

ACTRIS In Situ Aerosol: Guidelines for Manual QC of TSI 3563 Integrating Nephelometer Data

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The manual data QC is performed on the level 0 data, i.e. the raw data output, augmented with essential discovery and use metadata, and brought to a standardised data format. For the purpose of manual QC, temporary level 1 and 2 data versions are produced from the initial level 0 version. When performing manual QC for a given time period of data, e.g. a year for an annual submission of data, the parameters contained in the level 0, 1, or 2 data listed below are to be plotted as time series, and visually inspected in intervals of maximum 2 weeks at a time. Data sequences exhibiting issues are to be flagged with an appropriate flag contained in this list:

Group 0: Valid data

Flag	Validity	Description
000	V	Valid measurement

Group 1: Exception flags for accepted, irregular data

Flag	Validity	Description
110	V	Episode data checked and accepted by data originator. Valid measurement

Group 3: Flags for aggregated datasets (used for level 1.5 & 2 only)

Flag	Validity	Description
390	V	Data completeness less than 50%
392	V	Data completeness less than 75%
394	V	Data completeness less than 90%

Group 5: Chemical problem

Flag	Validity	Description
559	V	Unspecified contamination or local influence, but considered valid

Group 6: Mechanical or instrumental problem

Flag	Validity	Description
640	V	Instrument internal relative humidity above 40%
686	I	Invalid due to zero check. Used for Level 0
687	I	Invalid due to span check. Used for Level 0

Group 9: Missing flags [MF1]

Flag	Validity	Description
999	M	Missing measurement, unspecified reason

Regardless in which data level the issue is found, the flags are added to the initial level 0 data version, thereby producing level 0a (manually QCed level 0) as output of the QC process. Some flags are used for level 0 only. The corresponding data lines are marked as missing in level 1, and are excluded from calculating hourly averages in levels 1.5 and 2.

The flags for aggregated datasets in group 3 apply only to levels 1.5 and 2. They indicate which fraction of the averaging period is covered by active sample time of the instrument.

The following parameters are to be inspected for the following issues:

Level 0:

1. Periods of zero and span checks

If not done automatically by the data acquisition software, periods of zero and span checks are to be flagged with separate flags (flags 686 and 687, respectively).

2. Sample pressure, sample inlet temperature, sample outlet temperature

Sample pressure varies with ambient pressure. Other types of variations should not occur, e.g. variations with fluctuating sample flow, apart from periods with zero and span checks. Sample temperature at inlet and outlet normally varies only with lab temperature, and during zero and span checks. Other variations and spikes need to be inspected, the reason determined, and flagged according to issue if needed.

3. Sample relative humidity at inlet and outlet

Sample relative humidity varies with ambient relative humidity and the temperature difference between ambient and lab. The sample should be dried so that the sample has RH < 40% already at the instrument inlet. If RH is higher, apply flag 640. Spikes can occur during zero and span checks. Other variations and spikes need to be inspected, the reason determined, and flagged according to issue if needed.

4. Sample flow

Sample flow, both through the main inlet and the instrument, should be constant, with small variations caused by wind gusts. Sample flow under normal operation should typically be at least 3 l/min, with drops by 20% max. Spikes can occur during zero and span checks. Other variations and spikes need to be inspected, the reason determined, and flagged according to issue if needed.

5. Lamp voltage and current

Both should stay constant during operation. An increase in current and drop in voltage indicate the approaching end of the bulb, which should be swapped before failing to protect the electronics. Periods with failed or non-operational lamp are to be flagged invalid.

6. Zero scattering calibrations

These depend only on wavelength, and very slightly on sample pressure. Thus, they should essentially be constant. Spikes or shifts need to be examined carefully. Spikes can occur due to erroneous measurements caused by remaining CO₂ after a span check (data period until next zero is invalid). Shifts can be caused by a leaky zero air filter, which can potentially be corrected if the leak rate is constant.

7. Scattering and backscattering coefficients

These need to be inspected on 2 scales, logarithmic and linear. The (back)scattering coefficients change with air mass origin at the station. Thus, expected features in this time series are station dependent. Spikes are discovered on the logarithmic plot, and investigated using the station log and trajectory / backward plume analysis. Instrumental malfunctions are flagged with 999, local influence with 559, other episodes (dust, wildfires, long-range transport, ...) with 110. The linear plot displays data around or just below 0. At values near the detection limit, some noise around or below 0 is normal and expected. When averaging to hourly means, this noise cancels out to positive values around the detection limit. Negative spikes to values below the noise level are invalid and need to be removed (flag 999). These negative spikes are often caused by faulty zero measurements.

Level 2:

1. Scattering and backscattering coefficients

These are plotted on a linear scale for the region around 0. If negative spikes have been flagged correctly in level 0, the level 2 (back)scattering data don't exhibit negative values. If this is the case nevertheless, the flagging of the level 0 data needs to be revisited and corrected for the time sequence concerned. A new temporary level 2 data file is produced, and verified that the negative data have vanished.

Appendix A: Examples of Conditions requiring flagging

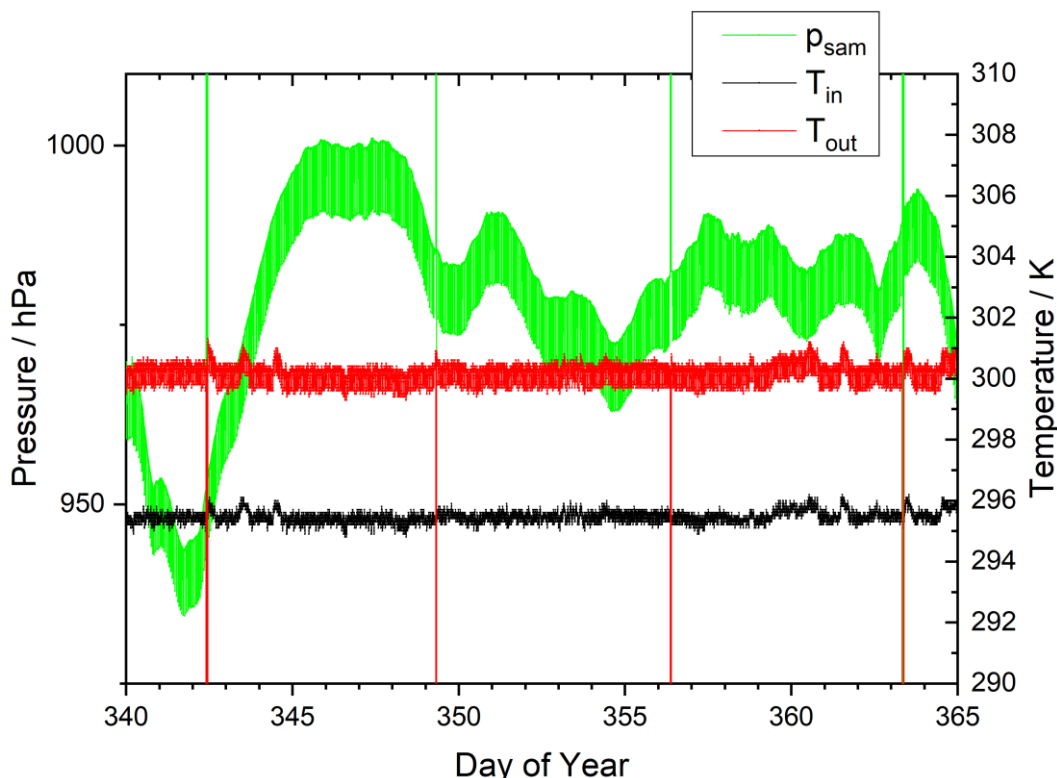


Figure 1: Spikes in both pressure and temperature can occur after instrument upstart, e.g. after a span check, and need to be flagged as missing (flag 999). The span and zero check data themselves are marked with the corresponding flag. Zero and span check data are invalid for further analysis, but valid data for their purpose of instrument QC. Zero and span check data are therefore replaced by invalid flags in level 1.

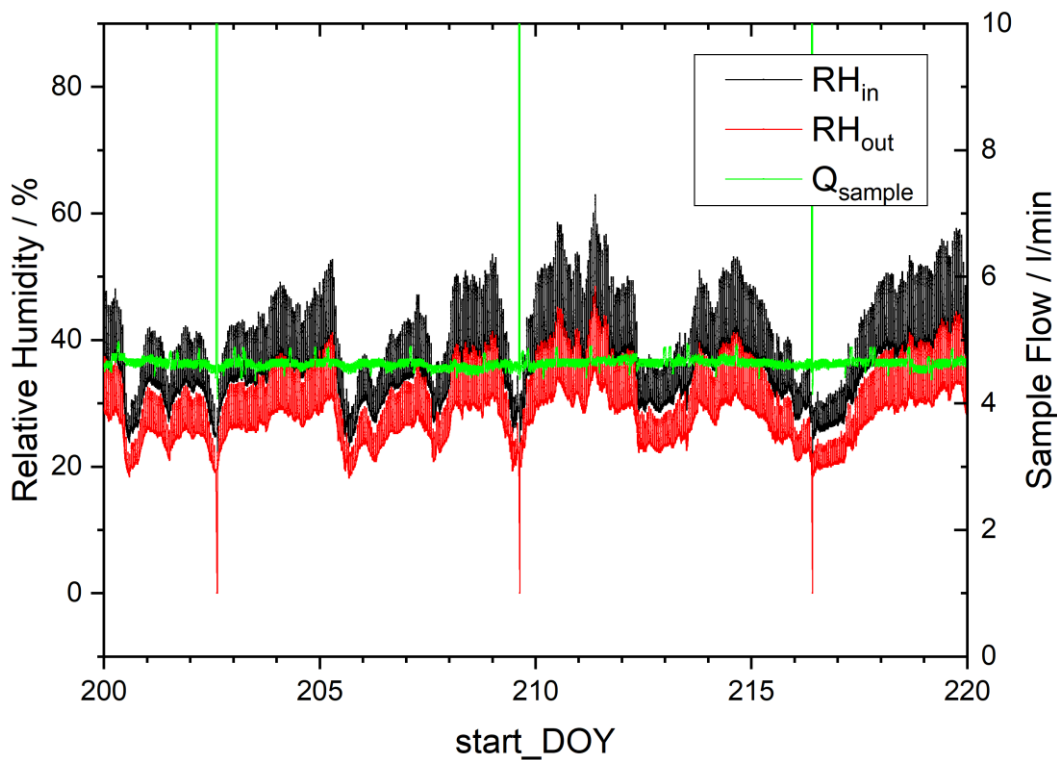


Figure 2: Spikes in RH and sample flow can occur during instrument upstart. The corresponding lines are flagged as missing (flag 999). The same applies for sample flows below 3 l/min. The relative humidity at the instrument outlet (RH_{out}) is considered to represent RH inside the measurement chamber. If it exceeds 40%, the corresponding data line is flagged with flag 640. Any occurrence of flag 640 is copied to level 1 and the corresponding hourly average in level 1.5 and 2.

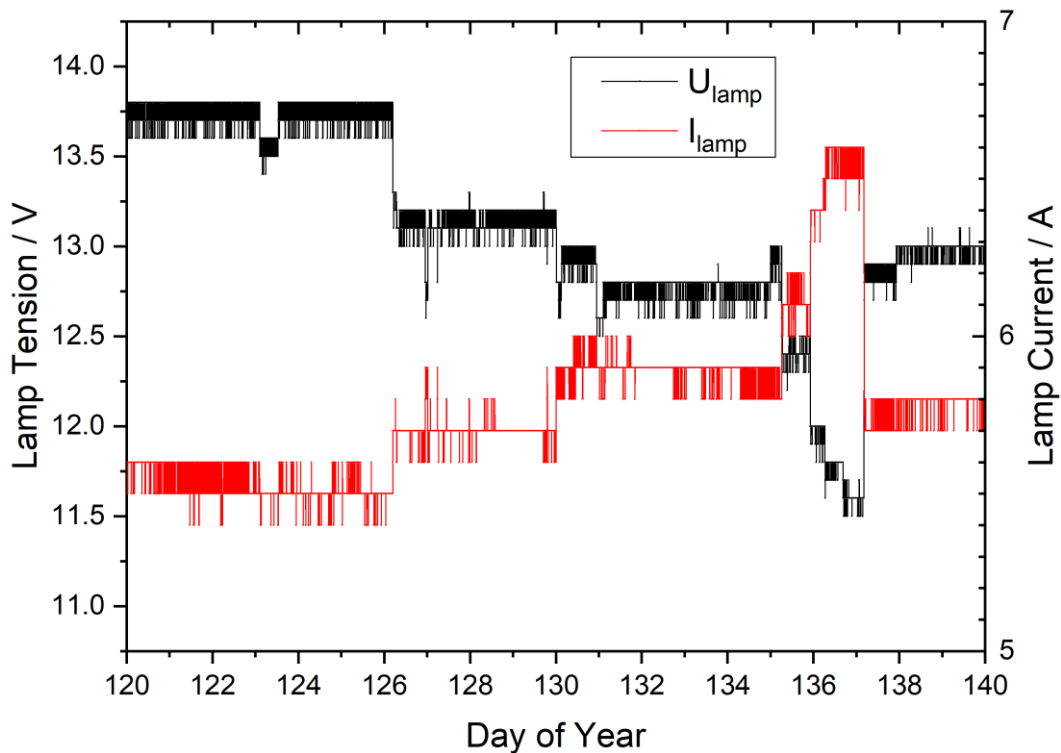


Figure 3: Lamp tension and current are monitored to prevent the lamp from failing in service. A failing lamp can cause damage to the instruments circuit boards. Exchange the lamp once the current starts to increase as shown here. In case the lamp fails in service (current drops to 0), the corresponding data lines are flagged invalid (flag 999).

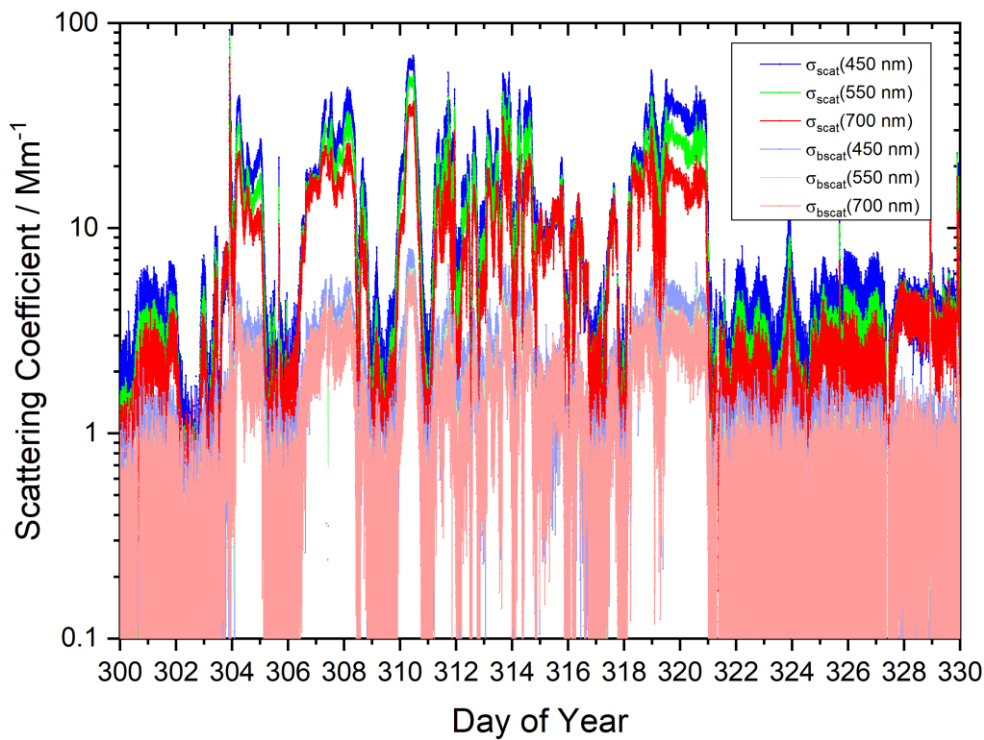


Figure 4: Time series of scattering and backscattering coefficients, excluding zero values. Inspect for spikes, sudden changes, periods of constant values, “anything out of the ordinary”, determine the cause, and flag accordingly. Spikes can be local influence (flag 559) or a faulty zero value (flag 999). Only instrument malfunctions are to be flagged invalid (flag 999), use local influence flag 559 otherwise. Sudden changes can be caused by air mass changes or instrument fault. Periods of constant values are usually due to instrument fault.

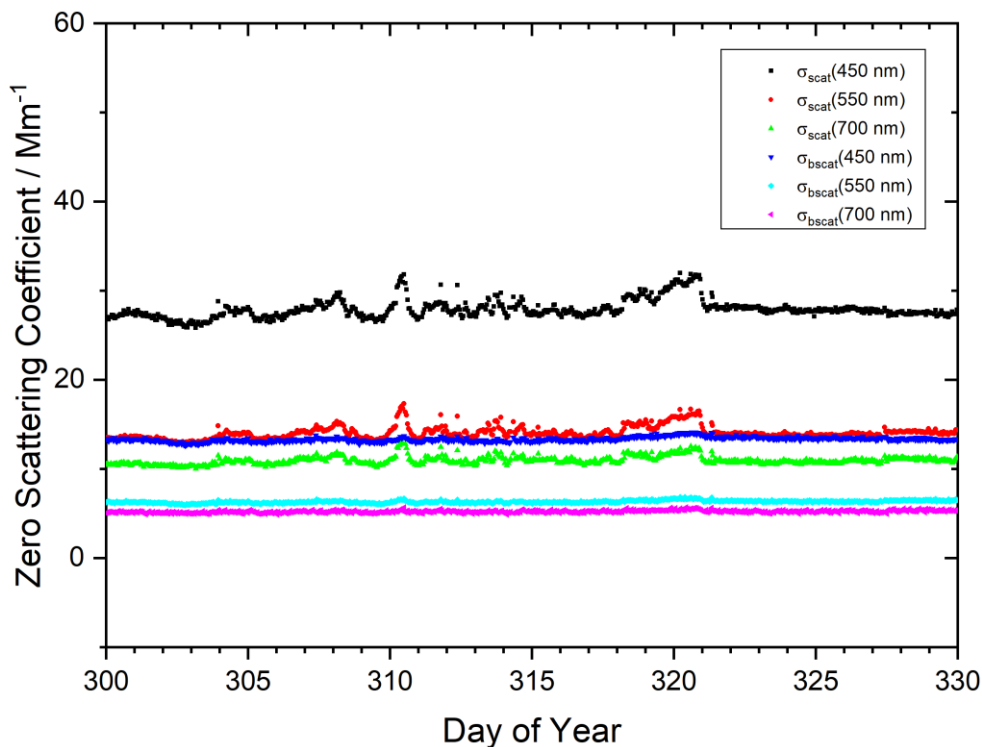


Figure 5: A plot of the zero scattering coefficients obtained during zero tests can reveal serious problems such as zero filter leaks or insufficient flushing of span gas between span check and subsequent zero check. The zero scattering coefficient normally varies only gradually. Variations as seen here are caused by a zero filter leak. Correcting such a problem is often impossible, and requires flagging the affected data sequence invalid. Insufficient span gas flushing causes a single zero scatter outlier value. In this case, only the data sequence between the faulty zero value and the next zero value needs to be flagged invalid.

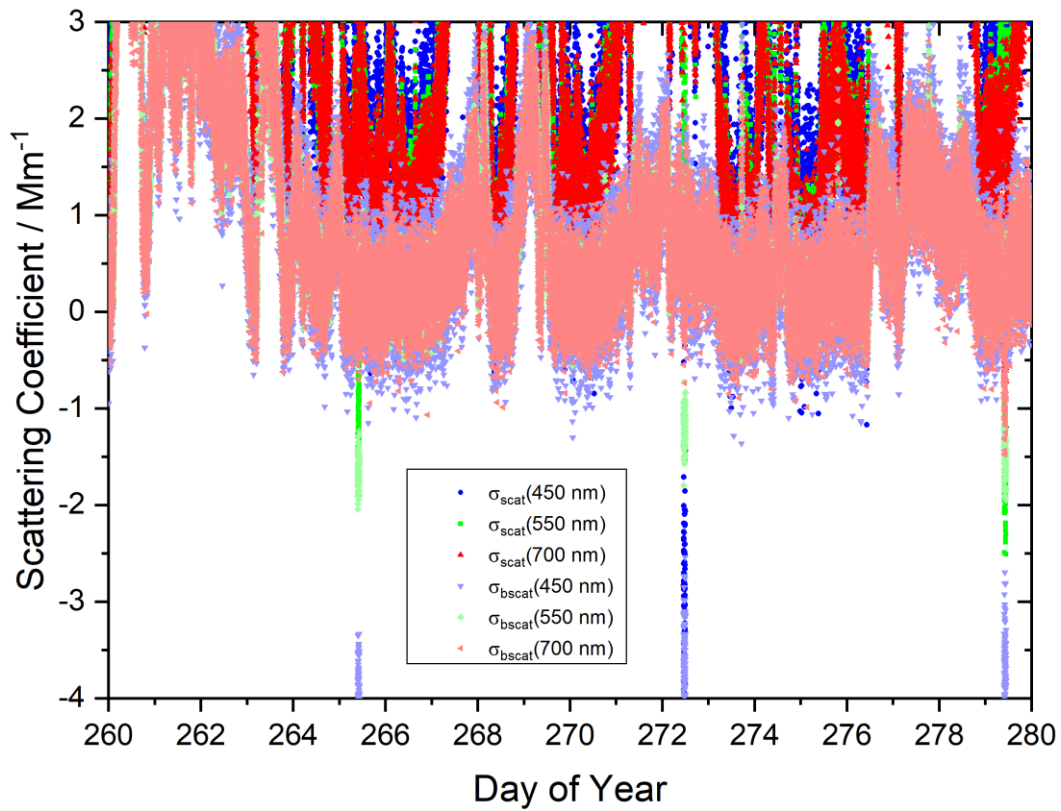


Figure 6: Time series of scattering and backscattering coefficient focussing on the value range below 0. Scattering values below 0 can occur due to statistical variations at values close to the detection limit. These values are visible as lower boundary of a “noise cloud”. Spikes below this boundary are normally caused by faulty zero measurements following insufficient flushing of span gas after span test. The data pertaining to these spikes are to be flagged missing (flag 999).