WORLD METEOROLOGICAL ORGANIZATION

COMMISSION FOR INSTRUMENTS AND METHODS OF OBSERVATION

THIRTEENTH SESSION

BRATISLAVA, 25 SEPTEMBER–3 OCTOBER 2002

ABRIDGED FINAL REPORT WITH RESOLUTIONS AND RECOMMENDATIONS

WMO-No. 947

Secretariat of the World Meteorological Organization - Geneva - Switzerland

REPORTS OF RECENT WMO SESSIONS

Congress and Executive Council

902 — **Thirteenth World Meteorological Congress**. Geneva, 4–26 May 1999.

903 — **Executive Council**. Fifty-first session, Geneva, 27–29 May 1999.

915 — **Executive Council.** Fifty-second session, Geneva, 16–26 May 2000.

929 — **Executive Council**. Fifty-third session, Geneva, 5–15 June 2001.

932 — **Thirteenth World Meteorological Congress**. Proceedings, Geneva, 4–26 May 1999.

945 — **Executive Council**. Fifty-fourth session, Geneva, 11–21 June 2002.

Regional associations

891 — **Regional Association I** (Africa). Twelfth session, Arusha, 14–23 October 1998.

924 — **Regional Association II** (Asia). Twelfth session, Seoul, 19–27 September 2000.

927 — **Regional Association IV** (North and Central America). Thirteenth session, Maracay, 28 March–6 April 2001.

934 — **Regional Association III** (South America). Thirteenth session, Quito, 19–26 September 2001.

942 — **Regional Association VI** (Europe). Thirteenth session, Geneva, 2–10 May 2002.

944 — **Regional Association V** (South–West Pacific). Thirteenth session, Manila, 21–28 May 2002.

Technical commissions

881 — **Commission for Instruments and Methods of Observation**. Twelfth session, Casablanca, 4–12 May 1998.

893 — **Commission for Basic Systems**. Extraordinary session, Karlsruhe, 30 September–9 October 1998.

899 — **Commission for Aeronautical Meteorology**. Eleventh session, Geneva, 2–11 March 1999.

900 — **Commission for Agricultural Meteorology**. Twelfth session, Accra, 18–26 February 1999.

921 — **Commission for Hydrology**. Eleventh session, Abuja, 6–16 November 2000.

923 — **Commission for Basic Systems**. Twelfth session, Geneva, 29 November–8 December 2000.

931 — **Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology**. First session, Akureyri, 19–29 June 2001.

938 — **Commission for Climatology**. Thirteenth session, Geneva, 21–30 November 2001.

941 — **Commission for Atmospheric Sciences**. Thirteenth session, Oslo, 12–20 February 2002.

In accordance with the decision of Thirteenth Congress,
the reports are published in the following languages:

Congress	—	Arabic, Chinese, English, French, Russian, Spanish
Executive Council	—	Arabic, Chinese, English, French, Russian, Spanish
Regional Association I	—	Arabic, English, French
Regional Association II	—	Arabic, Chinese, English, French, Russian
Regional Association III	—	English, Spanish
Regional Association IV	—	English, Spanish
Regional Association V	—	English, French
Regional Association VI	—	Arabic, English, French, Russian
Technical Commissions	—	Arabic, Chinese, English, French, Russian, Spanish

WORLD METEOROLOGICAL ORGANIZATION

COMMISSION FOR INSTRUMENTS AND METHODS OF OBSERVATION

THIRTEENTH SESSION

BRATISLAVA, 25 SEPTEMBER–3 OCTOBER 2002

ABRIDGED FINAL REPORT WITH RESOLUTIONS AND RECOMMENDATIONS

WMO-No. 947

Secretariat of the World Meteorological Organization - Geneva - Switzerland
2003

ISBN 92-63-10946-8

NOTE

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

CONTENTS

GENERAL SUMMARY OF THE WORK OF THE SESSION

1. OPENING OF THE SESSION (agenda item 1)

INTRODUCTION

1.1 The president of the Commission for Instruments and Methods of Observation (CIMO), Mr S.K. Srivastava (India), opened the thirteenth session of the Commission at 2.00 p.m. on Wednesday, 25 September 2002 at the INCHEBA Exhibition Centre, Bratislava, Slovakia. The president welcomed the delegates and invited Mr Stefan Škulec, General Director of the Slovak Hydrometeorological Institute and Permanent Representative of Slovakia with WMO, to address the session, followed by Prof. G.O.P. Obasi, Secretary-General of WMO.

1.2 Mr Škulec, noting that that was the first time CIMO had met in Bratislava, thanked the Minister of the Environment, the staff of the Slovak Hydrometeorological Institute and the WMO Secretariat who had made arrangements for the session of the Commission, and wished Members a very successful meeting.

1.3 Prof. Obasi welcomed the delegates, especially those participating in a session of the Commission for the first time. He expressed his sincere appreciation and that of WMO to the Government of Slovakia for hosting the session and noted that further expression of the Slovak Government's strong support and commitment to the Programmes and activities of WMO, which were also demonstrated by the support given to maintaining a high-quality national observing network in the context of WMO's World Weather Watch Programme.

1.4 Prof. Obasi thanked Mr Škulec and his staff for the excellent arrangements made to ensure the success of the session.

1.5 Prof. Obasi reviewed the major events of the past four years of relevance to the Commission, including the Geneva Declaration of the Thirteenth World Meteorological Congress; the setting up of the International Strategy for Disaster Reduction (ISDR) by the United Nations; the continuing implementation of Agenda 21 of the United Nations Conference on Environment and Development (UNCED) and its related conventions on climate change, desertification and biodiversity; and most recently the United Nations World Summit on Sustainable Development (WSSD). In all of those events high priority had been given to weather, climate and water-related issues, and in particular to the need to strengthen observational networks with appropriate instrumentation for systematic observations and measurement of the environment.

1.6 Prof. Obasi therefore emphasized the challenge to CIMO to ensure continued accuracy of meteorological observations, standardization and compatibility between current and new instrumentation, and the training of staff for instrument maintenance, so that WMO could contribute to meeting the objectives of national development plans and international strategies while contributing to the study of complex meteorological questions.

1.7 Prof. Obasi highlighted the collaborative developments between WMO and the International Bureau of Weights and Measures (BIPM), the International Telecommunication Union (ITU) (for addressing interdisciplinary issues of radio frequency allocations) and the International Organization for Standardization (ISO), and noted that that collaboration helped avoid duplication of effort and gave greater visibility to WMO activities.

1.8 Prof. Obasi informed the session that the Executive Council had granted consultative status to the Association of Hydro-Meteorological Equipment Industry (HMEI), and encouraged the private instrument sector to use that mechanism as actively as possible to enhance mutual collaboration.

1.9 Referring to the work of the Commission during the intersessional period, Prof. Obasi welcomed progress in improving quality and reliability of measurements through calibration and intercomparisons, particularly in the case of GPS radiosondes, pyrheliometers and rain gauges. He also commended collaborative work between experts of different WMO commissions and manufacturers in achieving those results. Recognizing budgetary constraints, Prof. Obasi called on Members to sponsor CIMO training events to facilitate capacity building.

1.10 Turning to the agenda of the session, Prof. Obasi emphasized several topics requiring particular attention. He stressed the need for imaginative ways to continue capacity building, including training programmes for instrument specialists, despite financial constraints. In that regard, he was pleased that a total of 13 Regional Instrument Centres had been established. Prof. Obasi recalled that all six WMO regional associations had designated Rapporteurs on Regional Aspects of Instrument Development, Related Training and Capacity Building to serve as focal points for the Commission. He stated that of paramount importance was the preparation of the IMOP activities as part of the Sixth WMO Long-term Plan, and encouraged the Commission to give its full attention to priorities and expected outcomes. Noting that the session would be considering a new working structure to improve efficiency and cost-effectiveness, he proposed that the Commission should take stock of its performance over the last decade and consider ways for improved coordination and responsiveness and better information flow, while promoting creativity and innovation. Lastly, Prof. Obasi noted that, considering the steady increase in the number of Member countries participating in the work of the Commission, including developing countries with economies in transition, there was need for an appropriate balance with regard to the officers of the Commission and membership of expert groups to effectively guide the Commission's work during the next intersessional period.

1.11 The president invited His Excellency Professor Dr László Miklós, Minister of the Environment, to address the session. His Excellency welcomed the delegations to Bratislava and emphasized that the meeting occurred at a significant time immediately following the Johannesburg United Nations World Summit on Sustainable Development, which included an active debate on the Kyoto Protocol to the United Nations Framework Convention on Climate Change. In Slovakia, recent flooding of the Danube River had endangered the city of Bratislava, and the Government, the private sector and citizens were aware of the importance of reliable measurements that were at the centre of the work of CIMO. He referred to the enhancement of the capability of the Slovak Hydrometeorological Institute, and assured the delegates of his personal interest in that work. Declaring the thirteenth session of the Commission open, His Excellency expressed the wish that those present would continue to meet many times within the family of those with a deep concern for the environment.

1.12 At the request of the president of the Commission, the Secretary-General then presented a Certificate for Outstanding Services to Mr Jaan Kruus (Canada) in recognition of his long and outstanding contributions to capacity building and training in instruments and methods of observation and to strengthening the functions of CIMO, and his vigorous and devoted leadership as president and vice-president of CIMO.

1.13 There were 99 participants at the session. These included representatives of 54 Members of WMO and of three international organizations. A complete list of participants attending the session is given in Appendix A to this report.

2. ORGANIZATION OF THE SESSION (agenda item 2)

2.1 CONSIDERATION OF THE REPORT ON CREDENTIALS (agenda item 2.1)

The representative of the Secretary-General presented reports on credentials, taking into account the documents received prior to and during the session. The Commission accepted the reports, and agreed that, in accordance with General Regulation 22, it would not be necessary to establish a Credentials Committee.

2.2 ADOPTION OF THE AGENDA (agenda item 2.2)

The provisional agenda for the session was unanimously adopted as given in Appendix B to this report.

2.3 ESTABLISHMENT OF COMMITTEES (agenda item 2.3)

2.3.1 In accordance with Regulation 24, the Commission established the following committees:

NOMINATION COMMITTEE

2.3.2 A Nomination Committee was established consisting of the Principal Delegates of Canada, Czech Republic, Egypt, Oman and Malaysia. The Principal Delegate of Oman was requested to serve as convenor.

WORKING COMMITTEE

2.3.3 One working committee was set up to consider agenda items 4, 5, 6, 8 and 10. The following co-chairpersons were appointed:

(*a*) Ms Carolin Richter (Germany) to consider agenda item 4;
(*b*) Mr Rainer Dombrowsky (United States) to consider agenda item 5;
(*c*) Mr Eliphaz Bazira (Uganda) to consider agenda items 6, 8 and 10.

COORDINATION COMMITTEE

2.3.4 As stipulated by General Regulations 24 and 28, a Coordination Committee was set up, comprising the president of CIMO, the vice-president of CIMO, the co-chairs of the Working Committee, the representative of Slovakia and the representative of the Secretary-General.

OPEN AD HOC GROUP ON THE FUTURE WORKING STRUCTURE OF THE COMMISSION

2.3.5 An open Ad hoc Group on the Future Working Structure of the Commission was established to review the final proposal for the new CIMO structure, the future work programme of CIMO, and the need for expert teams and other working mechanisms. The group was also requested to coordinate a proposal for the selection of co-chairpersons of the Open Programme Area Groups. The following delegates were invited to serve on the Ad hoc Group as core members:

(*a*)	Mr R.P. Canterford	(Australia)	Chair
(*b*)	Mr T. Allsopp	(Canada)	
(*c*)	Mr Zheng Guoguang	(China)	
(*d*)	Ms M. Sagbom	(Finland)	
(*e*)	Mr A. Ivanov	(Russian Federation)	
(*f*)	Mr A. Heimo	(Switzerland)	
(*g*)	Mr E. Bazira	(Uganda)	
(*h*)	Mr C. Bower	(United States of America)	

2.4 OTHER ORGANIZATIONAL MATTERS (agenda item 2.4)

2.4.1 The Commission established its working hours for the session.

2.4.2 The Commission agreed that no minutes of the plenary meetings would be produced unless a Member specifically requested that it should be done for a particular item.

2.4.3 The Commission designated Mr I.K. Essendi (Kenya) as rapporteur on agenda item 14, Review of Previous Resolutions and Recommendations of the Commission and of Relevant Resolutions of the Executive Council.

2.4.4 A full list of documents presented at the session is contained in Appendix B to this report.

3. REPORT BY THE PRESIDENT OF THE COMMISSION (agenda item 3)

INTRODUCTION

3.1 The Commission noted with appreciation the report presented by Mr S.K. Srivastava (India), the president of CIMO, on the Commission's activities since its twelfth session.

3.2 At the twelfth session of the Commission, Messrs S.K. Srivastava (India) and R.P. Canterford (Australia) were elected president and vice-president of the Commission, respectively. That session established three Working Groups: the Advisory Working Group, the Working Group on Surface Measurements and the Working Group on Ground-based Upper-air Observing Systems. The Commission also designated four Rapporteurs: on Weather Radars, on Ultraviolet Measurements, on Instruments and Methods of Atmospheric Composition Measurements and on Atmospheric Ozone Measurements.

3.3 Subsidiary bodies of the Commission were active and did excellent work in fulfilling their terms of reference, as could be seen from the reports submitted by the chairpersons of the working groups or rapporteurs under the relevant agenda items.

IMPLEMENTATION OF THE IMOP PROGRAMME

3.4 The major issues addressed during the intersessional period were:

(*a*) Aspects related to merging CIMO with CBS;
(*b*) The importance of urban and road meteorology;
(*c*) Capacity building, education and training, and technology transfer through RICs;
(*d*) Intercommission cooperation;
(*e*) Publication of the Instrument Catalogue;
(*f*) Collaboration with manufactures;
(*g*) Instrument intercomparisons;
(*h*) New structure and the working mechanism for the next intersessional period.

3.5 Progress was made in the work programme of the Commission, including efforts to coordinate and strengthen RICs and to prepare and implement effectively instrument intercomparisons. The Commission thanked all Members that supported the work of CIMO by making available experts and especially those Members that hosted RICs and instrument intercomparisons. Work performed under the IMOP greatly benefited all WMO Members and was particularly important in view of the increasing demands for accuracy, coverage, homogeneity and reliability of observations by other technical commissions and programmes.

3.6 The president elaborated on several recommendations to strengthen the role and performance of RICs, which were addressed under agenda item 7.

3.7 The Commission was pleased to note that an update to the sixth edition of the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8) had been drafted (see agenda item 10). The Commission highlighted the value of the technical publications prepared by CIMO experts containing the results of intercomparisons, specific studies and status reports on various instrument systems for achieving homogeneity and high quality in meteorological and related geophysical and environmental measurements.

3.8 As requested by Thirteenth Congress, several activities were initiated to better involve manufacturers and suppliers of meteorological equipment in the work of CIMO and in related technical conferences and exhibitions which led, among other activities, to the establishment of the Association of Hydro-Meteorological Equipment Industry (HMEI) in September 2001 (see agenda item 7).

3.9 The Commission underlined the continuing importance of collaboration with international organizations, such as ITU and BIPM (see agenda item 12).

3.10 The Commission noted with satisfaction the very good interaction that existed between CIMO and other technical commissions and the responsiveness of the Commission to the requirements expressed by other technical commissions (see agenda item 12).

3.11 As regards activities related to capacity building, the Commission regretted that training workshops for instrument specialists could not be held to the extent required by the developing countries, mainly due to budgetary constraints. The Commission underlined again the importance of training for securing an uninterrupted operation of instruments and the generation of data of high quality, and recorded its recommendations and decisions on this subject under agenda item 7.

MEETINGS AND CONFERENCES

3.12 During the intersessional period, the following major meetings and conferences were organized:

(*a*) Expert Meeting on Requirements and Representation of Data from Automatic Weather Stations (De Bilt, Netherlands, 19–23 April 1999);
(*b*) Meeting of the International Programme Committee for TECO-2000 (Beijing, China, 20–22 September 1999);
(*c*) Expert Meeting on Capacity Building Related to Instruments and Methods of Observation (Beijing, China, 23–25 September 1999);
(*d*) Expert Meeting on Operational Issues for Radiosonde Application in the Tropics and Subtropics (Geneva, Switzerland, 18–22 October 1999);
(*e*) Meeting of the Working Group on Ground-based Upper-air Observing Systems (New Delhi, India, 6–10 December 1999) – Side meeting with upper-air instrument manufacturers;
(*f*) Meeting of the International Organizing Committee for the WMO Intercomparison of GPS Radiosondes, Phase I (Brasilia, Brazil, 21–25 August 2000);
(*g*) Ninth WMO International Pyrheliometer Comparison (IPC-IX), combined with Regional Pyrheliometer Comparison (Davos, Switzerland, September/ October 2000);
(*h*) Technical Conference on Meteorological and Environmental Instruments and Methods of

Observation (TECO-2000) and METEOREX-2000 (Beijing, China, 23–27 October 2000) – Side meeting with instrument manufacturers;

(*i*) Expert Meeting on Rainfall Intensity Measurements (Bratislava, Slovakia, 23–25 April 2001);

(*j*) WMO Intercomparison of GPS Radiosondes (Alcantara, Brazil, May/June 2001);

(*k*) Meeting of the Working Group on Surface Measurements (Geneva, Switzerland, 27–31 August 2001);

(*l*) Meeting of the Advisory Working Group (Geneva, Switzerland, 21–25 January 2002);

(*m*) Technical Conference on Meteorological and Environmental Instruments and Methods of Observation (TECO-2002) and METEOREX-2002 (Bratislava, Slovakia, 23–25 September 2002).

MISSIONS OF THE PRESIDENT

3.13 The president participated in several of the above events. In addition, he participated in the sessions of the Executive Council and in the Meetings of the Presidents of Technical Commissions.

DECISIONS OF CONGRESS AND THE EXECUTIVE COUNCIL RELATED TO THE COMMISSION

3.14 Under this agenda item, the Commission also addressed those decisions of Thirteenth Congress and the Executive Council that were of relevance to the work of CIMO.

3.15 The Commission noted that Thirteenth Congress had discussed IMOP and had adopted Resolution 4 (Cg-XIII) – Instruments and Methods of Observation Programme. That Resolution, together with the 5LTP, namely those sections relevant to IMOP, and the terms of reference of CIMO (Resolution 39 (Cg-XII)), provided guidance for the work of the Commission during the intersessional period. The president informed the Commission on the activities aimed at increasing the efficiency of WMO to make best use of the available resources.

3.16 The decisions of Thirteenth Congress and those from the most recent sessions of the Executive Council and relevant to the work of the Commission were the following:

(*a*) By Resolution 4 (Cg-XIII) – Instruments and Methods of Observation Programme, Congress requested CIMO to study and develop guidance on siting and exposure of instruments operated in urban areas;

(*b*) Thirteenth Congress also requested CIMO to study the requirement of operating equipment, in particular Automatic Weather Stations (AWSs), under harsh environmental conditions and develop guidance material for use by Members and manufacturers, and to develop guidance material on the maintenance of equipment, especially of AWSs;

(*c*) The fifty-third session of the Executive Council requested CIMO to develop technical guidance material on standards, application and maintenance for AWSs;

(*d*) The fifty-third session of the Executive Council also requested CIMO to continue further in developing the role and functions of the RICs and invited CIMO to develop the necessary input to capacity building projects for enhancements of RICs, thus contributing effectively to the rehabilitation and reliable operation of many observing stations in developing countries.

3.17 The president informed the Commission that four papers had been proposed for the seventeenth Professor Dr Vilho Vaisala Award in 2002. The Council followed the proposal of the Selection Committee and decided that Mr Rolf Philipona (Switzerland) would receive the Award for the paper entitled “Sky-scanning radiometer for absolute measurements of atmospheric long-wave radiation”, published in *Applied Optics*, Volume 40, Number 15, 20 May 2001.

NEW STRUCTURE OF CIMO

3.18 The CIMO Advisory Working Group, taking into account the rapid advances in technologies and techniques and the decreasing availability of resources and of instrument experts, studied more efficient ways of organizing the working structure of the Commission. The Advisory Working Group invited the vice-president, Mr Canterford, to lead in this important task and to present a proposal to the present session of the Commission (see agenda item 13).

ACKNOWLEDGEMENTS

3.19 The president thanked all the CIMO members who had contributed to the work of the Commission, the vice-president, the chairpersons, the rapporteurs and members of working groups for their work, and those Members who had offered to host the various meetings that had taken place. He also thanked the Secretary-General of WMO and the WMO Secretariat staff for their assistance and collaboration.

4. INSTRUMENTS AND METHODS OF OBSERVATION FOR SURFACE MEASUREMENTS (agenda item 4)

4.1 REPORT OF THE WORKING GROUP ON SURFACE MEASUREMENTS (agenda item 4.1)

4.1.1 The Commission noted with appreciation the report of the chairperson of the Working Group on Surface Measurements (WG-SM), Mr J.P. van der Meulen (Netherlands).

4.1.2 The Commission was pleased to note the fruitful cooperation between the core members, the rapporteurs and the representatives of other technical commissions. It was recognized that they provided an essential link for optimal coordination with all the WMO Programmes in relation to meteorological observations.

4.1.3 The Commission underlined the rapidly progressing implementation of new automatic observing instruments, such as present weather sensors/ systems in AWSs. Considering the need to determine clear criteria and requirements for data generated by instrument measurements, the Commission noted the great value of the Expert Meeting on Requirements and Representation of Data from Automatic Weather Stations held in De Bilt, Netherlands, in April 1999, which was jointly organized with CBS and included representatives of many other technical commissions. The Commission endorsed the recommendations of that expert meeting, especially those concerning the use of BUFR, which would overcome restrictions caused by the inflexible alphanumeric SYNOP code and thus promote the further development of modern and automated observing systems, including the automation of visual and subjective observation. The Commission noted with appreciation the results of the meetings of the CBS Expert Team on Requirements and Representation of Data from Automatic Weather Stations (ET-AWS) held in Geneva in July 2000 and September 2002 regarding the development of functional specifications for AWS to support BUFR/CREX table driven codes, practices for reporting instantaneous precipitation intensity, possible replacement of manually observed types of clouds using automated technology and quality control procedures for data from AWSs.

4.1.4 The Commission noted with appreciation the results of the Expert Meeting on Rainfall Intensity Measurements, Bratislava, Slovakia, April 2001, which formulated "present and future requirements for rainfall intensity (RI) measurements" because no such requirements and related guidance were available. In that regard, the Commission considered and approved for publication in the *Guide to Meteorological Instruments and Methods of Observations* (WMO-No. 8) the measuring range, precision and uncertainty requirements for rainfall intensity measurements as given in Annex I to this report. The Commission further recommended that Members:

(*a*) Develop a standardized procedure for generating consistent and laboratory-reproducible flow rates designated for use as the laboratory standard for rainfall intensity calibration of catchment type gauges. That should include calibration equipment and its proper configuration, and the expected performance as well as standard method(s) of testing, taking into account the variability of conditions including intermittence of the test facilities;

(*b*) Develop appropriate correction procedures and instrument specific factors for the application on long-term data series to maintain temporal homogeneity. Special consideration should be given to extreme values;

(*c*) Make available the results of national tests of rain gauges for further evaluation.

4.1.5 The Commission recognized the important work undertaken on the international intercomparisons of radiation, rainfall intensity, temperature and humidity measurements. It appreciated a plan to start a WMO Laboratory Intercomparison of RI gauges in 2003, with the aim of determining performance characteristics and, depending on the results, to consider both organizing a field test and the development of a secondary standard suitable for field tests. The Commission considered organization of combined intercomparisons of thermometer screens in conjunction with humidity measurements in various climatic regions and agreed to organize those intercomparisons in close cooperation with the RICs. Taking into account that none of the CIMO members had requested assistance for national evaporation pan intercomparisons, the Commission agreed that no further activities related to that matter should be undertaken. The Commission also recognized the ongoing need for instrument intercomparisons caused by the rapid development of automatic measuring systems, especially in the fields of optics and solid-state technology. However, because of the limited resources of IMOP, no new intercomparisons were endorsed.

4.1.6 As for the tentative WMO hygrometer and temperature screen intercomparison, the working group had studied a number of issues to be resolved before such an intercomparison could be organized and concluded that it would be more effective to organize a combined intercomparison of both humidity and temperature screens. The intercomparisons should be carried out at various test sites in different climatic regions over a 12-month period. As a consequence, the organization, siting, data acquisition and analysis would be much more complex than at previous intercomparisons on surface measurements. The Commission recommended that an intercomparison should be organized in collaboration with the RICs. In addition, specific attention should be given to the definition of reference instruments. For testing of temperature screens it was recommended to consider the ISO Committee Draft CD 17714 entitled "Meteorology – Air temperature measurements – Test methods for comparing the performance of thermometer shields/screens and defining important characteristics".

4.1.7 The Commission was pleased to note the results of a questionnaire on the use of algorithms for AWS and the publication of the results of the seventh Inquiry on Instrument Development. Both were recognized as important steps towards the standardization of such algorithms. While many algorithms, in practice, were dedicated to specific use in synoptic, aviation, climatology and agriculture applications, it was acknowledged that such algorithms should be made easily accessible, e.g. through the WMO Web server. The algorithms should be presented together with guidance materials on AOS, because it was noted that excellent, although separate, guidance materials on both algorithms and AOSs had been available for many years, however Members were not sufficiently informed about the existence of those materials. The Commission, therefore, underlined the need to develop a Web portal for access to all types of information on instruments, such as methods of observation, AWSs, algorithms, intercomparisons, TECO papers, etc.

4.1.8 The Commission stressed that attention should be given to the development of guidance on siting of systems and stations for various applications and on the administration of "metadata".

4.1.9 The Commission pointed out that close cooperation with other technical commissions was highly important and that representatives of those commissions inside the WG-SM played a vital role in that interaction. In particular, the support provided to CAeM and CAgM and the close cooperation with CBS was acknowledged by the Commission. It was, however, recognized that such cooperation with certain other technical commissions was not always possible, and the Commission therefore invited the president to take action to ensure participation of experts from all the technical commissions.

4.1.10 The Commission noted with some concern that the review on advances in calibration methods and the recommendation on calibration standards and procedures indicated no significant progress. It emphasized that regular calibrations (with adjustments) of instruments were essential to keep the quality of measurements at a sufficient level. However, it was equally important to have the traceability of the calibration reference standards to international standards and to use approved calibration procedures. Intercomparisons of reference standards and calibration procedures should be organized to guarantee uniformity of data. Within that framework, the RICs should organize such activities and report on them to the Members to assess the level of uniformity and the uncertainty of data. Calibration of instruments and quality control of data should be given a high priority. The RICs should play a crucial role in that connection. The Commission invited the president, in collaboration with the Heads of RICs, to further strengthen their services, such as calibration practices and reporting. The Commission was advised by the representative of BIPM that ISO/IEC 17025 “General requirements for the competence of testing and calibration laboratories” was the appropriate standard to which Members’ calibration laboratories should be compliant and thus might be accredited by an appropriate accreditation authority.

4.1.11 The Commission underlined the need for guidance materials on instruments and methods of observation for use in developing countries and noted with appreciation the update of WMO-TD No. 873 (IOM Report No. 68) *Guidance Materials on the Choice of Meteorological Instruments for Surface Data Suitable for Use in Developing Countries*.

4.1.12 As regards further work on the *Guide to Meteorological Instruments and Methods of Observation* (*CIMO Guide*, WMO-No. 8), the Commission recalled that the table on Operational Accuracy Requirements and Typical Instrument Performance, developed ten years ago, should be urgently reviewed. The Commission invited its president to request the other technical commissions to provide assistance in reviewing the requirements. During the preparation phase of the next edition of the *Guide*, updated chapters should be made available on the WMO Web site for information.

4.1.13 The Commission underlined the need for achieving consistency in Manuals and Guides, which were under the auspices of other technical commissions, with the *CIMO Guide*. In particular, the *Manual* and *Guide on the Global Observing System* (WMO-Nos. 544 and 488, respectively) and the *Technical Regulations* (WMO-No. 49) should be reviewed as regards observational meteorological variables, siting and design of AWSs. The Commission recognized that the *International Meteorological Tables* (WMO-No. 188, TD-No. 94) was out of date, although it was referred to in several WMO Guides, such as the *CIMO Guide*. Since many WMO Guides and Manuals were updated frequently, updating the cross-links and other references was of utmost importance to guarantee uniformity and standardization of requirements and recommendation within WMO. Each technical commission was responsible for its own Guides and Manuals, but consistency could only be guaranteed by close cooperation between those commissions. Commissions responsible for guides that contained paragraphs or sections on surface measurements were CIMO, CBS, CCl, CAeM, CAgM, CAS, CHy and JCOMM. The Commission invited the president to request the presidents of the commissions to consider such updates. The Commission noted with concern that publication WMO-No. 622 entitled *Compendium of Lecture Notes on Meteorological Instruments for Training Class III and Class IV Meteorological Personnel* – Volumes I and II, was for the most part out of date and recommended to discontinue that publication.

4.1.14 The Commission was briefed on the continued collaboration with the International Organization for Standardization (ISO) which was related to the work of Subcommittee SC 5 of TC 146 – Air Quality. Standardization related to reference thermometer screens had significantly progressed, the European Committee for Standardization (CEN) had adopted the standard for rain measurements (Reference Pitgauge) and also work was ongoing in the field of hydrometry and thermometry. The Commission encouraged Members to maintain close liaison with ISO to support adequately the development of ISO standards in relation to meteorological observations.

4.1.15 The Commission agreed to record its decisions concerning the future work programme in that specific area under agenda item 13.

4.2 ISSUES RELATED TO THE AUTOMATION OF OBSERVATIONS (agenda item 4.2)

REPORT OF THE RAPPORTEURS ON THE DEVELOPMENT AND IMPLEMENTATION OF AUTOMATED OBSERVING SYSTEMS AND ON AUTOMATION OF VISUAL AND SUBJECTIVE OBSERVATIONS

4.2.1 The Commission considered with appreciation the report of the chairperson of the Working Group on Surface Measurements (WG-SM), Mr J.P. van der Meulen (Netherlands), on the work carried out by Messrs K. Hegg (Norway), Rapporteur on the Development and Implementation of Automated Observing Systems and G. Pearson (Canada), Rapporteur on Automation of Visual and Subjective Observations. The Commission noted that, following the resignation of Mr G. Pearson, the terms of reference of both Rapporteurs had been combined. It was appreciated that other members of the working group had become actively involved in those activities.

4.2.2 The Commission appreciated the results of the CIMO/CBS Expert Meeting on Requirements and Representation of Data from Automatic Weather Stations (De Bilt, Netherlands, April 1999), in particular with respect to data representation in the binary codes (see also agenda item 4.1).

4.2.3 The Commission supported the view of the Expert Meeting, which was also supported by CBS, on the phasing out of alphanumeric codes, such as SYNOP, in favour of BUFR while giving due consideration to the requirements of data users. That process would stimulate new development in the area of methods of observations, especially concerning the automation of visual observations. It was noted that that may have an impact on the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8) and the *Manual* and *Guide on the Global Observing System* (WMO-Nos. 544 and 488, respectively).

4.2.4 The Commission endorsed the recommendation of the Expert Meeting to represent and report instrument measurements in terms of physical quantities using SI units only. It was recognized that qualitative observations introduced subjectivity might be misleading to end users, while representation of meteorological phenomena in terms of physical quantities required clear and unambiguous definitions.

4.2.5 The Commission agreed that full automation, i.e. replacing human observation by automatic observing systems, should be complemented by remote-sensing measurements. Integrated and composite observing systems would have a paramount importance in that endeavour. In that regard, the remote-sensing technologies should play an important role in automation of visual and subjective observations.

4.2.6 The Commission was informed about the availability of publications on the automation of observations. In particular, it was noted with satisfaction that several publications that had been published as IOM Reports many years ago were still up to date.

4.2.7 The Commission welcomed the list of Web sites provided by the Rapporteur on the Development and Implementation of Automated Observing Systems that would be linked through the WMO/CIMO Web page.

4.2.8 The Commission was pleased to note that the first draft of an IOM report of guidance material on equipment for use in harsh environmental conditions had been finalized as requested by Thirteenth Congress (Resolution 4 (Cg-XIII) – Instruments and Methods of Observation Programme). It requested its members to continue providing their experiences with automatic observing systems in harsh environments. With reference to that topic, the Commission highly appreciated the work done by EUMETNET on severe weather systems, which was related to the Arctic environment. It was recognized that there was only limited guidance material on the implementation and maintenance of automatic observing systems in tropical regions and deserts and, therefore, further studies were necessary.

4.2.9 The Commission agreed that the important work in the field of automation of visual and subjective observations as well as of the development and implementation of automated observing systems should be continued, and recorded pertinent decisions under agenda item 13.

4.3 INSTRUMENT DEVELOPMENT (agenda item 4.3)

REPORT OF THE RAPPORTEUR ON INSTRUMENT DEVELOPMENT

4.3.1 The Commission considered with appreciation the report of the Rapporteur on Instrument Development, Mr T. Prager (Hungary), on his work carried out within the Working Group on Surface Measurements. The Commission expressed satisfaction that the Rapporteur had prepared the seventh edition of the *Instrument Development Inquiry* (IDI), which would be published in the WMO Instruments and Observing Methods Report series.

4.3.2 The Commission noted that the IDI contained information only on instruments under development and on instruments put into operational use mainly in the years 2000–2002. That emphasized the requirement for a complementary relationship between the IDI and the World Meteorological Instrument Catalogue, which was issued by the China Meteorological Administration in 2000. The IDI should focus on new instrument developments and the Catalogue should give an overview of all existing operational surface-based instrumentation worldwide.

4.3.3 The IDI also contained information as to which instruments included in the sixth IDI as being under development were now being put into operational use. Information on experience with newly developed instruments in operational use and indications on results of intercomparisons of them against reference instruments and standards, or earlier types of instruments for the same purpose, were also included together with data about number and locations of operational installations. The Commission agreed on the usefulness of including that information also in the next issue of the IDI.

4.3.4 The Commission agreed that the exchange of information on instrument development and technology transfer should receive continued emphasis. To that end, it was considered valuable to periodically compile reports on the newest instrument and observing developments. Those reports may result from the work of working groups, rapporteurs, from technical conferences or otherwise, and may be distributed most readily via the Internet.

4.3.5 The Commission noted the worldwide increasing trend to procure meteorological instruments from manufacturers rather than developing and building them within NMHSs. While many NMHSs had established good relationships with selected manufacturers, the Commission noted that many gaps still existed in communication between manufacturers and users of meteorological instruments, especially in less developed countries.

4.3.6 The Commission noted that the worldwide automation of observational networks had been proceeding at an accelerating pace and posed problems with respect to the homogeneity of data series and the need for new and sophisticated maintenance and calibration procedures, particularly in developing countries, which was identified as a capacity building issue for the future work of the Commission.

4.3.7 The Commission agreed that the work in the area of instrument development should be continued, and recorded pertinent decisions under agenda item 13.

4.4 PRECIPITATION AND EVAPOTRANSPIRATION MEASUREMENTS (agenda item 4.4)

REPORT BY THE CO-RAPPORTEURS ON POINT PRECIPITATION AND EVAPOTRANSPIRATION MEASUREMENTS

4.4.1 The Commission considered with interest the report the of Co-rapporteurs on Point Precipitation and Evapotranspiration Measurements, Mr J. Michaely (Israel) and Mr B. Sevruk (Switzerland), on their work carried out within the Working Group on Surface Measurements.

4.4.2 With respect to the request of the Commission at its twelfth session for provision of assistance to members by the Co-rapporteurs in developing guidelines for the organization of national evaporation pan intercomparisons, the Commission noted that no such requests had been received.

4.4.3 The Commission noted with interest that a Questionnaire on Recording Precipitation Gauges was prepared and dispatched to Members. As a result of that activity, an Expert Meeting on Rainfall Intensity Measurements was organized in Bratislava, Slovakia in April 2001. The results of the Questionnaire were considered by that meeting and summarized in its Final Report.

4.4.4 The Commission noted that 90 per cent of the responses received from 112 Members were in favour of organizing a WMO intercomparison of recording precipitation gauges. Almost one-half of respondents offered to host such an intercomparison. Therefore, the Commission endorsed the recommendation of the Expert Meeting to organize an intercomparison of recording precipitation gauges, preferably in 2003, as a first step in recognized laboratories to determine their performance characteristics for rain intensity measurements under well-defined conditions. As a result of the evaluation of those test data, consideration might be given to organizing field tests in various climatic regions according to users' needs.

4.4.5 The Commission noted from the evaluation of the questionnaire that a variety of types of gauges and installation conditions existed worldwide. The gauges most in use were the float and the tipping-bucket types. As already found in earlier WMO intercomparisons, the latter seemed not to satisfy all users' requirements, especially when heating was applied, which could cause significant losses in the measurement during mixed precipitation or snowfall. The Commission recognized that gauges should also be tested under tropical conditions for dependency on temperature and other environmental effects.

4.4.6 The Commission noted that recent developments in electronic weighing recording gauges seemed very promising and that those instruments were used only in small numbers at present. They provided high resolution of 0.03 mm at one-minute intervals under controlled conditions and the use of special software gave measured and corrected precipitation data online.

4.4.7 The Commission noted with concern that there had been no progress so far in the introduction of precipitation correction procedures by national meteorological agencies. Only measured precipitation data were available from databanks and yearbooks. However, the number of studies using corrected precipitation data in different timescales was increasing. In that connection, various correction procedures had been developed, although standard methods of correction should be preferred as recommended in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8, sixth edition), Part I, Chapter 6, Annex 6.B. The Commission therefore urged Members to provide both corrected and uncorrected precipitation data.

4.4.8 The Commission noted with appreciation that correction procedures for wind-induced errors based on simulations had further been developed for application by recording precipitation gauges, such as for the commercially available weighing type Pluvio (Ott, Germany) and tipping-bucket gauge Lambrecht as well as for standard gauges of the German Hellmann type and the English Mk2 gauge. Since correction algorithms were part of their software, it was now possible to obtain online measured as well as corrected minute, hourly or daily precipitation values.

4.4.9 The Commission noted the need to continue work on observation of blowing snow and corrections of precipitation measurements under Arctic and Antarctic conditions. There were some results available derived from tests carried out in the former USSR, published in the Russian language, which might further be evaluated. Some progress had been made with simulation techniques to assess the effects of blowing and drifting snow on engineering constructions such as roads, tunnels, railways, etc. which were, unfortunately, not applicable for meteorological measurements. It was expected that some more information on that area of concern would be available from the results of the WCRP GCOS Workshop on Precipitation Measurements in Cold Regions, held in June 2002 in Fairbanks, Alaska.

4.4.10 The Commission noted that a number of amendments had been developed for inclusion in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8, sixth edition), Part I, Chapter 6, Measurement of Precipitation.

4.4.11 The Commission agreed that the work in the field of point precipitation and evapotranspiration measurements should be continued, and recorded pertinent decisions under agenda item 13.

4.5 METEOROLOGICAL RADIATION MEASUREMENTS (agenda item 4.5)

REPORT OF THE RAPPORTEUR ON METEOROLOGICAL RADIATION MEASUREMENTS

4.5.1 The Commission noted with appreciation the report of the Rapporteur on Meteorological Radiation Measurements, Mr K. Behrens (Germany), on his work carried out within the Working Group on Surface Measurements.

4.5.2 The Commission noted that the Ninth International Pyrheliometer Comparison (IPC-IX) and, conjointly, the Regional Pyrheliometer Comparisons of all regional associations, took place in 2000 at the World Radiation Centre (WRC) Davos, Switzerland, with 65 participating experts. Pyrheliometers from 18 of the 21 Regional Radiation Centres, 22 National Radiation Centres and 11 institutions or manufacturers were calibrated. The Rapporteur assisted in the preparation of and participated in IPC-IX.

4.5.3 The Commission was pleased that the Final Report of IPC-IX had been published by the WRC so that the confirmed or new correction factors for participating pyrheliometers could be applied accordingly.

4.5.4 The Commission noted that there had been no new developments in absolute radiometers. However, the WRC, which developed the PMO-6 type pyrheliometer some 30 years ago, was designing a new generation of that radiometer type with improved electronics and firmware.

4.5.5 The Commission noted that the so-called “Alternate Method” of Mr B. Forgan (1996) for calibrating pyranometers had been implemented by an increasing number of users. It agreed that that method should also adequately be reflected within Part I, Chapter 7 of the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8, sixth edition), because it was easy to use and generated improved results. Furthermore, in the framework of the Baseline Surface Radiation Network (BSRN), new improved calibration methods of pyranometers were under discussion. First results were presented during the BSRN Workshop in June 2002 and were expected to be published.

4.5.6 The Commission took note of the status of atmospheric long-wave radiation measurement methods and the significant progress achieved especially at the WRC (characterization of pyrgeometers; development of a sky-scanning radiometer for absolute measurements of atmospheric long-wave radiation) and within the framework of the BSRN Pyrgeometer round-robin calibration experiment. Several activities related to the development of improved equipment and the intercomparison of those instruments. It was expected that those results would lead to operational applications in the near future.

4.5.7 In the framework of the BSRN, improvements, especially in long-wave radiation measurements through the replacement of pyrradiometers with pyrgeometers with a lower uncertainty, were achieved.

4.5.8 The Commission noted the results of two International Pyrgeometer and Absolute Sky-scanning Radiometer Comparisons, which demonstrated the good agreement between measurements and model calculation, and that the sensitivity of the Precision Infrared Radiometer (PIR) was very stable with time. Two types of commercially available pyrgeometers in operational use in various radiation networks were produced by Eppley Inc. (United States) and Kipp & Zonen (Netherlands). Those instruments fulfilled the high demands of the BSRN at night and also during daytime, if shaded. However, pyrradiometers widely used for that kind of measurement did not reach the required high level of accuracy. As a resulting of an informal inquiry, it was found that less than 50 per cent of the 40 Regional and National Radiation Centres that participated at the IPC-IX had carried out long-wave radiation measurements. In summary, the Commission urged further development towards establishment of a World Standard Group of absolute long-wave radiometers.

4.5.9 The Commission recalled that several WMO Programmes required radiation data and decided that its future work in meteorological radiation measurements should concentrate on the following actions:

(*a*) Support the dissemination of World Radiometric Reference (WRR) factors to regional and national radiation standards;

(*b*) Initiate activities so that high-quality solar radiation measurements may be widely guaranteed in all national radiation networks, and support on request the National Radiation Centres through training courses and in the establishment of networks in areas with a low density of radiation stations, such as in RA I.

4.5.10 The Commission also noted that an ad hoc group established during IPC-IX prepared an information document entitled “International and Regional Pyrheliometer Comparisons – some proposals for their organization”. It was noted with concern that the WMO budgetary situation had not provided for individual Regional Pyrheliometer Intercomparisons. The Commission recognized the concerns of the ad hoc group and noted its recommendations. The Commission felt that the recommendations included in Annex II to this report would help reactivate Regional Pyrheliometer Comparisons (RPCs) and thereby increase the capability of National Radiation Centres (NRCs) through practical training programmes run during the RPCs. The Commission therefore invited regional associations to give careful consideration to those recommendations as a means of a necessary improvement in the quality of surface radiation measurements at the national level. While recognizing budgetary constraints, the Commission considered that the application of those recommendations was necessary to provide effective traceability of national network measurements to the WRR and the high quality of radiation data demanded by the scientific community.

4.5.11 In the above context, the Commission greatly appreciated that during 2000 and 2002 the Regional Radiation Centres (RRCs) in Tokyo (Japan), Norrköping (Sweden) and St Petersburg (Russian Federation) organized intercomparisons, where the national standards of Hong Kong, China and the Republic of Korea (both in Japan), Finland (in Sweden) and Belarus, Kazakhstan, Republic of Moldova and Ukraine (all in the Russian Federation) were compared with the standards of the relevant RRC. The comparisons took place without the participation of an instrument of the World Standard Group.

4.5.12 The Commission recalled that for more than 20 years methods were being developed to derive radiation variables on the surface from satellite data. While in the past it was only possible to derive data for larger areas and integration times, e.g. monthly means, today procedures were able to give hourly values. The uncertainty in the data depended on the satellite platform, method of data retrieval and the end use. Cloud cover and the particular characteristics of the terrestrial region also affected data quality. Unfortunately, validations had only been made for short periods and for single regions. Several studies showed that the radiation fluxes derived from satellites exceeded the corresponding measurements on the surface by about 10 W/m2. The accuracy of space-based remote sensing radiation observations was still not at a level comparable to the corresponding measurements at the ground.

4.5.13 The Commission noted that within the WCRPs' BSRN infrared sensor comparisons were ongoing, but calibration of such instruments had never been traced to a common reference. However, the calibration of solar radiation instruments had been undertaken by the WRC in Davos over many years. The Commission also noted the recommendation of the EC Panel of Experts/CAS Working Group on Environmental Pollution and Atmospheric Chemistry that the issue of where to locate the long-wave radiation standard should be addressed by WMO as a matter of urgency.

4.5.14 Noting the positive response of the Permanent Representative of Switzerland with WMO to the proposal of the Secretary-General of WMO that the Physikalisch-Meteorologisches Observatorium Davos (PMOD) could undertake international IR calibration responsibilities, the Commission recommended that a World Infrared Radiometer Calibration Centre be established and adopted Recommendation 1 (CIMO-XIII). The Commission noted the request of PMOD for CIMO to provide guidance in the establishment and on procedures for the continuing quality assurance, of the World Infrared Radiometer Calibration Centre and agreed to provide that technical/scientific guidance through the relevant CIMO Open Programme Area Group (OPAG).

4.5.15 The Commission agreed that the important work in the field of meteorological radiation measurements should be continued, and recorded pertinent decisions under agenda item 13.

4.6 ROAD METEOROLOGICAL OBSERVATIONS (agenda item 4.6)

REPORT BY THE CO-RAPPORTEURS ON ROAD METEOROLOGICAL OBSERVATIONS

4.6.1 The Commission considered with appreciation the report of the Co-rapporteurs on Road Meteorological Observations, Mr J. Terpstra (Netherlands) and Mr T. Ledent (Belgium), on their work carried out within the Working Group on Surface Measurements.

4.6.2 The Commission was pleased that the co-rapporteurs conducted in early 2000 a survey among road managers and meteorologists in order to assess the current practices in road meteorological observations and to gauge the willingness of the responsible agencies to adopt WMO observing standards for such roadside observing stations.

4.6.3 The survey showed that so far only one country complied with the WMO standards for synoptic stations at road meteorological observing stations. Other respondents pointed to the need to carry out roadside observations at locations that were the most dangerous for road users, or optimal for traffic monitoring. Those locations often did not comply with the WMO standard specifications for synoptic stations. The Commission agreed that that difference in perception deserved further exploration in the light of the requirements of modern road monitoring and traffic management systems.

4.6.4 The Commission agreed that it was necessary to eventually develop specific guidance material on road meteorology. It was expected that new evolving road weather measurement specifications and observing practices would lead to standardization, which would make the exchange of road weather data possible between regions and countries, as was the case with synoptic weather data. In that connection, the Commission recognized the work of France in classifying non-standard observing sites to indicate their representativity for synoptic purposes, and noted that such a scheme might be applied to road meteorological observing sites.

4.6.5 It was agreed that those specifications for road meteorological observations should be drawn up by CIMO in collaboration with road managers, taking into account the needs and experiences of both camps in defining observing methods and standards. The Commission felt that experts of the NMHSs had a role in assisting road managers in choosing appropriate observing sites along roads, and as more observations from road sites became available to NMHSs, adequate documentation (metadata) of road weather observing sites should be compiled and made available to users.

4.6.6 The Commission invited the Secretary-General to organize an international workshop for road managers and meteorologists to develop a consensus on observing definitions, sites, methods and specifications concerning road meteorology. It agreed to make available on the WMO/CIMO Web page the co-rapporteurs' report on the survey.

4.6.7 The Commission noted with appreciation that work on a chapter on "Road Meteorological Observations" for Part II of the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8, sixth edition) had been started and agreed that that work should be finalized within the next intersessional period.

4.6.8 The Commission agreed that the work in the field of Road Meteorological Observations should be continued, and recorded its pertinent decision under agenda item 13.

4.7 URBAN METEOROLOGICAL MEASUREMENTS (agenda item 4.7)

REPORT OF THE CO-RAPPORTEURS ON URBAN METEOROLOGY

4.7.1 The Commission noted that following a request of Thirteenth Congress, the president of CIMO invited Mr T. Oke (Canada) and Mr R. Vashistha (India) to serve as Co-rapporteurs on Urban Meteorology. The scope of the work was to initially cover aspects related to the siting, exposure, instrumentation and operation of a standard climatological station in urban areas for the measurement of air and soil temperature, humidity, wind speed and direction, precipitation, pressure, solar radiation and sunshine duration.

4.7.2 The Commission noted with satisfaction that the Co-rapporteurs had written papers and made presentations at conferences to raise awareness, identify the type of technical guidance expected from CIMO and seek feedback from the user community of urban meteorological observations. Those included the European project COST-715 “Meteorology Applied to Urban Air Pollution Problems” and the Third American Meteorological Symposium on the Urban Environment.

4.7.3 The Commission noted that in April 2001 the Co-rapporteurs prepared a survey among all WMO Members on urban meteorological measurements, guidelines for stations, the meteorological variables and the application of special systems for urban meteorological observations; 71 Members responded, of whom 45 were involved in urban observations and 19 in planned urban stations. Forecasting, climate change and air quality were the principal reasons given for establishing urban stations. Thirty-one Members used automatic weather stations for urban measurements and a small number of Members were currently using sophisticated sensing systems (radars, sodars, wind and temperature profilers and minisondes), while 23 Members reported future plans for the use of such systems.

4.7.4 The Commission was pleased that a new chapter on “Urban Meteorological Observations” for Part III of the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8, sixth edition) had been drafted and agreed that that work should be finalized within the next intersessional period.

4.7.5 The Commission agreed that the work in the field of urban meteorology should be continued, and recorded its pertinent decisions under agenda item 13.

5. INSTRUMENTS AND METHODS OF OBSERVATION FOR UPPER-AIR MEASUREMENTS AND REMOTE SENSING (agenda item 5)

5.1 REPORT OF THE WORKING GROUP ON GROUND-BASED UPPER-AIR OBSERVING SYSTEMS (agenda item 5.1)

5.1.1 The Commission considered with appreciation the report of the chairperson of the Working Group on Ground-based Upper-air Observing Systems (WG GUOS), Mr John Nash (United Kingdom), on the work carried out within the working group.

5.1.2 The Commission recognized that during the intersessional period the group had one official meeting where most of the members participated. Other opportunities, such as TECO-2000 in Beijing, were also used to hold ad hoc meetings with a limited number of participating members.

5.1.3 The Commission noted with deep concern the decreasing number of experts in the field of upper-air measurements. That could lead to degradation of upper-air measurements for NWP and climate purposes. In particular, requirements of the GOS and GCOS may not be able to be met. The Commission therefore urged Members to recognize the importance of maintaining expertise in radiosonde measurements.

5.1.4 The Commission noted that the GPS radiosonde systems introduced widely during 1998 were found to have significant operational failures. In the worst cases, 30 to 40 per cent of the wind measurements were considered inadequate for operational purposes. The Commission expressed its thanks for the large amount of work performed by members of the working group in identifying the critical issues and taking actions to remedy the problems. In 1999, technical advice was provided to CBS in preparing a survey used to identify the true magnitude of the problems. The concerted work of many experts generated numerous recommendations, most of which were adopted by the CIMO Working Group. Practical advice on operating GPS radiosondes was circulated to users. Flight testing of the systems continued with the manufacturers to identify the origins of production faults and inherent system problems, and technical improvements were developed and proposed to manufacturers. The result of a new survey in 2001 showed a marked improvement in system performance, but significant operational problems still remained.

5.1.5 The Commission noted that some countries had avoided the problems with the GPS radiosondes by using modern radiotheodolite systems. The United States had supplied information on the successful use of modern radiotheodolites at some locations in the Caribbean. The success of that operation relied on a central operational servicing support agreement for the systems. Review of locations where radiotheodolite operations would be successful was provided in Information Document No. 6.

5.1.6 The Commission was pleased to note that representatives of radiosonde manufacturers had actively participated in the work of the working group. That was clearly seen in the planning of the WMO GPS Radiosonde Comparison, where manufacturers contributed to the design of the test. The manufacturers also supported the implementation of the test in various ways.

5.1.7 The Commission noted with great interest the results of the WMO Intercomparison of GPS Radiosondes, which was held in the Brazilian Air Force Satellite/Rocket Launch Centre in Alcantara from 25 May to 5 June 2001. It was informed that the current operational GPS radiosonde systems had demonstrated some of the faults that still limited operational performance, as noted earlier. Newer generation GPS radiosonde windfinding systems performed more reliably, and the current operational problems with wind measurements should be reduced once the new designs became more widely available. Valuable information on the performance of radiosonde relative humidity sensors in the tropics was also obtained. Operational radiosonde relative humidity measurements were compared with measurements from a Snow White chilled mirror hygrometer. At high relative humidity the differences between day and night comparisons were significant, with operational measurements lower in the day than at night. Almost all the radiosonde systems deployed in Brazil had operational problems, which had not been noted in other evaluations. That demonstrated that thorough flight investigations of the main operational radiosonde systems were essential if quality and calibration standards were to be sustained. The Commission agreed that it was essential that another extensive WMO Radiosonde Comparison be performed within the next four years to check for progress with both the operational radiosondes and the operational reliability of chilled mirror references.

5.1.8 As a result of experience in Brazil, the manufacturers requested methods of speeding up the publication of results. The Commission agreed to review procedures, but also to exercise some caution, because the results may have significant implications. It felt that the reports did need to be peer-reviewed by the working group before publication.

5.1.9 The Commission recognized that the working group had continued to support radiofrequency allocation issues. The outcome of current negotiations at ITU was expected to be favourable to radiosonde operations. The Russian Federation emphasized the importance of protecting radiosonde operations in the frequency band between 1683 to 1690 MHz for newly-developed radiotheodolite and radar systems. The competing services attempting to use 405 to 406 MHz appeared to have withdrawn their proposals, although that would not be confirmed until the next World Radiocommunication Conference in 2003. Mobile satellite service systems were still trying to gain access to the MetAids frequency band between 1683 and 1690 MHz. That issue affected MetSat operations and there was a need to continue collaboration in dealing with the problem through the CBS Steering Group on Radiofrequency Coordination.

5.1.10 The Commission emphasized that the radiosonde operators needed to carefully note that strong signals transmitted from space to Earth, often from meteorological satellites, would soon exist in bands adjacent to those used by radiosondes. Radiosonde ground systems that currently relied on wide-band reception (assuming negligible signals in adjacent bands to the MetAids bands) may become impractical in future once the satellite transmissions were implemented. Thus, it was essential that radiosonde operations became spectrum-efficient for the future, occupying the smallest bandwidth practical at a sensible price in all national networks. Many Members may have to pay for access to the radio spectrum for radiosonde operations in the future, so narrower band radiosondes would offer economic advantages in minimizing operational costs.

5.1.11 The Commission noted with appreciation that members of the WG GUOS had participated in the CBS Steering Group on Radiofrequency Coordination, at various national and ITU Study Groups and at the World Radiocommunication Conference held in Istanbul (Turkey) in 2000. WG members also contributed chapters to the WMO/ITU *Handbook – Use of Radio Spectrum for Meteorology*, which was published jointly by both organizations in 2002.

5.1.12 The Commission urged Members to continue to coordinate with their national telecommunication administrations to emphasize the requirements and importance of suitable radiofrequency bands for meteorological operations, including radiosondes, wind profilers and weather radars. Both weather radar and wind profiler radiofrequency allocations were under some pressure from competing services and it was necessary for Members to ensure that the meteorological use was recognized by those other services. Given the importance of radiofrequency issues, the Commission agreed that coordination and protection of radiofrequencies for ground-based observing systems should be dealt with as a high-priority matter during the next intersessional period.

5.1.13 The Commission agreed that large changes in the radiosondes in use would be necessary, if all the systems throughout the network were to meet modern observing standards with temperature measurements accurate to better than 0.5°C throughout the ascent, and relative humidity accurate to better than 5 per cent relative humidity, in the troposphere. Members working on replacing the systems with the poorer measurement quality appeared to make slow progress and in the worst case no improvement in measurement quality could be identified in the last intersessional period. The Commission agreed that actions were required in all regions to improve the discussion of radiosonde design problems on an international basis and to improve the training material available for instrumentation and software experts moving into that area of work.

5.1.14 The Commission agreed that an Expert Team was necessary to deal with the technical issues involved in modernizing and improving the accuracy of the radiosonde component of the upper-air network. It should address the issue of whether Members should rely on the calibration standards and chamber test facilities owned by the main manufacturers or whether NMHSs should combine resources to provide regional test facilities and standards. In addition, the team should also consider a programme for testing new candidate systems to be used as working references for future international radiosonde comparisons. It should also take on responsibility for improving the circulation of material on radiosonde design and the solution of operational problems found in new designs.

5.1.15 The Commission also noted with thanks the good level of collaboration with the manufacturers when testing and resolving software problems associated with the Year 2000 issue. Software problems were identified in some systems and had then been resolved. As a result, the transitions through the critical dates had been achieved without any significant loss of operational radiosonde measurements.

5.1.16 The Commission was grateful that the reports from the WMO Relative Humidity Comparison had been prepared and would be published as WMO Radiosonde Relative Humidity Sensor Intercomparison: reports of Phases I and II, under the Instruments and Observing Methods Report series.

5.1.17 The Commission agreed that more efforts should be made in the future to include the research community in the work of CIMO on upper-air observations technology.

5.1.18 The Commission also noted that a summary of the first five WMO Radiosonde Comparisons had been prepared and would be published in the Instruments and Observing Methods Report series. That report was to demonstrate the limitations imposed by solar and infrared errors on temperature sensors exposed externally from the radiosonde and the greater limitations imposed on sensors when in older radiosonde designs the sensors were mounted into internal ducts on the radiosondes.

5.1.19 The Commission noted that radiosonde processing algorithms and message reporting procedures were often introducing much larger errors than the measurement errors of the sensors in flight. It was agreed that reported measurements, which were interpolated and not based on actual measurements, should be clearly identifiable to users in future. Similarly, parts of the radiosonde report, where measurement accuracy was considered very poor, should also be identified. Furthermore, some radiosonde manufacturers required feedback on the status of their ground equipment, along with the reported measurements. The Commission agreed that the best solution to those problems for the future was to transmit radiosonde measurements in BUFR, wherever possible. However, the radiosonde BUFR messages for future use would need to include additional data than were presently contained in the TEMP message. Every effort should be made to agree upon tables that could accommodate all radiosondes used worldwide, so that there would be one common processing method for all radiosonde BUFR messages. The Commission agreed that standardizing the BUFR tables was an urgent task, which should be pursued in collaboration with the appropriate CBS Team.

5.1.20 The Commission was informed that members of the working group had taken initial actions to review the performance of operational radiosonde sensors, but the measurements by those sensors were still not widely monitored. At some sites, the performance of radiosonde sensors had been measured by comparison with microwave radiometer, or GPS measurements of total water vapour. The results obtained with Vaisala radiosondes in the United Kingdom and the United States differed significantly, with poorer reproducibility of the radiosonde measurements in the United States. Similarly, large dry bias in Vaisala radiosondes appeared to have been more common in the United States than in Europe. Unfortunately, there were only a few locations where adequate monitoring of the sensor performance were taking place. Relative humidity measurements obtained with other manufacturer sensors were also not very consistent. It therefore was agreed to concern a specific expert with the task of developing monitoring procedures with manufacturers and users so that weaknesses in relative humidity calibration or observation procedures could be more readily identified.

5.1.21 The Commission noted that, as several national radiosonde networks had been upgraded since 1997, the opportunity had been taken to locate the surface measurements used with the radiosonde measurements much closer to the point of radiosonde launch than in the past.

5.1.22 The Commission was informed that more than 30 automated, or semi-automated, radiosonde launch systems were in use in the global network. In some countries, those had reduced the staff effort associated with radiosonde operations from five to one person employed for half a day per week. Although some systems were found to have initial problems, particularly when parachutes were included in the flight configuration, those problems appeared to have been resolved and satisfactory operation obtained.

5.1.23 The Commission noted that the WG GUOS had found it difficult to develop generalized guidance for manufacturers on future radiosonde developments to meet the requirements of users. Members required more reliable GPS windfinding than was currently available from the main systems. However, many Members might benefit from the development of a cheap but reliable radiotheodolite system. In the case of relative humidity sensors, there was an enormous difference in performance between the best and worst sensors in the network. That raised questions as to how those discrepancies could be minimized whilst retaining an affordable pricing structure for all Members. It was hoped that future work would lead to an improvement in the consideration of strategic issues associated with radiosonde development.

5.1.24 The Commission noted that there had been significant progress in the availability of aircraft temperature and wind measurements since 1997. The procedures set up by the various national and regional aircraft projects seemed to be effective in ensuring basic compatibility between aircraft and radiosonde wind measurements, so that users appeared to accept the measurements as interchangeable. Working group members had participated in some of those projects and the chairperson had provided advice when requested to the WMO AMDAR project. Relative humidity sensors for widespread use in commercial aircraft were still under development. The Commission agreed to continue to collaborate with those involved in that development.

5.1.25 The Commission noted that plans were being made for a WMO Ozonesonde Comparison in the next intersessional period. The Commission noted that it would be beneficial if available test results on radiosonde pressure and temperature sensor performance were forwarded to those responsible for organizing the comparison.

5.1.26 The Commission noted that there had been extensive progress in the use of ground-based remote sensing systems in most regions and urged that in the next intersessional period adequate funding should be made available for expert meetings for those involved in those technical developments. The Commission was grateful for the activities of the Rapporteur on Wind Profilers (see agenda item 5.7), who had provided an extensive report on the practical use of wind profilers, to be published in the Instruments and Observing Methods Report series, and agreed that several of the developments raised in that report would need to be monitored in the next intersessional period, as that use might impact on the procurement specifications for future wind profiler radars.

5.1.27 The Commission was informed that it had now become possible to deliver measurements of total water vapour from ground-based GPS receivers in near-real time (i.e. with delays of less than two hours). The Commission noted with appreciation the activities of the Rapporteur on GPS-derived Precipitable Water Content of the Atmosphere (see agenda item 5.4). The Commission agreed that further work was required in the next intersessional period to keep track of the practical problems associated with moving the technique towards full operational status.

5.1.28 The Commission noted with gratitude that the Rapporteur on the Calibration of Satellite Sounding Systems had produced a useful report on existing calibration procedures (see agenda item 5.3). The Commission agreed that any future expert nominated to work on those issues would need to be delegated and funded to participate in the work of CBS teams dealing with satellite issues as a CIMO representative.

5.1.29 The Commission noted that several regional projects had been set up to integrate different ground-based observing techniques together to provide improved sensing of vertical profiles of temperature, humidity and cloud structure. It was agreed that the progress of that project should be monitored by CIMO.

5.1.30 The Commission noted with appreciation that members of the WG GUOS had reviewed relevant chapters of the WMO *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), and suggested updates to those chapters.

5.1.31 The Commission agreed that there was a strong requirement for continuing the work in both *in situ* and remotely sensed upper-air measurement systems and decided to address the most appropriate working mechanisms for that purpose under agenda item 13.

5.2 RADIOSONDE COMPATIBILITY MONITORING (agenda item 5.2)

REPORT BY THE RAPPORTEUR ON RADIOSONDE COMPATIBILITY MONITORING

5.2.1 The Commission noted with appreciation the report of the Rapporteur on Radiosonde Compatibility Monitoring, Mr J.B. Elms (United Kingdom), who had worked as a member of the Working Group on Upper-air Measurements.

5.2.2 The Commission was informed that the monitoring of long-term system performance of all upper-air stations in the Global Observing System had again been based on monitoring statistics generated by ECMWF, the CBS lead centre for monitoring upper-air measurements. Contentious results had been double-checked using monitoring statistics from the UK Met Office model. The Commission recognized the expanding work of the Rapporteur as changes in upper-air systems had continued since 1997. The Commission was informed that the report on "Compatibility of Radiosonde Geopotential Measurements (for 1998, 1999, 2000 and 2001)" would be published in the near future in the Instruments and Observing Methods Report series.

5.2.3 The Commission noted that there were still very large differences in the uncertainty of measurements of different radiosonde types. The measurement uncertainty of some national systems was still too great for their data to be easily used in numerical weather prediction forecasts. The majority of radiosonde types had been rated as having "good" overall performance from 1995 to 1997 and the measurement quality of those types was still usually "good" between 1998 and 2001. However, most systems with large systematic errors or poor reproducibility had still not shown any substantial improvement since 1992. There was evidence of improved measurements from the surface to 100 hPa for some radiosonde types. However, radiosonde geopotential height increments at pressures lower than 100 hPa were less consistent than in 1997 for many radiosonde types. Even with the widely used Vaisala RS80 radiosondes there was a significant difference (approximately 20 m, equivalent to a 0.3 K temperature bias between surface and 100 hPa) in 100 hPa geopotential measurements made in Europe and Canada and those in the United States network. Similarly, the range of systematic bias in Vaisala RS80 (100–30) hPa geopotential height increment was much larger in summertime conditions in the United States than in Europe. That information had been forwarded to the manufacturers and the national authorities to allow the reasons for the differences to be identified.

5.2.4 The Commission was pleased to learn that a new 2002 edition of the WMO *Catalogue of Radiosondes and Upper-air Wind Systems in Use by Members* was published on the WMO Web Site. The Commission asserted the great importance of updating the Catalogue regularly. It noted in that connection that, since May 2000, five stations in the Russian Federation had incorporated the new RF95 radiosonde (utilizing Vaisala RS80 temperature and humidity sensors) with the AVK secondary radar.

5.2.5 The Commission was informed that during the reporting period, 48 stations had changed from using the Vaisala RS80 to the RS90 radiosonde. Remote-controlled Vaisala Autosondes had replaced manually-operated stations at 31 sites, mostly in

Western Europe and Australia. Three new radiosonde designs had been tested in the WMO GPS radiosonde test and those were beginning to be introduced into operation. Overall, the number of operational radiosonde sites had decreased from about 900 to about 800 since 1997. The Commission was informed that the rapporteur had continued to monitor the use of the Code Group “31313” of FM 35 within the upper-air message. Recommendations to update the code tables had been passed to CBS. That Code Group was now being reported by approximately 77 per cent of stations worldwide and had proven invaluable in updating and checking the correctness of the Catalogue data. Members were encouraged to implement use of the “31313 group” at all stations as soon as possible.

5.2.6 The Commission appreciated the significant amount of work required to maintain an accurate and useful catalogue of upper-air equipment and wind systems. Significant changes to the networks were occurring yearly as countries upgraded ground equipment or changed to more cost-effective radiosonde types.

5.2.7 The need for global monitoring statistics of radiosonde observations would continue because of frequent changes of radiosonde systems expected. Considering the need for global monitoring statistics of radiosonde geopotential height observations and an accurate and up-to-date Catalogue of Upper-air Equipment, the Commission agreed to continue that work in the future (see agenda item 13).

5.3 CALIBRATION OF SATELLITE SOUNDING SYSTEMS (agenda item 5.3)

REPORT BY THE RAPPORTEUR ON CALIBRATION OF SATELLITE SOUNDING SYSTEMS

5.3.1 The Commission noted with interest the report of the Rapporteur on Calibration of Satellite Sounding Systems, Mr D. Griersmith (Australia), which primarily concerned matters related to the compatibility of ground-based upper-air observations with other observing systems, notably satellite sounding systems. Calibration of satellite sounder data and accuracy of satellite-derived winds were two key issues of importance in the integration of satellite data and ground-based data to meet the user needs of WMO Members. The Commission also recognized that the Rapporteur’s report contributed to better integration of satellite and ground-based systems and the transfer of information and knowledge from the satellite community to the upper-air observation community and vice versa.

5.3.2 The Commission was informed that detailed, improved descriptions of satellite calibration systems had been provided in the last five years including, for example, the NOAA KLM User’s Guide (NOAA, 1999). There was an increasing need for improved satellite instrument calibration methodologies driven by:

(*a*) Intercomparison studies with ground-based systems, e.g. radiosondes;

(*b*) A rapid increase in the application of satellite data to climate studies which required very accurate long-time series of data sets (e.g. International Satellite Cloud Climatology Project of WCRP);

(*c*) The accelerating progress in assimilation of complementary data sets including ground and space-based data into NWP models.

5.3.3 The Commission noted that there were many complex issues and approaches to calibration of satellite instruments.

5.3.4 The Commission noted that satellite upper-air observations arose primarily from sounders or from wind derivation by tracking clouds. Satellite sounding instruments provided vertical temperature and moisture profiles. Errors could arise from the instruments and their inherent limitations and from the application of radiative transfer processes used to derive vertical profiles. Retrieval of temperatures or moisture from radiances which a satellite measures could be undertaken by statistical and physical retrieval methods (see *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part II, Chapter 8).

5.3.5 The Commission was informed that two of the main systems currently in operational use were the Advanced Microwave Sounding Unit (AMSU) on board NOAA polar-orbiting meteorological satellites, and the sounder on board the United States’ GOES geostationary meteorological satellites. For those types of satellite sounding systems, accuracies were around 1–2 K for temperature profiles and vertical resolution around 2–3 km.

5.3.6 The Commission noted that comparisons of satellite soundings with colocated radiosonde data had been used by the satellite community to estimate accuracy of satellite data and that for temperature the RMS differences were usually around 1 to 2 K and slightly larger near the surface and tropopause, after taking into account errors resulting from the assumption that sonde data and satellite soundings were colocated in space and time (often not the case) and errors in sonde data. Agencies such as NOAA/NESDIS undertook detailed ongoing quantitative evaluations of the accuracy of their operational satellite-derived vertical soundings and over the last decade there had been substantial improvements. In recent years, due to the increased use of microwave sounders, the accuracy of soundings in cloudy areas had become very close to that for clear-sky soundings.

5.3.7 The Commission was informed that the International TOVS Working Group (ITWG), which met around every 18–24 months, was a key body that dealt with the exchange of information on satellite-based atmospheric sounding from research and operational perspectives. Working groups such as “TOVS/ATOVS Data in Climate Studies” and “Advanced Infrared Sounders” address issues of calibration and validation of satellite sounders, and intercomparisons with radiosonde data. Both the satellite and ground-based observing communities had an ongoing requirement for standardized climatological data sets for intercomparison purposes.

5.3.8 The Commission noted that for about two decades estimates of winds had been made by tracking the movement of clouds on sequences of geostationary meteorological satellite images and more recently polar orbiters over polar regions. Atmospheric motion vectors (AMVs) were produced operationally from satellites such as GOES, GMS, METEOSAT, FY-2 and INSAT, generally by tracking cloud tracers at visible and infrared wavelengths, on a sequence of three successive usually half-hourly images. Water vapour imagery allowed winds to be calculated in cloud-free regions. As with satellite sounder data, the AMVs were exchanged over the GTS from major generating sites such as JMA, NOAA/NESDIS, EUMETSAT and UK Met Office. The Commission was informed that considerable progress had been made in recent years on the accuracy of satellite-derived AMVs. International systems were now incorporating quality flags as a matter of required practice, particularly to assist in assimilation of AMVs into NWP models.

5.3.9 The Commission noted that comparisons of satellite-derived winds with those measured by wind-finding radars or similar (non-satellite) systems had shown typical errors (mean vector differences) of 3, 5 and 7 m/s for low, middle and high level clouds respectively. Therefore, at low levels, accuracy of satellite winds was similar to that for conventional data. Organizations such as NOAA/NESDIS, ECMWF, EUMETSAT and the Coordination Group on Meteorological Satellites (CGMS) had for a long time been involved with comparisons of satellite-derived winds with conventional data and collation of detailed information on the use and accuracy of satellite-derived wind products from geostationary meteorological satellites at major NWP centres.

5.3.10 The Commission noted that the International Winds Workshop (IWW) had been meeting every two years or so since 1991 and it exchanged information on satellite-derived winds with emphasis on research and operational use and assimilation into NWP models. Working groups addressed various issues such as methods, data utilization and verification and quality indicators.

5.3.11 The Commission also noted the importance of WMO participation in activities of the CGMS, which often included discussions of calibration and validation issues, and AMVs via a special CGMS Working Group. The Committee on Earth Observation Satellites (CEOS) established a Working Group on Calibration and Validation in 1984. The CBS OPAG on Integrated Observing Systems Expert Team on Satellite Systems Utilization and Products also addressed issues on calibration and validation of satellite data.

5.3.12 The Commission was informed of major developments in the satellite community of relevance to the ground-based observation community. A new generation of more accurate satellite sounders was beginning following the launch of the AIRS/AMSU/HSB (Atmospheric Infrared Sounder; Advanced Microwave Sounding Unit; Humidity Sounder Brazil) triplet of instruments on board the Aqua satellite in May 2002. AIRS had 2 378 channels and in combination with AMSU and HSB was expected to bring measurement performance to improved levels, namely tropospheric temperature sounding accuracy at ±1 K in layers 1 km thick and for humidity ± 20 per cent in layers 2 km thick. A number of other hyperspectral instruments like AIRS would be launched in the next few years culminating in operational satellite sounding capabilities comparable in accuracy to radiosondes.

5.3.13 The Commission was informed that the space-based component of the GOS was now incorporating R&D satellite systems and that that involved commitments and greater involvement of satellite agencies such as NASA, EUMETSAT and NASDA in discussions with user groups represented by WMO. That was a dramatic change which would result in gradual increase in the operational availability and use of R&D satellite data including advanced sounders.

5.3.14 The Commission noted the Rapporteur's suggestion of the need for enhanced regular liaison between the satellite communities and relevant bodies within the CIMO community. The advent of advanced sounders plus the need for integration of observing systems to meet user needs (especially for NWP Centres) meant that closer coordination of satellite and conventional observing system activities was essential. Therefore, it would be desirable to, *inter alia*, consider building more formalized or regular interactions with bodies such as the relevant expert teams of CBS. Finally, the Commission welcomed the intention of the Rapporteur to provide, through the WMO/CIMO Web site, more information on the subject.

5.3.15 The Commission agreed that work in that area should be continued (see agenda item 13).

5.4 GPS-DERIVED PRECIPITABLE WATER CONTENT OF THE ATMOSPHERE (agenda item 5.4)

REPORT BY THE RAPPORTEUR ON GPS-DERIVED PRECIPITABLE WATER CONTENT OF THE ATMOSPHERE

5.4.1 The Commission noted with interest the report of the Rapporteur on GPS-derived Precipitable Water Content of the Atmosphere (GPS-PWC), Mr N. Mannoji (Japan).

5.4.2 The Commission noted that much progress has been achieved in that field through the work within research and development projects such as WAVEFRONT, MAGIC and COST-716 in Europe, experiments by NOAA/FSL in the United States, PS meteorology in Japan, and SALPEX and TARPEX in New Zealand.

5.4.3 The Commission noted that the permanent GPS networks for geodesy, navigation (differential GPS) or surveying were established in many countries, and most of the studies on GPS-PWC, aimed at promoting the use and availability of GPS-PWC in weather forecasting, made use of the data observed by those networks.

5.4.4 As regards the measurement quality, the Commission was informed that the quality of the GPS-PWC was evaluated by comparing it with PWC measured by microwave radiometers or with PWC calculated from specific humidity measured with radiosonde soundings. PWC varied from a few mm up to 80 mm in warm regions. The RMS difference between GPS-PWC and PWC calculated from radiosonde observations was about 2 to 3 mm, whereas the standard deviation was about 1 to 2 mm.

5.4.5 The Commission noted that the impact of assimilation of GPS-PWC into NWP models had been studied. The Japan Meteorological Agency conducted an experiment on assimilating GPS-PWC into a 4D-VAR system, and NOAA/FSL conducted a similar test. Both experiments showed small but consistent improvements of the forecasts.

5.4.6 Relation between GPS-PWC and precipitation was also studied, and it was found that the increase of GPS-PWC could be used as a precursor of precipitation in torrential rain by convective systems.

5.4.7 The Commission recognized that the important potential of the use of GPS-PWC to numerical weather prediction should be continued, and recorded pertinent decisions under agenda item 13.

5.5 ATMOSPHERIC TURBIDITY MEASUREMENTS (agenda item 5.5)

REPORT BY THE RAPPORTEUR ON ATMOSPHERIC TURBIDITY MEASUREMENTS

5.5.1 The Commission noted with interest the report of the Rapporteur on Atmospheric Turbidity Measurements, Mr B.W. Forgan (Australia), on his work carried out within the Working Group on Ground-based Upper-air Observing Systems. The Commission was informed that since its twelfth session, significant progress had been made in providing traceable measurements for the determination of aerosol optical depth (turbidity).

5.5.2 At a workshop in May 2000, the WCRP/Baseline Surface Radiation Network (BSRN) established a protocol for archiving spectral radiometer data for its stations. That protocol required the archiving of spectral transmission and station level pressure data at a frequency of approximately one sample per minute, rather than recording of derived aerosol optical depth values. Spectral transmission data were archived so that uncertainties due to various algorithmic differences (for example molecular and ozone extinction and air mass determination) could be avoided, different interpolation schemes for instrument reference ccould be tested and the data set could be used for producing spectral irradiance time series. An uncertainty analysis provided at the same BSRN meeting had shown that filter radiometry remained difficult, but that with care it was possible to achieve 95 per cent uncertainties of 0.010 in aerosol. Recent intercomparisons in Canada, Australia, United States and Switzerland had shown that the BSRN uncertainty analysis provided a useful baseline for further improvements in the measurement technologies.

5.5.3 The Commission noted that several international networks had been established or extended over the previous four years, most notably the expansion of the United States NASA/AERONET (over 100 sites providing data at different frequencies and a significant and easily accessed data archive) and the smaller but complementary GAW Precision Filter Radiometer (PFR) network financed by MétéoSwiss and established by the PMOD/WRC. The former network monitored both direct spectral irradiance and sky radiance, and the latter using direct irradiance sensors that had been calibrated against detector-based standards. Also, other Members had expanded their spectral irradiance observations. Linkages between those two major networks and the metrology provided by the WCRP/BSRN were continuing to strengthen with a number of colocated sites either established or planned.

5.5.4 The Commission welcomed that there had been a number of other meetings, intercomparisons and published works focusing on providing traceable aerosol optical depth measurements, coordination of networks and measurement methods, introduction of new technologies and examination of older methods. Recently developed methods included the use of trap detectors in radiometers and use of dispersive element charged coupled device (CCD) detectors for routine measurements but referenced to the World Radiometric Reference through the use of broad-band glass filters. That latter study had also been used to examine the uncertainties involved in the old Schott-glass filter pyrheliometer methods. The results showed that such methods were only appropriate at very high aerosol optical depth locations, where 95 per cent uncertainties of greater than 0.030 were acceptable. The Commission agreed to discourage the use of such methods in the next edition of the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8).

5.5.5 The Commission agreed that the high level of activity in the aerosol optical depth metrology in both the GAW and BSRN communities and their close linkage with other major networks had made it unnecessary to organize a specific CIMO-sponsored intercomparison. Within the next four years it could be expected that both those metrology groups would converge on standards and protocols sufficient to provide traceable measurements to detector-based irradiance standards. Assisting in that process was a small but successful intercomparison of spectral radiometers at the last International Pyrheliometer Comparison (IPC-IX) at the World Radiation Centre (WRC), Davos, Switzerland, September–October 2000. It showed that, if conditions were suitable for successful IPC data collection, it would also be possible to provide transfer of spectral irradiance scales at the same venue. Furthermore, it enabled the transfer of calibration of participating instruments to the spectral irradiance scale established at the WRC Davos, for the PFRs. The IPC was considered the ideal vehicle to promote the transfer of those standards to the majority of Regional Radiation Centres (RRCs) with instrument-based standards.

5.5.6 The Commission recommended that WMO invite the World Radiation Centre to hold in tandem with IPC-X in 2005 an intercomparison of spectral radiometers (used for aerosol optical depth determination) from the Regional Radiation Centres to provide traceability to a detector-based spectral irradiance reference.

5.5.7 The Commission noted that there was limited value in maintaining aerosol optical depth networks using manually-oriented spectral radiometers. The volume of data was in most cases inadequate to maintain suitable quality assurance on the data, and the data were biased by operator or procedural preferences. The Commission believed that where possible Members should be encouraged to seek either a partnership with an existing international network or obtain their own equipment to provide automatic data sampling.

5.5.8 The Commission noted that at a site providing a good logistical environment for spectral irradiance measurements, direct solar spectral radiometers on solar trackers provided data with the least uncertainties. However, there was considerable evidence to suggest that diffuse spectral irradiance and spectral radiance measurement could add significantly to the information content on aerosol extinction in the atmosphere. The Commission encouraged Members to incorporate such measurements into their aerosol optical depth monitoring programmes.

5.5.9 The Commission expected that the next four years should see a consolidation of the progress made in the last decade and that the Commission should play an important role in transferring the new knowledge to Members. Therefore, the Commission agreed that the work in the field of atmospheric turbidity (aerosol optical depth) measurements should be continued (see agenda item 13).

5.6 UV MEASUREMENTS (agenda item 5.6)

REPORT OF THE RAPPORTEUR ON UV MEASUREMENTS

5.6.1 The Commission noted with interest the report of the Rapporteur on UV Measurements, Mr B. McArthur (Canada).

5.6.2 The Commission welcomed that the Scientific Steering Committee on UV Measurements (SSC-UV) of the Commission for Atmospheric Sciences (CAS) had been working on the production of a number of definitive reports on the measurement of UV radiation, including information on the various types of instrumentation and associated quality assurance and control procedures. It was agreed that the Commission should monitor the efforts of the SSC-UV and use the relevant reports, when available, as the basis for updating Chapter 7, Measurement of radiation, of Part I of the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8).

5.6.3 The Commission noted that the CAS Scientific Advisory Group on UV (UV-SAG) had completed documents on quality assurance – *Guidelines for Site Quality Control of UV Monitoring* (GAW Report No. 126, WMO/TD-No. 884) – and on spectral instruments to measure solar ultraviolet radiation – *Instruments to Measure Solar Ultraviolet Radiation, Part 1: Spectral Instruments* (GAW Report No. 125, WMO/TD-No. 1066). It was felt, however, that the report on quality assurance did not address all of the issues relevant to maintaining operationally-used UV instruments and that more work was still needed to meet CIMO requirements. A document describing broadband instruments for ultraviolet radiation measurements provided useful information for updating the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8).

5.6.4 The Commission noted that a draft document on filter instruments had been initiated, which was considered very important for CIMO, because of the large number of instruments of that type that were being used in various networks. The Commission encouraged CAS to accelerate that work.

5.6.5 The Commission further noted that instrument calibration continued to present significant difficulties in the measurement of UV radiation and recognized the work of GAW in establishing a World UV Radiation Centre by mid-2003, similar to the World Radiation Center in Davos, Switzerland, and that the Surface Radiation Budget Research Branch of NOAA's Air Resources Laboratory for North America had been operational for several years and the Joint Research Centre of the European Commission for Europe was nearly ready to assume operations. Those facilities were expected to greatly enhance the quality of UV measurements. The Commission appreciated the establishment of those laboratories as regional centres and would monitor and, as far as possible, support the GAW initiative to establish a global centre. It welcomed the progress in the development of detector-based standards in lieu of standard lamps for the calibration of UV instruments that would eventually further reduce the uncertainty of UV measurements, although it would take several years before they were broadly used.

5.6.6 The Commission expressed concern that the frequency of national and international comparisons of UV instruments was decreasing and that during the previous two years no comparisons had been undertaken. The most recent published results for a comparison were in 2001 for the 1997 SUSPEN spectrometer comparison.

5.6.7 The Commission considered that more efforts needed to be dedicated to providing comparisons of instruments of all types (spectrometers, broadband instruments and filter instruments). Therefore, the Commission proposed that during the fourteenth intersessional period a combined CAS/GAW and CIMO intercomparison, designed to include a large number of instrument manufacturers and types, should be held.

5.6.8 The Commission was disappointed to be informed that few members were submitting UV observations to the World Ozone and Ultraviolet Data Centre (WOUDC). Submission of data to the WOUDC contributed to the quality and uniformity of observations throughout the globe. Therefore, the Commission encouraged members to submit data in a regular and timely manner.

5.6.9 The Commission agreed that the work in the field of UV measurements should be continued (see agenda item 13).

5.7 **WIND PROFILERS** (agenda item 5.7)

REPORT OF RAPPORTEUR ON WIND PROFILERS

5.7.1 The Commission noted with appreciation the report of the Rapporteur on Wind Profilers, Mr J. Dibbern (Germany), on his work carried out within the Working Group on Ground-based Upper-air Observing Systems. The Commission also noted that more than 150 wind profiler radars were operated worldwide by NMHSs, universities, research institutes, environmental agencies and airport authorities.

5.7.2 The Commission noted that the NOAA Profiler Network (NPN), which had been operating since 1992, currently had 32 profiler sites in the continental United States operating at 404 MHz and three sites in Alaska operating at 449 MHz. That network produced hourly wind data in real time for dissemination on the GTS in BUFR format. A steady progress in the NPN data quality had been observed over recent years. In addition, NOAA/FSL (Forecast Systems Laboratory) had started a project in cooperation with about 30 other agencies owning profilers to acquire boundary layer profiler wind and temperature data from about 65 profilers which would be collected by the Profiler Control Center and processed into hourly, quality-controlled products, and distributed.

5.7.3 In Europe, networking of wind profiler radars had been coordinated by the COST-76 project, a cooperation between NMHSs, research institutes, universities and industry. Sixteen systems sent data operationally to the UK Met Office which, in collaboration with European partners, had developed an infrastructure for network operations and real-time Internet display. After COST-76 concluded in 2000, the Council of EUMETNET agreed in October 2001 to establish the wind profiler programme WINPROF to enable continuation of the operational network.

5.7.4 The JMA had completed an operational network of 25 1.3 GHz wind profilers in 2001. The profilers were installed throughout the Japanese islands with a control centre at Tokyo where, after quality control of the data, the Doppler velocities obtained every ten minutes at each site were translated into wind vectors. That profiler data would be used as initial data to the JMA mesoscale model for numerical weather prediction, aiming at improvement of numerical forecasts particularly for severe rain storms. The JMA was planning further improvement of the spatial resolution of the profiler network by increasing the number of systems to 31 by the end of March 2003.

5.7.5 The BUFR code tables for wind profiler data were approved by CBS in November 1998. Those code tables, which were suitable for all types of wind profilers, were drafted by COST-76 and had been coordinated with NOAA.

5.7.6 The Commission noted with satisfaction that the quality of data from wind profiler radars had improved over recent years. For the NOAA profiler network, that was seen from the monitoring results of the ECMWF, the WMO lead centre for the monitoring of upper-air data. For the European profiler network, the UK Met Office had developed facilities for quality control and display of wind profiler data so that most data were of reliable quality and so was expected to improve the operational standard within the WINPROF project. Quality evaluation by comparing observations against numerical prediction fields had been very useful to identify bias in wind speed and direction measurements, and thus providing improvements to the different profiler networks. Further, the Commission noted that the quality of the measurements depended on the data-processing algorithms used on the raw data and, in order to obtain comparable measurements from the different types of profilers, it was important to encourage the standardization of data-processing algorithms.

5.7.7 The Commission noted that guidance material on operational aspects of wind profiler radar would be prepared by experts from Europe, United States and Japan. That material was expected to evolve as experience was gained with various systems. A report reflecting those matters would be published in the IOM Report series.

5.7.8 The Commission, considering that the development of operational wind profiler radars was evolving rapidly and that standardization and the improvement of quality control procedures were vital to wide operational acceptance of that system, agreed that the work in the field of wind profilers should be continued (see agenda item 13).

5.8 **WEATHER RADAR MEASUREMENTS** (agenda item 5.8)

5.8.1 The Commission noted the developments and implementation of weather radar technology in Europe, where about 125 weather radars were being used operationally, mostly C-band with a decreasing number of S-band radars. About two-thirds of the radars had Doppler capability and the number was increasing, but there were no operational dual-polarization radars. All operational radars provided plan-position indicators (PPIs) or constant-altitude plan-position indicators (CAPPIs) of radar reflectivity at five- or 15-minute intervals for weather surveillance and precipitation estimation, often combined with rain gauge data for hydrological purposes. A minority of the weather radars produced, operationally, wind profiles and/or severe weather detection products such as probability of hail.

5.8.2 The Commission noted that within EUMETNET the Operational Programme for the Exchange of Weather Radar Information (OPERA) was launched to facilitate operational exchange of weather radar information between European NMHSs, with about 23 countries participating at present.

5.8.3 The European COST-717 project on "Use of radar observations in hydrological and NWP models" was investigating how radar data might be most effectively used in model assimilation schemes and in combination with other observations. Regarding three-dimensional wind distribution, several NHMSs had investigated the impact of the assimilation of Doppler radar data wind profiles and radial wind data in NWP models. Results had been presented within COST-717 and published.

5.8.4 Regarding evaluation methods in Europe, radar precipitation estimates were evaluated mainly by comparison with rain gauge data, while radar wind profiles could be verified using selected radiosonde data. The detection of damaging hail by radar had been evaluated mostly by using data from insurance companies.

5.8.5 The Commission noted with concern that some of the weather radars operated by developing countries had not functioned as reliably as expected. Some of the problems expressed related to inadequate training of technical personnel, lack of spare parts and general malfunction of the radars. The Commission felt that weather radars currently available on the market were too expensive and were not particularly suitable to the specific needs of developing countries. There was, hence, a need to take into account the requirements of developing countries when designing new weather radar systems.

5.8.6 The United Kingdom delegation informed the Commission that recently, three additional weather radars had been acquired for its operational network. As the United Kingdom experts were not satisfied with the mechanical reliability of most modern radar systems they had decided to buy back Doppler weather radar systems supplied many years ago to some African countries. Those systems had been replaced by more modern systems from other donors, but were considered suitable for the United Kingdom network, following rectification of maintenance problems.

5.8.7 The United States continued to operate 158 NEXRAD Doppler Radars (WSR-88D) that had been upgraded in 2001 to an open systems computer architecture with much increased capability, which would permit the more rapid application of new algorithm science. In the next two years, new algorithms (e.g. a new snow accumulation, data quality improvement, high-resolution vertically integrated liquid, improved precipitation estimation algorithms and new scanning strategies) would be added. The NEXRAD agencies had begun an Open Radar Data Acquisition Project that would enable the rapid incorporation of new data quality and velocity ambiguity mitigation techniques, which would reduce the amount of range-folded data and introduce new features necessary for the potential introduction of dual polarization capability to the WSR-88D, providing information on the three-dimensional structure of precipitation particles.

5.8.8 The United States had focused on upgrading the capability of the WSR-88D to support forecasters in making forecasts and severe weather/tornado warnings, and in planning to integrate complementary weather data from air traffic control radars with the NEXRAD data. From a central product server users could obtain the products via a dedicated connection or ftp. The United States National Weather Service had provided a subset of WSR-88D radar products on the Internet and was using those data to complete national and regional displays of higher-resolution mosaics of reflectivity data, vertically-integrated liquid water and precipitation accumulation products. The NEXRAD agencies were considering implementing a real-time, electronic data collection method that would enable real-time distribution of base data to all interested users via the Internet. The NEXRAD agencies were expecting to deploy an algorithm that would provide an advanced capability for inserting radial velocity data into NWP models at the National Weather Services Environmental Meteorological Center.

5.8.9 Australia operated a network of 60 weather radars. Many of those radars were of the older style and had been very reliable. New radars were being installed and were usually of non-Doppler capability (S and C band) to suit the weather monitoring requirements in the specific locations. However, a small number of Doppler radars were being installed in certain locations for additional severe weather monitoring.

5.8.10 The China Meteorological Administration was making efforts to implement a new weather radar network consisting of 126 Doppler Weather Radars. The implementation of the network had started with the expectation that 52 radars would be implemented by the end of 2002. The new network would mainly consist of WSR-98D Doppler Weather Radars (S band and C band) made in China, which was based on the technology of NEXRAD/WSR-88D of the United States with improvements on the hardware configuration, software package and the cost benefit.

5.8.11 New Zealand continued to operate three dual mode (intensity and Doppler) C-Band Doppler Weather Radars (Ericsson) and one EEC WF100 windfinding radar with the Australian Bureau of Meteorology RAPIC Weather Radar add-on (Intensity mode). The Ericsson radars were maintained to a combined network availability of 98 per cent over the 12 months to September 2002. There were no significant upgrades to those systems in the last four years and none were planned within the next four years. The only major maintenance issues over the last four years were the failure of slip rings and azimuth gear boxes.

5.8.12 In 2001, the Russian Federation and Finland developed and agreed on the protocols for exchange of digital radar data in real-time mode and introduced into operational practice a composite radar chart of severe weather for the area Helsinki–St Petersburg. That provided a possibility to connect the developing automated radar network in the European part of the Russian Federation with similar networks in Europe.

5.8.13 The Canadian network of 31 Doppler radars was being upgraded through an in-house project, which started in 1997 and was scheduled to end in 2004. Currently, 26 of those C-band radars were in place. Standard receiving hardware was being installed across the network and commercially available signal processing hardware was used. Internally developed software was used to present data from all Canadian and United States radars in the forecasters' area of responsibility in a single multi-radar/multi-product composite with the capability of identifying, ranking and tracking severe storms. Development was under way to develop

Quantitative Precipitation Estimation products, which correct for problems of radar remote sensing. The installation of a dual polarization C-band system was in progress at the Meteorological Service of Canada research facility.

5.8.14 MétéoSwiss operated three C-Band Doppler weather radars (GEMATRONIX) since 1993. In operation 24 hours a day, the combined radars network availability was better than 96.5 per cent over the past five years. It was planned in the next six years to replace the three radars and to install a new X-band mini radar for a better coverage of the Rhone Valley in the Swiss Alpine Region.

5.8.15 India operated a network of 45 weather radars, X- and S-band radars for wind finding, storm detection and cyclone tracking purposes. Three S-band, klystron-based Doppler radars were introduced in 2000 which were working satisfactorily. Radar sites had also been equipped with rain gauge network and disdrometers for calibration. One of the radar sites was working for ground validation and calibration of TRMM satellite. India had also developed klystron-based, high power S-band hydrological radar which was undergoing on-site testing. India proposed to cover the entire country with a digital C/S-band Doppler weather radar network during the next five years for hydrological purposes.

5.8.16 Japan continued to operate 20 C-band weather radars. The radar data were combined with rain gauge data from automatic weather stations into radar-rain gauge composite maps. An experiment on assimilating Doppler radar data to NWP models using a 4D-VAR system had been started. Japan had started the exchange of radar data using the universal radar data format with the Republic of Korea.

5.8.17 The Republic of Korea had operated seven C-band Doppler weather radars and one S-band Doppler radar. The Republic of Korea would install two more Doppler radars (S and C band) in 2003 and had a plan to install two radars by 2005. Radar-rain gauge composite maps were produced every 30 minutes. The exchange with China as well as with Japan had been done, which had contributed to improvement of monitoring severe weather, particularly in approaching typhoons.

5.8.18 Botswana procured and installed a weather radar system with Doppler component in 1994. Unfortunately, the weather radar system never worked. The radar had since been replaced with a more modern system with Doppler capability. It was hoped that once capacity in terms of maintenance and interpretation of products had been gained, a few more radar systems would be procured and deployed strategically within the country.

5.8.19 Under the WMO Voluntary Cooperation Programme (VCP), Mauritius was donated a 10-cm S-band radar system in the early 1970s. Since 1975 the radar had been successfully used in tracking cyclones, fronts and other weather phenomena and was still in excellent working condition due to regular maintenance and judicious use. There was a plan to upgrade the system with Doppler capability and install two least costly systems in the strategically located outer islands to achieve more complete radar coverage of cyclone-prone areas.

5.8.20 The Commission was informed that there had been significant radio frequency issues associated with both S-band and C-band radar operations. Extensive studies had been performed in the United States in defending the S band, while European countries had been participating in C-band studies. That work was continued.

5.8.21 The Commission, considering the ongoing development of that important weather surveillance tool, agreed that the work in the field of weather radar measurement should be continued and decided on the appropriate mechanism under agenda item 13.

6. ENVIRONMENTAL MEASURES (agenda item 6)

6.1 ATMOSPHERIC COMPOSITION MEASUREMENTS (agenda item 6.1)

REPORT OF THE RAPPORTEUR ON INSTRUMENTS AND METHODS OF ATMOSPHERIC COMPOSITION MEASUREMENTS

6.1.1 The Commission considered with interest the report of the Rapporteur on Instruments and Methods of Atmospheric Composition Measurements, Mr R. Artz (United States), noting that the GAW network required continued attention and guidance in the areas of instrument calibration, standardization of sampling and analysis techniques, observational techniques and instrument development.

6.1.2 The Commission noted with satisfaction that *The Strategic Plan of the Global Atmosphere Watch (GAW)* (WMO/TD-No. 802), published as a guide for the development of implementation plans for several measurement programmes sponsored by GAW, had been updated and was available as WMO/TD-No. 1077. Also, the *Global Atmosphere Watch Measurements Guide* had been updated and published as WMO/TD-No. 1073.

6.1.3 The Commission was informed that to improve the quality of global data, the GAW Precipitation Chemistry Scientific Advisory Group (PC-SAG) was revising the standard operating procedures of the GAW precipitation chemistry network including all on-site, laboratory, data management and quality assurance aspects of the measurement system. A new GAW precipitation chemistry operating manual should be ready in late 2002 and would give strict data acceptance criteria, clear procedures and effective feedback for nations and laboratories wishing to make precipitation chemistry measurements.

6.1.4 The Commission also noted that PC-SAG had identified a need to carry out an assessment of the global requirement for trace metal and persistent organic pollutant measurements in precipitation; and for dry deposition (air-surface exchange) measurements, and that the information was incorporated into the updated *Global Atmosphere Watch Measurements Guide*.

6.1.5 The Commission was informed that, after the 22nd WMO/GAW Trace Metals Intercomparison, the PC-SAG decided to discontinue that series of intercomparisons and to focus available resources on improving the important ion programme. However, an opportunity for a one-time intercomparison was presented to the PC-SAG by Mr Philip Taylor and the Institute for Reference Materials and Measurements at the European Commission's Joint Research Centre in Geel, Belgium. The Commission noted with great appreciation that Mr Taylor had provided samples free of charge and that the intercomparison had involved the WMO Quality Assurance/Science Activity Center (QA/SAC) in Albany, New York, and many of the WMO laboratories that had participated in the previous programme. Results were to be disseminated in late 2002.

6.1.6 The Commission, considering that monitoring of atmospheric composition was important to improve understanding of the global atmosphere-ocean-biosphere system, noted a recent major study of atmospheric contributions to coastal eutrophication in Eastern North America.

6.1.7 The Commission, recognizing that the monitoring of atmospheric composition required data of assured high quality, noted that standard reference materials for GAW precipitation chemistry programmes had been developed by the precipitation chemistry QA/SAC in Albany, New York, and that those standards had been used in the biannual laboratory intercomparison programme started in 2000.

6.1.8 Further, the Commission noted that progress had been made toward the comparison of various precipitation chemistry sample preservation methods, with field testing completed and recommendations which would be made to GAW in due course.

6.1.9 The Commission noted that close collaboration between all bodies in the field of operational atmospheric composition measurements was desirable for the purposes of upgrading equipment, standardizing calibration procedures, improving quality control, and comparing instruments and sampling techniques. To further those goals, PC-SAG had met with representatives of the Acid Deposition Monitoring Network in East Asia (EANET) in Tokyo in December 2000 prior to the Sixth International Conference on Acidic Deposition held in Tsukuba, Japan. The Commission also noted with satisfaction that EANET was participating in a United States Geological Survey laboratory intercomparison programme involving six other laboratories, with results indicating that each of the seven laboratories was routinely generating high-quality data.

6.1.10 The Commission expressed concern that not all aspects of the CAS/GAW observation and QA/QC programmes were considered in similar depth to the treatment of precipitation chemistry. The Commission recognized, however, that the scope of the task was broad, and increased activity and broad expertise were necessary to adequately cover that area of work, and to improve cooperation between CAS/GAW and CIMO. Therefore, the Commission agreed that under agenda item 13 that concern should be addressed.

6.1.11 The Commission recognized the importance of enhancing, through capacity building, the capability of RICs with regard to the testing of atmospheric composition samples.

6.1.12 The Commission noted the progress made by the Global Atmosphere Watch Science Advisory Groups and encouraged those efforts to continue, while acknowledging that expansion of programmes and improvements in data quality would require the identification of financial resources, in particular for the continued support of the Quality Assurance/Science Activity Centres (QA/SAC) located in SUNY/Albany, Germany and Japan.

6.1.13 The Commission noted with appreciation that a review of the relevant chapter of the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8) had been completed and agreed that the work in the field of atmospheric composition measurements should be continued and recorded pertinent decisions under agenda item 13.

6.2 ATMOSPHERIC OZONE MEASUREMENTS (agenda item 6.2)

REPORT OF THE RAPPORTEUR ON ATMOSPHERIC OZONE MEASUREMENTS

6.2.1 The Commission noted with satisfaction the report of the Rapporteur on Atmospheric Ozone Measurements, Mr V. Dorokhov (Russian Federation).

6.2.2 The Commission appreciated that the quality assurance/quality control (QA/QC) of the global total ozone monitoring network with Dobson spectrometers had been guaranteed over the last two decades by the NOAA-operated World Dobson Calibration Center (WDCC) in Boulder, Colorado, United States. The WDCC had organized several major International Dobson Intercomparisons under the auspices of WMO mostly at Arosa (Switzerland). Smaller campaigns were organized by the Meteorological Observatory Potsdam (Germany), in Potsdam, Belsk (Poland) and Siofok (Hungary).

6.2.3 However, increased demands for data quality, the expanded Dobson spectrometer network in Europe, and reduced resources in the WDCC required modifications to the worldwide Dobson calibration system. The Commission agreed that regional centres should be mainly responsible for the calibration programme in their regions in cooperation with the WDCC. In that respect, the Commission noted with satisfaction that in preparation for the duties of a Regional Dobson Calibration Centre (RDCC) the Meteorological Observatory Hohenpeissenberg (Germany) had already upgraded its capabilities. In addition, an agreement had been concluded between Germany and the Czech Republic on the cooperation between the Hohenpeissenberg centre and the Solar and Ozone Observatory Hradec Králové with a view to sharing in the responsibilities of an RDCC for Europe.

6.2.4 The Commission welcomed the information that:

(*a*) Standard operating procedures were being prepared in cooperation between the European RDCCs and the WDCC;

(*b*) The publication of a new Dobson Manual under WMO auspices was in process;

(*c*) Both European RDCCs planned to provide training for Dobson spectrometer operators from stations both in Europe and in developing countries in consultation with WMO.

6.2.5 The Commission was informed by the Delegation of India that the Indian network operated six Dobson stations which had been in service for at least 40 years. There were also three upper-air ozone measuring stations which had 30 years' service. Indian data were sent to the World Ozone and Ultraviolet Radiation Data Centre (WOUDC). Total ozone, Umkehr and ozone profiles were being measured. India also operated ten surface ozone measuring stations using electrochemical sensors. India was replacing a few of its Dobson instruments with Brewer spectrophotometers. An Indian Antarctic station had operated a special Brewer instrument since 1998. The Australian delegation also informed the Commission of extensive ozone measurement work in the southern hemisphere. Australia had provided support to the Republic of Korea, New Zealand and South Africa. Australia and New Zealand had participated in an international campaign coordinated by NOAA, in New Zealand.

6.2.6 The Commission noted that approximately 35 Brewer spectrophotometers per year had been serviced and calibrated in recent years. Those calibrations had been carried out periodically at the field sites using travelling standard instruments that were frequently checked with the Brewer triad reference. Calibration of the Brewer reference had continued at Mauna Loa Observatory, Hawaii. All three instruments had been calibrated recently: Instrument #8 in 1999, Instrument #14 in 2000 and Instrument #15 in 2002. The Commission recognized the need for regional calibration centres for Brewer instruments providing similar services to the RDCCs. The United Kingdom delegation expressed concern over the long-term sustainability of total ozone observations using either the Dobson or Brewer spectrophotometers. The Commission noted the need for expert study of present and emerging technologies to determine the most suitable method of maintaining long-term, cost-effective, total ozone measurements.

6.2.7 With respect to the SAOZ (*Système d'analyse par observations zénithales*) UV-visible spectrometer, the Commission noted that there were 18 SAOZ instruments in network operation for total ozone and NO_2 observations.

6.2.8 The Commission recognized that Umkehr measurements, which enabled the reliable monitoring of ozone recovery rates with respect to altitude and latitude, needed to be quality controlled and quality assured, and new guidelines for Umkehr QA/QC had to be developed. The three Umkehr techniques had provided long historical records for both Dobson and Brewer determinations. The Commission agreed that Umkehr intercomparisons should become a regular part of total ozone calibration/validation campaigns.

6.2.9 The Commission noted further that the Network for the Detection of Stratospheric Change (NDSC) comprised high-quality remote-sounding research stations for measurements of the physical and chemical state of the stratosphere, in particular ozone and ozone-related chemical compounds and parameters.

6.2.10 The Commission noted that the Total Ozone Mapping Spectrometer (TOMS) was the main satellite instrument for total ozone measurements, and that the TOMS instrument on board the Earth Probe (EP) satellite was operating with 5 per cent calibration error. It was hoped to maintain operation of the EP to provide an overlap with the ozone-monitoring instrument (OMI) on the EOS AURA platform to be launched in early 2004. The SAGE III mission on the Russian Meteor 3M-1 spacecraft was launched December 2001. SAGE III would play a critical role in NASA's Mission to Planet Earth Observing System programme by providing high latitude long-term measurements of the vertical structure of aerosols, ozone, water vapour, and other important trace gases in the upper troposphere and stratosphere. The European Environment Satellite (ENVISAT) was launched in March 2002 with an instrument GOMOS (Global Ozone Monitoring by Occultation of Stars), providing altitude-resolved global ozone mapping and trend monitoring with very high accuracy. The Advanced Earth Observation Satellite (ADEOS-II), including a TOMS instrument, was scheduled to be launched in late 2002.

6.2.11 The Commission agreed that the work in the field of atmospheric ozone measurements should be continued and recorded pertinent decisions under agenda item 13.

7. EDUCATION AND TRAINING, CAPACITY BUILDING, TECHNOLOGY TRANSFER AND MATTERS RELATED TO REGIONAL INSTRUMENT CENTRES (agenda item 7)

7.1 The Commission recalled that its own terms of reference and the IMOP in the 5LTP both emphasize education, training and technology transfer as applied to instruments and methods of observation. It also recalled the endorsements of Congress and the Executive Council on the need for increased activities for education and training and the requirements of all data users for more and better quality observations of a greater range of variables than had been available thus far. In addition, the Commission recognized that in the light of UNCED capacity building was the process of developing endogenous capability to achieve desired results by applying knowledge, skills and resources, and that there was an urgent need to assist developing countries in their efforts to overcome deficiencies related to the observing technique applied.

7.2 The Commission underlined the need for technical training in all NMHSs, but especially those in developing countries, and the necessity to ensure that all NMHSs had access to the best possible advice on meteorological observing and instrument technology. In that regard, it pointed to the valuable information contained in the sixth edition of the *Guide to Meteorological Instruments and Methods of Observation*

(WMO-No. 8), which gave a wealth of essential material for preparing training events and on-the-job training. It especially referred to the chapters directly related to Training of Instrument Specialists and to Testing, Calibration and Intercomparison.

7.3 The Commission noted with appreciation the use of the WMO/CIMO Web page for rapid publication of documents and expressed the need for all IMOP reference documents (manuals, guides, technical reports, etc.) to be made available as soon as possible for the purpose of easy access to the information by Members and for timely distribution of updates.

7.4 In noting the value of publishing reports and other documents in printed form, the Commission appreciated publications in CD-ROM format. Little progress had been made in taking advantage of cost-effective distance-learning media and computer-assisted instruction with respect to training in instruments and methods of observation. The Commission agreed that more efforts in that respect were needed and that those developments should continue to be monitored and reported on.

7.5 The Commission emphasized the important role of technical instrument conferences and associated exhibitions as a means for training and capacity building through presentations and lectures and through facilitating direct contact of experts from other Services, equipment manufacturers and suppliers for obtaining advice for proper handling and maintaining instruments. The Commission was pleased that the WMO Technical Conference on Meteorological and Environmental Instruments and Methods of Observation organized together with METEOREX-2000 by the China Meteorological Administration (CMA) in Beijing in 2000, was a great success. More than 200 participants from 61 countries, including 40 developing countries, had the opportunity to present, learn and discuss issues related to the present status and future developments related to instruments and methods of observations. It invited the Secretary-General to support the regular organization of those conferences and to provide, as far as possible, financial support for participation of delegates from developing countries. It felt, however, that CIMO should be more actively involved in the selection of candidates to ensure appropriate expertise and renewal of participants. It also invited Members to offer hosting those conferences.

7.6 The Commission also noted that Brazil had been chosen as the location for the WMO GPS Comparison in order to provide training and capacity building in Region III. More than 50 people from various agencies and universities within Brazil gained practical experience in radiosonde operations and the benefits of improved radiosonde technology. In addition, the test provided practical experience in the tropics to 15 engineers from the radiosonde manufacturers. That would lead to products that were better suited for use in tropical conditions.

7.7 The Commission noted with concern that it was possible to organize only one workshop for instrument specialists (for RA II at the Regional Instrument Centre (RIC) in Tsukuba, Japan, 1998). However, the Commission welcomed that at the Ninth International Pyrheliometer Comparison (IPC-IX) held at the World Radiation Center in Davos, Switzerland, scientific symposia were organized for 65 participating radiation experts from 39 Member countries. In addition, less experienced experts were trained in the intercomparison techniques (see also agenda item 8). Additionally, some RICs organized brief visits of instrument staff from developing countries to provide more specialized training.

7.8 The Commission recognized that the Training Workshop for upper-air specialists had been postponed. That had been mainly due to budgetary constraints, but Members also failed to supply the necessary staff to generate the training material. The Commission felt that that was clearly the problem that would have benefited from more active intervention from the Management Group. The Commission was pleased to note that Botswana had confirmed its willingness to host the Training Workshop for upper-air specialists in 2003 and requested the Management Group and the WMO Secretariat to specify urgently the major topics for that training event.

7.9 The Commission recognized efforts for education and training provided by the Regional Meteorological Training Centre (RMTC) in Pune, India. Furthermore, it noted with appreciation the offer of India to hold training courses at that RMTC for surface, radiation and calibration practices at no cost for training. It was also pleased to note that RMTC Pune could provide specialized training to trainers on the above and other areas. The Commission recommended to make that information available to all concerned and urged Members to use that unique opportunity in capacity building activities.

7.10 The Commission noted with appreciation the opportunity for CIMO to review and make use of the National Weather Service-produced one-hour training video for radiosonde operators offered by the United States.

7.11 The Commission was informed that during the intersessional period, the Interstate Council for Hydrometeorology of CIS countries carried out a series of instruments calibration, related seminars, courses and exhibitions. The Commission felt that, where possible, it would be desirable for more countries from RA II and RA VI to have the opportunity to take advantage of those capacity building activities, which would be of direct interest to the implementation of IMOP.

7.12 The Commission stressed the importance of sharing information related to training events between institutions and individual experts and recommended that the OPAG on Capacity Building, in coordination with the WMO Secretariat, solicit and post on the Web information on pending national, regional and interregional training sessions and workshops.

7.13 In emphasizing the high importance of training instrument operators and maintenance staff to assure the required level of measurement accuracy and reliability, the Commission stressed the need for more frequent regional training events. In that regard, it invited the Secretary-General to make necessary arrangements and urged Members to provide experts for those events.

7.14 The Commission underlined the role that RICs play in capacity building, such as active support towards the organization of training workshops, and providing assistance and advice in calibration of national standards/reference instruments within the region. It noted with appreciation the efforts of its president to enhance collaboration between the Commission and regional associations. In particular, the Expert Meeting on Capacity Building, held in Beijing, China, in 1999, dealt with the preparation of Guidance Material for the Choice of Instruments for Developing Countries and made concrete proposals to strengthen the RICs and to support them by CIMO experts with a view to enhancing services provided by RICs. The Commission noted with satisfaction that almost all regional associations had meanwhile established a Rapporteur on Instrument Matters, Training and Capacity Building, which would enhance the collaboration between the regional associations and CIMO.

7.15 The Commission took note of the increasing need for assistance in the repair of sophisticated operational monitoring instrument/systems, especially in several developing countries. The Commission invited those Members that operate RICs to consider the possibility of enhancing the capability of the RIC towards meeting that urgent need. At the same time, it requested the RICs to regularly inform Members within their area of responsibility on the capability and services they provided as well as on calibration and training events they were planning.

7.16 The Commission recognized their responsibility to ensure that measured meteorological variables met stated accuracy and uncertainty requirements in order to comply with GOS requirements for the uniformity of the quality of measured variables. It was stressed that the RICs played a crucial role and endorsed that each regional association must have at least one RIC. A key responsibility of the RICs was to guarantee that values of their reference standards used for calibrations were traceable to existing international measurement standards.

7.17 Furthermore, the Commission felt that there was an urgent need for improving the guidance for RICs. It also recommended that an appropriate procedure be developed to assist in the evaluation of RICs. It recommended that the Commission's representative or regional authority should conduct periodic visits to RICs to provide needed training/briefings and validate the compliance to the stated terms of reference.

7.18 Based on the positive experience gained in the establishment and operation of the GAW global baseline network in Region II, the Commission recommended to explore the possibility of strengthening cooperation among RICs in other regions and encouraging the establishment of a mutual relationship between RICs in the developed and the developing countries.

7.19 Regarding further ways and means to strengthen the role and performance of RICs, the Commission recommended that RICs should:

(*a*) Demonstrate their capabilities and performance to the regional association concerned according to the requirements established by the relevant RA and/or CIMO;

(*b*) Be established in response to the agreed requirements of the regions and should report annually to the presidents of the regional association concerned, with a copy to the president of CIMO, on the activities of the previous year and on planned actions for the following year;

(*c*) Consider, in addition to the agreed terms of reference, assisting Members through provision of advice on technical specifications, procurement, maintenance and repair of observing systems by instrument repair teams;

(*d*) Facilitate the exchange of information with other RICs, including information on their collaboration, performance, services provided and activities planned, through the CIMO Web site.

In that regard, the Commission invited the Secretary-General to facilitate the organization of a meeting of heads of RICs with the objective to agree upon the concrete steps in strengthening RICs.

7.20 The Commission expressed its appreciation to Mr Baoxiang Xu (China) and Mr M. Diop (Senegal) for their work while serving as Rapporteur and Co-rapporteur on Capacity Building within the CIMO Advisory Working Group. The Commission acknowledged in particular the efforts of the Rapporteur on Capacity Building in supporting the preparation of the Instrument Catalogue. The Catalogue was very useful for instrument experts in providing information for selecting instruments and related equipment for procurement. The Commission expressed its gratitude to the China Meteorological Administration for the production and distribution of the first edition of the Catalogue before TECO-2000 and provision of the second updated version by the time of the thirteenth session of CIMO. It also noted that the 2002 version of the Catalogue had been compiled with a new software to ensure cross-platform compatibility and passed to the WMO Secretariat to arrange checking before distribution.

7.21 The Commission agreed to continue with the updating of a RIC database, which contained information on existing and planned RIC facilities and activities. It was of the opinion that suitable criteria and procedures should be developed and applied to ensure quality of services provided by RICs.

7.22 The Commission acknowledged that with the support of the rapporteurs and some other CIMO experts, the IOM Report No. 68 by Mr J.B. Odero entitled *Guidance Material on the Choice of Meteorological Instruments for Surface Observations Suitable for Use in Developing Countries* had been updated and would be made accessible through the WMO Web site.

7.23 The Commission expressed its appreciation that several activities requested by Thirteenth Congress had been initiated within IMOP to better involve manufacturers and suppliers of meteorological equipment in the work of CIMO. Noting the important contribution to instrument technology made by the private sector, the Commission agreed that there should be a continuing active dialogue with manufacturers, and that their collaboration should be sought in providing comprehensive training on their systems, especially in developing countries. The Commission urged Members as well as private industry to sponsor IMOP training events, to support RICs, instrument intercomparisons and related technical conferences. The Commission agreed that experts from manufacturers should be more involved in the work of the Commission.

7.24 In that connection, the Commission welcomed the establishment of the Association of Hydro-Meteorological Equipment Industry (HMEI) in 2001, which was seen as another important step to promote cooperation between Members, the WMO Secretariat and instrument manufacturers. That Association, once the legal instruments had been deposited, would serve as the forum for the exchange of information between private industry and WMO and its Members.

7.25 The Commission was informed of the work being carried out by the South African Weather Service to develop, install, operate and maintain its own automated weather observing stations. It recognized the benefits which could be accrued by having Meteorological Services, alone or with other NMHSs or in cooperation with the private sector, develop and operate low-cost, good quality meteorological and hydrological observing systems that were particularly suited to regions or subregions. The Commission therefore urged the Secretary-General to become more involved in working with Members and groups of Members, in cooperation with the private sector where appropriate, to encourage those types of development and implementation activities. It also urged the Secretary-General to become more active in working with manufacturers to secure reasonable, uniform pricing for observing systems and expendables, particularly where costs were a major factor in the operation and maintenance of observing systems.

7.26 The Commission expressed deep concern at the dwindling resources WMO had been able to make available for the Instrument and Methods of Observing Programme. It was, in particular, concerned that capacity building measures, such as the organization of TECOs, held under the auspices of CIMO, could not be adequately funded in the future and that specialists from developing countries would be unable to participate as necessary. The Commission discussed several options of IMOP programme implementation that could increase cost-effectiveness with a view to using savings achieved within IMOP for strengthening and supporting other IMOP activities.

7.27 Based on previous experience, the Commission felt that savings could be achieved in the interpretation services foreseen for the TECOs. In particular, the Commission agreed to provide interpretation (from French, Russian and Spanish, if required) only into English for those conferences. The Commission urged the Secretary-General to seek, in addition, other innovative ways and means to reduce the cost of TECOs, for example as regards the organization of the interpretation services, the working mechanisms of the programme committee, the production of the conference proceedings, etc. The Commission emphasized very strongly that all savings achieved through such a *modus operandi* must be re-allocated to supporting IMOP.

7.28 Considering the need for capacity building in the areas of instruments and methods of observation, training and management skills, and the need to strengthen the RICs, the Commission agreed that the work in that important field should continue and decided on the appropriate mechanisms under agenda item 13.

8. INSTRUMENT COMPARISONS (agenda item 8)

8.1 The Commission noted with pleasure the actions taken on WMO global and regional instrument comparisons during the intersessional period, namely:

(*a*) The Ninth WMO International Pyrheliometer Comparison (IPC-IX), combined with Regional Pyrheliometer Comparison of all WMO Regions, held at the World Radiation Center, Davos, Switzerland, in 2000;

(*b*) The WMO Intercomparison of GPS Radiosondes, Alcantara, Brazil, in 2001.

8.2 The Commission noted with appreciation that:

(*a*) At the Ninth International Pyrheliometer Comparison (IPC-IX), held at the WRC Davos, Switzerland, in September/October 2000, 65 radiation experts from 39 WMO Member countries participated and 85 pyrheliometers were successfully calibrated despite unfavourable weather conditions. The representatives from 18 of the 21 Regional Radiation Centres participated at the comparison. During IPC-IX, symposia and workshops also were provided for the participants and lectures and discussions during those side events contributed significantly to the exchange of information and transfer of knowledge to participants, especially those from developing countries. The Commission noted with satisfaction that the Final Report, containing the confirmed or corrected calibration factors of the regional and/or national standard instruments, had been prepared and distributed shortly after IPC-IX, so that the results could be applied in national radiation networks without delay.

(*b*) The WMO Intercomparison of GPS Radiosondes, hosted by the Meteorological Service of Brazil, was held at the Brazilian Air Force Satellite/Rocket Launch Centre in Alcantara under tropical conditions in May/June 2001. The trial was organized according to recommendations developed by the International Organizing Committee. The performance of the main types of GPS-radiosonde used for operational measurements (Vaisala (Finland), Sippican (United States), Modem (France), and Dr Graw Messgeräte (Germany)) was compared in more than 40 comparison flights. It was noted that all the GPS wind measurement systems produced high-quality wind data when working correctly. Detailed information on the performance of humidity sensors was assessed during the 20 flights. Preliminary results revealed that significant differences between the two commonly used radiosonde relative humidity sensors had not yet been resolved. The Commission was of the opinion that the results of that intercomparison would significantly improve the operational reliability of radiosonde designs. It noted that an initial summary report had been prepared and encouraged the experts involved to publish the final report as soon as possible. The Commission was informed that despite the delay in publication of the report, rectification of radiosonde system problems had occurred very soon after the tests.

8.3 The Commission noted that, as a result of an expert meeting held in Bratislava, Slovakia, in 2001, significant efforts had been made to initiate an International Rainfall Intensity Measurement Intercomparison. It was agreed that, as a first step in obtaining the required information, calibration of suitable types of rain gauges should be carried out in two independent certified laboratories. Depending on those results, field tests under the required climatological conditions might be undertaken.

8.4 The Commission stressed the importance of timely publishing of the results, conclusions and recommendations of WMO intercomparisons within the WMO Instruments and Observing Methods Report series. It emphasized that information on operation and calibration of sensors and equipment was of great interest to both NMHSs and manufacturers. However, the Commission noted the delays that had occurred in publishing some reports and agreed to address that problem with a view to achieving a timely publication of such reports in the future, within its new working structure.

8.5 The Commission recognized the importance of organizing national, regional and global tests according to the guidelines contained in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8).

8.6 The Commission noted with appreciation the support and contributions of several CIMO members in organizing the tests. It acknowledged the support of those countries that hosted the comparisons events. The cooperation of manufacturers in the events was also greatly welcomed. The Commission invited all Members to continue providing effective support to future instrument comparisons. It agreed that more intercomparison tests should be carried out in tropical and subtropical climate zones in order to properly investigate the performance of instruments, and noted the kind offer of the delegation of Mauritius to host a radiosonde intercomparison during the first half of the intersessional period.

8.7 The Commission noted that, considering the increased number of manufacturers of UV instruments, more effort was needed to provide intercomparisons of all types of spectrometer, broadband and filter instruments. Such comparisons should be considered in cooperation with CAS/GAW.

8.8 The Commission agreed to consult with the Commission for Hydrology through their respective presidents on collaboration in intercomparisons of methods and instruments for the measurement of water flow.

8.9 The Commission, recognizing the needs for further instrument comparisons and evaluation tests, agreed on the provisional programme of future WMO comparisons as contained in Annex III to this report. It also agreed to support or participate actively in tests organized by other technical commissions and programmes, if requested.

9. ADDITIONAL MATTERS RELATED TO THE INSTRUMENTS AND METHODS OF OBSERVATION PROGRAMME (agenda item 9)

COASTAL ZONE NATURAL HAZARDS

9.1 The Commission noted that the Meeting of Presidents of WMO Technical Commissions in 2001 discussed a Joint Programme to Contribute to Natural Disaster Reduction in Coastal Lowlands. Following that discussion, the president of CIMO requested a review of the issue from CIMO’s point of view and to consider additional tasks to be undertaken by relevant experts in future. The coastal zone, a transitional area between land and sea, was defined as a strip of land and sea of varying width depending on the nature of the environment and management needs. It seldom corresponded to existing administrative or planning units. The natural coastal systems and the areas in which human activities used coastal resources could therefore be extended well beyond the limit of territorial waters as well as many kilometres inland.

9.2 Natural disasters were events caused by the forces of nature that adversely affected human settlements and the environment. A dense network of observation was required to assess and mitigate weather-related hazards near coastal zones. Wider use of AWSs would immensely help in monitoring and warning of weather-related hazards in those areas.

9.3 The topography and the vulnerability of the coastal zone to severe weather was an important factor in assessing AWS network requirements. The network should also be capable of disseminating the observational data collected in real time for operational use by forecasting and warning offices. That would enable prompt diagnosis, planning and preparedness measures.

9.4 The Commission further noted that severe weather systems affecting coastal areas mostly originated in the seas and ocean adjoining the coast. It was therefore necessary to enhance the data monitoring efforts over those areas. Although space-based and remotely sensed data were available, it was important to have real-time surface-based observations as so-called "ground-truth". The data from ships' observations and the data from ocean buoys were crucial for tracking the storms and for providing reliable forecasts. Both *in situ* and remote sensing techniques had evolved during recent years. The monitoring system for a specific type of natural disaster needed a combination of several techniques and its design required a high degree of expertise and investment.

INTEGRATED STRATEGIES FOR COASTAL ZONE MANAGEMENT

9.5 The Commission reiterated that integrated management strategies should ensure the safety of inhabitants and safeguard property from natural hazards such as high waves, storm surges and tsunamis. In that connection, adequate and timely arrangements by local authorities for disaster preparedness were crucial. Those strategies, comprising a wide spectrum ranging from the development of an appropriate instrumentation and technologies to training material, needed to be properly designed and put into operation. In highly populated coastal zones, the vulnerability of the supporting infrastructure, such as roads, waste facilities and water supply, also had to be taken into consideration. Disaster prevention facilities along the coast could be strengthened if potential threats (including those due to climate change) were properly analysed. An increased water table due to sea-level rise could weaken coastal structures, making them more vulnerable to other natural hazards, such as earthquakes and severe weather storms.

9.6 The Commission agreed that the process of risk assessment and mitigation required development of:

(*a*) An efficient and robust early warning system;

(*b*) A fast and reliable data and information dissemination system;

(*c*) A study of pre-disaster hazards, vulnerability and risk assessment inventories;

(*d*) An efficient post-disaster management and recovery strategy;

(*e*) A high level of public awareness.

9.7 The Commission noted that integrated strategies for coastal zone management had already been launched by some Members of the WMO/ESCAP Panel on Tropical Cyclones for the Bay of Bengal and the Arabian Sea. It therefore agreed to interact with that body as well as with JCOMM in order to join the available experience and activities for the transfer of technology to assist in implementing an effective operational strategy required for coastal zone management.

INSTRUMENT REQUIREMENTS FOR COASTAL ZONE MONITORING

9.8 The Commission noted that in addition to conventional techniques, a number of new techniques, such as remote sensing, were available for weather and climate monitoring. High-resolution mesoscale and limited area models also had been developed and used for nowcasting, very-short- and short-range forecasting. Their worldwide operational use had become possible due to the availability of high-performance affordably-priced computers. Thus, in addition to existing surveillance systems, those models had become an effective tool for early warning systems of weather-related natural disasters. To achieve the best results, models required as much data as possible for assimilation within the geographic domain of a model. That created an additional requirement for data in support of such numerical models.

9.9 Computer systems had been deployed in natural disaster management strategies using GIS as a very effective tool for management in different phases of a natural disaster. Those systems were still in an evolutionary phase and needed further improvements; however, GIS, even in its early stages, depended on operational meteorological data from monitoring networks.

9.10 The Commission also noted that existing ocean-based monitoring systems provided ocean parameters both above and below the sea surface. The application of AWS in an ocean environment was affected by the harsh environment and needed further enhancement. The measurement of parameters, such as sea surface temperature, salinity, wave periods and wave heights, with the required accuracy was a challenging task. Integrated observing systems for the ocean-to-land interface needed improvement to meet the requirements of forecasting and warning systems. One of the challenging tasks was also the design of wind measuring equipment that would reliably measure wind gusts in tropical cyclones reaching 300 km/h or more.

9.11 The Commission agreed that more attention should be given to the application of meteorological instruments, suitable for use in advanced forecasting and warning systems, for use in coastal zone monitoring.

9.12 Recognizing that coastal zone management and related NMHSs activities had become increasingly important, the Commission agreed that the work of CIMO in that field should continue through appropriate mechanisms discussed under agenda item 13.

10. GUIDE TO METEOROLOGICAL INSTRUMENTS AND METHODS OF OBSERVATION (agenda item 10)

10.1 The Commission expressed its appreciation to the Secretary-General that the translation of the sixth edition of the *Guide to Meteorological Instruments and Methods of Observation* (WMO No. 8, 1996) in the four WMO languages was accomplished and that it had been distributed to all Members accordingly. It noted with interest that the China Meteorological Administration had translated the Guide into the Chinese language. The Commission stressed that the Guide was an important means to guarantee a continued high quality of observations.

10.2 The Commission learned that during the intersessional period several proposals for supplementing and updating as well as for corrections had been received from CIMO experts as well as from scientists working outside of the meteorological community and taking benefit of the Guide for their work. It noted that significant work had been done in reviewing the Guide and implementing those proposals but it recognized that that work could not be finished prior to the session of the Commission and had to be continued.

10.3 The Commission noted with appreciation that two new chapters had been drafted for implementation in Part II of the Guide, namely Chapter 11 on Urban Observations, prepared by the Co-rapporteurs on Urban Meteorological Measurements, Prof. T. Oke (Canada) and Mr R.D. Vashistha (India); and Chapter 12 on Road Meteorological Measurements prepared by the Co-rapporteurs on Road Meteorological Observations, Mr T. Ledent (Belgium) and Mr J. Terpstra (Netherlands). It recognized that more reviewing and editing work was still needed before the president of CIMO in consultation with the Management Group could approve it for publication.

10.4 The Commission expressed concern that too few experts were available to update and expand the Guide in a timely manner, primarily because of the expertise and time required for that task. The Commission invited the Secretary-General to inform Permanent Representatives of the importance to all Members and technical commissions of the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8) for providing definitive guidance and as an indispensable training resource, and to encourage them to make available their experts and to afford them time and due recognition in that important work.

10.5 Understanding the need for continuous updates of the Guide in implementing corrections, supplements or new Chapters and taking into account requirements for fast and easy access to the Guide, the Commission invited the Secretary-General to make arrangements for the production of an electronic version of the Guide, as a matter of urgency.

10.6 The Commission stressed the need for a continuous review and update of the Guide due to fast development of observing technology and observing practices. In that regard, it invited the newly established OPAGs and Expert Teams to support that work by providing the necessary contributions for its further update. The Commission invited its president to monitor the process of reviewing and collaborate on that matter with the newly-established Management Group.

11. LONG-TERM PLANNING AND FUTURE WORK PROGRAMME OF THE COMMISSION (agenda item 11)

FOURTH AND FIFTH WMO LONG-TERM PLANS

11.1 The Commission noted that Thirteenth Congress had adopted the Fifth WMO Long-term Plan (5LTP) and noted that the Executive Council at its fifty-third session adopted Guidelines on Monitoring and Evaluation of the Implementation of the 5LTP. Since the implementation period of the 5LTP was 2000–2009, the intersessional period overlapped both the 4LTP and 5LTP. The chairpersons of the working groups and rapporteurs of the Commission were requested to keep the plans under review. The president of the Commission, with the support of the Advisory Working Group (AWG), evaluated the activities of the Commission during the intersessional period, and submitted his report to the EC Working Group on Long-term Planning established for that purpose by the fifty-first sessions of the Executive Council.

11.2 The Commission summarized the monitoring and evaluation of the IMOP in 2000–2001 as follows. There had been definite progress in improving quality and reliability of instruments through calibrations and intercomparisons, specifically with respect to GPS-based radiosondes, rain gauges and pyrheliometers. The development of functional definitions and standards for automated weather stations assisted in the production and application of those systems. The provision of technical assistance to developing countries, the IMOP technical publications, including new or revised chapters to the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), as well as technical conferences, improved the installation, applications and maintenance of instruments. Collaboration with international organizations such as BIPM, ISO and ITU was important for addressing interdisciplinary issues. Close collaboration with the instrument industry, *inter alia*, resulting in the establishment of the Association of the Hydro-Meteorological Equipment Industry, strengthened the position of the Members' NMHSs vis-à-vis that community and furthered mutual understanding of needs and opportunities. The advancement of the RICs in developing countries and the linkage between the needs of NMHSs and the potential services of the RICs progressed more slowly than planned. The low availability of instrument experts from NMHSs and of financial resources was the reason for some delays or postponements in certain programme activities, including training events.

11.3 The individual achievements in the period 2000–2002 were as follows:

(*a*) The Commission continued its work related to the development and publication of standardized procedures and practices for meteorological and related environmental observing methods and systems;

(*b*) The International/Regional Pyrheliometer Comparisons were held at the World Radiation Center, Davos, Switzerland in 2000; 65 radiation experts participated in the test and associated workshops and symposia (see also agenda item 8);

(*c*) The intercomparison of GPS radiosondes was held in Brazil in 2001, with the scale of the test enlarged to accommodate five radiosonde types, at the request of the manufacturers. A test of recording precipitation gauges was under preparation (see also agenda item 8);

(*d*) Besides the meetings of CIMO working groups, several expert meetings, some in collaboration with CBS, developed functional specifications and future requirements for automatic weather stations, the automation of visual observations, the implementation of new BUFR code tables, rain intensity measurements, and radiosonde application in the tropics;

(*e*) Activities related to strengthening capacity building addressed actions to enhance the collaboration of

CIMO with regional associations and enhancement of performance and services of RICs;

(*f*) Technology transfer through technical conferences (TECO/METEOREX 2000 and 2002) and training workshops;

(*g*) The WMO Instrument Catalogue on CD-ROM was compiled and published by the China Meteorological Administration;

(*h*) The establishment of an Association of Hydro-Meteorological Equipment Industry (HMEI) was successfully promoted in order to enhance the collaboration between WMO and the private instrument sector;

(*i*) Interdisciplinary issues were supported through collaboration with other technical commissions and bodies outside WMO, such as ISO and BIPM, including a draft formal working agreement between WMO and the latter;

(*j*) Guidance and expert visits were provided to some NMHSs to help develop their germane instrument manufacturing facilities, organize coordinated procurement of instruments and consumables and develop coordinated instrument projects.

11.4 The Commission expressed general satisfaction with the achievements of the IMOP. The Commission was, however, of the opinion that the programme output fell somewhat short of the targets of the 5LTP, specifically concerning the technical and training support planned for developing countries' instrument maintenance and calibration. Furthermore, it noted that progress was slower than expected in some specific areas of instrument development and standardization of procedures and practices. The reasons for those shortfalls were seen in the insufficient number and/or time of experts made available by Members for that work, which was compounded by the limited financial resources allocated to that programme by Congress.

DRAFT SIXTH WMO LONG-TERM PLAN

11.5 As regards the draft 6LTP, the Commission noted that the draft proposal on the IMOP that had been reviewed by the CIMO Advisory Working Group, had been reviewed and agreed by the forty-fourth session of the Executive Council for submission to Fourteenth Congress. The Commission agreed to recommend to Congress the adoption of the IMOP section of the 6LTP.

FUTURE WORK PROGRAMME

11.6 The Commission, in considering the IMOP programme activities given in the 5LTP and further developed in the draft 6LTP, as well as the proposed new structure of CIMO (see agenda item 13), decided to concentrate on the following main activities:

(*a*) Develop performance measures to demonstrate continuous improvement in the quality of observations;

(*b*) Conduct instrument intercomparisons;

(*c*) Contribute to the review and update of WMO Technical Regulations, Guides and other material related to Quality Management and standardization of observations;

(*d*) Evaluate existing Regional Instrument Centres and review their terms of reference;

(*e*) Facilitate standardization of measurements of long-wave radiation;

(*f*) Facilitate the automation of manual, visual and subjective observations;

(*g*) Strengthen links with relevant international organizations.

11.7 The Commission also made suggestions on key results for the implementation period 2004–2007 of the draft 6LTP as stated in Annex IV to this report.

12. COLLABORATION WITH OTHER WMO PROGRAMMES AND RELEVANT INTERNATIONAL ORGANIZATIONS (agenda item 12)

12.1 The Commission noted with appreciation the work of its president, vice-president and members of the Advisory Working Group aimed at improving the collaboration with other technical commissions and Programmes of WMO and relevant international organizations. It also expressed its appreciation that the CIMO experts concerned, supported by the WMO Secretariat, responded in a timely manner to the requests received.

COMMISSION FOR BASIC SYSTEMS (CBS)

12.2 The Commission noted that work related to surface and upper-air observations as well as on improvement of the consistency between the *Guide on the Global Observing System* (WMO-No. 488), the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8) and the *Manual on the Global Observing System* (WMO-No. 544) had continued.

12.3 The Commission noted with appreciation that CIMO experts provided continued support related to radiofrequency allocations available to MetAids, such as for radiosonde, weather radar and wind profiler operations. The Commission also noted the activities carried out in the framework of radiofrequency protection for satellite observing systems and stressed the need of maintaining close coordination with similar activities related to the ground-based observing systems.

12.4 The Commission noted that, based on reported deficiencies in upper-air measurements in the tropics, an Expert Meeting on Operational Issues for Radiosonde Applications in the Tropics and Subtropics had been held in Geneva in 1999. The Commission appreciated that the meeting's proposal to carry out WMO radiosonde intercomparisons, with the main objective of obtaining information on the performance and reliability of the GPS wind-finding system as well as on temperature and humidity observations, had been achieved (see agenda item 5.1).

12.5 The Commission noted with interest the increased collaboration between CIMO and CBS in the field of automation of observations, especially automation of visual and subjective observations such as users' requirements in the light of integrated observing systems and AWS data representation. In that regard, it recalled the outcomes of the Expert Meeting on Requirements and Representation of Data from

Automatic Weather Stations, held in The Netherlands in 1999, and also meetings of the CBS/OPAG/IOS Expert Team on Requirements for Data from AWS held in 2000 and 2002 in Geneva (see agenda item 4.1). The Commission also noted the valuable input CIMO representatives provided to the CBS Expert Team on Requirements and Representation of Data from Automatic Weather Stations, specifically the Expert Team's first meeting held in Geneva in 2000.

COMMISSION FOR AERONAUTICAL METEOROLOGY (CAEM)

12.6 The Commission noted the prompt reply to a request of the president of CAeM asking for further assistance in establishing appropriate definitions for precipitation intensity and definitions of weather phenomena suitable for aeronautical meteorological use.

12.7 The Commission noted a request from ICAO to review the "Operationally Desirable and Currently Attainable Accuracy of Measurement or Observation" related to the update of Attachment B of ICAO Annex 3/ WMO Technical Regulation [C.3.1] (WMO-No. 49, Volume II). That would be considered when updating the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8, Annex 1.B – Operational accuracy requirements and typical instrument performance).

COMMISSION FOR AGROMETEOROLOGY (CAGM)

12.8 The Commission noted the timely reply to a request from the president of CAgM asking for information on automatic observing technology for agricultural applications, especially related to humidity parameters, soil temperature and object wetness duration.

COMMISSION FOR CLIMATOLOGY (CCl)

12.9 The Commission stressed the need for close cooperation with CCl, especially in view of the replacement of traditional measurements/instruments by automatic weather stations to assure homogeneous time series. In particular, CIMO Expert Teams should interact closely with relevant CCl Expert Teams such as the ET on Observing Requirements and Standards for Climate, the ET on Metadata for Climate Applications and the ET on National Networks and Observations in Support of Climate Activities. The Commission also noted the need to support the requirements of the atmospheric, terrestrial and oceanographic observational components of the Global Climate Observing System.

NATURAL DISASTER REDUCTION

12.10 The Commission noted that an action had been taken as a result of the 2001 Meeting of Presidents of Technical Commissions, related to a Joint Programme to Contribute to Natural Disaster Reduction in Coastal Lowlands (see agenda items 3 and 9).

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

12.11 The Commission was informed that some CIMO members took an active part in the work of Subcommittee SC 5 Meteorology established within Technical Committee TC 146 Air Quality of ISO. It was noted that the work of SC 5 had significantly progressed and standards of interest to both WMO and ISO had been drafted and were in the process of being approved (see agenda item 4.1). In that regard, the Commission encouraged Members to maintain close liaison with ISO.

INTERNATIONAL BUREAU OF WEIGHTS AND MEASURES (BIPM)

12.12 In recognizing the value of closer WMO collaboration with the *Bureau International des Poids et Mesures* (International Bureau of Weights and Measures)*, the Commission was pleased to note that an Agreement of Collaboration with WMO, approved by the International Committee for Weights and Measures (CIPM) had been submitted to the fifty-fourth session of the Executive Council for approval. The Commission noted that in accordance with that Agreement, WMO and CIPM with the aim of effectively attaining the objectives set forth in their respective constituent mechanisms, would act in close cooperation with each other and would consult each other regularly in regard to matters of common interest. Both organizations agreed to consult together to ensure that data, related in particular to atmospheric composition and water resources, coming from the WMO programmes were properly based on units traceable to the International System of Units (SI) through the procedures drawn up by the CIPM and those of the WMO *Technical Regulations*. Suitable arrangements would be made for the participation of each Party to the Agreement as an observer in those sessions and meetings of the other Party at which matters of common interest were discussed. The Commission noted with appreciation the presentation to the session by the representative of BIPM, who outlined the major activities of his international organization.

COOPERATION WITH OTHER INTERNATIONAL ORGANIZATIONS

12.13 The Commission recognized that meteorological and related geophysical and environmental observations played an essential role in many programmes carried out by other international organizations. It was stressed that the work of the Commission provided important contributions towards the cooperation between WMO and other international organizations, such as FAO, IOC, ITU, UNEP and UNESCO.

COLLABORATION WITH MANUFACTURERS OF HYDRO-METEOROLOGICAL EQUIPMENT

12.14 At the request of Thirteenth Congress to strengthen the collaboration with the private instrument industry, meetings were carried out, under the auspices of CIMO, with the representatives of manufacturers to enhance the collaboration between WMO and manufacturers. The Commission noted with appreciation that the Association of Hydro-Meteorological Equipment Industry (HMEI)** had been established in 2001 (see agenda item 7). Furthermore, the Commission was

* See more information at http://www.bipm.org

** See more information at http://www.hydrometeoindustry.org pleased to note that the Executive Council considered the objectives and main activities of HMEI, and agreed that it would be of mutual benefit to both WMO and HMEI to establish a close working relationship. It also underlined that collaboration with manufacturers and suppliers could lead to better and more cost-effective equipment availability to Members and concluded that WMO, especially through CIMO, should continue efforts to enhance that collaboration which would also help to provide advice to developing countries in choosing adequate observing technologies. The Council had considered the request submitted by HMEI and granted the Association consultative status with WMO, which gave the right to HMEI to participate in meetings and sessions of relevant WMO bodies as observer. The Web site arranged by HMEI should further facilitate for Members to review the state-of-the-art of operational instrumentation and methods of observations. The Commission also noted with appreciation the presentation to the session provided by the Chairman of HMEI, who outlined ongoing and planned activities of the Association.

12.15 The Commission expressed its gratitude to the radiosonde manufacturers who had provided support for the organization of the WMO Intercomparison of GPS Radiosondes held in Brazil in 2001.

EUROPEAN UNION COOPERATION ON SCIENCE AND TECHNOLOGY (COST)

12.16 The Commission noted the increased involvement of CIMO members in the activities of the European Union Cooperation on Science and Technology, such as COST-715 (meteorology applied to urban air pollution problems) (see agenda item 4.7), COST-76 (networking of wind profiler radars) (see agenda item 5.7), COST-717 (use of radar observations in hydrological and NWP models) (see agenda item 5.8), COST-716 (total water vapour) (see agenda item 5.4) and COST-720 (integrated atmospheric profiling). In that regard, the Commission urged Members to continue their active participation in COST actions relevant to IMOP and requested the Secretary-General to ensure WMO representation in those actions to facilitate the rapid transfer of results and knowledge to all interested parties.

13. FUTURE WORKING STRUCTURE OF THE COMMISSION, ESTABLISHMENT OF GROUPS AND NOMINATION OF EXPERTS (agenda item 13)

13.1 The Commission considered structures that would enable it to meet the needs of Members most effectively during the next intersessional period. In doing so, it took account of its performance over the previous period, the recommendations of its working groups and Rapporteurs, the conclusions of other WMO constituent bodies on issues related to CIMO, and the roles of other relevant intergovernmental and non-governmental organizations. In particular, the Commission took note of the conclusions of Thirteenth Congress and the Executive Council on the WMO structure, including that of the technical commissions.

13.2 The Commission noted that, when discussing the WMO structure, the fifty-third session of the Executive Council agreed that structural changes should better facilitate the realization of WMO's Long-term Plans. The Executive Council also agreed that in the light of rapid changes, new structures should allow for flexibility, responsiveness and delegation of responsibility. In that connection, the Council noted that the implementation of a new structure within CBS had been successful in achieving objectives of the World Weather Watch Programme, and in improving links with other technical commissions and regional associations. The Council considered that the CBS experience might also be useful to other commissions, but that it was up to each commission to consider its appropriateness, in all or in part, to its particular requirements.

13.3 The Commission recognized the need for a structure that would improve its efficiency and effectiveness and permit greater participation of Members, regional associations and other WMO technical commissions in its activities, while responding more effectively to their evolving needs. The kind of structure adopted should lead to the Commission achieving its goals as defined in the WMO Long-term Plan and its terms of reference to the maximum extent possible.

13.4 The Commission agreed that a new structure would need to relate to the operational responsibilities facing NMHSs, including commercialization, the important private manufacturing sector and prevailing global financial constraints. The working mechanisms should support improved coordination, flexibility, timeliness, appropriate delegation of responsibilities, better information flow, responsiveness to the needs of stakeholders, and promote creativity and innovation. The new structure would enable the use of appropriate expertise to tackle specific problems, lead to closer working relationships with the regional associations and other technical commissions to better address cross-cutting issues, and would facilitate the use of expertise from outside the Commission.

13.5 The Commission concluded that the most effective, flexible and responsive means of carrying out CIMO tasks would be a system of Expert Teams (ET) complemented by suitable ways to inform and involve all CIMO members in the process. The Commission agreed that its activities and teams should be grouped together and handled by Open Programme Area Groups (OPAGs) that do not hold meetings and whose members would be regularly consulted and informed by the chairpersons of each group by e-mail or correspondence or through the WMO/CIMO Web site. That would achieve a broad ownership through the involvement of experts from among Members. The Commission noted that the success of the system would depend on the selection of active and committed co-chairpersons of each OPAG. An ET would be based mainly on the expertise needed, equitably selected from different geographical areas whenever feasible.

13.6 The co-chairpersons would determine the appropriate allocation of responsibilities for the leadership of the ETs, including coordination of their work, reports, etc., and were responsible for the management and scientific/technical guidance of the work of the OPAG area.

13.7 The Commission decided to establish three Open Programme Area Groups, each group comprising a set of specific programme activity areas, and adopted Resolution 1 (CIMO-XIII). It agreed on preliminary terms of reference given in Annex V to this report. The OPAGS were as follows:

(*a*) OPAG on Surface Observation Technology (OPAG-Surface). Taking into account user requirements, the OPAG would evaluate appropriate instrumentation in varying environments, recommend observing methods and provide information on new technologies and systems for measurement of surface meteorological variables;

(*b*) OPAG on Upper-air Observation Technology (OPAG-Upper-air). Taking into account user requirements, the OPAG would evaluate appropriate instrumentation (both *in situ* and remote sensing) in a variety of atmospheric conditions and provide information on new sensors for measurement of upper-air meteorological variables;

(*c*) OPAG on Capacity Building (OPAG-CB). The OPAG would address all CIMO aspects of capacity building activities (through training, technical conferences and RICs). It would also coordinate the ongoing update of the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), as well as publications in the IOM Report series and on the WMO/CIMO Web site. Furthermore, it would interact with other organizations and other WMO technical commissions.

13.8 The Commission noted that topics could overlap among the programme areas and therefore stressed the need for appropriate interactions to ensure that such topics were managed effectively. The Commission agreed that a highly effective Management Group was needed to ensure proper integration of its programme areas, evaluate progress achieved, decide upon priorities, coordinate strategic planning and decide on necessary adjustments to the working structure during the intersessional period. It recognized that a complex structure of teams with many active links to other technical commissions, regional associations and relevant bodies outside WMO required an effective and flexible management. It requested the CIMO Management Group (see Annex to Resolution 1 (CIMO-XIII)) to ensure the technical and scientific integrity of the IMOP programme areas and to review the availability of resources, and it authorized the president to make the necessary adjustments as needs arose.

13.9 The Commission agreed that overarching activities, such as the development of the Commission's strategy regarding the integrated observing systems, resource mobilization and cost reduction of high-cost observational systems, also pertained to the responsibility of the Management Group.

13.10 The Commission emphasized that the essential criteria for establishing ETs and defining their membership were the achievement of the identified tasks and the assessment of how they should be implemented. The Commission also requested each of the OPAG co-chairpersons to ensure that specific work areas, described in respective parts of the final report of the thirteenth session of CIMO, were adequately addressed as well as the WMO 6LTP. The Commission agreed that ETs should normally be established at sessions of the Commission. However, the Commission found it difficult to establish the ETs during the session and authorized the president, with assistance from the Management Group, to establish the ETs that would address programme activity areas, and to determine their membership in the near future to facilitate early activation of their work on agreed priorities. The Commission also urged that special efforts should be made to explore extrabudgetary resources to support the work programme.

13.11 The Commission noted with appreciation the experts proposed by the Members who were available to work within the OPAGs. A preliminary list of experts proposed to actively support the working programme of the Commission is given in Annex VI to this report. The Commission underlined the open nature of the OPAGs, meaning that any interested expert could become a member of an OPAG. The Commission also welcomed Members to propose additional experts, who would be suitable for the tasks identified by the Commission, prior to the first meeting of the Management Group, which was intended to be held in the first quarter of 2003.

13.12 The Commission agreed to establish a CIMO Management Group by adopting Resolution 2 (CIMO-XIII), and to designate the co-chairpersons of the OPAGs by adopting Resolution 3 (CIMO-XIII).

14. REVIEW OF PREVIOUS RESOLUTIONS AND RECOMMENDATIONS OF THE COMMISSION AND OF RELEVANT RESOLUTIONS OF THE EXECUTIVE COUNCIL (agenda item 14)

14.1 The Commission examined those resolutions and recommendations adopted prior to its thirteenth session and also the Executive Council resolutions relating to the Commission which were still in force.

14.2 The Commission noted that actions on most of its previous recommendations had either been completed or their contents were being included in the relevant WMO Manuals and in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8). However, the Commission agreed to maintain in force recommendations on which action had not been completed.

14.3 The Commission accordingly adopted Resolution 4 (CIMO-XIII).

14.4 The Commission agreed that the contents of the relevant recommendations confirmed by the Executive Council should, as far as possible, be included in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8) and when that was accomplished they should not be kept in force.

14.5 The Commission reviewed the Executive Council resolutions relating to the Commission.

14.6 The Commission accordingly adopted Recommendation 2 (CIMO-XIII).

15. ELECTION OF OFFICERS (agenda item 15)

Mr S.K. Srivastava (India) was elected as president of the Commission and Mr R.P. Canterford (Australia) was elected as vice-president.

16. DATE AND PLACE OF THE FOURTEENTH SESSION (agenda item 16)

In the absence of any formal invitation from Members represented at the session, the Commission decided that the date and place of the fourteenth session should be decided at a later date and requested its president to make the necessary arrangements in consultation with the Secretary-General.

17. CLOSURE OF THE SESSION (agenda item 17)

17.1 In his closing address, Mr Srivastava, the president of CIMO, thanked all members of the Commission and particularly the experts, who had served as rapporteurs and as members of the working groups, for their valuable contributions made during the intersessional period, and specifically for the reports they had submitted to the session. He further expressed his thanks to the delegates for their active participation in the work of the session, and the chairpersons of the working committee and the members of the ad hoc group set up during the session, for their valuable work.

17.2 Several delegates expressed their appreciation to the host country for the excellent organization of the session and the warm hospitality provided by the Government of Slovakia and the Slovak Hydrometeorological Institute (SHMI). He also thanked the president and vice-president for the excellent leadership during the intersessional period and during the session.

17.3 Mr Škulec, the Director-General of the Slovak Hydrometeorological Institute (SHMI), thanked WMO for having had the chance to host the thirteenth session of CIMO, TECO-2002 and METEOREX-2002. He believed that the facilities and support provided by local organizers to all delegates and WMO staff contributed to the smooth run and outcomes achieved during those events.

17.4 On behalf of the Secretary-General, Mr D.C. Schiessl expressed his cordial thanks to the Government of Slovakia and to the SHMI, the local organizer of the thirteenth session of CIMO, TECO-2002 and METEOREX-2002, especially to Mr Stefan Škulec, General Director of SHMI, and his staff for the excellent organization and arrangements made for the success of those events. He also expressed his appreciation to the president and vice-president of the Commission for their leadership in guiding the Commission over the past four years and for the outstanding work, which had been accomplished during the intersessional period. He congratulated the president and vice-president on their re-election.

17.5 The thirteenth session of the Commission for Instruments and Methods of Observation closed at 12.23 p.m. on 3 October 2002.

RESOLUTIONS ADOPTED BY THE SESSION

RESOLUTION 1 (CIMO-XIII)

WORKING STRUCTURE OF THE COMMISSION FOR INSTRUMENTS AND METHODS OF OBSERVATION

THE COMMISSION FOR INSTRUMENTS AND METHODS OF OBSERVATION,

NOTING:

(1) The endorsement by Thirteenth Congress (1999) of the need to encourage and promote overall participation in, and cooperation among, the technical commissions and regional associations,

(2) The agreement at the fifty-third session of the Executive Council (Geneva, 2001) that structural changes would better facilitate the realization of WMO's Long-term Plans and that, in the light of rapid changes, would allow for more flexibility, responsiveness and delegation,

(3) The consideration of the fifty-third session of the Executive Council that the new structure within the Commission for Basic Systems had been successful in achieving objectives of the World Weather Watch Programme and in improving the links with other technical commissions and the regional associations,

(4) The need for far greater resources in terms of expertise to fulfil its responsibilities,

CONSIDERING the need to:

(1) Provide a greater opportunity for experts, including representation from other bodies dealing with issues related to CIMO, to work in highly focused teams on important specific technical problems,

(2) Enhance participation of experts from developing countries in the work of the Commission,

(3) Build and maintain effective links to the regional associations, and relevant instrument manufacturers,

(4) Improve the flow of technical information concerning the activities of the Commission to all Members,

DECIDES:

(1) To implement the new working structure consisting of Open Programme Area Groups (OPAGs) as given in the annex to this resolution;

(2) To keep under review and evolve further the terms of reference of the OPAGs through the Management Group, in response to the evolving requirements during the intersessional period;

AUTHORIZES the president to establish and activate Expert Teams in accordance with priorities agreed by the Commission and the Management Group;

AUTHORIZES FURTHER the president, with assistance from the Management Group, to establish during the intersessional period Expert Teams for areas additional to those agreed by the Commission, if a demand arises;

REQUESTS the president of the Commission, with assistance from the Management Group, to keep the impact and effectiveness of the new working structure under review and to provide a report to the next session of the Commission;

INVITES the Secretary-General to arrange, within available resources, for the support of the new structure that will facilitate the participation of the members of the OPAGs and the Expert Teams in the work of CIMO.

ANNEX TO RESOLUTION 1 (CIMO-XIII)

WORKING STRUCTURE OF THE COMMISSION FOR INSTRUMENTS AND METHODS OF OBSERVATION

1. The working structure of the Commission will comprise a system of small, task-focused Expert Teams (ETs) complemented by suitable ways to involve and inform all CIMO members in the process. The activities of CIMO are grouped under three main open programme areas:

(*a*) Surface Observation Technology (Surface);

(*b*) Upper-air Observation Technology (Upper-air);

(*c*) Capacity Building (CB).

2. The activities under each of these open programme areas are handled by Open Programme Area Groups (OPAGs):

(*a*) OPAG on Surface Observation Technology (OPAG-Surface);

(*b*) OPAG on Upper-air Observation Technology (OPAG-Upper-air);

(*c*) OPAG on Capacity Building (OPAG-CB).

3. The members of the OPAGs are regularly consulted and informed through suitable means of distribution, such as circular letters from the CIMO president or co-chairpersons and the WMO/CIMO Web site.

CIMO Management Group (MG)

4. The CIMO MG shall consist of the president and vice-president, the co-chairpersons of the three OPAGs, along with the minimum additional experts needed to ensure regional representation. The CIMO MG should not normally exceed eight members in total. The group has a strong, active and pivotal role in guiding and managing the Commission's activities between sessions. It is responsible for ensuring the integration of the programme areas, for strategic planning issues, for the evaluation of the progress achieved in the agreed work programme and for related necessary adjustments to the working structure in the intersessional period. The CIMO MG should meet at least once, preferably twice, in the intersessional period. The Commission, by means of a resolution, decides the terms of reference for the CIMO MG. The reports of the CIMO MG meetings will be accessible through the WMO/CIMO Web site and distributed to members of CIMO.

5. The Management Group must be fully committed to its management responsibilities. The MG should:

- Focus on user requirements;
- Monitor and make adjustments to the terms of references of the OPAGs;
- Coordinate the specific tasks and schedules resulting from the work of the specific programme activities (ETs);
- Set standards for the documentation/reporting of the Commission;
- Conduct a regular management review.

Open Programme Area Groups (OPAGs)

6. The terms of reference of the OPAGs and the designation of co-chairpersons are decided by the session of the Commission. The terms of reference of a general nature are defined for each OPAG, together with specific tasks, and are approved by the Commission. The co-chairpersons of each OPAG coordinate and manage the work of the ETs. The ETs, established by the Commission or its president with the assistance of the CIMO Management Group, carry out specific tasks assigned to them. The co-chairpersons will determine the appropriate allocation of responsibilities for the leadership of the ETs, including coordination of their work, reports, etc. The co-chairpersons are responsible for the management and technical guidance of the work of the OPAG area.

Expert Teams (ET)

7. An ET is mainly based on expertise to develop proposed solutions to scientific/technical problems and for studying issues for which specific expert knowledge is needed. In some cases it may be more effective to establish a Rapporteur instead of a team for certain specific tasks. The Rapporteur should be seen within this working structure as a "one-member" team, for example either providing expert guidance or input, or enhancing the reporting on regional issues and on implementation. The terms of reference of the ETs are established by the session of the Commission, the president, or the MG.

8. The leaders of the ETs are normally designated by a session of CIMO. If this is not possible, the team leaders will be designated by the president upon a recommendation from the co-chairpersons of the OPAG.

9. Members of the ETs will be designated by their team leaders in consultation with the OPAG co-chairpersons and approved by the MG. If this is not possible, an alternative mechanism agreed to by the president will be invoked. Subsequent establishment and activation of the ETs is normally done by the session of CIMO or its president under guidance from the MG. The OPAG co-chairpersons will invite suitable experts from other interested bodies to participate in CIMO Expert Teams.

10. The ETs are expected to deliver their working results within a specific time period to their parent body. Work by correspondence or meetings, as necessary, should achieve this. The need for the meetings of the ETs will be considered by the MG in consultation with the Secretariat taken due note of the nature and urgency of the task(s) entrusted to the teams. The reports of the ETs will generally be accessible through the WMO/CIMO Web site or distributed by regular mail, as necessary.

11. ET chairs may, with the approval of the MG, draw upon CIMO experts as required to accomplish their tasks. ET chairs should plan their tasks and milestones and report regularly on the progress achieved in carrying out tasks assigned to their teams.

RESOLUTION 2 (CIMO-XIII)

COMMISSION FOR INSTRUMENTS AND METHODS OF OBSERVATION MANAGEMENT GROUP

THE COMMISSION FOR INSTRUMENTS AND METHODS OF OBSERVATION,

NOTING:

(1) The *Abridged Final Report with Resolutions and Recommendations of the Twelfth Session of the Commission for Instruments and Methods of Observation* (WMO-No. 881),

(2) The *Abridged Final Report with Resolutions of the Thirteenth World Meteorological Congress* (WMO-No. 902), paragraph 6.4.3,

RECOGNIZING:

(1) That the effectiveness of the Commission depends to a large extent on the effective management of its activities between sessions,

(2) That an ongoing management function is required to ensure the integration of programme areas, decide upon priorities taking account of the availability of resources, evaluate the working progress achieved, coordinate strategic planning, and decide on necessary adjustments to the working structure of the Commission during the intersessional period,

DECIDES:

(1) To establish a CIMO Management Group (CIMO-MG) with the following terms of reference:

(*a*) Advise the president on all matters related to the work of the Commission;

(*b*) Plan, coordinate and actively manage the work of the Commission, its Open Programme Area Groups and Expert Teams, including evaluating the progress achieved in the work programmes and advising on the new priority activities;

(*c*) Ensure the overall integration of the programme areas and coordinate strategic planning issues, focusing on user requirements;

(*d*) Advise the president on matters related to cooperation with other technical commissions, regional associations and other relevant international organizations and governmental or non-governmental bodies;

(*e*) Mobilize resources to enable the work of the Commission to be achieved;

(*f*) Keep under review the internal structure and working methods of the Commission and make adjustments, as necessary, with a view to increasing its efficiency;

(*g*) Keep under review the terms of reference of the Open Programme Area Groups and Expert Teams and make necessary adjustments;

(*h*) Advise the president on all team leader designations necessary between sessions of the Commission;

(2) That the composition of the CIMO Management Group shall be as follows:

(*a*) The president of CIMO (chairperson);

(*b*) The vice-president of CIMO;

(*c*) The co-chairpersons of the OPAGs.

RESOLUTION 3 (CIMO-XIII)

OPEN PROGRAMME AREA GROUPS (OPAGs) OF THE COMMISSION FOR INSTRUMENTS AND METHODS OF OBSERVATION

THE COMMISSION FOR INSTRUMENTS AND METHODS OF OBSERVATION,

RECALLING:

Resolution 1 (CIMO-XIII) – Working Structure of the Commission for Instruments and Methods of Observation,

Resolution 2 (CIMO-XIII) – Commission for Instruments and Methods of Observation Management Group,

DECIDES:

To select, in accordance with WMO General Regulation 32, the co-chairpersons for each of the Open Programme Area Group as follows:

(*a*) OPAG on Surface Observation Technology:
- Co-chairpersons:
  C. Richter (Ms) (Germany), J. van der Meulen (Netherlands)

(*b*) OPAG on Upper-air Observation Technology:
- Co-chairpersons:
  R. Dombrowsky (United States), J. Nash (United Kingdom), A. Ivanov (Russian Federation)

(*c*) OPAG on Capacity Building:
- Co-chairpersons:
  E. Bazira (Uganda), H. Zhou (China).

RESOLUTION 4 (CIMO-XIII)

REVIEW OF THE PREVIOUS RESOLUTIONS AND RECOMMENDATIONS OF THE COMMISSION

THE COMMISSION FOR INSTRUMENTS AND METHODS OF OBSERVATION,

NOTING the action taken on the recommendations adopted prior to its thirteenth session,

CONSIDERING:

(1) That all resolutions adopted prior to its thirteenth session are now obsolete,

(2) That all recommendations adopted prior to its thirteenth session and still in force have been reconsidered,

DECIDES:

(1) Not to keep in force any of the resolutions adopted prior to its thirteenth session;

(2) To keep in force the following past recommendations: 4 (CIMO-XI); 6 (CIMO-XI), 8 (CIMO-XI); 11 (CIMO-XI) 12 (CIMO-XI); 13 (CIMO-XI); 1 (CIMO-XII); 3 (CIMO-XII).

RECOMMENDATIONS ADOPTED BY THE SESSION

RECOMMENDATION 1 (CIMO-XIII)

ESTABLISHMENT OF A WORLD INFRARED RADIOMETER CALIBRATION CENTRE

THE COMMISSION FOR INSTRUMENTS AND METHODS OF OBSERVATION,

NOTING:

(1) That WMO is developing standards in the form of recommendations for application by users,

(2) That bodies/programmes within and external to WMO, such as the Global Atmosphere Watch, the Baseline Surface Radiation Network, and the United States Surface Radiation Network (SURFRAD), are increasingly dealing with long-wave radiation-related measurements,

(3) The efforts of MétéoSwiss to establish a Calibration Centre for Infrared Radiometers at the Physikalisch-Meteorologisches Observatorium Davos (PMOD) in Davos, Switzerland,

CONSIDERING the proposal of the Secretary-General of WMO, based on the recommendation of the Expert Group of the Executive Council/Working Group of the Commission for Atmospheric Sciences to establish a calibration centre for infrared (IR) radiation at the PMOD in Davos, Switzerland,

WELCOMING the positive response from Switzerland to that proposal of the Secretary-General of WMO,

RECOMMENDS that a World Infrared Radiometer Calibration Centre consonant with guidelines given in the annex to this Recommendation be established at PMOD in Davos, Switzerland;

AGREES to provide technical/scientific guidance in the establishment and continuing quality assurance of such a centre.

ANNEX TO RECOMMENDATION 1 (CIMO-XIII)

GUIDELINES FOR A WORLD INFRARED RADIOMETER CALIBRATION CENTRE

1. The World Infrared Radiometer Calibration Centre should serve as a centre for the international calibration of meteorological instruments measuring infrared (IR) radiation and maintaining the standard instruments for this purpose.

2. The calibration results should be disseminated in a hierarchical manner, through Regional Radiation Centres to National Radiation Centres and then to other government laboratories and private sector laboratories.

3. The World Infrared Radiometer Calibration Centre should fulfil the following requirements:

(*a*) It should establish and maintain a group of at least three of the most stable pyrgeometers from different manufacturers, which are periodically calibrated with instruments capable of measuring the IR radiation on an absolute level;

(*b*) It should take all steps necessary to ensure at all times the highest possible quality of its standards, testing equipment and procedures;

(*c*) It should serve as a centre for the calibration of pyrgeometers from Regional Radiation Centres;

(*d*) It should have the necessary laboratory facilities, in particular a blackbody radiation source for the (temperature) characterization of the instruments, and outdoor facilities for the simultaneous comparisons of instruments;

(*e*) It should follow closely or initiate developments leading to improved standards and/or methods in meteorological IR radiometry;

(*f*) It should organize expert meetings to discuss and disseminate reports on progress and issues concerning the measurements and calibration of instruments used in observing meteorological long-wave radiation.

RECOMMENDATION 2 (CIMO-XIII)

REVIEW OF THE RESOLUTIONS OF THE EXECUTIVE COUNCIL RELATED TO THE COMMISSION

THE COMMISSION FOR INSTRUMENTS AND METHODS OF OBSERVATION,

NOTING with satisfaction the action taken by the Executive Council on the previous recommendations of the Commission for Instruments and Methods of Observation;

CONSIDERING that many of these recommendations have become redundant in the meantime;

RECOMMENDS:

(1) That Resolution 4 (EC-L) – Report of the twelfth session of the Commission for Instruments and Methods of Observation no longer be considered necessary;

(2) That Resolution 13 (EC-XXXIV) – Development and comparison of radiometers, be kept in force.

ANNEXES

ANNEX I

Annex to paragraph 4.1.4 of the general summary

MEASURING RANGE AND UNCERTAINTY REQUIREMENTS FOR RAINFALL INTENSITY MEASUREMENTS

The measuring range and uncertainty requirements for data on rainfall intensity (RI) measurements are defined as follows for publication in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8):

(*a*) Minimum time resolution: $\Delta t = 1$ min (data transmission every 10 min);

(*b*) Required measuring range(s) and related uncertainties (DRI) (referred to the above measuring period of 1 minute):

Total range: 0.02 to 2 000 mm/h with the following distinction in uncertainty:

0.02 to 0.2 mm/h (trace – see *CIMO Guide* (WMO-No. 8))
yes/no information (for RI > 0) as precipitation indication (mainly used for present weather observations, such as for road meteorology)

0.2 to 2 mm/h ΔRI = 0.1 mm/h

2 to 2 000 mm/h ΔRI = 5%

ANNEX II

Annex to paragraph 4.5.10 of the general summary

RECOMMENDATIONS FOR REGIONAL PYRHELIMOTER COMPARISONS AND TRAINING

(1) The dissemination of the World Radiometric Reference (WRR) through Regional Pyrheliometer Comparisons (RPCs) should be reactivated to protect the integrity and global traceability of calibration with respect to the WRR during a five-year period through participation in regional comparisons in each of the six WMO Regions;

(2) Each regional association should assume responsibility for hosting an RPC to be held in the period from six months to four years following the completion of an International Pyrheliometer Comparison (IPC), the date and duration of the RPC to be established in consultation with the World Radiation Centre (WRC);

(3) Experts from Regional Radiation Centres (RRCs) should receive training courses and materials related to the hosting and conducting of RPCs during their attendance at the IPC; and

(4) During an RPC, training courses and materials should be provided to experts from the National Radiation Centres (NRCs) in order to enhance the capability of these centres in the traceable calibration of radiometers and the development and maintenance of national radiation networks.

ANNEX III

Annex to paragraph 8.9 of the general summary

PROVISIONAL PROGRAMME OF WMO INTERNATIONAL COMPARISONS AND EVALUATIONS OF METEOROLOGICAL INSTRUMENTS (2002–2006)

No.	*Title of proposed WMO intercomparisons*	*Year(s)*	*Site(s)*
1.	Tenth International Pyrheliometer Comparison (IPC-X)	2005	WRC, Switzerland
2.	Regional Pyrheliometer Comparisons (RPCs)	2004–2006	Either in conjunction with IPC-X or at RRCs concerned
3.	International Rainfall Intensity Measurement Intercomparison	2003	In various climatic regions
4.	Thermometer Screen/Shielding Intercomparison(s)	2003–2005	In various climatic regions
5.	International Hygrometer Intercomparison	2003–2005	In various climatic regions
6.	International/National Radiosonde Intercomparisons	Ongoing	—
7.	Intercomparison of remote and *in situ* upper-air sounding systems	2003–2005	—

ANNEX IV

Annex to paragraph 11.7 of the general summary

KEY RESULTS FOR THE IMPLEMENTATION PERIOD 2004–2007 OF THE 6LTP

It is expected that in the implementation phase, 2004–2007, the following key results will be achieved:

(*a*) Basic procedures for quality management of observations, instrument maintenance, calibration and operational practices will be developed within an overall performance management framework. A methodology to demonstrate the effectiveness of such management procedures will be established;

(*b*) At least four instrument intercomparisons will be completed;

(*c*) The seventh edition of the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8) will be published.

(*d*) Regional Instrument Centres will be evaluated against established criteria and regional associations will have enhanced capability in instrument maintenance;

(*e*) A World Infrared Radiometer Calibration Centre will be established;

(*f*) Standards for automation of manual, visual and subjective observations will be agreed;

(*g*) Relevant international organizations participate in the work programme of CIMO and attend as observers at relevant meetings/conferences.

ANNEX V

Annex to paragraph 13.7 of the general summary

PRELIMINARY TERMS OF REFERENCE OF OPAGs

A. GENERAL TERMS OF REFERENCE OF THE SURFACE AND UPPER-AIR TECHNOLOGY OPAGs

1. Carry out the activities of the OPAG and ensure contributions are relevant and timely.
2. Review and publish results and recommendations relating to the state-of-the-art of operational instrumentation, calibrations and methods of observation as well as their use in different application areas and report on their performance.
3. Work closely with other technical commissions and regional associations through representatives.
4. Respond to requirements of users of all WMO Programmes and to recommend appropriate action of the Commission, including provision of guidance material.
5. Facilitate effective collaboration on cross-cutting issues.
6. Propose, coordinate implementation, review and evaluate intercomparisons of

instrumentation in collaboration with relevant manufacturers.

7. Review, develop and update guidance material related to instruments and methods of observation.
8. Monitor and cooperate with the relevant work of international and regional bodies, such as the International Organization for Standardization (ISO) and the International Committee for Weights and Measures (CIPM/BIPM), report on such work and advise on action as necessary.

B. GENERAL TERMS OF REFERENCE OF THE OPAG ON CAPACITY BUILDING

1. Work closely with other technical commissions and regional associations on issues related to capacity building, such as their involvement in instrument comparison, workshops, seminars and activities of the RICs.
2. Maintain close liaison with the regional Rapporteurs on Instrument Development, Related Training and Capacity Building, review their reports and recommend action to deal with indicated deficiencies.
3. Develop proposals on resource mobilization including how to engage manufacturers in building capacity.
4. Review the needs for building national capacities related to IMOP with the view to making developing countries more self-reliant.
5. Review, develop and update guidance and training material related to instruments and methods of observation and liaise with the RMTCs on these matters.
6. Ensure guidance information on modern technology is available to Members.
7. Promote the use of calibration standards by RICs and Members and facilitate associated technology transfer activities.
8. Develop further basic procedures for quality management of observations, instrument maintenance, calibration and operation (based on the sixth edition of the *CIMO Guide*).
9. Provide guidance to Members on strategies for the procurement process of instrumentation and related management.

PROPOSED TASKS TO BE UNDERTAKEN BY THE OPAGs

A. OPAG-SURFACE

1. Report and recommend methods for automated visual and subjective observations:
   - Systems measuring present weather (including clouds, icing, state of the ground, lightning and thunderstorms);
   - Standardization of algorithms.
2. Provide guidance on the state-of-the-Art of Instruments and Automated Surface Observing Systems:
   - Review and report on development of instruments and ASOS;
   - Provide guidance to members and other users on the implementation of ASOS;
   - Provide guidance on implementation in varying environmental conditions;
   - Provide improved guidance for siting of meteorological instrumentation and update WMO regulations;
   - Provide guidance on meta data requirements.
3. Prepare proposals for instrument intercomparisons:
   - Newly developed instruments;
   - Currently operational instruments;
   - National, regional and international intercomparisons.
4. Review advances in calibration methods.
5. Facilitate further activities related to meteorological radiation measurements:
   - Liaise with the World Climate Research Programme on matters related to Baseline Surface Radiation Network and inform Members of developments;
   - Review operational practice associated with total ozone measurements. Prepare recommendations for automation of ozone measurements suitable for a standard automated observational site;
   - Review operational practice associated with UV and aerosol optical depth measurements.
6. Report on progress of urban and road meteorological measurements:
   - Monitor the emerging requirements for measurements and develop pertinent technical recommendations for standards and practices to be included in the *CIMO Guide*.

B. OPAG-UPPER AIR

1. Facilitate upgrading the global radiosonde network:
   - Prepare and perform comparison tests to detect error characteristics of various types of aerological measurement systems, establish links to previous designs and systematic differences between new radiosonde designs (over four years);
   - Develop techniques and report annually on the performance of radiosonde types in the GOS;
   - Solicit agreement on BUFR code table and descriptors for international use (1–2 years).
2. Investigate error characteristics of water vapour measurements and explore compatibility between the different types of measurement:
   - Prepare guidance material on developing national GPS water vapour network;

   – Monitor and assist in the introduction of humidity measurements by AMDAR.
3. Investigate the suitability of modern conventional and Doppler radars for deployment in NMHSs:
   – Improve quality and availability of remotely sensed upper wind measurements;
   – Report on the suitability of modern radars and wind profilers for deployment in NMHSs;
   – Report and advise manufacturers on the operational performance of weather radars in developing countries.
4. Monitor and report on new development of other upper-air measurement techniques:
   – The techniques are expected to include lidar, microwave radiometer, sodar, RASS, etc.
5. Monitor and report on calibration of satellite remote sensing instrumentation.
6. Investigate the standardization of data-processing algorithms for radiosondes.
7. Report on progress of lightning detection:
   – Monitor and report on national and regional lightning detection projects and networks;
   – Propose evaluation methods for operational lightning detection systems;
   – Review the progress in the compatibility of lightning detection remote sensing and conventional *in situ* observations.
8. Promote, facilitate and assist with developments in integrated observing systems.
9. Continue radiofrequency allocation studies for ground-based observing systems:
   – Improve coordination of radiosonde operating frequencies between neighbouring countries.

C. OPAG-CAPACITY BUILDING

1. Work with regional associations to ensure effective RIC activities and to develop proposals for strengthening the role of the RICs, particularly those located in developing countries.
2. Organize technical conferences and training in collaboration with other technical commissions and the HMEI as appropriate.
3. Provide advice on *Quality Management Systems* procedures for instruments and methods of observations (based on the *CIMO Guide*) and implement links with relevant international organization active on this area.
4. Maintain and update the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8) and advise on changes required for the Instrument Catalogue.
5. Review available and prepare additional training material for scientists beginning work in instrumentation development.
6. Review and provide guidance to develop the IMOP capacities of developing countries, in particular the development and fabrication of instruments.
7. Develop proposals for joint procurement mechanisms for consumables to assist developing countries in achieving a reduction in the cost of instrument operation.
8. Evaluate technical reports concerning instrument requirements in developing countries generated by experts, and provide technical advice on related project implementation.

ANNEX VI

Annex to paragraph 13.11 of the general summary

PRELIMINARY LIST OF EXPERTS PROPOSED TO ACTIVELY SUPPORT THE WORKING PROGRAMME OF THE COMMISSION

The preliminary list of experts and their areas of expertise are given in the table.

Areas of expertise:

1. Development of Instruments and Automated Observing Systems;
2. Meteorological Radiation including UV Measurements;
3. Point Precipitation and Evapotranspiration Measurements;
4. Road and Urban Meteorological Observations;
5. Atmospheric Composition, including Atmospheric Ozone Measurements;
6. Atmospheric Turbidity Measurement;
7. Wind and Temperature Profilers;
8. Weather Radars;
9. Lightning Detection;
10. GPS-derived Precipitable Water Content;
11. Radiosonde Systems;
12. Other Upper-air Measurement Techniques;
13. Capacity Building;
14. Regional Instrument Centres (RICs);
15. Training.

No.	Country	Name of expert	Specific area of expertise														
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Argentina	Mr Mario Jorge GARCIA											x	x			
2	Argentina	Mr Osvaldo Marcelo HARTUREN		x			x	x									
3	Argentina	Mr Maurice Vernon SALDIVAR						x									
4	Argentina	Mr Raul Hector SANTILLAN								x						x	
5	Argentina	Mr Eduardo Alberto VIOTTI	x														
6	Armenia	Mr Armen DIPIRIAN									x						
7	Armenia	Mr David MELKONIAN		x													
8	Australia	Dr Roger ATKINSON							x	x							
9	Australia	Mr Graeme BROUGH								x			x	x			
10	Australia	Mr David EVANS	x			x											
11	Australia	Ms Nicole FARNSWORTH									x						
12	Australia	Dr Bruce FORGAN						x									
13	Australia	Mr Dean LOULETT												x			
14	Australia	Mr Paul MORABITO	x														
15	Australia	Mr Paul SMITH											x				
16	Australia	Mr Russell STINGER	x		x	x				x	x				x		
17	Austia	Mr Martin MAIR	x														
18	Austria	Mr Kurt ZIMMERMANN											x				
19	Bahrain	Mr A.E.M. ABDALLA	x			x			x								x
20	Bangladesh	Mr Sujitt Kumar DEBSARMA															x
21	Bangladesh	Mr Taslima IMAM															x
22	Bangladesh	Mr Muzammel H. TARAFDER															x
23	Benin	Mr Ahogla D. AGBANGLA			x												
24	Botswana	Mr Dira Fred MOLOTSI													x	x	
25	Bulgaria	Mr Hristomir BRANZOV	x														
26	Bulgaria	Ms Anna BRATOEVA				x											
27	Bulgaria	Mr Staytcho KOLEV									x						
28	Bulgaria	Mr Rangel PETROV															
29	Bulgaria	Mr Videnov PLAMIEN					x										
30	Bulgaria	Mr Petio SIMEONOV							x								
31	Bulgaria	Mr Nedialko VALKOV											x				
32	Canada	Dr Godelieve DEBLONDE										x					
33	Canada	Mr Paul DELANNOY				x											
34	Canada	Mr Dave DOCKENDORFF											x				
35	Canada	Dr Paul JOE								x							
36	Canada	Dr L.J. Bruce McARTHUR		x													
37	Cape Verde	Mr Francisco EVORA	x														
38	Cape Verde	Mr Jose Carlos Da LUZ		x													
39	Chad	Mr Mahamt Bilal ADAM	x	x	x	x	x	x	x	x	x	x	x				x
40	Chile	Mr Horacio PENA														x	
41	Chile	Mr Gaston TORRES		x			x									x	
42	Chile	Mr Manuel VARGAS		x													
43	China	Mr Lingen BIAN													x		
44	China	Mr Yatian GUO											x				
45	China	Mr Yufeng HU	x														
46	China	Ms Li XU		x			x	x						x		x	x
47	China	Mr Zhiqiang ZHAO							x								
48	China	Mr Heng ZHOU							x	x	x	x	x	x			
49	Colombia	Ms Xiomara L. SANCLEMENTE M.														x	
50	Congo	Mr Benjamin BOUNGOU	x													x	x
51	Croatia	Mr Janja MILKOVIC			x												
52	Croatia	Mr Krunoslav PREMEC	x														
57	Croatia	Mr Zvonko ZIBRAT				x											
54	Cuba	DrJesus RAMIREZ A.					x										
55	Cuba	Dr Orlando L. RODRIGUEZ G.								x							
56	Cuba	Mr Pedro SANCHEZ N.					x								x		x

No.	Country	Name of expert	Specific area of expertise														
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
53	Cuba	Mr Pable E. De VARONA	x														
58	Djibouti	Mr Hassan ABOURAHMAN M.	x	x	x	x	x			x							x
59	Djibouti	Mr Mohamed KAMIL	x	x	x		x						x				
60	Ecuador	Mr Ramon CHANGO S.	x	x													x
61	Egypt	Mr Ali Abdel Samea ALI				x											
62	Egypt	Mr Mostafa Abd El-Hamid AMER											x				
63	Egypt	Mr Sabry M. El-FOULY											x	x			
64	Egypt	Mr Mohammed Esmael REFAIE	x												x		
65	El Salvador	Mr Ricardo ZIMMERMANN M.			x												
66	Fiji	Mr Muni SINGH															
67	France	Mr Jean-Luc CHEZE								x							
68	France	Mr Jerome DUVERNOY														x	x
69	France	Mr Jean-Louis GAUMET											x				
70	France	Mr Pierre GREGOIRE	x														
71	France	Mrs Françoise MONTARIOL									x						
72	Gambia	Mr Fatou SIMA	x														
73	Georgia	Mr David MACHARASHIRLI	x							x							
74	Germany	Mr Klaus BEHRENS		x													
75	Germany	Dr Dirk ENGELBART							x								
76	Germany	Dr Eckhard LANZIGER	x														
77	Germany	Dr Ulrich LEITERER											x	x			
78	Germany	Dr Jörg SELTMANN								x							
79	Guatemala	Mr Fulgencio GARAVITO	x		x												
80	Guinea	Mr Facimé SOUMAH															
81	Guinea	Mr Abdoul AZIZ BARRY	x	x	x	x	x	x									
82	Guinea-Bissau	Mr Ocunda CA		x					x								
83	India	Mr N.Y. APTE			x												
84	India	Mr S.K. BANERJEE								x							
85	India	Dr S.S. BHANDARI							x			x					
86	India	Mr R.C. BHATIA									x	x					
87	India	Mr A.A. FARUQI													x		x
88	India	Mr V.V. GANESAN			x												
89	India	Mr M.K. GUPTA		x													
90	India	Mr K.C. KRISHNAN												x			
91	India	Mr S.K. KUNDU								x							
93	India	Mrs Ranju MADAN												x			
92	India	Mr R.R. MALI														x	
94	India	Mr P.N. MOHANAN	x														
95	India	Mr B. MUKHOPADHYAY						x									
96	India	Dr S.K. PERSHIN					x										x
97	India	Mr C.G. RCHALKER		x													
98	India	Mr A.K. SHARMA									x						
99	India	Mr J.K. SHARMA															x
100	India	Mr Devendra SINGH					x										
101	India	Mr Lakmi SINGH														x	
102	India	Mr D.K. SRIVASTAV											x				
103	India	Dr R. SURESH								x							
104	India	Mr S.B. THAMPI								x							
105	India	Mr R.D. VASHISTHA	x			x											
106	Iran, Islamic Republic of	Mr Navid CHINIFORUSH		x						x							x
107	Iran, Islamic Republic of	Mr Elham FARMAN															x
108	Iran, Islamic Republic of	Mr G. HASSAMI	x														

No.	Country	Name of expert	Specific area of expertise														
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
109	Iran, Islamic Republic of	Mr Akbar HOSSEINZADEH							x	x	x						
110	Iran, Islamic Republic of	Mr Mostafa JOORABCHI							x	x	x	x	x	x			
111	Iran, Islamic Republic of	Mr Robarch KALANTARNIA															
112	Iran, Islamic Republic of	Mr Faraidoon MINOVI							x								
113	Iran, Islamic Republic of	Mr Mohammad R. PARVARI	x	x	x	x	x										
114	Israel	Mr Jacob MISHAELY	x	x	x	x	x	x									
115	Israel	Mr Ammon POLLACK		x					x	x	x	x	x				
116	Italy	Ms Carmen BELTRANO			x												
117	Italy	Mr Giovanni CASU														x	
118	Italy	Mr Casimiro CIOTTI								x							
119	Italy	Mr Alessandro GALLIANI					x										
120	Italy	Mr Luigi DE LEONIBUS	x														
121	Italy	Mr Adriano RASPANTI							x								
122	Italy	Mr Fabio TRAVAGLIONI															x
123	Japan	Mr Kenji AKAEDA								x							
124	Japan	Mr Masato FUKUDA	x														
125	Japan	Mr Yasuo HIROSE		x													
126	Japan	Mr Ko KOIZUMI										x					
127	Japan	Mr Kouji MATSUBARA														x	
128	Japan	Mr Yukitomo TSUTSUMI						x									
129	Kazakstan	Mr Erdos KUBAKOV								x							
130	Kenya	Mr Patrick KIMOTHO	x	x	x	x	x	x									x
131	Kenya	Mr Peter K. MUTAI							x	x	x	x	x	x			x
132	Kenya	Mr William W. NDIRANGU	x						x	x	x	x	x	x			x
133	Libyan Arab Jamahiriya	Mr K.I. ELFADLI	x		x		x										
134	Madagascar	Mr Zoé Michel RAJAONARIVONY			x										x	x	
135	Malawi	Mr Rodrick G. WALUSA													x		
136	Malaysia	Mr Huvi Vein TAN	x						x								x
137	Mauritius	Mr Y. BOODHOO													x		x
138	Mauritius	Mr R.P. PADARUTH								x			x		x		
139	Mauritius	Dr B. PATHACK													x		x
140	Mauritius	Mr G. SEEVATHIAN								x			x				
141	Mauritius	Mr S.N. SOK APPADU													x		x
142	Morocco	Mr Rachid ABBOUA										x					
143	Morocco	Mr Abdelaziz BELHOUJI													x	x	
144	Morocco	Mr Noureddine F. BOOUBRAHMI								x	x						
145	Morocco	Mr Bouchra ELJOHRA		x			x	x									
146	Morocco	Mr Brahim LOUAKED	x														x
147	Morocco	Mr Mohamed SABRE														x	
148	Netherlands	Mr Siebren de HAAN										x					
149	Netherlands	Dr Iwan HOLLEMAN									x	x					
150	Netherlands	Mr Henk KLEIN BALTINK							x								
151	Netherlands	Dr Wouter KNAP		x				x									
152	Netherlands	Mr Wim MONNA											x				
153	Netherlands	Mr Jan TERPSTRA				x											
154	Netherlands	Dr Jitze P. VAN DER MEULEN	x														
155	Netherlands	Dr Ge VERVER					x										
156	Netherlands	Dr Wiel WAUBEN	x														
157	Niger	Mr Chetima ABARI BOULAMA	x		x										x		x
158	Nigeria	Mr Samuel A. ADERINTO	x							x				x	x	x	x

No.	Country	Name of expert	Specific area of expertise														
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
159	Nigeria	Mr Olatokungo OKULAJA	x		x	x					x				x	x	x
160	Norway	Mr Kjell HEGG	x														
161	Pakistan	Mr Abdul HAMEED															x
162	Pakistan	Mr Arif MAHMOOD															x
163	Pakistan	Mr Abdul Hamid MALIK								x							
164	Pakistan	Mr Abdul RAZZAQUE								x							
165	Philippines	Mr Ferdinand BARCENAS															
166	Philippines	Mr Romeo M. CADAG														x	
167	Philippines	Mr Silvestre L. SELPA													x		
168	Poland	Mr Pawek BODZAK									x						
169	Poland	Mr Piotr CYGAN															
170	Poland	Mr Zdzislaw DZIEWIT															
171	Poland	Mr Andrzej MACIAZEK	x								x						
172	Poland	Mr Piotr PIETRZYKOWSKI	x														
173	Poland	Mr Kazimierz ROZDZYNSKI															
174	Portugal	Mr Sergio BARBOSA								x							
175	Portugal	Ms Fernanda CARVALHO		x				x									
176	Portugal	Mr Diamantino HENRIGUES					x										
177	Portugal	Mr Luis Filipe NUNES	x										x				
178	Portugal	Mr Victor PRIOR				x					x						
179	Portugal	Mr Manuel ROSA DIAS								x							
180	Republic of Korea	Mr Won-Geun EOM								x							
181	Republic of Korea	Dr Rok-Haeng HEO							x								
182	Republic of Korea	Mr Sin-Ho KIM											x				
183	Republic of Korea	Dr Jae-Won LEE					x										
184	Republic of Korea	Dr Sung-Nam OH		x													
185	Republic of Moldova	Mr Sergei KAYUDIN	x						x						x		
186	Russian Federation	Mr Alexei IVANOV												x			
187	Russian Federation	Mr Vladimir IVANOV						x									
188	Russian Federation	Mr Vladimir JHUKOV								x							
189	Russian Federation	Mr Eugeny KADYGROV							x								
190	Russian Federation	Mr Alexander KATZ											x				
191	Russian Federation	Mr Arkady KOLDAEV							x								
192	Russian Federation	Mr Dmitry KONOVALOV			x												
193	Russian Federation	Mr Igor KUZMINYKH													x		
194	Russian Federation	Mr Vadim OKORENKOV														x	
195	Russian Federation	Dr Alexander PAVLOV		x													
196	Russian Federation	Mr Vyacheslav POPOV	x														
197	Russian Federation	Mr Eugeny ROMANOV				x											
198	Russian Federation	Dr Arkady SHALAMYANSKY					x										
199	Russian Federation	Dr Victor SNEGUROV									x						
200	Slovakia	Mr Miroslav CHMELIK											x	x			
201	Slovakia	Mr Branislav CHVILA			x												
202	Slovakia	Ms Olga NOVANSKA													x		x
203	Slovakia	Mr Igor STRMIEKA								x	x						
204	Slovakia	Mr Igor ZAHUMENSKY													x	x	
205	South Africa	Mr Nico SWART															
206	Sri Lanka	Mr Kithsiri R.A. BANDARA									x						
207	Switzerland	Mr Bertrand CALPINI		x					x				x	x			
208	Switzerland	Mr Alain HEIMO	x	x				x									
209	The FYR of Macedonia	Mr Aleksandar KARANFILOVSKI								x							
210	The FYR of Macedonia	Ms Vesna PAVLOVSKA	x														
211	The FYR of Macedonia	Mr Pece RISTEVSKI			x												

No.	Country	Name of expert	Specific area of expertise														
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
212	Turkey	Mr Ercan BüYüKBAS	x	x	x	x	x	x	x	x	x	x	x				x
213	Turkey	Mr Hayati CICEK															
214	Turkey	Mr Zafer Turgay DAG	x	x	x	x	x	x	x	x	x	x	x				x
215	Turkey	Mr Denizhan EROL								x							
216	Turkey	Mr Fazli ERGUN							x	x	x	x	x	x			
217	Turkey	Mr Aytag HAZER							x	x	x	x	x	x			
218	Turkey	Mr Yakup NAS															
219	Turkey	Mr Oguzhan SIRECI							x	x	x	x	x	x			
220	Turkey	Mr Yüksel YAGAN							x	x	x	x	x	x	x		
221	Uganda	Mr Eliphaz BAZIRA	x														
222	Ukraine	Mr Viktor TRODIMENKO	x		x				x	x			x				
223	United Arab Emirates	Mr Ali Abdulla AL GIFRI							x	x				x			
224	United Kingdom	Mr John ELMS															
225	United Kingdom	Dr Catherine GAFFORD							x					x			
226	United Kingdom	Mr Stuart GOLDSTRAW	x	x	x												
227	United Kingdom	Mr Dave HATTON															
228	United Kingdom	Dr John NASH															
229	Uruguay	Ms Maria Lydia BERNASCONI I.			x												
230	Uzbekistan	Dr Zakhidjan NAZIROV	x							x							
231	Yugoslavia	Mr Ivan BROCOVIC				x											
232	Yugoslavia	Mr Slobodan HADZIVUKAVIC		x													
233	Yugoslavia	Ms Jasmina KNEZEVIC					x										
234	Yugoslavia	Ms Gordana MARKOVIC	x														
235	Yugoslavia	Mr Mladen MILINKOVIC								x							x
236	Yugoslavia	Ms Slavica RADOVANOVIC			x												
237	Yugoslavia	Mr Zoran RISTOVIC			x												
238	Zimbabwe	Mr Morris Vengesai SAHANGA													x		x

APPENDIX A

LIST OF PERSONS ATTENDING THE SESSION

A. Officers of the session

S.K. Srivastava	President
R.P. Canterford	Vice-president

B. Representatives of WMO Members

Member	*Name*	*Capacity*
Algeria	R. Naili	Principal delegate
Argentina	E.A. Viotti	Principal delegate
Australia	R.P. Canterford	Principal delegate
	R.K. Stringer	Delegate
Austria	E. Rudel	Principal delegate
Belarus	I.M. Skuratovitch	Principal delegate
Belgium	D. De Muer	Principal delegate
	J. Leten	Delegate
Botswana	D.F. Molotsi	Principal delegate
Bulgaria	H. Branzov	Principal delegate
Canada	T. Allsopp (25–30/09)	Principal delegate
	B. Angle (1–3/10)	Principal delegate
	J. Kruus	Delegate
	B. McArthur	Delegate
	R. Fordyce	Delegate
	T. Vandal	Delegate
China	Zheng Guoguang	Principal delegate
	Guo Yatian	Delegate
	Shen Xiaonong	Delegate
	Xu Baoxiang	Delegate
	Zhou Heng	Delegate
Croatia	K. Premec	Principal delegate
Czech Republic	V. Vozobule	Principal delegate
Denmark	S. Overgaard	Principal delegate
Egypt	Magdy A. Abass	Principal delegate
Finland	M. Sagbom (Ms)	Principal delegate
	P. Valkovuori	Delegate
	J. Poutiainen	Delegate
France	P. Tchang	Principal delegate
	M. Leroy	Delegate
Germany	C. Richter (Ms)	Principal delegate
	K. Behrens	Delegate
	K.-H. Klapheck	Delegate
Ghana	S. Nyarko	Principal delegate
Hungary	J. Nagy	Principal delegate
Iceland	H. Hjartarson	Principal delegate
India	S.K. Srivastava	Principal delegate
Iran, Islamic Republic of	A. Hosseinzadeh	Principal delegate
Israel	J. Mishaely	Principal delegate
Italy	P. Pagano	Principal delegate
	L.G. Lanza	Delegate
	L. Stagi	Delegate
Japan	M. Ishihara	Principal delegate
Jordan	M.H. Omari	Principal delegate
Kenya	I.K. Essendi	Principal delegate
Latvia	M. Vitols	Delegate
	V. Barkans	Delegate
	L. Beinerts	Delegate
Libyan Arab Jamahiriya	H S. Gnedi	Principal delegate
	K.I. El Fadli	Delegate
Malaysia	Tan Huvi Vein	Principal delegate
Mauritius	R.P. Padaruth	Principal delegate
Morocco	A. Belhouji	Principal delegate
Namibia	W.J. Gaoeb	Principal delegate
Netherlands	J. van der Meulen	Principal delegate
New Zealand	B. Hartley	Principal delegate
Nigeria	L.E. Akeh	Principal delegate
	S. Aderinto	Delegate
	A.C. Anuforom	Delegate
	O. Okulaja	Delegate
Norway	K. Hegg	Principal delegate
Oman	A.H.M. Al Harthy	Principal delegate
	M.D.H. Al Saadi	Delegate
Republic of Korea	Won-Geun Eom	Principal delegate
	Jeong Seog Lee	Delegate

Member	*Name*	*Capacity*
Russian Federation	A. Gusev	Principal delegate
	V. Popov	Delegate
	A. Ivanov	Delegate
	V. Ivanov	Delegate
	I. Kuzminykh	Delegate
	A. Kats	Delegate
Saudi Arabia	Ahmed Y.A. Hussein	Principal delegate
	A.A. Gari	Delegate
Senegal	O. Sene	Principal delegate
Slovakia	V. Pastircák	Principal delegate
	I. Zahumenský	Delegate
	B. Chvíla	Delegate
	M. Chmelík	Delegate
	J. Danc	Delegate
Slovenia	J. Knez	Principal delegate
Spain	M. Lambas	Principal delegate
Swaziland	P. Mbingu	Principal delegate
Sweden	E. Boholm (Ms)	Principal delegate
	O. Pettersson	Alternate
Switzerland	B. Calpini	Principal delegate
	A. Heimo	Delegate
	W. Schmutz	Delegate
Tunisia	A. Slimi	Principal delegate
Turkey	H. Bacanli	Principal delegate
Uganda	E. Bazira	Principal delegate
United Kingdom of Great Britain and Northern Ireland	K. Groves	Principal delegate
	J. Nash	Alternate
	S. Goldsmith	Delegate
United States of America	R.N. Dombrowsky	Principal delegate
	C.A. Bower	Delegate
Uzbekistan	G. Rakhman-Zada	Principal delegate

Name	*Organization*
C.	REPRESENTATIVES OF INTERNATIONAL ORGANIZATIONS
R. Wielgosz	International Bureau of Weights and Measures (BIPM)
B. Minárik	International Commission on Irrigation and Drainage (ICID)
B. Dieterink	Association of Hydro-Meteorological Equipment Industry (HMEI)

D. WMO SECRETARIAT

G.O.P. Obasi	Secretary-General
D.C. Schiessl	Director, WWW – Basic Systems Department
A. Karpov	Acting Chief, Observing System Division
M. Ondras	Senior Scientific Officer, Observing System Division
R. Pannet	Consultant, Observing System Division
M. Peeters	Conference Officer

APPENDIX B

AGENDA

Agenda item		*Document No.*	*PINK No., submitted by*	*Resolutions and Recommendations adopted*
1.	OPENING OF THE SESSION		1, president of CIMO	
2.	ORGANIZATION OF THE SESSION			
2.1	Consideration of the report on credentials			
2.2	Adoption of the agenda	2.2(1); 2.2(2)	2, president of CIMO	
2.3	Establishment of committees			
2.4	Other organizational matters			
3.	REPORT OF THE PRESIDENT OF THE COMMISSION	3	3, president of CIMO	
4.	INSTRUMENTS AND METHODS OF OBSERVATION FOR SURFACE MEASUREMENTS			
4.1	Report of the Working Group on Surface Measurements	4.1	4.1, chairperson, Working Committee	
4.2	Issues related to the automation of observations Report by the Rapporteurs on the Development and Implementation of Automated Observing Systems and on Automation of Visual and Subjective Observations	4.2	4.2, chairperson, Working Committee	
4.3	Instrument development Report by the Rapporteur on Instrument Development	4.3	4.3, chairperson, Working Committee	
4.4	Precipitation and evapotranspiration measurements Report by the Co-rapporteurs on Point Precipitation and Evapotranspiration Measurements	4.4	4.4, chairperson, Working Committee	
4.5	Meteorological radiation measurements Report by the Rapporteur on Meteorological Radiation Measurements	4.5	4.5, president of CIMO	Rec. 1
4.6	Road meteorological observations Report by the Co-rapporteurs on Road Meteorological Observations	4.6	4.6, chairperson, Working Committee	
4.7	Urban meteorological measurements Report by the Co-rapporteurs on Urban Meteorology	4.7	4.7, chairperson, Working Committee	
5.	INSTRUMENTS AND METHODS OF OBSERVATION FOR UPPER-AIR MEASUREMENTS AND REMOTE SENSING			
5.1	Report of the Working Group on Ground-based Upper-air Observing Systems	5.1	5.1, chairperson, Working Committee	
5.2	Radiosonde compatibility monitoring Report by the Rapporteur on Radiosonde Compatibility Monitoring	5.2	5.2, co-chairperson, Working Committee	
5.3	Calibration of satellite sounding systems Report by the Rapporteur on Calibration of Satellite Sounding Systems	5.3	5.3, co-chairperson, Working Committee	
5.4	GPS-derived precipitable water content of the atmosphere Report by the Rapporteur on GPS-derived Precipitable Water Content of the Atmosphere	5.4	5.4, president of CIMO	

	Agenda item	*Document No.*	*PINK No., submitted by*	*Resolutions and Recommendations adopted*
5.5	Atmospheric turbidity measurements Report by the Rapporteur on Atmospheric Turbidity Measurements	5.5	5.5, chairperson, Working Committee	
5.6	UV measurements Report by the Rapporteur on UV Measurements	5.6	5.6, chairperson, Working Committee	
5.7	Wind profilers Report by the Rapporteur on Wind Profilers	5.7	5.7, chairperson, Working Committee	
5.8	Weather radar measurements	5.8	5.8, president of CIMO	
6.	ENVIRONMENTAL MEASUREMENTS			
6.1	Atmospheric composition measurements Report by the Rapporteur on Instruments and Methods of Atmospheric Composition Measurements	6.1	6.1, chairperson, Working Committee	
6.2	Atmospheric ozone measurements Report by the Rapporteur on Atmospheric Ozone Measurements	6.2	6.2, chairperson, Working Committee	
7.	EDUCATION AND TRAINING, CAPACITY BUILDING, TECHNOLOGY TRANSFER AND MATTERS RELATED TO REGIONAL INSTRUMENT CENTRES	7	7, president of CIMO	
8.	INSTRUMENT COMPARISONS	8	8, chairperson, Working Committee	
9.	ADDITIONAL MATTERS RELATED TO THE INSTRUMENTS AND METHODS OF OBSERVATION PROGRAMME	9	9, president of CIMO	
10.	*GUIDE TO METEOROLOGICAL INSTRUMENTS AND METHODS OF OBSERVATION*	10	10, chairperson, Working Committee	
11.	LONG-TERM PLANNING AND FUTURE WORK PROGRAMME OF THE COMMISSION	11	11, president of CIMO	
12.	COLLABORATION WITH OTHER WMO PROGRAMMES AND RELEVANT INTERNATIONAL ORGANIZATIONS	12	12, chairperson of committee	
13.	FUTURE WORKING STRUCTURE OF THE COMMISSION, ESTABLISHMENT OF GROUPS AND NOMINATION OF EXPERTS	13	13, president of CIMO	Res. 1, Res. 2, Res. 3
14.	REVIEW OF PREVIOUS RESOLUTIONS AND RECOMMENDATIONS OF THE COMMISSION AND OF RELEVANT RESOLUTIONS OF THE EXECUTIVE COUNCIL	14	14; 14, ADD. 1, president of CIMO	Rec. 2; Res. 4
15.	ELECTION OF OFFICERS	15, 15(2)	15, chairperson, Nomination Committee 15(2), president of CIMO	
16.	DATE AND PLACE OF THE FOURTEENTH SESSION	16	16, president of CIMO	
17.	CLOSURE OF THE SESSION	17	17, president of CIMO	

APPENDIX C

LIST OF ABBREVIATIONS

4D-VAR	Four-dimensional variational system
4LTP	Fourth Long-Term Plan
5LTP	Fifth Long-term Plan
6LTP	Sixth Long-term Plan
ADEOS	Advanced Earth Observation Satellite
AERONET	Aerosol Robotic Network (NASA)
AIRS	Atmospheric Infrared Sounder
AMDAR	Aircraft meteorological data relay
AMSU	Advanced Microwave Sounding Unit
AMV	Atmospheric motion vector
AOS	Automated Observing Systems
ATOVS	Advanced TIROS operational vertical sounder
AWG	Advisory Working Group
AWS	Automatic weather station
BIPM	International Bureau of Weights and Measures (*Bureau International des Poids et Mesures*)
BSRN	Baseline Surface Radiation Network
CAeM	Commission for Aeronautical Meteorology
CAgM	Commission for Agricultural Meteorology
CAPPI	Constant-altitude plan-position indicator
CAS	Commission for Atmospheric Sciences
CB	Capacity Building (OPAG)
CBS	Commission for Basic Systems
CCD	Charged coupled device
CCl	Commission for Climatology
CEN	European Committee for Standardization
CEOS	Committee on Earth Observation Satellites
CGMS	Coordination Group on Meteorological Satellites
CHy	Commission for Hydrology
CIMO	Commission for Instruments and Methods of Observation
CIPM	International Committee for Weights and Measures
CIS	Commonwealth of Independent States
CMA	China Meteorological Administration
COST	Cooperation on Science and Technology (European Union)
EANET	Acid Deposition Monitoring Network in East Asia
EC	Executive Council
ECMWF	European Centre for Medium-range Weather Forecasts
EP	Earth Probe (satellite)
ENVISAT	European Environment Satellite
EOS	Earth Observing System
ESCAP	Economic and Social Commission for Asia and the Pacific (United Nations)
ET	Expert Team
EUMETNET	European Meteorological Services Network
EUMETSAT	European Organization for the Exploitation of Meteorological Satellites
FAO	Food and Agriculture Organization of the United Nations
FSL	Forecast Systems Laboratory (NOAA)
FY-2	Meteorological satellite (China)
GAW	Global Atmosphere Watch
GCOS	Global Climate Observing System
GIS	Geographical Information System

GMS	Geostationary meteorological satellite (Japan)
GOES	Geostationary operational environmental satellite (United States)
GOMOS	Global Ozone Monitoring by Occultation of Stars
GOS	Global Observing System
GPS	Global Positioning System
GPS-PWC	GPS-derived Precipitable Water Content of the Atmosphere
GTS	Global Telecommunication System
GUOS	Ground-based Upper-air Observing Systems
HMEI	Association of Hydro-Meteorological Equipment Industry
HSB	Humidity Sounder Brazil
ICAO	International Civil Aviation Organization
IDI	Instrument Development Inquiry
IEC	International Electrotechnical Commission
MOP	Instruments and Methods of Observation Programme
IOC	International Oceanographic Commission (UNESCO)
IOM	Instruments and Observing Methods
IOS	Integrated Observing Systems
IPC	International Pyrheliometer Comparison
IR	Infrared
ISDR	International Strategy for Disaster Reduction
ISO	International Organization for Standardization
ITU	International Telecommunication Union
ITWG	International TOVS Working Group
IWW	International Winds Workshop
JCOMM	Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology
JMA	Japan Meteorological Agency
KLM	Royal Dutch Airlines
LTP	Long-term Plan
MAGIC	Meteorological Applications of GPS Integrated Column Water Vapor Measurements in the Western Mediterranean (European Commission project)
METEOREX	Exhibition of Meteorological Instruments, Equipment and Services
METEOSAT	EUMETSAT series of meteorological geostationary satellites
MG	Management Group
NASA	National Aeronautics and Space Administration
NASDA	National Space Development Agency (Japan)
NESDID	National Environmental Satellite, Data and Information Service (NOAA)
NEXRAD	Next Generation Weather Radar
NDSC	Network for the Detection of Stratospheric Change
NMHS	National Meteorological and Hydrological Services
NO_2	Nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
NPN	NOAA Profiler Network
NRC	National Radiation Centres
NWP	Numerical weather prediction
OMI	Ozone-monitoring instrument
OPAG	Open Programme Area Group
OPERA	Operational Programme for the Exchange of Weather Radar Information
PC-SAG	GAW Precipitation Chemistry Scientific Advisory Group
PFR	Precision Filter Radiometer
PIR	Precision Infrared Radiometer
PMOD	Physikalisch-Meteorologisches Observatorium Davos (Swtizerland)

PPI	Plan-position indicator
PWC	Precipitable Water Content
QA/QC	Quality assurance/quality control
QA/SAC	Quality Assurance/Science Activity Center (SUNY, Albany, New York)
R&D	Research and development
RA	Regional Association
RASS	Radio-Acoustic Sounding System
RDCC	Regional Dobson Calibration Centre
RI	Rainfall intensity
RIC	Regional Instrument Centre
RMS	Root mean square
RMTC	Regional Meteorological Training Centre
RPC	Regional Pyrheliometer Comparison
RRC	Regional Radiation Centre
SALPEX	Southern Alps Experiment
SAOZ	*Système d'analyse par observations zénithales*
SHMI	Slovak Hydrometeorological Institute
SI	International System of Units
SSC-UV	Scientific Steering Committee on UV Measurements
SURFRAD	Surface Radiation Network
TARPEX	Tararuas Precipitation Experiment
TECO	Technical Conference on Meteorological and Environmental Instruments and Methods of Observation
TIROS	Television infra-red observation satellite (US)
TOMS	Total Ozone Mapping Spectrometer
TOVS	TIROS operational vertical sounder
TRMM	Tropical Rainfall Measuring Mission
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
USSR	Union of Soviet Socialist Republics
UV	Ultraviolet
UV-SAG	Scientific Advisory Group on UV
VCP	Voluntary Cooperation Programme
WCRP	World Climate Research Programme
WDCC	World Dobson Calibration Center (Boulder, Colorado, United States)
WG	Working Group
WG-SM	Working Group on Surface Measurements
WMO	World Meteorological Organization
WOUDC	World Ozone and Ultraviolet Radiation Data Centre
WRC	World Radiation Center (Davos, Switzerland)
WRR	World Radiometric Reference
WSSD	World Summit on Sustainable Development