Observing wind, aerosol particles, clouds and precipitation: Finland's new ground-based remote-sensing network

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Observing wind, aerosol particles, cloud and precipitation: Finland's new ground-based remote-sensing network

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This supplement contains additional complementing material for the manuscript. Shown are technical details of Doppler and Raman lidars, and cloud radar (Tables S1-S3). Effect of telescope focus on Doppler lidar data acquisition is presented in Figure S1. Wind speed measured with Doppler lidar and sonic anemometer is compared in the Figure S2.

Table S1. Technical details of the Doppler lidars by HALO Photonics (Pearson et al., J. Atmos. Ocean. Tech., 26, 240-250, 2009).

Input voltage	230V AC
Power supply output	24V DC (includes UPS)
Data and other connections	2xRJ45, 2xUSB
Power consumption	Nominal 140W (max 250W, when fully cooling or heating)
Pulses per ray	15000, adjustable
Pulse repetition frequency	15kHz
Fast Fourier Transform length	1024 (3.8 cm s^{-1} velocity resolution), adjustable
Maximum Doppler velocity measurement	±19.2 m s^{-1}
Velocity resolution	0.038 m s^{-1}
Points per range gate (1 point = 3m)	10 (vertical resolution 30m, adjustable: minimum 18m)
Sample frequency	50MHz
Line of site maximum range	9600m
Line of site minimum range	90m
Focus setting	Infinity, electronically adjustable (500m-infinity)
Heating set point	15°C
Cooling set point	25°C
Ambient operation specification	-15°C to +40°C

Table S2. Technical details of emitter and receiver of Polly^{XT} Raman lidar.

Emitter	**Laser type**	**Nd:YAG**
	Emitted energy per pulse (mJ)	180 (1064 nm); 110 (532 nm); 60 (355 nm)
	Repetition frequency (Hz)	20
	Beam divergence (mrad)	< 0.2 (after beam expansion)
	Pulse duration (ns)	6-8 (1064 nm); 6-8 (532 nm); 5-7 (355 nm)
	Polarization orientation	Parallel (532 nm); vertical (355 nm)
Receiver	Telescope type	Newton, primary parabolic, flat folding mirror
	Telescope aperture diameter (m)	0.3
	Telescope obscuration diameter (mm)	66
	Focal length (m)	0.9
	Field of view (mrad)	1 (changeable)
	Fieldstop type	Circular aperture
	Fieldstop size (mm)	0.9 (changeable)
	Telescope-laser axes distance (m)	~ 0.2
	Collimation focal length (mm)	60

Table S3. Technical details of Doppler cloud radar Mira 35S (Metek GmbH).

Transmitter frequency corresponding wavelength	35.2 GHz 8.5 mm
Transmitter pulse power	30 kW
Pulse length τ corresponding range resolution	100 – 400 ns (standard setting τ_0 =200 ns) 15 – 60 m
Pulse Repetition frequency (PRF) corresponding velocity range corresponding maximum range	2.5 – 10 kHz (standard PRF_0=5 kHz) +/- 5.3 – +/- 21.3 m/s 58 – 13 km
Maximum duty cycle	1:500
Maximum number of range gates	2 * 1000 (co- and cross-channel)
Minimum range:	150 m, full sensitivity above 300 m
Antenna diameter corresponding beam divergence:	1 m 0.56° (one way, 3 dB diameter)
Number of pulse cycles accounted for Doppler processing NFFT: corresponding velocity resolution:	128, 256, 512, or 1024 (standard $NFFT_0$=512) 4.1 cm/s $\frac{\mathrm{PRF}/\mathrm{PRF}_0}{\mathrm{NFFT}/\mathrm{NFFT}_0}$
Minimal detectable radar reflectivity factor at range R, reference range $R_0 = 5$ km, averaging time T_{AV}, $T_{AV0} = 10$ s, and assuming a Doppler peak width of 8 cm/s:	For averaged data -52 dBZ $\frac{R^2/R_0^2}{\tau^2/\tau_0^2 \sqrt{T_{\mathrm{AV}}/T_{AV0}}}$ Single shot $= -23.4$ dBZ $\frac{R^2/R_0^2}{\tau^2/\tau_0^2}$
Polarization	Transmit: linear, E-Field vertically Receive: co and cross signal simultaneous
Scanner range	Elevation: -1° – +181° Azimuth: 0° – 360° (continuous rotations)
Maximum scanning speed	15°/s

Figure S1. Backscatter profiles from Doppler lidar measured in Kuopio on 10th May 2012. The example shows the change in ABL data acquisition when telescope focus length was altered from infinite to 2 km at 10:00.

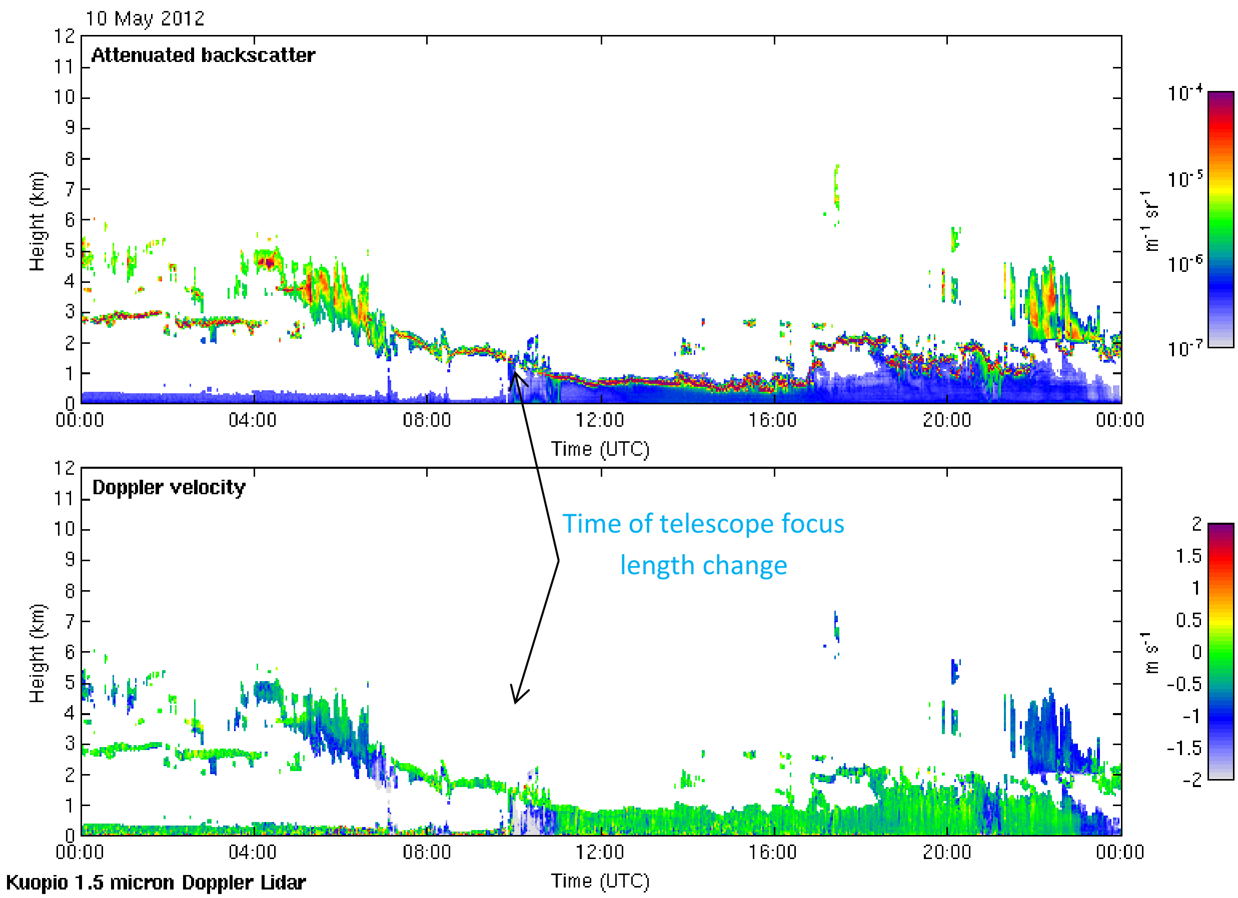

Figure S2. Comparison of wind speed measured with HALO Photonics Doppler lidar and AWS-sensor at 220-m height in Kuopio during 20th September 2011-20th September 2012. Blue curve is linear fit and green curve is one-to-one line. Statistical analysis of 17494 points resulted in following values: k = 1.08, r = 0.84, $rmse$ = 1.89 m s^{-1}.