SURVEY ON METEOROLOGICAL INSTRUMENTS, CALIBRATION AND TRAINING

Regional Association II (Asia)

K. Nakashima (Japan)

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FOREWORD

A view shared by many Members of World Meteorological Organization is that, with respect to effective operation of the WMO Integrated Global Observing System, one of the greatest challenges faced is in achieving regular maintenance and calibration of their meteorological instruments to ensure the quality and traceability of their measurements to international standards.

The regional associations and their associated Regional Instrument Centres (RICs) and Regional Radiation Centres (RRCs) can play a crucial role in improving this situation, by first identifying the key areas requiring improvement within a region, that is, by measuring gaps, and by providing guidance and conducting necessary capacity development activities to address these shortcomings.

This report describes the efforts of Regional Association II (Asia), through the RICs and RRCs of China, India and Japan, to demonstrate the value of this regional approach. Analysis of the responses received to their questionnaire, which was sent to all Members in RA II, confirms the utility of this approach, and provides a detailed review of the capacity of the region and its needs in terms of instrumentation, calibration, maintenance and training.

The questionnaire also took the opportunity to measure the dependence of RA II Members on mercury-based instruments and therefore to measure the extent of the possible impact, at the regional level, of the adoption of the Minamata Convention and the need for replacement of these types of instruments by the horizon of 2020.

The survey results reveal that significant efforts are being made in many RA II Members to ensure traceability of measurements: a number of Members has engaged the necessary material and human resources to perform such activities, and these set an excellent example for all WMO Members. It is commendable, too, that some RA II Members are now regularly offering training activities and support to their regional neighbours.

This excellent collaboration between the RICs and RRCs of RA II and other Members serves as a shining example of the benefits of such an approach and is certain to have a major impact on the quality and traceability of measurements throughout RA II.

I wish to express my sincere gratitude and that of CIMO to the authors of this excellent report, which, on the one hand, will assist strategic planners of all WMO Members, and, on the other, will encourage other regional associations and their RICs and RRCs to follow the example of RA II.

(Prof. B. Calpini)

President

Commission for Instruments and Methods of Observation

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EXECUTIVE SUMMARY

This publication reports on the results of a survey on meteorological instruments, calibration and training in Regional Association (RA) II (Asia). The survey was conducted via a questionnaire distributed to all 35 WMO Members in RA II through the WMO Secretariat in December 2011. A total of 24 (approx. 70%) of all National Meteorological and Hydrological Services (NMHSs) in the region responded.

The questionnaire was based on the work of the Regional Instrument Centre (RIC) Tsukuba and RIC Beijing together with the Regional Radiation Centre (RRC) Tokyo and RRC Pune to assess the calibration capability of RA II Members as well as their requirements for services provided by RICs and RRCs, including the provision of training materials and training events. It contained a variety of questions on operational observation instruments, meteorological standards, calibration laboratories, requirements for calibration with RIC or RRC standards, and training needs.

The major results of the survey are as follows:

(1) In RA II, meteorological instrument calibration was not conducted properly in many cases; fewer than half of the Members responding to the questionnaire had national meteorological standards that were traceable to international standards.

(2) Calibration and maintenance of meteorological instruments were identified as major issues to be tackled by Members and to be supported by RICs and RRCs, as most Members required calibration with RIC or RRC standards and recognized the significance of training on meteorological instruments.

(3) Conventional instruments such as mercury barometers and liquid-in-glass thermometers were still used rather than electrical instruments for most meteorological parameters.

The results of the survey will be utilized for RICs and RRCs in an efficient and effective manner to enhance their capability and available services toward the improvement of observational data quality in RA II.

1 INTRODUCTION

1.1 Background

The implementation of this survey was based on the conclusion of the JMA/WMO Workshop on Quality Management in Surface, Climate and Upper-air Observations in RA II (Tokyo, Japan, 27 – 30 July 2010). The work was designed to follow the arguments and recommendations of the 15th session of the Commission for Instruments and Methods of Observation (CIMO) (Helsinki, Finland, September 2010) and to meet the responsibilities of RRCs.

(1) Discussions at the workshop led to the conclusion that the primary factors adversely affecting data quality in RA II were instrument calibration and maintenance issues caused mainly by a lack of measurement traceability to international standards and calibration facilities. This indicated a strong need for Member capacity building programs on calibration and data quality management. It was recommended that RA II Members fully utilize the services of RICs to address these issues.

(2) It was recognized at the 15th session of CIMO that RICs should play an important role in the WMO Integrated Global Observing System (WIGOS) in order to ensure the quality of observations. This was decided in consideration of the fact that the worldwide compatibility of data strongly depends on assuring the traceability of measurements to international standards. It was also recommended that RICs maintain a database of the standards that are used by Members and already calibrated by RICs, develop necessary training materials, and organize training events to improve understanding of measurement traceability to international standards in the Region in collaboration with CIMO.

(3) With regard to radiation measurement, RRCs are designated to serve as centres for intraregional comparison of radiation instruments within the Region and to maintain the standard instruments necessary for this purpose. They are also tasked with providing the necessary outdoor facilities for simultaneous comparison of national standard radiometers from the Region.

1.2 Organization

The survey was conducted via a questionnaire distributed to all WMO Members in RA II through the WMO Secretariat in December 2011 (Appendix A). The questionnaire had two parts: Instruments and calibration (Part I) and Training (Part II). Part I was designed to support analysis of the current situation in the Region regarding instruments in operational use, national meteorological standards, requirements for standard-instrument calibration and calibration laboratories. Part II was designed to support analysis of requirements for meteorological instrument training courses or materials that could be shared among RA II Members. The questions in each part were as follows:

Part I. Instruments and calibration

Q1. Instruments in operational use

Q2. National meteorological standards and traceability to an international standard

Q3. Needs for calibration of standard instruments with RIC or RRC standards

Q4. Calibration laboratories

Q5. Questions or comments about instruments and calibrations, if any.

Part II. Training

Q1. Do you wish to join any training courses on meteorological instruments held by RICs? Please tick the appropriate box.

Q2. If your answer is “Yes” in Q1, which kind of trainings do you require? Please tick the *appropriate boxes.*

Q3. If your answer is "Yes" in Q1, how do you wish the training programs are conducted? Please tick the appropriate boxes.

Q4. Do you have any training courses or materials which can be shared among RA II Members? Please tick the appropriate boxes.

Q5. Supplementary comments with regard to Q1 – Q4, if any.

Q6. Questions or comments about trainings, if any.

1.3 Responses

A total of 24 NMHSs out of 35 RA II Members responded to the questionnaire. A list of NMHSs replying is provided in Appendix B.

2 SURVEY RESULTS

2.1 Part I: Instruments and calibration

2.1.1 Q1: Instruments in operational use

Q1 was designed to clarify types/methods of instruments used in actual operation and the status of/interval between calibrations with regard to seven meteorological parameters (pressure, temperature, humidity, wind, precipitation, radiation, sunshine duration). A total of 24 NMHSs responded to this part of the questionnaire.

It was found that conventional instruments such as mercury barometers and liquid-in-glass thermometers were used more commonly than electrical instruments for most meteorological parameters.

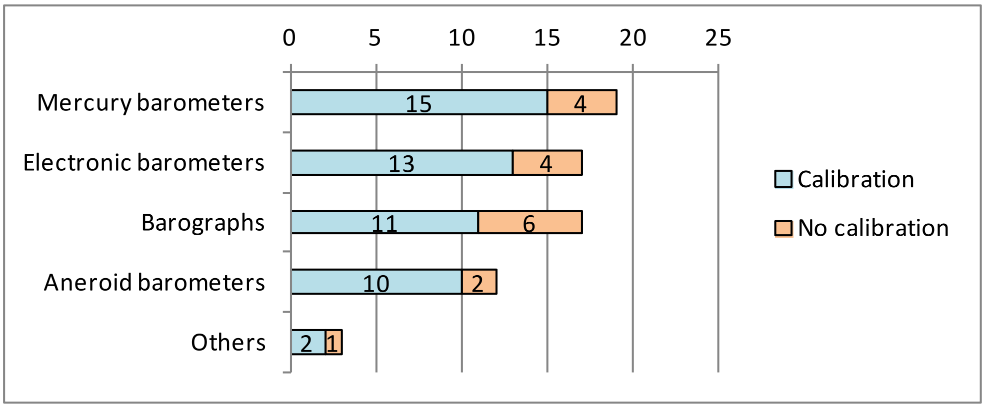
The implementation status of calibration varied by instrument, with calibration intervals mostly varying between one and three years.

(a) Pressure

Conventional instruments such as mercury barometers, barographs and aneroid barometers were still widely used to measure pressure. The most commonly used instrument was the mercury barometer, followed by the electronic barometer and the barograph (multiple answers, Figure 1).

- Mercury barometers were used by 19 out of 24 Members (79%), and calibration was carried out by 15 of these 19 (79%).
- Electronic barometers were used by 17 out of 24 Members (71%), and calibration was carried out by 13 of these 17 (76%) .
- Barographs were used by 17 out of 24 Members (71%), and calibration was carried out by 11 of these 17 (65%).

Calibration intervals were between six months and six years, with the majority between one and three years.



(N = 24)

Figure 1. Instruments in operational use (pressure)

(b) Temperature

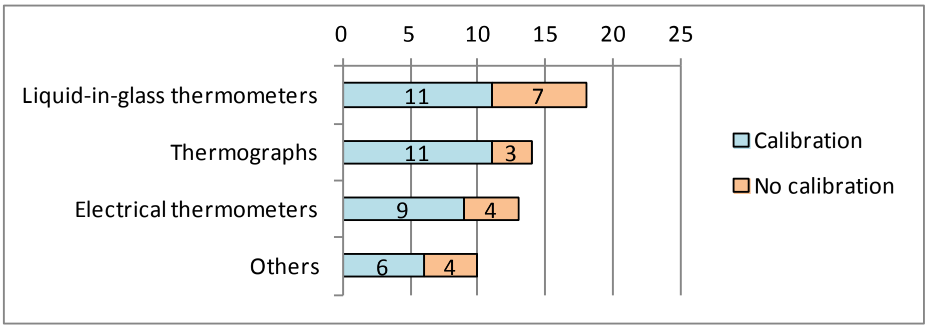
Conventional instruments such as liquid-in-glass thermometers and thermographs were still widely used to measure temperature. The most commonly used instrument was the liquid-in-glass thermometer, followed by the thermograph and the electrical thermometer (multiple answers, Figure 2).

- Liquid-in-glass thermometers were used by 18 out of 24 Members (75%), and calibration was carried out by 11 of these 18 (61%).

- Thermographs were used by 14 out of 24 Members (58%), and calibration was carried out by 11 of these 14 (79%).
- Electrical thermometers were used by 13 out of 24 Members (54%), and calibration was carried out by 9 of these 13 (69%).

"Others" in the graph includes liquid-in-glass thermometers (for maximum and minimum temperature) and soil thermometers.

Calibration intervals were between one and four years, with the majority at one year.



(N = 24)

Figure 2. Instruments in operational use (temperature)

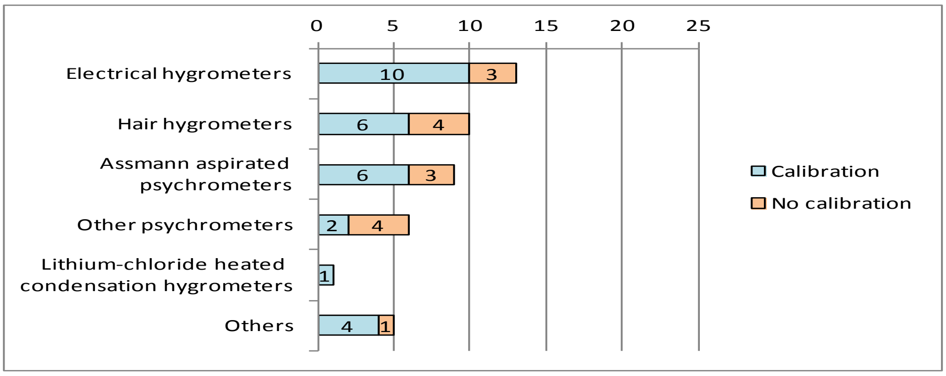
(c) Humidity

Electrical hygrometers were mainly used to measure humidity. However, conventional instruments such as hair hygrometers and psychrometers were still widely used. The most widely used instrument was the electrical hygrometer, followed by the hair hygrometer and the Assmann aspirated psychrometer (multiple answers, Figure 3).

- Electrical hygrometers were used by 13 out of 24 Members (54%), and calibration was carried out by 10 of these 13 (77%).
- Hair hygrometers were used by 10 out of 24 Members (42%), and calibration was carried out by 6 of these 10 (60%).
- Assmann aspirated psychrometers were used by 9 out of 24 Members (38%), and calibration was carried out by 6 of these 9 (67%).

"Others" in the graph includes hydrographs.

Calibration intervals were between one and three years, with the majority at one year.



(N = 24)

Figure 3. Instruments in operational use (humidity)

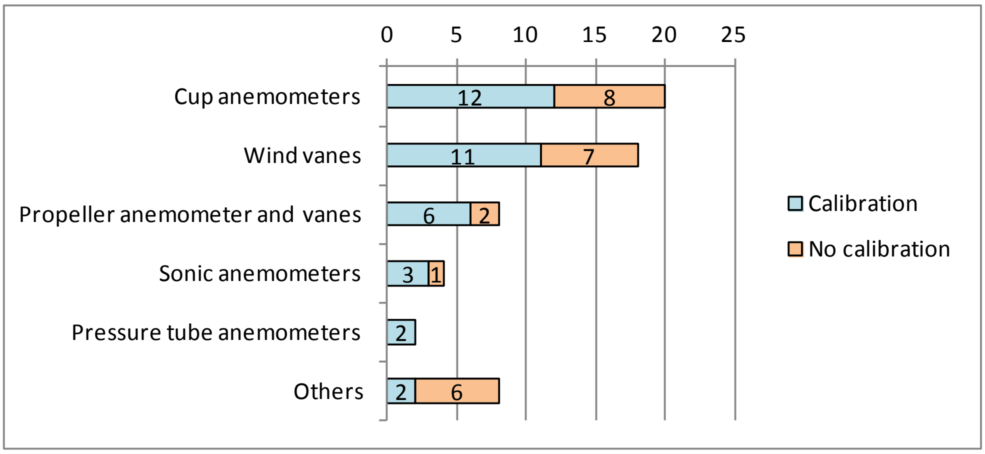
(d) Wind

Cup anemometers and wind vanes were mainly used to measure wind. The most widely used instrument was the cup anemometer, followed by the wind vane and the propeller anemometer (multiple answers, Figure 4).

- Cup anemometers were used by 20 out of 24 Members (83%), and calibration was carried out by 12 of these 20 (60%).
- Wind vanes were used by 18 out of 24 Members (75%), and calibration was carried out by 11 of these 18 (61%).
- Propeller anemometers were used by 8 out of 24 Members (33%), and calibration was carried out by 6 of these 8 (75%).

"Others" in the graph includes mechanical wind recorders and thermal anemometers.

Calibration intervals were between one and five years, with the majority at one year.



(N = 24)

Figure 4. Instruments in operational use (wind)

(e) Precipitation

Ordinary gauges and tipping bucket gauges were mainly used to measure precipitation. The most widely used instruments were ordinary gauges and tipping bucket gauges, followed by float gauges (multiple answers, Figure 5).

- Ordinary gauges were use by 15 out of 24 Members (63%), and calibration was carried out by 10 of these 15 (67%).
- Tipping bucket gauges were used by 15 out of 24 Members (63%), and calibration was carried out by 9 of these 15 (60%).
- Float gauges were used by 4 out of 24 Members (17%), and calibration was carried out by 2 of these 4 (50%).

"Others" in the graph includes pluviographs and siphon rain gauges.

Calibration intervals were between three months and six years, with the majority at one year.

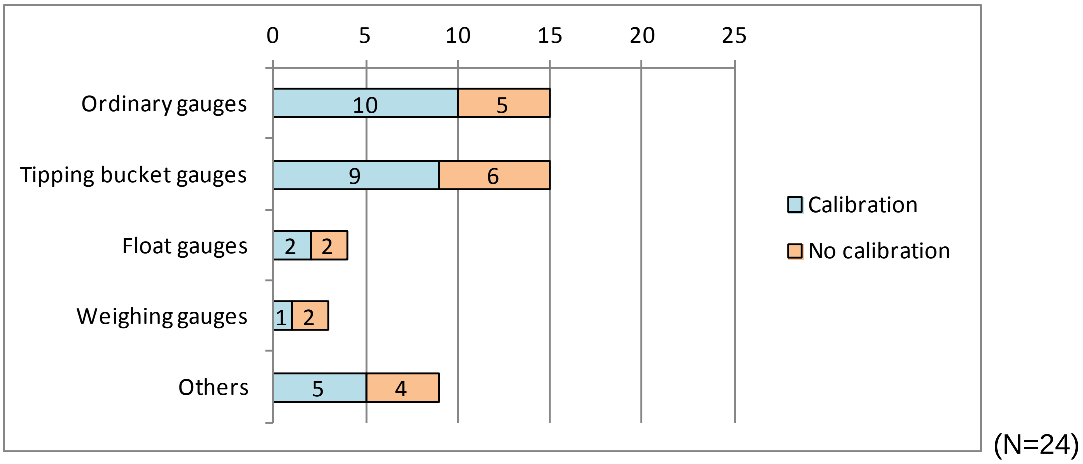


Figure 5. Instruments in operational use (precipitation)

(f) Radiation

Pyranometers were widely used to measure radiation. The most widely used instrument was the pyranometer, followed by the pyrheliometer and the net radiometer (multiple answers, Figure 6).

- Pyranometers were used by 18 out of 24 Members (75%), and calibration was carried out by 12 of these 18 (67%).
- Pyrheliometers were used by 10 out of 24 Members (42%), and calibration was carried out by 8 of these 10 (80%).
- Net radiometers were used by 9 out of 24 Members (38%), and calibration was carried out by 6 of these 9 (67%).

“Others” in the graph includes photoelectrical photometers and sky radiometers.

Calibration intervals were between three months and six years, with the majority at one year.

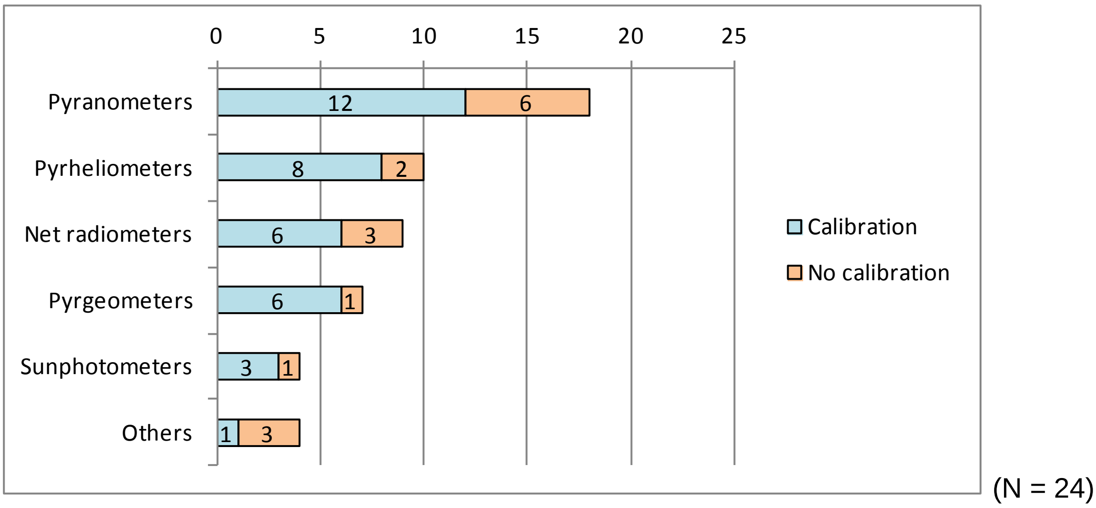


Figure 6. Instruments in operational use (radiation)

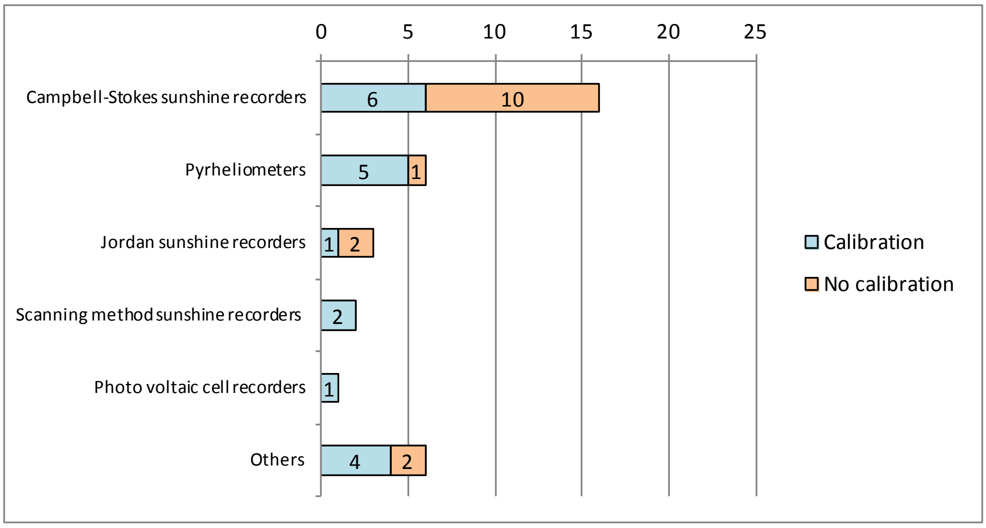
(g) Sunshine duration

Campbell-Stokes sunshine recorders were widely used to measure sunshine duration. The most widely used instrument was the Campbell-Stokes sunshine recorder, followed by the pyrheliometer and the Jordan sunshine recorder (multiple answers, Figure 7).

- Campbell-Stokes sunshine recorders were used by 16 out of 24 Members (67%), and calibration was carried out by 6 of these 16 (38%).
- Pyrheliometers were used by 6 out of 24 Members (25%), and calibration was carried out by 5 of these 6 (83%).
- Jordan sunshine recorders were used by 3 out of 24 Members (13%), and calibration was carried out by 1 of these 3 (33%).

“Others” in the graph includes sunshine duration sensors.

Calibration intervals were between six months and five years, with the majority at around three years.



(N = 24)

Figure 7. Instruments in operational use (sunshine duration)

Supplementary comments on instruments in operational use (free description) are listed in Table 1.

Table 1. Comments on instruments in operational use (free description)

Comments
– Financial difficulties high
– Station of Baseline Surface Radiation Network from June 2010. Temperature and wind speed – US Climate Reference Network
– According to the Law on Metrology and "Instructions on carrying out meteorological observations" in the Republic of Uzbekistan, all meteorological instruments and systems must undergo a process of verification. The procedure for calibration in the working and standard measurement of meteorological parameters is not provided in guiding documents.

2.1.2 Q2: National meteorological standards and traceability to an international standard

Q2 was designed to clarify maintenance of national meteorological standards and traveling standards and the calibration situation of national meteorological standards with superior standards traceable to international standards. A total of 21 Members responded to this part of the questionnaire.

It was found that more than half of the 21 Members maintained national meteorological standards for pressure, temperature and humidity, while fewer than half maintained them for other meteorological parameters. Even in the maximum case (pressure), only 9 out of 21 Members (43%) calibrated their national meteorological standards with superior standards traceable to international standards.

(a) Pressure

(a-i) National meteorological standards

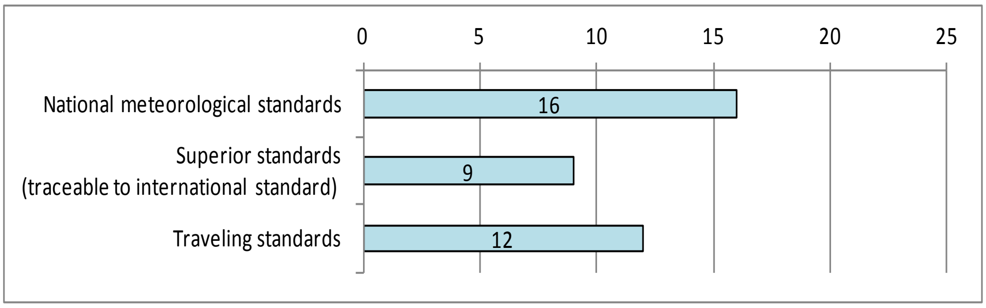
National meteorological standards were maintained by 16 out of 21 Members (76%) (Figure 8). The most widely used meteorological standard was the mercury barometer (8 Members), followed by the electronic barometer (6 Members) (multiple answers, Figure 9). The uncertainties of individual Members' national meteorological standards are listed in Table 2. Intervals between calibration with superior standards were between one and ten years, with the majority at one or two years.

(a-ii) Superior standards

Standards calibrated with superior standards traceable to international standards were maintained by 9 out of 16 Members (56% of Members maintaining national meteorological standards). The most widely used superior standard was the pressure balance (dead weight tester).

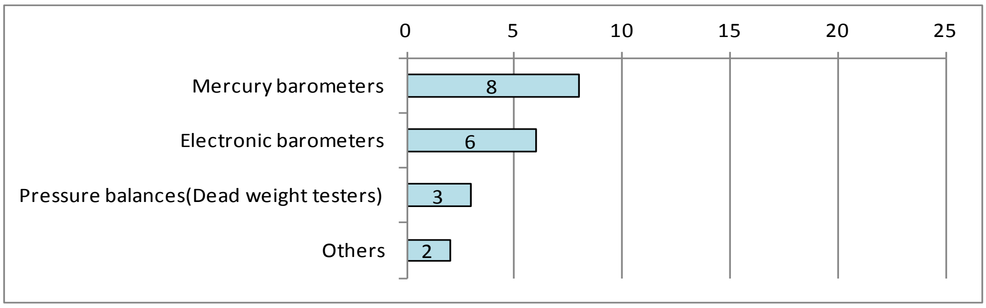
(a-iii) Traveling standards

Traveling standards were maintained by 12 out of 21 Members (57%). Six of these were the electronic type and four were mercury-type barometers.



(N = 21)

Figure 8. Maintenance of standards and traceability to an international standard (pressure)



(N = 21)

Figure 9. Instrument type/method used for national meteorological standards (pressure)

Table 2. Uncertainty of national meteorological standards (pressure)

Description
– Corr.: ± 00, up to ± 0.3 hPa
– 1.3 Pa
– ± 0.07 hPa
– ± 0.08 hPa
– -0.01 mb
– 0.01 mb
– 0.05 mb
– 0.01%
– 0.0035% of the value or 3.0 Pa (k = 2)
– 8 ppm, k = 2

(b) Temperature

(b-i) National meteorological standards

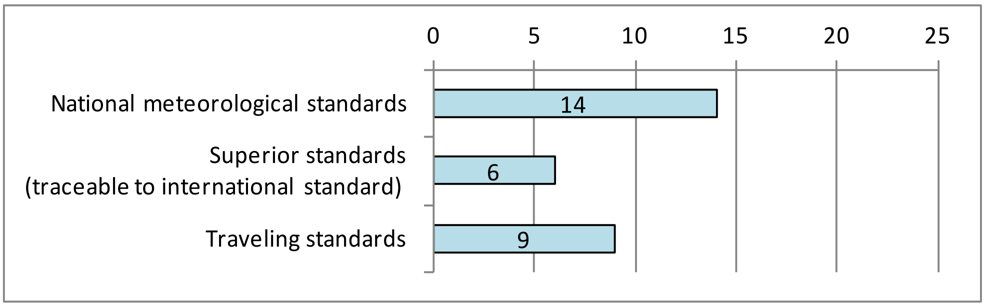
National meteorological standards were maintained by 14 out of 21 Members (67%) (Figure 10). The most widely used meteorological standard was the platinum resistance thermometer (7 Members), followed by the liquid-in-glass thermometer (5 Members) (multiple answers, Figure 11). The uncertainties of individual Members' national meteorological standards are listed in Table 3. Intervals between calibration with superior standards were between one and five years, with the majority at one year or two years.

(b-ii) Superior standards

Standards calibrated with superior standards traceable to international standards were maintained by 6 out of 14 Members (43% of Members maintaining national meteorological standards). The most widely used superior standard was the platinum resistance thermometer.

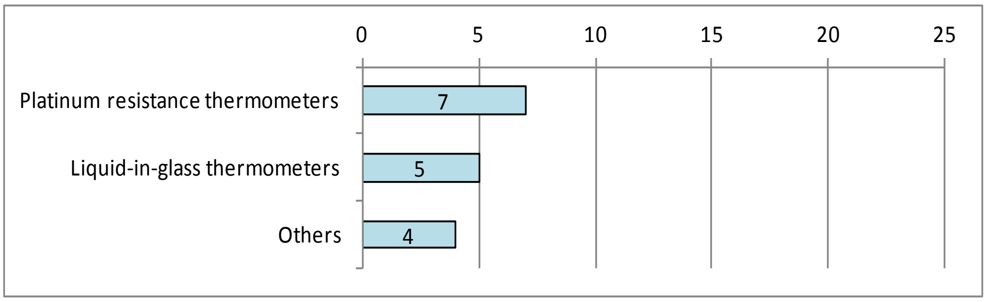
(b-iii) Traveling standards

Traveling standards were maintained by 9 out of 21 Members (43%). Seven of these were the electronic type (including platinum resistance thermometers).



(N = 21)

Figure 10. Maintenance of standards and traceability to an international standard (temperature)



(N = 21)

Figure 11. Instrument type/method used for national meteorological standards (temperature)

Table 3. Uncertainty of national meteorological standards (temperature)

Description
– Corr.: ± 0°C
– ± 0°C
– 0.001°C
– ± 0.002°C
– 0.003°C
– 7 mK
– 0.01°C
– 0.03°C
– 0.1°C
– 0.17°C
– Mercury triple point (-38.8344°C): 2 mK; indium freezing point (156.5985°C): 3 mK (*k* = 2)

(c) Humidity

(c-i) National meteorological standards

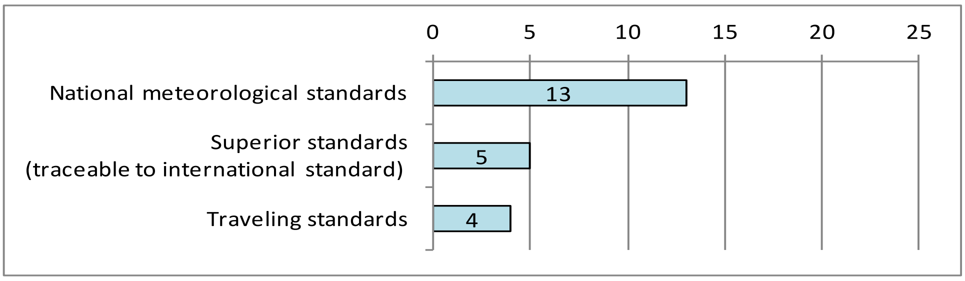
National meteorological standards were maintained by 13 out of 21 Members (62%) (Figure 12). The most widely used meteorological standard was the psychrometer (4 Members) (multiple answers, Figure 13). The uncertainties of individual Members' national meteorological standards are shown in Table 4. The interval between calibration with superior standards was one year.

(c-ii) Superior standards

Standards calibrated with superior standards traceable to international standards were maintained by 5 out of 13 Members (38% of Members maintaining national meteorological standards). Types were chilled mirror dew-point hygrometers, humidity generators, hygrometer-comparators and others.

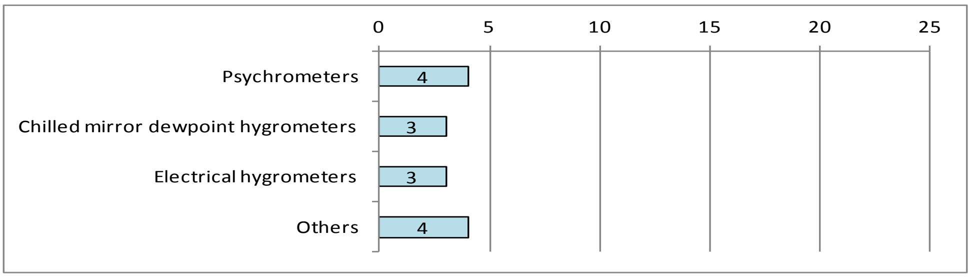
(c-iii) Traveling standards

Traveling standards were maintained by 4 out of 21 Members (19%). Types were chilled mirror dew-point hygrometers, electronic hygrometers, psychrometers and others.



(N = 21)

Figure 12. Maintenance of standards and traceability to an international standard (humidity)



(N=21)

Figure 13. Instrument type/method used for national meteorological standards (humidity)

Table 4. Uncertainty of national meteorological standards (humidity)

Description
− R.H. ± 00% to R.H. ± 5%
− 0.1%
− from 15 to 25°C ± 0.5%, from 25 to 80°C ± 1%
− 1%
− ± 1.0 (%)
− 3%
− ± 0°C
− 0.04°C (at 25°C) - 0.09°C (at - 10°C) (*k* = 2)
− 0.13°C (dew-point temperature)
− 0.15°C (dew-point temperature)

(d) Wind

(d-i) National meteorological standards

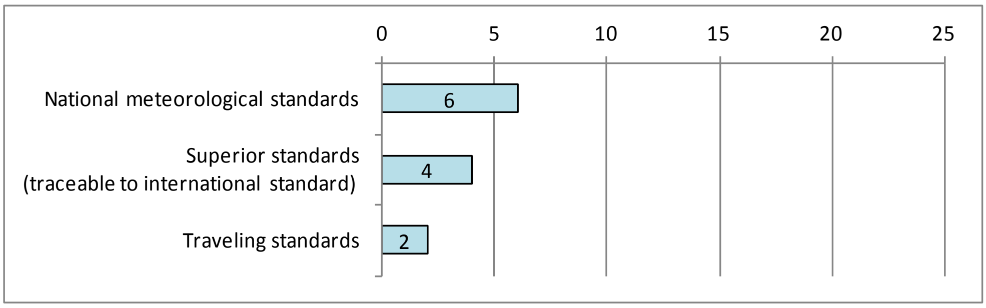
National meteorological standards were maintained by 6 out of 21 Members (29%) (Figure 14). The most widely used meteorological standards were the pitot tube and differential pressure (3 Members each) (multiple answers, Figure 15). The uncertainties of individual Members' national meteorological standards are shown in Table 5. Intervals between calibration with superior standards were between two and five years.

(d-ii) Superior standards

Standards calibrated with superior standards traceable to international standards were maintained by four out of six Members (67% of Members maintaining national meteorological standards).

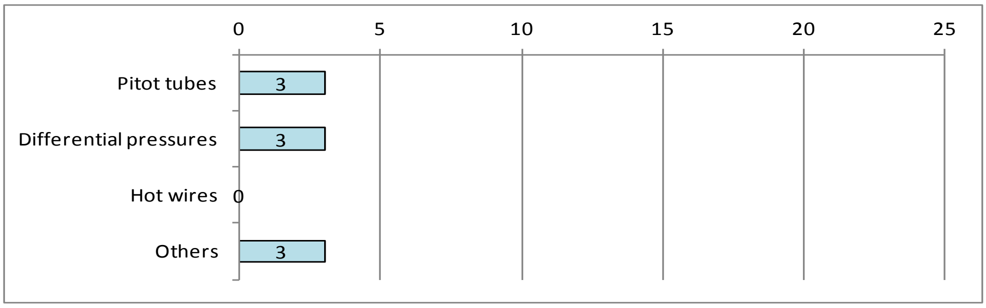
(d-iii) Traveling standards

Traveling standards such as hand anemometers were maintained by 2 out of 21 Members (10%).



(N = 21)

Figure 14. Maintenance of standards and traceability to an international standard (wind)



(N = 21)

Figure 15. Instrument type/method used for national meteorological standards (wind)

Table 5. Uncertainty of national meteorological standards (wind)

Description
− 0.1%
− 0.1%
− 0.062 m/s (at 20 m/s), 0.29% (at 40 m/s) (k = 2)
− 0.1 m/s
− ± (0.003 + 0.005 V)

(e) Precipitation

(e-i) National meteorological standards

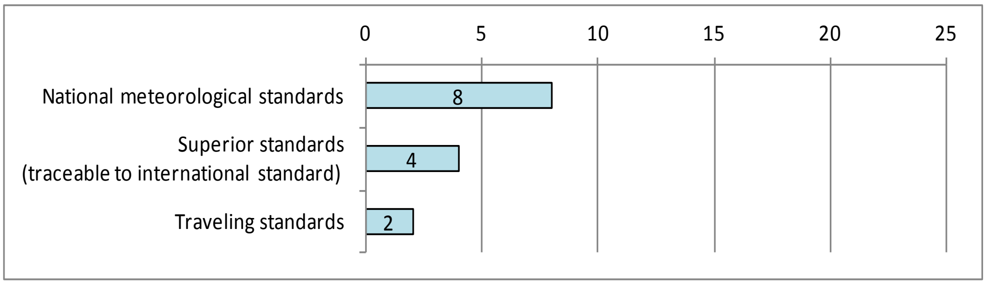
National meteorological standards were maintained by 8 out of 21 Members (38%) (Figure 16). The most widely used meteorological standard was volume measuring method (5 Members) (multiple answers, Figure 17). The uncertainties of individual Members' national meteorological standards are shown in Table 6. Intervals between calibration with superior standards were between one and ten years.

(e-ii) Superior standards

Standards calibrated with superior standards traceable to international standards were maintained by four out of eight Members (50% of Members maintaining national meteorological standards).

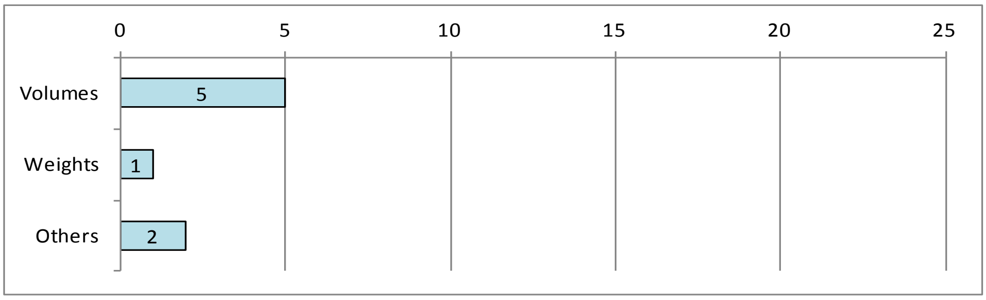
(e-iii) Traveling standards

Traveling standards were maintained by 2 out of 21 Members (10%). The types were measuring cylinders and ordinary raingauges.



(N = 21)

Figure 16. Maintenance of standards and traceability to an international standard (precipitation)



(N = 21)

Figure 17. Instrument type/method used for national meteorological standards (precipitation)

Table 6. Uncertainty of national meteorological standards (precipitation)

Description
− ± 0 mm
− 0.1 mm
− ± 0.01 g
− 0.1 ml

(f) Radiation

(f-1) Pyrheliometers

(f-1-i) National meteorological standards

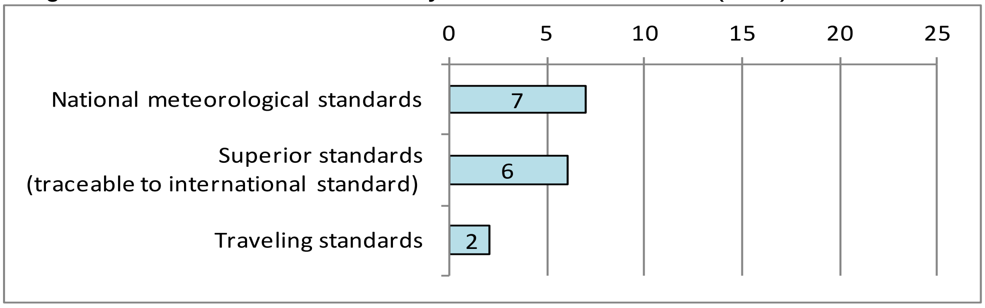
National meteorological standards were maintained by 7 out of 21 Members (33%) (Figure 18). The types were absolute cavity radiometers, thermopiles and similar (multiple answers). The uncertainties of individual Members' national meteorological standards are shown in Table 7. Intervals between calibration with superior standards were between three and ten years.

(f-1-ii) Superior standards

Standards calibrated with superior standards traceable to international standards were maintained by six out of seven Members (86% of Members maintaining national meteorological standards).

(f-1-iii) Traveling standards

Traveling standards were maintained by 2 out of 21 Members (10%).



(N = 21)

Figure 18. Maintenance of standards and traceability to an international standard (pyrheliometers)

Table 7. Uncertainty of national meteorological standards (pyrheliometers)

Description
− < 0.15% absolute (W/m^2)
− 0.2%
− 0.3%
− 0.1 W/m^2

(f-2) Pyranometers

(f-2-i) National meteorological standards

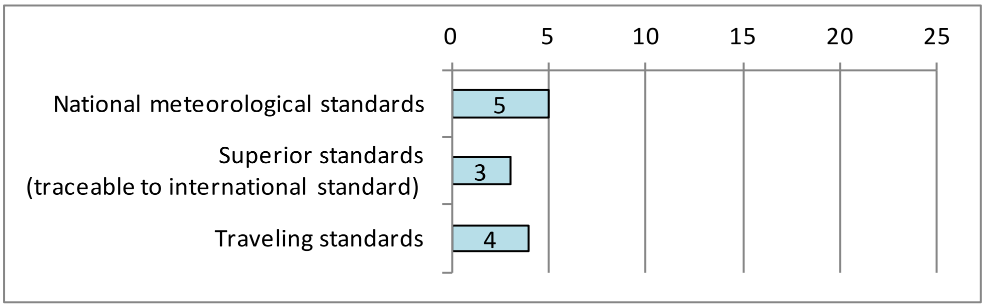
National meteorological standards were maintained by 5 out of 21 Members (24%) (Figure 19). The types were thermopiles and similar. The uncertainties of individual Members' national meteorological standards are shown in Table 8. Intervals between calibration with superior standards were between one and four years.

(f-2-ii) Superior standards

Standards calibrated with superior standards traceable to international standards were maintained by three out of five Members (60% of Members maintaining national meteorological standards).

(f-2-iii) Traveling standards

Traveling standards were maintained by 4 out of 21 Members (19%).



(N = 21)

Figure 19. Maintenance of standards and traceability to an international standard (pyranometers)

Table 8. Uncertainty of national meteorological standards (pyranometers)

Description
− 0.2%

(f-3) Pyrgeometers

(f-3-i) National meteorological standards

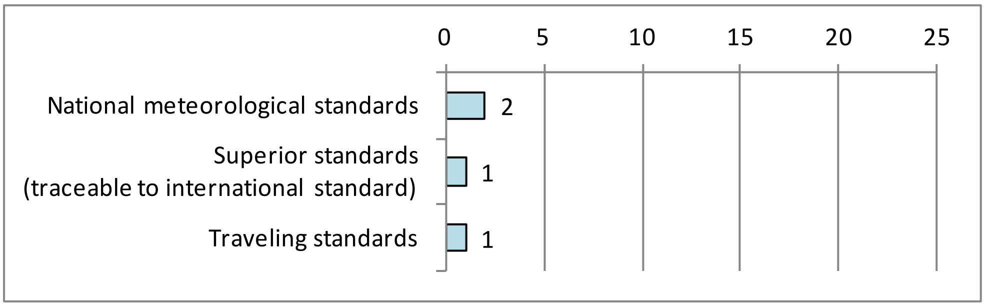
National meteorological standards were maintained by 2 out of 21 Members (10%) (Figure 20). The types were thermopiles and similar. The uncertainties of individual Members' national meteorological standards are shown in Table 9. Intervals between calibration with superior standards were between three and five years.

(f-3-ii) Superior standards

Standards calibrated with superior standards traceable to international standards were maintained by one out of two Members (50% of Members maintaining national meteorological standards).

(f-3-iii) Traveling standards

Traveling standards were maintained by 1 out of 21 Members (5%).



(N = 21)

Figure 20. Maintenance of standards and traceability to an international standard (pyrgeometers)

Table 9. Uncertainty of national meteorological standards (pyrgeometers)

Description
− 1.6%

(f-4) Sunphotometers

(f-4-i) National meteorological standards

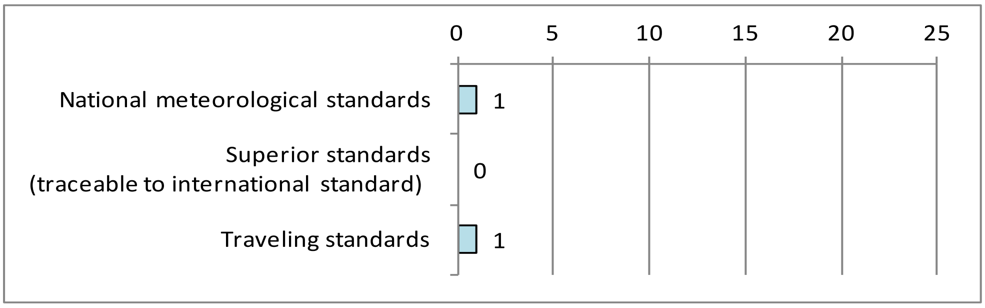
National meteorological standards were maintained by 1 out of 21 Members (5%) (Figure 21). The type was the filter radiometer. The uncertainty of the Member's national meteorological standard is shown in Table 10. The interval between calibration with a superior standard was five years.

(f-4-ii) Superior standards

Standards calibrated with superior standards traceable to international standards were not maintained by any Members.

(f-4-iii) Traveling standards

Traveling standards were maintained by 1 out of 21 Members (5%).



(N = 21)

Figure 21. Maintenance of standards and traceability to an international standard (sunphotometers)

Table 10. Uncertainty of national meteorological standards (sunphotometers)

Description
– 368 nm: 0.043 V; 412 nm: 0.023 V; 500 nm: 0.010 V; 862 nm: 0.016 V

(g) Sunshine duration

(g-i) National meteorological standards

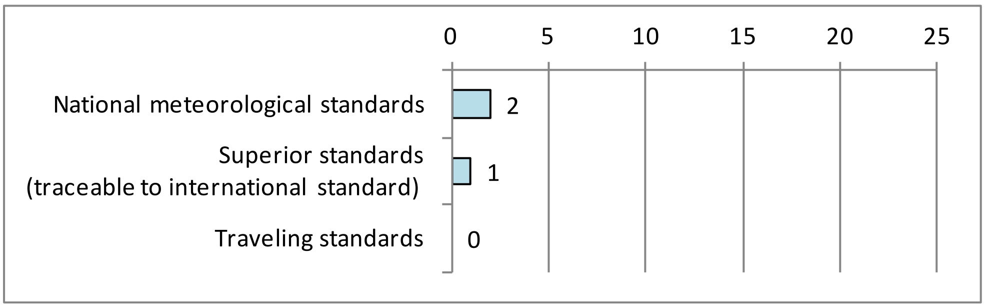
National meteorological standards were maintained by 2 out of 21 Members (10%) (Figure 22). The types were thermometers and similar. No answers were received on the uncertainties of individual Members' national meteorological standards. The interval between calibration with a superior standard was three years.

(g-ii) Superior standards

Standards calibrated with superior standards traceable to international standards were maintained by one out of two Members (50% of Members maintaining national meteorological standards).

(g-iii) Traveling standards

Traveling standards were not maintained by any Members.



(N = 21)

Figure 22. Maintenance of standards and traceability to an international standard (sunshine duration)

Supplementary comments on national meteorological standards, superior standards and traveling standards are listed in Table 11.

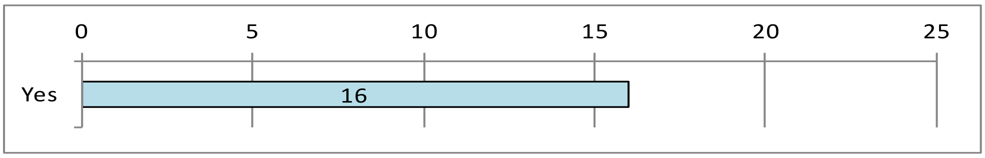
Table 11. Comments on national meteorological standards, superior standards and traveling standards (free description)

Comment
– No facilities for routine calibration

2.1.3 Q3: Needs for calibration of instruments with RIC or RRC standards

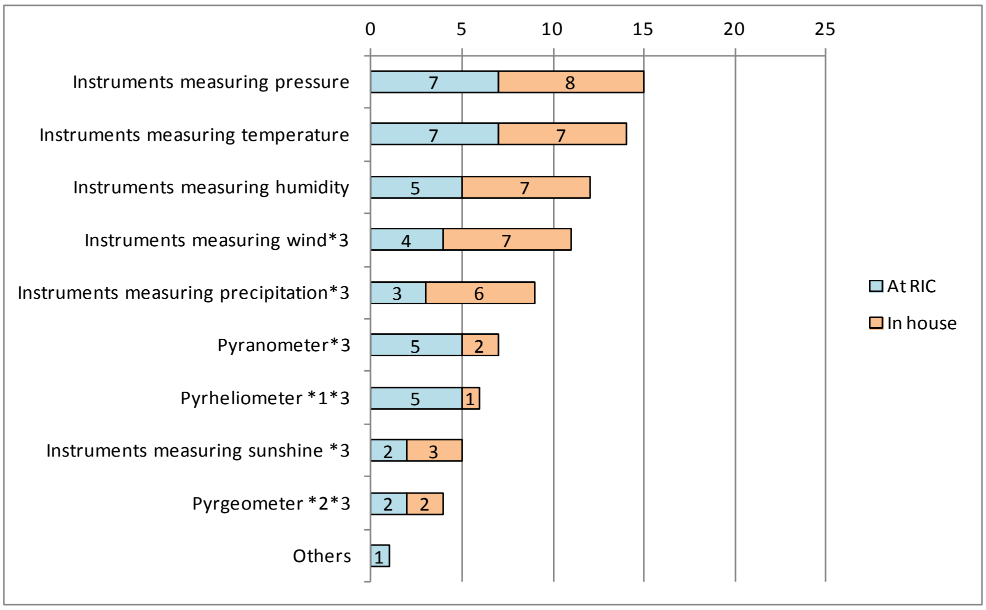
Q3 was designed to clarify requirements for the calibration of standard instruments with RIC or RRC standards. A total of 18 Members responded to this part of the questionnaire, 16 (89%) of which required such calibration (Figure 23).

The major meteorological parameters for calibration were pressure (15 out of 18 Members (83%)), temperature (14 out of 18 Members (78%)) and humidity (12 out of 18 Members (67%)). Figure 24 shows requirements for calibration regarding individual meteorological parameters.



(N = 18)

Figure 23. Requirements for calibration of standard instruments with RIC or RRC standards



(N = 18)

Figure 24. Requirements for calibration regarding individual meteorological parameters

Supplementary comments on requirements for the calibration of standard instruments are listed in Table 12.

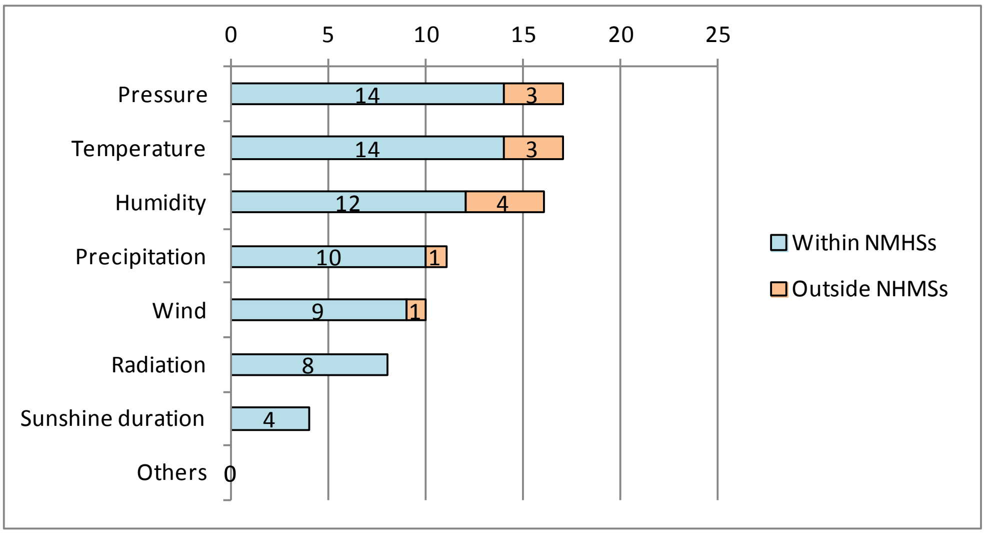
Table 12. Comments on requirements for the calibration of standard instruments with RIC or RRC standards (free description)

Comment
– We plan to calibrate our meteorological equipment with regional standards every five years.
– It is better to calibrate using manufacturer standards since we don't have a national standard.
– In terms of availability, language compatibility, standard basis community and service capacity, the most desirable RIC/RRC is the Federal State Budgetary Organization's Main Geophysical Observatory in St. Petersburg, Russia.

2.1.4 Q4: Calibration laboratories

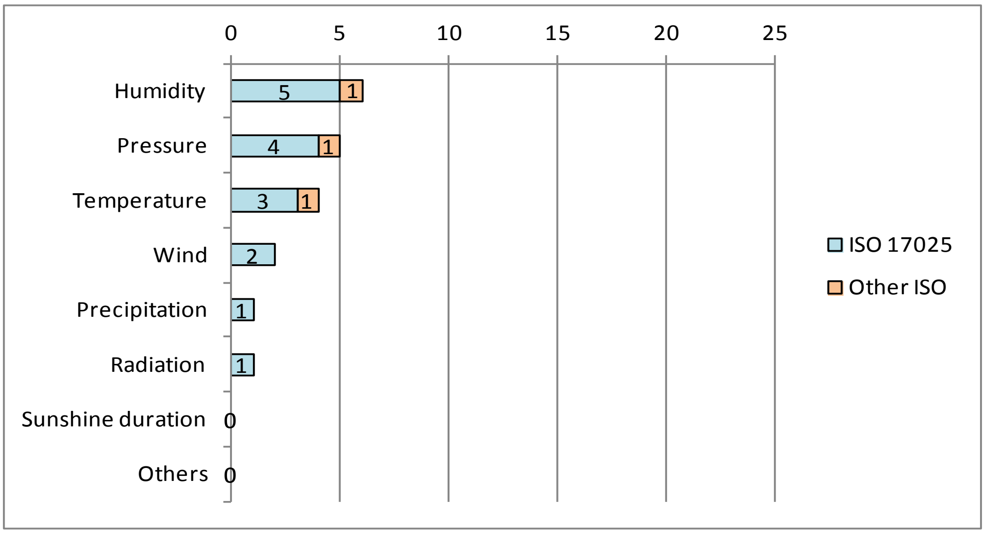
Q4 was designed to clarify the presence of calibration laboratories. In cases where Members managed laboratories, situations of ISO accreditation or certification were also surveyed. A total of 22 Members responded to this part of the questionnaire, 16 or more (over 2/3) of which had laboratories (mostly within NMHSs) for pressure, temperature and humidity (Figure 25). A total of 5 out of these 22 (23%) had no laboratories.

Accreditation or certification (ISO/IEC 17025 or other ISO) was held by six Members' laboratories for humidity, by five for pressure and by four for temperature (Figure 26). It should be noted that some Members reporting ISO 17025 accreditation did not have national standards traceable to international standards, which is inconsistent with the ISO 17025 criteria. Accordingly, some Members may have misunderstood the question and the actual number with ISO 17025 accreditation may be smaller. One Member had "Other ISO" certification (ISO 9001).



(N = 22)

Figure 25. Presence of calibration laboratories



(N = 22)

Figure 26. ISO/IEC 17025 or other ISO accreditation or certification

Supplementary comments on calibration laboratories are listed in Table 13.

Table 13. Comments on calibration laboratories (free description)

Comment
– We plan to follow ISO 17025.
– We do not have technical capabilities for calibration.
– Calibration instruments for thermographs and hygrographs are available, but are very old and no intercomparision with international standards has been conducted since its establishment in the 1980s. An intercomparision chamber for barometers and a thermometer temperature bath are also available. Calibration chambers have not been in operational use recently but can be used after comparison with international standards and necessary training for operation. Calibration laboratories do not have ISO accreditation or other certification. The calibration chamber for thermographs and hygrographs has electrical ports that could be utilized for sensor calibration if an expert team from a regional center could visit to ensure standards and provide guidelines.
– Details of ISO 17025 certification can be provided to PMD.

2.1.5 Q5: Questions or comments about instruments and calibration

Q5 asked for questions or comments on instruments and calibration. Two Members responded to this part of the questionnaire (Table 14).

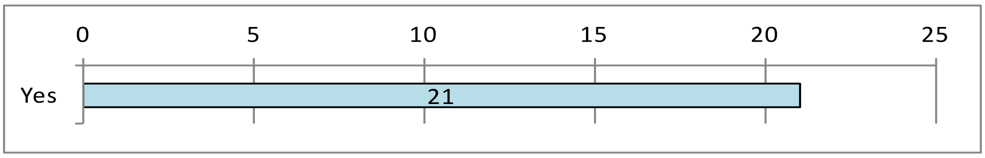
Table 14. Comments on instruments and calibration (free description)

Comment
– Meteorological instruments are laboratory-calibrated using in-house standards.
– We require such facilities and training.

2.2 Part II: Training

2.2.1 Q1: Do you wish to join any training courses on meteorological instruments held by RICs?

Q1 was designed to ascertain interest in for RIC training courses on meteorological instruments. A total of 21 Members responded to this part of the questionnaire (Figure 27). All 21 Members (100%) expressed interest in attending such courses.

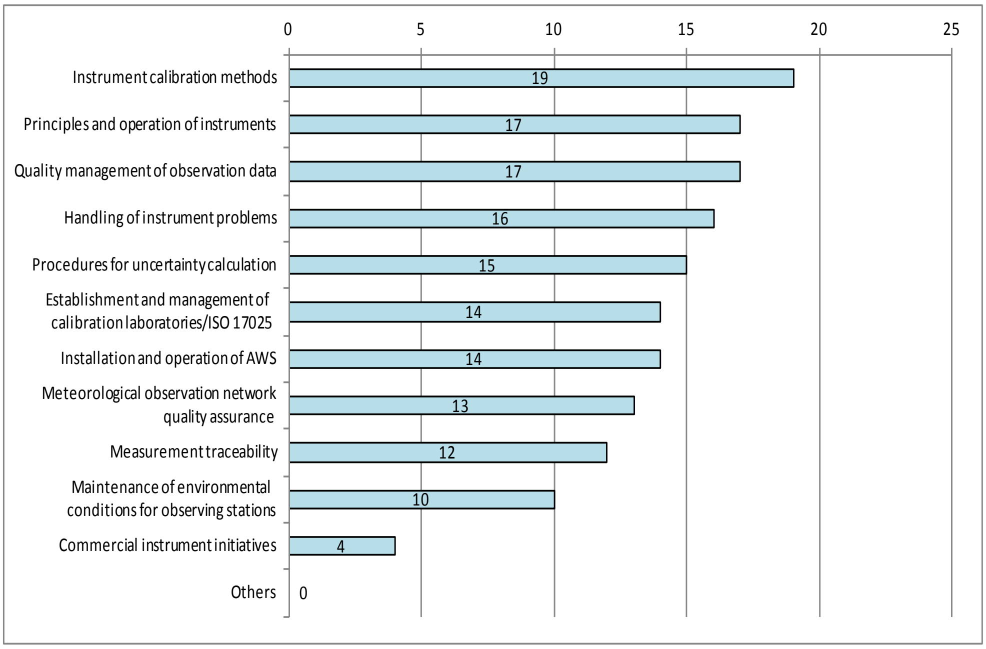


(N = 21)

Figure 27. Interest in training courses on meteorological instruments

2.2.2 Q2: If your answer is “Yes” in Q1, which kind of trainings do you require?

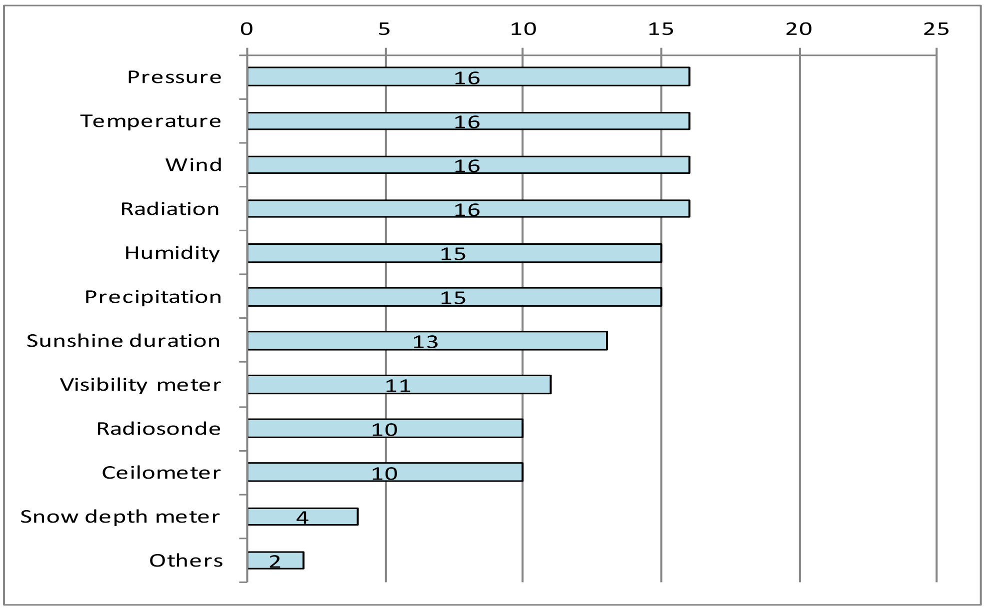
Q2 was designed to ascertain the type of training desired by NMHSs wishing to attend RIC training courses on meteorological instruments. A total of 21 Members responded to this part of the questionnaire. Major areas of interest were instrument calibration methods (19 out of 21 Members (90%)), principles and operation of instruments (17 out of 21 Members (81%)) and quality management of observation data (17 out of 21 Members (81%)) (multiple answers, Figure 28).



(N = 21)

Figure 28. Areas of Member interest in RIC training

In Q2, if "Principles and operation of instruments" was selected, an additional question "For which instruments do you wish to receive training?" was asked. Instruments used to measure pressure, temperature, wind and radiation were the most common responses (16 out of 17 Members) followed by those used to measure humidity and precipitation (15 out of 17 Members) (multiple answers, Figure 29).

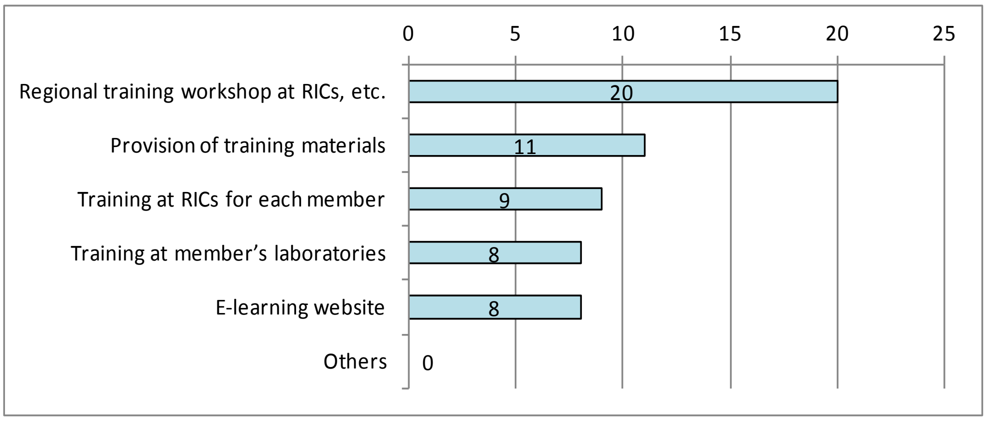


(N = 21)

Figure 29. Areas of Member interest in training on principles and operation of instruments

2.2.3 Q3: If your answer "Yes" in Q1, how do you wish the training programs conducted?

In Q3, if "Yes" was selected for Q1, areas of Member interest in training methods were additionally surveyed. A total of 21 Members responded to this part of the questionnaire (multiple answers, Figure 30). Most Members (20 out of 21 (95%)) expressed interest in regional training workshops at RICs and similar, while 11 out of 21 Members (52%) expressed interest in the provision of training materials.

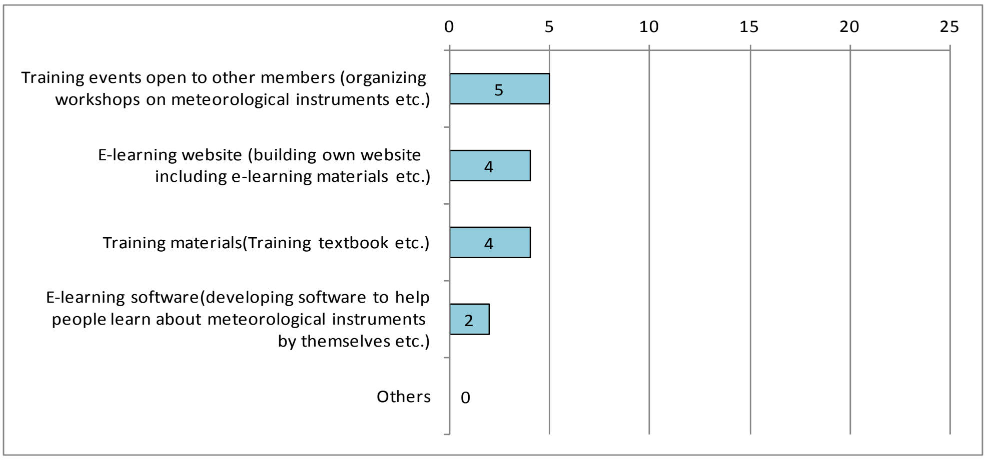


(N = 21)

Figure 30. Areas of Member interest in training methods

2.2.4 Q4: Do you have any training courses or materials which can be shared among RA II Members?

Q4 was designed to clarify provisions for training courses or materials that could be shared among RA II Members. A total of six Members had such courses or materials (multiple answers, Figure 31).



(N = 6)

Figure 31. Training courses or materials that could be shared among RA II Members

Details of training events, E-learning websites, training materials and E-learning software open to other Members are listed in Tables 15, 16, 17 and 18, respectively.

Table 15. Training events open to other members

– Bangladesh Details: Calibration of met. equipment Language: English
– Hong Kong, China
– Japan Details: WMO training workshop for instrument specialists in RA II (Japan, 1998) Language: English
– Russian Federation – Details: Language: Russian
– Pakistan Details: Language: English

Table 16. E-learning websites

– Bangladesh Details: Calibration of met. Equipment Language: English
– Japan Details: RIC Tsukuba website Language: English
– Russia Details: http://www.ipk.meteorf.ru, http://www.tech.meteorf.ru, http://www.vlab.meteorf.ru Language: Russian
– Viet Nam Details: Installation and operation of AWS Language: English Details: Instrument calibration methods Language: English

Table 17. Training materials

– Bangladesh Details: Calibration of met. Equipment Language: English
– Japan Details: Lecture notes on WMO training workshop for instrument specialists in RA II (Japan, 1998), revised version 2010 Language: English
– Russia Details: Language: Russian
– Viet Nam Details: Installation and operation of AWS Language: English Details: Instrument calibration methods Language: English

Table 18. E-learning software

– Bangladesh Details: Calibration of met. Equipment Language: English
– Russian Federation Details: Language: Russian

2.2.5 Q5: Supplementary comments on Q1 – Q4

Q5 asked for supplementary comments on training courses or materials. A total of two Members responded to this part of the questionnaire (Table 19).

Table 19. Comments on training courses or materials (free response)

– The above-mentioned training would be very helpful for proper handling and maintenance of all types of meteorological equipment used at BMD.
– Regarding Q4, the Hong Kong Observatory conducted the WMO VCP Training Course on Automatic Weather Station Networks in 2010.

2.2.6 Q6: Questions or comments about trainings

Q6 asked for questions or comments on training. A total of four Members responded to this part of the questionnaire (Table 20).

Table 20. Questions or comments on training (free response)

Questions or comments
– Training on a huge scale is needed for the Bangladesh Meteorological Department to support proper handling and maintenance of met. equipment.
– There is an urgent need for support and advice on how to establish or to be equipped with national standard instruments.
– Training of officials is very important for the capacity building of PMD.
– Education and training should ideally be provided at the Federal State Budgetary Organization's Main Geophysical Observatory in St. Petersburg, Russia.

3 CONCLUSIONS

The results of the survey are summarized below based on the answers provided by the 24 Members who responded.

(1) More than half of all Members maintained national meteorological standards for pressure, temperature and humidity, while fewer than half had them for other meteorological parameters. Fewer than half calibrated their national meteorological standards with superior standards traceable to international standards.

(2) More than half of all Members had laboratories for pressure, temperature and humidity. Laboratories for other meteorological parameters, especially for radiation instruments, were not widely used. Five Members had no laboratories.

(3) A total of 16 Members required calibration of standard instruments with RIC or RRC standards.

(4) A total of 21 Members expressed interest in attending RIC training courses on meteorological instruments.

(5) Conventional instruments such as mercury barometers and liquid-in-glass thermometers were still more widely used than electrical instruments for most meteorological parameters.

The results confirm that instrument calibration and maintenance, which influence the quality of observational data, are not performed appropriately in the region. Members should ensure the traceability of their observations to SI and to the WRR (World Radiometric Reference) for solar radiation by utilizing RICs and RRCs or other calibration laboratories, or by establishing calibration laboratories within individual NMHSs. RIC utilization is a useful option because one of the main roles of RICs is to assist Members in calibrating their national meteorological standards.

The outcomes of the survey will be utilized for RICs and RRCs in an efficient and effective manner to enhance their capability and available services toward the improvement of observational data quality in RA II. Based on these results and as a follow-up activity by RIC Tsukuba to the JMA/WMO Workshop in 2010, JMA in collaboration with WMO held a training workshop on the calibration and maintenance of meteorological instruments from 19 to 22 February 2013 at JMA Headquarters in Tokyo and RIC Tsukuba. The workshop was attended by 13 experts from 13 NMHSs in RA II and a meteorological instrument expert from RIC Beijing. The training included lectures on the traceability and maintenance of meteorological instruments and exercises on instrument calibration for pressure, humidity and temperature.

4 ACKNOWLEDGEMENTS

RIC Tsukuba, RIC Beijing, RRC Tokyo and RRC Pune would like to thank participating Members for their input in the survey. Thanks also go to Dr. Miroslav Ondras (WMO) and Mr. Kuniyuki Shida (WMO) for their assistance in formulating the questionnaire.

5 REFERENCES

- JMA/WMO Training Workshop on Calibration and Maintenance of Meteorological Instruments in RA II (Asia) (Tokyo and RIC Tsukuba, Japan, 19 – 22 February 2013) http://www.wmo.int/pages/prog/dra/rap/documents/Final-Report-JMA-WMO-Training-WS-Calibration-Maintenance.pdf
- Commission for Instruments and Methods of Observation fifteenth session. Abridged final report with resolutions and recommendations. WMO-No. 1064. World Meteorological Organization. Helsinki 2 – 8 September 2010.
- JMA/WMO Workshop on Quality Management in surface, climate and upper-air observations in RA II (Asia) (Tokyo, Japan, 27 – 30 July 2010). http://www.wmo.int/pages/prog/dra/rap/documents/JMA-WMO-OBS-Workshop-Final-Report.pdf.
- Regional Association II (Asia) fourteenth session. Abridged final report with resolutions. WMO-No. 1037. World Meteorological Organization, Tashkent, 5 – 11 December 2008.
- Guide to Meteorological Instruments and Methods of Observation. 2008 edition, WMO-No. 8. World Meteorological Organization, Geneva.
- Survey on the Surface, Climate and Upper-air Observations and Quality Management in RA II (Asia) June 2011. Instrument and Observing Methods Report No. 111. World Meteorological Organization, Geneva.

APPENDIX A: QUESTIONNAIRE
APPENDIX B: LIST OF NMHSs REPLYING TO THE QUESTIONNAIRE

World Meteorological Organization
Organisation météorologique mondiale

Secrétariat
7 bis, avenue de la Paix – Case postale 2300 – CH 1211 Genève 2 – Suisse
Tél.: +41 (0) 22 730 81 11 – Fax: +41 (0) 22 730 81 81
wmo@wmo.int – www.wmo.int

TEMPS • CLIMAT • EAU
WEATHER • CLIMATE • WATER

Our ref.: DRA-AP/RA II/OBS (Survey) GENEVA, 12 December 2011

Annex: 1 (available in English only)

Subject: Questionnaire on Meteorological Instruments, Calibration and Training in Regional Association II (Asia)

Action required: Completed questionnaire to be returned to the Regional Instrument Centre Tsukuba (Japan) not later than **31 January 2012**

Dear Sir/Madam,

I would like to inform you that the JMA/WMO Workshop on Quality Management in Surface, Climate and Upper-air Observations in Regional Association II (Asia) held in Tokyo, Japan, in July 2010, concluded that the primary factors adversely affecting data quality in RA II are calibration and maintenance of instruments mainly due to lack of traceability of measurements to international standards and calibration facilities. It indicated that there are strong needs for capacity building programmes on calibration and data quality management among Members. It recommended that services of Regional Instrument Centres (RICs) should be fully utilized by RA II Members to address these issues.

The Commission for Instruments and Methods of Observation (CIMO), at its fifteenth session held in Helsinki, Finland in September 2010, recommended that RICs maintain a database of the standards used by the Members of the Region and already calibrated by the RICs, develop necessary training materials, and organize training events to improve understanding of traceability of measurements to international standards in the Region in collaboration with CIMO.

With regard to measurement of radiation, Regional Radiation Centres (RRCs) are designated to serve as centres for intraregional comparisons of radiation instruments within the Region and to maintain the standard instrument necessary for this purpose and they shall provide the necessary outdoor facilities for simultaneous comparison of national standard radiometers from the Region.

To: Permanent Representatives of Members of Regional Association II (ASE-603)

cc: President of RA II)
Vice-president of RA II) (for information)
President of CIMO)

The attached questionnaire is based on the work of RIC Tsukuba and RIC Beijing together with RRC Tokyo and RRC Pune to assess the capability of calibrations of the RA II Members as well as their needs for services provided by RICs and RRCs including provision of training materials and training events to the Members. The results of the survey will be utilized for RICs and RRCs to enhance their capability and available services for improvement of quality of observational data in RA II in an efficient and effective manner.

In this connection, and to facilitate the work of RICs and RRCs, I would appreciate it if you could kindly send to the RIC Tsukuba (Japan) the duly completed questionnaire as soon as possible, but preferably **not later than 31 January 2012**.

Your cooperation in this matter will be highly appreciated.

Yours faithfully,

(M. Jarraud)
Secretary-General

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 METEOROLOGICAL INSTRUMENTS, CALIBRATION AND TRAINING IN REGIONAL ASSOCIATION II (ASIA)

This questionnaire is based on the work of Regional Instrument Centre (RIC) Tsukuba and RIC Beijing together with Regional Radiation Centres (RRC) Tokyo and RRC Pune to assess the capability of calibrations of the RA II Members as well as their needs for services provided by RICs and RRCs including provision of training materials and training events to the Members.

Results of the survey will be utilized for RICs and RRCs to fully utilize their capability and available services for improvement of quality of observational data in RA II in an efficient and effective manner.

Name of Member:________________________

Person filling out this form:

Title: Mr ☐ Ms ☐ Dr ☐ Prof. ☐ (Please tick appropriate)

Name: _________________________________

Organization: ____

Address: ____

____

Telephone: ______________________________

Facsimile: ______________________________

Email: _______________________________

Date: _____________ _________________________________

(Signature of Permanent Representative)

Part I. Instruments and calibration

Q 1. Instruments in operational use

(Q 1-1) Which instruments do you use for operational observation? Please choose the types/methods of instruments by ticking the appropriate boxes and describe the manufactures and the models of the instruments. If you use two or more manufacturers or models in one type/method of instruments, please describe it/them in "others " box(es) additionally.

Then follow the questions on the status of calibration. Are the instruments calibrated with standard instruments? If "Yes", how often calibrations are performed?.

(a) Pressure

□ Mercury barometer
Manufacturer: ___________________ Calibration:
Model: ___________________________ □Yes-> □Regular intervals: every__years
□Irregular intervals
□No

□ Aneroid barometer
Manufacturer: ___________________ Calibration:
Model: ___________________________ □Yes-> □Regular intervals: every__years
□Irregular intervals
□No

□ Barograph
Manufacturer: ___________________ Calibration:
Model: ___________________________ □Yes-> □Regular intervals: every__years
□Irregular intervals
□No

□ Electronic barometer
Manufacturer: ___________________ Calibration:
Model: ___________________________ □Yes-> □Regular intervals: every__years
□Irregular intervals
□No

□ Others (Type/method of the instrument: _______________________)
Manufacturer: ___________________ Calibration:
Model: ___________________________ □Yes-> □Regular intervals: every__years
□Irregular intervals
□No

□ Others (Type/method of the instrument: _______________________)
Manufacturer: ___________________ Calibration:
Model: ___________________________ □Yes-> □Regular intervals: every__years
□Irregular intervals
□No

(b)Temperature

□ Liquid-in-glass thermometer

Manufacturer: ____________________ Calibration:

Model: ____________________________ □Yes-> □Regular intervals: every__years

□Irregular intervals

□No

□ Thermograph

Manufacturer: ____________________ Calibration:

Model: ____________________________ □Yes-> □Regular intervals: every__years

□Irregular intervals

□No

□ Electrical thermometer

Manufacturer: ____________________ Calibration:

Model: ____________________________ □Yes-> □Regular intervals: every__years

□Irregular intervals

□No

□ Others(Type/method of the instrument: ________________________)

Manufacturer: ____________________ Calibration:

Model: ____________________________ □Yes-> □Regular intervals: every__years

□Irregular intervals

□No

□ Others(Type/method of the instrument: ________________________)

Manufacturer: ____________________ Calibration:

Model: ____________________________ □Yes-> □Regular intervals: every__years

□Irregular intervals

□No

(c) Humidity

□ Assmann aspirated psychrometer

Manufacturer: ____________________ Calibration:

Model: ____________________________ □Yes-> □Regular intervals: every__years

□Irregular intervals

□No

□ Other psychrometer (Name of the instrument: ________________________)

Manufacturer: ____________________ Calibration:

Model: ____________________________ □Yes-> □Regular intervals: every__years

□Irregular intervals

□No

□ Hair hygrometer

Manufacturer: ____________________ Calibration:

Model: ____________________________ □Yes-> □Regular intervals: every__years

□Irregular intervals

□No

□ Lithium-chloride heated condensation hygrometer

Manufacturer: ____________________ Calibration:

Model: ____________________________ □Yes-> □Regular intervals: every__years

□Irregular intervals

□No

□ Electrical hygrometer

Manufacturer: ____________________ Calibration:

Model: ____________________________ □Yes-> □Regular intervals: every__years

□Irregular intervals

□No

□ Others(Type/method of the instrument: ________________________)

Manufacturer: ____________________ Calibration:

Model: ____________________________ □Yes-> □Regular intervals: every__years

□Irregular intervals

□No

□ Others(Type/method of the instrument: ________________________)

Manufacturer: ____________________ Calibration:

Model: ____________________________ □Yes-> □Regular intervals: every__years

□Irregular intervals

□No

(d) Wind

□ Cup anemometer

Manufacturer: ____________________ Calibration:

Model: ____________________________ □Yes-> □Regular intervals: every__years

□Irregular intervals

□No

□ Wind vane

Manufacturer: ____________________ Calibration:

Model: ____________________________ □Yes-> □Regular intervals: every__years

□Irregular intervals

□No

□ Pressure tube anemometer

Manufacturer: ____________________ Calibration:

Model: ____________________________ □Yes-> □Regular intervals: every__years

□Irregular intervals

□No

□ Propeller anemometer and vane

Manufacturer: ____________________ Calibration:

Model: ____________________________ □Yes-> □Regular intervals: every__years

□Irregular intervals

□No

□ Sonic anemometer

Manufacturer: ____________________ Calibration:

Model: ____________________________ □Yes-> □Regular intervals: every__years

□Irregular intervals

□No

□ Others(Type/method of the instrument: ________________________)

Manufacturer: ____________________ Calibration:

Model: ____________________________ □Yes-> □Regular intervals: every__years

□Irregular intervals

□No

□ Others(Type/method of the instrument: ________________________)

Manufacturer: __________________ Calibration:

Model: __________________________ □Yes-> □Regular intervals: every__years

□Irregular intervals

□No

(e) Precipitation

□ Ordinary gauge

Manufacturer: __________________ Calibration:

Model: __________________________ □Yes-> □Regular intervals: every__years

□Irregular intervals

□No

□ Weighing gauge

Manufacturer: __________________ Calibration:

Model: __________________________ □Yes-> □Regular intervals: every__years

□Irregular intervals

□No

□ Tipping bucket gauge

Manufacturer: __________________ Calibration:

Model: __________________________ □Yes-> □Regular intervals: every__years

□Irregular intervals

□No

□ Float gauge

Manufacturer: __________________ Calibration:

Model: __________________________ □Yes-> □Regular intervals: every__years

□Irregular intervals

□No

□ Others(Type/method of the instrument: ______________________)

Manufacturer: __________________ Calibration:

Model: __________________________ □Yes-> □Regular intervals: every__years

□Irregular intervals

□No

□ Others(Type/method of the instrument: ______________________)

Manufacturer: __________________ Calibration:

Model: __________________________ □Yes-> □Regular intervals: every__years

□Irregular intervals

□No

(f) Radiation

□ Pyrhe

Manufacturer: __________________ Calibration:

Model: __________________________ □Yes-> □Regular intervals: every__years

□Irregular intervals

□No

□ Pyranometer(thermoelectric, photoelectric, pyroelectric, bimetallic etc.)

Manufacturer: __________________ Calibration:

Model: __________________________ □Yes-> □Regular intervals: every__years

□Irregular intervals

□No

□ Pyrgeometer
Manufacturer: __________________ Calibration:
Model: __________________________ □Yes-> □Regular intervals: every__years
□Irregular intervals
□No

□ Net radiometer
Manufacturer: __________________ Calibration:
Model: __________________________ □Yes-> □Regular intervals: every__years
□Irregular intervals
□No

□ Sunphotometer
Manufacturer: __________________ Calibration:
Model: __________________________ □Yes-> □Regular intervals: every__years
□Irregular intervals
□No

□ Others(Type/method of the instrument : ____________________)
Manufacturer: __________________ Calibration:
Model: __________________________ □Yes-> □Regular intervals: every__years
□Irregular intervals
□No

□ Others(Type/method of the instrument: _______________________)
Manufacturer: __________________ Calibration:
Model: __________________________ □Yes-> □Regular intervals: every__years
□Irregular intervals
□No

(g) Sunshine duration

□ Campbell-Stokes sunshine recorder
Manufacturer: __________________ Calibration:
Model: __________________________ □Yes-> □Regular intervals: every__years
□Irregular intervals
□No

□ Jordan sunshine recorder
Manufacturer: __________________ Calibration:
Model: __________________________ □Yes-> □Regular intervals: every__years
□Irregular intervals
□No

□ Pyrheliometer
Manufacturer: __________________ Calibration:
Model: __________________________ □Yes-> □Regular intervals: every__years
□Irregular intervals
□No

□ Photo voltaic cell recorder
Manufacturer: __________________ Calibration:
Model: __________________________ □Yes-> □Regular intervals: every__years
□Irregular intervals
□No

□ Scanning method sunshine recorder

Manufacturer: ____________________ Calibration:

Model: ____________________________ □Yes-> □Regular intervals: every__years

□Irregular intervals

□No

□ Others(Type/method of the instrument: ____________________)

Manufacturer: ____________________ Calibration:

Model: ____________________________ □Yes-> □Regular intervals: every__years

□Irregular intervals

□No

□ Others(Type/method of the instrument: ________________________)

Manufacturer: ____________________ Calibration:

Model: ____________________________ □Yes-> □Regular intervals:every__years

□Irregular intervals

□No

(Q 1-2) Supplementary comments with regard to (Q 1-1), if any.

____

____

____

Q 2.National meteorological standards and traceability to an international standard

(Q 2-1) Do you maintain national meteorological standards*? Please tick the appropriate boxes. If your answer is "Yes", please describe them.
If your answer is "No", skip to (Q 2-3).
*(*National meteorological standard: A standard recognized by a NMHS decision to serve, in a member country, as the basis for assigning values to other standards.)*

(Q 2-2) If your answer is "Yes" in some questions of (Q 2-1), do you calibrate your national meteorological standards with superior standards which are traceable to international standards* ? Please tick the appropriate boxes.
If your answer is "Yes", please describe the superior standard.
*(*International standard: A standard recognized by an international agreement to serve internationally as the basis for assigning values to other standards of the quantity concerned.)*

(Q 2-3) Do you have your traveling standards*? Please tick the appropriate boxes.
If your answer is "Yes", please describe them.
*(*Traveling standard: A standard, sometimes of special construction, intended for transport between different locations.)*

(a) Pressure

(Q 2-1) National meteorological standard

□Yes --> Instrument type/method used:
□Pressure balance(Dead weight tester)
□No □Mercury barometer
□Electronic barometer
□Others(____)
Instrument manufacturer: ________________________________
Instrument model: ______________________________________
The year of manufacture: ________________________________
Uncertainty: ______________________________________(unit)
Date of the last calibration with a superior standard: _____________
Interval of calibration with a superior standard : every________years

(Q 2-2) Superior standard

□Yes --> Instrument type/method used: ______________________________
Instrument manufacturer: ________________________________
□No Instrument model: ______________________________________
Uncertainty: ______________________________________(unit)
Possessor of the instrument: ______________________________

(Q 2-3) Traveling standard

□Yes --> Instrument type/method used: ______________________________
Instrument manufacturer: ________________________________
□No Instrument model: ______________________________________
Uncertainty: ______________________________________(unit)

(b) Temperature

(Q 2-1) National meteorological standard

□Yes --> Instrument type/method used:

□Platinum resistance thermometer

□No □Liquid-in-glass thermometer

□Others(____)

Instrument manufacturer: ______________________________

Instrument model: ___________________________________

The year of manufacture: ______________________________

Uncertainty: ____________________________________(unit)

Date of the last calibration with a superior standard: _____________

Interval of calibration with a superior standard : every________years

(Q 2-2) Superior standard

□Yes --> Instrument type/method used: _____________________________

Instrument manufacturer: _______________________________

□No Instrument model: ____________________________________

Uncertainty: ______________________________________(unit)

Possessor of the instrument: ______________________________

(Q 2-3) Traveling standard

□Yes --> Instrument type/method used: _____________________________

Instrument manufacturer: _______________________________

□No Instrument model: _____________________________________

Uncertainty: ______________________________________(unit)

(c) Humidity

(Q 2-1) National meteorological standard

□Yes --> Instrument type/method used:

□Chilled mirror dewpoint hygrometer

□No □Electrical hygrometer

□Psychrometer

□Others(____)

Instrument manufacturer: ______________________________

Instrument model: ___________________________________

The year of manufacture: ______________________________

Uncertainty: ____________________________________(unit)

Date of the last calibration with a superior standard: _____________

Interval of calibration with a superior standard : every________years

(Q 2-2) Superior standard

□Yes --> Instrument type/method used: _____________________________

Instrument manufacturer: _______________________________

□No Instrument model: ____________________________________

Uncertainty: ______________________________________(unit)

Possessor of the instrument: ______________________________

(Q 2-3) Traveling standard

□Yes --> Instrument type/method used: _____________________________

Instrument manufacturer: _______________________________

□No Instrument model: ____________________
Uncertainty: ____________________(unit)

(d) Wind

(Q 2-1) National meteorological standard

□Yes --> Instrument type/method used:
□Pitot tube
□No □Differential pressure
□Hot wire
□Others(____________________)
Instrument manufacturer: ____________________
Instrument model: ____________________
The year of manufacture: ____________________
Uncertainty: ____________________(unit)
Date of the last calibration with a superior standard: __________
Interval of calibration with a superior standard : every__________years

(Q 2-2) Superior standard

□Yes --> Instrument type/method used: ____________________
Instrument manufacturer: ____________________
□No Instrument model: ____________________
Uncertainty: ____________________(unit)
Possessor of the instrument: ____________________

(Q 2-3) Traveling standard

□Yes --> Instrument type/method used: ____________________
Instrument manufacturer: ____________________
□No Instrument model: ____________________
Uncertainty: ____________________(unit)

(e) Precipitation

(Q 2-1) National meteorological standard

□Yes --> Instrument type/method used:
□Weight
□No □Volume
□Others(____________________)
Instrument manufacturer: ____________________
Instrument model: ____________________
The year of manufacture: ____________________
Uncertainty: ____________________(unit)
Date of the last calibration with a superior standard: __________
Interval of calibration with a superior standard : every__________years

(Q 2-2) Superior standard

□Yes --> Instrument type/method used: ____________________
Instrument manufacturer: ____________________
□No Instrument model: ____________________
Uncertainty: ____________________(unit)
Possessor of the instrument: ____________________

(Q 2-3) Traveling standard

□Yes --> Instrument type/method used: ______________________________

Instrument manufacturer: ______________________________

□No Instrument model: ______________________________

Uncertainty: ______________________________(unit)

(f) Radiation

(f-1) Pyrheliometer

(Q 2-1) National meteorological standard

□Yes --> Instrument type/method used: ______________________________

Instrument manufacturer: ______________________________

□No Instrument model: ______________________________

The year of manufacture: ______________________________

Uncertainty: ______________________________(unit)

Date of the last calibration with a superior standard: ______________

Interval of calibration with a superior standard : every__________years

(Q 2-2) Superior standard

□Yes --> Instrument type/method used: ______________________________

Instrument manufacturer: ______________________________

□No Instrument model: ______________________________

Uncertainty: ______________________________(unit)

Possessor of the instrument: ______________________________

(Q 2-3) Traveling standard

□Yes --> Instrument type/method used: ______________________________

Instrument manufacturer: ______________________________

□No Instrument model: ______________________________

Uncertainty: ______________________________(unit)

(f-2) Pyranometer

(Q 2-1) National meteorological standard

□Yes --> Instrument type/method used: ______________________________

Instrument manufacturer: ______________________________

□No Instrument model: ______________________________

The year of manufacture: ______________________________

Uncertainty: ______________________________(unit)

Date of the last calibration with a superior standard: ______________

Interval of calibration with a superior standard : every__________years

(Q 2-2) Superior standard

□Yes --> Instrument type/method used: ______________________________

Instrument manufacturer: ______________________________

□No Instrument model: ______________________________

Uncertainty: ______________________________(unit)

Possessor of the instrument: ______________________________

(Q 2-3) Traveling standard

□Yes --> Instrument type/method used: ______________________

Instrument manufacturer: ______________________

□No Instrument model: ______________________

Uncertainty: ______________________(unit)

(f-3) Pyrgeometer

(Q 2-1) National meteorological standard

□Yes --> Instrument type/method used: ______________________

Instrument manufacturer: ______________________

□No Instrument model: ______________________

The year of manufacture: ______________________

Uncertainty: ______________________(unit)

Date of the last calibration with a superior standard: ____________

Interval of calibration with a superior standard : every__________years

(Q 2-2) Superior standard

□Yes --> Instrument type/method used: ______________________

Instrument manufacturer: ______________________

□No Instrument model: ______________________

Uncertainty: ______________________(unit)

Possessor of the instrument: ______________________

(Q 2-3) Traveling standard

□Yes --> Instrument type/method used: ______________________

Instrument manufacturer: ______________________

□No Instrument model: ______________________

Uncertainty: ______________________(unit)

(f-4) Sunphotometer

(Q 2-1) National meteorological standard

□Yes --> Instrument type/method used: ______________________

Instrument manufacturer: ______________________

□No Instrument model: ______________________

The year of manufacture: ______________________

Uncertainty: ______________________(unit)

Date of the last calibration with a superior standard: ____________

Interval of calibration with a superior standard : every__________years

(Q 2-2) Superior standard

□Yes --> Instrument type/method used: ______________________

Instrument manufacturer: ______________________

□No Instrument model: ______________________

Uncertainty: ______________________(unit)

Possessor of the instrument: ______________________

(Q 2-3) Traveling standard

□Yes --> Instrument type/method used: ______________________

Instrument manufacturer: ______________________

□No Instrument model: ____
Uncertainty: ____(unit)

(g) Sunshine duration

(Q 2-1) National meteorological standard

□Yes --> Instrument type/method used: ________________________________
Instrument manufacturer: ____________________________________
□No Instrument model: ____
The year of manufacture: ____________________________________
Uncertainty: ____(unit)
Date of the last calibration with a superior standard: ________________
Interval of calibration with a superior standard : every__________years

(Q 2-2) Superior standard

□Yes --> Instrument type/method used: __________________________________
Instrument manufacturer: _____________________________________
□No Instrument model: ____
Uncertainty: ____(unit)
Possessor of the instrument: ____________________________________

(Q 2-3) Traveling standard

□Yes --> Instrument type/method used: __________________________________
Instrument manufacturer: _____________________________________
□No Instrument model: ____
Uncertainty: ____(unit)

(h) Others(Name of the instrument: ___________________)

(Q 2-1)National meteorological standard

□Yes --> Instrument type/method used: ________________________________
Instrument manufacturer: ____________________________________
□No Instrument model: ____
The year of manufacture: ____________________________________
Uncertainty: ____(unit)
Date of the last calibration with a superior standard: ________________
Interval of calibration with a superior standard : every__________years

(Q 2-2) Superior standard

□Yes --> Instrument type/method used: __________________________________
Instrument manufacturer: _____________________________________
□No Instrument model: ____
Uncertainty: ____(unit)
Possessor of the instrument: ____________________________________

(Q 2-3) Traveling standard

□Yes --> Instrument type/method used: __________________________________
Instrument manufacturer: _____________________________________
□No Instrument model: ____
Uncertainty: ____(unit)

(Q 2-4) Supplementary comments with regard to (Q2-1)-(Q2-3), if any.

Q 3. Needs for calibration of standard instruments with <u>RIC or RRC standards</u>

(Q 3-1) If your answer is "<u>Yes</u>" in (<u>Q 2-1</u>), do you wish to calibrate your standard instruments with <u>the standard instruments that RICs or RRCs own</u>? Please tick the appropriate box.
If your answer is "<u>No</u>", skip to (<u>Q 3-4</u>).

□Yes　　□No

(If your answer is "<u>yes</u>", we will additionally contact you to ask your requirements in detail at a later date.)

(Q 3-2) If your answer is "<u>yes</u>" in (<u>Q 3-1</u>), which standard instruments do you wish to calibrate? Please tick the appropriate boxes.
Then follow the questions on how you wish to perform the calibration? If you want to bring your own standard instruments to RICs/RRCs and have them calibrated there, <u>choose "1"</u>. If you want to calibrate your standard instruments on your own with traveling standards that RICs/RRCs send to your laboratory, <u>choose "2"</u>. Please tick the appropriate boxes.

□**Instruments measuring pressure**
- □1.You bring your standards to RIC.　RIC calibrates them at RIC.
- □2.RIC sends its traveling standard to your laboratory. You calibrate your standards with RICs' standard by yourself.

□**Instruments measuring temperature**
- □1.
- □2.

□**Instruments measuring humidity**
- □1.
- □2.

□**Instruments measuring wind***3
- □1.
- □2.

□**Instruments measuring precipitation***3
- □1.
- □2.

□**Pyrheliometer** *1*3
- □1.
- □2.

□**Pyranometer***3
- □1.
- □2.

□**Pyrgeometer** *2*3
- □1.
- □2.

□**Instruments measuring sunshine recorder** *3
- □1.
- □2.

□**Others(Name of the instrument: ____________________)**

□1.

□2.

*1: Calibration is limited only to comparison with Regional standard when Regional intercomparison is conducted at RRCs in every five years.

*2: Calibration is not available now, but for the future consideration. This is the question for investigating potential requests of calibration in the future.

*3: RIC Beijing and RIC Tsukuba don't have these traveling standards now. This is the question for investigating potential requests of calibration in the future.

(Q 3-3) Supplementary comments with regard to (Q 3-1)-(Q 3-2), if any.

____

____

____

Q 4. Calibration laboratories

(Q 4-1) Do you have calibration laboratories? Please tick the appropriate boxes.
If your answer is "Yes", is the laboratory accredited with ISO 17025(General requirements for the competence of testing and calibration laboratories)? Please tick the appropriate boxes.

(a)Pressure

□Yes, I have a laboratory -->□in the NMHS.
-->□out of the NMHS.
--> ISO17025 □Yes.
□No.
□Other ISO accreditation or certification(ISO:)
□No.

(b)Temperature

□Yes, I have a laboratory -->□in the NMHS.
-->□out of the NMHS.
--> ISO17025 □Yes.
□No.
□Other ISO accreditation or certification(ISO:)
□No.

(c)Humidity

□Yes, I have a laboratory -->□in the NMHS.
-->□out of the NMHS.
--> ISO17025 □Yes.
□No.
□Other ISO accreditation or certification(ISO:)
□No.

(d)Wind

□Yes, I have a laboratory -->□in the NMHS.
-->□out of the NMHS.
--> ISO17025 □Yes.
□No.
□Other ISO accreditation or certification(ISO:)
□No.

(e)Precipitation

□Yes, I have a laboratory -->□in the NMHS.
-->□out of the NMHS.
--> ISO17025 □Yes.
□No.
□Other ISO accreditation or certification(ISO:)
□No.

(f)Radiation

□Yes, I have a laboratory -->□in the NMHS.
-->□out of the NMHS.
--> ISO17025 □Yes.
□No.
□Other ISO accreditation or certification(ISO:)
□No.

(g)Sunshine duration

□Yes, I have a laboratory -->□in the NMHS.
-->□out of the NMHS.
--> ISO17025 □Yes.
□No.
□Other ISO accreditation or certification(ISO:)
□No.

(h)Others(Meteorological variable __________)

□Yes, I have a laboratory -->□in the NMHS.
-->□out of the NMHS.
--> ISO17025 □Yes.
□No.
□Other ISO accreditation or certification(ISO:)
□No.

(Q4-2) Supplementary comments with regard to (Q4-1), if any.

____

____

____

Q5. Questions or comments about instruments and calibrations, if any.

____

____

____

Part II Training

Q1. Do you wish to join any <u>training courses on meteorological instruments</u> held by RICs? Please tick the appropriate box.
If your answer is "No", skip to Q4.
□Yes □No

Q2. If your answer is "Yes" in Q1., which kind of trainings do you require? Please tick the appropriate boxes.
□Principle and operation of instruments
Which instruments do you wish to be trained about?
□Pressure
□Temperature
□Humidity
□Wind
□Precipitation
□Radiation
□Sunshine duration
□Radiosonde
□Visibility meter
□Ceilometer
□Snow depth meter
□Others(Meteorological variable :____________________)
□Measurement traceability
□Procedure of uncertainty calculation
□Calibration methods of instruments
□Establishment and management of calibration laboratories/ISO 17025
□Quality management of observation data
□Quality assurance of meteorological observation network
□Handling to instruments troubles
□Maintenance of the environmental condition of observing stations
□Installation and operation of AWS
□Commercial instrument initiatives
□Others(______________________________)

Q3. If your answer is "Yes" in Q2., how do you wish the training programs are conducted ? Please tick the appropriate boxes.
□Regional training workshop at RICs, etc.
□Training at member's laboratory(lecturers are dispatched from WMO or RICs etc.)
□Training at RICs for each member
□Provision of training materials
□E-learning website
□Others(__________)

Q4. Do you have any training courses or materials which can be shared among RAII members? Please tick the appropriate boxes.

□**E-learning website (building own website which includes some e-learning materials etc.)**

(1)Contents: ______________________ Language: ____________________

(2)Contents: ______________________ Language: ____________________

□**Training materials(Training textbook etc.)**

(1)Contents: ______________________ Language: ____________________

(2)Contents: ______________________ Language: ____________________

□**E-learning software(developing a software which people can learn about meteorological instruments by themselves etc.)**

(1)Contents: ______________________ Language: ____________________

(2)Contents: ______________________ Language: ____________________

□**Training events open to other members (organizing workshops on meteorological instruments etc.)**

(1)Contents: ______________________ Language: ____________________

(2)Contents: ______________________ Language: ____________________

□**Others(_________)**

(1)Contents: ______________________ Language: ____________________

(2)Contents: ______________________ Language: ____________________

□**Others(_________)**

(1)Contents: ______________________ Language: ____________________

(2)Contents: ______________________ Language: ____________________

Q5. Supplementary comments with regard to Q1-Q4, if any.

____

____

____

Q6. Questions or comments about trainings, if any.

____

____

____

*Please send the completed questionnaire to the Regional Instruments Centre Tsukuba at the following address not later than **31 January 2012**:*

WMO Regional Instruments Centre Tsukuba for RA II (Asia)
Attention: Mr Koichi NAKASHIMA
Nagamine 1-2, Tsukuba, 305-0052
JAPAN
E-mail: ric-tsukuba@met.kishou.go.jp
FAX: +81-298-51-1670

____

Appendix B: List of NMHSs replying to the survey

NMHSs	Reply to the questionnaire
Afghanistan	Yes
Bahrain	No
Bangladesh	Yes
Bhutan	No
Cambodia	No
China	Yes
Hong Kong	Yes
India	No
Iran	Yes
Iraq	No
Japan	Yes
Kazakhstan	Yes
Kuwait	Yes
Kyrgyzstan	No
Lao	Yes
Macao	Yes
Maldives	Yes
Mongolia	Yes
Myanmar	Yes
Nepal	Yes
North Korea	No
Oman	Yes
Pakistan	Yes
Qatar	No
Russia	Yes
Saudi Arabia	No
South Korea	Yes
Sri Lanka	Yes
Tajikistan	No
Thailand	Yes
Turkmenistan	Yes
United Arab Emirates	Yes
Uzbekistan	Yes
Viet Nam	Yes
Yemen	No