Upper-air measurements at King George Island, Antarctica (V1.0): Data Archive Description

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- ***Time of interest****: 20th - 24th January 2020, 14th February - 6th March 2022.*
- ***Area of interest****: King George Island, Antarctica (58.96°W, 62.20°S; Fig. 1), a polar region site over the Antarctic Peninsula.*
- ***Data frequency****: 2 times per day during normal operations (00 and 12 UTC) and 4 times a day during Intensive Observation Periods (00, 06, 12, 18 UTC).*
- ***Spatial type of data****: point, in situ measurements.*
- ***Dataset description summary****: the dataset presented here contains sounding measurements collected at King George Island, Antarctica (58.96°W, 62.20°S) during the Colombian scientific expedition to Antarctica, 2020 and 2022 campaigns using a Vaisala DigiCORA MW41 Sounding System. The observations were carried out between 20th January and 25th January 2020, and 14th February and 6th March 2022, launching twice-daily soundings (00 UTC and 12 UTC)during regular days, and 4 soundings per day (00 UTC, 06 UTC, 12 UTC and 18 UTC) during Intensive Observing Periods (IOPs), for a total of 53 soundings.*

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1. Overview

The occurrence of austral summer sea fog events at King George Island off the Antarctic Peninsula was investigated using surface observations, special upper-air soundings, reanalysis data, and WRF model cloud-resolving simulations. This document provides a data description of the observations that were gathered on two Colombian Antarctic Program research campaigns in the Antarctic Peninsula that were designed to observe marine fog vertical and temporal variability as well as their synoptic drivers, the first campaign in January 20-24, 2020 and the second one in February 14-March 6, 2022. During the austral summer, observations based on ship tracks shows that the region is a hotspot of high frequency of marine fog with mean occurrences of 20% of the time. Analysis based on long term in-situ surface observations at King Island agrees with the climatological frequencies showing fog frequency in the range of 15-20%. During the field campaigns, sea fog episodes were present 10 out of 24 days. Northwesterly low-level flow prevails during fog days as rather extratropical short wave low-pressure propagated over the Drake Channel. The warm quadrant of the cyclonic system promoted warm air advection over sea surface colder waters, leading to the fog formation. WRF simulations (not shared nor shown here) confirm the advective nature of the fog episodes with the model adequately capturing the observed fog day-to-day variability and overall vertical structure characteristics of the moist processes.

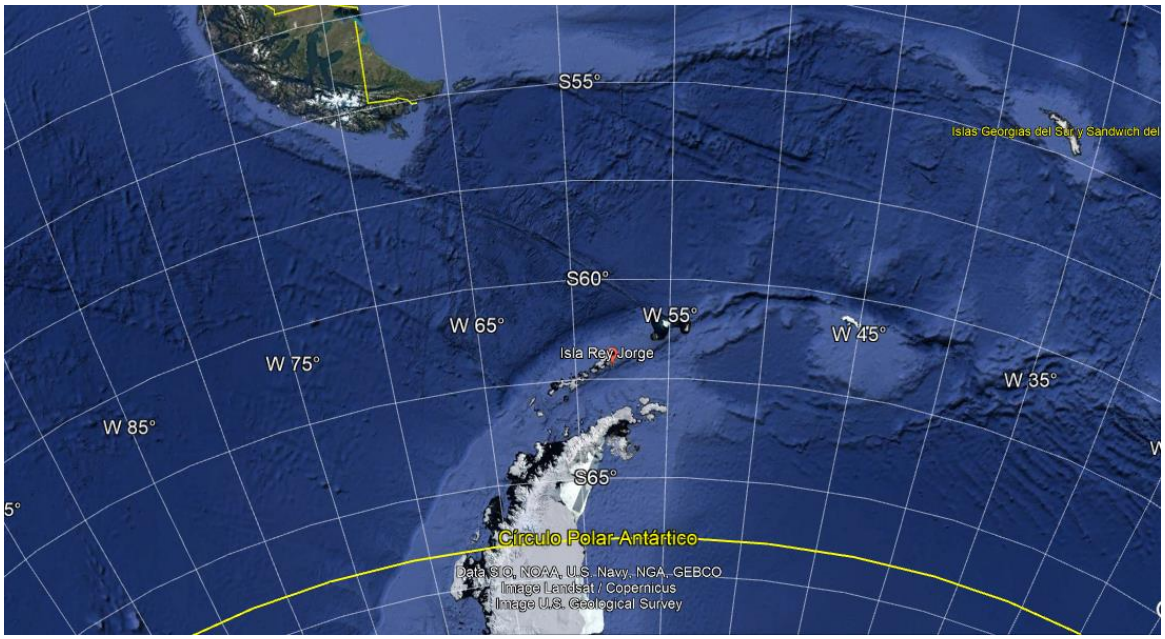

Fig. 1 King George Island, Antarctica sounding sites. Map canvas courtesy of Google Earth.

2. Instrument Description

The Vaisala DigiCORA MW41 sounding systems consists of an unidirectional receptor antenna, a RI41 Ground Check Device, a Vaisala RS41-SGP radiosondes, and TA200 meteorological balloons. This system allows to measure vertical profiles of atmospheric pressure, temperature, relative humidity, and wind speed and wind direction. Table 1 describes the RS41-SGP radiosonde technical characteristics. In particular, wind and height readings are derived from velocity and location measurements of the RS41 GPS receiver. Wind is calculated independently based on satellite carrier frequency changes. With RS41-SGP height and pressure are also calculated from satellite ranging codes, combined with differential corrections from the MW41 ground station.

Parameter	Measurement range	Resolution/Accuracy
Temperature sensor	60°C to -90°C	0.01°C/ <0.4°C
Humidity sensor	0 to 100 %	0.10%/< 4%
Pressure (calculated from GPS)	surface to 3 hPa	0.01 hPa / < 0.3 hPa
Geopotential height	surface to 40000 m	0.1 gpm / --
Wind speed	Max 160 m/s	0.1 m/s / < 0.15 m/s
Wind direction	0 to 360 deg	0.1 deg / < 2 deg
Telemetry		
Transmitter type	Synthesized	
Tunning range	400.15-405.99 MHz	
Maximum transmitting range	Up to 350 km	
GPS receiver		
Number of channels	> 48	
Frequency	1575.42 MHz, LI C/A code	
Correction	Differential	

Table 1. RS41-SGP technical data summary (source Vaisala white paper)

3. Quality Assurance and Quality Control (QA/QC) Procedures

The Vaisala ground system performs default internal corrections to the records, including: time lag correction applied to both temperature and humidity measurements due to delays in the response time of the radiosonde temperature sensor, which varies by ambient pressure, sensor ventilation and the thermal properties of the sensor; a radiation correction to minimize the effect of solar radiation during daytime temperature measurements. The Vaisala documentation (see Vaisala white paper) contains further information about the Vaisala standards quality and expected performances. Additionally, a more general QA/QC procedure was applied based on Loherer et al. (1996), who recommended to check for internal and physical consistency and to impose thresholds in vertical gradients of the parameters. Finally, a thorough visual inspection was performed over skew-T/P and time-height diagrams (Fig. 3 and 4) to examine any possible outliers missed in previous steps. Of interest for our research objectives were the relatively high low-level day-to-day variability capturing the environmental atmospheric conditions leading to fog episodes, here shown as profiles with persistent low-level moistening accompanied by warming and wind shifting from westerly to northwesterly.

Table 2 shows a general description of all soundings collected at King George Island, including the maximum altitude reached, and the percentage of missing data. Our QA/QC procedure indicates that all missing records were related to wind retrievals and most of them above 356 hPa (8000m), which in most cases do not compromise an adequate diagnostics of the surface-to-low-level environments driving the fog genesis. In all, more than 96% of the data points were flagged as "good".

To examine the climatological conditions of the fog episodes, this study used long-term surface METAR (METeorological Aerodrome Reports) hourly observations reported by the Teniente Rodolfo Marsh (SCRM) aerodrome located on King George Island during October 30th, 2009 to April 04, 2022. Observations were QA/QC and composited based on the observed Fog (FG; visibility < 1000 m) or mist (BR; visibility < 5000 m) occurrences. The METAR data was downloaded from OGIMET web portal (https://www.ogimet.com/credits.phtml), starting on 30-OCT-2009 until 04-APR-2022 (see Fig. 2), with missing data in the years 2012, 2013 and 2014, some METAR did not have information and were registered as NULL (missing data), these were removed from the database, at the same as the data recorded in intermediate hours. From a total of 88.627 reports, 74.685 were kept for research analysis and 13.942 (15.7%) were eliminated. A Python script was developed (also shared in this data publications), which allows interpreting the METAR information and performing a quality control on temperature, dew point, visibility, wind direction and speed, and corresponding meteorological phenomenon at the aerodrome.

No.	Sounding Site ID_YYYMMHH_HHMMSS (HH in UTM)	Maximum altitude (hPa)	Missing data (%)
1	SCRM_20200120_220704	147.34	0.0
2	SCRM_20200121_011642	29.71	0.0
3	SCRM_20200121_063238	29.69	0.0
4	SCRM_20200121_124057	40.74	0.0
5	SCRM_20200121_182023	95.20	0.0
6	SCRM_20200122_010653	26.53	0.0
7	SCRM_20200122_063829	29.53	0.0
8	SCRM_20200122_124941	30.53	0.0
9	SCRM_20200122_192858	51.24	0.0
10	SCRM_20200123_005324	69.64	0.0
11	SCRM_20200123_062828	219.98	0.0
12	SCRM_20200123_091904	32.98	0.0
13	SCRM_20200123_131221	43.80	0.0
14	SCRM_20200123_160833	106.15	0.0
15	SCRM_20200123_180534	134.66	0.0
16	SCRM_20200123_231247	28.76	0.0
17	SCRM_20220214_122122	62.05	0.0
18	SCRM_20220215_234037	31.68	0.0
19	SCRM_20220216_114352	42.63	0.0
20	SCRM_20220216_233948	36.90	0.0
21	SCRM_20220217_115240	32.78	0.0
22	SCRM_20220218_114524	108.75	0.0
23	SCRM_20220218_234821	42.17	0.0
24	SCRM_20220219_113936	39.35	0.0
25	SCRM_20220219_234425	111.82	0.0
26	SCRM_20220220_114524	32.10	0.0
27	SCRM_20220220_233848	155.99	0.0
28	SCRM_20220221_114239	344.77	0.0
29	SCRM_20220221_174110	275.60	0.0
30	SCRM_20220221_234407	330.34	0.0
31	SCRM_20220222_114156	63.26	0.0
32	SCRM_20220222_234751	37.05	0.0
33	SCRM_20220223_114133	81.10	0.0
34	SCRM_20220223_234709	180.00	0.0
35	SCRM_20220224_114525	224.00	0.0
36	SCRM_20220224_234846	63.99	0.0
37	SCRM_20220225_235017	126.32	0.0
38	SCRM_20220226_114213	210.86	0.0
39	SCRM_20220226_235435	176.74	0.0
40	SCRM_20220227_114236	356.88	0.2
41	SCRM_20220227_234937	65.44	0.0
42	SCRM_20220228_114224	69.70	0.0
43	SCRM_20220228_234107	32.79	0.0

44	SCRM_20220301_113931	118.65	0.0
45	SCRM_20220301_233826	114.00	0.0
46	SCRM_20220302_114354	206.20	0.0
47	SCRM_20220302_234420	168.06	0.0
48	SCRM_20220303_114016	112.08	0.0
49	SCRM_20220303_234250	65.95	0.0
50	SCRM_20220304_114200	55.85	0.0
51	SCRM_20220304_234120	51.01	0.0
52	SCRM_20220305_120500	55.40	0.0
53	SCRM_20220306_000846	478.32	25.6

Table 2. Colombian Antarctic program King George Island soundings inventory. Soundings column refers to the time at which the sounding was activated, typically within 30 minutes of the synoptic times (00, 06, 12, 18 UTC).

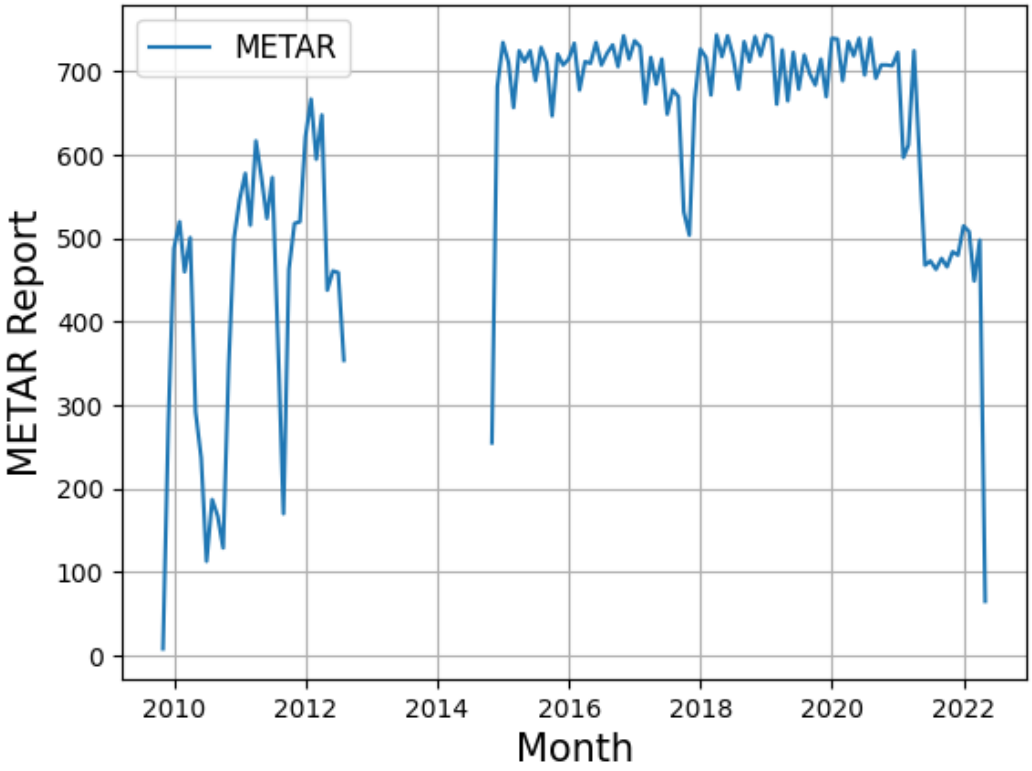

Fig. 2: METAR reports by month for October, 2009 to April, 2022

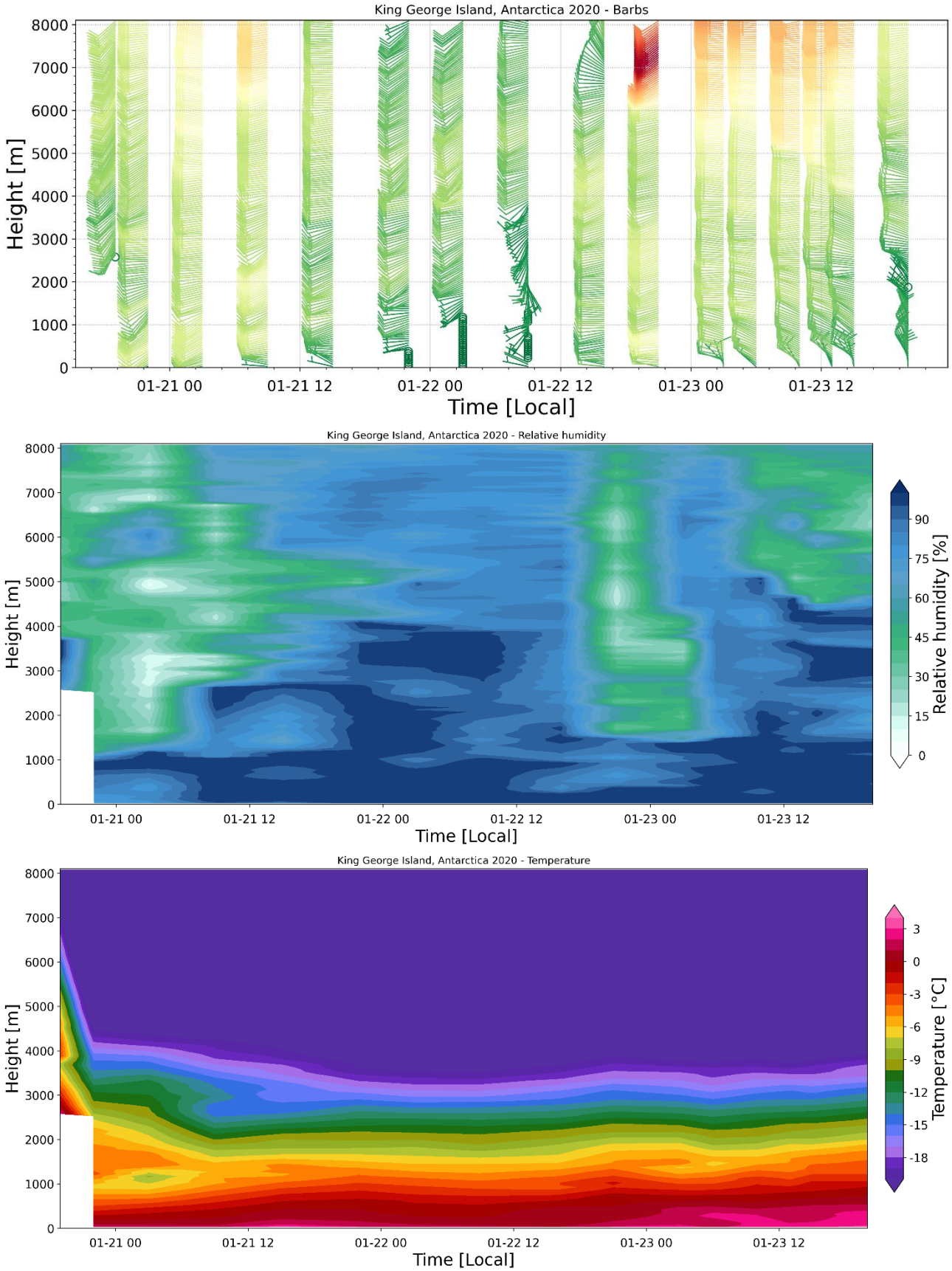

Fig. 3 King George Island, Antarctica time-height diagrams using 2020 soundings for (from top to bottom) windbarbs, relative humidity, and temperature.

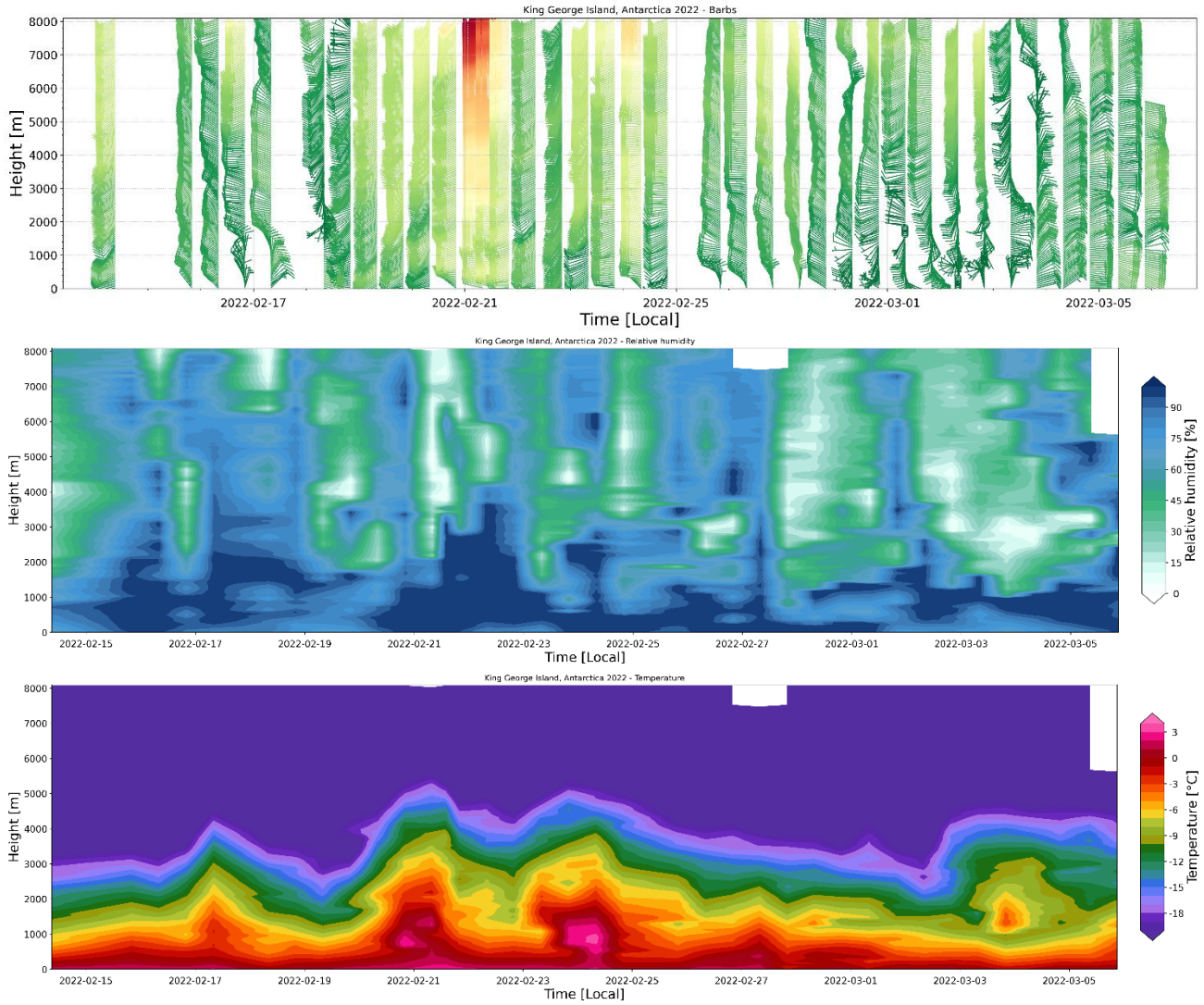

Fig. 4 King George Island, Antarctica time-height diagrams using 2022 soundings for (from top to bottom) windbarbs, relative humidity, and temperature.

4. Data Formats

The native Vaisala data is based on the Extensible Markup Language (XML) that we converted into comma-separated values (CSV) tabular format to facilitate access to the data and to compress it into a smaller volume database. The CSV (ASCII) format allows the files to be recognized and read easily by any platform or operating system without the need of special libraries or procedures. Each King George Island sounding is archived in individual files with the file name (SCRM_YYYYMMDD_HHMMSS.csv) indicating the time that the sounding was initiated, where YYYY, MM, DD, HH, MM, SS correspond to the year, month, day, hour (UTC), minutes, and seconds, respectively. Records (rows) were archived at 1-second increments with missing records indicated as NaNs. Data are tabulated in columns corresponding to the different parameters described in Table 3. On note is that the time column shows the time in seconds since the activation of the sounding, with the first record indicating the time in which the sounding was released.

VARIABLE	UNITS	LONG NAME
Time	s	Time in seconds since activation of sounding
Press	hPa	Pressure
Temp	°C	Temperature
RH	%	Relative humidity
U	m/s	Zonal wind
V	m/s	Meridional wind
Wind	m/s	Wind
Wdir	deg	Wind direction
Lon	deg	Longitude
Lat	deg	Latitude
Alt	m/s	Altitude

Table 3. Parameter name and units archived in the soundings CSV files.

Besides, METAR is a format for reporting weather information. A METAR weather report is predominantly used by aircraft pilots, and by meteorologists, who use aggregated METAR information to assist in weather forecasting. The King Jorge Island METAR data was converted into comma-separated values (CSV) tabular format to facilitate access to the data and to compress it into a smaller database, into two columns: "valid" for the timestamps in DD/MM/YYYY HH:MM, where DD, MM, YYYY, HH, MM as the day, month, year, hour (UTC) and minutes, respectively; and "wxcodes" or METAR codes describing the reporting weather information (WMO-No. 306).

5. Upper-air Sounding System Operators

Dr. Mejia and Mj. Jiménez collaborated with campaign design and deployment, weather briefings, data management plan, and data analysis. All soundings were performed by trained military officers of the Colombian Air Force.

Rank	Name	E-mail	Campaign
Major	Mauricio Jiménez García	mauricio.jimenezg@fac.mil.co	2020
Colonel	Nayid Eduardo Iglesias Everstsz	nayid.iglesias@fac.mil.co	2020
Lieutenant Colonel	Guillermo Alberto Poveda Zamora	guillermo.poveda@fac.mil.co	2020
Major	Álvaro Rafael Martínez Mancera	alvaro.martinez@fac.mil.co	2020
Lieutenant Colonel	Jorge Giovanni Jiménez Sánchez	jorge.jimenez@fac.mil.co	2022
Captain	Kevin Alexander Chicaeme Ordoñez	kevin.chicaeme@fac.mil.co	2022

Sounding operators during the Colombian scientific expedition to Antarctica, campaign 2020 using a Vaisala DigiCORA MW41 Sounding System. Left to right Guillermo Poveda, Nayid Eduardo Iglesias, Mauricio Jiménez and Rafael Martínez.

Sounding operators during the Colombian Antarctic Program scientific expedition to the Antarctica Peninsula, campaign 2022 using a Vaisala DigiCORA MW41 Sounding System. Left to right Jorge Giovanni Jiménez and Kevin Chicaeme.

6. References

Loehrer, S. M., T. A. Edmands, and J. A. Moore, 1996: TOGA COARE upper-air sounding data archive: Development and quality control procedures. Bull. Amer. Meteor. Soc., 77, 2651– 2672

Vaisala White paper: Radiosonde RS41 Measurement Performance, https://www.vaisala.com/sites/default/files/documents/WEA-MET-RS41-Performance-White-paper-B211356EN-B-LOW-v3.pdf

World Meteorological Organization (WMO-No. 306), Manual on codes - International Codes, WMO Technical Regulations: part A- Alphanumeric Codes, FM 15–XV METAR - Aerodrome routine meteorological report, https://library.wmo.int/doc_num.php?explnum_id=10235