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Dropsonde Data Quality Report

Clouds, Aerosol and Monsoon Processes-Philippines Experiment (CAMP^{2}Ex, 2019)

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Campaign Websites:
CAMP^{2}Ex home page:
https://espo.nasa.gov/camp2ex
AVAPS dropsondes home page:
https://www.eol.ucar.edu/observing_facilities/avaps-dropsonde-system

To refer to this data quality report, please include the following citation:

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To refer to the data set, please include the following citation:

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Document Version Control

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1.0	6 Jan 2020	H. Vömel	Initial Version

1 Table of Contents

2 Dataset overview

The Clouds, Aerosol and Monsoon Processes-Philippines Experiment (CAMP²Ex) is a NASA airborne mission with the goal to characterize the role of anthropogenic and natural aerosol particles in modulating the frequency and amount of warm and mixed phase precipitation in the vicinity of the Philippines during the Southwest Monsoon. In partnership with Philippine research and operational weather communities, CAMP²Ex provides a comprehensive 4-D observational view of the environment of the Philippines and its neighboring waters in terms of microphysical, hydrological, dynamical, thermodynamical and radiative properties of the environment, targeting the environment of shallow cumulus and cumulus congestus clouds.

The NASA Earth Science Division operated NASA's P-3 (tail number N426NA) research aircraft and the SPEC, Inc. Lear Jet 35A out of Clark Airport in the Philippines during the period 20 August to 10 October 2019. The NASA P-3 conducted nineteen research flights, during which between five and eighteen NCAR RD41 dropsondes were released for a total of 197 sondes.

The flight tracks of all 19 research flights are shown in Figure 1, including the locations of all dropsonde releases.

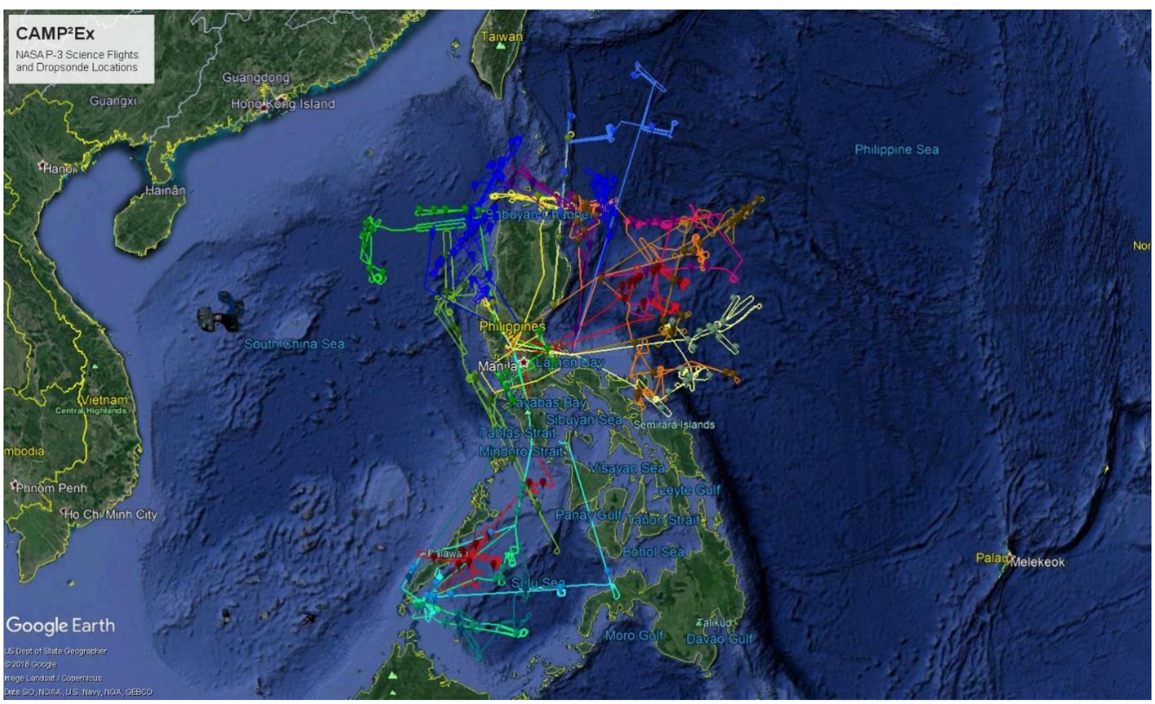

Figure 1: NASA P-3 science flights and dropsonde locations.

Table 1 provides a summary of all dropsondes that were released during CAMP²Ex. The quadrant indicates where, relative to Clark Airport, the majority of the dropsondes in a particular research flight were released. A detailed listing of all profiles is provided in Section 8.

Table 2 provides a summary of the performance of the dropsonde system as whole. In total, 197 sondes were released from the aircraft. Three soundings failed at launch and provided no data. In three soundings, the GPS unit failed completely and provided no useful wind and position information. In all, entire profile data down to the surface were retrieved. However, GPS wind and position information was delayed in a significant fraction of the soundings, leading to some loss of wind data at the top of the profile below flight level. This issue is discussed in more detail below.

Table 1: Summary of all successful sonde releases during CAMP²Ex. The quadrant indicates where the majority of the drops were released during that flight relative to Clark Airport.

Flight	Quadrant	Date	# of Soundings
SF01	NE	24 Aug	15
SF02	NW	27 Aug	11
SF03	SW	29 Aug	9
SF04	SW	31 Aug	9
SF05	SW	04 Sep	5
SF06	SW	07 Sep	9
SF07	NE	09 Sep	10
SF08	NE	13 Sep	7
SF09	SW	15 Sep	11
SF10	SW	16 Sep	18
SF11	NE	19 Sep	5
SF12	NE	21 Sep	11
SF13	SW	24 Sep	16
SF14	SE	25 Sep	7
SF15	NE	27 Sep	8
SF16	NW	29 Sep	17
SF17	SW	01 Oct	13
SF18	SE	03 Oct	7
SF19	NE	05 Oct	10

Table 2: Summary of the dropsonde system performance.

	# of Sondes	Percent
Total number of sondes released	197	100
Successful releases	194	98.5
Complete thermodynamic profiles to the ground	194	98.5
Complete wind profiles to the ground*	191	97.0

*) Wind and position data were delayed in a number of soundings, which is not considered in this summary statistics. All but three sondes provided wind measurements in the lower part of the profile.

3 Dropsonde sounding system

The NCAR dropsonde system deployed in CAMP²Ex used a manual launcher and the NCAR Dropsonde model RD41, which is produced and marketed in license by Vaisala.

The RD41 dropsonde uses the pressure, temperature, and humidity sensor of the Vaisala RS41 radiosonde and includes an improved version of the GPS, telemetry, and parachute release system of the previous RD94 dropsonde, which had been in use between 2010 and 2018. The RD41 dropsonde has been extensively evaluated by NOAA/AOC and the Air Force and has been in operational use for hurricane observations since 2019.

The smaller version of this dropsonde, the NCAR Research Dropsonde NRD41, was developed in parallel to the RD41 and has most recently been used during the Organization of Tropical East Pacific Convection (OTREC) campaign, which took place in the Eastern Pacific and Caribbean in parallel with CAMP²Ex.

All dropsonde humidity sensors were reconditioned on the aircraft prior to take off. This process, which is unique to the xRD41 dropsondes, reduces the potential of humidity contamination to a minimum and assures the best measurement performance of the humidity sensor throughout the entire altitude and temperature range of a dropsonde profile.

The AVAPS LabVIEW based software receives and stores data from the dropsondes and the aircraft data system and monitors the entire AVAPS system. The AVAPS station and manual launch tube were installed in the rear of the NASA P-3. All sondes were initialized by the dropsonde operators prior to a drop and then placed inside the launch tube. At the intended drop location, the operator released the sondes by activating the electrically controlled launcher release valve. Due to the shielding provided by the launch tube, no data were received while the dropsondes were inside the launch tube.

CAMP²Ex scientific staff controlled the quality of each sounding after each science flight using the Atmospheric Sounding Processing ENvironment (ASPEN) software package.

The GPS units of the dropsondes were initialized as part of the pre-launch preparations to speed up the lock onto the satellite signals. This required continued reception of GPS signals by the GPS receivers after initialization. The GPS signals were provided by a GPS antenna outside the aircraft and sent through a series of splitters in the AVAPS rack and the launch tube. Unfortunately, the cable feeding the GPS signals to the re-radiation unit of the launch tube had been disconnected between the test flights and the main campaign. In addition, a post campaign inspection of the setup found that the cable used during the campaign was most likely broken. While this component had been working properly during the test flights, it was no longer working during the campaign. As a result, all sondes were launched without proper GPS lock, which forced them to acquire proper GPS lock after launch and significantly delayed the start of wind measurements.

4 Quality control procedures

4.1 Standard quality control

Standard quality control in near real time and as part of the final data QC is based on the algorithms implemented in the ASPEN software. The following quality checks, corrections, and calculations are performed:

- Removal of outliers and suspect data points in pressure, temperature, humidity, zonal and meridional wind, latitude, and longitude
- Removal of data between release from the aircraft and equilibration with atmospheric conditions
- Dynamic correction to account for the lag of the RD41 temperature sensor using the appropriate coefficients for the RD41 dropsondes
- Dynamic correction to account for the sonde inertia in the determination of the wind profile using the appropriate parameters for the RD41 dropsondes
- Smoothing of pressure, temperature, humidity, zonal and meridional wind
- Recomputation of wind speed and wind direction after smoothing of the wind components
- Extrapolation of the last reported pressure reading to a surface pressure value, based on the fall rate of the sonde
- Recalculation of the geopotential height from the surface to the top of the profile
- Computation of the vertical wind speed component

This campaign used the new RD41 dropsonde, which has a faster temperature sensor and faster RH sensor than the older RD94 sondes. This has been considered in the final dropsonde QC by changing the ASPEN QC parameters for these two sensors. The equilibration time for the temperature and RH sensor has been adjusted to 10 s, and the smoothing wavelength for both parameters has been adjusted to 5 s.

4.2 Custom quality control

4.2.1 Pressure corrections

The pressure sensor of the RD41 dropsonde is known to have a small bias. The sensor bias is measured during the production of the dropsondes and stored in the sonde to minimize the bias during observation. A correction has already been applied in the generation of the raw data and all data are assumed to have only a minimal bias.

The statistics of the pressure correction built into the sonde is shown in Figure 2. The mean pressure offset is -0.56 hPa and the standard deviation 0.18 hPa.

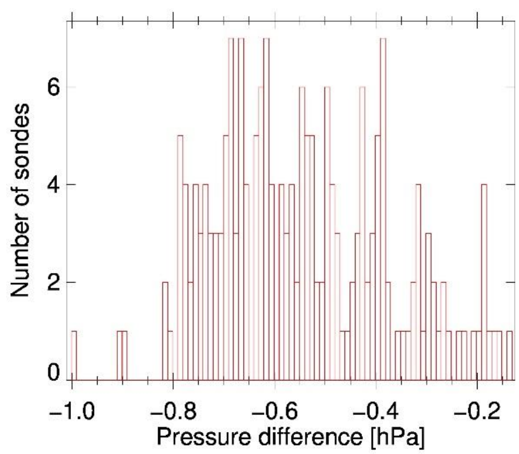

Figure 2: Pressure offset between the dropsonde and the reference stored in the sonde.

In sounding 20190830_014139, the pressure correction has erroneously not been applied in real time. This was corrected in the post processing, and a pressure offset correction of 0.76 hPa was added to the entire profile.

During CAMP²Ex, most sondes exhibit a small pressure measurement issue. For reasons currently unknown, the dropsondes occasionally repeated a reported pressure measurement. This happened up to 20 times per sounding and in a few cases more frequently. While this is barely noticeable in any vertical profile, it slightly increases the noise in the calculated vertical fall rate. In post processing, these repeated pressure readings were interpolated and the fall rates recalculated. Only pressure readings had to be corrected. Temperature and relative humidity readings do not show any artificial repetition of measurements.

4.2.2 Temperature performance

The performance of the temperature sensor was without anomalies. In all soundings the sensor equilibrated to ambient conditions within less than 10 s after release.

4.2.3 Relative humidity

The RH sensor on the RD41 dropsondes should be reconditioned prior to launch and the sondes store whether the reconditioning was successful. With this information, we could verify that all sondes were properly reconditioned prior to take off on each flight. Any contamination in the sensor material was removed and the relative humidity sensors are expected to have a negligible calibration drift.

The RH sensor worked as expected in all profiles. Four soundings show shallow layers with a relative humidity well above 100% (Table 3). All high RH layers correlate with significant updrafts or turbulence, where water loading may influence the humidity sensor and microphysics may lead to humidities above 100%. While in these layers the uncertainty of the RH sensor may be larger than normal, there is no indication that the relative humidity measurements outside of these layers have been affected.

In the quality-controlled data, these layers have been set to 100% following meteorological convention.

Table 3: Layers with measurements of relative humidity well above 100%.

#	Research Flight	Sounding	Layer thickness	Layer RH
1	SF03	20190829_235222	300 m	103.6
	SF03	20190829_235222	200 m	105.6
2	SF13	20190924_030458	2 km	< 108 %
3	SF13	20190924_063601	200 m	103.5
4	SF13	20190924_064021	1.3 km	< 109 %

Sounding 20190904_013129 (SF05) shows an unusually dry boundary layer with a minimum relative humidity of 42 % at about 500 m altitude. This is about 50% drier than the median at that altitude and 20% drier than the next driest profile. At the same time, the profile is nearly isothermal in the boundary layer, showing the warmest temperatures of the entire data set. The fall rate is normal and the profile does not indicate extreme atmospheric conditions. All engineering data of the sonde indicate proper functioning of the instrument, and the humidity profile lies within the normal range between flight level and about 2 km. Below 2 km, the profile shows a smoother profile than all other soundings. The last data point above the surface shows a relative humidity within the distribution of all other profiles. This profile may require more scientific attention and validation.

4.2.4 Data coverage

Almost all soundings transmitted data to landing in the water and some sondes continued transmitting data from the ocean surface before sinking. Data from the ocean surface were removed from the final data set.

Although sounding 20190907_071254 stopped transmitting abruptly, which normally indicates landing in the water, the GPS altitude, the downward integrated geopotential altitude, and the last reported pressure indicate that telemetry transmission may have stopped about 60 m above the water surface. As a result, this sounding was processed with a downward integrated geopotential altitude and no reported surface pressure.

Due to the poor GPS performance in two soundings, some data immediately after launch were not processed properly. Table 4 lists these soundings and the length of the data gap in the processed data. These data were recovered from the raw data and added to the processed data.

Table 4: Soundings with gaps in processed data after launch.

#	Research Flight	Sounding	Data gap after launch [s]
1	SF10	20190916_225538	12
2	SF16	20190929_070644	36

Two soundings did not produce any data after launch, and one sounding produced a negligible amount of data after launch. These sondes are listed in Table 5 and are omitted in the final data set.

Table 5: Failed sondes at launch.

#	Research Flight	Sounding	Comment
1	SF10	20190917_022806	No data after launch
2	SF13	20190924_022511	No data after launch
3	SF17	20191002_020925	Parachute not released, PTU data after launch sparse, no wind data

4.2.5 Parachute performance

The parachute performed as expected in 97.8 % of all soundings. The median fall rate at the time of landing was 9.9 ± 0.7 m/s. In four sondes (Table 6), the parachute apparently did not function properly throughout the profile and these sondes fell significantly faster. The failure is possibly due to the parachute not opening properly or the delay ribbon properly unwinding. The data of these soundings are included in the data set since no other issues were observed related to the parachute performance.

Some soundings experienced significant variations in the fall rate throughout the profile. These variations are related to strong up- and down-drafts and are not considered a performance issue of the parachute.

Table 6: Fast fall soundings

#	Research Flight	Sounding	Median fall rate
1	SF01	20190825_010501	16.3
2	SF04	20190831_034811	18.3
3	SF06	20190907_032811	19.1
4	SF19	20191005_061720	18.3

4.2.6 GPS performance

As described above, the GPS performance of all sondes was severely affected by a broken cable for the re-radiation of the GPS signal inside the launch tube, which significantly delayed the start of wind measurements. The median time to acquire GPS lock after launch was 32 s, which is consistent with laboratory measurements of GPS cold starts, with some sondes requiring more than 6 min to acquire GPS lock.

The availability of GPS after launch across all soundings is shown in Figure 3. Half of all soundings report proper GPS position and winds 500 m below flight level and 80 % of all soundings report proper GPS at 2.5 km below flight level. Unfortunately, this is a significant degradation from the nominal operation of the dropsondes.

Relative to the surface, the GPS availability increases from about 80% at 2.5 km to more than 98 % in the lowest 500 m above the surface. This availability would have been expected throughout the entire profile, had the re-radiation of the GPS signal inside the launch tube worked properly.

Once GPS lock had been acquired, horizontal speed accuracies reported by the GPS were typically around 0.2 m/s with only three sondes reporting horizontal speed accuracies of up to 0.5 m/s. The horizontal wind uncertainty is slightly larger than this reported value due to the drag correction of the falling dropsonde, which was applied in post processing.

In two soundings (20190831_034811 and 20191005_061720), the GPS unit failed completely and did not report any position or wind measurements. In one sounding (20190922_025606), the GPS measurements reported an excessive speed error and altitude offset. The GPS data in this sounding were removed.

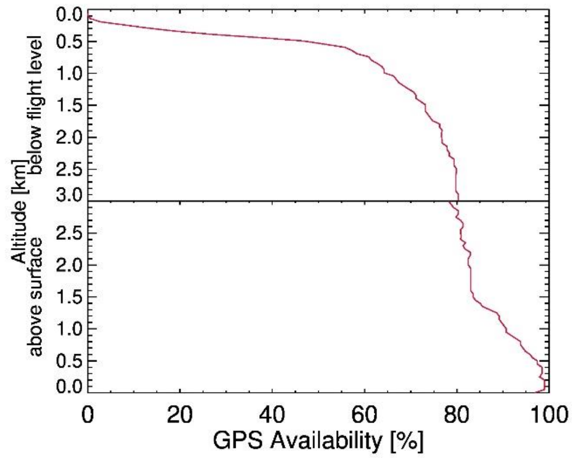

Figure 3: Availability of GPS across all soundings as function of altitude below flight level (top) and above surface (buttom).

5 Data file format

The format follows that defined for the NCAR/EOL/ISF radiosonde NetCDF data files. It is based on the Climate and Forecasting (CF) convention version 1.6 and is compatible with any tool accepting this convention. The data file format is described in Vömel et al. (2018). A similar data format description for dropsondes is in preparation and will describe the more extensive metadata.

The format description can be found at:

Vömel, H., I. Suhr, and G. Granger, 2019,NCAR/EOL/ISF Dropsonde NetCDFData Files, UCAR/NCAR -Earth Observing Laboratory. https://doi.org/10.26023/54wh-rj45

6 Sounding metrics

6.1 Horizontal drift

Wind speeds during CAMP²Ex were generally weak. As a result, the horizontal drift of the dropsondes was relatively small (Figure 4). The mean horizontal distance the dropsondes traveled was 3.1 km and only one sonde traveled more than 10 km horizontally.

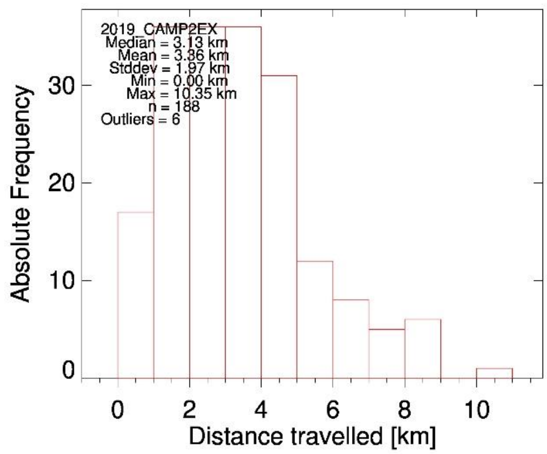

Figure 4: Distance between launch and landing for all dropsondes during CAMP²Ex.

6.2 Surface pressure

The surface pressure reported by the sondes is an extrapolation of the last measured air pressure above the surface to sea level using the current fall rate. The surface pressure reported by all sondes, which transmitted to the surface is shown in Figure 5.

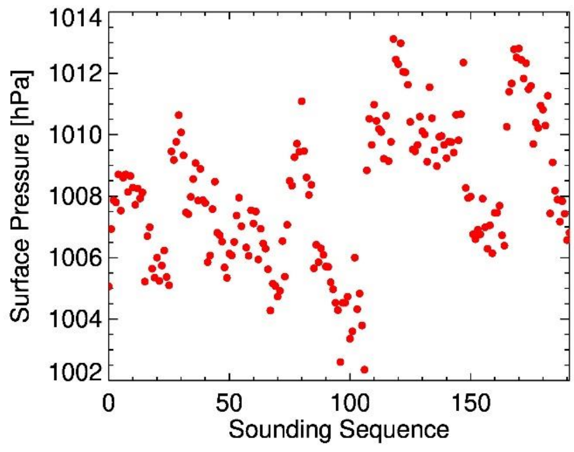

Figure 5: Surface pressure reported by all sondes

6.3 Humidity measurements

Relative humidity measurements from dropsondes are most challenging due to the fast fall rate relative to the typical response time of the sensors. The humidity sensor on the xRD41 dropsondes is identical to that on the Vaisala RS41 radiosondes and suitable for dropsonde observations. The correlation between all temperature and all relative humidity measurements, shown in Figure 6, reveals the sensitivity of this sensor over the parameter space during the campaign. Figure 6 shows that the entire range between 0 and 100% can be observed and that there is a very sharp drop-off above 100%. Following meteorological convention, values above 100% are limited to 100% in the quality controlled data.

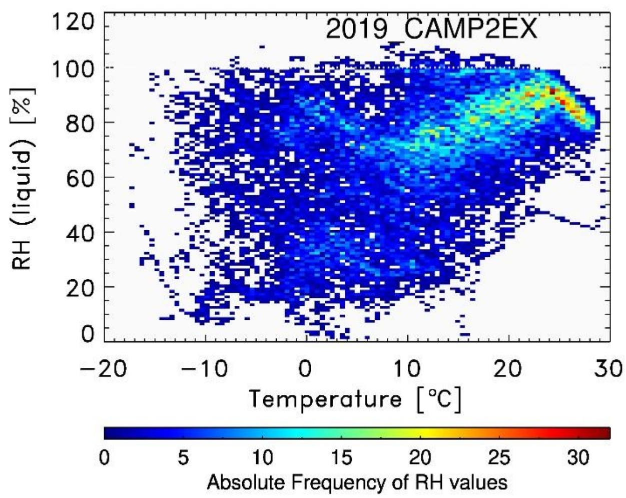

Figure 6: Density plots showing the correlation between all temperature and relative humidity measurements based on raw data.

6.4 Fall rate

A histogram of the fall rate at the time of landing is shown in Figure 7. The median fall rate at landing was 9.9 m/s. The spread of this distribution is due to the performance of the parachutes, as well as atmospheric

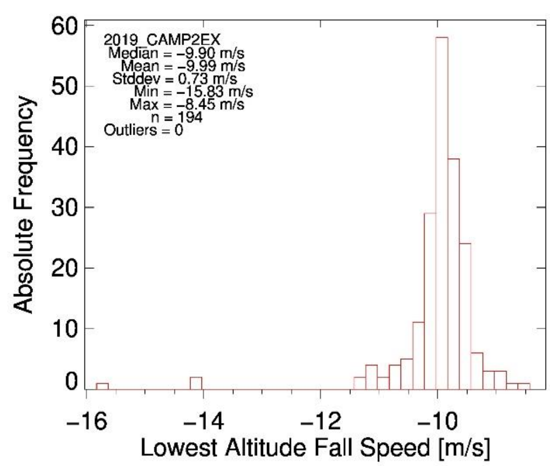

Figure 7: Fall speed near the surface for all dropsondes.

variability in the surface layer. The median fall rate over the entire profile is 11.3 m/s. The consistency of the fall times highlights the quality of the parachute performance of the dropsondes used in CAMP²Ex.

7 Atmospheric observations

7.1 Temperature

The temperature measured by all dropsondes is shown as contour plot in Figure 8. The individual research flights are separated by vertical lines. The temperature at flight level were in the range of -17°C to +10°C and near the surface in the range of 25°C to 31°C.

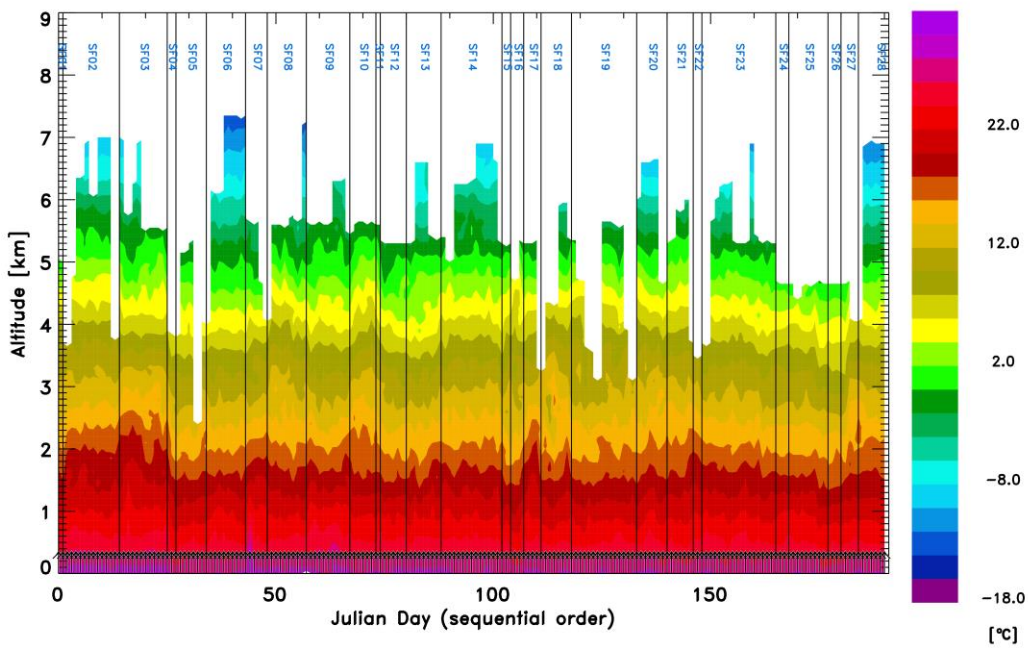

Figure 8: Color contours for all temperature measurements. All soundings are shown in the sequence in which they were released. White areas reflect the different release altitudes. The different science flights are separated by vertical lines and indicated near the top.

7.2 Relative humidity

Relative humidity measured by all dropsondes is shown in Figure 9. At temperatures below 0°C, relative humidity is expressed as relative humidity over ice instead of the conventional relative humidity over liquid water.

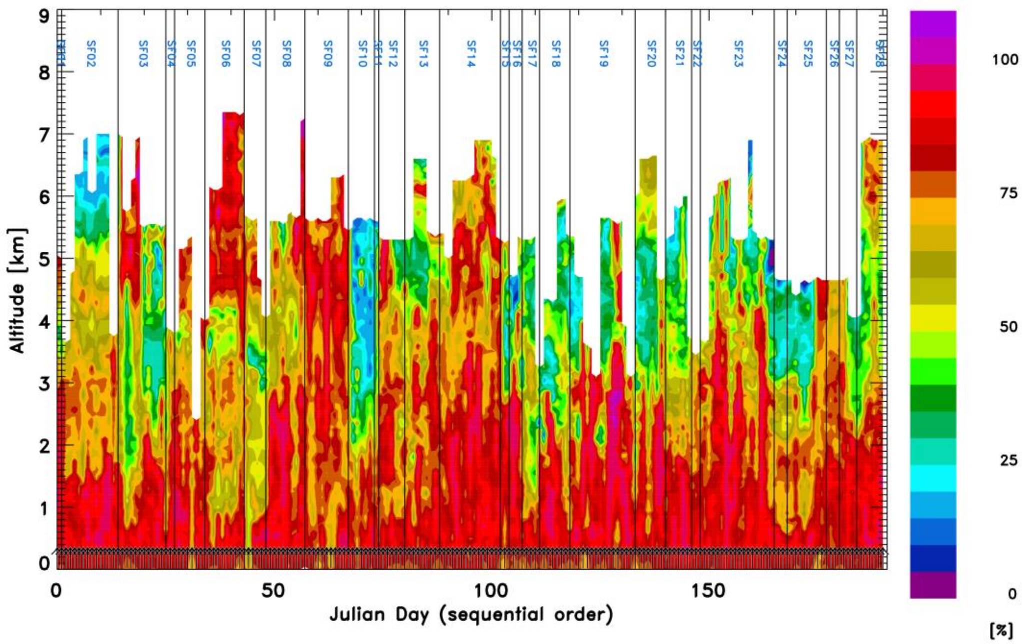

Figure 9: Color contours for all relative humidity measurements. Note that at temperatures below freezing, relative humidity is calculated with respect to ice.

7.3 Zonal winds

Zonal wind speeds are shown in Figure 10. Yellow to reddish colors indicate westerly winds, green to blue colors indicate easterly winds. The white areas indicate mostly missing data, because of the late lock of the GPS unit.

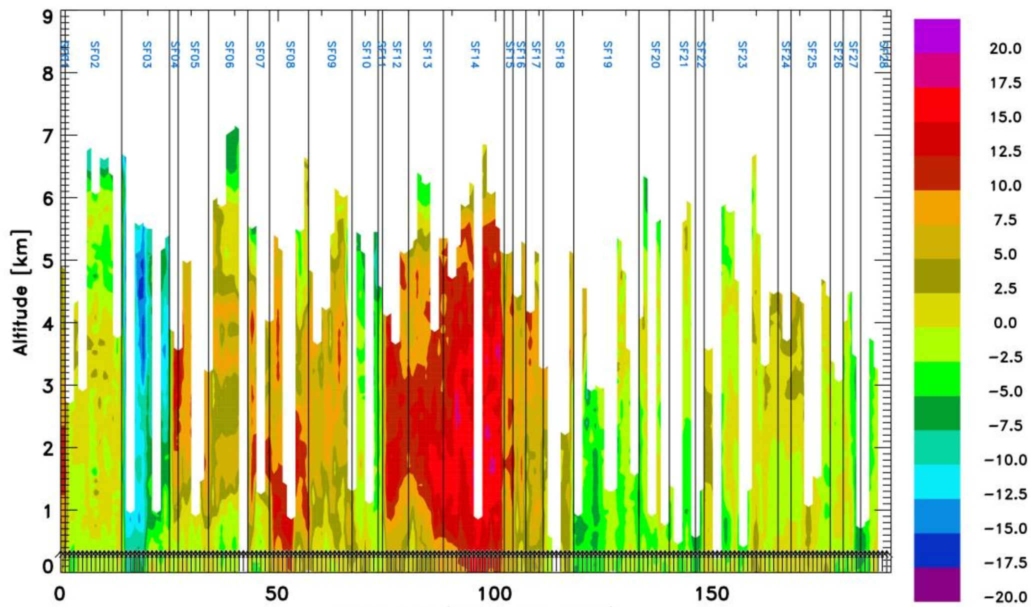

Figure 10: Color contours for all zonal wind speed measurements

8 List of all soundings

#	Date [UTC]	Time [UTC]	Drop Name	Serial number	Alt. [km]	Latitude [deg]	Longitude [deg]	Duration [min]
1	24 Aug 2019	23:11:45	SF01_S01	182440092	6.8	18.24600	118.66646	9.3
2	24 Aug 2019	23:34:23	SF01_S02	182510813	5.2	18.53179	120.49197	7.5
3	25 Aug 2019	00:27:41	SF01_S03	182440095	3.8	19.05619	123.78547	5.7
4	25 Aug 2019	00:31:52	SF01_S04	182510683	4.9	19.26097	123.95997	7.3
5	25 Aug 2019	00:42:18	SF01_S05	182510602	6.5	19.17851	123.36396	9.5
6	25 Aug 2019	00:46:33	SF01_S06	182430265	6.5	18.85147	123.45320	9.3
7	25 Aug 2019	00:56:53	SF01_S07	182520103	7.1	18.50024	123.76839	10.3
8	25 Aug 2019	01:01:29	SF01_S08	182430269	7.2	18.91487	123.69113	10.3
9	25 Aug 2019	01:05:00	SF01_S09	182440070	7.2	19.24966	123.62818	7.1
10	25 Aug 2019	01:32:25	SF01_S10	182440316	7.2	18.33297	123.90068	10.1
11	25 Aug 2019	01:49:03	SF01_S11	182511246	7.2	19.23900	123.71709	10.1
12	25 Aug 2019	01:51:10	SF01_S12	182440071	7.2	19.04735	123.69650	10.3
13	25 Aug 2019	01:55:08	SF01_S13	182520108	7.2	18.69405	123.61471	9.7
14	25 Aug 2019	03:55:54	SF01_S14	182510681	8.1	19.35286	123.51954	11.1
15	25 Aug 2019	04:13:58	SF01_S15	182430263	8.1	17.74378	123.65341	11.3
16	27 Aug 2019	01:01:19	SF02_S01	182720746	7.1	18.73007	120.02476	10.0
17	27 Aug 2019	01:21:55	SF02_S02	182511238	6.0	18.90345	118.32220	8.8
18	27 Aug 2019	01:27:46	SF02_S03	182650211	7.1	18.87233	118.74640	9.8
19	27 Aug 2019	01:31:48	SF02_S04	183320982	7.1	18.85038	119.07968	10.1
20	27 Aug 2019	01:37:59	SF02_S05	183320255	7.1	18.80803	119.64871	10.2
21	27 Aug 2019	03:34:33	SF02_S06	183321086	5.7	18.00049	116.66986	8.3
22	27 Aug 2019	03:50:30	SF02_S07	182720748	5.7	17.36382	116.78424	8.2
23	27 Aug 2019	04:04:06	SF02_S08	182720636	5.7	18.46195	116.88981	8.2
24	27 Aug 2019	04:11:52	SF02_S09	182650212	5.7	18.62255	116.74038	8.1
25	27 Aug 2019	04:15:28	SF02_S10	183320257	5.7	18.31644	116.66205	7.5
26	27 Aug 2019	04:32:31	SF02_S11	182730027	8.1	17.24052	117.19701	11.0
27	29 Aug 2019	23:46:14	SF03_S01	182720793	5.0	9.98249	119.66130	7.5
28	29 Aug 2019	23:52:21	SF03_S02	183321191	5.3	9.72807	119.26957	7.5
29	30 Aug 2019	00:02:04	SF03_S03	182720674	5.3	9.17998	118.75092	7.8
30	30 Aug 2019	00:08:50	SF03_S04	183320983	5.3	9.53697	118.89978	7.3
31	30 Aug 2019	01:04:52	SF03_S05	183320984	7.1	9.24769	119.05355	10.0
32	30 Aug 2019	01:41:38	SF03_S06	182650215	7.1	9.44020	118.08552	10.1
33	30 Aug 2019	02:22:34	SF03_S07	182650213	2.6	9.09929	119.70391	4.1
34	30 Aug 2019	04:33:05	SF03_S08	182510824	4.5	11.29824	120.87186	6.4
35	30 Aug 2019	04:38:04	SF03_S09	182511240	4.2	11.28389	121.25897	6.3
36	31 Aug 2019	00:02:22	SF04_S01_mostlyclrair	182440073	6.4	10.02793	119.72642	9.1
37	31 Aug 2019	00:32:33	SF04_S02_wpalawan	182430270	6.3	9.15755	117.46692	9.0
38	31 Aug 2019	00:58:14	SF04_S03_sattrack	183510468	6.3	8.20907	117.95542	9.0
39	31 Aug 2019	02:42:06	SF04_S04_sattrackNend	182440079	7.5	8.70199	118.08686	10.4
40	31 Aug 2019	02:46:43	SF04_S05_satpass0247	183451041	7.5	8.35025	117.99399	10.5
41	31 Aug 2019	03:05:11	SF04_S06_strtlnE	183510095	7.6	8.37532	117.80926	10.3
42	31 Aug 2019	03:13:16	SF04_S07_strtlnE2	182650207	7.6	8.37601	118.48341	10.4
43	31 Aug 2019	03:48:11	SF04_S08_strtlnE3	182630336	7.5	8.38065	121.50705	6.6
44	31 Aug 2019	05:26:00	SF04_S09_CALIPSOdrop	183320254	8.4	8.72733	122.83495	11.2
45	04 Sep 2019	01:31:29	SF05_S01_SWpalawan	182440076	5.8	8.88627	117.33017	8.4
46	04 Sep 2019	02:04:09	SF05_S02_1stcldstrt_transect	182440075	5.8	7.34791	118.66481	8.6
47	04 Sep 2019	03:49:02	SF05_S03_1stcldstrt_alongN	182510605	6.4	7.65014	118.58438	9.2
48	04 Sep 2019	05:06:19	SF05_S04_overshiptrk	182440078	4.8	7.50015	120.23288	7.3
49	04 Sep 2019	06:17:36	SF05_S05_2ndcldstrt_transect	182440074	4.2	8.37993	120.53648	6.4
50	07 Sep 2019	00:31:18	SF06_S01_envcloud	182440077	5.8	16.57766	118.97271	8.4
51	07 Sep 2019	00:42:13	SF06_S02_abovestreets	183340018	5.8	17.52451	118.97423	8.4
52	07 Sep 2019	03:05:51	SF06_S03_vicinity_strong_conv	182440094	5.8	15.65487	119.07204	8.5
53	07 Sep 2019	03:28:10	SF06_S04_afterlear_depart	182430267	5.8	16.75851	119.46842	5.8
54	07 Sep 2019	04:28:13	SF06_S05_ne_env_conds	182440093	5.9	15.53239	119.23268	8.3
55	07 Sep 2019	05:11:06	SF06_S06_envcond_mindorost	182430268	6.5	11.99564	120.47302	8.8

56	07 Sep 2019	05:59:51	SF06_S07_throughaltocu	182430264	5.8	10.61400	121.07404	8.5
57	07 Sep 2019	06:35:58	SF06_S08_env_before_sec_lr	182440086	7.4	13.61691	119.98608	10.3
58	07 Sep 2019	07:12:54	SF06_S09_beforeboxspiral	182440085	7.4	14.22304	119.62713	10.2
59	09 Sep 2019	00:47:37	SF07_S01_intransit	182510625	5.8	17.73682	122.78715	8.6
60	09 Sep 2019	00:52:36	SF07_S02_aheadconv	182510626	5.8	18.22267	122.79524	8.5
61	09 Sep 2019	00:59:25	SF07_S03_behindconv	183510011	5.8	18.87323	122.80625	8.5
62	09 Sep 2019	01:09:00	SF07_S04_edgeconv	182510629	5.8	18.51009	123.16419	8.7
63	09 Sep 2019	01:14:53	SF07_S05_convtowr	182430266	5.8	18.58303	123.02254	7.8
64	09 Sep 2019	02:17:58	SF07_S06_behindcldpl	182510611	6.4	18.69540	123.11454	9.0
65	09 Sep 2019	02:22:51	SF07_S07_aheadcldpl	183510096	6.4	18.34131	123.35563	9.2
66	09 Sep 2019	02:30:18	SF07_S08_multicldlayrs	182510628	6.4	17.97302	122.97718	9.4
67	09 Sep 2019	05:42:14	SF07_S09_hsrltrnsct	182440096	7.8	17.34292	126.21512	10.7
68	09 Sep 2019	07:29:58	SF07_S10_convrgn	183451043	5.6	17.13511	126.02403	8.3
69	13 Sep 2019	21:09:28	SF08_S01_A1drop	182510608	5.8	16.04301	121.92909	8.4
70	13 Sep 2019	21:29:45	SF08_S02_A2drop	182510635	5.8	17.83537	122.25091	8.4
71	13 Sep 2019	21:37:20	SF08_S03_A3drop	182510633	5.8	18.50586	122.37108	8.3
72	13 Sep 2019	21:48:41	SF08_S04_A5drop	183510461	5.8	19.50643	122.55112	8.4
73	13 Sep 2019	22:00:23	SF08_S05_A7drop	182510609	5.8	20.53951	122.74158	8.5
74	13 Sep 2019	22:31:18	SF08_S06_PPmid	182510607	5.8	19.01857	121.74931	8.2
75	14 Sep 2019	03:48:20	SF08_S07_boxsprltop	184040103	5.8	16.21134	120.25441	8.3
76	15 Sep 2019	22:47:26	SF09_S01_preconvline1	183330177	5.5	11.22451	120.70703	7.8
77	15 Sep 2019	22:50:41	SF09_S02_preconvline2	184020527	5.5	10.97967	120.63493	8.0
78	15 Sep 2019	22:56:22	SF09_S03_postconvline	184040023	5.5	10.54805	120.50824	8.1
79	15 Sep 2019	23:43:02	SF09_S04_HSRLleg1	183510462	5.5	8.05191	117.62803	8.0
80	15 Sep 2019	23:51:18	SF09_S05_HSRLleg2	182830551	5.5	7.59824	118.22146	7.8
81	15 Sep 2019	23:59:50	SF09_S06_HSRLleg3	182510610	5.5	7.42042	118.99636	8.1
82	16 Sep 2019	00:13:10	SF09_S07_HSRLleg4	182510631	5.5	7.14372	120.18756	8.0
83	16 Sep 2019	02:42:26	SF09_S08_ASTERdrop	184040104	6.8	8.05299	117.48553	9.7
84	16 Sep 2019	03:13:17	SF09_S09_over2ndconvline	182510636	6.8	8.75271	119.75403	8.8
85	16 Sep 2019	03:15:16	SF09_S10_E2ndconvline	182510612	6.8	8.74016	119.91882	9.4
86	16 Sep 2019	03:23:47	SF09_S11_W2ndconvline	182440313	6.8	9.03018	119.96270	9.4
87	16 Sep 2019	22:55:38	SF10_S01	182830533	4.8	13.00952	124.68217	7.0
88	16 Sep 2019	23:49:59	SF10_S02	184040024	5.6	13.43236	124.94033	8.2
89	16 Sep 2019	23:56:12	SF10_S03	184020490	5.6	13.67961	125.44557	8.3
90	17 Sep 2019	00:46:34	SF10_S04	182830540	5.6	13.76539	126.12018	8.0
91	17 Sep 2019	00:53:56	SF10_S05	182830550	5.6	13.78041	125.55654	8.1
92	17 Sep 2019	01:00:09	SF10_S06	183330988	5.2	14.02311	125.35039	7.8
93	17 Sep 2019	02:26:40	SF10_S07	184020528	6.4	15.31464	125.22253	9.3
94	17 Sep 2019	02:34:15	SF10_S09	184020525	6.4	14.78195	125.59869	9.1
95	17 Sep 2019	02:37:30	SF10_S10	182830552	6.4	14.56006	125.73892	9.1
96	17 Sep 2019	02:47:11	SF10_S11	184040019	6.4	14.97011	125.95905	9.1
97	17 Sep 2019	02:50:28	SF10_S12	184020524	6.4	15.07775	126.24057	8.7
98	17 Sep 2019	03:07:06	SF10_S13	183331041	7.1	15.76866	127.00380	9.8
99	17 Sep 2019	03:17:01	SF10_S14	182830537	7.1	15.17451	126.63655	9.7
100	17 Sep 2019	03:48:36	SF10_S15	183331042	7.1	14.76032	126.46775	9.9
101	17 Sep 2019	03:57:32	SF10_S16	183340016	7.1	14.46125	126.92049	9.7
102	17 Sep 2019	04:05:54	SF10_S17	183331047	7.1	15.04075	126.41884	9.7
103	17 Sep 2019	04:53:09	SF10_S18	183340017	6.8	14.98248	126.33122	9.5
104	19 Sep 2019	23:20:49	SF11_S01_Sconvline	182510814	5.4	15.34030	122.52217	7.9
105	19 Sep 2019	23:49:23	SF11_S02_S2ndconvline	182830543	5.4	17.58093	123.10215	8.0
106	20 Sep 2019	00:00:53	SF11_S03_N2ndconvline	182511237	5.8	18.46549	123.42223	8.3
107	20 Sep 2019	03:46:42	SF11_S04_SENWcldline	182520107	4.8	19.42110	121.62183	7.2
108	20 Sep 2019	05:26:24	SF11_S05_boxsprltop	182510604	7.7	19.44430	121.02909	10.4
109	21 Sep 2019	23:09:11	SF12_S01_ESARSI1	182730030	5.5	16.72868	123.35138	8.0
110	21 Sep 2019	23:23:10	SF12_S02_ESARSI2	182510680	5.5	16.75157	124.63150	8.2
111	21 Sep 2019	23:37:25	SF12_S03_ESARSI3	182650216	5.5	16.76285	125.90570	8.1
112	21 Sep 2019	23:42:27	SF12_S04_NWshlwculn	182650206	5.5	16.72181	126.34772	7.9
113	22 Sep 2019	02:21:56	SF12_S05_WVoverpass	182511248	4.5	18.06596	124.83409	6.7
114	22 Sep 2019	02:34:25	SF12_S06_nearconvcell	182650205	4.5	18.17326	124.37217	6.6

115	22 Sep 2019	02:49:32	SF12_S07_nearconvcell2	184020492	4.5	18.12490	124.41769	6.8
116	22 Sep 2019	02:56:05	SF12_S08_nearconvcell3	183331045	4.5	18.11234	124.42124	6.9
117	22 Sep 2019	03:11:34	SF12_S09_Woutflow	182730028	6.1	18.07589	125.12965	8.9
118	22 Sep 2019	03:15:52	SF12_S10_Eoutflow	182510651	6.1	18.09288	125.54010	8.8
119	22 Sep 2019	04:14:15	SF12_S11_shlwcufld	183340059	6.1	16.07219	124.68055	8.9
120	24 Sep 2019	01:51:14	SF13_S01_satchar	182511244	5.5	18.40951	128.03883	8.2
121	24 Sep 2019	01:57:14	SF13_S02_satchar2	182520123	5.5	18.18093	127.59440	8.1
122	24 Sep 2019	02:21:41	SF13_S02_satchar3	183330777	4.9	17.19607	125.76529	7.3
123	24 Sep 2019	02:51:21	SF13_S05_aheadconv	182520122	4.9	17.92460	127.35940	6.7
124	24 Sep 2019	03:00:09	SF13_S06_NEconvcell	183330980	3.8	18.20554	127.78173	5.9
125	24 Sep 2019	03:04:57	SF13_S07_NEconvcell	183331040	3.7	17.98733	127.48119	5.7
126	24 Sep 2019	03:13:21	SF13_S08_SWconvcell	183331103	3.2	17.84758	127.21107	4.9
127	24 Sep 2019	06:19:32	SF13_S09_convappr	182520105	5.8	16.40818	125.34873	8.5
128	24 Sep 2019	06:31:26	SF13_S10_nearconv	183330778	5.8	15.35119	124.97456	8.4
129	24 Sep 2019	06:36:00	SF13_S11_convtwr	183331099	5.8	15.24552	125.23954	8.2
130	24 Sep 2019	06:40:20	SF13_S12_entrconvtwr	182650210	5.8	15.46633	125.50101	7.9
131	24 Sep 2019	06:48:20	SF13_S13_entrconvtwr2	183331015	5.8	15.46383	125.49837	7.1
132	24 Sep 2019	06:52:21	SF13_S14_convtwrno2	182730029	5.8	15.23617	125.24485	7.8
133	24 Sep 2019	08:05:13	SF13_S15_convflnk	183330780	4.0	15.01782	125.16837	6.3
134	24 Sep 2019	08:07:39	SF13_S16_overconv	183331046	3.3	15.08702	125.23095	5.0
135	25 Sep 2019	03:41:04	SF14_S01_envcharSSARSI	183331005	6.2	16.64021	123.33877	8.6
136	25 Sep 2019	04:06:15	SF14_S02_charconvrgn1	183330339	6.8	14.84056	124.11906	9.6
137	25 Sep 2019	04:17:19	SF14_S03_charconvrgn2	183330997	6.8	13.98222	124.54953	9.8
138	25 Sep 2019	04:45:39	SF14_S04_Eshallowcell	183330982	6.8	13.74697	126.78096	9.6
139	25 Sep 2019	04:54:22	SF14_S05_ovrshallowcell	183331137	6.8	13.82338	126.58554	9.4
140	25 Sep 2019	06:21:59	SF14_S06_Sdeepconv	182440318	6.8	13.45681	124.04438	9.9
141	25 Sep 2019	06:40:52	SF14_S07_Wflnkdeepconv	183331013	4.8	13.47349	124.10999	6.6
142	27 Sep 2019	20:58:12	SF15_S01_aeolus1	182440314	5.5	16.05580	121.91020	8.0
143	27 Sep 2019	21:19:05	SF15_S02_aeolus2	183340003	5.5	17.83800	122.22658	8.2
144	27 Sep 2019	21:27:20	SF15_S03_aeolus3	182440317	6.1	18.53053	122.35152	8.3
145	27 Sep 2019	21:39:50	SF15_S04_aeolus4	183340055	6.1	19.60284	122.54713	8.7
146	27 Sep 2019	22:02:08	SF15_S05_aeolus5	183331124	6.2	21.15666	122.86006	9.1
147	27 Sep 2019	22:24:58	SF15_S06_wall1	182510601	6.2	20.65351	124.08073	8.8
148	28 Sep 2019	00:43:03	SF15_S07_wall2	183331140	3.9	20.69528	125.21254	5.6
149	28 Sep 2019	02:35:13	SF15_S08_wall3	182440315	3.6	22.18031	124.84843	5.5
150	29 Sep 2019	02:54:25	SF16_S01_fieldshlwcu	183331138	4.2	16.28768	120.21484	6.3
151	29 Sep 2019	03:03:37	SF16_S02_learcomparea	183331136	3.8	16.59286	120.10750	5.7
152	29 Sep 2019	04:13:31	SF16_S03_topofbs1	183340013	5.8	16.87515	119.71376	8.5
153	29 Sep 2019	04:57:37	SF16_S04_cp1	183331135	6.2	18.53801	120.19555	8.9
154	29 Sep 2019	05:00:38	SF16_S05_cp2	183340029	6.4	18.39121	119.96600	9.1
155	29 Sep 2019	05:03:18	SF16_S06_cp3	183330981	6.4	18.23902	119.77083	9.0
156	29 Sep 2019	05:05:33	SF16_S07_cp4	183451040	6.4	18.09691	119.63047	9.1
157	29 Sep 2019	05:07:59	SF16_S08_cp5	183510465	6.4	17.93991	119.48123	8.9
158	29 Sep 2019	05:19:05	SF16_S09_CP6	183510006	5.5	18.10539	119.66911	8.0
159	29 Sep 2019	05:22:47	SF16_S10_CP7	183451039	5.5	18.29233	119.90040	8.1
160	29 Sep 2019	05:25:50	SF16_S11_CP8	183510007	5.5	18.45006	120.08857	8.2
161	29 Sep 2019	05:31:40	SF16_S12_CP9	183451042	5.5	18.76193	120.46188	8.0
162	29 Sep 2019	07:05:03	SF16_S13_CP2_1	183510105	7.1	17.34817	118.76653	9.9
163	29 Sep 2019	07:06:44	SF16_S13_CP2_2	183510009	7.1	17.45564	118.87294	9.7
164	29 Sep 2019	07:11:02	SF16_S14_CP2_3	182510627	7.1	17.64537	119.22962	10.1
165	29 Sep 2019	07:30:03	SF16_S15_CP2_4	182510634	5.6	18.24846	120.30191	8.4
166	29 Sep 2019	07:42:40	SF16_S16_outsidecp	183330837	5.5	17.53510	119.75576	8.0
167	01 Oct 2019	22:14:00	SF17_S01_charWLuzon	182510630	5.5	16.97047	120.19277	8.1
168	01 Oct 2019	22:40:57	SF17_S02_charNWLuzon	183510008	5.5	18.74708	119.81078	8.1
169	01 Oct 2019	23:04:59	SF17_S03_charNWLuzon2	182510632	5.5	18.71139	119.88367	8.1
170	02 Oct 2019	02:15:59	SF17_S04_boxsprltop	183331139	4.8	19.45009	119.94759	7.1
171	02 Oct 2019	02:26:45	SF17_S05_PPtrsct1	182720750	4.8	19.70203	120.61869	7.1
172	02 Oct 2019	02:27:52	SF17_S06_PPtrsct2	183510466	4.8	19.64716	120.68499	7.1
173	02 Oct 2019	02:28:56	SF17_S07_PPtrsct3	183510104	4.8	19.59611	120.74682	7.1

174	02 Oct 2019	03:03:17	SF17_S09_nearWV	183510094	4.8	18.53480	119.72113	6.8
175	02 Oct 2019	03:34:52	SF17_S10_NLuzon	182650208	4.8	20.06211	120.75438	7.1
176	02 Oct 2019	03:41:08	SF17_S11_NLuzon2	183311025	4.8	20.55173	121.08987	7.1
177	02 Oct 2019	04:01:04	SF17_S12_SWcldstrt	183510010	4.8	19.98548	120.50305	7.2
178	02 Oct 2019	05:45:03	SF17_S13_recharNWLuzon	183311033	4.8	18.35608	119.75379	7.3
179	03 Oct 2019	23:13:35	SF18_S01_midHSRLtrsct	183330166	6.1	14.88287	121.68468	8.8
180	03 Oct 2019	23:26:02	SF18_S02_NHSRLtrsct	182720634	4.8	15.35813	121.50284	7.0
181	03 Oct 2019	23:37:43	SF18_S03_SHSRLtrsct	183330174	4.8	14.50718	121.83488	7.2
182	04 Oct 2019	00:51:06	SF18_S04_WManilaBay	183321190	4.8	14.32504	120.51329	7.2
183	04 Oct 2019	00:54:46	SF18_S05_N_WWall	183510463	4.8	14.15790	120.34621	7.2
184	04 Oct 2019	00:58:35	SF18_S06_midpt_WWall	183510093	4.8	13.89385	120.45665	7.3
185	04 Oct 2019	01:03:22	SF18_S07_S_WWall	183321189	4.8	13.55738	120.59604	7.3
186	05 Oct 2019	02:33:31	SF19_S01	182650209	5.5	15.89128	124.46170	8.0
187	05 Oct 2019	04:27:45	SF19_S02	183311026	4.2	16.71724	124.83980	6.4
188	05 Oct 2019	04:39:49	SF19_S03	183330173	4.2	16.38263	125.53044	6.0
189	05 Oct 2019	05:58:39	SF19_S03	183321193	7.0	16.81197	124.96883	9.9
190	05 Oct 2019	06:05:00	SF19_S05	183311030	7.1	16.58675	124.41272	10.1
191	05 Oct 2019	06:08:20	SF19_S06	183321192	7.1	16.46738	124.11503	10.0
192	05 Oct 2019	06:10:44	SF19_S07	183311032	7.1	16.38238	123.90349	9.9
193	05 Oct 2019	06:17:19	SF19_S08	183311021	7.1	16.04107	123.93610	6.4
194	05 Oct 2019	06:23:52	SF19_S09	183320168	7.1	16.49021	124.26899	9.7