AquaVIT

Aqua Validation and Instrument Tests

October 8-26, 2007, Karlsruhe, Germany

- Program and Instrument Positions -

Purpose and type of intercomparison:

Determine the instrument performances for static conditions (pressure-, temperature-, & water constant) and dynamic conditions (changing pressure, temperature, water, cloud density) for low water concentrations (e.g. 1 - 20 ppm) in comparison with other instruments all connected to the AIDA chamber. The intercomparison will have a formal part in which no exchange of data among the participants is allowed and single blind experiments will be performed. The referees will collect the data immediately after each experiment and do the intercomparison.

Organisers	**Referees**
Cornelius Schiller	Dave Fahey
Volker Ebert	Ru-Shan Gao
Harald Saathoff	Ottmar Möhler

Program

Installation of the instruments starts October 4th and should be completed on October 10th so that the instruments and the AIDA chamber can make test runs. If the installation is delayed this will shorten the test experiments:

- October 11th : ~295 K in AIDA, leak tests, variation of pressure and water concentration
- October 12th : ~243 K in AIDA, variation of pressure and water vapour concentration

A meeting to discuss the suggested program and the positions of the different instruments will be held on October 8th, 2007 at approximately 17:00.

Static "calibration" with defined amounts of water in AIDA at different temperatures and pressures: October 15-19

- Constant temperature for each day, pressure & water variation
  - Temperatures: 230, 210, 200,190, 185 K
  - Range of pressure: 50 – 500 hPa
  - Water concentrations: ~1-20 ppm (may be varied by Referees)
  - Total pressure cycle: 50 ⇒ 500 ⇒ 50 hPa
    - Steps at 50, 100, 200, 500 hPa up & down, pressure kept constant by adding synthetic air (containing ~3 ppm H_2O) at each pressure level to compensate for sampling
    - Starting water concentration ~20 ppm at 50 hPa
    - End water concentration ~3 ppm or saturation over ice at 50 hPa
  - Possibility to characterise water absorption lines (TDL systems)
  - Possibility to calibrate with a water source of the PTB (German NIST)

Dynamic expansion/compression experiments with different aerosol & cloud densities: October 22-26

- Adiabatic expansion without aerosol particles
  - Gas phase water = total water, only changes of r.h.
- Static periods with water containing aerosol
  - Salt aerosol with defined water content
  - Ice particles injected into the chamber (ice saturation)
- Ice, liquid & mixed phase clouds by adiabatic expansion
  - Starting temperatures: 230, 210, 200,190, 185 K (?)
  - Water concentrations: saturation vapour pressure over ice at AIDA temperature
  - Cooling rates: 0.1 – 4 K/min will be varied
  - Pressure ranges: 500-100 hPa (to be decided)

Time Table

October 2007	Experiment	T_{gas} K	P_{total} hPa	$H_2O^{\#}$ ppm	Exp. No.
4	Preparation of AIDA	295	1000		
5	Installation of Instruments	295	1000		
6					
7					
8	Installation of Instruments	295	1000		
9	Installation of Instruments	295	1000		
10	Installation of Instruments	295	1000		
11	AIDA test experiments	295	0-1000	3-50	
12	AIDA test experiments	243	0-1000	3-50	
13					
14					
15	Static intercomparison	230	50-500-50	300-30	
16	Static intercomparison	210	50-500-50	20-3	
17	Static intercomparison	200	50-500-50	20-3	
18	Static intercomparison	190	50-500-50	6.5-0.65*	
19	Static intercomparison	185	50-500-50	2.7-0.27*	
20					
21					
22	Dynamic intercomparison	230	500-100	179-895*	
23	Dynamic intercomparison	210	500-100	14.0-70.2*	
24	Dynamic intercomparison	200	500-100	3.25-16.3*	
25	Dynamic intercomparison	190	500-100	0.65-3.24*	
26	Dynamic intercomparison	185	500-100	0.27-1.35*	
27					
28					

*Saturation with respect to ice at total pressure given; # The accessible water concentrations are limited by the amount of water (~3 ppm) in the synthetic air added to keep and to increase the pressure levels and by the saturation vapour pressure of ice at the AIDA wall temperatures.

Daily program for static intercomparison:

Time	AIDA status	Activity*	
8:00	evacuated	Adding water vapour	
8:30	filling	Adding synthetic air ($H_2O \leq 3$ ppm)	
9:00	50 hPa	Sampling for 30 minutes	
9:30	filling	Adding synthetic air ($H_2O \leq 3$ ppm)	
10:00	100 hPa	Sampling for 30 minutes	
10:30	filling	Adding synthetic air ($H_2O \leq 3$ ppm)	
11:00	200 hPa	Sampling for 30 minutes	
11:30	filling	Adding synthetic air ($H_2O \leq 3$ ppm)	
12:30	500 hPa	Sampling for 30 minutes	
13:00	pumping	Slow pumping	
14:00	200 hPa	Sampling for 30 minutes	
14:30	pumping	Slow pumping	
15:00	100 hPa	Sampling for 30 minutes	
15:30	pumping	Slow pumping	
16:00	50 hPa	Sampling for 60 minutes	
17:00	pumping	Slow pumping	
17:30	pumping	Meeting of all participants: status of instruments, feed back, discussion with referees, etc. (room 405, building 321)	
18:30	evacuated		

*The pressure changes in AIDA can be done slower or faster; in either case it takes some time for the AIDA temperature to equilibrate after the expansion or compression. There is also the option of adding ice particles to the AIDA e.g. at the end of the final 50 hPa step.

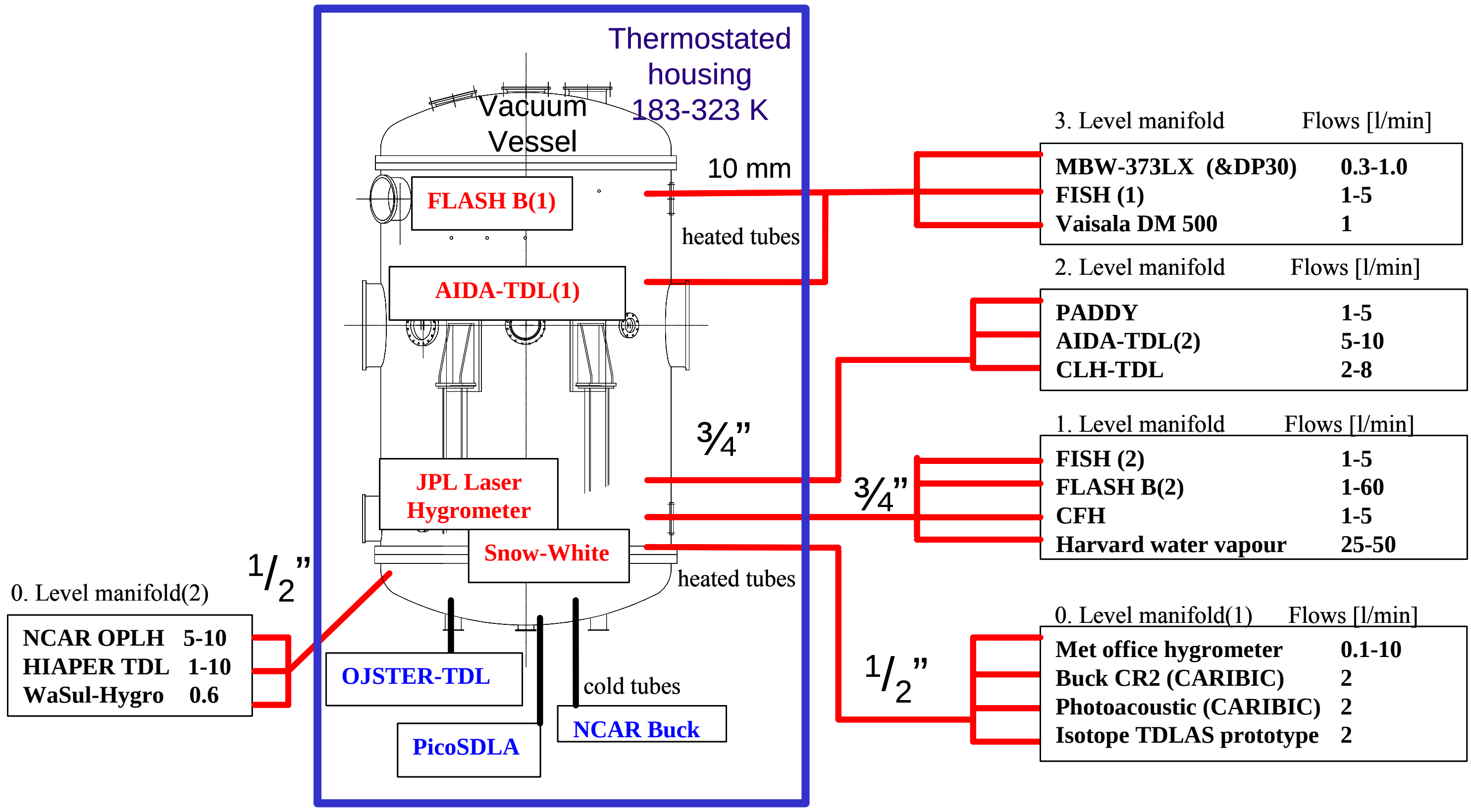
Daily program for dynamic intercomparison:
This may include 3-4 adiabatic expansion experiments in AIDA or injection of ice particles from outside both starting at water concentrations close to ice saturation. The first expansion may be done without adding aerosol particles to the chamber (only background aerosol). The next expansions will be done with different cooling rates and particle concentrations in order to vary the density of the clouds formed. Start pressures, injection/adiabatic expansion, aerosol particle types, and cloud types (ice, mixed phase) still have to be chosen.

Data delivery
All participants should inform the organisers when they plan to submit final data after the experiment. First data should be submitted within 24 hours after the experiments. Submitting final data during the campaign is highly desirable. At a minimum, absolute uncertainty ranges should be submitted with the data from each test run. If the range is ±5%, for example, we would consider that to be final since later adjustments within such a range would not impact our conclusions from the campaign. The NASA AMES data format must be used: For a description see: http://badc.nerc.ac.uk/help/formats/NASA-Ames/ . Time synchronisation may be made via respective time servers.

Suggested positions for the different instruments at AIDA:
The instruments are connected to the AIDA in three different ways:

- The instrument measures inside the AIDA chamber
- The instrument measures inside a cold flow tube connected to AIDA by a tube
- The instrument measures in the warm laboratory connected to AIDA by a heated stainless steel tube, several instruments can be connected to one sampling line via a manifold

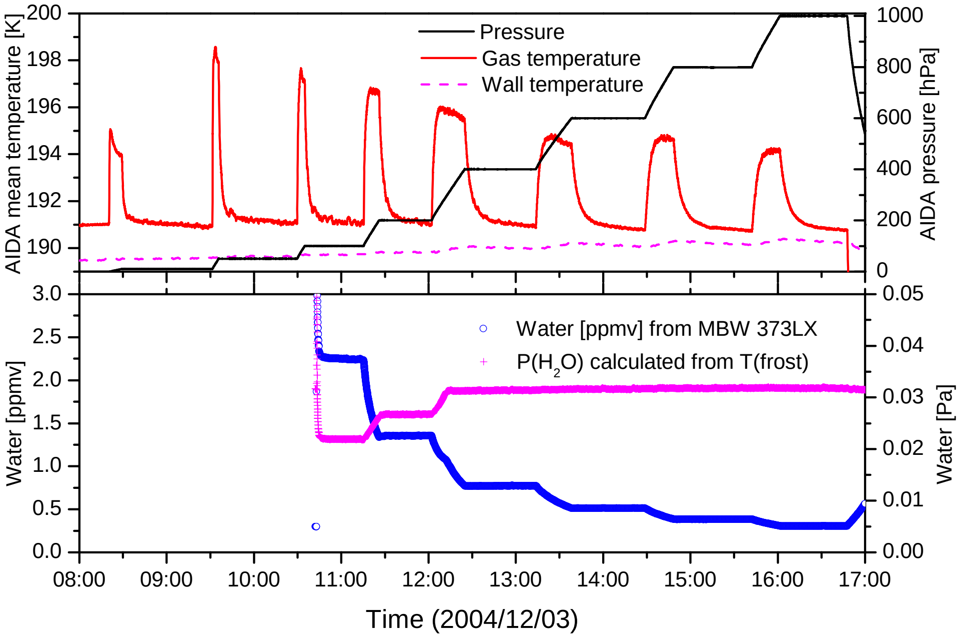
The exhaust of the instrument can be connected to a central vacuum pump e.g. via mass flow controller. The heated stainless steel tubes on the third Level have outer diameters of 10 mm (8 mm i.d.), One tube on the first Level and one on the zero Level have outer diameters of 12 mm (10 mm i.d.), and two tubes on the first Level have an outer diameter of ¾". All are heated to ~303 K until the end of the tube which ranges 30-40 cm into the AIDA chamber. The cold stainless steel tubes have outer diameters of ¾" (AIDA bottom) ranging 30 cm into the AIDA volume. They contain vacuum valves which are kept at 223 K or above.
The different instruments are grouped to the 5 heated sample lines according to their measurement ranges, space, and sample flow requirements.

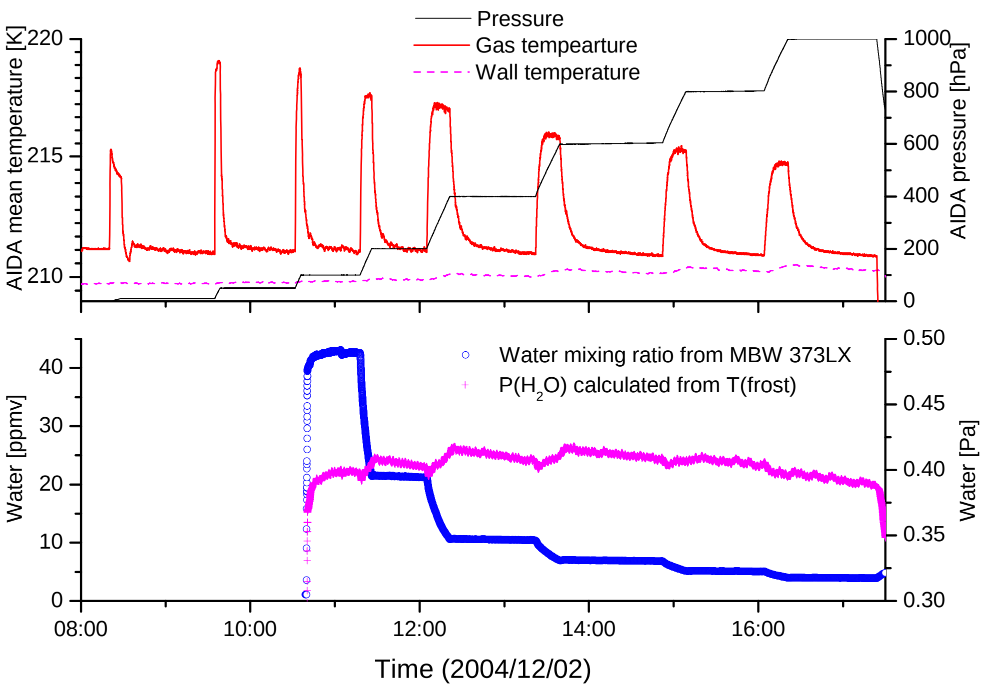


For the connection of the instruments to the central vacuum pump eight 200 SLM, one 660 SLM, and one 3300 SLM mass flow controllers are available. Some smaller flow controllers are also available.

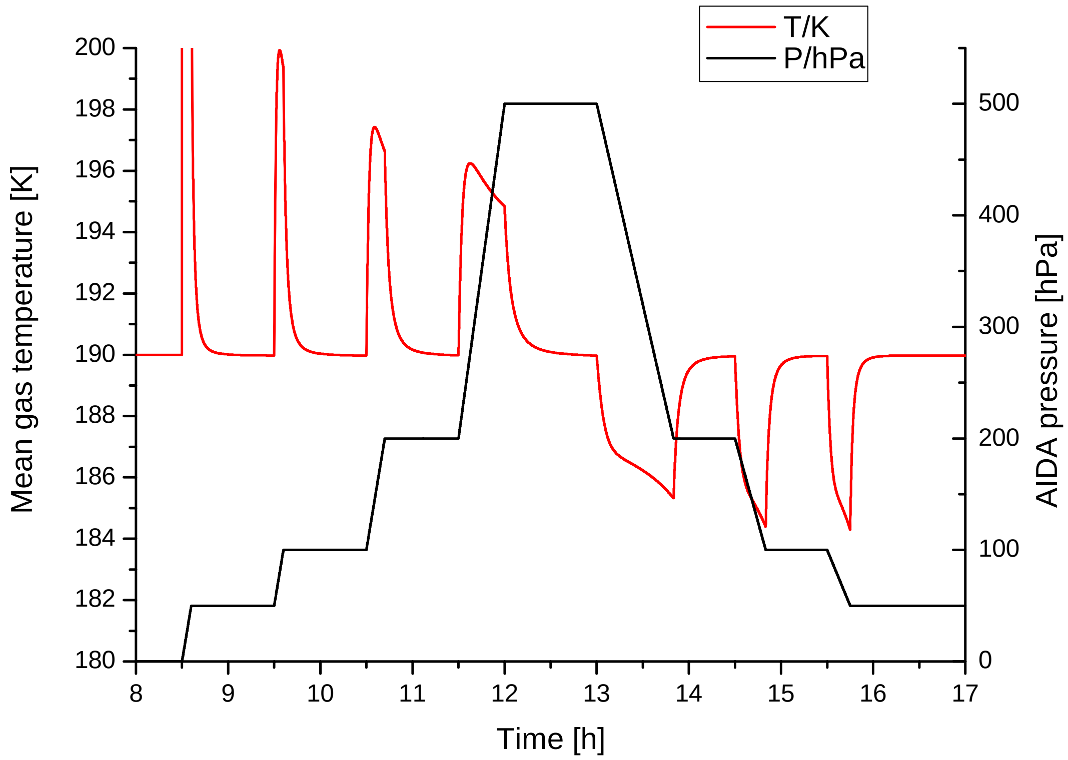
Two examples of AIDA water vapour, pressure, and temperature profiles during a measurement campaign in 2004:

Stepwise increase of AIDA pressure leads to temperature increases due to compression. The water mixing ratio decreases due to addition of dry air (< 3 ppm H_2O) but the total water concentration calculated from the frost point temperature shows only small changes. At 191 K ice saturation is reached but not at 211 K.





Model calculation for a static intercomparison experiment (P, T, only)
The model calculation overestimates the temperature changes but the temporal behaviour is quite representative.



Result of a NACHE* model calculation by Helmut Bunz based on the pressure profile suggested for a 'static' intercomparison experiment.

Participants & Instruments

Participant	Institute	Instrument
Linnea Avallone	University of Colorado	CLH, TDL
Sean Davis	University of Colorado	CLH, TDL
Zoltán Bozóki	University of Szeged, Hilase Ltd.	Photoacoustic water sensor, WaSul-Hygro
Árpád Mohhácsi	University of Szeged, Hilase Ltd.	Photoacoustic water sensor, WaSul-Hygro
Theo Brauers	Research Centre Jülich	Vaisala Sensor DM 500
Rolf Häseler	Research Centre Jülich	Vaisala Sensor DM 500
Ulrich Bundke	University of Frankfurt	PADDY dew point mirror
Teresa Campos	NCAR Boulder	NCAR OPLH & Buck Hygrometer
Frank Flocke	NCAR Boulder	NCAR OPLH & Buck Hygrometer
Dennis Krämer	NCAR Boulder	NCAR OPLH & Buck Hygrometer
George Durry	University of Reims	PicoSDLA
Nadir Amarouche	INSU/CNRS	PicoSDLA
Jacques Deleglise	INSU/CNRS	PicoSDLA
Fabien Frerot	INSU/CNRS	PicoSDLA
Volker Ebert	University of Heidelberg	AIDA TDL
Christian Lauer	University of Heidelberg	AIDA TDL
Stefan Hunsmann	University of Heidelberg	AIDA TDL
Harald Saathoff	Research Centre Karlsruhe	AIDA TDL & MBW-373LX & FTIR
Robert Wagner	Research Centre Karlsruhe	AIDA TDL & MBW-373LX & FTIR
Debbie O'Sullivan	UK met office	Met office fluorescence hygrometer
Robert L. Herman	JPL	JPL-Laser-Hygrometer
Robert F. Troy	JPL	JPL-Laser-Hygrometer
Cornelius Schiller	Research Centre Jülich	Two FISH & Ojster TDL & MBW-DP30
Martina Krämer	Research Centre Jülich	Two FISH & Ojster TDL & MBW-DP30
Armin Afchine	Research Centre Jülich	Two FISH & Ojster TDL & MBW-DP30
Reimar Bauer	Research Centre Jülich	Two FISH & Ojster TDL & MBW-DP30
Jessica Meyer	Research Centre Jülich	Two FISH & Ojster TDL & MBW-DP30
Nicole D. Spelten	Research Centre Jülich	Two FISH & Ojster TDL & MBW-DP30
Andres Thiel	Research Centre Jülich	Two FISH & Ojster TDL & MBW-DP30
Miriam Kübbeler	Research Centre Jülich	Two FISH & Ojster TDL & MBW-DP30
Sergey Khaykin	Central aerological observatory	Two FLASH-B (Lyman-a)
Leonid Korshunov	Central aerological observatory	Two FLASH-B (Lyman-a)
Holger Vömel	University of Colorado	CFH, frost point hygrometer
Elliot Weinstock	Harvard University	Harvard water vapour
Jessica Smith	Harvard University	Harvard water vapour
Frank Wienhold	ETH Zürich	Snow-White
Ulrich Krieger	ETH Zürich	Snow-White
Martin Brabec	ETH Zürich	Snow-White
Andreas Zahn	Research Centre Karlsruhe	CARIBIC (Buck CR-2 & photoacoustic)
Julia Keller	Research Centre Karlsruhe	CARIBIC (Buck CR-2 & photoacoustic)
Christoph Dyroff	Research Centre Karlsruhe	Water isotope composition TDLAS
Mark Zondlo	Southwest Science, Inc.	HIAPER VCSEL TDL-System