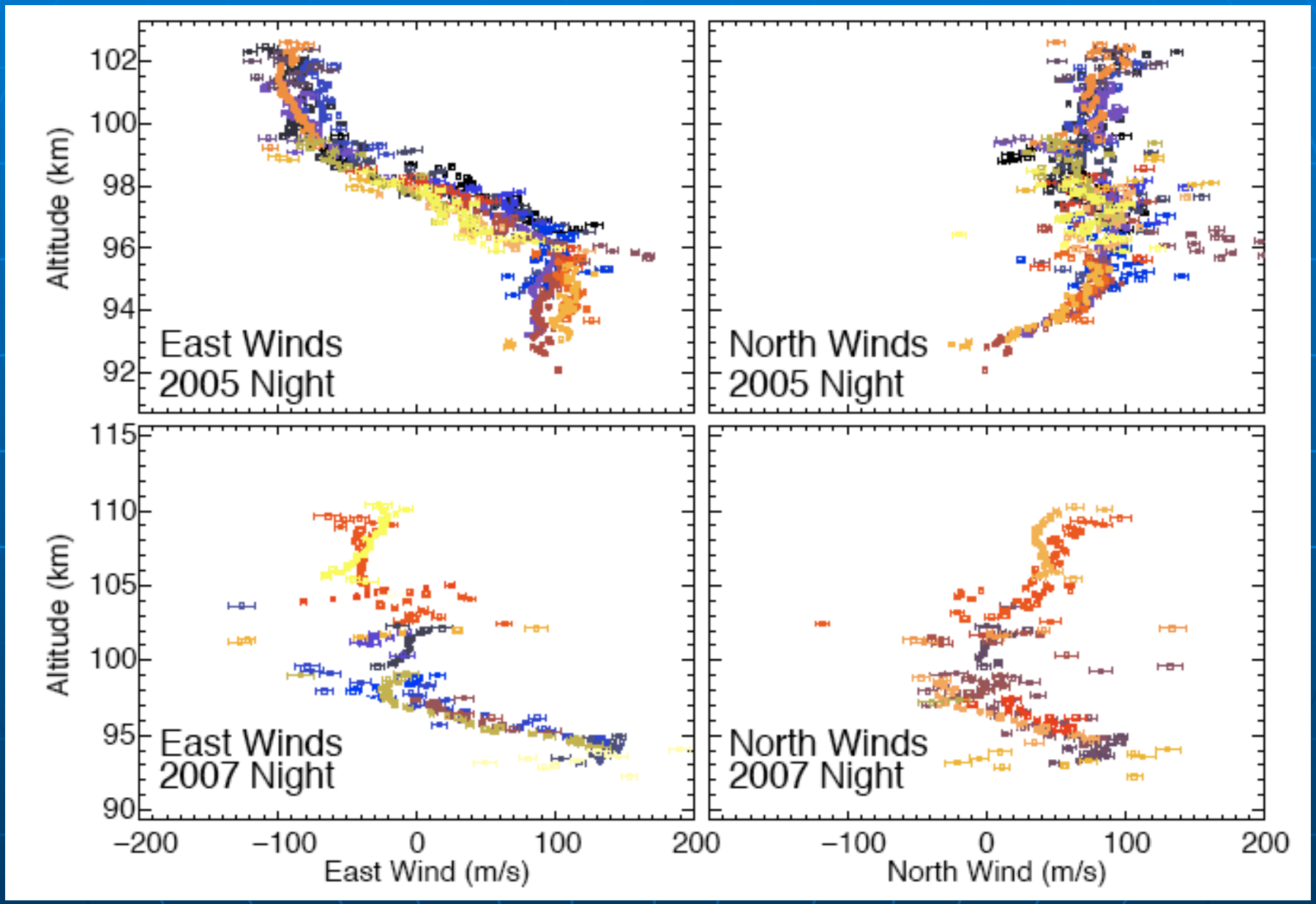


Winds from all altitudes

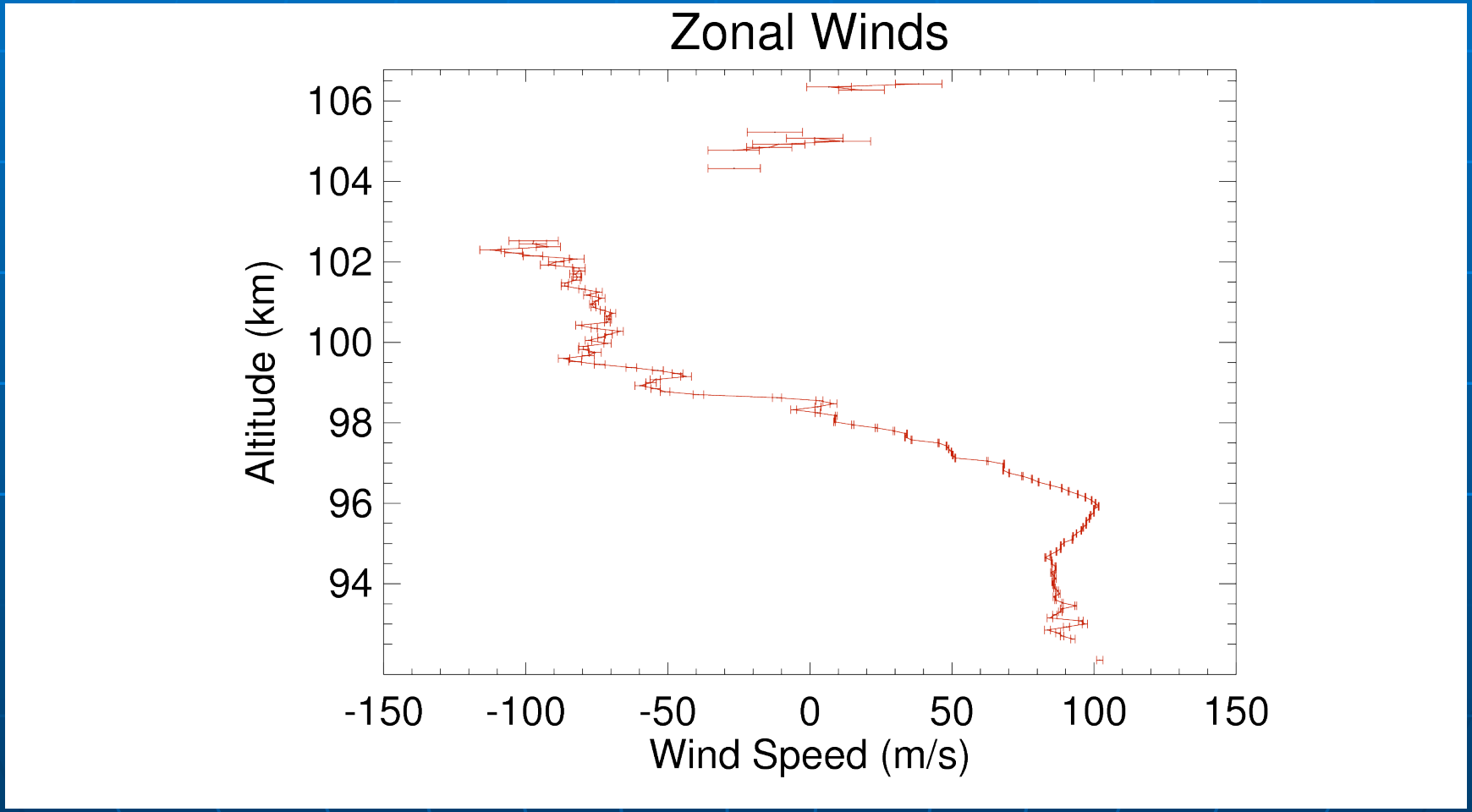



BC Phase at 96 km
BC Phase
5
4
3
2
1
0
-1
0
5
10
15
20
Time (sec) t0 – 3:45:00

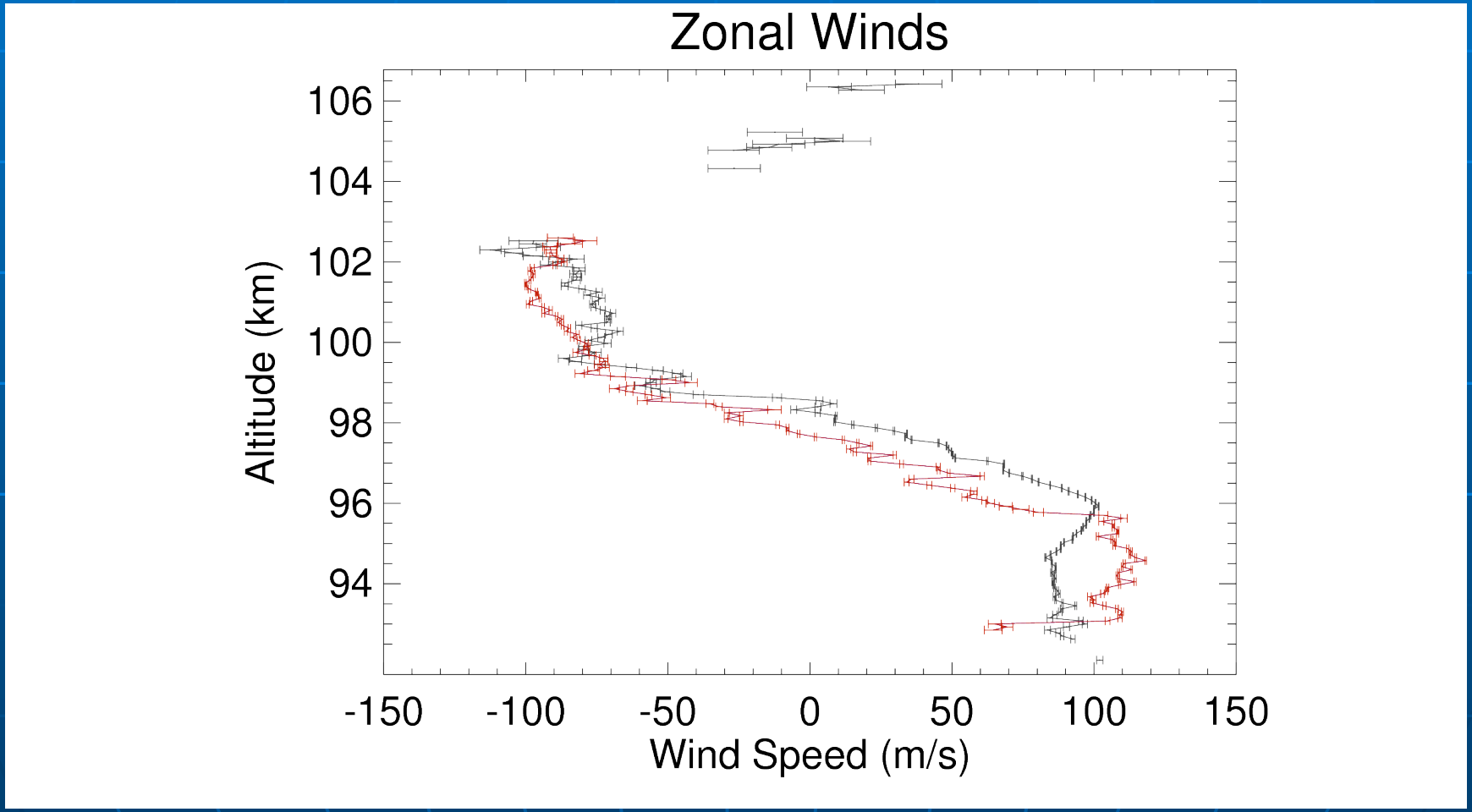
Wind Profiles from many trails



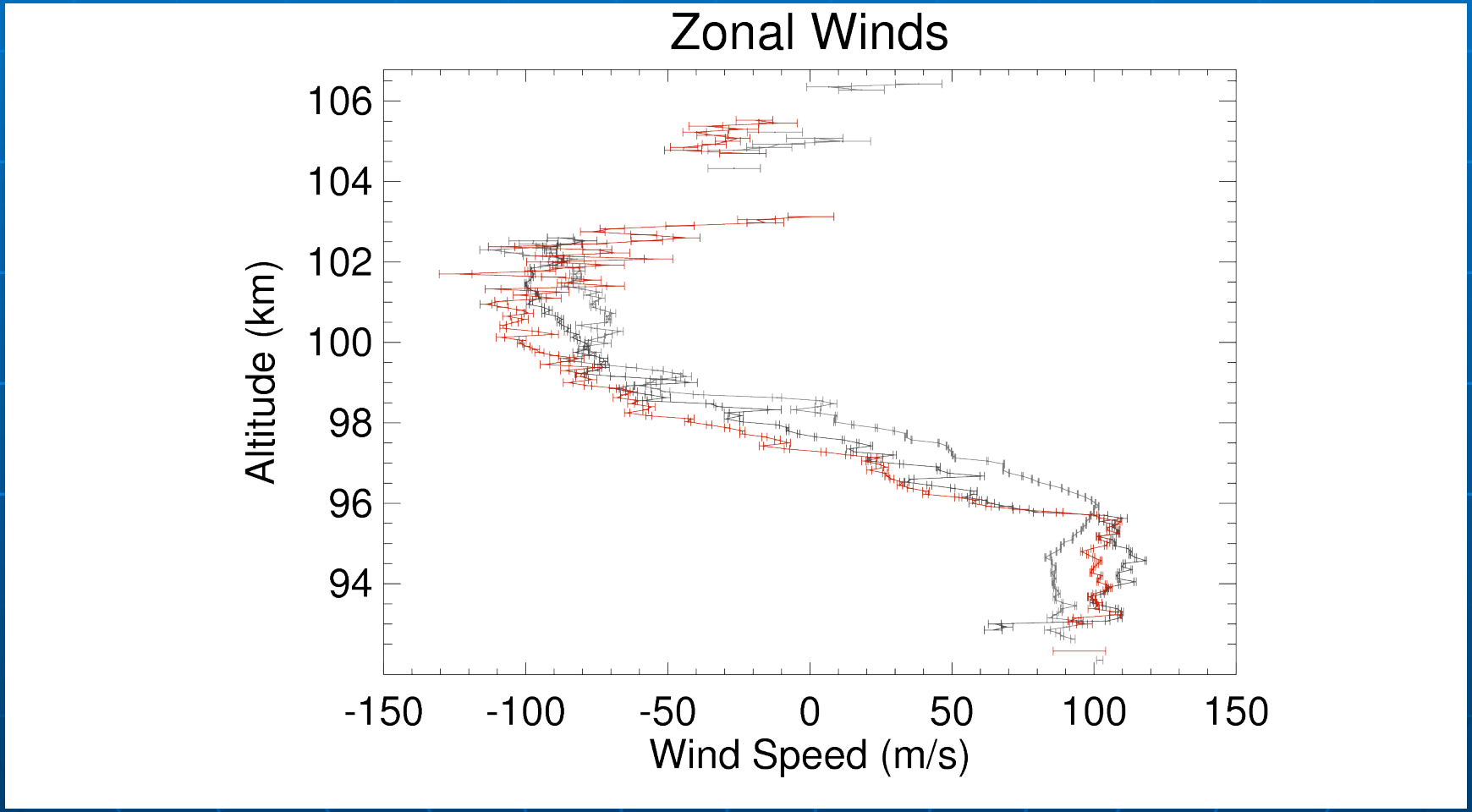
Zonal Winds from 15 min of data



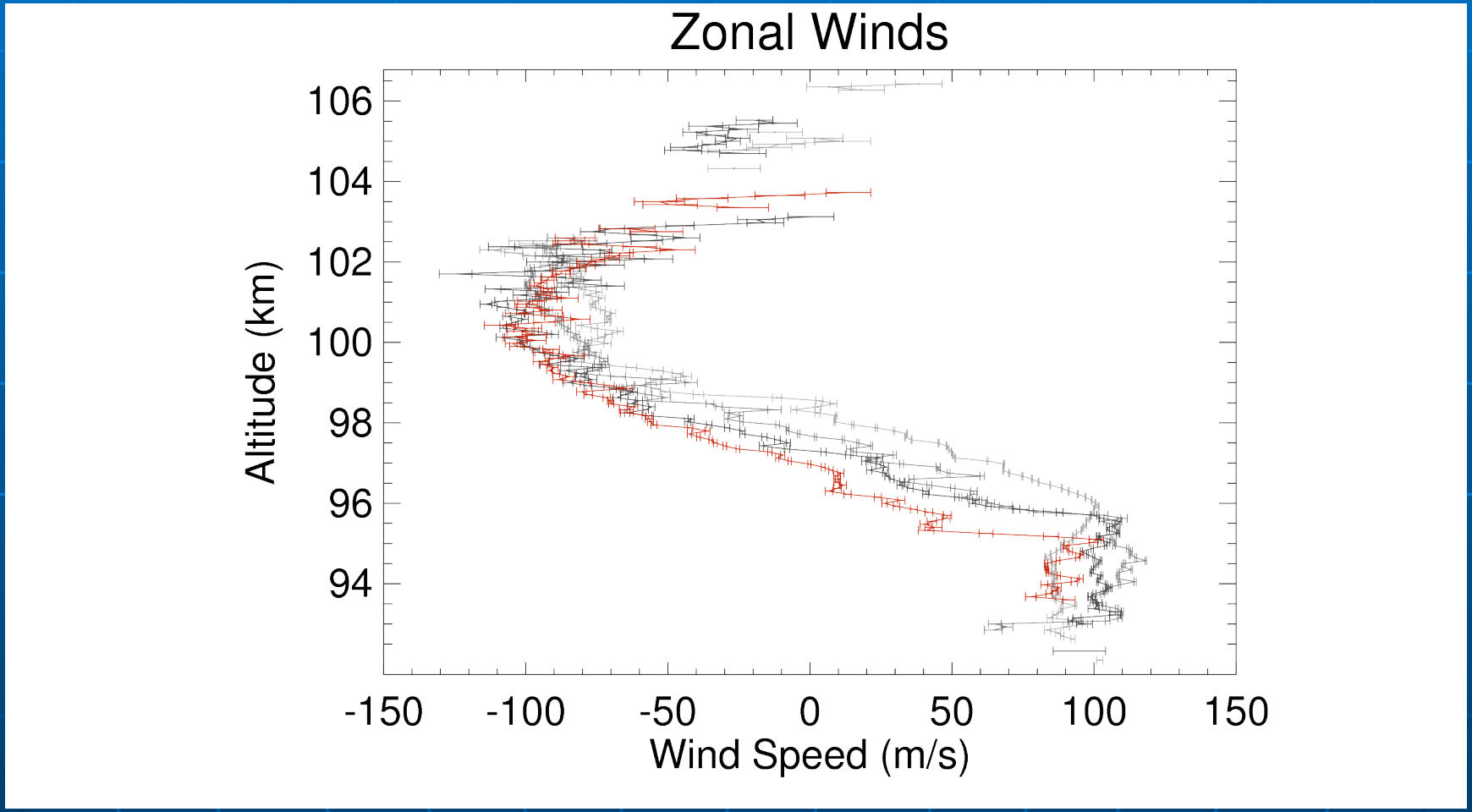
Zonal Winds from 15 min of data



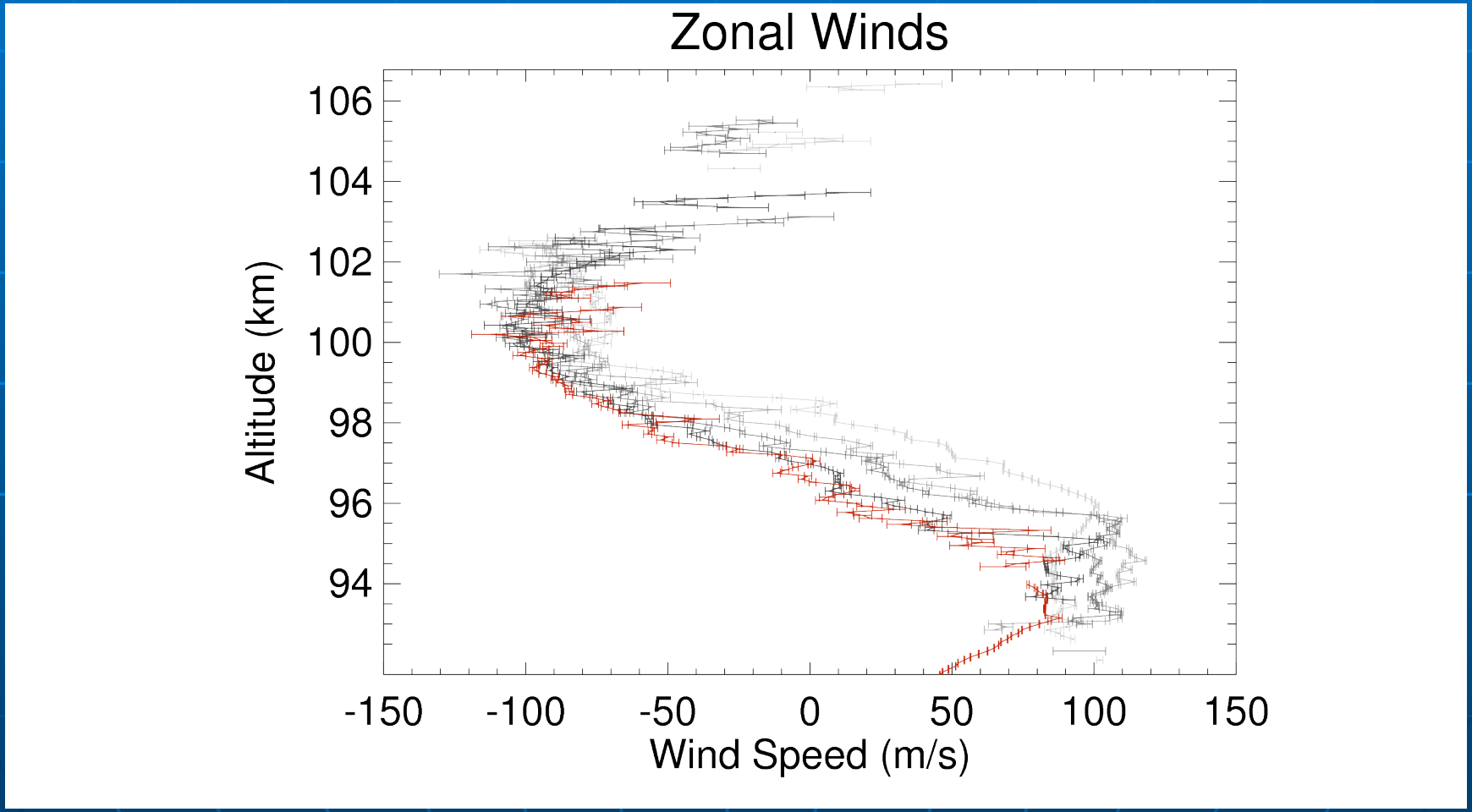
Zonal Winds from 15 min of data



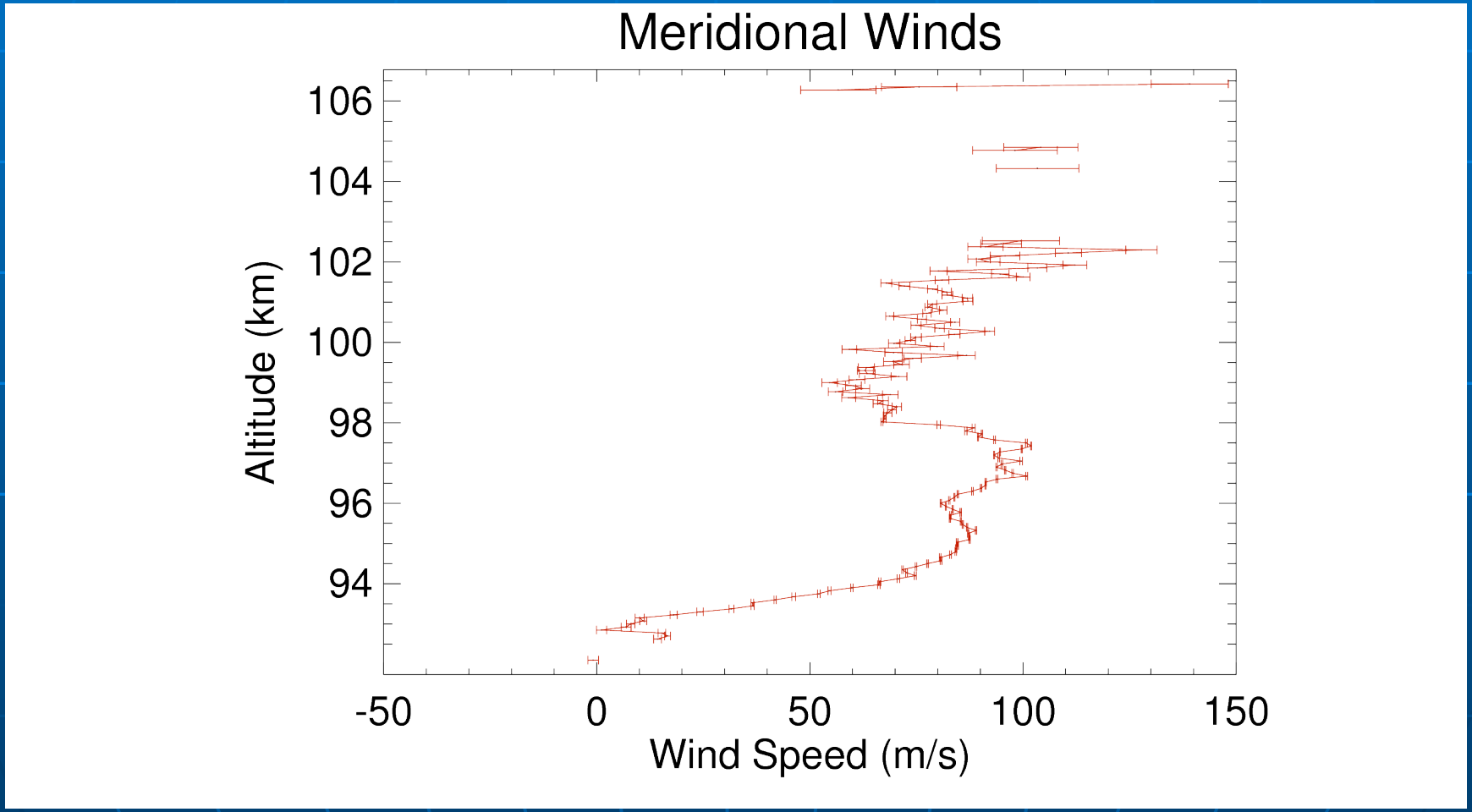
Zonal Winds from 15 min of data



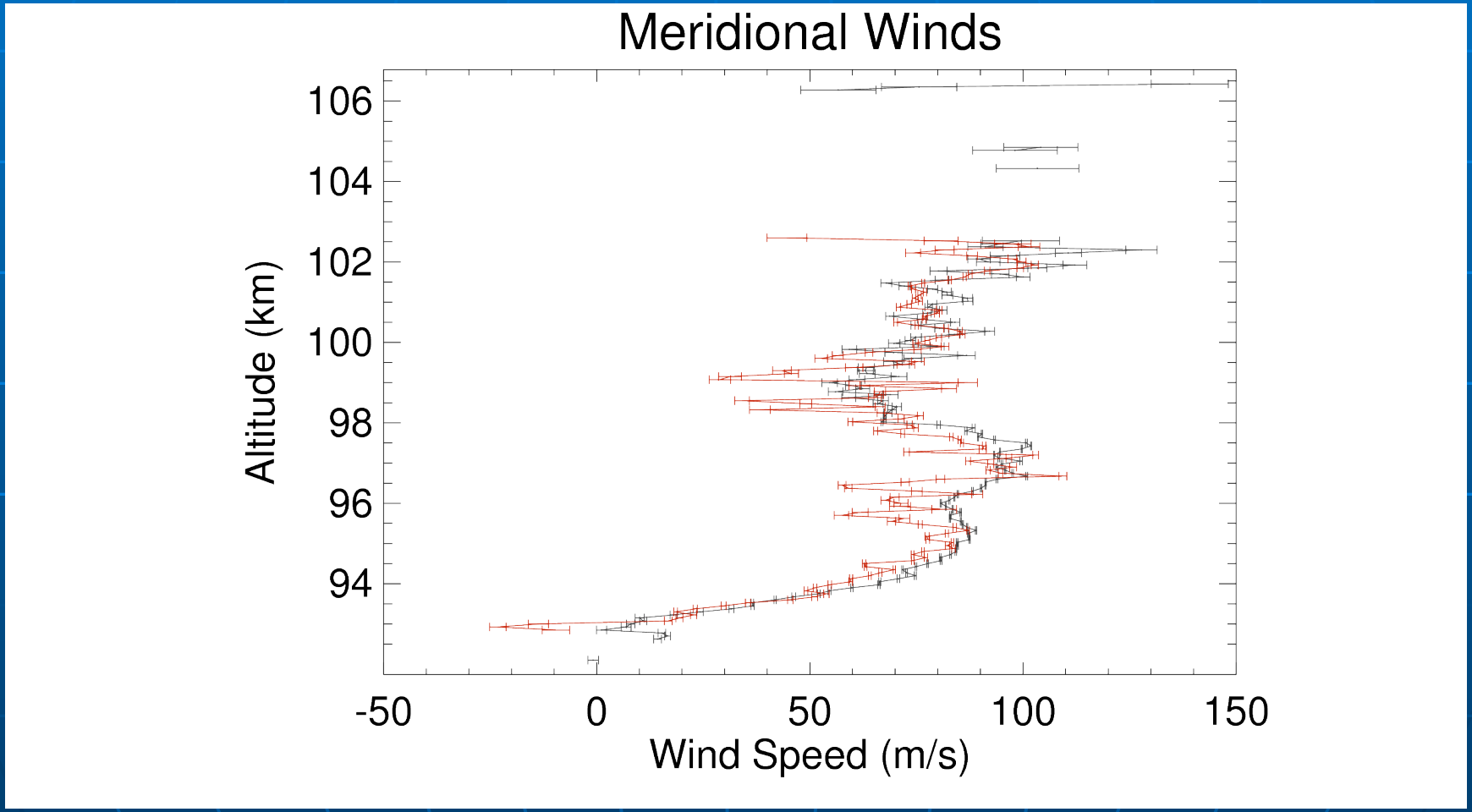
Zonal Winds from 15 min of data



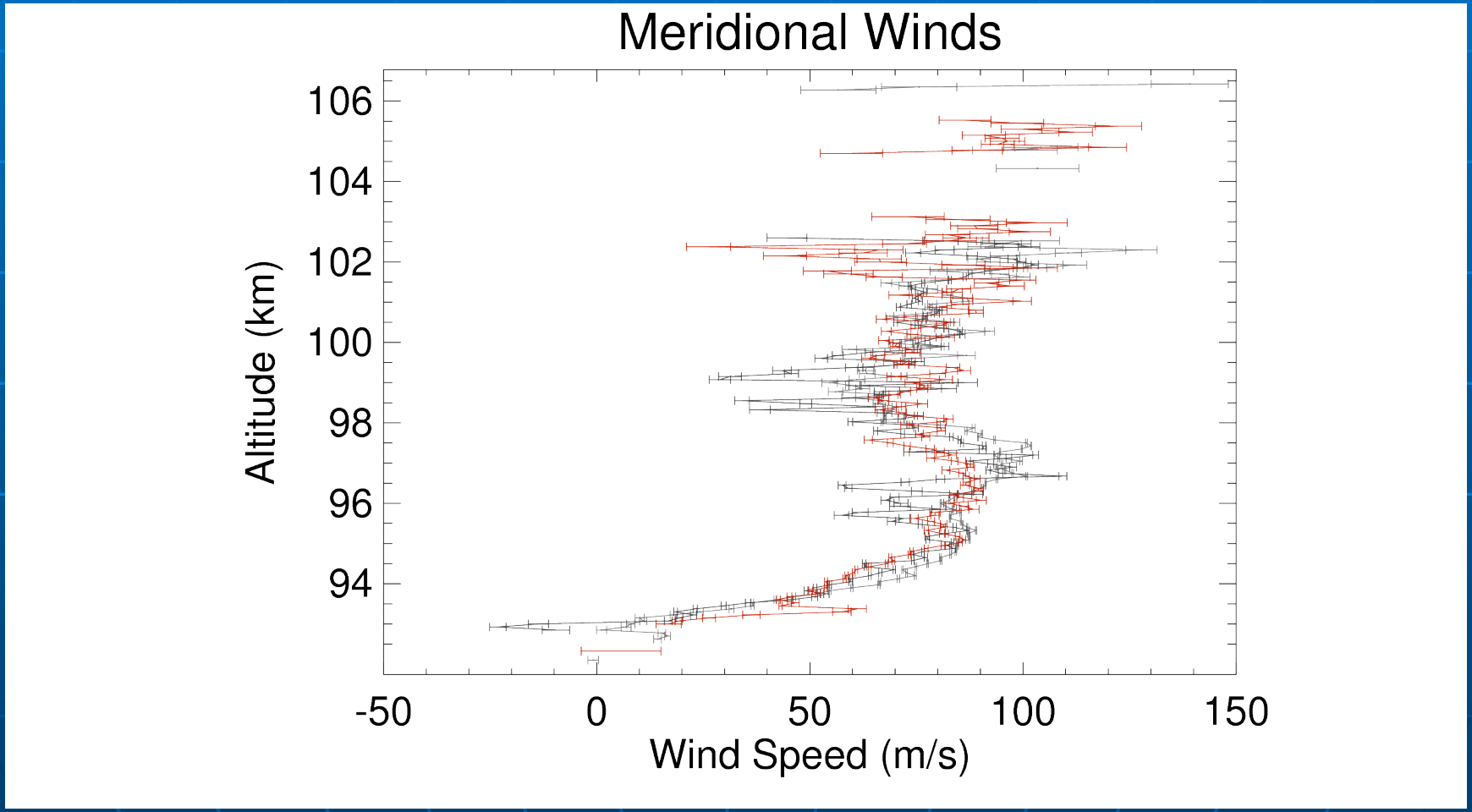
Meridional Winds from 15 min of data



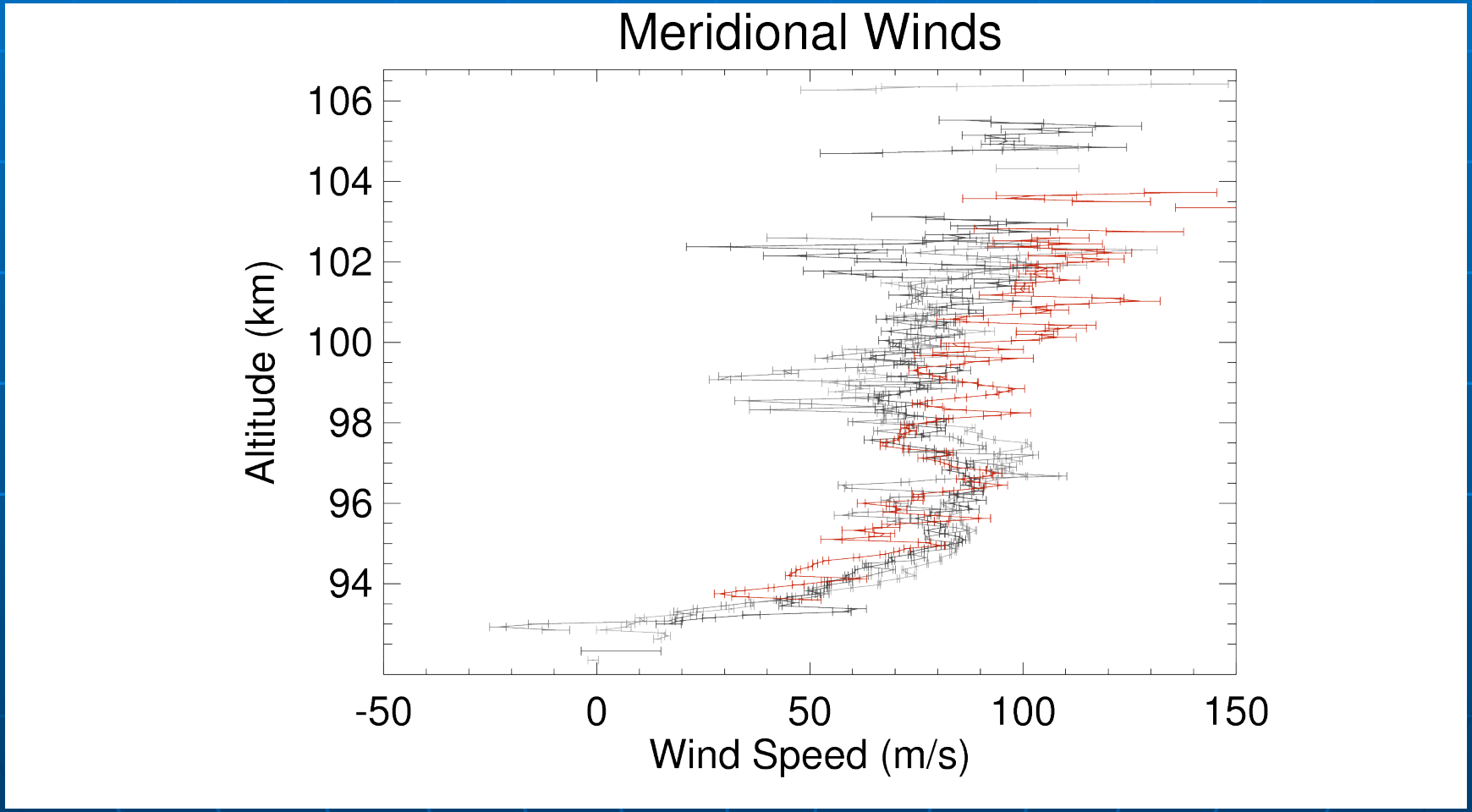
Meridional Winds from 15 min of data



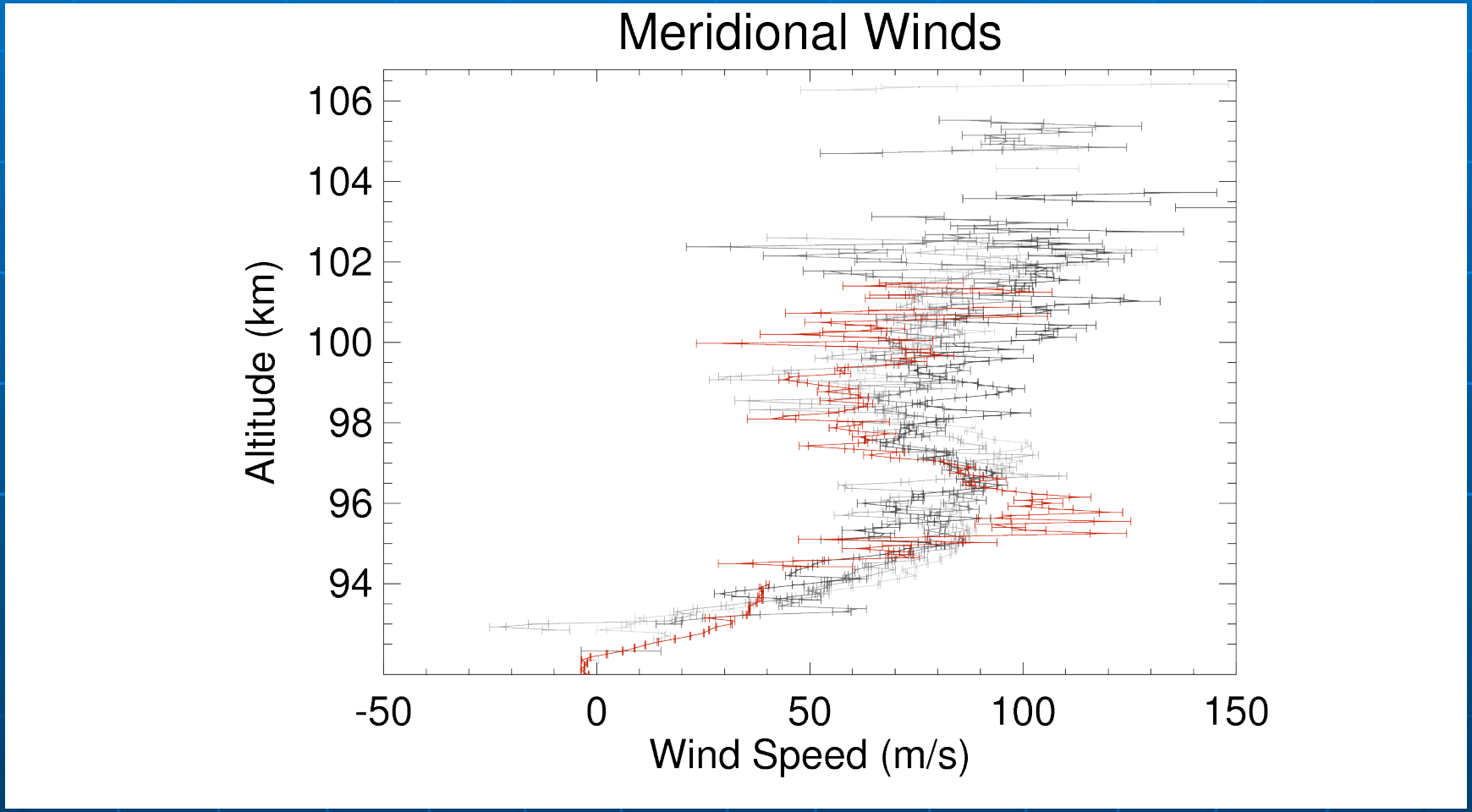
Meridional Winds from 15 min of data



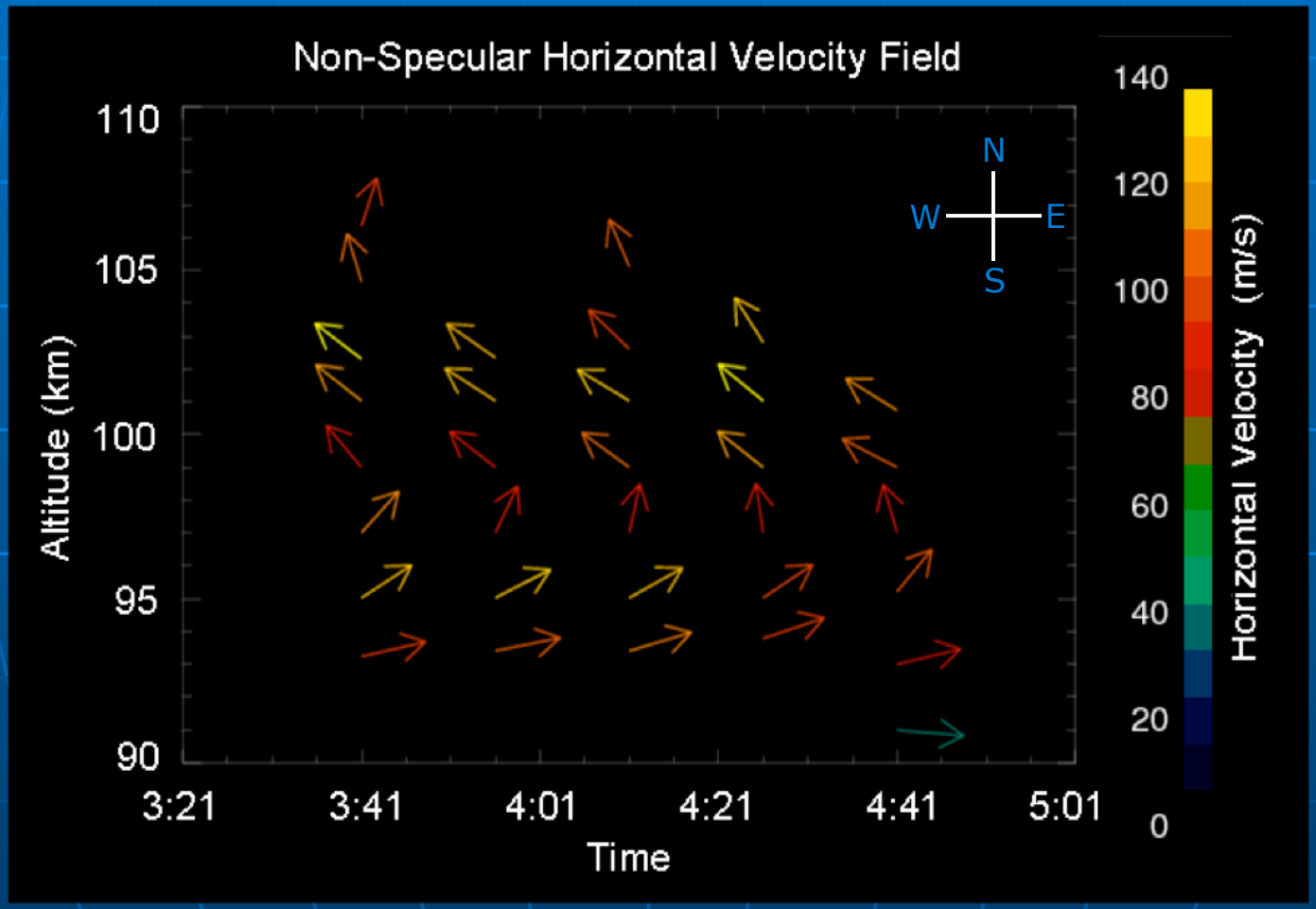
Meridional Winds from 15 min of data



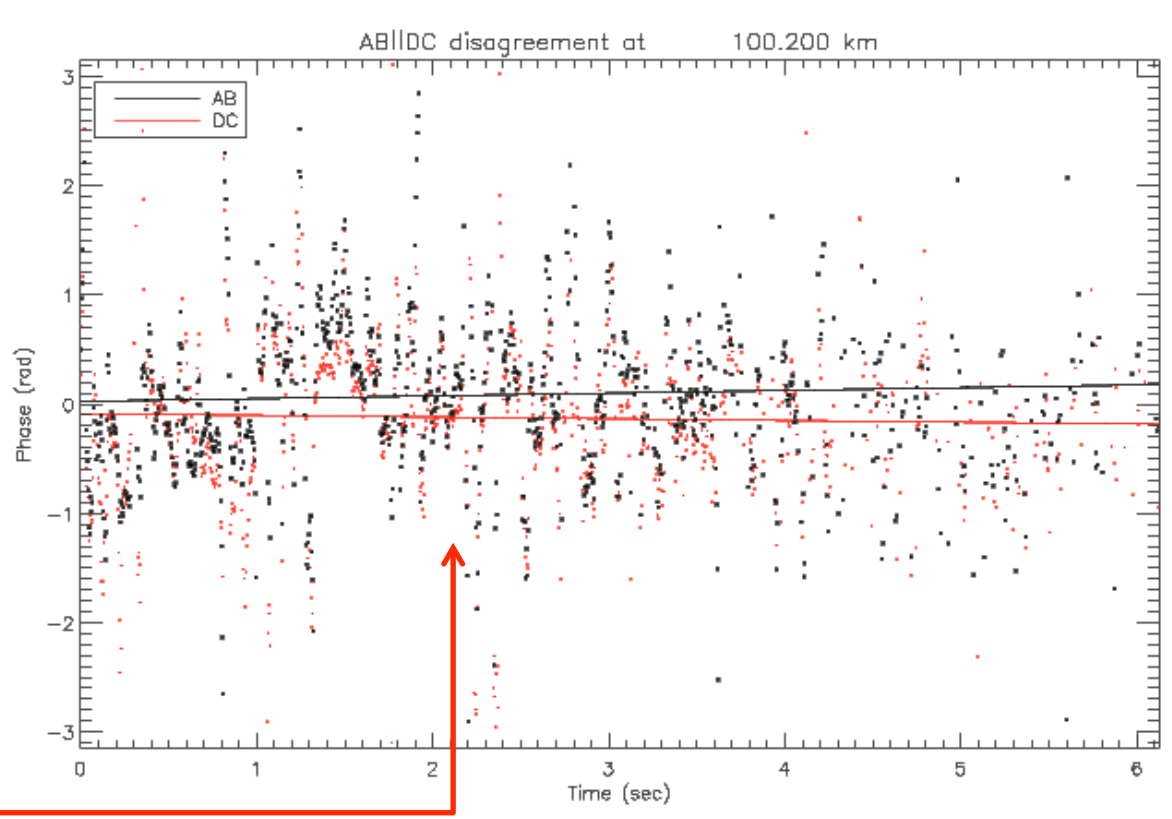
Meridional Winds from 15 min of data

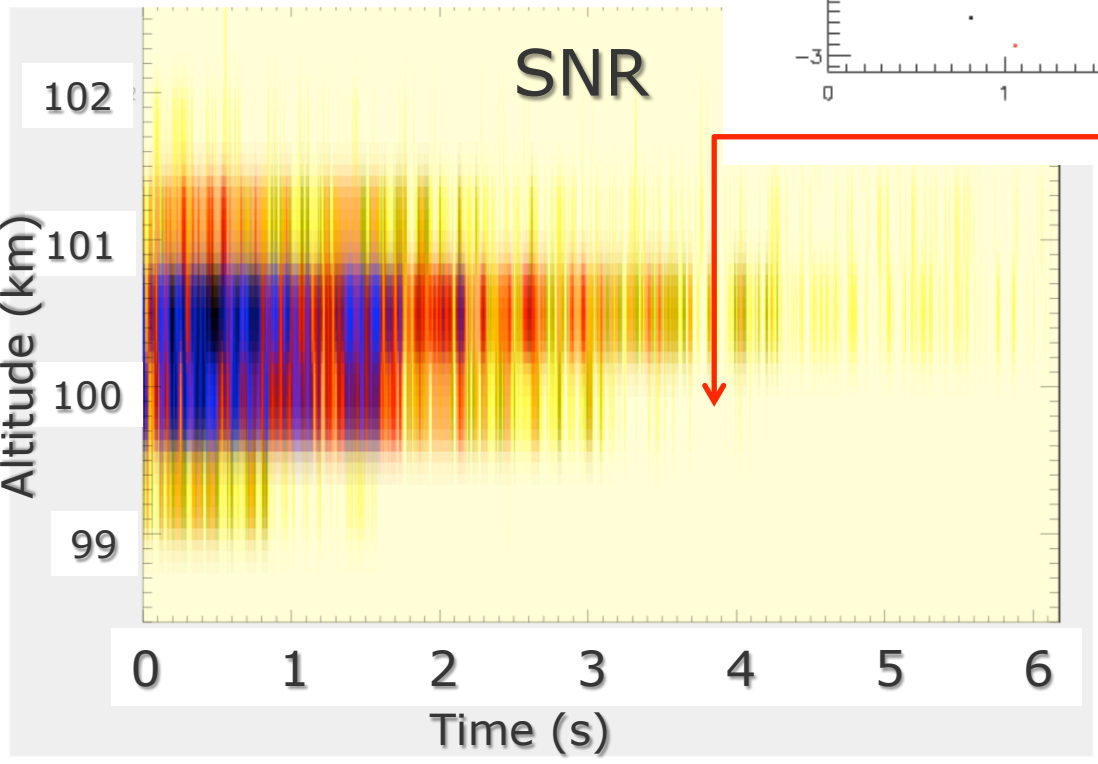


Wind fields


Non-Specular Horizontal Velocity Field
110
105
100
95
90
Altitude (km)
3:21
3:41
4:01
4:21
4:41
5:01
Time
N
W
E
S
140
120
100
80
60
40
20
0
Horizontal Velocity (m/s)

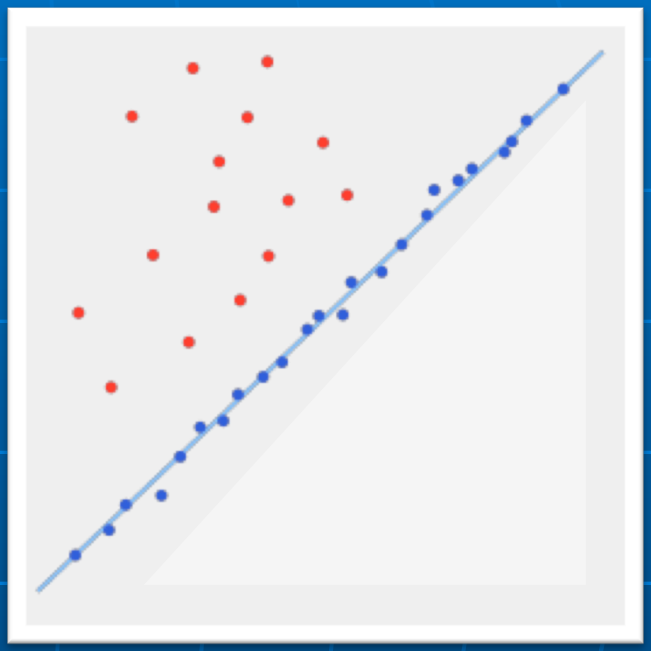
Obtaining Winds from Short Trails





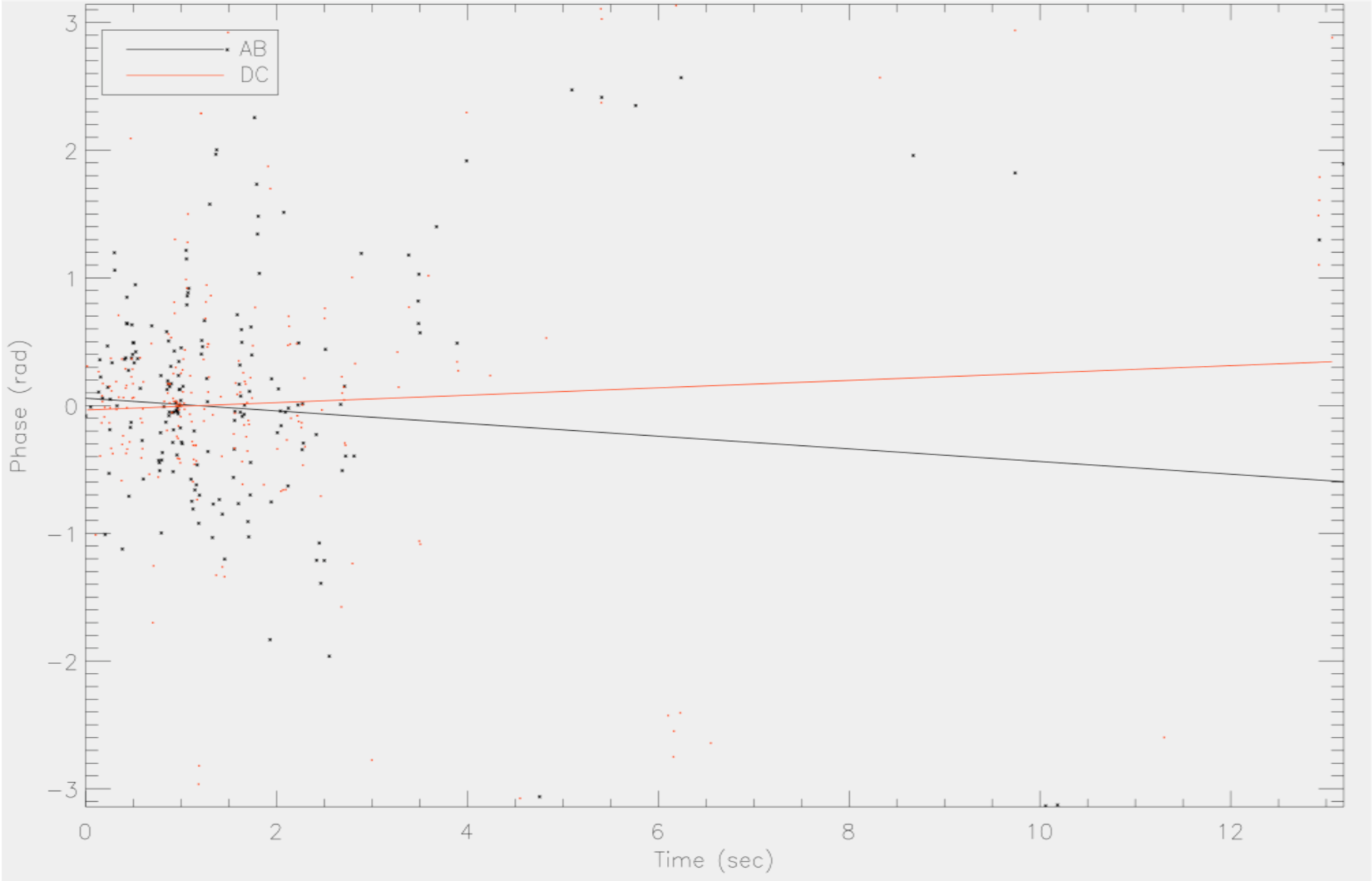
RANSAC: **RAN**dom **SA**mple **C**onsensus

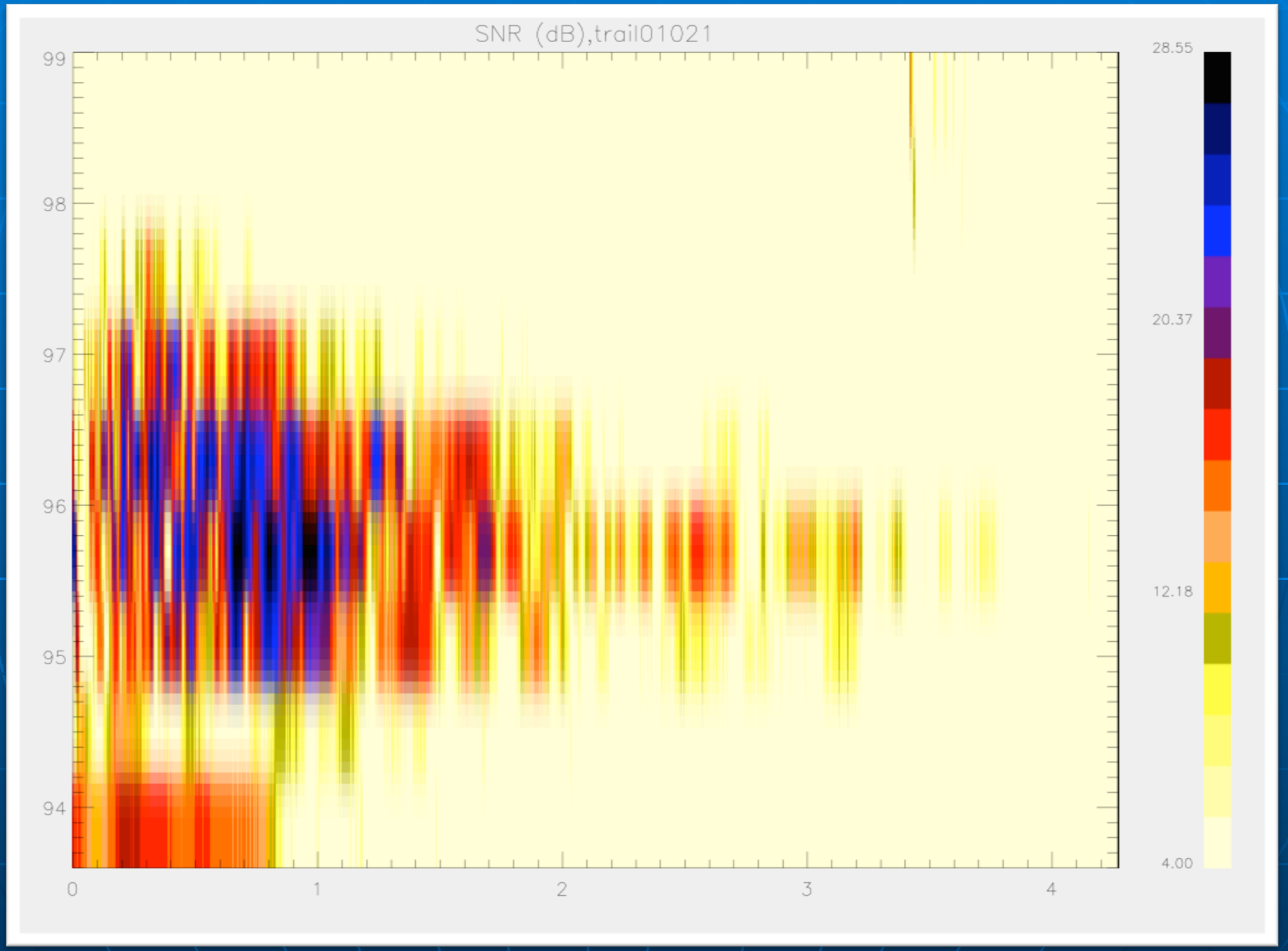
Fitting data with outliers

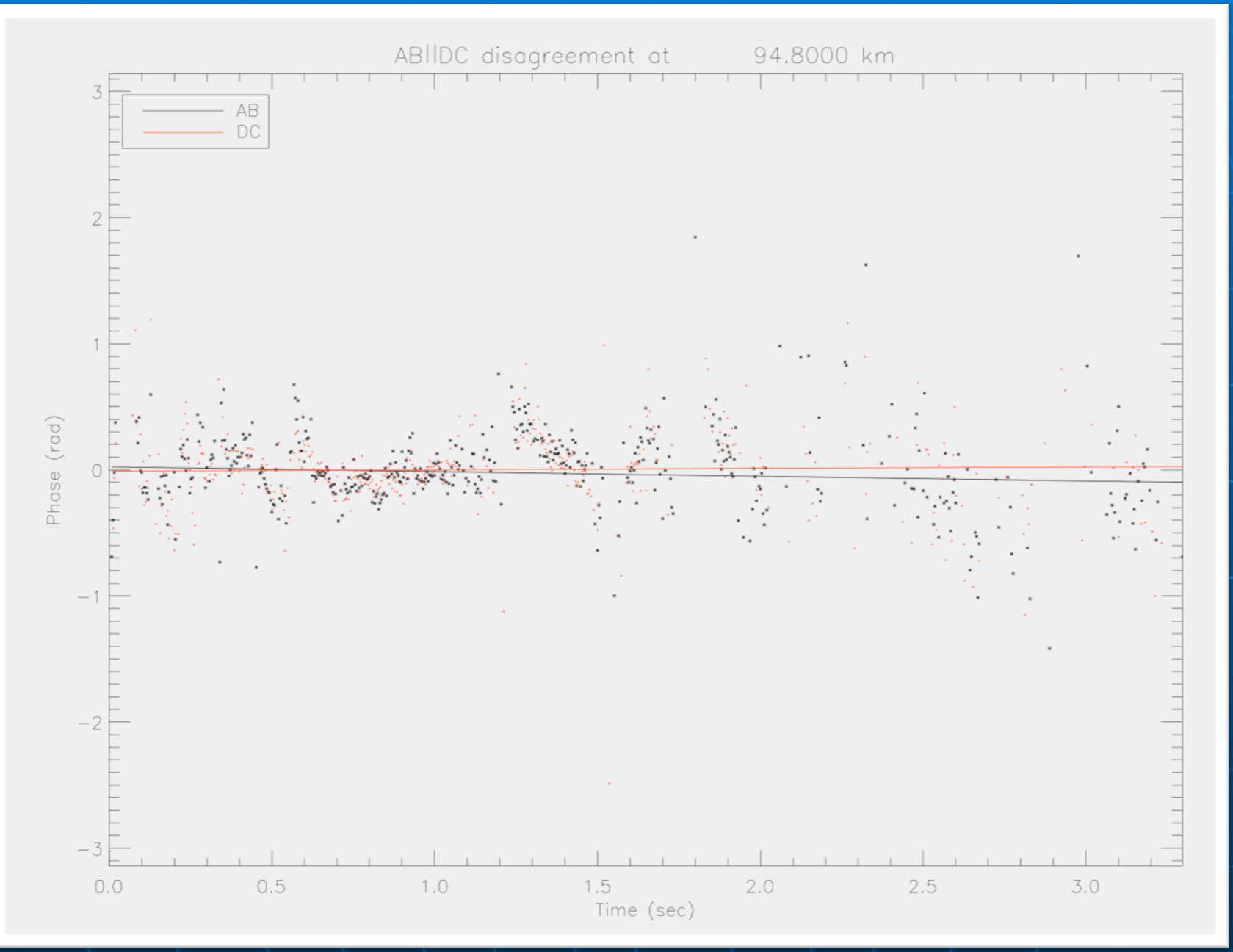


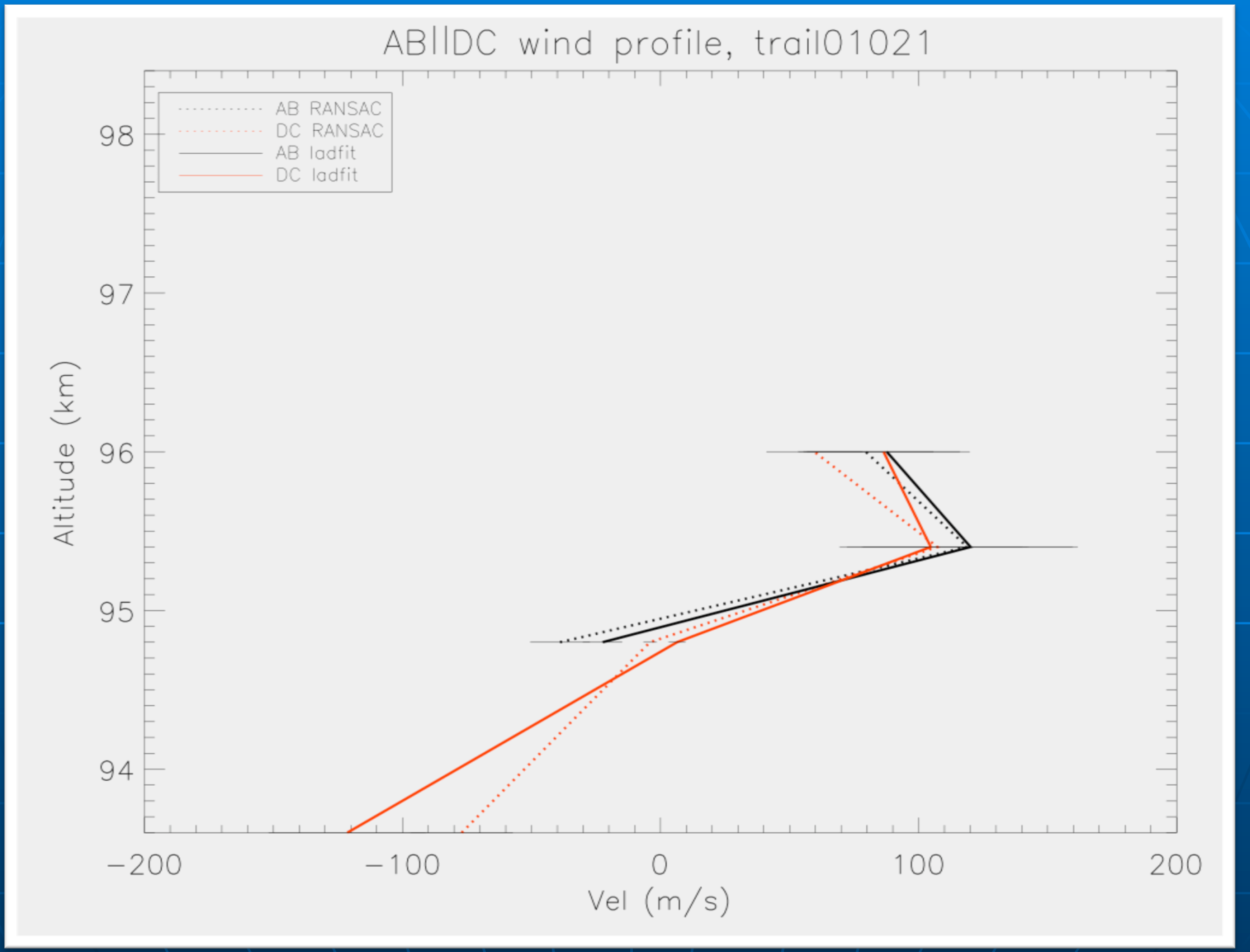
- A line is fitted to the hypothetical inliers – a random subset of points
- The line is "good" if a sufficient number of points are inliers (defined as a certain distance between the line and the points)
- Repeat procedure a fixed number of times to find the line with the most inliers and lowest RMSE error measure.

How does RANSAC do?




SNR (dB),trail01021
99
98
97
96
95
94
0
1
2
3
4
28.55
20.37
12.18
4.00


ABIIDC disagreement at 94.8000 km
AB
DC
Phase (rad)
3
2
1
0
−1
−2
−3
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Time (sec)


ABllDC wind profile, trail01021
AB RANSAC
DC RANSAC
AB ladfit
DC ladfit
98
97
96
95
94
Altitude (km)
−200
−100
0
100
200
Vel (m/s)

Conclusions

- Field Aligned Trail Winds are a new method of detecting lower thermospheric winds
  - 92-112 km altitude
  - ~10 Min Resolution
  - Best around Dawn (not useful around dusk)
- Don’t require a full ISR sized radar
  - JRO at low power
  - Smaller radars