Doppler validation with WINDAS

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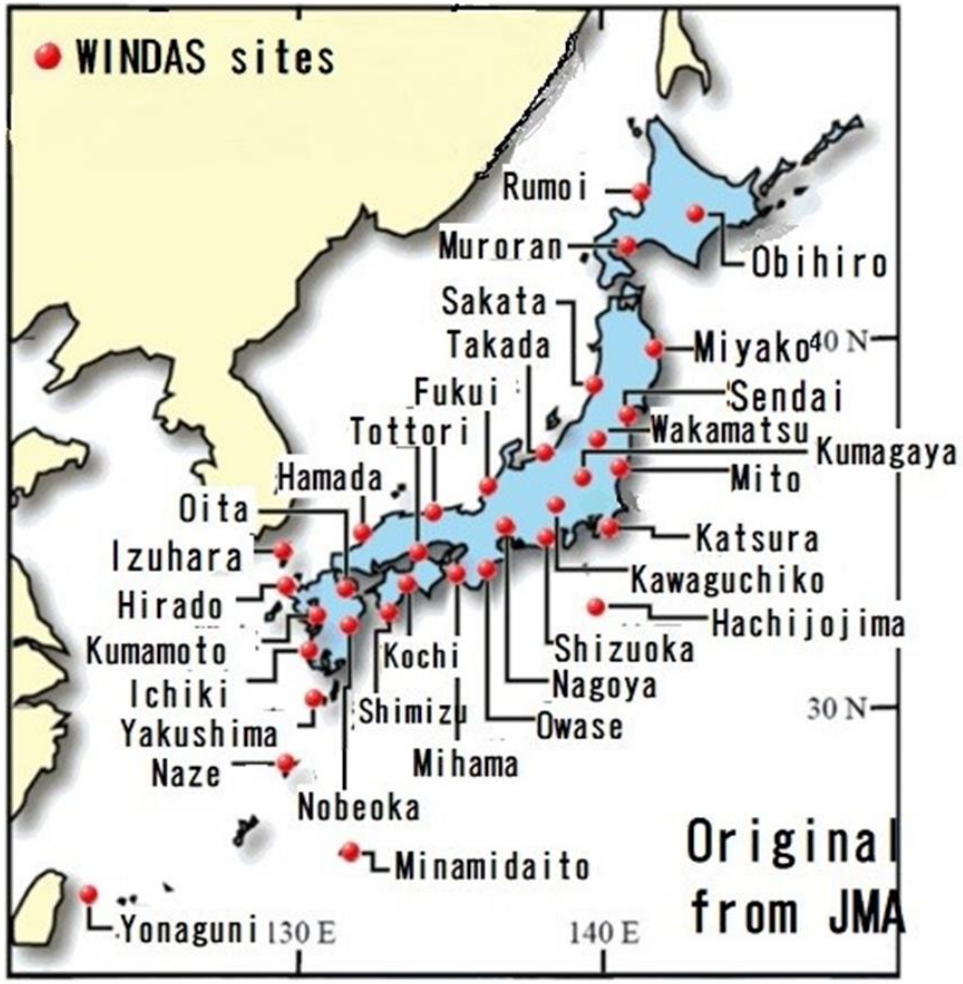
A Doppler measurement function is one of the unique features of EarthCARE/CPR and calibration using ground-based radar is important to get vertical Doppler velocity with good accuracy. However, simultaneous observation chance is a few because of narrow footprint size of CPR and revisiting cycle of 25 days.

In order to validate CPR Doppler velocity, we are utilizing the data obtained by wind profiler networks (WINDAS) operated by Japan Meteorological Agency.

WINDAS consist of 33 sites of L-band wind profilers from north to south of Japan. Main object of WINDAS observation is horizontal wind measurement in the troposphere, and vertical velocity is also observed by vertical pointing observation.

Echo target of L-band wind profiler is not only atmospheric turbulent, but also ice cloud and/or rain particle. We need to identify ice cloud echo from WINDAS observation. Then, we compare CPR Doppler velocity with WINDAS vertical velocity. WINDAS measures vertical velocity every 10 minutes and is operated in 24 hours continuously.



WINDAS:1.357GHz Wind profiler

Main target: atmospheric turbulence

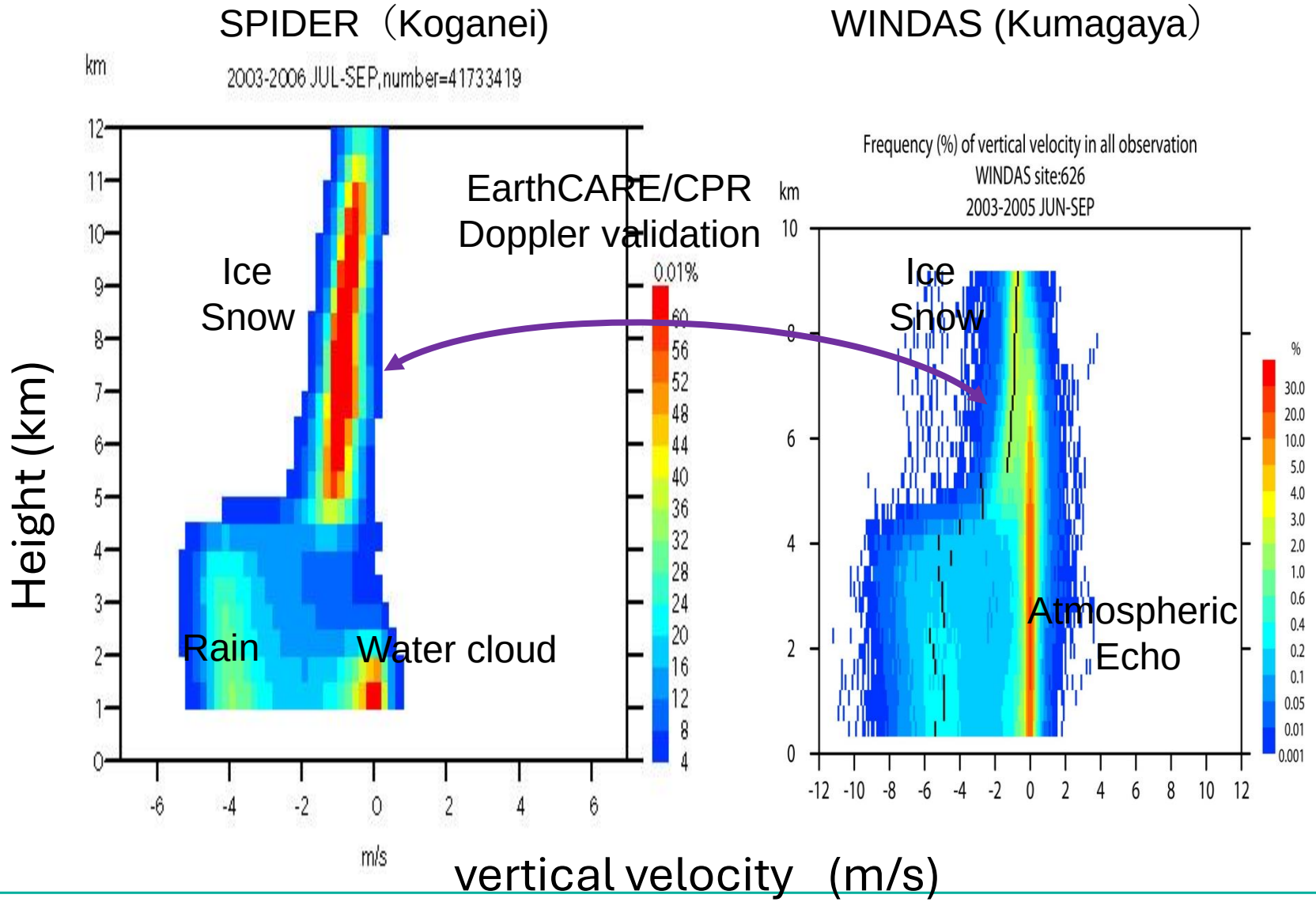
Horizontal wind profile with good height and time resolution

Sub target: Ice cloud and rain

Vertical velocity of cloud & rain particle

EarthCARE Doppler validation

Echo appearances (Cloud Radar & WINDAS)



EarthCARE path is close to WINDAS site within 10km
June–July 2024

	Pass time(UTC)	Orbit	Frame	Site name	Latitude	Longitude	Distance(km)
○	2024/06/18 05:07	316	D	Sakata	38.911529	139.834258	0.9
	2024/06/19 16:14	339	B	Muroran	42.314125	140.893176	6.5
	2024/06/20 05:02	347	D	Katsuura	35.156907	140.26783	4.1
	2024/06/20 05:02	347	D	Mito	36.364272	140.570892	9.4
	2024/06/20 05:03	347	D	Hachijoujima	33.123633	139.772376	0.6
	2024/06/21 05:46	363	D	Izuhara	34.168633	129.144033	7.4
	2024/07/19 16:09	805	B	Rumoi	43.94594	141.633385	0.1
○	2024/07/26 16:25	914	B	Hachijoujima	33.114654	139.725344	5.1
	2024/07/29 05:05	953	D	Sakata	38.911393	139.82702	1.5
	2024/07/31 04:57	984	D	Miyako	39.619977	142.072318	9.2

○ Cloud echo in CPR & WINDAS

EarthCARE path is close to WINDAS site within 10km
August 2024

Pass time(UTC)	Orbit	Frame	Site name	Latitude	Longitude	Distance(km)
2024/08/01 16:03	1007	B	Obihiro	42.931542	143.269397	4.8
2024/08/02 16:42	1023	B	Mihama	33.895514	135.152135	2.6
2024/08/04 16:34	1054	B	Nagoya	35.169821	136.973824	0.8
2024/08/09 05:03	1124	D	Muroran	42.329562	140.941892	2.4
2024/08/09 05:05	1124	D	Kumagaya	36.166844	139.279226	9.3
2024/08/09 16:57	1132	B	Nobeoka	32.571471	131.59641	5.9
2024/08/10 17:37	1148	B	Yonagunijima	24.459756	122.975736	3.6
2024/08/11 16:48	1163	B	Kouchi	33.585038	133.651059	9.6
2024/08/14 05:31	1202	D	Minamidaitoujima	25.843702	131.141101	8.9
2024/08/17 06:02	1249	D	Yonagunijima	24.474489	122.964451	4.7
2024/08/17 16:20	1256	B	Wakamatsu	37.496885	139.954073	4
2024/08/18 17:00	1272	B	Kumamoto	32.827758	130.804173	9.2
2024/08/19 16:10	1287	B	Miyako	39.630586	141.927044	3.5
2024/08/20 04:57	1295	D	Miyako	39.637213	141.945775	1.9
2024/08/25 17:08	1381	B	Naze	28.373512	129.467008	2.9
2024/08/26 16:19	1396	B	Mito	36.386257	140.500216	2.9
2024/08/26 16:19	1396	B	Sakata	38.90849	139.843616	0
2024/08/27 05:07	1404	D	Shizuoka	34.959352	138.504236	9.4

EarthCARE path is close to WINDAS site within 10km
September 2024

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	Pass time(UTC)	Orbit	Frame	Site name	Latitude	Longitude	Distance(km)
	2024/09/01 05:26	1482	D	Kouchi	33.581938	133.472121	7.3
	2024/09/04 16:15	1536	B	Sendai	38.276504	140.971234	6.7
	2024/09/06 05:43	1560	D	Izuhara	34.16647	129.142817	7.5
	2024/09/08 05:32	1591	D	Ooita	33.219579	131.715963	9.2
	2024/09/08 05:33	1591	D	Nobeoka	32.596701	131.567561	8.6
	2024/09/08 05:32	1591	D	Hamada	34.886211	132.120854	4.7
	2024/09/13 16:11	1676	B	Muroran	42.328436	141.005303	2.9
	2024/09/20 06:01	1778	D	Yonagunijima	24.463229	123.033307	2.3
	2024/09/20 16:19	1785	B	Mito	36.36181	140.3695	9.1
	2024/09/21 05:07	1793	D	Shizuoka	34.979762	138.369977	3.1
	2024/09/23 16:47	1832	B	Kouchi	33.587068	133.657627	10.3
○	2024/09/24 05:38	1840	D	Naze	28.386438	129.446711	4.8
	2024/09/25 16:36	1863	B	Owase	34.085611	136.298616	9.9
○	2024/09/28 05:15	1902	D	Owase	34.085444	136.101833	8.6
	2024/09/30 05:02	1933	D	Muroran	42.325504	140.968577	0.3
	2024/09/30 05:04	1933	D	Kumagaya	36.164504	139.306006	6.9
	2024/09/30 16:56	1941	B	Nobeoka	32.594026	131.736864	7.5
	2024/09/30 16:56	1941	B	Ooita	33.229375	131.585409	3.3

EarthCARE path is close to WINDAS site within 10km
October 2024

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	Pass time(UTC)	Orbit	Frame	Site name	Latitude	Longitude	Distance(km)
	2024/10/06 16:22	2034	B	Kumagaya	36.152428	139.382384	0.3
	2024/10/07 17:01	2050	B	Yakushima	30.388204	130.685026	2.7
	2024/10/07 17:01	2050	B	Ichiki	31.717408	130.3776	5.3
○	2024/10/09 04:58	2073	D	Katsuura	35.144733	140.361457	4.5
	2024/10/09 04:59	2073	D	Hachijoujima	33.106896	139.865511	8.2
○	2024/10/09 16:50	2081	B	Shimizu	32.721555	133.012045	0.3
	2024/10/15 06:01	2167	D	Yonagunijima	24.46284	123.032181	2.2
	2024/10/15 16:18	2174	B	Mito	36.368716	140.384144	7.7
○	2024/10/15 16:19	2174	B	Sakata	38.891831	139.727348	10.2
○	2024/10/16 05:06	2182	D	Shizuoka	34.980748	138.372441	2.9
	2024/10/18 16:47	2221	B	Kouchi	33.572796	133.578964	2.8
	2024/10/20 16:36	2252	B	Owase	34.077343	136.233751	3.8
	2024/10/22 16:25	2283	B	Kawaguchiko	35.493917	138.712135	4.5
	2024/10/22 16:26	2283	B	Takada	37.115205	138.301182	4.9
○	2024/10/23 05:14	2291	D	Owase	34.059134	136.265252	6.7
	2024/10/25 05:00	2322	D	Rumoi	43.940668	141.669625	3.1
	2024/10/25 05:02	2322	D	Wakamatsu	37.493462	139.869789	3.6
○	2024/10/29 16:32	2392	B	Nagoya	35.180772	137.04815	7.7
	2024/10/31 16:21	2423	B	Kumagaya	36.164244	139.46531	7.8

EarthCARE path is close to WINDAS site within 10km
November 2024

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	Pass time(UTC)	Orbit	Frame	Site name	Latitude	Longitude	Distance(km)
○	2024/11/01 17:01	2439	B	Yakushima	30.377709	130.632693	2.5
	2024/11/01 17:01	2439	B	Ichiki	31.70916	130.32445	0.2
	2024/11/03 04:58	2462	D	Mito	36.379457	140.483333	1.3
	2024/11/03 04:58	2462	D	Sendai	38.248457	140.966635	6.3
	2024/11/04 05:40	2478	D	Hirado	33.358997	129.564596	1.2
	2024/11/04 16:01	2485	B	Obihiro	42.910301	143.131604	6.7
	2024/11/08 05:18	2540	D	Mihama	33.878943	135.21896	8.8
	2024/11/09 06:01	2556	D	Yonagunijima	24.482496	122.915222	9.8
	2024/11/09 16:18	2563	B	Wakamatsu	37.497007	139.967769	5.2
	2024/11/12 04:53	2602	D	Obihiro	42.914769	143.269283	4.7
	2024/11/13 05:37	2618	D	Naze	28.393536	129.423669	7.2
○	2024/11/14 16:36	2641	B	Owase	34.073827	136.216442	2.2
○	2024/11/15 05:25	2649	D	Shimizu	32.71237	133.07309	6
	2024/11/19 05:01	2711	D	Muroran	42.322922	140.965685	0.4
	2024/11/19 05:03	2711	D	Kumagaya	36.161991	139.302368	7.1
	2024/11/19 16:55	2719	B	Nobeoka	32.592643	131.730109	6.9
	2024/11/19 16:55	2719	B	Ooita	33.227883	131.57879	3.9
	2024/11/20 16:06	2734	B	Rumoi	43.948947	141.656726	2
	2024/11/21 16:44	2750	B	Takamatsu	34.322052	134.076238	2.1

EarthCARE path is close to WINDAS site within 10km
December 2024

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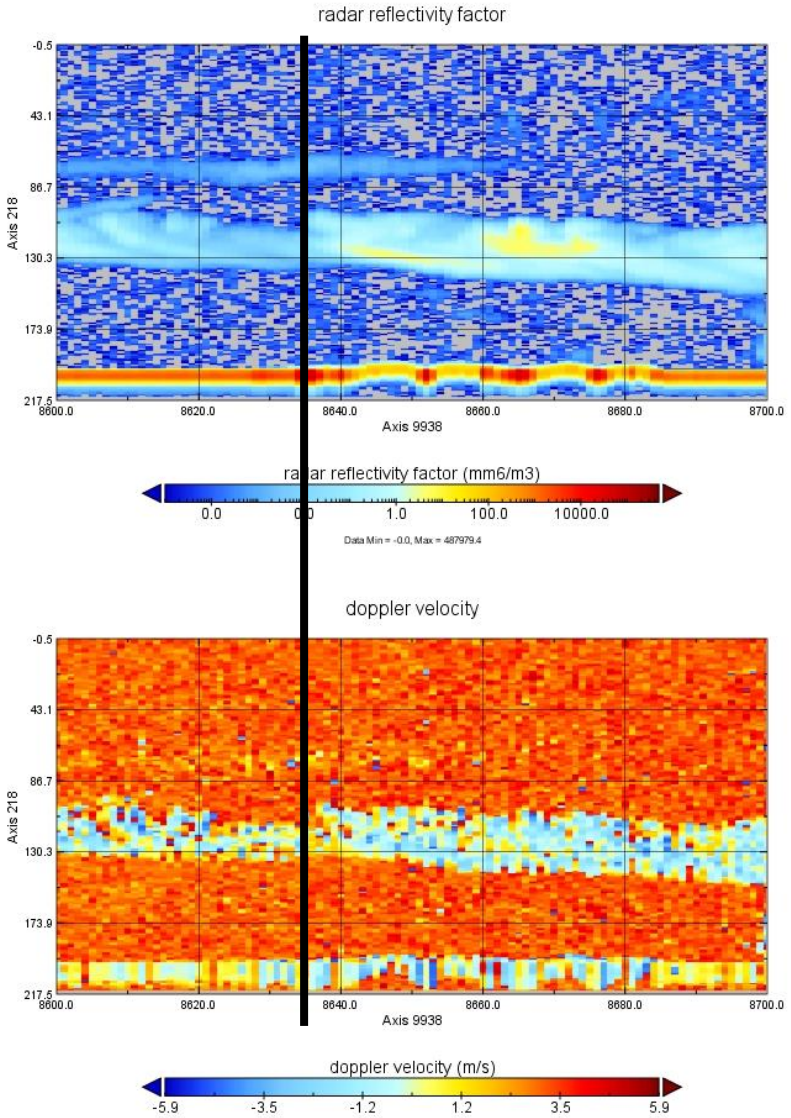
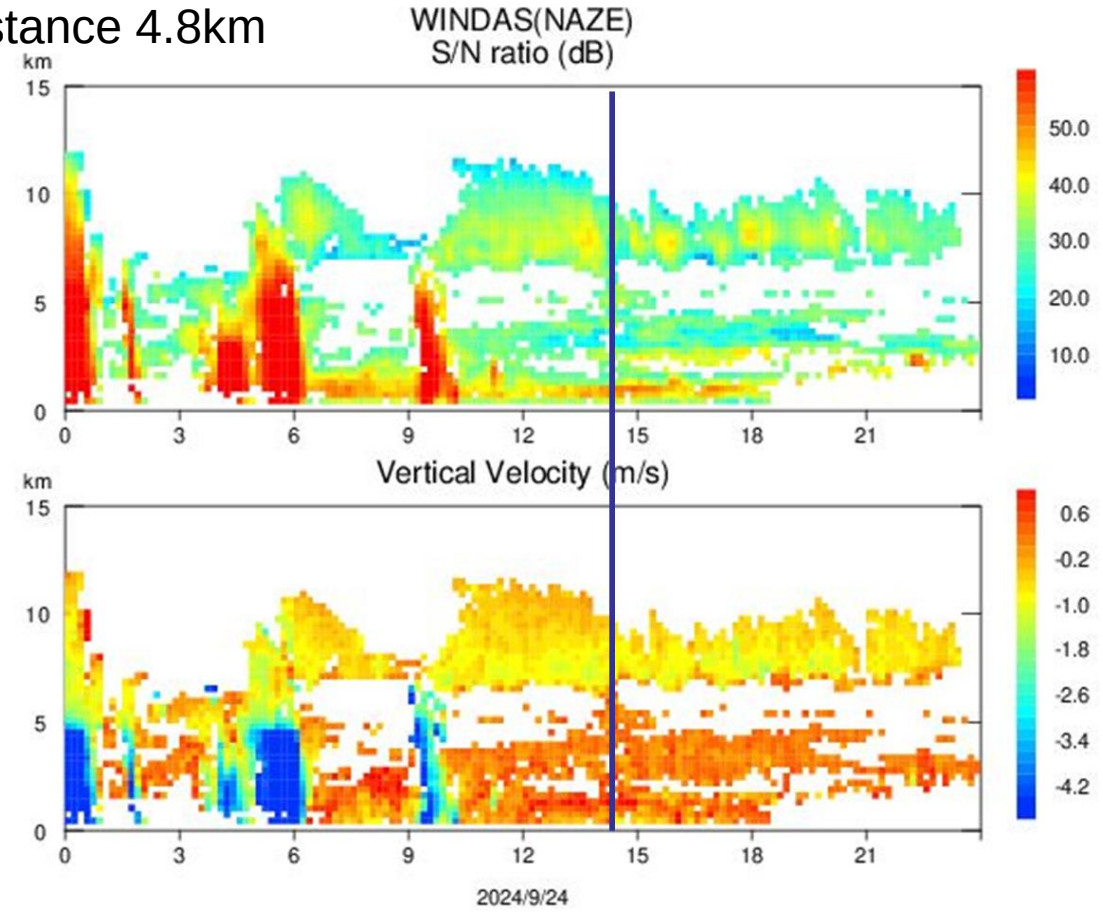
	Pass time(UTC)	Orbit	Frame	Site name	Latitude	Longitude	Distance(km)
	2024/12/04 06:00	2945	D	Yonagunijima	24.471649	122.994686	1.7
	2024/12/05 05:05	2960	D	Shizuoka	34.982548	138.357459	4.3
	2024/12/07 04:52	2991	D	Obihiro	42.91327	143.259854	4
○	2024/12/7 16:46	2999	B	Kouchi	33.576922	133.619704	6.6
	2024/12/08 05:37	3007	D	Naze	28.398548	129.396119	9.9
	2024/12/09 16:35	3030	B	Owase	34.081389	136.275429	7.7
	2024/12/11 16:24	3061	B	Kawaguchiko	35.487094	138.688979	6.7
○	2024/12/11 16:25	3061	B	Takada	37.110974	138.277784	2.8
	2024/12/12 05:13	3069	D	Owase	34.06158	136.234816	3.9
○	2024/12/14 04:59	3100	D	Rumoi	43.945234	141.630519	0.2
○	2024/12/14 05:01	3100	D	Wakamatsu	37.499347	139.830418	7.2
	2024/12/20 16:21	3201	B	Kumagaya	36.144229	139.352454	2.6
○	2024/12/21 17:00	3217	B	Yakushima	30.365669	130.562016	9.4
○	2024/12/21 17:01	3217	B	Ichiki	31.697657	130.254805	6.5
	2024/12/24 05:39	3256	D	Hirado	33.359686	129.567586	1.5
	2024/12/24 16:00	3263	B	Obihiro	42.911437	143.142011	5.8

EarthCARE path is close to NAZE site 24 September 2024

CPR L1b

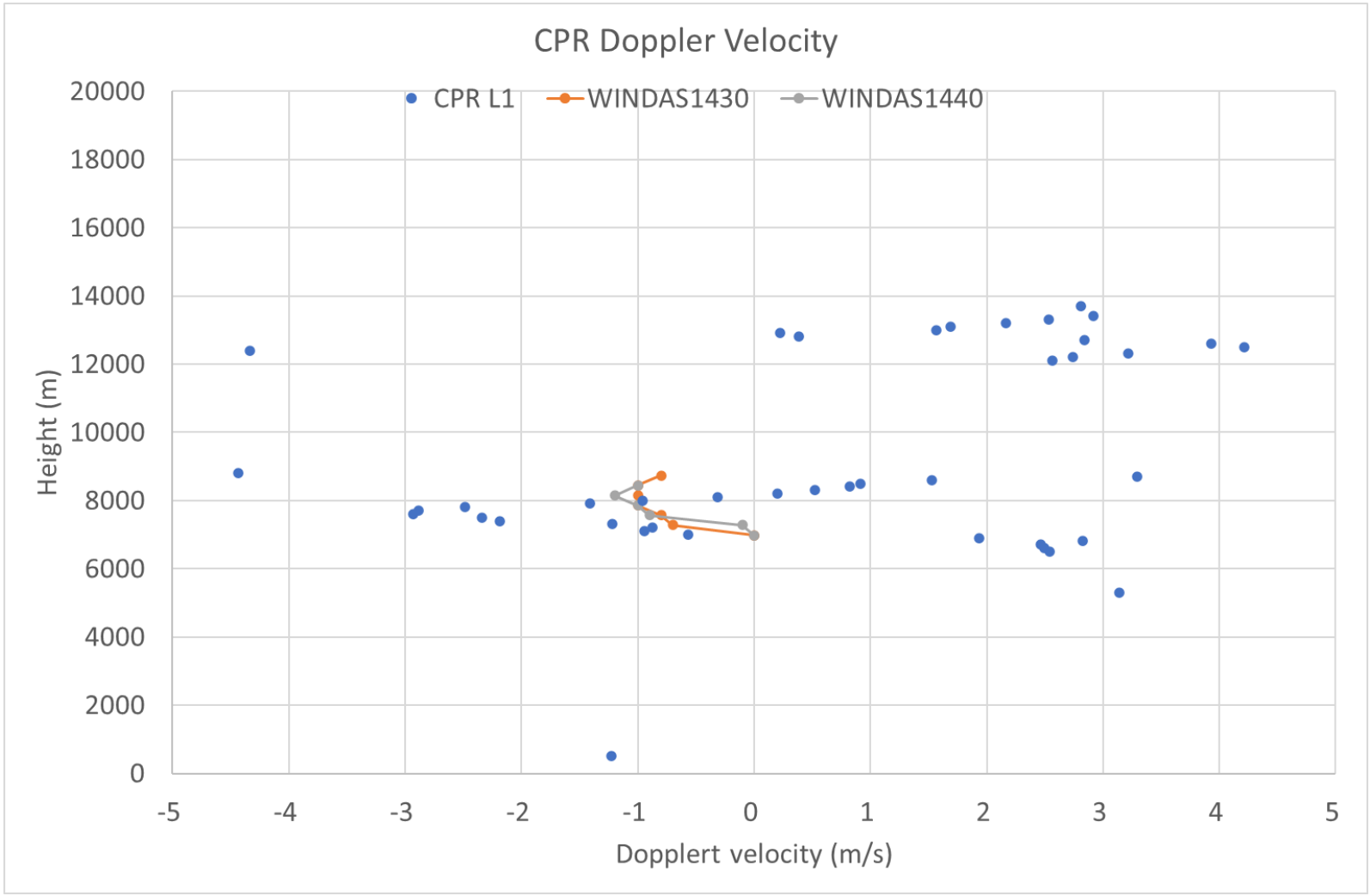


WINDAS NAZE
distance 4.8km



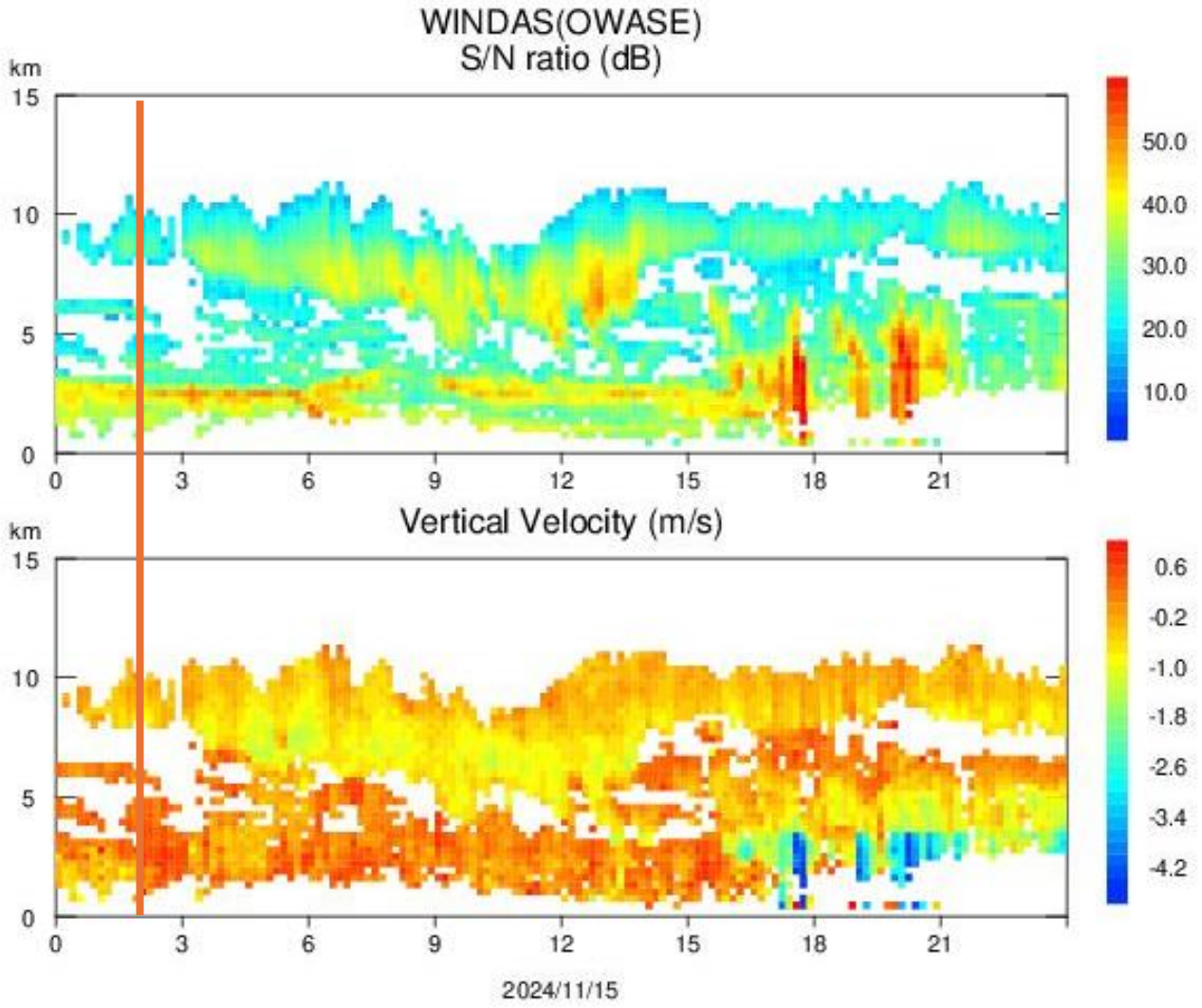
EarthCARE path is close to NAZE site 24 September 2024

WINDAS NAZE
distance 4.8km



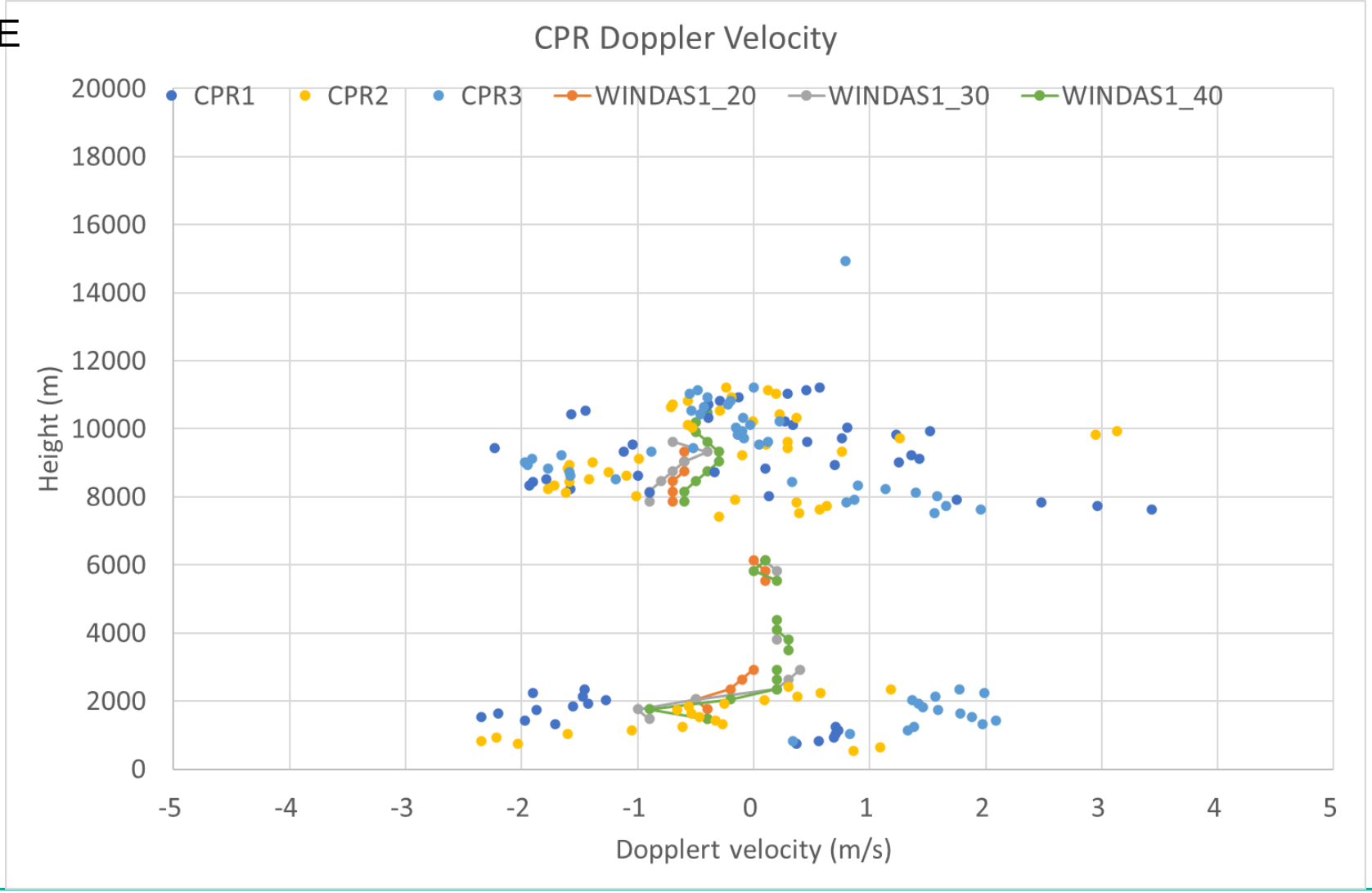
EarthCARE path is close to OWASE site 15 November 2024

WINDAS OWASE
distance 2.2km



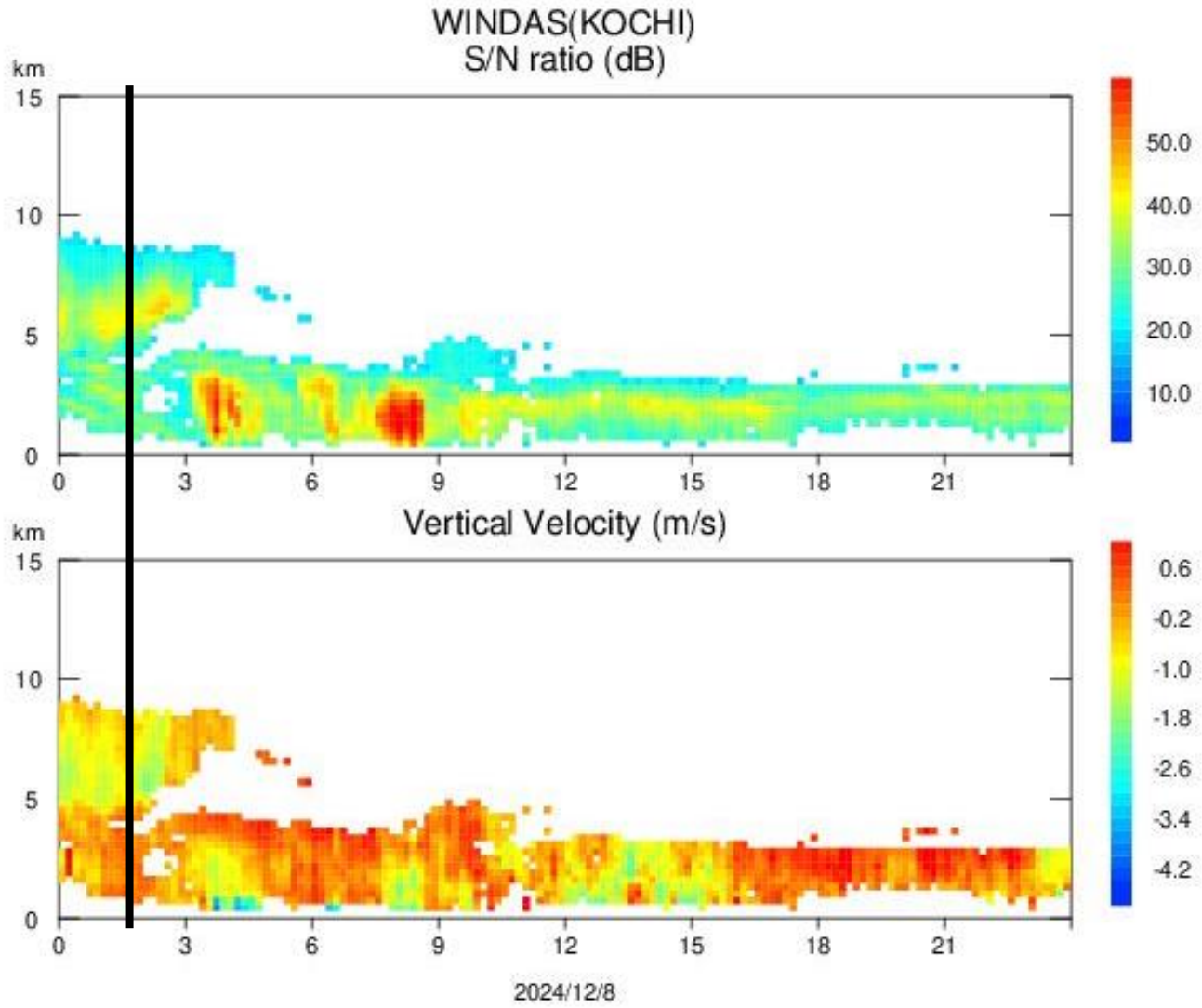
EarthCARE path is close to OWASE site 15 November 2024

WINDAS OWASE
distance 2.2km



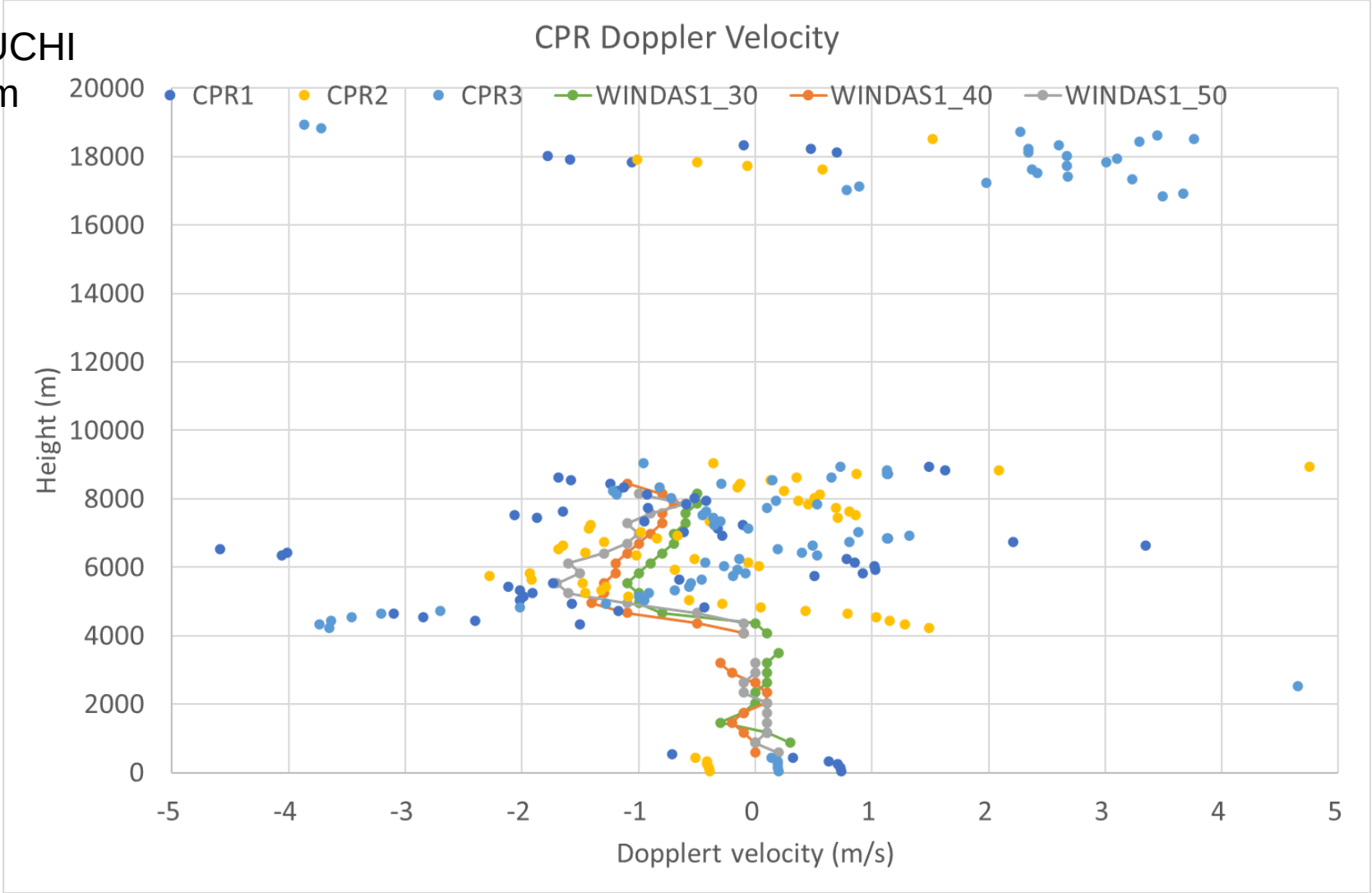
EarthCARE path is close to KOUCHI site 8 December 2024

WINDAS KOUCHI
distance 6.6km



EarthCARE path is close to OWASE site 15 November 2024

WINDAS KOUCHI
distance 6.6km



Summary

- Using 33 WINDAS sites in Japan, CPR Doppler velocity is checked with vertical pointing data of WINDAS.
- There is around 18 chances per month that EarthCARE satellite path close to WINDAS sites within 10km.
- However, chances that both CPR and WINDAS detected cloud echoes are not so many around 2-6 times.
- Since Doppler velocity of CPR L1 data have large random error, so averaging of CPR Doppler is needed to compare with WINDAS data.
- We will continue this validation using WINDAS data, and we will make statistically check in future.