

DRAFT AirSensEUR: an open data/software /hardware multi-sensor platform for air quality monitoring.

*Part D: DRAFT
Calibration of sensor
data*

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Contents

1	Installation	1
2	Selection of AirSenseEUR box	2
2.1	Create a new AirSenseEUR Box config file.....	4
2.2	Select an AirSenseEUR box.....	5
2.3	Configuration of an AirSenseEUR box data download	6
2.3.1	Averaging time, delays and sensor config file	6
2.3.2	Proxy server.....	6
2.3.3	Sensor InfluxDB data download.....	6
2.3.4	SOS sensor data download.....	8
2.3.5	Downloading data from reference instrument	9
2.3.5.1	Using SOS reference data download	10
2.3.5.2	Using csv file on a ftp server	11
3	Data treatment	13
3.1	Preparing data for treatment.....	13
3.2	Procedure for data treatment	17
3.3	Observing Configuration	17
3.4	Observing downloaded data	18
3.5	Filtering invalid data.....	20
3.5.1	Warming time	20
3.5.2	Data outside interval of tolerance for temperature and humidity	22
3.5.3	Discarding negative reference data	22
3.5.4	Discarding invalid sensor data	23
3.5.5	Filtering sensor data.....	24
3.6	Plotting covariates	25
3.7	Calibration	28
3.7.1	Creating new calibration model.....	28
3.7.1.1	Scatterplot.....	28
3.7.2	Plotting existing calibration model.....	29
3.7.2.1	Scatterplot.....	29
3.7.2.2	Goodness of fit of the calibration model	31
3.7.2.3	Time Series.....	32
3.7.2.4	Matrix plot	32
3.8	Extrapolation.....	33
3.8.1.1	Scatterplot, summary Calibration, Times series and Residual matrix... 33	
3.8.1.2	Uncertainty	34
3.8.1.3	Target diagram.....	34

3.8.1.4 Drift	34
4 Troubleshooting	35
4.1 Missing parameters.....	35
4.2 Missing parameters.....	35
4.3 "ERROR: arguments imply differing number of rows: 5, 4" after merging data ..	36
4.4 Impossible to plot the scatterplot of calibration model	36
5 Flow chart of filtering and calibration procedures	1
6 Reference	1

1 Installation

For ideal displaying, the shiny Graphical User Interface should be run with a display resolution of 1920 x 1024 pixels.

First, the R environment (R: A Language and Environment for Statistical Computing., 2017) has to be installed selecting your correct Operating System at <https://cran.r-project.org/bin/windows/base/>. The R scripts have been tested with R version 3.3.0 and 3.4.0 version 64 bits for windows and Linux.

It is recommended to download and install RStudio at <https://www.rstudio.com/products/rstudio/download/> to ease operations (RStudio: Integrated Development for R. RStudio, 2017).

It is necessary to download the R and Shiny scripts with config files at <ftp://ftp-ccu.jrc.it/pub/gerbomi/AirSenseEUR/Shiny/>. Follow the following steps:

1. Extract the AirSenseEUR archive in a new directory. Make sure that the following scripts are present in the directory: app.R, Functions4ASE.R, 151016 Sensors_ToolBox.R and config files ASEConfigxx.R where xx is the names of AirSenseEUR boxes. Check that the directories Shield_files and xx exist. The Shield_Files subdirectory shall contain at least the following files for electronic configuration of sensors on the AirSenseEUR shield:
 - 170604 ASE_R24 NO2B43F_COA4_OXA431_NOB4 _Training.asc. This file is appropriate for AlphaSense sensors NO2B43F in position 1, CO-A4 in position 2, OX-A431 in position 3 and NO-B4 in position 4 of the sensor shield as during the AirSenseEUR training course in June 2017 (Ispra).
 - 160513 NO2B43F_COMF200_O3M5_NOB4_ Training.asc. This file is appropriate for AlphaSense sensors NO2-B43F in position 1, Membrapor CO/MF-200 in position2, Membrapor O3/M-5 in position 3 and AlphaSense NO-B4 in position 4, as during the training course in May 2016, the config file is "160513 NO2B43F_COMF200_O3M5_NOB4_ Training.asc". Other configuration files with City technology sensors are available on request.
2. Open RStudio, and open the File app.R
3. Run the R/Shiny script by clicking on the "Run App" button, upper right under the main menu (see Figure 1)

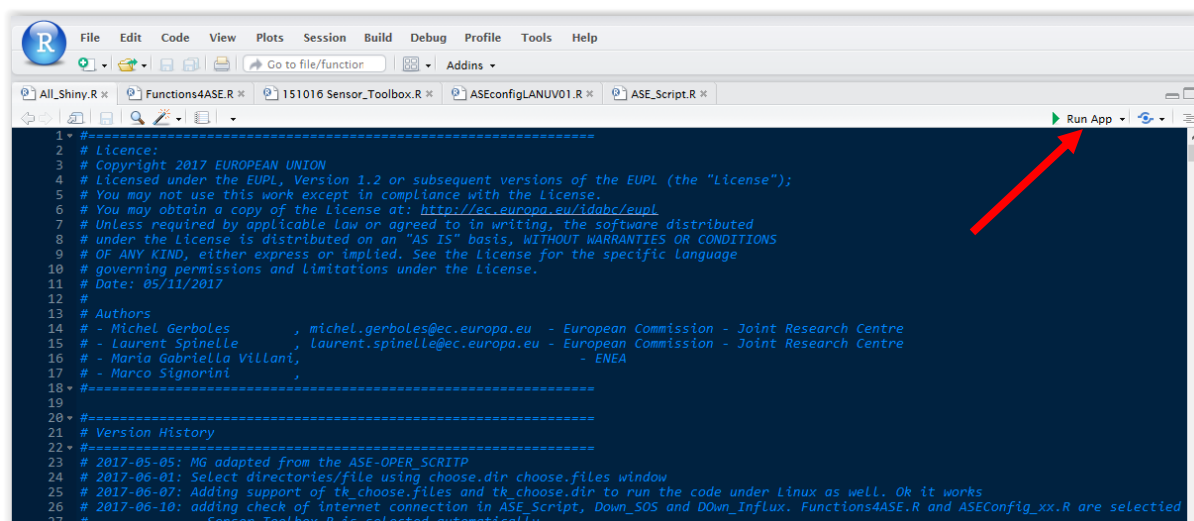


Figure 1: Starting the AirSenseEUR R/Shiny web interface in RStudio

2 Selection of AirSenseEUR box

Next the R/Shiny web interface starts and the window shown in Figure 2 opens in a browser. It is divided into a navigation bar menu with blue background color, a sidebarLayout where entering parameters on the left and a mainPanel showing information and plots on the right.

When opening, the combo box named "List of Configured AirSenseEURs" points to the first config file available (all file names like ASEconfigxx.R e.g. ASEconfigLANUV01.R). The content of the config file is shown on the 4 tabPanels called "Push data", "Filtering" "Calibration" and "SetTime" (see Figure 2). It is possible to click on each panel to read the content of any config file. The information given in the 4 panels are read out of the config file ~/xx/General_data/xx.cfg, ~/xx/General_data/xx_Servers.cfg and ~/xx/General_data/ xx_SETTIME.cfg (where xx is the AirSenseEUR name taken from ASEconfigxx.R, e. g. LANUV_01 in Figure 2)

AirSenseEUR v0.7

SelectASE

GetData

Data Treatment

About

Help

Navbar

List of configured AirSenseEURs

ASEconfigJRC_01.R

Selected AirSenseEUR

ASEconfigJRC_01.R

Select AirSenseEUR

New config file (ASEconfig*, * = SOS id)

ASEconfig

Create new AirSenseEUR

Quit

SideBar Layout

Push data

Filtering

Calibration

SetTime

Filtering Sensors data

name.sensor	CO_3E300	NO_3E100	NO2_3E50	O3_3E1F
hoursWarming	12	7	7	7
temp.thres.min	-20	-20	-20	-20
temp.thres.max	40	40	40	40
rh.thres.min	15	15	15	15
rh.thres.max	100	100	100	100
Sens.Inval.Out	TRUE	TRUE	TRUE	TRUE
Sens.rm.Out	TRUE	TRUE	TRUE	TRUE
Sens.window	19	19	19	19
Sens.threshold	20	20	20	20
Sens.Ymin	25000	NA	NA	NA
Sens.Ymax	32710	45000	45000	65536
Sens.ThresholdMin	0	0	0	0
Sens.iterations	1	1	1	1

Filtering Reference data

remove.neg	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
ref.unitgas	ppm	ppb	ppb	ppb	ppb	ppb
uxi	0	0	0	NA	0	NA
Ref.rm.Out	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
Ref.window	19	19	19	19	19	19
Ref.threshold	20	15	25	25	5	25
Ref.Ymin	0	0	0	0	0	0
Ref.Ymax	30	150	500	3000	200	30
Ref.ThresholdMin	0	0	0	0	0	0
Ref.iterations	1	1	1	1	1	1
gas.reference	CO_ppm	NO	NO2	NOx	O3	SO2
gas.reference2use	Ref.CO_ppm	Ref.NO	Ref.NO2	Ref.NOx	Ref.O3	Ref.SO2

Main TabPanel

Push data
Filtering
Calibration
SetTime

colnames(Servers_file) V1
PROXY FALSE
URL 10.168.209.72
PORT 8012
LOGIN
PASSWORD
Down.Influx FALSE
Host influxdb1.liberaintentio.com
Port 8086
User shinyreader
Pass sqwEgzli
Db jrcispra
Dataset
TZ Europe/Rome
Down.SOS FALSE
AirsensWeb http://sossvr1.liberaintentio.com:8080/52nSOS/api/v1/
AirsensEur.name JRC_01
sens.tzone UTC
Down.Ref FALSE
urlref ftp://cidportal.jrc.ec.europa.eu/jrc-opendata/ABCIS/InorganicGases/Ver2016-01-01/InorganicGases_2016.csv, ftp://cidportal.jrc.ec.europa.eu/jrc-opendata/ABCIS/InorganicGases/Ver2018-01-01/InorganicGases_2018.csv
Reference.name Reference_EMEP_station
coord.ref 45 49' N, 8 38' E
alt.ref 209 m
ref.tzone UTC
asc.File 160514 ASE4_R22 CityTech CO_NO_NO2_O3_JRC_ASE1.asc
UserMins 10
Delay 20

Push data
Filtering
Calibration
SetTime

name.sensor CO_3E300
Cal.func JRC_01_CO_3E300_nA_Linear.Robust_20151223_20151230.rds
Cal.Line Previous calibration
mod.eta.model.type Linear.Robust
Slope 8.11733e-05
Intercept 1.08358
Sens.raw.unit nA
Sens.unit ppb
Neg.mod FALSE
eta.model.type Linear

Push data
Filtering
Calibration
SetTime

name.sensor CO_3E300
Cal.func JRC_01_CO_3E300_nA_Linear.Robust_20151223_20151230.rds
Cal.Line Previous calibration
mod.eta.model.type Linear.Robust
Slope 8.11733e-05
Intercept 1.08358
Sens.raw.unit nA
Sens.unit ppb
Neg.mod FALSE
eta.model.type Linear

Figure 2: AirSensEUR R/Shiny web interface for AirSensEUR

The button “Quit” is used to close the R/Shiny App at any moment provided that no R computation is going on.

During all data transfer and data treatment, R messages are printed on the R console and on the Log menu.

2.1 Create a new AirSenseEUR Box config file

It is only possible to create a new if no AirSenseEUR box has been selected yet. The selection of AirSenseEUR box is described in section 2.2. To create a new set of AirSenseEUR Box config files execute the following steps:

- Select one of the existing config files in the "List of configured AirSenseEURs" combo box,
- Write a new AirSenseEUR config file name in the "New Config file" combo box,
- Click of the button labelled "Create new config file" (see Figure 3, lower left figure).

The following process is carried out:

- A new directory is created (e. g. LANUV_02) with a file structure including the directories Calibration, Drift, Estimated_coef, General_data, Models, Modelled_gas, Outliers, scriptsLog, SensorDataRetrieved_plots, Statistics, Verification_plots.
- The name file in the "New Config file" combo box shall respect the name convention: ASEconfigxx.R, e. g. ASEconfigLANUV_02.R where "LANUV_02" is the AirSenseEUR name used for SOS data push, if available. If the new name is empty the process stops. Blank character and special characters (+, -, *, \$, %, ., " ...) except "_" are stripped out of the new file name. "ASEconfig" and ".R" can be omitted in the "New Config file" combo box.
- A copy of the selected config file in "List of configured AirSenseEURs" is copied and named as in the "New config file" combo box. Existing or empty file name does not allow to run the whole process.
- the config files of the Selected AirSenseEUR that are found in ~/xx/General_data/xx.cfg, ~/xx/General_data/xx_Servers.cfg and ~/xx/General_data/xx_SETTIME.cfg (where xx is the selected AirSenseEUR in the "List of configured AirSenseEURs"), are copied into the directory of the new AirSenseEUR. The file of effects including explanatory variables for all sensors are also copied (e. g. LANUV_01_Effect_Sens1_COA4.cfg). The name of sensors are also the ones of the sensors of the AirSenseEUR taken the "List of configured AirSenseEURs" combo box.
- At the end of the process, the "Select config file" combo box automatically points to the newly created config file and the 4 panels called "Push data", "Filtering" "Calibration" and "SetTime" are updated (see Figure 3, upper figure).
- A list of messages corresponding to each operation is displayed in the R console.

Sensors	Push data	Filtering	SetTime
colnames(cfg_file)	V1		V2
name.gas	CO		NO
Intercept	1.08358		0.84113
Slope	8.11733e-05		1.37200e-04
Sens.unit	ppb		ppb
name.sensor	COA4		NOB4
mod.eta.model.type	Linear.Robust		Linear.Robust
eta.model.type	Linear		Linear
Cal.Line	New calibration with current data		New calibration with current data

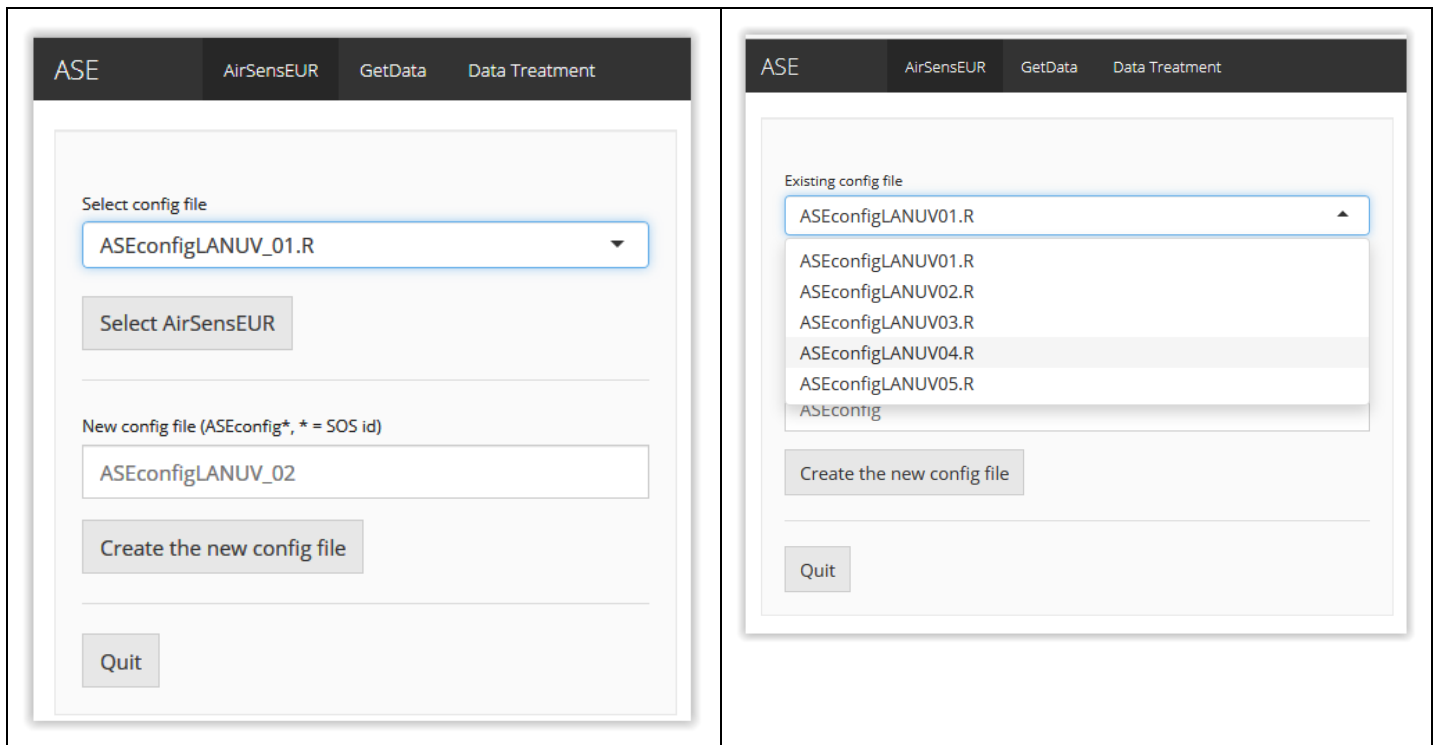


Figure 3: AirSenseEUR R/Shiny web interface for AirSenseEUR, left: selecting an AirSenseEUR config file and right creating a new AirSenseEUR config file

2.2 Select an AirSenseEUR box

It is possible to select another AirSenseEUR config file by clicking on the combo box named "List of configured AirSenseEURs", see Figure 3, lower right figure. The 4 panels describing the AirSenseEUR configuration called "Push data", "Filtering" "Calibration" and "SetTime" are updated accordingly. Click on "Select AirSenseEUR" button, see Figure 4. The following process is run:

- Check that the file system exists or create it under the working directory
- Create a log file of messages in `~/xx/ scriptsLog/console_Date.log`
- Source `xx.R`. The config files (`~/xx/General_data/xx.cfg`, `~/xx/General_data/xx_Servers.cfg` and the effect files for each sensors (e. g. `LANUV_01_Effect_Sens1_COA4.cfg`) are loaded. If the config files do not exist the default value of LANUV_01 are used. The proxy is set if "PROXY" TRUE or reset if false.
- At the end of the process, select the Navbar menu "GetData" at the top of the browser window.

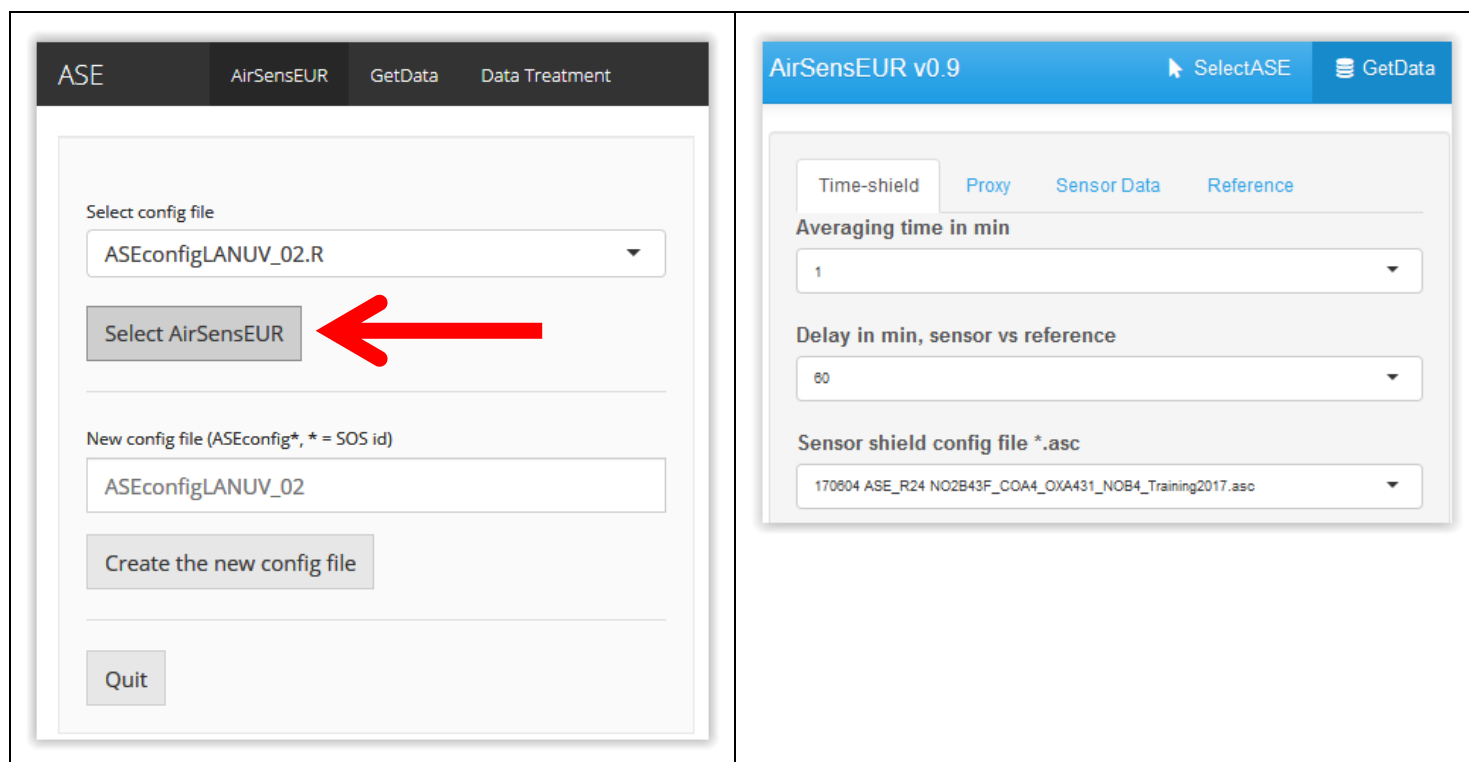


Figure 4: AirSenseEUR R/Shiny web interface for AirSenseEUR, left: selecting an AirSenseEUR unit, right setting the time average, delay between sensor and reference data and firmware of sensor shield.

2.3 Configuration of an AirSenseEUR box data download

Once a config file is selected, see section 2.2, the "GetData" tabPanel opens on the "Proxy" tab. Parameters can be changed on the sideBarLayout while updated parameters are shown on the main TabPanel ("GetData Panel"), see Figure 5. The "GetData" tabPanel allows downloading Influx, SOS and reference data.

2.3.1 Averaging time, delays and sensor config file

"Averaging time in min" (UserMins): with this list box, it is possible to select a time average for all calculations (default 10 minutes) in order to adapt to the periodicity of reference data. The default AirSenseEUR box configuration is set to push all available values. After changing this parameter, it is necessary to run again the Download of sensor and reference data in order to take the new time average into account.

"Delay in minutes" allows to fine tune clock time differences between reference and AirSenseEUR data, see Figure 5. Any change of this parameter trigger a real-time change of time synchronisation.

In the "Sensor shield config file *.asc" combo box, the shield config file found in `~/xx/General_data/xx_Servers.cfg` is selected. The .asc file is used with the AirSenseEURPanel java application to configure the AirSenseEUR shield (REF NEEDED). If other sensors are mounted on the AirSenseEUR shield, another .asc file shall be selected in the "Sensor shield config file *.asc" combo box, see Figure 5.

2.3.2 Proxy server

Click on the "Proxy" tab which allows to take into account a proxy during data transfer. Click on "Enable Proxy" to put into force your Proxy then fill the 4 boxes "URL of your proxy", PORT, LOGIN for the proxy and PASSWORD of the proxy. Unchecking "Enable Proxy" will reset the use of proxy.

2.3.3 Sensor InfluxDB data download

NOTE: In the current situation, it is assumed that only one chemical shield is connected on the channels 0, 1, 2 and 3 of the chemical shield. The name of the sensors (NOB4, COA, O3_M5 ...) that is downloaded from the InfluxDB can change without effect on the data treatment. In fact, each sensor name is associated with a pollutant name (e. g. "carbon_monoxide", "nitrogen_dioxide", "ozone" ...) that is set in the shield config file (.asc). boardTimeStamp is calculated for data of the pollutants*

whose names are included in the shield config file (e. g. "carbon_monoxide", "nitrogen_dioxide", "ozone" ... without considering boardTimeStamp of other shields (e. g. OPCs..). This is to avoid wrong boardTimeStamp calculation considering boardTimeStamp of more than one shield at a time with effect on the warming time of sensors (see 3.5.1). There is an exception when rows do not include valid data for pollutant names of chemical sensor shield. In this case an average of boardTimeStamp of all other shields is used.

Click on the "Influx" tab. It is necessary to check on the "Enable InFluxDB" to be able to list the AirSenseEUR unit available at the Influx server and to download data. As soon as the "Enable InFluxDB" control is checked, the list of available AirSenseEUR influx dataset is updated from the Influx server in the "Select available Datasets" combo box. Any AirSenseEUR can be selected but it shall be in line with the name of the AirSenseEUR config file, e.g AirSenseEUR01 for ASEconfigLANUB_01.R file). The Input Parameters for the Influx download consist of:

- Host URL: mandatory, this is the URL of the Influx server (e. g. 'influxdb1.liberaintentio.com', without "http" and without port number).
- Port: port used for the Influx transfer, the port must be an open in your browser. default value = 8086 alternative 3000 which is the native port for data transfer from the Influx server. The port 3000 may be closed according to security rules on your internet.
- User: your login at the Influx server.
- Pass: your password at the Influx server.
- Name of the SQLite database (Db): name of the database at the Influx server.
- Select available Datasets: name of the table(Dataset) in the database Db that you want to download, e. g. "AirSenseEUR01". It is necessary to check "Enable InFluxDB" to be able to select a dataset and to download.
- Time Zone (TZ): time zone of the influx data, default value NULL. if NULL the function will try to determine the time zone otherwise TZ will be used.
- Click on the "Download Influx data" making sure that "Enable InFluxDB" is checked.
- First all influx data are downloaded and saved in airesenseur.db. During further download, the same data download is not repeated unless the file airesenseur.db in the directory General_data is deleted. Then, data in airesenseur.db are loaded and all data are put into a tabulated dataframe. Finally all data are averaged using the time average set in the "Time" tab. All data are associated to a compound according to the names of sensors. Here below is table which gives details of the association for the LANUV_01 AirSenseEUR (from log file).

Record number	channel	Sensor	Pollutants	Date	Time
1	0	NO2B43F	Nitrogen_dioxide	2017-05-26	09:10:19
2	6	Humid	Relative_humidity	2017-05-26	09:10:19
3	2	O3_M5	Ozone	2017-05-26	09:10:19
4	5	Tempe	Temperature	2017-05-26	09:10:19
5	1	COMF200	Carbon_monoxide	2017-05-26	09:10:19
6	3	NOB4_P1	Nitric_oxide	2017-05-26	09:10:19
7	4	Press	Atmospheric_pressure	2017-05-26	09:10:20
194339	2	O3-A431	Ozone	2017-06-01	08:13:47
194341	1	CO-A4	Carbon_monoxide	2017-06-01	08:13:47
387154	2	OX_A431	Ozone	2017-06-07	11:31:26
387155	3	NOB4	Nitric_oxide	2017-06-07	11:31:26
387157	1	COA4	Carbon_monoxide	2017-06-07	11:31:26

- When the process is finished 3 files are created in ~/xx/General_data/: airesenseur.db (a sqlite data base replicating the database on the AirSenseEUR host), InfluxData.csv and InfluxData.Rdata that contains all the data downloaded from the Influx server in tabulated sheets.
- During data transfer, messages are printed on the R console.
- At the end of the process, the "SOS" tab is opened (see **Error! Reference source not found.**, eft). The whole process can be very long according to the size of data to be downloaded.

- The download from the Influx server can be completed at any moment. The process only adds new data.

The screenshot displays the AirSenseEUR v0.9 web interface. The top navigation bar includes 'ASE', 'AirSenseEUR', 'GetData', and 'Data Treatment'. The main content area is divided into three tabs: 'Time-shield', 'Proxy', and 'Sensor Data'. The 'Time-shield' tab is active, showing a table of sensor data. The 'Proxy' tab shows fields for proxy configuration, including 'Enable PROXY', 'URL of your proxy', 'PORT', 'LOGIN for the proxy', and 'PASSWORD of the proxy'. The 'Sensor Data' tab shows fields for InfluxDB configuration, including 'Enable InFluxDB', 'Host URL', 'Port', 'Login for the Host', 'Password', 'SQLite database', 'Available Datasets', and 'Time Zone'. A 'Download Influx data' button is located at the bottom of the 'Sensor Data' tab.

gas.sensor	name.sensor	TIA	Rload	TIA_Gain	GAIN	REF	Int_Z	Bias_Sign	Bias	Fet_Short	Mode	Ref	RefAD	VREF	board.zero.set	BIAIS
Nitrogen_dioxide	NO2B43F	1E	50.00	350000.00	7001.00	A0	0.50	-1.00	0.00	0	3	1.70	0.50	4.30	2.15	-0.00
Carbon_monoxide	COA4	1E	50.00	350000.00	7001.00	D0	0.67	1.00	0.00	0	3	1.50	0.50	1.64	1.10	0.00
Ozone	OX_A431	1E	50.00	350000.00	7001.00	A0	0.50	-1.00	0.00	0	3	1.70	0.50	4.30	2.15	-0.00
Nitric_oxide	NOB4	1E	50.00	350000.00	7001.00	B7	0.50	1.00	0.12	0	3	1.20	0.50	1.66	0.83	0.20

Figure 5: AirSenseEUR R/Shiny web interface for AirSenseEUR. Up: "GetData" - "Time-shield" tab. Down left: "Proxy" tab. Down Right: "Sensor Data" tab

2.3.4 SOS sensor data download

Click on the "SOS" tab. It is necessary to check on the "Enable SOS" to be able to list the AirSenseEUR unit available at the SOS server and to download data. As soon as the "Enable SOS" control is checked, the list of available AirSenseEUR SOS data set is updated in the "SOS ID of the AirSenseEUR box" combo box. Any AirSenseEUR can be selected but it shall be in line with the name of the AirSenseEUR config file, e.g JRC_C5_05 for ASEconfigJRC_05.R config file). The Input Parameters for the SOS download consist of:

- SOS server URL: mandatory, this is the url of the SOS server (e. g. <http://sossvr1.liberaintentio.com:8080/AirSenSOS/api/v1/>, with <http://>)
- SOS ID of the AirSenseEUR box: name of the Dataset in the SOS server that you want to download, e. g. "LANUV01". It is necessary to check "Enable SOS" to be able to select a dataset and to download and select an AirSenseEUR box as shown in Figure 6.

The screenshot shows the 'AirSensEUR v0.9' application interface. At the top, there are buttons for 'SelectASE' and 'GetData'. Below this, there are four tabs: 'Time-shield', 'Proxy', 'Sensor Data', and 'Reference Data'. The 'Sensor Data' tab is active, and within it, the 'SOS' sub-tab is selected. The 'Enable SOS' checkbox is checked. The 'SOS Rest API URL' field contains 'http://sossvr1.liberaintentio.com:8080/52nSOS/api/v1/'. The 'SOS ID of the AirSensEUR box' dropdown menu is set to 'JRC_C5_05'. A red arrow points to this dropdown with a callout box that says 'Automatic detection of AirSensEUR box'. The 'Time Zone' dropdown is set to 'UTC'. At the bottom, there is a 'Download SOS data' button.

Figure 6: Selection of AirSensEUR box for downloading sensor data under the SOS protocol.

- Time Zone: time zone of the reference data, default is "UTC"
- Click on the "Download SOS data" making sure that "Enable SOS" is checked. **Asking to download data if no SOS data are available at the SOS server may crash the Shiny App. In this case it is necessary to uncheck the "Enable SOS" control box.**
- First all SOS data are downloaded and averaged using the time average set in the "Time-shield" tab. During further download, the same data download is not repeated unless the file SOSData.csv in the General_Data directory is deleted. All data are associated to a compound defined within the SOS server configuration
- When the process is finished 2 files are created in ~/xx/General_data/: SOSData.csv and SOSData.Rdata that contains all the data downloaded from the Influx server in tabulated sheets.
- During data transfer, messages are printed on the R console.
- At the end of the process, the "Reference Data" tab is opened (see Figure 7). right. The whole process can be very long according to the size of data to be downloaded.
- The download from the SOS server can be resumed at any moment even after a crash without the need for repeating already downloaded data. The process only adds new data.

2.3.5 Downloading data from reference instrument

First thing to do is to select the type of data download between SOS, local csv file or csv file on a dtp server (see Figure 7).

The data download is carried out by clicking on the button "Download Reference data" which is only enabled if the "Enable download Reference data" is crosschecked and if all needed parameters are correctly filled in.

NOTE : Two tabPanels: "Influx Sensor Data" and "Reference Data" are added in the mainTab Panel of the NavBar Menu "Get data" to be able to observe downloaded sensor and reference data just after these 2 processes are ended.

2.3.5.1 Using SOS reference data download

The figure displays two side-by-side screenshots of the AirSenseEUR v0.9 web interface, specifically the 'Reference Data' tab. Both screenshots show the same form fields, but with different selections for the download method.

Left Screenshot (SOS download):

- Enable download Reference data:** ☐
- Selected download:** ☒ SOS ☐ csv ☐ ftp
- Reference station SOS Rest API URL:**
- SOS ID of the Reference station:**
- List of pollutants at the Reference station:**
- Range of dates for Downloading SOS data of Reference station:** to
- Identifier of the reference station:**
- Longitude and latitude of the reference station:**
- Altitude of the reference station:**
- Time Zone:**
- Download Reference data:**

Right Screenshot (csv download):

- Enable download Reference data:** ☐
- Selected download:** ☐ SOS ☒ csv ☐ ftp
- reference data can only be in 1 csv file with headers:** date(Y-m-d H:M:S), CO_ppm or CO/co,NO,NO2,O3,NOx,SO2, PM2.5, PM10
- Choose CSV File:**
- Browse:**
- Header:** ☒
- Separator:** ☐ Comma ☐ Semicolon ☐ Tab
- Quote:** ☐ None ☐ Double Quote ☐ Single Quote
- Identifier of the reference station:**
- Longitude and latitude of the reference station:**
- Altitude of the reference station:**
- Time Zone:**
- Download Reference data:**

Figure 7: AirSenseEUR R/Shiny web interface for AirSenseEUR. Left: Download of reference data using the SOS protocol Left: Download of reference data using a local csv file.

The same parameters as for the SOS Influx data download are needed:

Click on the "SOS" tab. It is necessary to check on the "Enable download Reference data" to be able to list the list of available Reference stations at the SOS Rest API and to download data. As soon as the "Enable SOS" control is checked, the list of available station is updated in the "SOS ID of the Reference station" combo box. Any station can be selected but it shall be in line with the position of the AirSenseEUR box between the interval dates selected in "Range of dates for Downloading SOS data of Reference station:" date pickers. The Input Parameters for the SOS download consist of:

- Reference station SOS Rest API URL: mandatory, this is the url of the SOS server (e. g. <http://sossrv1.liberaintentio.com:8080/AirSenSOS/api/v1/>, with <http://>)
- SOS ID of the Reference station: select the name of the station in the SOS server that you want to download.

- The list of available pollutants at the station is automatically updated in "List of pollutants at the Reference station".
- The SOS coordinates is updated in "Longitude and latitude of the reference station".
- Enter the Time Zone: time zone of the SOS reference data, default is "UTC"
- Enter the "Identifier of the reference station" as a static string to indicate the station used
- Click on the "Download Reference data" making sure that "Enable SOS" is checked.
- First all SOS data are downloaded and averaged using the time average set in the "Time-shield" tab. During further download, the same data download is not repeated unless the file RefData.csv in the General_Data directory is deleted. All data are associated to a compound defined by:

```
Ref.NO2    = c("NO2" , "Nitrogen dioxide (air)", "Ref.NO2"),
Ref.SO2    = c("NO2" , "Sulfur dioxide (air)", "Ref.SO2"),
Ref.O3     = c("O3" , "Ozone (air)", "Ref.O3"),
Ref.NO     = c("NO" , "Nitrogen monoxide (air)", "Ref.NO") ,
Ref.PM10   = c("PM10" , "Particulate matter < 10 µm (aerosol)", "Ref.PM10"),
Ref.PM2.5  = c("PM2.5" , "Particulate matter < 2.5 µm (aerosol)", "Ref.PM2.5"),
Ref.CO_ppm = c("CO" , "Carbon monoxide (air)", "co", "Ref.CO_ppm")
```

- When the process is finished 2 files are created in ~/xx/General_data/RefData.csv and RefData.Rdata that contains all the data downloaded from the Influx server in tabulated sheets.
- During data transfer, messages are printed on the R console.
- The download from the SOS server can be resumed at any moment even after a crash without the need for repeating already downloaded data. The process only adds new data.

2.3.5.2 Using local csv file

Click on the "Reference Data" tab and select "csv" on the "Selected download" radio buttons. It is necessary to check on the "Enable download Reference data" control to be able to download data.

- Click on button "Browser" and select your local csv files (.dat or .txt accepted) with the reference data. First row of the file shall contain headers with variable names: date, CO_ppm, NO, NO2, O3, NOx, SO2, PM2.5 PM10. It is not mandatory that all parameters are included in the file. Format date: 2017-05-26 09:00:00, CO in ppm other variables in ppb. Missing data or errors shall be -999.99 value. Only one column for date named with one of the string c("date", "time", "Date", "Time", "DATE", "TIME", "dateTime").
- It is mandatory to select the correct column separator and string delimiter otherwise the App may crash
- Reference.name : Name of for Reference station to be plotted
- Latitude and longitude of the reference station: spherical coordinates of the reference station separated by comma.
- Altitude of the reference station: altitude of the reference station in m
- Time Zone: time zone of the reference data, default is "UTC"
- Click on the "Download Reference data" making sure that "Enable download Reference data" is checked.
- First all reference data are downloaded and averaged using the time average set in the "Time-shield" tab.
- When the process is finished 2 files are created in ~/xx/General_data/RefData.csv and RefData.Rdata that contains all the downloaded data. Plot are added in the same directory showing the reference values downloaded. The file name has a format RefData_YYYYMMDD_YYYYMMDD.png with starting and ending date.
- During data transfer, messages are printed on the R console see the Log menu.

2.3.5.3 Using csv file on a ftp server

Click on the "Reference Data" tab and select "ftp" on the "Selected download" radio buttons. It is necessary to check on the "Enable download Reference data" control to be able to download data. The Input Parameters for the download of Reference data consist of:

- URL of the server with full name: mandatory, vector of URLs linking to csv files with the reference data. In case of a list of ftp files, each url without quote shall be separated with comma with or without blank space. Each url shall start with ftp://. Data structure of the csv data files: first row: header with variable names: date, CO_ppm, NO, NO2, O3, NOx, SO2. Format date: 2017-05-26 09:00:00, CO in ppm other variables in ppb. Missing data or errors and shall be -999.99 value. Only one column for date named with one of the string c("date","time","Date", "Time", "DATE", "TIME"). Example with 3 ftp files:

```
http://cidportal.jrc.ec.europa.eu/jrc-opendata/ABCIS/InorganicGases/Ver2015-01-01/InorganicGases_2015.csv, http://cidportal.jrc.ec.europa.eu/jrc-opendata/ABCIS/InorganicGases/Ver2016-01-01/InorganicGases_2016.csv,
http://cidportal.jrc.ec.europa.eu/jrc-opendata/ABCIS/InorganicGases/Ver2017-01-01/InorganicGases_2017.csv, http://cidportal.jrc.ec.europa.eu/jrc-opendata/ABCIS/InorganicGases/Ver2018-01-01/InorganicGases_2018.csv
```

- Reference.name : Name of for Reference station to be plotted
- Latitude and longitude of the reference station: spherical coordinates of the reference station separated by comma.
- Altitude of the reference station: altitude of the reference station in m
- Time Zone: time zone of the reference data, default is "UTC"
- Click on the "Download Reference data" making sure that "Enable download Reference data" is checked.
- First all reference data are downloaded and averaged using the time average set in the "Time-shield" tab. During further download, the downloading and averaging is repeated. All data are associated to a compound defined in the header of the ftp site. If several files are entered in the
- When the process is finished 2 files are created in ~/xx/General_data/: RefData.csv and RefData.Rdata that contains all the data downloaded from the ftp server. Plot are added in the same directory showing the reference values downloaded. The file name has a format RefData_yyyymmdd_yyyymmdd.png with starting and ending date.
- During data transfer, messages are printed on the R console see the Log menu.

3 Data treatment

At the end of the downloading of sensor and reference analysers data, click on the NavBar menu "Data Treatment" on top of the browser window. A new window will open in the browser. as shows Figure 8 and). The three tabs "Filtering", "Calib" and SetTime are opened once and all controls are updated. This may take a bit of time. It is suggested to click at least once on all sub menu.

3.1 Preparing data for treatment

- Check that all control boxes of the Tab "SetTime" of the SideBar Layout is filled with dates, otherwise manually select dates using the date Pickers for all sensors. Missing dates in the "SetTime" Tab may crash the Shiny App.
- Click on the "Merge Influx, SOS – Ref" button", see Figure 8.
- Wait for all processes to stop, checking the message boxes at the right lower corner of the browser window.
- Check gain that all date Pickers at filled with correct date. Update if needed. It is suggested to save data and configuration file using the "Save" button on the top SideBar Layout. You can use the main TabPanel sub menu "SteTimeMain" to see all parameters at one glance, see Figure 9. See also Troubleshooting, section 4.3 for a typical error after merging data: *"arguments imply differing number of rows"*.

This create or update a "General" dataFrame with all downloaded and averaged Influx, SOS and Reference data with files airsenseur.db, General.*, InfluxData.*, RefData.* and SOSData.* where .* stands for .csv or .Rdata files in the ~\xx\General_data directory. In the same directory, it also updates the AirSenseEUR config files xx.cfg , xx_Servers.cfg, xx_SETTIME.cfg xx_Covariates_SensorName.cfg, xx_Effect_Sens__SensorName.cfg, xx_Valid__SensorName.cfg and xx_CovMod_SensorName.cfg.

When the downloading processes work correctly, it is not necessary to perform the Influx, SOS, Ref. downloads separately anymore in the "GetData" NavBar menu, tab "Influx", "SOS" and "Reference Data". It is possible to use the "Merge Influx, SOS – Ref" button and performs all necessary download actions. However, all the "Enable ..." control boxes shall be checked in the tabs "Influx", "SOS" and "Reference Data" to be able to download. If all data are already downloaded and only data treatment should be carried out, it is advised to uncheck the "Enable ..." control boxes in the tabs "Influx", "SOS" and "Reference Data" in order to speed up the opening of tabs. By clicking again on the "Merge Influx, SOS – Ref" button at any time, newly downloaded dated are appended to any existing data.

If the download of data should be repeated from scratch, it is sufficient to delete the following files: airsenseur.db, General.*, InfluxData.*, RefData.* and SOSData.* files in the ~\xx\General_data directory.

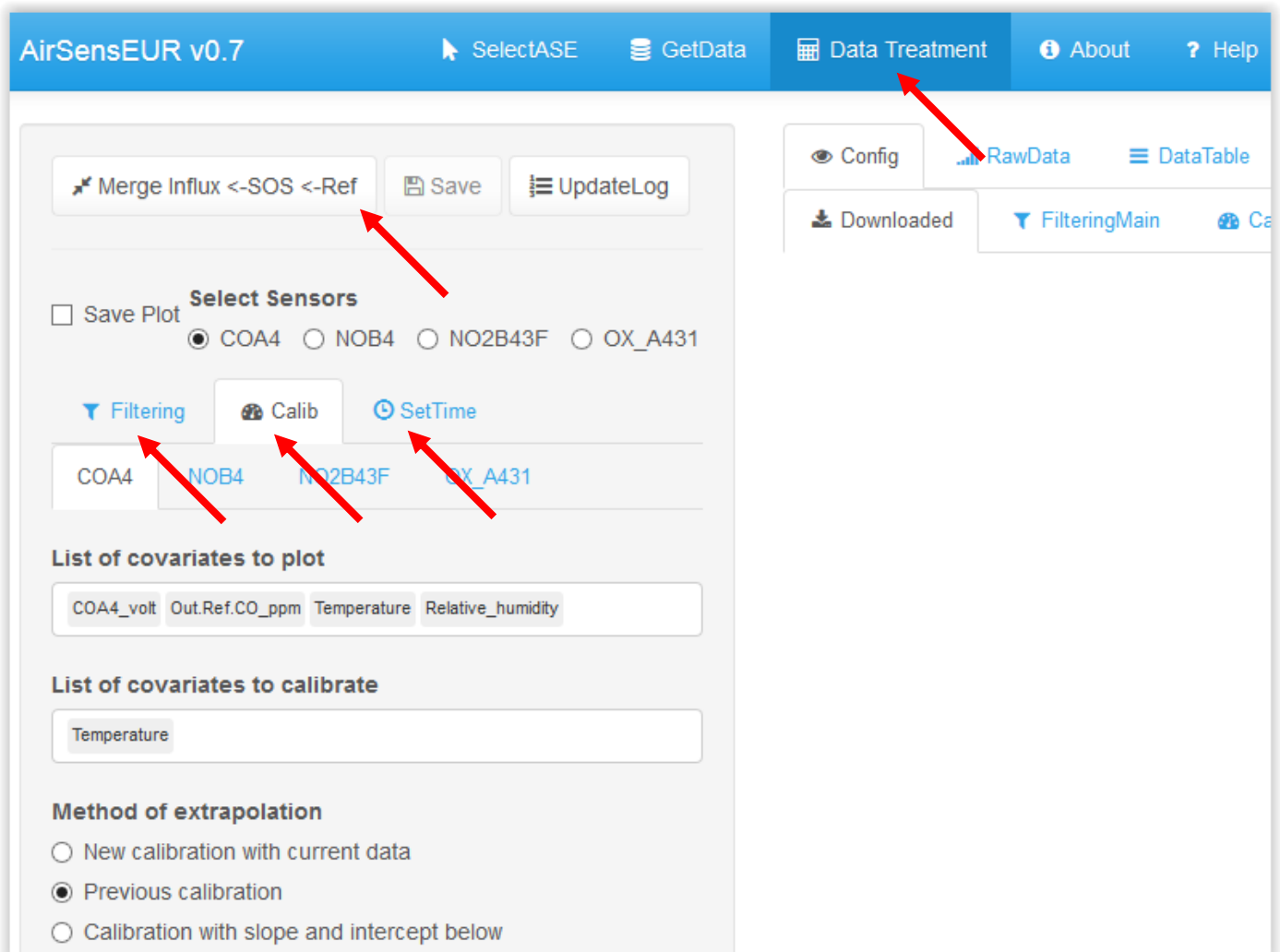


Figure 8: AirSensEUR R/Shiny web interface for AirSensEUR. Menu "Data Treatment"

AirSensEUR v0.7

SelectASE

GetData

Data Treatment

About

Help

Merge Influx <-SOS <-Ref

Save

UpdateLog

Save Plot

Select Sensors

☒ CO_3E300
☐ NO_3E100
☐ NO2_3E50
☐ O3_3E1F

Filtering

Calib

SetTime

CO_3E300

NO_3E100

NO2_3E50

O3_3E1F

<<

Range of valid dates (invalid are hidden):

>>

2016-10-23

to

2017-11-13

<<

Range of dates for plotting RawData, DataTable, Retrieved, Warming, Temp&Humid, Invalids and outliers:

>>

2017-02-22

to

2017-11-13

<<

Range of dates for plotting covariates:

>>

2017-02-22

to

2017-11-13

<<

Range of dates for calibration:

>>

2017-02-24

to

2017-02-28

Cal

Cov

Ext

<<

Range of dates for plotting calibration:

>>

2017-02-22

to

2017-11-13

<<

Range of dates for extrapolation:

>>

2017-02-22

to

2017-11-07

<<

Range of dates for plotting extrapolated data:

>>

2017-02-22

to

2017-11-13

Config

RawData

DataTable

Retrieved

PlotFiltering

Covariates

Calibration

Extra

Downloaded

FilteringMain

CalibMain

SetTimeMain

name.gas	CO	NO	NO2	NOx	O3	SO2
name.sensor	CO_3E300	NO_3E100	NO2_3E50	NA	O3_3E1F	NA
Out.Ref.IN	16-05-12 14:30	16-05-12 14:30	16-05-12 14:30	16-05-12 14:30	16-05-12 14:30	18-07-22 20:40
Out.Ref.END	18-07-22 20:40	18-07-22 20:40	18-07-22 20:40	18-07-22 20:40	18-07-22 20:40	18-07-22 20:40
Out.Sens.IN	17-02-22 00:00	17-02-22 00:00	17-02-22 00:00	NA	17-02-22 00:00	NA
Out.Sens.END	17-11-13 00:00	17-11-13 00:00	17-11-13 00:00	NA	17-11-13 00:00	NA
Sens.Inval.Out	TRUE	TRUE	TRUE	NA	TRUE	NA
Apply.Invalid	FALSE	FALSE	FALSE	NA	FALSE	NA
Valid.IN	16-10-23 00:00	16-10-23 00:00	17-02-22 00:00	NA	17-02-22 00:00	NA
Valid.END	17-11-13 00:00	17-11-13 00:00	17-11-13 00:00	NA	17-11-13 00:00	NA
Cov.Date.IN	17-02-22 00:00	17-02-22 00:00	17-02-22 00:00	NA	17-02-22 00:00	NA
Cov.Date.END	17-11-13 00:00	17-11-13 00:00	17-11-13 00:00	NA	17-11-13 00:00	NA
DateCal.IN	17-02-24 00:00	17-02-22 00:00	17-02-22 00:00	NA	17-02-28 00:00	NA
DateCal.END	17-02-28 00:00	17-11-13 00:00	17-11-13 00:00	NA	17-11-13 00:00	NA
DatePlotCal.IN	17-02-22 00:00	17-02-22 00:00	17-02-22 00:00	NA	17-02-22 00:00	NA
DatePlotCal.END	17-11-13 00:00	17-11-13 00:00	17-11-13 00:00	NA	17-11-13 00:00	NA
Datemeas.IN	17-02-22 00:00	17-02-22 00:00	17-02-22 00:00	NA	17-02-22 00:00	NA
Datemeas.END	17-11-07 00:00	17-11-07 00:00	17-11-07 00:00	NA	17-11-13 00:00	NA
DatePlotmeas.IN	17-02-22 00:00	17-02-22 00:00	17-02-22 00:00	NA	17-02-22 00:00	NA
DatePlotmeas.END	17-11-13 00:00	17-11-13 00:00	17-11-13 00:00	NA	17-11-13 00:00	NA

Figure 9: AirSensEUR R/Shiny web interface for AirSensEUR. Main TabPanel "Config", sub menu SetTimeMain"

The figure displays two side-by-side screenshots of the AirSensEUR v0.7 web interface, specifically the 'Data Treatment' menu. Both screenshots show a top navigation bar with 'AirSensEUR v0.7', 'SelectASE', and 'GetData' buttons. The main interface is divided into several sections:

- Buttons:** 'Merge Influx <-SOS <-Ref', 'Save', and 'UpdateLog' are present in both screenshots.
- Select Sensors:**
 - Left screenshot: COA4 (selected), NOB4, NO2B43F, OX_A431.
 - Right screenshot: CO_3E300, NO_3E100 (selected), NO2_3E50, O3_3E1F.
- Filtering, Calib, SetTime:** These tabs are visible in both screenshots.
- List of covariates to plot:**
 - Left screenshot: COA4_volt, Out.Ref.CO_ppm, Temperature, Relative_humidity.
 - Right screenshot: CO_3E300, NO_3E100, NO2_3E50, O3_3E1F.
- Method of extrapolation:**
 - Left screenshot: New calibration with current data, Previous calibration (selected), Calibration with slope and intercept below.
 - Right screenshot: Same options, but 'Previous calibration' is selected.
- Raw unit of sensor data:** nA (selected in both).
- Model for calibration:** Linear.Robust (selected in both).
- Force Conversion to V/nA:** Unchecked in both.
- Apply Calibration:** Unchecked in both.
- Select a previous calibration:** JRC_05_COA4_nA_Linear.Robust_20170105_20170112.rds (selected in both).
- Discard negative extrapolated data?:** Checked in both.
- Slope for linear calibration:** 0.0000811733 (selected in both).
- Intercept for calibration:** 1.08358 (selected in both).
- Unit for calibrated sensor:** ppm (selected in both).
- u(xi), random uncertainty of the reference data:** 0.05 (selected in both).
- Model chosen for comparison with ref. data:** Linear (selected in both).
- Date Ranges:**
 - Range of valid dates (invalid are hidden): 2016-10-07 to 2018-07-22.
 - Range of dates for plotting RawData, DataTable, Retrieved, Warming, Temp&Humid, Invalids and outliers: 2016-10-07 to 2018-07-22.
 - Range of dates for plotting covariates: 2017-02-22 to 2017-11-13.
 - Range of dates for calibration: 2017-02-24 to 2017-02-28.
 - Range of dates for plotting calibration: 2017-02-22 to 2017-11-13.
 - Range of dates for extrapolation: 2017-02-22 to 2017-11-07.
 - Range of dates for plotting extrapolated data: 2017-02-22 to 2017-11-13.

Figure 10: AirSensEUR R/Shiny web interface for AirSensEUR. Menu "Data Treatment"

A "General" dataframe is created and saved in ~/xx/General_data/ as General.csv and General.Rdata. It includes Reference data tabulated with Influx or SOS data. Influx data having more info (geographical coordinates, up time) are preferred over SOS data if available.

Data with NA and NaN only are discarded in (# discarding rows with NA and NaN for all variables).

Once the merging is ended, the TabPanel "Downloaded" will be filled with parameters values as shown in Figure 11 showing available data under the main TabPanel "Config", subtab "Downloaded".

At this point it is possible to use the button "Save" in the SideBar Layout to save data and configuration files at any moment, in particular after any change in configuration

Data Treatment				
About Help				
Config	RawData	DataTable	Retrieved	PlotFiltering
Downloaded	FilteringMain	CalibMain	SetTimeMain	
DataSets	Exists	NeedRetrieve	INdate	ENDdate
airsenseur.db	TRUE	TRUE	2016-08-11 14:40	2018-02-02 14:40
InfluxData	TRUE	TRUE	2016-08-11 14:40	2018-02-01 23:50
SOSData	FALSE	TRUE	NULL	NULL
ReferenceData	TRUE	TRUE	2016-08-11 14:40	2018-02-11 23:50
General	TRUE	TRUE	2016-08-11 15:00	2018-01-06 19:20

Figure 11: AirSenseEUR R/Shiny web interface for AirSenseEUR. Example of data available for an AirSenseEUR box.

3.2 Procedure for data treatment

The data treatment includes the following steps:

- Set the number of hours to discard sensor data after each switch on corresponding to the warming period
- Set interval of valid temperature and humidity during sampling in ambient air
- Decide whether to discard or not negative values from reference data,
- Discard outliers for sensor and reference data
- Select covariates for plotting with each sensor
- Method of calibration: New calibration with current data, Previous calibration and Calibration with slope and intercept below. For now only the "Previous Calibration" and "New calibration with current data" method is implemented
- Choose a model for calibration
- Decide whether or not to discard negative sensor data after calibration
- Set units for calibration of the sensors (V or nA) and of the reference values (ppb or ppm)
- Select range of dates for plotting, valid periods, calibration and extrapolation periods.

3.3 Observing Configuration

All calibration parameters can be observed in the main TabPanel under tab "Config", sub Tab "FilteringMain", "Calibmain" and "SetTimeMain" as shows Figure 12.

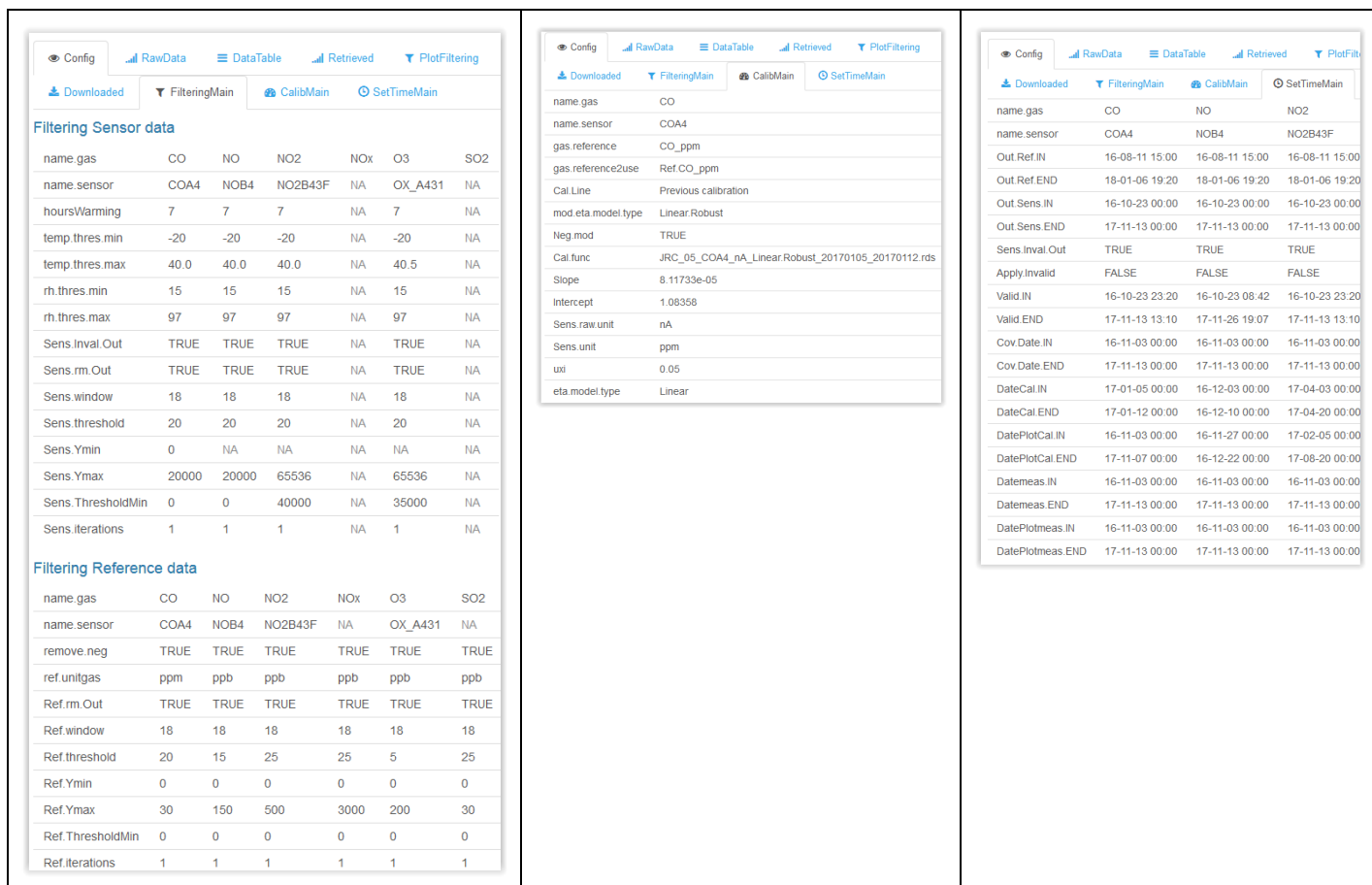


Figure 12: AirSensEUR R/Shiny web interface for AirSensEUR. Example of data available for an AirSensEUR box.

3.4 Observing downloaded data

- Click on the mainPanel, TabPanel "Rawdata" to plot the whole "General" data frame, see Figure 13.
- It is possible to modify the date range being plotted to update the plot, using the "Range of dates for plotting RawData, DataTable, Retrieved, Warming, Temp&Humid, Invalids and outliers:" in the "SetTime" TabPanel of the SideBar Layout of the 1st sensor.

Please note that the Date Picker "Range of valid data (Invalid are hidden):" in the "SetTime" Tabpanel of the SideBar Layout gives the minimum and maximum dates that can be set in the "SetTime" TabPanel with all DatePickers. When changing the Date Picker "Range of valid data un UTC (Invalid are hidden):", the range of dates of the following datePickers are updated when they stand outside of the range of valid date:

- "Range of dates for plotting RawData, DataTable, Retrieved, Warming, Temp&Humid, Invalids and outliers"
- "Range of dates for plotting covariates"
- "Range of dates for calibration".
- "Range of dates for plotting calibration"
- "Range of dates for extrapolation"
- "Range of dates for plotting extrapolated data"

If the Control box labelled "Save Plot" is checked in the SideBar layout,, the "Rawdata" plot is saved in ~/xx/General_data/ with name xx_Full_time_series _yyyymmdd_yyyyymmdd.png where yyyymmdd is the starting and ending dates for plotting set in the "Range of dates for plotting RawData, DataTable, Retrieved, Warming, Temp&Humid, Invalids and outliers:" under the TabPanel "SetTime" of the 1st sensor.

- Click on the mainPanel, TabPanel "Retrieved" to plot the whole "General" data frame, see Figure 13.

- It is possible to modify the date range being plotted to update the plot, using the "Range of dates for plotting RawData, DataTable, Retrieved, Warming, Temp&Humid, Invalids and outliers:" in the "SetTime" TabPanel of the SideBar Layout of the 1st sensor.

The last downloaded data are plotted under the main TabPanel "Retrieved" and saved in ~/xx/Retried_Plots/ with name xx _Retrieved_yyyymmdd_yyyymmdd.png with starting and ending dates. When no data are downloaded a blank screen will be shown .

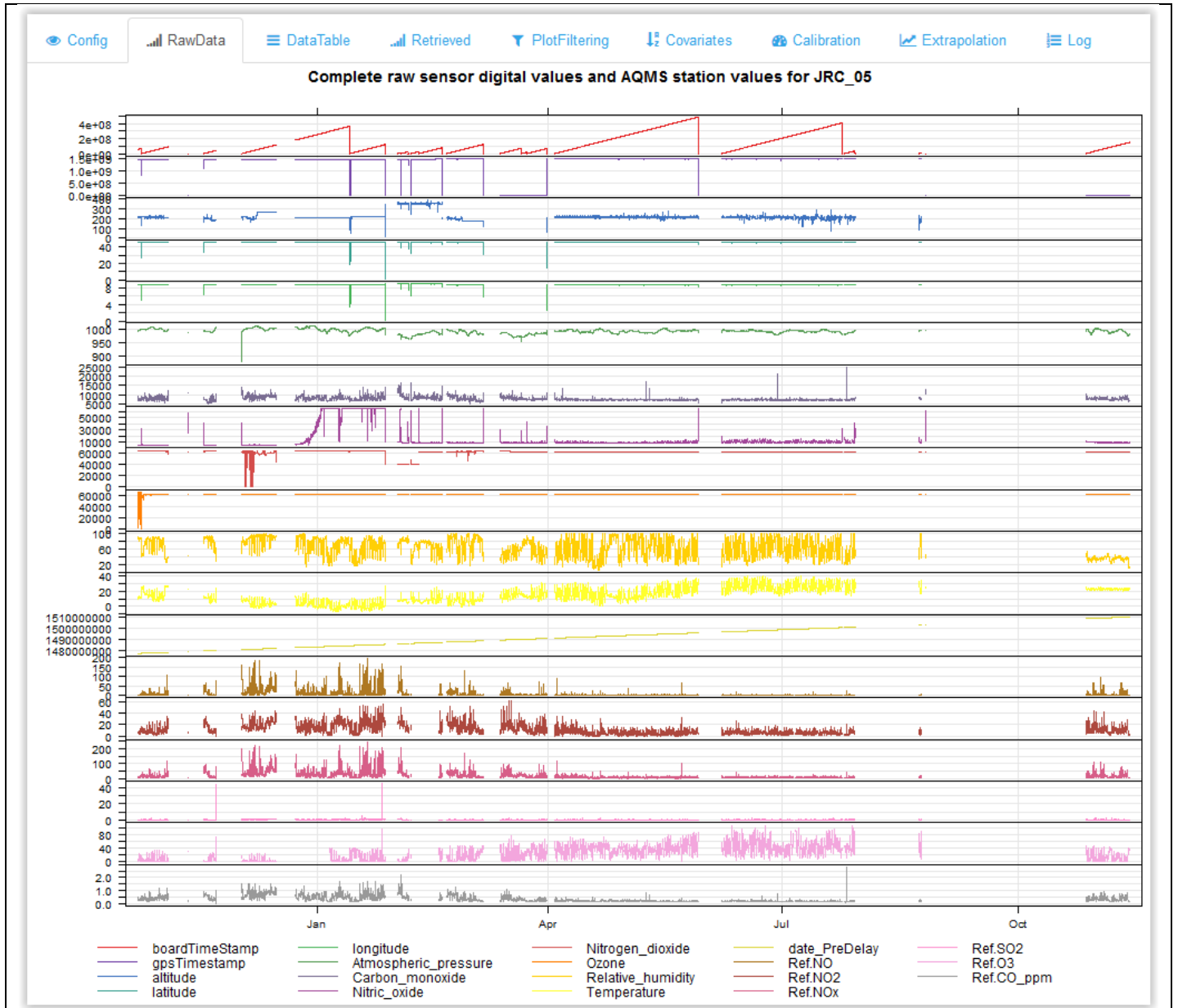


Figure 13: AirSensEUR R/Shiny web interface for AirSensEUR. Menu "Data Treatment". Plotting raw General data series

- Click on the mainPanel, TabPanel "DataTable", all data are shown in tabulated form as shows Figure 14.
- It is possible to modify the date range being plotted to update the plot, using the "Range of dates for plotting RawData, DataTable, Retrieved, Warming, Temp&Humid, Invalids and outliers:" in the "SetTime" TabPanel of the SideBar Layout of the 1st sensor.

Config	RawData	DataTable	Retrieved	PlotFiltering	Covariates	Calibration	Extrapolation	Log
Show	24	entries						
date	boardTimeStamp	gpsTimestamp	altitude	latitude	longitude	Atmospheric_P		
2366	2016-10-23T00:00:00Z	53959377.5	1477179904.20357	220.308839285714	45.8073862440571	8.62637659095803	992.3815	
2367	2016-10-23T00:10:00Z	54018975	1477180500.28304	220.288035714286	45.8073826353625	8.62637651935	992.3815	
2368	2016-10-23T00:20:00Z	54078572.5	1477181096.21696	220.183482142857	45.80738293435	8.62637754016249	992.3815	
2369	2016-10-23T00:30:00Z	54138410.8333333	1477181694.67341	219.728273809524	45.8073828658148	8.62637732877222	992.2994	
2370	2016-10-23T00:40:00Z	54198602.5	1477182296.45159	219.446693121693	45.8073826052268	8.62637742932711	992.2722	
2371	2016-10-23T00:50:00Z	54258217.5	1477182892.77768	219.297142857143	45.8073835800732	8.62637226932054	992.2643	
2372	2016-10-23T01:00:00Z	54318745.0294117	1477183498.30252	218.981176470588	45.8073823922	8.62636850250168	992.3163	
2373	2016-10-23T01:10:00Z	54379272.5	1477184103.84196	218.635625	45.8073837557036	8.62636967701875	992.3163	
2374	2016-10-23T01:20:00Z	54438870	1477184699.91786	218.565803571428	45.8073857977786	8.62637	992.3163	
2375	2016-10-23T01:30:00Z	54498893.7638889	1477185300.23264	218.847222222222	45.8073858566528	8.62637015049306	992.2163	
2376	2016-10-23T01:40:00Z	54558917.5	1477185900.40268	219.125357142857	45.8073891503527	8.626372735025	992.0843	
2377	2016-10-23T01:50:00Z	54618515	1477186496.20536	219.595446428572	45.807393333	8.6263703750009	991.9903	
2378	2016-10-23T02:00:00Z	54678112.5	1477187092.31071	219.880625	45.8073932854312	8.62636229324017	991.9753	
2379	2016-10-23T02:10:00Z	54737710	1477187688.34643	219.658392857143	45.8073885566919	8.62635955348215	991.9753	
2380	2016-10-23T02:20:00Z	54798663.75	1477188298.04248	219.144199346405	45.8073840235547	8.62636140414788	991.9463	
2381	2016-10-23T02:30:00Z	54859436.2857143	1477188905.67411	218.851071428572	45.8073834304897	8.62636108206161	991.9463	

Figure 14: AirSensEUR R/Shiny web interface for AirSensEUR. Menu "Data Treatment". Raw General data series in tabulated form

3.5 Filtering invalid data

The filtering of invalid data is set under TabPanel "Filtering" of the SideBar Layout in the "data Treatment" NavBar menu. All parameters of the sideBarLayout can be modified with direct effect on the main TabPanel output. Any change of configuration parameters can be saved by clicking the "Save Config" button (see Figure 8) in order to save all config files: *.cfg, xx_Servers.cfg, xx_SETTIME.cfg, xx_Covariates_SensorName.cfg, xx_CovMod_SensorName.cfg, xx_Effect_Sens_SensorName.cfg and xx_Valid_SensorName.cfg. It is suggested to save the config files again every time a main change to the configuration parameters is applied.

- Click on the mainPanel, TabPanel "PlotFiltering".

Some treatments takes time to be processed, please avoid clicking on other menu while the resulting plots are not displayed.

IMPORTANT NOTE: All models for any sensors store the sensor and reference data. This mean that any time the data filtering is changed all models fitted with data before applying a filtering change should be deleted (see 3.7.1) and made new.

3.5.1 Warming time

Sensor data shall be discarded during the warming time of the sensor following a cold or warm start of the sensor. Execute the following steps to discard data:

- Select the sub tabPanel "Warming" in The main TabPanel "PlotFiltering"
- In the SideBar layout, select the "Filtering" tab and desired sensor
- In each sensor tab, change the number of hours of warming using the control box labelled "Number of hours of warming" combo box,
- When finished ckeck the control box "Apply filter for warming of sensors" to apply changes.

The warming time of the sensor is plotted in the main Tabpanel. Discarded data are plotted with red dots, see Figure 15.

It is possible to modify the date range being plotted for all sensors, using the “Range of dates for plotting RawData, DataTable, Retrieved, Warming, Temp&Humid, Invalids and outliers:” datePicker of the sideBarLayout under the TabPanel “SetTime”, sub menu “COA4” (1st sensor). If the “Save Plot” control box is checked, a png file showing the discarded data is saved in ~/xx/Outliers/ as xx_Warming.png.



Figure 15: AirSenseEUR R/Shiny web interface for AirSenseEUR. Menu "Data Treatment", filtering general data series: warming time and temperature and humidity.

3.5.2 Data outside interval of tolerance for temperature and humidity

Sensor data can be discarded when atmospheric temperature and relative humidity are outside defined interval of tolerance. Execute the following steps to discard data:

- Select the sub tabPanel "Temp.&Humid." in The main TabPanel "PlotFiltering"
- In the SideBar layout, select the "Filtering" tab and desired sensor
- In each sensor tab, using "Range of accepted temperature (°C):" and "Range of accepted relative humidity (%):" slides it is possible to change the intervals of tolerance for temperature and humidity.
- When finished check the control box "Apply filter for warming of sensors" to apply changes.

The discarded sensor are plotted in the main Tabpanel. Discarded data are plotted with red dots, see Figure 15. In this plot, the data discarded for the warming time, see section 3.5.1, are plotted with green dots.

It is possible to modify the date range being plotted for all sensors, using the "Range of dates for plotting RawData, DataTable, Retrieved, Warming, Temp&Humid, Invalids and outliers:" datePicker of the sideBarLayout under the TabPanel "SetTime", sub menu "COA4" (1st sensor). If the "Save Plot" control box is checked, a png file showing the discarded data is saved in ~/xx/Outliers/ as xx_TRh.png.

3.5.3 Discarding negative reference data

Measurement from reference analysers should not include any negative values. However, sometimes negative values can be found into reference data series by mistake. It is possible to discard these negative values if desired. Execute the following steps to discard data:

- Select the sub tabPanel "Neg.values" in The main TabPanel "PlotFiltering"
- In the SideBar layout, select the "Filtering" tab, "Reference" subTab and desired pollutant
- In each pollutant tab, check control box "Remove negative reference values" to discard negative reference data.

The discarded sensor are plotted in the main Tabpanel. Discarded data are plotted with red dots, see Figure 16.

It is possible to modify the date range being plotted for all reference pollutant, using the "Range of dates for plotting outliers and negative values for this pollutant:" date Slider above the control box "Remove negative reference values" in the SideBar layout, Tab "Filtering" sub Tab "Reference" for each pollutant. If the "Save Plot" control box is checked, a png file showing the discarded data is saved in ~/xx/Outliers/ as xx_RefNeg.png.

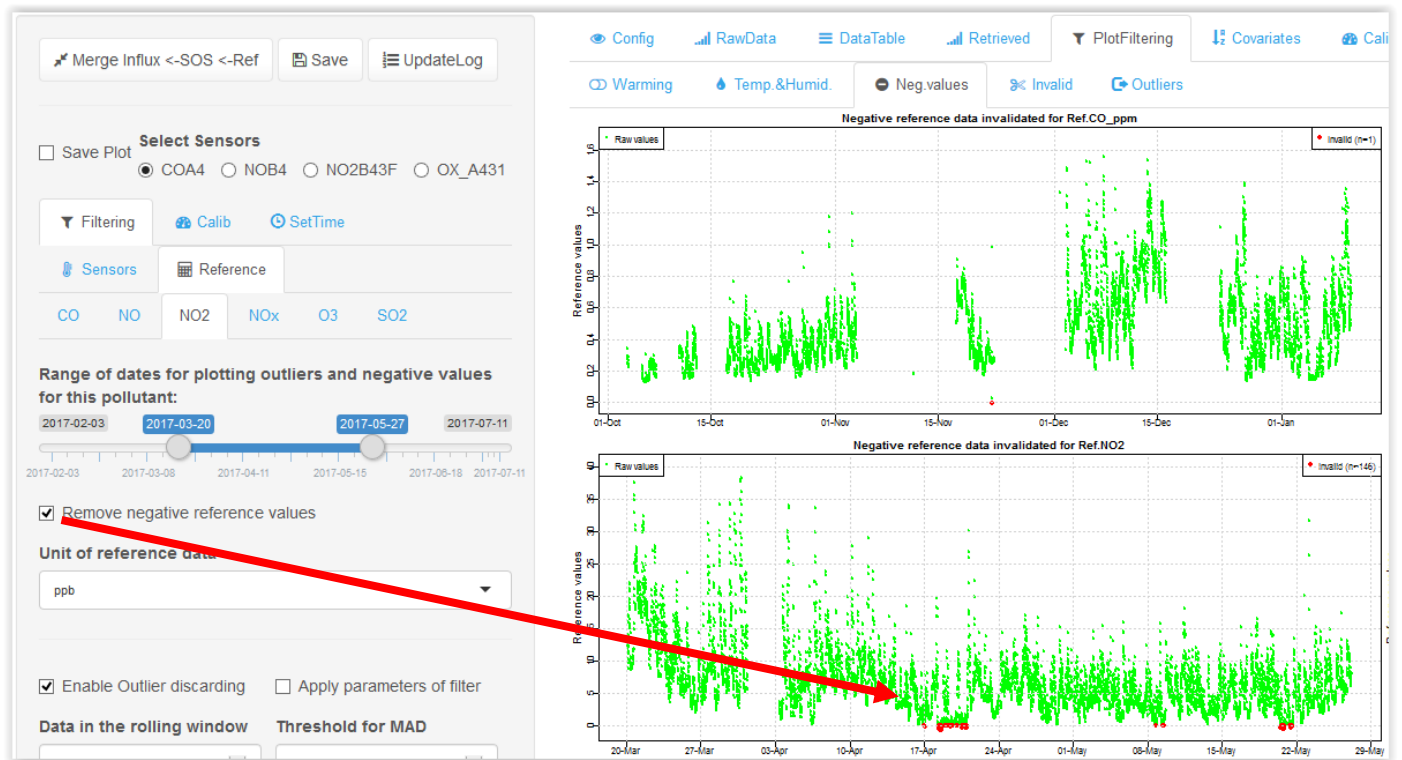


Figure 16: AirSenseEUR R/Shiny web interface for AirSenseEUR. Menu "Data Treatment", filtering general data series: negative values

3.5.4 Discarding invalid sensor data

It may happen that an AirSenseEUR box does not work for a long period or that it is operated at a place different than the one of the reference monitoring site for long periods of time. In this case, it is necessary to discard all data collected during invalid periods. A tools is provided to filter data during long time period. Execute the following steps to discard outliers:

- Select the sub tabPanel "Invalid" in The main TabPanel "PlotFiltering"
- Select "Sub Tab "Table" in the main TabPanel
- In the SideBar layout, under "Select Sensors" select the desired sensor
- A worksheet will appear as in Figure 17 which shows time periods of Invalid data for the selected sensor
- To update the worksheet:
- Right-click on the table to delete/insert rows. Do not delete or add columns.
- Double-click on a cell to edit. Be sure to ensure consistency of the time period, respect the date and time format and add comments where possible. It is possible to add lines using CTRL + ENTER.
- When finished click on the button "Save", chnage are saved but not implemented.
- Discarding of invalids is carried out by setting the CheckBoxes "Apply validity periods" to TRUE.

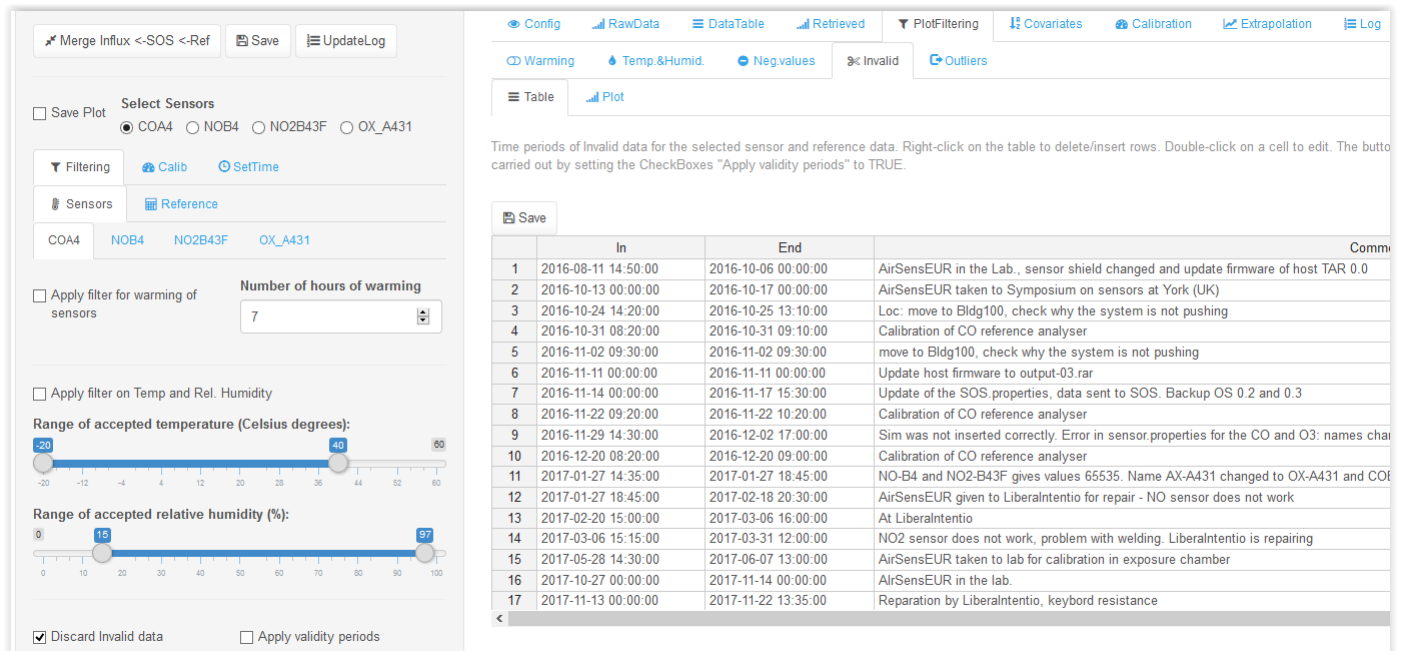


Figure 17: AirSenseEUR R/Shiny web interface for AirSenseEUR. Menu "Data Treatment", filtering invalid sensor data

The invalid sensor data are plotted in the main Tabpanel under "Plot Filtering", sub tab "Invalid" and then selecting "Plot" or "Ref.Outliers". Invalid data are plotted with red dots, see Figure 18.

It is possible to modify the date range being plotted for all sensors, using the "Range of dates for plotting RawData, DataTable, Retrieved, Warming, Temp&Humid, Invalids and outliers:" datePicker of the sideBarLayout under the TabPanel "SetTime", sub menu "COA4" (1st sensor). If the "Save Plot" control box is checked, a png file showing the discarded data is saved in `~/xx/Outliers/` as `xx_Invalid.png`.

3.5.5 Filtering sensor data

It is difficult to avoid that sensor data include several types of abnormal values and outliers that may be created because of malfunctioning, erroneous measurements, electromagnetic interference ... A tool is provided to filter these outliers. Outliers are evidenced if data do not satisfy the following equation:

$$x_i \in median \pm threshold MAD_i$$

With $MAD_i = median|x_j - median(x_j)|$ in a rolling window x_j (Data in the rolling window)

Execute the following steps to discard outliers:

- Select the sub tabPanel "Outliers" in The main TabPanel "PlotFiltering"
- In the SideBar layout, select the "Filtering" tab
- It is possible to filter outliers both for sensor and reference data by selecting either "Sensors" or "Reference" subTab. Then select the sub-sub Tab of desired sensor or pollutant
- Check the "Enable Outlier discarding" control box to enable outlier discarding
- Set values of the "Data in the rolling window" control box, the number of data in the rolling window, for example 19 values with an averaging time of 10 min correspond to a 3-hour window
- Set values of the "Threshold for MAD" control box, typical values should range between 3 and 20, smaller values result in more outliers being detected, see 1st equation above for explanation of the effect of this parameter.
- It is also possible to set the minimum and maximum values for each data series in the text boxes "Minimum values in digital data series" and "Maximum values in digital data series".
- Set the minimum values of the interval of tolerance $median \pm threshold MAD_i$ in the input box "Minimum difference between mean and median". This is interesting in order to avoid that negative values are accepted, by setting for example this parameter to 0, all negative $median \pm threshold MAD_i$ will be set to 0.
- The number of iterations of the outlier detection allows repeating the same outlier detection process in a row

- Once all parameters have been set check the “Apply parameters of filter” control box and the process will start, be patient this can be long, observe the message boxes on the lower right corner.
- Starting with the menu “Outliers”, it is suggested to go through the list of sensors given in the sideBarLayout “SelectSensors” to display the plot of outliers while changes in the outlier detection parameters are carried out under the sideBarLayout tabPanel “Filtering”. It is also mandatory to click once in each reference compound in the sideBarLayout, tabPanel “reference”.

The outlier sensor data are plotted in the main Tabpanel under “Plot Filtering”, sub tab “Outliers” and then selecting “Sens.Outliers” or “Ref.Outliers”. Discarded data are plotted with black (high outlier), orange (low outlier) blue (low value) and pink (high value) dots, see Figure 18. Select the sensor you want to plot clicking on the “Select Sensors” radio buttons on top of the Sidear layout.

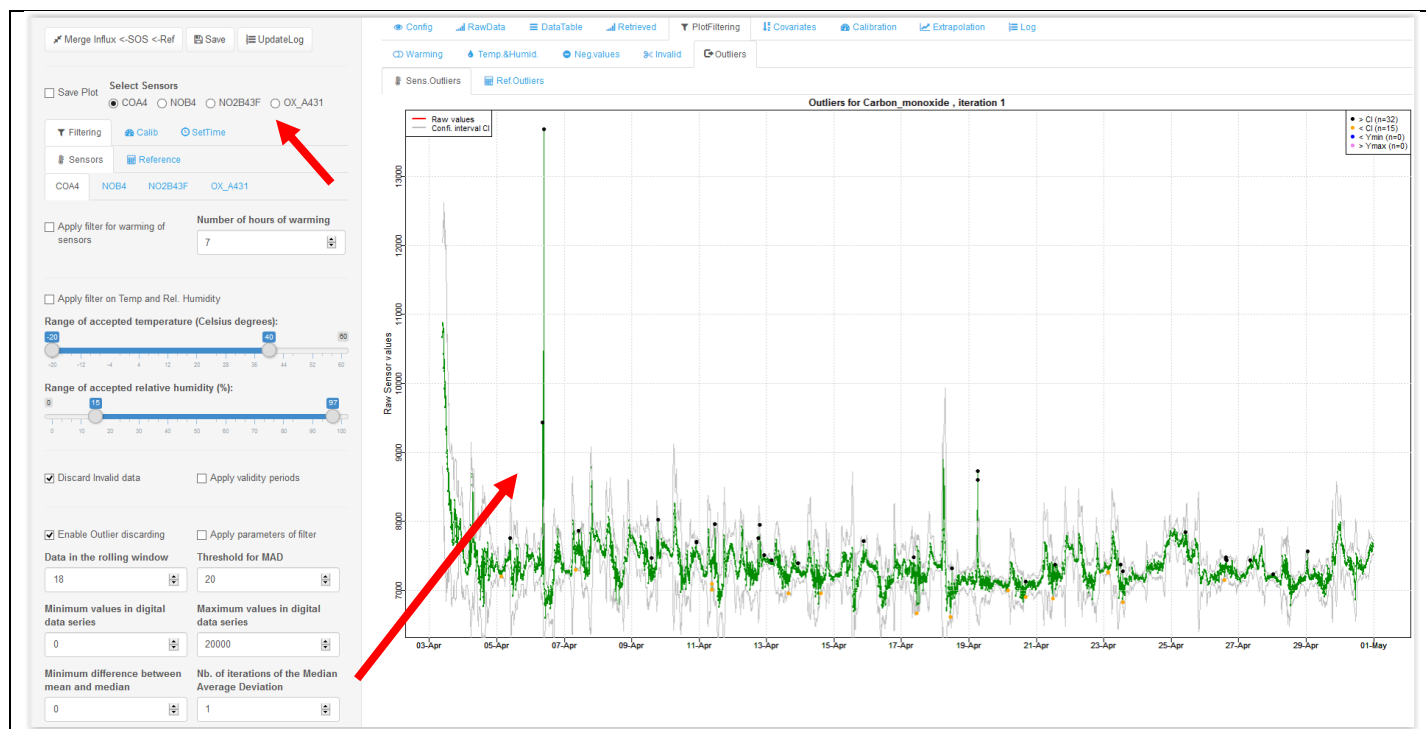


Figure 18: AirSenseEUR R/Shiny web interface for AirSenseEUR. Menu “Data Treatment”, filtering general data series: negative values, outliers

It is possible to modify the date range being plotted for all sensors, using the “Range of dates for plotting RawData, DataTable, Retrieved, Warming, Temp&Humid, Invalids and outliers:” datePicker of the sideBarLayout under the TabPanel “SetTime”, sub menu “COA4” (1st sensor). If the “Save Plot” control box is checked, a png file showing the discarded data is saved in ~/xx/Outliers/ as xx_Outliers_sensorName_j.png where j is the iteration number.

It is possible to modify the date range being plotted for all reference pollutant, using the “Range of dates for plotting outliers and negative values for this pollutant:” date Slider above the control box “Remove negative reference values” in the SideBar layout, Tab “Filtering” sub Tab “Reference” for each pollutant. If the “Save Plot” control box is checked, a png file showing the discarded data is saved in ~/xx/Outliers/ as xx_Outliers_Pollutant.png.

3.6 Plotting covariates

The most basic relationship between sensor values and reference measurements would be a linear relationship. However, things are often not so clear and it may be useful to explore possible relationships with more than one variables. It is possible to use the “Covariates” tools to explore such possible relationships. Execute the following steps to discard outliers:

- Select the sub tabPanel “TimeSeries” or “Matrix” in The main TabPanel “Covariates”
- In the SideBar layout, under “Select Sensors” select the desired sensor
- Select the TabPanel “Calib” in the SideBar Layout.

- Under the "List of covariates to plot" select the parameters whose time series should be plotted. Parameters are added by clicking on their names. To remove one parameter, use the left/right arrow and use backspace or delete on your keyboard.
- It is necessary to select at least one sensor and one reference data series together. It is suggested to add temperature and humidity whose effect is better seen under the "matrix" tab of the main TabPanel. Other known interferences should be investigated.
- It is important to note that data relationship will strongly depend on the selected time period and relationships should be investigated for different time periods. The range of dates are set into the "SetTime" Tab of the sidebar layout by changing the "Range of dates for plotting covariates:" date picker for each sensor.

In the "List of covariates to plot", several types of variables are listed:

1. Digitalized sensor values are shown with the molecule pollutant names, e.g. "carbon_monoxide", "nitric_oxide", "Nitrogen_dioxide", "ozone"
2. Filtered sensors values converted in current or volt: these variable names show as "SensorName_volt", e.g. "COA4_volt", "NOB4_volt", "NO2B43F_volt" and "OX_A431_volt". Although these variable names include "_volt", the raw sensor may be converted into current in nA or voltage in V by selecting "na" or "V" in the "Raw unit of sensor data" control box of the "Calib" tab of the SideBar Layout. It is suggested to select "nA" in order to be able to compare slopes of calibration with sensor sensitivities claimed by manufacturers, that are generally in nA/ppb or nA/ppm.
3. Filtered reference measurements that starts with "Out.Ref.": e.g. "Out.Ref.CO_ppm", "Out.Ref.NO", "Out.Ref.NO2", "Out.Ref.O3", "Out.Ref.SO2".

AirSenseEUR shields transfer sensor digitalized values (Digital) between 0 and 65535 (2^{16} corresponding to the 16-bit analogue to digital conversion used in the shield). The digitalized values can be converted back to voltages (V) using Equation 1 or in current (nA) using Equation 2. The configuration parameters of sensor shields is given in the main TabPanel of the NavBar menu "GetData", see Figure 19. More details are given in some of the AirSenseEUR reports^{1,2}.

$$V_{nA} = (Ref - RefAD) + Digital \frac{2 RefAD}{2^{16}} \quad \text{Equation 1}$$

$$I_{nA} = \left(\frac{V}{R_{load} GAIN} - board.zero.set \right) 10^{-9} \quad \text{Equation 2}$$

Where Ref, RefAD, Rload, GAIN and board.zero.set are the configuration parameters of the sensor shield, see Figure 19.

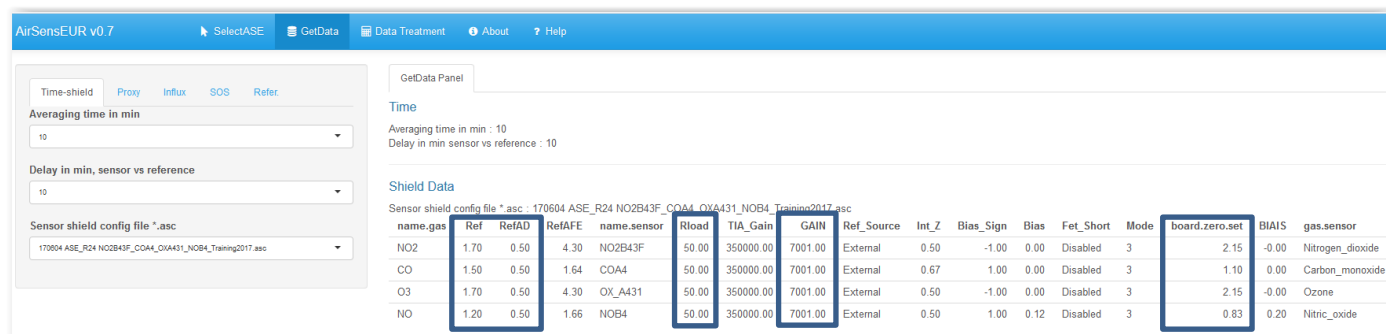


Figure 19: AirSenseEUR R/Shiny web interface for AirSenseEUR. Menu "GetData", configuration of sensor shield with conversion parameters being highlighted

The Times series are plotted in the main TabPanel under "Covariates", sub tab "TimeSeries" and "Matrix" see Figure 20. Select the sensor you want to plot clicking on the "Select Sensors" radio buttons on top of the Sidear layout.

¹ Gerboles M., et al., AirSenseEUR: an open data/software /hardware multi-sensor platform for air quality monitoring. Part A: sensor shield, 2015, <http://dx.doi.org/10.2788/30927>

² Gerboles M. et al., "Evaluation of low-cost sensors for air pollution monitoring - Effect of gaseous interfering compounds and meteorological conditions", 2017, <http://dx.doi.org/10.2760/548327>

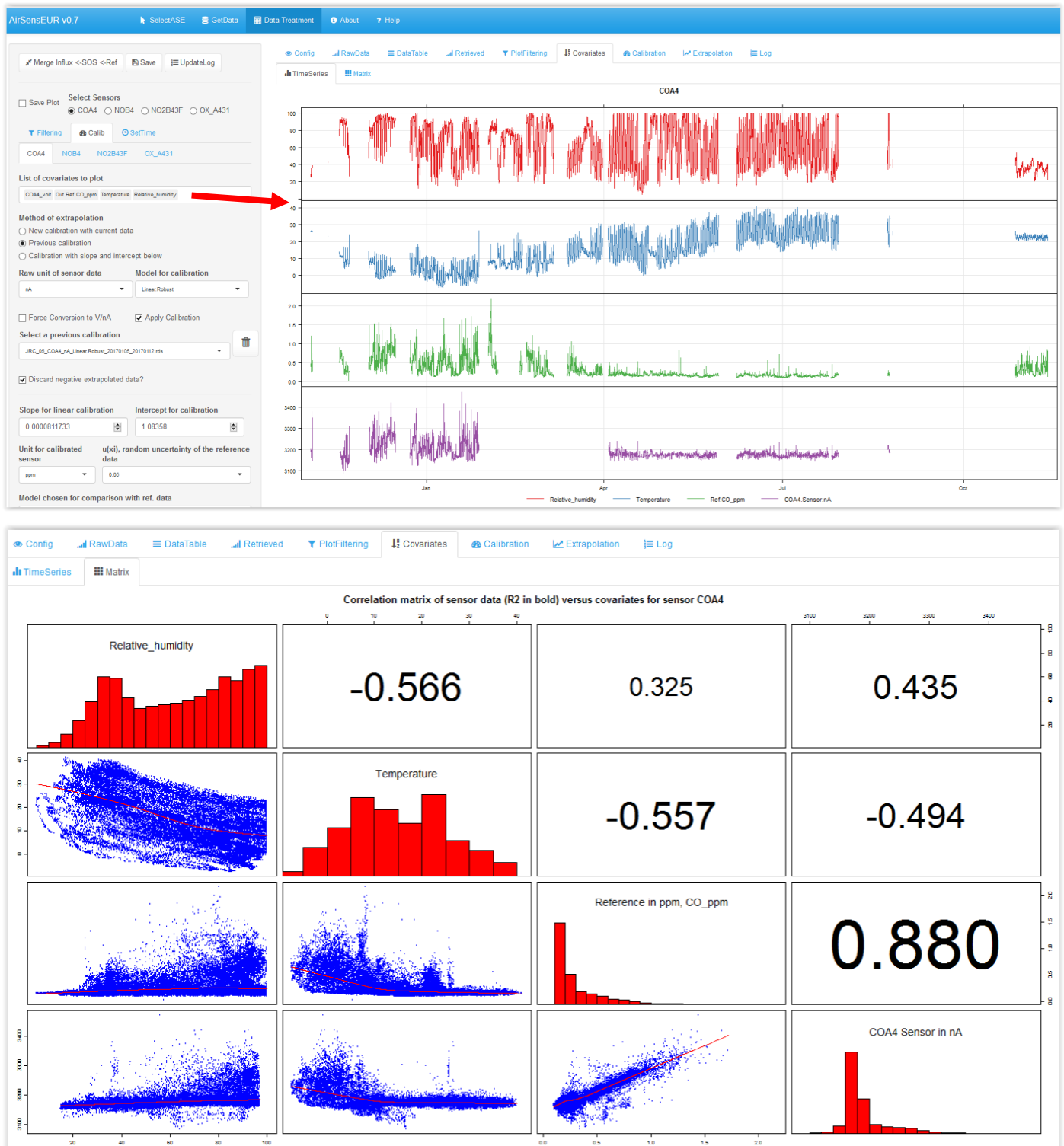


Figure 20: AirSensEUR R/Shiny web interface for AirSensEUR. Menu "Data Treatment", plotting covariates in times series and matrix plot

If the "Save Plot" control box is checked, a png file showing the time series plots are saved into $\sim\backslash\text{xx}\backslash\text{Verification_plots}$ with name $\text{SensName_ts_yyyymmdd_yyyymmdd.png}$ with yyyymmdd corresponding to starting and ending dates.

If the "Save Plot" control box is checked, a png file showing the matrix plots are saved into $\sim\backslash\text{xx}\backslash\text{Verification_plots}$ with name $\text{SensName_pairs_yyyymmdd_yyyymmdd.png}$ with yyyymmdd corresponding to starting and ending dates.

Plotting the time series of covariates allows identifying short range of dates, e. g. 1 or 2-weeks for calibration. It is possible to set the 1 or 2-week ranges in the SideBar layout under tab "SetTime" using the DatePicker "Range of dates for plotting covariates". Then use the tow button ">" and ">" to scroll

the times series and identify dates when sensor values and reference measurements are correlated. The ">>" and "<<" set the ranges to minimum and maximum dates, see Figure 21

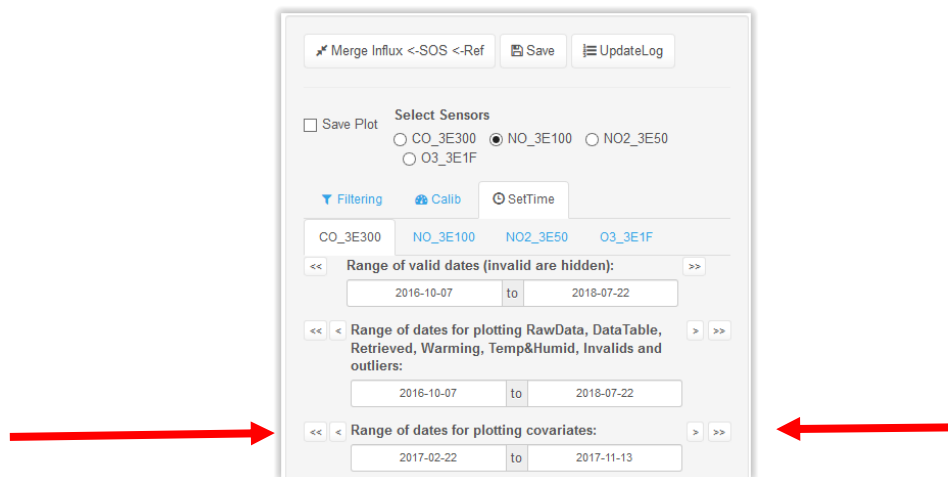


Figure 21: AirSensEUR R/Shiny web interface for AirSensEUR. Menu "Data Treatment", setting the range of dates for plotting times series of covariates. Button for scrolling dates and setting range to minimum and maximum dates.

3.7 Calibration

3.7.1 Creating new calibration model

3.7.1.1 Scatterplot

New calibration models can be designed in the following way:

- Select the sub TabPanel "Scatterplot" in The main TabPanel "Calibration"
- Be sure to set the "Method of extrapolation" radio buttons to "Previous calibration"
- In the SideBar layout, under "Select Sensors", select the desired sensor.
- Select the TabPanel "Calib" in the SideBar Layout.
- Set the "Raw unit of sensor data" and "Model for calibration" according to your need, see Figure 23.
- If "multilinear" is chosen for the "Model for calibration", a new parameter list called "List of covariates to calibrate" is displayed. For now, the multiLinear model only allows 1st order models. Set the "List of covariates to calibrate" in the same manner as for the "List of covariates to plot" (see section 3.6). It is not necessary to select the NameSensor_volt parameter in this list since it is automatically selected. It is suggested not to select parameters that are correlated, e. g. temperature and relative humidity. You can check correlation with the plot of covariates, see section 3.6.
- In the "SetTime" TabPanel of the SideBar Layout, set the "Range of dates for calibration:", in order to select the data interval during which the calibration is established. You can use the "Covariates" mainTabPanel to help you selecting an appropriate date interval, see section 3.6.
- In the "SetTime" tab, set the "Range of dates for plotting calibration:" that should be consistent with the "Range of dates for calibration:", see Figure 22. Dates can be set manually using the date Pickers or with the button "<<" (minimum date), "<" (moving one date window backwards), ">" (moving one date window forwards) and ">>" (maximum date).
- Go back to "Calib" TaPanel of the SideBar Layout and to set the "Method of extrapolation" radio buttons to "New calibration with current data". The calculation process will start and a new scatter plot of calibration is shown, see Figure 24. The list of "Select a previous calibration" is set to the new calibration model.
- It is not possible to re-fit a calibration model if it already exists in the "Select a previous calibration", including same "Raw unit of sensor data", "Model for calibration", "Range of dates for calibration" and "List of covariates to calibrate". You can use the button with icon of a bin in front of the "Select a previous calibration" to delete any selected model and be able to fit again. Be sure to confirm deletion only for the model name that is to be deleted.
- Under the "Method of extrapolation" radio buttons be sure to select "Previous calibration".

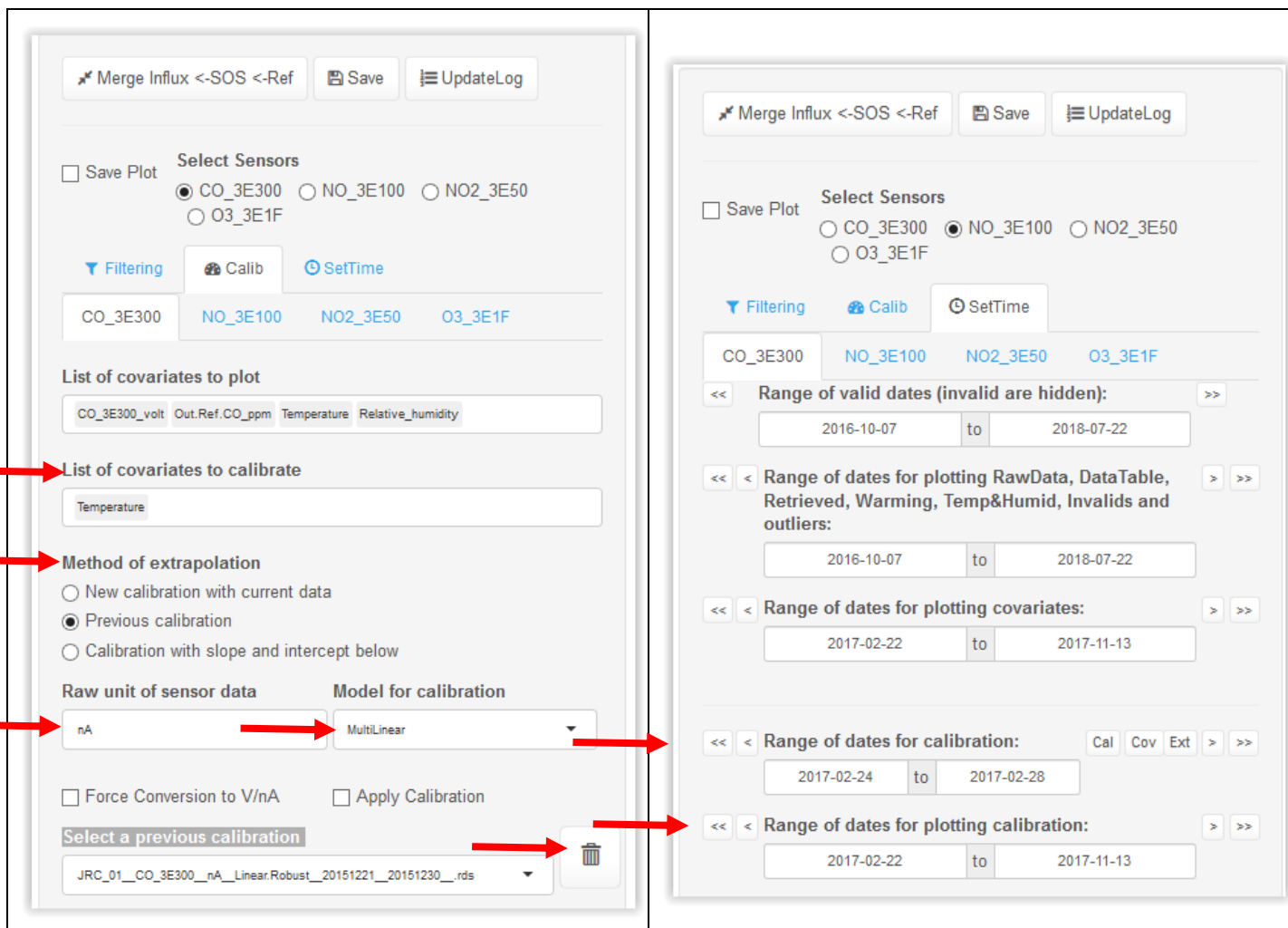


Figure 22: AirSenseEUR R/Shiny web interface for AirSenseEUR. Menu "Data Treatment", SideBar Layout "Calib" and "SetTime". Setting a new calibration model and setting the range of dates of the Calibration model. Button for automatic setting of dates using the name of the calibration model ("Cal") or the date interval of the "Range of dates for plotting covariates: " ("Cov").

There are several cases in which the calibration plot is not shown and an error message is displayed. Please check in section 36 to look for a solution.

Other tools allow checking the goodness of fit of the calibration, see sections 3.7.2.2, 3.7.2.3 and 3.7.2.4.

3.7.2 Plotting existing calibration model

3.7.2.1 Scatterplot

- Select the sub tabPanel "Scatterplot" in the main TabPanel "Calibration"
- In the SideBar layout, under "Select Sensors" selected the desired sensor
- Select the TabPanel "Calib" in the SideBar Layout.
- Under the "Method of extrapolation" radio buttons be sure to select "Previous calibration".
- The "Raw unit of sensor data" (V or nA) shall be the same as in the name of calibration model chosen under "Select a previous calibration". If you change any unit of sensor (e.g. from V to nA) or if the filtering of sensor data (main TabPanel "PlotFiltering") is changed, it may be necessary to check the "Force Conversion to V/nA" and "Apply calibration" control boxes if changes are not detected and then establish a new calibration model, see section 3.7.1.
- Under the "Select a previous calibration", the list of available calibration model will appear. If the list is empty refers to section 3.7.1.

All calibration model are labelled as follows: AirSenseEURName__SensorName__SensorUnit__CalibrationModel__yyyymmdd__yyyymmdd__.rds with yyyymmdd corresponding to starting and ending dates of the calibration range. The rds calibration model are saved into ~\xx1\Models directory.

- The "Raw Unit of sensor data", "Model for Calibration" are automatically adjusted when selecting a previous model in order to match the calibration model name in the "Calib" tab of the sideBar layout, see Figure 23.
- In the "SetTime" tab, the "Range of dates for Calibration" and "Range of dates for plotting calibration:" are automatically adjusted when selecting a previous model in order to match the calibration model name in the "Calib" tab of the sideBar layout, see Figure 23. Dates can be changes manually or clicking of the "Cal" button to automatically set the dates of the calibration model.

The figure consists of two side-by-side screenshots of the AirSensEUR R/Shiny web interface. The left screenshot shows the 'Calib' tab selected in the top navigation bar. It features a 'List of covariates to plot' section with a search bar containing 'CO_3E300_volt', 'Out.Ref.CO_ppm', 'Temperature', and 'Relative_humidity'. Below this is the 'Method of extrapolation' section with three radio buttons: 'New calibration with current data', 'Previous calibration' (which is selected), and 'Calibration with slope and intercept below'. Further down is the 'Raw unit of sensor data' section with a dropdown menu showing 'nA', and the 'Model for calibration' section with a dropdown menu showing 'Linear.Robust'. There are checkboxes for 'Force Conversion to V/nA' and 'Apply Calibration'. At the bottom is the 'Select a previous calibration' section with a dropdown menu showing 'JRC_01_CO_3E300_nA_Linear.Robust_20151223_20151230_rds' and a trash icon. A checkbox for 'Discard negative extrapolated data?' is also present. The right screenshot shows the 'SetTime' tab selected. It features a 'Range of valid dates (invalid are hidden):' section with a date range from '2016-10-07' to '2018-07-22'. Below this is a 'Range of dates for plotting RawData, DataTable, Retrieved, Warming, Temp&Humid, Invalids and outliers:' section with a date range from '2016-10-07' to '2018-07-22'. Further down is a 'Range of dates for plotting covariates:' section with a date range from '2017-02-22' to '2017-11-13'. At the bottom is a 'Range of dates for calibration:' section with a date range from '2017-02-24' to '2017-02-28'. A red arrow points to the 'Cal' button in this section.

Figure 23: AirSensEUR R/Shiny web interface for AirSensEUR. Menu "Data Treatment", SideBar Layout "Calib" and "SetTime". Selecting the calibration model and setting the range of dates of the Calibration model. Button for automatic setting of dates using the name of the calibration model ("Cal").

- Click on all sensors of the sideBarLayout, tabPanel "SelectSensors" to switch between sensors. The plots are automatically saved into directory `~\xx1\Calibration` with name `nameModel__Calibration.png`, see an example in Figure 24:

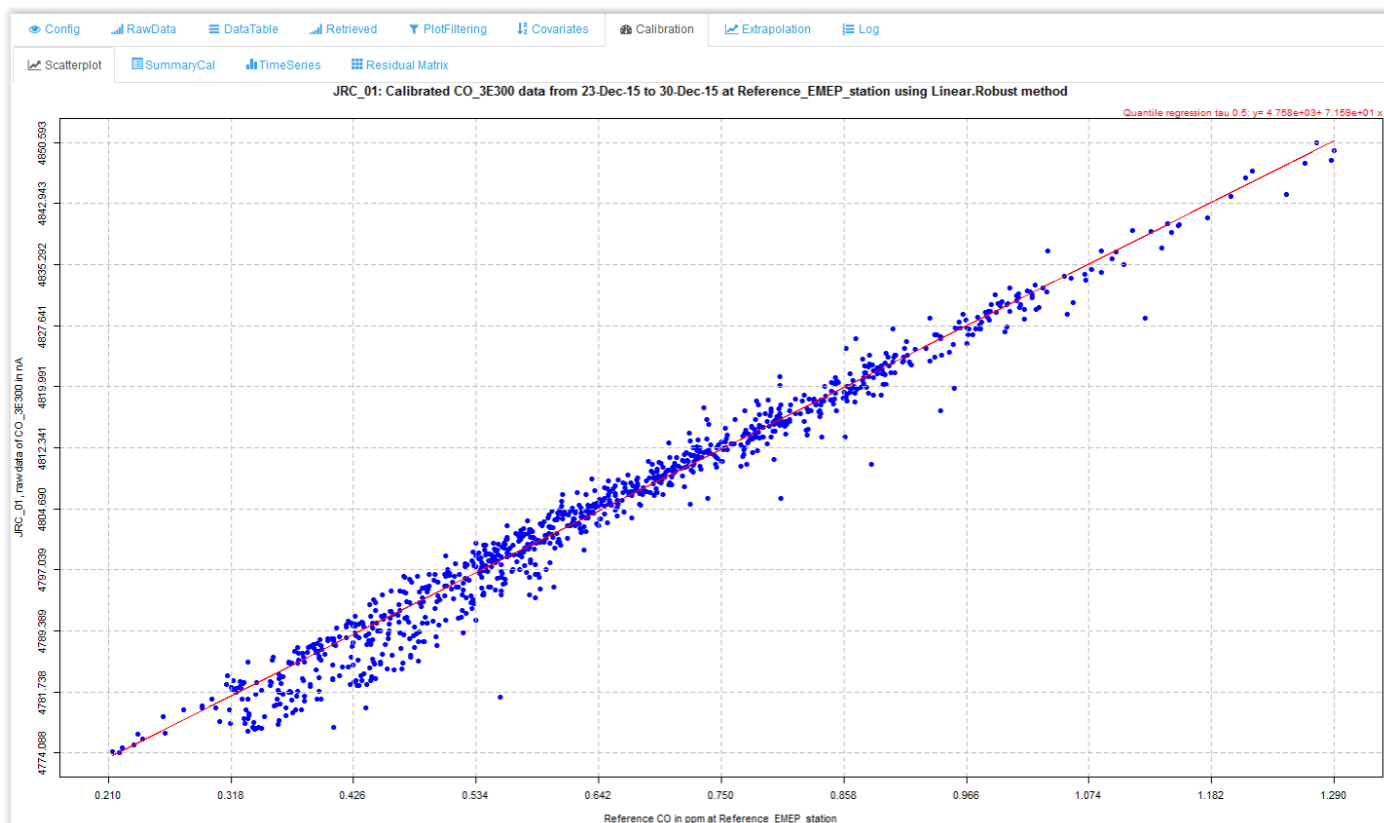


Figure 24: AirSenseEUR R/Shiny web interface for AirSenseEUR. NavBar Menu "Data Treatment", maiTabPanel "calibration" – "ScatterPlot", calibration plot.

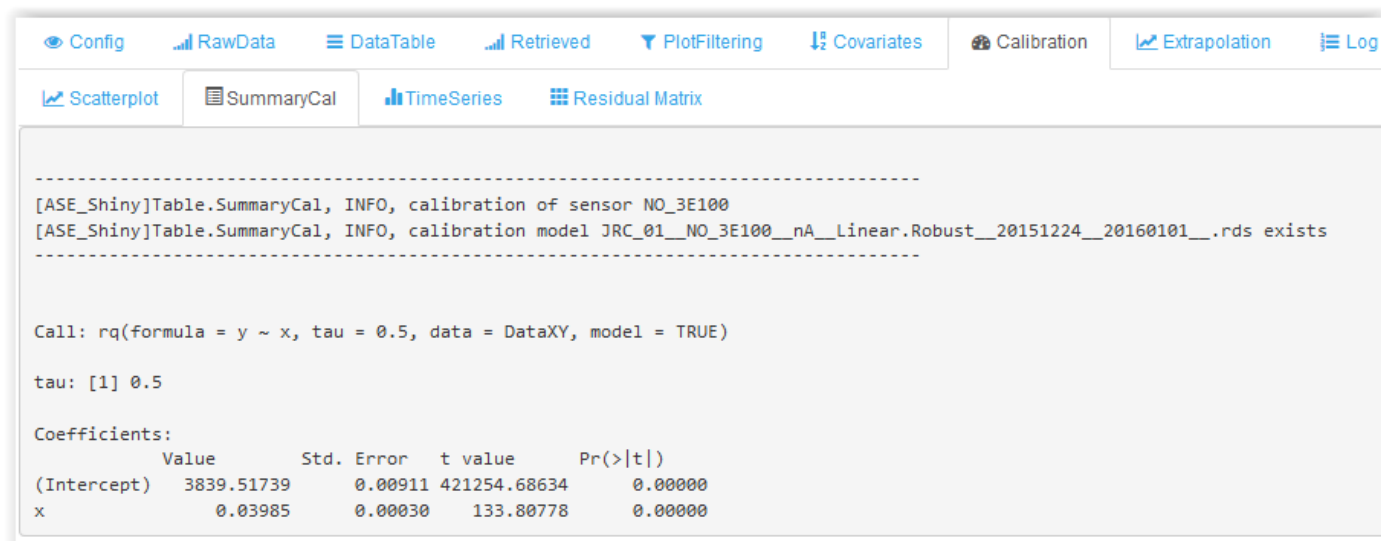
- The range of dates for calibration is set into the sideBarLayout "SetTime" for each sensor. The range of date shall be consistent with the "Range of dates for plotting:" and the "Range of valid dates (invalid are deleted):" of each sensor.

There are several cases in which the calibration plot is not shown and an error message is displayed. Please check in section 36 to look for a solution.

3.7.2.2 Goodness of fit of the calibration model

Once the scatterplot of the calibration model is plotted (see section 3.7.2.1), you can:

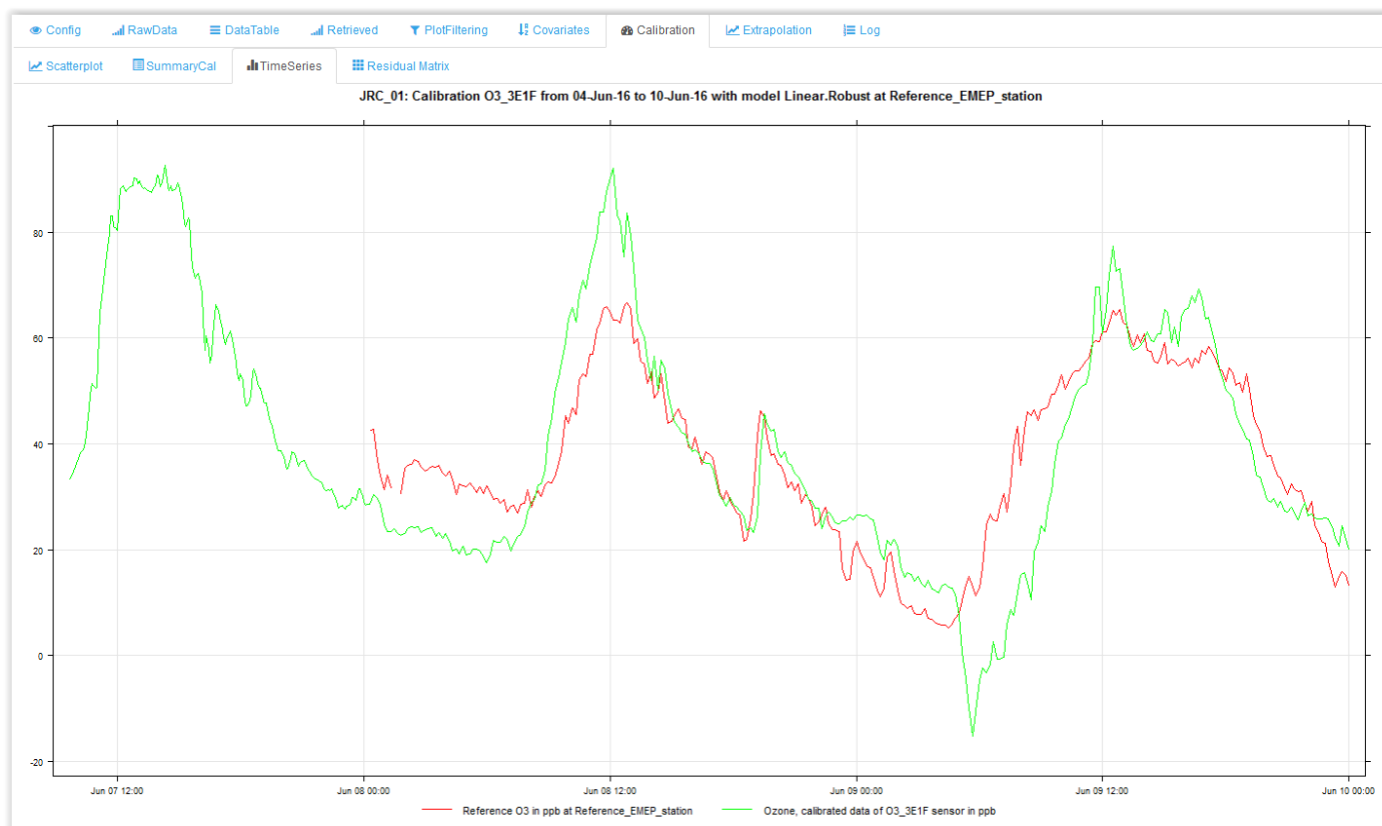
- Select the sub tabPanel "SummaryCal" in the main TabPanel "Calibration" to get information of the lack of fit of the calibration model, see for example figure below.
- In the SideBar layout, under "Select Sensors" select the desired sensor



3.7.2.3 Time Series

Once the scatterplot of the calibration model is plotted (see section 3.7.2.1), you can:

- Select the sub tabPanel "TimeSeries" in the main TabPanel "Calibration" to plot the reference measurements together iwth the calibrated sensor data, see for example figure below.
- In the SideBar layout, under "Select Sensors" select the desired sensor

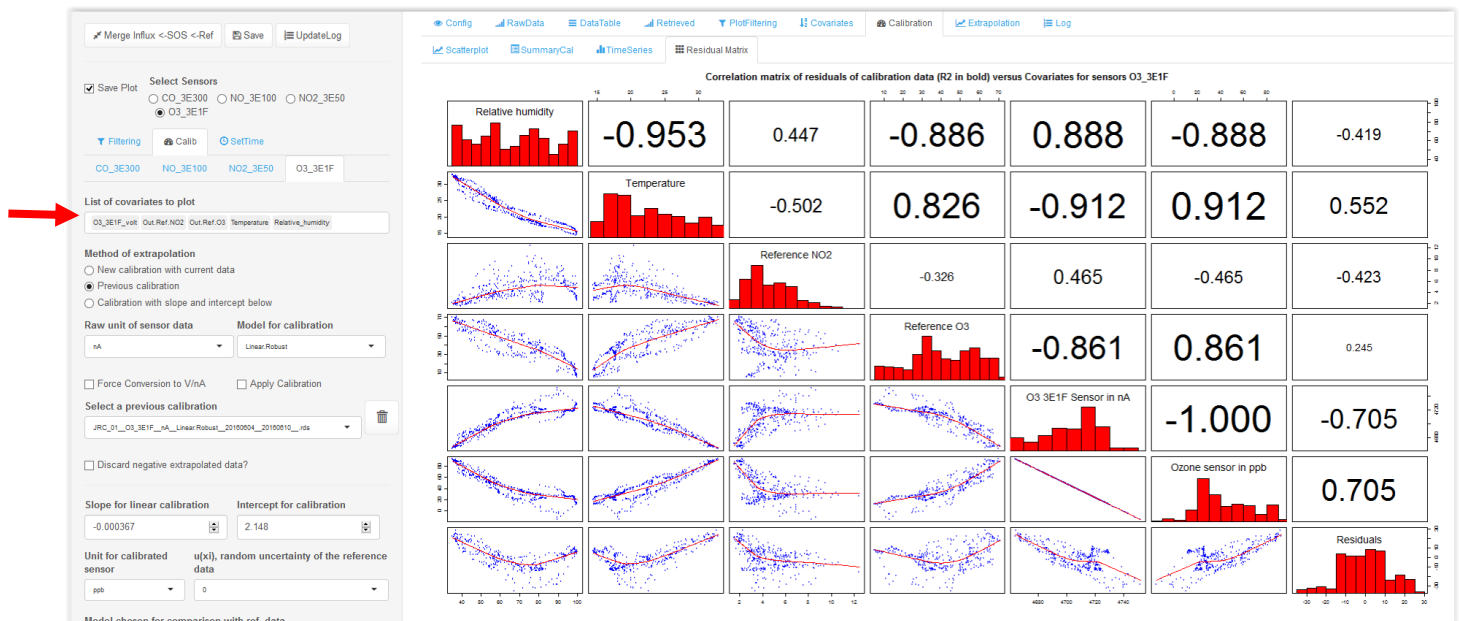


3.7.2.4 Matrix plot

Once the scatterplot of the calibration model is plotted (see section 3.7.2.1), you can:

- Select the sub tabPanel "Residual Matrix" in The main TabPanel "Calibration" to get information of the lack of fit of the calibration model and relationship with other covariates, see for example figure below.
- In the SideBar layout, under "Select Sensors" select the desired sensor
- Select the list of covariates to plot, see section 3.6

Two variables are added to the matrix plot: the 1st one is the calibrated sensor data series, e. g. "Ozone sensor in ppb" and the 2nd one is "Residuals" the difference between the calibrated sensor data series and the reference measurements. Observe any correlation of the residuals with the List of covariates to plot in order to improve the calibration model, see 3.7.1.



3.8 Extrapolation

3.8.1.1 Scatterplot, summary Calibration, Times series and Residual matrix

- Be sure that the calibration model has been correctly selected and is effective, see section 3.7.
- Click on the mainPanel, TabPanel "Extrapolation", select "Scatterplot",
- Select desired sensors on the "Select sensors" radio button of the Sidebar Layout. Make sure that every time you select a new sensor, you click once on the mainTabPanel "calibration" and "Scatterplot" to load the sensor calibration model.
- Be sure to select the same sensor tab under "Calib" and "SetTime" Tab Panels and "Select Sensors" radio buttons.
- In the "Calib" Tab Panel, check the "Discard negative extrapolated data?" check box is you want to discard negative extrapolated data (this improve the correlation but it is a bit of cheating ;-).
- In the "SetTime" tab panel, ajust the "Range of dates for extrapolation:" and "Range of dates for plotting extrapolated data:" in order to apply and plot the calibration model, see Figure 25. Dates can be changes manually or by clicking on the "<<", "<", ">", ">>" that works as for the "Range of dates for plotting covariates:", see section 3.6. These slide pickers are also affected by the date interval of the "Range of valid dates (invalid are hidden)" as explained in section 3.4.

As for the "Calibration" mainTabPanel, in extrapolation it is possible to get more information on the agreement between extrapolated sensor data and reference measurements.

- Under "Extrapolation" mainTabPanel, click on "SummaryExtra" to observe the results of the Linear regression between extrapolated sensor data and reference measurements. Use the same information as in section 3.7.2.2.
- Click on "TimesSeries" to plot time series of the the extrapolated sensor data and reference measurements. Use the same information as in section 3.7.2.3.
- Click on "ResidualMatrix" to plot a matrix of residuals with the covariates set in "List of covariates to plot" of the Calib" Tab Panel of the Sidebar layout. The extrapolated sensor data and the residuals of the extrapolated sensor data are added to the list. Use the same information as in section 3.7.2.4.

The plots are saved into ~\xx1\Modelled_gas with name sesors_yyyymmdd_yyyymmdd.png with starting and ending dates (see Figure 25, upper picture).

If the "Save Plot" control box is checked, a png file showing the scatterplot is saved into ~\xx1\Modelled_gas with name CalibrationModelName_Calibrated_yyyymmdd_yyyymmdd.png with yyyymmdd corresponding to starting and ending dates.

If the "Save Plot" control box is checked, a png file showing the time series plots are saved into ~\xx1\Modelled_gas with name CalibrationModelName_Calibrated_ts_yyyymmdd_yyyymmdd.png with yyyymmdd corresponding to starting and ending dates.

If the "Save Plot" control box is checked, a png file showing the matrix plots are saved into $\sim\backslash\text{xx1}\backslash\text{Modelled_gas}$ with name CalibrationModelName_Res_pairs_yyyymmdd_yyyymmdd.png with yyyymmdd corresponding to starting and ending dates.



Figure 25: AirSensEUR R/Shiny web interface for AirSensEUR. Menu "Data Treatment", plotting covariates, calibration and extrapolation.

3.8.1.2 Uncertainty

To be completed

3.8.1.3 Target diagram

To be completed

3.8.1.4 Drift

To be completed

4 Troubleshooting

4.1 Missing parameters

In the mainTabPanel, if a message in red font "Error: argument is of length zero appears" (see Figure 26, it is likely that it is necessary one TabPanel in the sideBarLayout and possibly select or enter parameter options. It is suggested to open first all TabPanels of the sideBarLayout first and second all TabPanels of the mainPanel in order to avoid this type of error message.

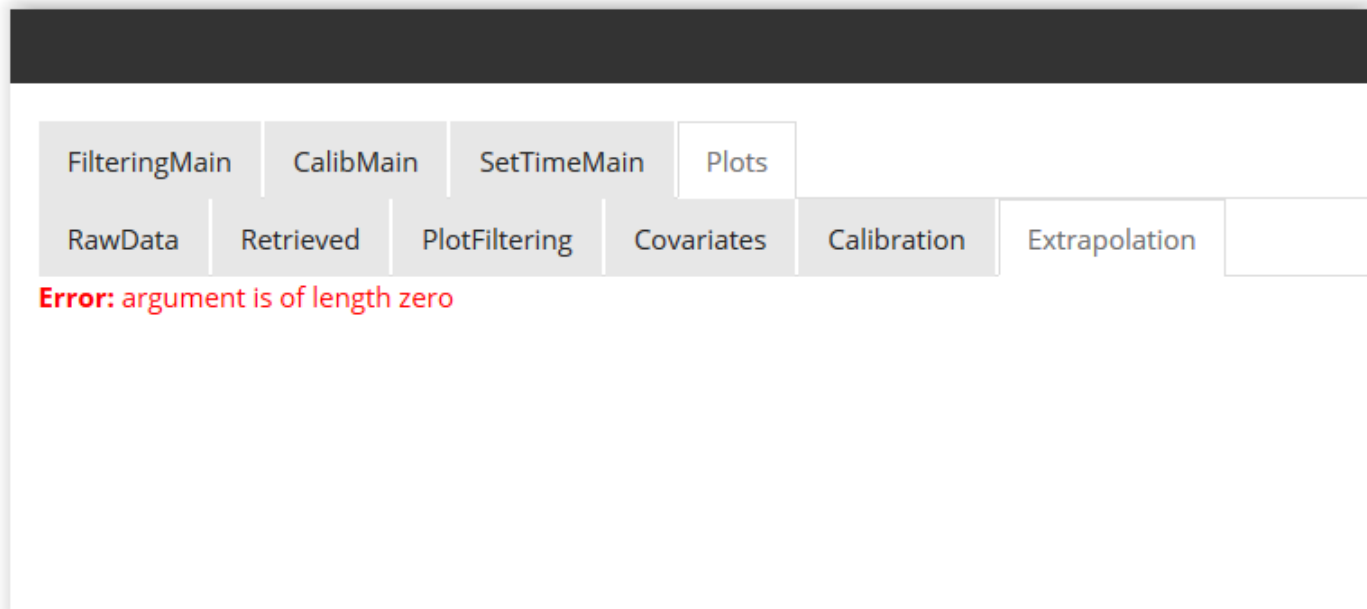
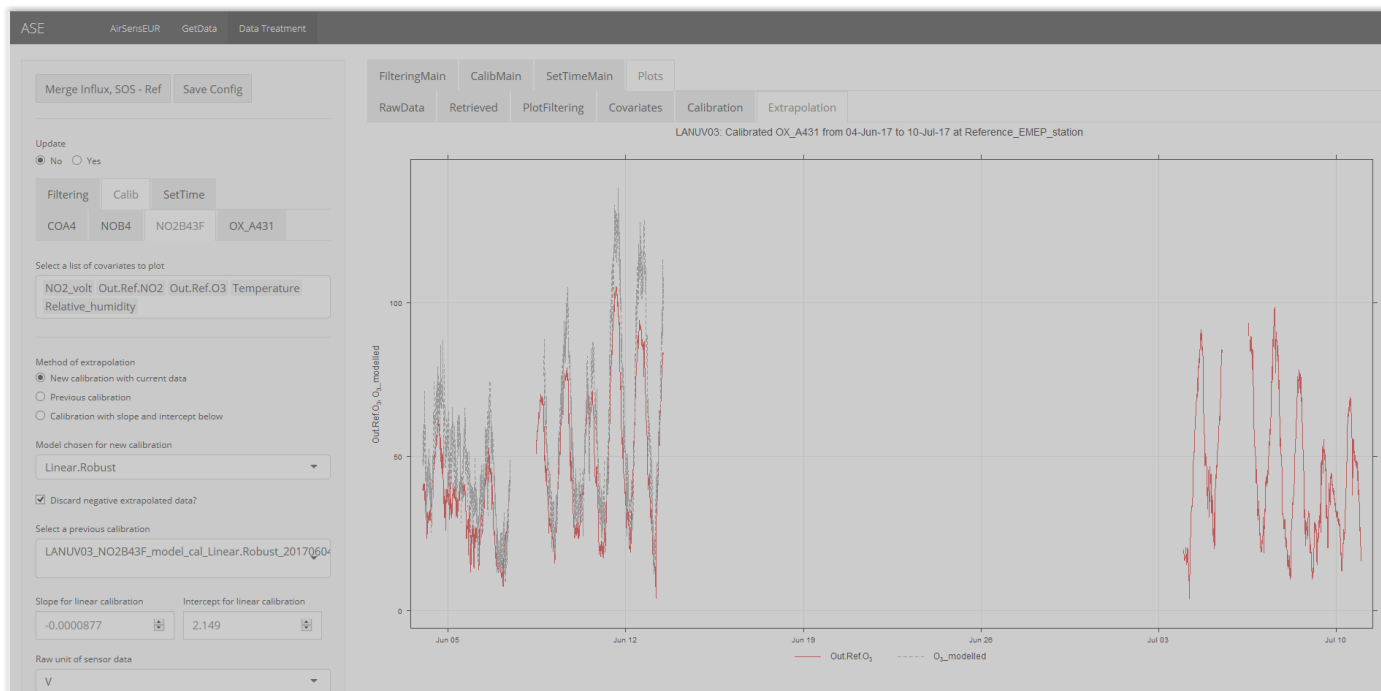


Figure 26: Error message when TabPanel has to be opened)

4.2 Missing parameters

When the Shiny web interface shows a grey display, the R code as crashed. The only possibility is to re-start the whole application (see figure beow).



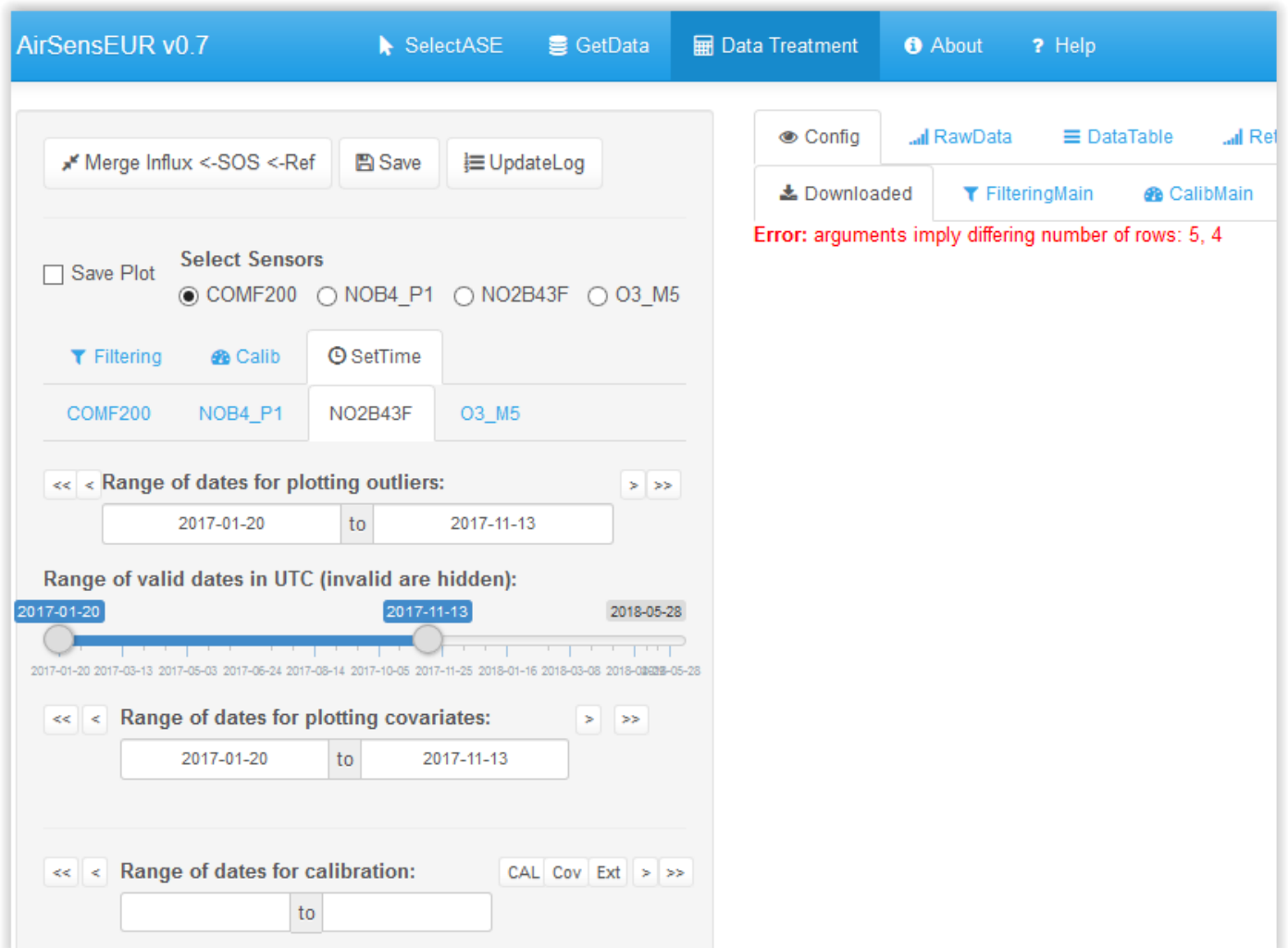
4.3 "ERROR: arguments imply differing number of rows: 5, 4" after merging data

After merging data from Influx, SOS and reference data, it is possible that an error appear in the main TabPanel "Config", subtab "Downloaded".

This is likely caused by a missing date in the "SetTime" of the SideBar Layout under one of the sensor. It might be that the existing SetTime dates were not included into the data series after downloading or merging of data.

It is necessary to manually adjust missing dates with the date Pickers that only show existing dates.

The Downloaded table cannot be updated in the main TabPanel. It is suggested to re-start since the effect of missing information of the Downloaded data on subsequent data treatment is unknown.



4.4 Impossible to plot the scatterplot of calibration model

The possibles error messages include:

1. [ASE_Shiny]Plot.Calibration, ERROR: "\"Range of date for calibration:\" or \"Range for plotting calibration\" not consistent with \"Selected previous calibration\". Change \"Range of date for calibration:\" or select another previous calibration.
2. [ASE_Shiny]Plot.Calibration, ERROR: \"List of covariates to calibrate\" not consistent with \"Selected previous calibration\". Change \"List of covariates to calibrate\" or select another previous calibration.
3. [ASE_Shiny]Plot.Calibration, ERROR: \"Raw unit of sensor data\" or \" Model for calibration\" not consistent with \"Selected previous calibration\". Click on \"New calibration with current data\" or select another previous calibration.

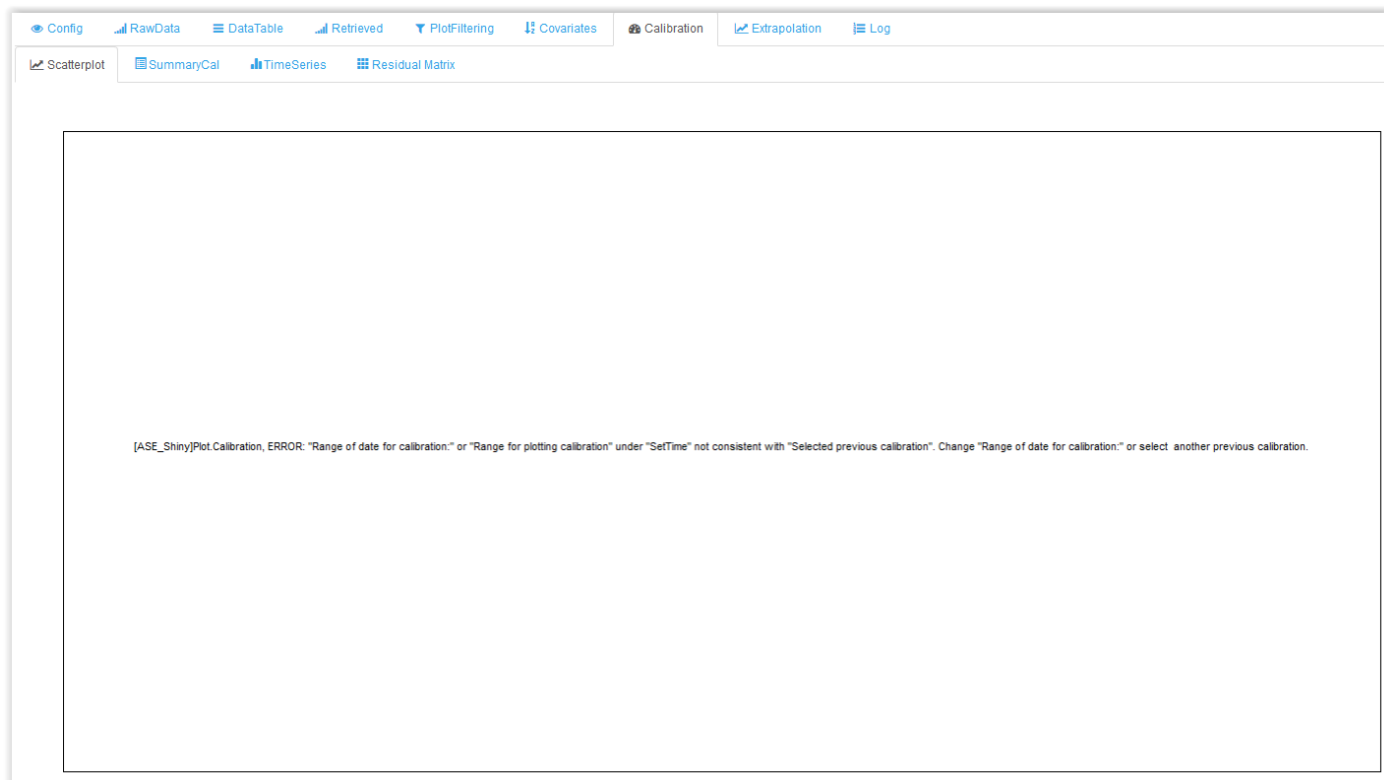
4. [ASE_Shiny]Plot.Calibration, ERROR: " Model for calibration" is empty, select a model o choose "New calibration with current data

For Error 1: set correct "Range of date for calibration:" or "Range for plotting calibration" under "SetTime", you can use button "Cal" that will automatically set the "Range of date for calibration:" using the name of the calibration mode.

For Error 2: set correct " List of covariates to calibrate" under "Calib, the order of covariates is not relevant.

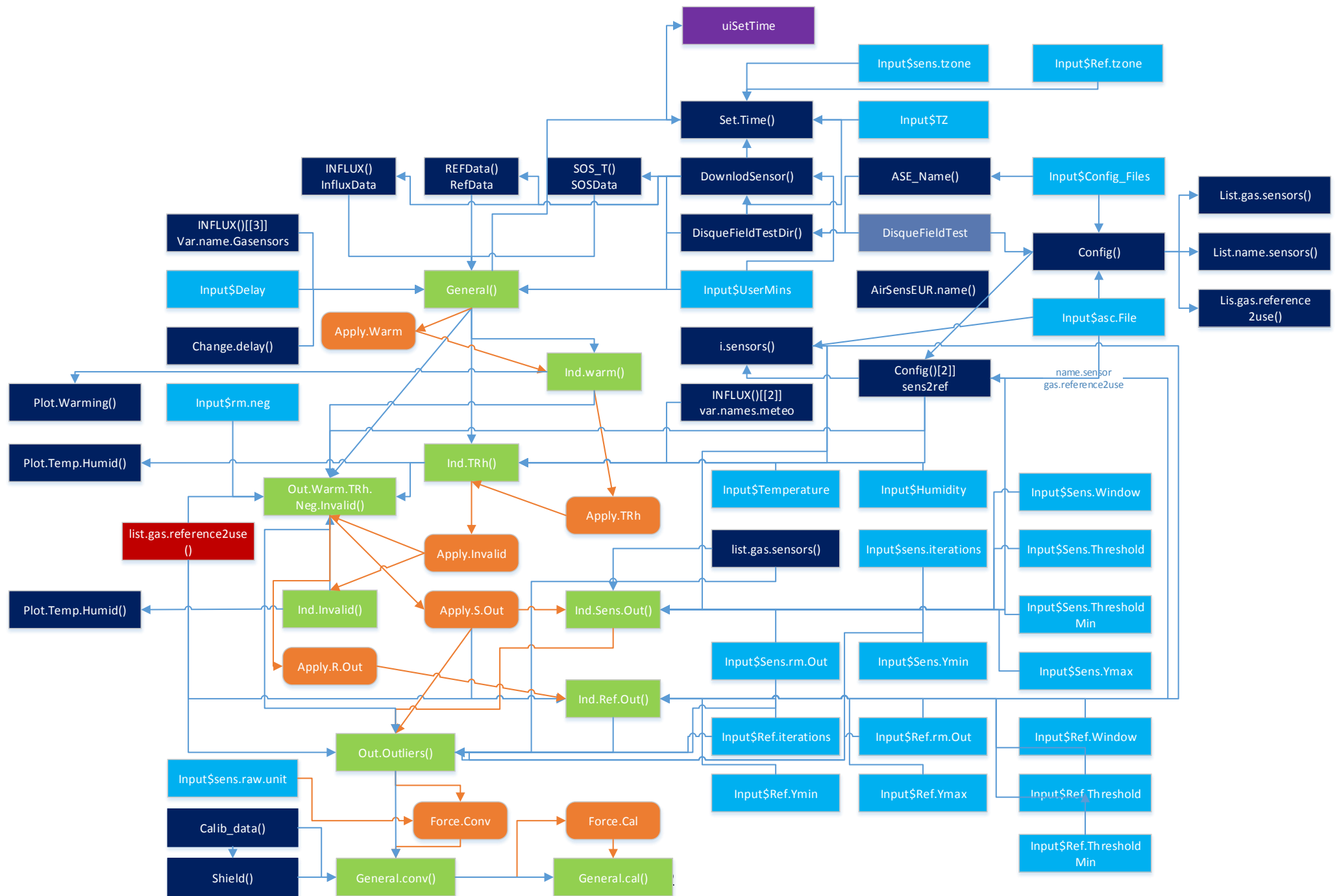
For Error 3: set correct "Raw unit of sensor data" and "Model for calibration" and "List of covariates to calibrate" if "MultiLinear" model is used under the "Calib" Tabpanel. Please use the same order of "List of covariates to calibrate" as in the name of the calibration model.

For Error 4: just selct one model in the "Select a previous calibration" list of the "Calib" TabPanel. If the list is empty, see section 3.7.1.



5 Flow chart of filtering and calibration procedures

Add legend of the flowing flow chart with color legend



6 Reference

R Core Team (2017). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL <https://www.R-project.org/>.

RStudio Team (2015). RStudio: Integrated Development for R. RStudio, Inc., Boston, MA URL <http://www.rstudio.com/>.