A study of the atmospheric boundary layer in the Weddell Sea using a wind lidar

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Grants:
DFG HE 2740/19
Polarstern AWI_PS96_03

Verification data for atmospheric models
- radiosondes and observations from Polarstern
- boundary layer measurements using a wind lidar


Scanning Doppler wind lidar
High-resolution boundary layer measurements:
Profiles, stares and RHI scans (range up to 10km) of wind, turbulence, aerosols

“Halo-Photonics Streamline” scanning wind lidar
- wavelength 1.5 μm
- pulse rate of 15 kHz
- eye-safe (class 1m)
- resolution 0.038 m/s
- accuracy 0.1 m/s (depending on SNR)
- band width 19.4 m/s
- 18m gates (6x3), overl.
Scanning patterns

Dual stare, triple stare

\[ V_R = \text{radial (line of sight LOS) wind) } \]

Moving ship dual stare

Equivalent to a two-lidar system observing the same volume within a few minutes

Scanning patterns: Dual stare

Horizontal wind

Wind speed \( V \), direction \( \beta \)

\[ V_{R1}(r) = -V(r) \cos(\beta(r) - \alpha_1) \]
\[ V_{R2}(r) = -V(r) \cos(\beta(r) - \alpha_2) \]

Scanning patterns: RHI

Dual RHI

\[ V_{HR}(r,z) = -V(r,z) \cos(\beta(r,z) - \alpha_1) \]
\[ V_R(r,\theta) = -V_{HR}(r,z) \cos(\theta) \]
Scanning patterns: VAD

8 beams with constant zenith angle $\theta$ (15°)

Wind data processing

LR = radial (line of sight LOS) wind

V$_R$ = radial (line of sight LOS) wind

LIDAR INS/GPS (10Hz -400Hz)
Roll, pitch

Ship roll and pitch angles (1Hz)

Ship time server (1Hz)

Roll/pitch-corrected LIDAR beams $V_R$

Wind vector relative to the ship's heading

Correction for ship heading and velocity

radial wind 28 Dec. 1500 UTC

Turbulence Ronne polynya
radial wind 13 Jan. 2016, 0800 UTC

Fast ice edge Lee of the ship

dual stare 280, 255, 30 repeats
60 seconds 60 seconds
2s averages

0, 35 deg
Iceberg A23A

- **Station 1**
- **Station 2**
- **Station 3**

**Iceberg A23A Start**

- **LLJ**
- **VAD**

**Wind Speed (m/s)**

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**Wind Direction (°)**

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Between 23 December 2015 and 30 January 2016: Vertical wind profiles (VAD) scans every 10-15 min, at lot of RHI scans and stares 2-3 radiosondes per day. 

First time of wind lidar measurements on a ship in the Antarctic.

Atmospheric model: COSMO-CLM

- CCLM-15km simulations for 2002-2015 (ERA-I)
- CCLM-5km 2002-2016

Sea ice / ocean model FESOM (down to 3km)

Ebner et al. (2014)