Royal Netherlands
Meteorological Institute
*Ministry of Infrastructure
and Water Management*

Scanning Doppler wind lidar for Ruisdael Observatory

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Within the Ruisdael Observatory program Doppler wind lidars are planned to provide detailed measurements of the wind field, aerosols and clouds around the Cabauw site and obtain vertical profiles of the vertical wind speed and turbulence. Recently, the Windcube 200S scanning Doppler wind lidar has been purchased. This instrument has first been tested at KNMI, De Bilt, before installation and deployment at the Cabauw site. Here we introduce the Windcube 200S and show examples of the measurements done at KNMI.

Ruisdael Observatory

The Ruisdael Observatory is a national initiative, a nationwide observatory for measurements of the atmosphere. It is set up to enable more concrete, detailed forecasts of the weather and air quality. At the Cabauw site, a large set of instruments is operated to study the atmosphere and its interaction with the land surface. The scanning Doppler wind lidars will provide detailed measurements of the wind field, aerosols and clouds around the Cabauw site.

Doppler wind lidar

Doppler wind lidars are laser-based remote sensing instruments that measure the wind. The radial wind speed, which is the component of the wind vector along the laser beam (line of sight), is obtained by measuring the Doppler shift of the backscattered light (see Fig. 1). Commercial Doppler wind lidars use the laser wavelength of 1.5 μm and therefore backscatter is mainly from aerosols. The backscatter signal also provides information on aerosols and clouds.

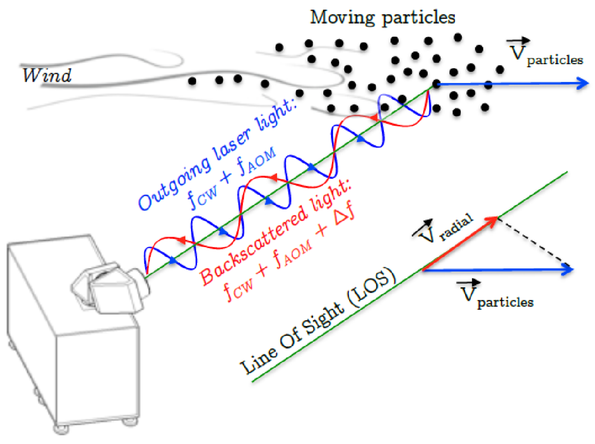

Figure 1: *Doppler wind lidar principle (from Vasiljević, PhD thesis (2014)).*

Windcube 200S scanning Doppler wind lidar

The Windcube 200S (Leosphere/Vaisala) is a long-range scanning Doppler wind lidar, with full hemisphere scanning capabilities (see Fig 2). The maximum range is 14 km, but in practice this depends strongly on the atmospheric conditions, and the user-configurable settings. The height range is limited to the boundary layer, as the presence of aerosols are required. Several scan patterns can be scheduled: PPI, RHI (see Fig. 3) and DBS (to obtain vertical wind profiles). The output data is the radial wind speed, CNR (Carrier to Noise Ratio) and relative attenuated backscatter coefficient (for DBS also horizontal and vertical wind speed, wind direction).

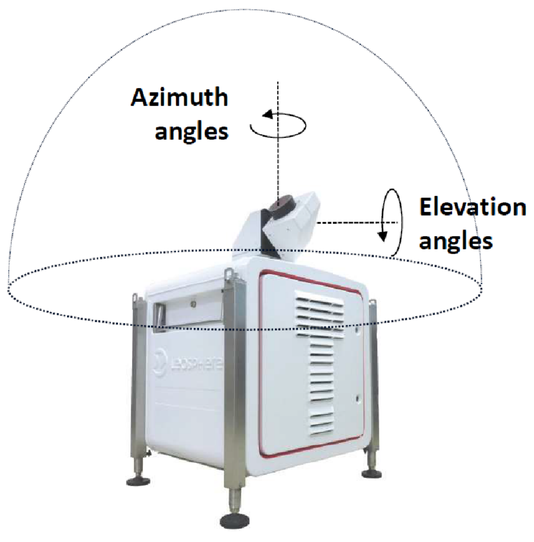

Figure 2: *The scanning capabilities of the Windcube 200S. Pointing accuracy is 0.1°, rotation speed typically 0.5°/s to 6°/s (from Leosphere).*

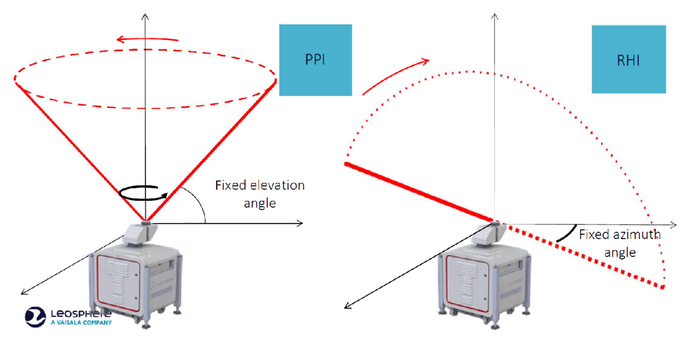

Figure 3: *Schematics of the PPI (Plane Position Indicator) azimuthal scan and RHI (Range Height Indicator) elevation scan (from Leosphere).*

Test at KNMI, De Bilt

The Windcube 200S was installed on March 3rd, 2021, at the test field of the KNMI, De Bilt (see Fig. 4), as part of a two-day training by Leosphere. For four weeks the instrument has been measuring 24/7, while different scans modes and user-configurable settings are being tested. Examples of the measurements are given in Figs. 5-8, with details of scans provided in the figure captions.

Figure 4: *Windcube 200S at KNMI, De Bilt.*

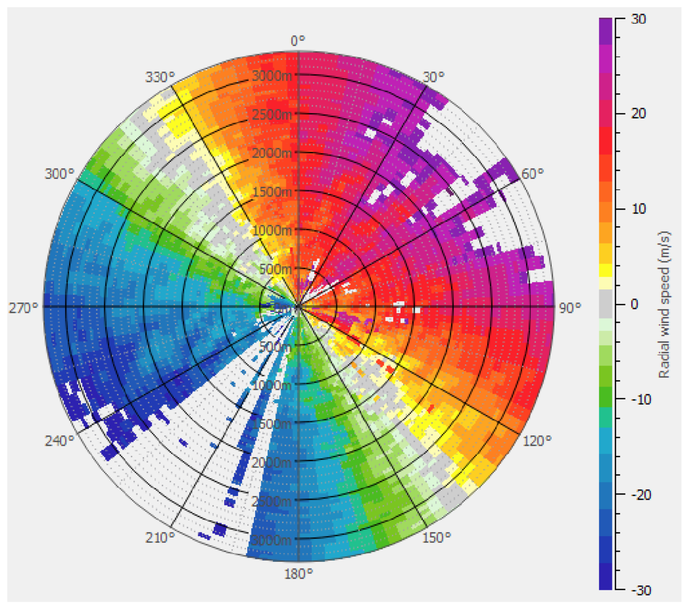

Figure 5: *PPI scan: elevation angle 15°, range resolution 25 m, accumulation time 1 s, and angular resolution of 3° (i. e. rotation speed is 3°/s and the duration of a single scan 120 s). Radial wind speeds of a single scan are shown; scan starts at 2021-03-11 07:47:11.*

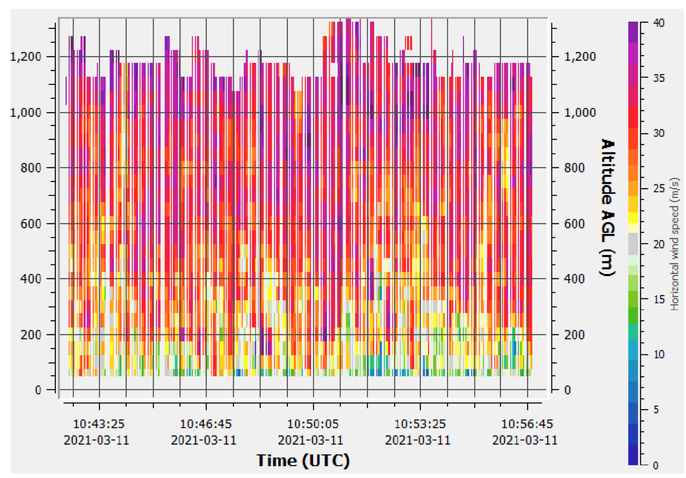

Figure 6: *DBS scan: elevation angle 75°, range resolution 25 m, accumulation time 1 s. Horizontal wind speeds are shown. A single DBS scan takes 11 seconds.*

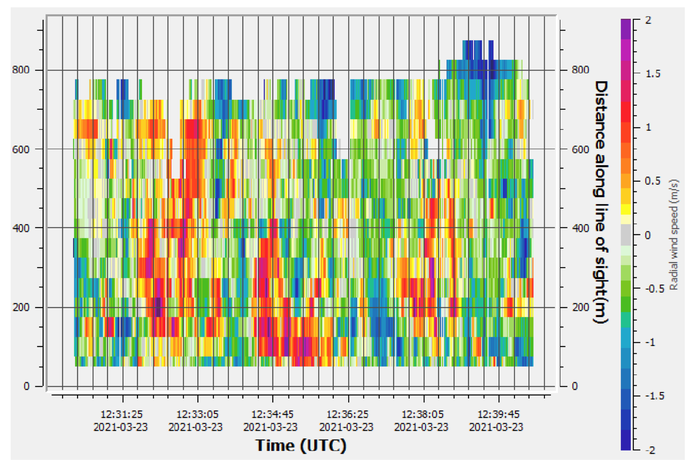

Figure 7: *Vertical staring (i. e. elevation angle 90°): range resolution 25 m, accumulation time 1 s. Radial wind speeds are shown, which here are equal to the vertical wind speeds.*

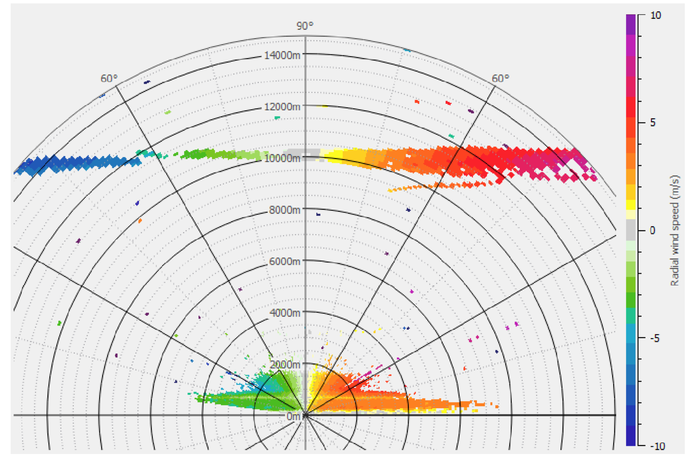

Figure 8: *RHI scan: azimuthal angle 88°, range resolution 100 m, accumulation time 1 s, and angular resolution of 1° (i. e. rotation speed is 1°/s and the duration of a single scan 180 s). Radial wind speeds of a single scan are shown; scan starts at 2021-03-30 09:19:24. Data at 10km altitude comes from clouds.*

What's next?

The instrument has been installed at the Cabauw site at April 6th, 2021, and will participate in the Ruisdael test campaign of May 2021 (CMTRACE/SLOCS). Afterward, an operational program, consisting of various scan modes, will be implemented and data will be made available.

Ruisdael observatory

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