

**Supplementary Materials:** The following are available online at [www.mdpi.com/xxx/s1](http://www.mdpi.com/xxx/s1), Table S1. The acquisition time of the ten flights at July 24, Table S2. The acquisition time of the ten flights at July 26, Table S3. The acquisition time of the ten flights at August 2, Table S4. Equipment parameter table, Table S5. Emissivity values for each surface type, Table S6. Meteorological sensor parameters, Table S7. UAV TIR LSTs and in-situ LSTs by land cover type 9:15AM at August2, Table S8. UAV TIR LSTs and in-situ LSTs by land cover type 11:10AM at August2, Table S9. UAV TIR LSTs and in-situ LSTs by land cover type 1:13PM at August2, Table S10. UAV TIR LSTs and in-situ LSTs by land cover type 3:13PM at August2, Table S11. UAV TIR LSTs and in-situ LSTs by land cover type 5:12PM at August2, Table S12. UAV TIR LSTs and in-situ LSTs by land cover type 7:14 PM at August2, Table S13. UAV TIR LSTs and in-situ LSTs by land cover type 9:08 PM at August2, Table S14. Rain event on July 26, Table S15. Rain event on August 2, Table S16. UAV TIR LSTs and in-situ LSTs by land cover type 9:12AM at July 24, Table S17. UAV TIR LSTs and in-situ LSTs by land cover type 10:58AM at July 24, Table S18. UAV TIR LSTs and in-situ LSTs by land cover type 1:21PM at July 24, Table S19. UAV TIR LSTs and in-situ LSTs by land cover type 3:17PM at July 24, Table S20. UAV TIR LSTs and in-situ LSTs by land cover type 5:16PM at July 24, Table S21. UAV TIR LSTs and in-situ LSTs by land cover type 7:08PM at July 24, Table S22. UAV TIR LSTs and in-situ LSTs by land cover type 9:07PM at July 24, Table S23. UAV TIR LSTs and in-situ LSTs by land cover type 11:08PM at July 24, Table S24. UAV TIR LSTs and in-situ LSTs by land cover type 1:20AM at July 25, Table S25. UAV TIR LSTs and in-situ LSTs by land cover type 3:16AM at July 25, Table S26. UAV TIR LSTs and in-situ LSTs by land cover type 5:16AM at July 25, Table S27. UAV TIR LSTs and in-situ LSTs by land cover type 7:16AM at July 25, Table S28. UAV TIR LSTs and in-situ LSTs by land cover type 4:10PM at July 26, Table S29. UAV TIR LSTs and in-situ LSTs by land cover type 7:01PM at July 26, Table S30. RMSE between the in-situ LSTs and UAV TIR LSTs (°C) at July 24, Table S31. RMSE between the in-situ LSTs and UAV TIR LSTs (°C) at August 2, Table S32. MAE between the in-situ LSTs and UAV TIR LSTs (°C) at July 24, Table S33. MAE between the in-situ LSTs and UAV TIR LSTs (°C) at August 2, Figure S1. Images UAV's of the first and second flight on July 24, Figure S2. Images UAV's of the third and fourth flight on July 24 , Figure S3. Images UAV's of the fifth and sixth flight on July 24 , Figure S4. Images UAV's of the seventh flight on July 24, Figure S5. Images UAV's of the eighth on July 24 and ninth flight July 25, Figure S6. Images UAV's of the tenth and eleventh flight on July 25, Figure S7. Images UAV's of the twelfth flight on July 25, Figure S8. Images UAV's of the first and second flight on July 26, Figure S9. Images UAV's of the first and second flight on August 2 , Figure S10. Images UAV's of the third and fourth flight on August 2, Figure S11. Images UAV's of the fifth and sixth flight on August 2, Figure S12. Images UAV's of the seventh flight on August 2, Figure S13. Images of night UAV on August 2

**Table S1. The acquisition time of the ten flights at July 24**

Mission	Acquisition time		
	First image	Last image	Average
Flight 1	9:00 AM, Jul 24	9:21 AM, Jul 24	9:12 AM, Jul 24, 2020
Flight2	10:40 AM, Jul 24	11:15 AM, Jul 24	10:58 AM, Jul 24, 2020
Flight3	12:56 AM, Jul 25	1:44 PM, Jul 25	1:21 PM, Jul 25, 2020
Flight4	3:05 PM, Jul 25	3:30 PM, Jul 25	3:17 PM, Jul 25, 2020
Flight5	5:02 PM, Jul 25	5:32 PM, Jul 25	5:16 PM, Jul 25, 2020
Flight6	6:51 PM, Jul 25	7:22 PM, Jul 25	7:08 PM, Jul 25, 2020
Flight7	8:55 PM, Jul 25	9:20 PM, Jul 25	9:07 PM, Jul 25, 2020
Flight8	10:52 PM, Jul 25	11:21 PM, Jul 25	11:08 PM, Jul 25, 2020
Flight9	1:03 AM, Jul 25	1:32 AM, Jul 25	1:20 AM, Jul 25, 2020
Flight10	2:59 AM, Jul 25	3:26 AM, Jul 25	3:16 AM, Jul 25, 2020
Flight11	5:00 AM, Jul 25	5:29 AM, Jul 25	5:16 AM, Jul 25, 2020
Flight12	7:00 AM, Jul 25	7:27 AM, Jul 25	7:16 AM, Jul 25, 2020



**Table S2. The acquisition time of the ten flights at July 26**

Mission	Acquisition time		
	First image	Last image	Average
Flight 1	4:04 PM, Jul 26	4:24 PM, Jul 26	4:14 AM, Jul 26, 2020
Flight2	6:50 PM, Jul 26	7:17 PM, Jul 26	7:05 PM, Jul 26, 2020

**Table S3. The acquisition time of the ten flights at August 2**

Mission	Acquisition time		
	First image	Last image	Average
Flight 1	9:04 AM, Aug 2	9:29 AM, Aug 2	9:15 AM, Aug 2, 2020
Flight2	10:56 AM, Aug 2	11:20 AM, Aug 2	11:10 AM, Aug 2, 2020
Flight3	1:00 AM, Aug 2	1:25 PM, Aug 2	1:13 PM, Aug 2, 2020
Flight4	2:59 PM, Aug 2	3:25 PM, Aug 2	3:13 PM, Aug 2, 2020
Flight5	5:00 PM, Aug 2	5:24 PM, Aug 2	5:12 PM, Aug 2, 2020
Flight6	7:01 PM, Aug 2	7:27 PM, Aug 2	7:14 PM, Aug 2, 2020
Flight7	8:53 PM, Aug 2	9:17 PM, Aug 2	9:08 PM, Aug 2, 2020

**Table S4. Equipment parameter table**

Item	Detailed Specifications
	Weight: 3.84 kg Max. flight time: 25 to 27 min Max. speed: 23 m/s Operating temperature: -20 to 45 °C
	<b>DJI Matrice 210</b>
	<b>Thermal imaging camera</b> Size: 123.7 × 112.6 × 127.1 mm Spectral range: 7.5 to 13.5 μm Accuracy: ±5 °C Weight: 629 g Operating temp. range: -25 to 135 °C Resolution: 640 × 512 pixels NETD: <50 mk@f/1.0
	<b>Visible light camera</b> Sensor: 1/1.7" CMOS effective pixels: 12 million Field of View (FOV): 8 mm, 57.12° × 42.44°
<b>Zenmuse XT2</b>	Size: 175 x 85 x 75 mm Weight: 255 g Operating temp. range: 0 to 50 °C Temperature: -30°C to 500 °C Emissivity: 0.1 to 1.0



**62 MAX radiation thermometer**

**Table S5. Emissivity values for each surface type**

Land Use Type	Emissivity	Reference
Pervious Brick	0.95	(Wang et al. 2019)
Lawn	0.97	(Yang et al. 2021)
Water	0.98	(Wei et al. 2017)
Concrete	0.91	(Qin et al. 2017)
Asphalt	0.95	(Sen and Roesler 2019)

**Table S6. Meteorological sensor parameters**

Name	Measuring range	Resolution ratio	Error
wind velocity sensor	0 — 70m/s	0.1m/s	$\pm (0.3 \pm 0.03v)$ m/s
wind transducer sensor	0 — 360°	1°	$\pm 3^\circ$
Air temperature sensor	-50 — +100°C	0.1°C	$\pm 0.4^\circ\text{C}$
Air humidity sensor	0 — 100%RH	0.1%RH	$\pm 3\%$
barometric pressure sensor	10 — 1100hpa	0.1hpa	$\pm 0.3\text{hpa}$

**Table S7. UAV TIR LSTs and in-situ LSTs by land cover type 9:15AM at August2**

Land cover	N	UAV		In-Situ		Different	
		Average	S.D.	Average	S.D.	Average	S.D.
Pervious brick1	14	26.3	2.00	23.8	0.88	-2.5	-1.12
Pervious brick2	14	24.2	0.93	22.8	2.49	-1.4	1.56
Lawn	14	27.2	0.34	23.2	0.73	-4	0.39
Concrete	14	30.2	2.99	27.8	0.00	-2.4	-2.99
Asphalt	14	30.9	0.42	31.6	0.21	0.7	-0.21
Water1	14	22.8	0.11	21.5	0.17	-1.3	0.06
Water2	14	22.7	0.16	24.9	0.00	2.2	-0.16
Water3	14	22.5	0.11	22.2	0.14	-0.3	0.03
Average	--	25.8	0.88	24.7	0.58	-1.1	-0.3

**Table S8. UAV TIR LSTs and in-situ LSTs by land cover type 11:10AM at August2**

Land cover	N	UAV		In-Situ		Different	
		Average	S.D.	Average	S.D.	Average	S.D.
Pervious brick1	14	30.5	1.21	30.4	0.43	0.1	-0.78
Pervious brick2	14	31.2	0.40	31.3	0.50	0.1	0.10
Lawn	14	26.7	0.76	25.0	0.32	-1.7	-0.44
Concrete	14	33.8	1.37	32.5	0.00	-1.3	-1.37
Asphalt	14	36.9	1.28	39.9	0.17	3.0	-1.11
Water1	14	23.7	0.10	22.2	0.18	-1.5	0.08
Water2	14	23.3	0.15	24.7	0.00	1.4	-0.15
Water3	14	23.4	0.26	22.8	0.09	-0.6	-0.17
Average	--	28.7	0.69	28.6	0.21	-0.1	-0.48

**Table S9. UAV TIR LSTs and in-situ LSTs by land cover type 1:13PM at August2**

Land cover	N	UAV		In-Situ		Different	
		Average	S.D.	Average	S.D.	Average	S.D.
Pervious brick1	14	34.4	0.33	34.6	0.32	0.2	-0.01
Pervious brick2	14	35.4	0.32	36.1	0.79	0.7	0.47
Lawn	14	29.4	1.17	28.5	2.25	-0.9	1.08
Concrete	14	38.8	1.12	37.2	0.00	-1.6	-1.12
Asphalt	14	40.3	0.28	43.4	0.18	3.1	-0.1
Water1	14	24.1	0.10	22.4	0.20	-1.7	0.10
Water2	14	23.8	0.20	25.0	0.00	1.2	-0.20
Water3	14	24.9	0.15	22.9	0.27	-2.0	0.12
Average	--	31.4	0.46	31.3	0.50	-0.1	0.04

**Table S10.UAV TIR LSTs and in-situ LSTs by land cover type 3:13PM at August2**

Land cover	N	UAV		In-Situ		Different	
		Average	S.D.	Average	S.D.	Average	S.D.
Pervious brick1	14	36.3	0.87	34.1	0.67	-2.2	-0.20
Pervious brick2	14	33.4	0.59	34.2	0.26	0.8	-0.33
Lawn	14	29.2	0.54	24.3	0.83	-4.9	0.29
Concrete	14	35.9	0.38	35.0	0.00	-0.9	-0.38
Asphalt	14	36.1	0.21	39.2	0.17	3.1	-0.04
Water1	14	23.9	0.07	22.7	0.16	-1.2	0.09
Water2	14	24.4	0.12	25.1	0.00	0.7	-0.12
Water3	14	25.4	0.13	24.5	0.31	-0.9	0.18
Average	--	30.6	0.36	29.8	0.30	-0.8	-0.06

**Table S11. UAV TIR LSTs and in-situ LSTs by land cover type 5:12PM at August2**

Land cover	N	UAV		In-Situ		Different	
		Average	S.D.	Average	S.D.	Average	S.D.
Pervious brick1	14	26.5	0.34	24.8	0.18	-1.7	-0.16
Pervious brick2	14	27.7	0.45	25.8	0.47	-1.9	0.02
Lawn	14	23.6	0.37	19.5	0.63	-4.1	0.26
Concrete	14	28.2	0.36	28.3	0.00	0.1	-0.36
Asphalt	14	29.0	0.21	29.3	0.27	0.3	0.06
Water1	14	23.6	0.12	22.6	0.16	-1.0	0.04
Water2	14	24.2	0.07	25.1	0.00	0.9	-0.07
Water3	14	24.4	0.10	22.9	0.09	-1.5	-0.01
Average	--	25.9	0.25	24.8	0.22	-1.1	-0.03

**Table S12. UAV TIR LSTs and in-situ LSTs by land cover type 7:14 PM at August2**

Land cover	N	UAV		In-Situ		Different	
		Average	S.D.	Average	S.D.	Average	S.D.
Pervious brick1	14	25.2	0.41	23.5	0.38	-1.7	-0.03
Pervious brick2	14	24.7	0.26	24.0	0.51	-0.7	0.25
Lawn	14	22.6	0.11	19.1	0.44	-3.5	0.33
Concrete	14	25.4	0.82	23.7	0.00	-1.7	-0.82
Asphalt	14	25.8	0.24	27.3	0.18	1.5	-0.06
Water1	14	23.2	0.09	22.9	0.12	-0.3	0.03
Water2	14	24.8	0.10	25.1	0.00	0.3	-0.1
Water3	14	24.2	0.27	23.7	0.12	-0.5	-0.15
Average	--	24.5	0.29	23.7	0.22	-0.8	-0.07

**Table S13. UAV TIR LSTs and in-situ LSTs by land cover type 9:08 PM at August2**

Land cover	N	UAV		In-Situ		Different	
		Average	S.D.	Average	S.D.	Average	S.D.
Pervious brick1	14	24.9	0.21	21.3	0.18	-3.6	-0.03
Pervious brick2	14	23.3	0.63	22.3	0.21	-1.0	-0.42
Lawn	14	21.7	0.15	18.1	0.20	-3.6	0.05
Concrete	14	23.1	0.74	22.1	0.00	-1.0	-0.74
Asphalt	14	24.1	0.18	23.9	0.18	-0.2	0.00
Water1	14	23.2	0.09	22.5	0.22	-0.7	0.13
Water2	14	23.9	0.16	24.9	0.00	-1.0	-0.16
Water3	14	24.3	0.11	22.7	0.10	-1.6	-0.01
Average	--	23.6	0.29	22.2	0.14	-1.4	-0.15

**Table S14. Rain event on July 26**

Note: "---" is missing data

Land cover	Surface temperature before rain (°C)		Air temperature around the underlying surface after rainfall (°C)												
	in-situ LSTs	UAV TIR LSTs	0min	5min	10 min	15 min	20 min	25 min	30 min	35 min	40 min	45 min	50 min	55 min	60 min
Water 3	24.2	26.1	24.1	20.6	19.0	18.3	18.0	18.0	18.1	18.1	18.0	17.8	17.4	17.3	17.1
Water 2	24.5	---	23.9	22.1	20.0	19.2	18.5	18.6	18.5	18.4	18.0	17.7	17.7	17.6	17.6
Water 1	----	---	24.5	20.6	18.4	18.1	18.1	18.0	17.6	17.4	17.3	17.2	17.2	16.9	16.7
Lawn	22.4	26.2	24.5	20.6	18.4	18.1	18.1	18.0	17.6	17.4	17.3	17.2	17.2	16.9	16.7
Pervious brick 2	31.8	31.5	24.1	20.6	19.0	18.3	18.0	18.0	18.1	18.1	18.0	17.8	17.4	17.3	17.1
Pervious brick 1	33.5	33.0	24.5	20.6	18.4	18.1	18.1	18.0	17.6	17.4	17.3	17.2	17.2	16.9	16.7
Concrete	31.7	33.1	24.1	20.6	19.0	18.3	18.0	18.0	18.1	18.1	18.0	17.8	17.4	17.3	17.1
Asphalt	33.5	---	24.5	20.6	18.4	18.1	18.1	18.0	17.6	17.4	17.3	17.2	17.2	16.9	16.7

**Table S15. Rain event on August 2**

Land cover	Surface temperature before rain (°C)		Air temperature around the underlying surface after rainfall (°C)												
	in-situ LSTs	UAV TIR LSTs	0min	5min	10 min	15 min	20 min	25 min	30 min	35 min	40 min	45 min	50 min	55 min	60 min
Water 3	24.5	25.4	23.7	21.7	20.4	20.0	19.9	19.5	19.6	19.6	19.7	19.8	19.9	19.9	19.9
Water 2	25.1	22.4	23.3	21.9	20.7	20.3	20.1	19.4	19.3	19.4	19.4	19.5	19.4	19.4	19.6
Water 1	22.7	23.9	23.3	21.1	20.1	19.8	19.7	19.3	19.3	19.5	19.5	19.6	19.7	19.7	19.8
Lawn	24.3	29.2	23.3	21.1	20.1	19.8	19.7	19.3	19.3	19.5	19.5	19.6	19.7	19.7	19.8
Pervious brick 2	34.2	33.4	23.7	21.7	20.4	20.0	19.9	19.5	19.6	19.6	19.7	19.8	19.9	19.9	19.9
Pervious brick 1	34.1	36.3	23.3	21.1	20.1	19.8	19.7	19.3	19.3	19.5	19.5	19.6	19.7	19.7	19.8
Concrete	35.0	35.9	23.7	21.7	20.4	20.0	19.9	19.5	19.6	19.6	19.7	19.8	19.9	19.9	19.9
Asphalt	39.2	36.1	23.3	21.1	20.1	19.8	19.7	19.3	19.3	19.5	19.5	19.6	19.7	19.7	19.8

**Table S16. UAV TIR LSTs and in-situ LSTs by land cover type 9:12AM at July****24**

Land cover	N	UAV		In-Situ		Different	
		Average	S.D.	Average	S.D.	Average	S.D.
Pervious brick1	14	26.0	0.12	24.6	0.10	-1.4	-0.02
Pervious brick2	14	24.7	0.17	23.6	0.15	-1.1	-0.02
Lawn	14	24.4	0.42	20.8	0.00	-3.6	-0.42
Concrete	14	26.6	0.72	25.6	0.00	-1	-0.72
Asphalt	14	27.4	0.08	27.8	0.21	0.04	0.13
Water1	14	22.1	0.08	20.8	0.14	-1.3	0.06
Water2	14	23.1	0.21	23.1	0.00	0	-0.21
Water3	14	23.1	0.08	21.1	0.12	-2	0.04
Average	--	24.7	0.23	23.4	0.09	-1.29	-0.14

**Table S17. UAV TIR LSTs and in-situ LSTs by land cover type 10:58AM at July****24**

Land cover	N	UAV		In-Situ		Different	
		Average	S.D.	Average	S.D.	Average	S.D.
Pervious brick1	14	30.7	0.69	30.1	0.23	-0.6	-0.46
Pervious brick2	14	30.8	0.64	27.8	0.18	-3	-0.46
Lawn	14	30.0	0.59	21.4	0.00	-8.6	-0.59
Concrete	14	33.6	0.96	30.2	0.00	-3.4	-0.96
Asphalt	14	33.2	0.35	36.3	0.24	3.1	-0.11
Water1	14	21.3	0.15	19.4	0.37	-1.9	0.22
Water2	14	22.5	0.19	22.3	0.00	-0.2	-0.19
Water3	14	22.1	0.15	20.1	0.39	-2	0.24
Average	--	28.0	0.46	25.95	0.17	-2.0	-0.28

**Table S18. UAV TIR LSTs and in-situ LSTs by land cover type 1:21PM at July 24**

Land cover	N	UAV		In-Situ		Different	
		Average	S.D.	Average	S.D.	Average	S.D.
Pervious brick1	14	41.6	0.89	39.3	0.41	-2.3	-0.48
Pervious brick2	14	38.2	0.38	40.6	1.18	2.4	0.8
Lawn	14	36.3	0.87	23.8	0.00	-12.5	-0.87
Concrete	14	41.8	1.00	44.1	0.00	2.3	-1.00
Asphalt	14	45.8	0.46	49.2	0.30	3.4	-0.16
Water1	14	24.8	0.31	20.3	0.20	-4.5	-0.11
Water2	14	23.3	0.17	22.3	0.00	-1	-0.17
Water3	14	25.1	0.17	21.3	0.24	-3.8	0.07
Average	--	34.6	0.53	32.6	0.29	-2.0	-0.24

**Table S19. UAV TIR LSTs and in-situ LSTs by land cover type 3:17PM at July 24**

Land cover	N	UAV		In-Situ		Different	
		Average	S.D.	Average	S.D.	Average	S.D.
Pervious brick1	14	42.7	3.14	45.8	0.50	3.1	-2.64
Pervious brick2	14	41.5	0.97	43.7	0.63	2.2	-0.34
Lawn	14	36.0	0.82	23.5	0.00	-12.5	-0.82
Concrete	14	46.5	1.60	43.1	0.00	-3.4	-1.60
Asphalt	14	47.3	0.28	53.1	0.37	5.8	0.09
Water1	14	23.5	0.47	22.3	0.22	-1.2	-0.25
Water2	14	24.1	0.29	22.7	0.00	-1.4	-0.29
Water3	14	25.4	0.17	22.5	0.22	-2.9	0.05
Average	--	35.8	0.96	34.5	0.24	-1.2	-0.72

**Table S20. UAV TIR LSTs and in-situ LSTs by land cover type 5:16PM at July 24**

Land cover	N	UAV		In-Situ		Different	
		Average	S.D.	Average	S.D.	Average	S.D.
Pervious brick1	14	38.6	1.73	34.8	0.20	-3.8	-1.53
Pervious brick2	14	39.0	1.63	42.8	0.67	3.8	-0.96
Lawn	14	29.9	0.29	23.2	0.00	-6.7	-0.29
Concrete	14	43.4	0.82	42.9	0.00	-0.5	-0.82
Asphalt	14	44.6	0.22	45.0	0.30	0.4	0.08
Water1	14	24.8	0.14	22.4	0.25	-2.4	0.11
Water2	14	24.1	0.26	22.7	0.00	-1.4	-0.26
Water3	14	27.5	0.25	23.4	0.23	-4.1	-0.02
Average	--	33.9	0.51	32.1	0.20	-1.8	-0.30

**Table S21. UAV TIR LSTs and in-situ LSTs by land cover type 7:08PM at July 24**

Land cover	N	UAV		In-Situ		Different	
		Average	S.D.	Average	S.D.	Average	S.D.
Pervious brick1	14	32.2	0.79	29.9	0.30	-2.3	-0.49
Pervious brick2	14	31.3	1.10	33.5	0.53	2.2	0.57
Lawn	14	25.3	0.20	22.9	0.00	-2.4	-0.2
Concrete	14	32.7	0.80	32.2	0.00	-0.05	-0.8
Asphalt	14	32.0	0.10	34.8	0.28	2.8	0.18
Water1	14	21.9	0.08	22.5	0.20	0.6	0.12
Water2	14	23.9	0.14	22.7	0.00	-1.2	-0.14
Water3	14	26.7	0.26	22.9	0.22	-3.8	-0.04
Average	--	28.2	0.43	27.6	0.19	-0.5	-0.24

**Table S22. UAV TIR LSTs and in-situ LSTs by land cover type 9:07PM at July 24**

Land cover	N	UAV		In-Situ		Different	
		Average	S.D.	Average	S.D.	Average	S.D.
Pervious brick1	14	28.4	0.54	27.2	0.23	-1.2	-0.31
Pervious brick2	14	27.3	0.40	27.5	0.36	0.2	-0.04
Lawn	14	23.9	0.23	22.6	0.00	-1.3	-0.23
Concrete	14	28.1	0.46	27.3	0.00	-0.8	-0.46
Asphalt	14	27.2	0.26	28.3	0.15	1.1	-0.11
Water1	14	22.1	0.07	22.0	0.21	-0.1	0.14
Water2	14	24.4	0.19	22.7	0.00	-1.7	-0.19
Water3	14	24.7	0.13	22.6	0.07	-2.1	-0.06
Average	--	25.7	0.28	25.0	0.12	-0.7	-0.15

**Table S23. UAV TIR LSTs and in-situ LSTs by land cover type 11:08PM at July****24**

Land cover	N	UAV		In-Situ		Different	
		Average	S.D.	Average	S.D.	Average	S.D.
Pervious brick1	14	27.4	0.26	25.0	0.28	-2.4	0.02
Pervious brick2	14	24.7	0.44	25.0	0.24	0.3	-0.2
Lawn	14	22.4	0.20	22.3	0.00	-0.1	-0.2
Concrete	14	25.7	0.20	25.2	0.00	-0.5	-0.2
Asphalt	14	26.1	0.13	26.2	0.24	0.1	0.11
Water1	14	22.8	0.08	21.3	0.12	-1.5	0.04
Water2	14	24.4	0.13	22.9	0.00	-1.5	-0.13
Water3	14	24.0	0.12	22.3	0.18	-1.7	0.06
Average	--	24.6	0.19	23.7	0.13	-0.9	-0.06

**Table S24. UAV TIR LSTs and in-situ LSTs by land cover type 1:20AM at July****25**

Land cover	N	UAV		In-Situ		Different	
		Average	S.D.	Average	S.D.	Average	S.D.
Pervious brick1	14	25.9	0.22	24.1	0.23	-1.8	0.01
Pervious brick2	14	23.3	0.58	21.9	0.37	-1.4	-0.21
Lawn	14	21.0	0.29	22.1	0.00	1.1	-0.29
Concrete	14	24.0	0.15	23.4	0.00	-0.6	-0.15
Asphalt	14	23.3	0.30	24.0	0.20	0.7	-0.1
Water1	14	21.3	0.08	21.4	0.24	0.1	0.16
Water2	14	23.5	0.19	22.9	0.00	-0.6	-0.19
Water3	14	22.8	0.12	21.9	0.14	-0.9	0.02
Average	--	23.1	0.24	22.7	0.14	-0.4	-0.09

**Table S25. UAV TIR LSTs and in-situ LSTs by land cover type 3:16AM at July****25**

Land cover	N	UAV		In-Situ		Different	
		Average	S.D.	Average	S.D.	Average	S.D.
Pervious brick1	14	23.5	0.27	22.8	0.18	-0.7	-0.09
Pervious brick2	14	22.0	0.21	20.6	0.25	-1.4	0.04
Lawn	14	19.8	0.23	21.8	0.00	2	-0.23
Concrete	14	23.1	0.22	22.1	0.00	-1	-0.22
Asphalt	14	22.8	0.24	21.8	0.21	-1	-0.03
Water1	14	22.1	0.07	20.8	0.27	-1.3	0.2
Water2	14	22.9	0.06	23.0	0.00	0.1	-0.06
Water3	14	22.5	0.08	21.8	0.09	-0.7	0.01
Average	--	22.3	0.17	21.8	0.12	-0.5	-0.04

**Table S26. UAV TIR LSTs and in-situ LSTs by land cover type 5:16AM at July****25**

Land cover	N	UAV		In-Situ		Different	
		Average	S.D.	Average	S.D.	Average	S.D.
Pervious brick1	14	22.6	0.21	21.7	0.27	-0.9	0.06
Pervious brick2	14	22.6	0.28	20.3	0.24	-2.3	-0.04
Lawn	14	19.7	0.33	21.7	0.00	2.0	-0.33
Concrete	14	23.2	0.15	21.6	0.00	-1.6	-0.15
Asphalt	14	22.2	0.14	21.3	0.18	-0.9	0.04
Water1	14	21.6	0.12	20.7	0.21	-0.9	0.09
Water2	14	23.5	0.14	23.0	0.00	-0.5	-0.14
Water3	14	23.1	0.06	21.8	0.10	-1.3	0.04
Average	--	22.3	0.17	21.5	0.1	-0.8	-0.05

**Table S27. UAV TIR LSTs and in-situ LSTs by land cover type 7:16AM at July****25**

Land cover	N	UAV		In-Situ		Different	
		Average	S.D.	Average	S.D.	Average	S.D.
Pervious brick1	14	24.1	0.19	22.5	0.18	-1.6	-0.01
Pervious brick2	14	22.7	0.21	21.6	0.22	-1.1	0.01
Lawn	14	20.8	0.21	21.4	0.00	0.6	-0.21
Concrete	14	23.2	0.11	22.5	0.00	-0.7	-0.11
Asphalt	14	24.4	0.13	23.2	0.08	-1.2	-0.05
Water1	14	22.6	0.07	20.8	0.18	-1.8	0.11
Water2	14	22.8	0.47	22.9	0.00	0.1	-0.47
Water3	14	22.7	0.12	21.9	0.11	-0.8	-0.01
Average	--	22.9	0.18	22.1	0.09	-0.8	-0.09



**Table S28. UAV TIR LSTs and in-situ LSTs by land cover type 4:10PM at July 26**

Land cover	N	UAV		In-Situ		Different	
		Average	S.D.	Average	S.D.	Average	S.D.
Pervious brick1	14	33.0	0.19	33.5	0.28	0.5	0.09
Pervious brick2	14	31.5	0.37	31.8	0.34	0.3	-0.03
Lawn	14	26.2	0.32	22.4	0.30	-3.8	-0.02
Concrete	14	33.1	0.37	31.7	0.00	0.6	-0.37
Asphalt	14	**	**	33.5	0.31	**	**
Water1	14	**	**	**	**	**	**
Water2	14	**	**	24.5	0.00	**	**
Water3	14	26.1	0.17	24.2	0.21	-1.9	0.04
Average	--	--	--	--	--	--	--

\*\*When it rains, UAV operations cannot be carried out, and data is missing

**Table S29. UAV TIR LSTs and in-situ LSTs by land cover type 7:01PM at July 26**

Land cover	N	UAV		In-Situ		Different	
		Average	S.D.	Average	S.D.	Average	S.D.
Pervious brick1	14	22.4	0.21	21.3	0.60	-1.1	0.39
Pervious brick2	14	23.3	0.11	21.2	0.21	-2.1	0.10
Lawn	14	18.1	0.28	16.3	0.33	-1.8	0.05
Concrete	14	22.3	0.12	21.5	0.00	-0.8	-0.12
Asphalt	14	24.1	0.16	22.3	0.12	-1.8	-0.04
Water1	14	24.5	0.07	22.0	0.12	-2.5	0.05
Water2	14	25.0	0.14	23.9	0.00	-1.1	-0.14
Water3	14	24.1	0.08	22.5	0.06	-1.6	-0.02
Average	--	23.0	0.15	21.4	0.18	-1.6	0.03

**Table S30. RMSE between the in-situ LSTs and UAV TIR LSTs (°C) at July 24**

Land cover	RMSE(°C)					
	9:12 AM	10:58 AM	1:21 PM	3:17 PM	5:16 PM	7:08 PM
Pervious brick1	1.43	1.07	2.41	4.60	4.20	2.49
Pervious brick2	1.05	3.00	2.63	2.38	4.07	2.52
Lawn	3.64	8.62	12.49	12.48	6.70	2.43
Concrete	1.22	3.48	2.54	3.73	0.44	0.91
Asphalt	0.42	3.17	3.49	5.84	0.60	2.80
Water1	1.32	1.92	4.48	1.29	2.44	0.59
Water2	0.21	0.31	1.05	1.41	1.41	1.19
Water3	1.98	2.13	3.86	2.94	4.08	3.77
Average	1.41	2.96	4.12	4.33	2.99	2.09
Land cover	9:07 PM	11:08 PM	1:20 AM	3:16 AM	5:16 AM	7:16 AM
Pervious brick1	1.32	2.36	1.78	0.80	0.98	1.57
Pervious brick2	0.69	0.54	1.46	1.38	2.23	1.07
Lawn	1.29	0.24	1.09	2.00	1.99	0.62
Concrete	0.95	0.53	0.64	1.02	1.58	0.70
Asphalt	1.11	0.23	0.86	1.06	0.94	1.23
Water1	0.24	1.56	0.24	1.25	0.91	1.84
Water2	1.74	1.51	0.61	0.11	0.52	0.48
Water3	2.14	1.74	0.94	0.71	1.36	0.81
Average	1.19	1.09	0.95	1.04	1.31	1.04

**Table S31. RMSE between the in-situ LSTs and UAV TIR LSTs (°C) at August 2**

Land cover	RMSE(°C)						
	9:15 AM	11:10 AM	1:13 PM	3:13 PM	5:12 PM	7:14 PM	9:08 PM
Pervious brick1	6.06	1.14	0.66	2.44	1.70	1.68	3.62
Pervious brick2	2.62	0.50	1.06	1.05	2.03	0.78	1.24
Lawn	4.01	1.94	2.55	5.00	4.19	3.52	3.60
Concrete	3.83	1.91	1.98	1.00	0.38	1.86	1.21
Asphalt	0.76	3.31	3.13	3.06	0.43	1.48	0.38
Water1	1.26	1.52	1.66	1.15	1.03	0.35	0.74
Water2	2.24	1.46	1.26	0.71	0.91	0.28	1.05
Water3	0.34	0.63	2.04	0.97	1.50	0.60	1.68

**Table S32. MAE between the in-situ LSTs and UAV TIR LSTs (°C) at July 24**

Land cover	MAE( ° C)					
	9:12 AM	10:58 AM	1:21 PM	3:17 PM	5:16 PM	7:08 PM
Pervious brick1	1.42	0.72	2.22	3.62	3.79	2.29
Pervious brick2	1.04	2.96	2.34	2.17	3.84	2.23
Lawn	3.62	8.60	12.46	12.46	6.70	2.43
Concrete	0.99	3.35	2.34	3.37	0.51	0.77
Asphalt	0.35	3.15	3.42	5.84	1.40	2.80
Water1	1.32	1.89	4.48	1.15	2.40	0.55
Water2	0.18	0.26	1.04	1.39	0.49	1.19
Water3	1.98	2.09	3.84	2.94	4.08	3.76
Average	1.36	2.88	4.02	4.12	2.90	2.00
Land cover	9:07 PM	11:08 PM	1:20 AM	3:16 AM	5:16 AM	7:16 AM
Pervious brick1	1.19	2.35	1.75	0.71	0.93	1.55
Pervious brick2	0.53	0.38	1.33	1.35	2.21	1.07
Lawn	1.28	0.22	1.06	1.99	1.96	0.59
Concrete	0.83	0.50	0.63	1.00	1.57	0.69
Asphalt	1.09	0.22	0.76	1.00	0.92	1.22
Water1	0.22	1.55	0.24	1.23	0.90	1.83
Water2	1.74	1.51	0.59	0.09	0.51	0.39
Water3	2.14	1.73	0.93	0.70	1.36	0.80
Average	1.13	1.06	0.91	1.01	1.30	1.02

**Table S33. MAE between the in-situ LSTs and UAV TIR LSTs (°C) at August 2**

Land cover	MAE( ° C)						
	9:15 AM	11:10 AM	1:13 PM	3:13 PM	5:12 PM	7:14 PM	9:08 PM
Pervious brick1	2.71	0.90	0.61	2.24	1.65	2.94	5.14
Pervious brick2	1.86	0.38	0.93	0.99	0.64	2.42	4.15
Lawn	3.96	1.67	1.79	4.86	6.98	7.39	8.32
Concrete	3.34	1.71	1.64	0.92	1.84	2.77	4.37
Asphalt	0.68	3.01	3.11	0.70	2.84	0.79	2.57
Water1	1.24	1.50	1.64	1.14	3.89	3.55	3.99
Water2	2.23	1.45	1.24	3.05	1.37	1.37	1.57
Water3	0.33	0.56	2.00	0.91	3.61	2.75	3.79

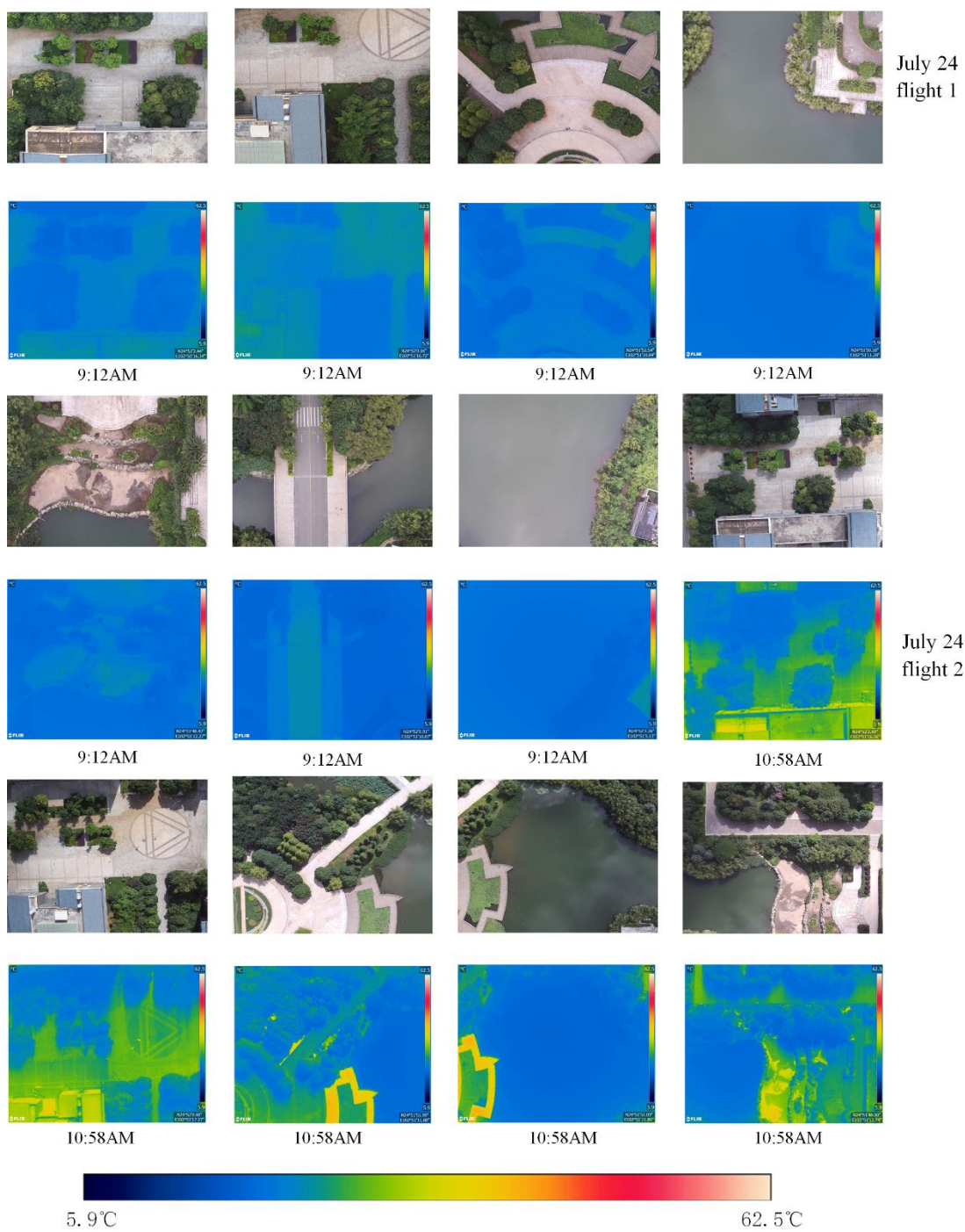


Figure S1. Images UAV's of the first and second flight on July 24

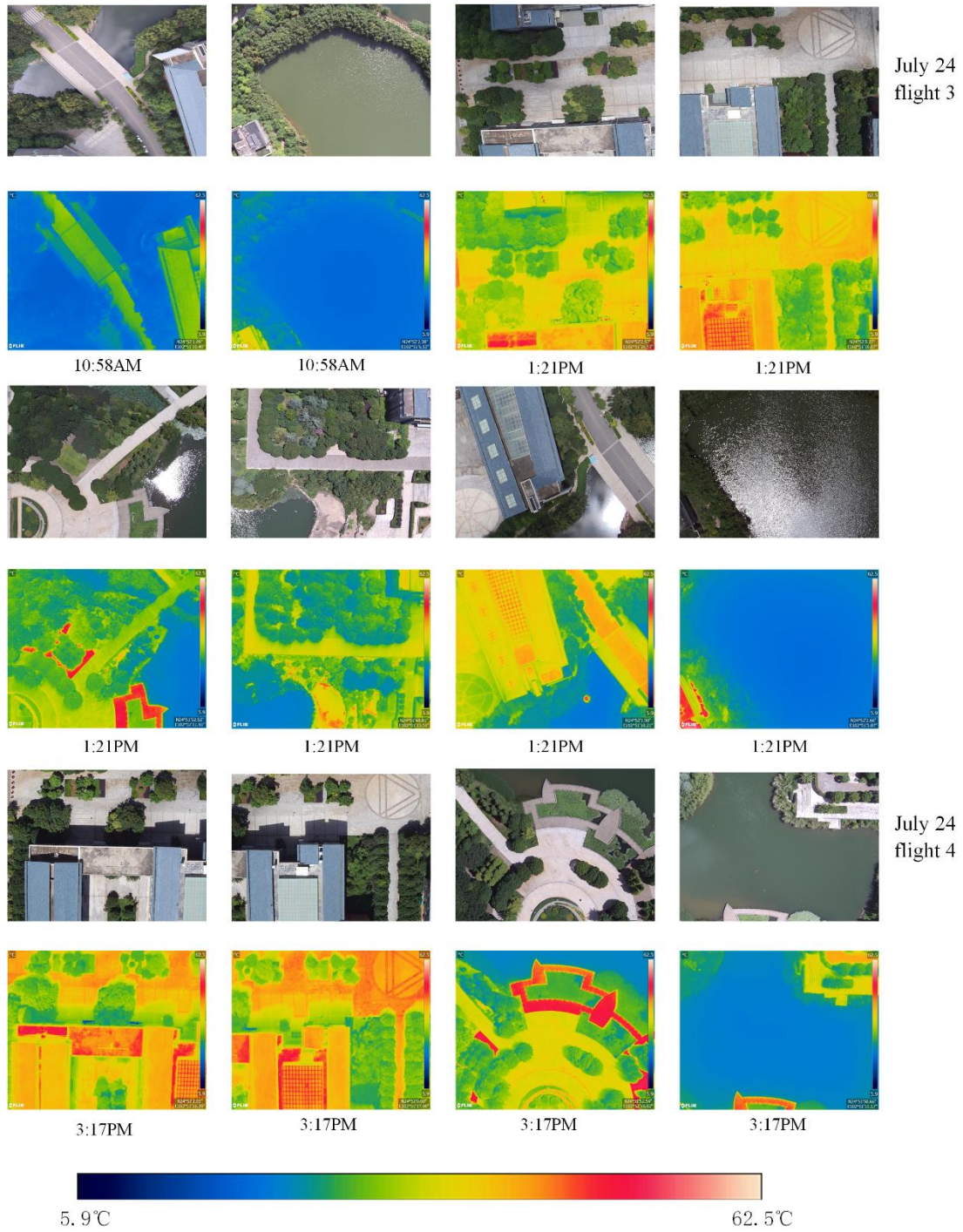


Figure S2. Images UAV's of the third and fourth flight on July 24



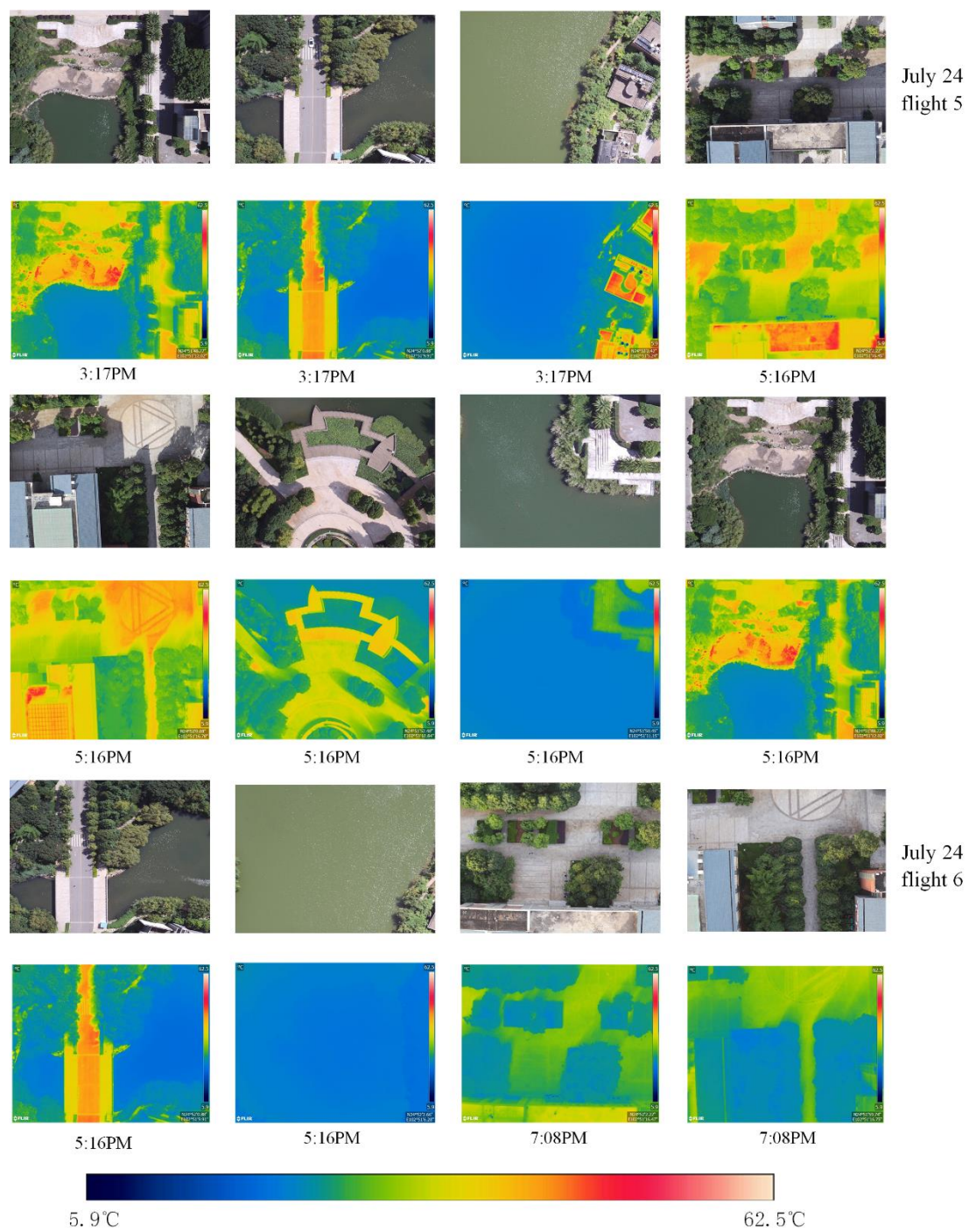


Figure S3. Images UAV's of the fifth and sixth flight on July 24

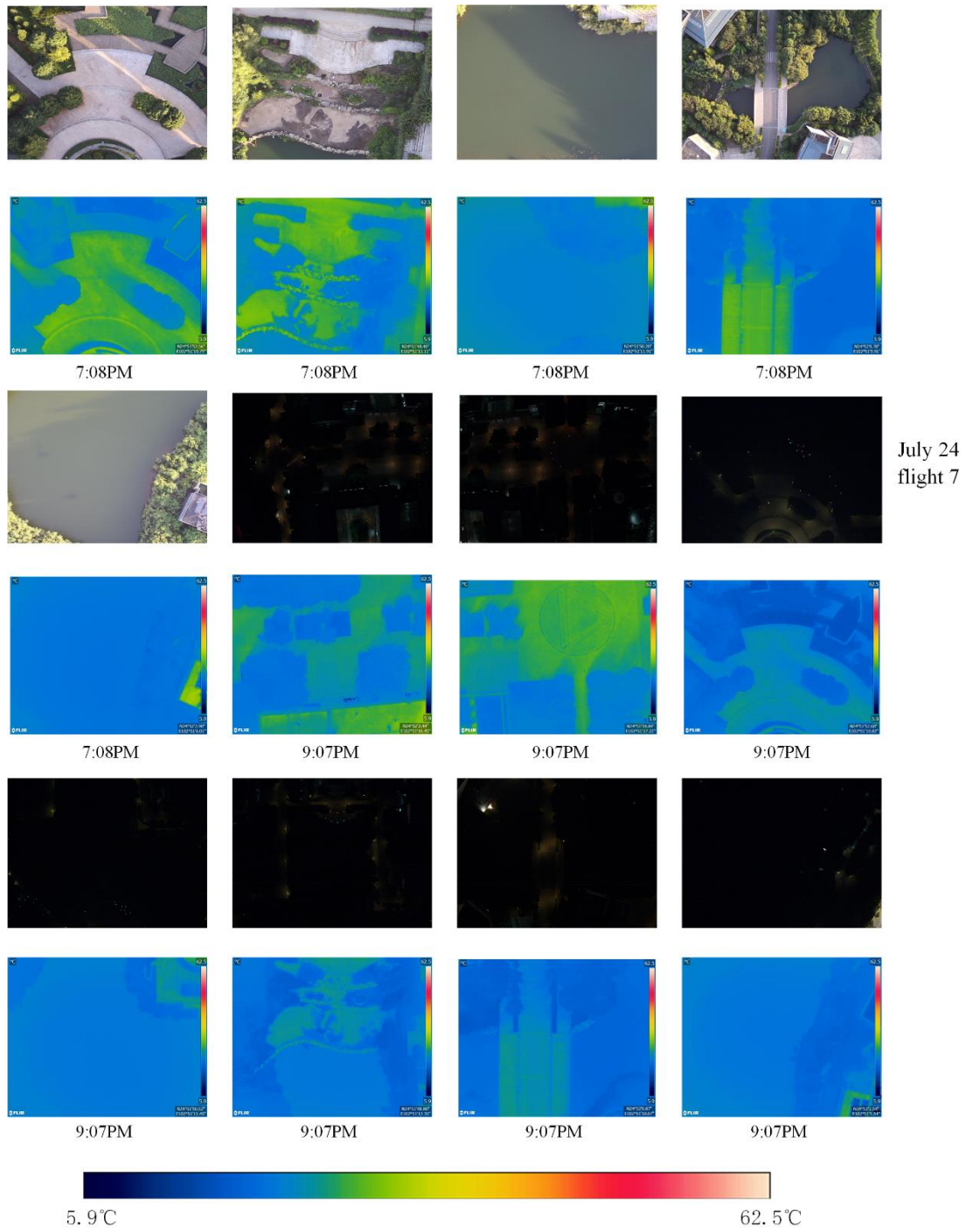


Figure S4. Images UAV's of the seventh flight on July 24

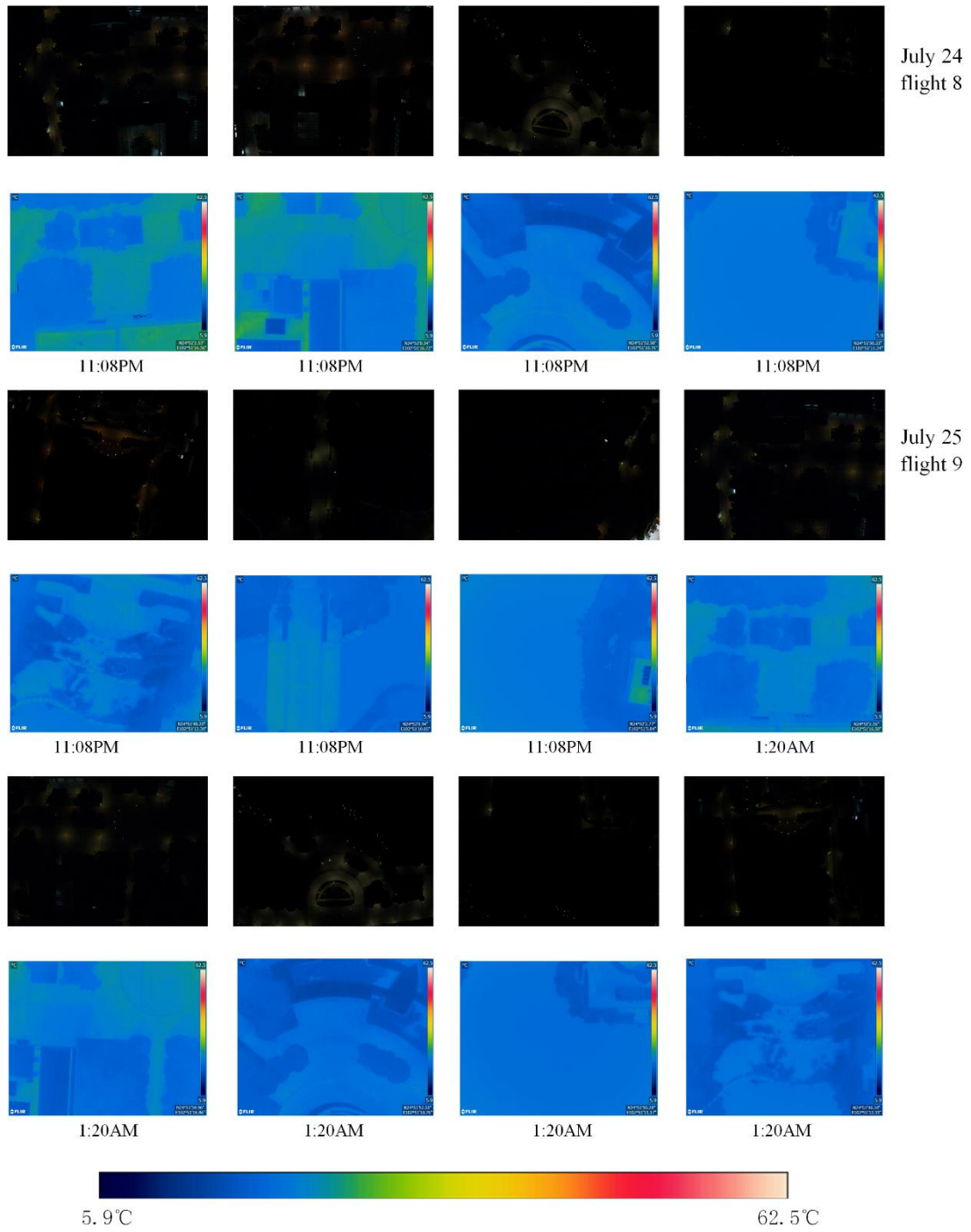


Figure S5. Images UAV's of the eighth on July 24 and ninth flight July 25

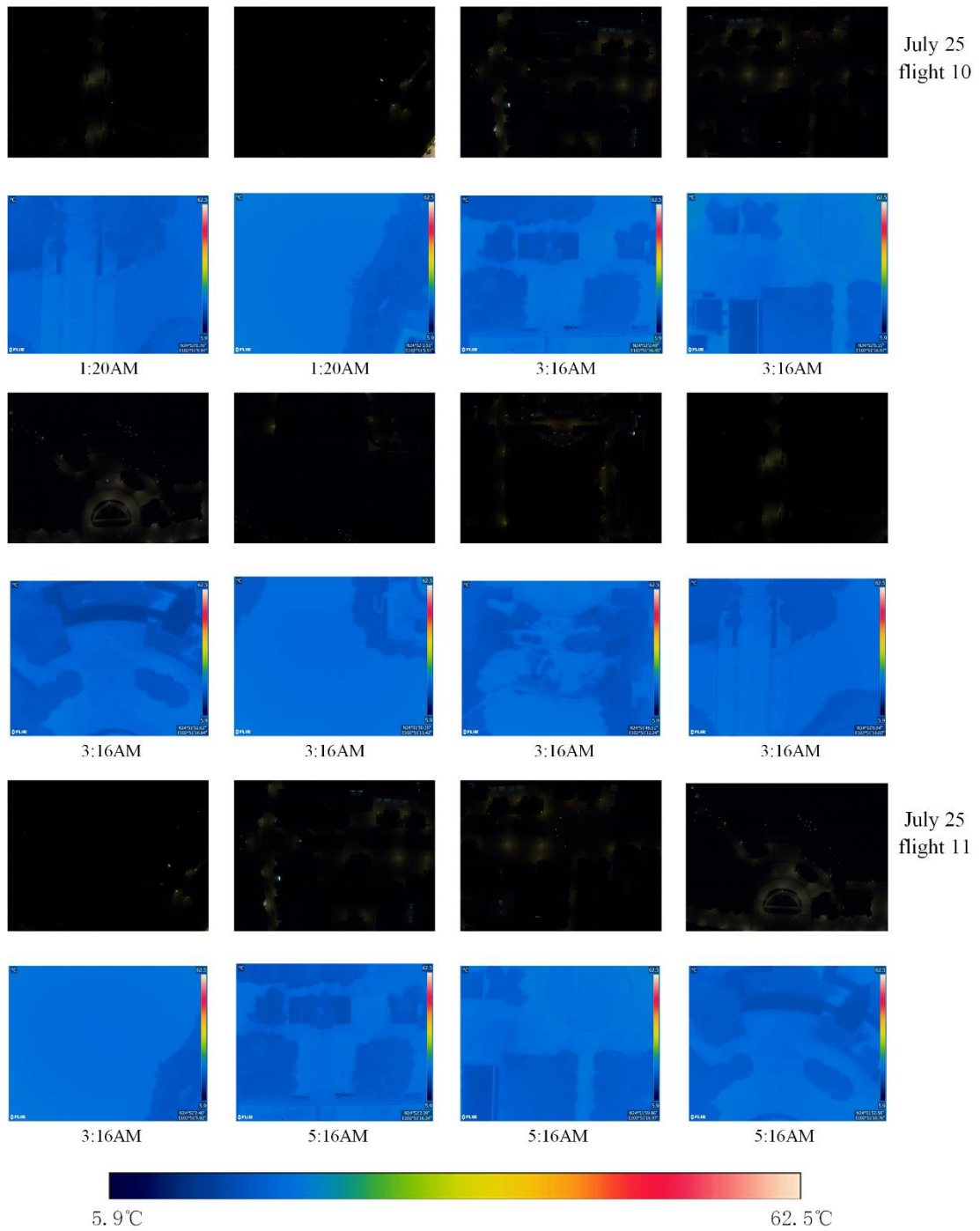


Figure S6. Images UAV's of the tenth and eleventh flight on July 25



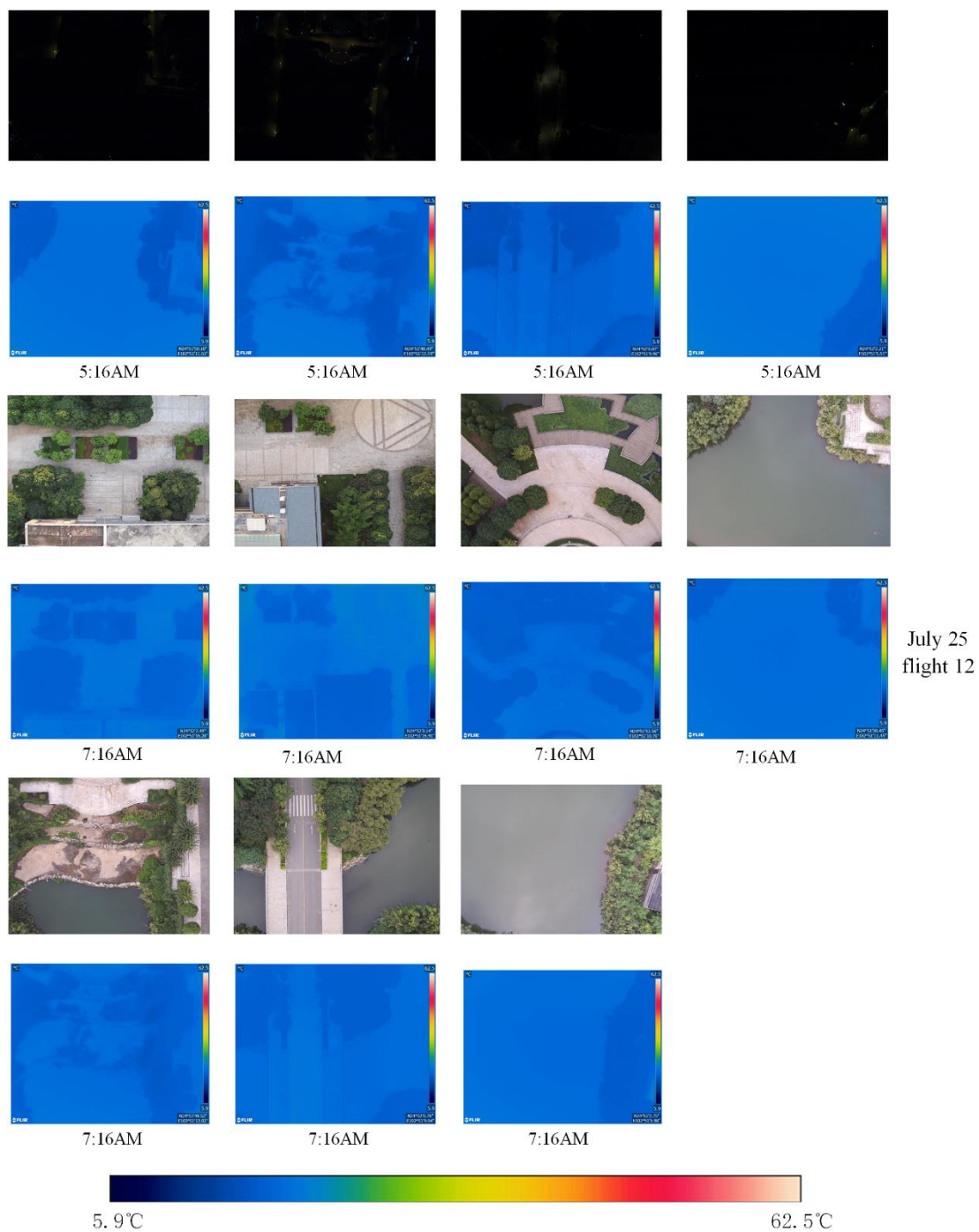


Figure S7. Images UAV's of the twelfth flight on July 25

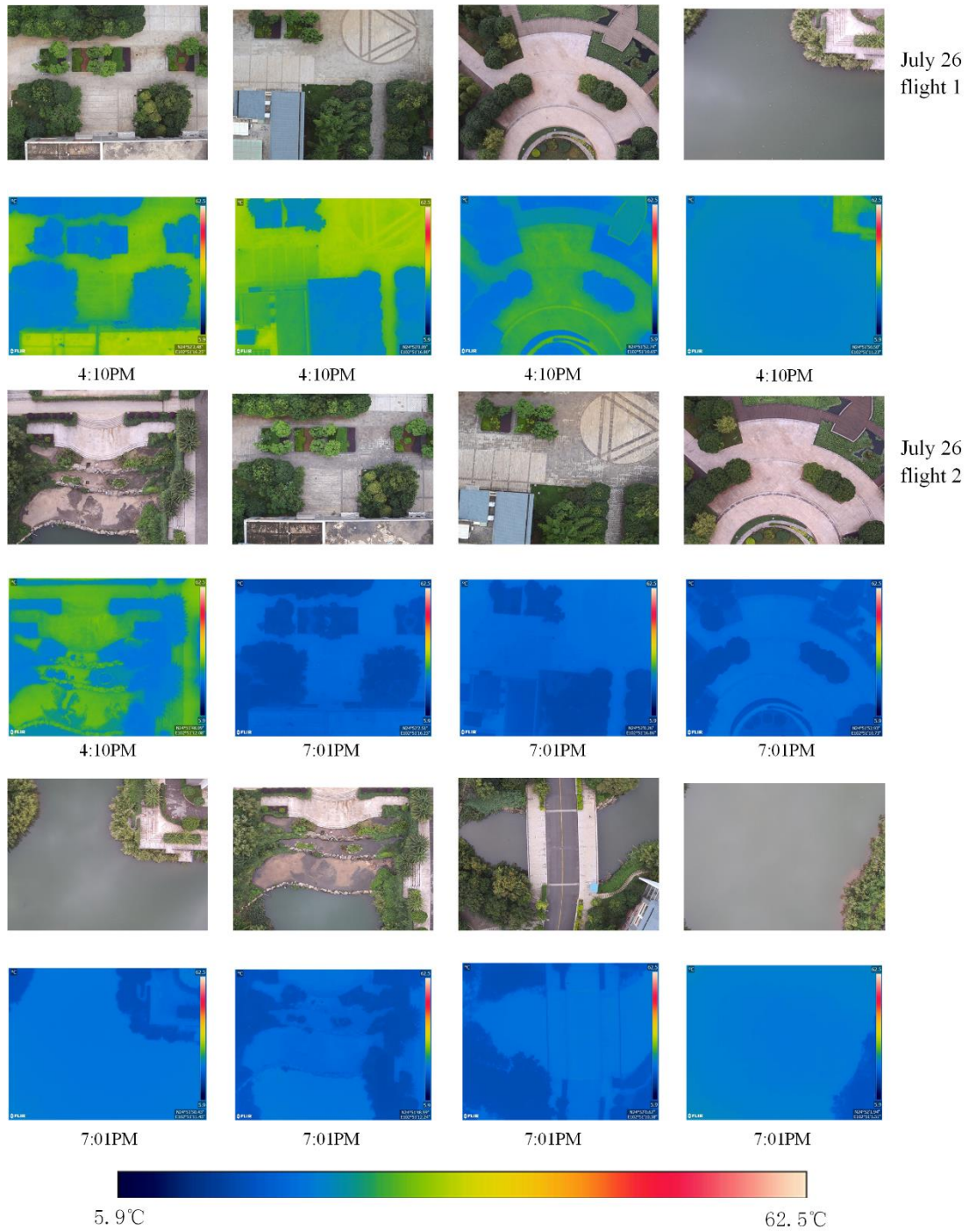


Figure S8. Images UAV's of the first and second flight on July 26

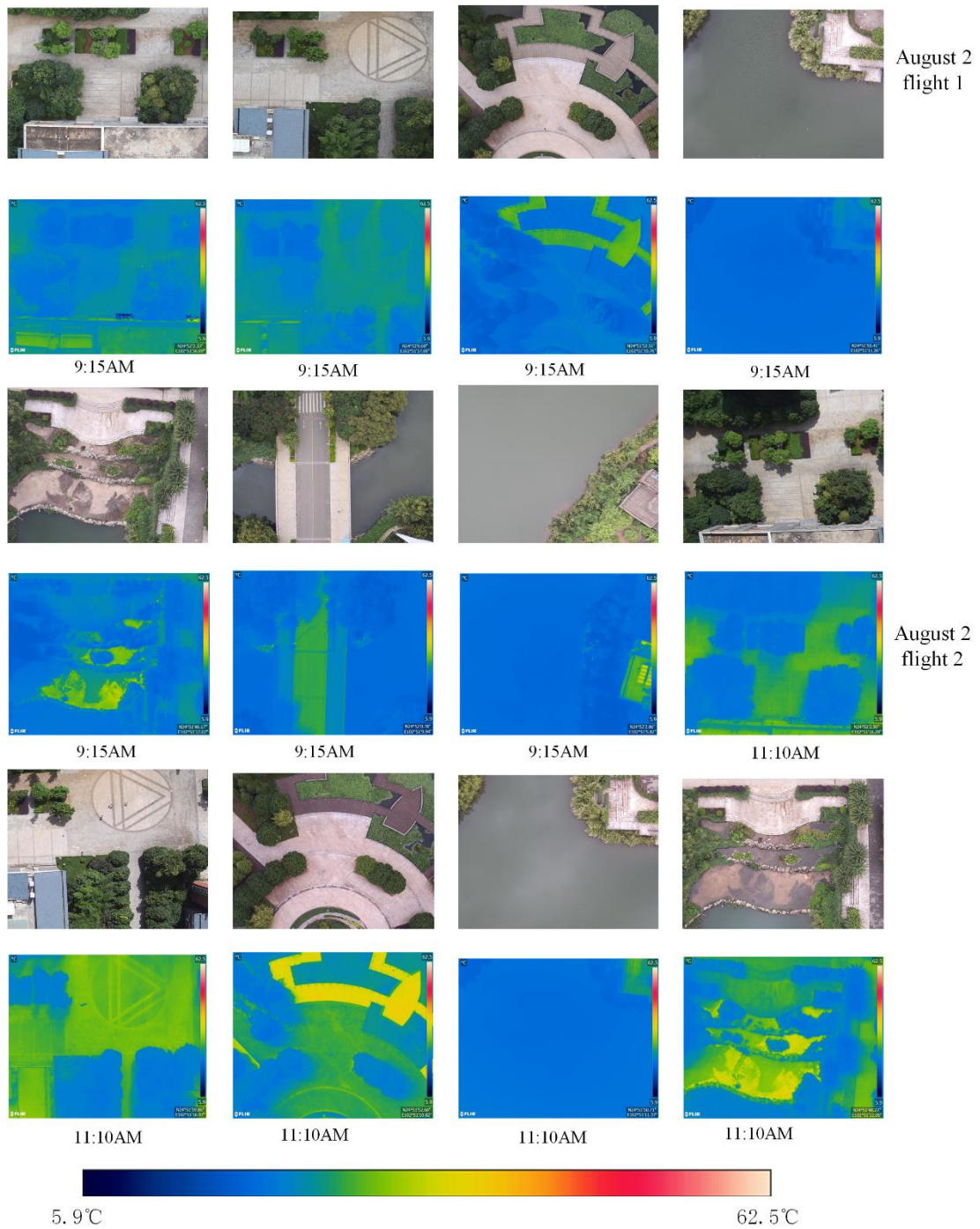


Figure S9. Images UAV's of the first and second flight on August 2



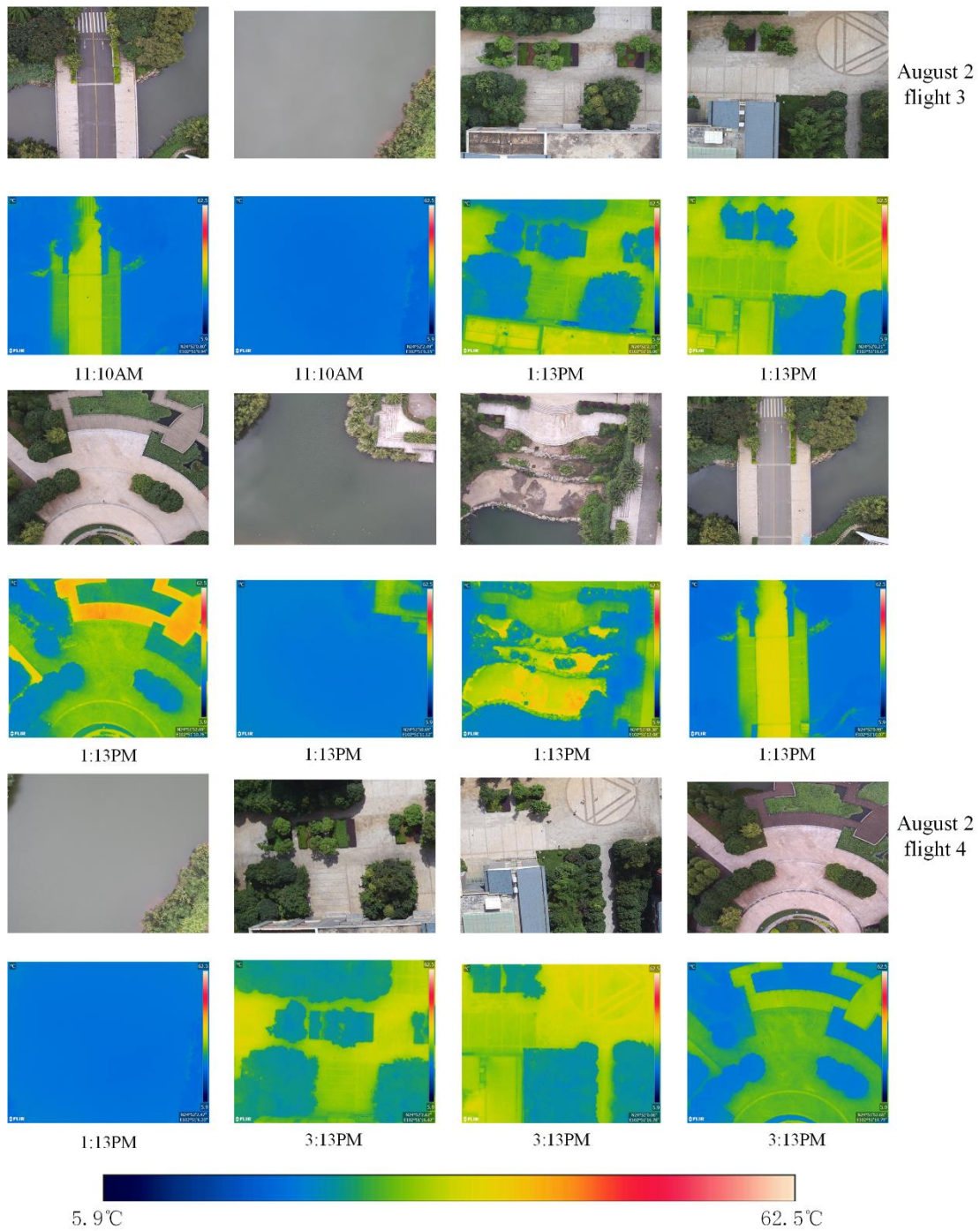


Figure S10. Images UAV's of the third and fourth flight on August 2

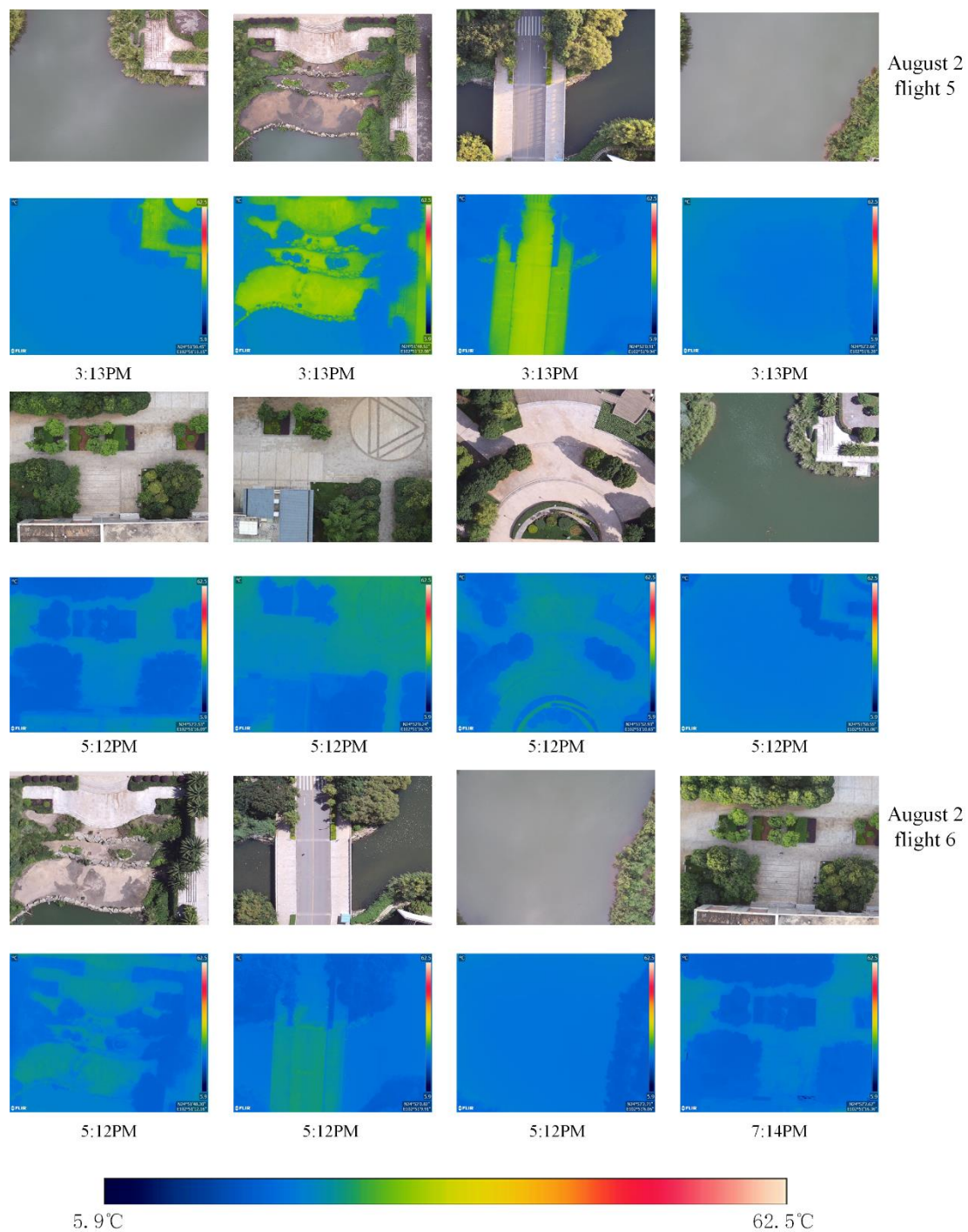


Figure S11. Images UAV's of the fifth and sixth flight on August 2

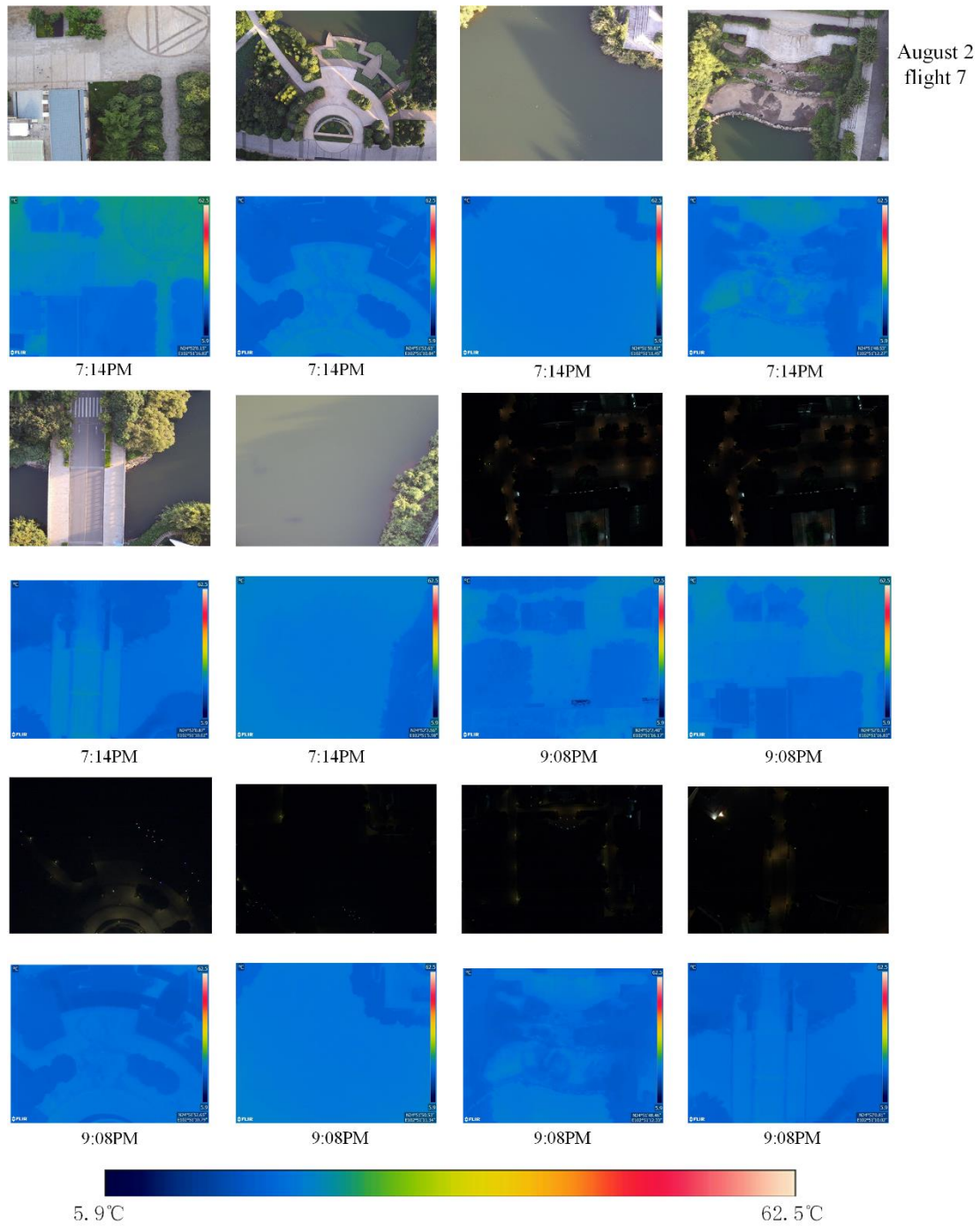


Figure S12. Images UAV's of the seventh flight on August 2

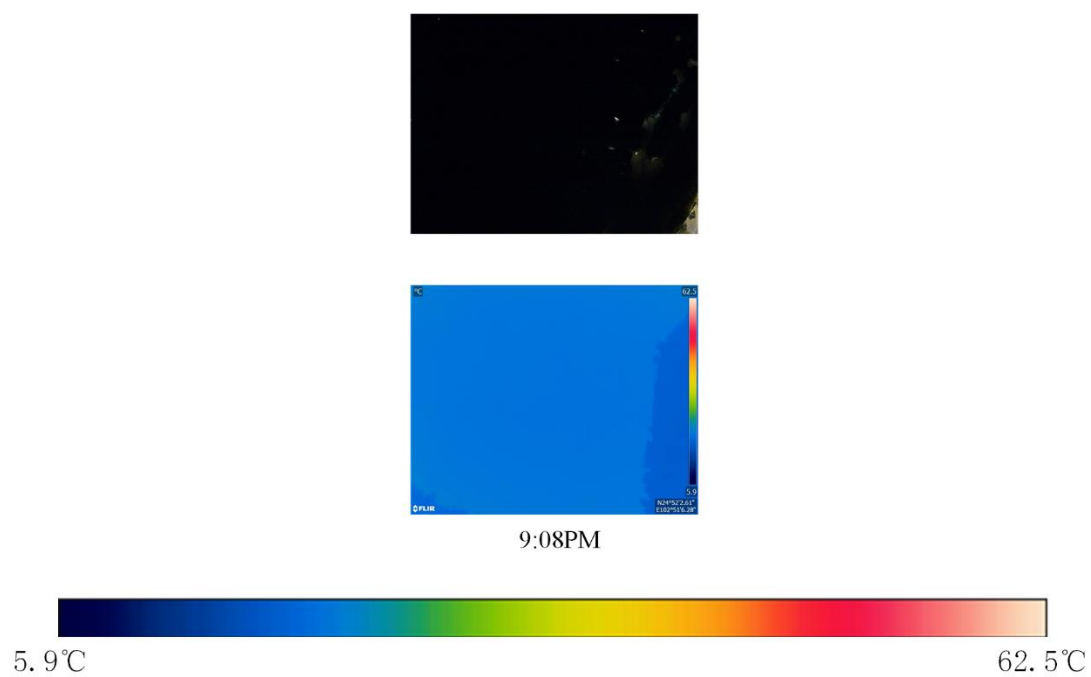


Figure S13. Images of night UAV on August 2