

**WORLD METEOROLOGICAL ORGANIZATION**

**COMMISSION FOR INSTRUMENTS AND METHODS OF OBSERVATION**

**JOINT**

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

*Second Session*

*AND*

**INTERNATIONAL ORGANIZING COMMITTEE ON  
SURFACE-BASED INSTRUMENT INTERCOMPARISONS**

*Second Session*

**Geneva, Switzerland**

**5-9 December 2005**

**FINAL REPORT**



## CONTENTS

	<u>Pages</u>
<u>Agenda</u>	ii
<u>Executive summary</u>	iii
<u>General summary of the work of the meeting</u>	p.1- p.6
<b>Annexes:</b>	
<u>List of participants</u>	ANNEX I, p.1 - p.5
<u>Final Report of the WMO Laboratory Intercomparison of Rainfall Intensity Gauges, France, Italy, The Netherlands, 2004-2005</u>	ANNEX II p.1
<u>Operational aspects of the WMO Field Intercomparison of RI Gauges, Vigna di Valle, Italy, mid 2007 to mid 2008</u>	ANNEX III p.1 – p.14
<u>Preliminary planning of the WMO Combined intercomparison of thermometer screens/shields, in conjunction with humidity measuring instruments</u>	ANNEX IV p.1
<u>Work Plan</u>	ANNEX V, p.1 – p.3

## AGENDA

### 1. ORGANIZATION OF THE SESSION

1.1 Opening of the session

1.2 Adoption of the agenda

1.3 Working arrangements for the session

### 2. REPORT OF THE CHAIRMAN

### 3. WMO LABORATORY INTERCOMPARISON OF RAINFALL INTENSITY GAUGES

### 4. FIELD INTERCOMPARISONS OF RAINFALL INTENSITY (RI) GAUGES

### 5. COMBINED INTERCOMPARISON OF THERMOMETER SCREENS/SHIELDS, IN CONJUNCTION WITH HUMIDITY MEASURING INSTRUMENTS, IN VARIOUS CLIMATIC REGIONS

### 6. WORK PLAN

### 7. DRAFT REPORT OF THE SESSION

### 8. CLOSURE OF THE SESSION

## **EXECUTIVE SUMMARY**

This report provides a summary of the second session of the Joint Expert Team on Surface-Based Instrument Intercomparisons and Calibration Methods (ET) and International Organizing Committee on Surface-Based Instrument Intercomparisons (IOC).

The ET/IOC discussed and agreed on the Final Report of the WMO Laboratory Intercomparison of Rainfall Intensity (RI) Gauges held in Trappes (France), Genoa (Italy) and De Bilt (The Netherlands) from September 2004 to September 2005.

The ET/IOC evaluated the proposal of Italy to host the WMO Field Intercomparison of RI Gauges in Vigna di Valle, Italy. In doing so, it considered the results of the evaluation of the testing site done by CIMO experts as well as the local climatology of the site and concluded that the Vigna di Valle test site fulfills all of the required characteristics and it is therefore suitable for the planned field RI intercomparison. Subsequently, the ET/IOC agreed to organize the intercomparison in Vigna di Valle in the time frame as proposed by the representative of Italy. The meeting also reviewed the operational aspects related to the intercomparison, such as conditions for participation, type of instruments, intercomparison rules, responsibility of host(s) and participants, data acquisition, processing analysis methodology and publication results.

The ET/IOC evaluated the proposal of Algeria to host the WMO Combined Intercomparison of Thermometer Screens/Shields, in Conjunction with Humidity Measuring Instruments in Ghardaïa, Algeria. On behalf of the Algeria, the chairman of ET/IOC presented the Algerian project for hosting the intercomparison in Ghardaïa. Subsequently, the meeting agreed to hold the intercomparison in Ghardaïa, Algeria, approved the operational aspects related to the intercomparison including a draft time frame of the related activities.

## **GENERAL SUMMARY**

### **1. ORGANIZATION OF THE SESSION**

#### **1.1 Opening of the session**

1.1.1 The second session of the Joint Meeting of the Expert Team on Surface-Based Instrument Intercomparisons and Calibration Methods (ET) and International Organizing Committee on Surface-Based Instrument Intercomparisons (IOC) was held in Geneva, Switzerland, 5-9 December 2005. Mr Michel Leroy, the Chairman of the ET and IOC, opened the session. The list of participants is given in Annex I.

1.1.2 Following the opening of the session, on behalf of the Secretary-General of WMO, Mr Alexander Karpov, Chief of the Observing Systems Division, WWW Department, welcomed the participants to Geneva. In his statement to the ET and IOC, he recalled that the main objectives of the meeting were to finalize the report of the WMO Laboratory Intercomparison of Rainfall Intensity Gauges and to discuss the operational aspects of the planned surface-based instrument intercomparisons in 2006 and 2007.

1.1.3 Mr Karpov thanked Météo France, University of Genoa and Italian Meteorological Service, KNMI, manufacturers and the WMO project team for all the arrangements made and the hard work carried out for the success of the WMO Laboratory Intercomparison of Rainfall Intensity Gauges held in Trappes (France), Genoa (Italy) and De Bilt (The Netherlands) from September 2004 to September 2005. He wished participants a productive meeting and an enjoyable stay in Geneva.

1.1.4 Mr Leroy also welcomed participants and wished everyone a fruitful and productive meeting.

#### **1.2 Adoption of the agenda**

1.2.1 The ET/IOC adopted the Agenda for the meeting, which is reproduced at the beginning of this report.

#### **1.3 Working arrangements for the session**

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

### **2. REPORT OF THE CHAIRMAN**

2.1 Mr Leroy presented a report of ET's activities since the last meeting in November 2003. He pointed out that the activities of the team were concentrated on the preparation of, and carrying out the WMO Laboratory Intercomparison of Rainfall Intensity (RI) Gauges organized in three laboratories from September 2004 to September 2005. After the intercomparison, substantial time was devoted to analysis of the results and preparation of a draft report.

2.2 The chairman informed that he had contacted the ONM (Office National de Météorologie) of Algeria, to check the possibility for Algeria to host an international intercomparison of thermometer screens. These contacts were made in the framework of a bilateral cooperation between Algeria and France, with the objective to help Algeria to develop further the Regional Instrument Center in Alger. The conclusions of these contacts are dealt with in item 5.

### **3. WMO LABORATORY INTERCOMPARISON OF RAINFALL INTENSITY GAUGES**

3.1 Nineteen pairs of equipment from eighteen manufacturers were successfully tested in each of the three laboratories involved in the intercomparison. Apart of the performance evaluation of the participating instruments, the main outcome includes 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<sup>-1</sup> and identification of the most suitable method and equipment for reference purposes for field intercomparisons. The preliminary results show that only those tipping bucket rain gauges that have proper dynamic correction software perform accurately enough. The accuracy of the weighing gauges is better than the tipping buckets however most of the ones tested had a slower response time. The performance of instruments measuring water level by conductivity showed some shortcomings, presenting a challenge to the industry.

3.2 Mr Lanza, Italy, the Project Leader, with the assistance of the chairman of the ET/IOC, the Site Managers and other contributors, especially Mr van der Meulen (The Netherlands) and WMO Secretariat, prepared the draft version of the Final Report for the discussion during the ET/IOC meeting. This draft took into consideration the preliminary report presented during the WMO Technical Conference on Meteorological and Environmental Instruments and Methods of Observation (TECO-2005) and the Exhibition on Meteorological Instruments, Related Equipment and Services (METEOREX-2005), Bucharest, Romania, 4-7 May 2005, and published as the IOM Report No. 82.

3.3 The draft Final Report provides a valuable source of factual and scientific information for the whole range of readers, from staff employed in the operation of the observing networks, through managers to scientific personnel and private manufacturing industry. It is expected that further improvements in the performance of rain gauges will be done as a follow-up of the laboratory intercomparison, especially due to the response delay of the weighing gauges and dynamical correction of the tipping bucket rain gauges.

3.4 ET/IOC members, invited experts, Hydro-Meteorological Equipment Industry Association (HMEI) representatives and participating manufacturers concluded that the objectives of the intercomparison were achieved and congratulated the ET/IOC chairman, Project Leader and Site Managers for the work done and for the preparation of the draft report.

3.5 The comments presented by ET/IOC members, invited experts, HMEI representatives and participating manufacturers were discussed and incorporated in the Draft Final Report. The HMEI representative, on behalf of the participating manufacturers, thanked the meeting for the opportunity to comment on the draft report and for incorporating their comments in the Final Report. The HMEI, expressing the opinion of manufacturers, stated that a period of two days, over a weekend, between receipt of the draft final Intercomparison report and the start of the meeting to finalize the report was too short to enable adequate response from the participating manufacturers concerned in the Intercomparison, not attending the meeting personally. The HMEI therefore proposed that the period for comments be in future extended to allow for comments before the ET/IOC meeting.

3.6 No additional proposals were made to Data policy.

3.7 The ET/IOC agreed on the Final Report (see [Annex II](#)). The Final Report will be published by WMO, at first on the CIMO/IMOP website and later as the IOM Report, and it will be distributed to WMO Members and participating manufacturers. It is expected that a number of scientific papers will also be published on this subject. The complete intercomparison database will be kept by Météo France, the Royal Netherlands Meteorological Institute, University of Genoa and WMO and available for further scientific studies.

### **4. FIELD INTERCOMPARISONS OF RAINFALL INTENSITY (RI) GAUGES**

4.1 Mr Pagano, the representative of Italy, presented the invitation of the Italian Meteorological Service to host the WMO Field Intercomparison of RI Gauges in Vigna di Valle, Italy from mid 2007 to mid 2008.

4.2 Mr Vuerich, the representative of the Italian Meteorological Service Centre of Meteorological Experimentation (ReSMA), which operates the testing site in Vigna di Valle, presented the Project for hosting the WMO Field Intercomparison and invited WMO to evaluate the capability of ReSMA to hold the intercomparison from mid 2007.

4.3 The ET/IOC evaluated the proposal of Italy to host the WMO Field Intercomparison of RI Gauges in Vigna di Valle, Italy. In doing so, it considered the results of the evaluation of the testing site done by CIMO experts on 20 April 2005 as well as the local climatology of the site provided by Mr Vuerich. The ET/IOC concluded that the Vigna di Valle test site fulfills all of the required characteristics and is therefore suitable for the planned RI intercomparison.

4.4 The ET/IOC agreed to organize the intercomparison in Vigna di Valle in the time frame as proposed by the representative of Italy. A formal exchange of letters between WMO and Italian Meteorological Service will be done at the beginning of 2006 to reconfirm the current planning of WMO for holding the intercomparison.

4.5 The representative of Italy proposed two site managers to be responsible for the field intercomparison at the test site:

- Mr Fabio Malaspina (Air Force Major), ReSMA deputy director and senior physicist, as the Site Manager responsible for Quality Assurance (SM-QA), and
- Mr Emanuele Vuerich (Air Force Lieutenant), young physicist, as the Site Manager responsible for all technical aspects and contact with ET/IOC and WMO (SM-CP).

The ET/IOC agreed with the proposal.

4.6 The ET/IOC reviewed the main objectives, possible places, dates and duration of the intercomparisons, as well as operational aspects, such as conditions for participation, type of instruments, intercomparison rules, responsibility of host(s) and participants, data acquisition, processing analysis methodology and publication results (see Annex III).

## **5. COMBINED INTERCOMPARISON OF THERMOMETER SCREENS/SHIELDS, IN CONJUNCTION WITH HUMIDITY MEASURING INSTRUMENTS, IN VARIOUS CLIMATIC REGIONS**

5.1 The WMO Secretary-General requested the Permanent representative of Algeria with WMO to consider hosting the WMO Combined intercomparison of thermometer screens/shields, in conjunction with humidity measuring instruments in Ghardaïa. The WMO request was positively received and Algeria agreed with the hosting of the intercomparison.

5.2 On behalf of Algeria, the chairman of the ET/IOC presented the Algerian project for hosting the intercomparison in Ghardaïa, which included the infrastructure available and planned, support provided by Algeria for the preparation and conduct of the intercomparison and the climatology of the test site. Météo France will support the project through a bilateral agreement. The expected support from WMO only needs to cover the supporting of the IOC to overlook the intercomparison.

5.3 The ET/IOC agreed with the proposal to hold the intercomparison in Ghardaïa, Algeria. It also confirmed the operational aspects related to the intercomparison as defined by the ET/IOC-1 and prepared the draft time frame of the related activities (see Annex IV). WMO Secretariat was requested to inform the Permanent Representative of Algeria with WMO on the current planning of the intercomparison so that the infrastructure of the test site could be ready on time.

5.4 Mr Zahumenský, the Project Leader, will prepare the Questionnaires to be sent along with the invitation letters to Members and to manufacturers. The Questionnaires should be ready by 5 January 2006.

## **6. WORK PLAN**

6.1 The ET/IOC checked the deliverables achieved so far according to the Work Plan of the team and made necessary adjustment to reflect the changes in the organization of the planned intercomparisons. The updated Work Plan is in ANNEX V.

## **7. DRAFT REPORT OF THE SESSION**

7.1 The members of Expert Team and International Organizing Committee prepared their inputs for the Final Report, a draft of which was subsequently prepared by the Secretariat. The meeting requested Secretariat to allow two more weeks for additional comments, if any, before publishing this report.

## **8. CLOSURE OF THE SESSION**

8.1 The session was closed on 9 December 2005 at 17.00 h.

**List of participants**

<b>Mr Michel LEROY ET Chair</b>	Météo France DSO/DOS 7, rue Teisserenc de Bort B.P. 202 F-78195 Trappes France Tel.: +33 1 3013 6405 Fax: +33 1 3013 6020 E-mail: <a href="mailto:michel.leroy@meteo.fr">michel.leroy@meteo.fr</a>
<b>Mr Eckhard LANZINGER</b>	Deutscher Wetterdienst Frahmredder 95 22393 Hamburg Germany Tel.: +49 40 6690 2455 Fax: +49 40 6690 2499 E-mail: <a href="mailto:eckhard.lanzinger@dwd.de">eckhard.lanzinger@dwd.de</a>
<b>Prof. Luca LANZA</b>	DIAM – Department of Environmental Engineering University of Genoa Via Montallegro, 1 16145 Genoa Italy Tel.: +39 010 353 2123 Fax: +39 010 353 2481 E-mail: <a href="mailto:luca@diam.unige.it">luca@diam.unige.it</a>
<b>Mr Khalid I. EL FADLI</b>	Libyan Meteorological Department P.O Box 81734 Tripoli Libyan Arab Jamahiriya Tel.: + Fax: +218 204 623 074 E-mail: <a href="mailto:K_eIFadli_met@mail_Ittnet.net">K_eIFadli_met@mail_Ittnet.net</a>
<b>Dr Igor ZAHUMENSKY</b>	Slovak Hydrometeorological Institute Jeséniova 17 P.O Box 15 833 15 Bratislava Slovakia Tel.: +421 46 541 3624 Fax: +421 46 541 3624 E-mail: <a href="mailto:igor.zahumensky@shmu.sk">igor.zahumensky@shmu.sk</a>

<b>Dr Bruce BAKER</b>	U.S. Climate Reference Network National Climate Data Center NOAA-NESDIS 151 Patton Avenue Asheville, NC 28801 United States of America Tel.: +1 828 272 4018 Fax: +1 828 271 4022 E-mail: <a href="mailto:Bruce.Baker@noaa.gov">Bruce.Baker@noaa.gov</a>
<b>Dr Luigi STAGI</b>	DIAM – Department of Environmental Engineering University of Genoa Via Montallegro, 1 16145 Genoa Italy Tel.: +39 010 353 2482 Fax: +39 010 353 2481 E-mail: <a href="mailto:luigi@diam.unige.it">luigi@diam.unige.it</a>
<b>Mr Christophe ALEXANDROPOULOS</b>	Météo France DSO/DOS 7, rue Teisserenc de Bort B.P. 202 F-78195 Trappes France Tel.: +33 1 3013 6405 Fax: +33 1 3013 6020 E-mail: <a href="mailto:christophe.Alexandropoulos@meteo.fr">christophe.Alexandropoulos@meteo.fr</a>
<b>Mr Willem WAUBEN</b>	Royal Netherlands Meteorological Institute Wilhelminalaan 10 P.O. Box 201 NL-3730 AE De Bilt Netherlands Tel.: +31 30 220 6482 Fax: +31 30 221 0407 E-mail: <a href="mailto:Wauben@knmi.nl">Wauben@knmi.nl</a>
<b>Mr Jitze van der MEULEN</b>	Royal Netherlands Meteorological Institute R & D Observations Division Wilhelminalaan 10 P.O Box 201 NL-3730 AE de BILT Netherlands Tel.: +31 30 220 6432 Fax: +31 30 221 0407 E-mail: <a href="mailto:Jitze.van.der.Meulen@knmi.nl">Jitze.van.der.Meulen@knmi.nl</a>

<b>Dr Emanuele VUERICH</b>	Italian Air Force Met Service - Experimentation Centre of Met Instrumentation Via Braccianese km18 00062 Vigna di Valle, Bracciano Rome Italy Tel.: +3906 99801013 Fax: +3906 9987297 E-mail: <a href="mailto:Vuerich@meteoam.it">Vuerich@meteoam.it</a> E-mail: <a href="mailto:vigna@meteoam.it">vigna@meteoam.it</a>
<b>Dr Paolo PAGANO</b>	Italian Meteorological Service Aeroporto F. Baracca – Centocelle Via di Centocelle 301 I-00175 Rome Italy Tel.: +39 06 2400 2470 Fax: +39 06 2440 1359 E-mail: <a href="mailto:p.pagano@meteoam.it">p.pagano@meteoam.it</a>
<b>Ms Muriel LACOMBE</b>	Météo France 7 rue Teisserenc de Bort 78195 TRAPPES CEDEX France Tel.: +33 1 30 13 65 30 Fax: +33 1 30 13 60 20 E-mail: <a href="mailto:muriel.lacombe@meteo.fr">muriel.lacombe@meteo.fr</a>
<b>Mr Gerhard PEVNY</b>	LOGOTRONIC GmbH Phorusgasse 8 A-1040 Vienna Austria Tel.: +43 1 587 2971-0 Fax: +43 1 587 2971-41 E-mail: <a href="mailto:gerhard.pevny@logotronic.co.at">gerhard.pevny@logotronic.co.at</a>
<b>Mr Panu KOPSALA</b>	Vaisala Oyj P.O. Box 26 FIN-00421 Helsinki Tel.: +358 9 8941 Fax: +358 9 8949 2210 E-mail: <a href="mailto:panu.kopsala@vaisala.com">panu.kopsala@vaisala.com</a>
<b>Mr Bruce SUMNER</b>	HMEI Executive Secretary HMEI Secretariat Room 7L21 7 bis, Avenue de la Paix CH 1211 Geneva 2 Switzerland Tel.: +41 22 730 8334 Fax: +41 22 730 8340 E-mail: <a href="mailto:hmei@wmo.int">hmei@wmo.int</a>

<b>Ms Christine CHARSTONE</b>	HMEI Administrator HMEI Secretariat Room 7L21 7 bis, Avenue de la Paix CH 1211 Geneva 2 Switzerland Tel.: +41 22 730 8334 Fax: +41 22 730 8340 E-mail: <a href="mailto:hmei@wmo.int">hmei@wmo.int</a>
<b>WMO Secretariat</b> 7 bis, avenue de la Paix CH-1211 Geneva 2 Switzerland	<b>WWW website</b>  <a href="http://www.wmo.int/web/www/www.html">www.wmo.int/web/www/www.html</a>
<b>Dr Miroslav Ondráš</b>	Senior Scientific Officer Observing System Division World Weather Watch Department Tel.: +41 22 730 8409 Fax: +41 22 730 8021 E-mail: <a href="mailto:MOndras@wmo.int">MOndras@wmo.int</a>

**Final Report**  
**WMO Laboratory Intercomparison of Rainfall Intensity Gauges**  
**Trappes (France), Genoa (Italy), De Bilt (The Netherlands)**  
**September 2004 – September 2005**

See: <http://www.wmo.int/web/www/IMOP/reports.html>

**Operational aspects of the WMO Field Intercomparison of RI Gauges  
Vigna di Valle, Italy  
Mid 2007 to Mid 2008**

**Objectives**

1. The main objectives of the WMO field intercomparison have been reviewed and confirmed by the ET/IOC. Date and duration had to be updated to allow for proper preparation of the test site. 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:
2. The main objective of this field intercomparison is to intercompare the performance of in situ rainfall intensity instruments of different measuring principles in high RI conditions.
3. 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-XV.

**Date and duration**

4. The field intercomparison should commence in August 2007. The updated time schedule is attached in [Appendix I](#) to this Annex.
5. 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.

**Conditions for participation, type of instruments**

6. Participation in the intercomparison will be accepted based on the following conditions:
  - a) Only in situ, both catchment and non-catchment, RI 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  $200 \text{ mmh}^{-1}$  at a time resolution of 1 minute will be accepted.
  - c) Due to field acquisition system restrictions, only instruments with digital output (preferably serial) will be considered. Due to large cable lengths at the test site participants will be asked to provide an RS485/422 output. Instruments with other types of outputs may be accepted only with an appropriate adaptor interface. The instruments with a pulse output do not require a converter unless the manufacturer usually provides the sensor with an interface (see also paragraph 23).

- d) Preferences will be given to two identical instruments, one for testing, one as a spare, however this is not a condition for participation.
  - e) Participants should agree that their instruments (only catching types) will be calibrated/tested in the laboratories of Météo France and /or Genoa before the intercomparison. No adjustments will be made to the instruments. The point of delivery will be decided after selection of the participating instruments.
  - f) The laboratory calibration phase should start 3 months ahead of the beginning of the field test. It was agreed that all instruments of manufacturers from overseas will be tested in Genoa. Instruments from manufacturers from EU will be tested in Trappes. Météo France will provide the transportation of these instruments from Trappes to the test site. Furthermore instruments shall be tested regularly on site during and after the field test by a dynamical field calibration to identify a possible drift of the calibration.
7. The number of instruments will be limited to 20 (plus 4 reference instruments in a pit and 4 of the same type in the field). 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) For those equipment tested in the laboratory intercomparison, results of the laboratory test will be taken into consideration.
  8. Every instrument should be installed as it is done in the operational use of the respective participating member. Windshields will not be requested, if an instrument is operationally used without one. If an instrument is operationally used in combination with a windshield, then the appropriate shield has to be provided by the member.
  9. Every instrument that is installed as reference gauge in the pit, shall also be installed on the field in order to quantify the effect of wind losses in the catchment of rainfall.
  10. 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.
  11. 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 details 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 replies and to supply adequate documentation.
  12. 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 instrument intercomparisons and to propose instruments to be tested. The invitation should include all relevant information agreed by ET/IOC.

### **Responsibilities of participants**

13. 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.

14. The presence of participant's staff is not required during the intercomparison, however assistance in operation should be provided in order to allow the test to be carried out properly and with minimum effort by the host country.
15. The participants will be responsible for the shipment and insurance of the their instruments, and installation if requested by the testing site.

## **Data acquisition, processing and analysis methodology and publication of results**

### **Equipment set-up**

16. The ET/IOC discussed the data acquisition system as proposed by the Site Manager of Vigna di Valle test site and the Project Leader. It was acknowledged that the data would be recorded by one single computer in order to provide an inherent synchronization of all data.

### **Standards and references**

17. The ET/IOC agreed that preferably the below requirements should be applied in selection of the reference gauges:
18. Uncertainty of a gauge has to satisfy the WMO requirement of +/- 5 % over the range of rain intensities expected at the test site, e.g. 2 - 400 mmh<sup>-1</sup>.
19. Minimum resolution of 0.1 mm.
20. Time delay less than 1 minute.
21. Correction of a tipping bucket gauge should be applied on each tip, rather than delivering an extra pulse (catching types).
22. The reference rainfall intensity will be determined by four catchment gauge(s) installed in a standard pit (EN-13798 "Reference Raingauge Pit"). The selection of the gauges will make use of the recommendations of the Laboratory Intercomparison (See the Final Report of the Intercomparison). Documentation of the calibration of this instrument will be made available to participating members. The Project Leader 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**

23. The field intercomparison site should be equipped with instruments for meteorological measurements of temperature, humidity, pressure, wind speed, wind direction, present weather, and precipitation. This ancillary information should be measured according to WMO recommendations and should be available on a resolution of at least 1 minute. Measurements of visibility, rain droplet size distribution, 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**

24. The host country shall provide the necessary data acquisition system capable of recording the required pulse and digital (serial) signals from all participating instruments.
25. The data will be automatically transmitted daily for preliminary analysis.

26. The daily data will be backed up with an appropriate system to be approved by the chairman of ET/IOC.
27. Draft proposal of data acquisition system is in [Appendix II](#) to this Annex.

#### **Data acquisition methodology**

28. 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.

#### **Analysis methodology**

29. A detailed working plan containing objectives, concepts for data storage and analysis including Quality Assurance and Quality Control will be developed by the Project Leader.

#### **Schedule of intercomparison**

30. 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.
31. A final inspection of the prepared test site will be held in February 2007 by the ET/IOC.
32. The ET/IOC agreed on the time schedule of the field intercomparison as given in the time chart in [Appendix I](#).

#### **Questionnaires**

33. The ET/IOC agreed on the draft Questionnaire I on potential participants ([Appendix III](#)) to be sent to WMO Members and HMEI with the invitation letters and the Questionnaire II ([Appendix IV](#)) to be sent directly to potential participants requesting more detailed information on their instruments.





**Appendix II to Annex III****Vigna di Valle testing site****Description of the data acquisition system**

The data acquisition system as described in Figure 1 is able to connect all RS232, RS422 and RS485 serial sensor outputs. Analog signals like voltages, currents, resistances, pulses and relay contacts have to be converted first to digital by a data logger or an appropriate A/D-converter with a serial output. All serial lines are connected to one or more port servers that have a large number of individually configurable serial (see also Note 1) inputs. All electrical components are installed in an outdoor box beside the test field.

A decision was taken to restrict the allowed types of serial interfaces to RS422 and RS485 because the cable length between the instruments and the port servers would be more than 15 m, which is e.g. the maximum specified distance for the RS232 interface. For any sensor equipped with another serial interface than RS485/422 a suitable interface converter (1 piece) has to be provided by the participating institution or manufacturer. If any other than serial digital output is provided (e.g. pulse, voltage,...), the participating institution/company should submit either an appropriate transmitter/amplifier or an A/D-converter (1 piece) with RS485/422 output.

The power supply for 220 V AC, 50 Hz and 12 VDC is also provided in the outdoor box and can be distributed to the individual sensor installation sites. All data and power lines are routed by a switch board to insure the most flexible connectivity.

The necessary Ethernet connection between the port servers on the test field and the local data acquisition PC in the Meteorological Station is implemented by a WLAN access point. The data transmission rate is typically better than 11 Mbit/s. For backup a DSL modem connection can be installed with a minimum data transmission rate of 2 Mbit/s by using a 2 or 4 wire signal cable. All data are collected by the local data acquisition PC which guarantees good synchronization of all timestamps in the datafiles. The local PC is connected to the intranet of ReSMA and routinely transfers all data to an ftp server allowing daily quality control and immediate diagnostics by WMO expert.

The data will be acquired every 15 seconds and will not be averaged by the data acquisition system. If possible the instruments should provide the most recent one-minute average value updated frequently. The final time interval for evaluation will be 1 minute.

**Note 1:**

Regarding analogue sensors, allowed signal transmissions are restricted to three possibilities: (1) analogue sensor + A/D converter or (2) analogue sensor + own data logger or (3) analogue sensor + transmitter/amplifier for long distance (> 5 m) analogue signals transmission in order to be correctly measured by data logger in outdoor boxes. Serial output from analogue instruments are preferred in order to avoid measuring uncertainties with outdoor data loggers but are not strictly requested.

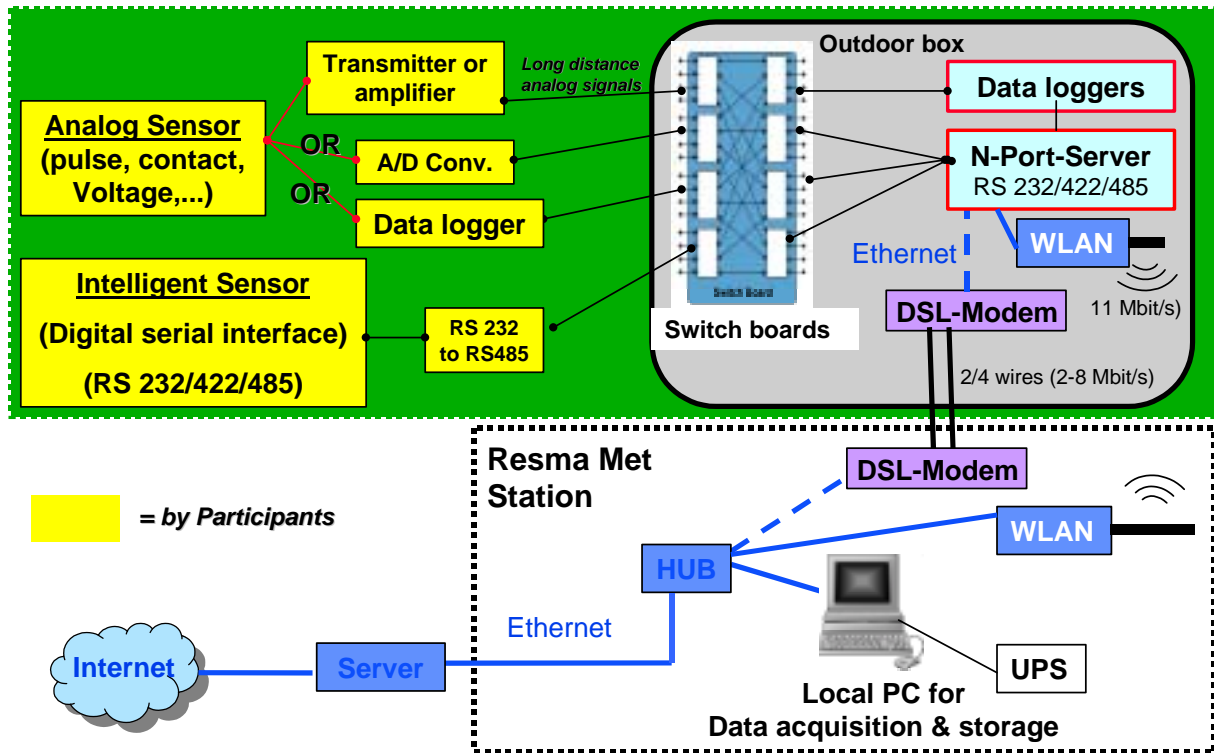


Figure 1: Schematic setup of the data acquisition system at the ReSMA test site in Vigna di Valle.

**WORLD METEOROLOGICAL ORGANIZATION**

**QUESTIONNAIRE I**

on potential participants

of the WMO field intercomparison of Rainfall Intensity (RI) gauges

Italy 2007-2008

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** <sup>(1)</sup> (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 <sup>(2)</sup>

e) Principle of operation <sup>(2)(3)</sup>

TB [ ]      WG [ ]      DC [ ]      OD [ ]      OT [ ] <sup>(4)</sup>

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

RI [ ]      RA [ ]      TT [ ] <sup>(4)</sup>

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

DG [ ]      PS [ ]      OT [ ] <sup>(4)</sup>

3.2 **Model/Type II** <sup>(1)(7)</sup> (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 <sup>(2)</sup>
- e) Principle of operation <sup>(2)(3)</sup>  
 TB       WG       DC       OD       OT  <sup>(4)</sup>
- f) What kind of parameter does the sensor/system report <sup>(2)(5)</sup>  
 RI       RA       TT
- g) What kind of output does the sensor/system provide <sup>(6)</sup>  
 DG       PS       OT  <sup>(4)</sup>

\_\_\_\_\_  
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.

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

<sup>(2)</sup> Submission of two identical instruments is preferred. Please tick the appropriate box.

<sup>(3)</sup> Principle of operation

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

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

<sup>(5)</sup> Parameters reported

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

<sup>(6)</sup> Sensor/System Output

DG = Digital Output      PS = Pulse Signal      OT = Other

<sup>(7)</sup> 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 ..... to the following address:

Secretary-General  
 World Meteorological Organization  
 P.O. Box 2300  
 1211 Geneva 2  
 Switzerland  
 Telefax: +41 22 730 8181

**Appendix IV to Annex III**  
**WORLD METEOROLOGICAL ORGANIZATION**  
**QUESTIONNAIRE II**  
on potential participants  
of the WMO field intercomparison of Rainfall Intensity (RI) gauges  
*Italy 2007-2008*

*Note: please complete a separate questionnaire for each type of Sensor /System.  
If necessary, attach additional pages.*

*Electronic version of the Questionnaire is available at:  
<http://www.wmo.int/web/www/IMOP/intercomparisons.html>*

1.	Member country
----	----------------

2.	Name of participating institution/company
	Address

3.	Person responsible for the intercomparison	
	Surname	First name
	Tel.:	Fax:
	E-mail:	Other:

4.	Alternative contact person	
	Surname	First name
	Tel.:	Fax:
	E-mail:	Other:

5.	Name and address of the manufacturer <i>(if different from no.2 above)</i>	
	Name	
	Address	

6.	<b>Shipment of participating instruments</b>	
	Approx. commercial value      Euro	Total weight of consignment      kg
	Number of boxes	Overall volume of boxes      cm <sup>3</sup>
	Overall dimension, in cm (i.e. for storage purposes) Length      x Width      x Height      cm	
	Other information concerning shipping	

7.	<b>Instrument specifications</b> <i>Please enclose a diagram showing, preferably, the different elements (photos are welcomed).</i>	
	Instrument name	Model/Type
	Number of sites where the instrument is in operational use or intended to be in your country:	Could you submit One <input type="checkbox"/> or Two <input type="checkbox"/> identical instruments? (Two identical instruments are preferred - one as backup.)
	Principle of operation: Tipping bucket <input type="checkbox"/> Optical disdrometer <input type="checkbox"/> Other <input type="checkbox"/>	Weighing gauge <input type="checkbox"/> Drop counter <input type="checkbox"/> please describe:
	Which parameter(s) does the sensor report? Rainfall Intensity <input type="checkbox"/> Rainfall Accumulation <input type="checkbox"/> Time of Tipping <input type="checkbox"/>	
	Orifice area: cm <sup>2</sup> .	
	Rain Intensity (RI) range ( <i>for a sensor measuring rain accumulation (RA), it should be possible to calculate RI over a period of one minute. RI range must be stated in such conditions</i> ). RI from      mm/h                      to      mm/h	
	Rain Intensity (RI) resolution ( <i>for RI measured or calculated over a period of one minute</i> ): mm/h.	
	Delay time for Rain Intensity (RI) measurement: minutes.	
	Internal update cycle for the output of a new measurement value: s.	
	Rain accumulation limit ( <i>if the sensor has an accumulation limit (i.e. weighing sensor), please indicate it and the related limitation for RI range (if relevant)</i> ). Accumulation limit      mm, and corresponding RI range from      mm/h                      to      mm/h over a period of      minutes.	

8.	<b>Sensor/System Output</b>	
	<i>Serial Digital</i>	RS485 <input type="checkbox"/> RS422 <input type="checkbox"/>
	<i>Note: If any other digital serial interface than RS485/422 is provided the participating institution/company should submit an appropriate converter (1 piece) with RS485/422 output.</i>	
	<i>Analog</i>	<i>Pulse</i> <input type="checkbox"/> <i>Reed Relay</i> <input type="checkbox"/> <i>Current</i> <input type="checkbox"/> <i>Voltage</i> <input type="checkbox"/>
	<i>Other</i> <input type="checkbox"/> Please describe	
	<i>Note: If any other than serial digital output (i.e. analog output) is provided, the participating institution/company should submit an appropriate converter (1 piece) with RS485/422 output.</i>	

9.	<b>Information for field installation</b>	
	<i>Notes on the power supply: Sensors should be able to operate on 220V AC, 50 Hz or unregulated 12V DC (if power supply is necessary); For other voltages, converters must be provided.</i>	
	Power supply/Voltage required	Maximum total power consumption (watts)
	...to be continued	

9.	<b>Information for field installation</b>	
	<i>Notes on the amount of space for installation:</i> there will be an area of 50 cm x 50 cm on a separate concrete foundation for each instrument.	
	Overall dimensions of the instrument, in cm Length      x Width      x Height      cm	Total weight kg
	Is the instrument in operational use equipped with a windshield?    Yes <input type="checkbox"/> No <input type="checkbox"/> <i>Note: In case of Yes you have to provide 1 windshield as used operationally in your network.</i>	
	Dimensions: Length x Width x Height (in cm); and Weight (in kg) of main elements	
	Part id            L      x W      x H	kg
	Part id            L      x W      x H	kg
	Part id            L      x W      x H	kg
	Part id            L      x W      x H	kg
	Part id            L      x W      x H	kg

10.	<b>Sensor/System siting requirements</b>	
	Installation alignment required Please describe	Yes <input type="checkbox"/> No <input type="checkbox"/>
	<i>Notes on the cable lengths:</i> Cable lengths for power supply and signal cable should be at least 4 m.	
	Cable length for power supply      m	for signal cable      m
	<i>It is expected, that an expert from the Member country will assist with the installation of the Sensor/System on the test field.</i> Will an expert give that assistance with the field installation?                      Yes <input type="checkbox"/> No <input type="checkbox"/>	
	Will an installation tools kit accompany the shipment?                      Yes <input type="checkbox"/> No <input type="checkbox"/>	
	Any special tools required for the installation? Please describe	
	Special fixtures required for the installation?                      Yes <input type="checkbox"/> No <input type="checkbox"/> Please describe	
	Maintenance period / item:	
	Any other special requirements? Please specify	
	Yes <input type="checkbox"/> No <input type="checkbox"/>	

11.	<b>Calibration</b>
	Calibration reference
	Calibration intervals
	Procedure

12.	<b>Any other relevant information.</b> For example, if internal processing software introduces corrections or smoothing over a period of time longer than 1 minute, this should be carefully documented.
	<b>Documentation</b>

---

 Date

---

 Name/Signature of the Permanent Representative  
 or Name/Signature of a manufacturer if proposed by the HMEI

Please send the electronic version of the completed form as an E-mail Attachment and at the same time the hard copy by fax to Dr Ondras:

Dr Miroslav Ondras  
 Senior Scientific Officer  
 WMO/OMM  
 World Weather Watch  
 P.O. Box 2300  
 CH 1211 Geneva, Switzerland

E-mail: [Mondras@wmo.int](mailto:Mondras@wmo.int)  
 Fax: +41 22 730 80 21

**Preliminary planning of the WMO Combined intercomparison of thermometer screens/shields, in conjunction with humidity measuring instruments**

- Designation of the hosting country: January 2006
- Finalization of the Questionnaires to Members and manufacturers: January 2006
- Invitation to Members and manufacturers: February 2006
- Preparation of a Test Plan: March 2006
- Questionnaire to potential participants: May 2006
- Selection of participants: July 2006
- Delivery of instruments to calibration laboratory of Météo France (Trappes): October-November 2006
- Pre-intercomparison calibration of instruments: October-November 2006
- Delivery of screens/shields to the test site: November 2006
- Installation of instruments and screens: November 2006
- Testing the acquisition system: December 2006
- Beginning of the intercomparison: December 2006
- End of the intercomparison: September 2007 \*
- Post-intercomparison calibration of instruments: September 2007\*
- Shipment of instruments back to manufacturers: September-October 2007\*

\* Depending on custom procedure in Algeria, the period of intercomparison may be extended over 1 year.

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

No.	Task description	Person responsible	Action	Deadline	Deliverables	Deadline
<b>1</b>	<b>Undertake and evaluate instrument intercomparisons:</b>					
1 a)	Establishment of the International Organizing Committee (IOC) for surface-based instrument intercomparisons	Michel LEROY	1. Identify and propose members of the IOC	Done	• IOC established	Done
		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	Done	<ul style="list-style-type: none"> <li>• Proposals for update of CIMO Guide (rainfall intensity)</li> <li>• Published results of intercomparisons</li> </ul>	May.06
		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	Done		Jan. 06
		Luca LANZA	3. Identify instruments for intercomparisons	Done		
		Luca LANZA	4. Start of the Intercomparison	Done		
		Luca LANZA	5. Overall supervision and coordination of intercomparisons	Done		

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 Emanuele VUERICH Fabio MALASPINA</p>	<ol style="list-style-type: none"> <li>1. Identify possible host countries for intercomparisons</li> <li>2. Designation of host country</li> <li>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</li> <li>4. Identify instruments for intercomparisons</li> <li>5. Start of Intercomparison</li> <li>6. Overall supervision and coordination of intercomparisons</li> </ol>	<p>Done</p> <p>Done</p> <p>Done</p> <p>Oct.06</p> <p>Jun.07</p> <p>Sep.08</p>	<ul style="list-style-type: none"> <li>• Proposals for update of CIMO Guide (rainfall intensity)</li> <li>• Status Report to CIMO-XIV</li> <li>• Published results of intercomparisons</li> </ul>	<p>Jun.08</p> <p>Jun. 06</p> <p>Dec.08</p>
1 d)	<p>Combined intercomparison of thermometer screens/shields, in conjunction with humidity measurements, in various climatic regions</p>	<p>Michel LEROY</p> <p>Igor ZAHUMENSKY</p>	<ol style="list-style-type: none"> <li>1. Identify possible host countries for intercomparisons</li> <li>2. Define and agree on the organization of the intercomparisons, namely: main objective, date, duration, conditions for participation, data</li> </ol>	<p>Done</p> <p>Done</p>	<ul style="list-style-type: none"> <li>• Status Report to CIMO-XIV</li> <li>• Proposals for update of CIMO Guide (thermometer screens/shields, humidity measurements)</li> </ul>	<p>Jun. 06</p> <p>Feb. 09</p>

No.	Task description	Person responsible	Action	Deadline	Deliverables	Deadline
		Igor ZAHUMENSKY	acquisition, processing and analysis methodology, publication of results, intercomparison rules, responsibility of the hosts and responsibilities of participants  3. Designation of host country  4. Identify instruments for intercomparisons  5. Start of intercomparison in Arctic  6. Start of intercomparison in desert region  7. Overall supervision and coordination of intercomparisons	Done  May. 06  2008  Dec.06  Dec. 07	<ul style="list-style-type: none"> <li>Published results of intercomparisons</li> </ul>	May.08
<b>2</b>	<b>Address the data homogeneity issue</b>					
2 a)	In collaboration with CCI, JCOM, CHy, CAS and HMEI address the data homogeneity issue	Bruce BAKER	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	TBD  TBD  TBD	<ul style="list-style-type: none"> <li>Report (Guide) to network managers and RAs</li> <li>Updated CIMO Guide on the role of intercomparisons in data homogeneity</li> </ul>	TBD  TBD

