W O R L D M E T E O R O L O G I C A L O R G A N I Z A T I O N

INSTRUMENTS AND OBSERVING METHODS
R E P O R T No. 78

ALGORITHMS USED IN AUTOMATIC WEATHER STATIONS

Evaluation of questionnaire

by

M. D. Gifford, USA

WMO/TD No. 1160

2003

NOTE

The designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the Secretariat of the World Meteorological Organization concerning the legal status of any country, territory, city or area, or its authorities, or concerning the limitation of the frontiers or boundaries.

This report has been produced without editorial revision by the Secretariat. It is not an official WMO publication and its distribution in this form does not imply endorsement by the Organization of the ideas expressed.

FOREWORD

The twelfth session of the Commission for Instruments and Methods of Observation requested its Working Group on Surface Measurements to review algorithms applied in automatic weather stations and recommended those most commonly used. For this purpose the *Questionnaire on algorithms used in automatic weather stations* was distributed, by the end of 2001, to the Permanent Representatives of Member countries with WMO for completion. Since the development of the instruments and of algorithms is often pursued outside National Meteorological Services, the Permanent Representatives were also requested to seek relevant information from instrument manufacturers of respective countries.

Responses received from 40 countries were evaluated and summarized in mid 2002. The evaluation covers a summary of the types of automatic weather stations in use, the parameters that have been automated, the use of quality control algorithms, and the availability of algorithm documentation. Results of the evaluation are presented in a text and tabular form. I would like to thank all those who provided information from their networks and the CIMO Surface Measurements Working Group, especially Mr M. Doug Gifford.

(Dr. R.P. Canterford)

Acting President of the Commission for
Instruments and Methods of Observation

Abstract

The WMO distributed a Questionnaire on Algorithms Used in Automatic Weather Stations to all member nations on 30 October 2001. A copy of the questionnaire is attached as an Annex. Information concerning the implementation of algorithms in automatic weather stations (AWS) was evaluated and summarized. The evaluation included a summary of the types of AWS in use today, the parameters that have been automated, the use of quality control algorithms, and the availability of algorithm documentation. Responses were received from 40 countries. Results of the evaluation are discussed and displayed in tabular form.

1 Introduction

Resolution 2 of CIMO-XII established a CIMO Working Group on Surface Measurements with a term of reference "In order to gather information regarding current baseline algorithms used by member nations, the working group decided that the first step should be the drafting and distribution of a concise questionnaire on algorithm usage. The WMO Secretariat distributed the questionnaire to member nations on 30 October 2001. Forty nations have returned completed questionnaires.

The questionnaire was comprised of seven areas of interest. First, members were asked if automatic weather stations (AWS) were used operationally in their country. If so, the members were asked to specify the types of applications which used AWS. Members were then asked to indicate the types of single-sensor and multi-sensor algorithms used in their AWS. The use of quality control algorithms was also queried. To facilitate comparisons between member nations' algorithms, the questionnaire also inquired concerning the documentation of baseline algorithms. Finally, the member nations were asked to provide a nominated expert to act as a focal point for future contacts.

2 Evaluation

Of the 40 respondents, only one nation (Kyrgyz Republic) stated that automatic weather stations were not used. The responses of the remaining 39 nations were then evaluated with regard to the operational applications of the AWS. Operational uses of automatic weather stations are summarized in Table 1. The three most frequent uses of AWS are synoptic meteorology (90%), followed by climatology (87%), and aviation support (74%). Other less frequent uses of AWS are agricultural meteorology (44%), hydrology (38%), urban meteorology (28%), and atmospheric composition (13%).

The types of automated parameters were then evaluated according to the percentage of nations implementing each algorithm. Single-sensor parameter algorithms are summarized in Table 2. The most frequently implemented single-sensor parameter algorithms were wind speed and wind direction (95%), temperature (92%), relative humidity (85%), sea level pressure (79%), precipitation accumulation (74%), dew point (64%), and precipitation intensity (54%). Parameters that were less commonly automated include altimeter setting (51%), visibility (49%), sky condition (41%), runway visual range (36%), present weather (33%), pressure altitude (28%), thunderstorm (13%), and density altitude (8%).

Only one-third of responding nations have implemented multi-sensor parameter algorithms. A summary of multi-sensor algorithm applications is found in Table 3. The most frequently implemented algorithms were those involving backup sensors for visibility (18%), freezing precipitation (18%), and backup sensors for sky condition (13%). Obstructions to vision algorithms were employed by 10% of the responding nations. Meteorological discontinuity algorithms for visibility and sky condition were implemented by 10% and 8% of the respondents respectively. Redundant wind, precipitation type, precipitation intensity, and pressure sensor processing algorithms were also mentioned on a few responses.

Various levels of real-time quality control (QC) algorithms have been implemented by 63% of responding nations. The parameters and types of quality control measures employed are shown in Table 4. Virtually all automatic weather stations perform range checking and some type of parameter consistency checking. Many also use rate of change criteria, trend checks, or comparison to similar sensors as a means of quality control.

Only 62% of responding nations have documented algorithms used in their automatic weather stations (see Table 5). Only one nation has posted comprehensive algorithm documentation on an internet web site. However, Hong Kong and the United States plan to establish web access to documentation in 2002. Other nations have indicated that algorithm documentation could be made available upon request. Nominated experts for future contacts on algorithm issues are listed in Table 6.

3 Conclusions

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.

Table 1. Operational Uses of Automatic Weather Stations

Use / Country	Synoptic Meteorology	Aviation Support	Climatology	Hydrology	Agricultural Meteorology	Urban Meteorology	Atmospheric Composition	Other Applications	No AWS
Argentina	✔	✔	✔						
Austria	✔		✔		✔				
Australia	✔	✔	✔	✔	✔	✔		Marine Support	
Bahamas	✔		✔						
Belgium	✔		✔	✔	✔				
Benin	✔	✔	✔		✔				
Canada	✔	✔	✔	✔					
Chile	✔	✔	✔		✔				
Costa Rica	✔		✔						
Czech Rep.	✔	✔	✔	✔	✔			Support of NPS	
Denmark	✔	✔	✔	✔	✔		✔		
Finland	✔		✔			✔			
Germany	✔	✔	✔	✔					
Hong Kong	✔	✔	✔	✔		✔		Nuclear Accident Assessment	
Hungary	✔	✔	✔		✔	✔	✔		
India	✔		✔	✔	✔				
Ireland	✔	✔	✔						
Japan	✔								
Jordan				✔					
Kyrgyz									✔
Latvia	✔				✔	✔			
Lithuania		✔							
Macedonia		✔	✔		✔				
Malaysia	✔	✔	✔						
Morocco	✔	✔	✔		✔				
Netherlands	✔	✔	✔	✔				Radiation	
New Zealand	✔	✔	✔	✔	✔	✔			
Norway	✔	✔	✔			✔			
Portugal	✔		✔		✔	✔			
Singapore		✔							
Slovak Republic	✔	✔	✔	✔					
Slovenia	✔	✔	✔	✔	✔	✔	✔	Tourism, Road Wx	

Use / Country	Synoptic Meteorology	Aviation Support	Climatology	Hydrology	Agricultural Meteorology	Urban Meteorology	Atmospheric Composition	Other Applications	No AWS
Sri Lanka	✔								
Sweden	✔	✔	✔					Road Wx	
Switzerland	✔	✔	✔	✔	✔	✔	✔		
Trinidad & Tobago	✔	✔	✔						
Turkey	✔	✔	✔						
United States of America	✔	✔	✔	✔	✔	✔	✔	Tourism, Road Wx, Emergency Management	
Uzbekistan	✔								
Zimbabwe	✔	✔	✔						

Table 2. Single-Sensor Parameter Algorithms Used

Parameter → / ↓Country	Temperature	Relative Humidity	Dew Point	Precipitation Accumulation	Precipitation Intensity	Wind Speed	Wind Direction	Sea Level Pressure	Pressure Altitude	Density Altitude
Argentina	✔	✔	✔	✔		✔	✔	✔	✔	
Austria	✔	✔	✔	✔		✔	✔	✔		
Australia	✔	✔	✔	✔	✔	✔	✔	✔		
Bahamas	✔	✔	✔	✔		✔	✔	✔		
Belgium	✔							✔		
Benin	✔	✔	✔	✔		✔	✔	✔		
Canada	✔		✔	✔	✔	✔	✔	✔		
Chile	✔	✔			✔	✔	✔	✔		
Costa Rica	✔	✔	✔	✔	✔	✔	✔			
Czech Rep.	✔	✔				✔	✔			
Denmark	✔	✔		✔	✔	✔	✔	✔	✔	
Finland	✔	✔	✔	✔	✔	✔	✔	✔		
Germany			✔			✔	✔	✔		
Hong Kong	✔	✔	✔	✔	✔	✔	✔	✔		
Hungary	✔	✔	✔	✔	✔	✔	✔	✔		
India	✔	✔	✔			✔	✔	✔		
Ireland	✔	✔	✔	✔		✔	✔	✔		
Japan	✔				✔	✔	✔			
Jordan	✔	✔		✔	✔	✔	✔			
Latvia	✔	✔				✔	✔	✔	✔	

Parameter → ↓Country	Temperature	Relative Humidity	Dew Point	Precipitation Accumulation	Precipitation Intensity	Wind Speed	Wind Direction	Sea Level Pressure	Pressure Altitude	Density Altitude
Lithuania						✔	✔	✔		
Macedonia	✔	✔	✔	✔	✔	✔	✔	✔	✔	
Malaysia	✔	✔	✔	✔	✔	✔	✔	✔	✔	
Morocco	✔	✔	✔	✔		✔	✔	✔		
Netherlands	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
New Zealand	✔	✔	✔	✔		✔	✔	✔		✔
Norway	✔	✔		✔		✔	✔			
Portugal	✔	✔		✔	✔	✔	✔			
Singapore	✔	✔	✔	✔	✔	✔	✔	✔		
Slovak Republic	✔	✔		✔	✔	✔	✔	✔	✔	
Slovenia										
Sri Lanka	✔	✔		✔		✔	✔	✔		
Sweden	✔	✔	✔	✔	✔	✔	✔	✔		
Switzerland	✔	✔	✔	✔	✔	✔	✔	✔	✔	
Trinidad & Tobago	✔	✔		✔		✔	✔	✔	✔	
Turkey	✔	✔	✔	✔	✔	✔	✔	✔	✔	
United States of America	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Uzbekistan	✔	✔	✔			✔				
Zimbabwe	✔	✔	✔	✔	✔	✔	✔	✔		

Table 2. Single-Sensor Parameter Algorithms Used, Continued

Parameter → ↓Country	Altimeter Setting (QNH)	Visibility (MOR)	Runway Visual Range	Sky Condition	Present Weather	Thunderstorm	State of Ground	Other Parameters
Argentina	✔							
Austria								
Australia	✔	✔		✔				
Bahamas								
Belgium								Pressure Tendency
Canada	✔	✔		✔	✔			Ice detection, precipitation type
Chile	✔	✔						

Parameter → ↓Country	Altimeter Setting (QNH)	Visibility (MOR)	Runway Visual Range	Sky Condition	Present Weather	Thunderstorm	State of Ground	Other Parameters
Costa Rica	✔							
Czech Rep.								
Denmark	✔	✔	✔	✔	✔	✔		
Finland		✔						
Germany	✔	✔	✔	✔				
Hong Kong			✔					
Hungary		✔			✔			Soil Temp, Grass Temp, Solar Radiation, UVB Radiation, Gamma Dose
India								Solar radiation
Ireland	✔		✔	✔	✔			
Japan								Sunshine Duration
Latvia								
Lithuania		✔				✔		
Macedonia	✔	✔	✔	✔	✔			Soil Temp, Global Solar Radiation
Malaysia	✔		✔	✔				
Morocco	✔	✔	✔		✔			
Netherlands	✔	✔	✔	✔		✔		Precipitation detection and duration, sunshine duration, global radiation
New Zealand	✔	✔	✔	✔	✔			
Norway	✔	✔		✔	✔			
Portugal								Station Pressure, Soil Temp, Surface Temp, Precipitation Duration, Global Radiation
Singapore	✔	✔	✔	✔				
Slovak Republic	✔	✔		✔	✔			
Slovenia								Vaisala AWS and OTT Sensors
Sri Lanka								Global Solar Radiation
Sweden	✔	✔	✔	✔	✔			Pressure Change
Switzerland	✔	✔	✔	✔	✔	✔		
Trinidad & Tobago								
Turkey	✔	✔	✔	✔	✔			Sunshine Duration, Solar Radiation

Parameter → ↓Country	Altimeter Setting (QNH)	Visibility (MOR)	Runway Visual Range	Sky Condition	Present Weather	Thunderstorm	State of Ground	Other Parameters
United States of America	✔	✔	✔	✔	✔	✔		Soil Temp, Soil Moisture, Leaf Wetness, Global Radiation
Uzbekistan								
Zimbabwe								

Table 3. Multi-Sensor Parameter Algorithms Used

Parameter → ↓Country	Meteorological Discontinuity Visibility	Meteorological Discontinuity Sky Condition	Backup Visibility	Backup Sky Condition	Other Backup Parameters	Obstructions to Vision	Freezing Precipitation	Other Present Wx Parameters
Australia			✔	✔				
Canada					Precip type and intensity		✔	
Denmark							✔	
Finland					Wind			
Lithuania						✔	✔	
Macedonia	✔		✔					
Morocco	✔		✔					
Netherlands							✔	Cloud Amount
Singapore			✔	✔				
Slovenia								Vaisala AWS and Sensors
Sweden	✔	✔	✔	✔		✔	✔	Almost all Synop Code 4680
Switzerland		✔	✔	✔		✔	✔	
United States of America	✔	✔	✔	✔	Wind, Pressure	✔	✔	

Table 4. Real-Time Quality Control Algorithms Used

Country	Parameter(s)	*Type of Quality Control Algorithms Used*
Austria	Temp, RH, RR, tp, dd, ff, Radiation, sunshine duration	Range check, rate of change, comparison with other stations
Australia	Temp, RH, Pressure, Rainfall	Range check, rate of change
Belgium	Temperature	Range check, parameter consistency
Czech Rep.	Temp, RH, Wind Direction	Range check
Denmark	Temp, Pressure, Wind, Precip Intensity, Sea Level	Range check, rate of change, consistency check, spatial coherence
Finland	All Temp, RH, Radiation	Range check, step error Deviation of sample values (analog measurements)
Germany	All	Range check, variability check
Hong Kong	Temp, Wind Direction, Wind Speed	Range check, consistency between operational and backup sensors
Hungary	All	Range check, consistency check, short-term variability, completeness
India	Temp, Pressure, RH, Wind Direction, Wind Speed	Range check, climatological consistency
Japan	Temp, Wind Speed, Wind Direction, Precip Intensity, Sunshine Duration	Range check
Latvia	Temp, RH, Wind Speed, Wind Direction, Pressure	Range check
Macedonia	All	QC as documented in AWOS 2000 (Artais)
Netherlands	In Work	Real-time QC based on HR now-casting regional NWP model
New Zealand	All	Range check
Norway	Temp, RH, Pressure, Wind Speed, Wind Direction	Range check, parameter consistency, step check, frozen value check
Portugal	Temp, RH, Pressure, Wind Speed, Wind Direction	Range check
Singapore	Temp, RH, Pressure, Wind Speed, Wind Direction, Clouds, Rainfall	Range check, rate of change
Slovak Republic	Temp, RH, Pressure, Wind Speed, Wind Direction, Precip Accumulation, Precip Intensity	Range check, temporal consistency
Slovenia		As implemented by Vaisala in AWS and Ott (sensors)
Sweden	All	Range check, rate of change, comparison to similar sensors
Switzerland	METAR	A. I. Neuronal Network
Turkey	Wind Speed, Wind Direction, Present Wx, Sky Condition, MOR, RVR	Range check (all), Parameter consistency (Present Wx Only)
United States of America	Temp, Dew Point, Wind Speed, Wind Direction, Pressure, Precip Accumulation, Precip Intensity, Visibility, Sky Condition	Range check, rate of change, inadequate sampling, trend check, parameter consistency, frozen value check, comparison to similar sensors
Uzbekistan	Temp, RH, Dew Point, Wind Speed, Wind Direction	Range check

Table 5. Algorithm Documentation

↓Country	Are Algorithms Documented?	Documentation on Web Site?	Other Access to Documentation?
Argentina	No	N/A	N/A
Austria	No	N/A	N/A
Australia	Yes	No	Available Upon Request
Bahamas	No	N/A	N/A
Belgium	No	N/A	N/A
Benin	No	N/A	N/A
Canada	Yes	No	N/A
Chile	No	N/A	N/A
Costa Rica	Yes	No	E-mail: imn@meteoro.imn.ac.cr
Czech Rep.	Yes	No	Available Upon Request
Denmark	Yes	No	Documented in Internal Reports (In Danish)
Finland	Yes	No	Documented in Internal Documents (In Finnish)
Germany	Yes	No	Available Upon Request
Hong Kong	Yes	Planned for 2002	Available Upon Request
Hungary	No	N/A	N/A
India	Under Development	N/A	N/A
Ireland	No	N/A	N/A
Japan	No	N/A	N/A
Jordan	Yes	No	Available through WMO Expert
Kyrgyz	N/A	N/A	N/A
Latvia	Yes	No	Available Upon Request
Lithuania	Yes	No	Available From AWS Manufacturer
Macedonia	Yes	No	Available From AWS Manufacturer
Malaysia	No	N/A	N/A
Morocco	Yes	No	Email: Skyview@rmplc.co.uk
Netherlands	Yes	http://www.knmi.nl/~meulenvd/ projects/avw	Available Upon Request
New Zealand	Yes	No	Available Upon Request
Norway	No	N/A	N/A
Portugal	Yes	N/A	Available Upon Request
Singapore	Yes	No	Available Upon Request
Slovak Republic	Yes	No	Available Upon Request
Slovenia	No	N/A	N/A
Sri Lanka	No	N/A	N/A
Sweden	Yes	No	Available Upon Request

↓Country	Are Algorithms Documented?	Documentation on Web Site?	Other Access to Documentation?
Switzerland	Yes	No	Available Upon Request
Trinidad & Tobago	No	N/A	N/A
Turkey	No	N/A	N/A
United States of America	Yes	Planned for 2002	Available Upon Request
Uzbekistan	Yes	No	Available Upon Request
Zimbabwe	Yes	No	Available Upon Request

Table 6. Nominated Expert for Future Contacts on Algorithms

Country	Name	Address	Telephone	Telefax	E-Mail
Argentina	Mr. Eduardo Viotti	Servicio Meteorologico Nacional 25 De Mayo 658 Buenos Aires, Argentina	+054-11-45141531	+054-11-51676709	Eviotti@meteofo.mil.arg
Austria	Mr. Kurt Zimmermann	Zentralanstalt fur Meteorologie und Geodynamik (ZAMG), Hohe Warte 38, A-1190, Wien	+43 1 360 26-2701	+43 1 360 26-2720	kurt.zimmermann@zamg.ac.at
Australia	Mr. Dean Lockett	Bureau of Meteorology, 22 College Road, Kent Town, South Australia, Australia 5067	+61 8 8366 2667	+61 8 8366 2693	d.locket@bom.gov.au
Bahamas	Mr. Byron V. Bain	Department of Meteorology, Chief Meteorological Officer (Electronics), Nassau International Airport, P.O. Box N-8330, Nassau, N.P., Bahamas	242-3777461	242-3771754	bvb.met@batelnet.bs or bbain@coralwave.com
Belgium	Mr. Herman Boyen	Royal Meteorological Institute of Belgium Ringlaan 3 B-1180 Brussel, Belgium	+32 (0)2 373026	+32 (0)2 3746788	Herman.Boyen@dma.be
Benin	Mr. A. Dominique Agbangla	Service Meteorologique B.P. 379 Cotonou, Benin	(229) 30 14 13	(229) 30 08 39	Meteo@leland.bj
Canada	Ms. Rodica Nitu	Meteorological Service Canada 4905 Dufferin Street Downsview, Ontario M3H 5T4	+1 (416) 739 4133	N/A	Rodica.Nitu@ec.gc.ca
Chile	Mr. Horacia Pena	Direccion Meteorologica de Chile Aeropuerto Arturo Merino Benitez, (Casilla 63)	56-2 6763454	56-2 6019590	
Costa Rica	Mr. Hugo Herrera	National Meteorological Institute P.O. Box 5583 - 1000 San Jose, Costa Rica	(506) 222-56-16	(506) 223-18-37	Hherrera@meteoro.imn.ac.cr

Country	Name	Address	Telephone	Telefax	E-Mail
Czech Republic	Dr. Vladimir Vozobule	CHMU Praha, Observatory Temelin, 373 01 Temelin, Czech Republic	+420 334 744 004	+420 334 744 204	Vozobule@chmi.cz
Denmark	Mr. Erik Bodtker	Danish Meteorological Institute, Lyngbyvej 100, DK-2100, Copenhagen, Denmark	+45 3915 7350	+45 3915 7390	Erik@dmi.dm
Finland	Mr. Jussi Haapalainen	Finnish Meteorological Institute, Sahaajankatu 20 E, 00810 Helsinki, Finland			Jussi.Haapalainen@fmi.fi
Germany	Mr. Karlheinz Klapheck	Deutscher Wetterdienst, TI23 Messsysteme, Postfach 65 01 50, D22361, Hamburg, Germany	+49 40 60173-200	+49 40 60173-211	karl-heinz.klapheck@dwd.de
Hong Kong	Dr. Ming Chung Wong	Hong Kong Observatory, 134A Nathan Road, Kowloon, Hong Kong	(852) 2926 8224	(852) 2721 6557	Mcwong@hko.gov.hk
Hungary	Mr. Zoltan Nagy	Hungarian Meteorological Service, 1675 Budapest P.O. Box 39, Hungary	+36 1346 4855	+36 1346 4849	Nagy.Z@met.hu
India	Mr. Ramdhan Vashistha	Instrument Division India Meteorological Department Pune, India 411 005	5893047	---	Ramdhan@hotmail.com
Ireland	Mr. Tom Bannon	Met Eireann, Glasnevin Hill, Dublin 9, Ireland	+35 318064232	+35 318065505	tom.bannon@met.ie
Japan	Saturo Tsunomura	Japan Meteorological Agency, Observations Division, 1-3-4 Ote-machi, Chiyoda-ku, Tokyo 100-8122 Japan	+81 3 3211 6019	+81 3 3213 1742	ric-jma@met.kishou.go.jp
Jordan	Dr. Ahmad Zioud	Ministry of Water and Irrigation P.O. Box 2412 Amman, Jordan	00962 5680100	00962 5680075	N/A
Latvia	Mr. Andris Plaudis	Latvian Hydrometeorological Agency, Maskavas Street 165, Riga, LV-1019, Latvia	+371 7 032602	+371 7 145154	Andris.Plaudis@meteo.lv
Lithuania	Mrs. Dalia Taraskeviciene	Lithuanian Hydrometeorological Service, 6 Rudnios St., LT-2600 Vilnius, Lithuania	(3702) 71 50 59	(3702) 72 88 74	avia@meteo.lt
Macedonia	Ms. Dragica Miatovic	CAA, Dame Gruev 1, 1000 Skopje, Republic of Macedonia	+389 2 148 204	---	Dmijatovic@dgca.gov.mk
Malaysia	Mr. Huvi Vein Tan	Malaysian Meteorological Service, Jalan Sultan, 46667 Petaling Jaya, Selangor, Malaysia	+6 03 79564422	+6 03 79550964	thv@kjc.gov.my
Morocco	Mr. Abderrahim Houjane	DMN Face prefecture Hay Hussani Ain Chock Casablanca, Morocco 2000	00 212 2 908757	00 212 2 908635	Moujane.abderrahim@caramail.com
Netherlands	Dr. Jitze P. van der Meulen	KNMI, Postbus 201, 3730 AE DeBilt, The Netherlands	+31 30 2206 432	+31 30 2210 407	Meulenvd@knmi.nl

Country	Name	Address	Telephone	Telefax	E-Mail
New Zealand	Mr. Bruce Hartley	Meteorological Service of New Zealand, Limited P.O. Box 722, Wellington, New Zealand	+64 4 4700 770	+64 4 4700 772	Hartley@MetService.com
Norway	Mrs. Merete Larre	Norwegian Meteorological Institute, PB 43 Blindern, 0313 Oslo, Norway	+47 2 2963000	+47 2 2963050	Metete.larre@dnmi.no
Portugal	Mr. Luis Nunes	Instituto de Meteorologia, Rua C, Aeroporto de Lisboa, 17490977 Lisboa, Portugal	+351 218483961	+351 218464744	Luis.nunes@meteo.pt
Singapore	Mr. Teo Suan Wong	Meteorological Service, P.O. Box 8, Changi Airport, Singapore 918141	65 545 7191	65 545 7192	WONG_Teo_SuanWMSS.gov.sg
Slovak Republic	Mr. Igor Zahumensky	Slovak Hydrometeorological Institute, Jeseniova 17, P.O. Box 15, 833 15 Bratislava 37, Slovak Republic	+421 46 5413 624	+421 2 5477 3620	Igor.Zahumensky@shmu.sk
Slovenia	Mr. Filip Stucin	Environmental Agency of the Republic of Slovenia, Vojkova 1B, 1000 Ljubljana, Slovenia	+386 1 47 84 075	+386 1 47 84 054	Filip.stucin@rzs-hm.si
Sri Lanka	Mr. Nuwan Kumarasinghe	Department of Meteorology, 383 Bauddhaloka Mawatha, Colombo 07, Sri Lanka	+94 1 681039	+94 1 691443	Nuwan1960@yahoo.com
Sweden	Mr. Ture Hovberg	SMHI, SE-601 76 Norrkoping, Sweden	+46 11 495 82 37	+46 11 495 80 01	Ture.hovberg@smhi.se
Switzerland	Dr. Alain Heimo	MeteoSwiss, Aerological Station, CH-1530 Payerne, Switzerland	+26 662 62 11	+26 662 62 12	Alain.heimo@meteoswiss.ch
Trinidad & Tobago	Mr. Nazim Mohammed	Trinidad and Tobago Meteorological Service, Piarco International Airport, Piarco, Trinidad	+1 (868) 669 5465	+1 (868) 669 4009	Dirmet@tstt.net.tt
Turkey	Mr. Selani Cakir	Turkish State Meteorological Service, P.O. Box 401, Ankara, Turkey	+90 312 302 2780	+90 312 360 2554	N/A
United States of America	Mr. Malcolm Gifford	National Weather Service, 1325 East-West Highway, Room 12110, Silver Spring, MD 20910, USA	+1 301 713 0304, Extension 156	+1 301 713 9395	Malcolm.gifford@noaa.gov
Uzbekistan	Mr. Vladimir Pavlovich Smirnov	Science and Production Enterprise “Hydrometpribor”, 4 Kh Asomov Str., 700084 Tashkent, Uzbekistan	998 712 34 93 61	998 712 34 74 30	N/A
Zimbabwe	Mr. Jonathan David Chifuna	Zimbabwe Meteorological Services, Met. Services Department, P.O. Box BE 150, Belvedere, Harare, Zimbabwe	263 4 778175	263 4 778161 or 263 4 778172	Jchifuna@weather.utande.co.zw

File: F:/WMO/Algorithm_Questionnaire.doc
Date: 6/17/03 3:57 a57/p57

ANNEX

W O R L D M E T E O R O L O G I C A L O R G A N I Z A T I O N

QUESTIONNAIRE
on
ALGORITHMS USED IN AUTOMATIC WEATHER STATIONS[1]

1 WMO Member Country: .....

2 Are automatic weather stations (AWSs) operationally used in your Service: ..... ☐

3 The AWSs are operationally used for:

3.1 Synoptic Meteorology ..... ☐
3.2 Aviation Support ..... ☐
3.3 Climatology ..... ☐
3.4 Hydrology ..... ☐
3.5 Agricultural Meteorology ..... ☐
3.6 Urban Meteorology ..... ☐
3.7 Atmospheric composition ..... ☐
3.8 Other applications (Please list) ..... ☐
.....
.....

4 Indicate whether for determination of the following variables / parameters *"single-sensor algorithms*[2]*"* are used:

4.1 Temperature ..... ☐
4.2 Relative Humidity ..... ☐
4.3 Dew Point ..... ☐
4.4 Precipitation Accumulation ..... ☐
4.5 Precipitation Intensity ..... ☐
4.6 Wind Speed ..... ☐
4.7 Wind Direction ..... ☐
4.8 Sea Level Pressure ..... ☐
4.9 Pressure Altitude ..... ☐
4.10 Density Altitude ..... ☐
4.11 Altimeter Setting (QNH) ..... ☐
4.12 Visibility (MOR) ..... ☐
4.13 Runway Visual Range ..... ☐
4.14 Sky Condition ..... ☐
4.15 Present Weather[3] ..... ☐
4.16 Thunderstorm ..... ☐
4.17 State of Ground ..... ☐
4.18 Other parameters (Please list) ..... ☐
.....
.....

5 Indicate whether for determination of the following variables / parameters any *"multi-sensor algorithms"* are used:

5.1 Meteorological Discontinuity Visibility ☐
5.2 Met. Discontinuity Sky Condition ..... ☐
5.3 Backup Algorithms ..... ☐
5.3.1 Visibility ..... ☐
5.3.2 Sky Condition ..... ☐
5.3.3 Other parameters (Please list) ..... ☐
.....
.....
5.4 Multi-Parameter Present Weather ..... ☐
5.4.1 Obstructions to Vision ..... ☐
5.4.2 Freezing Precipitation ..... ☐
5.4.3 Other parameters (Please list) ..... ☐
.....
.....

[1] Tick "✔" the box(es) as appropriate.
[2] Single-sensor-algorithms are developed for **one** variable or the output of **one** sensor only.
[3] See also 5.4 below.

6 Are any real-time Quality Control (QC) algorithms used to monitor data quality? ..... ☐

If so, please list below:

Parameter	Type of QC (such as Range Check, Parameter Consistency, etc.)
.....	.....
.....	.....
.....	.....
.....	.....

7 Are the current algorithms documented? ..... ☐

7.1 If algorithms are documented, is documentation available on a Web site ? ..... ☐

If available, please list Web site(s): .....

.....

7.2 If algorithms are documented but not available on a Web site, indicate below how they can be accessed:

.....

.....

8 Personal data of the expert nominated as focal person for further contacts:

Prof., Dr, Ms, Mrs, Mr[4] ..... , ...
Family name *First name*

Institution: .....

Position: .....

Address: .....

.....

Telephone: ..... E-mail: .....

Telefax: ..... URL/HTTP: www. . .....

Date: ..... Signature: .....
(Permanent Representative or designated expert)

Please, return the completed form at your earliest convenience, however if possible **not later than 15 December 2001** to the following address:

Mr Malcolm Gifford[5]
ASOS Development Manager
National Weather Service W/OST32
1325 East-West Highway, Room 12110
Silver Spring, MD 20910, USA
Telefax: (+1 301) 713-9395
E-mail: Malcolm.Gifford@noaa.gov

[4] Please underline the appropriate one.
[5] If needed, Mr Gifford can also be contacted by telephone: (+1) 301-713-0304 Extension 156.