Title: CLAMPS2 Doppler Lidar Vertical Stare Data

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1.0 Dataset Overview

These files contain 24 hour periods of data collected from the CLAMPS2 Halo Streamline XR+ Doppler lidar. While not conducting other scans, the lidar directs the beam to zenith, allowing for the measurement of vertical velocity. These data were collected during the AWAKEN project.

1.1 Date range: 3 October 2022 – 27 December 2022

1.2 Location: Atmospheric Radiation Measurement (ARM) site E36, 36.11716° N, 97.51086° W, 337.11 m elevation

1.3 Estimated data availability

2.0 Instrument Description

The Halo Streamline XR+ is a commercial platform. The Doppler lidar (DL) is an active remote-sensing instrument that provides range- and time-resolved measurements of radial velocity, attenuated backscatter, and signal-to-noise ratio (SNR). The principle of operation is similar to radar in that pulses of electromagnetic energy (infrared in this case) are transmitted into the atmosphere; the energy scattered back to the transceiver is collected and measured as a time-resolved signal. From the time delay between each outgoing transmitted pulse and the backscattered signal, the distance to the scatterer is inferred. The radial or line-of-sight velocity of the scatterers is determined from the Doppler frequency shift of the backscattered radiation. The DL uses a heterodyne detection technique in which the return signal is mixed with a reference laser beam (i.e., local oscillator) of known frequency. An onboard signal-processing computer then determines the Doppler frequency shift from the power spectra of the heterodyne signal. The energy content of the Doppler spectra can also be used to estimate attenuated backscatter. The DL operates in the near-infrared (IR;1.5 microns) and is sensitive to backscatter from micron-sized aerosols. Aerosols are ubiquitous in the lower troposphere and behave as ideal tracers of atmospheric winds. In contrast to radar, the DL is capable of measuring radial

velocities under clear-sky conditions with very good precision – typically ~10 cm/sec (Newsom and Krishnamurthy 2020). It is important to note that DL scans are fully user configurable, so special attention should be paid to the scan strategy applied for this dataset.

Instrument specifications:

Max range	12 km (aerosol load dependent)
Min. range	50-90m
Nyquist Limit	~39 m/s
Range gate	Configurable, 18-60m
Precision	Velocity: <0.2 m/s

3.0 Data collection and processing:

The Doppler lidar provides range-resolved, line-of-sight measurements of radial velocity, intensity (signal-to-noise ratio [SNR]+1), and attenuated backscatter. This measurement of vertical velocity is much more direct than that provided with the VAD scan files. For the AWAKEN campaign, the CLAMPS2 Doppler lidar collected vertical stares at a 1-second time resolution (same as CLAMPS1 vertical stares time resolution during AWAKEN).

The provided files provide the intensity field (SNR+1), which can be used as a 'filter' for noise. A good rule of thumb cutoff is 1.01.

4.0 Data format:

Data are provided in netcdf format. The typical naming convention is clampsdlfpC2.c1.YYYYMMDD.HHmmss.cdf, following closely to ARM file naming convention. The files have time and height dimensions.

Variables provided:

Name	Dimension	Unit
base_time	Single value	Seconds (since 00 UTC 1 Jan 1970)
time_offset	Time	Second (since base_time)
hour	Time	Hours since 00UTC this day
height	Height	km AGL
azimuth	Time	Deg, azimuth angle of the scanner
elevation	Time	Deg, elevation angle of the scanner
velocity	Time, Height	m/s, **NOTE that this is the *w* field, so positive is up, negative is down despite the netcdf comment**

intensity	Time, Height	Unitless, SNR+1
backscatter	Time, Height	$km^{-1}\,sr^{-1}$, attenuated backscatter
cbh	Time	km AGL, cloud base height
internal_temp, internal_rh, tec_flag, and tec_voltage are all 'housekeeping' variables noting the instrument temperature and rh and the thermoelectric cooler status		
lat	Time	Deg N, latitude
lon	Single value	Deg W, longitude
alt	Single value	m MSL, altitude above mean sea level

5.0 Data Remarks

Data should be consistently available, but note that periods of precipitation, fog, or other very low cloud may limit the level to which good data are collected. Note also that vertical velocity in light precipitation will be contaminated by the fall speed of the precipitation itself. Though the files in THREDDS depict data availability up until 12/27/22, the CLAMPS2 vertical stares data stops producing useful observations 12/14/22, about a week earlier than the CLAMPS1 vertical stares during AWAKEN.

6.0 References

Newsom, R. K., R. Krishnamurthy, 2020: Doppler lidar (DL) handbook. DOE Office of Science Atmospheric Radiation Measurement (ARM) Program (United States). DOE/SC/ARM/TR-101.