WORLD METEOROLOGICAL ORGANIZATION

COMMISSION FOR INSTRUMENT AND METHODS OF OBSERVATION
OPAG-SURFACE

EXPERT TEAM ON SURFACE TECHNOLOGY AND MEASUREMENT TECHNIQUES
First Session

Geneva, Switzerland, 13-16 October 2004

CIMO/OPAG-SURFACE/
ET ST&MT-1/Doc. 3.2(1)

(20.IX.2004)

ITEM: 3.2

Original: ENGLISH ONLY

STANDARDS FOR AUTOMATED VISUAL AND SUBJECTIVE OBSERVATIONS
Standardization of algorithms for AWSs

Submitted by Chairman

Summary and Purpose of Document

The document contains an introduction on the requirements for standards of systems measuring present weather.

ACTION PROPOSED

The meeting is invited to take notice of the document and to supply suggestions or recommendations on how to provide documentation and guidelines to standardize present weather observing systems.

References:

1. CIMO-XIII, Abridged final report
2. CIMO MG (2003) Final report
3. CBS ET-AWS-3 (28 June - 2 July 2004) Final report.
4. EC-LV & CAeM XII (2002)
5. CIMO Guide (WMO-No. 8, 6th edition)
6. IOM Report 78 (TD 1160) *AWS Algorithms Used in Automatic Weather Stations - Evaluation of Questionnaire*, M.D. Gifford (USA)

Background

1.1. Introduction

Most of the traditional instrument measurements are purely based on a mechanical concept. After the introduction of electrical sensors, instruments could be read out remotely. Today, electronics and modern sensor technology is applied and sophisticated IC processing provide us with digital output for easy data processing and transmission. This processing facility in particular makes it possible to derive level II geophysical variables from the sensor output using relatively complex computer calculations. Typically, the reductions to a specific variable, auto calibration with offset reduction and temperature compensation are popular today. Nevertheless these calculations are based on relatively simple formulas or linear approximations that can easily be referred to already well-defined standard methods as *e.g.* described in the CIMO Guide.

For a number of observing systems, developed in the past 15 years, a more sophisticated processing was necessary to derive variables, which were previously obtained by manual, visual or subjective observations. Examples of such systems are LIDAR based ceilometers and present weather systems (PWS). For the processing by an internal CPU, decision criteria are introduced, in particular for the provision of binary information ("yes" or "no" results): clouds or no clouds, liquid or solid precipitation. In some cases these algorithms make use of observed trends to provide observational information. Typically, these algorithms are developed as an alternative for visual observations, which could not be automated by simple means. A well-known example off such an algorithm is that used to derive cloudiness.

Although the results of these algorithms demonstrate a high correlation with the traditional methods, it is not clear how the observing system has derived such a result. Not only diversity or non-uniformity in methods but also lack of documentation in open literature makes that the algorithms used can be identified as obscure and the systems themselves as black boxes. Because of that it is not possible to determine the measurement uncertainty of those system or to identify their level of performance as a function of all kinds of weather. Moreover some algorithms are fine-tuned to get a better correlation with the traditional methods. This fine-tuning, however, is more or less based on qualitative assumptions and not on any type of calibration. Even worse such fine-tuning of decision criteria is sometimes based on the local climate. This situation is highly unacceptable, not only for synoptic meteorology, but also for climatology, because climate changes can only be studied if the source of the datasets is well understood. Also the aeronautical meteorology has made a statement on the lack of standardization of algorithms, especially with respect of the measurement of cloud base and cloud amount. A recommendation by the Conjoint WMO CAeM Session/ICAO Meteorological Division Meeting was adopted by EC-LV (see Annex). As a consequence EC-LV has requested CIMO to recommend one method to be standard. Within this context use can be made of the 'parameter' extinction profile as it is recommended recently by CBS as one of the parameters to be measured by a principle synoptic station (see Manual on the GOS, edition 2003). However, first a suitable definition for this parameter should be developed, which was recommended by the ET-AWS-3 (2004):

RECOMMENDATION 5.10 "Optical extinction profile"
Considering that:
1. *WMO has adopted the optical extinction profile as a new variable published in the Manual on the Global Observing System, WMO-No. 544, and*
2. *There is no corresponding definition in the Guide to Meteorological Instruments and Methods of Observation, WMO-No.8,*

The expert team recommended that:
CBS asks CIMO to develop a suitable definition for inclusion in the Guide to Meteorological Instruments and Methods of Observation, WMO-No.8

1.2. Algorithm development

In an earlier stage, CIMO has recognized the development of all type of algorithms and the lack of documentation and uniformity. Because of the missing documentation it was not possible to identify methods, which could be nominated as standard. As a result, any tractability of operational systems to any standard, necessary for calibrations or uncertainty calculation cannot be determined as well. For that reason CIMO XII has adopted a resolution to provide CIMO with information on the current practices. It was requested, "To review and recommend algorithms for common use, including those for the reduction of data for observations of surface variables through automated systems". In order to gather information regarding current baseline algorithms used by member of countries, a concise questionnaire on algorithm usage was send out to all Member by the end of 2001. It turned out that one-third of responding 40 countries has implemented multi-sensor parameter algorithms. However it was experienced that very limited documentation was available, and even worse that it was not allowed to publish any available documentation. It was concluded that finding a solution was a great challenge. In the final report (IOM 78) containing results of the analysis of this questionnaire the following conclusion is stated: "*The task of reviewing and recommending meteorological sensor processing algorithms for standardization is perceived to be a monumental task. Almost half of the nations using automatic weather stations do not have fully documented algorithms. When it is available, documentation is typically developed in a nation's native language. Algorithm documentation currently in use by the respondents is seldom accessible through an Internet web site. Therefore, evaluation and standardization of processing logic would be very expensive, time consuming, and labor intensive. Also, the algorithms used in support of aviation may be very different from those used by synoptic meteorologists, climatologists, agricultural meteorologists, etc.*". Nevertheless standardization of such algorithms must be regarded as a strong requirement to prevent future chaos in all kinds of observational data.

Activity plan

2.1. Planned activities

In line with CIMO XIII, the CIMO management group has decided to continue the work on standardization of automated visual and subjective observations. Standardization algorithms to derive parameters related to this type of observations have to be proposed to CIMO.

To realize this request, further review of existing algorithms will be carried out and studied. As a result, recommendations for standards will be developed and proposed at the next CIMO.

2.2. Time Table

	Deliverable	***Deadline***
a.	IOM report on methods used by current systems, including proposal on standardization.	September 2005
b.	Report the EC and other TCs on their request	November 2005
b.	Recommendations to CIMO XIV	May 2006

ANNEX

Recommendation 2/4 by the Conjoint WMO CAeM Session/ICAO Meteorological Division Meeting. (adopted by EC-LV)

2.1:1.5 **Algorithms for the automatic assessment of cloud base height and cloud amount**

2.1:1.5.1 The meeting's attention was drawn to the fact that the calculation of cloud base height by an automated system (laser ceilometer) was currently done using algorithms developed by the sensor manufacturers or by the meteorological service themselves. Regarding the development and implementation carried out by the manufacturers, assumptions had been made based on backscatter profiles measured by the laser ceilometer. Therefore, the development and implementation of the algorithms to provide the user with information on the height of cloud layers and vertical visibility were based on the manufacturer's interpretation of the physics of a measured backscatter profile. Generally, only the output was standardized for presentation purposes (observer/end-user) and for report generation. It could therefore be concluded that no generally accepted algorithm for the relation between measured backscatter profile and the height of cloud layers was available within the aeronautical meteorological domain.

2.1:1.5.2 The meeting agreed that the creation of a standard algorithm would be a challenging task and that the feasibility of doing so should be assessed as a first step with a view to the production of a standard algorithm as the next step. The meeting formulated the following recommendation:

Recommendation 2/4 — Development of standard algorithms for the processing of cloud base height and cloud amount to be used in the automation of the aeronautical meteorological observations

That WMO, in coordination with ICAO, investigate the feasibility of creating standard algorithms for the processing of cloud base height and cloud amount taking into account the different aerodrome layouts and the availability of sensors, with a view to developing such a standard algorithm.

Note.— These algorithms, if and when created should be reflected in the appropriate ICAO and WMO documents including the proposed manual on the use of automatic meteorological observing systems at aerodromes called for by Recommendation 2/2.

_____