Optimizing scanning lidars for turbulence measurements

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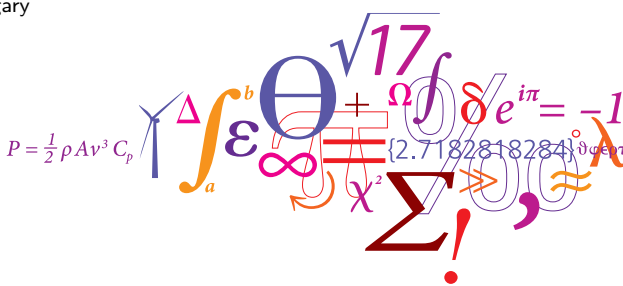
EMS annual meeting 2018

Corvinus University of Budapest, Hungary



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Outline

- Motivation and relevance
- The reality
- An experiment
- Summary and conclusions

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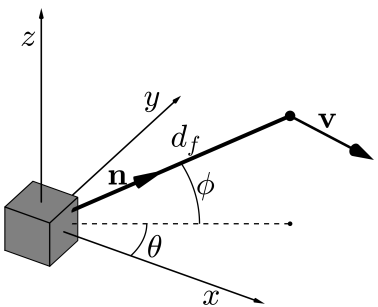

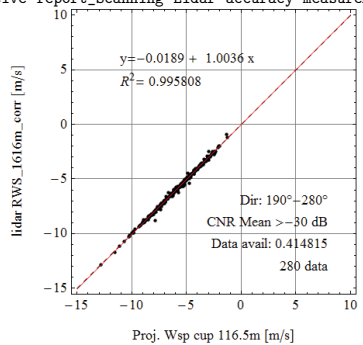

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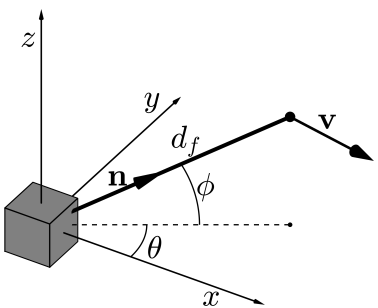
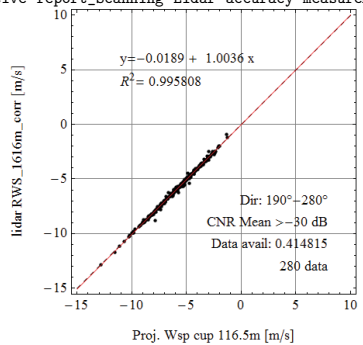
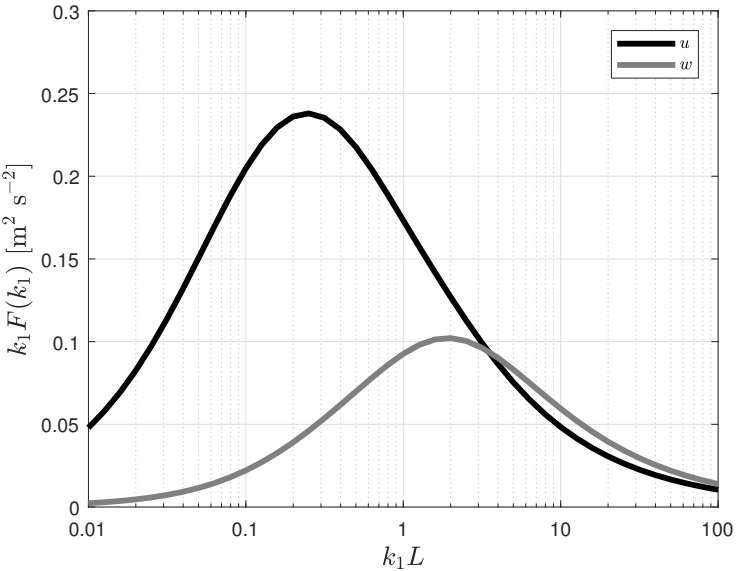




- turbulence measurements are of major importance for flow modelling (wind siting) and are still an issue for lidars due to ‘contamination’ and ‘filtering’

Motivation and relevance (II): turbulence



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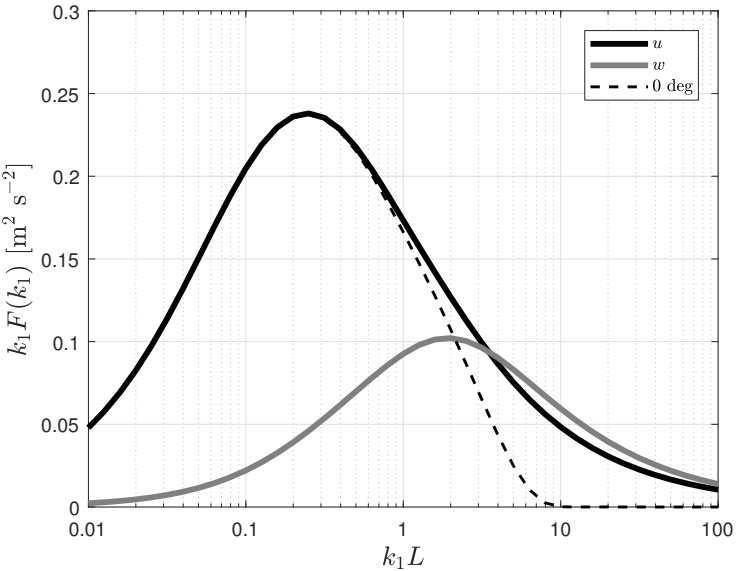

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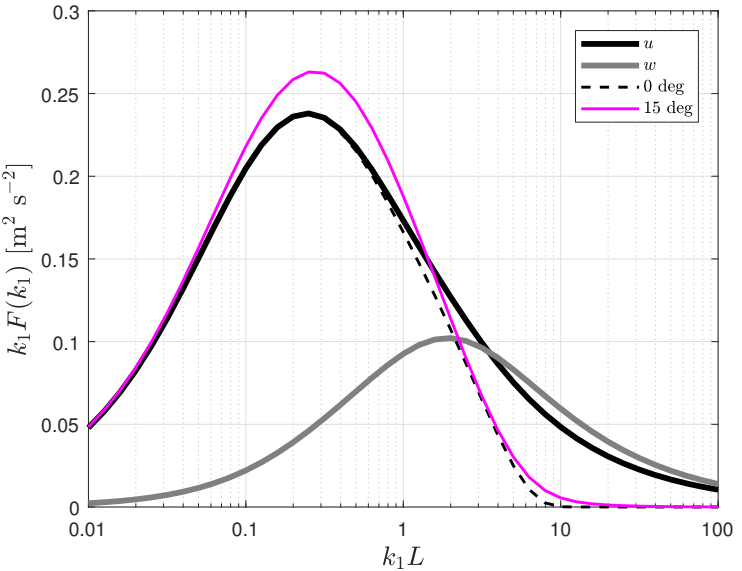

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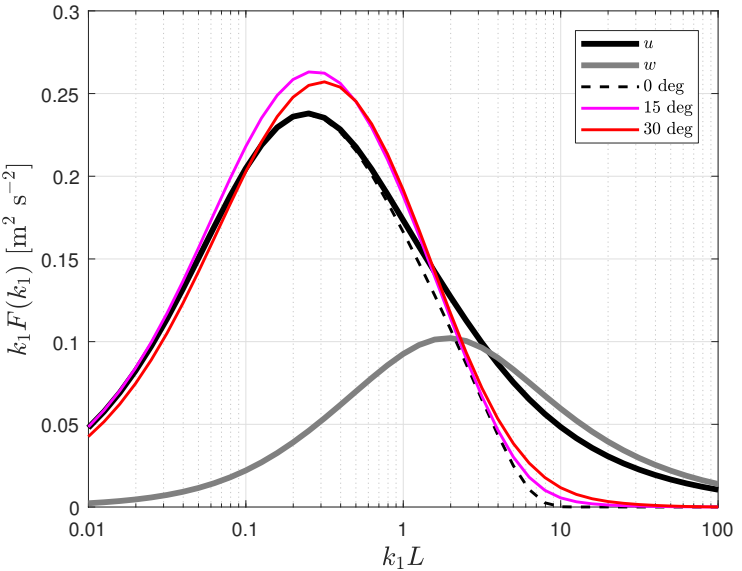

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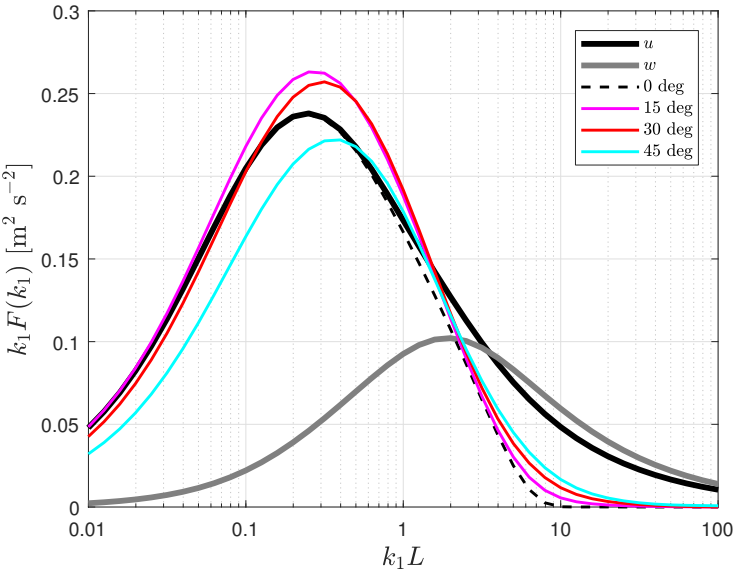

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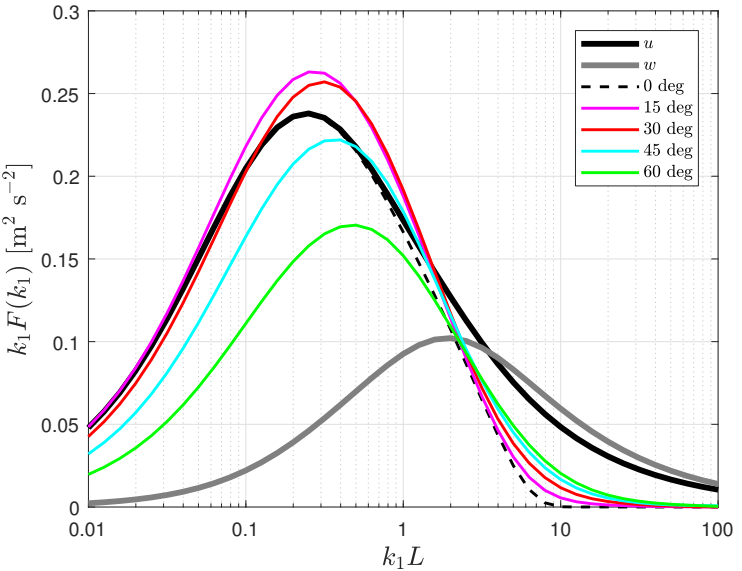

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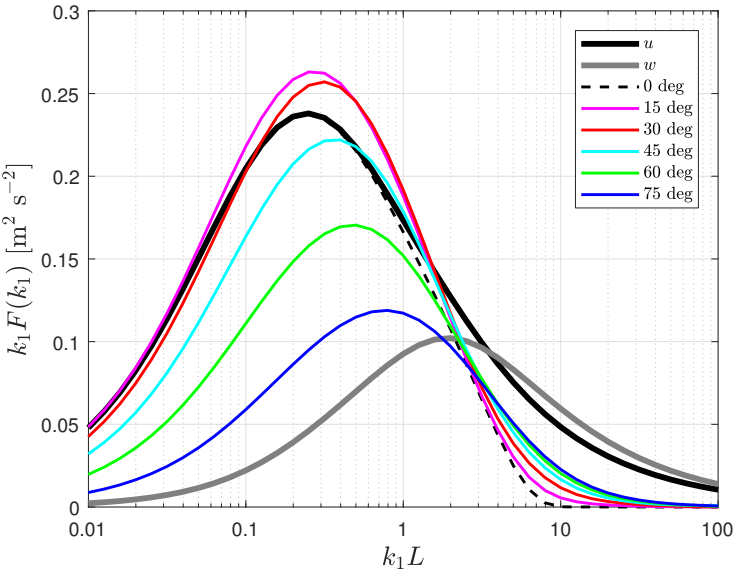

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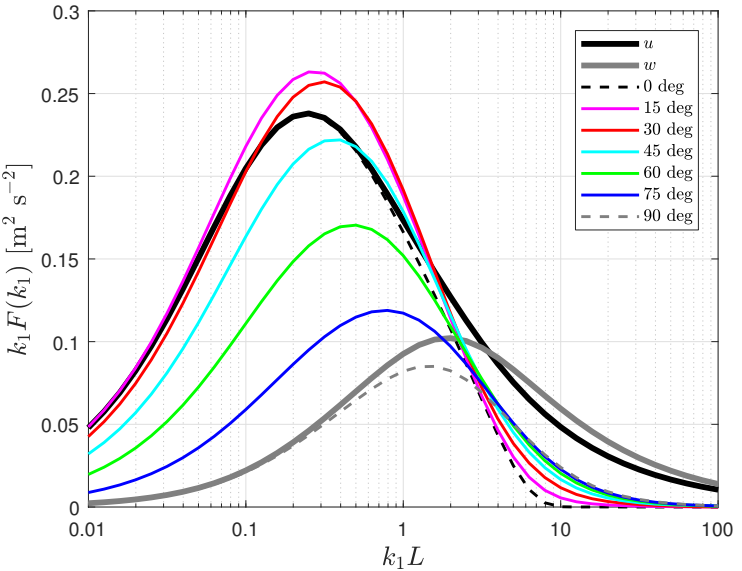

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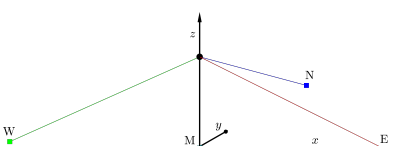
- you could use 4 assuming $\langle u'v' \rangle = \langle v'w' \rangle = 0$ and try Sathe et al.'s approach:



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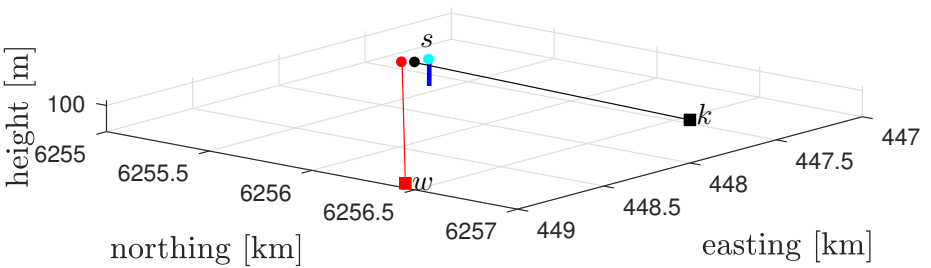
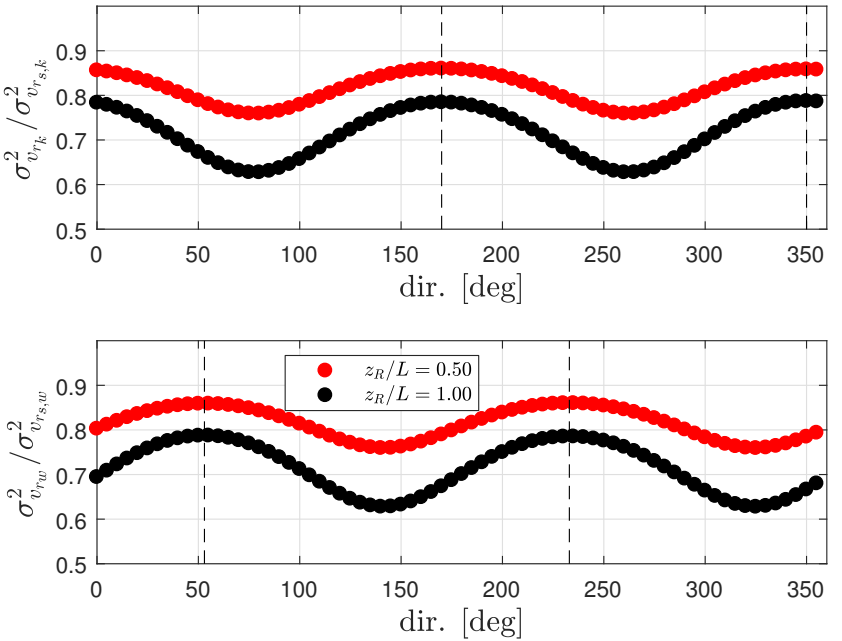
- $\langle v_{r,k}' v_{r,l}' \rangle$ depends on the turbulence structure

The ssvsdd experiment

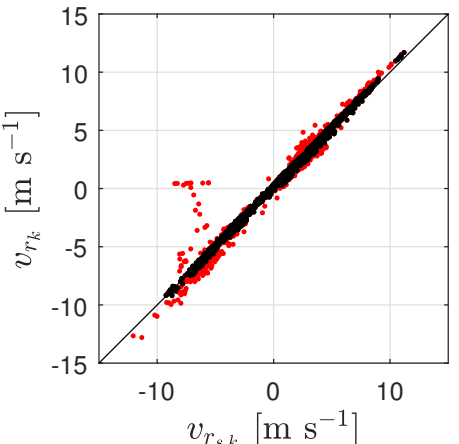
- 2 scanning lidars (k and w) at Høvsøre test station
- 3 and 5 deg elevations and ranges of about 1100 and 1600 m
- about 1 month of concurrent data with a sonic (s) at 100 m
- 2190 10-min periods in total

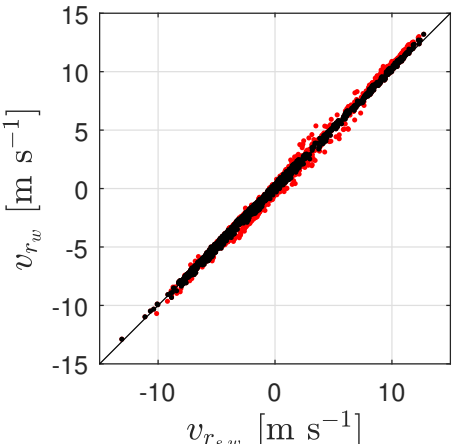


Radial velocity variance ratio with direction - prediction



Radial velocity intercomparison





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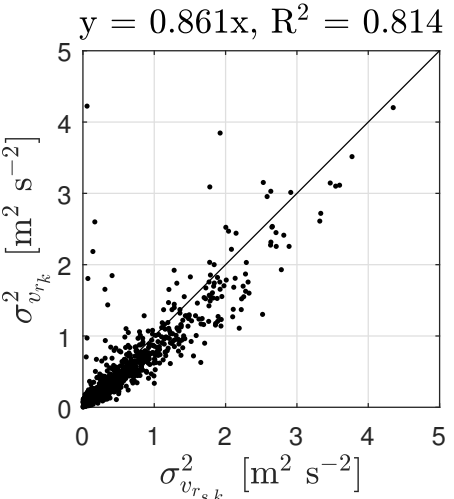
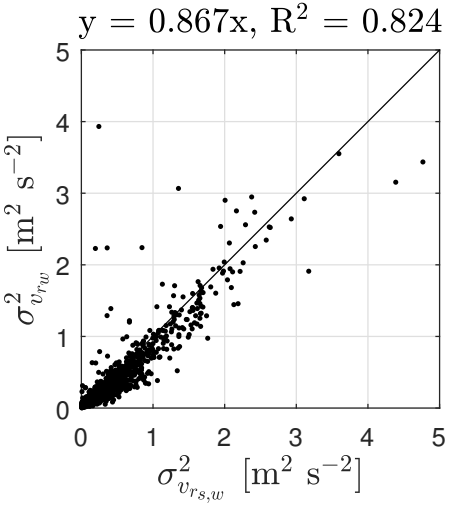
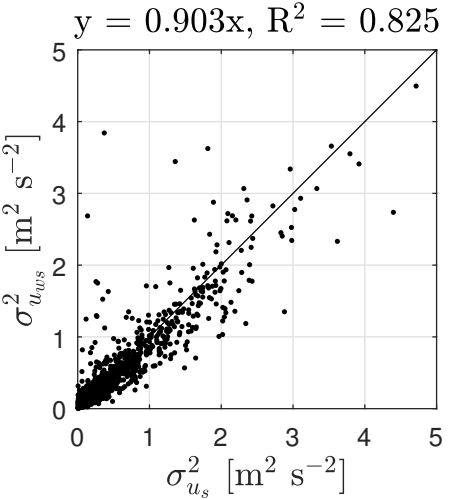
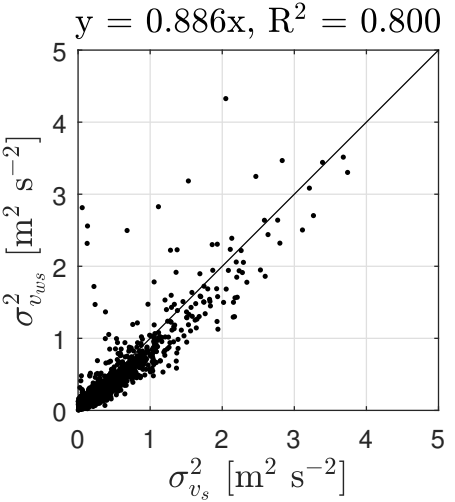


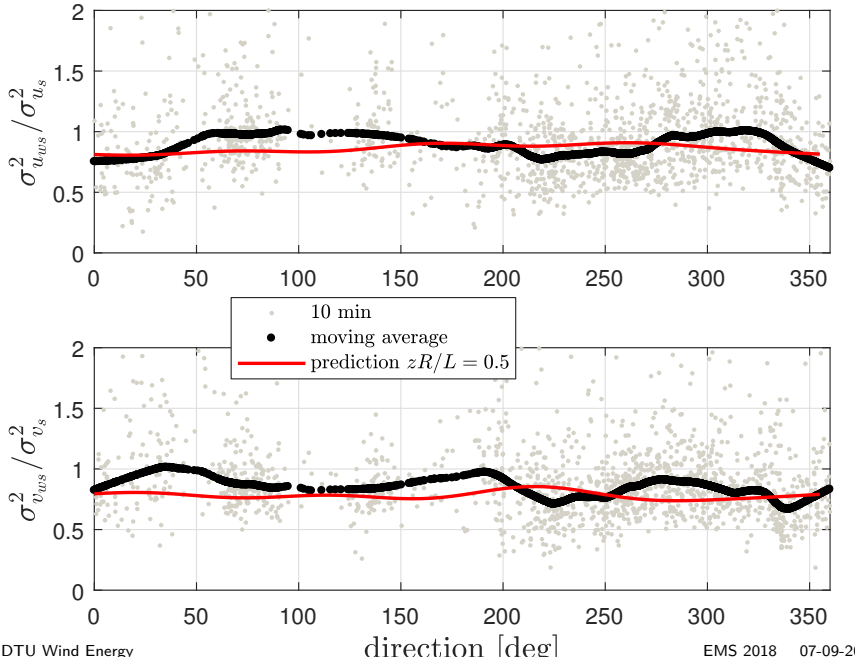


Reconstructed horizontal variance intercomparison





Reconstructed horizontal variance behavior with direction



Summary

- we can measure accurately radial velocities with scanning lidars
- radial velocity variance is filtered due to the lidar's probe volume and the degree of filtering is a function of turbulence
- velocity variances from reconstructed velocity components can be filtered and (positively or negatively) contaminated by other components
- it is possible to estimate the unfiltered radial velocity variance (expensive storage-wise)
- we can estimate 4 or 6 elements of the Reynolds stress tensor (very expensive money-wise)
- we can estimate the ratio of the true horizontal velocity variance to the lidar-reconstructed horizontal velocity variance and this depends on turbulence and direction (not that expensive money-wise)