A quantitative approach to optimise the quality control system for surface data at MeteoSwiss

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Aim
• Improve the performance of the quality control system
• Reduce the amount of false alarms relative to the amount of corrected values
• And at the same time, keep the amount of corrected measurement errors at the same level

Introduction: The quality control system
• The analysed quality control system is based on three types of formulas
  • Extrema testing formulas (Fig. 1a)
  • Variability testing formulas (Fig. 1b)
  • Inter-parameter consistency testing formulas (Fig. 1c)

- The quality control system at MeteoSwiss consists of around 180 different rules. A rule is composed of a formula and a set of input parameters. For each rule, a station and time dependent set of limits is defined, e.g. \[ |T_{2m} - T_{2m, redundant}| > 5 ^\circ C \].
- The specific limits for each rule depend on the measurement parameter, location and acquisition time of the measurement.
- The quality control system operates for 154 automated stations, 103 out of 154 stations are examined by the experts (Fig. 2).

Method

Definitions
• The rule performance is evaluated with the following measures:

<table>
<thead>
<tr>
<th>Value corrected</th>
<th>Value not corrected</th>
</tr>
</thead>
<tbody>
<tr>
<td>True Positive (TP)</td>
<td>False Positive (FP)</td>
</tr>
<tr>
<td>False Negative (FN)</td>
<td>True Negative (TN)</td>
</tr>
</tbody>
</table>

- Corrected: measurement value manually corrected by an expert
- Flagged: measurement value flagged by the quality control system

Approach
• In the first step, the amount of FPs is compared to the amount of TPs for each rule.
• In the second step, rules with a high FP / TP ratio are tested with a range of new limits that reduce the amount of flags compared to the initial limit.
• A new limit is chosen if the FP / TP ratio can be improved without substantially decreasing the amount of TPs.
• The rule is removed from the quality control system if the FP / TP ratio cannot be improved.

Data
• The evaluation is done with 18 months of measurement data from 103 stations (see Fig. 2).
• Furthermore, test output data is used to associate flagged measurements to the 180 rules.

Results
• 31 rules are identified that have a high FP / TP ratio and at the same time, the ratio does not improve with other limits. These rules are removed.
• 6 rules are identified for which the FP / TP ratio can be improved with minimal decrease in TPs.
• These changes result in a decrease of the FP / TP ratio from 6.5 to 4.5 and in a mean decrease of flags per day from 1354 to 949 (Fig. 3).

Example
• Consistency test between 2m temperature and the redundant 2m temperature:
  \[ |T_{2m} - T_{2m, redundant}| > \text{Limit} \]
• Example of a rule violation

Conclusion
• The data quality is improved due to
  • Less flagged data to be inspected. Thus, more time to inspect and correct erroneous measurements which leads to better corrections.
  • Reduced amount of FPs on non-examined data which increases the value of the quality information flags.

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