1. ABOUT THE DATASET

Title: Sonning Farm Fog Modification Experiment

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Description: An experiment investigating introducing charge into a natural fog was conducted at Sonning Farm (51.48155 °N, 0.897154 °W), University of Reading, in Spring 2020. This archive contains data files from measuring instruments deployed there, for 15th and 16th March 2020, when fog events occurred. Measurements of droplet concentration were made with a LOAC (Light Optical Aerosol Counter), atmospheric electric field with a JCI131 electric field mill, and three-dimensional wind speed with a Gill sonic anemometer. Switching times of a negative corona ion source were also recorded.

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Related publication: Harrison R.G. et al, Influencing natural fog by corona ion injection (in preparation)

2. TERMS OF USE

3. PROJECT AND FUNDING INFORMATION

This dataset was generated as part of experimental work within UAE Rain Enhancement Programme's project "Electrical aspects of rainfall generation", funded at Reading (PI R.G. Harrison).

4. CONTENTS

The data set contains files from 15th and 16th March 2020, For each day, there are three data files from

(1) The field mill, corona emitters and Optical Cloud Sensor (1s samples, GPS synchronised)
(2) The sonic anemometer (sub-sampled from 21Hz samples to 1s samples, GPS synchronised)
(3) The LOAC droplet counter (1 minute scans, internal real time clock)

The filenames containing data for the instruments on these two days are:

Instrument	15th March 2020	16th March 2020
LOAC	2020-03-15_1.conc	2020-03-16_1.conc
Sonic anemometer	2020_3_15_0_0_0sonic_1s.txt	2020_3_16_0_0_0sonic_1s.txt
Field mill, OCS and corona emitters	2020_3_15_0_0_0mast.txt	2020_3_16_0_0_0mast.txt

Contents of data files

Table 1 Field mill, OCS and corona emitters

These are plain ascii text files, with each line of data values in columns running from left to right, comma separated.

Column number	Quantity	Description	unit
1	Year	Time variable (GPS)	UTC
2	Month	Time variable (GPS)	UTC
3	Day	Time variable (GPS)	UTC
4	Hour	Time variable (GPS)	UTC
5	Minute	Time variable (GPS)	UTC
6	Second	Time variable (GPS)	UTC
7	“LAT”	spacing column containing “LAT”	
8	Latitude	GPS location information	°N
9	“LON”	spacing column containing “LON”	
10	Longitude	GPS location information	°E
11	“Z”	spacing column containing “Z”	
12	Mean altitude		m
13	“PG”	spacing column containing “PG”	
14	Potential Gradient	Voltage reading from field mill	ADC counts (16bit, 5V fsd, with 2.5V offset added)
15	“CLOUD”	spacing column containing “CLOUD”	
16	OCS1	OCS CH0 (infra-red LED)	Digital uncalibrated value
17	OCS2	OCS CH1 (cyan LED)	Digital uncalibrated value
18	OCS3	OCS CH2 (orange LED)	Digital uncalibrated value
19	OCS4	OCS CH3 (infra-red LED)	Digital uncalibrated value
20	OCS4	Photodiode light level	Digital uncalibrated value

21	"CORONA"	spacing column containing "CORONA"	
22	CORONA status	1=Corona emitters on; 0=corona emitters off	

- The field mill on the Sonning measurement mast was calibrated in a subsidiary experiment at the Reading University Atmospheric Observatory, against the standard electric field mill operated there. (The Observatory's field mill's reduction factor had previously been found in a calibration experiment using a horizontal passive wire antenna). From this calibration, it was determined that the absolute PG on the Sonning mast could be found from: PG (in Vm^{-1}) = (ADCcounts*0.018)-460.849
- The optical cloud sensor (OCS) has a digital output, for all channels. The measurements using the LEDs are active, with the amount of scattered light returned from droplets measured. The photodiode channel provides a passive measurement of background light. 16 bit digital values are reported. Each minute, one of the four driving LEDs (one used per channel) is effectively shut down for 10s by removing the modulation in its drive waveform, on a cycle which repeats every 4minutes. This process is to allow the internal offsets to be removed. The output data values are only permitted to be even numbers during the measurement phase, and odd numbers during the shut-down, to allow the different operating phases to be distinguished. Further data processing is needed to separate the odd and even values to extract the measurement from the reference values. After doing this, the shut-down values should be interpolated with a smoothing spline, and subtracted from the measured values to give modified values adjusted for the internal offsets.

Table 2 Sonic anemometer

These are plain ascii text files, with each line of data values in columns from left to right, comma separated.

Column number	Quantity	Description	unit
1	Hour	Time variable (GPS)	UTC
2	minute	Time variable (GPS)	UTC
3	second	Time variable (GPS)	UTC
4	U	Horizontal wind speed component	cm s^{-1}
5	V	Horizontal wind speed component	cm s^{-1}
6	W	Vertical wind speed component	cm s^{-1}

Table 3 LOAC

These are plain ascii text files, with each line of data values in columns from left to right, tab separated. The first 19 lines are header line containing further information, including the size bins used.

Column number	Quantity	Description	unit
1	Year	Time variable	LOAC time
2	Month	Time variable	LOAC time
3	Day	Time variable	LOAC time
4	Hour	Time variable	LOAC time

5	Minute	Time variable	LOAC time
6	Second	Time variable	LOAC time
7	Latitude	GPS location information	°N
8	Longitude	GPS location information	°E
9	Temperature	No sensor connected – reads zero	°C
10	Pressure	No sensor connected – reads zero	hPa
11	Humidity	No sensor connected – reads zero	%
12	Mean altitude		m
13 to 31	Concentration	Concentrations for the 19 size classes	cm^{-3}
32	Error flag	flag=1 => data ok; flag=0 => possibility of inaccurate data	
33 to 51	Uncertainties	Uncertainties in the 19 size classes	cm^{-3}

- The LOAC clock is not GPS synchronised and was found to be significantly different to GPS time when the data was downloaded on 16th March 2020. By comparing similar variations during fog observed by the LOAC with those from the GPS-synchronised OCS between 02 and 04UTC on 16th March, the LOAC clock was concluded to be (40±2) minutes ahead of GPS time.

5. METHODS

The experiment was designed to monitor droplet properties during fog, into which corona ions were emitted on a 10minute on-off cycle. Two masts were used to carry the equipment, with control and logging systems specially designed and constructed (fig 1). The measurements mast carried a droplet detector, a sonic anemometer and an electric field mill, and the emitter mast an array of corona emitters. (The emitter mast also carried a further Optical Cloud Sensor, OCS, which works on the principles described in [1] but extended to have four channels as in [2]).

Measurements mast: The Light Optical Aerosol Counter (LOAC) [3] is self-contained, using a Raspberry Pi (RPi) computer, and a USB memory stick for data storage. Each scan across the 19 droplet size bins from 0.2 μm to 50 μm diameter takes 1 minute. It contains its own real-time clock, which is not GPS synchronised. The JCI 131 field mill was mounted at 3m and measured the local atmospheric electric field, sampled at 1 second. The wind speed was measured using a Gill R3 sonic anemometer, at 3m.

Emitter mast: Four small negative corona emitters were mounted at the top of a second mast displaced from the first mast. These were mass-produced items (Amazon type B01G1DA19O). A four channel optical cloud sensor (OCS) using LEDs and a photodiode was also mounted on this mast.

Control system: The emitters and instruments (other than the LOAC) were controlled using an Arduino microcontroller and RPi computer. The Arduino digitised the analogue field mill voltages at 1 s, storing them on a SD card. Serial data from the sonic anemometer was sent to the RPi and stored on a USB drive, with 21 Hz sampling. A GPS receiver synchronised the Arduino and the RPi The Arduino regularly switching the emitters on and off on a 10 minute cycle, with the switching times logged to the SD card.

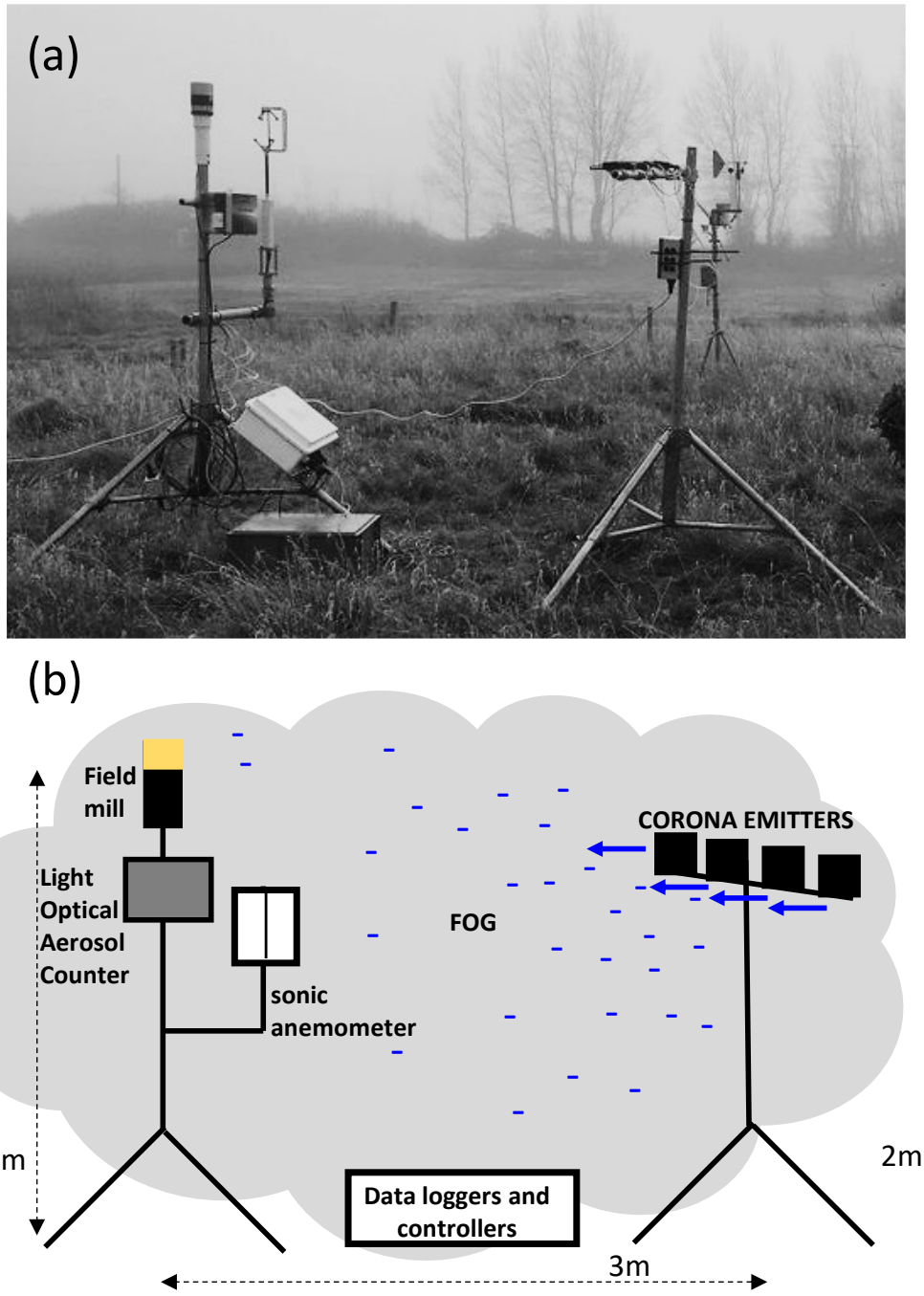

Fig 1. Practical (a) and functional (b) arrangement of apparatus at Sonning Farm, in light fog. The left-hand "measurements" mast carries a sonic anemometer, electric field mill, and the Light Optical Aerosol Counter (LOAC). The right-hand "emitter" mast carries a horizontal array of corona emitters. (A four channel Optical Cloud Sensor, OCS was also mounted at the top of the emitter mast, directed across the ion emission region.)

References

[1] R.G. Harrison and K.A. Nicoll, Active optical detection of cloud from a balloon platform *Rev Sci Instrum* **85**, 066104 (2014); doi: 10.1063/1.4882318

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[3] Renard, J.-B., Dulac, F., Berthet, G., et al, LOAC: a small aerosol optical counter/sizer for ground-based and balloon measurements of the size distribution and nature of atmospheric particles – Part 1: Principle of measurements and instrument evaluation *Atmos. Meas. Tech*., 9, 1721–1742, https://doi.org/10.5194/amt-9-1721-2016 (2016).