# LIDAR in complex terrain
# Validation of CFD correction tools

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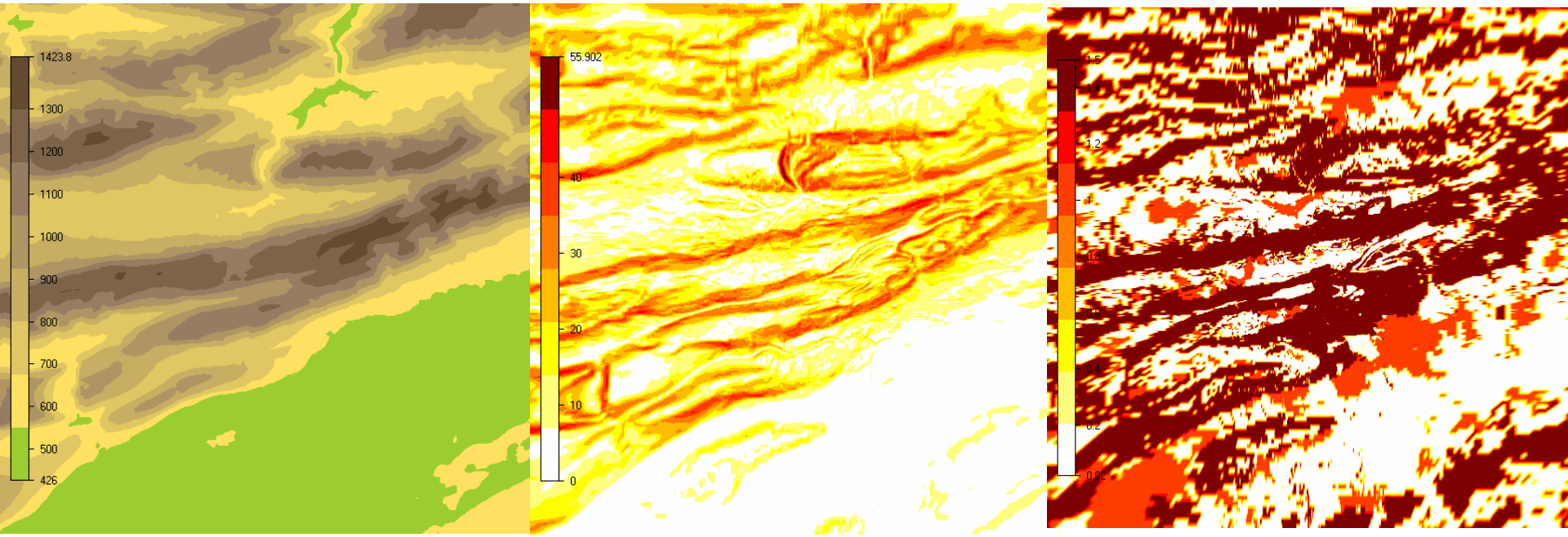
# Site a



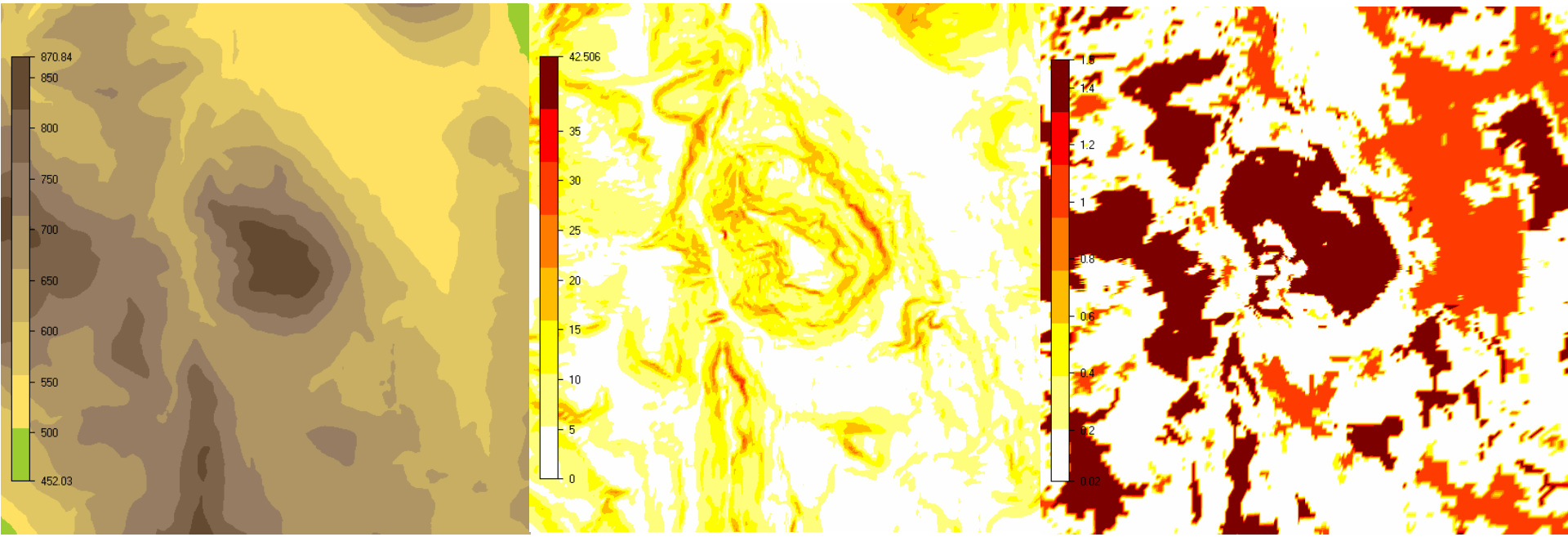

Highly complex terrain

- Elevation: 426m to 1424m
- Steepest slopes: 56deg
- Patchy forests and grassland

# Site a

- 80m met mast
- 3 months ZephIR 300 measurement campaign
- Data availability at 80m: 69%

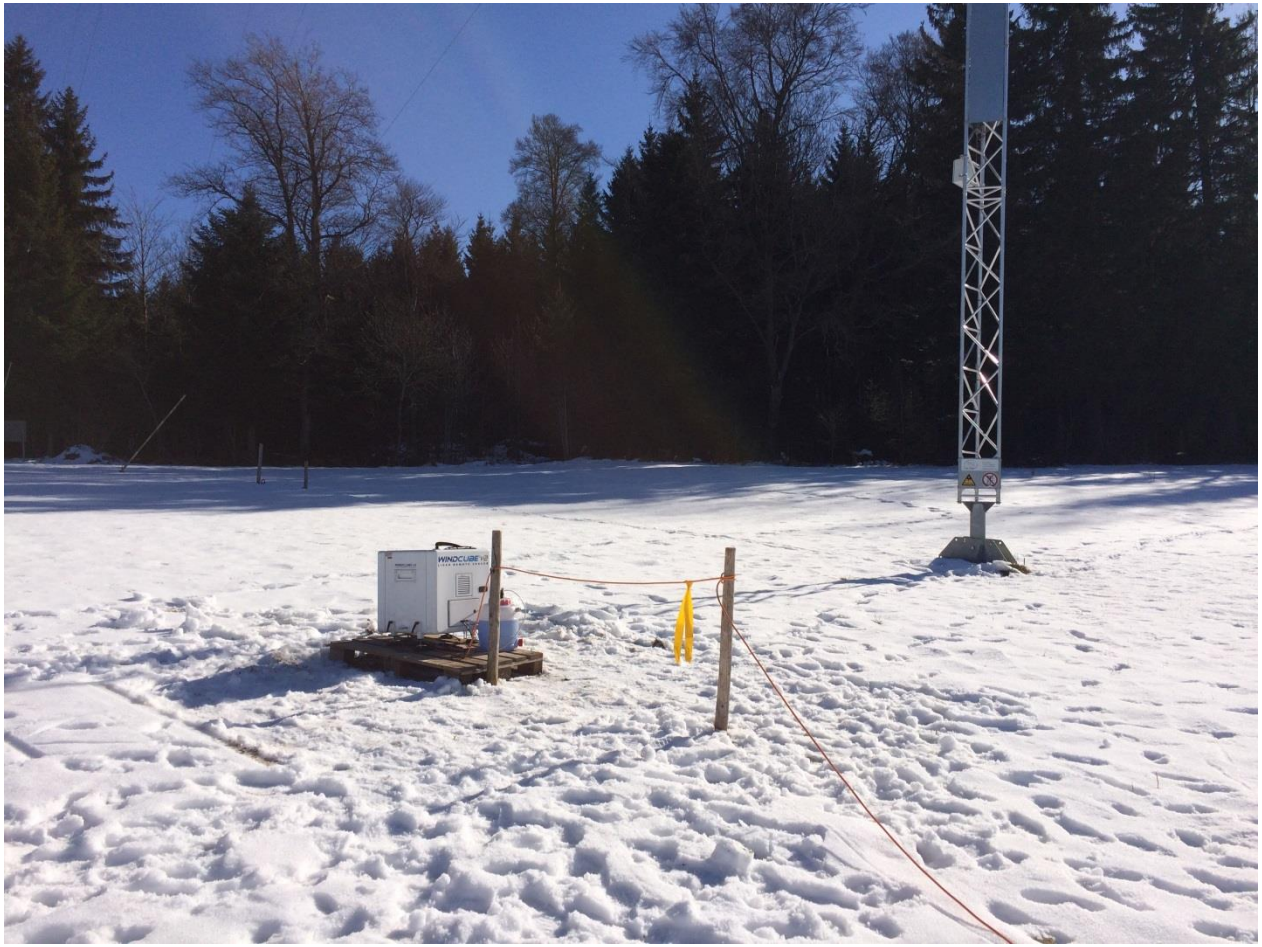
# Site b




Moderately complex terrain

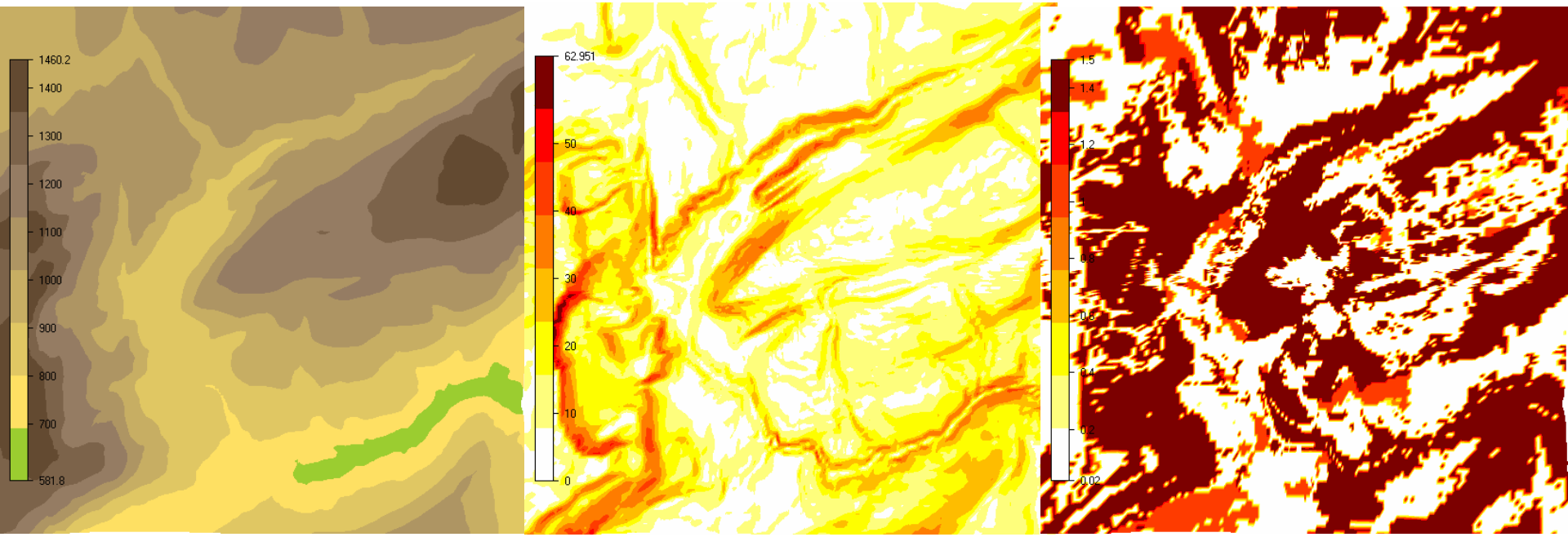
- Elevation: 452m to 870m
- Steepest slopes: 42deg
- Patchy forests and grassland

# Site b



- 85m met mast
- 2.5 months Windcube V2 measurement campaign, without FCR
- Data availability at 87m: 99%

# Site c




Highly complex terrain

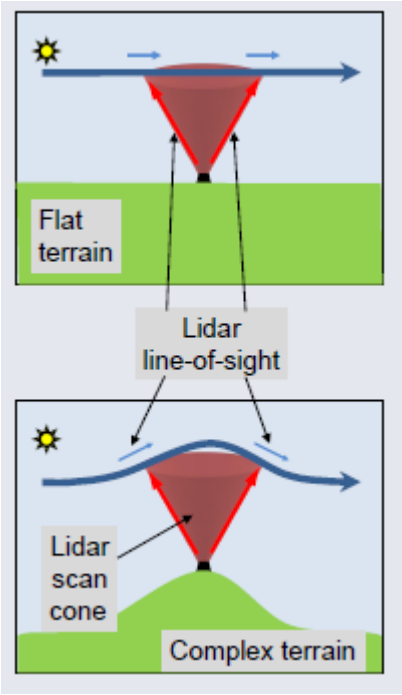
- Elevation: 582m to 1460m
- Steepest slopes: 63deg
- Patchy forests and grassland

# Site c

- 100m met mast
- 4 months Windcube V2 measurement campaign, without FCR
- Data availability at 100m: 99%

# Why correction with CFD?

LIDAR assumes homogeneous flow
→ Upstream and downstream vectors are horizontal (inflow angle = 0deg)




Homogeneous flow (constant wind velocity vectors)

Inhomogeneous flow (inconstant wind velocity vectors)

# CFD-correction

CFD-models:

- WindSim
- Meteodyn

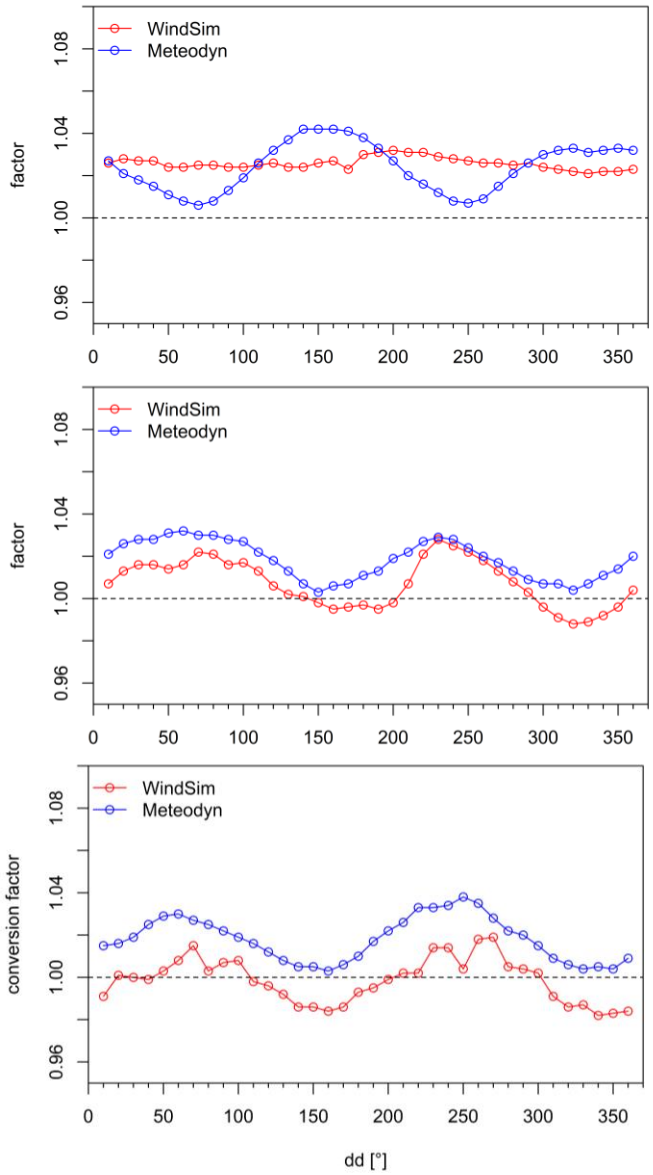
Set-up:

- Domain centered at LIDAR position
- Number of sectors: 36
- Domain:
  - Meteodyn: 5000m (square), 25m horizontal resolution (SRTM – 90m, CORINE land cover – 100m)
  - WindSim: 4000m (square), 15m horizontal resolution (Swiss DEM and roughness dataset)
- Atmospheric stability: neutral conditions

Output:

- Correction factor per sector and measurement height of the LIDAR

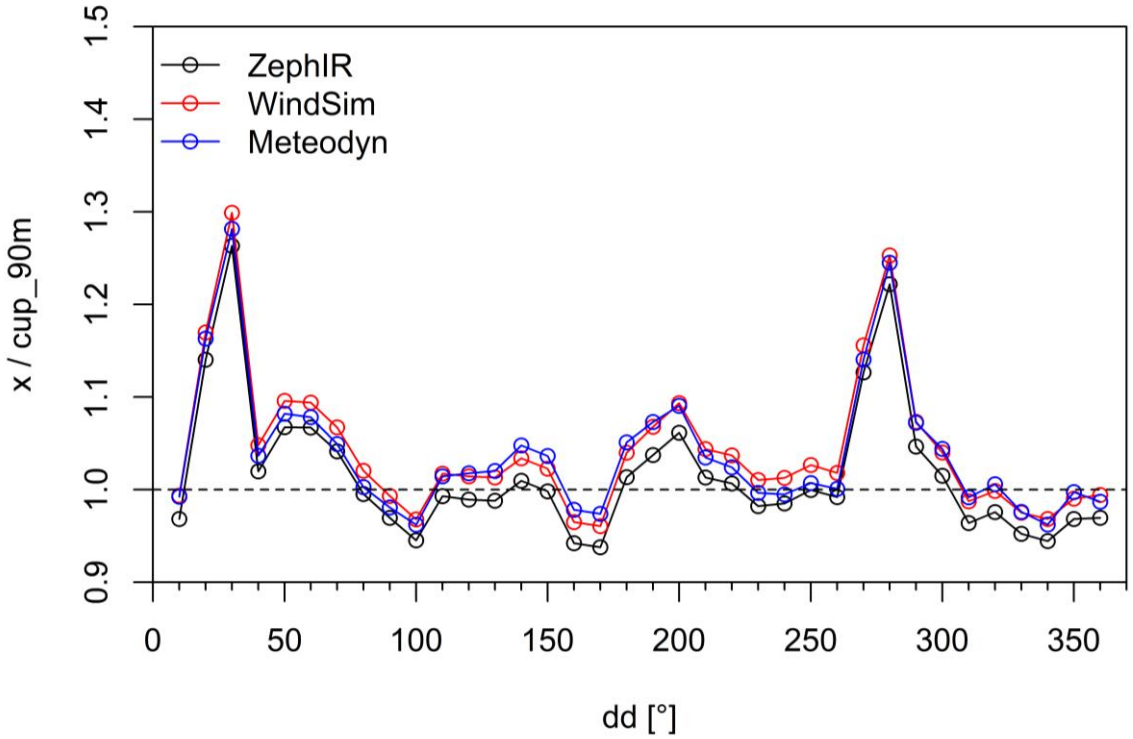
# Correction factors

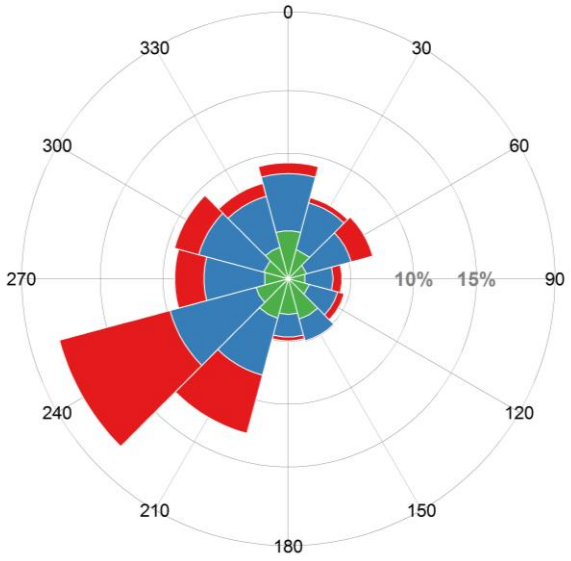



- Site a
- Site b
- Site c

# Results – site a

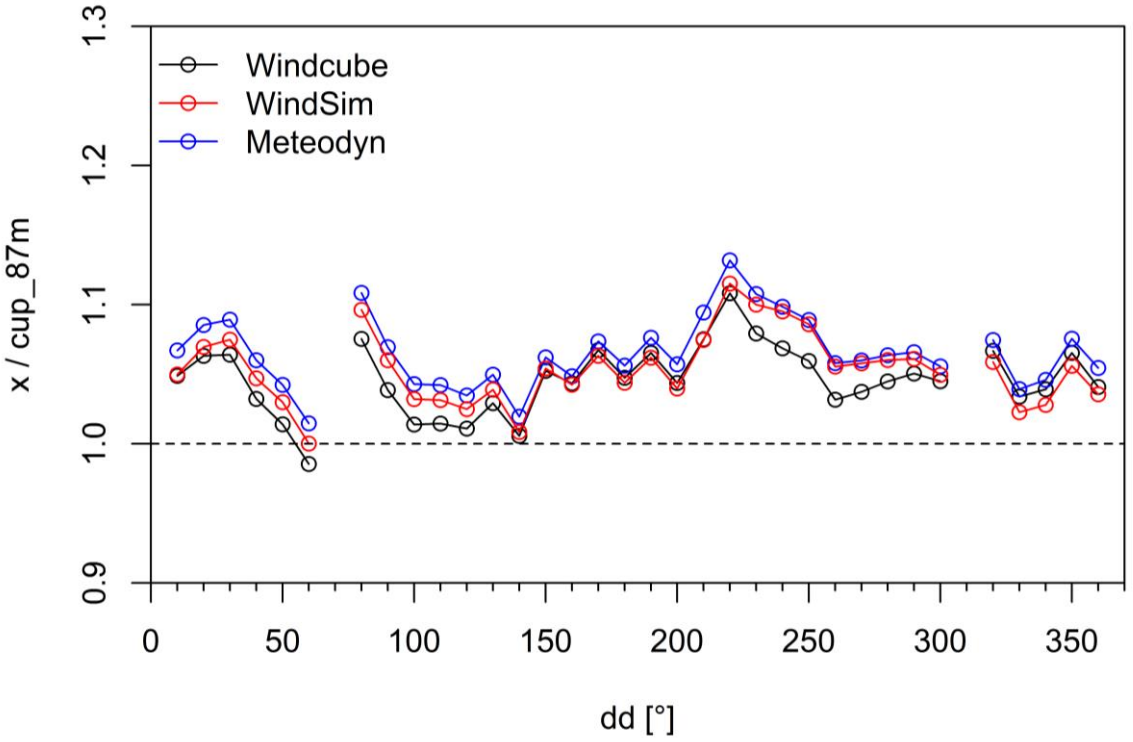
| | Correlation | Gap to cup |
|---|---|---|
| ZephIR | R2 = 0.958 | + 1.6% |
| WindSim | R2 = 0.957 | + 4.3% |
| Meteodyn | R2 = 0.958 | + 3.4% |

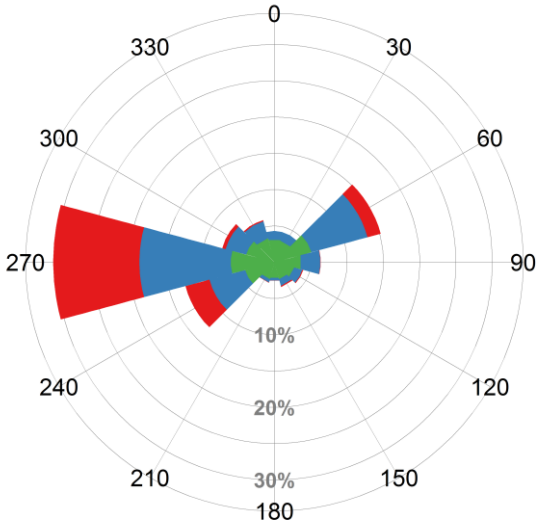


# Results – site b

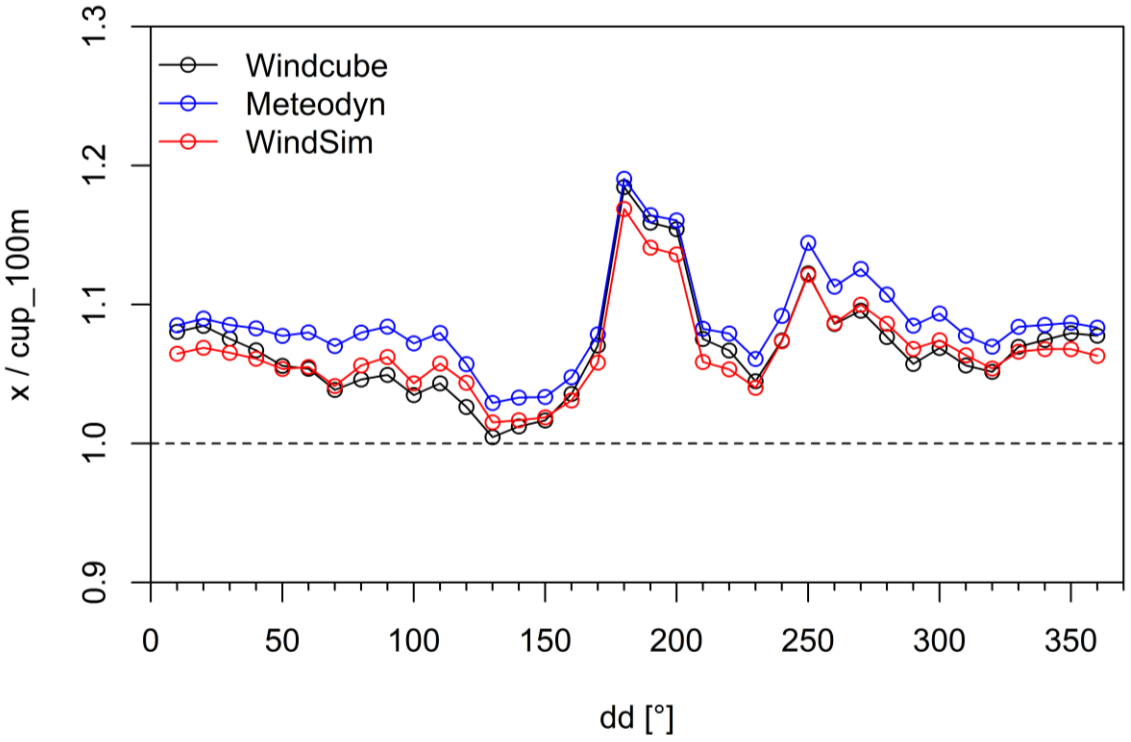
| | Correlation | Gap to cup |
|---|---|---|
| Windcube V2 | R2 = 0.997 | + 3.8% |
| WindSim | R2 = 0.997 | + 5.2% |
| Meteodyn | R2 = 0.997 | + 6.0% |

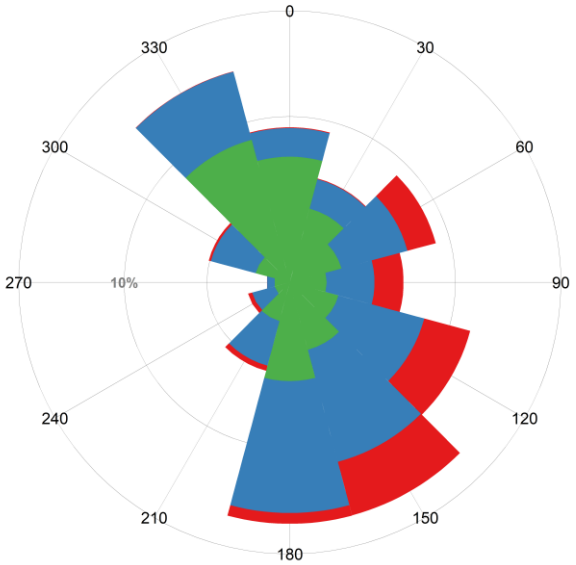


# Results – site c

| | Correlation | Gap to cup |
|---|---|---|
| Windcube V2 | R2 = 0.991 | + 6.6% |
| WindSim | R2 = 0.992 | + 6.3% |
| Meteodyn | R2 = 0.991 | + 8.2% |



# Conclusion

| Gain | Site a | Site b | Site c |
|---|---|---|---|
| WindSim | - 2.7% | - 1.4% | + 0.3% |
| Meteodyn | - 1.8% | - 2.2% | - 1.6% |

Very good correlation of ff Windcube V2 and ff cup

Overestimation of the wind speed by the LIDARs

CFD-correction doesn't compensate (enough)

Topics to consider

- Include other atmospheric stabilities than neutral conditions
- Cups as a reference sufficient?
- Model input with a higher resolution

# Acknowledgment

Meteotest would like to thank WindSim and Meteodyn for the participation in this validation study!

# Thank you for your attention

Meteotest

www.meteotest.ch