Comparison of LIDAR and mast measurements in complex terrain with/without FCR and CFD correction

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Winterwind 2014, February 11-12,
Sundsvall, Sweden

Courtesy of

austri
RASKIFTET

Outline

1. Site overview
2. FCR (Flow Complexity Recognition) correction
3. CFD (Computational Fluid Dynamics) correction
4. Comparisons
5. Conclusions
6. LIDAR in cold climate

Site overview

Raskiftet, Norway

- 100 m tall met mast
- Top anemometers @ 102.3 m
  - Thies FirstClass Advanced (cup)
- Direction vane @ 97 m
  - NRG200P

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- Complex terrain
- Altitude difference tower base to nearby lake: 340 m

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- Altitude difference tower base to nearby lake: 340 m
- LIDAR (WINDCUBE v2, with FCR) placed next to mast for two weeks in August/September
- Period will be extended summer 2014

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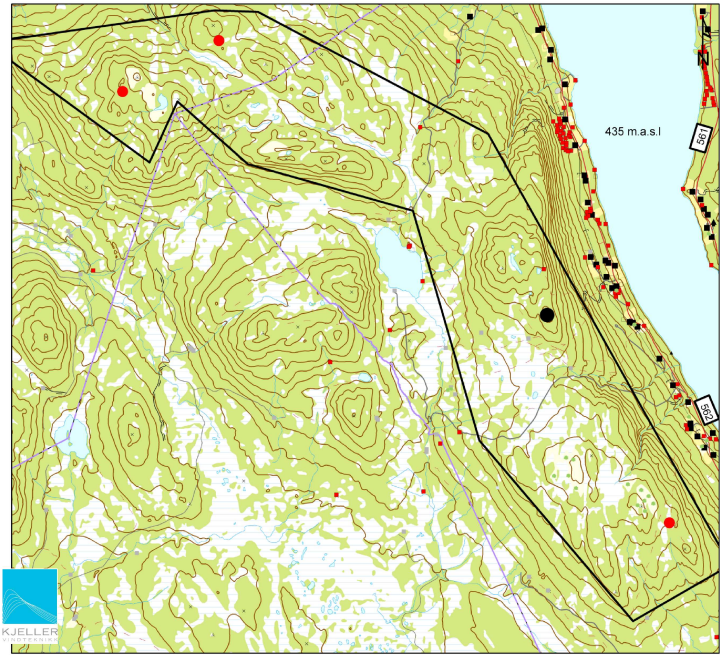

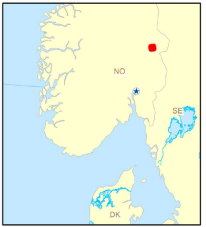

Raskiftet			
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Scales: 1:50 000		Papire Size: A4	
Datum: WGS84		Projection: UTM33	

0 0.5 1 2 km

- Lidar
- Mast 775 m.a.s.l
- Park area

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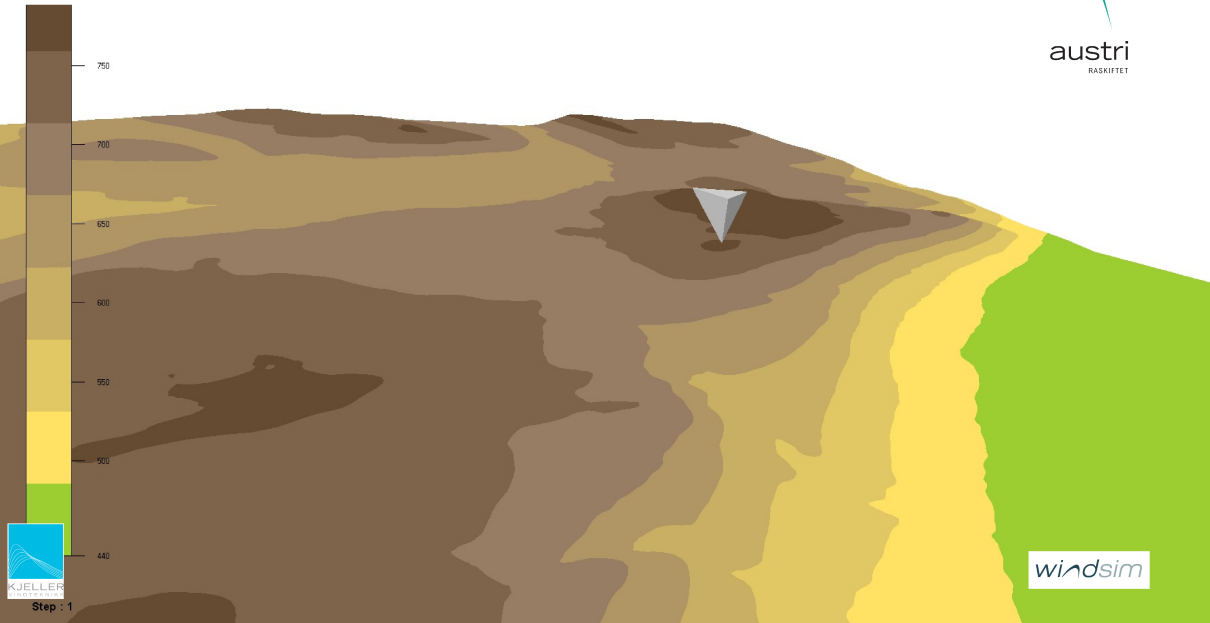
RASKIFTET

Raskiftet, Hedmark, Norway



Correction of raw LIDAR data in complex terrain

- Two correction techniques applied to raw LIDAR measurements:
  - FCR (Flow Complexity Recognition^{TM}, Leosphere)
  - CFD (Computational Fluid Dynamics, Windsim)

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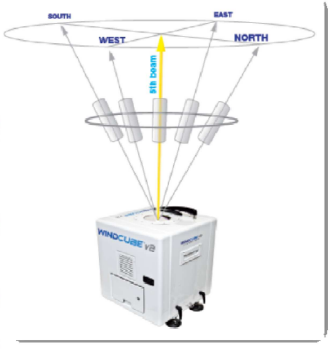
FCR: Flow Complexity Recognition™

Normal mode



Independent Heights Measurement
Assumption: Homogenous wind flow

FCR™ mode

Entire Profile Direct Measurement
No wind flow homogeneity assumption

1. Analysis and comparison of radial wind of all LOS gates
2. Characterization & classification of the complexity of the wind
3. Calculation of the final wind speed value

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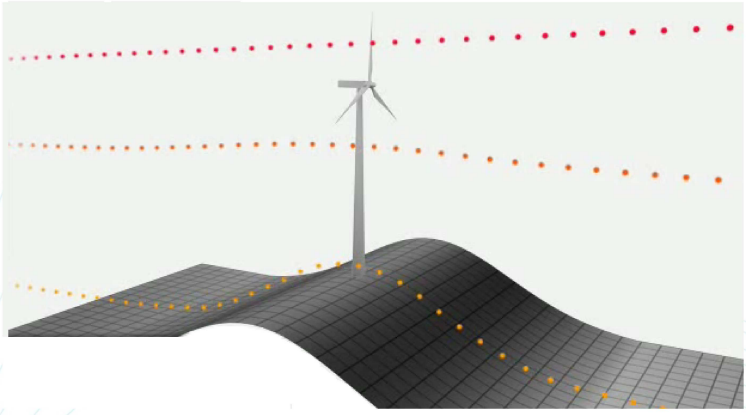
LEOSPHERE

CFD (Computational Fluid Dynamics) correction

WindSim Remote Sensing Correction Tool



- Corrects raw LIDAR data based on CFD simulation

http://www.windsim.com/remote-sensing-correction-tool.aspx

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windsim

Comparison MAST vs LIDAR (RAW, CFD-corrected, and FCR-corrected)

Comparison of mast cup anemometer and vane with:

- Raw LIDAR data
- CFD-corrected LIDAR data
- FCR-corrected LIDAR data

First, time series of wind speed $\rightarrow$

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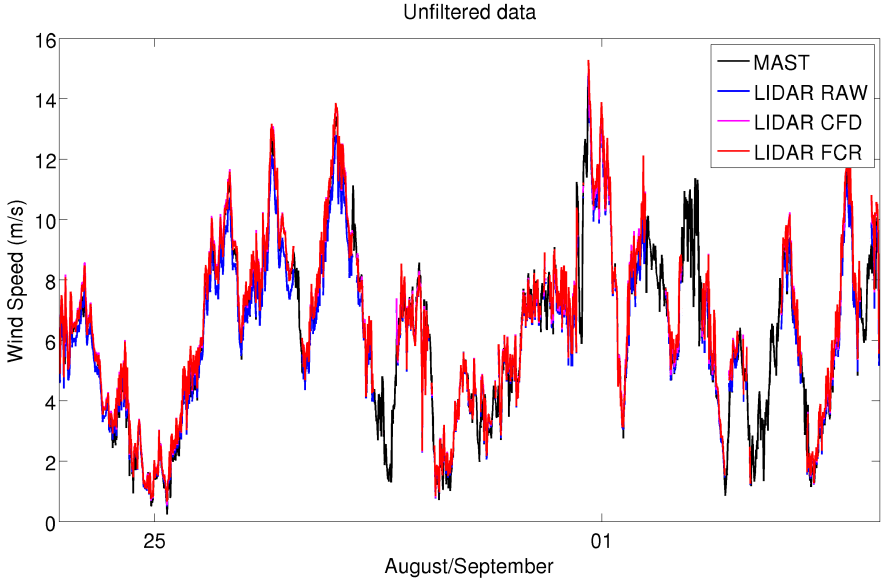
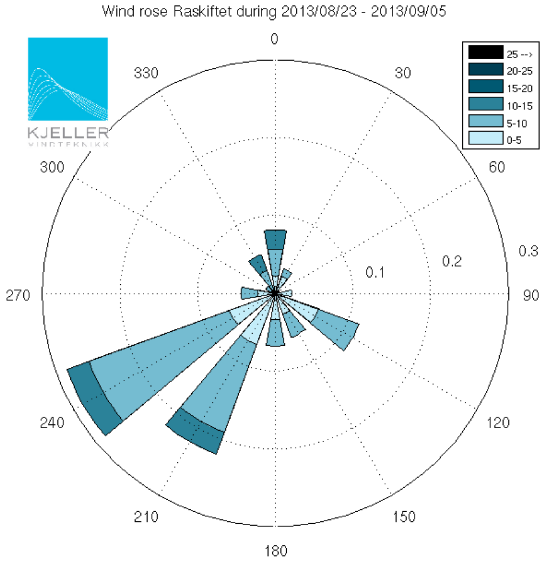
Time series Wind Speed

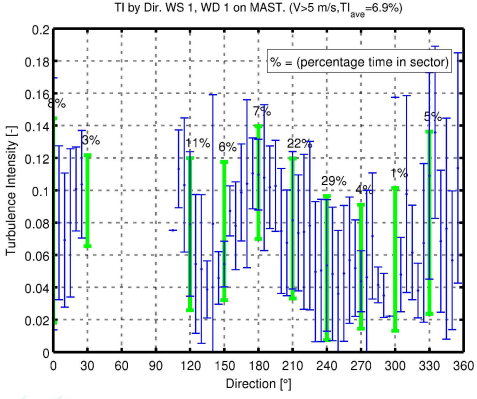
UNFILTERED data

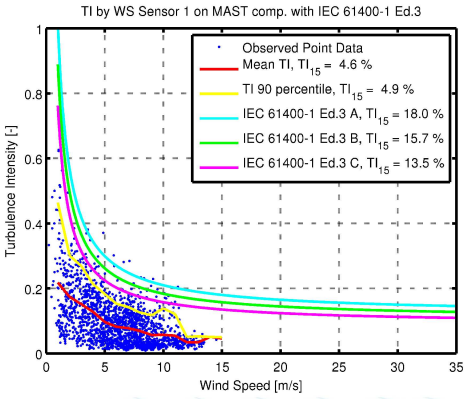


Wind rose for the period



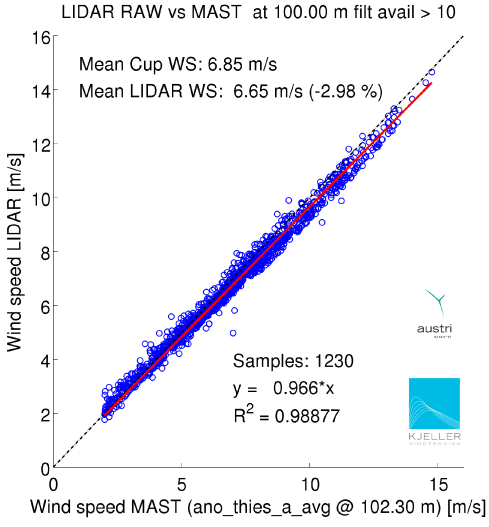
Turbulence conditions for the period

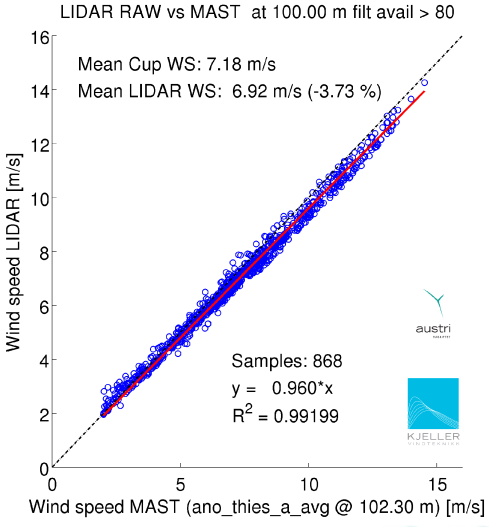




Effect of filtering on data availability (10% vs 80%)

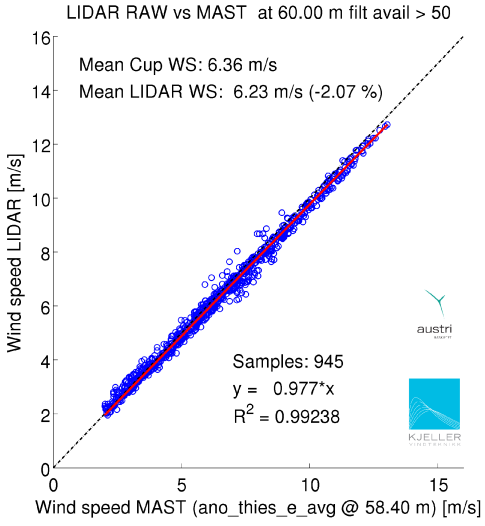
MAST vs RAW LIDAR WIND SPEED DATA

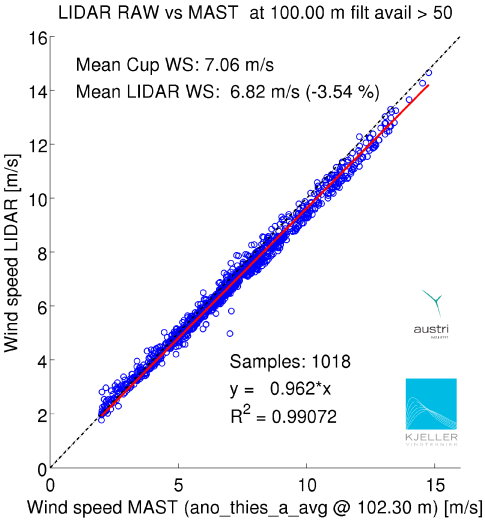




Effect of comparing mast vs LIDAR at different heights

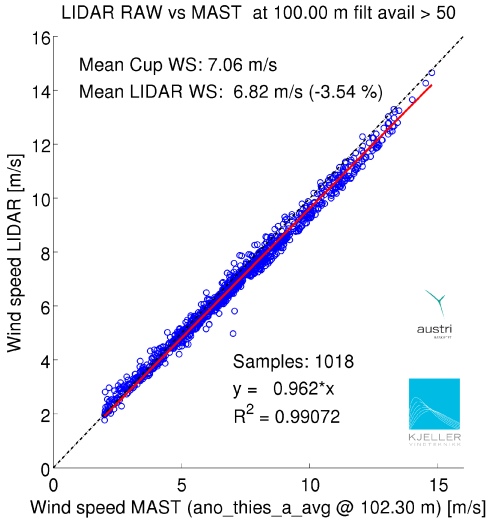
RAW DATA

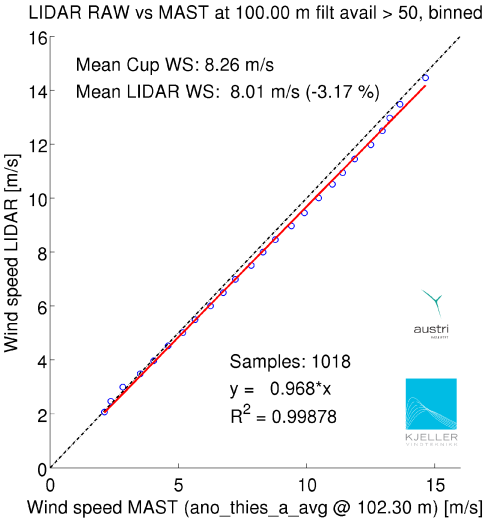




Effect of binning data

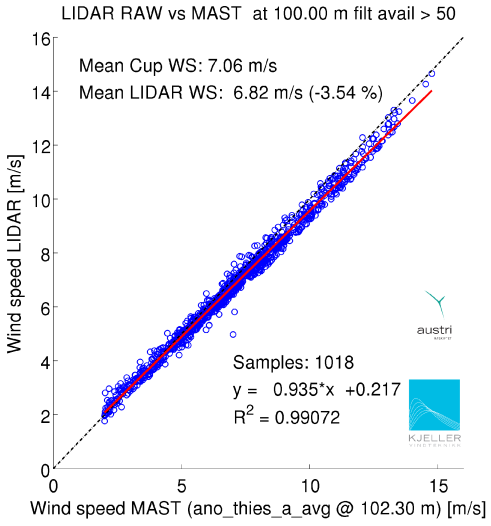
Binning: Give equal weight to all speed classes

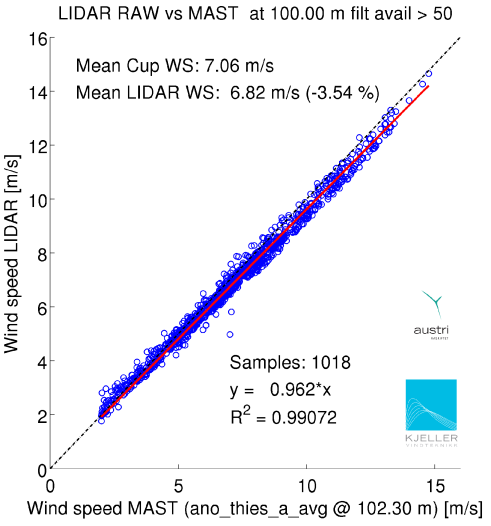




Effect of locking regression line offset ($b = 0$)

Free or constrained offset: Force regression line through the origin

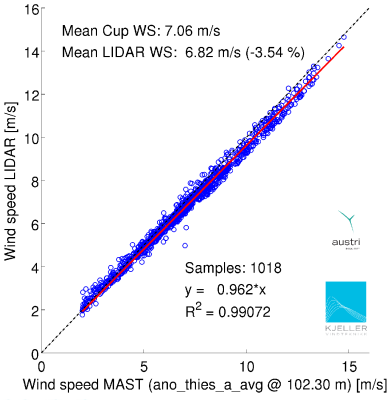




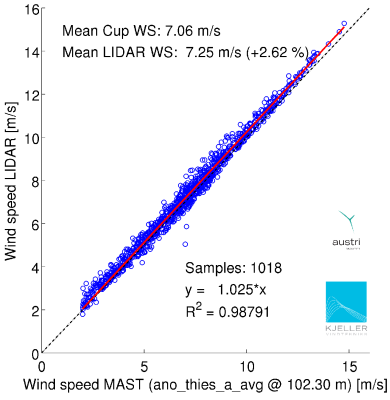
Comparison MAST vs LIDAR (RAW, CFD-corrected, and FCR-corrected) I

Wind speed, Height 100 m, availability > 50%, no offset

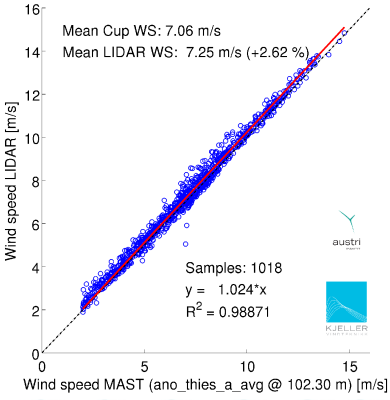
RAW



FCR



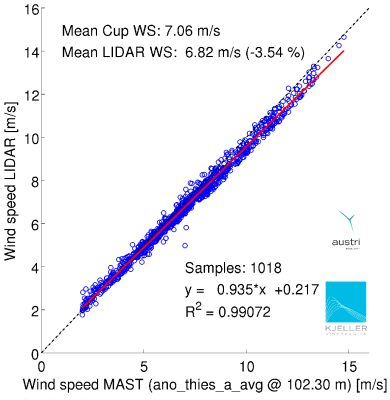
CFD



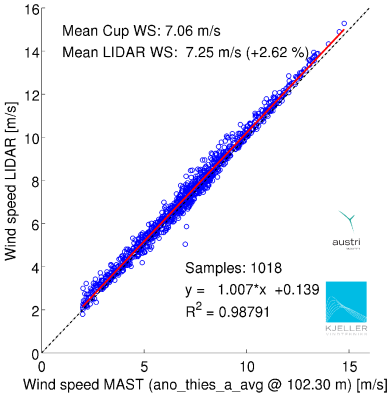
Comparison MAST vs LIDAR (RAW, CFD-corrected, and FCR-corrected) II

Wind speed, Height 100 m, availability > 50%, free offset

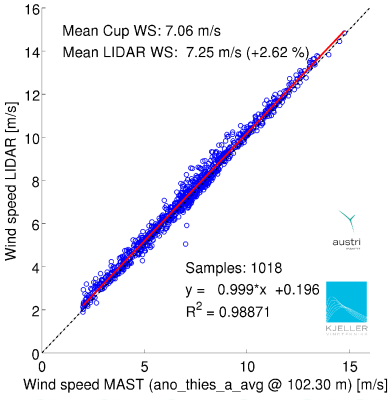
RAW



FCR



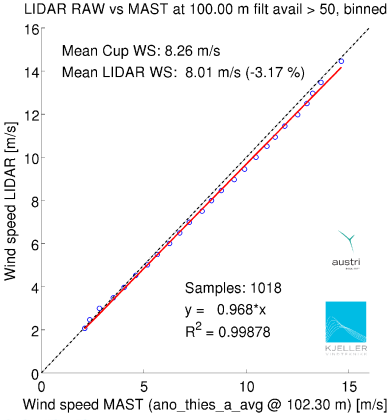
CFD



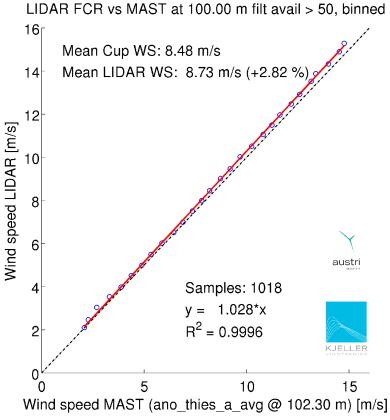
Comparison MAST vs LIDAR (RAW, CFD-corrected, and FCR-corrected) III

Wind speed, Height 100 m, availability > 50%, no offset, binned

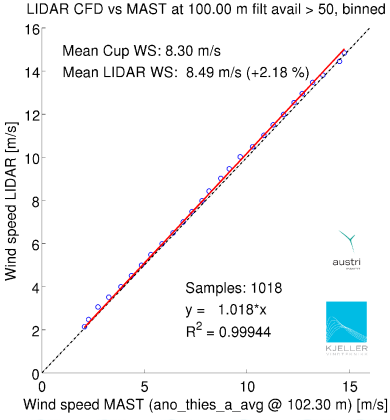
RAW



FCR



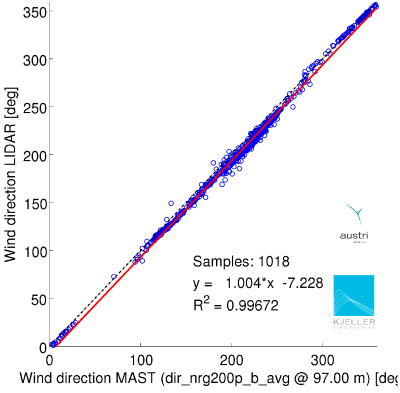
CFD



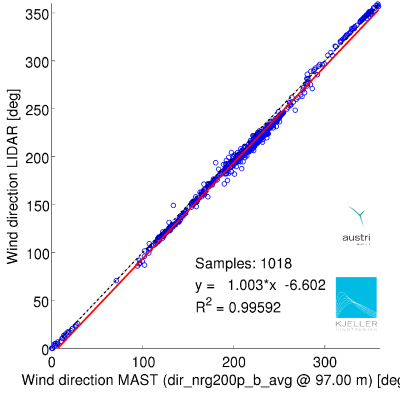
Comparison MAST vs LIDAR (RAW, CFD-corrected, and FCR-corrected) III

Wind direction, Height 100 m, availability > 50%, free offset

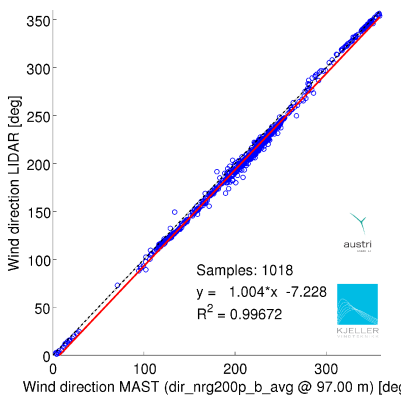
RAW



FCR



CFD (==RAW)



Conclusions

- Preliminary results:
  - Few samples
  - Poor sector coverage

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Conclusions

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Conclusions

- Preliminary results:
  - Few samples
  - Poor sector coverage
- Both CFD and FCR correction improves the result
- Only FCR corrects wind direction
- CFD correction scores best on this data set

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Outline

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LIDAR in cold climate

What is the biggest challenge for a LIDAR in cold climate?

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LIDAR in cold climate

What is the biggest challenge for a LIDAR in cold climate?

Keeping the lens free of ice and snow

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Special LIDAR mounting tower

- 2 m high tower

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Special LIDAR mounting tower

- 2 m high tower
- Bolted to the mountain

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Special LIDAR mounting tower

- 2 m high tower
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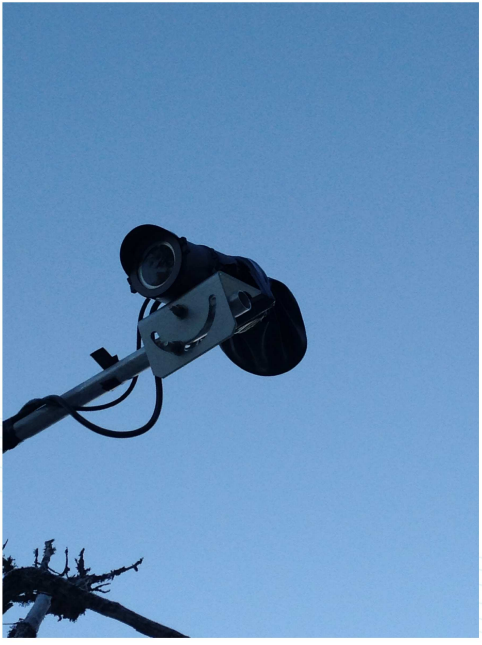
- Web camera (visual inspection of lens/wiper)



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Special LIDAR mounting tower

- 2 m high tower
- Bolted to the mountain
- Web camera (visual inspection of lens/wiper)
- Different locations

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10
AQPower
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Thank you!
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