




MPSS data processing with R

Community Meeting February 12, 2026

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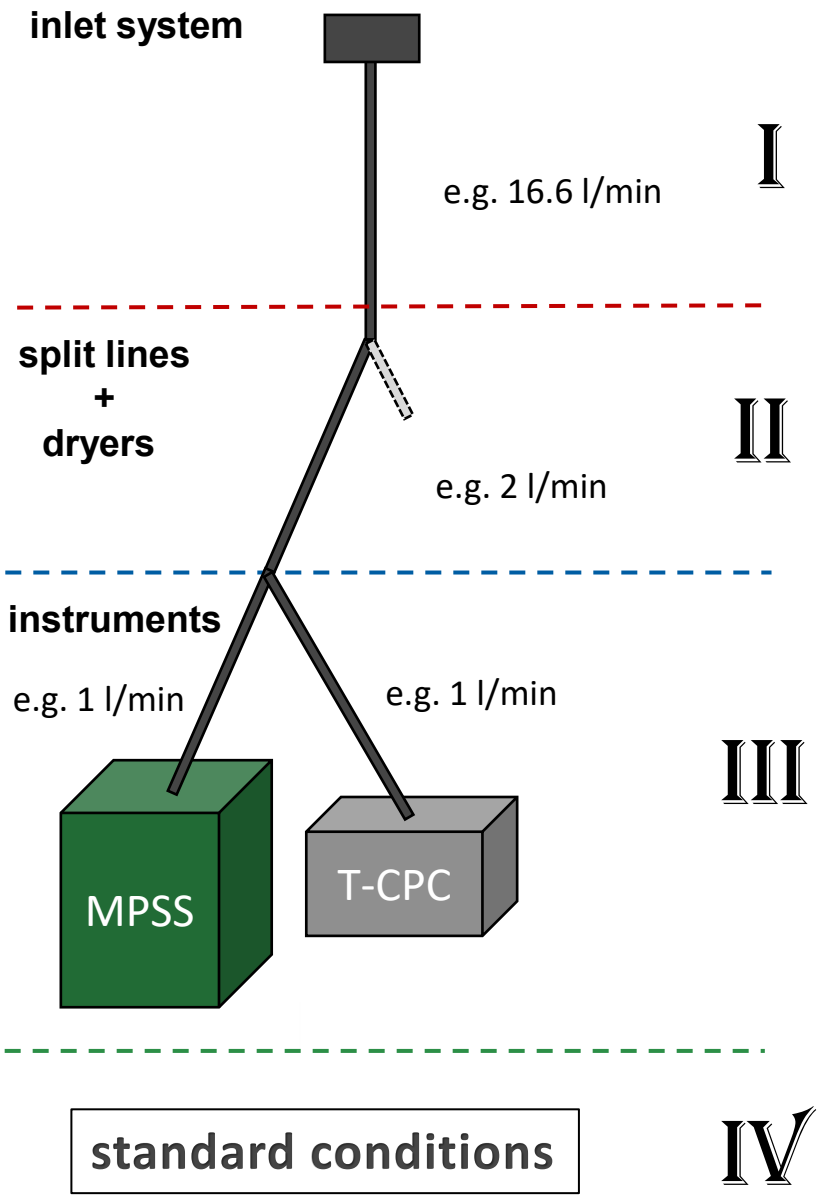
WCCAP

Basics: what goes in the processing



Station conditions

- ✓ altitude
- ✓ pressure
- ✓ temperature
- ✓ time zone
- ✓ MPSS type
- ✓ CPC type
- ✓ ….

Corrections

- inlet
- splitting
- instruments
- standard conditions

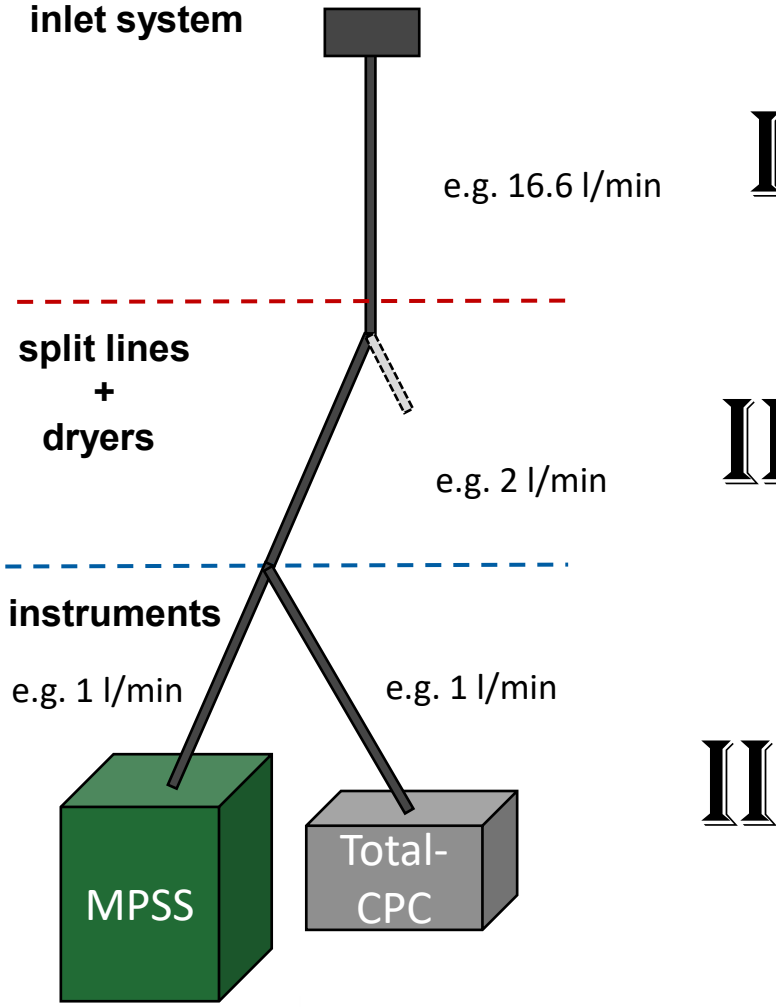
Workshops at CF

- CPC-workshop
- MPSS-workshop

Level 0

- raw concentration
- status values

Basics: what goes in the processing

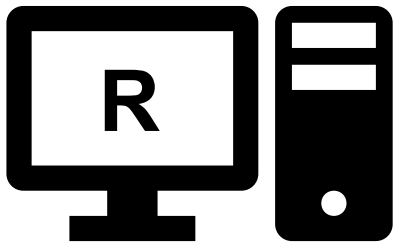


I

II

III

IV



offline → R routine v.1.0

inversion
+
corrections

- TROPOS MPSS
- TSI MPSS
- other MPSS types

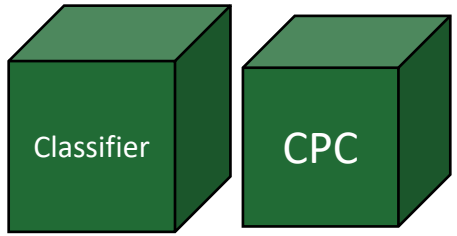
must be ACTRIS compliant level 0 data output

TROPOS MPSS

online on MPSS laptop

standard conditions

TROPOS MPSS



pulse output (BNC)

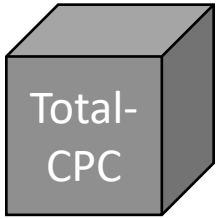
raw counts

no flow correction

raw concentration (*.raw)

diagnostics (*.dia)

Level 0



pulse output (BNC)

raw counts

no flow correction

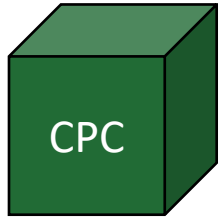
raw concentration

Level 0

serial or digital

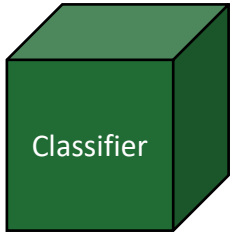
status values

TSI MPSS



- ✓ no flow correction
- ✓ k-factor
- ✓ coincidence correction

serial



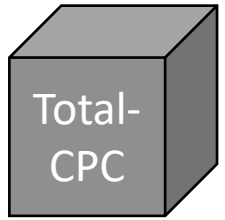
TSI – data acquisition

raw concentration

TSI monitoring raw file (*.csv)

Level 0

CPC type



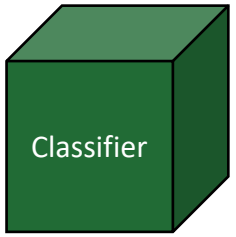
internal data processing

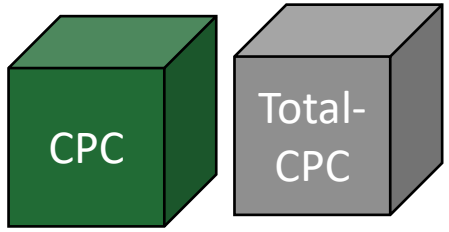
NRT

total concentration #/cm³

Level 1

TROPOS MPSS





raw concentration (*.raw)

11.5	296.15	1000	71	8.753	9.002	9.521
11.5	296.15	1000	71	0.015	0.03	0.046
11.583333	296.15	1000	71	8.753	9.002	9.521
11.583333	296.15	1000	71	0.015	0.015	0.061
11.666667	296.15	1000	71	8.753	9.002	9.521
11.666667	296.15	1000	71	0.015	0.03	0.107
11.75	296.15	1000	71	8.753	9.002	9.521
11.75	296.15	1000	71	0.046	0.03	0.076

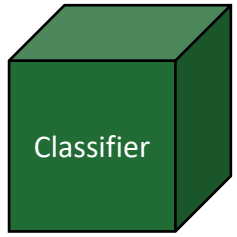
diagnostics (*.dia)

11.500000,Sheathair:,flow,5.00,t,20.37,rH,31.5,Aerosol:,flow,1.032,
11.583333,Sheathair:,flow,5.00,t,20.40,rH,25.0,Aerosol:,flow,1.030,
11.666667,Sheathair:,flow,5.00,t,20.42,rH,24.8,Aerosol:,flow,1.033,
11.750000,Sheathair:,flow,5.00,t,20.43,rH,25.3,Aerosol:,flow,1.034,
11.833333,Sheathair:,flow,5.00,t,20.41,rH,25.4,Aerosol:,flow,1.025,
11.916667,Sheathair:,flow,5.00,t,20.40,rH,25.0,Aerosol:,flow,1.030,
12.000000,Sheathair:,flow,5.00,t,20.46,rH,25.9,Aerosol:,flow,1.037,

status values (*.csv)

condenserTemp:	[23.1]	saturatorTemp:	[39]	orificePressure:	[76.400002]	liquidLevel:	[1]
condenserTemp:	[23.1]	saturatorTemp:	[39]	orificePressure:	[74]	liquidLevel:	[1]
condenserTemp:	[23.1]	saturatorTemp:	[39]	orificePressure:	[71.5]	liquidLevel:	[1]
condenserTemp:	[23.1]	saturatorTemp:	[39]	orificePressure:	[79.5]	liquidLevel:	[1]
condenserTemp:	[23.1]	saturatorTemp:	[39]	orificePressure:	[77.300003]	liquidLevel:	[1]
condenserTemp:	[23.1]	saturatorTemp:	[39]	orificePressure:	[75]	liquidLevel:	[1]
condenserTemp:	[23.1]	saturatorTemp:	[39]	orificePressure:	[72.5]	liquidLevel:	[1]
condenserTemp:	[23.1]	saturatorTemp:	[39]	orificePressure:	[70]	liquidLevel:	[1]
condenserTemp:	[23.1]	saturatorTemp:	[39]	orificePressure:	[78.199997]	liquidLevel:	[1]

TSI MPSS



TSI monitoring raw file (*.csv)

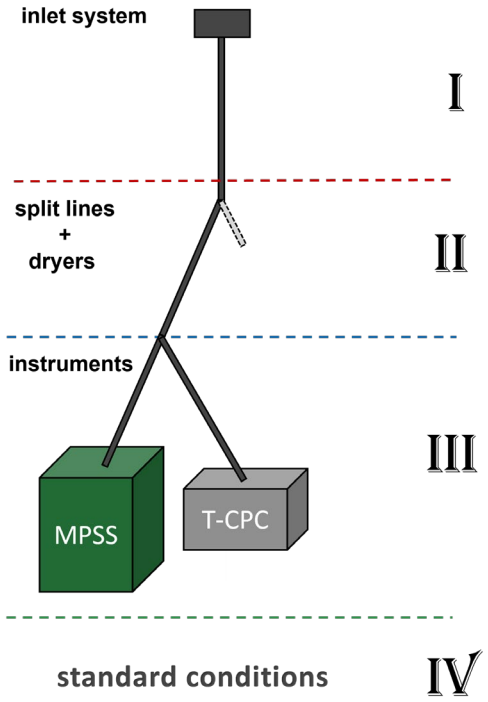
AIM Version11.5.0
Dataset Nameambient
Classifier Model3082
Classifier S/N3082022218001
Classifier Firmware Version3.1
Calibration statusLast calibration < 365 days
Classifier HV Power SupplyDual
Neutralizer Model3077
Neutralizer S/N
Impactor ModelNone
Impactor S/N
DMA Model3083

select „TSI monitoring“!

					Raw Concentration		
DateTime Sample Start	Sheath Flow (L/min)	Sheath Temp (C)	Sheath Pressure (kPa)	....	_10.37	_11.14	_11.97
10/02/2026 00:00:02	4.800	20.7	99.0	....	0.243	0.686	0.927
10/02/2026 00:05:01	4.800	20.7	99.0	....	0.399	0.513	0.966
10/02/2026 00:10:03	4.800	20.7	99.0	....	0.369	0.415	0.832
10/02/2026 00:15:02	4.800	20.7	99.0	....	0.260	0.489	0.698
10/02/2026 00:20:02	4.800	20.7	99.0	....	0.252	0.305	0.538
10/02/2026 00:25:03	4.800	20.7	99.0	....	0.252	0.379	0.489

IV

I + II



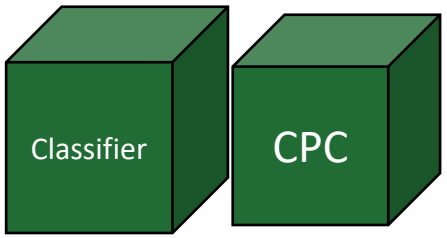
corrections applied on level 0

- coincidence
- k-factor
- aerosol flow
- inversion
- diffusion loss
- cpc counting efficiency
- inlet losses
- standard conditions

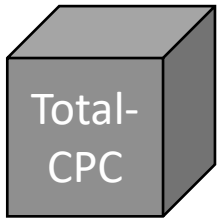
III

Corrections applied in R

TROPOS MPSS

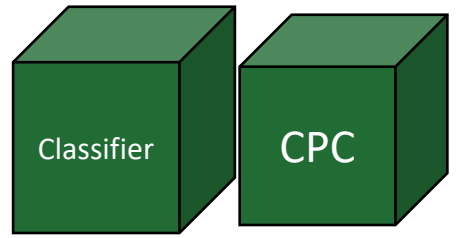


- ✓ coincidence correction
- ✓ k-factor
- ✓ inversion
- ✓ diffusion loss
- ✓ flow correction



- ✓ coincidence correction
- ✓ k-factor
- ✓ flow correction

TSI MPSS



~~k-factor~~
~~coincidence correction~~

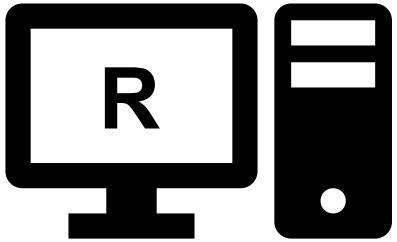
- ✓ inversion
- ✓ aerosol flow correction
- ✓ diffusion loss
- ✓ cpc counting efficiency
- ✓ inlet losses
- ✓ standard conditions

correlation between T-CPC and MPSS

- ✓ cpc counting efficiency
- ✓ inlet losses
- ✓ standard conditions

- ✓ size classes integration
- ✓ regridding
- ✓ …

R software for data evaluation



Install software

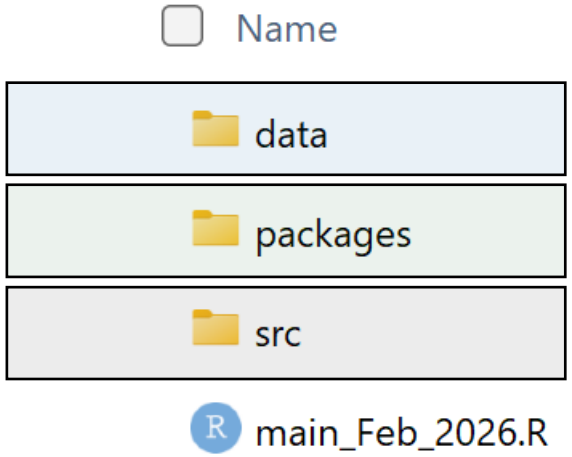
- ✓ R
- ✓ Rtools
- ✓ R-Studio

Install all required packages

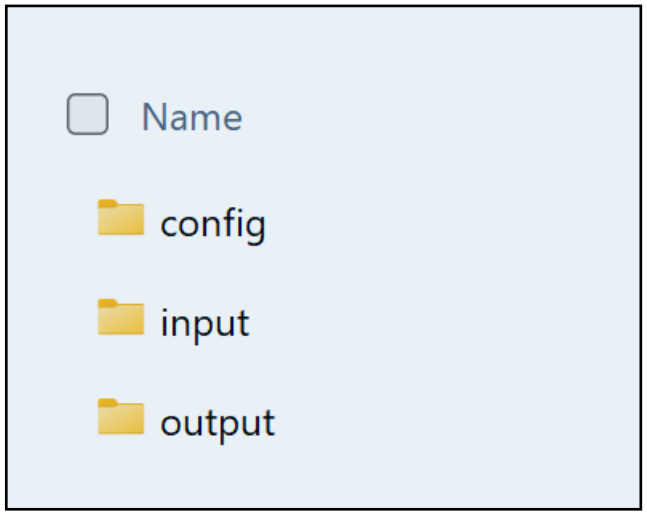
- ✓ Tidyverse, Hmisc, viridis, pracma, grDevices, metR, scales, graphics
- ✓ Timetk, DBI, RPostgres
- ✓ R-Studio cowplot, plotly, lubridate

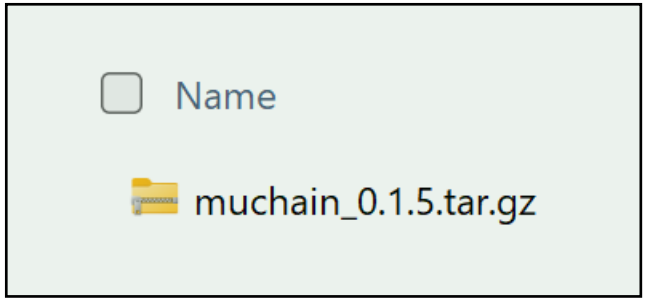
R software for data evaluation

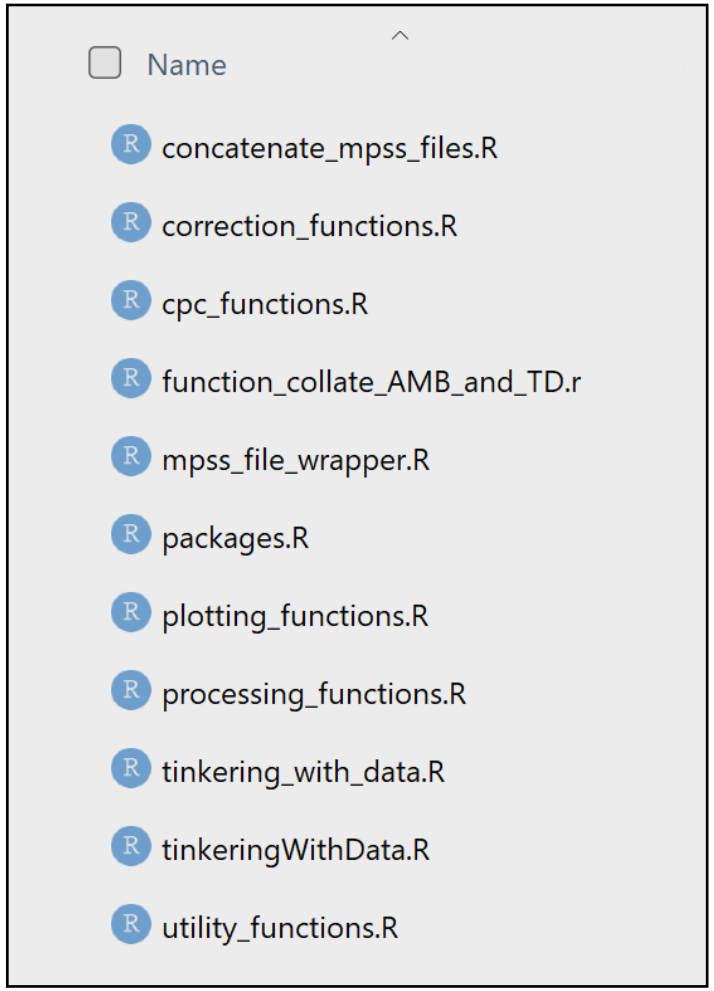
main R folder



subfolder







R software for data evaluation

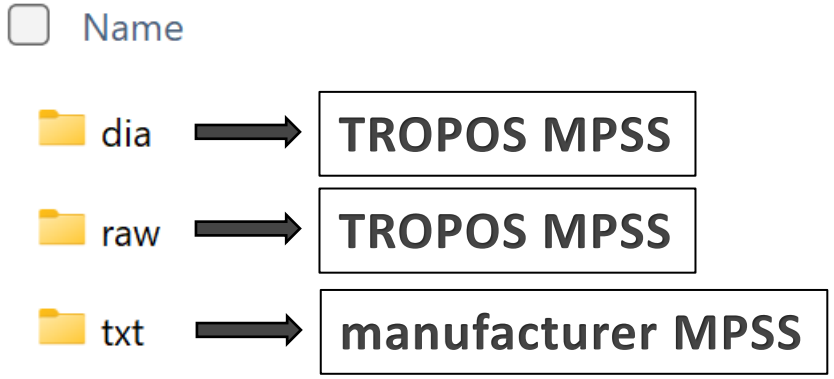
data -> config

config file

evaluation settings

1) general
2) corrections
3) mpss (classifier)
4) mpss-cpc
5) total-cpc
6) inlet
7) period

data -> input

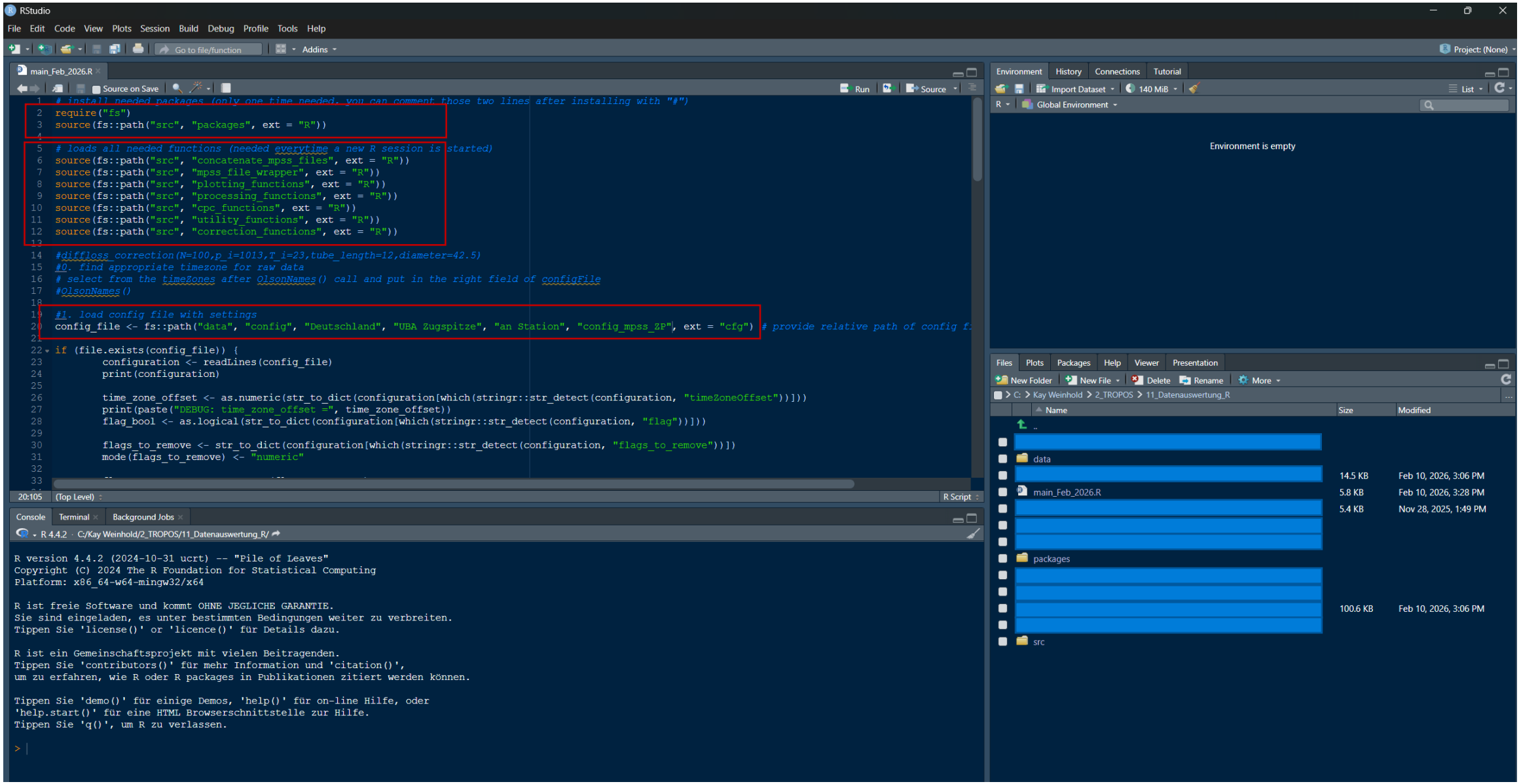


data -> output

- ✓ backup of config file
- ✓ evaluated data

Level 1

R software for data evaluation



config file

1) general settings:

- ✓ time zone offset
- ✓ standard temperature
- ✓ standard pressure
- ✓ flag
- ✓ output file name
- ✓ extension for output
- ✓ data folder
- ✓ format of time
- ✓ time average period
- ✓ regrid
- ✓ new grid
- ✓ size classes
- ✓ volume
- ✓ particle density
- ✓ shape factor
- ✓ time format

```
General
-------
timeZoneOffset|time_zone_offset=0|#select correct timezone offset
standard_temperature|temp_standard=273.15|# reference temperature in K
standard_pressure|pressure_standard=1013.25|# reference temperature
flag|flagging=TRUE|#should data be flagged
output|output_name=MPSS_ZP #custom output name to identifiy files later on, e.g., sys
extension|extension=in2|#ending of output file depending on analysis, can be decided
data_folder|data_folder=data|#in which folder data is stored, relative to the main.R
format_of_time|time_format=%Y-%m-%dT%H:%M:%S%z|#String that describes the date time f
time_average_period|avg_period=1 hours|#length of averaging interval, or "all" if the
regrid|regridding=TRUE #new grid of data
new_grid|d_min=10,d_max=800,n_bins=40|#parameters for new grid
temp_format|temp_format=C|#(K)elvin or (C)elsius temperature of reference T at statio
size_classes|size_classes=TRUE|#size classes yes or no
volume_bool|volume_bool=TRUE|#vol. size dist. + total volume yes(TRUE) or no(FALSE)
particle_density|rho_p=1600|#density of particle in kg per m³
shape_factor|xhi=1|#shape factor of particles (has to be implemented)
time_format_in_raw|time_rep=hod|#hod (hour of day) or doy (day of year)
```

config file

2) corrections settings:

- ✓ coincidence mpss cpc
- ✓ coincidence total cpc
- ✓ k-factor mpss cpc
- ✓ k-factor total cpc
- ✓ mpss cpc efficiency
- ✓ inversion
- ✓ diffusion loss correction
- ✓ stp correction
- ✓ inlet loss correction
- ✓ t-cpc flow correction
- ✓ mpss cpc flow correction

```
Corrections
-----------
coincidence_MPSS_cpc|coincidence=TRUE|#enable (TRUE) or disable (FALSE) coincidence corre
coincidence_tot_cpc|coincidence=TRUE|#enable (TRUE) or disable (FALSE) coincidence correc
k_factor_mpss_cpc|k_factor_correction=TRUE|#enable (TRUE) or disable (FALSE) k-factor cor
k_factor_tot_cpc|k_factor_correction=TRUE|#enable (TRUE) or disable (FALSE) k-factor corr
MPSS_cpc_efficiency_correction|cpc_eff=TRUE|#enable (TRUE) or diable (FALSE) efficiency c
inversion_boolean|invert=TRUE|#enable inversion (TRUE) or disable (FALSE)
diffusion_loss_correction|diff_lost=TRUE|#en/disbale diffusion loss correction
stp_correction|stp_corr=TRUE|#en-/disable correction to standard conditions (see general)
time_average_boolean|avg_per_time_interval=FALSE|#en-/disable time average
station_conditions_boolean|station_cond=TRUE|#measurement conditions from dia (FALSE) or
inlet_losses_boolean|inlet_losses=TRUE|#enable (TRUE) disable (FALSE) inlet loss correcti
clean_data_boolean|clean_data=FALSE|#enabale(TRUE) disable(FALSE) data cleaning
flags_to_remove|flag1=1,flag2=2,flag3=4|### give flags amount can be infinite flag1=x,...
tot_cpc_flow_correction|tot_cpc_flow_corr=TRUE |#enable disbale flow corr for total CPC
mpss_cpc_flow_correction|mpss_cpc_flow_corr=TRUE|#enable disbale flow corr for MPSS CPC
```

config file

3) MPSS settings:

- ✓ hv polarity
- ✓ neutralizer type
- ✓ dma sheath air flow
- ✓ sp dma sheath air flow
- ✓ mpss type
- ✓ station temperature
- ✓ station pressure
- ✓ mpss file name
- ✓ effective lenght

```
MPSS_settings
-------------
HV_polarity|polarity=pos|#pos, neg
Neutralizer_type|neutralizer=rad|#xray, rad, custom
DMA_Sheathair_flow|sheath_air_flow=5|#float value or "dia"
SP_DMA_sheath_flow|sheath_air_flow=5|# setpoint of sheath air flow
MPSS_type|mpss_type=TROPOS|#TSI, Tropos: which type of MPSS is used
station_temperature|t_ref=292.15|# in Kelvin; reference temperature at static
station_pressure|p_ref=725.5|# in hPa; reference pressure at station (assumed
MPSS_Name|mpss_name=SMPS_ufs_|# to save files unique identifier is needed
Effective_length|eff_length2=2.6,eff_length3=4.6|#effective length of system
```

config file

4) MPSS CPC settings:

- ✓ manufacturer
- ✓ efficiency parameter
- ✓ coincidence parameter
- ✓ k-factor
- ✓ aerosol flow measured
- ✓ flow of cpc type

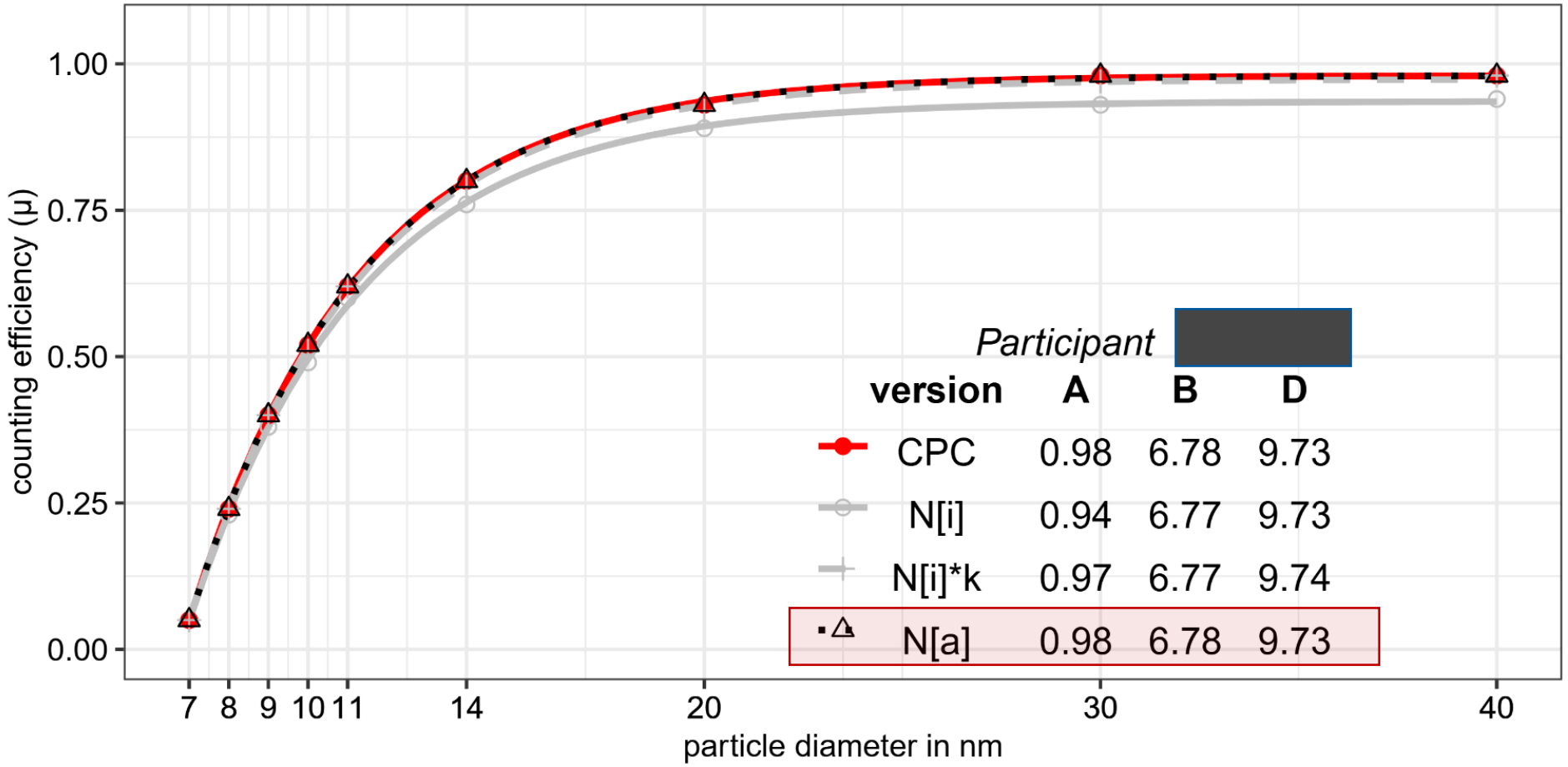
```
MPSS_CPC_settings
-----------------
Manufacturer_MPSS_CPC|man_mpss_cpc=TSI|#TSI, AIRMODUS, AVL, GRIMM
Efficiency_parameter_mpss_cpc|d0=6.93,d50=10.27,plateau=1|#d0 in nm, d50,
Coincidence_parameters_mpss_cpc|c_param=5.0e-6|#scalar or vector (3772 CE
K_Factor_MPSS_CPC|k_factor=1.0526|#scalar, if no k-factor needed set to 1

MPSS_CPC_Flow_value|mpss_cpc_flow=0.98|# float or string "dia" if flow fr
SP_flow_mpss_cpc|sp_mpss_cpc=1.0|# setpoint of cpc mpss flow
```

info out of CPC report
from last workshop at CF

config file

CF Workshop: CEN Certificate for Condensation Particle Counter



config file

5) Total CPC settings:

- ✓ manufacturer
- ✓ efficiency parameter
- ✓ coincidence parameter
- ✓ k-factor
- ✓ aerosol flow measured
- ✓ flow of cpc type

```
Total_CPC_settings
------------------
Manufacturer_total_CPC|man_tot_cpc=TSI|#TSI, AIRMODUS, AVL, GRIMM
Efficiency_parameter_tot_cpc|d0=6.81,d50=10.21,plateau=0.99|#d0=xx.x, d50=x
Coincidence_parameters_tot_cpc|c_param=4.2e-6|#scalar or vector (3750)
K_Factor_tot_CPC|k_factor=1.04167 #scalar, if no k-factor needed set to 1

Tot_CPC_Flow_value|tot_cpc_flow=0.98|# float or string "dia" if flow from d
SP_flow_tot_cpc|sp_tot_cpc=1|# setpoint of cpc tot flow
```

config file

6) Inlet settings:

- ✓ Inlet system
- ✓ Split lines
- ✓ dryer
- ✓ thermodender
- ✓ …

```
Inlet_settings
--------------
Segment_1|length=11,tube_dia=0.01,flowrate=153.0|#length in me
Segment_2|length=0.65,tube_dia=0.004826,flowrate=1|#length in
Segment_3|length=0,tube_dia=0.004826,flowrate=1|#length in met
Segment_4|length=0,tube_dia=0.004826,flowrate=1|#length in met
Segment_5|length=0,tube_dia=0.004826,flowrate=1|#length in met
```

7) Period settings:

- ✓ Evaluation time period

```
Period
------
Filter_for_period|datefiltering=FALSE|#boolean if data set should be
eval_period|start=2023-01-01 00:00:00 UTC,end=2023-01-31 23:55:00 UTC
```

R software output as an example (*.csv)

MPSS including raw data

Config file used: C:/SMPS_Data/config/config.cfg
File created and config file used from: 2025-12-18 13:05:42.169618
===== DATA STARTS BELOW =====

date	T0	p0	n_bins	conc	dp_0	sheath_air_T	sheath_air_rh	sheath_air_flow	aerosol_flow_T	aerosol_flow_rh	aerosol_flow	aerosol_pressure	cpc_conc
2025-12-18T1	296.15	980	71	{1.297904566	{8.98,9.235,9.	18.36	19.6	5	18.33	25.1	1	1002.2	{5237.079384
2025-12-18T1	296.15	980	71	{0.592635305	{8.98,9.235,9.	17.73	19.8	5	17.38	24.9	1	1003.2	{5364.423669
2025-12-18T1	296.15	980	71	{1.009481329	{8.98,9.235,9.	18.06	18.2	5	17.3	19.4	1	1003.1	{5428.708697
2025-12-18T1	296.15	980	71	{1.057899876	{8.98,9.235,9.	19.15	15.9	5	18.16	18.8	1	1003.3	{5595.147677
2025-12-18T1	296.15	980	71	{0.945265920	{8.98,9.235,9.	20	15.2	5	19.06	17.7	1	1003.7	{5282.462504

raw data

T-CPC

Total CPC status

Q_sam_dia	Q_sh_dia	Total_CPC_conc_serial	Total_CPC_status_flag	Total_CPC_T_sat	Total_CPC_T_cond	Total_CPC_T_opt	Total_CPC_T_cab	Total_CPC_pressure	Total_CPC_pressure_nozzle	Total_CPC_pressure_orifice	Total_CPC_laser	Total_CPC_fill_state
0.943	5.01	5010	0	39	22.7	40	33.2	99.9	87.1	2.535	41	1
0.957	5.01	5010	0	39	22.7	40.1	33.2	99.9	87.1	2.533	41	1
0.95	5.02	5370	0	39	22.7	40.1	33.6	99.9	87.1	2.535	41	1
0.948	5	4890	0	39	22.7	40.1	34	99.9	87.1	2.533	41	1
0.962	5.02	4880	0	39	22.7	40.1	34.5	99.8	87.1	2.533	41	1
0.962	5.01	4700	0	39	22.7	40	34.5	99.9	87.1	2.533	41	1

MPSS

R software output

MPSS CPC

MPSS_CPC_conc_serial	MPSS_CPC_status_flag	MPSS_CPC_T_sat	MPSS_CPC_T_cond	MPSS_CPC_T_opt	MPSS_CPC_T_cab	MPSS_CPC_pressure	MPSS_CPC_pressure_nozzle	MPSS_CPC_pressure_orifice	MPSS_CPC_laser	MPSS_CPC_fill_state	flag
6	0	39	23.5	40	31.2	98.3	86.5	2.111	51	1	64
4.8	0	39.2	23.5	40	30.9	98.3	86.5	2.107	51	1	10
6.6	0	38.9	23.5	40	31.5	98.3	86.5	2.109	51	1	66
7.2	0	39.1	23.5	40	32.2	98.3	86.5	2.109	51	1	64
7.2	0	39	23.5	40	32.9	98.3	86.5	2.111	51	1	0
9	0	38.9	23.5	40	33	98.3	86.5	2.111	51	1	0

Size classes and dN/dlogDp data

n_closure	N10_20	N20_30	N30_50	N50_70	N70_100	N100_200	N200_500	N500_800	N10_100	N10_800	N100_500	N_tot	dp	dndlogdp
4156.12728	1163.01203	512.340968	711.937304	606.191905	629.910648	653.58948	245.508601	13.5282291	3623.40679	4536.00414	899.075263	4723.22809	{10,10.72032(	{4240.3105042976,3828.56
4343.72963	1166.57903	664.308414	744.534853	604.513553	630.392627	672.003669	250.827612	13.6958888	3810.37191	4746.89452	922.82939	4904.35003	{10,10.72032(	{3188.64565367588,3987.7
4335.14133	1288.41805	551.551448	731.796328	614.816171	651.049276	665.861848	252.126222	13.9844217	3837.62638	4769.59109	917.983445	4936.64657	{10,10.72032(	{4101.23636286343,4464.6
4405.84275	1236.10145	566.590985	773.537814	644.762857	656.154886	669.261518	249.885865	14.3905001	3877.15492	4810.66677	919.126422	5008.87212	{10,10.72032(	{4112.72083444054,4195.0
4395.80943	1139.092	560.072069	784.565454	665.42357	680.979999	677.958143	246.416767	14.3611798	3830.15215	4768.87571	924.368031	4983.80355	{10,10.72032(	{4538.3531641601,3784.90
4373.7629	1147.603	562.48835	730.971032	682.098322	696.945422	688.80151	250.761539	12.9550196	3820.12832	4772.63809	939.56111	4931.44869	{10,10.72032(	{3474.2520770855,4008.40

without cpc efficiency curve

level 1

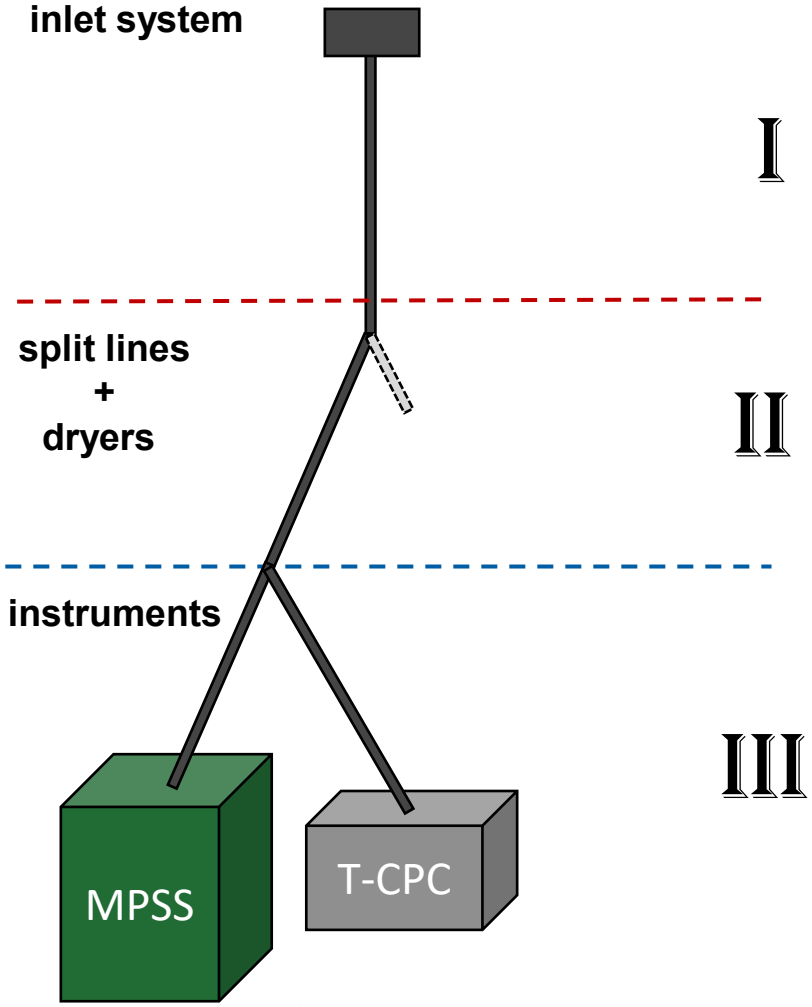
dNdlogDp

R software flagging

still under development!

Observed variable	Parameter in data	Flag	tolerance
aerosol flow rel. humidity	aerosol_flow_rh	1	0 – 40 %
aerosol flow temperature	aerosol_flow_T	2	18 – 28 °C
sheath air rel. humidity	sheath_air_rh	4	0 – 40 %
aerosol flow	Aerosol_flow	16	+/- 5 %
sheath flow	Sheath-flow	32	+/- 2 %
difference of MPSS integral anf Total CPC	n_closure, cpc_conc	64	+/-20 %
…	…	…	…

collecting and providing



station conditions

level 0

corrections

CF workshop results

Level 1