Aerological data in August 1945 at Hiroshima, Japan

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5 Abstract

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Aerological data are essential for simulations of local fallout and black rain originating from the Hiroshima A-bomb on 6 August 1945, but no extant data were previously known. We recovered aerological data for 6 August 1945 that were recorded by aircraft of the U.S. Air Force, and data for July and August 1945 that were recorded at Tateno and Sapporo observatories and archived by the Japan Meteorological Agency. Nevertheless we have insufficient data for modeling the regional wind field of 6 August 1945.

Introduction

Aerological data are a key parameter for conducting simulations of local fallout and black ¹⁵ rain originating from the Hiroshima A-bomb on 6 August 1945, along with data on surface heat flux and water flux as boundary conditions (Aoyama et al., 2011). Such data are also important for modeling the initial shape of the mushroom cloud (Baba et al., 2011), from which the distribution of fission products and neutron activation products can be constrained.

In the absence of aerological data, a previous simulation (Yoshikawa, 1991) assumed a ²⁰ vertically uniform wind field with a SSE direction and a wind speed of 3 m s⁻¹ throughout the air column of the model domain up to 10 km. This assumption was justified by aerological observations at Fukuoka and Shionomisaki observatories at certain days when surface weather condition / map were similar with 6 August 1945. We conducted a search for aerological data from August 1945 within several hundred kilometers of Hiroshima, Japan, because such data,

- ²⁵ especially wind direction and wind speed, can provide more realistic simulations of the distribution of fallout and black rain. However, very few observations were being carried out at this time in mainland Japan, just weeks before the end of World War II on 15 August 1945. It is also likely that many extant records were destroyed during this period and immediately afterward.
- ³⁰ Our search yielded aerological data recorded by aircraft of the United States Air Force, including the bomber Enola Gay, which delivered the A-bomb to Hiroshima on 6 August 1945. We also recovered data from Japanese observatories at Tateno and Sapporo, recorded by the Japan Meteorological Agency in July and August 1945. This report summarizes those aerological data.

35 Wind data from Enola Gay

In the navigation log of the Enola Gay flight to Hiroshima on 6 August 1945, five records of upper wind data were recorded along a flight track from Tinian Island, to Hiroshima, Japan as shown in Table 1 and Figure 1.

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Figure 1 Portion of the first page of the navigation log of Enola Gay

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Year	Month	Day	Time UTC+10	Altitude	Latitude		Latitude Longitude		Wind direction	Wind speed
			hhmm	feet	deg.	min.	deg.	min.	degree	knot*
1945	8	6	402	4200	18	49	144	7	80	16
1945	8	6	629	9300	26	0	140	30	196	25
1945	8	6	650	9300	27	20	140	30	186	10
1945	8	6	715	9250	28	53	138	5	140	9
1945	8	6	815	23500	31	15	136	12	240	20

s *Note: knot = 1 nautical mile per hour, 1 knot = 0.5 m s^{-1}

Upper wind data fromU.S. Air Force tactical mission report

Twelve records of upper wind data at boming, including a record from over Hiroshima on 6

August 1945 by Enola Gay that was not included in the navigation log, were found in a report by the U.S. Twentieth Air Force (U.S. Air Force, 1945). The cover of this report is shown in Figure 2. Unfortunately, only city names rather than exact latitudes and longitudes were included in the report. Exact time of observation for each record were not available, too. These 12 records are shown in Table 2 together with mission number in the report by the U.S. Twentieth Air Force (U.S. Air Force, 1945).



Figure 2 Cover of the U.S. Air Force tactical mission report

City	Year	Month	Day	Altitude	Wind direction	Wind-speed	Mission #
				feet	degree	knot*	
Toyama	1945	7	20	28000	256	50	1, 2, 3, 4
Kobe	1945	7	24	28000	338	48	5, 6, 7
Niihama	1945	7	24	28000	335	38	5, 6, 7
Nagoya	1945	7	26	29000	300	26	5, 6, 7
Tokyo	1945	7	29	28000	125	35	10, 11, 12
Ube	1945	7	29	26000	250	28	10, 11, 12
Koriyama	1945	7	29	28000	325	33	10, 11, 12
Osaka	1945	7	29	28000	135	20	10, 11, 12
Maizuru	1945	7	29	25000	260	25	10, 11, 12
Hiroshima	1945	8	6	28000	165	15	13
Nagoya	1945	8	14	29000	45	34	17, 18
Toyoda (Toyota)	1945	8	14	29000	41	40	17, 18

Table 2 Twelve records in the tactical mission report of U.S. 20th Air Force

*Note: knot = 1 nautical mile per hour, 1 knot = 0.5 m s^{-1}

Aerological data archived by Japan Meteorological Agency

Aerological data observed at Tateno and Sapporo in Japan were archived by the Japan ⁵ Meteorological Agency. Station information and parameters of the data are shown in Table 3, and part of the data for August 1945 are shown in the Appendix. These time series of aerological data may be of value in reconstructing the wind field in August 1945 for simulations of local fallout and black rain in the future.

10	Table 3 Station information at Sapporo and Tateno								
_	Station	Station ID	Latitude degree	Longitude degree	Data Type	Data Obtained from JMA			
-	Sapporo	2842	43.07N	141.33E	height, pressure, temperature, humidity	1 July to 8 August 1945			
_	Tateno	2938	36.05N	140.13E	height, pressure, temperature, humidity, wind direction, wind speed	1 July to 15 August 1945			

In Figure 3, the aerological data from Enola Gay and Tateno 6 AM on 6 August 1945 are plotted together. Over Hiroshima, the wind direction was SSE and the wind speed was 15 knot (7.5 m s^{-1}) at 28000 ft (8400 m).



Figure 3 Aerological data along the flight track of Enola Gay and at Tateno, Japan.

Summary

⁵ We recovered 12 records of aerological data in July and August 1945 in documents of the U.S.Air Force and 5 records of aerological data along a flight track from Tinian Island, to Hiroshima in the navigation log of the Enola Gay flight on 6 August 194. Time series of aerological data in July and August 1945 from observatories at Tateno and Sapporo archived by the Japan Meteorological Agency were also recovered. These data, however, are not yet ¹⁰ sufficient for a reconstruction of the regional wind field at the time of the Hiroshima bombing.

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Appendi	x		3.0	143	4.3
Table	1Aerological data at	Tateno, Japan	5.5 4.0	150	2.7
			4.0	105	5.7
Altitude	Wind direction	Wind speed	4.5	172	4.4
km	degree	m s ⁻¹	5.0	170	3.2
			7.0	99	3.8
	<u>1945 Aug. 1, 14:0</u>	<u>)0</u>	7.0	104	3.7
0.04	80	2.2	0.0	121	J.7 4.2
0.25	125	9.1	9.0	108	4.2
0.5	118	5.0	11.0	108	8.0 15.0
1.0	195	5.9	12.0	109	15.0
1.5	205	5.6	12.0	02	62
2.0	204	5.1	14.0	67	16.8
2.5	198	3.0	14.0	07	10.0
3.0	179	0.9		10/5 Aug 3 1	4.00
3.5	63	3.6	0.04	<u>1945 Aug. 5, 1</u> 100	3.0
4.0	83	4.8	0.04	178	5.0
4.5	56	3.3	0.23	178	0.3
5.0	118	2.6	0.5	104	5.0
6.0	111	1.1	1.0	194	5.5 4.2
7.0	127	2.7	2.0	224	4.2
8.0	239	3.6	2.0	186	3.5
9.0	216	4.2	2.5	200	5.6
10.0	260	6.2	3.0	200	3.0
11.0	291	8.6	3.3 4.0	128	3.0 2.4
12.0	342	2.4	4.0	120	2.4
13.0	86	2.9	4.5 5.0	184	2.2
14.0	54	2.1	5.0	150	5.0 6.4
15.0	337	4.5	0.0 7 0	160	23
16.0	306	6.9	7.0 8.0	130	2.3 5.2
17.0	306	4.7	9.0	91	5.0
18.0	350	4.4	10.0	80	6.2
19.0	23	5.7	11.0	116	10.6
20.0	12	10.8	12.0	120	11.6
	1045 1 0 6 0	0	13.0	120	18.2
0.04	<u>1945 Aug. 2, 6:0</u>	<u>0</u>	15.0	125	10.2
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0.25	164	4.2	0.04	<u>17 18 / 145t, 1</u>	03
0.5	192	4.5	0.04	161	3 1
1.0	198	5.3	0.25	182	3.0
1.5	218	6.5	1.0	172	4 2
2.0	217	7.6	1.5	50	10.4
2.5	196	5.0	1.5	50	10.1
3.0	183	5.1		1945 Aug 5 6	5.00
3.5	158	4.1	0.04	<u>1)+5 Mug. 5, (</u>	0.0
4.0	122	5.7	0.25	234	0.0
4.5	114	5.2	0.5	200	2.1
5.0	102	4.7	1.0	9	2.1
6.0	123	1.1	1.5	14	5.9
	1045 4 0 14	00	2.0	40	4.8
0.04	<u>1945 Aug. 2, 14</u>	.00	2.5	65	5.0
0.04	152	0.6	3.0	82	4 8
0.25	197	4.9	3.5	115	2 5
0.5	207	6.8	4.0	136	2.0
1.0	189	5.6	4.5	193	49
1.5	214	4.2	5.0	196	63
2.0	1/3	3.2	6.0	192	49
2.5	142	2.3	0.0	1/4	т.)

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7.0	207	7.2
8.0	184	5.2
9.0	150	11.2
10.0	135	12.0
11.0	130	12.8
12.0	137	11.3
	<u>1945 Aug. 6, 6</u>	<u>5:00</u>
0.04		0.2
0.25	225	4.3
0.5	206	1.8
1.0	5	3.0
1.5	72	4.6
2.0	71	3.8
2.5	72	5.0
3.0	140	2.2
3.5	250	3.1
4.0	241	3.4
4.5	211	3.9
5.0	212	3.4
6.0 7.0	262	6.1
/.0	264	0.0
8.0	254	1.0
9.0	222	5.0
10.0	199	8.0
	<u>1945 Aug. 6, 1</u>	<u>4:00</u>
0.04	195	3.5
0.25	176	4.5
0.5	187	2.9
1.0	106	2.2
1.5	84	3.5
2.0	101	4.1
2.5	82	1.2
3.0	232	2.9
3.5	242	4.7
4.0	209	4.8
4.5	250	2.7
5.0	218	2.7
6.0	318	2.7
7.0	310	5.2