



Supplement of

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 H₂O mixing ratio measured by all instrument during the corresponding period. Note that the duration of all setpoints is 10 min.

Date	Start time	T_{AIDA} [°C]	p_{AIDA} [mbar]	H ₂ O mixing ratio [ppm]						
				MBW 373LX	APicT	SP- APicT	ALBA- TROSS	Pico- Light H ₂ O	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 H₂O 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.

$$5 \quad (S1) \quad \Delta H_2O_n = \frac{H_2O_n^{Instr} - H_2O_n^{Ref}}{H_2O_n^{Ref}} \times 100 [\%]$$

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., $t_{start}^i < t_n < t_{end}^i$).

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

$$10 \quad (S3) \quad s_i = \sqrt{\frac{1}{N-1} \sum_{n=n_1^i}^{n_N^i} (\Delta H_2O_n - \mu_i)^2}$$

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 $i_1^x, \dots, i_N^x$ is the ensemble of setpoints belonging to range x (e.g., such that $H_2O_i^{Ref} < 10$ ppm).

$$15 \quad (S4) \quad \mu_x = \frac{1}{N} \sum_{i=i_1^x}^{i_N^x} m_i$$

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

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

S3. Precision analysis

The following table summarizes the equations and coefficients used for fitting the timeseries of the setpoint interval selected for the precision analysis, as discussed in Section 5.2 (see Fig. 9, black dashed and solid lines). Note that y represents the fitted value (in units of ppm) and t represents time (in units of min).

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Instrument	Fitting function	a [ppm/min]	b [ppm]	c [ppm]	d [min ⁻¹]	e
APicT	$y = a \cdot t + b$	$9.66 \cdot 10^{-4}$	5.954	-	-	-
PicoLight H ₂ O		$6.94 \cdot 10^{-4}$	5.338	-	-	-
SAWfPHY (interval 1)		0.0081	5.752	-	-	-
SAWfPHY (interval 2)		0.0074	5.700	-	-	-
DLH		$-4.63 \cdot 10^{-4}$	5.822	-	-	-
MBW373LX	$y = a \cdot t + b + c \cdot \sin(d \cdot t + e)$	0.0028	6.001	0.037	2.150	-0.308
ALBATROSS		0.0026	5.822	0.043	2.147	0.856

Table S2. List of fitting functions and coefficients used for the precision analysis (see Section 5.2 for more details).