Measuring meteorology in urban areas – some progress and many problems

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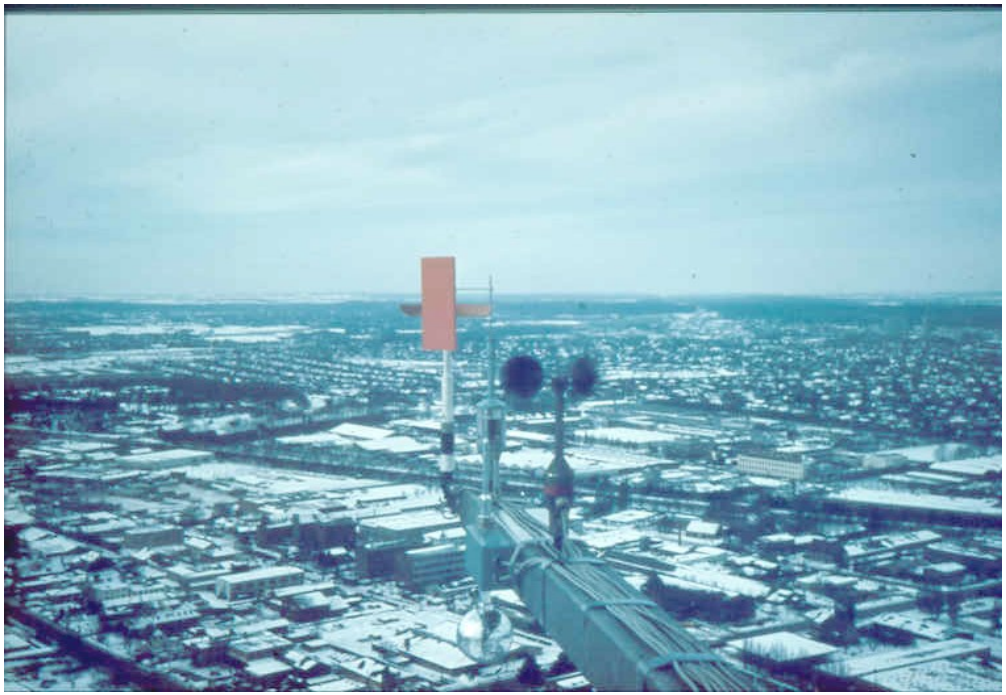
Presented by Sue Grimmond as a contribution from COST728

The cup anemometer is still the reference instrument for wind speed at a given point

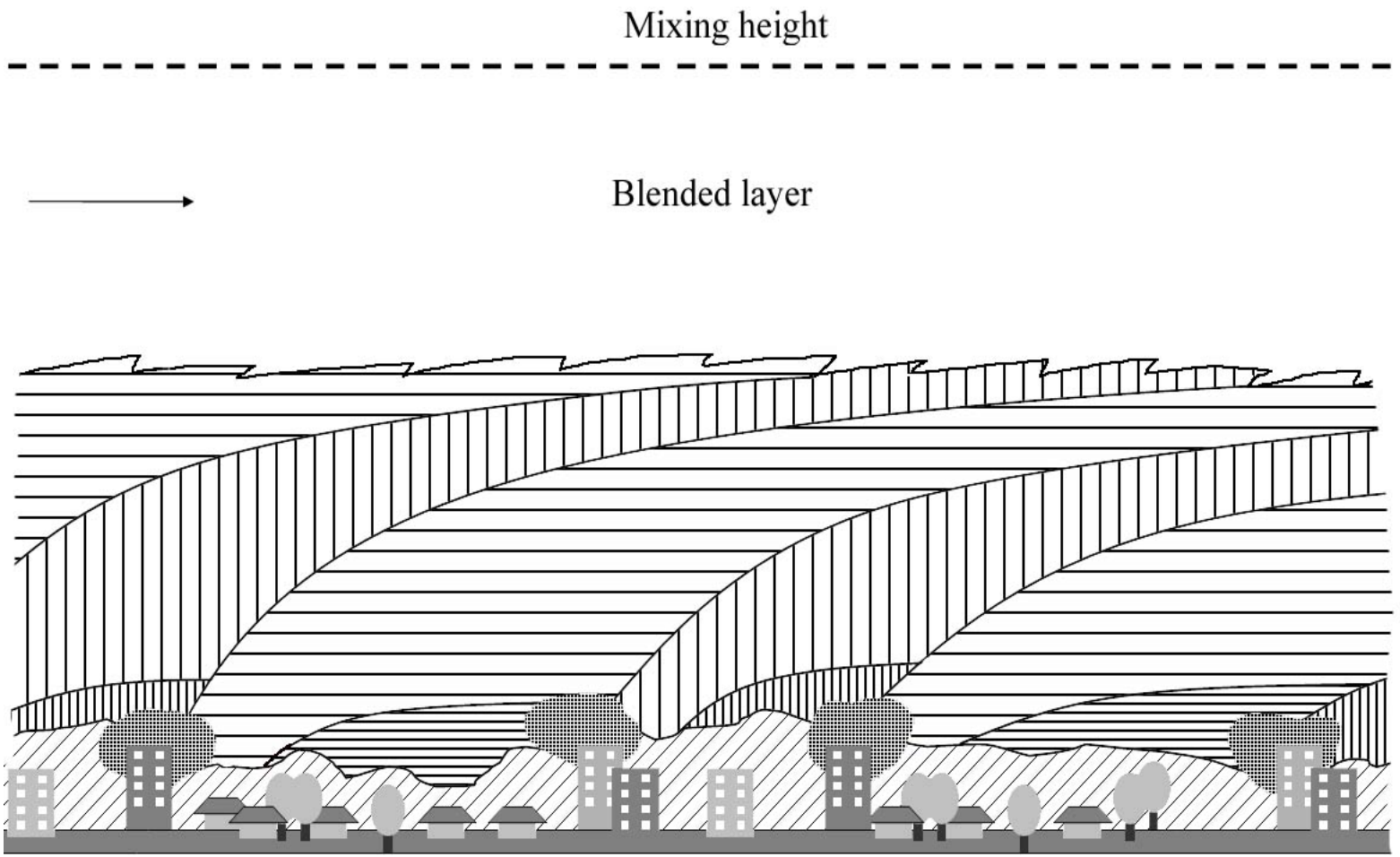


BUBBLE experiment (Basel-2002)

and for point fluxes the sonic anemometer dominates

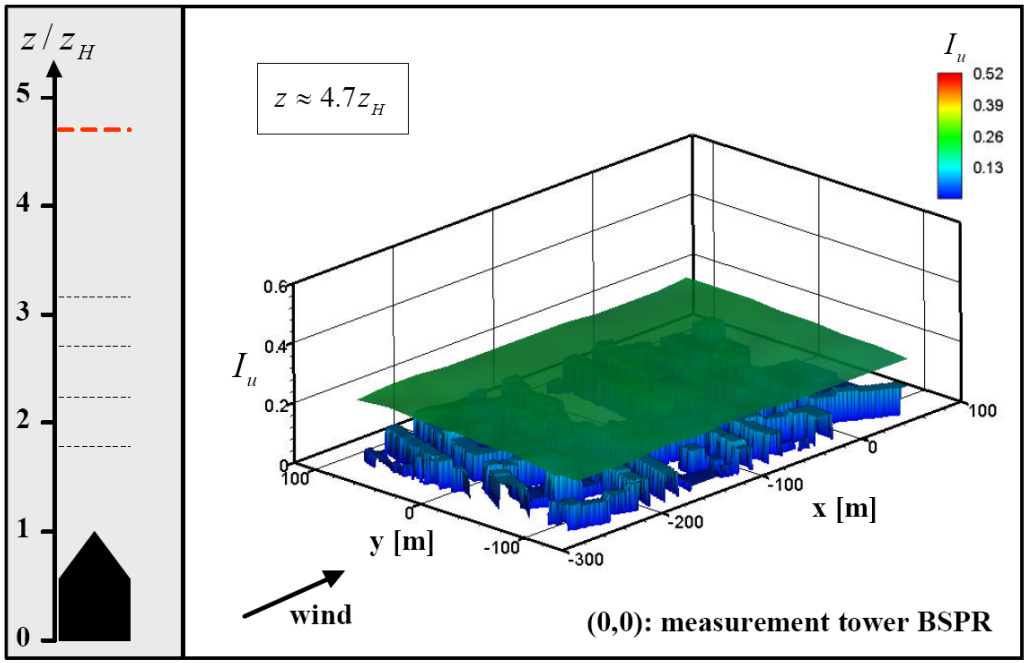
Schematics of the boundary layer structure over an urban area

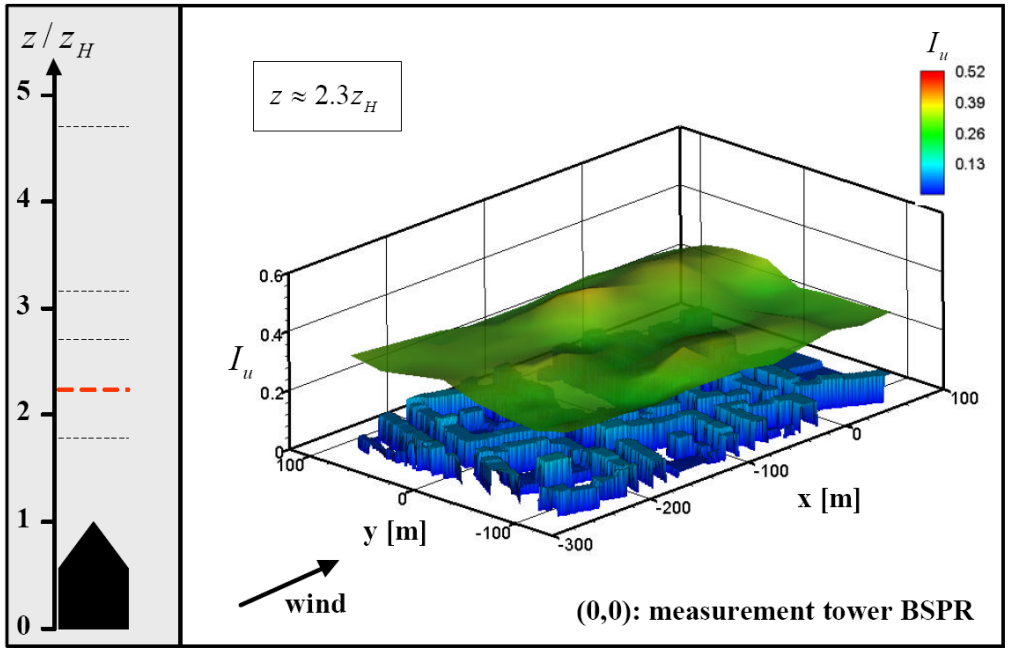
but the structure of the turbulence is very complicated
what are point measurements good for?



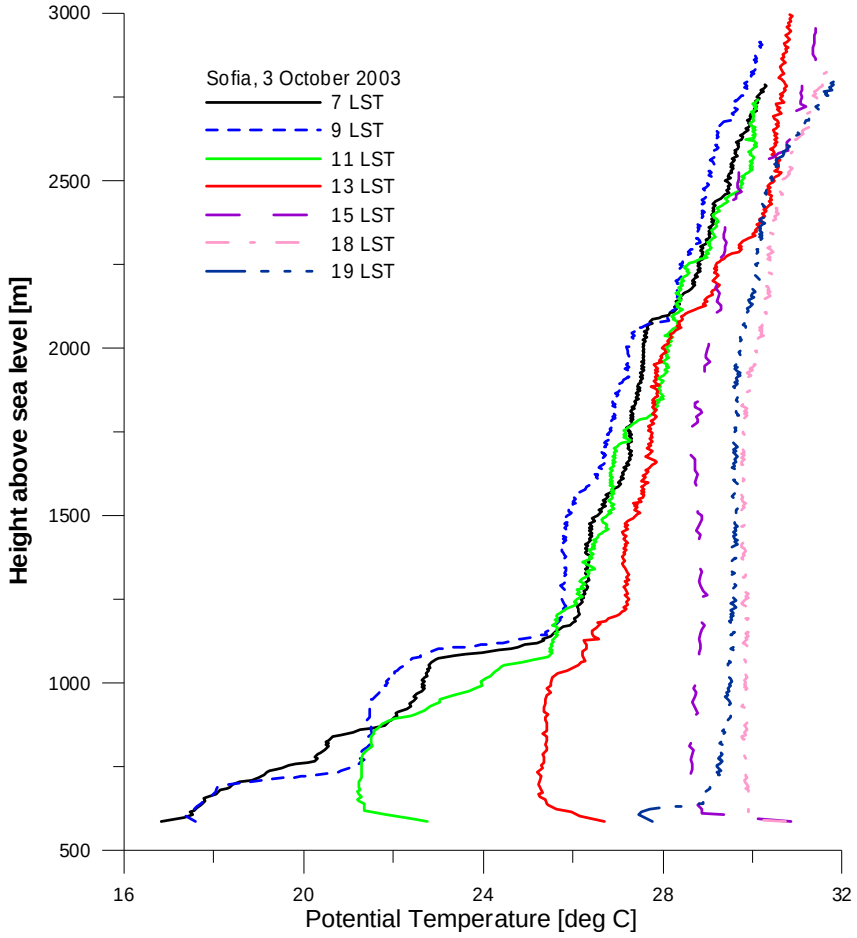
From Feddersen 2005
(PhD thesis)
ETH Zürich

wind tunnel simulation
of BUBBLE





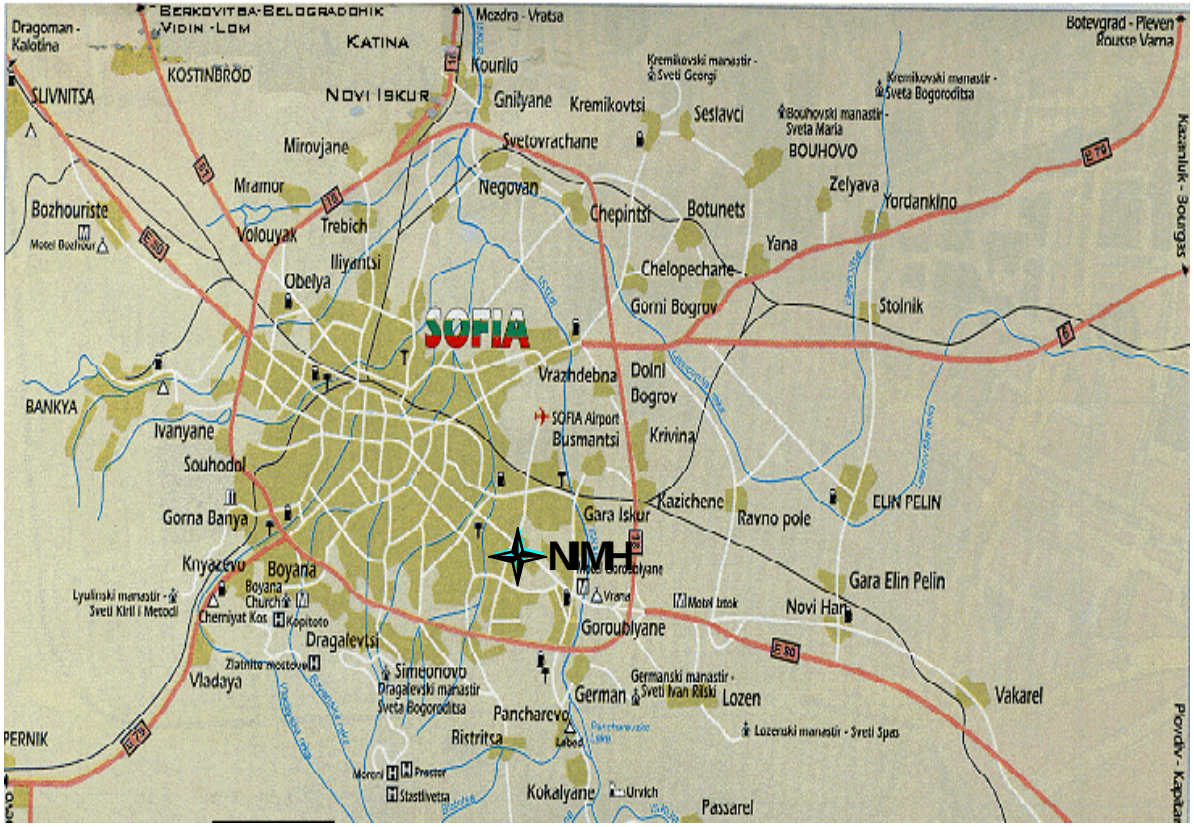
Mixed layer development – 3, aggregated fluxes

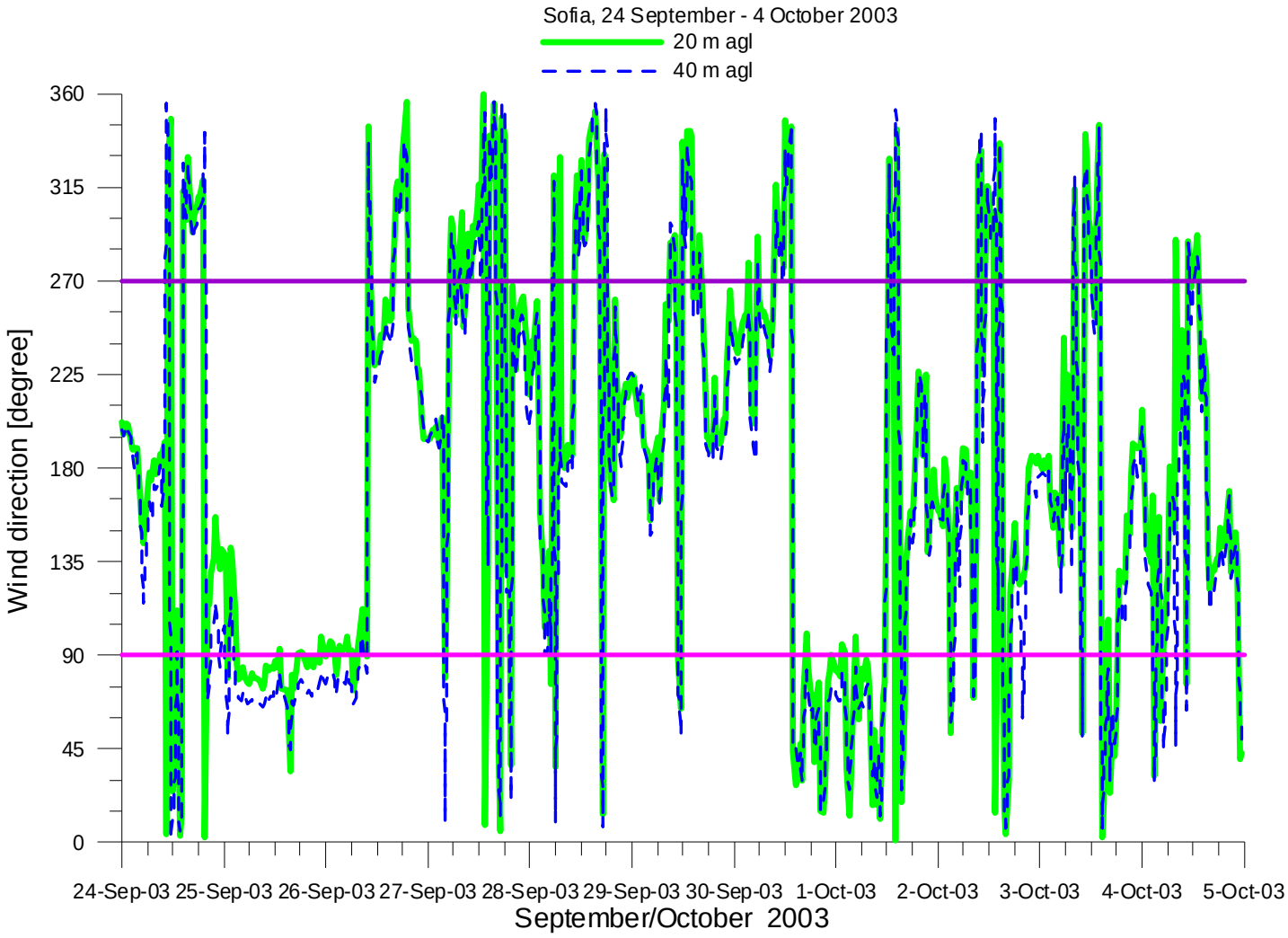


During 5 days with sunshine

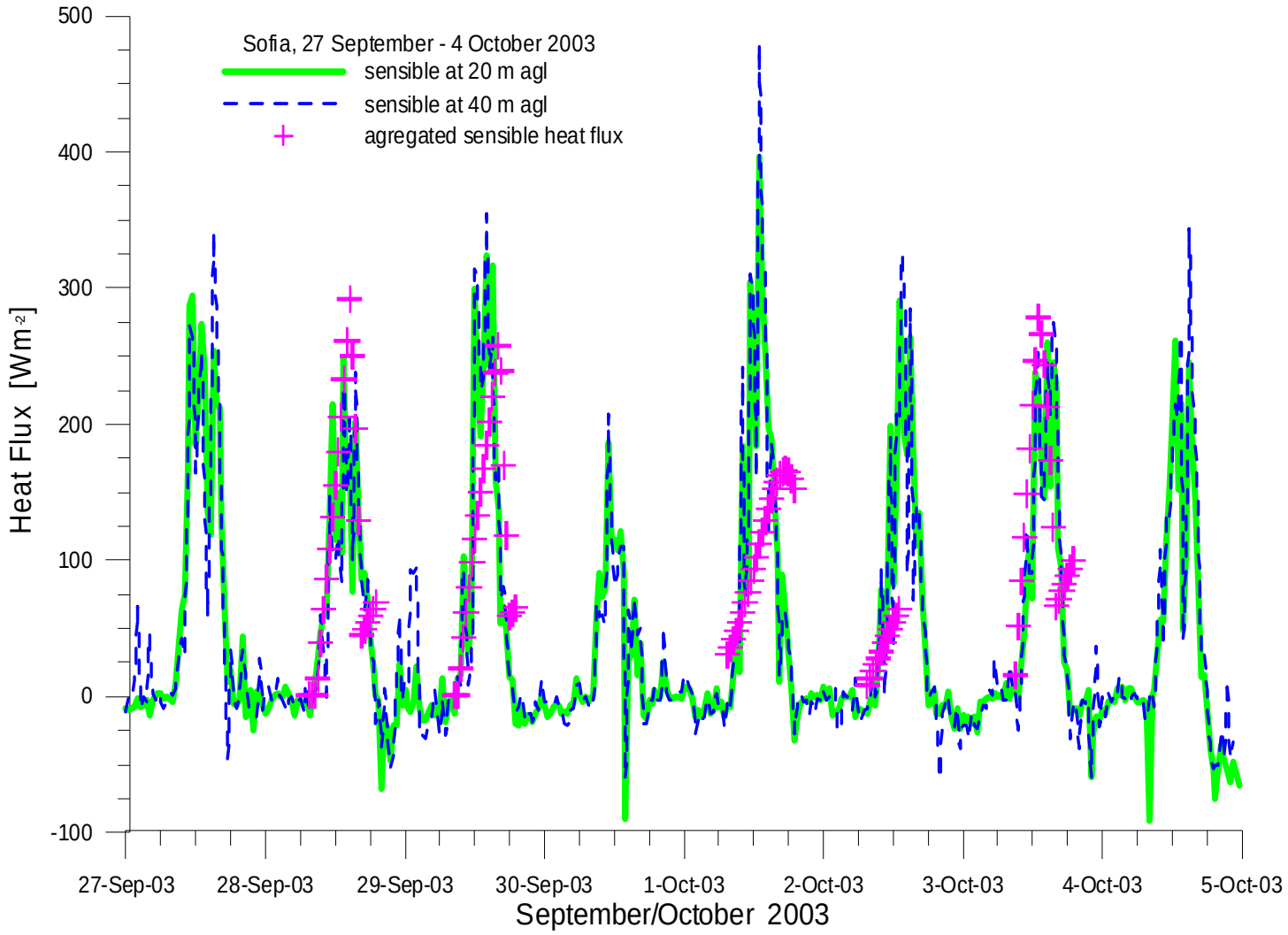
7 successive high-resolution radiosoundings were performed starting at 7 a.m. and ending at 7 p.m. Local Summer Time

Map of Sofia and close rural areas (56 by 28 km approximately

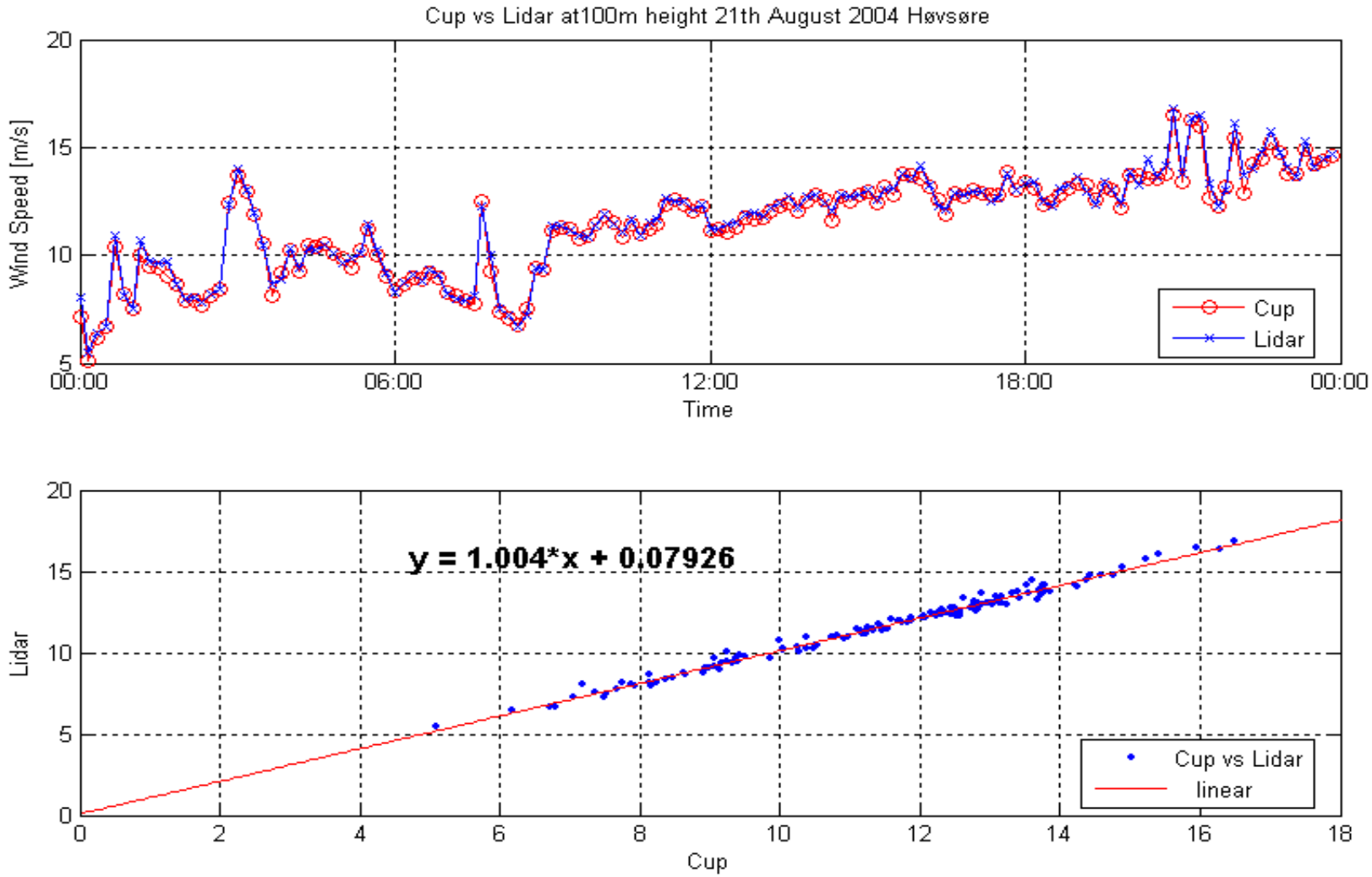



Sofia, 24 September - 4 October 2003
20 m agl
40 m agl
Wind direction [degree]
360
315
270
225
180
135
90
45
0
24-Sep-03
25-Sep-03
26-Sep-03
27-Sep-03
28-Sep-03
29-Sep-03
30-Sep-03
1-Oct-03
2-Oct-03
3-Oct-03
4-Oct-03
5-Oct-03
September/October 2003

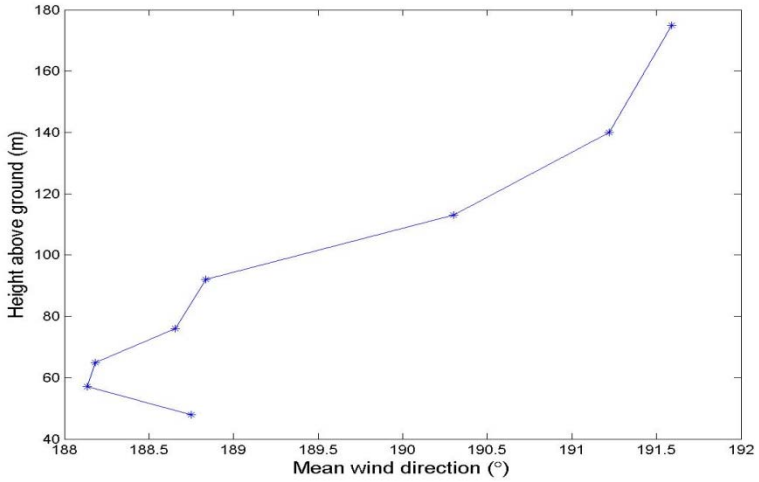
Aggregated vs measured kinematic heat flux

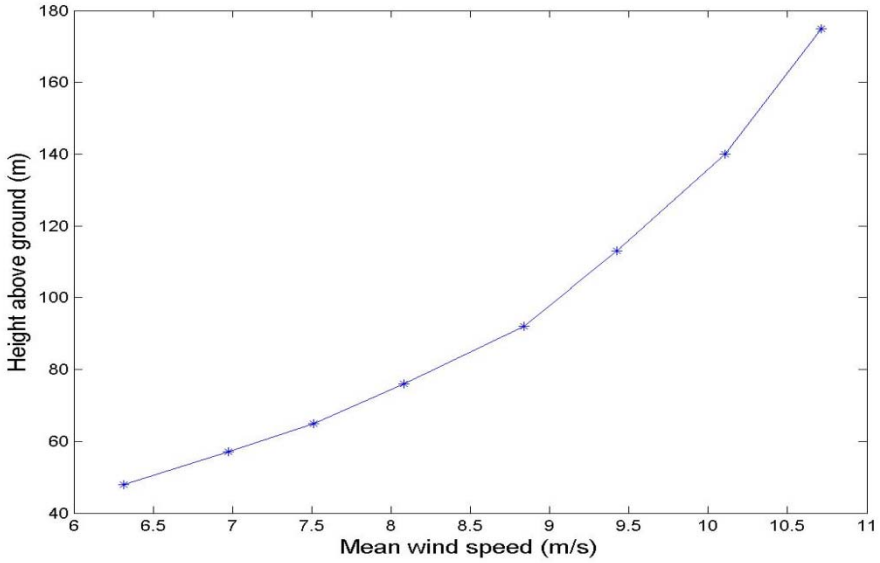


Use of LIDAR looks promissing (focussed and pulssed)

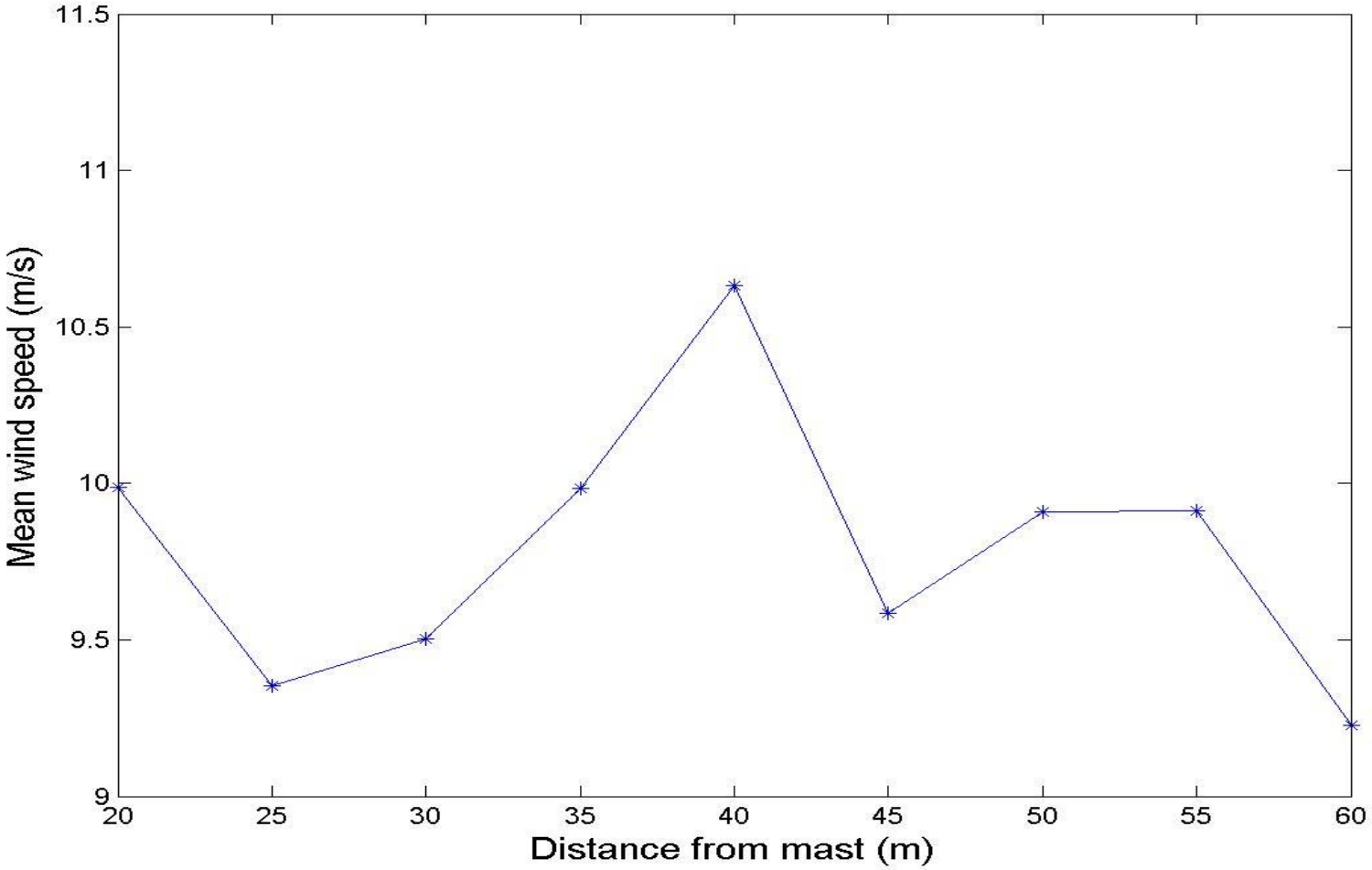

Cup vs Lidar at100m height 21th August 2004 Høvsøre
Wind Speed [m/s]
Time
00:00
06:00
12:00
18:00
00:00
Cup
Lidar
y = 1.004*x + 0.07926
Lidar
Cup
Cup vs Lidar
linear

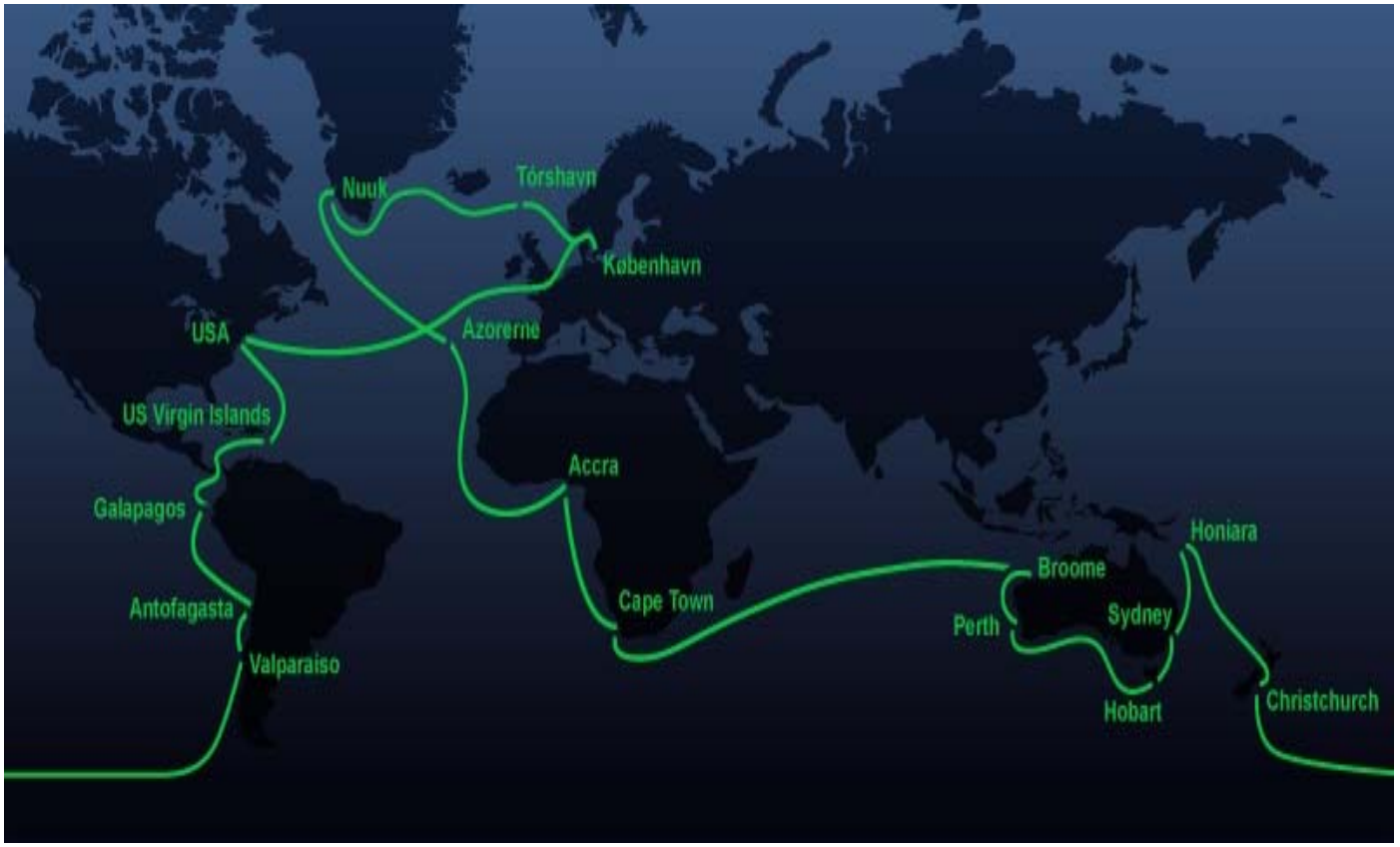
Wind direction and speed over a forest, measured by LIDAR

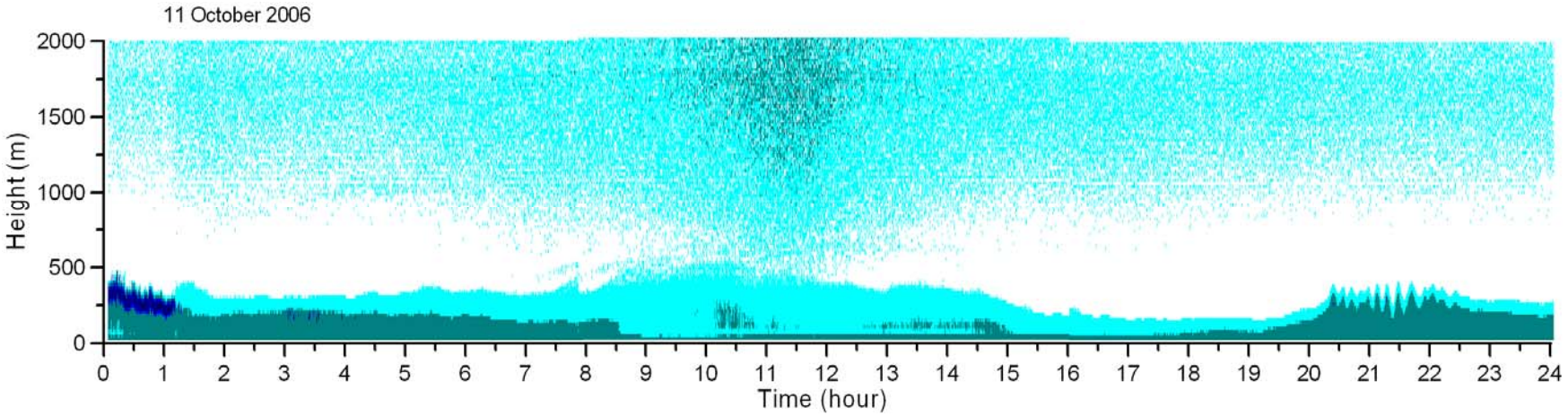




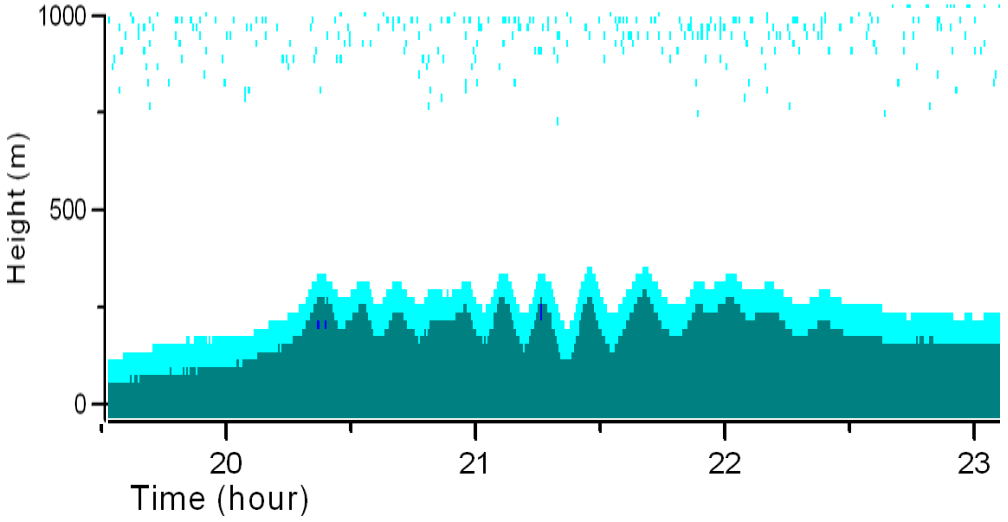
Horizontal wind profile (half hour averaged) over a forest at 40 meters
we should do this for an urban area




Nuuk
Tórshavn
København
USA
Azorerne
US Virgin Islands
Accra
Galapagos
Honiara
Broome
Antofagasta
Cape Town
Perth
Sydney
Valparaiso
Hobart
Christchurch

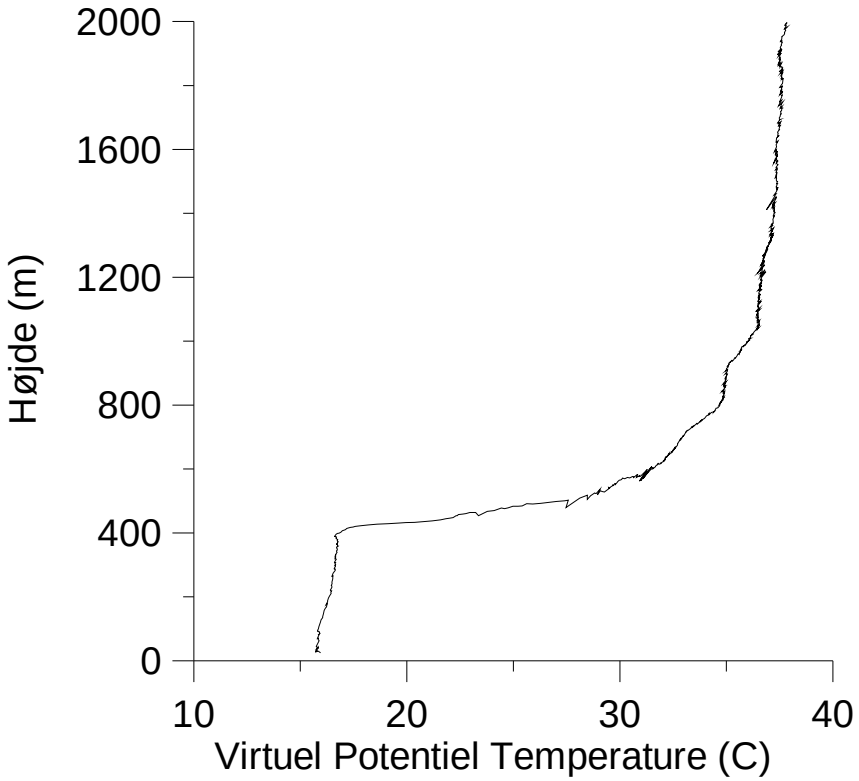


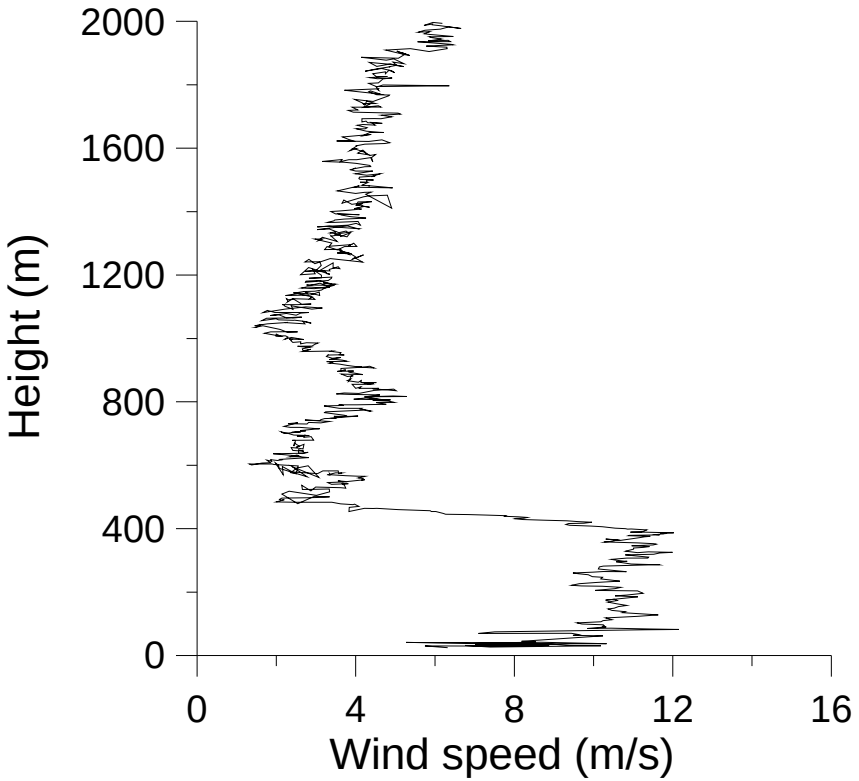
Outside Namibia (upwelling)



and the indispensable radiosonde

Outside Namibia where we found the waves in the atmosphere





- Some conclusions

- Lidar is a promising tool for urban meteorological measurements and should be used to measure the horizontal variation of the of the wind field and maybe even the turbulence field in addition to the vertical profile.

- Can a ceilometer be used to measure the height of the boundary layer in an urban settelment? It proved to be very successful over the sea.

- Radiosoundings are always good.

- The boundary layer is the turbulent layer adjacent to he ground, it should not be confused (mixed-up) with an non-turbulent residual layer. Instruments based on backscatter from particles cannot distinguish between the two layers. Maybe we can see the turbulence and in this way distingush between the two layers, if we measure the variance of the particle concentration?

Acknowledgements

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