Delft University of Technology

Clouds Blowing in the Wind: Momentum Transport in Cloudy Boundary Layers Observed From Collocated Wind Lidar and Cloud Radars and Simulated With Dales

Dias Neto, José; Nuijens, Louise; Unal, Christine; Knoop, Steven

DOI
10.13140/RG.2.2.33138.58564

Publication date
2022

Document Version
Final published version

Citation (APA)
Dias Neto, J., Nuijens, L., Unal, C., & Knoop, S. (2022). *Clouds Blowing in the Wind: Momentum Transport in Cloudy Boundary Layers Observed From Collocated Wind Lidar and Cloud Radars and Simulated With Dales*. Poster session presented at 11th European Conference on Radar in Meteorology and Hydrology, Locarno, Switzerland. https://doi.org/10.13140/RG.2.2.33138.58564

Important note
To cite this publication, please use the final published version (if applicable).
Please check the document version above.

Copyright
Other than for strictly personal use, it is not permitted to download, forward or distribute the text or part of it, without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license such as Creative Commons.

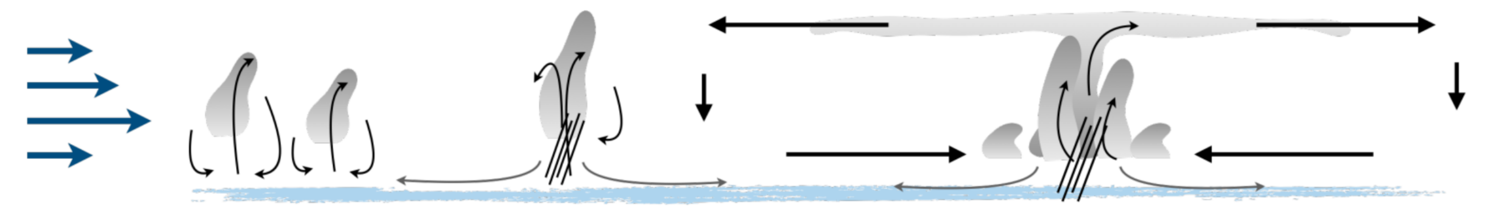
Takedown policy
Please contact us and provide details if you believe this document breaches copyrights.
We will remove access to the work immediately and investigate your claim.

This work is downloaded from Delft University of Technology.
For technical reasons the number of authors shown on this cover page is limited to a maximum of 10.

Clouds blowing in the wind: momentum transport in cloudy boundary layers observed from collocated wind lidar and cloud radars and simulated with DALES.

José **Dias Neto**[1], Louise Nuijens[1], Christine Unal[1], Steven Knoop[2]
[1]Delft University of Technology, Department of Geoscience & Remote Sensing
[2]Royal Netherlands Meteorological Institute

1. Motivation & Objectives



Convective momentum transport (CMT) has mainly been studied with models. In contrast, there are only a few experimental studies focused on CMT and how it relates to different cloud types.

Produce a high quality controlled dataset for visualising winds below and throughout cloud fields;

Derive momentum flux profiles extending through the boundary layer across different temporal/spatial scales;

Categorize wind and momentum flux profiles by large-scale wind and cloud regimes to understand the variability and impact of CMT;

Evaluate momentum fluxes in weather models and Large Eddy Simulations run in "weather mode"

2. Experimental Campaign

WindCube Lidar

CLARA: Ka-W-Band Radar

MARA: W-Band Radar

CMTRACE took place in Cabauw (Netherlands), between **13.09 - 03.10.2021**, in parallel to the Ruisdael Land-Atmosphere Interactions Intensive Trace-gas and Aerosol measurement campaign (RITA).

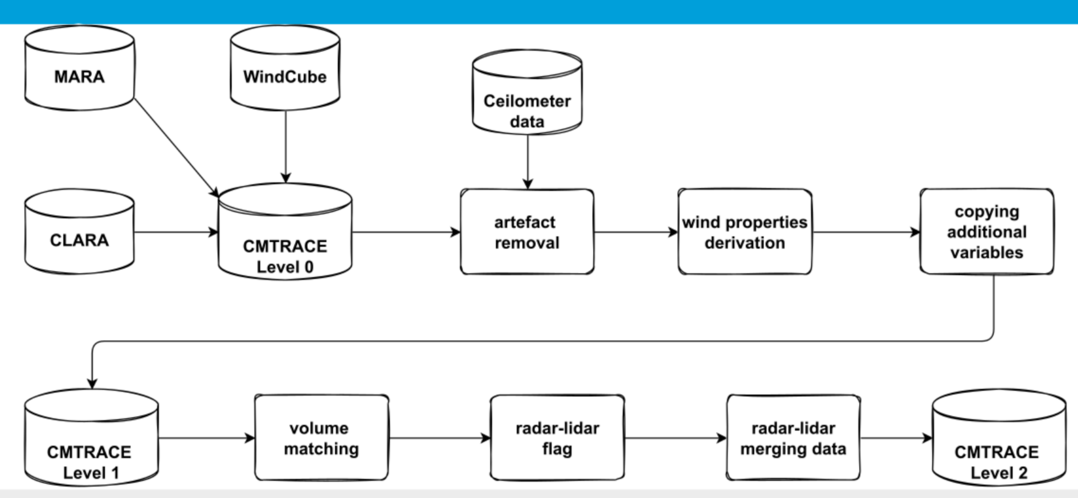
KNMI mast

Why those instruments?
Wind lidar allows retrieving wind profiles in the sub cloud layer.
Radar allows retrieving wind profiles in the cloud layer

WindCube Lidar: Operated using the 6 beam strategy (Sathe et al. 2015)
Azimuths: 0°, 72°, 144°, 216°, 288°
Elevations: 90°, 75°
Range resolution: 50 m
Scan period: 27 s

Dual Ka-W-Band Radar: Operated performing continuous PPI scans
Azimuths(a): Azm 0 - 360°
Azimuths:(b): Azm 360 - 0°
Elevation: 75°
Range resolution: 22 - 40 m
Scan period: 72 s

3. Data Processing

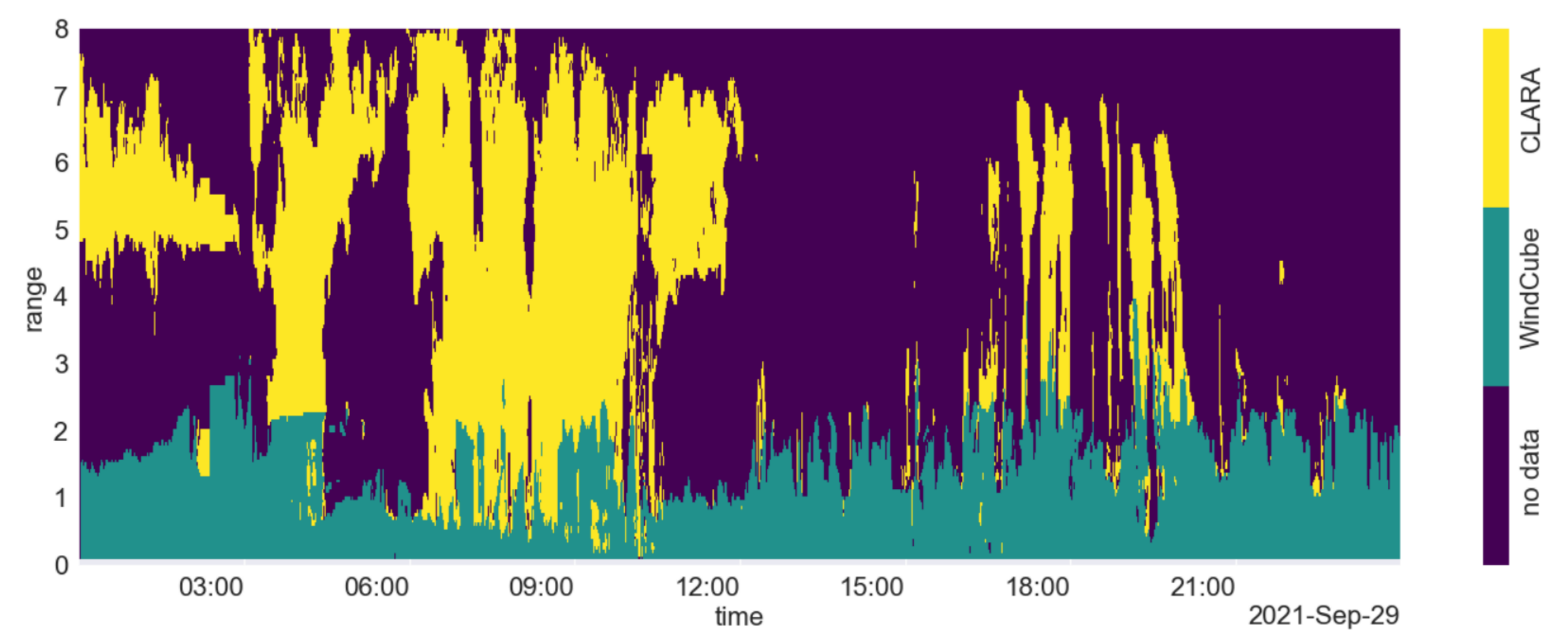


Data is organized in **3 Levels**:

Level 0: Original data output from each instrument without any information about wind speed or direction

Level 1: Removal of spurious signals from the lidar observations, offset correction of the radar azimuths, final data contains wind speed and direction in the original time and height resolution

Level 2: Regrinding of Radar vertical coordinate to the Lidar vertical coordinate, Temporal volume correction of the Lidar observation to match the Radar volume, final data is a merge of Radar and Lidar wind observations



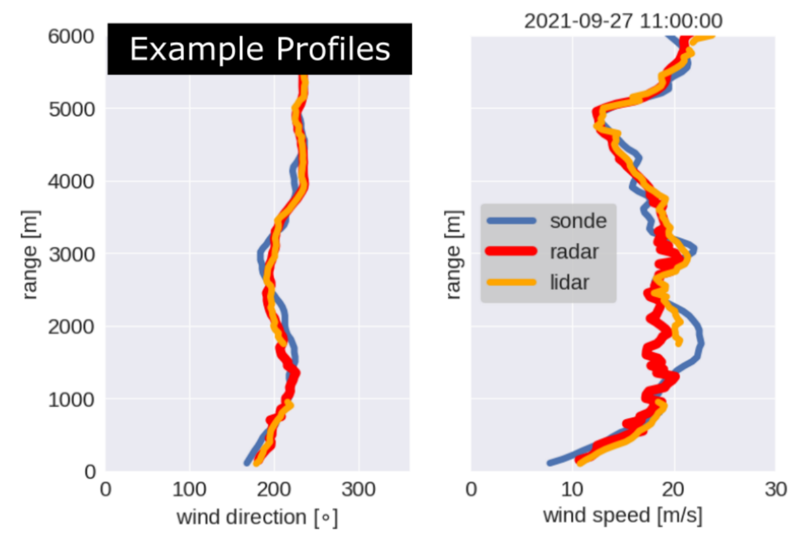
4. Data Evaluation

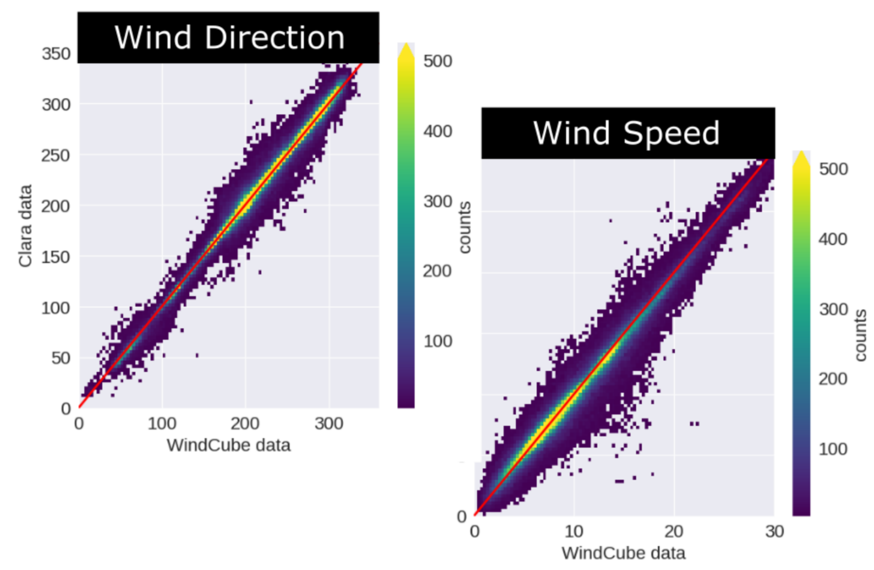
WindCube and CLARA X Radiosondes:

34 radiosondes lunched by the KNMI at De Bilt

The lanching site is 23 km apart from the remote sensing site

	WindCube		Clara	
metrics	wind direction	wind speed	wind direction	wind speed
bias	0.37	0.52	-0.24	-0.34
RMSE	12.62	1.98	14.03	2.35
correlation	0.98	0.92	0.96	0.94





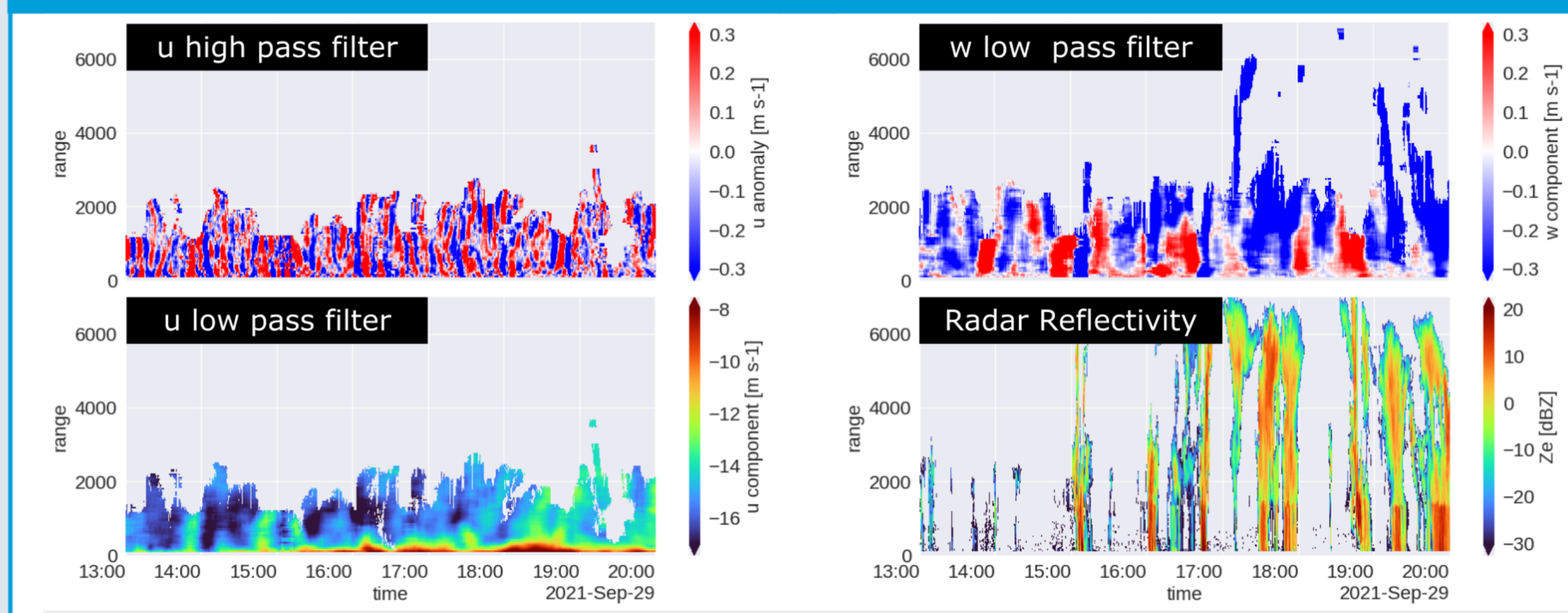
WindCube X CLARA

Statistics from the entire campaign suggest good correlations between WindCube and CLARA

The broadening of velocity histogram could be related to remaining artefacts (WindCube problem) and cloud edges (CLARA problem)

CLARA x WindCube		
metrics	wind direction	wind speed
bias	0.26	-0.21
RMSE	11.88	1.32
correlation	0.98	0.97

6. Can we see the circulations?



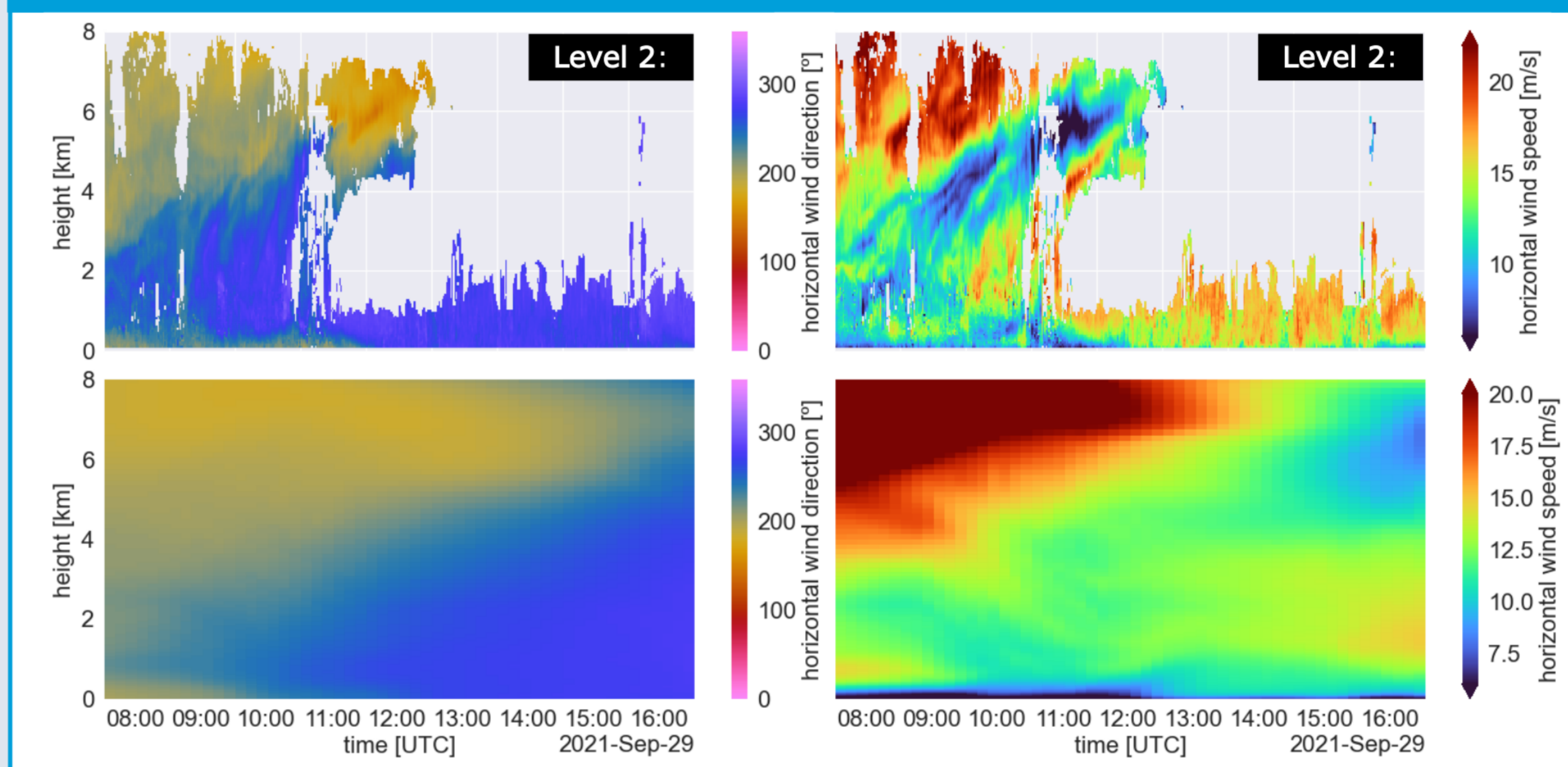
The zonal wind anomaly (**u'**) indicates that the observations captured circulation patterns from scales < 10 km.

The observations also captured circulations patterns from > 10 km (**u - u'**), indicated by slowdown and speeding up shown in **u - u'**.

The large scale circulations are also visible in the vertical component (**w - w'**). The upward motion correlates with slower **u**, whereas downward motion correlates with faster **u**.

The **Radar Reflectivity** reveals the occurrence of deep convective clouds accompanied by precipitation. It also suggests that the periods of slower **u** and upward motion correlates with regions in the vicinity of the clouds. On the other hand, periods of faster **u** and downward motion correlates with the deep convective clouds.

7. Outlook & Application



The observations and DALES' simulation show similarities in large-scale processes. For example, the change in direction and speed between 7 and 12 UTC.

The small-scale fluctuations captured by observations are not visible in DALES' simulation, likely due to the average over the domain (15 x 15 km).

Outlook:

Frequency analyses to identify the frequency range that contributes the most to the vertical transport of momentum.

Statistical analysis of the convective momentum fluxes profiles for different types of clouds

Validation of DALES momentum fluxes: the domain will span over the Netherlands with a grid spacing of 100 m.

Contact: J.DiasNeto@tudelft.nl