Unpacking and Demystifying ARM Standardized QC

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ALWG Translator: Connor Flynn

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Outline

- Instrument data QC challenges
  - Easy – threshold checks applied to data values
  - Harder – indeterminate data.
- Value-Added Processing (VAP) QC challenges
- Challenges in forging a common standard
  - Lack of definition of what constitutes “QC”
  - Mutually exclusive requirements of different users
- The current standard:
  - Includes a concise **definition of “QC”**
  - **Simplifies interpretation**
  - **Facilitates automation**

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Instrument-level flags: “Mentor QC”

Immediate real-time indicators of data quality.

Simple design for automation

- Min / max / delta checks
  - Provided for each field of interest.
  - These checks apply only to the parent field.
  - E.g., qc for data field named “RH” would be named “qc_RH” and would record results of threshold tests of that field alone. For instance valid_min = 0 and valid max = 100 in this case.
- Obviously not the answer to all data quality issues.
  - Doesn’t consider relevant house-keeping data.
  - May be difficult to express useful threshold for some fields. CBH
  - Reflectivity or backscatter, multi-dimension fields in general.

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VAP QC: much broader scope

- As post-processed products VAPs have access to wider range of information to assess data quality.
  - Related house-keeping fields within input data stream
  - Pertinent measurements in other data streams
  - Application of physical or model based constraints
  - Noise estimation
  - And so on…
- But because many VAPs were first-of-a-kind efforts representing unique products QC was not reported in uniform or consistent formats.
- Moreover, some VAPs retrieved quantities for which no direct validation was apparent, so quality assessment was sometimes deferred to later comparisons.

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No consensus on what constitutes QC.

There is an abundance of different types of meta data and data information in ARM data files, but not all are “QC”.

- Status information
- Sentinel values
- Relative “Quality Metrics”

RESOLVED:

- Quality Check: T/F test pertaining to data quality

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How to satisfy competing requirements?

Requirements on QC standard:

- Comprehensive and complete
- Rigid format for automation
- Easy to use/interpret for data users.

Essentially each identified QC test includes:

1. A proscribed form of QC tests as T/F expressions with "T" indicating a failed test. Eg, data < valid_min.
2. An explicit statement of the implications of the test on the data quality. That is, does a failed test indicate the data is merely suspect or that it is truly bad.

In addition we defined a means of "distilling" the detailed QC information into a final summary file.

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Example of a QC field definition:

- Description: This field contains bit packed values which should be interpreted as listed. No bits set (zero) represents good data.
- bit_1_description: “aerosol_optical_depth_filter2 value < 0.0”
- bit_1_assessment Bad
- bit_2_description solar_zenith_angle > 90,
- bit_2_assessment Bad
- bit_3_description total_optical_depth_filter1 < 0
- bit_3_assessment Bad
- bit_4_description solar_zenith_angle > 84
- bit_4_assessment Indeterminate
- … etcetera…

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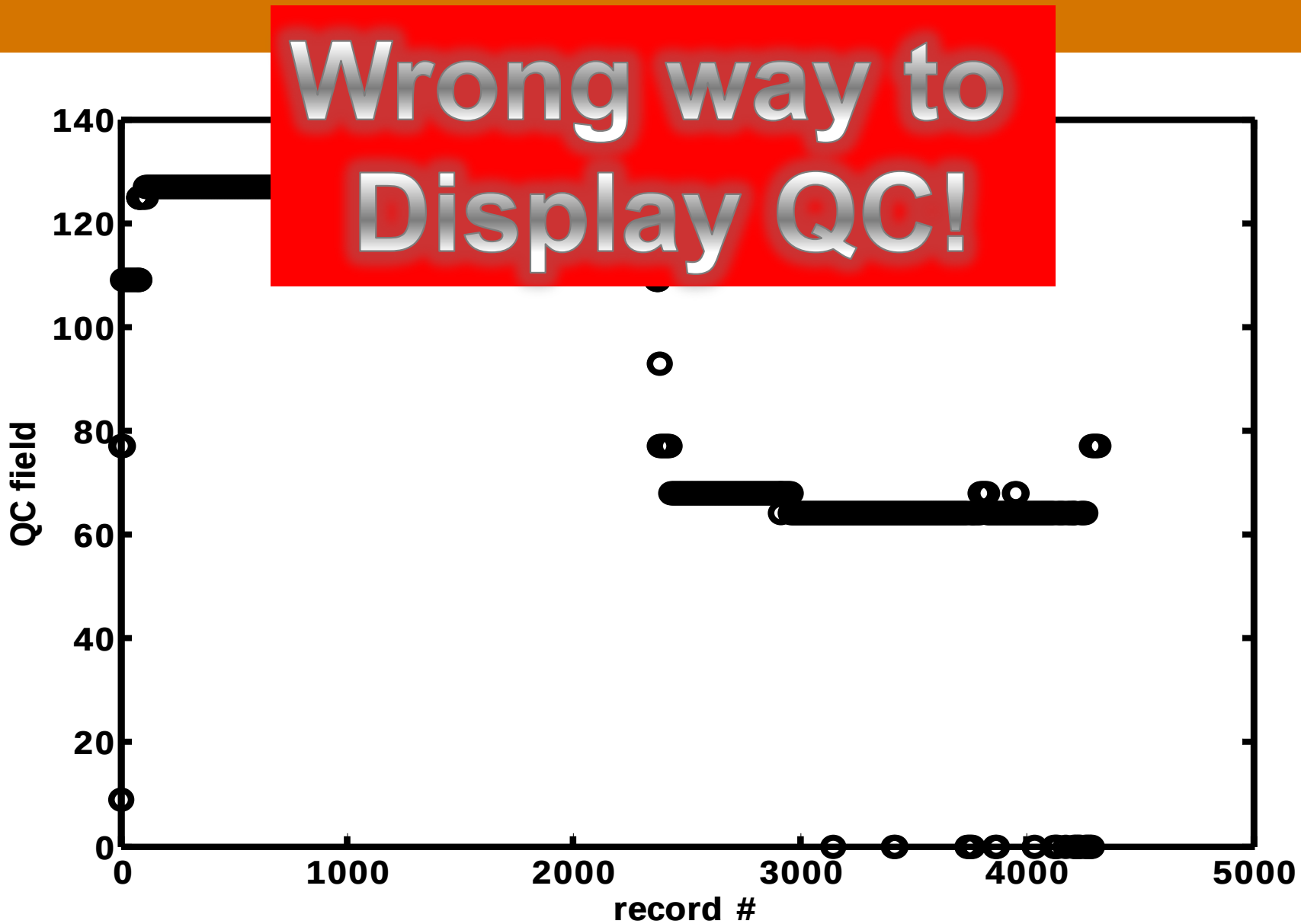
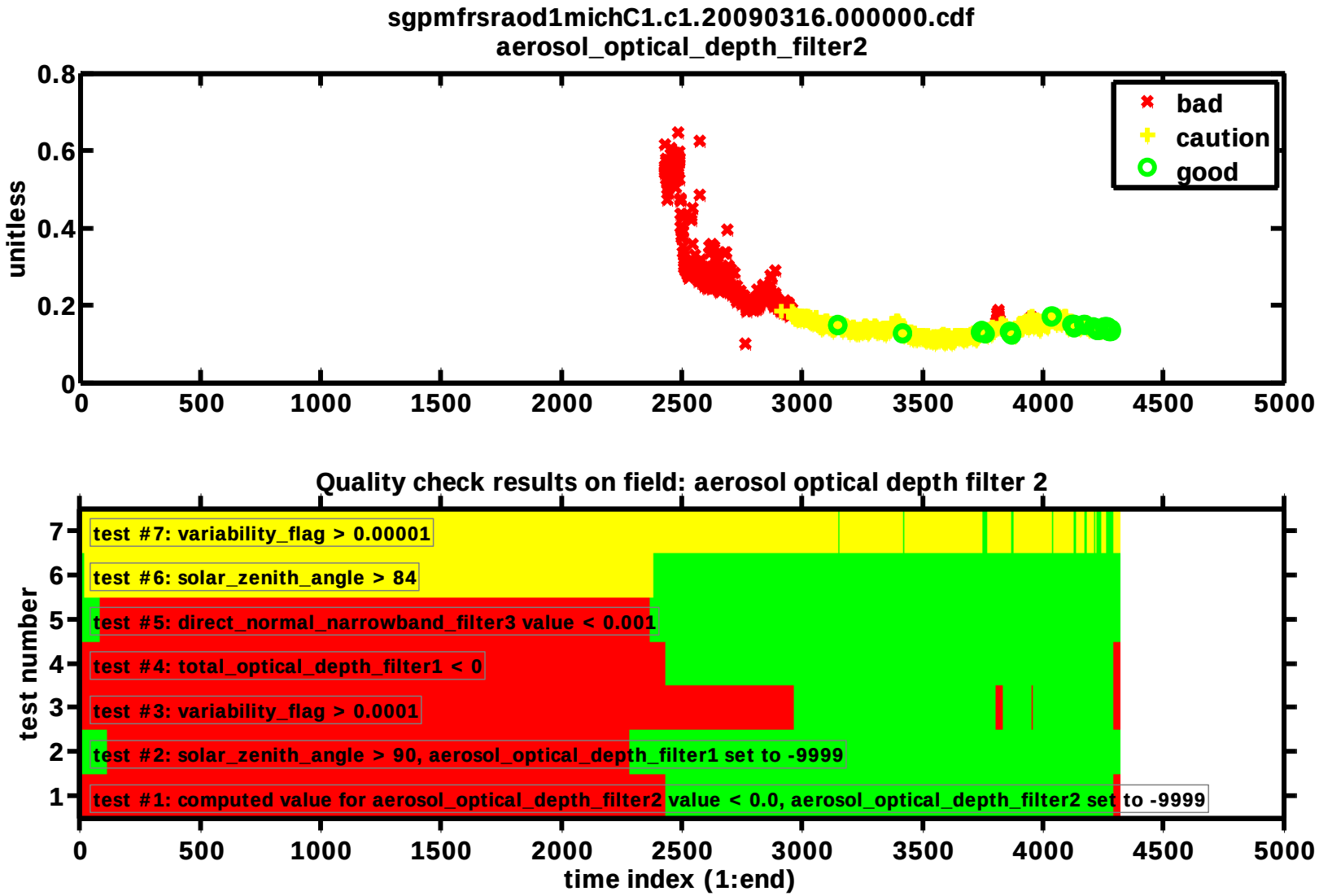
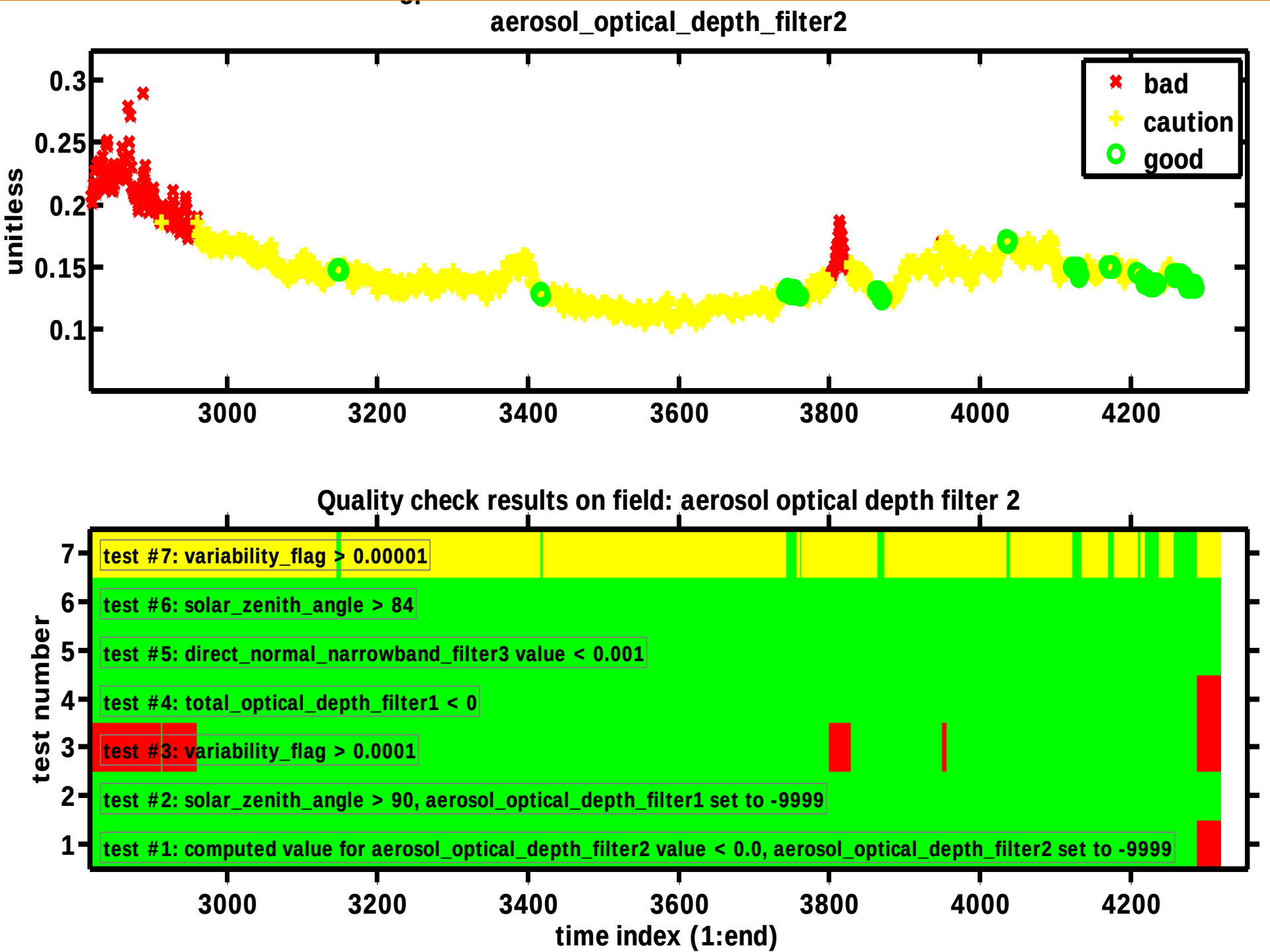
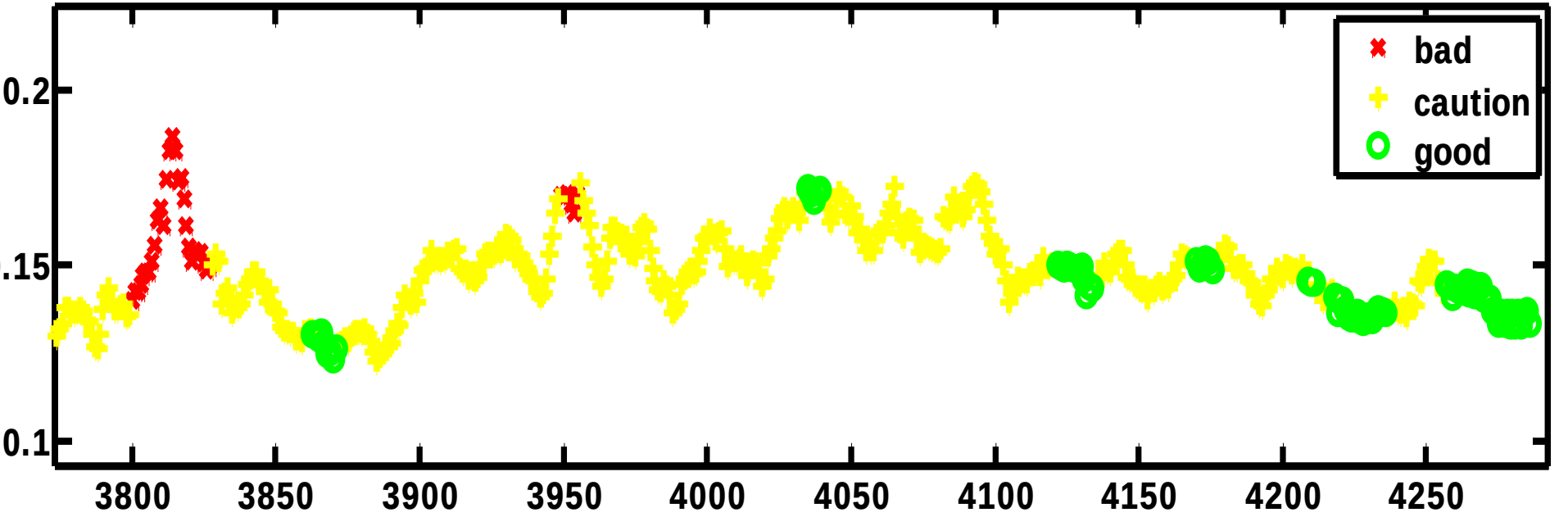
Efficient storage as bit-packed integer, but not really a “number”.

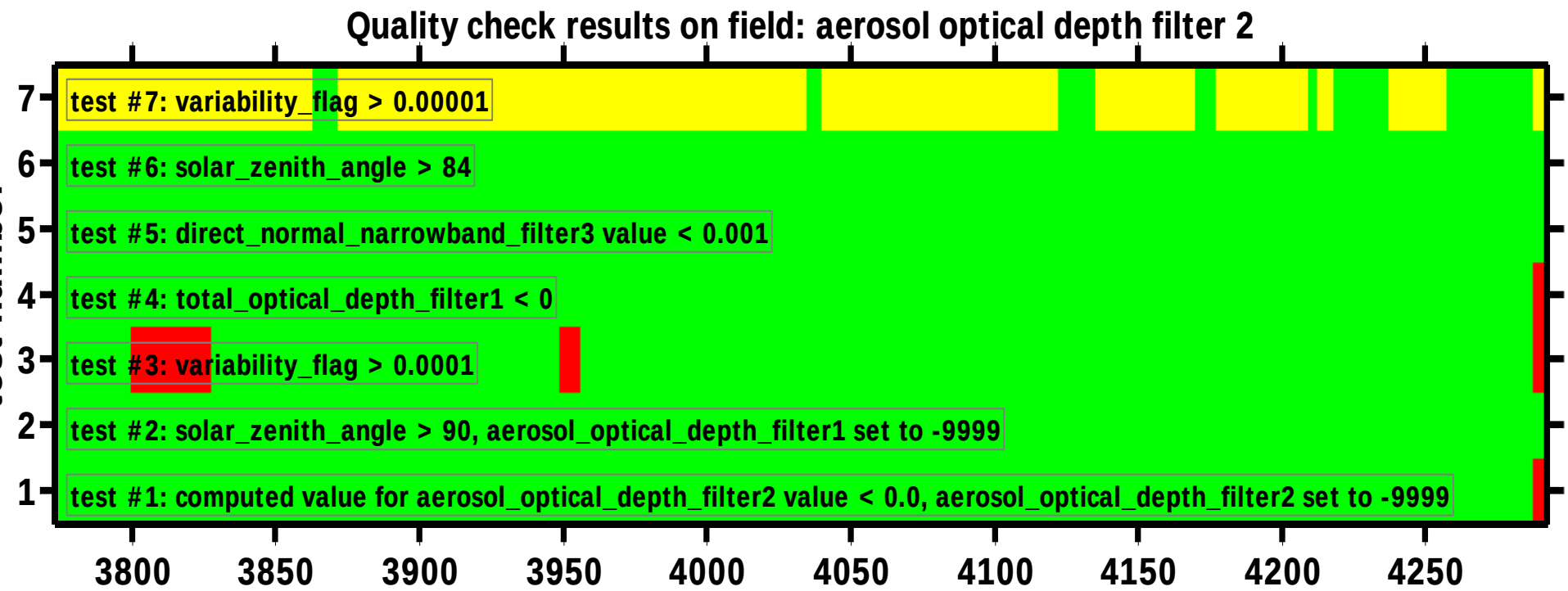


The QC field stores a collection of tests – each with a defined impact on data quality.




aerosol_optical_depth_filter2
unitless
0.3
0.25
0.2
0.15
0.1
3000
3200
3400
3600
3800
4000
4200
bad
caution
good
Quality check results on field: aerosol optical depth filter 2
test number
7
6
5
4
3
2
1
test #7: variability_flag > 0.00001
test #6: solar_zenith_angle > 84
test #5: direct_normal_narrowband_filter3 value < 0.001
test #4: total_optical_depth_filter1 < 0
test #3: variability_flag > 0.0001
test #2: solar_zenith_angle > 90, aerosol_optical_depth_filter1 set to -9999
test #1: computed value for aerosol_optical_depth_filter2 value < 0.0, aerosol_optical_depth_filter2 set to -9999
3000
3200
3400
3600
3800
4000
4200
time index (1:end)


bad
caution
good
0.2
.15
0.1
3800
3850
3900
3950
4000
4050
4100
4150
4200
4250


Quality check results on field: aerosol optical depth filter 2
test #7: variability_flag > 0.00001
test #6: solar_zenith_angle > 84
test #5: direct_normal_narrowband_filter3 value < 0.001
test #4: total_optical_depth_filter1 < 0
test #3: variability_flag > 0.0001
test #2: solar_zenith_angle > 90, aerosol_optical_depth_filter1 set to -9999
test #1: computed value for aerosol_optical_depth_filter2 value < 0.0, aerosol_optical_depth_filter2 set to -9999
7
6
5
4
3
2
1
3800
3850
3900
3950
4000
4050
4100
4150
4200
4250

Brief Demo…

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