

WORLD METEOROLOGICAL ORGANIZATION

COMMISSION FOR INSTRUMENTS AND METHODS OF OBSERVATION

JOINT

**CIMO EXPERT TEAM ON
SURFACE-BASED INSTRUMENT INTERCOMPARISONS
AND CALIBRATION METHODS**

First Session

AND

**INTERNATIONAL ORGANIZING COMMITTEE (IOC) ON
SURFACE-BASED INSTRUMENT INTERCOMPARISONS**

First Session

Trappes, France

24-28 November 2003

FINAL REPORT



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EXECUTIVE SUMMARY

This report provides a summary of the first session of the Joint Expert Team on Surface-based Instrument Intercomparisons and Calibration Methods (ET on SBII&CM) and International Organizing Committee (IOC) on Surface-based Instrument Intercomparisons. The ET/IOC, in response to the request of CIMO-XIII discussed both operational and organizational aspect for WMO Laboratory Intercomparisons of Rainfall Intensity (RI) Gauges, WMO Field Intercomparisons of RI Measuring Instruments and WMO Intercomparison of Thermometer Screens/Shields in conjunction with Humidity Measurements.

The ET/IOC agreed on the main objectives, possible places, dates and duration of the intercomparisons. Also operational aspects were discussed in details, namely conditions for participation, type of instruments, intercomparison rules, responsibility of host(s) and participants, data acquisition, processing analysis methodology and publication results.

It was suggested that Laboratory Intercomparisons of RI gauges should be held in recognized laboratories of KNMI, Météo France and University of Genova. The preparatory works should be finished in mid 2004 so that the intercomparisons may start in mid September 2004 and last until end of March 2005. Only catchment type of instruments that are currently being used in national networks or are being considered for use in national networks and are capable of measuring rainfall intensity of at least 200 mm/h at a time resolution of 1 minute will be accepted for participation.

WMO Field Intercomparisons of RI Measuring Instruments should be preferably held in areas of good likelihood of high intensity rainfall events. Proposals from Italy and Slovakia were discussed. The proposed site in Slovakia does not satisfy the need for high probability of high rainfall intensities. Additional possible places in Germany and USA were discussed, however further efforts should be made to identify suitable locations for the field intercomparison. The intercomparison would start as soon as the laboratory intercomparisons are concluded, preferably in April 2005 and should last until December 2005. Only in situ instruments that are currently being used in national networks or are being considered for use in national networks and are capable of measuring rainfall intensity of at least 200 mm/h at a time resolution of 1 minute will be accepted for participation.

As for the WMO Intercomparison of Thermometer Screens/Shields in conjunction with Humidity Measurements, at least two test sites will be necessary. One in an arctic region and one in tropical or desert regions, the main interest being warm temperature and high solar radiation, as a combination of different conditions, e.g. warm/hot humid region, warm/hot dry region, cold region. Further efforts should be made to identify suitable locations for the field intercomparison, giving priorities to existing RICs or other centers such as ASECNA, which existing infrastructure may be strengthened through an assistance from a developed RIC (e.g. RIC Trappes). Intercomparison in an arctic region may start as soon as in mid 2005 and in a tropical/desert region in the beginning of 2006. The duration should be at least 12 month, however in case of a region with no significant changes during the year, it may be shortened to about 6 months.

GENERAL SUMMARY

1. ORGANIZATION OF THE SESSION

1.1 Opening of the session

1.1.1 The first session of the Joint Expert Team on Surface-based Instrument Intercomparisons and Calibration Methods (ET on SBII&CM) and International Organizing Committee (IOC) on Surface-based Instrument Intercomparisons was held in Trappes, France, 24-28 November 2003.

1.1.2 The session was opened by Mr Michel Leroy, ET SBII&CM and IOC Chairperson. He welcomed the participants, thanked them for coming and wished everyone a fruitful and productive meeting. The list of participants is given in [Annex I](#).

1.2 Adoption of the agenda

1.1.3 The ET adopted the [Agenda](#) for the meeting, which is reproduced at the beginning of this report.

1.3 Working arrangements for the session

1.1.4 The working hours and tentative timetable for the meeting were agreed upon.

2. REPORT OF THE CHAIRMAN

2.1 Mr Leroy presented a brief report of ET's activities since the establishment of the ET. He concentrated on the preparation of the working plan for the ET that would be discussed in details during the meeting.

3. WORK PLAN

3.1 The outcome of the discussion on the agenda items 4, 5 and 6 were recast into a detailed Work Plan that specifies actions and deliverables for all tasks that were put forward to the team by CIMO-XIII and CIMO-MG. The Work Plan is in [Annex II](#).

3.2 It was agreed that a concise Summary Report of intercomparisons, containing the most important conclusions, should be prepared not later than 3 months after intercomparisons. The comprehensive Final Report should be published not later than 12 months after intercomparisons.

3.3 It was also agreed that Final Reports of the intercomparison shall be published in the WMO Instruments and Observing Methods Report series either in hard copy or electronically (CD-ROM). Final Report of the intercomparison should also be made accessible through WMO IMOP/CIMO home page.

4. LABORATORY INTERCOMPARISONS OF RAINFALL INTENSITY (RI) GAUGES, IN TWO INDEPENDENT CERTIFIED LABORATORIES

In addition to the general rules and procedures for WMO Intercomparisons as defined in the Guide to Instruments and Methods of Observation, WMO - No.8, Part III, Chapter 5, Annex 5.A and 5.B, the ET/IOC agreed to the following rules and procedures:

4.1 Main objective, place(s), date and duration

4.1.1 In defining the main objectives, the meeting took into account proposals made by the *Expert Meeting on Rainfall Intensity Measurements* (Bratislava, Slovak Republic, 23-25 April 2001) that were endorsed by CIMO-XIII. These proposals were further elaborated taking into account present knowledge and capabilities of recognized laboratories.

Objectives

4.1.2 The main objective of this laboratory intercomparison is to test the performances of catchment type rainfall intensity gauges of different measuring principles under documented conditions.

4.1.3 ET/IOC agreed on further objectives as follows:

- a) To define a standardized procedure for laboratory calibration of catchment type rain gauges, including uncertainty of laboratory testing devices within the range from 2 to 2000 mm/h.
- b) To evaluate the performance of the instruments under test.
- c) To comment on the need to proceed with a field intercomparison of catchment type of rainfall intensity gauges.
- d) To identify and recommend the most suitable method and equipment for reference purposes within the field intercomparison of catching and non-catching types of gauges.
- e) To provide information on different measurement systems relevant to improving the homogeneity of rainfall time series with special consideration given to high rainfall intensities.
- f) To make available the executive summary of the intercomparison within three months after the end of the testing period and to publish the Final Report of the intercomparison within the WMO IOM Report Series within 9 months after the testing is finished;
- g) To draft recommendations for consideration by CIMO-XIV.

Place

4.1.4 The Italian Meteorological Service (IMS) presented an invitation to host the WMO Laboratory Intercomparison of Rainfall Intensity (RI) gauges at the laboratory of the Department of Environmental Engineering (DIAM) of the University of Genova. The Director of DIAM presented a letter of willingness to host the intercomparison at the conditions specified in this document.

4.1.5 Other two potential candidate laboratories have been identified during the meeting as being the Météo France and the Royal Netherlands Meteorological Institute (KNMI).

4.1.6 Mr Lanza, on behalf of the Italian Meteorological Service, presented a description of the proposed intercomparison site and facilities. The ET/IOC examined the suitability of the proposed site and facilities, and agreed on using the DIAM laboratory for the intercomparison.

- 4.1.7 Mr Leroy, on behalf of Météo France, presented the potential intercomparison site, including the infrastructure available. Participants paid a visit to laboratories in Trappes and examined testing devices to be used for intercomparison. The ET/IOC agreed on the suitability of Trappes laboratories for the intercomparison. Mr Leroy informed the meeting that Météo France would soon inform WMO on its decision to host laboratory intercomparison of RI gauges in Trappes.
- 4.1.8 Mr van der Meulen, on behalf of KNMI, presented facilities of KNMI laboratories and their appropriateness for the intercomparison. The ET/IOC examined the suitability of the proposed site and facilities, and tentatively agreed on using the KNMI laboratory for the intercomparison. In this regard, Mr van der Meulen proposed that WMO requests PR of Netherlands with WMO to consider hosting the laboratory intercomparison of RI gauges in KNMI laboratories.
- 4.1.9 In discussing the overall management of the laboratory intercomparisons, the ET/IOC nominated Mr Luca Lanza as the Project Leader (PL) for the laboratory intercomparisons of RI gauges, responsible for the overall laboratory intercomparisons' management.
- 4.1.10 Representatives of the above laboratories informed the meeting on the names of Site Managers (SMs) responsible for the proper conduct of the intercomparison. The names of SMs will be confirmed to WMO later by the PRs of host countries. The following SMs were suggested by representatives of the above laboratories:
- Mr Luigi Stagi, DIAM laboratory, Italy
 - Mr Christophe Alexandropoulos, Météo France, France
 - Mr André van Londen, KNMI, Netherlands

Date and duration

- 4.1.11 The meeting considered the earliest possible starting dates given the restrictions of sending appropriate letters, awaiting responses and allowing for the decision process of which instruments will be included. In consultation with the PL, the ET/IOC decided that the laboratory intercomparison will begin no earlier than September 15th, 2004 and is expected to continue through the end of March 2005.

4.2 Procedures for intercomparisons

Conditions for participation, type of instruments

- 4.2.1 The meeting considered technical and operational aspects, desirable features and preferences, restrictions, priorities and descriptions of different instrument types for the laboratory intercomparison. In this regard, the meeting agreed on the following conditions for participation:
- a) Only catchment type of instruments that are currently being used in national networks or being considered for use in national networks will be considered.
 - b) Only instruments that are capable of measuring rainfall intensity of at least 200 mm/h at a time resolution of 1 minute will be accepted.
 - c) Preference will be given to instruments with uncertainty less than 5% over the range of measurement.
 - d) Appropriate documentation on participating instruments (see item 4.2.10) must be provided in advance in order to evaluate the feasibility of the test.

- e) Once the intercomparison begins, assistance in operation must be provided by participants, if requested by SM, to allow the test to be carried out properly.
- f) Due to laboratory acquisition system restrictions, only instruments with digital output (serial or pulse) can be tested. Instruments with other types of outputs may only be accepted with appropriate adaptor interface.
- g) To achieve more confidence in the results, preferences will be given to testing of two identical instruments, however this is not a condition for participation.

4.2.2 Due to limited resources, the number of instruments will be limited to a maximum of twelve pairs of gauges. In case of higher demand, based on the proposal of the project leader, the ET/IOC will select instruments taking into account the following criteria:

- a) Instruments will be selected in a way to cover a variety of measurement techniques;
- b) Preference will be given to new promising measuring techniques;
- c) Preference will be given to instruments that are widely used.

4.2.3 It will be the responsibility of the participating Members to calibrate their instruments against any suitable recognized standard before shipment and to provide appropriate calibration certificates. Participants are requested to provide, if possible, two identical instruments of each type in order to increase confidence in the data.

4.2.4 The ET/IOC agreed on a questionnaire to be sent to PRs in order to obtain the required information on each instrument proposed for the intercomparison (see Appendix I). The PL shall provide further detail and prepare the final version of the questionnaire as soon as possible. Participants will be requested to specify very clearly the hardware connections and software characteristics in their reply and to supply adequate documentation. A detailed questionnaire (see Questionnaire II in Appendix I) will be sent to potential participants before the final selection, as technical constraints may restrict the selection.

4.2.5 Participants are requested to arrange for the transportation of their instruments between the three laboratories involved according to a schedule to be provided by the PL in coordination with the SMs by the end of June 2004. It was estimated that the intercomparison of one batch of instruments at one intercomparison site would last approximately two months, after which instruments will have to be transported by participants to a next intercomparison site and so forth.

4.2.6 The ET/IOC requested Secretariat to invite, at the earliest convenience, Members of WMO and Association of the Hydro-Meteorological Equipment Industry (HMEI) to participate in the laboratory intercomparisons and to propose instruments to be tested. The invitation should include all relevant information agreed by this meeting.

4.2.7 All further contacts with the participants will be handled by PL and SMs.

Responsibilities of participants

4.2.8 Appropriate documentation including all detailed instructions and manuals needed for installation, operation, calibration, and routine maintenance have to be provided in advance in order to evaluate the feasibility of the test.

4.2.9 The presence of participant's staff is not required during the intercomparison, however assistance in operation has to be provided on request in order to allow the test to be carried out properly and with minimum effort by the host country.

Host country support

- 4.2.10 A reasonable amount of auxiliary equipment for installation in the laboratory will be provided by the host country.
- 4.2.11 Necessary electrical power for all instruments shall be provided. The participants will be informed of the network voltage and frequency and their stability. The connection of instruments to the data acquisition system and the power supply will be done in collaboration with the participants. The Site Manager will agree with each participant on the provision, by the participant or the host country, of power and signal cables of adequate length (and with appropriate connectors).
- 4.2.12 The host country will provide information on accommodation, travel, local transport, daily logistic support, etc.

Host country servicing

- 4.2.13 The host country will provide normal operator servicing for each instrument, such as cleaning, and routine adjustments as specified in the participant's operating instructions;
- 4.2.14 The SM will maintain regular records of performance of all equipment participating in the intercomparison in a log. This log should contain notes on everything at the site that may have an effect on the intercomparison, all events concerning participating equipment, and all events concerning equipment and facilities provided by the host country.

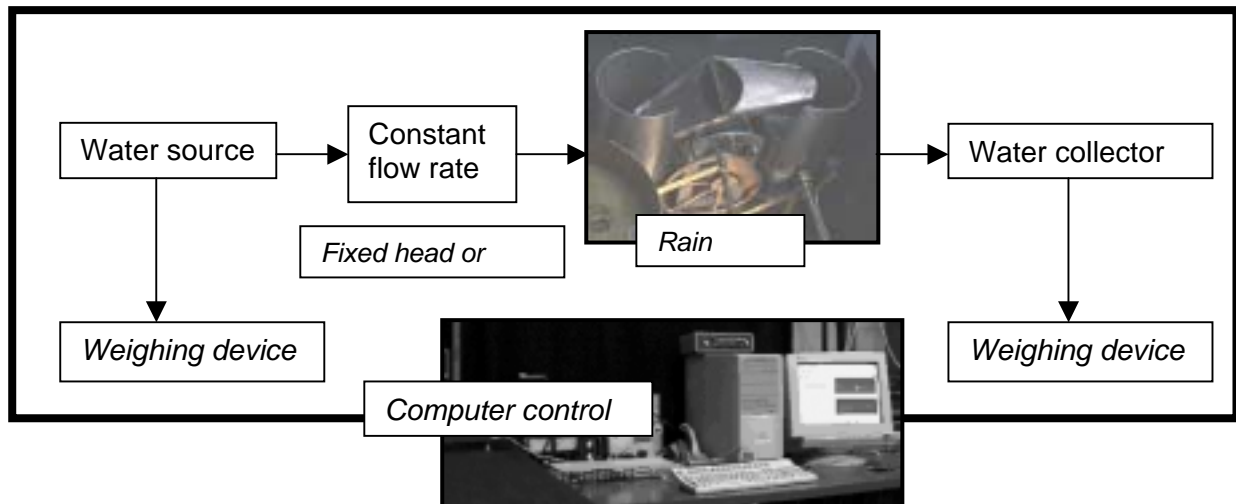
Rules during the intercomparison

- 4.2.15 The PL shall exercise general control of the intercomparison on behalf of the ET/IOC.
- 4.2.16 No changes to the equipment hardware or software shall be permitted without the concurrence of the PL.
- 4.2.17 Minor repairs, such as the replacement of fuses, will be allowed with the concurrence of the SM, and recorded in a log as from Item 4.2.17.
- 4.2.18 Any problems that arise and concern the participants' equipment shall be addressed to the PL.

4.3 Data acquisition, processing and analysis methodology and publication of results

Equipment set-up

- 4.3.1 The layout of the testing devices and the instruments' installation in the three proposed laboratories has been evaluated and agreed by the ET/IOC, according to the following scheme:



4.3.2 Each laboratory will use its own calibration system, based on the same principle:

- Generation of a constant flow.
- Measurement of the flow by weighting the used water over a given period of time.
- Measurement of the output of the tested instrument at regular periods of time or when a pulse occurs (typical for a majority of tipping-bucket rain gauges).

The calibration system and the way it is used, is designed to get an uncertainty below 1%. The calculation of the flow rate is based on the measurements of mass and time. The measurement of mass is made with at least one order of magnitude better than 1%. Duration of the test will be large enough to guarantee an uncertainty lower than 1%, taking into account the measurement principle of the sensor tested and the requirement to test instrument based on rainfall intensity over periods of 1 minute. Rainfall intensity values, from 2 mm/h up to 2000 mm/h, will be generated.

4.3.3 Full documentation about the layout of the instrument installation shall be prepared by the SMs and provided to the chairman of ET/IOC by the end of March 2004.

4.3.4 The PL will consider and approve, if acceptable, on behalf of the IOC, any specific request of participants for equipment installation.

Standards and references

4.3.5 The reference rainfall rate is determined by the equipment described under Item 4.3.1. The calibration of this instrument can be traced to international standards as far as the measurement of mass and time are concerned. A description and specification of the calibration procedures including uncertainty estimates of calibration will be provided by the laboratories to the chairman of ET/IOC before the end of March 2004.

Related observations and measurements

4.3.6 The ET/IOC agreed on related measurements at the laboratories during the intercomparisons. The temperature of the water will be measured by thermometer with uncertainty of 0.5 °C maximum. The water temperature will be measured at the beginning and the end of the test and recorded in a suitable format. Ambient humidity, air temperature and pressure will also be measured; uncertainty of these measurements will

be provided. Vibration will not be measured, however all precautions will be taken to assure that vibrations do not influence the results.

Data acquisition system

- 4.3.7 The host country shall provide the necessary data acquisition system capable of recording the required pulse and digital (serial) signals from all participating instruments.
- 4.3.8 The data acquisition system hardware and software will be well tested before the comparison is started and measures will be taken to prevent gaps in the data record during the intercomparison period.

Data acquisition methodology

- 4.3.9 The appropriate data acquisition procedure for the laboratory intercomparisons is defined as follows:

4.3.9.1 Measurements based on constant flows:

- a) Whenever possible, each rain gauge will be tested over the range of intensities declared by the manufacturer by generating a set of at least seven fixed water flow rates that are compared with the recording of the instrument under test.
- b) At any given constant flow rate, the duration of the single test is determined based on the type of instrument under examination, and will allow reducing the sampling error to less than 1%.
- c) Per each of the seven constant flow rates generated, the measured rainfall rate I_r is recorded based on the output of the instrument under test, while the reference rainfall rate I (the "true" rainfall intensity) is determined by weighting the total amount of water actually given as input to the instrument, using an independent device.
- d) An error curve is determined by interpolating the seven data obtained above, using a second order polynomial. Parameters will be derived as follows:
Polynomial
$$E = a \cdot I_r^2 + b \cdot I_r + c$$
- e) Five tests will be performed in the same conditions, resulting in obtaining five different calibration curves. The best performing and the worst performing curves will be discarded and an average curve is obtained from the remaining three tests.

4.3.9.2 Measurements to determine the step response of weighing gauges:

- a) The internal software of weighing gauges uses averaging algorithms for purposes of reducing possible errors induced by environmental factors. (vibrations due to wind etc.) The time period of this averaging algorithms can influence the result of the measurement heavily especially for short high intensity rainfalls. High peaks of rainfall intensity can be "smoothed" by the averaging procedure.
- b) It should be proved, that the basic requirement of the intercomparison, namely the time resolution of 1 minute can be fulfilled by the tested weighing gauges also when using averaging algorithms.
- c) The step response of the weighing gauges will be measured by switching between two different constant flows, namely from flow 0 mm/h and 200 mm/h and back to 0 mm/h. The constant flow will be applied until the output signal of the weighing raingauge is stabilized. The time resolution of the measurement should be higher as 1 minute, e.g. 10 seconds.

- 4.3.13 After completion of the intercomparison, the host country will provide to each participating Member, if requested, full dataset related to participating instrument(s). This dataset will also contain related environmental, and reference data.

Data analysis

- 4.3.14 Based on the Site Managers proposals, the PL will prepare a framework for data analysis and processing and for the presentation of results to be submitted for approval by the chairman of the ET/IOC by May 2004. This will include a comprehensive description of statistical methods to be used and correspond to the intercomparison objectives, according to the data acquisition methodology described under item 4.3.9 and 4.3.10.
- 4.3.15 The SMs will be responsible for the data processing and analysis. The PL will, as early as possible, verify the appropriateness of the selected analysis procedures and, as necessary, prepare interim reports for comment by the members of the ET/IOC. Changes will be considered, as necessary, on the basis of these reviews.
- 4.3.16 After completion of the intercomparison, the ET/IOC will review the results and analysis prepared by the PL in the form of an executive summary to be provided by the end of June 2005.

Publication of results

- 4.3.17 The SMs will submit to the PL, not later than by the end of April 2005, the results of the intercomparisons performed, detailed information describing the facilities used, data processing, analysis and storage at each laboratory according to the framework defined under item 4.3.14.
- 4.3.18 The ET/IOC agreed on the following procedures for approval of the final report:
- a) The draft final report will be prepared by the PL before the end of July 2005 and submitted by electronic mail to all ET/IOC members and, if appropriate, also to participating Members and the HMEI Association.
 - b) Comments and amendments will be sent back to the PL by the end of October 2005, with a copy to the chairman of the ET/IOC.
 - c) In case of only minor amendments proposed, the report is completed by the PL. Final report, approved by the chairman of ET/IOC, will be sent to the WMO Secretariat for publication before the end of December 2005.
 - d) In case of major amendments or if serious problems arise that cannot be resolved by correspondence, an additional meeting of the ET/IOC will be convened in order to resolve deficiencies and have a Final Report not later than May 2006.
- 4.3.19 The ET/IOC agreed that any approved intermediate and final results could be presented by the PL with the SMs at technical conferences, or in journals and other technical/scientific publications. A paper will be prepared for the nearest CIMO/TECO event.

5. FIELD INTERCOMPARISONS OF RAINFALL INTENSITY (RI) GAUGES, IN VARIOUS CLIMATIC REGIONS

In addition to the general rules and procedures for WMO Intercomparisons as defined in the Guide to Instruments and Methods of Observation, WMO - No.8, Part III, Chapter 5, Annex 5.A and 5.B, the ET/IOC agreed on below rules and procedures:

5.1 Main objective, place(s), date and duration

- 5.1.1 In defining the main objectives, the meeting took into account proposals made by the *Expert Meeting on Rainfall Intensity Measurements* (Bratislava, Slovak Republic, 23-25 April 2001) that were endorsed by CIMO-XIII.
- 5.1.2 The ET/IOC concluded that there is enough information available to justify a field intercomparison of both catchment and non-catchment types of instruments with the emphasis on high rainfall intensity (RI). However, it was felt that low intensity, mixed and solid precipitation were also of interest for a future intercomparison. It was recognized that non-catchment type instruments could only be evaluated in the field in parallel with catchment type gauges. It was further decided that remote sensing instruments would not be tested at this time.
- 5.1.3 The ET/IOC agreed on principles and basic procedures for the field intercomparison of RI instruments.

Objectives

- 5.1.4 The main objective of this field intercomparison is to intercompare the performances of in situ rainfall intensity instruments of different measuring principles in high RI conditions.
- 5.1.5 Further objectives have been identified as follows:
- a) To evaluate the performance of the instruments in field conditions.
 - b) To offer advice on the need for additional laboratory tests especially for the non-catching type rain gauges.
 - c) To provide guidance material for further improvements in the area of intercomparisons of instruments for precipitation measurements.
 - d) To provide guidance on improving the homogeneity of long-term records of rainfall with special consideration given to high rainfall intensities.
 - e) To make available the summary of initial results of the intercomparison within three months after the end of the testing period and to publish the Final Report of the intercomparison within the WMO IOM Report Series within twelve months after the testing is finished.
 - f) To draft recommendations for consideration by CIMO-XIV.

Place

- 5.1.6 Concerning the location, a number of criteria were discussed. These included the occurrence of high rainfall events, availability of technical infrastructure and support for operating the intercomparison.
- 5.1.7 Italy and Slovakia informed on their intention to be host field RI intercomparisons.
- 5.1.8 It was concluded that the offered test site in Slovakia was not appropriate because of low probability of high intensity rainfall events during the test period.
- 5.1.9 It was discussed and decided that the test site in Italy was a possibility.
- 5.1.10 Germany has also test sites but with limited space and very few high RI events.
- 5.1.11 The United States has areas of high RI events and also locations with appropriate infrastructure where the intercomparison could be performed.

- 5.1.12 The tropical and monsoon regions have high RI events with considerable regularity and could be considered for the intercomparison.
- 5.1.13 Further efforts should be made to identify the suitable location for the field intercomparison, given the criteria of high RI events as well as appropriate facilities and resources. The optimal site should have some of the following characteristics:
- a) Good likelihood of high intensity rainfall events for example a 90% likelihood of the rainfall events higher than 100 mm/hr lasting for at least several minutes.
 - b) Appropriate facilities for running 10-30 instruments and collecting the data.
 - c) Support for installation, maintenance, communication, data collection, storage and analysis.
 - d) An open area with at least 300 m² with appropriate meteorological measurements nearby (see 5.3.3).
 - e) A long-term record of precipitation from a catchment gauge.
 - f) A pit for containing a standard precipitation gauge similar to that referenced in EN 13798-2002 or the WMO Guide to Hydrological Practices, WMO-No.168.
 - g) Internet connection.
 - h) It is currently not the intention of this field intercomparison to have wind shielding, even while wind is recognized as an important factor in catchment. To address this, an ideal site would have low wind speeds during rainfall.

Date and duration

- 5.1.14 The field intercomparison should commence as soon as possible after finishing the laboratory intercomparison. If the agreed schedule is maintained for the laboratory intercomparison, the field intercomparison could begin as early as April 2005.
- 5.1.15 The intercomparison should continue for a sufficient period of time to include several high intensity rainfall events. This time may be adjusted based on logistical considerations and meteorological conditions. The instruments may be held for as long as one year to complete the goals of this intercomparison.

5.2 Procedures for intercomparisons

Conditions for participation, type of instruments

- 5.2.1 Participation in the intercomparison will be accepted based on the following conditions:
- a) Only in situ instruments that are currently being used in national networks or being considered for use in national networks will be considered.
 - b) Only instruments that are capable of measuring rainfall intensity of at least 200 mm/h at a time resolution of 1 minute will be accepted.
 - c) Due to field acquisition system restrictions, only instruments with digital output (serial or pulse) will be considered. Instruments with other types of outputs may be accepted only with an appropriate adaptor interface.

d) To achieve more confidence in the results, preferences will be given to testing of two identical instruments, however it is not a condition for participation.

5.2.2 The number of instruments to be tested will depend on both the resources and space available for the field intercomparison. If the number of instruments applying to participate exceeds capacity of the field site, based on the proposal of the project leader, the ET/IOC will select instruments for participation based on the following criteria:

- a) Instruments will be selected to cover a variety of measurement techniques;
- b) Preference will be given to new promising measuring techniques;
- c) Preference will be given to instruments that are widely used.
- d) Preference will be given to instruments supplied in pairs.
- e) For those equipment tested in the laboratory intercomparison, results of the laboratory testing will be taken into consideration.

5.2.3 Participants are requested to calibrate their instruments against any suitable recognized standard before shipment and to provide appropriate calibration certificates. This can be a manufacturer's certificate.

5.2.4 Participants are requested to provide, as far as possible, two identical instruments of each type.

5.2.5 The ET/IOC will provide a detailed questionnaire in order to obtain the required information on each instrument proposed for the intercomparison. The Project Leader shall provide further detail and prepare the final version of the questionnaire to the chairman of the ET/IOC. Participants will be requested to specify very clearly the hardware connections and software characteristics in their reply and to supply adequate documentation.

5.2.6 The ET/IOC requested Secretariat to invite, at the earliest convenience, Members of WMO and Association of the Hydro-Meteorological Equipment Industry (HMEI) to participate in the field RI instruments intercomparisons and to propose instruments to be tested. The invitation should include all relevant information agreed by ET/IOC.

Responsibilities of participants

5.2.7 Appropriate documentation including all detailed instructions and manuals needed for installation, operation, calibration, and routine maintenance have to be provided in advance in order to evaluate the feasibility of the test.

5.2.8 The presence of participant's staff is not required during the intercomparison, however assistance in operation has to be provided on request in order to allow the test to be carried out properly and with minimum effort by the host country.

5.3 Data acquisition, processing and analysis methodology and publication of results

Equipment set-up

5.3.1 The project leader will provide the chairman of ET/IOC with a description of the site facilities, climatological information, available resources and the layout of the proposed instrument installation. The ET/IOC will evaluate this information and provide feedback. The PL will consider and approve, if acceptable, on behalf of the ET/IOC, any specific request of participants.

Standards and references

- 5.3.2 The reference rainfall rate will be determined by a catchment gauge set in a pit. The selection of this gauge will make use of the recommendations of the laboratory intercomparison. Documentation of the calibration of this instrument will be made available to participating members. The PL shall propose the method and equipment to be used as the reference for estimating rainfall intensities that will be confirmed by the ET/IOC.

Related observations and measurements

- 5.3.3 The field intercomparison site should be equipped with meteorological measurements including: temperature, humidity, pressure, wind speed, wind direction, present weather, and precipitation. Measurements of visibility, upwelling and downwelling solar radiation would be additionally useful but not necessary. The meteorological data will be available to the ET/IOC along with the intercomparison data for diagnostic purposes.

Data acquisition system

- 5.3.4 The host country shall provide the necessary data acquisition system capable of recording the required pulse and digital (serial) signals from all participating instruments.
- 5.3.5 The data will be automatically transmitted daily for preliminary analysis of emerging data.
- 5.3.6 The daily data will be backed up with an appropriate system to be approved by the chairman of ET/IOC.

Data acquisition methodology

- 5.3.7 The data will be acquired sufficiently fast (e.g. every fifteen seconds) to allow data evaluation on a one-minute time base. The data acquisition system will not average. If possible, the instrument should provide the most recent one-minute average value updated frequently.

Schedule of intercomparison

- 5.3.8 The ET/IOC agreed that the scheduling of the field intercomparison would be restricted by the completion of the laboratory testing. It was recognized that the high intensity precipitation events may occur at specific times of the year, necessitating possible changes in the timing of the field intercomparison.
- 5.3.9 The ET/IOC agreed on the time schedule of the field intercomparison as synthesized in the following time chart.

Year	2004					2005									2006												
Month	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	
Designation of host country																											
Letter of invitation to participants																											
Response to invitation																											
Selection of participants																											
Planned end of the laboratory intercomparison																											
Field intercomparison (planned)																											
Initial report of intercomparison (contingent on dates of intercomparison)																											
Final report of intercomparison																											

5.3.10 These dates assume appropriate preparations of the host country, all participants and the laboratory testing. If problems arise, the dates will be adjusted. The ET/IOC should agree on a more detailed outline of a time schedule for the intercomparison, including normal and specific tasks, and prepare a time chart. Details should be further worked out by the PL.

6. COMBINED INTERCOMPARISON OF THERMOMETER SCREENS/SHIELDS, IN CONJUNCTION WITH HUMIDITY MEASUREMENTS, IN VARIOUS CLIMATIC REGIONS

In addition to the general rules and procedures for WMO Intercomparisons as defined in the Guide to Instruments and Methods of Observation, WMO - No.8, Part III, Chapter 5, Annex 5.A and 5.B, the ET/IOC agreed on below rules and procedures:

6.1 Main objective, place(s), date and duration

6.1.1 Several different intercomparisons of radiation screens/shields in relationship with the temperature measurements were organized by WMO or National Meteorological Services, in temperate climatic regions, but not in arctic and tropical regions. Knowledge of the characteristics of temperature measurements in such regions is particularly important for climatological studies and climate change. Many new screen designs are also used in conjunction with automatic stations.

6.1.2 Since the last humidity sensors Intercomparison held by WMO in the period 1985-1989, there is a need to update the knowledge about humidity sensors available on the market and widely used.

- 6.1.3 Due to past intercomparisons already conducted in temperate climatic regions, the ET/IOC agreed that the priority should be given to thermometer screen intercomparisons in arctic and tropical regions. To minimize effort related to the organization of two separate screen/shield and humidity sensor intercomparisons, respectively, a goal is to combine these two, considering the common technical environment needed for such intercomparisons.
- 6.1.4 The ET/IOC agreed on principles and basic procedures for the field intercomparison of thermometer screens/shields, in conjunction with humidity measurements.

Objective

- 6.1.5 The main objectives of the planned intercomparisons are as follows:
- a) To update the knowledge on performance characteristics and operational factors of radiation screens/shields tested in the intercomparison;
 - b) To update the knowledge on performance characteristics and operational factors of humidity sensors tested in the intercomparison;
 - c) To analyze performance characteristics (especially reliability, accuracy and long-term stability) of tested humidity sensors;
 - d) To estimate an impact of radiation, wind speed, precipitation on humidity measurements inside the different screens/shields;
 - e) To improve the accuracy of the humidity measurements using the tested radiation screens/shields;
 - f) To make available the summary of initial results of the intercomparison within three months after the end of the testing period and to publish the Final Report of the intercomparison within the WMO IOM Report Series within twelve months after the testing is finished;
 - g) To draft recommendations for consideration by CIMO-XIV.

Place(s), date and duration

- 6.1.6 Considering the priority given to arctic and tropical regions, at least two test sites will be necessary : One in an arctic region and one in tropical or desert regions, the main interest being warm temperature and high solar radiation, as a combination of different conditions, e.g. warm/hot humid region, warm/hot dry region, cold region.
- 6.1.7 For the arctic region, contacts will be taken by Ms Elizabeth Weatherhead and Mr Jitze van der Meulen to identify possible partners interested in organizing such an Intercomparison.
- 6.1.8 Some Regional Instrument Centres (RICs) exist in tropical/desert regions. Organization of intercomparisons is in the scope of the tasks of a RIC, but many of the existing RICs have not yet developed facilities suitable for these activities. The organization of such an Intercomparison is thought as an occasion to both developing the expertise of a RIC and to fulfilling the objective of the Intercomparison. Possible assistance of another experienced RICs (e.g. Trappes) would be a great advantage, for organizing technically the Intercomparison and/or to calibrate the sensors. As direct funding by WMO/CIMO is not possible, funding by VCP could be a solution.
- 6.1.9 Other possibilities must be checked, based on existing willingness of WMO members or other organizations, such as ASECNA. Contacts will be taken by ET/IOC members, especially the ET/IOC chairman and the WMO Secretariat.

- 6.1.10 It is desirable to start the intercomparison as soon as possible. But, taking into account the preparation work, including identification of host countries, it is proposed to start the intercomparison in 2006. The schedule will have to be updated after identification of host countries, considering also aspects influencing the intercomparison. The identification of appropriate host countries should start as soon as possible.
- 6.1.11 Duration should be at least 12 months. In case of a region with no significant changes during the year, duration can be shorter but not less than 6 months.

6.2 Procedures for intercomparisons

Conditions for participation, type of instruments

- 6.2.1 Both naturally and artificially ventilated screens should be considered. In both cases it is proposed:
- a) To install two identical instruments of each type in order to increase confidence in the data;
 - b) To select the radiation screens/shields that are in operational use also taking into account new development in the area;
 - c) To select the suitable humidity sensors that are in operational use also taking into account new development in the area;
 - d) As much as possible, to use the same type of temperature sensor (Pt100) with a time constant of about 30 seconds, with a tolerance (IEC 751) of the probe equivalent to 0.1 K or less and/or an uncertainty of the temperature measurement of 0.1 K or less.
- 6.2.2 Here is a list of possible candidates for the intercomparisons (in the alphabetical order):
- a) The naturally ventilated screens/shields:
 - MetSpec Ltd., thermometer screen
 - Met One Instruments, Inc., Radiation Shield, model 5980;
 - Meteoservis v.o.s., Radiation Shield, model MetCover3;
 - Socrima, radiation shield, model BMO 1167A;
 - Vaisala, Solar Radiation and Precipitation shield, model DTR503A;
 - Vaisala, Radiation shield, model DTR13;
 - Vaisala, Radiation shield, model HMP243;
 - Young, multi-plate radiation shield, model 41003.
 - b) The humidity sensors:
 - Campbell Scientific Ltd, Temperature and Relative Humidity Probe, model HMP45C;
 - Delta-T, Relative Humidity & Air Temperature Sensors, types RHT2nl;
 - Rotronic, Temperature and Relative Humidity Probe, model MP101A;
 - Vaisala, Temperature and Relative Humidity Probe, model HMP45A/D;
 - Young, Relative Humidity/Temperature Probe, model 41372.
 - c) The artificially ventilated screens/shields:
 - Climatronics Corporation, Motor Aspirated Shield, model TS-10;

- Met One Instruments, Inc., Fan Aspirated Radiation Shield, model 076B;
- Yankee Environmental Systems, Inc., Precision meteorological thermo-hygrometer Model MET-2010;
- Young, aspirated radiation shield, model 43408

6.2.3 The ET/IOC will provide a detailed questionnaire in order to obtain the required information on each instrument proposed for the intercomparison. The final list of instruments/participants selected for the intercomparisons will be established from the responses to invitation to participants which will be issued after designation of host countries.

6.3 Data acquisition, processing and analysis methodology

Equipment set-up

- 6.3.1 All the tested screens/shields should be installed above the level area covered by homogeneous natural ground cover. All the screens should be freely exposed to sunshine and wind according to the CIMO Guide, WMO - No.8. They should be installed at a minimum distance of 30 meters from any source of heat or other constructions that could artificially influence the air temperature or atmosphere humidity, such as concrete, asphalt, buildings, standing water, etc. The grass or natural ground at the test site should completely cover the surface and it should be kept at a height below 10 cm.
- 6.3.2 The screens should be set out on a regular rectangular grid if possible, with the distance between adjacent screens 3-4 meters. The separation between screens should be a compromise to make interactions between the screens insignificant while keeping them all on a small area of ground to minimize temperature and humidity gradients across the test site. Additional radiation shields of the same type should be installed at the four corners of the grid to act as a check for temperature/humidity gradients across the site.
- 6.3.3 All screens should be installed so that the sensitive parts of all sensors are at the same level, at 1.5 meters above the ground, with the maximum tolerance of $\pm 5\%$ of the height. The screen manufacturer should state which point of the screen should be used for measurement of the representative height. Afterwards a selection of sensors has been done, a detailed questionnaire to manufactures and/or members should be prepared and sent, with the aim to receive all the necessary information.

Standards and references

- 6.3.4 Taking into account the previously carried out related intercomparisons and relevant WMO recommendations, it is suggested that the ventilated thermohygrometer VTP 6 (Thygan chilled mirror dew point hygrometer), produced by METEOLABOR AG, Switzerland, should be used as the reference system for both thermometer screen/shield and humidity sensor intercomparisons.

Related observations and measurements

- 6.3.5 The meteorological and environmental variables, in addition to the air temperature and humidity measurements, that should be measured or observed at the intercomparison site during the whole intercomparison period should be as follows:

Variable	Type of observation	Proposed type of the instrument
Global solar radiation	Automatic	Pyranometer
Wind speed and direction ¹⁾	Automatic	Ultrasonic wind sensor
Sun elevation and azimuth	Calculated	
Direct solar radiation ⁵⁾	Automatic	Pyrheliometer
Long-wave radiation ⁵⁾	Automatic	Pyrgeometer
Sunshine duration ⁵⁾	Automatic	Sun detector
Surface albedo ⁵⁾	Automatic	Albedometer
Cloud cover ⁵⁾	Automatic ⁴⁾	Ceilometer
Hydrometeors ^{2) 5)}	Automatic ⁴⁾	Present weather sensor, Precipitation detector
Precipitation intensity	Automatic	Rain gauge
State of the ground (emphasis on the snow cover) ^{3) 5)}	Manual	Observer

Notes:

- 1) *One-minute wind speed and direction measured at the height closed as much as possible to the height of the temperature/humidity measurements. If the screens can shelter the wind sensors in certain wind directions then it is preferred to raise them slightly above the level of the top of the screens; Besides this, measurement of 10-minute wind speed and direction measured at 10 m height (representative measurement height) should be considered to enable comparison of the wind conditions during the intercomparison period to the climatological wind data;*
- 2) *All types of precipitation, e.g. rain, snow, drizzle, dew, fog, rime, etc. (type, occurrence, and intensity). Manual observations may be required for this purpose;*
- 3) *Regular observations during daytime (at least every 3 hours);*
- 4) *Additional manual observations may be required for this purpose, if possible;*
- 5) *These parameters are supplementary.*

6.3.6 Automatic measurements should have priority. All data should be recorded with date and time of the measurements or observations.

6.3.7 During the intercomparison, regular manual checking of the screens is required to determine their cover states; in case of artificial ventilated screens checking of the aspirators is absolutely necessary. Digital photos should be taken regularly in order to document the state of the screens in various environmental conditions.

Data acquisition system

6.3.8 Data from tested sensors/shields should be collected by a separate data logger, while data from additional measurements together with data from the reference sensors by other. Both data loggers should be connected to a PC where the data acquisition and storing software runs.

6.3.9 Two types of automatic real-time quality control procedures of all measured data should be implemented:

a) **The monitoring of measurement range.** The below listed limit values are suggested for checking both signal measurement data (samples) and one-minute average, in case of wind one-minute and 10-minute averages:

- Air temperature: -50 °C ... +50 °C;
- Relative humidity: 1 ... 100 %;
- Wind speed: 0 - 50 m.s⁻¹ (one-minute average), 0 - 30 m.s⁻¹ (10-minute average);
- Global radiation: 0 ... 1600 Wm⁻²;
- Precipitation intensity: 3 mm/minute.

b) **The time variance of the signal.** After each signal measurement, the current sample is compared to the previous one. If the difference of these two samples is more than the specified limit then the current sample is identified as suspected and not used for the computation of an average. However, it is still used for checking the temporal consistency of the samples; it means that a new sample is still checked with the suspected one. The result of this procedure is that in case of large noise one or two successive samples are not used for the computation of the average. The limits of the time variance of the samples are as follows:

- Air temperature: 2 °C;
- Relative humidity: 5 %;
- Wind speed: 20 ms⁻¹;
- Global radiation: 800 Wm⁻².

6.3.10 There must be at least 66 % of samples available in order to compute the one-minute average in case of temperature, humidity, or sum in case of global radiation and at least 75 % of the samples to compute a 1- or 10-minute average in case of wind direction and speed.

6.3.11 The system should enable to monitor data in real-time on the PC-screen, both as absolute values and as differences. All data should be recorded with date and time. The time synchronization of all measured systems should be ensured.

6.3.12 Other requirements for the data acquisition and processing system should be considered.

Data acquisition methodology

6.3.13 All parameters should be measured every 5-10 seconds. In case of the intelligent sensors used for the variables mentioned in the section "Standards and references", the measuring frequency is predefined by the producer of the sensor. One-minute averages of all measured parameters with corresponding date and time should be logged.

6.3.14 Usage of two independent data collection systems (a backup system) shall be considered to avoid potential loss of data.

6.3.15 Besides one-minute data, statistical data such as means and data extremes over different time periods will be calculated.

6.3.16 The THYGAN (a proposed reference) is programmed to give a new dataset every ten minutes. The dataset from the THYGAN consists of averaged measured values for ambient temperature and dew point temperature. Relative humidity is calculated from the temperature and dew point measurements by the instrument itself and included in the data telegram from the sensor.

Data processing and analysis

6.3.17 Data analysis should be widely based on the methodology dealt with in the international standard, ISO 17714 (Test methods for comparing the performance of thermometer shields/screens and defining important characteristics).

Database and data availability

6.3.18 The database of one-minute data of all measured parameters is the basic presumption of later statistical analysis and processing of the weather conditions during the intercomparison period. For the purposes of detailed analysis of the special situations, the database of all temperature/humidity samples (signal measurement data) would be useful.

Suitable database of all manually observed parameters and results (notes) of the shield checks should be considered, too.

- 6.3.19 All sensors used in the intercomparison should be calibrated at least at the beginning and at the end of the intercomparison period. The data should be stored without correction. All corrections should be applied later during data processing and analysis. The corrections will be obtained by linear regression from the calibration data taking into account all calibrations made during the intercomparison.
- 6.3.20 BUFR should be considered to be used as the common data format for data transmission as well as for data archiving.
- 6.3.21 Near-real-time monitoring and data quality control shall be implemented and can consist of several procedures, e.g.:
- Missing data analysis;
 - Time-series plots of all measured parameters on a daily (24-hour) basis;
 - Statistical analysis of means (10-minute, 1-hour, 24-hour);
 - Detection of potential anomalies (extreme values of differences);
 - Error data analysis.
- 6.3.22 During long-term continuous logging of data there are always some values that are not representative and have to be rejected. In case of double installation of the same type of screens there is a possibility to reject any measurements in which the corresponding values in a pair of screens of the same type differ more than 0.5 °C (in case of temperature) or more than 5 % (in case of relative humidity).
- 6.3.23 As global radiation can vary rapidly, the radiation data should be smoothed with a low pass exponential filter with a time constant of 20 minutes in order to reduce random errors.

Data analysis

- 6.3.24 The ET/IOC agreed on the use of the following statistical procedures.
- 6.3.25 Analysis of mean values of temperature/humidity measurements:
- a) Analysis of the daily profiles of the temperature and humidity;
 - b) Analysis of the differences of one-minute values of the measured temperature/humidity parameter (reference screen - tested screen). A histogram of these differences should be drawn for the whole period to give a first indication of the observed differences. The differences should be further analyzed.
 - c) Analysis of one-minute data provides the information on the effect of solar radiation and wind speed respectively on the temperature/humidity parameter measured in each screen: means and standard deviations of differences in temperature/humidity in various screens for different classes of global radiation (with a span of 100Wm⁻²) and wind speed (with a span of 1ms⁻¹) respectively should be analyzed.
- 6.3.26 Analysis of mean values of differences of temperature/humidity measurements (reference screen – tested screen):
- a) Micrometeorological and short-term effects should be considered first, before any statistical analysis of the mutual differences of the temperature/humidity measurements, averaged over a specified time period (e.g. an hour, a day).
 - b) Analysis of mean diurnal/monthly differences of humidity measurements: Analysis of deviation for the tested screen/shield as the function of the reference humidity measurements. The mean differences will be computed for humidity intervals of 5 % and for different temperature classes (with a span of 5 °C).

6.3.27 Analysis of extreme differences of temperature/humidity measurements (reference screen – tested screen):

- a) The conditions leading to extreme measurement errors of temperature/humidity measurements are not readily apparent. This can be overcome by identifying extreme differences between the reference screen and the tested screen and then investigating the current meteorological conditions during these differences. If the screens have different time constants and temperature/humidity variation with time is high, this may be the cause of such differences. Therefore, such comparison should be conducted on daily extreme values, to be more representative.
- b) Daily extreme values (minimum and maximum) with time of occurrence should be computed for each screen from the one-minute database. The histograms of the differences of corresponding daily extreme values (reference screen – tested screen) for the whole period should be drawn and the differences should be further analyzed.

6.3.28 Analysis of temperature/humidity measurements for typical conditions experienced during the intercomparison period:

- a) A statistical analysis of temperature/humidity differences (reference screen – tested screen) for different classes of meteorological conditions should be done with the goal to analyze the effects of the individual meteorological variables and their combinations. Below listed effects should be analyzed using the whole database and specific filters on the influence parameters and appropriate combinations of them:
 - Direct solar radiation to be consider with the categories (to be adjusted to the region):
 - radiation $\leq 1000 \text{ Wm}^{-2}$
 - radiation $> 1000 \text{ Wm}^{-2}$
 - Wind speed to be consider with the categories:
 - wind speed $\leq 1.0 \text{ m.s}^{-1}$
 - $1.0 \text{ m.s}^{-1} < \text{wind speed} \leq 4.0 \text{ m.s}^{-1}$
 - wind speed $> 4.0 \text{ m.s}^{-1}$.
 - Day/night (radiation effect);
 - Night time: clear sky/overcast (radiation effect);
 - Hydrometeors occurrence, especially precipitation, fog (dry/wet conditions);
- b) A graphical description of weather experienced during the intercomparison should be drawn, with temporal curves of temperature, relative humidity, global radiation, wind speed and significant precipitation occurrence. From this description periods with typical conditions for the whole intercomparison period should be identified. Temperature/humidity differences (reference screen – tested screen) should be displayed for these typical conditions. These curves should help to explain the screen or sensor performance and to understand the origin of the differences. Differences plotted against time quickly show the changes with respect to changes in the weather conditions.
- c) Another solution is to define typical meteorological conditions and then analyze the performance of the tested screens during periods with these conditions to get a detailed knowledge of the screen performance in known conditions. This may allow an extrapolation of the screen performance in climatic regions other than the test site. Typical meteorological conditions could be periods of at least 2 hours with:
 - Direct solar radiation $> 1000 \text{ Wm}^{-2}$ and wind speed $\leq 1.0 \text{ m.s}^{-1}$;
 - Direct solar radiation $> 1000 \text{ Wm}^{-2}$ and $1.0 \text{ m.s}^{-1} < \text{wind speed} \leq 4.0 \text{ m.s}^{-1}$;
 - Direct solar radiation $> 1000 \text{ Wm}^{-2}$ and wind speed $> 4.0 \text{ m.s}^{-1}$;
 - Direct solar radiation $< 1000 \text{ Wm}^{-2}$ and wind speed $\leq 1.0 \text{ m.s}^{-1}$;
 - Direct solar radiation $< 1000 \text{ Wm}^{-2}$ and $1.0 \text{ m.s}^{-1} < \text{wind speed} \leq 4.0 \text{ m.s}^{-1}$;

- Direct solar radiation < 1000 Wm⁻² and wind speed > 4.0 m.s⁻¹;
 - Humidity variation > 50 % and wind speed ≤ 1.0 m.s⁻¹;
 - Humidity variation > 50 % and wind speed > 4.0 m.s⁻¹.
 - Direct solar radiation values to be adjusted depending on the site.
- The direct radiation threshold is to be adjusted to the region.

6.3.29 Analysis of special situations (selected periods containing events of particular significance):

- (a) Statistics calculated from a large number of observations can show small differences between screens and hide differences that occur in only a few, rather rare, circumstances.
- (b) A combination of the daily profiles of those differences with temperature/humidity profiles can reveal these situations. Examples of those could be:
- a day with fog and rapid change of relative humidity;
 - a day with precipitation occurrence and rapid change of relative humidity;
 - sunrises and sunsets in case of clear sky, etc.

6.3.30 The ET/IOC agreed on the time schedule of the intercomparison as synthesized in the following time chart.

Year	2004	2005												2006									
Month	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	
Designation of host countries																							
Selection of participants																							
Start of intercomparison in Artic																							
Start of intercomparison in tropical regions																							

6.3.31 These dates assume appropriate preparations of the host countries and all participants. If problems arise, the dates will be adjusted. The ET/IOC should agree on a more detailed outline of a time schedule for the intercomparison, including normal and specific tasks, and prepare a time chart. Details should be further worked out by the PL.

7 CLOSURE OF THE SESSION

7.1 The session was closed on 28 November 2003 at 13h00.

APPENDIX I

WORLD METEOROLOGICAL ORGANIZATION

QUESTIONNAIRE I

to potential participants
of the WMO laboratory intercomparison of Rainfall Intensity (RI) gauges
France/Italy/Netherlands 2004-2005

1. Member Country:

2. Expert (point-of-contact) responsible for the intercomparison in your country:

Name, First Name:

Address:

Tel./Fax:

E-mail:

3. Information on sensor/systems foreseen in the intercomparison:

.....
.....
.....
.....

3.1 **Model/Type I** ⁽¹⁾ (highest priority for participation):

a) Model/Type:

b) Manufacturer: Country:

c) Number of sites where the instrument is in operational use or intended to be in your country:

d) Will you submit **one** [] or **two** [] instruments ⁽²⁾

e) Principle of operation ⁽²⁾⁽³⁾

TB [] WG [] DC [] OT [] ⁽⁴⁾

f) What kind of parameter does the sensor/system report ⁽²⁾⁽⁵⁾

RI [] RA [] TT [] ⁽⁴⁾

g) What kind of output does the sensor/system provide

DG [] PS [] OT [] ⁽⁴⁾

3.2 **Model/Type II** ⁽¹⁾⁽⁷⁾ (lower priority for participation):

- a) Model/Type:
- b) Manufacturer: Country:
- c) Number of sites where the instrument is in operational use or intended to be in your country:
- d) Will you submit **one** [] or **two** [] instruments ⁽²⁾
- e) Principle of operation ⁽²⁾⁽³⁾
 - TB [] WG [] DC [] OT [] ⁽⁴⁾
- f) What kind of parameter does the sensor/system report ⁽²⁾⁽⁵⁾
 - RI [] RA [] TT []
- g) What kind of output does the sensor/system provide ⁽⁶⁾
 - DG [] PS [] OT [] ⁽⁴⁾

Date

Signature of the Permanent Representative

NOTES:

Further information on organizational and technical issue for the preparation of the intercomparison will be distributed in due course to the experts designated by you, as appropriate.

(1) It is necessary to prioritize the submission on participation because of limited testing facilities.

(2) Please tick the appropriate box.

(3) Principle of operation

TB = Tipping Bucket WG = Weighing Gauge DC = Drop counter OT = Other

(4) If "Other", please attach a brief description of the applied principle/sensor output.

(5) Parameters reported

RI = Rainfall Intensity RA = Rainfall Accumulation TT = Time of Tipping

(6) Sensor/System Output

DG = Digital Output PS = Pulse Signal OT = Other

- (7) In case it is intended to submit more than two types of rainfall intensity gauges, attach another completed copy of this questionnaire.

Please return the completed questionnaire, as soon as possible, but not later than March 30, 2004 to the following address:

Secretary-General
World Meteorological Organization
P.O. Box 2300
1211 Geneva 2
Switzerland
Telefax: +41 32 7342326

WORLD METEOROLOGICAL ORGANIZATION

QUESTIONNAIRE II¹

to potential selected participants
of the WMO laboratory intercomparison of Rainfall Intensity (RI) gauges
France/Italy/Netherlands 2004-2005

GENERAL:

1. Member country:
2. Name of Participating Institution:
3. Address:.....
.....
4. Name of person responsible for the intercomparison:
Tel./Fax:
E-mail:
- 4.1 Alternative name:
Phone/Fax:
E-mail:
5. Manufacturer of Sensor/System (Name and Address):
.....
6. Approximate commercial value²:
7. Shipping
 - Total weight:
 - Number of boxes:
 - Dimensions of parcels:

RAINFALL INTENSITY GAUGE SPECIFICATIONS:

8. Model/Type:
9. Principle of Operation (short description):
.....
.....

¹ NOTE: One questionnaire per type of Sensor/System. If necessary please attach additional pages.

² Preferably in EURO

Information for laboratory installation

- 10. Dimensions³:
- 11. Weight⁴:
- 12. Power supply requirements⁵
 - Voltage required:
 - Total power consumption:
- 13. Sensor/System siting requirements:
 - Installation alignment required: Yes/No
 - Special fixtures or tools for installation (please describe):
.....
.....
 - Maximum distance to the data logger:
 - Any special requirements:
.....
.....
- 14. Calibration⁶:
.....
.....
.....
.....
- 15. Will member country expert be assisting the installation of the Sensor/System:
Yes/No

Sensor/System Output

- 16. Output type:
 - 16.1 Pulse:
 - Duration:
 - Voltage:
 - 16.2 Reed Relay: Yes / No
 - 16.3 Digital:

³ Please enclose a diagram of the instrument
⁴ Specify separately for all included items
⁵ Sensor should be able to be supplied by 220 VAC, 50 Hz. Organising countries will not provide standard converters. Host countries provide unregulated 12 VDC.
⁶ Describe procedure, reference and calibration intervals.

- RS232
- Other (please specify and propose and clearly describe an interface for data acquisition)

.....
.....
.....
.....

17. Any other relevant information⁷

.....
.....
.....
.....
.....

⁷ For example, if internal processing software introduces smoothing over period of time larger than 1 minute, this should be carefully documented.

ANNEX I

List of participants

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ET Chair

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ANNEX II

WORK PLAN
Expert Team on Surface-based Instrument intercomparisons and Calibration Methods
(2003-2006)

No.	Task description	Person responsible	Action	Deadline	Deliverables	Deadline
1	Undertake and evaluate instrument intercomparisons:					
1 a)	Establishment of the International Organizing Committee (IOC) for surface-based instrument intercomparisons	Michel LEROY	1. Identify and propose members of the IOC	Nov.03	• IOC established	Dec.03
		Michel LEROY	2. Overall supervision and coordination of the work of IOC	Dec 06	• Status Report to CIMO-XIV	Jun.06
1 b)	Laboratory intercomparisons of rainfall Intensity (RI) gauges, in two independent certified laboratories	Michel LEROY	1. Identify laboratories for intercomparisons	Nov.03	<ul style="list-style-type: none"> • Proposals for update of CIMO Guide (rainfall intensity) • Published results of intercomparisons 	Dec. 05
		Luca LANZA Akbar Hosseinzadeh	2. Define and agree on the organization of intercomparisons, namely: main objective, place, date, duration, conditions for participation, data acquisition, processing and analysis methodology, publication of results, intercomparison rules, responsibility of the host(s) and responsibilities of participants	Dec.03		Dec. 05
		Luca LANZA	3. Identify instruments for intercomparisons	May.04		
		Luca LANZA	4. Start of the Intercomparison	Sep. 04		
		Luca LANZA	5. Overall supervision and coordination of	Dec.05		

No.	Task description	Person responsible	Action	Deadline	Deliverables	Deadline
1 c)	<p>Field intercomparisons of rainfall Intensity (RI) gauges, in various climatic regions</p> <p>(Depending on the results of laboratory RI gauges intercomparisons)</p>	<p>Michel LEROY</p> <p>Eckhard LANZINGER</p> <p>Eckhard LANZINGER</p> <p>Eckhard LANZINGER</p> <p>Eckhard LANZINGER</p> <p>Eckhard LANZINGER</p> <p>Eckhard LANZINGER</p>	<p>intercomparisons</p> <p>1. Identify possible host countries for intercomparisons</p> <p>2. Designation of host country</p> <p>3. Define and agree on the organization of intercomparisons, namely: main objective, date, duration, conditions for participation, data acquisition, processing and analysis methodology, publication of results, intercomparison rules, responsibility of the host(s) and responsibilities of participants</p> <p>4. Identify instruments for intercomparisons</p> <p>5. Start of Intercomparison</p> <p>6. Overall supervision and coordination of intercomparisons</p>	<p>Apr. 04</p> <p>Aug. 04</p> <p>May 04</p> <p>Feb.05</p> <p>May 05</p> <p>Sep.06</p>	<ul style="list-style-type: none"> • Proposals for update of CIMO Guide (rainfall intensity) • Status Report to CIMO-XIV • Published results of intercomparisons 	<p>Jun.06</p> <p>Jun. 06</p> <p>Sep. 06</p>

No.	Task description	Person responsible	Action	Deadline	Deliverables	Deadline
2	Address the data homogeneity issue					
2 a)	In collaboration with CCI, JCOM, CAS and HMEI address the data homogeneity issue	Michel LEROY	<ol style="list-style-type: none"> 1. Review the implication of data (in)homogeneity on climatological, marine and atmospheric science applications 2. Study the role of intercomparison in data homogeneity 3. Develop a guide to network managers on data homogeneity issue 	<p>TBD</p> <p>TBD</p> <p>TBD</p>	<ul style="list-style-type: none"> • Report (Guide) to network managers and RAs • Updated CIMO Guide on the role of intercomparisons in data homogeneity 	<p>TBD</p> <p>TBD</p>