NCAR | EARTH OBSERVING LABORATORY

SWEX

NCAR/EOL ISS Wind Lidar Products Data Report

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In situ Sensing Facility

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Web References

SWEX Homepage: https://www.eol.ucar.edu/field_projects/swex
SWEX Field Catalog: https://catalog.eol.ucar.edu/swex
ISS Operations during SWEX: https://www.eol.ucar.edu/content/iss-operations-swex
ISS Homepage: https://www.eol.ucar.edu/observing_facilities/iss
Real-time Lidar Plots: https://catalog.eol.ucar.edu/swex/lidar
Interactive VAD winds plots:
http://datavis.eol.ucar.edu/time-height-plot/SWEX/iss1-lidar/30-minute-consensus
ISS Daily Summary Plots:
https://archive.eol.ucar.edu/docs/isf/projects/swex/iss/realtime/summary/iss1/index.html
LROSE (Lidar Radar Open Software Environment): http://lrose.net/

Dataset Version Control

Version	Date	Author	Change Description	Data Status
1.0	31 Mar 2023	M. Paulus	Initial Release	Final

Citations

If these data are used for research resulting in publications or presentations, please acknowledge EOL and NSF by including the following citations, as appropriate:

The ISS Platform

UCAR/NCAR - Earth Observing Laboratory. (1997). NCAR Integrated Sounding System (ISS). UCAR/NCAR - Earth Observing Laboratory. https://doi.org/10.5065/D6348HF9.

ISS Wind Lidar Data Products

NCAR/EOL ISS Team. 2023. SWEX: ISS Wind Lidar Data Products. Version 1.0. UCAR/NCAR - Earth Observing Laboratory. https://doi.org/10.26023/Q28P-EEBS-0Y0E.

Acknowledgement

Users of EOL data are expected to add the following acknowledgement to all of their publications, reports and conference papers that use those data:

"We would like to acknowledge operational, technical and scientific support provided by NCAR's Earth Observing Laboratory, sponsored by the National Science Foundation."

In the event that information from this document is used for publication or presentation purposes, please provide the above acknowledgement to NSF and NCAR/EOL and make reference to

- *Paulus, M. and W.O.J. Brown, (2023): SWEX 2022 NCAR/EOL ISS Wind Lidar Products Data Report.*

Overview

NCAR/EOL operated three Integrated Sounding Systems (ISS), along with a suite of other instruments, in the Santa Ynez Mountains in Santa Barbara County, California as part of the Sundowner Wind Experiment (SWEX). As part of the integrated suite of sensors, ISS operated one Leosphere (a Vaisala company), Windcube 200S scanning lidar at the Santa Barbara Fire Headquarters (SBHQ) site. Please note that pre-project lidar data are available upon request, but should be used with caution due to uncertainty in instrument level.

Time period:	01 Apr - 15 May 2022
Location:	Santa Barbara, California, USA

Site Description

The lidar was on top of a seatainer (approximately 4 m AGL) at the SBHQ site. Also at the site were a surface meteorology station, 449 MHz modular wind profiler, and ceilometer. Regular radiosondes were launched nearby by the University of California, Santa Barbara (UCSB).

Latitude: 34.45275°N
Longitude: 119.7713°W
Elevation: 4 m AGL

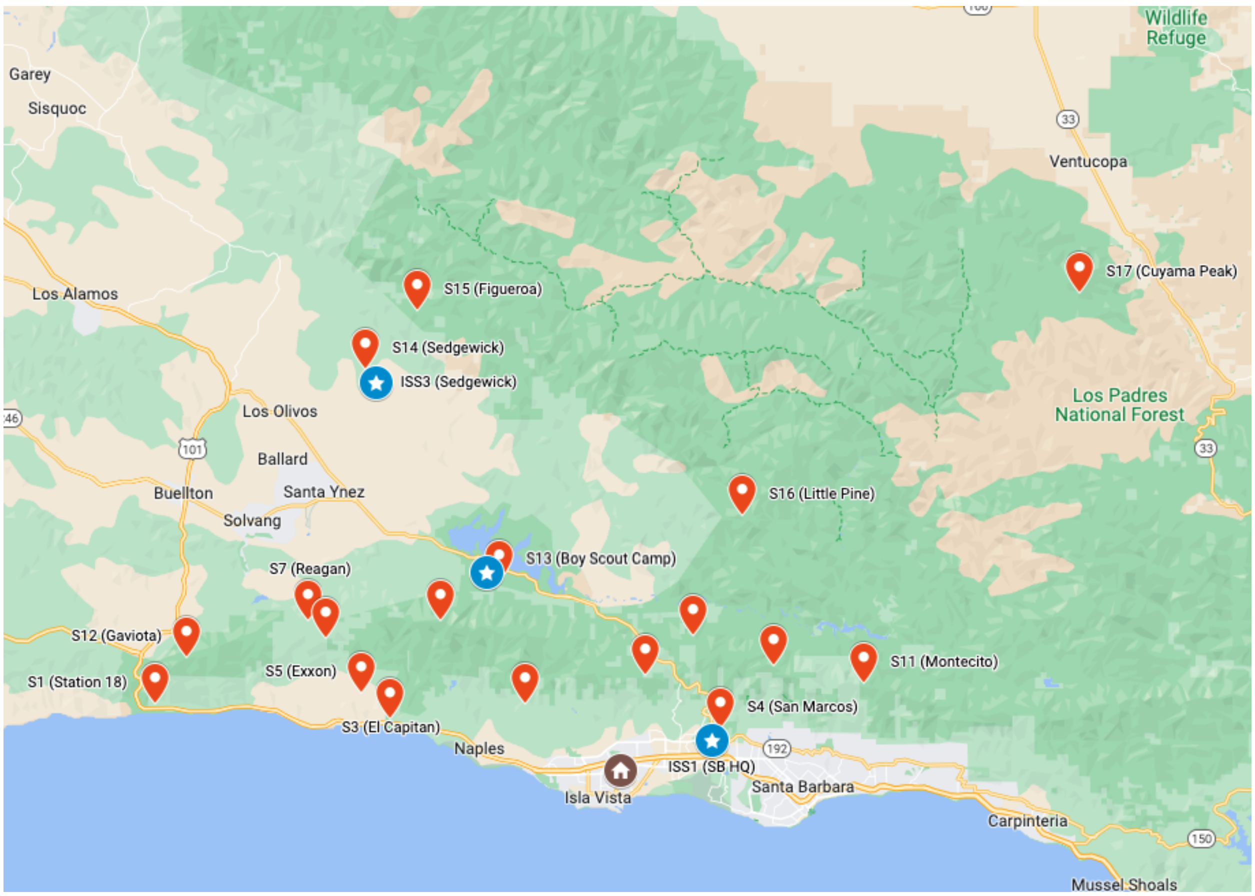

Figure 1*. The ISS Windcube lidar was located at the Santa Barbara Fire Headquarters (SBHQ) site, depicted by the blue circle with white star icon labeled ISS1 (SB HQ) in this Google Map rendering. Also shown are the ISS2 Boy Scout Camp site, the ISS3 Sedgewick site, and the Integrated Surface Flux System (ISFS) instrumented tower sites (red balloons).*

Figure 2. *ISS instrumentation set up at the SBHQ site during SWEX. The Windcube lidar (sitting atop the trailer at left), the 449 MHz Modular Wind Profiler (in the center fenced area), and instrumented surface meteorology tower to the right can all be seen.*

Instrument Description

Leosphere/Vaisala Windcube 200S Scanning Lidar

The Leosphere/Vaisala Windcube 200S scanning lidar is a commercial instrument designed to measure wind and aerosol backscatter at distances up to 10 km across a variety of scanning geometries. The scanning strategies and measurement parameters are customizable to perform a wide range of research applications.

Instrument Fact Sheet:
https://www.vaisala.com/sites/default/files/documents/WEA-MET-WindCube-Scan-Lidar-Product-Spotlight-B212058EN-A.pdf

Data Set Description

Leosphere/Vaisala Windcube 200S Scanning Lidar CF-Radial

Dataset Name: NCAR/EOL ISS Windcube Lidar CF-Radial Products
Data format: NetCDF4, each scan strategy assigned numeric Scan ID (SID)

(1) Vertical Stare (VER)
cfrad.YYYYMMDD_hhmmss_WLS200s-181_SID_VER_50m.nc
(2) Plan-position indicator (PPI)
cfrad.YYYYMMDD_hhmmss_WLS200s-181_SID_PPI_50m.nc
(3) Range Height Indicator (RHI)
cfrad.YYYYMMDD_hhmmss_WLS200s-181_SID_RHI_50m.nc
(4) Doppler-Beam-Swinging (DBS)

cfrad.YYYYMMDD_hhmmss_WLS200s-181_SID_DBS_100m.nc

Data file frequency: single file per sweep/stare
Data version: v1.0
Data status: final
Data access: public
Resolution: variable depending on scan strategy, see Table 2

Refer to the global metadata attributes example below:

```
// global attributes:
		:Conventions = "CF-1.7" ;
		:Sub_conventions = "CF-Radial instrument_parameters lidar_parameters" ;
		:version = "CF-Radial 2.0 , CF-1.7" ;
		:title = "Leosphere Windcube data" ;
		:institution = "Leosphere" ;
		:references = "" ;
		:source = "Lidar measurements" ;
		:history = "Windcube Lidar server 3.3.3" ;
		:comment = "" ;
		:original_format = "CFRADIAL2" ;
		:driver = "RadxConvert(NCAR)" ;
		:created = "2022/05/05 22:28:25.634" ;
		:start_datetime = "2022-05-01T21:47:41Z" ;
		:time_coverage_start = "2022-05-01T21:47:41Z" ;
		:start_time = "2022-05-01 21:47:41.800" ;
		:end_datetime = "2022-05-01T21:49:11Z" ;
		:time_coverage_end = "2022-05-01T21:49:11Z" ;
		:end_time = "2022-05-01 21:49:11.300" ;
		:instrument_name = "WLS200s-181" ;
		:site_name = "" ;
		:scan_name = "ppi" ;
		:scan_id = 42 ;
		:platform_is_mobile = "false" ;
		:n_gates_vary = "false" ;
		:ray_times_increase = "true" ;
```

Leosphere/Vaisala Windcube 200S Scanning Lidar VAD Winds

Dataset Name: NCAR/EOL ISS Windcube Lidar VAD Winds
Data format: NetCDF4; VAD_SID_YYYYMMDD.nc
Data file frequency: 1 daily file per PPI scan strategy used for VAD generation
Data version: v1.0
Data status: final
Data access: public
Resolution: variable depending on scan strategy, see Table 2
Variables:

```
	int base_time ;
		base_time:string = "2022-04-15 00:01:15 UTC" ;
```

```
		base_time:long_name = "Base time in Epoch" ;
		base_time:units = "seconds since 1970-01-01 00:00:00 UTC" ;
		base_time:ancillary_variables = "time_offset" ;
	double time_offset(time) ;
		time_offset:long_name = "Time offset from base_time" ;
		time_offset:units = "seconds since 2022-04-15 00:01:15 UTC" ;
		time_offset:ancillary_variables = "base_time" ;
	double time(time) ;
		time:long_name = "Time offset from midnight" ;
		time:units = "seconds since 2022-04-15 00:00:00 UTC" ;
		time:bounds = "time_bounds" ;
	double time_bounds(time, bound) ;
	float height(height) ;
		height:long_name = "Height above ground level" ;
		height:units = "m" ;
		height:standard_name = "height" ;
	float lat ;
		lat:missing_value = -9999.f ;
		lat:long_name = "North latitude" ;
		lat:units = "degree_N" ;
		lat:valid_min = -90.f ;
		lat:valid_max = 90.f ;
		lat:standard_name = "latitude" ;
	float lon ;
		lon:missing_value = -9999.f ;
		lon:long_name = "East longitude" ;
		lon:units = "degree_E" ;
		lon:valid_min = -180.f ;
		lon:valid_max = 180.f ;
		lon:standard_name = "longitude" ;
	float alt ;
		alt:missing_value = -9999.f ;
		alt:long_name = "Altitude above mean sea level" ;
		alt:units = "m" ;
		alt:standard_name = "altitude" ;
	float u(time, height) ;
		u:missing_value = -9999.f ;
		u:long_name = "Eastward component of wind vector" ;
		u:units = "m/s" ;
	float v(time, height) ;
		v:missing_value = -9999.f ;
		v:long_name = "Northward component of wind vector" ;
		v:units = "m/s" ;
	float w(time, height) ;
		w:missing_value = -9999.f ;
		w:long_name = "Vertical component of wind vector" ;
		w:units = "m/s" ;
	float wind_speed(time, height) ;
		wind_speed:missing_value = -9999.f ;
		wind_speed:long_name = "Wind speed" ;
		wind_speed:units = "m/s" ;
	float wind_direction(time, height) ;
```

```
                wind_direction:missing_value = -9999.f ;
                wind_direction:long_name = "Wind direction" ;
                wind_direction:units = "degree" ;
        float residual(time, height) ;
                residual:missing_value = -9999.f ;
                residual:long_name = "Fit residual" ;
                residual:units = "m/s" ;
        float correlation(time, height) ;
                correlation:missing_value = -9999.f ;
                correlation:long_name = "Fit correlation coefficient" ;
                correlation:units = "unitless" ;
        float mean_snr(time, height) ;
                mean_snr:missing_value = -9999.f ;
                mean_snr:long_name = "Signal to noise ratio averaged over nbeams (derived from CNR)" ;
                mean_snr:units = "unitless" ;
        float u_error(time, height) ;
                u_error:missing_value = -9999.f ;
                u_error:long_name = "Sampling uncertainty in eastward component of wind due to azimuths used
assuming 1 m/s error in radial velocities" ;
                u_error:units = "m/s" ;
        float v_error(time, height) ;
                v_error:missing_value = -9999.f ;
                v_error:long_name = "Sampling uncertainty in northward component of wind due to azimuths used
assuming 1 m/s error in radial velocities" ;
                v_error:units = "m/s" ;
        float w_error(time, height) ;
                w_error:missing_value = -9999.f ;
                w_error:long_name = "Sampling uncertainty in vertical component of wind due to azimuths used
assuming 1 m/s error in radial velocities" ;
                w_error:units = "m/s" ;
        float scan_duration(time) ;
                scan_duration:missing_value = -9999.f ;
                scan_duration:long_name = "PPI scan duration" ;
                scan_duration:units = "second" ;
        float elevation_angle(time) ;
                elevation_angle:missing_value = -9999.f ;
                elevation_angle:long_name = "Beam elevation angle" ;
                elevation_angle:units = "degree" ;
        int nbeams(time) ;
                nbeams:long_name = "Number of beams (azimuth angles) in each PPI" ;
                nbeams:units = "unitless" ;
        int nbeams_used(time, height) ;
                nbeams_used:missing_value = -9999 ;
                nbeams_used:long_name = "Number of beams (azimuth angles) used in wind vector estimations" ;
                nbeams_used:units = "unitless" ;
```

Leosphere/Vaisala Windcube 200S Scanning Lidar VAD 30-minute Consensus Winds

Data set Name:	NCAR/EOL ISS Windcube Lidar VAD 30-minute Consensus Winds
Data format:	NetCDF4; 30min_winds_SID_YYYYMMDD.nc
Data file frequency:	daily

Data version: v1.0
Data status: final
Data access: public
Resolution: half-hourly
Variables:

```
int base_time ;
        base_time:string = "2022-04-04 00:00:00 UTC" ;
        base_time:long_name = "Base time in Epoch" ;
        base_time:units = "seconds since 1970-01-01 00:00:00 UTC" ;
        base_time:ancillary_variables = "time_offset" ;
double time_offset(time) ;
        time_offset:long_name = "Time offset from base_time" ;
        time_offset:units = "seconds since 2022-04-04 00:00:00 UTC" ;
        time_offset:ancillary_variables = "base_time" ;
double time(time) ;
        time:long_name = "Time offset from midnight" ;
        time:units = "seconds since 2022-04-04 00:00:00 UTC" ;
        time:bounds = "time_bounds" ;
double time_bounds(time, bound) ;
float height(height) ;
        height:long_name = "Height above ground level" ;
        height:units = "m" ;
        height:standard_name = "height" ;
float lat ;
        lat:missing_value = -9999.f ;
        lat:long_name = "North latitude" ;
        lat:units = "degree_N" ;
        lat:valid_min = -90.f ;
        lat:valid_max = 90.f ;
        lat:standard_name = "latitude" ;
float lon ;
        lon:missing_value = -9999.f ;
        lon:long_name = "East longitude" ;
        lon:units = "degree_E" ;
        lon:valid_min = -180.f ;
        lon:valid_max = 180.f ;
        lon:standard_name = "longitude" ;
float alt ;
        alt:missing_value = -9999.f ;
        alt:long_name = "Altitude above mean sea level" ;
        alt:units = "m" ;
        alt:standard_name = "altitude" ;
float u(time, height) ;
        u:missing_value = -9999.f ;
        u:long_name = "Eastward component of wind vector" ;
        u:units = "m/s" ;
float v(time, height) ;
        v:missing_value = -9999.f ;
        v:long_name = "Northward component of wind vector" ;
        v:units = "m/s" ;
float w(time, height) ;
```

```
                w:missing_value = -9999.f ;
                w:long_name = "Vertical component of wind vector" ;
                w:units = "m/s" ;
        float wind_speed(time, height) ;
                wind_speed:missing_value = -9999.f ;
                wind_speed:long_name = "Wind speed" ;
                wind_speed:units = "m/s" ;
        float wind_direction(time, height) ;
                wind_direction:missing_value = -9999.f ;
                wind_direction:long_name = "Wind direction" ;
                wind_direction:units = "degree" ;
        float residual(time, height) ;
                residual:missing_value = -9999.f ;
                residual:long_name = "Fit residual" ;
                residual:units = "m/s" ;
        float correlation(time, height) ;
                correlation:missing_value = -9999.f ;
                correlation:long_name = "Fit correlation coefficient" ;
                correlation:units = "unitless" ;
        float mean_snr(time, height) ;
                mean_snr:missing_value = -9999.f ;
                mean_snr:long_name = "Signal to noise ratio averaged over nbeams (derived from CNR)" ;
                mean_snr:units = "unitless" ;
        float u_npoints(time, height) ;
                u_npoints:missing_value = -9999.f ;
                u_npoints:long_name = "Number of points used in consensus averaging window for eastward
component of winds" ;
                u_npoints:units = "unitless" ;
        float v_npoints(time, height) ;
                v_npoints:missing_value = -9999.f ;
                v_npoints:long_name = "Number of points used in consensus averaging window for northward
component of winds" ;
                v_npoints:units = "unitless" ;
        float w_npoints(time, height) ;
                w_npoints:missing_value = -9999.f ;
                w_npoints:long_name = "Number of points used in consensus averaging window for vertical component
of winds" ;
                w_npoints:units = "unitless" ;
```

Data Collection and Processing

Raw CF-Radial Product

Lidar control and data processing was performed by proprietary Leosphere/Vaisala Windcube software (see versions in Table 1 below). The raw data produced by the lidar software was stored directly to a disk drive at the lidar location and transmitted to servers at EOL for archival and added back-up. The raw data were then converted into the CfRadial (CF-1.7) compliant, netCDF4 format included in this data release. This format conversion was performed in near real-time by RadxConvert, which is part of a Lidar Radar Open Software Environment (LROSE) data processing package jointly developed by Colorado State University and NCAR/EOL. LROSE also includes visualization tools to analyze and plot CfRradial data, and documentation on using those tools are on the LROSE website http://lrose.net/. The LROSE HawkEye display tool was used to produce data visualizations, which can be browsed on the CFACT Field Catalog (link provided in Web References section above). In most cases, no data quality control was performed to these data, with the exception being to correct azimuth and elevation angles of all Range Height Indicator (RHI) scans that went beyond 90 degrees elevation (i.e. beyond vertical). The corrected files are indicated by "_v2" appended to the filenames. As one step in these corrections, we also applied a SNR threshold of -27.5 dB in order to filter out questionable data.

On 6 April the ISS team confirmed directional accuracy of the wind lidar by pointing at a distant hard target, using a prominent cell phone tower not far across the valley to serve as a target. These measurements imply the uncertainty is within 1 - 2 degrees in orientation and about 3 meters in range.

Lidar Hardware	Windcube 200S	S/N: WLS200s-181
Lidar Software	Package	20.e
	WindForge	3.3.3
	API	1.2.0
	Tools	1.1.0
	OS	3.2.0
VAD/Consensus Processing	Software	1.1

Table 1. *Windcube lidar model, serial number, and software versions.*

Lidar Scan Strategy Settings

During the project a variety of scan strategies were used to make measurements. These included Plan Position Indicator (PPI) scans at various elevations, sectors, and resolutions; Range Height Indicator (RHI) scans at various azimuths, vertical stares (VER), Doppler-Beam-Swinging (DBS), and horizontal stares at manually prescribed azimuth and elevation angles (MAN, not included in dataset but available on request). A summary of pertinent lidar parameters for each scan strategy is included in Table 2 below. Some of these scan strategies were used sparingly, while others were implemented over longer periods of time.

SCAN ID	Type	Elevation Angle (deg)	Sweep Azimuth (deg)	N Rays	Angular Resolution (deg)	Gate Spacing (m)	Gate Start Range (m)	Scan Duration (s)	Dates	VAD usage
1	DBS	75, 90	0, 90, 180, 270	5	na	100	414	15	3-4 Apr	
14	PPI	35	0-360	144	2.5	50	100	72	29 Mar - 3 Apr	Yes
18	PPI	75	0-360	60	6	50	100	118	29 Mar - 3 Apr	Yes
28	PPI	35	0-360	144	2.5	100	200	72	3-4 Apr	Yes
42	PPI	35	0-360	180	2	50	100	90	4 Apr -13 May	Yes
64	PPI	75	2-144	72	2	50	100	36	13 Apr - 11 May	Yes
66	PPI	35	0-360	60	6	50	100	119	13 - 16 May	Yes
40	RHI	3-178	100/280	176	1	50	100	88	4 - 10 Apr	
41	RHI	3-178	10/190	176	1	50	100	88	4 - 10 Apr	
62	RHI	3-180	95/275	178	1	50	100	89	10 Apr - 13 May	
63	RHI	3-180	18/198	178	1	50	100	89	10 Apr - 13 May	
67	RHI	4-180	18/198	89	2	50	100	177	13 - 16 May	
68	RHI	4-180	95/275	89	2	50	100	177	13 - 16 May	
39	VER	90	na	300	na	50	100	300	4 Apr -13 May	
70	VER	90	na	210	na	50	100	419	13 - 16 May	

Table 2. *Windcube lidar settings according to the scan ID.*

Data Example

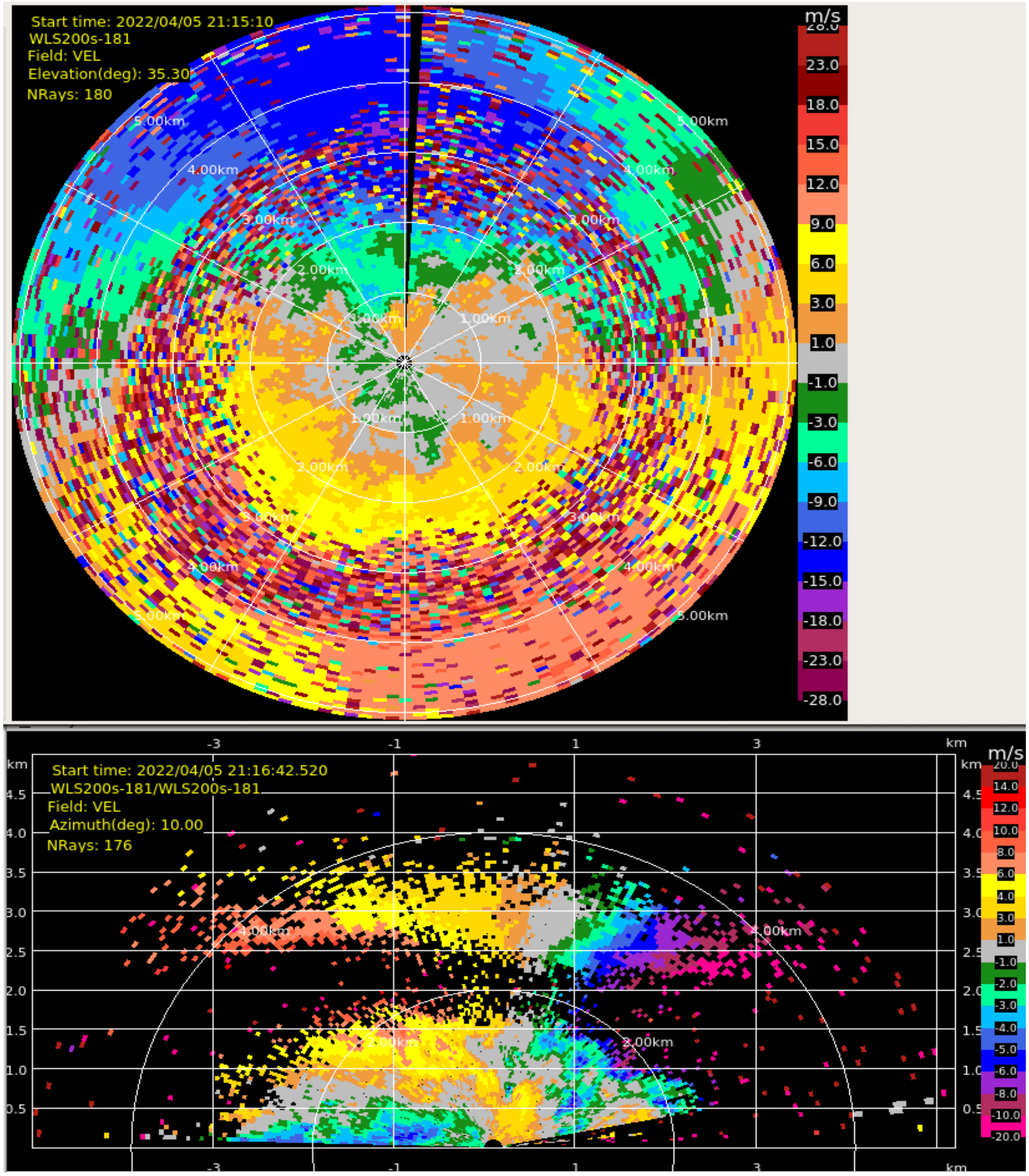

Figure 3. *Plots of radial velocity for PPI (top) and RHI (bottom) scans made during IOP 1 (April 5 at around 2115 UTC). North is upwards in the PPI plot. The RHI is a scan along the 10 degree azimuth angle on the right of the plot, through to 190 degree azimuth on the left of the RHI plot. The lidar is at the center of the PPI plot and at the bottom center for the RHI plot. Measurements out to about 5 km range are shown. Cool colors (blue/green) indicate motion towards the lidar, and warm colors (red/orange) indicate motion away from the lidar. Speckly and black areas indicate low signal regions where there were few aerosols and poor measurements. The scan ID numbers for these scans are 42 for the PPI and 41 for the RHI scan (see* *Table 2**).*

Figure 3 shows examples of measurements made during IOP 1. Doppler radial velocity along the lidar beam for a PPI scan (cone scan at 35 degrees elevation) is shown on the upper plot and for a RHI scan (horizon to horizon vertical slice) on the lower plot. The cool colors on the upper part and warm colors on the lower part of the PPI scan indicate winds were predominantly from the north, although the mix of colors indicate there were complicated flow patterns close to the lidar in the center of the plot. The RHI plot shows a vertical slice through the atmosphere running approximately south towards the coast (on the left) to the north towards the mountains (on the right). The layered structure indicates northerly winds above around 1 km and return flow from the south below about 500 meters, although there is also suggestion of rolls along the slope to the left.

VAD Winds Product

In addition to the CfRadial data, a Velocity-Azimuth Display (VAD) wind profile product was generated and is available as part of this dataset. These data are available in daily files, calculated using select PPI scans (14, 18, 28, 42, 64, 66), as indicated in the filenames. These netCDF files follow the convention produced by the U.S. Department of Energy Atmospheric Radiation Measurement (ARM) user facilities (Newsom et al. 2015).

To create the VAD product, profiles of wind speed and direction are calculated from radial velocities, using an algorithm adapted from ARM (Newsom et al. 2015). In the algorithm, CF-Radial files corresponding to a selected scan ID are read and radial velocities are filtered by a threshold value for signal-to-noise ratio (SNR), such that no radial velocities are used for SNR values below this threshold. Please note that the SNR values referenced herein are actually carrier-to-noise, as used by the lidar community, but are always depicted as SNR in keeping with the ARM conventions noted above. After this initial filtering, a sinusoid is fit to the data at each range gate (a given range gate will be at a constant height at all azimuths in a PPI scan). From this analysis, estimates of wind vector components, speed, direction, and uncertainty estimates are obtained. The uncertainty values can be found in the netCDF error values for each wind component (u_error, v_error, w_error). These uncertainties assume a 1 m/s error in radial velocities, and are based on the location and number of azimuth angles used. Thus, if all azimuth angles are available for a given range gate, then the errors will be the same for all range gates that also use all the azimuth angles. Additionally, the quality of the fit is provided as residual and correlation coefficient quantities using standard numerical matrix inversion methods. The quality of the least squares fit is assessed using the fit residual and the linear correlation coefficient. This process is repeated at each range gate (and corresponding height) to produce a profile of winds.

Following the ARM methodology, a minimum SNR threshold was applied in order to exclude poor quality measurements from the calculation of VAD wind profiles. Through experimentation and consideration of the atmospheric conditions present throughout the campaign, a threshold of -35 dB was chosen. As part of our quality control process, additional threshold parameters were applied in order to filter VAD winds from the netCDF files after the ARM algorithm was applied. In order to fine-tune selection of filtering parameters and threshold values, VAD wind profiles were compared to radiosonde soundings launched by the University of California

Santa Barbara (UCSB) nearby. A total of 90 GRAW soundings were launched, primarily during when the wind events of interest to the SWEX campaign were predicted. An example of this analysis is shown in Figure 4. This example examines the distribution of the correlation coefficient of the VAD fit for wind estimates that agree with the radiosondes and those that disagree. In this case, 80% of the agreeing samples had a correlation coefficient of 0.8 or more, so this threshold was chosen as an indicator of a good measurement. Similar analyses were performed for the mean SNR (leading to a threshold of -28.5 dB), fit residuals (threshold of 3 m/s), and the percentage of raw samples around a VAD circle (threshold of 75%). All thresholds used in creating a VAD winds data file are included as global attributes within the netCDF file.

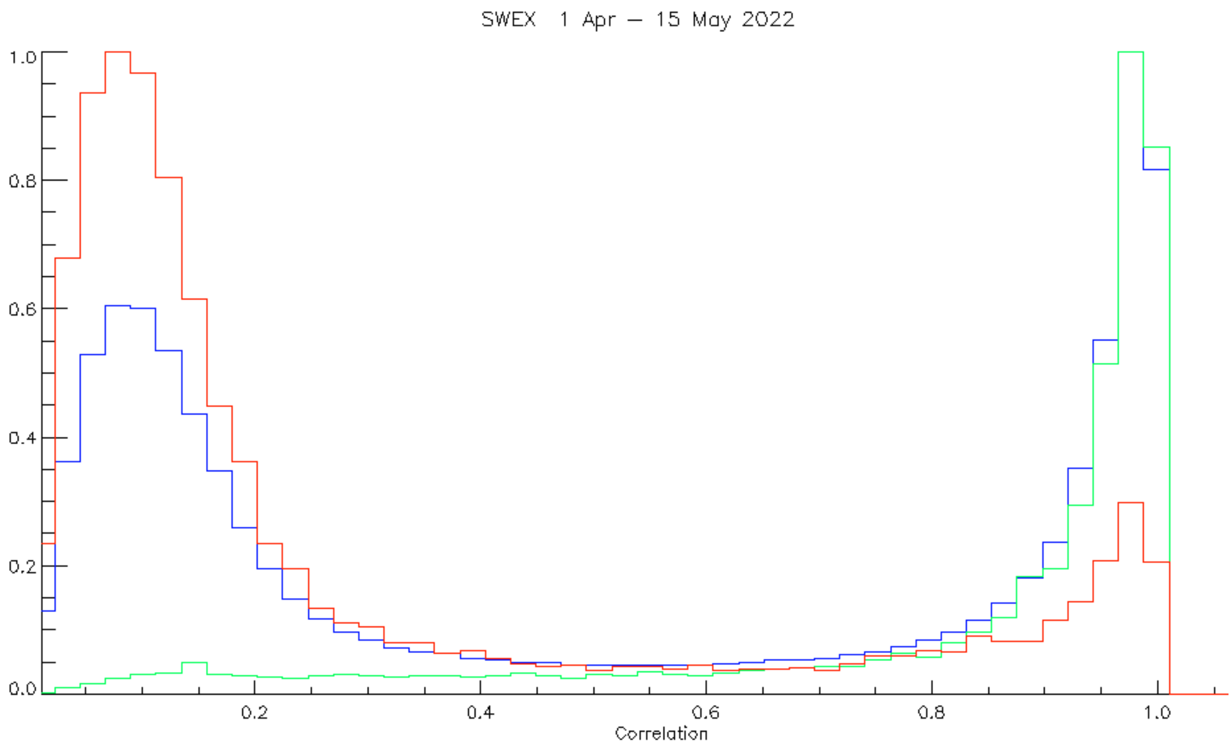

Figure 4. *Histograms of the VAD fit correlation coefficient. The green histogram indicates VAD samples that agree with the UCSB soundings, the red histogram indicates those that disagree, and the blue indicates the entire population of samples. Agreement is defined as points where VAD winds agree within 2 m/s.*

Figure 5 compares the VAD winds from the lidar with the above threshold filtering applied with winds measured by the radiosonde soundings. The median and standard deviations for speed were 0.49 m/s and 0.82 m/s, and for direction they were 6.5 and 10.4 degrees. The best fit slopes were 1.040 for speed and 1.001 for direction. As compared with similar comparisons for other field campaigns, this is a very good agreement.

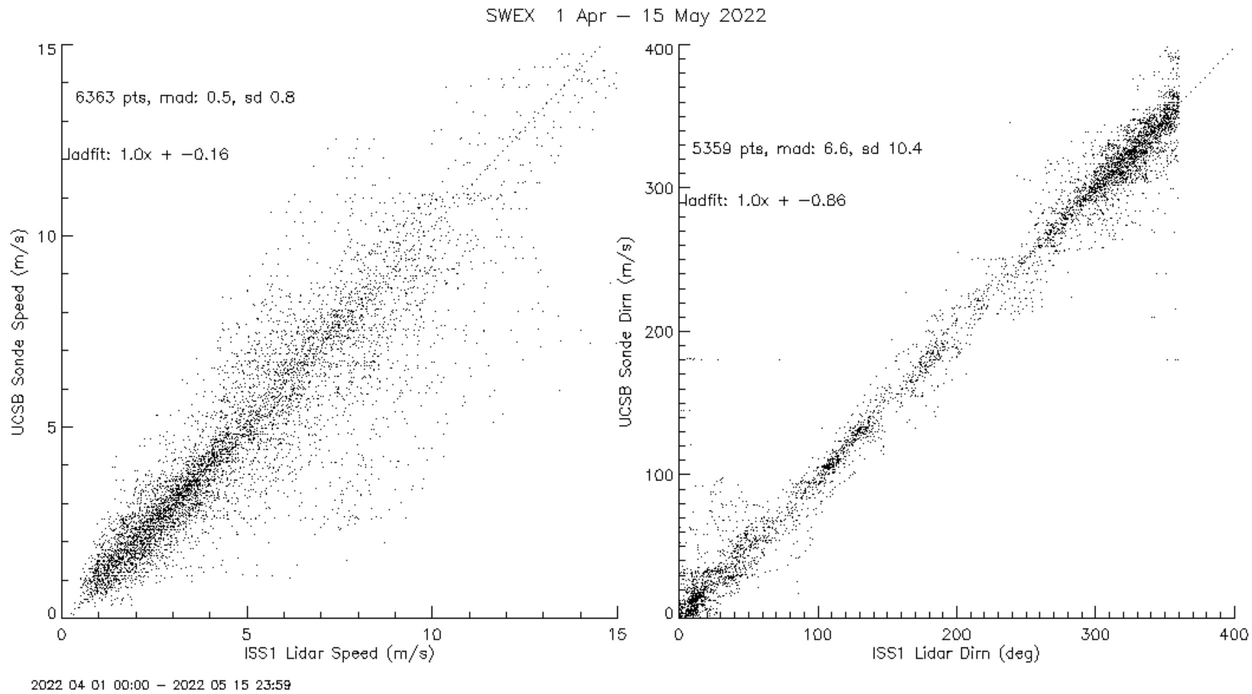

Figure 5. *A comparison of post-filtering VAD winds from the lidar and winds from radiosonde soundings.*

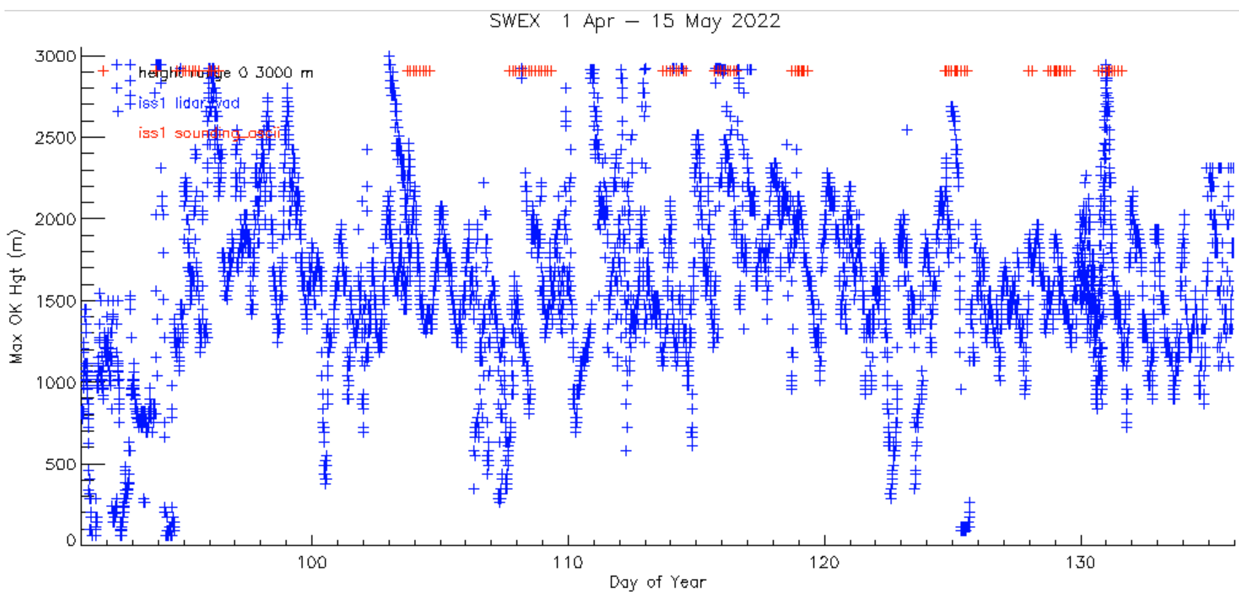

Figure 6. *The maximum height to which a VAD measurement was made over the course of the campaign (blue crosses). The red crosses indicate the times of radiosonde soundings, clustering of the red crosses represents the increased rate of soundings during IOPs.*

The scattering from the atmosphere varied during the project. This can be seen in the varying range that the lidar saw, and also in the varying height to which VAD wind measurements could be determined. Figure 6 shows a time series plot of this height. Around 75% of the time, VAD measurements were made to about 900 meters or higher, the median height was 1600 m, and 25% of the time VAD measurements were made to 2.2 km or higher. The variation in coverage would have been mostly due to variations in the aerosol content of the atmosphere, although from time to time there were changes in the sampling strategy that may have also affected the height coverage.

VAD 30-minute Consensus Winds Product

As a companion to the Velocity-Azimuth Display (VAD) wind profile product, a 30-minute consensus average wind product was generated and is also available as part of this dataset. These data were calculated from the quality-controlled VAD wind profiles described in the preceding section. These netCDF files again follow the convention produced by the U.S. Department of Energy Atmospheric Radiation Measurement (ARM) user facilities.

These data were created by consensus averaging the VAD winds, for which were calculated the mean value of all data points that lie within a given window size (5 m/s) of each other. The final values used in the average are chosen as the subset of values in the data having the most points and smallest spread in values. Included in the data files are the u, v, and w wind components, separately consensus averaged; wind speed and direction calculated from the consensus average u and v; the number of points used in the averaging; and median values of the residual, correlation, and mean SNR from the indices of points used to calculate the w consensus average.

Data Remarks

The lidar functioned mostly as expected throughout the project, however the scan strategies varied throughout the campaign as they were fine-tuned according to the science objectives.

In calculating VAD wind profiles, multiple PPI scan strategies were used throughout the campaign. At the beginning of the project three different 360 degree sweeps with varying angular resolutions, gate spacings, and elevation angles were used (ID 14, 18, 28). A few days into the project we settled into a 35 degree elevation scan for all VAD wind profiles, which was used almost exclusively until the last few days of the campaign. After this point, a PPI scan at 35 degrees elevation (ID 64) and a limited sector sweep at 75 degrees elevation (ID 66) were used in place of ID 42. Scan ID 64 was also used during IOP 3 earlier in the project. Prior to the beginning of the project, VAD winds were calculated from additional scan IDs, but these data are available only upon request and are not included in this dataset due to data quality concerns.

Atmospheric Structure

In addition to standard Doppler radial velocity, spectral width and backscatter data, much of the scan data also includes a variable called atmospherical_structures_type. This is a variable derived from Leosphere's WALS atmospheric condition and cloud algorithm which analyzes CNR and radial velocity data to make inferences about the atmosphere. These data have not been verified for this campaign and should be used with caution, however they may provide some useful information about the boundary layer depth and other parameters.

Atmospherical_structures_type value	meaning
0	No data
20	Residual layer
30	Mixed layer
200 - 400	Clouds
2000 - 4000	Aerosols

Intensive Operating Periods (IOP's)

Summaries of most IOP and EOP missions can be found under Missions in the SWEX Field Catalog. The scan modes and scan ID numbers (refer to Table 2) for the IOPs were as follows:

IOP1 - Eastern Sundowner - April 4-5, 2022

Scan Modes
- PPI - 42
- RHI - 40, 41
- VER - 39

IOP2 - Eastern Sundowner occurring during hot/dry conditions preceding a weak Santa Ana - April 6-7, 2022

Scan Modes
- PPI - 42
- RHI - 40, 41
- VER - 39

IOP3 - Western Sundowner - April 13-14, 2022

Scan Modes
- PPI - 42, 64
- RHI - 62, 63
- VER - 39

EOP1 - Western Sundowner - April 17, 2022

Scan Modes

PPI - 42
RHI - 62, 63
VER - 39

IOP4 - Western Sundowner - April 18-19, 2022

Scan Modes
PPI - 42
RHI - 62, 63
VER - 39

IOP5 - Eastern Sundowner hybrid with strong winds in the east and west - April 23-24, 2022

Scan Modes
PPI - 42
RHI - 62, 63
VER - 39

EOP2 - Eastern Sundowner - April 25-26, 2022

Scan Modes
PPI - 42
RHI - 62, 63
VER - 39

IOP6 - Western Sundowner - April 28-29, 2022

Scan Modes
PPI - 42
RHI - 62, 63
VER - 39

EOP3 - Western Sundowner - May 4-5, 2022

Scan Modes
PPI - 42
RHI - 62, 63
VER - 39

IOP7 - Western Sundowner - May 7-8, 2022

Scan Modes
PPI - 42
RHI - 62, 63

VER - 39

IOP8 - Western Sundowner - May 8-9, 2022

Scan Modes
PPI - 42
RHI - 62, 63
VER - 39

IOP9 - Western Sundowner - May 10-11, 2022

Scan Modes
PPI - 42
RHI - 62, 63
VER - 39

IOP10 - Western Sundowner - May 12-13, 2022

Scan Modes
PPI - 42
RHI - 62, 63
VER - 39

References

Newsom, R. K., C. Sivaraman, T. R. Shippert, and L. D. Riihimaki, 2015: *Doppler Lidar Wind Value-Added Product*. https://doi.org/10.2172/1238069.