NCAR | EARTH OBSERVING LABORATORY

SWEX

NCAR/EOL ISS Surface Meteorology, PurpleAir and Webcam Products Data Report

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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
Calculation of long-wave radiation:
https://www.eol.ucar.edu/content/calculation-long-wave-radiation

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:

ISS Surface Meteorology Products

NCAR/EOL ISS Team. 2023. SWEX: ISS Surface Meteorology Products. Version 1.0. UCAR/NCAR - Earth Observing Laboratory. https://doi.org/10.26023/FHZJ-PF5C-W602. Accessed 14 Mar 2023.

ISS Webcam Imagery

NCAR/EOL ISS Team. 2023. SWEX: ISS Webcam Imagery. Version 1.0. UCAR/NCAR - Earth Observing Laboratory. https://doi.org/10.26023/G4ZW-WDWV-1R0A. Accessed 14 Mar 2023.

ISS PurpleAir Aerosol Products

NCAR/EOL ISS Team. 2023. SWEX: ISS PurpleAir Aerosol Products. Version 1.0. UCAR/NCAR - Earth Observing Laboratory. https://doi.org/10.26023/8DTV-187M-Q207. Accessed 14 Mar 2023.

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

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In the event that information from this document are used for publication or presentation purposes, please provide the above acknowledgement to NSF and NCAR/EOL and make reference to *Witte, J., (2023): SWEX 2022 NCAR/EOL ISS Surface Meteorology, PurpleAir and Webcam Products Data Report.*

Overview

The Sundowner Wind Experiment (SWEX) was conducted in the Santa Ynez Mountains in Santa Barbara County, California for the period 01 April - 15 May 2022. The Integrated Sounding System (ISS) operated three systems at three sites located near-coastal (Santa Barbara Fire Department Headquarters) and the interior mountain region (Rancho Alegre and UCSB Sedgwick Reserve). Each system contained a full suite of meteorology sensors, radiometers, web cameras, PurpleAir aerosol sensors, ceilometers, and wind profilers. A wind lidar was operated out of the SB Fire Dept. HQ and radiosondes were launched from the Rancho Alegre and Sedgwick Reserve sites. This data report focuses on the surface meteorology and PurpleAir sensors, and web camera images.

Project time period: 01 April - 15 May 2022

Datasets

Locations: iss1 = Santa Barbara Fire Dept
iss2 = Rancho Alegre
iss3 = Sedgwick Reserve

Dataset Name: **SWEX: ISS Surface Meteorology Products**

Data format:	iss1_swex_sfcmet_yyyymmdd.nc iss2_swex_sfcmet_yyyymmdd.nc iss3_swex_sfcmet_yyyymmdd.nc
Data file frequency:	Daily files
Data version:	v1.0
Data status:	final
Data resolution:	1 minute

Dataset Name:	**SWEX: ISS Webcam Imagery**
Data files:	iss1_swex_microseven_camera_1min_yyyymmdd-yyyymmdd.tar.gz iss1_swex_sonyelp_camera_5min_yyyymmdd-yyyymmdd.tar.gz iss2_swex_panasonic_camera_5min_yyyymmdd-yyyymmdd.tar.gz iss3_swex_allsky_camera_1min_yyyymmdd-yyyymmdd.tar.gz iss3_swex_panasonic_camera_5min_yyyymm.tar.gz
Data version:	v1.0
Data status:	final

Dataset Name:	**SWEX: ISS PurpleAir Aerosol Products**
Data files:	iss1_swex_purpleair_aerosol.tar.gz iss2_swex_purpleair_aerosol.tar.gz iss3_swex_purpleair_aerosol.tar.gz
Data format:	CSV
Data file frequency:	Daily files
Data version:	v1.0
Data status:	final

Site Description

ISS operated three trailers of instrumentation at the Santa Barbara Fire Department Headquarters (SB Fire Dept), Rancho Alegre near Lake Cachuma, and the University of California, Santa Barbara (UCSB) Sedgwick Reserve. Refer to **Figure 1** and **Table 1** for a map and coordinates of the sites.

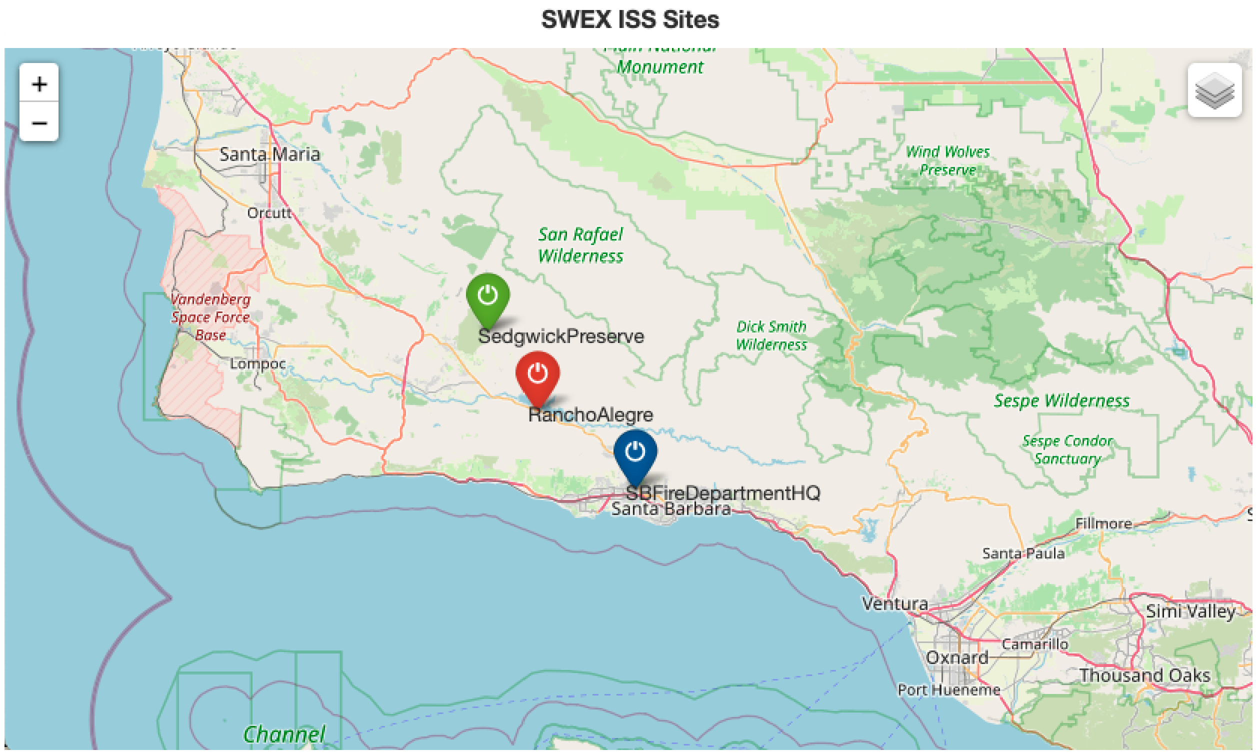


Figure 1. Map of the ISS sites relative to Santa Barbara, CA.

ISS	Latitude	Longitude	Elevation
SB Fire Dept (ISS1)	34.4527°N	119.7712°W	90.99 m
Rancho Alegre (ISS2)	34.5624°N	119.9505°W	284.45 m
Sedgwick Reserve (ISS3)	34.6874°N	120.0384°W	322.81 m

Table 1. General location and elevation of the ISS sites.

Instrument Description

Each ISS site was equipped with a full sensor suite of meteorological instruments, web cameras and PurpleAir aerosol sensors. An overview of the distribution of instruments by site are shown in **Photos 1 - 3** below.

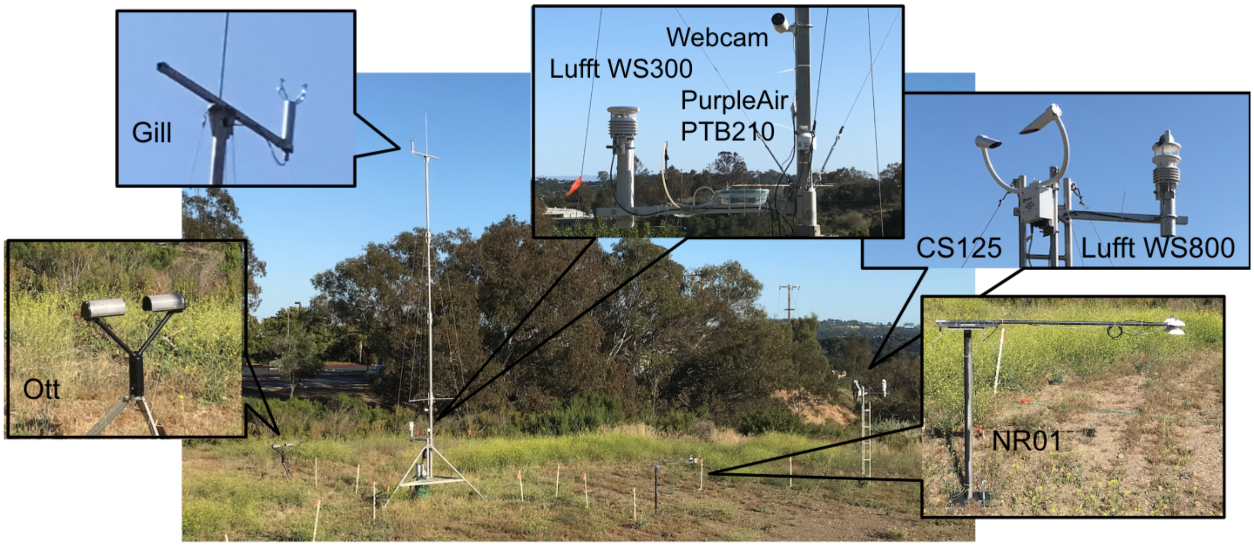


Photo 1. Sensors at the SB Fire Dept site (ISS1) looking southeast. From left are the Ott Parsivel 2 disdrometer, Gill WindObserver 2D sonic anemometer, Lufft WS300, web camera, PurpleAir, PTB210 pressure, Campbell CS125 visibility, Lufft WS800, and HukseFlux NR01 sensors.

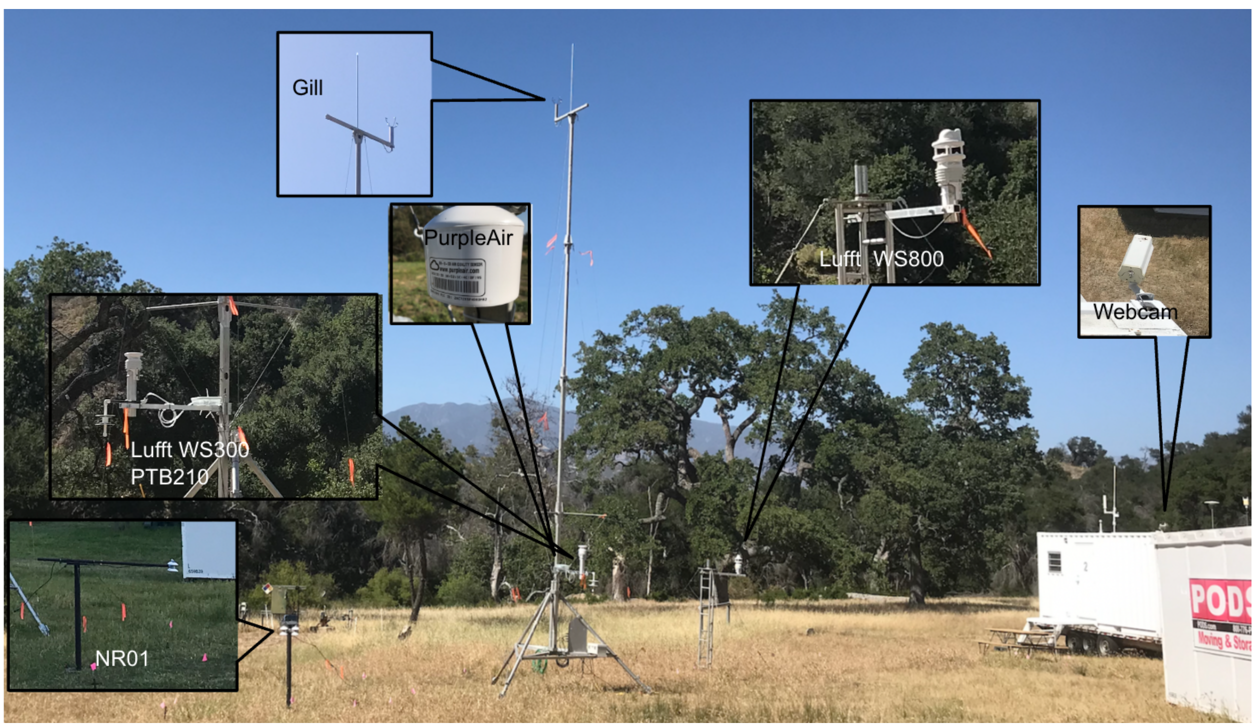


Photo 2. Sensors at the Rancho Alegre site (ISS2) looking north. From left are the HukseFlux NR01, Lufft WS300, PTB210 pressure, Gill WindObserver 2D sonic anemometer, PurpleAir, PTB210 pressure, Lufft WS800, and web camera.

Photo 3. Sensors at Sedgwick Reserve (ISS3) looking east. From left are the PurpleAir, web camera, Gill WindObserver 2D sonic anemometer, Lufft WS300, PTB210 pressure, HukseFlux NR01 and Lufft WS800.

Surface Meteorology Instruments

The meteorological sensors were mounted on 10 m towers (see **Photo 4**). **Table 2** lists the sensors mounted on each met tower.

Photo 4. Left: Raising the 10 m meteorology tower at the Rancho Alegre site. Right: The 10 m met tower at the SB Fire Dept site. The 2D Gill Windobserver can be seen at the tops of the towers.

Table 2. ISS suite of surface meteorology sensors at each site. The exception is the CS125 and OTT which operated only at the SB Fire Dept site.

Sensor	Height	Parameters

2D Gill Windobserver	10 m	U, V, Wind speed and direction
Lufft W800	3 m - SB Fire Dept and Sedgwick 2m - Rancho Alegre	P, T, Td, Tchill, RH, wind speed and direction, precipitation, radiation
Lufft WS300	2 m	P, T, Td, RH
Vaisala PTB210	2 m	P
Campbell Scientific CS125**	3 m	Visibility, particle count, precipitation
Hukseflux NR01	1 m	Incoming/outgoing shortwave radiation and thermopile (see calculation of longwave radiation)
Ott Parsivel 2 disdrometer **	1 m	Rain rate, particle count, visibility

** Operated only at SB Fire Dept site.

Webcam Instruments

Table 3. Camera types and location.

Manufacturer	Model	Site	Location and viewing direction
Sony ELP HD	USBFHD06H - IMX322	SB Fire Dept	ISS trailer roof, pointed south
MicroSeven	M7B 5MP - SWSAA	SB Fire Dept	ISS on the surface met tower, pointed north
Sony ELP HD	USBFHD06H - IMX322	Rancho Alegre	ISS trailer roof. Direction changed from initially pointing north to south after 0015 UT April 5, 2023
Moonglow Tech Allsky	ASC-N1	Sedgwick Reserve	ISS trailer roof, pointing north
Panasonic	BL-C140A	Sedgwick Reserve	ISS trailer roof, pointing south

Table 4. Camera file name convention, format and resolution.

Manufacturer	File name convention	Format	File Freq.

Sony ELP HD	camera_south-yyyymmdd-hhmmss.png	png	5 min
MicroSeven	PyymmddhhMMss00.jpg	jpeg	1 min
Sony ELP HD	rancho_alegre_south-20220505-221504.png	png	5 min
Moonglow Tech Allsky	panoramic - yyyymmdd_hhmm_pano.jpg reprojected - yyyymmdd_hhmm_reproj.jpg raw - yyyymmdd_hhmm_raw.jpg	jpeg	1 min
Panasonic	camera_south-yyyymmdd-hhmmss.png	jpeg	5 min

PurpleAir Instrument

The commercial PurpleAir aerosol sensors operated at all three ISS sites. The sensors were mounted on the roofs of the ISS trailers.

Table 5. PurpleAir specifications

Manufacturer	Model	Variables	Resolution	Location
PurpleAir	PA-II-SD	PMX.X** T P RH	2 min	SB Fire Dept., Rancho Alegre and Sedgwick Reserve

There are a range of PM sizes reported. Refer to the CSV file header description in **Appendix B.

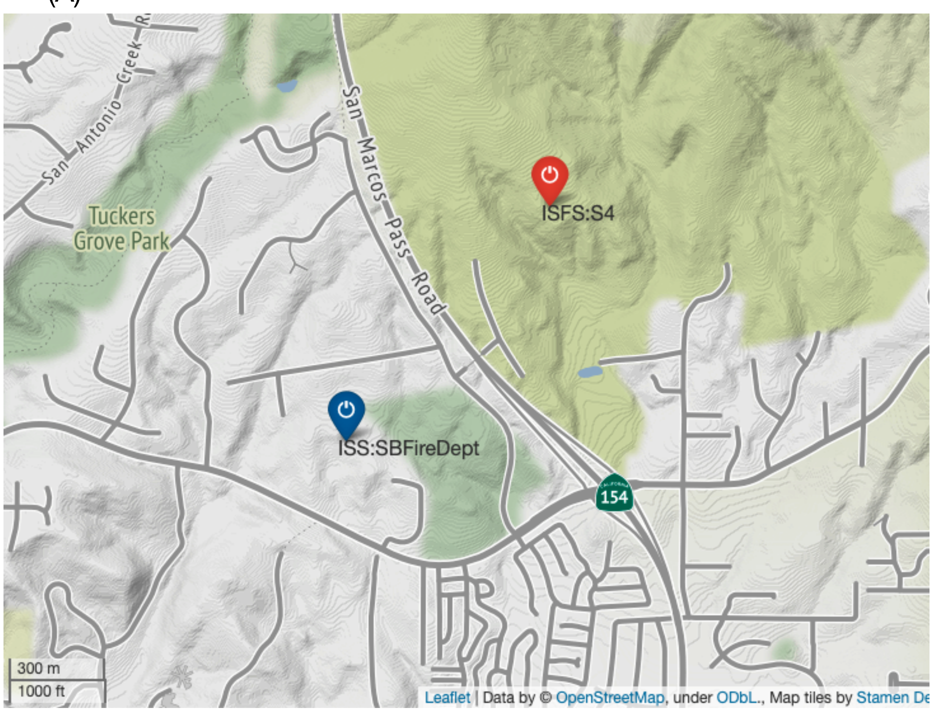
Surface Meteorology Data Collection and Processing

All surface met. sensors were sampled independently with a Linux-based Data System Module or DSM. Data was stored directly onto USB sticks provided for every DSM. All DSMs were connected by either local network or cell modem, so raw data could also be archived in real-time on a Linux computer at the ISS base trailers. Data was also transmitted from the base trailers to servers at EOL for local storage and added back-up. Data processing was performed by the in-house created data acquisition system called NIDAS. NIDAS (NCAR In-situ Data Acquisition System) is a linux based software that handles the data processing for all ISS surface meteorology measurement systems.

Each sensor is sampled independently in an asynchronous manner. A time tag of microsecond resolution is assigned to each sample at the moment it is received, based on a system clock, which is continually conditioned from a directly connected GPS with a pulse-per-second (PPS) signal - this allows us to compare and combine data from multiple towers. Minimal data interpretation is performed to differentiate individual messages from a sensor, assembling the data exactly as it was received into a sample, with the associated time-tag and an identifier of the sensor and data system. The concatenated stream of samples from all sensors is then passed on for averaging and saved as netCDf daily files. Refer to **Appendix A** for the netcdf variable names and their attributes.

All surface sensors functioned as expected. No problems were noted during operations. No sensors were replaced during operations. The NCAR Integrated Surface Flux System (ISFS) operated 10 m flux towers near ISS sites. **Figure 2** shows maps of the nearest ISFS sites (red) relative to the ISS sites (blue). The distance between ISS and ISFS sites was around 1 km.

(A)



(B)

(C)

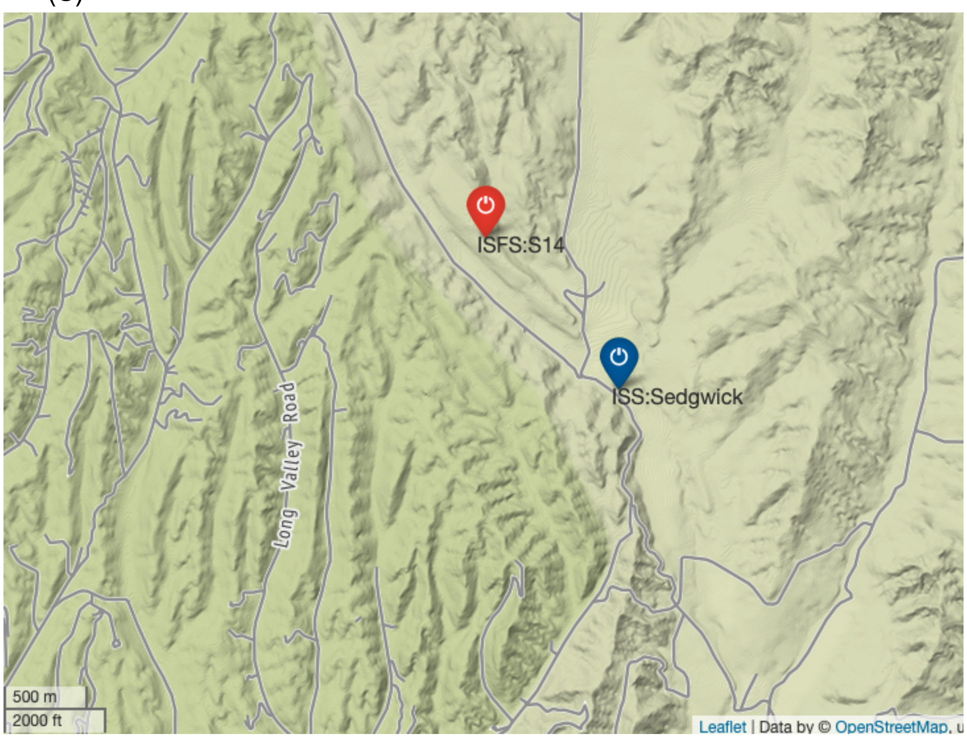


Figure 2. ISS sites and nearest ISFS sites. (A) ISS SB Fire Dept (blue). The nearest ISFS site is s4: San Marco. (B) ISS Rancho Alegre (blue). The nearest ISFS site is s13: Boy Scout Camp. (C) ISS Sedgwick (blue). The nearest ISFS site is s13: Sedgwick.

10 m 2D Gill Observer winds

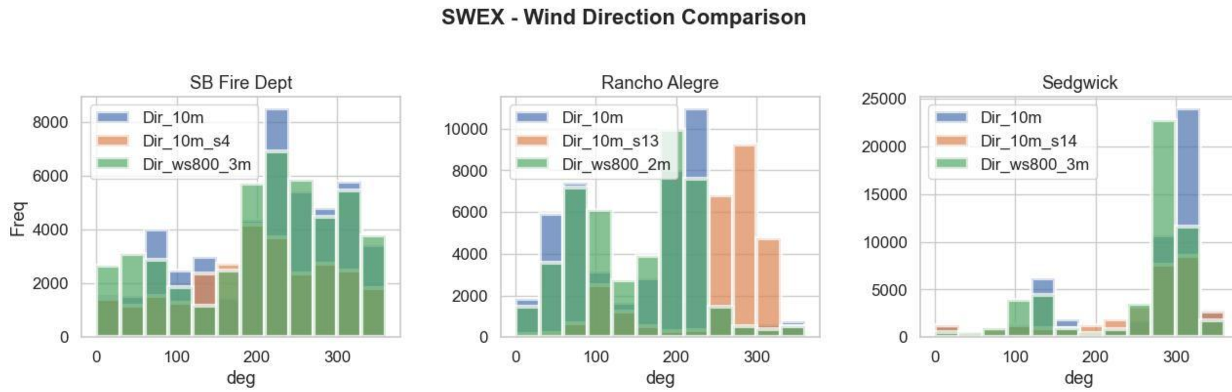
Like ISS, ISFS operated a 10 m 2D Gill Windobserver instrument. The 10m Gill reports 1-second data that are averaged to 1 minute in the final data. A table of research variables in the data files and wind accuracy are in **Table 6**. **Figure 3** shows a comparison of the winds between ISS and the nearest ISFS site. Winds at SB Fire Dept and Sedgwick are relatively comparable. At Rancho Alegre, the wind directions diverge due to the distinct wind regime. ISS was set-up in a protected valley where air recirculation was common, whereas ISFS was set-up on an exposed ridge facing persistent wind flow from the west and north and a broader range of wind speeds. Windrose plots for both the 2D Gill and Lufft WS800 sensors are shown in **Figure 4**. Both sensors compare well with either.

Variable name	Quantity Measured	Unit
Spd_10m	Wind speed	m/s
Dir_10m	Wind direction	deg
Tc_10m	2D sonic temperature	degC
U_10m	Wind U component	m/s
V_10m	Wind U component	m/s

	Wind Speed	Wind Direction
Range	0 - 65 m/s	0 - 359°
Accuracy	±2% @12 m/s	±2° @12 m/s
Resolution	0.01 m/s	1°

Table 6. Gill Windobserver variables in the netCDF data files and the sensor accuracy of the winds.

(A)



(B)

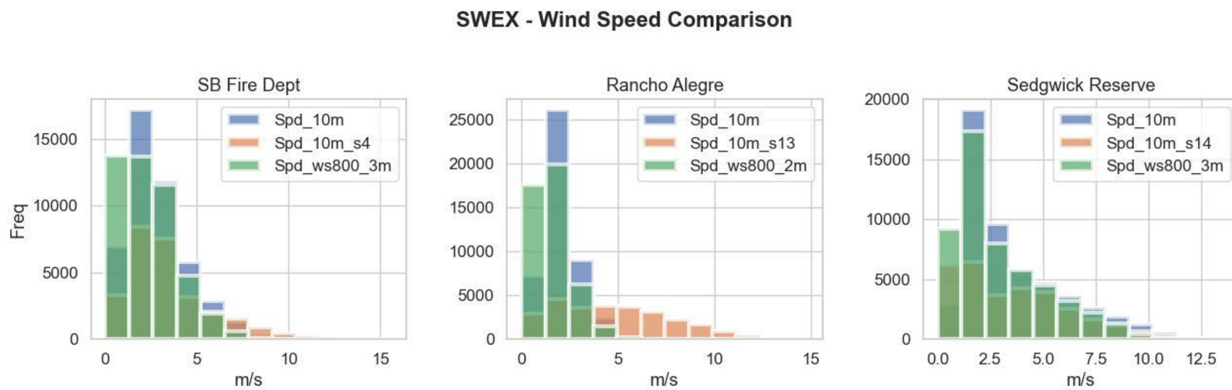
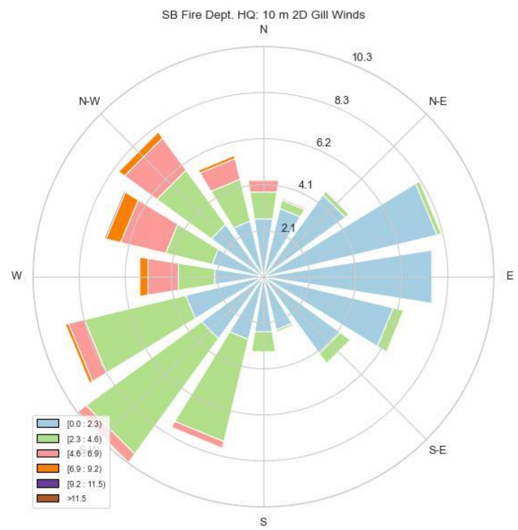
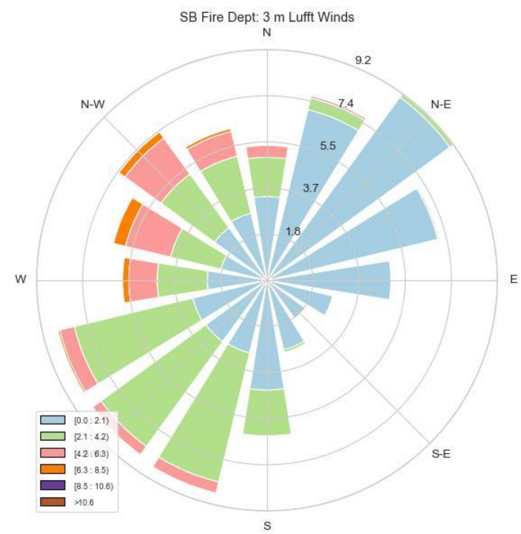


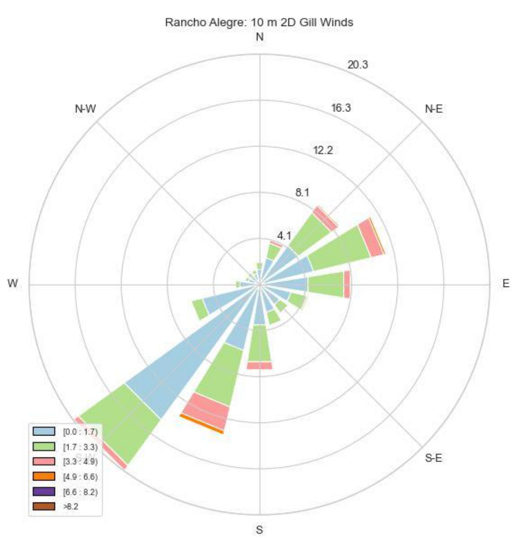
Figure 3. Comparison of 2D Gill Observer winds between ISS and ISFS sites closest to each other. Blue = ISS 2D anemometer at 10m, Green = ISS Lufft WS800 winds, Orange = ISFS nearest site 10 m 2D anemometer.

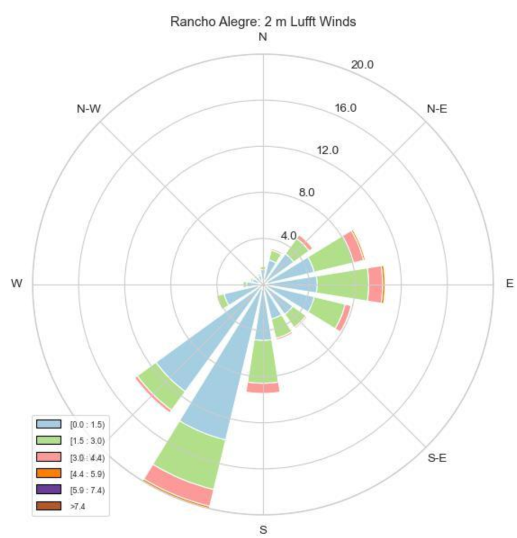
(A)


SB Fire Dept. HQ: 10 m 2D Gill Winds
N
N-E
E
S-E
S
W
N-W
2.1
4.1
6.2
8.3
10.3
[0.0 : 2.3)
[2.3 : 4.6)
[4.6 : 6.9)
[6.9 : 9.2)
[9.2 : 11.5)
>11.5


SB Fire Dept: 3 m Lufft Winds
N
N-E
E
S-E
S
W
N-W
1.8
3.7
5.5
7.4
9.2
[0.0 : 2.1)
[2.1 : 4.2)
[4.2 : 6.3)
[6.3 : 8.5)
[8.5 : 10.6)
>10.6

(B)


Rancho Alegre: 10 m 2D Gill Winds
N
N-E
E
S-E
S
W
N-W
4.1
8.1
12.2
16.3
20.3
[0.0 : 1.7)
[1.7 : 3.3)
[3.3 : 4.9)
[4.9 : 6.6)
[6.6 : 8.2)
>8.2


Rancho Alegre: 2 m Lufft Winds
N
N-E
E
S-E
S
W
N-W
4.0
8.0
12.0
16.0
20.0
[0.0 : 1.5)
[1.5 : 3.0)
[3.0 : 4.4)
[4.4 : 5.9)
[5.9 : 7.4)
>7.4

(C)

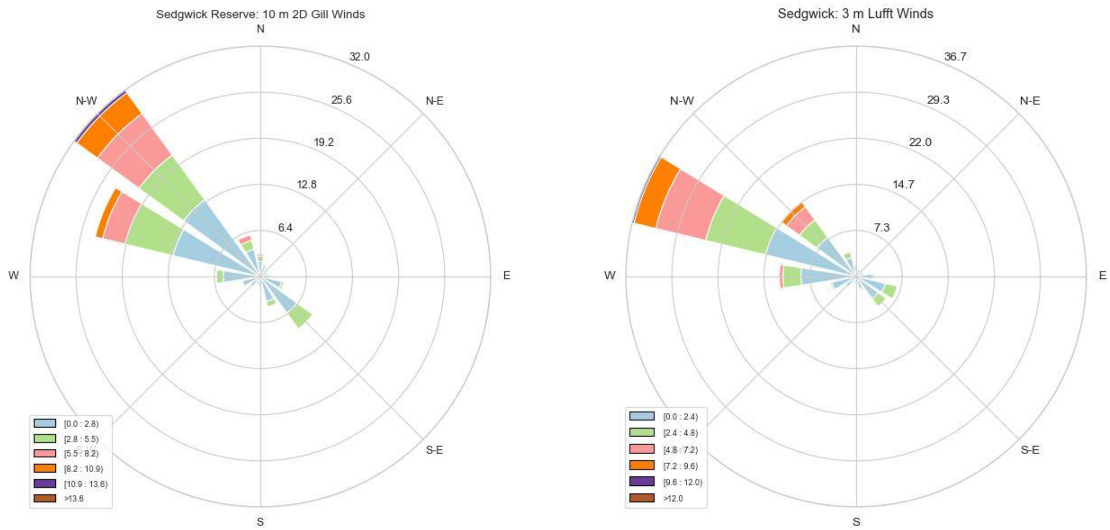


Figure 4. Windrose plots of the 10 m 2D Gill Windobserver (left) and Lufft WS800 (right) sensors at (A) SB Fire Dept, (B) Rancho Alegre, and (C) Sedgwick Reserve.

Vaisala PTB210

ISS operated a Vaisala PTB 210 pressure sensor at 2m at each site. The variable name in the netcdf data files is P_ptb_2m. **Table 7** provides the accuracy and sampling rate. **Figure 5** shows the time series of the Vaisala PTB measurements at the three ISS sites.

Vaisala PTB210	hPa
Hysteresis	± 0.05
Precision	± 0.05
Calibration uncertainty	± 0.07
Accuracy at +20°C	± 0.15
Temperature dependence	± 0.20
Total accuracy (-40 - +60 °C)	± 0.25

Table 7. Vaisala PTB210 accuracy

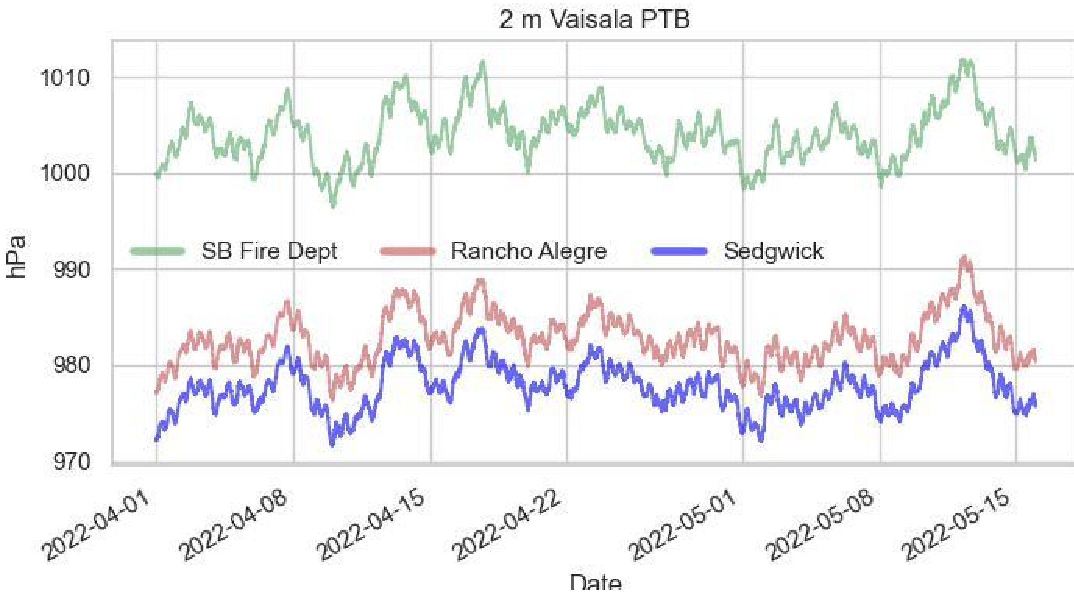


Figure 5. Pressure measured by the Vaisala PTB210 at the three sites.

Lufft WS300 and WS800

PTU and Winds

Pressure was also measured by the Lufft WS800 and WS300. The WS300 was mounted at 2 m at the three sites. However, the WS800 was mounted at 2 m at the Rancho Alegre site and at 3 m for the other two sites. **Table 8** provides a list of research variables and definitions for both Lufft sensors. **Table 9** provides the accuracy and sampling rate of key measurements for both Lufft sensors. Note that the precision and accuracy of the Vaisala pressure sensor is higher than the Lufft which reports a 0.1 hPa accuracy. We recommend using the Vaisala pressures for analysis.

At the Rancho Alegre site, the Lufft WS300 measurements were comparable to that of the WS800 (**Figure 6)** where both sensors were mounted at the same height of 2m. From **Figures 3 and 4** the Lufft WS800 wind data compares well with the 10 m 2D Gill instrument.

The Lufft WS800 reports additional wind statistics - min/max, average, vector wind speed. Generation of average, max/min value of wind speed and direction are calculated using a time interval of 10 minutes (refer to **Table 8**). The wind speeds are also calculated vectorially with the same configured time interval as that for the minimum, maximum and average values. **Figure 7** shows an example of a single day of the various Lufft WS800 wind speeds listed in **Table 8** at the SB Fire Dept site.

Variable name	Quantity Measured	Unit	Instrument
P_ws300_2m	Pressure	mb	Lufft WS300
T_ws300_2m	Temperature	degC	
RH_ws300_2m	Relative Humidity	%	
Td_ws300_2m	Dewpoint Temperature	degC	
P_ws800_2m* P_ws800_3m	Pressure	mb	Lufft WS800
T_ws800_2m* T_ws800_3m	Temperature	degC	
Td_ws800_2m* Td_ws800_3m	Dewpoint Temperature	degC	
Tchill_ws800_2m* Tchill_ws800_3m	Wind Chill Temperature	degC	
RH_ws800_2m* RH_ws800_3m	Relative Humidity	%	
Spd_ws800_2m* Spd_ws800_3m	Wind Speed	m/s	
Sn_ws800_2m* Sn_ws800_3m	Min. wind speed**	m/s	
Sx_ws800_2m* Sx_ws800_3m	Max. wind speed**	m/s	
Sg_ws800_2m* Sg_ws800_3m	Moving average wind speed**	m/s	
Sv_ws800_2m* Sv_ws800_3m	Averaged vectorial wind speed**	m/s	
Dir_ws800_2m* Dir_ws800_3m	Vector wind direction	deg	
Dn_ws800_2m* Dn_ws800_3m	Min. wind direction**	deg	
Dx_ws800_2m* Dx_ws800_3m	Max wind direction**	deg	

*2m Lufft WS800 only at the Rancho Alegre site
**The interval for the calculation of minimum, maximum and average values is set at 10 minutes.

Table 8. List of Lufft research variables and definitions.

Lufft WS800/WS300	T, °C	RH, %	Td, degC	P, hPa	Wind Spd, m/s	Wind Dir, °
Measuring Range	-50 - +60	0 - 100	-50 - +60	300 - 1200	0 - 75	0 - 360
Resolution	0.1	0.1	0.1	0.1	0.1	0.1
Accuracy	± 0.2	± 2	± 0.7	± 0.5	±0.3	< 3
Sampling rate	1 min	1 min	1 min	1 min	20 s	20 s

Table 9. Lufft sensor accuracy. Wind speed and direction measured by the WS800 only.

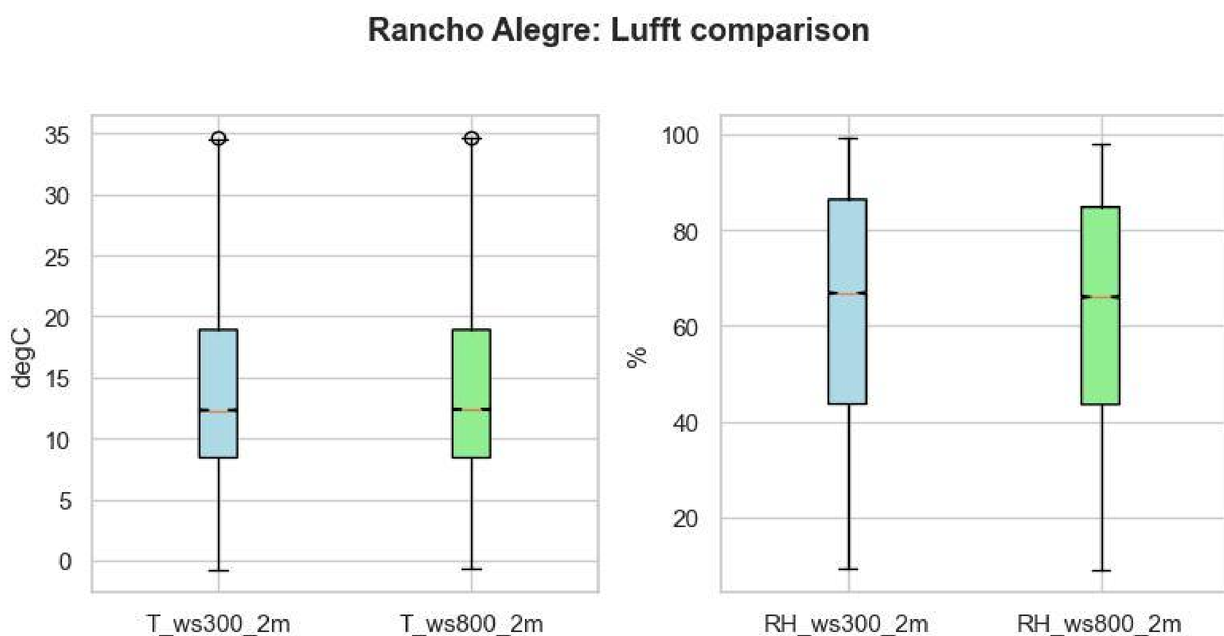


Figure 6. Comparison of the Temperature for Luffts at Rancho Alegre where the WS300, WS800 were mounted at the same height.

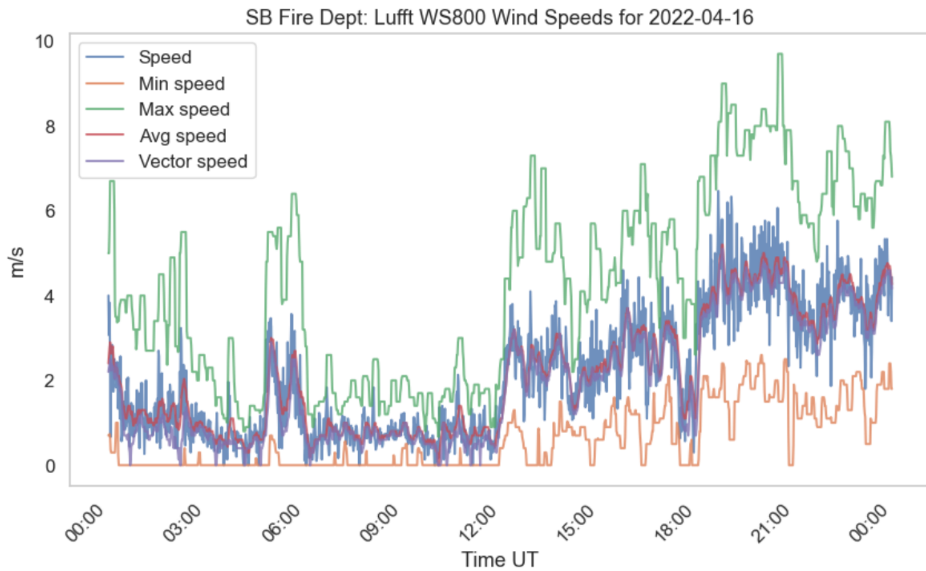


Figure 7. An example of one day of Lufft WS800 wind speed measurements taken at the SB Fire Dept site on 16 April 2022.

Lufft WS800 Radiation

Lufft WS800 measurements of radiation quantities are listed in **Table 10**. The global radiation is measured by a pyranometer mounted in the top cover of the sensor. The sampling rate is 10 s with a resolution of less than 1 W/m^2. **Figure 8** shows an example of a single day of the various Lufft WS800 wind speeds listed in **Table 10** at the Rancho Alegre site. We recommend using the Hukseflux NR01 radiation data over the Lufft. Accuracy values are unknown.

Variable name	Quantity Measured	unit
Ga_ws800_2m* Ga_ws800_3m	Global radiation	W/m^2
Gn_ws800_2m* Gn_ws800_3m	Min. global radiation**	W/m^2
Gx_ws800_2m* Gx_ws800_3m	Max. global radiation**	W/m^2
Gg_ws800_2m* Gg_ws800_3m	Avg. global radiation**	W/m^2

*2m Lufft WS800 only at the Rancho Alegre site
**The interval for the calculation of minimum, maximum and average values is set at 10 minutes.

Table 10. List of Lufft research variables and definitions.

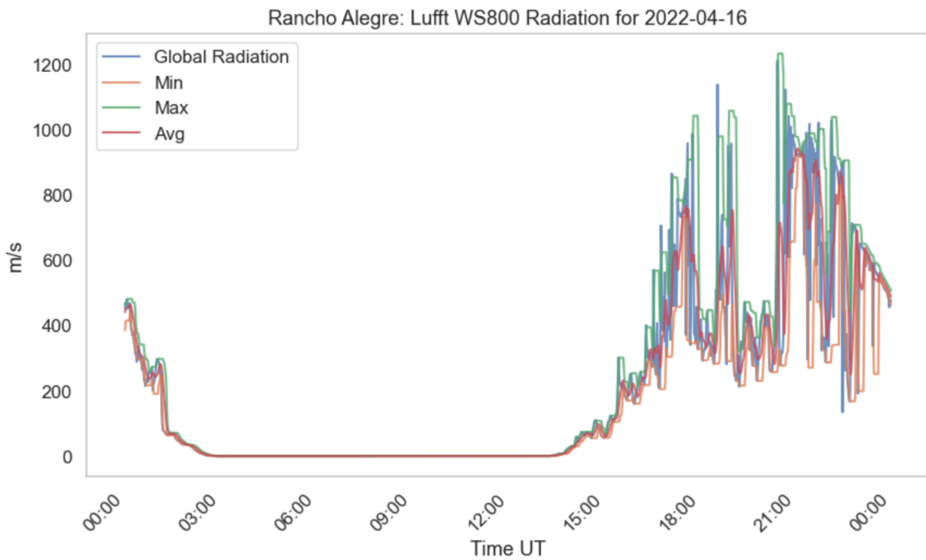


Figure 8. An example of one day of Lufft WS800 radiation measurements taken at the Rancho Alegre site on 16 April 2022.

Hukseflux NR01 Radiometer

ISS operated Hukseflux NR01 radiometers at each of the three sites. All sensors functioned as expected. No problems were noted during operations. No sensors were replaced during operations. Key variables in the netcdf files are shown in **Table 11**. Calculation of long-wave radiation from the thermopile and case temperatures can be found here: https://www.eol.ucar.edu/content/calculation-long-wave-radiation. **Figure 9** shows the time series of radiometer parameters.

Variable name	Quantity Measured	unit
Rsw_in	Incoming Shortwave	W/m^2
Rsw_out	Outgoing Shortwave	W/m^2
Rpile_in	Incoming Thermopile	W/m^2
Rpile_out	Outgoing Thermopile	W/m^2
Tcase	Case temperature	degC

Table 11. Variables measured by the Hukseflux NR01 radiometer.

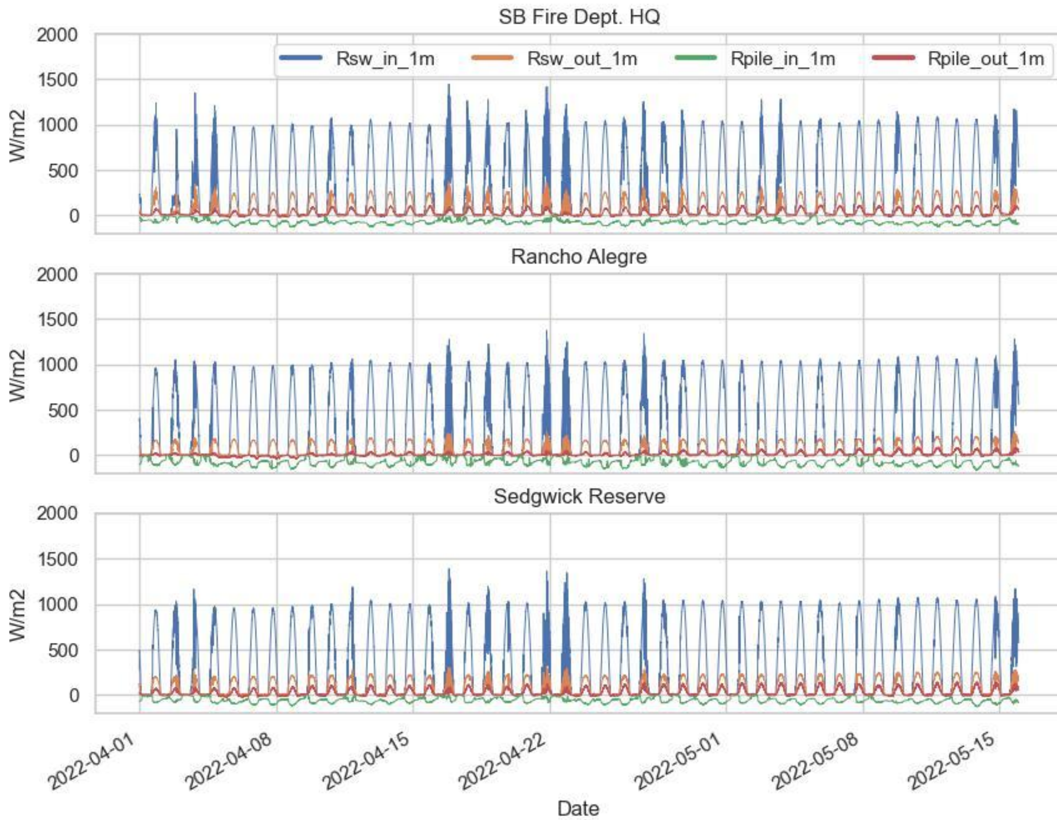


Figure 9. NR01 radiometer time series.

Precipitation and visibility data products

The CS125 visibility sensor and OTT Parsivel[2] disdrometer operated at the SB Fire Dept site only. The CS125 was mounted at 3m. All sensors functioned as expected. No problems were noted during operations. No sensors were replaced during operations. The Lufft WS800 that operated at all three sites also measured precipitation variables. The table below shows the netcdf variable names, attributes, and overall accuracy.

Instrument - CS125 (SB Fire Dept site only)

Variable name	Quantity Measured	unit	Accuracy
Rainr_3m	Rain rate	mm/h	±15% (against factory calibration standards in the laboratory, for liquid precipitation)
Vis_3m	Visibility	m	±8% (up to 600 m) ±10% (600 to 10,000 m) ±15% (10,000 to 15,000 m)

			±20% (above 15,000 m)
Part_3m	Particle count	count/min	

Instrument - OTT Parsivel^2 (SB Fire Dept site only)

Variable name	Quantity Measured	unit	Accuracy
Rainr	Rain rate	mm/h	± 5 % (liquid) /± 20 % (solid)
WX	Weather code according to SYNOP code*	-	
Vis	MOR visibility in precipitation	m	
N	Particle count	count/5min	

*For interpretation, refer to Appendix D of the Parsivel2 Operation Manual

Instrument - Lufft WS800

Variable name	Quantity Measured	unit	Accuracy
rainr_ws800_3m	Rain rate	mm/h	± 2%
raina_ws800_3m	Rain accumulation	mm	
preciptype_ws800_3m	Precipitation type	1	

Data Capture

The surface sensors at all three sites ran almost uninterrupted for the entire SWEX campaign and final data capture was close to 100% for all variables in the final netCDF files.

Webcam Images

The images are collected as is. No processing was applied. The data set includes the raw images taken every 1 - 5 minutes, depending on the camera (refer to **Table 4**). Hourly images are on the web at the links below.

- Weblink to SB Fire Dept South facing hourly images
- Weblink to Rancho Alegre South facing hourly images
- Weblink to Sedgwick Reserve South facing hourly images
- Weblink to Sedgwick Reserve North facing Allsky raw hourly images
- Weblink to Sedgwick Reserve North facing Allsky panoramic hourly images

The Allsky camera operating at Sedgwick Reserve provides three types of images every minute:

1. Raw - file name convention = yyyymmdd_hhmm_raw.jpg
2. Reprojected - file name convention = yyyymmdd_hhmm_reproj.jpg
3. Panoramic - files name convention = yyyymmdd_hhmm_pano.jpg

The Sony ELP camera at Rancho Alegre was changed direction from facing north to south on April 5th 0015 UT.

PurpleAir Data Products

The PurpleAir is a low-cost aerosol sensor based on PMS5003 and PMS1003 laser particulate counters with on-board SD card logger and linked to a PurpleAir's archiving and analysis web service. ISS deployed two PurpleAir PA-II-SD sensors to SWEX at the Rancho Alegre and Sedgwick Reserve sites. The data reported includes estimates of particle counts for the following sizes: 0.3, 0.5, 1.0, 2.5, 5.0, and 10um. Refer to **Appendix B** for the CSV file header descriptions.

Refer to the PurpleAir website https://www2.purpleair.com/ for instrument overview, specifications and processing. Data is provided as is according to PurpleAir processing.

Ardon-Dryer et. al. 2020 provides a useful discussion of PurpleAir measurements as compared to EPA research quality sensors.

Ardon-Dryer, K., Dryer, Y., Williams, J. N., and Moghimi, N., 2020: Measurements of PM2.5 with PurpleAir under atmospheric conditions, Atmos. Meas. Tech., 13, 5441–5458, doi:10.5194/amt-13-5441-2020.

Intensive Operating Periods (IOP)/Extended Operating Periods (EOP)

IOP1 - April 4-5 - Eastern Sundowner

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

IOP3 - April 13-14 - Western Sundowner

EOP1 - April 17 - Western Sundowner

IOP4 - April 18-19 - Western Sundowner

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

EOP2 - April 25-26 - Eastern Sundowner

IOP6 - April 28-29 - Western Sundowner

EOP3 - May 4-5 - Western Sundowner

IOP7 - May 7-8 - Western Sundowner

IOP8 - May 8-9 - Western Sundowner

IOP9 - May 10-11 - Western Sundowner

IOP10 - May 12-13 - Western Sundowner

Appendix A: NetCDF metadata contents

Netcdf file contents taken from the SD Fire Dept site which contains all the ISS sensor measurement suite.

```
dimensions:
	time = UNLIMITED ; // (1440 currently)
variables:
	int base_time ;
		base_time:units = "seconds since 1970-01-01 00:00:00 00:00" ;
	double time(time) ;
		time:units = "seconds since 2022-04-27 00:00:00 00:00" ;
		time:interval\(sec\) = 60. ;
	float T_ws800_3m(time) ;
		T_ws800_3m:_FillValue = 1.e+37f ;
		T_ws800_3m:long_name = "Air Temperature" ;
		T_ws800_3m:short_name = "T.ws800.3m" ;
		T_ws800_3m:units = "degC" ;
	float Td_ws800_3m(time) ;
		Td_ws800_3m:_FillValue = 1.e+37f ;
		Td_ws800_3m:long_name = "Dewpoint Temperature" ;
		Td_ws800_3m:short_name = "Td.ws800.3m" ;
		Td_ws800_3m:units = "degC" ;
	float Tchill_ws800_3m(time) ;
		Tchill_ws800_3m:_FillValue = 1.e+37f ;
		Tchill_ws800_3m:long_name = "Wind Chill Temperature" ;
		Tchill_ws800_3m:short_name = "Tchill.ws800.3m" ;
		Tchill_ws800_3m:units = "degC" ;
	float RH_ws800_3m(time) ;
		RH_ws800_3m:_FillValue = 1.e+37f ;
		RH_ws800_3m:long_name = "Relative Humidity" ;
		RH_ws800_3m:short_name = "RH.ws800.3m" ;
		RH_ws800_3m:units = "%" ;
	float P_ws800_3m(time) ;
		P_ws800_3m:_FillValue = 1.e+37f ;
		P_ws800_3m:long_name = "Relative Air Pressure" ;
		P_ws800_3m:short_name = "P.ws800.3m" ;
		P_ws800_3m:units = "mb" ;
	float Spd_ws800_3m(time) ;
		Spd_ws800_3m:_FillValue = 1.e+37f ;
		Spd_ws800_3m:long_name = "Wind Speed" ;
		Spd_ws800_3m:short_name = "Spd.ws800.3m" ;
		Spd_ws800_3m:units = "m/s" ;
	float raina_ws800_3m(time) ;
		raina_ws800_3m:_FillValue = 1.e+37f ;
		raina_ws800_3m:long_name = "Precipitation quantity" ;
```

```
        raina_ws800_3m:short_name = "raina.ws800.3m" ;
        raina_ws800_3m:units = "mm" ;
float preciptype_ws800_3m(time) ;
        preciptype_ws800_3m:_FillValue = 1.e+37f ;
        preciptype_ws800_3m:long_name = "Precipitation type" ;
        preciptype_ws800_3m:short_name = "preciptype.ws800.3m" ;
        preciptype_ws800_3m:units = "1" ;
float rainr_ws800_3m(time) ;
        rainr_ws800_3m:_FillValue = 1.e+37f ;
        rainr_ws800_3m:long_name = "Precipitation intensity" ;
        rainr_ws800_3m:short_name = "rainr.ws800.3m" ;
        rainr_ws800_3m:units = "mm/hr" ;
float Sn_ws800_3m(time) ;
        Sn_ws800_3m:_FillValue = 1.e+37f ;
        Sn_ws800_3m:long_name = "Min. wind speed" ;
        Sn_ws800_3m:short_name = "Sn.ws800.3m" ;
        Sn_ws800_3m:units = "m/s" ;
float Sx_ws800_3m(time) ;
        Sx_ws800_3m:_FillValue = 1.e+37f ;
        Sx_ws800_3m:long_name = "Max. wind speed" ;
        Sx_ws800_3m:short_name = "Sx.ws800.3m" ;
        Sx_ws800_3m:units = "m/s" ;
float Sg_ws800_3m(time) ;
        Sg_ws800_3m:_FillValue = 1.e+37f ;
        Sg_ws800_3m:long_name = "Avg. wind speed" ;
        Sg_ws800_3m:short_name = "Sg.ws800.3m" ;
        Sg_ws800_3m:units = "m/s" ;
float Sv_ws800_3m(time) ;
        Sv_ws800_3m:_FillValue = 1.e+37f ;
        Sv_ws800_3m:long_name = "Vct. wind speed" ;
        Sv_ws800_3m:short_name = "Sv.ws800.3m" ;
        Sv_ws800_3m:units = "m/s" ;
float Da_ws800_3m(time) ;
        Da_ws800_3m:_FillValue = 1.e+37f ;
        Da_ws800_3m:long_name = "Act. wind direction" ;
        Da_ws800_3m:short_name = "Da.ws800.3m" ;
        Da_ws800_3m:units = "deg" ;
float Dn_ws800_3m(time) ;
        Dn_ws800_3m:_FillValue = 1.e+37f ;
        Dn_ws800_3m:long_name = "Min. wind direction" ;
        Dn_ws800_3m:short_name = "Dn.ws800.3m" ;
        Dn_ws800_3m:units = "deg" ;
float Dx_ws800_3m(time) ;
        Dx_ws800_3m:_FillValue = 1.e+37f ;
        Dx_ws800_3m:long_name = "Max. wind direction" ;
        Dx_ws800_3m:short_name = "Dx.ws800.3m" ;
```

```
        Dx_ws800_3m:units = "deg" ;
float None(time) ;
        None:_FillValue = 1.e+37f ;
        None:short_name = "None" ;
float Ca_ws800_3m(time) ;
        Ca_ws800_3m:_FillValue = 1.e+37f ;
        Ca_ws800_3m:long_name = "Act. compass heading" ;
        Ca_ws800_3m:short_name = "Ca.ws800.3m" ;
        Ca_ws800_3m:units = "deg" ;
float Ga_ws800_3m(time) ;
        Ga_ws800_3m:_FillValue = 1.e+37f ;
        Ga_ws800_3m:long_name = "Act. global radiation" ;
        Ga_ws800_3m:short_name = "Ga.ws800.3m" ;
        Ga_ws800_3m:units = "W/m" ;
float Gn_ws800_3m(time) ;
        Gn_ws800_3m:_FillValue = 1.e+37f ;
        Gn_ws800_3m:long_name = "Min. global radiation" ;
        Gn_ws800_3m:short_name = "Gn.ws800.3m" ;
        Gn_ws800_3m:units = "W/m" ;
float Gx_ws800_3m(time) ;
        Gx_ws800_3m:_FillValue = 1.e+37f ;
        Gx_ws800_3m:long_name = "Max. global radiation" ;
        Gx_ws800_3m:short_name = "Gx.ws800.3m" ;
        Gx_ws800_3m:units = "W/m" ;
float Gg_ws800_3m(time) ;
        Gg_ws800_3m:_FillValue = 1.e+37f ;
        Gg_ws800_3m:long_name = "Avg. global radiation" ;
        Gg_ws800_3m:short_name = "Gg.ws800.3m" ;
        Gg_ws800_3m:units = "W/m" ;
float Ea_ws800_3m(time) ;
        Ea_ws800_3m:_FillValue = 1.e+37f ;
        Ea_ws800_3m:long_name = "Act. specific enthalpy" ;
        Ea_ws800_3m:short_name = "Ea.ws800.3m" ;
        Ea_ws800_3m:units = "KJ/kg" ;
float Ba_ws800_3m(time) ;
        Ba_ws800_3m:_FillValue = 1.e+37f ;
        Ba_ws800_3m:long_name = "Act. Web Bulb Temperature" ;
        Ba_ws800_3m:short_name = "Ba.ws800.3m" ;
        Ba_ws800_3m:units = "degC" ;
float Ad_ws800_3m(time) ;
        Ad_ws800_3m:_FillValue = 1.e+37f ;
        Ad_ws800_3m:long_name = "Act. Air Density" ;
        Ad_ws800_3m:short_name = "Ad.ws800.3m" ;
        Ad_ws800_3m:units = "kg/m" ;
float La_ws800_3m(time) ;
        La_ws800_3m:_FillValue = 1.e+37f ;
```

```
        La_ws800_3m:long_name = "Leaf Wetness" ;
        La_ws800_3m:short_name = "La.ws800.3m" ;
        La_ws800_3m:units = "mV" ;
float Lb_ws800_3m(time) ;
        Lb_ws800_3m:_FillValue = 1.e+37f ;
        Lb_ws800_3m:long_name = "Leaf Wetness State (0=dry, 1=wet)" ;
        Lb_ws800_3m:short_name = "Lb.ws800.3m" ;
        Lb_ws800_3m:units = "1" ;
float Dir_ws800_3m(time) ;
        Dir_ws800_3m:_FillValue = 1.e+37f ;
        Dir_ws800_3m:long_name = "Vector wind direction" ;
        Dir_ws800_3m:short_name = "Dir.ws800.3m" ;
        Dir_ws800_3m:units = "deg" ;
float T_ws300_2m(time) ;
        T_ws300_2m:_FillValue = 1.e+37f ;
        T_ws300_2m:long_name = "Air Temperature" ;
        T_ws300_2m:short_name = "T.ws300.2m" ;
        T_ws300_2m:units = "degC" ;
float RH_ws300_2m(time) ;
        RH_ws300_2m:_FillValue = 1.e+37f ;
        RH_ws300_2m:long_name = "Relative Humidity" ;
        RH_ws300_2m:short_name = "RH.ws300.2m" ;
        RH_ws300_2m:units = "%" ;
float P_ws300_2m(time) ;
        P_ws300_2m:_FillValue = 1.e+37f ;
        P_ws300_2m:long_name = "Relative Air Pressure" ;
        P_ws300_2m:short_name = "P.ws300.2m" ;
        P_ws300_2m:units = "mb" ;
float Td_ws300_2m(time) ;
        Td_ws300_2m:_FillValue = 1.e+37f ;
        Td_ws300_2m:long_name = "Dewpoint Temperature" ;
        Td_ws300_2m:short_name = "Td.ws300.2m" ;
        Td_ws300_2m:units = "degC" ;
float P_ptb_2m(time) ;
        P_ptb_2m:_FillValue = 1.e+37f ;
        P_ptb_2m:long_name = "Barometric Pressure, Vaisala PTB 210" ;
        P_ptb_2m:short_name = "P.ptb.2m" ;
        P_ptb_2m:units = "mb" ;
float P_P__ptb_2m(time) ;
        P_P__ptb_2m:_FillValue = 1.e+37f ;
        P_P__ptb_2m:long_name = "2nd moment" ;
        P_P__ptb_2m:short_name = "P\'P\'.ptb.2m" ;
        P_P__ptb_2m:units = "(mb)^2" ;
float Rsw_in_1m(time) ;
        Rsw_in_1m:_FillValue = 1.e+37f ;
        Rsw_in_1m:long_name = "Incoming Short Wave, Hukseflux NR01" ;
```

```
        Rsw_in_1m:short_name = "Rsw.in.1m" ;
        Rsw_in_1m:units = "W/m^2" ;
float Rsw_out_1m(time) ;
        Rsw_out_1m:_FillValue = 1.e+37f ;
        Rsw_out_1m:long_name = "Outgoing Short Wave, Hukesflux NR01" ;
        Rsw_out_1m:short_name = "Rsw.out.1m" ;
        Rsw_out_1m:units = "W/m^2" ;
float Rpile_in_1m(time) ;
        Rpile_in_1m:_FillValue = 1.e+37f ;
        Rpile_in_1m:long_name = "Incoming Thermopile, Hukseflux NR01" ;
        Rpile_in_1m:short_name = "Rpile.in.1m" ;
        Rpile_in_1m:units = "W/m^2" ;
float Rpile_out_1m(time) ;
        Rpile_out_1m:_FillValue = 1.e+37f ;
        Rpile_out_1m:long_name = "Outgoing Thermopile, Hukesflux NR01" ;
        Rpile_out_1m:short_name = "Rpile.out.1m" ;
        Rpile_out_1m:units = "W/m^2" ;
float Tcase_1m(time) ;
        Tcase_1m:_FillValue = 1.e+37f ;
        Tcase_1m:long_name = "Case temperature, Hukesflux NR01" ;
        Tcase_1m:short_name = "Tcase.1m" ;
        Tcase_1m:units = "degC" ;
float Dir_10m(time) ;
        Dir_10m:_FillValue = 1.e+37f ;
        Dir_10m:long_name = "Vector wind direction" ;
        Dir_10m:short_name = "Dir.10m" ;
        Dir_10m:units = "deg" ;
float Spd_10m(time) ;
        Spd_10m:_FillValue = 1.e+37f ;
        Spd_10m:long_name = "Wind speed, Gill WindObserver" ;
        Spd_10m:short_name = "Spd.10m" ;
        Spd_10m:units = "m/s" ;
float Tc_10m(time) ;
        Tc_10m:_FillValue = 1.e+37f ;
        Tc_10m:long_name = "Sonic temperature, Gill WindObserver" ;
        Tc_10m:short_name = "Tc.10m" ;
        Tc_10m:units = "degC" ;
float Status_10m(time) ;
        Status_10m:_FillValue = 1.e+37f ;
        Status_10m:long_name = "Status, Gill WindObserver" ;
        Status_10m:short_name = "Status.10m" ;
float U_10m(time) ;
        U_10m:_FillValue = 1.e+37f ;
        U_10m:long_name = "Wind U component, Gill WindObserver" ;
        U_10m:short_name = "U.10m" ;
        U_10m:units = "m/s" ;
```

```
float V_10m(time) ;
        V_10m:_FillValue = 1.e+37f ;
        V_10m:long_name = "Wind V component, Gill WindObserver" ;
        V_10m:short_name = "V.10m" ;
        V_10m:units = "m/s" ;
float GPSnsat(time) ;
        GPSnsat:_FillValue = 1.e+37f ;
        GPSnsat:long_name = "Number of GPS satellites tracked" ;
        GPSnsat:short_name = "GPSnsat" ;
        GPSnsat:units = "count" ;
float GPSstat(time) ;
        GPSstat:_FillValue = 1.e+37f ;
        GPSstat:long_name = "GPS rcvr status: 1=OK(A), 0=warning(V)" ;
        GPSstat:short_name = "GPSstat" ;
        GPSstat:units = "none" ;
float GPSdiff(time) ;
        GPSdiff:_FillValue = 1.e+37f ;
        GPSdiff:long_name = "GPS NMEA receipt time - NMEA time value" ;
        GPSdiff:short_name = "GPSdiff" ;
        GPSdiff:units = "s" ;
float Status_3m(time) ;
        Status_3m:_FillValue = 1.e+37f ;
        Status_3m:long_name = "System status" ;
        Status_3m:short_name = "Status.3m" ;
float Vis_3m(time) ;
        Vis_3m:_FillValue = 1.e+37f ;
        Vis_3m:long_name = "Visibility" ;
        Vis_3m:short_name = "Vis.3m" ;
        Vis_3m:units = "m" ;
float Part_3m(time) ;
        Part_3m:_FillValue = 1.e+37f ;
        Part_3m:long_name = "Particle counts" ;
        Part_3m:short_name = "Part.3m" ;
        Part_3m:units = "count/min" ;
float Rainr_3m(time) ;
        Rainr_3m:_FillValue = 1.e+37f ;
        Rainr_3m:long_name = "Precipitation intensity" ;
        Rainr_3m:short_name = "Rainr.3m" ;
        Rainr_3m:units = "mm/h" ;
float Generic_3m(time) ;
        Generic_3m:_FillValue = 1.e+37f ;
        Generic_3m:long_name = "Generic code" ;
        Generic_3m:short_name = "Generic.3m" ;
float SYNOP_3m(time) ;
        SYNOP_3m:_FillValue = 1.e+37f ;
        SYNOP_3m:long_name = "SYNOP code" ;
```

```
        SYNOP_3m:short_name = "SYNOP.3m" ;
float T_3m(time) ;
        T_3m:_FillValue = 1.e+37f ;
        T_3m:long_name = "Temperature" ;
        T_3m:short_name = "T.3m" ;
        T_3m:units = "degC" ;
float Rainr(time) ;
        Rainr:_FillValue = 1.e+37f ;
        Rainr:long_name = "Rain rate" ;
        Rainr:short_name = "Rainr" ;
        Rainr:units = "mm/h" ;
float Tcell(time) ;
        Tcell:_FillValue = 1.e+37f ;
        Tcell:long_name = "Sensor temperature" ;
        Tcell:short_name = "Tcell" ;
        Tcell:units = "degC" ;
float WX(time) ;
        WX:_FillValue = 1.e+37f ;
        WX:long_name = "Present weather code" ;
        WX:short_name = "WX" ;
float Vis(time) ;
        Vis:_FillValue = 1.e+37f ;
        Vis:long_name = "MOR visibility" ;
        Vis:short_name = "Vis" ;
        Vis:units = "m" ;
float N(time) ;
        N:_FillValue = 1.e+37f ;
        N:long_name = "Number of particles" ;
        N:short_name = "N" ;
```

Appendix B: PurpleAir SD card CSV File Header Descriptions

URL Reference

The SD Card version of the PA-II (PA-II-SD) has a built in real time clock and OPENLOG serial logger. The SD card contains data in CSV format with the following headers:

`UTCDateTime, mac_address, firmware_ver, hardware, current_temp_f, current_humidity, current_dewpoint_f, pressure, adc, mem, rssi, uptime, pm1_0_atm, pm2_5_atm, pm10_0_atm, pm1_0_cf_1, pm2_5_cf_1, pm10_0_cf_1, p_0_3_um, p_0_5_um, p_1_0_um, p_2_5_um, p_5_0_um, p_10_0_um, pm1_0_atm_b, pm2_5_atm_b, pm10_0_atm_b, pm1_0_cf_1_b, pm2_5_cf_1_b, pm10_0_cf_1_b, p_0_3_um_b, p_0_5_um_b, p_1_0_um_b, p_2_5_um_b, p_5_0_um_b, p_10_0_um_b`

UTCDateTime: The Date and time derived from the Real Time Clock and synced with NTP where possible (in UTC).

Mac_address: The MAC address of the WiFi module on the sensor (used as an ID for the unit).

Firmware_ver: Firmware version of the control board.

Hardware: Hardware the control board has detected.

current_temp_f: Current temperature in F.

Current_humidity: Current Humidity in %.

Current_dewpoint_f: Calculated dew point in F.

Pressure: Current pressure in millibars.

Adc: The voltage reading on the analog input of the control board.

Mem: Free HEAP memory on the control board.

Rssi: WiFi signal strength in dBm

Uptime: Firmware uptime in seconds.

Pm1_0_atm: Channel A ATM PM1.0 particulate mass in ug/m3

Pm2_5_atm: Channel A ATM PM2.5 particulate mass in ug/m3

Pm10_0_atm: Channel A ATM PM10.0 particulate mass in ug/m3

Pm1_0_cf_1: Channel A CF=1 PM1.0 particulate mass in ug/m3

Pm2_5_cf_1: Channel A CF=1 PM2.5 particulate mass in ug/m3

Pm10_0_cf_1: Channel A CF=1 PM10.0 particulate mass in ug/m3

P_0_3_um: Channel A 0.3 micrometer particle counts per deciliter of air

P_0_5_um: Channel A 0.5 micrometer particle counts per deciliter of air

P_1_0_um: Channel A 1.0 micrometer particle counts per deciliter of air

P_2_5_um: Channel A 2.5 micrometer particle counts per deciliter of air

P_5_0_um: Channel A 5.0 micrometer particle counts per deciliter of air

P_10_0_um: Channel A 10.0 micrometer particle counts per deciliter of air

Pm1_0_atm_b: Channel B ATM PM1.0 particulate mass in ug/m3.

Pm2_5_atm_b: Channel B ATM PM2.5 particulate mass in ug/m3

Pm10_0_atm_b: Channel B ATM PM10.0 particulate mass in ug/m3

Pm1_0_cf_1_b: Channel B CF=1 PM1.0 particulate mass in ug/m3

Pm2_5_cf_1_b: Channel B CF=1 PM2.5 particulate mass in ug/m3

Pm10_0_cf_1_b: Channel B CF=1 PM10.0 particulate mass in ug/m3

P_0_3_um_b: Channel B 0.3 micrometer particle counts per deciliter of air

P_0_5_um_b: Channel B 0.5 micrometer particle counts per deciliter of air

P_1_0_um_b: Channel B 1.0 micrometer particle counts per deciliter of air

P_2_5_um_b: Channel B 2.5 micrometer particle counts per deciliter of air

P_5_0_um_b: Channel B 5.0 micrometer particle counts per deciliter of air

P_10_0_um_b: Channel B 10.0 micrometer particle counts per deciliter of air

PA-II NOTES:

Each sensor contains two identical laser counters, hence channel A and B. If these two channels do not agree to some extent then there is something wrong with one or both channels.

Plantower PMS sensor notes:

ATM is "atmospheric", meant to be used for outdoor applications

CF=1 is meant to be used for indoor or controlled environment applications

However, PurpleAir uses CF=1 values on the map. This value is lower than the ATM value in higher measured concentrations.