



Hybrid wind reconstruction algorithm

Unique, patent-pending method enables lowest measurement uncertainty



"Overall, better accuracy classes than evaluated for WindCube v2.1 in the height range above 100m can hardly be expected for any monostatic remote sensing devices implementing probe volume spatially separated by about 50m to 150m for detecting different radial wind speed components."

Axel Albers

Managing Director, Deutsche WindGuard Consulting GmbH

New breakthrough: Combining scalar and vector averaging

The hybrid wind reconstruction algorithm, or hybrid method, is a scientific breakthrough unique to Leosphere, a Vaisala company, that combines scalar and vector averaging to achieve the lowest measurement uncertainty.

While both scalar and vector averaging methods have proven high accuracy in meeting wind industry standards, they depend quadratically on the wind direction turbulence, but with opposite sign. After observing these phenomena in the field and deriving the physics behind them, Leosphere, a Vaisala company, developed the hybrid wind reconstruction algorithm — combining both methods to mathematically eliminate the turbulence sensitivity and provide a truly cup-equivalent 10-minute value.

This innovative hybrid method further increases the measurement quality and reduces its uncertainty level. Following an independent review conducted over 44 verification campaigns, DNV confirms that WindCube® v2.1 with hybrid wind reconstruction:

- Meets all verification criteria (just like previous WindCube versions using scalar and vector averaging)
- Improves the sensitivity to turbulences, which may lead to further reduction in the measurement uncertainty in a wind resource assessment or Power Performance Testing campaign.

IEC classification and unrivaled accuracy class

WindCube v2.1 with hybrid wind reconstruction was fully classified by Deutsche WindGuard® in December 2020 according to IEC 61400-12-1, Edition 2, 2017 (report PP20063.A0).

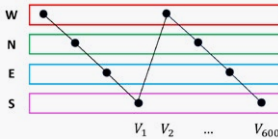
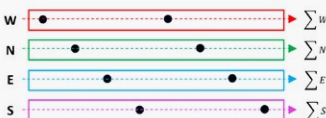
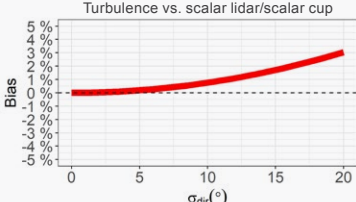
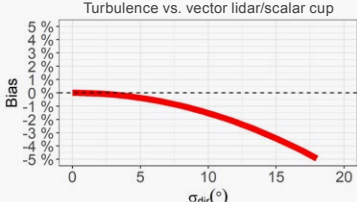
	Class number at 120m	Standard uncertainty at 120m
WindCube (scalar averaging)	4.4	2.5%
WindCube (vector averaging)	2.1	1.2%
Other lidar technology	2.6	1.5%
WindCube (hybrid averaging)	1.1	0.6%

Wind speed reconstruction: Scalar, vector, and hybrid averaging

According to IEC standards, the cup anemometer is still the industry standard for wind speed measurement. Remote sensing devices are always compared to cups to validate their performance.

However, wind is a three-dimensional vector, and cups measure only the horizontal component — they are not sensitive to the vertical component or the wind direction. In contrast, WindCube measures in 3D, along its oblique laser beams, and is sensitive to both the vertical component and the wind direction — so the horizontal wind speed must be mathematically reconstructed.

There were originally two methods to reconstruct the 10-minute scalar horizontal wind speed from 1Hz samples.

Scalar averaging	Vector averaging
<ol style="list-style-type: none">1. Measurement of radial wind speeds2. Reconstruction of horizontal wind speeds3. Average over 10 minutes	<ol style="list-style-type: none">1. Measurement of radial wind speeds2. Average over 10 minutes3. Reconstruction of horizontal wind speeds
	
<p>In an ideal case, with no fluctuations in wind speed or direction, these two methods yield the exact same wind speed. However, there is always some turbulence in the wind, and it has different effects on scalar and vector averages.</p>	
The scalar average overestimates the cup average because uncorrelated fluctuations of the vertical wind component enter the lidar 1Hz reconstruction algorithm.	The vector average underestimates the cup average because wind direction fluctuations perpendicular to the prevailing wind direction reduce the 10-minute average values.
	

Mixing both scalar and vector averages in a single wind reconstruction method reduces the sensitivity to turbulence.

For a more detailed look at this new breakthrough, view our [on-demand webinar](#).

Why Leosphere, a Vaisala company?

We are modern innovators, scientists, and discoverers who enable our customers to harness the power of wind energy in new ways. We are driven by passion, relentless curiosity, and the desire to create a better world, as evidenced in our commitment to four guiding principles:

1. Trustworthy, superior metrology
2. Unrivalled thought leadership
3. Innovative lidars from a one-stop shop
4. Easy, reliable global solution

As a result, Leosphere, a Vaisala company, is the iconic and trusted gold standard in wind lidar. Our turnkey WindCube product suite offers innovative, reliable, and highly accurate solutions for thousands of customers across the globe. All of this has enabled us to be catalysts for change and ambassadors for wind energy, always advancing the field and those we serve.



windcubelidar.com

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