EDUCE Site Audits

Introduction

Before the end of the EDUCE project in May 2003, a "quality audit" will be performed at many of the EDUCE measuring sites. The main purpose of this audit is to verify the quality control procedures followed at sites which will submit data to the EDUCE database.

At least 10 different sites will be visited. Each visit will last for a minimum of two full days. The audit will be executed according to a predefined checklist of questions and observations (see below). The subjects covered include: the local environment and operating regime; calibration techniques and maintenance routines; measurement schedules and data analysis procedures.

The audits are conducted by the EDUCE project's Scientific Secretary. The Scientific Secretary is responsible for drafting a confidential summary (which is sent to the site operator and the EDUCE project coordinator) and a formal report (which is published at the project web pages). The wording of both the summary and the full report is agreed with the site operator. The full terms and scope of the audit are described within this audit definition, which may be retrieved from the EDUCE project website.

Each visit will be scheduled so that a full calibration of at least one spectroradiometer can be witnessed. It should be possible to observe the normal measuring routine.

The objectives of the quality audit are twofold. Firstly, the audit aims to provide assurance to users of the database that a certain level of quality has been achieved. The purpose here is not to take responsibility for data management; data quality and quality control are, and remain, primarily the responsibility of the originator of the data. Nor is the absolute accuracy of the measurements important. Rather, the audit will attempt to examine, in a more qualitative fashion, the whole process of data production. The site operator is expected to be able to present a detailed and comprehensive description of the calibration, measurement and data analysis procedures, together with the results of their customary application. The site operator should also be able to make a quantitative statement about the accuracy of the measurements and be able to justify this assessment.

The second objective of the audit is to provide site operators with information that will allow them to improve the standard of their QC and QA procedures, and thus the value of their data. The final report will attempt to identify and promote best practice, and may also highlight the relative strengths and weaknesses of the quainter or more innovative customs and systems employed at the sites visited.

Presentation of results

The findings of each audit will be presented within a confidential summary, a formal statement and a final report. The formal statement and final report will be circulated to all EDUCE PIs and made available to registered users of the European UV Database. Results from the audits will not be made publicly available, although pictures and general site descriptions may be published.

Following each visit a formal statement will be prepared, which will give a short, point-by-point evaluation of the checklist items. Where appropriate, each item on the checklist will be graded according to a four-level scheme:

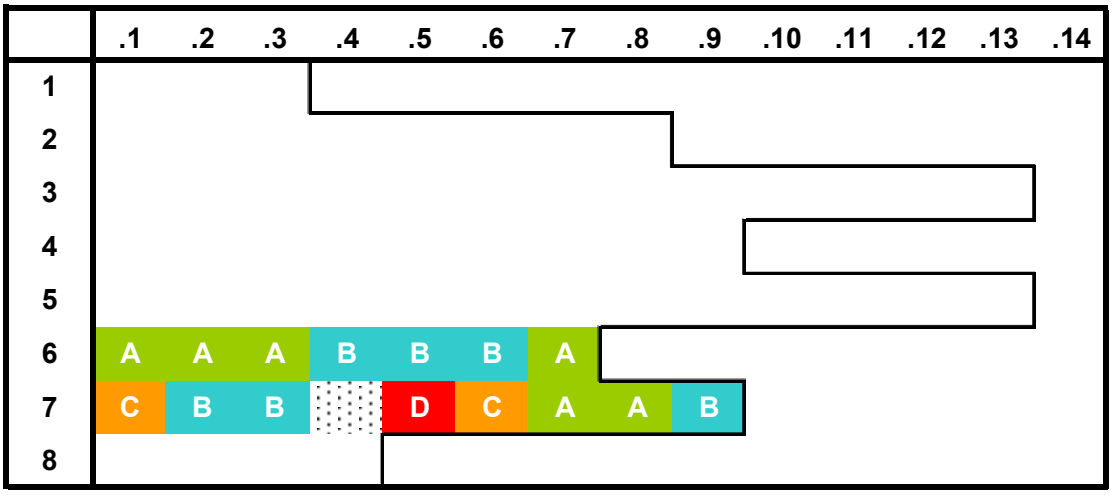
A	Exemplary
B	Satisfactory
C	Could be improved
D	Should be improved

These definitions are necessarily rather broad. In general, the first category will be used for those items which may be considered to represent best-practice, or are otherwise of a standard that invites imitation. The third category might be applied in situations where the operators have themselves identified limitations in current practice and plan to make future improvements. The fourth category will be applied to those items which might prevent the site objectives being met, or which might affect data quality in a manner not previously considered by the operator. In all cases, the assessment should be considered in the context of the aims and objectives for the individual site together with the more detailed explanation provided against each item.

Because of the structure of the checklist, which groups related items according to eight separate classifications, some points may appear under more than one heading. For example, the WMO document on guidelines for site quality control is considered specifically under point 8.4 (“application of WMO guidelines”), but may also be included in the assessment of points 7.6 (“estimates of errors”) and 3.7 (“publications read”).

Lastly, some items clearly do not invite sensible classification. For example, a knowledge of the location (point 2.1) or representativeness of the site (point 2.3).

A graphical summary will also be provided:



Operators will have the opportunity to comment on the statement, and to append further explanatory information or comments of their own, before it is circulated. The statement should be seen more as a self-assessment than an external evaluation. Following any changes in operating procedures, new information may also be added to the statement at a later date.

In addition to the formal statement, operators will also receive a more detailed summary, with a copy sent to the project co-ordinator. This summary will be one or two pages in length, with a short discussion under the headings of “Introduction”, “Overview”, “Best practice”, “Room for improvement” and “Conclusions”.

The final report will contain all the formal statements, and will include a discussion focusing on general findings and conclusions, with the aim of promoting improvements in data quality.

Checklist

Much of the audit will be concerned with gaining a general impression of how things are done. The site operator should be able to persuade an interested visitor that the measurement and collection of data are carried out diligently and to a standard that justifies any claims made to the quality of the data.

The following points will also be considered: -

General things

The audit will examine:

- the objectives of the site operator, in relation to the quantity and quality of the data collected;
- data management;
- the full calibration procedure;
- the normal measuring routine;
- the records and documentation for all calibration, measurement and data analysis procedures;
- the records and documentation for instruments and instrumental characteristics (e.g., certification, determination of slit function, angular response, dark current offset, etc.);
- the records and documentation supporting any error analysis.

The audit will assess:

- whether the site is representative of the local environment;
- whether the measurements made at the site are representative of the local conditions;
- the standard of documentation and record keeping;
- whether all procedures relating to data measurement and analysis are demonstrably repeatable and reproducible;
- whether the facilities and resources available are sufficient for the site objectives to be fulfilled;
- whether the error analysis is defendable.
- whether measurement and collection of data are carried out diligently and to a standard that justifies any claims made to the quality of the data;

The audit will utilise information collected by the University of Innsbruck as part of the QC inventory.

Specific points considered:

The following items will be considered during the audit (there is some overlap and repetition within and between categories).

The background information, a 'mission statement' and details of available resources (items in sections 0 and 1) should, if possible, be provided two weeks ahead of the visit.

Items in sections 2 to 8 will be graded according to the 4-point scheme:

Exemplary/Satisfactory/Could be improved/Should be improved.

0. Background information

0.1. A short introduction and history for the site (e.g., when measurements began; major milestones in the site development; primary funding agencies, etc.)
0.2. Future plans (e.g., changes to instrumentation or measuring regime; new research activities)
0.3. The longitude, latitude and altitude of site
0.4. A description of local horizon, including nearby and tall objects (include horizon/altitude map, if available)
0.5. A description of the local environment (include photographs, if available)
0.6. A description of the local climate (e.g., seasonal variation in precipitation, sunshine duration and temperature; typical seasonal variation in aerosol loading)
0.7. Details of personnel, including who is responsible for what and an estimate of the percentage of each operator's working week dedicated to measurement activities (include photographs, if available)
0.8. Estimates of the total and relative amount of time dedicated to maintenance, calibration, data collection and data analysis activities
0.9. List of major publications read/adopted in the pursuit of excellence

1. Resources and mission statement

1.1. The site 'mission statement', i.e. the site objectives in relation to the quantity and quality of data collected;
1.2. Available instrumentation (please list & describe all instruments);
1.3. Available person-power (i.e., the number of person-months a year available for maintenance, calibration, measurement, data analysis, etc.)

2. Location

2.1. The source and accuracy of the longitude, latitude and altitude coordinates;
2.2. The availability and accuracy of a horizon/altitude map and description;
2.3. The representativeness of the site of the local environment;

3. Operational matters

3.1. Protocols/documentation;
3.2. The amount of time dedicated to maintenance, calibration, data collection and data analysis;
3.3. The experience of staff;
3.4. The frequency of staff changes;
3.5. The training of new staff;
3.6. The frequency of changes in calibration, measurement and data analysis procedures (give details of major changes);
3.7. Publications read/adopted in the pursuit of excellence (e.g., WMO guidelines, etc.);

4. Instrumentation

4.1. Documentation;
4.2. Instruments available;
4.3. Frequency of instrument characterisation;
4.4. Measurement of angular response (spectroradiometers);
4.5. Measurement of slit function(s) (spectroradiometers);
4.6. Frequency of regular instrument maintenance;
4.7. Calibration of non-spectral instruments;

5. Calibration (spectroradiometers)

5.1. Documentation (including written protocols and record keeping);
5.2. Standard calibration procedures (*modus operandi*, steps taken to eliminate stray light, definition of fiducial plane, measurement of lamp distance, measurement of lamp power, etc.);
5.3. Certificates;
5.4. Irradiance scale;
5.5. Lamp husbandry;
5.6. Source and age of lamps;
5.7. Level of agreement between lamps (internal consistency);
5.8. Measurement of lamp drift;
5.9. Frequency of calibrations;
5.10. Typical instrument drift between calibrations;
5.11. Evidence that the calibration is reliable at the quoted level of accuracy;
5.12. Level of repeatability/consistency in calibration regime;
5.13. Wavelength calibration;
5.14. Evaluation with the JRC calibration equipment;

6. Measurement regime

6.1. Documentation;
6.2. Standard operating procedures;
6.3. Type and quantity of data collected;
6.4. Resolution and frequency of spectral measurements;
6.5. Typical downtime for repairs/maintenance;
6.6. Demonstrable repeatability;

7. Data Analysis

7.1. Documentation;
7.2. Standard procedures;
7.3. Analysis of: cosine errors, lamp-drift errors, horizon errors, wavelength errors, stray-light errors; temperature-induced errors;
7.4. Correction for: cosine errors, lamp-drift errors, horizon errors, wavelength errors, stray-light errors; temperature-induced errors;
7.5. Use of auxiliary measurements;
7.6. Estimates of relative/absolute spectral uncertainty;
7.7. Estimates of relative/absolute uncertainty for integrated values;
7.8. Procedures for the application of retrospective corrections;
7.9. Data management/storage;

8. Quality management

8.1. Documentation;
8.2. Standard procedures;
8.3. QC tools available and applied;
8.4. Application of WMO guidelines or similar;
8.5. Details of past/future instrument intercomparisons;
8.6. Details of data version control;
8.7. Internal audits;

Supporting documentation

Bernhard, G., and G, Seckmeyer, "Uncertainty of measurements of spectral solar UV irradiance", *J. Geophys. Res.*, Vol. 104, No. D12, 14,321-14,345 (1999).

Gardiner, B.G., "QA in ultraviolet spectroradiometry: the state of the art", WMO QC/QC working group.

Heikkilä, A., *et al.*, "SUVDAMA data storage Edition 4", Final SUVDAMA Report (1999).

Seckmeyer, G., *et al.*, "Instruments to measure solar ultraviolet radiation Part 1: Spectral instruments", WMO/GAW Rep. 125, World Meteorological Organization, Geneva, WMO TD No. 1066, 30 pp.

Webb, A., *et al.*, "Guidelines for site quality control of UV monitoring", WMO/GAW Rep. 126, World Meteorological Organization, Geneva, WMO TD No. 884, 39 pp.