1. **ABOUT THE DATASET**

**Title:** Chargeemission data from 2023 Al Ain campaign

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Description: A charge releasing device was flown on a crewed cloud-seeding aircraft during a campaign of preliminary test experiments over the United Arab Emirates, in August and September 2023. The flights were made from Al Ain airport. Internal logging data from the device are provided here, obtained during the brief bursts of operation at the surface and aloft.

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**Related publication:** Harrison, R. G., Alkamali, A. A., Escobar-Ruiz, V., Nicoll, K. A. and Ambaum, M. H. P. (2024) *Providing charge emission for cloud seeding aircraft.* AIP Advances, 14 (9). 095307. <https://doi.org/10.1063/5.0227533>

1. **TERMS OF USE**

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1. **PROJECT AND FUNDING INFORMATION**

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1. **CONTENTS**

A charge emitter was integrated into a crewed cloud-seeding aircraft for a series of campaign flights during August and September 2023, flown from Al Ain airport in the United Arab Emirates. The device is described in Nicoll et al., (2024). It contains an internal data logger to record its operating conditions, specifically the electrode voltage and emission current, as well as the meteorological parameter of pressure, with the internal temperature and internal relative humidity.

The data logger was constructed using an Arduino Nano microcontroller. Pressure, internal temperature and internal relative humidity were sampled using a BME280 sensor. Voltages were measured using the 10bit analogue to digital converter of the Arduino Nano, against the regulated 5 V supply. (The supply was also monitored against the internal bandgap 1.2 V reference of the Arduino Nano.) The emitter’s operating voltage was determined using a 1000 MW:1 MW potential divider and the emission current obtained using the analogue opto-isolated LED method described by Harrison et al., (2023). In the emission current monitoring implementation used in these experiments, the symmetry of the pair of optocouplers was assumed, with the balancing current supplied to the second optocoupler’s LED recorded. A 1 MW resistor was used in the associated voltage-to-current stage, hence 1 V recorded corresponds to 1 mA emission current.

This dataset contains multiple files from the internal data logger of the charge emitter, during the flights and on the runway. A new file was generated each time the device was activated, with sampling at 10 Hz and logging duration 120 s (electrode on for the first 60 s). The electrode voltage was negative with respect to the aircraft chassis.

A list of the data logger files provided is given below. The filename is given in the first column, followed by the date and the start time (UTC). Median values for quantities sampled are given in the subsequent columns, as pressure (hPa), internal device temperature (°C), battery (volts), high tension (volts) and the number of data lines in the file (Nlines).

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| *filename* | *Date* | *start* | *pressure* | *temperature* | *battery* | *HT* | *Nlines* |
| 030758.CSV | 03/09/2023 | 07:58.6 | 976.05 | 30.1 | 6.17 | 3342 | 1193 |
| 030801.CSV | 03/09/2023 | 08:01.1 | 976 | 32.7 | 6.18 | 3346 | 1193 |
| 030803.CSV | 03/09/2023 | 08:03.2 | 976.03 | 34.5 | 6.15 | 3350 | 1193 |
| 030805.CSV | 03/09/2023 | 08:05.4 | 976.02 | 35.7 | 6.15 | 3353 | 1193 |
| 030935.CSV | 03/09/2023 | 09:35.3 | 974.8 | 42 | 6.25 | 3383 | 1193 |
| 040946.CSV | 04/09/2023 | 09:46.3 | 974.73 | 33.9 | 6.14 | 3354 | 1193 |
| 041015.CSV | 04/09/2023 | 10:15.4 | 974.44 | 39 | 6.13 | 3369 | 1193 |
| 050945.CSV | 05/09/2023 | 09:45.2 | 974.9 | 41.9 | 6.24 | 3376 | 1193 |
| 110726.CSV | 07/07/2023 | 11:26.3 | 1008.86 | 22.5 | 4.5 | NA | 284 |
| 110727.CSV | 07/07/2023 | 11:27.0 | 1008.86 | 23.2 | 4.34 | NA | 593 |
| 110728.CSV | 07/07/2023 | 11:28.0 | 1008.84 | 23.7 | 4.16 | NA | 312 |
| 130739.CSV | 07/07/2023 | 13:39.2 | 1007.74 | 25.1 | 5.65 | 3064 | 417 |
| 130740.CSV | 07/07/2023 | 13:40.0 | 1007.8 | 25.5 | 5.01 | 3039 | 593 |
| 130741.CSV | 07/07/2023 | 13:41.0 | 1007.77 | 25.7 | 4.95 | NA | 179 |
| 140717.CSV | 07/07/2023 | 14:17.3 | 1007.35 | 23.4 | 5.48 | 3073 | 251 |
| 140718.CSV | 07/07/2023 | 14:18.0 | 1007.38 | 23.9 | 5.18 | 3046 | 592 |
| 140719.CSV | 07/07/2023 | 14:19.0 | 1007.39 | 24.2 | 4.96 | NA | 345 |
| 141243.CSV | 14/08/2023 | 12:43.2 | 996.82 | 25.2 | 5.89 | 3259 | 99 |
| 141246.CSV | 14/08/2023 | 12:46.3 | 996.81 | 25.3 | 5.92 | 3296 | 1193 |
| 160534.CSV | 16/09/2023 | 05:34.3 | 684.86 | 24.4 | 6.13 | 3303 | 1193 |
| 160537.CSV | 16/09/2023 | 05:37.1 | 684.73 | 25.2 | 6.13 | 3299 | 1193 |
| 160540.CSV | 16/09/2023 | 05:40.0 | 684.73 | 25.5 | 5.93 | 3298 | 1193 |
| 160546.CSV | 16/09/2023 | 05:46.4 | 684.78 | 24.4 | 5.12 | 3060 | 1193 |
| 160549.CSV | 16/09/2023 | 05:49.6 | 684.86 | 24.5 | 4.82 | 2853 | 1193 |
| 160553.CSV | 16/09/2023 | 05:53.3 | 684.86 | 24.5 | 4.73 | 2742 | 1193 |
| 160559.CSV | 16/09/2023 | 05:59.5 | 684.78 | 23.3 | 4.76 | 2717 | 74 |
| 281110.CSV | 28/08/2023 | 11:10.2 | 971.25 | 45.7 | 6.33 | 3383 | 1193 |
| 281231.CSV | 28/08/2023 | 12:31.3 | 628.06 | 21.5 | 5.89 | 3273 | 1193 |
| 310721.CSV | 31/08/2023 | 07:21.1 | 977.835 | 26.4 | 5.83 | 3311 | 1192 |
| 310724.CSV | 31/08/2023 | 07:24.1 | 977.87 | 27.2 | 6.12 | 3307 | 1193 |
| 310754.CSV | 31/08/2023 | 07:54.0 | 977.6 | 24.9 | 5.89 | 3319 | 1192 |
| 310945.CSV | 31/08/2023 | 09:45.4 | 976.27 | 29.5 | 6.17 | 3322 | 1193 |

**Data file format**

*Table 1 – data logger files*

Each data logger file is a comma-separated plain ascii file, with consecutive lines providing new samples as the operating time progresses. Table 1 summarises the data columns, with a description of processing, where required. Needed for interpretation of the data.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Data column | Quantity | units | Column designator (and variable for calculations) | Processing required (or coding information) | Final units |
| 1 | Elapsed time (from switch-on) | microseconds | time(us) |  | ms |
| 2 | Calendar year |  | YY |  |  |
| 3 | Calendar month |  | MM |  |  |
| 4 | Day of month |  | DD |  |  |
| 5 | Time – Hour | hour UTC | HH |  | hour |
| 6 | Time – minute | min UTC | MM |  | min |
| 7 | Time – second | sec UTC | SS |  | sec |
| 8 | Switch setting | bit pattern | Switchbits | 0101: Neg ioniser, 1min ON  0110: Neg ioniser, 0.5min ON  0111: Neg ioniser, 5min ON, 5min OFF (for an hour)  1001: Pos ioniser, 1min ON  1010: Pos ioniser, 0.5min ON  1011: Pos ioniser, 5min ON, 5min OFF (for an hour)  XX00: Manual- not implemented  XXXX: No function |  |
| 9 | Transformer setting | bit | Xformerbits  X9 | HT supply is on for X9==1 | boolean |
| 10 | Divider voltage (if operating as positive ioniser) | ADC counts | Vdiv\_Pos  X10 |  | V |
| 11 | Divider voltage (if operating as a negative ioniser) | ADC counts | Vdiv\_Neg  X11 |  | V |
| 12 | Electrode emission current | ADC counts | uI  X12 |  | uA |
| 13 | Internal temperature | Integer value | T  X13 |  | °C |
| 14 | Internal relative humidity | Integer value | RH  X14 |  | % |
| 15 | Internal pressure | Pa | P  X15 |  | hPa |
| 16 | Battery voltage | ADC counts | batt  X16 |  | mV |
| 17 | Internal supply voltage | mV | Vcc |  |  |

*Table 2 – Aircraft position file*

20230916\_Track.txt is a space separated file which contains aircraft location information for the flight made from Al Ain on 16 Sep 2023. There are two header lines

|  |  |  |
| --- | --- | --- |
| Column | Quantity | units |
| 1 | Date (as Year-month-day\_of\_month) | UTC |
| 2 | Time (as hour:minute:second) | UTC |
| 3 | Longitude East | degrees |
| 4 | Latitude North | degrees |
| 5 | altitude | feet |

**References**

Harrison, R. G., Escobar-Ruiz, V., Nicoll, K. A., and Ambaum, M. H. P.: Isolated corona current monitoring using a compensated light-emitting diode as an unpowered sensor, Review of Scientific Instruments, 94, https://doi.org/10.1063/5.0170176, 2023.

Nicoll, K. A., Escobar-Ruiz, V., Harrison, R. G., Ambaum, M. H., and Alkamali, A. A.: A charge emitter for use in evaluating aircraft rainfall enhancement, in: Journal of Physics: Conference Series, https://doi.org/10.1088/1742-6596/2702/1/012005, 2024.