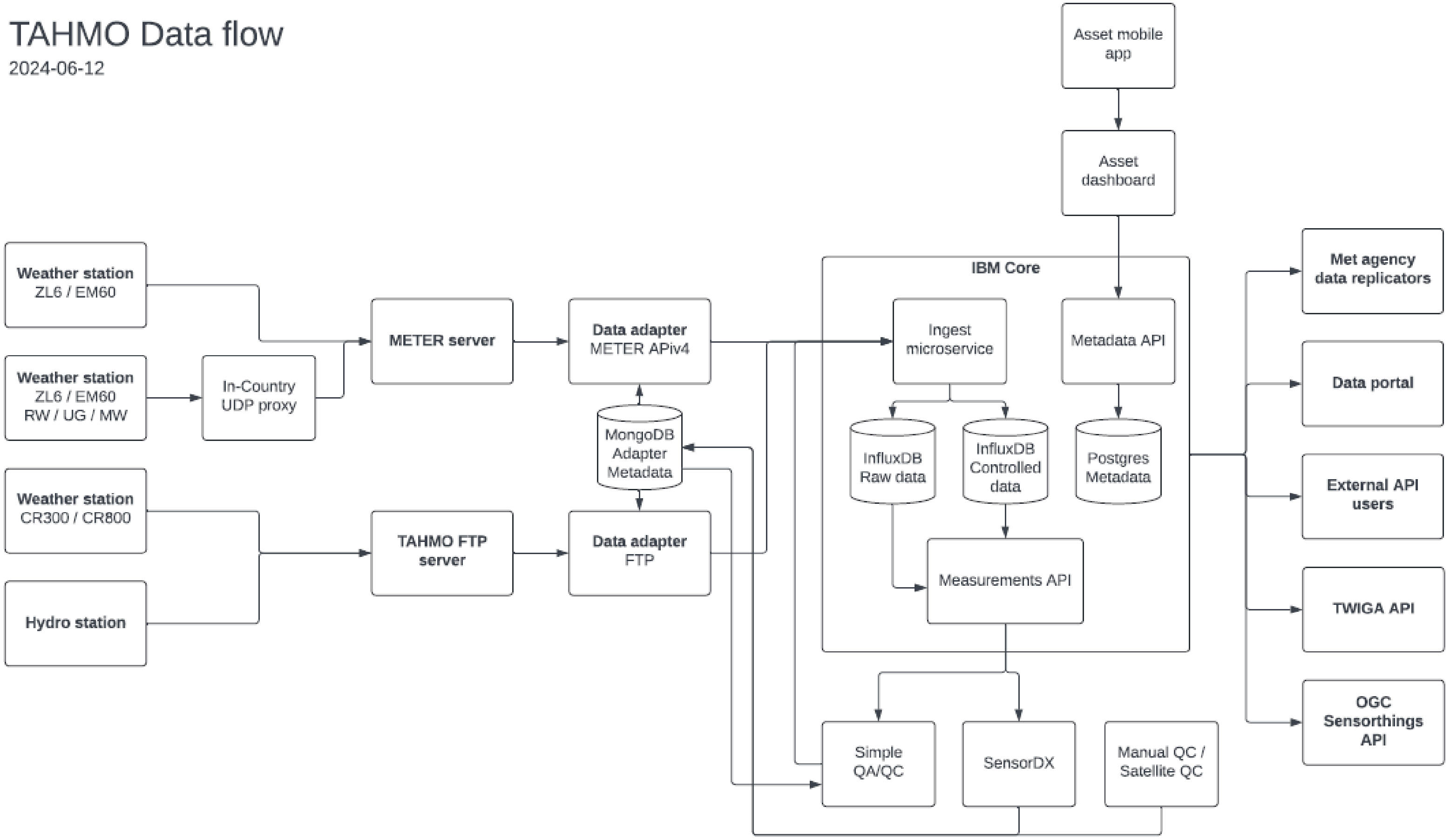
Understanding TAHMO Data Flow for QC

Tom Dietterich

Goal: Understand where QC happens

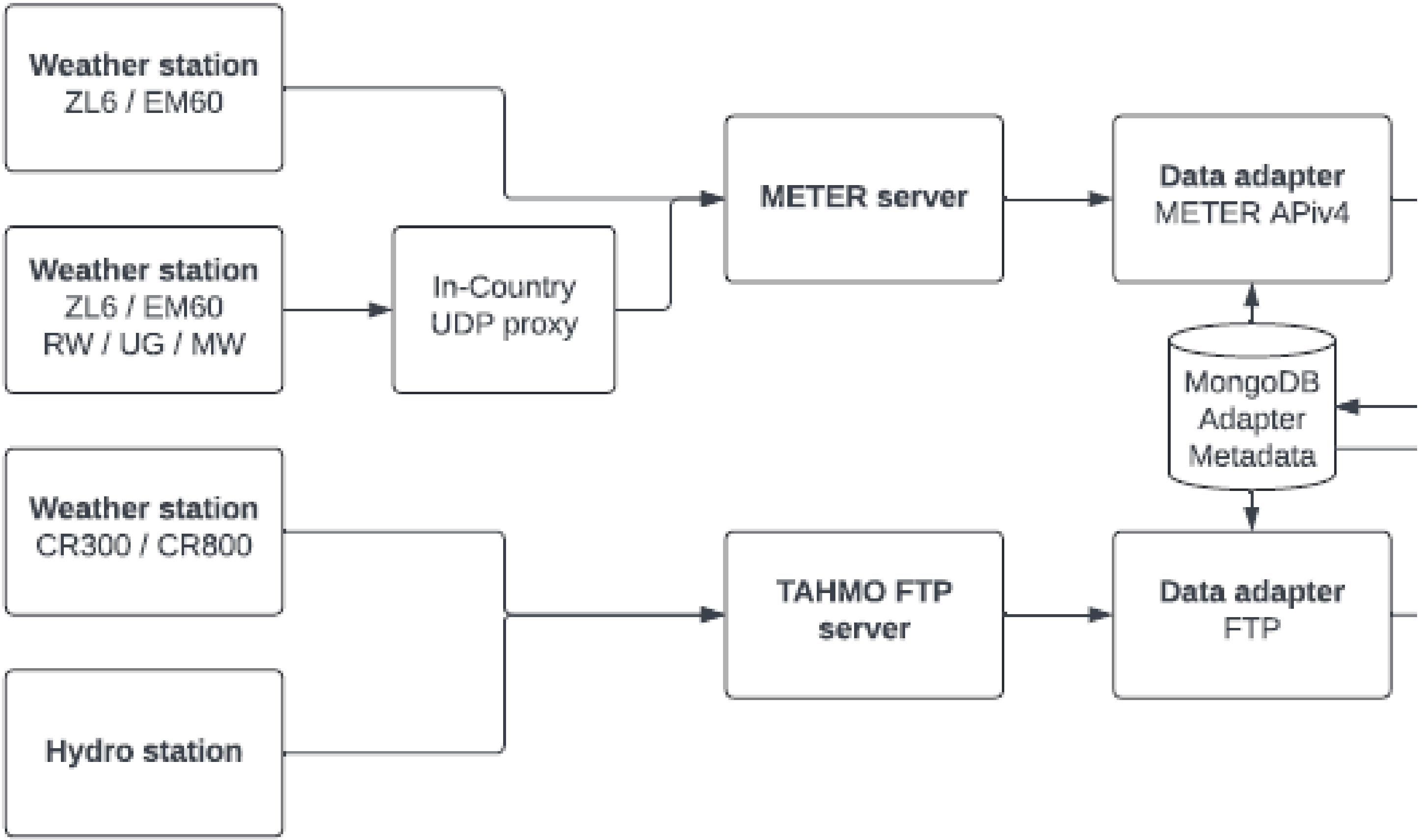


TAHMO Data flow

2024-06-12

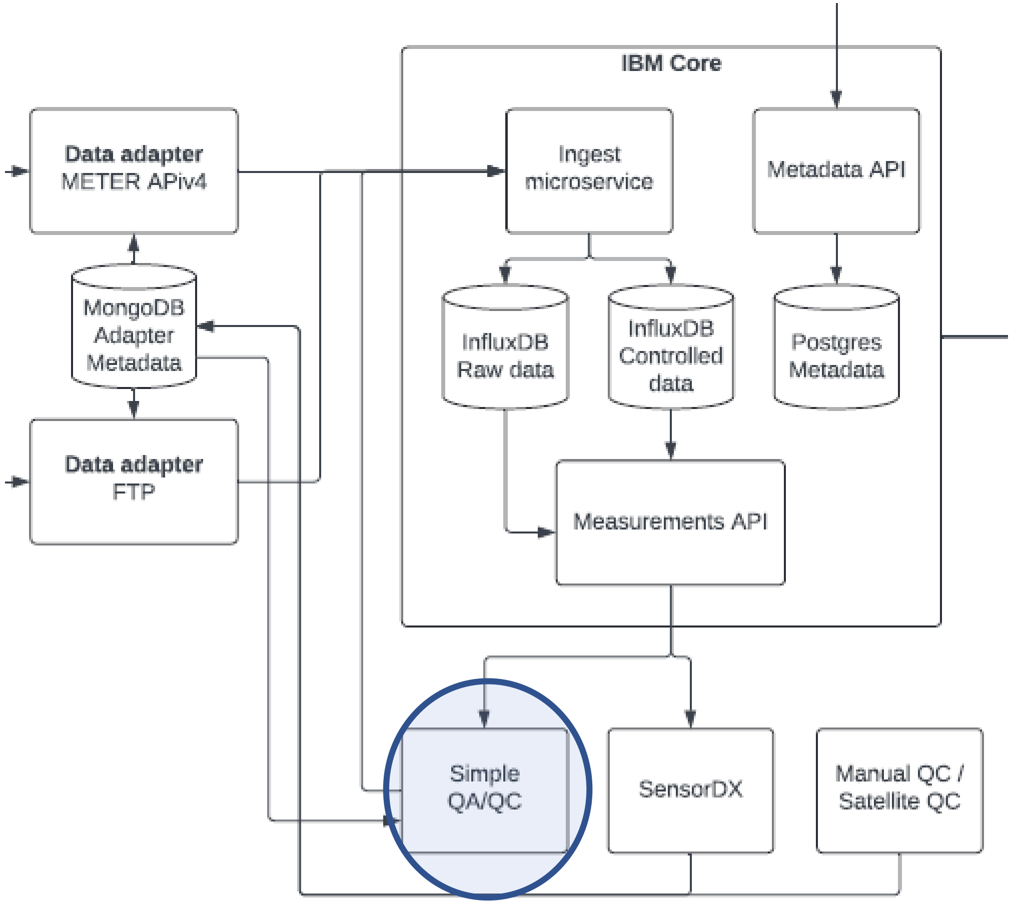
Data Acquisition

- The data loggers from various types of stations send information to TAHMO via three different paths
  - Most stations report hourly to the METER server
  - In some countries, the MET service wants the data to flow through them. “In-Country UDP proxy”
  - Some stations report directly to the TAHMO FTP server
- Note:
  - Output from the two Data adapters goes to the Ingest Microservice



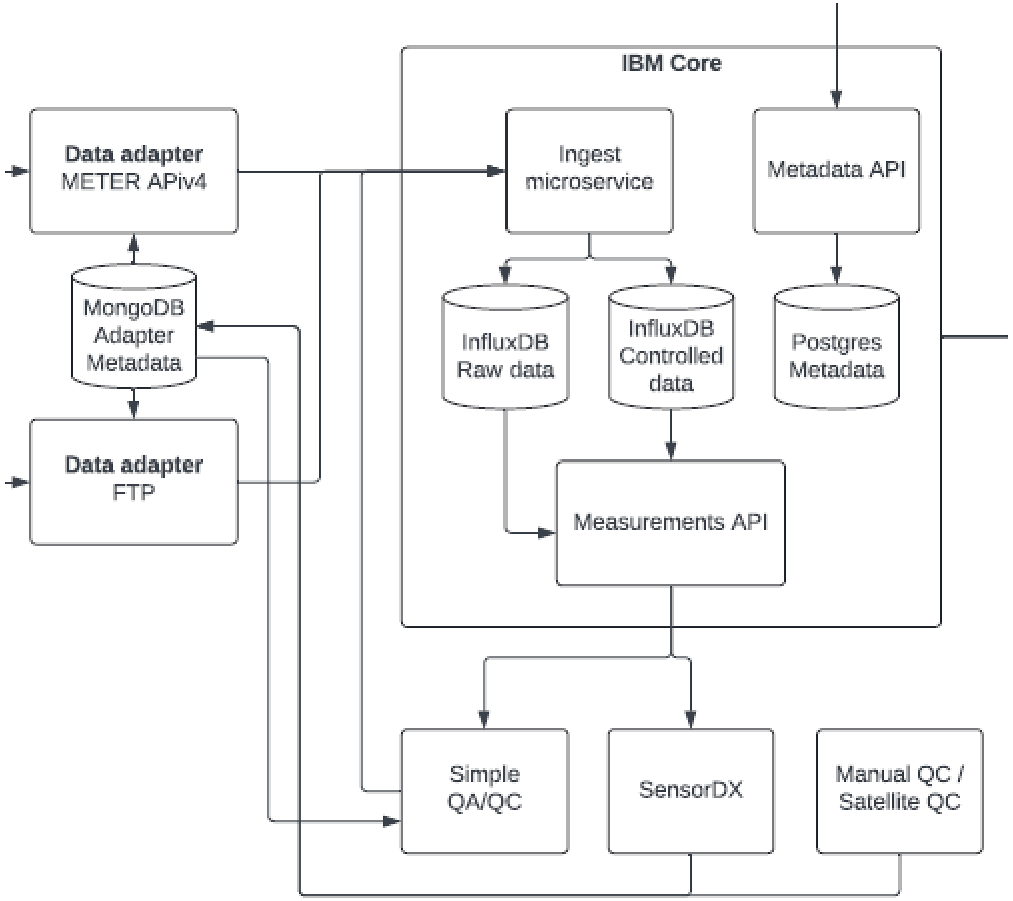
Simple QA/QC "Rule-based Checks"

- When data arrives in the InfluxDB Raw database, the Simple QA/QC system runs. It performs a variety of checks
- Range checks verify that the observation is within realistic ranges (e.g., no negative precipitation)
- Step checks verify that the observations do not exhibit sudden big changes, which are symptoms of electrical problems
- Minimum variance checks verify that the signal is real and not stuck at some constant value



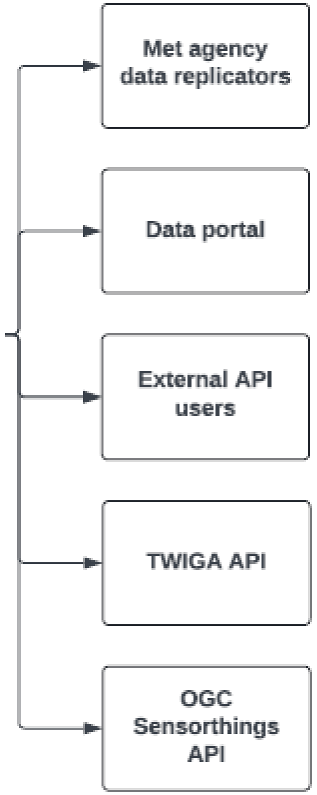
Order of Processing

- Raw data →Ingest → InfluxDB Raw data
- Simple QA/QC requests raw data, applies rule-based checks → Ingest → InfluxDB Controlled data
- SensorDX requests Controlled data and applies neighbor regression → writes output to MongoDB
- Simple QA/QC reads MongoDB and adds the relevant flags to the InfluxDB Controlled Data
- Manual/Satellite. George prepares a spreadsheet, Gilbert & Victor manually compare and create QC Objects in MongoDB. The QC Objects assign a flag of 3, and are initially “on-going”, so new data for the flagged sensor will be flagged with a 3 in the Controlled data. They also create tickets in the ticketing system
- When a technician visits the station and adds notes to the ticket, Gilbert & Victor update the QC Object.
  - If the problem was real and was repaired, they enter an end date on the QC Object.
  - If the problem was a false alarm, they change the end date to match the start date so that it has zero duration. We have discussed alternatives such as downgrading the flag to be 1.



Customer Data Access

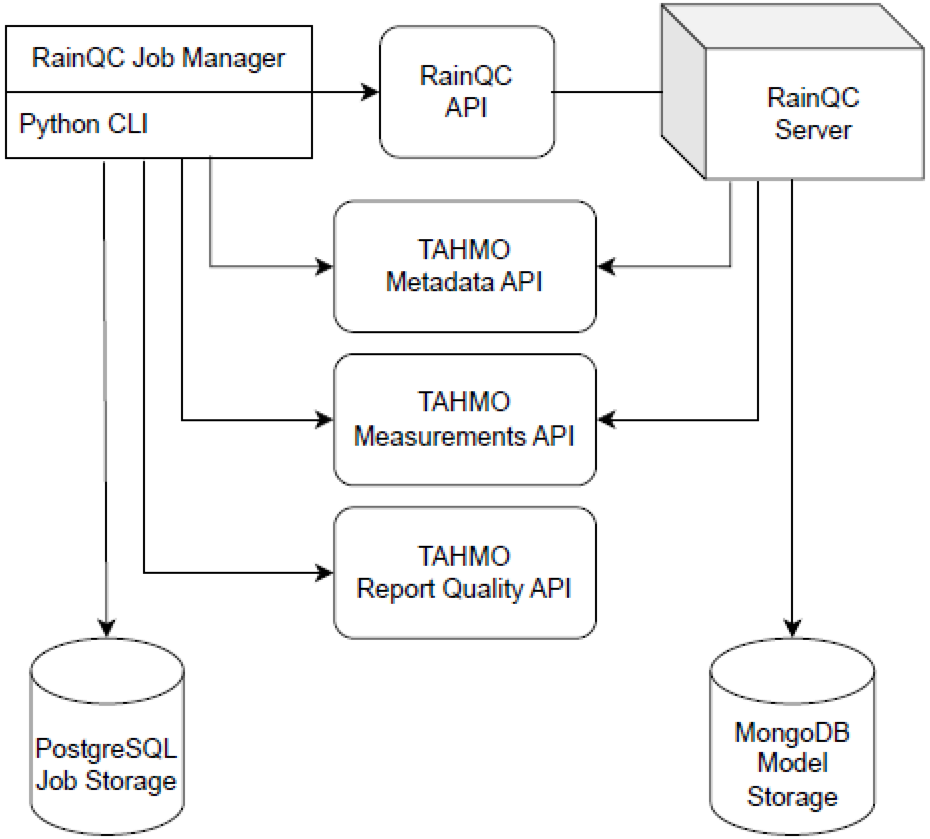
- Customers accessing data through the External API are shown data with flags 1 and 2, but data with flags 3 and 4 are not shown
- Met agencies see all of the data values



SensorDX Quality Control

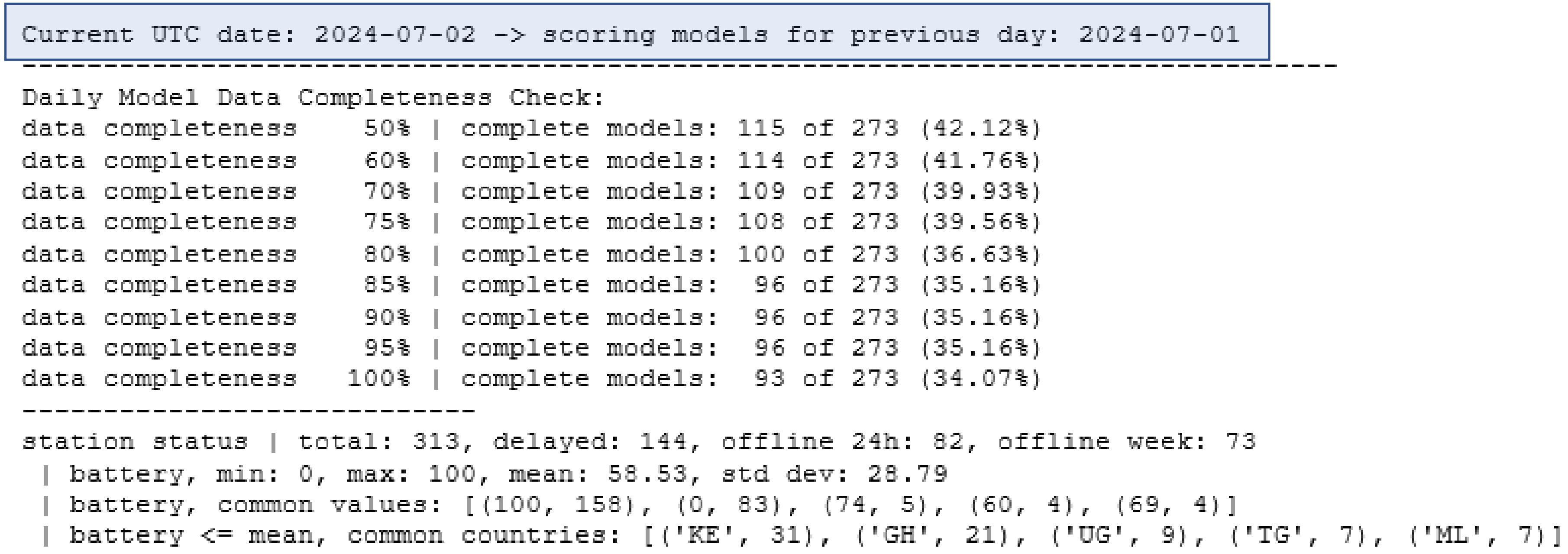
[Not to be confused with the ticketing system]

- JobManager queries RainQC API to get the list of stations having models (“target stations”) and their neighbors
- JobManager queries PostgreSQL to find list of complete and incomplete jobs from the active job table. Jobs that completed or that hit their retry limit are moved to the job history table
- JobManager creates a new job for each target station for the current day and adds them to the active job table in PostgreSQL
- JobManager creates a list of all stations that are either targets or neighbors, then queries the Measurements API to determine which jobs are “data complete”. [This is for sanity checking only.] This is based on “raw” values (does not include Simple QC processing; BUG?).
- JobManager invokes RainQC server on each job in the active job table
- RainQC server retrieves data for the target station and its neighbors from the Measurements API. RainQC uses “controlled” values.
- RainQC server computes the data quality score (1 or 2) and returns this to the Job Manager
- JobManager writes the results to the Report Quality API
- JobManager updates the PostgreSQL active job table to indicate which jobs succeeded and which failed. The failed jobs will be re-tried the next day



Explanation of the Daily JobManager report

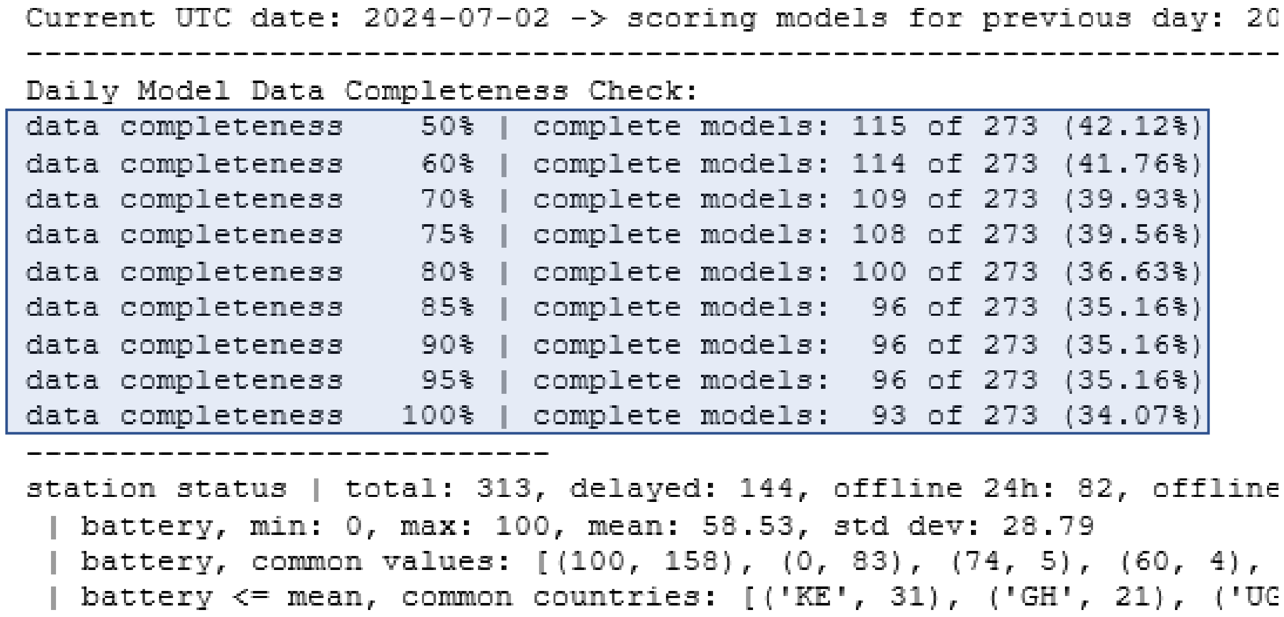
- Indicates which date is being scored
- Note: the Job Manager is stateful, rerunning it will create new jobs. There is a command line flag to prevent this



```
Current UTC date: 2024-07-02 -> scoring models for previous day: 2024-07-01
--------------------------------------------------------------------------------
Daily Model Data Completeness Check:
data completeness    50% | complete models: 115 of 273 (42.12%)
data completeness    60% | complete models: 114 of 273 (41.76%)
data completeness    70% | complete models: 109 of 273 (39.93%)
data completeness    75% | complete models: 108 of 273 (39.56%)
data completeness    80% | complete models: 100 of 273 (36.63%)
data completeness    85% | complete models:  96 of 273 (35.16%)
data completeness    90% | complete models:  96 of 273 (35.16%)
data completeness    95% | complete models:  96 of 273 (35.16%)
data completeness   100% | complete models:  93 of 273 (34.07%)
----------------------------
station status | total: 313, delayed: 144, offline 24h: 82, offline week: 73
 | battery, min: 0, max: 100, mean: 58.53, std dev: 28.79
 | battery, common values: [(100, 158), (0, 83), (74, 5), (60, 4), (69, 4)]
 | battery <= mean, common countries: [('KE', 31), ('GH', 21), ('UG', 9), ('TG', 7), ('ML', 7)]
```

Explanation of the Daily JobManager report

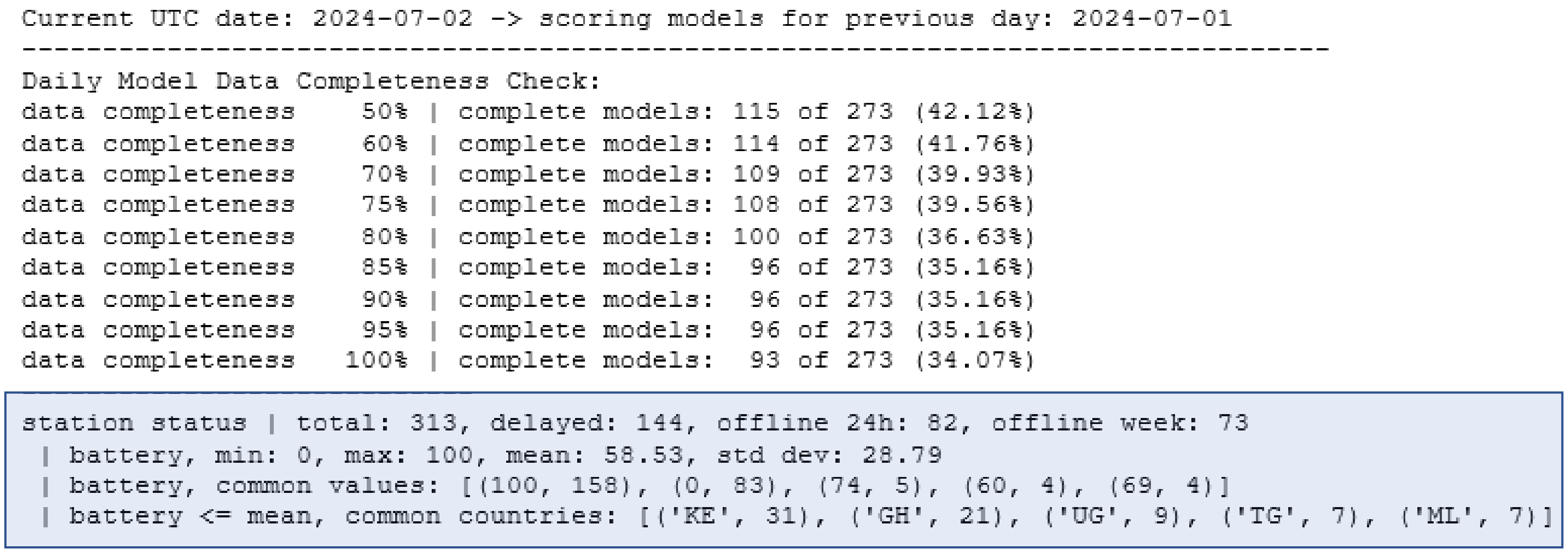
- What fraction of models (target stations) are data complete?
- I watch the 100% completeness number as an overall indication of network health
- A job is 100% data complete if the target and all of its neighbors reported 288 values (for most stations)
- A job is 80% data complete if the target and all of its neighbors reported 230 = 0.8×288 values, etc.



```
Current UTC date: 2024-07-02 -> scoring models for previous day: 20
-------------------------------------------------------------------
Daily Model Data Completeness Check:
data completeness    50% | complete models: 115 of 273 (42.12%)
data completeness    60% | complete models: 114 of 273 (41.76%)
data completeness    70% | complete models: 109 of 273 (39.93%)
data completeness    75% | complete models: 108 of 273 (39.56%)
data completeness    80% | complete models: 100 of 273 (36.63%)
data completeness    85% | complete models:  96 of 273 (35.16%)
data completeness    90% | complete models:  96 of 273 (35.16%)
data completeness    95% | complete models:  96 of 273 (35.16%)
data completeness   100% | complete models:  93 of 273 (34.07%)
----------------------------
station status | total: 313, delayed: 144, offline 24h: 82, offline
  | battery, min: 0, max: 100, mean: 58.53, std dev: 28.79
  | battery, common values: [(100, 158), (0, 83), (74, 5), (60, 4),
  | battery <= mean, common countries: [('KE', 31), ('GH', 21), ('UG
```

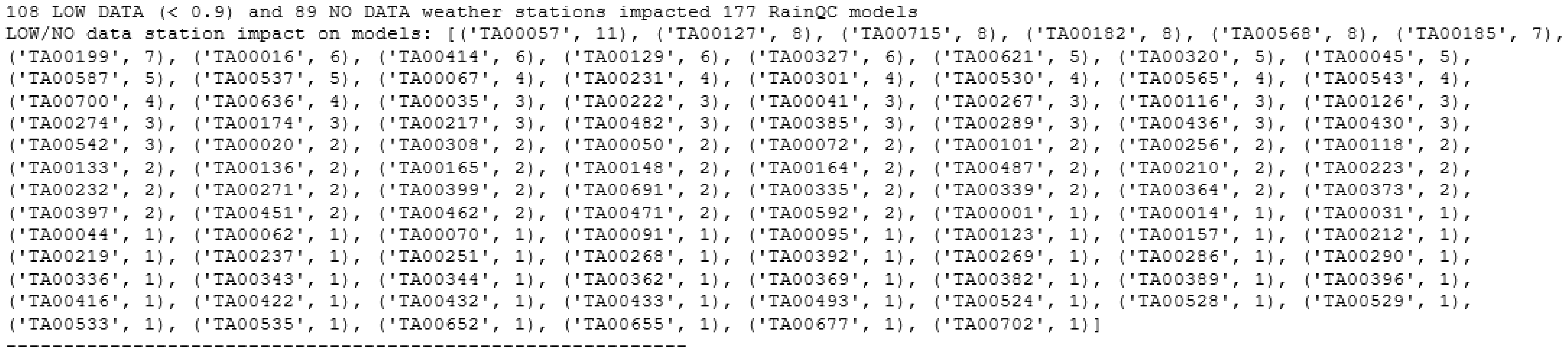
Explanation of the Daily JobManager report

- General status information (not required by JobManager, but it was easy to show)
- “total” is the total number of stations that are involved in the scoring (either as targets or neighbors)



```
Current UTC date: 2024-07-02 -> scoring models for previous day: 2024-07-01
---------------------------------------------------------------------------------
Daily Model Data Completeness Check:
data completeness    50% | complete models: 115 of 273 (42.12%)
data completeness    60% | complete models: 114 of 273 (41.76%)
data completeness    70% | complete models: 109 of 273 (39.93%)
data completeness    75% | complete models: 108 of 273 (39.56%)
data completeness    80% | complete models: 100 of 273 (36.63%)
data completeness    85% | complete models:  96 of 273 (35.16%)
data completeness    90% | complete models:  96 of 273 (35.16%)
data completeness    95% | complete models:  96 of 273 (35.16%)
data completeness   100% | complete models:  93 of 273 (34.07%)
station status | total: 313, delayed: 144, offline 24h: 82, offline week: 73
 | battery, min: 0, max: 100, mean: 58.53, std dev: 28.79
 | battery, common values: [(100, 158), (0, 83), (74, 5), (60, 4), (69, 4)]
 | battery <= mean, common countries: [('KE', 31), ('GH', 21), ('UG', 9), ('TG', 7), ('ML', 7)]
```

Number of targets affected by low-data stations

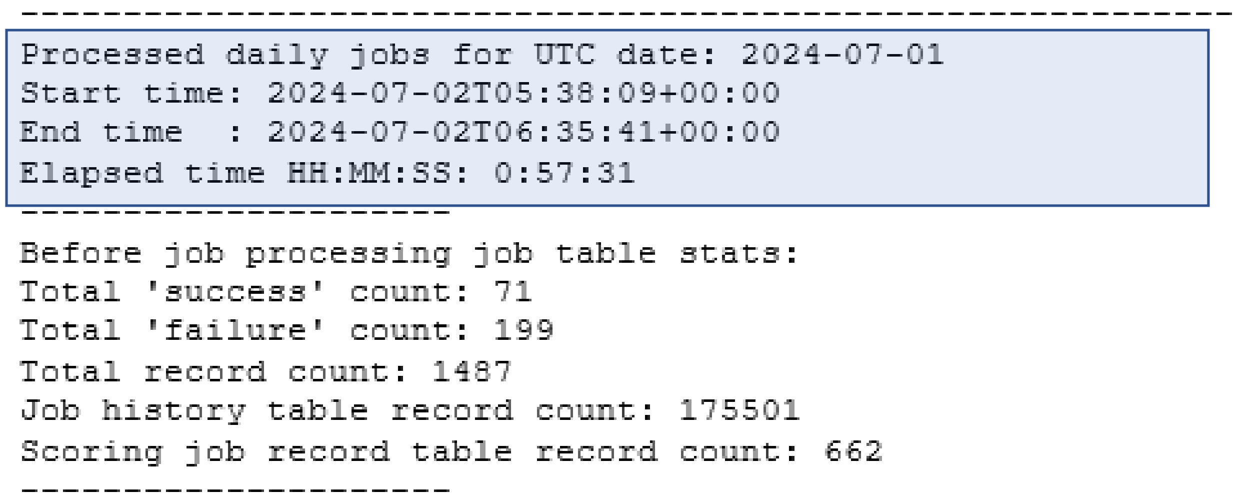


```
108 LOW DATA (< 0.9) and 89 NO DATA weather stations impacted 177 RainQC models
LOW/NO data station impact on models: [('TA00057', 11), ('TA00127', 8), ('TA00715', 8), ('TA00182', 8), ('TA00568', 8), ('TA00185', 7),
('TA00199', 7), ('TA00016', 6), ('TA00414', 6), ('TA00129', 6), ('TA00327', 6), ('TA00621', 5), ('TA00320', 5), ('TA00045', 5),
('TA00587', 5), ('TA00537', 5), ('TA00067', 4), ('TA00231', 4), ('TA00301', 4), ('TA00530', 4), ('TA00565', 4), ('TA00543', 4),
('TA00700', 4), ('TA00636', 4), ('TA00035', 3), ('TA00222', 3), ('TA00041', 3), ('TA00267', 3), ('TA00116', 3), ('TA00126', 3),
('TA00274', 3), ('TA00174', 3), ('TA00217', 3), ('TA00482', 3), ('TA00385', 3), ('TA00289', 3), ('TA00436', 3), ('TA00430', 3),
('TA00542', 3), ('TA00020', 2), ('TA00308', 2), ('TA00050', 2), ('TA00072', 2), ('TA00101', 2), ('TA00256', 2), ('TA00118', 2),
('TA00133', 2), ('TA00136', 2), ('TA00165', 2), ('TA00148', 2), ('TA00164', 2), ('TA00487', 2), ('TA00210', 2), ('TA00223', 2),
('TA00232', 2), ('TA00271', 2), ('TA00399', 2), ('TA00691', 2), ('TA00335', 2), ('TA00339', 2), ('TA00364', 2), ('TA00373', 2),
('TA00397', 2), ('TA00451', 2), ('TA00462', 2), ('TA00471', 2), ('TA00592', 2), ('TA00001', 1), ('TA00014', 1), ('TA00031', 1),
('TA00044', 1), ('TA00062', 1), ('TA00070', 1), ('TA00091', 1), ('TA00095', 1), ('TA00123', 1), ('TA00157', 1), ('TA00212', 1),
('TA00219', 1), ('TA00237', 1), ('TA00251', 1), ('TA00268', 1), ('TA00392', 1), ('TA00269', 1), ('TA00286', 1), ('TA00290', 1),
('TA00336', 1), ('TA00343', 1), ('TA00344', 1), ('TA00362', 1), ('TA00369', 1), ('TA00382', 1), ('TA00389', 1), ('TA00396', 1),
('TA00416', 1), ('TA00422', 1), ('TA00432', 1), ('TA00433', 1), ('TA00493', 1), ('TA00524', 1), ('TA00528', 1), ('TA00529', 1),
('TA00533', 1), ('TA00535', 1), ('TA00652', 1), ('TA00655', 1), ('TA00677', 1), ('TA00702', 1)]
-----------------------------------------------------------
```

- Example: TA00199 is used as a neighbor or target for 7 models, so it prevented 7 target stations from being scored
- This is for general information only, but it suggests that TA00199 should be a high priority to fix, if possible

Session Summary

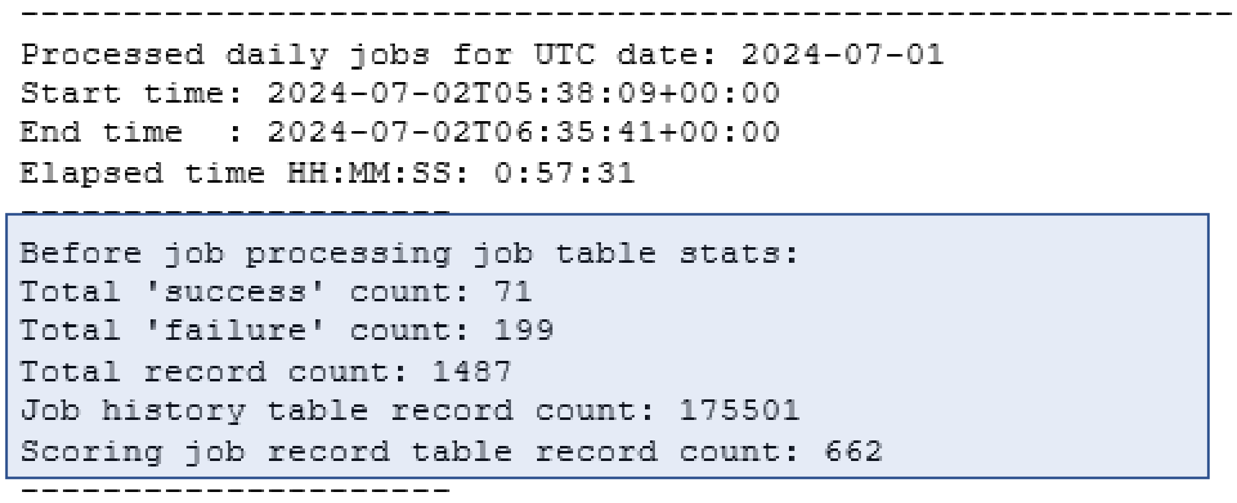
- Total time for RainQC scoring: 57 minutes + 31 seconds



```
------------------------------------------------------------
Processed daily jobs for UTC date: 2024-07-01
Start time: 2024-07-02T05:38:09+00:00
End time  : 2024-07-02T06:35:41+00:00
Elapsed time HH:MM:SS: 0:57:31
---------------------
Before job processing job table stats:
Total 'success' count: 71
Total 'failure' count: 199
Total record count: 1487
Job history table record count: 175501
Scoring job record table record count: 662
---------------------
```

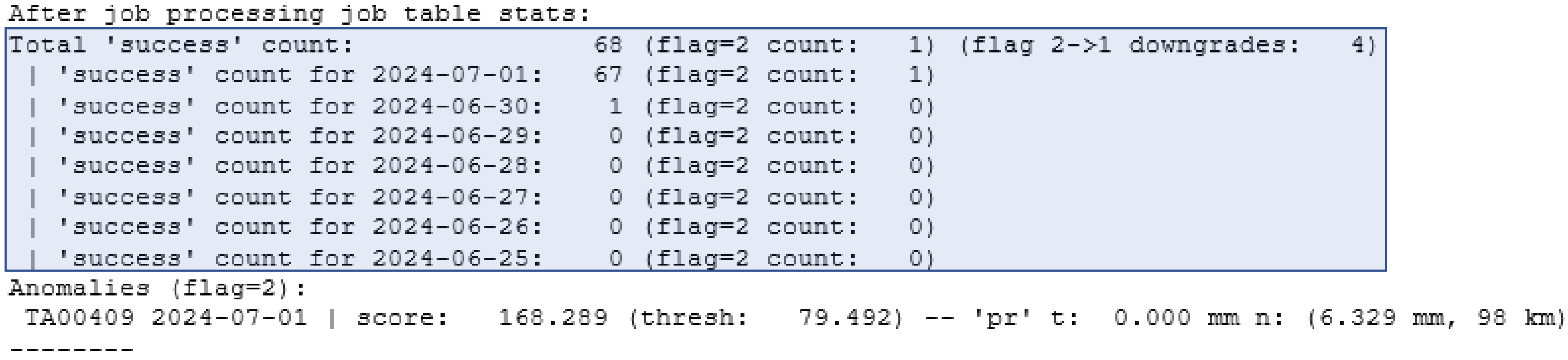
Session Summary

- The PostgreSQL database has two tables
  - Active Jobs table
  - History table
- At the start of this run, the active jobs table contained 71 jobs that succeeded in the previous day’s run and 199 jobs that have failed in previous days (up to 7 days)
- Job history table record count is the total number of jobs that have been created since the database was initialized. This will just keep growing
- I don’t know what the “Scoring job record table” is



```
-----------------------------------------------------------
Processed daily jobs for UTC date: 2024-07-01
Start time: 2024-07-02T05:38:09+00:00
End time  : 2024-07-02T06:35:41+00:00
Elapsed time HH:MM:SS: 0:57:31
---------------------
Before job processing job table stats:
Total 'success' count: 71
Total 'failure' count: 199
Total record count: 1487
Job history table record count: 175501
Scoring job record table record count: 662
---------------------
```

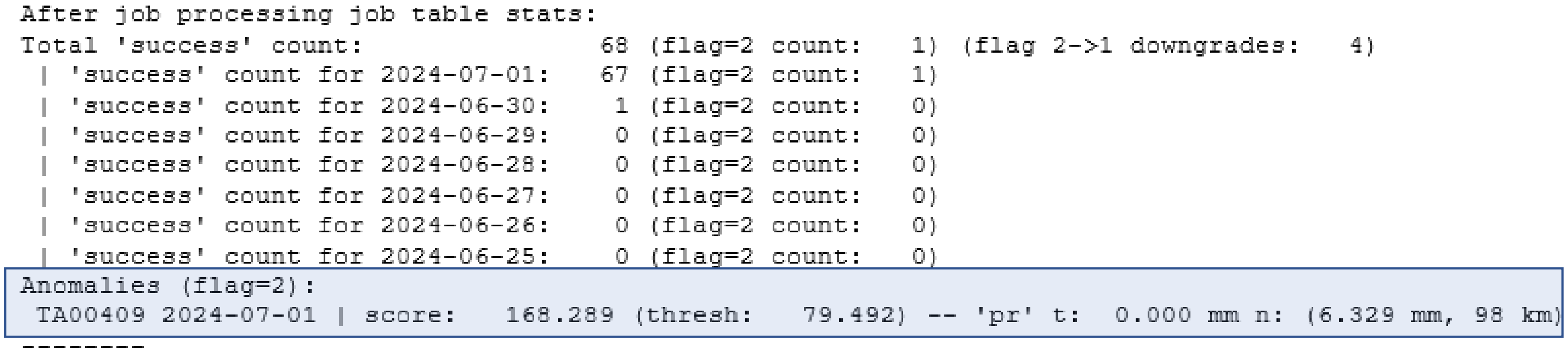
Job Results Table



```
After job processing job table stats:
Total 'success' count:              68 (flag=2 count:   1) (flag 2->1 downgrades:   4)
 | 'success' count for 2024-07-01:   67 (flag=2 count:   1)
 | 'success' count for 2024-06-30:    1 (flag=2 count:   0)
 | 'success' count for 2024-06-29:    0 (flag=2 count:   0)
 | 'success' count for 2024-06-28:    0 (flag=2 count:   0)
 | 'success' count for 2024-06-27:    0 (flag=2 count:   0)
 | 'success' count for 2024-06-26:    0 (flag=2 count:   0)
 | 'success' count for 2024-06-25:    0 (flag=2 count:   0)
Anomalies (flag=2):
 TA00409 2024-07-01 | score:   168.289 (thresh:   79.492) -- 'pr' t:  0.000 mm n: (6.329 mm, 98 km)
--------
```

- 68 jobs were successfully run
  - 67 for today
  - 1 left over from yesterday
- Two flag = 2 (“inconsistent”) QC flags were reported
- Four stations scored as “anomalous” (flag 2) by the neighbor regression model were “downgraded” (flag 1) by a special rule that detects and removes false alarms involving low, but non-zero, precipitation values
  - Rule 1: If target and neighbors all reported <= 1.0 mm, then convert flag 2 to flag 1
  - Rule 2: If target and neighbors all reported <= 5.0 mm, then convert flag 2 to flag 1
  - The rule is selected in the call to RainQC (??)

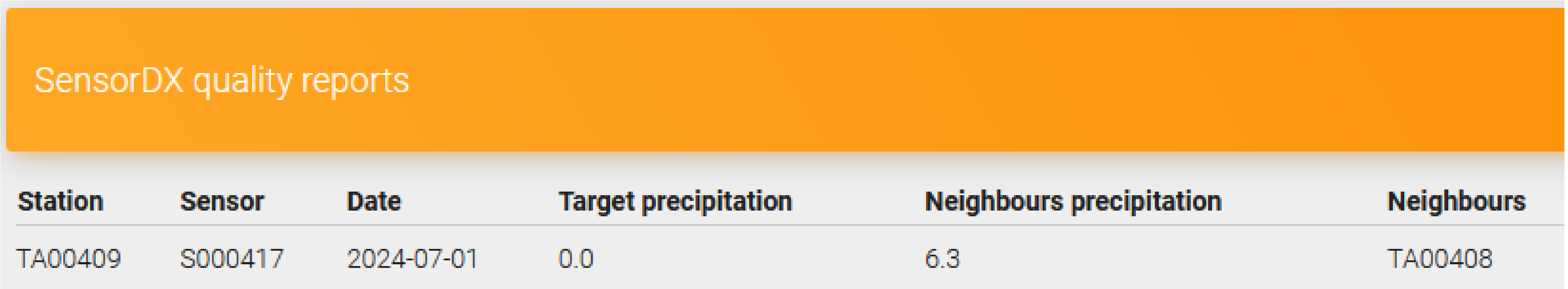
Most important result: List of flagged stations



```
After job processing job table stats:
Total 'success' count:               68 (flag=2 count:   1) (flag 2->1 downgrades:   4)
 | 'success' count for 2024-07-01:   67 (flag=2 count:   1)
 | 'success' count for 2024-06-30:    1 (flag=2 count:   0)
 | 'success' count for 2024-06-29:    0 (flag=2 count:   0)
 | 'success' count for 2024-06-28:    0 (flag=2 count:   0)
 | 'success' count for 2024-06-27:    0 (flag=2 count:   0)
 | 'success' count for 2024-06-26:    0 (flag=2 count:   0)
 | 'success' count for 2024-06-25:    0 (flag=2 count:   0)
Anomalies (flag=2):
 TA00409 2024-07-01 | score:   168.289 (thresh:   79.492) -- 'pr' t:  0.000 mm n: (6.329 mm, 98 km)
--------
```

- TA00409 was flagged as 2.
  - Score: 168.289 is an anomaly score assigned by the model
  - Thresh: is the anomaly threshold (also computed by the model)
  - Because 168.289 > 79.492, this is flagged as 2
  - Measured precipitation (‘pr’) was 0.000 mm
  - There is one neighboring station 98km away, and it reported 6.329mm

Asset Dashboard / Sensordx

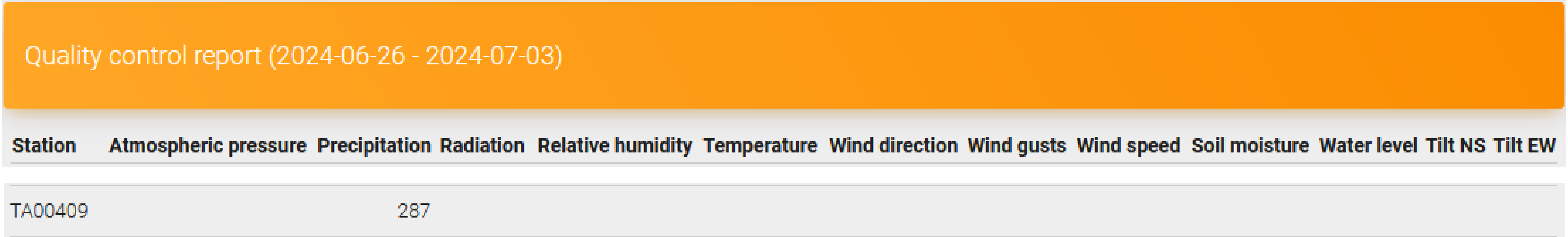


SensorDX quality reports

Station	Sensor	Date	Target precipitation	Neighbours precipitation	Neighbours
TA00409	S000417	2024-07-01	0.0	6.3	TA00408

- The results also appear here
- However, here the station ids are listed, but not the distances
- In the jobmanager report, the distances are listed, but not the station ids

Total flags are also summarized in assetdashboard/qc



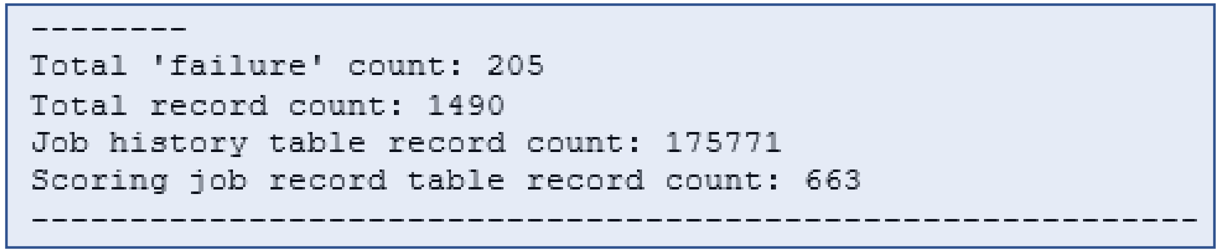
Quality control report (2024-06-26 - 2024-07-03)

Station	Atmospheric pressure	Precipitation	Radiation	Relative humidity	Temperature	Wind direction	Wind gusts	Wind speed	Soil moisture	Water level	Tilt NS	Tilt EW
TA00409		287										

- I don’t see how TA00409 could have been flagged 287 times in just one week. Rick?
- Neither dashboard is sortable or searchable
- No linkage to a time series of the ‘pr’ readings plotted along with the neighbors (e.g., as a double mass plot or parallel time series plot)

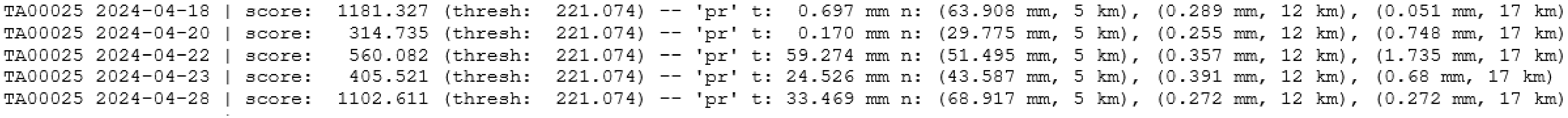
Job table statistics after scoring

- Failure count = number of jobs that hit the retry limit
- 1490 – 205 = 1285 jobs need to be retried



```
--------
Total 'failure' count: 205
Total record count: 1490
Job history table record count: 175771
Scoring job record table record count: 663
-----------------------------------------------------------
```

Monthly Summary



```
TA00025 2024-04-18 | score:  1181.327 (thresh:  221.074) -- 'pr' t:  0.697 mm n: (63.908 mm, 5 km), (0.289 mm, 12 km), (0.051 mm, 17 km)
TA00025 2024-04-20 | score:   314.735 (thresh:  221.074) -- 'pr' t:  0.170 mm n: (29.775 mm, 5 km), (0.255 mm, 12 km), (0.748 mm, 17 km)
TA00025 2024-04-22 | score:   560.082 (thresh:  221.074) -- 'pr' t: 59.274 mm n: (51.495 mm, 5 km), (0.357 mm, 12 km), (1.735 mm, 17 km)
TA00025 2024-04-23 | score:   405.521 (thresh:  221.074) -- 'pr' t: 24.526 mm n: (43.587 mm, 5 km), (0.391 mm, 12 km), (0.68 mm, 17 km)
TA00025 2024-04-28 | score:  1102.611 (thresh:  221.074) -- 'pr' t: 33.469 mm n: (68.917 mm, 5 km), (0.272 mm, 12 km), (0.272 mm, 17 km)
```

- Michael produces a monthly summary report. It is controlled by a command line flag on the Job Manager
- For each station, it prints one row for each day that station was flagged
- In this example, TA00025 was flagged 5 times in April
  - The first two times, TA00025 reported low precipitation when one of its neighbors was reporting high values
  - The final three times, TA00025 reported large values when two of its neighbors were reporting small values
    - These look like false alarms to me

Improving the QC Dashboard

- Our current web pages are not meeting the needs of Gilbert and Victor. This is causing them to do a lot of manual copying and pasting to build their own spreadsheet tables
- Some UI ideas:
    - Overview web page
        - Sort stations into two groups:
            - Stations with one or more outstanding tickets and no new problems
            - Stations for which a new problem has been flagged
                - Note that these stations might have existing tickets, but the new problem is not mentioned in the existing tickets
        - Within these groups, sort by some notion of "severity" (e.g., number of days with flagged observations, number of days offline)
    - Detailed web page: Shows data for a single station
        - Data browser:
            - Show time series for one or more sensors
            - Show time series for those same sensors on nearby stations
            - Show technician or host visits to the station
        - Issue browser:
            - Show existing open and closed issues for this station. Ability to examine the issue, edit it, and close the issue. Ability to open the associated QC Objects and update them
        - Station summary:
            - Station type/generation, installation date, data logger type, installation date
            - Host contact information
        - Button to create an issue and pre-fill the relevant fields