WORLD METEOROLOGICAL ORGANIZATION

FINAL REPORT

COMMISSION FOR BASIC SYSTEMS

OPEN PROGRAMME AREA GROUP ON INTEGRATED OBSERVING SYSTEMS

IMPLEMENTATION/COORDINATION TEAM ON

THE GLOBAL OBSERVING SYSTEM

SECOND SESSION

GENEVA, SWITZERLAND

14 - 18 OCTOBER 2002

WMO General Regulations 42 and 43

Regulation 42

Recommendations of working groups shall have no status within the Organization until they have been approved by the responsible constituent body. In the case of joint working groups, the recommendations must be concurred with by the presidents of the constituent bodies concerned before being submitted to the designated constituent body.

Regulation 43

In the case of a recommendation made by a working group between sessions of the responsible constituent body, either in a session of a working group or by correspondence, the president of the body may, as an exceptional measure, approve the recommendation on behalf of the constituent body when the matter is, in his opinion, urgent, and does not appear to imply new obligations for Members. He may then submit this recommendation for adoption by the Executive Council or to the President of the Organization for action in accordance with Regulation 9(5).

EXECUTIVE SUMMARY

The second session of the CBS Implementation and Coordination Team for Integrated Observing Systems convened by on Monday, 14 October 2002 at WMO Headquarters, Geneva, Switzerland. Mr. Evans Mukolwe welcomed the members on behalf of the Secretary-General of WMO. He stressed the importance of the present meeting to environmental monitoring in the first decade of the twenty-first century and beyond.

The Chairman presented his report. He noted that the ICT has several tasks that are addressed through the OPAG's three expert teams and Rapporteur's in four areas. He noted that the OPAG-IOS is nearly 3-years into its 4-year work programme, and that the latest meeting of the CBS Management Group led to several important changes that affected the OPAGs. It: reviewed the working programmes of the OPAGs, the terms of reference of teams, the division of responsibilities in the leadership of the OPAGs and the role of the new OPAG co-chairs. He highlighted the various activities of the ETs.

The Rapporteurs of each Regional Association presented their reports. Of special note was the creation of a Strategic Plan to Enhance the GOS in Africa. The plan developed by RA I Members provided for fundable, realizable projects that address the needs of developing countries and include capacity building, support of basic infrastructure through upgrading, restoring and substitution of applicable WWW systems.

The ICT received a report on Monitoring Statistics from the Monitoring Perios July 2001 – June 2002. The results showed relatively stable levels of receipt of SYNOP and TEMP reports over the last four years, although some variation was noted.

With regard to other *in situ* systems, the reports were generally encouraging. The number of reports from Marine observing systems continued to rise with monthly ship reports now stabilized at 160,000 and buoy reports approaching 200,000. The Array for Real-time Geostrofic Oceanography (ARGO) network had 535 floats in August of 2002 and expected 3,000 floats by the end of 2005. The number of ships making upper air reports was nearly 6000 and climbing.

The calibration of marine instrumentation had been a high priority of the Joint technical Commission for Oceanography and Marine Meteorology (JCOMM) and a committee of JCOMM had been looking into a joint effort with CIMO to provide for a calibration programme.

The number of aircraft reports had doubled since 2000 and was expected to continue to increase. In addition, new aircraft systems entering service next year promised to add significant new data capabilities.

The ICT heard reports concerning the efforts of its ET dealing with Automatic Weather Stations to organize a credible quality control programme for AWSs. In addition, the team had proposed specifications for the reporting of AWS data using binary codes and had collaborated with CIMO in reviewing the requirements for accuracy of instruments used on AWSs.

In the all-important area of efforts to improve satellite system utilization, the ICT heard a comprehensive report dealing with conclusions, recommendations, and strategies resulting from analysis of the latest Biennial Questionnaire. Not only had the data from the questionnaire been useful itself, but the responses to the questionnaire had shown that efforts are needed to ensure that more Members respond. One area, which the ET reported upon, which promises to have far-reaching effect in future years is that of Alternate Dissemination Means (ADM). This is a proposal for applying emerging telecommunications technologies to the task of disseminating satellite data. As a replacement for Direct Broadcast, which, until now, has been the only means for Members to obtain all satellite data, ADM is foreseen as a cost-effective path for NMHSs to receive and distribute high-volume satellite data and thereby improve the quality of forecasts and other services.

Progress on the investigation of Operational Data Requirements and Redesign of the Global Observing System had been similarly dramatic. The ET was nearing the end of its four-year work plan and had been applying the Rolling Review of Requirements (RRR) with success. A significant number of Operational System Experiments (OSEs), performed by the NWP Centres

and National Centres (NCs) had been monitored, producing a number of recommendations. It had looked into coordinated development of comprehensive tool for conducting Observing Systems Simulation Experiments (OSSEs), but a careful analysis of the resources needed to carry out OSSEs had led to the conclusion that limited resources for evaluating changes to the GOS would probably be better focussed on well-defined OSEs. In other activities, the ET had written and published Statements of Guidance (SoGs) in eleven areas. As a final result of its activities, the ET had published 42 recommendations for the orderly evolution of the GOS, which the ICT endorsed and the chair, ICT-IOS will present to CBS Ext.(02).

The ICT participants were informed that the periodic Monitoring Reports were not intended to measure the synoptic and climate data reaching the archives. In fact, they were intended as a check on communications via the Global Telecommunications System and supporting data processing carried out by the Monitoring Centres, National Centers and NWP Centres.

A significant action by the Regional Associations had been the creation of Regional Basic Climatological Networks (RBCNs) meeting specific goals for climate observing frequency, accuracy and geographic coverage. The newly established RBCNs consisted of 2,575 GSN stations and 511 GUAN stations world-wide. Only RA I and Antarctica remain to designate appropriate RBCNs and this is expected be accomplished by the forthcoming RA I-XIII and the eighth session of the EC Working Group on Antarctic Meteorology, respectively. Another significant accomplishment had been the first Expert Meeting on Coordination of the GSN and GUAN (EMCCG-1, Offenbach, 15-17 May 2002). This group had recommended, *inter alia*, the establishment of Lead CBS Centres for Climate Monitoring, a recommendation endorsed by the ICT.

Under its responsibility for review and revision of the GOS Regulatory Material, the ICT considered first the Manual on the GOS. Following a carefully prepared procedure, the Rapporteur on the Manual on the GOS, after following the suggestions of a Task Team, working with the Secretariat and soliciting comments from Members via the Internet, had prepared a revision of the Manual. Following this, the ET-ODRRGOS had reviewed the draft revision and a final revision had been prepared by the Secretariat. After careful consideration, the ICT decided that some of the changes recommended by Members during the review process may have the effect of regulatory change, rather than updating and clarifying. Accordingly, these changes were not inserted into the final revision that will finally be presented to CBS. For CBS Ext.(02), because of insufficient time for translation, the latest revision will be made available for information, in original language only, on CD-ROM.

A similar procedure (special team, comments solicited from Members via the Internet, *etc.*) was followed by the Rapporteur on Volume A of WMO Publication No. 9. Version 6 of Volume was available for review by the ICT, which endorsed the changes and recommended to CBS that they be introduced into Volume A and promulgated in accordance with approved procedures.

The Meeting adjourned on October 18 at 11h30 CET.

1. ORGANIZATION OF THE SESSION

1.1 Opening of the meeting

The second session of the CBS Implementation and Coordination Team for Integrated Observing Systems was convened by OPAG Chairman Dr. James Purdom at 09:30 AM on Monday, 14 October 2002 at WMO Headquarters, Geneva, Switzerland.

Mr. Evans Mukolwe welcomed the members on behalf of the Secretary-General of WMO. He stressed the importance of the present meeting to environmental monitoring in the first decade of the twenty-first century and beyond. He also noted that the ICT consisted of distinguished experts who would assure a constructive outcome. He wished the participants well in their critical endeavours.

1.2 Adoption of the agenda

The ICT adopted the agenda as contained in Annex I.

1.3 Working arrangements

The meeting agreed on working arrangements and adopted a tentative work plan for consideration of the various agenda items (See Annex II. The chairman announced that he intended to adhere rigidly to the work plan, starting each session precisely on time and ending on time. He further stated that it was his intention to leave a substantial time for drafting the final report of the meeting and the document for CBS Ext. (02), which would be the definitive result of the meeting.

2. CHAIRMAN'S REPORT

2.1 The Chairman presented his report. He thanked the members for their contributions to the OPAG IOS. He noted that the ICT had several tasks that had been addressed through the OPAG's three Expert Teams (ET) and Rapporteur's in four areas. He reviewed the ETs, Rapporteurs and their Terms of Reference (ToRs) including those of the ICT which may be viewed on the WMO web page "Membership Of CBS Expert And Implementation/Coordination Teams" at http://www.wmo.ch/web/www/BAS/CBS-teams.html.

2.2 The Chair noted that leadership changes had occurred within CBS and the OPAG IOS. Dr. Geoff Love resigned as President of CBS early this year to take a job within WMO, and Mr. Alexander Gusev took over leadership of CBS as acting President. The OPAG PWS chair was now Mr. Kevin O'Loughlin from Australia. At CBS-XII Mr. Mahaman Saloum was elected as Co-Chair of the OPAG-IOS, and Rapporteurs for the scientific evaluation of Observing Systems Simulation Experiments (OSSEs) and Operational System Experiments (OSEs) were added to the OPAG IOS structure. The Chair noted with appreciation the dedication of Mr. Miroslav Ondras as chair of the ET AWS during his tenure in that position, and on behalf of the OPAG wished him well in his new job within WMO. Mr. Ranier Dombrowsky was welcomed aboard as new chair of the ET AWS.

2.2.1 The Chairman noted that the OPAG-IOS is nearly 3-years into its 4-year work programme, and that the latest meeting of the CBS Management Group led to several important changes that effected the OPAGs:

- The MG reviewed the working programmes of the OPAGs and their teams and agreed on their working priorities and tentative meeting places.
- In future the terms of reference of teams should include more specific target dates for deliverables to clarify which teams are expected to accomplish their tasks within two years and which have been assigned tasks with longer range targets.
- The division of responsibilities in the leadership of the OPAGs and the role of the new OPAG co-chairs who had been elected at CBS-XII were developed.
- The Rapporteurs on Scientific Evaluation of OSEs and OSSEs were added to the OPAG, and the terms of reference of the Rapporteurs on Scientific Evaluation of

OSEs and OSSEs, the Rapporteur on GCOS Matters, and the Rapporteur on Regulatory Material were developed and adjusted.

2.2.2 The Chairman noted that he appreciated the efforts and accomplishments of the expert teams and Rapporteurs. Particularly they had all reported substantial progress with regard to their respective terms of reference, and in cases where changes were required had coordinated them through the OPAG Chair. Brief highlights of the various activities were presented:

Implementation and operation of the space-based GOS

- Research Satellite Operators to Provide Data for Operational Utilization
  - o The U.S. National Aeronautics and Space Administration (NASA) providing MODerate resolution Imaging Spectroradiometer (MODIS) Direct Readout from Terra and Aqua, Quikscat winds data, and Advanced Infrared Sounder (AIRS) data for NWP centers from Aqua.
  - o Altimetry data being provided by the European Space Agency (ESA).
  - o Plans in place for NASA, ESA, NASDA and Roshhydromet for providing data for Members
- Operational Satellite Data Available to Members from 4 polar satellites and 6 geostationary satellites
- Satellite operators have agreed to global contingency plans for both polar and geostationary constellations
- In coordination with ET SSUP the Virtual Lab for Satellite Data Utilization and International Precipitation Working Group have been formed and are active

Observational Data Requirements and Redesign of the Global Observing System

- Users Requirements and Observing System Capabilities were charted in ten application areas (after engaging ocean and climate communities), the Rolling Review of Requirements was pursued, and Statements of Guidance were issued in all ten areas (available in several WMO technical documents and summarized in the final report of the July 2002 ET-ODRRGOS meeting).
- Several Observing System Experiments (OSEs) were pursued to test possible re-configurations of the GOS
- Candidate Observing Systems (space based and ground based) for the coming decade were studied and a WMO Technical Document was published.
- Recommendations for evolution of space based and surface based components of GOS were drafted, reviewed, and submitted to CBS. The document summarizes the most pressing observational needs and recommendations for the most cost-effective actions for meeting them in the near term and next 10-15 years.
- A vision for the GOS of 2015 and beyond was drafted.
- The ET-ODRRGOS worked closely with the Rapporteurs on Scientific Evaluation of OSEs and Observing System Simulation Experiments (OSSEs), and with their aid had prepared reviews of OSEs that are being undertaken by various NWP Centres around the globe, and with the ET the Rapporteurs had developed proposals and guidance for specific OSE/OSSEs.
- Discussions focused on a coordinated development and utilisation of a comprehensive software tool for carrying out OSSEs as well as preparation, maintenance, and evolution of a realistic OSSE database with user-friendly access. Scientists often abandon undertaking an OSSE because of the huge human and computer resources required; this suggestion is aimed at leveraging and coordinating individual investments to facilitate more and better OSSEs. After some debate, the ET-ODRRGOS noted that the required resources for OSSEs are still so

large that the limited resources for evaluating changes to the GOS would probably be better focussed on well-defined OSEs.

- Seven OSEs were suggested and eight NWP centers were engaged in conducting them.
  - o **OSEs**
    - Impact of hourly SYNOPs,
    - Impact of denial of radiosonde data globally above the tropopause,
    - Information content of the Siberian radiosonde network and its changes during last decades,
    - Impact of AMDAR data over Africa through data denial in a 4D-Var analysis and forecasting system,
    - Impact of tropical radiosonde data,
    - Impact of three LEO AMSU-like sounders, and
    - Impact of AIRS data.
  - o **NWP Centers**
    - ECMWF
    - Canadian AES,
    - Univ St Petersburg,
    - NCEP
    - Meteo France
    - JMA
    - Met Office (UK)
    - BMRC (Australia)

Satellite System Utilization and Products

- From Biennial Questionnaire 2001 made recommendations, derived strategic goals for 2002-2003, and enhanced the Questionnaire with respect to Virtual Laboratory for Satellite Data Utilization;
- With CGMS Task Team reviewed concept of Direct Broadcast (DB) with respect to future systems and sensors;
- Identified need for Alternative Dissemination Methods (ADM) for satellite data. International Precipitation Working Group (IPWG) formed;
- Virtual Laboratory for satellite data utilization functioning;
- Published two WMO Satellite Activities Technical Documents:WMO/TD-No. 660 and WMO/TD-No. 1119;
- Reviewed and updated WMO Publication No. 258;

Automatic Weather Stations;

- A new chair has been named and the team is undergoing a review of its working arrangements;
- The team held its first meeting since CBS-XII from September 2-6, and the ICT will hear its report;
- Prior to leaving as Chair of this ET, Mr. Ondras expressed concern with regard to changes of membership within the ET and how the resulting lack of continuity affected the ability of the ET to meet its goals.

2.2.3 The Chair noted with appreciation the work of the Rapporteur in coordination with WMO Members in updating the Manual on the Global Observing System, Volume 1 (Annex V to the WMO Technical regulations) and having it posted to web for review by Members

2.2.4 He noted with appreciation the work of the Rapporteur in Coordination with the OPAG Members in developing a report on possible improvements to WMO No. 9, Volume A, and having it posted on the web for Members review

2.2.5 The Chair noted with appreciation the work of the Rapporteur in coordinating activities with GCOS. Particularly evident were the results from the first CBS/GCOS Expert Meeting on Co-Ordination of the GSN and GUAN that highlighted:

- The importance of baseline networks;
- Concern with regard to system performance in RA-1 where both surface and upper air data volume is low and dropping – the Chair and ICT particularly look forward to comments by the OPAG Vice-Chair and the Rapporteur concerning this item;
- The possibility of alleviation of observational performance problems within GCOS through the U.S. Climate Change Research Initiative;
- The report on performance of GSN and GUAN stations where the number of stations in the GSN meeting requirements was at 26% while the number of stations had increased from 624 to 688. The performance of the GUAN was 50% satisfactory with an additional 13% acceptable.
- Recommendations for CBS were developed, and the Chair looks forward to reviewing them

2.2.6 The Chair again thanked all members of the ICT for their contributions and looked forward to a productive meeting. Among the items that must to be developed at the meeting are activities for each Expert Team and Rapporteur area for presentation to CBS.

3. REVIEW OF THE GOS PERFORMANCE IN THE REGIONS

3.1 Region I (Africa)

3.1.1 General

Much attention had been given to the GOS in Africa, in particular and to the WWW in general. An important meeting for the Implementation/Coordination of a Strategy for the Enhancement and Improvement of the WWW Basic Systems in RA I was held in Nairobi 8-12 April 2002 . The main objectives of the meeting were to analyze detailed expert reports, identify weaknesses and gaps, and the reasons for those weaknesses and gaps to propose solutions based on the existing and potential infrastructures as well as to propose solutions that would combine existing and new and emerging technologies available to Africa.

Prior to the field missions, the RA I Working Group on Planning and Implementation of the WWW, had developed a Strategic-Plan which was reviewed by the RA I Advisory Working Group in Nairobi in April 2001. The Working Group had given the necessary orientation for further developments of this strategy, including the need for a detail survey.

With regard to the improvement of the GOS in Africa, the Strategic Plan had proposed project areas to enhance the availability of weather, climate and environmental data and information for sustainable socio-economic development in Africa.

In view of poor performance of the GCOS networks, a regional GCOS Workshop on improving observing systems for climate was held for Eastern and Southern African countries in Kisumu, Kenya in October 2001. At this Workshop many recommendations were made including the preparation of a Regional Action Plan and its completion by May 2002. The Action Plan will incorporate all the priorities raised in the workshop and in the initial country's reports.

3.1.2 Surface-Based Sub-System

The Regional Basic Synoptic Network (RBSN)

The reception rate of SYNOP, TEMP and CLIMAT reports from African stations is very poor. Only very few stations carry out a complete synoptic observation programme, while the reception of reports from the bulk of the stations is unsatisfactory or completely absent (about 70% of the total number of stations).

There are 593 surface stations listed in the RBSN. The overall implementation of the surface stations has shown a degree of stability; for instance, the percentage of stations conducting a full observing programme was 28% in 2001, 30% in 2000, 32% in 1999. Many stations carry out incomplete observing programmes because of the lack of personnel: 49% in 2001, 52% in 2000, 50% in 1999.

There are 96 upper air stations listed in the RBSN. Only 19 stations carry out 50 to 90% of the observing programme and less than 40 stations carry out 10 to 35% of their observing programme. The main reasons for this data loss continued to be either the absence of observations (due to lack of appropriate equipment and/or the lack of qualified personnel and consumables) or telecommunication problems.

The USA National Weather Service funded an upper air observational data rescue and archival project for seven African countries (Kenya, Senegal, Niger, Angola, Mozambique, Malawi and Zambia)

Difficulties of implementing the RBSN in Africa

In almost all countries in Africa, apart from those in areas of conflicts, the current network of stations is generally adequate, but is unevenly distributed, and the majority are not operating. The large gaps in the GOS implementation in Africa are linked to inadequate infrastructure, technical knowledge and security, and obsolete equipment, which is the result of insufficient financial resources. However, the causes and degree of non-availability of data vary from country to country.

The Regional Basic Climatological Network and GCOS

The performance of the GCOS networks is as follow

Network	Total number of station	Percentage of stations from which report are received	% of stations from which reports are not received properly
GSN	155	52%	48%
GUAN	23	47%	53%

The RBCN of Region I has been prepared and submitted to the next session of RA-I to be held in November in Swaziland. 616 surface stations (CLIMAT) and 96 upper air stations (CLIMAT TEMP) have been proposed to be in the RBCN. They include stations in the RBSN, the GSN and stations not within the RBSN but producing CLIMAT reports.

Marine observations

There are some large-scale projects where many African countries participate: Pilot Research moored Array in the Tropical Atlantic (PIRATA) and the Western Indian Ocean Marine Applications Project (WIOMAP).

Aircraft observations

One important solution to solve the lack of upper air data in Africa is the production and the use of Aircraft Meteorological Data Acquisition Relay (AMDAR) data in the Region. Currently, in Africa there is an ongoing sub-regional AMDAR Project in the Southern Africa region and Mauritius (under the Southern African Development Community (SADC)) where Quantas Airlines, Air Namibia and South African Airlines are participating along with some European airline such as KLM and BA. These produced targeted observations. Also some countries like Kenya, Morocco and the 15 countries in central and West Africa under the Agency for Air Traffic Security over Africa and Madagascar (ASECNA) have indicated interest in developing an AMDAR program. One major constraint of implementing AMDAR in Africa is that it is not clear to the majority of NMHSs, who should bear the cost of AMDAR equipment?

3.1.3 Space-Based Sub-System

3.1.3.1 Operational Satellites

Most NMHSs in Africa have Meteosat Data Distribution (MDD), Secondary Data User Stations (SDUS), Primary Data User Stations (PDUS) and/or High-resolution Picture Transmission (HRPT) systems. However, the level of implementation of the GDPS and human resource capacities for utilizing the NWP products vary from country to country. A great number of countries with potential have NOT made any notable progress in research, development and operation of Numerical Weather Prediction (NWP) models. There is one relevant ongoing Project: PUMA (Preparation for the Use of METEOSAT Second Generation In Africa). The European Union (EU) funded the PUMA project for the provision of MSG ground satellite receiving systems, including relevant training and outlook activities. With regard to data from the Low Earth Orbiting (LEO) satellites, several centres within RA-I, e.g. AGRHYMET (Specialised agro-meteorological centre for Inter-State Committee for combating drought in Sahel) and the Drought Monitoring Centres (DMCs) in Haare and Nairobi, utilize high-resolution data.

3.1.3.2 Research Satellites

Many NMHSs received data coming from the research and development constellations particularly NASA's Terra and Aqua. It is worth noting another important ongoing project in Africa: The African world space Radio and Internet (RANET) project initiated by the African Centre of Meteorological Applications for Development (ACMAD). This project will improve the distribution and availability of meteorological data and products to users communities, in particular the rural communities, by using digital, wind-up and solar radios.

3.1.3.3 Ground Systems

RA I had 45 out of 56 Members equipped with low-resolution LEO receivers (APT) but only 14 out of 56 Members equipped with high-resolution LEO receivers (HRPT). 49 out of 56 Members are equipped with at least one LEO HRPT receiver, an increase of four from the previous report in 1995. Large portions of Africa have no reception for LEO satellites. Since it is well recognized that high-resolution LEO imagery is most useful for operational meteorological and hydrologic forecasting, increasing the number of high-resolution LEO receivers should be a high priority to enhance the implementation of the WWW. With regard to the geostationary satellite receivers, the situation has changed since 1995. 46 out of 56 Members have low-resolution WEFAX receivers while 19 out of 56 Members have high-resolution receivers. 49 out of 56 have at least one geostationary receiver; and the number increased by five since the last survey in 1995. It should be noted that the percentage of Members with geostationary receivers increased by 9% since 1995. 48 out of 56 Members have at least one LEO receiver as well as one geostationary receiver. Although eight Members remain to be equipped, the percentage increased from 71% to 86% since 1995, the second highest increase among the Regions and similar to that during the period 1992 to 1995.

By February 2003 almost all NMHS's in the region will be equipped with a high resolution MSG ground receiving station (HRIT and LRIT) in the framework of the PUMA project.

3.1.4 Strategic Plan To Enhance The GOS In Africa

3.1.4.1 Causes of deficiencies in the GOS in Africa

The causes of non-implementation of a fully satisfactory RBSN affected the operation of the RBCN. Recent WMO missions identified the following as the key causes of deficiencies in the GOS in Africa

- The failure to catch up with rapid technological developments;
- Poor economic environment in many African countries;
- Difficulties in establishing stations in remote or uninhabitable areas and water bodies
- Inadequate or lack of telecommunication facilities in the rural areas;
- Inadequate capacities for the operation and maintenance of equipment;

- High costs of consumables especially for upper air stations;
- Lack of necessary infrastructure such as electricity, access roads, computing facilities and security;
- Lack of equipment and consumables for Marine observations;
- The inability of the majority of national airlines to equip aircraft with AMDAR equipment due to the high costs;
- Lack of personnel.

3.1.4.2 Proposed project areas to enhance the availability of weather, climate and environmental data and information for sustainable socio-economic development in Africa.

- Implement Automatic Weather Stations (AWSs) at the RBSN stations with appropriate communications to NMCs. Highest priority to be given to GCOS stations.
- Reactivate the upper air observing programs by deploying at each station a system using Global Positioning System (GPS) associated with reliable hydrogen producing equipment. Highest priority to be given to GCOS stations.
- Implement regional AMDAR projects and operational programs addressing observations on ascent and descent at the main local airports, and during en route flight.
- Enhance marine observations through active participation of the countries in the Voluntary Observing Ship (VOS) Program and the other JCOMM and scientific programs such as the Automated Shipboard Aerological Programme (ASAP), the Ship of Opportunity Programme (SOOP), the Data Buoy Cooperation Panel (DBCP), and PIRATA.
- Identify the potential VOS and requests for shipboard equipment and organization of training of port meteorological officers.
- Identify and prioritize remote locations, inland and coastal waters, where there is a need for observational data. Prepare specifications for AWSs for the priority remote locations, purchase and install.
- Rehabilitate the CLIMAT network of stations based on conventional instrumentation.
- Enhance environmental observations
- Implement the maintenance capability for the observational equipment on a sub-regional basis.
- Institute a programme of training in use and maintenance of the equipment.

3.2 Report of the GOS in Region II

3.2.1 General

Progress had been made on the GOS in RA II in recent years. In the surface-based subsystem, the RBSN list had been revised, and some new observing systems were developed. For the space-based subsystem, RA II Members deployed more satellite data receivers. There were, however, some problems in the RA II GOS.

3.2.2 Surface-Based Sub-System

3.2.2.1 The Regional Basic Synoptic Network (RBSN)

In order to improve the rate of implementation of the RBSN, a proposed new RBSN list had been prepared during 2000 by the rapporteur. This proposed list was passed to Members of

RA II for comments. After consideration of suggestions and comments by Members, a revised RBSN list was decided and was submitted to XII-RA II (Seoul, September 2000). The session approved the new RBSN list, which resulted in 1198 surface stations, 298 radiosonde stations and 35 rawin stations. When revising the RBSN, the following principals were applied:

- The revised RBSN should have a maximum spatial resolution of 150 km for the surface and 250 km for upper-air stations;
- If an RBSN station had been "silent" according to monitoring results and another RBSN station located nearby (less than 100 km) had regularly reported its observation, the "silent" station should be replaced by the neighbouring station. If there were no regularly reporting RBSN station nearby, the "silent" station should remain on the list;
- In data sparse areas, existing stations should fill gaps (according to Vol. A, publication No. 9) although these may have been previously included in the RBSN;
- Those stations that Members propose to be in the RBSN list should remain in or be added to the new RBSN list.

As indicated in the WWW twentieth status report on implementation issued by WMO secretariat in 2001, the level of implementation of RBSN surface stations as of 1 October 2000, according to information provided by RA II Members, is 92%, which is better than the global level 78%. The level of implementation of RBSN upper-air stations is 85% for radiosonde and 78% for rawin respectively, which are also better than the global level (71% for radiosonde and 70% for rawin). But the changes made at the twelfth session of RA II had yet to be considered, as the adjustments were not made before the monitoring period. Although the implementation level of surface RBSN stations in RA II has increased in recent years, the implementation level of upper-air RBSN stations is still low. Some measures should be taken by those Members to remedy the deficiency.

The October 2001 annual monitoring results show that the availability of RBSN in RA II is 82% for SYNOP reports and 61% for TEMP reports. It is thus seen that the availability of SYNOP reports from the Region II is generally satisfactory whilst the availability of TEMP reports is not satisfactory from northern, southeastern and western parts of the region. October 2001annual monitoring results also showed that among the RBSN stations, 101 SYNOP stations and 55 TEMP (part A) stations, which had been implemented, were "silent," and 13 SYNOP stations and 6 TEMP (part A) stations, which were not implemented, were also "silent." The reasons are generally known but the specific reason applicable for each country is less certain. Any one of the following reasons may lead to a silent station: unsettled conditions in the country, lack of resources, costly sondes, lack of trained manpower, non-availability of equipment, lack of allocation of funds to NMS, or poor communications infrastructure.

3.2.2.2 The Regional Basic Climatological Network (RBCN)

In order to evolve the network of stations necessary to provide a good representation of climate on a regional scale, a new concept of Regional Basic Climatological Networks (RBCN) had been established. Therefore, an RBCN list was made and approved by XII-RA II, which resulted in 593 RBCN surface observing stations and 194 upper-air-observing stations. The SMM result shows that the availability of RBCN in RA II is 50% for CLIMAT reports and 42% for CLIMAT TEMP reports. Thus the implementation rate of RBCN in RA II was not satisfactory because of low report availability. One reason may be that the concept of RBCN had not been fully understood by all Members, and some RBCN stations have not yet been prepared to provide CLIMAT reports.

Marine observations

More effort among RA II Members had been given to developing Marine observing networks. In RA II, Members had established their own ARGO programme. Japan has 85 ARGO stations; the republic of Korea has 16 ARGO stations; China has also established one ARGO station and more ARGO station will be established.

Aircraft observations

Although the progress on AMDAR in region II has not been fully satisfactory, several projects are under development. Saudi Arabia will become the first operational system in the Middle East, and data from 4 aircraft are being received and used for system testing; Hong Kong China is developing a programme and has begun testing onboard. Japan is receiving real-time data and is evaluating system components. The Republic of Korea is planning its own AMDAR programme; China Meteorological Administration and China civil aviation have reached an agreement to cooperate on an AMDAR plan and have initiated a pilot project. Egypt, the United Arab Emirates and Kazakstan have expressed their interests in the AMDAR program. In the Middle East, most countries are receiving E-AMDAR data, while some other countries are also receiving data from the US, Australia and E-AMDAR. Oman, Saudi Arabia and Egypt are interested in establishing dedicated target programmes.

However, in Region II, the availability of AMDAR reports was very low. In some countries, difficulties existed in communicating AMDAR data to the Meteorological Department. It is suggested that WMO develop a policy in cooperation with ICAO, for these projects. More detailed guidance materials should be developed and sent to Members, in order to increase AMDAR reports in Region II.

Other Observations

Several RA II Members are deploying new Meteorological Radar to help mitigate natural disasters. Japan, Hong Kong (China), Vietnam and China are deploying Doppler radar systems, for example. China had deployed about 20 new generation weather Radar systems and about 126 Doppler radars will be established in China in accordance with the “China new generation weather Radar monitoring network distribution plan” which has been approved by the Chinese Meteorological Administration (CMA).

3.2.2.3 Space-based Sub-System

Operational Satellites

With regard to LEO satellites, the polar orbiting meteorological satellites FY-1C and FY-1D had provided helpful meteorological data for RA II Members. RA II Members also benefit from NOAA (USA) and METEOR (Russian Federation) Satellite.

With regard to the geostationary satellite, FY(China) and GMS(Japan) series Satellites have greatly helped RA II Members in weather monitoring and forecast.

Research Satellites

In China, FY-1A and FY-1B satellites are mainly used in monitoring the vegetation growth, flooding, snow coverage, sea ice, distribution of sea surface temperature and the erosion paths at the mouths of rivers.

The MODIS instrument aboard a NASA R&D satellite had been used in preliminary applications in land surface and environmental monitoring in China. It was found that it had the obvious advantage of its 250 metre resolution, compared with the polar orbiting meteorological satellite. With the Ch-1 and Ch-2 (wave lengths 0.62-0.67 ìm and 0.841-0.867 ìm), some information not found in the polar orbiting meteorological satellite images had been detected. This included such details as: rich detail of water bodies, desert water body detection, sea ice monitoring, sleet and ice monitoring over Huanghe River, calculation of the coverage of burned area and snow coverage monitoring.

Ground Systems

RA II has 30 out of 34 Members equipped with low-resolution LEO receivers (APT) but only 14 out of 34 Members equipped with high-resolution LEO receivers (HRPT). 32 out of 34 Members are equipped with at least one LEO receiver, which is an increase of one from 1995. Large portions of Southern Asia have no reception for HRPT. A similar situation exists for the geostationary satellite receivers. Out of 34 Members, 30 have low-resolution WEFAX receivers while only 12 have high-resolution (HR) receivers. In all, 32 out of 34 Members have at least one geostationary receiver; the number has increased by six since the last survey. There were significant increases (192) in the numbers of receivers for both LEO and geostationary satellites and the percentage of equipped Members increased more than any other Region (+18%). The major improvement in this Region since 1992 has been in the area of the low-resolution LEO receivers, an increase of 100 receivers.

3.3 Report of the GOS in Region III

3.3.1 General

The GOS activities carried out by the Members of RA III had been consistent with the technological and economic capacity of the Region; however, efforts had been made to provide more information, whilst maintaining its availability and quality.

Another regional concern had been installation of automated observing systems in remote areas and development of aircraft data collection systems. Members had been urged to make efforts at a national level, with the assistance of the WMO Voluntary Cooperation Programme (VCP). Members had requested the assistance needed to create satellite data receiving capability so as to be able to obtain most of the products that will soon be available.

Finally, training and further qualification activities should continue to be assisted and promoted to ensure continuity of the homogenous technological capacity of the Region.

3.3.2 Surface Subsystems

3.3.2.1 Regional Basic Synoptic Network (RBSN)

The Annual Global Monitoring (AGM) of RA III, showed that, during the period 2001-2002, availability of SYNOP reports had reached 62%, whereas that of TEMP reports had remained insufficient at only 36%.

3.3.2.2 Regional Basic Climatological Network (RBCN)

The Special MTN Monitoring (SMM) of the RBCN stations showed 38% availability of CLIMAT reports (in 2001-2002 the number of stations decreased to 123) and that of CLIMAT TEMP reports had been only 6% (in 2001-2002 the number of stations decreased to 7). This showed that the availability of reports for the Region was unsatisfactory.

3.3.2.3 Marine observations

Under the International South Atlantic Buoy Programme (ISABP) the number of drifting buoys had considerably increased, whilst the PiRATA project covered the requirements of the equatorial Atlantic Ocean through the deployment of moored buoys. The information collected by both programmes and distributed via the Global Telecommunication System (GTS) had covered most of the information requirements for maritime activities within the Region.

The reception of this information by the National Meteorological Centres is, however, inadequate. A predominant cause of this had been that the channelling of information to the Regional Telecommunication Centres was not well understood.

3.3.2.4 Aircraft observations

The Region had carried out a pilot programme in implementation of AMDAR at a local level (Argentina, Chile). It planned to expand this subsequently to the Regional level. Initially, the USA provided the technical equipment so that this system could be installed in the Region and the Governments of the Members in RA III had been asked to assist.

3.3.2.5 Other observations

Data Collection Platforms (DCP) are of great importance for the Region for improving the density of the observing network, as in Chile, which had recently installed 20 or so DCP stations, experimentally included in the local telecommunication network. Chile had also carried out some feasibility studies on the installation of meteorological radar.

3.3.3 Space-Based Subsystem

3.3.3.1 Operational satellites

Data access

All Members of RA III had low-resolution receiving equipment for data from LEO satellites (APT). However, only 6 of the 13 Members had high-resolution equipment (HRPT) for these satellites. The changes in low- and high-resolution transmission formats anticipated by the end of the decade will cause a situation in the Region where the current equipment will be limited in its usefulness.

Data application

Satellite data in the Region is currently used in accordance with the technological means available to each of the Members.

Education and training

Technical Cooperation initiatives have been carried out within the Region with a view to building the capacity and raising the knowledge of the professionals who produce and disseminate meteorological information. Some Members also used training facilities of the Virtual Laboratory.

3.3.3.2 Research Satellites

Selected countries carried out research on satellite applications (Brazil). Some Members also received satellite wind data from Quikscat, using the Internet.

3.3.3.3 Ground Systems

Very little technological development has occurred in the field of satellite data reception in the Region. Nevertheless, the imminent changes in satellite data reception will significantly affect the Region, if only in the fact that adequate equipment has not been provided or delivered to overcome the above problems.

3.4 Report of the GOS in Region IV

3.4.1 Surface Systems

3.4.1.1 The Regional Basic Synoptic Network (RBSN)

The current RBSN in Region IV [Resolution 2 (XII-RA IV)] comprised 514 surface stations, 143 upper-air stations and 25 automatic marine stations. The overall status of implementation of the RBSN in Region IV had remained unchanged comprising 90% for surface observations and 91% for upper-air observations.

According to the results of monitoring carried out in October 2001, 451 stations, i.e. almost 88 % out of the total number of RBSN surface stations, had provided more than 50% of expected SYNOP reports. There was still a noticeable number of stations (35) providing less than 50% of expected reports. The number of “silent” stations had remained virtually unchanged: 26 stations or 5% of the total number of RBSN surface stations. It should be noted that gaps in the SYNOP data coverage existed over certain areas in the southern part of the Region.

The availability of upper-air data from the RBSN stations indicated that 119 stations i.e. 83% of the total number of RBSN upper-air stations had provided at least 50% of expected reports. The number of stations providing less than 50% of expected TEMP reports had continued to be noticeably high, consisting of 10 stations or almost 7% of the total number of RBSN stations. It should be noted that the number of “silent” stations had increased from 11 to 13 stations. There were gaps in expected TEMP data coverage from certain RBSN stations in Central America. The major difficulties experienced, especially by developing countries, in maintaining reliable implementation of RBSN stations had continued to be due to the high cost of consumables and spare parts, and residual negative consequences from hurricane Mitch in 1998.

3.4.1.2 Other Networks, Including Sea Stations

Marine Stations

The total number of ships recruited by Members of RA IV had increased to a total of about 2500 in the year 2000 compared to 1958 in the year 1996. However, the number of SHIP reports received at MTN centres in the Region, had decreased considerably to a daily average of 1233 over the 15-day monitoring period in October 1999 (3315 in the same period of 1996). To partially compensate for that problem, there had been a continuing increase in the deployment of other types of sea stations. The total number of active drifting buoys deployed by operators in 2 countries in the Region had increased to 750. Moreover, 120 moored buoys were now operating within regional waters. Reports from most of these automated sea stations had been exchanged on the GTS. More information needed to be provided to NMHSs on the development of drifting and moored buoys and the relevant observational data made available.

Aircraft Systems

The new Meteorological Data Communications and Reporting System (MDCRS) programme had begun within the US AMDAR programme. The goal of MDCRS was to develop a first generation operational water vapour sensor on up to 50 aircraft in the United States. Most recently, the development of a second generation sensor was almost complete and expected to become operational in 2002.

Canada had several discussions with airlines in Canada to obtain aircraft observations over the country. Air Canada recently reiterated their commitment to the AMDAR programme and will make every effort to implement AMDAR systems.

Radar Systems

A project to implement a digital radar network consisting of 5 radars in the Caribbean (including Martinique and Guadeloupe radars) had begun. Likewise the Committee of Hydrological Resources (CRRH, Central America regional committee) had established a project to implement one radar at each country of Central America by 2004/2005. Cuba was upgrading its current meteorological radars.

Information Systems and Services

The Star IV system will be substituted by January 2003 in all the countries that have it. T4 products will be transmitted until December 2003; the new products will be sent in Uniform Binary Representation (BUFR) digital code. The new workstation will be capable of processing both BUFR and GRIB (Numerical weather prediction data in gridpoint form, expressed in binary) codes.

Internet Services

The RTH Washington will place all data and products required by users on the Web site once a formal request has been submitted to the NWS. All of the global TEMP and surface synoptic data was already on line and the National Centers for Environmental Prediction (NCEP) model data were to a great extent also available.

3.4.1.3 The Regional Basic Climatological Network (RBCN)

GCOS (GSN and GUAN) stations: CBS through its Working Group on Observations, had substantially contributed to the design and selection of upper-air and surface stations to be included in the GCOS Upper-Air network (GUAN, 1996) and the GCOS Surface Network (GSN 1999). Both networks were established, the lists of GSN and GUAN stations having been approved by the Regional Association IV Meeting at Venezuela (2001).

Resolution 4.2.11 adopted by XIII-RA IV (Venezuela 2001) had acknowledged the ever-growing requirement for climate observations. This was particularly obvious, for example, in the scientific evaluation of the impact of the last El Niño episode. Other indications included research related to hurricane climatology, droughts and the growing potential of seasonal prediction products. In light of this the Association had agreed to request its WG-PIW to assess the various requirements and develop recommendations on how the requirements of RA IV could best be met in the future through modifications to the RBSN and RBCN, including consideration of an increased density of the latter.

3.4.2 Space-based Systems

3.4.2.1 *Ground Systems*

The transition to LRIT (digital) from WEFAX (analog) in 2005 will require some new receivers and totally new processing capability. The RAMSDIS system (images from GOES 8 each 30 minutes) had been implemented in Central America in 2001 with regional node in Costa Rica. All countries of Central America had been connected to the node via Internet. Likewise, the Auto Estimator of Rain (AE) is currently running over the same area. The Flash Flood Satellite Monitoring that will cover all the countries of the isthmus will probably be installed by 2002/2003.

3.5 Report of the GOS in Region V

3.5.1 *General*

RA V consisted of both very well developed and developing NMHSs covering large land and oceanic areas.

The Association had considered the difficulty in acquiring upper air information across the Region and had noted that many NMHSs had been adversely affected by the loss of the Omega radio navigation network. Without financial support for consumables, in some developing countries, the observation program could not meet the requirements for either weather forecasting or climate monitoring. The RA had noted large differences in the prices for GPS sondes.

The Association had considered that the public visibility of the NMHS could be affected by the location of observing systems. Observing networks had traditionally been designed according to the need for balanced geographical coverage. However, users expect observations to be available for high-profile locations and this can affect the public perception of the NMHS. The Association, therefore, urged NMHSs to balance these competing requirements to determine the most appropriate locations for observing stations within their territory.

In Region V, very useful guidance on the requirements for development of the GOS was contained in the Needs Analysis for the Strengthening of Pacific Island Meteorological Services (August 2000) related to the Strategic Action Plan for the Development of Meteorology in the Pacific Region. The Association had invited the Working Group on Planning & Implementation of the WWW (WG-PIW) to consider the Needs Analysis to identify the most important and achievable projects and pursue implementation of those projects.

The Association had noted that in some areas, observations are available from sources outside of the NMHSs, such as from universities, highway departments and other local authorities. These data could be useful to NMHSs wherever they are available. However, it should be noted that the data have to be quality controlled according to WMO standards and that these data are not reflected in the annual Monitoring Reports.

3.5.2 Surface-Based Sub-System

3.5.2.1 The Regional Basic Synoptic Network (RBSN)

The number of SYNOP reports received from RA-V during the 2001 monitoring period had increased slightly from 1001 per day in 2000 to 1023 in 2001 and the number of TEMP reports had increased from 108 per day in 2000 to 111 in 2001. The number of SYNOP reports over the Indonesian region had shown significant increases over the previous year.

The number of SYNOP reports in 1998 had been 857 per day. The considerable increase in the number of SYNOP observations since then had been due mainly to the commencement of Australian standard hour bulletins based on AWS observations. The exclusion of reports at non-standard hours had continued to affect the New Zealand and Papua New Guinea numbers. The number of TEMP reports had been the highest since 1997.

XIII-RA V (Manila, May 2002) had recommended some changes to the definition of the RBSN and the monitoring of its performance. It recommended that the RBSN list adopted by the Association should reflect the actual commitment of Members and that the monitoring should measure the number of reports received against this practical target rather than against an ideal. To support this requirement, the meeting had recommended that the RBSN list have an extra column, which listed exceptions to standard practice that are expected to be a long-term characteristic of the observing program at a station such as:

- Station planned (not implemented yet)
- Reduced daily observing program
- Variations in availability throughout the year
- Non-standard reporting hours

However, these proposed changes should not give the impression that standards are changing.

The Association had noted that CBS-XII had invited regional associations to develop objective criteria for the selection of RBSN stations, based on factors such as spatial distribution, performance and availability of data. It recognized the value in such a set of criteria, but had felt that it was not possible to apply these criteria to much of Region V where stations are widely distributed and very few alternative stations are available to replace non-performing RBSN stations.

Marine Observations

Because of the expanse of ocean within RA V, the trend is expected to continue of increased emphasis on and availability of marine observations. RA V had continued to play an active role in the drifting buoy program through chairing the Drifting Buoy Cooperation Panel (DBCP) and the Drifting Buoy Panel for the Indian Ocean (DBPIO).

The Expendable Bathythermograph (XBT) network had continued to operate successfully. A major recent development had been the rapid deployment of Argo floats to measure sub-surface temperature and salinity. 541 Argo floats were currently operational and the data from the floats had been distributed in TESAC code on the GTS in near real-time. This had been a major advance in the observing of the oceans surrounding RA V countries.

Another new activity had been the commencement of ASAP observations in the Southern Hemisphere. In April 2001 the M.V. Palliser Bay (call sign GWAN) began operating out of the UK, providing twice-daily upper air soundings. A study conducted in the Australian Bureau of Meteorology showed that the upper air soundings from this vessel had significant positive impact on numerical analyses, similar in magnitude to reports from isolated island stations in southern mid-latitudes. Recently the above vessel had been replaced by another vessel that would continue the programme on a 3 month cruise from South Africa to Australia and back. This will start in December 2002.

The South Pacific Applied Geoscience Commission (SOPAC) had defined a strategy for the Global Ocean Observing System (GOOS) for the Pacific. In addition SOPAC had called for stronger coordination between GOOS and GCOS for the Pacific in order to define a single coordinated observing network. Coordination should be easier with the location of the IOC Regional Office in Perth.

The Regional Association had asked the Rapporteur on Regional Aspects of the GOS and Rapporteur for Oceanographic and Marine Meteorological Services to coordinate their work closely to ensure cross-programme coordination between CBS and JCOMM on maritime observing systems.

Aircraft Observations

AMDAR had provided a valuable addition to the observing network in the Region and NMHSs should arrange for additional collection of these observations. Within the past year AMDAR reports had become available in geographically segmented bulletins, making it easier for smaller centres to use these data. In the Region, Australia and New Zealand had been collaborating with the AMDAR Panel to seek ways to improve the AMDAR programme in the Region. The failure of Ansett Airlines had adversely affected AMDAR Observations

3.5.2.2 The Regional Basic Climatological Network (RBCN)

The Association had noted that the concept of a Regional Basic Climatological Network had been adopted by several Regional Associations and was supported by CBS and CCl. This development recognizes that it is not practicable to have the network of CLIMAT reporting stations identical to the Regional Basic Synoptic Network (RBSN). Some CLIMAT reporting stations were not in the RBSN (including some GSN stations) and cannot meet RBSN requirements. Conversely, some RBSN stations were not suited for climate reporting.

The RBCN had been intended to be a separate network of CLIMAT and CLIMAT TEMP reporting stations based primarily on the RBSN stations and should include GSN and GUAN stations, supplemented by other CLIMAT and CLIMAT TEMP reporting stations needed for description of regional climate features. These supplemental stations should be selected under the same criteria used for GSN stations. Non-RBSN stations reporting CLIMAT messages should be considered, particularly those with long favorable records, as well as any Reference Climatological Stations. The Association had recommended that an RBCN be defined for RA V and Members had been requested to refine the draft network proposed by the WG-PIW.

GCOS activities with special relevance to RA-V had been the GCOS Pacific Island Regional Implementation Workshop held in Samoa in August 2000 and a Pacific GCOS Action Plan Workshop held in Honolulu in October 2001. The aim of these workshops had been to prepare an Action Plan to improve GCOS in the region. A Working Group had been established to develop projects and assist in implementation of the Action Plan. Many of the problems and issues of the GOS are common to GCOS, including the problems in the preparation and distribution of CLIMAT and CLIMAT TEMP messages.

The number of CLIMAT messages in RA-V had improved, but in the 2001 Annual Global Monitoring only 38% of CLIMAT reports and 66% of CLIMAT TEMP reports had been received. Reports from the GSN Monitoring Centres, established by CBS, had proven beneficial in improving performance and a means to seek remedies for problems encountered in the Region. Specific problems identified for RA V need to be followed up by Members and the WMO Secretariat.

In the SMM exercise carried out recently by the WMO secretariat it had been found that the number of RBCN stations that provided CLIMAT and CLIMAT TEMPs for the period from July 2001 to July 2002 for RA V had shown a decrease. These could be attributed to the recent amendments that took place at XIII-RA V (Manila 2002).

Other Observations

The Comprehensive Test Ban Treaty Organization (CTBTO) is installing a world-wide monitoring network that includes meteorological observations and WMO and CTBTO have signed an agreement to exchange data. Since the CTBTO network was expected to grow to nearly 300 sites with many in remote areas, there would certainly be many sites within the Region. The observations are to be collected by Canada and distributed on the GTS.

3.5.3 Spaced-based Sub-System

3.5.3.1 Operational Satellites

The space-based sub-system of the Global Observing System had continued to provide valuable data, products and services to WMO Members in RA-V with both geostationary and LEO satellites. The data from these satellites have been a vital component of the forecasting and warning services for the region, particularly for tropical cyclones and other severe weather events, and for monitoring the climate system and the environment.

Satellite measurements of surface wind speed and direction from the SeaWinds instrument on QuikSCAT instrument had been used more widely in operational meteorology and are proving a very valuable resource. The observations provided impressive detail on the structure of weather systems over oceanic areas.

Although beyond its design life, GMS-5 continued to operate well. The spatial extent of the images and a reduced frequency of images had been implemented on 4 July 2001 as precautionary measures. The scheduled replacement, MTSAT-1R, is currently scheduled to be launched in early 2003. The contingency arrangements with NOAA/NESDIS to move GOES-9 westwards is a welcome assurance of continued imagery in support of weather service in the region.

China is committed to an ongoing meteorological satellite program, which will be a major contribution to WMO Members in Region V. China's FY-1 LEO program is also providing valuable data now from two satellites after the launch of FY-1D in May 2002. These satellites carry a 10-channel radiometer giving high-resolution imagery for meteorological and oceanographic applications.

Member countries had been encouraged in the development of techniques for the utilization of satellite data and assimilation into NWP models, especially data from the microwave sensors such as QuikScat, AMSU-A, AMSU-B and SSM/I.

Other Observations

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Members are encouraged to complete the biannual questionnaire on satellite activities and Rapporteurs should play a role in making sure that this is done. It is also noted that all Regional Associations are encouraged to develop a template for reporting on satellite activities on a regular basis.

3.5.3.2 Res*earch Satellites*

Some Members of the Region have made extensive use of satellite data from environmental and R&D satellites for operational and research and development purposes. However, majority of Members need ongoing updating of skills, awareness and access for maximum use of such satellite data.

3.5.3.3 Ground Systems

All Members have either a polar-satellite receiver or a geostationary satellite receiver. In some countries, have both receivers. A majority of the developing countries of the Region have the EMWIN system to receive satellite imagery and other weather information. Now when GOES-N becomes operational within a few years, the power of the EMWIN broadcast will be reduced and the signal modulation will be changed. Existing antennae and receivers will be able to be used but the demodulators in the receivers will need to be replaced

3.6 Report of the GOS in Region VI

3.6.1 General

In general, the implementation of the GOS in Region VI has been satisfactory, though with considerable variability in the level of performance across the Region and within the networks. A significant development in the next 3 or 4 years will be the move of EUMETNET Climate Observing System (EUCOS) from an implementation programme to an operational programme. Close co-ordination between WMO and EUCOS will be required to ensure that benefits are optimized. EUCOS proposals to reduce the number of land based observing systems whilst increasing the number of observations from remote and sensitive areas had been aimed at improving the quality of numerical weather prediction products over Europe. EUCOS had conducted a number of studies aimed at identifying the optimum network of surface and upper-air observations to maximize the performance of NWP models over Europe in the period 0 to 72 hours ahead. Members of EUCOS will derive savings from the reduction of land based systems, but will need to invest in systems such as AMDAR and ASAP.

3.6.2 Surface-Based Sub-System

3.6.2.1 The Regional Basic Synoptic Network (RBSN)

The revised list of RBSN stations that had been presented at XIII-RA VI (Geneva,, 2-10 May 2002) showed 759 stations – an increase of 33 in 4 years. Monitoring by the European

Centre for Medium-range Weather Forecasts (ECMWF) of RBSN SYNOP reports for Region VI shows a very small increase in the frequency of reception of reports during the 2 years to July 2002. Frequency of reception had been broadly constant at 06, 12 and 18 UTC, but showed a minimum at 00 UTC. Analysis of the results of the October 2001 monitoring period indicated that 91% of SYNOP reports had been received against a target of 98%. Inevitably, there had been changes in stations during inter-sessional periods, and this may create an unduly pessimistic picture. An analysis of observations available in the UK Met Office database from surface RBSN stations at the beginning of September 2002 had shown 727 stations (95.7%) reporting at that time. However, some of the stations were not reporting a full programme of observations. 32 stations were not reporting at the time of this survey.

The list of upper-air stations presented for revision at XIII-RA VI had shown 135 stations, a reduction of 8 stations in 4 years. However, even this list was in need of some revision as changes had occurred since May. There is little evidence of significant change in the past 2 years for the reception of data from upper-air stations, though data monitoring at ECMWF shows a small increase in the frequency of reception of wind observations. The principal area of concern remains the relatively low figure of 72% of TEMP reports received in the 2001 monitoring period, compared to the 93% of reports expected. The main shortfall is evident in the eastern part of Region VI and Members are encouraged to provide assistance to help achieve higher figures for the reception of upper-air data. An analysis of the upper-air observations available in the UK Met Office database at the beginning of September 2002 had indicated that 28 stations (20.7%) were not reporting at that time. In addition, some stations had not been meeting the target of 2 ascents a day.

Vaisala radiosondes (RS80 or RS90) are in use at 75% of stations, 21% use the Russian Federation MARS or MRZ radiosonde with the remaining 4% using VIZ, Graw or ML-SRS radiosondes. In the last 2 years about 40 stations have changed from the Vaisala RS 80 to the RS 90 radiosonde, that offers improved temperature, pressure and humidity sensors.

There are 20 remotely controlled autosonde stations in 8 member states in RA VI.

A number of Members had continued to use the LORAN system for wind finding, despite concerns over availability of this system beyond 2005.

Marine Systems

A number of nations had supported the WMO VOS Programme, though there was no European forum to co-ordinate the operation of the European VOS. Globally, the number of VOS had been 7036 in 1998. Although no confirmed figures were available for later years, it was expected that the global number would be near to 6000 in Aug 2002. Some of this reduction has occurred through the removal of ships of poor quality. However, the Composite Observing System for the North Atlantic (COSNA) consolidated monitoring report for 2002 indicates that there has been little significant trend evident in either the global or North Atlantic numbers of SYNOP reports from manual and/or automatic ships in the past 4 years. The list of suspect ships within the North Atlantic, maintained by ECMWF, had shown a significant increase in the number of ships reporting suspect SYNOPs. The number had increased from about 13 in 1998 to about 40 in 2002. The JCOMM Ship Observing Team had noted the importance of maintaining a network of Port Met Officers to liaise with ships and improve the volume and quality of data. A continuing concern with the VOS Programme is that a small number of Members bear a significant proportion of the communications costs for the Programme.

A number of Members had supported the ASAP programme. Within the COSNA area, there were 14 mobile ASAP units aboard ships and a further 12 units outside the COSNA area. Within the COSNA area, the number of TEMP soundings had increased in each of the last 2 years, reaching 3880 soundings in 2001. However, the COSNA consolidated monitoring report had shown that the number of soundings available at ECMWF varies considerably from ship to ship, and that there are continuing problems over corrupted call signs. The number of TEMP SHIP observations available at ECMWF at 00 and 12 UTC had shown a decline in recent years, whilst the number available at 06 and 18 UTC had shown an increase in 2001. This had been the result of an increased number of automatic systems on board ships, allowing more frequent ascents. Once again the benefits of collaboration had been shown by the continued support by 6 Members of the ASAP unit on the Ekosfisk oil platform in the North Sea.

The number of drifting buoys in the North Atlantic Ocean operating within the European Group on Ocean Stations (EGOS) programme had reached a monthly average of 49 in 2000, but fallen to 43 in 2001. At 31 July 2002, the figure was 42, with a further 22 buoys expected to be deployed in the next 6 months. The average lifetime of the buoys has increased significantly, with the average lifetime of a buoy close to 400 days during 2001. The number of buoy deployments fell from 71 in 1999 to 57 in 2000 and to 41 in 2001. Budgetary constraints had been the main reason for the decline, though increased reliability had been an enabling factor.

The network of moored buoys maintained by the UK, France and Ireland had continued to operate, with all buoys functional at 30 June 2002. K16, in the northern North Sea had been cut adrift in March 2002, but had been recovered and re-deployed in May. The network had recently been augmented by the deployment of an additional buoy by Ireland, with 2 more to be deployed later. The benefits of international collaboration had been evident in this area as well, as the UK and France had maintained buoys in the Bay of Biscay, and the UK and Ireland are collaborating to improve the design of Buoys.

Aircraft Observations

The number of ASDAR aircraft had continued to decline. There were only 10 operational units in service, with on average only 4.5 reporting per day in June 2002, and fewer than 1000 reports per day. Although some of the aircraft operate in areas where other sources of data are limited, it is difficult to see how the programme can continue for much longer. Noting that the ASDAR programme was designed to be operational only until 1999, the ICT agreed that its continued operation has been a clear indication of a successful programme. Nevertheless, there may be more effective uses for the resources committed to supporting ASDAR. Noting the continued decline in observations, and as a consequence of the relocation of the UK Met Office, the UK had advised the ASDAR sub-group that the UK will be unable to provide operational support to the ASDAR Programme after 31 March 2003.

The number of AMDAR units and reports had continued to increase in the past 2 years, and although there had been a decline in the number of reports after 11 September 2001, reports had since recovered to pre-September 2001 levels. In April 2002, there had been over 500 units within the EUMETNET E-AMDAR project, with over 50% of these fully operational. 95% of reports had been available within 1 hour. There had still been some national airlines that do not participate in AMDAR. This may be a consequence of the lack of appropriately equipped aircraft, or that the NMS has not convinced the airline of the mutual benefits to be derived from participation in the programme. It should be noted that the EUCOS Implementation Report indicates that continued investment in the E-AMDAR project will allow for more efficient use of observing resources over national territories.

Other Systems

There had been a small increase in the number of tropospheric wind profiling stations in the region, and an increase in the number of weather radars measuring upper winds, though these were mostly in Scandinavian countries. These systems had the advantage of producing a continuous record of upper level winds, and providing a valuable source of information for numerical weather prediction models.

3.6.2.2 The Regional Basic Climatological Network (RBCN)

Based on recommendations of EC and CBS, XIII-RA VI (May 2002) had agreed to the concept of defining a separate RBCN for the Region. Furthermore, Members were urged to spare no efforts in implementing the revised RBCN. The new network now comprises 520 (714) CLIMAT stations and 91 (142) CLIMAT TEMP stations (previous numbers are given in parenthesis).

The results of the July 2002 monitoring period had indicated that 72% of CLIMAT and 64% of CLIMAT TEMP reports had been received at MTN centres during the monitoring period. Members are urged to take appropriate action to address the reasons for low availability of RBCN reports in their area of responsibility.

3.6.3 Space-based Sub-System

Operational Satellites

Members in RA-VI had been well supported by the EUMETSAT geostationary satellites Meteosat-7 and Meteosat-5, and by the LEO systems provided by NOAA/NESDIS, the Russian Federation and by China. The launch of the first MSG geostationary satellite on 28 August promised to bring the benefits of advanced imaging and sounding from geostationary orbit to the NMHSs in the RA VI and RA I areas.

Research Satellites

Member states, especially those with NWP capability, climate models, and ocean forecasting models had been making substantial and increasing use of data from research satellites. In particular, scatterometer data providing surface wind vectors were having a positive impact upon forecast skill. Within the UK Met Office Hadley Centre Along Track Scanning Radiometer (ATSR) and Advanced Along Track Scanning Radiometer (AATSR) data were having a significant impact upon sea surface temperature analyses, and in the study of the radiative properties of cirrus clouds. The assimilation of UARS data had led to improve analysis and understanding of stratospheric temperature and ozone. Products derived from MODIS data were being examined with the intention of using them in global and regional NWP models, in site specific models and in climate studies.

Ground Systems

RA VI had 36 out of 49 Members equipped with low-resolution LEO receivers (APT) and 21 out of 49 Members equipped with high-resolution LEO receivers (HRPT). The Region had 44 out of 49 Members equipped with at least one LEO receiver, which was an increase of five from the previous report. Most of RA VI had been adequately covered for reception of HRPT except Eastern Europe, and some Members are supported by receiving equipment located in another member state.

The situation was similar for GEO satellite receivers. Out of 49 Members, 40 had low-resolution WEFAX receivers and 27 had high-resolution receivers. Forty-four out of 47 Members had at least one GEO receiver, which was an increase of five since the last survey. One should note the large number (286) of low-resolution WEFAX GEO receivers reported by RA VI. Forty-three out of 49 Members had at least one LEO receiver <u>and</u> one GEO receiver.

3.7 Status Of The Space-Based Component Of The (GOS)

The session was informed of the status of the space-based component of the GOS. It recalled that there were three constellations: LEO, geostationary and Research & Development (R&D). The space-based component has a space segment for the three constellations as well as an associated ground segment.

3.7.1 The Polar-orbiting Constellation

With regard to the LEO constellation, the session noted the status for satellites operated by the People's Republic of China, EUMETSAT, NOAA/NESDIS (USA) and the Russian Federation. It noted that the polar orbiting meteorological satellite FY-1C was launched on 10 May 1999. This three-axis stabilised satellite has been operating since that time. FY-1D was launched on 15 May 2002. China's Haiyang-1 satellite, its first marine satellite for surveying ocean resources, was also launched on 15 May 2002. China's first satellite in its new FY-3 series, FY-3A, will be launched in 2004. NOAA-17 was launched on 24 June 2002 and is in its commissioning phase. NOAA-17 will be the last morning satellite launched by NOAA/NESDIS (USA). EUMETSAT's Metop-1, scheduled to be launched in July 2005, will be the successor to NOAA-17 in the morning orbit. The Metop series (3 satellites) is a new EUMETSAT Programme and will be Europe's contribution to the space-based component of the GOS LEO constellation in the morning orbit. NOAA-16 was launched on September 21, 2000. In March 2001, NOAA-16 was designated as the operational replacement for NOAA-14. As such, it operates in an orbit with a 13:53 p.m. ascending node (afternoon orbit). NOAA-15 was launched on May 13, 1998. By July 1998, NOAA-15 was designated as the operational replacement for NOAA-12. As such, it operates in an orbit with a 7:30 am descending node (morning orbit) and utilises the same set of instruments as NOAA-16 except the SBUV. The planning launch dates for the remaining ATN follow-on satellites are: NOAA-N - June 2004 and NOAA-N' - March 2008. The first converged NPOESS satellite is expected to be available for launch by 2010 to back-up the last launches of the current DMSP and POES satellites. Two satellites of the Russian Federation's METEOR-2 and –3 series are currently operated in circular orbit inclined at approximately 82^0. These satellites have operated far beyond their expected lifetimes and their capabilities are limited. METEOR-3M N1 satellite was launched on 10 December 2001 on a Zenit-2 launch vehicle. In addition to the normal instruments including imager and sounder, METEOR-3M N1 also has the Stratospheric Aerosol and Gas Experiment (SAGE-III) and the Scanner for Earth's Radiation Budget (SCARAB) instruments. Meteor-3M N2 will be launched in a sun-synchronised orbit in December 2004 by a Strela launcher from Svobodniy Kosmodrome.

3.7.2 The Geostationary Constellation

With regard to the geostationary constellation, the session noted the status for satellites operated by the People's Republic of China, Japan Meteorological Agency (JMA), EUMETSAT, NOAA/NESDIS (USA) and the Russian Federation. The second Chinese geostationary meteorological satellite, FY-2B, was launched on 25 June 2000 with a Long-March 3 vehicle from the Xichang Satellite Launching Center. The satellite is spin stabilised and stationed at 105^0E. FY-2C is planned for launch in 2004. EUMETSAT's Meteosat-5 has been used to support the Indian Ocean Data Coverage (IODC) Service at 63 E Longitude following its support to the INDOEX experiment, which commenced in July 1998. Meteosat-6 has been used both as an in-orbit spare at around 9.5°W, to support Rapid Scan trials, and to support validation of the re-engineered Meteosat-6 correction system (in addition to, or in place of, routine weekly imaging). Meteosat-7 has been used to provide the nominal 0°. The first of EUMETSAT's new generation of weather satellites was successfully launched from Kourou in French Guiana on an Ariane-5 launcher on 28 August 2002. It is currently undergoing commissioning tests. JMA's Geostationary Meteorological Satellite-5 (GMS-5), launched on 18 March 1995, has remained in continuous operation at 140 degrees East in geostationary orbit. Although GMS-5 is operating beyond its designed lifetime of 5 years, it will continue to operate until the Multi-functional Transport Satellite-1 Replacement (MTSAT-1R) assumes the meteorological mission of GMS-5 in the summer of 2003. In 2001, Rosaviakosmos together with Roshydromet and other Russian State departments issued a tender for a contract for the development of the GOMS- 2 satellite, which will be a 3-axis, stabilised platform. Besides a standard meteorological communication package (the DCS and the transponders), the key payload will consist of the imager MSU-G which will be SEVIRI-like. GOMS-2 launch to geostationary orbit at 76^0 E is planned for 2005. The in orbit satellites for NOAA/NESDIS included GOES-8, -9, -10, -11 and –12. GOES-8, launched in April 1994, is stationed over the East Coast of the United States at 75 degrees West longitude. The first of the series, GOES-8 retains the ability to provide the full range of products, although with some loss of redundancy. GOES-9 is expected to act as back-up for GMS-5 at 155 degrees East longitude from the Austral Spring 2003 until MTSAT-1R becomes operational towards the end of 2003. GOES-10 is the operational West Coast satellite at 135 degrees west longitude. The GOES-11 spacecraft was successfully launched on May 3, 2000 and will be used as the primary replacement in the event of a failed operational spacecraft. GOES-12 was successfully launched on July 23, 2001 and completed its checkout in December 2001.

3.7.3 The R & D Constellation

The session noted the status for satellites operated by NASA, ESA, NASDA and Rosaviakosmos. The National Aeronautics and Space Administration (NASA) of the USA confirmed its commitment to WMO and to the world community to make observations available without restriction. It further indicated that this policy would apply to all relevant missions. Therefore, since data from NASA's Earth observation missions were readily available, its satellites can be considered de facto as part of the space-based component of the Global Observing System (GOS). In particular, NASA's Aqua launched on 4 May 2002 into a sun-synchronous afternoon orbit provides a direct broadcast service for its data. NASA's Terra continues to provide data from its direct broadcast service. Terra was launched 18 December 1999. All data from NASA instruments and NASDA's Advanced Microwave Scanning Radiometer (AMSR-E) onboard Aqua are available to WMO Members. The European Space Agency (ESA) confirmed that it was establishing a dialogue towards the development of information for WMO Members concerning the availability of specific data and products from ESA's EO satellite missions, and in particular from the ENVISAT mission launched in March 2002. ESA further indicated that it would propose to its Programme Board for Earth Observation (PB-EO), to jointly organise a dedicated, specific Announcement of Opportunity (AO) to foster the use of ESA Earth Observation data by the WMO community. ESA's ENVISAT was launched on 1 October 2001 and continues to make its valuable data available through the ESA web site in Frascati, Italy. The National Space Development Agency of Japan (NASDA) indicated that its future satellite missions including ADEOS II and the GCOM series were candidate systems to contribute to the new R&D constellation for the space-based component of the GOS. Finally, the Russian Aviation and Space Agency (Rosaviakosmos) confirmed that experimental and R&D instruments on board its operational METEOR-3M N1 satellite as well as on its future Okean series and other missions could be considered as a potential contribution to the space-based component of the GOS.

3.7.4 Ground Segment

The session was informed that the latest survey conducted through National Meteorological and Hydrological Services (NMHS) as well as other users concerning the status of satellite receiving equipment within WMO Regions is contained in SAT-25, TD WMO/TD No. 1021. Four categories of satellite receiving equipment were surveyed: low-resolution polar-orbit data (APT), high-resolution polar-orbit data (HRPT), low-resolution geostationary data (WEFAX) and high-resolution geostationary data (HR). Since the 1995 survey (WMO/TD No. 719, SAT-16), there has been an increase of 277 receiving stations (from 1,086 to 1,363) in the total number of satellite receiving equipment reported to be operating within NMHSs. The database utilized in compiling TD No. 1021 contained a total of 8,766 satellite receiving stations from all user communities. The session recalled that the goals for the percentage of implementation for WMO Members equipped with satellite receiving equipment are 100% for LEO satellite data receivers (either APT or HRPT) and 100% for geostationary satellite data receivers (either WEFAX or HR). This meant that each WMO Member should be equipped with at least one LEO satellite data receiver and one geostationary satellite data receiver. WMO Regions have achieved an overall implementation of 82% as compared to 72% in 1995. With regard to each category of receivers, WMO Regions have achieved an overall implementation of 84% and 87% for LEO and GEO satellite receivers respectively, the former increasing by four percent and the latter increasing by six percent since 1995. The session also reviewed the geographical distribution of equipment in each WMO Region.

4. REVIEW OF THE RBSNs

The session discussed an advanced copy of the "Status Of World Weather Watch Programme Implementation And Operation" which had been prepared for CBS Ext.(02) later in the year. The ICT noted that the percentage of SYNOP reports received at MTN Centres (with respect to the numbers required by the RBSN) had remained relatively stable when viewed on a global basis at about 75%. Meanwhile the percentage of TEMP reports available at MTN centres, after decreasing from 65 per cent to 57 per cent during the period 1992-1999, had increased to 63 per cent since 1999. The greatest cause of missing reports continued to be lack of trained staff and consumables in countries where financial difficulties persist, notably in Regions I and III, but also in parts of the other four regions. The group felt that some of the proposals developed by its various Expert Teams and Working Groups could potentially contribute markedly to ameliorating these deficiencies.

5. REVIEW OF OTHER IN-SITU SYSTEMS (MARINE, AIRCRAFT, etc.)

5.1 Marine Systems

The ICT received a summary report on marine observing systems that had been derived from information provided and data collected by the Joint technical Commission for Oceanography and Marine Meteorology (JCOMM). Statistics had been prepared and presented by the Observations Programme Area (OPA) within JCOMM reflecting the status of the various observation networks supporting the international marine program.

5.1.1 Status of Programs

Volunteer Observing Ships Program (VOS): Despite a decline in the total number of reporting ships to around 6,000, the quality and total number of reports had stabilized at around 160,000 per month. Although statistics are not currently available it is estimated that the number of suspect ship reports has been reduced by 50 percent over the past decade.

Data Buoy Program: The number of drifting buoys was currently around 900, of which slightly over half had provided pressure observations. The number of monthly pressure reports received over the GTS had increased from 40,000 to 200,000 and continued to increase, as did the quality of the reports, thus providing a significant impact over data sparse areas. Data arrays such as Tropical Atmosphere Ocean Array/Triangle Trans-Ocean buoy Network (TAO/TRITON) (equatorial Pacific) and PiRATA (equatorial Atlantic) are essentially fully operational and plans for a similar array are being developed for the Indian Ocean.

The Ship of Opportunity Programme (SOOP): The SOOP network in 2001 was providing 24,000 reports a year over the GTS. The network was currently being transitioned from broadcast mode to concentrate on high density and frequently repeated lines, to compliment the Argo network.

Argo Program: The Argo network had 535 floats deployed and operational in August of 2002 with a planned network of 3,000 floats by the end of 2005. Virtually all floats had their BATHY or TESAC reports distributed in real time on the GTS.

Automated Shipboard Aerological Network (ASAP): After several years of decline the ASAP network had increased to a level just under 6,000 reports per day and this increase was projected to continue as the result of the introduction of new lines.

5.1.2 New developments

A VOS Climate Project (VOSClim) was being implemented to provide a subset of high quality VOS data for various applications, including global climate studies and the calibration of satellite observations. The plan calls for a fleet of 200 VOSClim ships. Three new ASAP lines were initiated in 2001/2002, two under the E-ASAP project of EUMETNET, the other the World-wide Recurring ASAP Project (WRAP) under the ASAP Panel. All were essentially operational. Developments in the International Maritime Satellite organization (Inmarsat), including new systems with greatly enhanced bandwidth, were expected to benefit ship operators.

5.1.3 Data Distribution

GTS distribution of drifting and moored buoy data through Argos in BUFR will commence in 2003. Work was also underway to initiate GTS distribution of Argo float data in BUFR. Due to the need for new hardware, the migration to BUFR will take some time and the need to transmit in traditional character codes will need to continue for the time being.

5.1.4 Instrument Evaluation and Intercalibration

The evaluation and intercalibration of operational marine instrumentation was undertaken within the context of specific platform-based groups. JCOMM-1, the SOT is investigating various possibilities, including a formal JCOMM instrument programme; providing expertise to CIMO to allow the Commission to undertake evaluation and intercalibration of marine instruments; or continuation of these activities within specialist groups. In the short term the third option was thought to be most likely.

5.1.5 System Performance

Most marine observing system components presently had performance metrics which allowed for the assessment of sensor performance to facilitate remedial actions and future enhancements. The Observations Coordination Group within JCOMM had developed a coherent approach to assessing and reporting the overall performance of the integrated observing system against multiple user requirements.

5.2 Aircraft Systems, including AMDAR

The ICT noted that EC LIV was aware that all the achievements of the AMDAR Panel were due to the financial contributions provided by a few Members. Furthermore, it recognized that continued development of a coordinated global programme was dependent on these voluntary contributions.

In his report, the Technical Coordinator of the AMDAR Panel recalled that the positive impact of AMDAR data on the ongoing improvement to the GOS had been well established through a number of important OSEs. It was noted that the average number of observations exchanged daily on the GTS had increased from 78,000 in 2000 to about 140,000 in 2002 and that this was expected to increase to 200,000 over the next few years. Although a large proportion of these AMDAR data were obtained over Europe and North America, and to a lesser extent over Australasia, Asia, and Southern Africa, work is proceeding to develop new operational programmes and/or programmes of targeted observations in data sparse regions. Of interest were a series of newly planned or developing programmes such as the targeted programme in RA I, in collaboration with ASECNA, and the extension of the Southern Africa operational programme. In RA II, the Saudi Arabian programme was nearing operational status and the developments by 3 additional countries in the Middle East and 4 countries in Eastern Asia were anticipated. Plans to develop or complete programme development by several countries in the eastern part of Region VI including the Russian Federation, and three countries in Region III, were also noted as was the interest in RA V to extend AMDAR into the SW Pacific Island countries of that region. It was also noted that collaboration was continuing with ICAO in regard to Aircraft Dependent Surveillance (ADS), meteorological reports over the North Atlantic and Pacific regions as observations were being passed to the World Area Forecast Centres (WAFCs) in London and Washington.

The ICT was pleased to note the commencement of services by smaller regional aircraft operating from more remote airports not serviced by existing AMDAR equipped aircraft. This will result in more data in the low to mid troposphere in data sparse areas. The work of the AMDAR Panel was recognized in completing several important steps in providing the AMDAR Reference Manual and establishing improvements in the exchange of data on the GTS through the development of additional code forms and new smaller regional AMDAR bulletins. The ICT was also informed of continuing work on development of a reliable humidity sensor with new operational trials to commence during 2004.

6. STATUS OF REQUIREMENTS OF DATA FROM AUTOMATIC WEATHER STATIONS

6.1 The ET/AWS report had noted the need for applying basic quality control procedures to all Automatic Weather Stations (AWS). Such monitoring is critical to data accuracy and quality prior to its use in the calculation of weather parameter values. The ICT also noted that the concept of quality control extended to three discrete levels, basic quality control and enhanced quality control with respect to time and space. In the Final Report of ET-AWS-1 (Geneva, 2-6 September 2002), the ET-AWS had identified the need for comprehensive AWS quality control procedures, produced an example of such procedures at the station level (See Annex 5 of the referenced final report of the ET-AWS), and recommended that a broader procedure be developed. The ICT recommended that this task be included in the future Work Plan of the ET-AWS.

6.2 The ICT noted that the ET/AWS had worked collaboratively with the ISS/ET/DR&C in the development of BUFR templates and descriptors for AWS. The results of this collaborative effort can be found in Annex 4 of the ET/AWS Final Report. The ICT was pleased to note this inter-OPAG collaboration and that the resultant BUFR templates and descriptor list would be taken up by the OPAG-ISS and would subsequently be forwarded to CBS for consideration and approval.

6.3 The ICT was also informed on the work of the ET-AWS on the issue of functional specifications for specific AWS sensors. The resulting recommendations of the ET called for: 1) improvement in the definition of identified meteorological variables reported by AWS, 2) consideration for the application of new methods in the calculation of meteorological parameters using simple calculations, and 3) the need for developing guidelines for AWS installations in meeting requirements for accurate and complete metadata.

7. STATUS OF EFFORT TO IMPROVE SATELLITE SYSTEM UTILISATION

An area in which the ICT received a great deal of input was from the ET-SSUP. The group had held three meetings in the last two years, resulting in numerous recommendations conclusions, and Action Items.

7.1 Biennial Questionnaire 2000-2001

The ICT was informed that the ET-SSUP had analysed cycle 2000-2001 of the Questionnaire on Availability and Use of Satellite Data and Products by WMO Members and compared it to the analysis of the cycle 1998-1999 (now available as SAT-30, WMO/TD-No. 1119). It enhanced the Questionnaire with respect to the Virtual Laboratory for Education and Training in Satellite Meteorology. The analysis yielded conclusions, recommendations, and strategies. ET-SSUP agreed that the specific strategic goals for 2002-2003 should include:

7.1.1 Data Access

- WMO, based on guidance developed by ET SSUP and approved by CBS, should advise NMHSs on alternative means for access to satellite data and products, including R&D missions;
- NMHSs should be encouraged to establish communications systems with appropriate capacity based on the data volumes to be disseminated from current and future satellite systems;
- CBS should consider and endorse the ADM concept;
- WMO should inform CGMS concerning the ADM concept and seek CGMS endorsement including agreement to converge on appropriate standards as well as the establishment of appropriate facilities in every WMO Region in order to allow an adequate response to the meteorological and environmental data requirements;
- ADM concept and principles should be further refined including matters related to R&D satellite missions and the inclusion of ADM in the FWIS vision;

7.1.2 Data Use

- NMHSs are strongly encouraged to increase the number of staff active in satellite meteorology in order to be able to benefit from the unique capabilities of satellite systems;
- Relevant Members should be encouraged to consider alternative solutions to achieve their computer programming requirements, e.g. through the formation of networks or consortia with shared responsibilities, activities and services;
- Appropriate strategies should be developed and implemented in order to improve the availability of application software and methods. Such an immediate solution would be important for increased interest in satellite data and products utilization;
- Operational space agencies are encouraged to provide space systems with more frequent observations of atmospheric instability parameters, and to develop capabilities for cloud base height observations, wind profiles and precipitation that meet WMO requirements;

7.1.3 Education and training

- A feedback mechanism should be developed between the “Centres of Excellence” including their cosponsoring satellite operator and the Members they serve to provide information on training activities during the evaluation period;
- The RA presidents and the Rapporteurs should be informed when the Biennial Questionnaire is sent out (next release early 2003);
- Future versions of the Questionnaire should also be distributed electronically to WMO Members as well as made available on the WMO Satellite Activities web pages;

- Centres of Excellence should participate in the analysis phase as well as in the subsequent feedback mechanism. They should actively engage WMO Members they serve within their region during the analysis phase to strive for a100% response to the Questionnaire;
- Centres of Excellence and their corresponding sponsoring satellite operators will participate in responding to the Questionnaire as well as providing information to WMO Members within their regions that may assist in responding to the Questionnaire;
- Centres of Excellence will use the Questionnaire during all relevant training events;
- Centres of Excellence will contact participants from prior training events to seek input for the Questionnaire;
- Centres of Excellence and the WMO Secretariat will establish list-servers for the exchange of related information;
- The Virtual Laboratory Focus Group will consider preparing a periodic newsletter that will be distributed electronically via appropriate list-servers;

7.2 Direct Broadcast (DB) and Alternative Dissemination Methods (ADM)

The ICT noted that ET-SSUP had reviewed DB from meteorological satellites during the past two years and held a joint meeting with CGMS Task Team dealing with this matter. Tasked by CBS-XII and EC-LIV, based on current and planned satellite systems, taking into account the evolving telecommunications technology, and having regard to NMHSs' requirements for a cost-optimized access to all necessary meteorological data/products, ET-SSUP had developed a proposal to extend the DB concept to ADM.

Access to satellite data and products by WMO Members should be through a composite data access service comprised of both DB from satellite systems and ADM. ADM would be the baseline while direct broadcast reception would serve as back up as well as for those WMO Members unable to take advantage of ADM.

As concerns DB, while recognizing that future satellite systems would not have duplicate instruments nor provide identical data, there would be a need for a direct broadcast capability as part of a global dissemination service based on the already approved CGMS global specification for AHRPT, *i.e.*, a WMO standard. The global service should be provided by all satellite operators with near-LEO satellites. The global service should have a common frequency in the 1698-1710 MHz band and common bandwidth. Finally, the global service should have a comparable data content with Metop considered as a target.

The ADM should be an open system to facilitate merging with other meteorological data streams. For example, this evolved concept will allow for a seamless inclusion of data/product sets from polar and geostationary operational satellites as well as from relevant R&D satellites. The concept was welcomed by CGMS and CM-2.

ET-SSUP had also discussed a set of preliminary user requirements, while leaving technical specifications to the telecommunication experts. The Expert Team could only provide preliminary views on such requirements in order to help define the order of magnitude and to initiate a dialogue with other experts. It was expected that the most demanding application would be NWP, and that NWP requirements could thus be taken as a benchmark for sizing the data communication means.

The Inter-Programme Task Team on Future WMO Information Systems (TT-FWIS-4, (Johannesburg, SA, 23-27 September 2002)) had been informed about the ADM concept and included it in its FWIS vision.

7.3 Other Issues

ET-SSUP had supported the excellent progress by the Virtual Laboratory Focus Group (Virtual Laboratory for Education And Training in Satellite Meteorology) towards achieving actions assigned. All core actions had already been completed.

On a proposal of the ET-SSUP the International Precipitation Working Group (IPWG) was formed.

WMO Publication No. 258 was reviewed and updated with respect to satellite meteorology. In particular, the section “Satellite Meteorology Branch” was added. Document WMO/TD-No. 660 was published.

ICT proposed the addition of a climate expert to ET-SSUP.

8. STATUS ON REDESIGN OF THE GLOBAL OBSERVING SYSTEM

8.1 The ICT received the report of the Expert Team on Observational Data Requirements and Redesign of the Global Observing System (ET-ODRRGOS). It had been working on two main tasks: (a) to continue the Rolling Requirements Review (RRR), under which requirements for observations to meet the needs of all WMO programmes are compared with the capabilities of present and planned observing systems to provide them, and; (b) to make recommendations to the Commission for Basic Systems (CBS) of WMO on the “re-design” of the Global Observing System (GOS).

8.2 ET-ODRRGOS was now coming to the end of its 4-year work programme during which the following was accomplished.

8.2.1 Users Requirements and Observing System Capabilities were charted in eleven application areas (after engaging ocean and climate communities), the Rolling Requirements Review was pursued, and Statements of Guidance were issued in all eleven areas (available in several WMO technical documents (WMO/TD No. 913, 992, 1052) and summarized in the final report of the July 2002 ET-ODRRGOS-5 (Oxford, UK, 1-5 July 2002) meeting).

8.2.2 Several OSEs were pursued to test possible re-configurations of the GOS.

8.2.3 Candidate Observing Systems Technologies (space based and ground based) and their use in the next decade had been studied and a WMO Technical Document had been published (WMO/TD No. 1040).

8.2.4 Recommendations for evolution of space based and surface based components of GOS had been drafted, reviewed, and submitted to CBS. An eleven-page document summarized the most pressing observational needs and recommendations for the most cost-effective actions for meeting them in the near term and 10-15 years from now (see Annex IV).

8.2.5 A vision for the GOS of 2015 and beyond had been drafted (included in Annex IV).

8.3 ET-ODRRGOS considered coordinated development and utilisation of a comprehensive software tool for carrying out OSSEs as well as preparation, maintenance, and evolution of a realistic OSSE database with user-friendly access. As undertaking of an OSSE requires huge human and computer resources with considerable leveraging and coordinating of individual investments, ET-ODRRGOS felt that the limited resources for evaluating changes to the GOS would probably be better focussed on well-defined OSEs.

8.4 In the course of developing a global approach to redesign of the GOS, the ET-ODRRGOS kept under permanent review the impact assessment studies being conducted by NWP centres under regional programmes such as COSNA, EUCOS and the North American Observing System (NAOS). The ET-ODRRGOS had found that findings of COSNA, EUCOS and NAOS as well as conclusions and recommendations of The Toulouse Workshop on Impact of Various Observing Systems on NWP (see WMO/TD No. 1034) provided essential input to the redesign process. The ET-ODRRGOS had strongly supported the workshop recommendation that impact studies should be carried out for a sufficiently long period, preferably in each of four seasons and that the statistical significance of the results should be established. In addition, the ET ODRRGOS had suggested eight OSEs for consideration by NWP centres and had asked the OSE/OSSE rapporteurs (Jean Pailleux and Nobuo Sato) to engage as many Centres as possible in this work. Good response had been received and results are coming in. The OSEs and the initial results from the contributing NWP centres are listed below:

8.4.1 Impact of hourly versus 6-hourly surface pressures. Using 4DVAR assimilation ECMWF had found positive impact especially over the north Atlantic and southern oceans.

8.4.2 Impact of denial of radiosonde data globally above the tropopause. The Canadian AES report was anticipated autumn 2002.

8.4.3 Information content of the Siberian radiosonde network and its changes during recent decades. The Main Geophysical Observatory in St Petersburg found that information content was ascending until 1985, descending thereafter. NCEP related a decrease in performance of 500 hPa height analysis over NA to a decrease in Siberian raobs.

8.4.4 Impact of AMDAR data over Africa through data denial in a 4D-Var analysis and forecasting system. ECMWF had showed that denial over NH of observations below 350 hPa had large significant impact in summer and winter. Investigation of African AMDAR impact is pending at Météo France.

8.4.5 Impact of tropical radiosonde data. Met Office had varied the density of SE Asia raobs used in assimilation and produced high impact on winds at all levels with occasional propagation of impact to mid latitudes. Temperature and wind information were the most important potential measurements from AMDAR in less well-observed tropical areas (*e.g.,* Africa, Central America).

8.4.6 Impact of three LEO AMSU-like sounders (NOAA –15, -16, and -17 plus AQUA). ECMWF had shown large positive impact from two AMSUs over one MSU. Met Office had shown positive impact of three over two AMSU when NOAA-17 had been added to the GOS.

8.4.7 Impact of AIRS data. ECMWF, Met Office, NCEP, BMRC, and JMA will be reporting on this in late 2002.

8.4.8 Impact of better than 3 hourly ascent descent AMDAR data. Preliminary NH AMDAR ascent/descent impact had suggested positive effect of higher frequency data. EUCOS is arranging higher frequency observations in 2003 to enable this study by Met Office and ECMWF.

8.5 The ICT noted that SoGs in eleven applications areas had been written and are being updated with further RRR iterations. They are in:

Global NWP

Regional NWP

Synoptic Meteorology

Nowcasting and Very Short Range Weather Forecast

Seasonal to Inter-annual Forecast

Aeronautical Meteorology

Atmospheric Chemistry

Agricultural Meteorology

Ocean Weather Forecasts

Coastal Marine Services

Hydrology

The most recent version of many of these SoGs had been published in SAT-26, Statement of Guidance Regarding How Well Satellite Capabilities Meet WMO User Requirements in Several Applications Areas (WMO/TD No. 1052) and Annex B thereto, addressing specific applications areas. Review of these documents by experts within the applications areas is being pursued.

8.6 The ICT noted that in WMO/TD No. 1040, the ET-ODRRGOS had summarized Observing Systems Technologies and their Use in the Next Decade.

8.7 ET-ODRRGOS had used the results from the OSEs (as well as conclusions and recommendations of The Toulouse Workshop on Impact of Various Observing Systems on NWP), their estimate of available technologies of the future, and the SoGs to make their recommendations for the evolution of the GOS. Annex IV, containing these recommendations, is attached. The ICT noted that the future GOS should build upon the existing components, both surface and space based, and capitalize on existing observing technologies not presently incorporated or fully exploited into the GOS. All experiments in testing hypotheses towards the redesign had indicated that each incremental addition to the GOS will be reflected in better data, products and services from the NMHSs. In consideration of the surface based component of the GOS, ET-ODRRGOS made 22 recommendations that include: improved data distribution; enhanced AMDAR ascent/descent as well as flight level data, especially over data sparse areas; optimized radiosonde launches; targeted observations; inclusion of ground based GPS, radars and wind profilers into the GOS; increased oceanic coverage through expanded Automated Ship balloon observations, drifting buoys, and ARGO; and use of Unmanned Aeronautical Vehicles (UAVs). Regarding the space based component of the GOS, ET-ODRRGOS made 20 recommendations (9 for operational GEO and LEO, 11 for R&D satellites) that build upon the known plans of the operational and R&D satellite operators that call for rigorous calibration of remotely sensed radiances as well as improved spatial, spectral, temporal, radiometric accuracies. In particular, the wind profiling and global precipitation measurement missions were singled out for their importance to the future GOS. The ET-ODRRGOS emphasized their belief that the benefits to be derived from the new GOS will be tremendous.

8.7.1 ICT/IOS noted that the scope of the changes to the GOS coming in the next decade will be so massive that new revolutionary approaches for science, data handling, product development, training, and utilization will be required. To emphasize this, the ICT agreed that CBS –Ext. (02) should be advised of the urgent need to study comprehensive strategies for anticipating and evaluating changes to the GOS and that a focused, funded activity needs to be developed to study observing system design.

8.7.2 The ICT accepted the ET-ODRRGOS recommendations for evolution of the GOS and agreed to forward them through the OPAG IOS chair to CBS.

8.8 In addition, the ICT agreed that the OPAG IOS chair should present to CBS the ET-ODRRGOS suggested workplan for the next two years. It includes (a) continue updating data bases of user requirements and observing system capabilities and include user reviewed R&D expected performance (b) continue RRR for eleven application areas and expand to new areas as advised by CBS, (c) update SoGs, (d) organize a new Workshop on Impact of Various Observing Systems on NWP, (e) follow up on progress in OSEs, especially those now possible with the NASA Advanced Infrared Sounder (AIRS) and 3 AMSUs and EUMETNET

9. CLIMATOLOGICAL OBSERVATIONS AND GCOS

The ICT was informed of climatological requirements by the representative of The Commission for Climatology (CCl). CCl is responsible for two main components of the World Climate Program (WCP) dealing with data and monitoring on the one hand and applications and services on the other. The great challenge for the future is presentation of climate outlooks to the public and early detection signals of climate change. Therefore the projects “Climate System Monitoring” (CSM) and Climate Information and Prediction Services (CLIPS) have been established.

For the redesign of GOS, representatives of CCl have stated requirements for data to run seasonal to inter-annual climate forecast models. This is already part of the Statement of Guidance (SoG) and the Rolling Review of Requirements (RRR) process.

Further requirements are related to monitoring of the climate on global and regional scales and to meeting the climate change detection issue. These requirements were discussed within the associated activities in GCOS and under the Framework Convention on Climate Change (UNFCC) in the Conference of the Parties (COP) session.

The redesign of the World Climate Program in 1993 had presented its future views in the framework program called “Climate Agenda.” One part is dealing with “dedicated observations for climate”.

Main elements to be considered were

- air temperature
- precipitation (liquid and solid)
- air pressure
- wind

- sunshine duration
- weather and climate events

and derived parameters and indices (listed in the report of the joint Working Group of CCI and CLIVAR (1999)).

Because climate modelling is a coupled system, observations include also environmental (*e.g.*, aerosols, UV-B), hydrological (*e.g.,* soil moisture) and marine components (*e.g.,* salinity).

If requirements for satellite missions for real-time purposes were met, most climatology requirements would be satisfied. This is still not true for precipitation where the spatial solution of satellites is unsatisfactory, especially concerning rainfall and snowfall data in high latitudes.

To use these data and provide comprehensive interpretations sophisticated ground truth stations are needed and complementary long historical records with homogeneous data and observations together with metadata are mandatory.

Operational Satellite missions should be designed as a long-term activity guaranteeing stability and homogeneity.

Special attention should be devoted to the establishment of the RBCN and complementary networks providing observation in a denser surface network (*e.g.,* precipitation). The role of volunteer observers should be strengthened, as a cost-effective way to get data and observations. As an example phenological networks exist in a many countries on a voluntary basis.

In developing countries the initiative of GCOS to hold regional workshops and to establish regional action plans is a major step to overcome deficiencies. These workshops are a forum to bring together those responsible for different disciplines and observing systems dealing with all parts of the climate system (*e.g.,* Atmosphere, Oceans, Terrestrial area, Cryosphere and Biosphere).

On a regional scale the concept of RBCN needs further development. Besides the already existing RSMC functions, it is obvious that a future system must comprise climatological "Centres of Excellence," providing quality controlled data and products. This requirement is under review in an Inter-Commission task team between CCI and CBS (ICTT-RCC) and will lead to a concept of Regional Climate Centres providing RSCC functions. The relevant report was already presented to the Executive Council.

9.1 CLIMAT And CLIMAT TEMP Reporting Monitoring Results

The Secretariat had analysed the monitoring results concerning CLIMAT and CLIMAT TEMP provided by Cairo, Melbourne and Toulouse for the July 2002 SMM exercise. The numbers of reports received during the SMM exercise were compared to the numbers of reports expected from the RBCNs as defined in July 2002. Cairo, Melbourne and Toulouse received in total 49 per cent of the CLIMAT reports and 53 per cent of the CLIMAT TEMP reports expected from the RBCNs. Further detailed information on the analysis of the SMM exercise is available in the FTP server under:

ftp://www.wmo.ch/GTS_monitoring/SMM/From_WMO/sm02701.015.

The Secretariat clarified to the ICT that the SMM Monitoring was for the purpose of checking the performance of the GTS among Monitoring Centres and NCs in processing climate messages and was not intended to reflect the data reaching the archives.

9.2 Implementation of Regional Basic Climatological Networks (RBCNs)

Based on the recommendations of the Executive Council and CBS, the sessions of XII-RA II (September 2000), XIII-RA III (September 2001), XIII-RA-IV (March-April 2001), XIII-RA V (May 2002) and XIII-RA VI (May 2002) considered and agreed to the concept of defining a separate RBCN for their regions and adopted appropriate resolutions. The WG on Planning and Implementation of the WWW in RA I (March 2001) also agreed to the concept. As of July 2002, all regions including the Antarctic comprise a total of 3086 stations. Out of these 2575 stations are listed as CLIMAT stations and 511 as CLIMAT TEMP stations. The regional breakdown is as follows:

RBCN	RA I	RA II	RA III	RA IV	RA V	RA VI	ANTARCTIC	TOTAL
CLIMAT	616	593	344	242	188	520	72	2575
CLIMAT TEMP	19	194	49	72	74	91	12	511

A total of 400 stations had been added and a total of 888 stations deleted from the approved list of RBCN stations for all regions during the period June 2001-June 2002. These high figures are primarily attributable to the amendments that took place with the 12th Session of RA II and the 13th Sessions of Regional Associations III, IV, V and VI being held during this period.

9.3 Status of GCOS Matters

9.3.1 Background

Two GCOS atmospheric networks had been established: the GCOS Upper Air network (GUAN) and the GCOS Surface Network (GSN). For both GCOS networks, monitoring centres had been designated at CBS-XI. The GUAN performance is monitored by the ECMWF and the UK Met Office Hadley Centre with respect to daily TEMP and monthly CLIMAT TEMP reports respectively, and the GSN is monitored jointly by the JMA and the Deutscher Wetterdienst (DWD). The monitoring centres had provided reports on the monitoring results on a regular basis.

The GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC) had established an Advisory Group for GSN and GUAN (AOPC AGG) which carefully reviews the design of the networks following monitoring results and changes proposed by WMO Members. A “Manual on the GCOS Surface and Upper-Air Networks: GSN and GUAN” (GCOS-73) had been published, *inter alia* to provide guidance for operators of GSN- and GUAN-stations.

9.3.2 Accomplishments

The monitoring procedures for GUAN and GSN had been well established. Monitoring results have regularly been reported and are available on the Internet[1] for the GSN. The first CBS/GCOS Expert Meeting on Co-ordination of the GSN and GUAN (EMCGG-1, Offenbach, 15-17 May 2002) had been held at the DWD Headquarters in Offenbach in order to optimize further actions and implementation and development of the GUAN and GSN. The meeting considered the major GCOS activities to implement and support GSN and GUAN. The meeting had also heard reports from the GUAN and GSN Monitoring Centres about their activities and results. The meeting report is available on the WMO web site.

9.3.3 Findings

With regard to GUAN, an improvement in the availability of CLIMAT TEMP reports was reported at a level of about 79%. However monitoring of the quality of the data received shows that in certain areas strong biases in the data still prevail.

With regard to the availability of CLIMAT reports from GSN-stations, since beginning of monitoring in January 2000, an improvement of the performance of the GSN had been noted, reaching 60% in June 2002. Reasons for this are effects from changes in the network design, improving of the monitoring software, and actions taken by NMHSs responsible for disseminating CLIMAT reports from GSN-stations as a reaction to monitoring results.

9.3.4 Proposals

The ICT endorsed the following recommendations proposed by EMCGG-1:

- CBS Lead Centres for GCOS Data (one for each GCOS network) should be established, on a trial basis, to facilitate the exchange of the monitoring information directly with the NMHSs involved. Draft ToRs for the CBS Lead Centres for GCOS Data are provided in the EMCGG-1 report;

[1] http://www.gsnmc.dwd.de/

- CBS to request that the Secretary-General request NMHSs to name Points of Contact within each NMHS responsible for operating the GCOS network stations, also with ToRs as given in theEMCGG-1 report;
- Members should be urged to operate the backbone observing networks (on global, regional and national levels) according to the GCOS-recommended climate monitoring procedures (Reference *inter alia* UNFCCC COP Decision 5/CP.5, November 1999 and WMO EC XLIV, June 2002). RBCN CLIMAT and CLIMAT TEMP reports should be produced and distributed on the GTS and results should be monitored by the CBS Lead Centres for GCOS Data;
- All parties including operators, monitoring centres, telecommunication centres, CBS Lead Centres for GCOS Data and the GCOS Data and Analysis Centres should adhere to the guidelines given in the "Manual on the GCOS Surface and Upper-Air networks: GSN and GUAN" published in GCOS-73;
- A project office dedicated to the task of implementation of GSN and GUAN activities should be established.

10. UPDATES OF THE GOS-RELATED REGULATORY MATERIAL

10.1 Update of the Manual on the GOS

10.1.1 The session considered the revised version of the Manual on GOS submitted by the Rapporteur on Regulatory Material. It was noted that in accordance with the decision of CBS and the CBS Management Group, the first draft revised text was considered by the meeting of Task Team on Regulatory Material (Geneva, 26-30 November 2001).

10.1.2 In reviewing and updating the Manual, the Task Team recommended that the original text of the Manual be retained as far as possible. The Task Team further recommended that no parts of the Manual should be deleted unless the material was erroneous, outdated, irrelevant or was not part of the regulatory material and could be located elsewhere. The meeting proposed a number of specific suggestions for updating and improving the content that were carried out by the Rapporteur in consultation with the Secretariat. The revised text of the Manual was posted on the WMO Web site in the middle of April 2002 with an invitation for comments by Members of CBS by June 2002.

10.1.3 The updating process for the Manual had also been considered by ET-ODRRGOS-5 (Oxford, UK, 1-5 July 2002), where the ET had agreed that regulatory material on the GOS should contain an updated methodology, the RRR process. The RRR had been used by ET to describe observational data requirements in term of horizontal, vertical, and temporal resolution in addition to accuracy and timeliness. In this connection the ET had strongly recommended adding to the Manual a description of that methodology.

10.1.4 This session of ICT discussed comments received from members of CBS as well as the recommendations of ET-ODRRGOS, concerning description of the RRR process. It was noted that most of the comments were of editorial nature and would improve the text. However some comments suggested changes to the substance of regulations and would require adoption by CBS and approval by EC prior to inclusion in the Manual. Taking into account that CBS had stipulated that no major revisions should be made, the session agreed to not include them in the revised version of the Manual. The session further agreed that the revised Manual should contain a description of the Rolling Review of Requirements (RRR) process as recommended by ET-ODRRGOS-5.

The session requested the Secretariat in consultation with the Rapporteur to amend the revised text and present it to CBS-Ext.(02) for approval. It was also recommended that the amended version be provided in CD-ROM form, in original version only and as an unofficial information item at CBS-Ext. (02).

10.2 Improvement of WMO Publication No. 9, Volume A

10.2.1 The CBS-Rapporteur on Possible Improvements of Volume A presented his report. The meeting noted the main topics and recommendations, which are:

(a) The purpose and scope of Volume A should be broadened with a view to users in the climatological community, requiring information on both actual and historical stations.

(b) The procedures for communication between Members and the Secretariat concerning changes and corrections in the Volume should be relaxed and allow practices on the working level vs only between the Secretary-General and Permanent Representatives as at present. The designation of authorised focal points in the NMHS's, communicating with the appropriate Secretariat officer directly, could help in a quick and timely updating of the Volume. The use of electronic mail for this purpose should be encouraged for non-proprietary exchanges.

(c) Monitoring results should be linked to the contents of Volume A. In particular, the reference standard of monitoring results should be available in the Volume.

(d) The contents of the Volume need revision; the Report provides detailed proposals for this revision. Information that cannot be absorbed by automated systems which read the Volume should be either excluded or converted into well-defined codes.

(e) The limitations of the index numbering system are raising problems already in several countries. This problem needs to be addressed on a short term. The Report provides some suggestions for extension.

(f) The meeting discussed the analysis and conclusions of the Report and agreed with the resulting recommendations.

11. FUTURE COMPOSITE GOS AND ITS IMPACT ON DEVELOPING COUNTRIES

The major issues reported to CBS-XII were still valid. They included: 1) difficulties facing some RBSNs in receipt and/or production of data and products; 2) deficiencies in the current RBSNs due to a variety of infrastructure related issues; and 3) under-utilization of satellite systems.

The redesign of the GOS envisioned over the next 15 years should have a positive impact on developing countries. For example, PUMA and its follow-on, and similar activities in other regions with respect to satellite data reception, analysis and communications will provide a major step forward in capability. Training to ensure full utilization of those data is being addressed through the Virtual Laboratory (VL) for Satellite Data Utilization. The proposed integration of ADM into the FWIS vision will allow for the rapid dissemination of satellite information together with other data sets to developing countries. This will provide information that can be used to improve forecasts for daily and seasonal to inter-annual timeframes.

It was noted that a stable GUAN/GSN in the context of the redesign presented in sections 7 and 8 will allow for optimization in rawinsonde utilization. Some developing countries are implementing radar systems to improve the measurement of precipitation and for improved warnings. AMDAR regional projects should provide badly needed data on winds and temperature profiles for use by NMHSs. Improvements in Automatic Weather Stations, other remote data collection platforms, and marine observational programs will allow for data from inaccessible regions to be available for a variety of applications.

The realization of the redesign will also require implementation of strategic plans within the various WMO Regions. Those implementation plans must address the needs of developing countries and include capacity building, support of basic infrastructure through upgrading, restoring and substitution of applicable WWW systems. Such implementation plans are currently under development in RA I and RA II.

12. ANY OTHER BUSINESS

None

13. CLOSURE OF THE SESSION

There being no further business to come before the ICT, the chairman closed the session at 11h23 on Friday, 18 October.

AGENDA

1. ORGANIZATION OF THE SESSION

1.1 Opening of the meeting

1.2 Adoption of the agenda

1.3 Working arrangements

2. CHAIRMAN'S REPORT

3. REVIEW OF THE GOS PERFORMANCE IN THE REGIONS

4. REVIEW OF THE RBSNs

4.1 RBSN Performance Monitoring Results

4.2 Trends in the Implementation of RBSNs

5. REVIEW OF OTHER IN-SITU SYSTEMS (MARINE, AIRCRAFT, etc.)

6. AUTOMATIC WEATHER STATIONS

7. STATUS OF EFFORT TO IMPROVE SATELLITE SYSTEM UTILISATION

8. STATUS OF REDESIGN OF THE GOS

9. CLIMATOLOGICAL OBSERVATIONS AND GCOS

9.1 CLIMAT And CLIMAT TEMP Reporting Monitoring Results

9.2 Implementation of Regional Basic Climatological Networks (RBCNs)

9.3 Status of GCOS Initial Networks (GSN and GUAN)

10. UPDATES OF THE GOS-RELATED REGULATORY MATERIAL

11. FUTURE COMPOSITE GOS AND ITS IMPACT ON DEVELOPING COUNTRIES

12. ANY OTHER BUSINESS

13. CLOSURE OF THE SESSION

WORK PLAN

October 14 - 18	Monday 14	Tuesday 15	Wednesday 16	Thursday 17	Friday 18
09h00 – 9h30 *9h30 – 10h30*	Registration Agenda Items **1 & 2**	Agenda Items **5** and **10** (Doc. 10/Add.3)	Agenda Item **9**	Drafting groups	Drafting groups
10h30 – 10h45	Coffee Break	Coffee Break	Coffee Break	Coffee Break	Coffee Break
10h45 – 12h30	Agenda Item **3**	Agenda item **6**	Agenda Item **10** (remaining Docs.)	Drafting groups	Approve Draft Final Report
12h30 – 13h30	Lunch	Lunch	Lunch	Lunch	Agenda Item 13
13h30 – 15h30	Agenda Item **3** (cont'd)	Agenda item **7**	Agenda Item **11**	Drafting groups	
Coffee Break	Coffee Break	Coffee Break	Coffee Break	Coffee Break	
15h45 – 17h30	Agenda Item **4**	Agenda item **8**	Agenda Item **12**	Drafting groups	

PROVISIONAL AGENDA

1. ORGANIZATION OF THE SESSION

1.1 Opening of the meeting
1.2 Adoption of the agenda
1.3 Working arrangements

2. CHAIRMAN'S REPORT

3. REVIEW OF THE GOS PERFORMANCE IN THE REGIONS

4. REVIEW OF THE RBSNs

4.1 RBSN Performance Monitoring Results
4.2 Trends in the Implementation of RBSNs

5. REVIEW OF OTHER IN-SITU SYSTEMS (Marine, Aircraft, etc.)

6. AUTOMATIC WEATHER STATIONS

7. STATUS OF EFFORT TO IMPROVE SATELLITE SYSTEM UTILISATION

8. STATUS OF REDESIGN OF THE GOS

9. CLIMATOLOGICAL OBSERVATIONS AND GCOS

9.1 CLIMAT And CLIMAT TEMP Reporting Monitoring Results
9.2 Implementation of Regional Basic Climatological Networks (RBCNs)
9.3 Status of GCOS Initial Networks (GSN and GUAN)

10. UPDATES OF THE GOS-RELATED REGULATORY MATERIAL

11. FUTURE COMPOSITE GOS AND ITS IMPACT ON DEVELOPING COUNTRIES

12. ANY OTHER BUSINESS

13. CLOSURE OF THE SESSION

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[The following are the recommendations adopted by the Expert Team on Operational Data Requirements and Redesign of the GOS
and endorsed by the
Implementation/Coordination Team for Integrated Observing Systems]

Recommendations for the Evolution of the Global Observing System

The Space-Based Component of GOS

The ET-ODRRGOS investigated an appropriate evolution towards the future space based component of the GOS using the Rolling Review of Requirements (RRR) process and observational requirements for the following applications areas:

- Global NWP
- Regional NWP
- Synoptic Meteorology
- Nowcasting and Very Short Range Forecasting
- Aeronautical Meteorology
- Hydrology
- Seasonal to Inter-Annual (SIA) Forecasting
- Coastal Marine Services
- Ocean Weather Forecasting, and
- Atmospheric Chemistry.

Since the decision by the WMO Executive Council in 2001 to expand the space based component of the GOS to include appropriate research and development missions, space based contributions fall in three categories: the operational polar orbiting, the operational geostationary, and the R&D (research and development) satellites. This considerably extends the range of user requirements that can be addressed and provides the mechanism for R&D demonstrations to evolve into operational systems. Recommendations were founded upon Observing System Experiments (OSEs), operational NWP experience, and evidence from field experiments with enhanced observations from ground-, aircraft-, and space-borne instruments. Operational satellite system evolution requires more than a decade to proceed from plans to demonstration to implementation; the individual satellite operator plans for change in the near term are already well formed and in place and change is not likely. Thus the ET focussed on comments / suggestions for coordination of these plans in the near term and recommendations for change in global satellite systems for the longer term.

As the space based remote-sensing system of the future develops and evolves four critical areas (all dealing with resolution) will need to be addressed in order to achieve the desired growth in knowledge and advanced applications. They are:

(1) spatial resolution (what picture element size is required to identify the feature of interest and to capture its spatial variability?);

(2) spectral coverage and resolution (What part of the continuous electromagnetic spectrum at each spatial element should be measured, and with what spectral resolution to analyze an atmospheric or surface parameter?);

(3) temporal resolution (How often does the feature of interest need to be observed?); and

(4) radiometric accuracy (What signal to noise is required and how accurate does an observation need to be taken?).

Each of these resolution areas should be addressed in the context of the evolving space based observing system wherein the satellite(s) exist, or will exist. High priority system specific recommendations for additional capabilities in the space based component of GOS (in order of priority for each category) are listed below; they are followed by comments on the planned improvements to space based component of GOS.

High-Priority General Recommendations

Calibration

1 A major issue for effective use of satellite data, especially for climate applications, is calibration. There should be more common spectral bands on GEO and LEO sensors to facilitate intercomparison and calibration adjustments; globally distributed GEO sensors can be intercalibrated using a given LEO sensor and a succession of LEO sensors in a given orbit (even without the benefit of overlap) can be intercalibrated with a given GEO sensor. The advent of high spectral resolution infrared sensors will enhance accurate intercalibration.

High Priority System Specific Recommendations for Additional Capabilities in the Space Based Component of GOS (in order of priority for each category)

GEO satellites

2 GEO Imagers - Imagers of future geostationary satellites should have improved spatial and temporal resolution (appropriate to the phenomena being observed), in particular for those spectral bands relevant for depiction of rapidly developing small-scale events and retrieval of wind information.

3 GEO Sounders - All meteorological geostationary satellites should be equipped with hyper-spectral infrared sensors (to be demonstrated by the Geostationary Interferometer Fourier Transform Sounder (GIFTS)) for frequent temperature/humidity sounding as well as tracer wind profiling with adequately high resolution (horizontal, vertical and time).

4 GEO Imagers and Sounders - To maximize the information available from the geostationary satellite systems, they should be placed “nominally” at a 60-degree sub-point separation across the equatorial belt. This will provide global coverage without serious loss of spatial resolution (with the exception of Polar Regions). In addition this provides for a more substantial backup capability should one satellite fail. In particular, continuity of coverage over the Indian Ocean region is of concern.

LEO satellites

5 LEO data timeliness - More timely data are needed. Improved communication and processing systems are required to meet the timeliness requirements in some applications areas (e.g. Regional NWP).

6 LEO temporal coverage - Coordination of orbits for LEO missions is necessary to optimize temporal coverage while maintaining some orbit redundancy.

7 LEO Sea Surface Wind - Sea-surface wind data from R&D satellites should continue to be made available for operational use; 6-hourly coverage is required. In the NPOESS and METOP era, sea surface wind should be observed in a fully operational framework. Therefore it is urgent to assess whether the multi-polarization passive MW radiometry is competitive with scatterometry.

8 LEO Altimeter - Missions for ocean topography should become an integral part of the operational system.

9 LEO Earth Radiation Budget - Continuity of ERB type global measurements for climate records requires immediate planning to maintain broad-band radiometers on at least one LEO.

R&D satellites

10 LEO Doppler Winds - Wind profiles from Doppler lidar technology demonstration programme (such as Aeolus) should be made available for initial operational testing; a follow-on long-standing technological programme is solicited to achieve improved coverage characteristics and reduced instrument size necessary for operational implementation.

11 GPM - The concept of the Global Precipitation Measurement Missions (combining active precipitation measurements with a constellation of passive microwave imagers) should be supported and the data realized should be available for operational use, thereupon, arrangements should be sought to ensure long-term continuity to the system.

12 RO-Sounders - To complement the METOP and NPOESS radio-occultation sounders, the opportunities for a larger constellation should be explored and expanded operational implementation planned. International sharing of ground network systems (necessary for accurate positioning in real time) should be achieved to minimize development and running costs.

13 GEO Sub-mm - An early demonstration mission on the applicability of sub-mm radiometry for precipitation estimation and cloud property definition from geostationary orbit should be provided, with a view to possible operational follow-on.

14 LEO MW - The capability to observe ocean salinity and soil moisture for weather and climate applications (possibly with only limited horizontal resolution) should be demonstrated in a research mode (as with ESA's SMOS and NASA's OCE) for possible operational follow-on. Note that the horizontal resolution from these instruments is unlikely to be adequate for salinity in coastal zones and soil moisture on the mesoscale.

15 LEO SAR - Data from SAR should be acquired from R&D satellite programmes and made available for operational observation of a range of geophysical parameters such as wave spectra, sea ice, land surface cover.

16 LEO Aerosol - Data from process study missions on clouds and radiation as well as from R&D multi-purpose satellites addressing aerosol distribution and properties should be made available for operational use.

17 Cloud Lidar - Given the potential of cloud lidar systems to provide accurate measurements of cloud top height and to observe cloud base height in some instances (stratocumulus, for example), data from R&D satellites should be made available for operational use.

18 LEO Far IR - An exploratory mission should be implemented, to collect spectral information in the Far IR region, with a view to improve understanding of water vapour spectroscopy (and its effects on the radiation budget) and the radiative properties of ice clouds.

19 Limb Sounders - Temperature profiles in the higher stratosphere from already planned missions oriented to atmospheric chemistry exploiting limb sounders should be made operationally available for environmental monitoring.

20 Active Water Vapor Sensing - There is need for an exploratory mission demonstrating high-vertical resolution water vapour profiles by active remote sensing (for example by DIAL) for climate monitoring and, in combination with hyper-spectral passive sensing, for operational NWP.

Comments on Planned Improvements to Space Based Component of GOS

GEO satellites

1 GEO Imagers -The GEO imagers will evolve in a synergistic way with the GEO Sounders. Depending on the characteristics of the evolved temperature/humidity sounder, the imager can focus on different channels with an emphasis on monitoring rapidly developing small scale events.

2 GEO Imagers - Future geostationary satellites will have improved capability for observing land surface temperatures and characterizing fire size and temperature.

3 GEO Sounders - IR sounding spectrometers from geostationary orbit are unlikely to be able to follow diurnal variations in boundary layer ozone important in air quality and hazard warnings, and thus will not meet the stated requirements of atmospheric chemistry.

LEO satellites

4 LEO Imagers - In the near and mid term future, vegetation and surface albedo data from R&D and operational satellites will be available for operational use. In the NPOESS era, continued access will improve small-scale applications.

5 LEO Sounders - The advent of hyper-spectral IR sounder on Aqua, METOP, NPP, and NPOESS will improve temperature and moisture profiling; plans for making early hyper-spectral IR data available for operational evaluation are being realized.

6 LEO GPS – Radio occultations offer the potential for very stable long term measurements of upper tropospheric and lower stratospheric temperature and moisture relevant for climate applications.

R&D satellites

7 LEO Imagers - Until the advent of NPOESS, high-quality sea-surface temperature data from R&D satellites (e.g. ATSR, AATSR, MODIS) will be made available for operational use, specifically for climate monitoring. Future geostationary satellites will have improved capability of observing sea surface temperatures and their diurnal variation.

8 LEO Imagers - Imagers on future polar satellites will enable trace motion wind determination in overlapping areas at high latitudes, similar to those from geostationary satellites.

9 LEO Imagers - On orbit channel selection for multi-disciplinary utilization is being demonstrated by ENVISAT's Medium Resolution Imaging Spectrometer (MERIS). The MERIS primary mission is ocean related (colour), however its flexibility allows for definition of spectral bands that can be used to retrieve information on clouds, vegetation, aerosols and total column water vapor.

10 LEO Ocean Colour - In the near and mid term future, ocean colour data from R&D satellites will be available for operational use. Even in the NPOESS era, continued access from R&D satellites will be complementary, especially in coastal zones.

Table linking observed parameters with a given system of the space based component of the GOS (If space agencies implement their current plans and recommendations listed above are acted upon, the space based component of the GOS would have the following characteristics)

System	Improved parameters	Instrumentation
GEOs upgraded	Temperature, humidity, ozone profiles, winds at tracer heights Atmospheric instability index, OLR	Frequent-sounding and imaging IR spectrometer
	Cloud pattern, cover, type, top temp and height, low stratus / fog sea-surface temp, land surface temp, fires, volcanic ash	Fast VIS/IR imager
LEOs upgraded (post-METOP)	Temp, humidity, & ozone profiles; total columns of key trace gases	IR/MW sounder
	Sea/land/ice surface temperatures, sea-ice cover, NDVI, fires, Aerosol size, Cloud pattern, cover, type, top height, cloud optical thickness, drop size, low stratus/fog, high lat winds at tracer heights	Improved VIS/NIR/IR imager
	Short- and long-wave outgoing radiation at TOA	Broadband imager
	Sea-surface wind and temp, sea-ice cover and surface temp snow cover, snow water equivalent, precipitation	MW radiometer with multi-polarisation/viewing
	Water and ice cloud properties, aerosol properties Ozone LAI, PAR, FPAR (large scale). Ocean colour	Imagers covering parts of UV, VIS, NIR, IR, FIR, & Sub-mm, with multi-polarisation
	Wave height, sea level, ocean topography, geoid	Altimeter

System	Improved parameters	Instrumentation
R&D GEO SubMM	Cloud water / ice, precipitation	Sub-mm radiometer
R&D LEO for ocean topography	Significant wave height, sea level, ocean topography, geoid. Polar ice thickness and sheet topography	Medium-class altimeter (follow-on Jason)
R&D LEO for wind Profiles	Wind profile in clear air. Aerosol profile (large scale), cloud top and base height	Doppler lidar (follow-on Aeolus)
R&D LEO for land & ocean ice	Wave spectra, ocean ice. Land snow & ice	SAR
R&D LEO for salinity & moisture	Ocean salinity (large scale). Soil moisture (large scale)	Low-frequency MW radiometer
R&D Constellation of mini-sats	UT/LS temperature profile, height of tropopause., LT moisture profile (with ground GPS)	Radio-occultation sounders

Vision of the Space-Based Component of the GOS in 2015

The space-based component of the GOS will provide observations crucial to maintaining and improving performance of systems in several application areas - in operational meteorology and in other aspects of WMO programmes. A few examples follow. It will provide multi-spectral images of cloud and water vapour at high spatial and temporal resolution for use in synoptic meteorology, nowcasting, hydrology, and aeronautical meteorology. It will also provide quantitative measurements of key atmospheric variables for assimilation into operational numerical weather prediction systems. Hyperspectral space borne measurements will expand the atmospheric chemistry applications. The space based component of the GOS must also provide long term stable global measurements of radiation for climate applications.

An analysis of user requirements in applications areas within WMO programmes indicates the need for an operational satellite constellation comprising four polar and six geostationary satellites. The geostationary component will provide visible/infra-red imagery of improved quality and also advanced infrared atmospheric sounding capability. The LEO component will provide many capabilities including advanced microwave and infrared atmospheric sounding, high-resolution multi-spectral visible/infrared imagery, microwave imagery, ultraviolet ozone sounding, GPS radio occultation sounding, and information from scatterometers, altimeters and microwave radiometers. These will provide quantitative information on many atmospheric and surface variables such as atmospheric profiles of temperature, humidity and ozone; surface temperature; clouds and precipitation; ice and snow cover; vegetation; and ocean surface wind and waves.

Beyond this, data from instruments on R&D satellites will make major new contributions to the GOS including:

- wind profiles from Doppler wind lidars;
- precipitation measurements from a constellation of active and passive microwave instruments;
- GPS radio occultation (RO) constellation;
- ocean colour;
- soil moisture;
- air quality.

Expansion of the space-based component of the GOS will require international collaboration. There will be efforts to facilitate contributions of single instruments to larger platforms. Replacement strategies of the current or near future GOS satellites by the next generation satellites will proceed with a phased implementation approach. The role of small satellites in the GOS will be expanded. Coordination of international contributions to the polar orbiting observing system to achieve optimal spacing for a balance of spectral, spatial, temporal and radiometric coverage will be a goal. Operational continuation of research capabilities with proven utility to the GOS will be occur as much as possible without interruption of the data flow.

There must be a commitment for adequate resources to sustain research developments necessary for improved utilization of these measurements. As much as possible, preparation for utilization of any new measurement will begin prior to launch with distribution of simulated data sets that test processing systems; this will increase the fraction of post-launch lifetime during which the data are used effectively in operational systems. (The current post-launch familiarization period of 6-24 months will be reduced). International development of data processing and assimilation methods and systems will assure best use of available talent and effort, and it will enhance uniformity in derived products.

The following table summarizes the space-based component of GOS in 2015.

GOS (2015)

6 operational GEOs
- all with multispectral imager (IR/VIS)
- some with hyperspectral sounder (IR)

4 operational LEOs
- optimally spaced in time
- all with multispectral imager (MW/IR/VIS/UV)
- all with sounder (MW)
- three with hyperspectral sounder (IR)
- all with radio occultation (RO)
- two with altimeter
- two with conical scan MW or scatterometer

Plus R&D satellites serving WMO Members:
- Constellation small satellites for radio occultation (RO)
- R&D LEO with wind lidar
- R&D LEO with advanced altimeter
- R&D LEO with active and passive microwave precipitation instruments
- LEO and GEO with advanced hyperspectral capabilities
- GEO lightning
- GEO microwave

It is envisaged after 2015 that many of the imaging and sounding functions will be served by hyperspectral instruments from both LEO and GEO orbit. R&D developments in wind profiling and precipitation monitoring will also be operational. Remote sensing needs for coastal monitoring and boundary layer chemistry will be addressed by R&D missions. Data movement, processing and utilization will be a large challenge; exploration of Alternative Dissemination Methods will be necessary to seek new solutions. The opportunity for instruments in L1 orbit to serve as environmental sentinels will be explored.

Recommendations for Evolution of Surface-Based Component of GOS

The recommendations below take into account known upgrades to current satellite systems and entirely new space-based instrumentation to be deployed by 2015. Proposed changes in surface-based and in situ atmospheric and oceanic observing systems include automation and greater utilization of existing systems and the development of a few relatively new systems – all designed to complement, and be fully consistent with, future satellite capabilities. The goal is to maximize the benefits of the composite observing system for a variety of operational weather services.

Ten years from now, two things are virtually certain: observations will increase markedly in volume, and they will be stored and transmitted almost entirely in binary formats. It is hazardous to guess what kind of surface and in situ atmospheric and oceanic observations will be available beyond ten years merely because new technologies may revolutionize how the atmosphere is measured. For example, ten years ago, few could anticipate the evolution of the AMDAR system or the exploitation of the Global Positioning System in meteorology. Therefore, the present strategy is to extrapolate into the future promising trends in observation technology.

The recommendations below address the Rolling Review of Requirements in a number of applications areas:

- Global NWP
- Regional NWP
- Nowcasting and very short-range forecasting
- Synoptic meteorology
- Ocean weather forecasting
- Coastal Marine services
- Aeronautical meteorology
- Season and inter-annual prediction, and
- Atmospheric chemistry.

The relevant impact studies that support the recommendation are cited in brackets; often the Observing System Experiment is just listed by number (see July 2002 report of ET-ODRRGOS for the list).

High-Priority General Recommendations

Data distribution and coding

1. Exchange internationally observational data not yet centrally collected but potentially useful in NWP, e.g., radar measurements to provide information on precipitation and wind, surface observations, including those from local or regional mesonets, wave buoys. Encourage WMO Members in regions where these data are collected to make them available via WMO real time information systems.

2. Data available at high temporal frequency should be distributed at least hourly. Recent studies have shown that 4D-Var data assimilation system or analysis system with frequent update cycles can make excellent use of hourly data, *e.g.,* from SYNOPs, buoys, profilers, aircraft (AMDAR). [OSE-1]

3. Assure that all sources are accompanied by good documentation including metadata, careful QC, and monitoring.

4. Use coding standards that assure that the content (e.g vertical resolution) of the original measurements, sufficient to meet the user requirements, is retained during transmission. Some current coding/formatting standards in the character codes degrade potentially useful information in meteorological reports. (Example: lost information at various levels in a rawinsonde sounding in the TEMP code could be retained in the BUFR code). [CBS decision to migrate to table driven and binary codes].

Broader use of ground based and in situ observations

5. Calibration of measurements from satellites depends on using ground-based and *in situ* observations, such as ozone profiles from sondes. Near real-time distribution of ozone sonde data is required for calibration and validation of newly launched instruments and for potential use in NWP. [Joint ECMWF / WMO expert team meeting on real time exchange of ground based ozone measurements, ECMWF, 17-18 October 1996]

Moving towards operational use of targeted observations

6. Transfer into operations the proven methodology of observation targeting to improve the observation coverage in data sensitive areas. This concept is in operational use at the US Weather Service in the north-eastern Pacific during the winter storm period. EUCOS is planning on field experiments in the Atlantic, possibly in the context of a THORPEX study. Designated major operational centres should share the responsibility for determining the target areas. [FASTEX results and Toulouse report]

High Priority System Specific Recommendations

Optimization of rawinsonde launches

7. Optimize the distribution and the launch times of the rawinsonde sub-system (allowing flexible operation while preserving the GUAN network and taking into consideration regional climate requirements). Examples include avoiding duplication of Automated Ship-borne Aerological Program (ASAP) soundings whenever ships are near a fixed rawinsonde site (freeing resources for observations at critical times) and optimizing rawinsonde launches to meet the local forecasting requirements. [EUCOS Studies, OPAG IOS Chairman]

Development of the AMDAR programme

8. AMDAR technology should provide more ascent/descent profiles, with improved vertical resolution. A good way to accomplish this is to extend the AMDAR programme to short-haul commuter flights, business aviation, and airfreight. Emphasis should be to expand into areas where vertical profile data from radiosondes and pilot balloons are sparse a well as into times that are currently not well observed such as 11 pm to 5 am local times. [Toulouse report, ECMWF northern hemisphere AMDAR impact study, OSEs 4, 5, 8]

9. AMDAR coverage is both possible and sorely needed in several currently data-sparse regions, especially Africa and South America, Canadian arctic, northern Asia and most of the world's oceans. Moreover, the timing and location of reports, whose number is potentially very large, can be optimized while controlling communications costs. The recommendation is to optimize the transmission of AMDAR reports taking into account, en route coverage in data-sparse regions, vertical resolution of ascent/descent reports, and targeting related to the weather situation. [Toulouse report, ECMWF northern hemisphere AMDAR impact study]

10. Lower-tropospheric water vapour measurements are vital in many forecast applications. To supplement the temperature and wind reports from AMDAR, the further development and testing of water vapour sensing systems is strongly encouraged. Example: WVSS-2 employs a laser diode to measure the absorption by water vapour of energy in the laser beam over a short path length. This is an absolute measurement of water vapour content that is expected to be accurate from the ground to flight altitudes. [Toulouse report]

Tropospheric Aircraft Meteorological Data Reporting (TAMDAR)

11. TAMDAR could potentially supplement AMDAR and radiosonde data by providing lower level en route observations and profiles over additional, regional airports not served by larger AMDAR compatible aircraft. Instrumentation would not necessarily be designed to function in the high troposphere and would therefore be less expensive. The development of the TAMDAR system should be monitored with a view towards operational use. [EUCOS Programme Plans]

Ground based GPS

12. Develop further the capability of ground-based GPS systems for the inference of vertically integrated moisture with an eye toward operational implementation. Distribute globally the measurements of total column water vapour from available and emerging ground based GPS systems for use in NWP. Such observations are currently made in Europe, North America and Japan. It is expected that the global coverage will expand over the coming years. [COSNA/SEG, NAOS, JMA reports]

Improved observations in ocean areas

13. Increase the availability of high vertical resolution temperature, humidity, and wind profiles over the oceans. Consider as options ASAP and dropsondes by designated aircraft. [EUCOS programme plan]

14. Considering the envisaged increase in spatial and temporal resolution of *in situ* marine observing platforms and the need for network management, either increase the bandwidth of existing telecommunication systems (in both directions) or establish new relevant satellite telecommunications facilities for timely collection and distribution. Examples include drifting buoys, profiling floats, XBTs. [JCOMM Operations Plan]

15. For both NWP (wind) and climate variability/climate change (sub-surface temperature profiles), it is recommended to extend the tropical mooring array into the tropical Indian Ocean at resolution consistent with what is presently achieved in the tropical Pacific and Atlantic Oceans. [JCOMM Operations Plan]

16. Ensure adequate coverage of wind and surface pressure observations from drifting buoys in the Southern Ocean in areas between 40S and the Antarctic circle based upon adequate mix of SVPB (surface pressure) and WOTAN technology (surface wind). The pressure observations are a valuable complement to the high density surface winds provided by satellite. [Toulouse report, ODRRGOS OSE study]

17. For Ocean Weather Forecasting purposes, improve timely delivery and distribute high vertical resolution data for sub-surface temperature/salinity profile data from XBTs and Argo floats. [JCOMM Operations Plan]

18. For NWP purposes, increase coverage of ice buoys (500 km horizontal resolution recommended) to provide surface air pressure and surface wind data. [JCOMM Operations Plan]

Improved observations over tropical land areas

19. Enhance the temperature, wind and if possible the humidity profile measurements (from radiosondes, pilots and aircraft) in the tropical belt, in particular over Africa and tropical America. There is evidence from recent impact studies with the radiosonde/pilot balloon network over the Indonesian/Australian region that such data give a better depiction of winds in the tropics and occasionally strongly influence the adjacent mid-latitude regions. [OSE-5]

New Observing Technologies

20. Demonstrate the feasibility of ground based interferometers and radiometers (e.g. microwave) to be an operational sub-system providing continuous vertical profiles of temperature and humidity in selected areas.

21. Demonstrate the feasibility of UAVs to be an operational sub-system.

22. Demonstrate the feasibility of high altitude balloons to be an operational sub-system

Vision of the Surface Based Component of the GOS in 2015

It is envisaged that by 2015 the technical advances will have led to substantial innovations in the surface based components of the global observing system. Measurements will be provided by automated systems, manual intervention and the role of humans in the observing chain will have been reduced to a minimum, and may not be required at all any more.

Automation will facilitate the targeting of data sensitive areas through an optimal operation of the upper air observing components, such as radiosondes, ASAP systems, data collection from aircraft in flight and vehicles on the road.

Rawinsondes

Automated launches with computerized data processing and real-time data transmission at high vertical resolution. The network will have been optimized to provide the measurements for the calibration of satellite data and to provide the baseline observing system for ground based vertical atmospheric profiling.

Aircraft observations

Fully automated observing system providing temperature, wind and humidity measurements of high quality from the majority of the civilian aircrafts, both in-flight and ascent/descent data at high temporal resolution. Tropospheric profile data will be available from most aerodromes around the world, including from the currently data void airports in Asia, Africa and South America.

Surface observations

From land and ocean observing platforms all measurements will be provided by automated systems. It is expected that the land areas will be covered by a network of sensors at a high spatial resolution, supporting local applications such as road weather. Such data will be of benefit to global and local NWP applications alike. Over the oceans an adequate number of platforms (ship, buoys, moorings will be available to complement the satellite measurements.

Radar observing systems

Multi-parameter scanning Doppler radars will enable hydrometeor identification and perhaps give information on their size distributions. This in turn will improve estimation of precipitation rate and accumulation. It will also assist in the initialization of cloud physics parameters for NWP Assimilation of high resolution reflectivity and radial velocity data will have reached the point of resolving the basic mass and wind structures of convective storms. Millimeter-wavelength radars will be able to observe multiple cloud layers, including the altitude of their bases and tops.

Data transmission

The fully automated observing system will produce data volumes which will exceed today's volumes by several orders of magnitude. Data communication technology is expected to have developed accordingly. The technical means to provide the appropriate and affordable communication will have become available. All observational data will be transferred by digital means in a highly compressed form. Data processing will be computerized entirely.

In summary

The rapid development of information technology in all areas of life will continue to give opportunities for obtaining and communicating observations as a by-product of systems installed (and paid for) for other purposes. Currently AMDAR and GPS observations fall into this category and other examples will emerge and should be exploited in the future. It is likely that such observations will form an important part of a cost effective future global observing system.

Table linking observed parameters with a given system of the surface based component of the GOS (If agencies pursue recommended actions and encourage indicated developments, surface based component of GOS would have the following characteristics)

System	Parameter	Action/Development
AMDAR	Vertical profiles of temperature and wind at airports Flight level data Vertical profiles of humidity	Increase coverage, increase vertical resolution Extend programme to short-haul, commuter and freight flights Study feasibility of adaptive use, demonstrate the need for high frequency data, in particular over Africa, South America Develop capability
TAMDAR	Vertical profiles of temperature and wind at regional airports	Develop the programme (currently undertaken by NASA), suitable for expansion to other regions, such as the arctic, Siberia, etc.
Radiosondes	Vertical profiles of temperature wind and humidity	Optimise horizontal spacing of raobs and vertical resolution of reports and operation of sub-system (launch times, adaptive operation) Increase the availability over the oceans (ASAP, dropsondes, etc.)
Ozone soundings	Vertical profile of ozone	Integrate into GOS

UAVs	Spatial coverage and vertical profile of wind, temperature and humidity	Demonstrate feasibility of an operational sub-system; target areas for operation are the ocean storm tracks (planned in THORPEX)
High-altitude balloons deploying sondes	Vertical profile of temp, wind and humidity	Demonstrate feasibility of an operational sub-system
Drifting buoys	Surface measurements of temp, wind and pressure, SST	Extend coverage especially in SH based on SVPB and WOTAN technology
Moored buoys	Surface wind, pressure, sub-surface temp profiles Wave height	Improve timely availability for NWP (monthly & seasonal forecasting) Extend coverage into Indian Ocean Provide data
Ice buoys	Ice temp, air pressure, temp and wind	Increase coverage
VOS	Surface pressure, SST, wind	Maintain their availability to provide complementary mix of observations
Ships of opportunity (SOOP)	Sub-surface temperature profiles (XBT)	Improve timely delivery and distribute high vertical resolution data
Subsurface profiling floats Argo programme	Sub-surface temperature and salinity	Improve timely delivery and distribute high resolution data
Tide gauges (GLOSS)	Sea level observations	Establish timely delivery
SYNOP and METAR data	Surface observations of pressure, wind, temperature, clouds and 'weather' Visibility Precipitation Snow cover and depth Soil moisture	Exchange globally for regional and global NWP at high temporal frequency (at least hourly), develop further automation Ditto Ditto Distribute daily Distribute daily
Wind profiling radar	Vertical profile of wind	Distribute data
Scanning weather radar	Precipitation amount and intensity Radial winds, Velocity Azimuth Display (VAD)	Provide data, demonstrate use in hydrological applications (regional and global NWP) Demonstrate use in regional NWP Ensure compatibility in calibration and data extraction methods
Ground Based GPS	Column Water Vapour	Demonstrate real-time capability
Ground Based Interferometers and other radiometers (e.g. MW)	Time continuous vertical profile of temp/humidity	Demonstrate capability