The AquaVIT-4 intercomparison of atmospheric hygrometers

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Supplementary material

S1. List of all setpoints

The following is a list of all setpoints (i.e., static intervals) measured during both the open and blind intercomparison phases of the campaign, including date/time, mean temperature and pressure of the AIDA chamber (T_{AIDA}, p_{AIDA}), and the mean H_2O mixing ratio measured by all instrument during the corresponding period. Note that the duration of all setpoints is 10 min.

				H_2O mixing ratio [ppm]						
Date	**Start time**	**T_{AIDA} [°C]**	**p_{AIDA} [mbar]**	MBW 373LX	APicT	SP-APicT	ALBA-TROSS	Pico-Light H_2O	SAW-fPHY	DLH
Open Day 1	29/03/22 10:47:01	−47.32	150.00	198.06	193.36	195.02	191.80	179.66	191.49	197.01
	29/03/22 11:47:01	−47.29	250.00	90.95	91.43	92.52	90.61	87.52	88.73	90.72
	29/03/22 12:44:01	−47.37	300.00	66.60	67.27	68.72	66.67	65.89	65.48	66.22
	29/03/22 13:56:01	−47.22	500.00	35.89	35.97	38.07	36.05	39.05	35.46	35.72
	29/03/22 15:02:01	−47.74	249.96	37.67	38.26	39.82	37.57	38.42	37.07	37.64
	29/03/22 15:38:01	−47.49	300.00	30.71	31.21	32.95	30.72	32.52	30.25	30.69
	29/03/22 17:14:01	−47.76	150.00	35.71	36.23	38.01	35.46	34.94	-	35.67

Open Day 2	30/03/22 10:26:01	−28.90	150.00	537.60	529.06	529.02	518.70	498.27	-	532.91
	30/03/22 11:26:01	−28.71	250.00	301.33	300.16	300.25	296.24	288.32	295.53	299.02
	30/03/22 12:20:01	−28.66	300.01	243.18	242.35	242.89	239.91	234.45	238.15	241.16
	30/03/22 13:50:01	−28.36	600.00	116.89	116.66	118.15	116.92	118.49	116.33	117.97
	30/03/22 15:11:01	−28.91	200.00	130.90	129.04	131.00	127.50	125.45	125.76	127.62
	30/03/22 15:59:01	−28.95	148.65	138.04	136.18	138.43	134.22	130.63	133.79	135.32
	30/03/22 16:35:01	−29.08	99.76	148.97	146.13	150.25	145.00	139.89	146.30	145.03
	30/03/22 17:26:01	−28.75	150.00	102.00	100.84	102.79	99.12	97.40	98.91	99.45
Open Day 3	31/03/22 11:38:01	−63.38	180.00	7.32	7.32	8.30	7.39	7.62	7.12	7.63
	31/03/22 12:50:01	−63.33	325.00	3.34	3.36	4.38	3.29	-	3.21	3.67
	31/03/22 14:17:01	−63.71	150.00	4.77	4.80	5.63	4.54	4.48	4.56	4.75
	31/03/22 15:14:01	−63.81	100.12	6.02	5.96	7.01	5.84	5.34	5.77	5.82
	31/03/22 16:11:01	−63.85	50.48	9.87	9.63	11.01	9.69	8.44	9.11	9.79
	31/03/22 17:17:01	−63.81	20.65	20.77	19.38	20.49	21.13	-	18.80	20.31
Open Day 4	01/04/22 10:35:01	−78.60	71.33	2.27	1.82	2.15	2.40	1.84	-	1.93
	01/04/22 11:32:01	−78.59	90.06	1.23	1.02	1.58	1.16	1.43	-	1.10
	01/04/22 12:32:01	−78.46	180.00	0.51	0.48	1.04	0.59	1.82	-	0.67
	01/04/22 13:56:01	−78.60	180.00	1.38	1.39	1.89	1.34	2.19	-	1.44
	01/04/22 14:59:01	−78.81	90.57	1.89	1.79	2.47	1.92	2.07	-	1.74
Blind Day 1	04/04/22 08:08:01	−52.99	50.40	2.56	0.93	1.27	3.03	-	-	0.87
	04/04/22 08:35:01	−53.12	50.46	4.47	3.30	3.59	5.03	3.12	-	3.13
	04/04/22 09:20:01	−53.32	34.93	4.25	2.97	3.32	4.59	2.84	-	3.04
	04/04/22 10:08:01	−53.33	20.13	7.60	5.11	4.99	10.49	4.31	-	5.22
	04/04/22 11:32:01	−53.24	250.00	79.97	80.10	80.33	79.64	75.23	68.63	76.74
	04/04/22 12:08:01	−53.55	200.06	66.77	66.46	66.66	65.83	61.24	65.97	65.93
	04/04/22 13:08:01	−53.67	149.79	59.15	59.50	60.14	58.58	55.30	58.32	59.25
	04/04/22 14:26:01	−49.12	198.39	70.06	69.03	69.21	67.85	65.27	41.08	68.57
	04/04/22 15:26:01	−52.77	200.01	21.64	21.54	22.00	20.90	21.81	20.92	21.22
	04/04/22 16:08:01	−53.39	250.01	17.52	17.59	18.16	17.06	19.22	17.06	17.44
Blind Day 2	05/04/22 08:35:01	−68.54	22.66	11.21	9.25	9.22	12.05	8.06	9.03	9.95
	05/04/22 09:20:01	−68.41	50.29	3.92	3.59	3.78	4.16	3.10	3.52	3.88
	05/04/22 09:50:01	−68.51	60.25	3.02	2.82	3.01	3.01	2.51	2.78	3.08
	05/04/22 10:17:01	−68.49	80.11	2.15	2.03	2.27	1.87	2.00	2.08	2.26

	05/04/22 10:50:01	−68.57	100.10	1.64	1.55	1.92	1.67	1.86	1.51	1.80
	05/04/22 12:02:01	−68.70	100.83	3.31	3.16	3.57	3.41	3.07	3.09	3.49
	05/04/22 12:38:01	−68.54	150.00	2.00	1.96	2.33	1.99	2.36	1.87	2.18
	05/04/22 13:14:01	−68.68	150.01	5.38	5.36	5.63	5.32	5.26	5.01	5.43
	05/04/22 14:38:01	−68.75	150.00	20.21	20.27	20.26	19.80	18.23	19.60	19.77
	05/04/22 16:26:01	−68.79	20.00	16.31	13.44	14.03	17.76	11.11	14.38	13.69
Blind Day 3	06/04/22 08:44:01	−83.38	70.00	0.81	0.48	1.01	0.94	1.17	-	0.54
	06/04/22 09:50:01	−83.41	80.00	1.14	0.98	1.73	1.28	1.18	-	0.95
	06/04/22 12:00:13	−83.50	100.00	0.83	0.77	1.39	0.82	1.21	-	0.79
	06/04/22 13:38:01	−83.67	70.45	2.50	2.46	3.14	2.91	2.24	-	2.56
	06/04/22 14:56:01	−83.61	80.00	2.90	2.93	3.57	2.97	2.68	-	3.02
	06/04/22 15:38:01	−83.54	100.00	2.48	2.50	3.14	2.78	2.26	-	2.54
	06/04/22 16:08:01	−83.56	100.00	8.11	3.16	3.62	8.30	2.98	-	3.28
Blind Day 4	07/04/22 07:18:49	−39.36	150.00	52.58	51.85	54.15	53.65	-	-	53.84
	07/04/22 08:20:01	−38.79	150.00	42.43	41.38	42.79	42.09	40.42	36.75	42.22
	07/04/22 08:50:01	−38.76	200.00	37.08	35.82	37.20	36.31	36.09	35.87	36.68
	07/04/22 09:20:01	−38.29	300.01	24.55	24.05	25.39	24.31	27.09	24.23	24.75
	07/04/22 09:56:01	−38.69	300.01	105.65	100.54	105.50	104.76	102.85	103.89	105.46
	07/04/22 10:26:01	−39.02	199.84	108.56	102.39	106.94	105.76	102.08	105.95	106.71
	07/04/22 11:44:01	−38.90	147.82	111.01	104.22	109.79	108.12	103.54	108.40	110.01
	07/04/22 12:14:01	−38.83	150.00	431.60	380.85	421.14	414.12	396.06	324.45	425.94
	07/04/22 12:50:01	−38.70	200.00	310.90	274.33	302.89	299.16	288.23	296.02	304.22
	07/04/22 13:32:01	−38.56	300.01	198.00	183.24	196.16	194.28	189.79	229.45	196.21
	07/04/22 14:18:49	−38.67	300.00	439.11	392.04	432.55	428.32	415.48	237.43	433.32
	07/04/22 15:08:01	−38.80	200.00	456.98	405.96	444.42	437.35	421.39	428.41	445.53
	07/04/22 15:56:01	−38.36	400.00	219.61	196.68	217.76	216.77	212.70	-	217.50

Table S1. List of all measured setpoints during the open and blind intercomparison, including interval start time (in UTC), AIDA temperature (T_{AIDA}), AIDA pressure (p_{AIDA}), and the mean H_2O mixing ratio measured by each instrument. Note that the interval duration is 10 min for all setpoints.

S2. Statistical intercomparison

The following equations are used for the statistical intercomparison of the data. First, for each instrument-reference pair, the relative difference (ΔH_2O_n) is calculated for each time step (n) according in Eq. S1, where $H_2O_n^{Instr}$ and $H_2O_n^{Ref}$ are the H_2O mixing ratios measured by the instrument and reference at time step n, with an integration time of 2 s.

(S1) $$\Delta H_2O_n = \frac{H_2O_n^{Instr} - H_2O_n^{Ref}}{H_2O_n^{Ref}} \times 100\ [\%]$$

Then, for each setpoint (i), the mean relative difference (m_i), and standard deviation (s_i) are calculated as the mean and standard deviation of ΔH_2O_n over setpoint i (Eq. S2–S3), where $n_1^i \ \dots, n_N^i$ is the ensemble of data points belonging to setpoint i (defined by a given start time and end time, i.e., $t_{start}^i < t_n < t_{end}^i$).

(S2) $$m_i = \frac{1}{N} \sum_{n=n_1^i}^{n_N^i} \Delta H_2O_n$$

(S3) $$s_i = \sqrt{\frac{1}{N-1} \sum_{n=n_1^i}^{n_N^i} (\Delta H_2O_n - \mu_i)^2}$$

Finally, the mean relative differences are further averaged over ensemble of setpoints, defined by a given condition in the average H_2O mixing ratio of the reference instrument (e.g., $H_2O^{Ref} < 10$ ppm). For each range (x), the mean relative deviation (μ_x) and standard deviation (σ_x) are calculated according to Eq. S4–S5, where $i_1^x, \ \dots, i_N^Z$ is the ensemble of setpoints belonging to range x (e.g., such that $H_2O_i^{Ref} < 10\ ppm$).

(S4) $$\mu_x = \frac{1}{N} \sum_{i=i_1^x}^{i_N^x} m_i$$

(S5) $$\sigma_x = \sqrt{\frac{1}{N-1} \sum_{i=i_1^x}^{i_N^x} (m_i - \mu_x)^2}$$

The results of the statistical comparison are discussed in Section 5 of the manuscript.