SATELLITE GROUND RECEIVING EQUIPMENT IN WMO REGIONS

STATUS REPORT

2000

SAT-25

TECHNICAL DOCUMENT

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1. EXECUTIVE SUMMARY

1.1 This report documents a survey conducted through National Meteorological and Hydrological Services (NMHS) as well as other users concerning the status of satellite receiving equipment within WMO Regions. 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). The report contains chapters describing the sources of data used in the analysis, geographical distribution, statistical information for both NMHSs' receiving stations as well as various other users, such as educational, for each WMO Region.

1.2 Since the 1995 survey (WMO/TD No. 719, SAT-16), there has been an increase of 277 receiving stations (1,086 to 1,363) in the total number of satellite receiving equipment reported to be operating within NMHSs. The database utilized in compiling this technical report contains a total of 8,766 satellite receiving stations from all user communities.

1.3 The goals for the percentage of implementation for WMO Members equipped with satellite receiving equipment are 100% for polar-orbiting satellite data receivers (either APT or HRPT) and 100% for geostationary satellite data receivers (either WEFAX or HR). This means that each WMO Member should be equipped with at least one polar-orbiting satellite data receiver and one geostationary satellite data receiver. In 1999, the 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 polar-orbiting and geostationary satellite receivers respectively, the former increasing by four percent and the latter increasing by six percent since 1995.

1.4 There have been large - almost double (698 to 1,363 since 1992) - and steady (277 since 1995) increases in the total number of satellite receiving stations with a concurrent increase in the WWW implementation, i.e. from 70% to 82% since 1992. The increase in percentage implementation would have been even greater save for the increase in new WMO Members who have not yet had an opportunity to report their number of receiving stations.

1.5 The expected change starting in the first decade of the new millenium to digital low resolution imagery coupled with improved capability to utilize satellite data within all WMO Members indicate that a strategy towards implementation of high resolution receivers should be pursued by WMO Members as well as through assistance programmes.

2. BACKGROUND

2.1 One of the main elements of the WWW is the Global Observing System (GOS) which is divided into the surface-based and the space-based portion. In accordance with the WWW Plan, environmental satellites constitute the space-based sub-system of the GOS, with the major goal of augmenting the information provided by the surface-based sub-system to complete the global coverage. Current environmental satellites are divided into two groups:

- Near polar-orbiting environmental satellites;
- Geostationary environmental satellites.

2.2 To a large extent the two types of environmental satellites are complementary. The geostationary satellites provide measurements and almost continuous surveillance in tropical and temperate latitudes, while the near-polar-orbiting satellites provide measurements for higher latitudes and over polar regions as well as for other parts of the globe.

Near-polar-orbiting environmental satellites

NOAA/NESDIS

2.3 The United States' meteorological satellite programme under the National Oceanic and Atmospheric Administration (NOAA) continues to produce a full complement of operational and research data and products. The polar-orbiting operational satellites, known as the "NOAA" series, and the Geostationary Operational Environmental Satellites (GOES) have been fully operational over the past year.

NOAA Polar-Orbiting Satellites

2.4. The Polar Operational Environmental Satellite (POES) constellation includes two primary, two secondary and one standby spacecraft. The primary operational spacecraft, NOAA-14 and NOAA-15 are in sun-synchronous afternoon and morning orbits, respectively. Two secondary spacecraft, NOAA-11 and NOAA-12, provide additional payload operational data, while the standby spacecraft, NOAA-10, supports minimal SAR functions and is only contacted once a week. USA also reported on the current DMSP constellation that consists of two primary, two secondary and one back-up operational spacecraft. While the direct broadcast of the DMSP satellites is encrypted, the data are available in near-real time from NOAA. The DMSP F-15 spacecraft was launched in December 1999.

EUMETSAT

2.5 The EUMETSAT Polar System (EPS) Programme is the European contribution to the joint European/US operation polar satellite system, the Initial Joint Polar System (IJPS), which will deliver continuous global observations for meteorological applications and climate monitoring. The EPS Programme will cover 14 years of operation with three Metop satellites to be launched nominally in 2003, 2007 and 2012. The first two EPS spacecraft, Metop-1 and Metop-2, are formally part of the IJPS, while the third one is expected to be part of the follow-on joint system, the Joint Polar System, subject to further agreements with NOAA. The purpose of the EPS system is to provide an end-to-end service for the morning polar orbit (ECT 09:30), as well as back-up cross support and data exchange with the US National Ocean and Atmosphere Administration (NOAA), which will continue to provide the afternoon orbit service, based on the NOAA N and N' satellite.

2.6 The EPS/Metop satellite is being developed in cooperation between EUMETSAT and ESA. Considerable progress was made during 1997 towards approval of the EPS Programme. In November 1997 a Resolution on the EPS Programme and the way forward for approval of the Metop Contract Proposal, in January 1998, was established. In April 1998 the EPS System Requirements Review (SRR) was completed. The EPS Bridging Phase, which had followed on from the EPS-Preparatory Programme (in 1995-1996), came to an end in September 1998 with the EUMETSAT Council's authorisation of the full start of the EPS Programme activities. In November 1998 EUMETSAT and NOAA signed the Cooperation Agreement for the implementation of the IJPS.

2.7 The Metop satellites will fly a set of operational sounding and imaging instruments:

- Advanced Microwave Sounding Unit-A (AMSU-A) (provided by NOAA);
- High Resolution Infrared Radiation Sounder (HIRS) (provided by NOAA);
- Advanced Very High Resolution Radiometer (AVHRR) (provided by NOAA);
- Space Environment Monitor (SEM) (provided by NOAA);
- Search and Rescue terminal (provided by NOAA);
- ARGOS Data Collection System (DCS) (provided by CNES);
- Advanced Scatterometer (ASCAT) for measuring wind vectors at the ocean surface (new European instrument);
- Global Ozone Monitoring Experiment (GOME) (provided by NOAA);

- Follow-on instruments for ozone monitoring (developed under ESA responsibility);
- GPS Receiver for Atmospheric Sounding (GRAS) for monitoring troposphere-stratosphere interactions (developed under ESA responsibility);
- Microwave Humidity Sounder (MHS) (developed under EUMETSAT responsibility);
- Infrared Atmospheric Sounding Interferometer (IASI) (developed by CNES).

2.8 The EPS core ground segment was approved in the EUMETSAT Council in November 1998. It is the main element of the EPS ground segment and will perform acquisition of platform and mission data, mission monitoring, control and planning, data processing, on-line calibration of instruments, quality control of the products, rolling archiving of data acquired at the acquisition site and near-real-time dissemination of data and products. It will include a communication infrastructure. The EPS Ground Segment elements will be distributed among various sites: the EUMETSAT headquarters, EPS Control and Data Acquisition Polar station site, EPS Back-up Control Centre site and near real-tile primary user terminal sites.

Russian Federation

2.9 The METEOR-3M system is an update of recently operated METEOR-2 (24 satellites were launched) and METEOR-3 (7 satellites were launched) systems.

2.10 One or two satellites will be in orbit and operational at any one time.

2.11 The data received at each regional centre are transmitted to SRC PLANETA in Moscow via telecommunication links. The products derived and orbital parameters of the satellites are distributed by SRC PLANETA via the GTS and widespread networks of various communication channels (including a link through the satellite) enabling a reliable and operational transmission of information to the users and facilitating the access to real-time data.

2.12 The first satellite METEOR-3M No. 1 is planned to be launched in 2000.

2.13 OKEAN-01 No. 7 satellite continues to support the operational oceanographic mission, providing environmental observations, radar and passive microwave data. The Arctic and Antarctic regions are observed regularly to allow an operational monitoring of the marine ice conditions.

2.14 In July 1998, RESURS-01 No. 4 satellite was launched to support RESURS mission. Together with traditional instruments a set of meteorological parameters measuring systems were installed onto this satellite: MR-900, RMK-M, NINA, SCARAB and ISP-2.

People's Republic of China

Fy-1C/D Polar Orbiting Meteorological Satellite

2.15 FY-1C/D is a hexahedron of 1.42 x 1.42 x 1.20m. The total length of the satellite is 10.556m when the solar cell arrays stretch out. The height of the satellite is 2.115m and the weight of it is 950kg. The average power of the satellite is 256W. FY-1C was launched in May 1999.

Functions of the satellite

2.16 The main functions of the FY-1 meteorological satellite are as follows:

- To acquire global surface and cloud images day and night, and to measure surface and cloud top temperatures;
- To measure composition of the space particle near the satellite orbit and to provide

space environmental parameters;

- To disseminate the observed data such as HRPT, DPT.

2.17 The satellite carries:

- Two 10-channel VIS/IR scanning radiometers working in a mutual back up mode, they can be switched according to the telecommand;
- A cosmic component monitor which transmits space environmental monitoring data to the ground through the telemetry system;
- A two-frequency transmitter used to detect satellite motion orbit and to be used as the telemetry transmitter.

Satellite specifications

2.18 FY-1C/D satellite specifications are shown in Table 2.1.

Table 2.1
FY-1C/D Satellite Specifications

Altitude	three-axis stabilized
Orbit	sun-syn.
Orbital height	870 km
Orbital period	102.3min
Orbital inclination	98.80
Eccentricity	0.005
Descending mode	8:35 ~ 9:00 (LST)

MVISR characteristics

2.19 Multi-spectral VIS/IR scanning radiometer (MVISR) has an optical scanner mounted on the satellite bottom opposite to the sun and facing the Earth. The direction of the scanning reflector's rotating axis is same as the direction of satellite's flight. When the 45° scanning mirror rotates, scanning radiometer receives emission and reflection signal of the Earth - atmosphere system perpendicular to the satellite orbital plane with fixed instantaneous FOV, thus to obtain the Earth's two-dimensional scenery signal along the satellite movement. The scanning rate is 360 RPM, sub-satellite - point ground resolution is 1.1km, scanning angle to earth is ± 55.4° and the orbital height is 870 km. The Characteristics of MVISR are shown in Table 2.2.

Table 2.2
The Characteristics of MVISR

Rotate rate:	360RPM
Channels:	10
Sub-point resolution:	1.1 km

VIS detector:	Si
IR detector:	HgCdTe
Data quantization:	10 bit
Calibration accuracy:	VIR-near-IR 5 - 10% ρ IR ± 1K(300K)

2.20 The channel wavelength, dynamic range, detecting sensitivity and primary use of MVISR shown in Table 2.3.

Table 2.3
The Channel Wavelength, Dynamic Range, Detecting Sensitivity and Primary Use of MVISR

Channel	Wavelength (μm)	Dynamic range	Detecting sensitivity	Primary use
1	0.58-0.68	ρ : 0~90%	S/N ≥ 3 (ρ =0.5%)	daytime image, vegetation monitoring, ice and snow coverage
2	0.84-0.89	ρ : 0.90%	S/N ≥ 3 (ρ=0.5%)	daytime image, water/land edge, vegetation monitoring, atmospheric correction
3	3.55-3.95	190-340K	NE Δ T ≤ 0.4K(300K)	surface temperature, high temperature thermal source, forest fire prevention, night image
4	10.3-11.3	190.330K	NE Δ T ≤ 0.22K(300K)	day/night image, sea surface temperature, surface temperature
5	11.5-12.5	190-330K	NE Δ T ≤ 0.22K(300K)	day/night image, sea surface temperature, surface temperature
6	1.58-1.64	ρ :0.-80%	S/N ≥ 3 (ρ=0.5%)	cloud and snow interpretation, drought monitoring, cloud phase distinguishing
7	0.43-0.48	ρ:0.50%	S/N ≥ 3 (ρ=0.5%)	ocean colour
8	0.43-0.53	ρ:0.50%	S/N ≥ 3 (ρ=0.5%)	ocean colour
9	0.53-0.58	ρ:0.50%	S/N ≥ 3 (ρ=0.5%)	ocean colour
10	0.900-0.965	ρ:0.90%	S/N ≥ 3 (ρ=0.5%)	water vapour

FY-1 Ground application facilities

2.21 The ground segment consists of a Satellite Control system and a Satellite Data Application system. The Satellite Control system is under the management of Xian Satellite Control Center. It carries out the satellite command and control. The ground application facilities are under the management of the National Satellite Meteorological Center of the China Meteorological Administration. It is composed of a Data Processing Center (DPC) in the National Satellite Meteorological Center and three ground stations (DAS) located in Beijing, Guangzhou and Urumqi respectively. The data received by the ground stations are transmitted to the Data Processing Center in real-time through communication satellite and the microwave/optical fibril link. A direct read out service is provided to the users. The raw data and the products are archived on digital tapes. The image and other types of operational products are broadcast to the public through CCTV and a dedicated communication network. Users can obtain these meteorological products via on-line terminal or receiving equipment.

2.22 The data processing of FY-1 satellite is composed of two parts: pre-processing and processing.

2.23 Data pre-processing includes raw data classification, quality control, format conversion, geographical location and calibration. The geographical location is to fit the geographical longitude and latitude on the image with the satellite attitude information, while the calibration is to decide the accurate radiative equivalent from the output data of the satellite sensor. After the geographical location and the calibration, the pre-processed data set is then archived.

2.24 The data processing can be divided into two types: image processing and meteorological parameter processing. The image processing is to make the projection conversion, mosaic, enhancement and channels composition. The meteorological parameter processing is to derive the physical parameter of atmosphere and land surface, such as out-going long radiation, cloud parameters, vegetation index, sea ice, ocean colour, land surface features and snow cover, from the satellite radiative information with quantitative methods.

Data transmission of FY-1 C/D

2.25 The High Resolution Picture Transmission of FY-1 C and D is named CHRPT. Besides CHRPT there is a Delayed Picture Transmission (CDPT) to acquire 4 channel global image data with 4 km resolution. CHRPT will be disseminated all over the world and CDPT will be only received by China.

2.26 The transmission characteristics of CHRPT are as follows:

- The transmission frequency of CHRPT: 1700.5 MHz and 1704.5 MHz as backup
  (The transmission frequency of CDPT: 1708.5 MHz and 1695.5 MHz as backup)
- EIRP: 39.4dbm
- Polarization: right hand circular
- Modulation: PCM-PSK
- Modulation index: 67.5° ± 7.5°
- Bit rate: 1.3308 Mbps

There is no APT transmission for FY-1C

2.27 The data format of CHRPT is similar to the data format of NOAA satellite series and is shown in Table 2.4.

Table 2.4
CHRPT Data Format

Function	Frame Sync	ID	Time Code	Telemetry (Ramp)	Telemetry (Temperature)	Black Body	Space	Spare	Earth Data	Aux. Sync
Number of words	6	2	4	10	10	60	100	1408	20480	100

The CHRPT parameters are as follows:

♦ Number of words of frame:	22180
♦ Number of channels:	10,2048 words/channel
♦ Rate of frame:	6 frames/second
♦ Number of bits of words:	10 bits/word
♦ Rate of bit:	1.3308 Mbps
♦ Bit format:	split phase
♦ Data 1, from high level to low level	
♦ Data 0, from low level to high level	

Geostationary environmental satellites

NOAA/NESDIS

GOES series

2.28 GOES-8 at 75° W is operating nominally with some loss of redundancy on certain sub-systems. In the past year GOES-10 was transitioned out of an on-orbit storage mode and brought into primary status at 135° W as a replacement to GOES-9, which had suffered from a lubricant starvation condition of its momentum wheels and was subsequently transitioned to a passive, spin-stabilised storage mode at 105° W. GOES-9 can be called up to replace either GOES-8 or GOES-10 in the event of a spacecraft failure.

2.29 GOES-11 was launched in May 2000. It joins GOES-9 in a spin-stabilised storage mode and will be used when needed to replace either GOES-8 or GOES-10 as primary operation spacecraft.

EUMETSAT

2.30 EUMETSAT presently has three Meteosat satellites in orbit, Meteosat-7 as operational satellite at zero degrees longitude, Meteosat-6 as a back-up satellite and Meteosat-5 at 63°E.

Meteosat Transition Programme (MTP)

2.31 Meteosat-6 was relocated from its stand-by location at 10°W to 0° in February 1997 in order to take over the primary mission from Meteosat-5. The pre-condition for the swap of satellites was the successful integration of the correction software to compensate for the Meteosat-6 radiometric image anomaly. The transfer of operations went ahead as planned and the overall operational performance of Meteosat-6 was found to be comparable or even slightly better than that of Meteosat-5. Meteosat-6 continued as the operational spacecraft at 0° until June 1998. Later in 1998, the satellite was used to conduct limited scan tests in preparation for its support to the Mesoscale Alpine Programme (MAP) in 1999.

2.32 Meteosat-7 was launched on 2 September 1997. The commissioning phase was completed by December 1997. It was used as in-orbit standby satellite from end of 1997 until it took over the operational service at 0° from Meteosat-6 on 3 June 1998.

2.33 Starting in January 1998, Meteosat-5 was drifted, over a four-month period, to a new position located at 63°E over the Indian Ocean in order to support the international INDOEX experiment. The EUMETSAT service to INDOEX commenced on 1 July 1998. The INDOEX Intensive Observation Phase runs from January to May 1999, but it is anticipated that operation imagery and products will be provided to at least December 1999. As part of this service, high resolution images from Meteosat-5 are disseminated by the satellite according to a special dissemination schedule. There are no DCP or MDD services provided from this satellite. Hourly INDOEX full disk images are also re-broadcast via Meteosat-7 as part of the 0° Operational Service. Meteosat-5 has continued service over the Indian Ocean as part of the Indian Ocean Data Coverage (IODC).

2.34 The orbital inclination of the satellite is no longer controlled and at the end of December 1998 it was relatively high when compared to normal Meteosat operations (i.e. over 2.4° and increasing at the rate of about 0.9° per year). However, it is still possible for all data to be acquired directly by PDUS user stations with smaller antennas within the field of view of the satellite.

2.35 The Meteosat ground segment comprises a Primary Ground Station in Fucino, Italy, a Back-up Ground Station in Germany; a Mission Control Centre made up of a Core Facility, User Station Display Facility, a Meteorological Products Extraction Facility and a Meteorological Archive and Retrieval Facility, all located at EUMETSAT headquarters in Darmstadt, Germany. The Lannion Data Relay Facility was upgraded at the end of May 1997 to allow the dissemination of more foreign satellite imagery data via Meteosat. The operational dissemination schedule now contains High Resolution Image data derived from GOES-E and GOES-W (USA), GMS (Japan) and WEFAX formats from GOES-E, GMS and GOMS.

Meteosat Second Generation (MSG)

2.36 Meteosat Second Generation is the follow-on of Meteosat, developed 20 years ago by ESA. The programme includes 3 satellites. MSG-1 is slated for launch in January 2002, MSG-2 one and a half years later in April 2004 and MSG-3 in 2006/7, in order to ensure 12 years of operations.

2.37 Within this programme, ESA is responsible for the development of the first MSG satellite based on requirements established and maintained by EUMETSAT. In December 1997 EUMETSAT finalised and signed the Programme Implementation Plan with ESA. For the follow-on MSG-2 and 3 satellites ESA will act on behalf of EUMETSAT as procurement agent.

2.38 All platform subsystem Preliminary Design Reviews (PDRs) have been completed and the Critical Design Reviews (CDRs) at unit and subsystem level for the data handling, power supply, attitude control, unified propulsion and structure have been held. The Satellite Critical Design Review was held within the period from end of September 1998 (data package delivery) and early November 1998. Manufacturing of the structural/thermal model was completed and mechanical thermal tests have been performed. The hardware of the satellite engineering model was also manufactured and its assembly, integration and test started and continued along the second half of 1998. The flight model manufacturing commenced following the Critical Design Reviews of various equipment.

2.39 The MSG spacecraft will rely on a spin-stabilized platform carrying an imaging radiometer, a meteorological communication package, a Search & Rescue transponder and possibly an experimental Global Earth Radiation Budget (GERB) instrument. The main instrument is the Spinning Enhanced Visible and InfraRed Imager (SEVIRI), an imaging radiometer including twelve channels described in Table 2.5:

- Eleven channels will cover the whole earth disk with a sampling distance of 3 km at the sub-satellite point and a repeat cycle of 15 minutes. They have been selected to offer maximum compatibility with those successfully experienced with the MTP imager, the GOES VAS and the NOAA AVHRR.

- The twelfth channel will be a high resolution visible broad-band channel with a sampling distance of 1 km at sub-satellite point and 15 minutes repeat cycle, mainly covering the European and African area.

Table 2.5
MSG SEVIRI Channels

BANDS	DESIGNATION	LIMITS (µm)

BANDS	DESIGNATION	LIMITS (µm)
VIS & NIR	HRV	Broad band visible (peak within 0.60 - 0.90)
	VIS 0.6	0.56 - 0.71
	VIS 0.8	0.74 - 0.88
	IR 1.6	1.50 - 1.78
WINDOW	NIR 3.9	3.48 - 4.36
	IR 8.7	8.30 - 9.10
	IR 10.8	9.80 - 11.80
	IR 12.0	11.00 - 13.00
WATER VAPOUR	WV 6.2	5.35 - 7.15
	WV 7.3	6.85 - 7.85
OZONE	IR 9.7	9.38 - 9.94
CARBON DIOXIDE	IR 13.4	12.40 - 14.40

2.40 The data and product dissemination will rely on the same frequency bands as MTP, and be based on the HRIT and LRIT digital formats internationally agreed within the CGMS. LRIT will replace the current HRI, WEFAX and MDD altogether and is expected to meet the needs of most users. HRIT will require higher reception and processing capabilities and is planned to be used only by some major weather prediction centres.

2.41 The Ground Segment design and development has progressed both at system and facility levels. The architecture of the MSG ground segment will comprise a central node in Darmstadt in charge of operating the satellites and processing core products, and decentralised Satellite Applications Facilities for more specific additional products relevant to various application areas. Following the kick-off of all Ground Segment facilities during 1997 and 1998, their Architectural Design phases have been completed. All schedule critical facilities have also completed their Detailed Design phases and started their production phase. A comprehensive review package was prepared for the Ground Segment Critical Design Review which took place in December 1998, final recommendations were presented in February 1999. System engineering validation of the integrated Ground Segment will commence in early 2000, followed by an operational (pre-launch) validation of the system. The detailed planning of the operational transition from MTP to MSG is not yet available but, as a baseline, the users should prepare to receive and process MSG data from 2002 onwards.

2.42 As part of a Ground Segment development contract, the design of the prototype User Stations was established and tested. In early 1999 the design information on these prototypes will be distributed to industry and the user community via the EUMETSAT WWW Pages and via CD-ROMs.

Russian Federation

Geostationary Meteorological Satellite Systems (GOMs)

2.43 GOMS-ELECTRO-N1 satellite was operated within the time frame of 1995-1998 supporting the operational GOMS mission at 76° longitude and providing both imaging service (in infrared channel) and WEFAX dissemination.

2.44 The main data receiving and processing centre is located in Moscow (SRC PLANETA). Seventeen global IR images are received and processed daily. Data and products are archived at SRC PLANETA. The WEFAX images from GOMS were disseminated via both ELECTRO and METEOSAT satellites.

2.45 The second satellite is planned to be launched in 2001.

2.46 All the above-mentioned data are received and processed in the main satellite data receiving and processing Centres of ROSHYDROMET; European (SRC PLANETA) receiving facilities are located in Moscow and Obninsk, main processing and distribution centre is in Moscow and Regional - Western (Novosibirsk) and far-Eastern (Khabarovsk). Imagery data of medium resolution are as well received as by the network of Secondary User Data Stations (SDUS). SRC PLANETA performs a scientific and methodological management and plans the activity of the above-mentioned acquisition centres and user stations.

2.47 The operational data catalogues (including quick-looks), as well as basic information on satellite systems are placed daily on the SRC Planeta Internet server http://sputnik.infospace.ru/

Japan Meteorological Agency

GMS-5

2.48 JMA operates GMS-5 at 140 ^{o}E above the equator. GMS-5 was launched on 18 March 1995, and put into operation on 13 June 1995 as the successor to the GMS-4. Spectral bands of sensors onboard GMS-5 and GMS-4 are summarized in Table 2.6.

Table 2.6
Spectral Bands of GMS-5 and GMS-4

Sensor	GMS-5	GMS-4
Visible	0.55-0.90	0.50-0.75
Infrared (thermal)	10.5-11.5 11.5-12.5	10.5-12.5
Infrared (water vapour)	6.5-7.0	none (unit: micrometer)

Products of GMS-5

S-VISSR

2.49 Digital images of the full disk with the same resolution as the original imagery are disseminated to Medium-scale Data Utilization Stations (MDUS) users as shown in Table 2.7.

Table 2.7
Dissemination of S-VISSR images

Band	Resolution at SSP	Frequency of observation
Visible	1.25 km	hourly
Infrared (thermal)	5 km	hourly
Infrared (water vapour)	5 km	hourly

WEFAX

2.50 Analogue facsimile images with coastal lines and latitude/longitude lines are disseminated for Small-scale Data Utilization Stations (SDUS) users as shown in Table 2.8.

Table 2.8
Dissemination of WEFAX images

Type of picture	Type of image	Spatial resolution	Frequency
Four-sectored full disk picture	IR	8.4 km (at SSP)	three-hourly
	WV	8.4 km (at SSP)	12-hourly
Polar-stereographic picture around Japan	IR	7.2 km (around Japan)	hourly
	VIS	7.2 km (around Japan)	hourly (daytime)
	Enhanced IR	7.2 km (around Japan)	hourly (night-time)

Other products

2.51 In addition to the direct dissemination of imagery, JMA retrieves the following products from imagery data and disseminates them to users concerned as shown in Table 2.9.

Table 2.9
Distribution of the other products
[Available on the GTS]

Type of data	Description	Region of interest	Output frequency
Cloud/Water Vapour motion vectors	Cloud/Water Vapour motion wind vectors data derived from time-sequential images	50 °N-49 °S, 90 °E-171 °W	00Z,06Z,12Z,18Z: four times / day
Typhoon analysis report(SAREP)	Location and Velocity of movement of the typhoon center (Special hourly observation)	For typhoons in EQ-60 °N, 100 °E-180 °	eight times/day (24 times / day)
	Estimation of the typhoon intensity	For typhoons in EQ-60 °N, 100 °E-180 °	four times / day

[For WMO/WCRP]

Type of data	Description	Region of interest	Output frequency
ISCCP data (AC data)	Original VISSR for inter-calibration between images from different geostationary satellites	2000 x 2000 km (Area selected by the Satellite Calibration Centre in France)	five times / month
ISCCP data (B1 and B2 data)	Nominally 10km spatial resolution full disk data for B1 data, 30km for B2 data	Full Disk coverage	eight times / day
GPCP data	Three-hourly histogram of TBB in 24 classes on 1 °x 1 ° grids	40 °N-40 °S, 90 °E-170 °W	eight times / day

2.52 In addition, some products such as cloud amount data, are provided for domestic users.

Data Collection System

2.53 GMS-5 is equipped with the Data Collection System (DCS) to collect meteorological observations from remote stations, ships and aircraft.

2.54 As of 1 December 1998, 187 stations are registered as regional data collection platforms and 290 stations are registered as international data collection platforms, respectively.

2.55 The DCS of the GMS-5 is used to relay emergency information on tsunamis and seismic intensity data.

Multi-functional Transport Satellite (MTSAT)

2.56 The launch of MTSAT-1R, the successor to GMS-5, is scheduled for early 2003. MTSAT-1R's direct broadcast service would contain LRIT, the replacement for the current WEFAX, as well as high resolution image (HR) transmissions. All users were strongly urged to prepare for the transition of operations from GMS to MTSAT receiving stations.

2.57 MTSAT is a three-axis stabilized satellite. The specifications of MTSAT are shown in Table 2.10.

Table 2.10
Specifications of MTSAT

Designed life time:	-	more than five years (meteorological mission)
	-	more than ten years (air traffic control mission)
Orbital position:	-	Geostationary orbit at 140 ^{o}E above the equator
Imaging period:	-	Within 27.5 minutes to take a full-disk image
Imager characteristics:		wavelength
	-	Visible 0.55 - 0.80
	-	IR110.3 - 11.3
	-	IR211.5 - 12.5
	-	IR36.5 - 7.0
	-	IR4 (new) 3.5 - 4.0
		(unit: micrometer)
Signal quantization:	-	10 bits for both Visible and IR channels
Resolution at sub-satellite point:	-	1 km for Visible and 4 km for IR
Imager data transmission rate:	-	2.62 Mbps
Telecommunication functions:	-	Transmission of original image data
	-	Relay of High Resolution Imager Data (HiRID), whose format is compatible with S-VISSR of GMS with the horizontal resolution of 1.25 km (VIS) and 5 km (IR)
	-	Relay of Low Rate Information Transmission (LRIT) signal including selected imager data, gridded numerical weather prediction products, surface, upper-air and satellite observations, and RSMC Tropical Cyclone Advisories
	-	Relay of WEFAX signal until March 2003
	-	Relay of DCP reports from remote stations, aircraft, ships buoys etc.

People's Republic of China

FY-2 Geostationary Meteorological Satellite

2.58 China launched its first FY-2 satellite, FY-2A, on 10 June 1997 with the Long March-3 vehicle from the Xi Chang Satellite Launching Center. The satellite has been located at the equator at 105^{o}E since 17 June 1997. It acquired its first visible image on 21 June 1997, both first infrared and water vapour image on 13 July 1997.

2.59 Ten months after the launch of the satellite, the S-band antenna of FY-2A could not point at the Earth due to the defect of de-spin subsystem. From 8 April 1998, FY-2A operation was interrupted and the image broadcast was interrupted. To recover the antenna subsystem, a lot of experience has been gained. From July 1998, the FY-2A has been working discontinuously. On 15 December 1998, FY-2A restarted to transmit S-VISSR data in UTC 03:00, 04:00, 05:00, 06:00, 07:00 and 08:00 daily.

2.60 FY-2 satellite data is open for international users. Satellite data can be shared with other countries. User stations covered by FY-2 can receive S-VISSR high resolution digital data and WEFAX low resolution analogue data. FY-2 S-VISSR images are being disseminated by Internet. The FY-2 programme and disseminated images can be accessed by http://nsmc.cma.gov.cn.

2.61 The second FY-2 satellite, namely, FY-2B, was launched in June 2000. The main specifications of the second FY-2 satellite are same as those of the first one.

Satellite-data ground receiving stations

2.62 The ground segment of the space-based sub-system of the GOS has two main functions:

- To provide for the reception of the signals from satellites containing qualitative and quantitative information, including observations from data-collection platforms and other similar systems (for example the ARGOS system);
- To process, format, display and distribute the information received, either by direct broadcast via the satellites themselves, or over the GTS in pictorial or alphanumeric form to meet the global, regional and national requirements of the WWW.

2.63 Global satellite data are required for the analysis and forecasting of large and planetary-scale atmospheric processes and the quantitative information meets (so far as is technically and logistically possible) the need for input to numerical models dealing with atmospheric processes in these scales. This kind of information is normally acquired and distributed by the major receiving and processing ground stations of the satellite operators themselves. Satellite derived data on cloud winds, sea-surface temperature and atmospheric temperature profiles are transmitted over the Global Telecommunication System (GTS).

2.64 In order to meet regional requirements, ground-segment receiving facilities need to be established which are capable of receiving the full-resolution images from the appropriate geostationary environmental satellite(s) as well as high-resolution images and sounding data from satellites in polar orbit. They may also receive and process data-collection signals from the data collection system which have been relayed by both types of satellite. Regional arrangements are also required to distribute high-resolution sounding data from polar-orbiting satellites and wind information based on cloud movements from geostationary satellites sufficiently widely to ensure their use in regional models for analysis and forecasting.

2.65 At the national level, satellite data requirements vary greatly from country to country. It is desirable that each NMC should receive frequent high and low resolution satellite information in order to maintain surveillance over global, synoptic, mesoscale and small-scale atmospheric processes in their respective areas. The goals for the percentage of implementation for WMO Members equipped with satellite receiving equipment are 100% for polar-orbiting satellite data receivers (either APT or HRPT) and 100% for geostationary satellite data receivers (either WEFAX or HR). This means that each WMO Member should be equipped with at least one polar-orbiting satellite data receiver and one geostationary satellite data receiver. In order to quantify better the level to which a WMO Member has achieved the goals, the following categories have been utilized:

- Satellite receivers for those Members without any receivers;
- Satellite receivers for those Members without a polar-orbiting receiver or a geostationary receivers;
- Satellite high resolution receivers for those Members with only low resolution polar-orbiting receiver or only low resolution geostationary receivers;
- Satellite receivers for those Members already exceeding the WWW goal.

2.66 The widely varying geographical location of countries and their meteorological regimes, together with the rapid technological advances which are being made in the satellites themselves and in the equipment available for receiving, processing and presenting quantitative and qualitative satellite data, have led to the establishment of over 1000 satellite receivers operated by WMO Members throughout the world during this reporting period. Examples of the wide range of stations are:

- comparatively simple APT-type stations (many converted from earlier versions);
- stations which are equipped to receive and process analogue information from polar-orbiting and geostationary satellites and to distribute this information over special networks;
- stations of the most elaborate type equipped to receive directly from satellites high-resolution qualitative data in digital form to be processed extensively for input to numerical models and for visual presentation on television-type screens as film-sequences in pseudo-colour, and in many other ways. This high-resolution data is most valuable to operational forecasters for global and mesoscale phenomena.

2.67 It should, however, be remembered that progress in this area is dependent not only on the maintenance of existing stations and the establishment of new stations, but also on improvements in their technical characteristics.

2.68 This report documents a survey conducted through National Meteorological and Hydrological Services (NMHS) as well as other users concerning the status of satellite receiving equipment within WMO Regions. 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). The report contains sections describing the sources of data used in the analysis, geographical distribution, statistical information for both NMHS(s) stations as well as various other uses, such as educational, for each WMO Region.

3. DATA SOURCES AND CATEGORIES

3.1 There were several different types of data sources utilized in compiling information concerning the implementation of satellite receiving equipment throughout the WMO Regions. The primary source of information was correspondence from each Member in response to a letter from the Secretary-General of the WMO dated 30 August 1998. Additional information was obtained from World Weather Watch questionnaires, the "Application of Satellite Technology, Annual Progress Reports", questionnaires to satellite rapporteurs of Regional Associations, reports from the project files for the Voluntary Cooperation Programme, correspondence from a satellite operator, operational feedback using the form in the WWW Operational News Letter, lists from manufacturers of satellite receiving equipment, information supplied over Internet using a form on the WMO home page, and personal correspondence with the WMO Satellite Activities Office.

3.2 Data have been categorized into two types, data related to receivers in the National Meteorological and Hydrological Services (NMHSs) only, and data related to the total number of receivers in a country including those in the NMHS(s). For clarity, the data in the report are referred to as either belonging to the NMHSs or to the All (including the NMHSs) category.

3.3 On a biennial basis, the Secretary-General of the WMO requests information from WMO Members to assist in determining the status of implementation of the WWW. The request is in the form of a questionnaire that seeks specific information. Upon receipt of the Member's response, the WMO Secretariat stores the information in appropriate databases for further analysis. The portion of the questionnaire related to satellites requested information as to the type of satellite receiving equipment, number and location. Additionally, and based on already existing information in the satellite ground receiving station database, the WMO Secretary-General informed each WMO Member of his/her national receiving equipment and requested a review and update. As described in the background section, four basic types of receivers have been identified. There are both low and high-resolution images and both polar-orbiting and geostationary satellites. Each requires a different set of components in a satellite receiving system although some components can be used for dual purposes. For the purpose of this status report, the four types of satellite receivers identified are APT (low-resolution imagery from polar-orbiting satellites), HRPT (high-resolution imagery from polar-orbiting satellites), WEFAX (low-resolution imagery from geostationary satellites), and HR (high-resolution imagery from geostationary satellites).

3.4 Table 3.1 describes, for each of the six WMO Regions and Antarctica, the number of each receiver type in each NMHS. With regard to NMHSs who reported that they did not have any receiver, the country is not listed. If there is a blank in any particular type of receiving equipment column, it indicates that the NMHS does not have that particular type of satellite receiving equipment. For example in Table I: Angola does not have any receiver while Benin indicated that they have one APT receiver and one WEFAX receiver. Each Region's section in Table I contains an entry for each Member in that Region. For example, France (Reunion) is listed in Table I under the RA I section as well as under the RA-VI section. There are a grand total of 1,363 receivers in the NMHSs.

Table 3.1
Number of stations in a country
(NMHS)

13-September 1999

WMO MEMBER	# of APTs	# of HRPTs	# of WEFAXs	# of HRs
RA I				
Algeria	1	1	4	1
Benin	1		1	
Botswana	1			1
Burkina Faso	2		1	
Cape Verde	2		2	
Central African Republic	1		1	
Chad	2		1	
Comoros	1		1	
Congo	1		1	
Côte d'Ivoire	2	1	1	1
Democratic Republic of the Congo	1		1	
Djibouti	2		2	
Egypt	1		1	1
Eritrea	1			
Ethiopia	1	1	1	1
France	3	1	2	
Gabon	1		1	
Gambia (The)	1		1	
Ghana	1		1	1
Guinea	2		2	
Kenya		1		1
Lesotho	2		2	
Libyan Arab Jamahiriya	1	1	1	1
Madagascar	2	1	5	2
Malawi	1		1	1
Mali	1		1	
Mauritania	1		1	
Mauritius	1		1	
Morocco		1	3	1
Mozambique	1		1	
Namibia		1		1
Niger	1	1	1	1
Nigeria	3		1	
Republic of Cameroon	1		1	
Rwanda			1	
Sao Tome and Principe	2		1	
Senegal	1		2	3
Seychelles	2	1	2	
Sierra Leone	2		1	
Somalia	1		1	
South Africa	1		1	1
Spain	7		13	
Sudan	1		1	1
Swaziland	1		1	
Togo	1	1	1	

WMO MEMBER **# of APTs # of HRPTs # of WEFAXs # of HRs**

Tunisia		1	1	1
Uganda	1		3	
United Republic of Tanzania	2		1	
Zambia	1	1	1	1
Zimbabwe	1		1	3
RA II				
Afghanistan, Islamic State of	1			
Bahrain	2		2	1
Bangladesh	1	1	1	
Cambodia	2		1	
China	7	6	3	6
Democratic People's Republic of Korea	1	1		1
Hong Kong, China	1		1	2
India	8	2	25	1
Iran, Islamic Republic of	1	1	1	1
Iraq	1		1	
Japan	1	12	32	1
Kazakhstan	10		1	
Kuwait	1	1	1	1
Kyrgyz Republic	2		1	
Lao People's Democratic Republic	2		2	
Macao, China	1		1	
Maldives	1		2	
Mongolia	1	1	1	
Myanmar	1		1	
Nepal	1		1	
Oman		1		1
Pakistan	5		1	
Qatar	2		2	
Republic of Korea		1	20	
Republic of Yemen	1		1	
Russian Federation	64	4	4	
Saudi Arabia	2	2	3	2
Socialist Republic of Viet Nam			3	
Sri Lanka	2		2	
Thailand	1	5	2	5
Turkmenistan	3		2	
United Arab Emirates	4		5	3
Uzbekistan	7	2	1	
RA III				
Argentina	7	1	16	
Bolivia	2		1	
Brazil	5	4	6	4
Chile	4	2	4	4
Colombia	2	1	3	1
Ecuador	1			1
France	2		3	1
WMO MEMBER	**# of APTs**	**# of HRPTs**	**# of WEFAXs**	**# of HRs**
Guyana	2		1	1
Paraguay	3	2	3	

Peru	1		1	
Suriname	1		1	
Uruguay	3		5	
Venezuela	1	1	1	
RA IV				
Antigua and Barbuda			1	
Bahamas	1		1	
Barbados	2		1	
Belize	1		1	
British Caribbean Territories	2		2	
Canada	4	4	5	25
Costa Rica	1	1	1	1
Cuba	2	1	2	
Dominican Republic			1	
El Salvador	1		1	
France	3		6	
Guatemala	1		1	
Haiti	1		2	
Honduras	1		1	
Jamaica	1		1	
Mexico		1		1
Netherlands Antilles and Aruba			1	2
Nicaragua	3	1	2	
Panama	2	1	2	
Trinidad and Tobago	4		5	
United States of America	4	13	5	7
RA V				
Australia	5	3	4	1
Brunei	1		4	
Fiji		1	1	2
French Polynesia	1		1	
Indonesia	5		1	1
Malaysia		1	6	1
New Caledonia	2	1	2	
New Zealand		1	2	2
Philippines		1	6	1
Singapore		1	1	1
Solomon Islands			1	
United States of America			2	
Vanuatu			1	
RA VI				
Armenia	1		1	
Austria	1		1	2
WMO MEMBER	**# of APTs**	**# of HRPTs**	**# of WEFAXs**	**# of HRs**
Azerbaijan	2		1	
Belgium	2	2	2	2
Bulgaria	1		1	
Croatia	4		5	4
Cyprus	2		1	

Czech Republic		2	15	1
Denmark	5	3	1	3
Estonia	1		1	
Finland		1		1
Former Yugoslav Republic of Macedonia			1	1
France	1	1	2	2
Georgia	3		1	
Germany	2	1	27	1
Greece	3	1	3	1
Hungary		1	3	2
Iceland	1			
Ireland	2		5	1
Israel	1		2	
Italy		3	59	1
Jordan	1	2	2	1
Latvia	1	1	1	
Lebanon	2		2	
Lithuania	2		1	
Luxemburg	1		1	
Malta	2		2	
Netherlands	1	1	1	1
Norway	1	2	1	2
Poland	3	2	17	3
Portugal		1		1
Republic of Belarus	1		1	
Republic of Moldova	2		1	
Romania	1		1	1
Russian Federation	39	4	6	1
Slovakia		1		1
Slovenia	1		1	1
Spain	56	1	98	2
Sweden	7	1	7	1
Switzerland		4	5	12
Syrian Arab Republic	1		1	
Turkey	1		1	1
Ukraine	5		2	
United Kingdom of Great Britain and Northern Ireland		2		5
Yugoslavia	1		2	
ANTARCTICA				
Argentina	1			
Australia	3	1		
Chile	3	1	1	
India	1			
Italy	1		1	
Japan	1			
Russian Federation	3			
Total : 460	**135**	**607**	**161**	

Grand Total: 1,363

3.5 As indicated in paragraph 3.2, this report contains information not only for the NMHS(s), but also information for all categories of users including the NMHS(s). Table 3.2 is identical in form to

Table 3.1 except that all receivers are included and hence it indicates the total number of stations in a country. With regard to countries that either did not report or indicated that they did not have any receiver, the columns for receiving equipment were left blank. If there is a zero in any particular type of receiving equipment, it indicates that there is no receiver for that particular type of satellite receiving equipment in that country. There are a total of 8,766 satellite receiving stations in Table 3.2.

Table 3.2
Number of stations in a country
(All)

13 September 1999

WMO MEMBER	# of APTs	# of HRPTs	# of WEFAXs	# of HRs
RA I				
Algeria	1	1	4	2
Benin	1		1	
Botswana	1			2
Burkina Faso	2		1	
Cape Verde	2		2	
Central African Republic	1		1	
Chad	2		1	1
Comoros	1		1	1
Congo	1		1	
Côte d'Ivoire	2	1	1	1
Democratic Republic of the Congo	1		1	
Djibouti	2		2	
Egypt	1		2	3
Eritrea	2			
Ethiopia	1	1	2	2
France	3	2	4	
Gabon	1		1	1
Gambia (the)	1		2	2
Ghana	1		2	1
Guinea	2		2	
Kenya		1	1	2
Lesotho	2		3	2
Liberia	1		1	
Libyan Arab Jamahiriya	2	1	3	2
Madagascar	2	1	5	3
Malawi	1		2	2
Mali	1		1	1
Mauritania	1		1	
Mauritius	2		1	1
WMO MEMBER	**# of APTs**	**# of HRPTs**	**# of WEFAXs**	**# of HRs**
Morocco	1	1	5	2
Mozambique	1		1	
Namibia	1	1		3
Niger	1	1	3	4
Nigeria	3		2	
Republic of Cameroon	1		1	
Rwanda			2	
Sao Tome and Principe	2		1	
Senegal 1	2		6	

Seychelles	2	1	2	
Sierra Leone	2		2	
Somalia	1		1	
South Africa	17	4	36	8
Spain	8		17	
Sudan	1		1	3
Swaziland	1		1	1
Togo	1	1	1	1
Tunisia		1	1	2
Uganda	1		4	
United Republic of Tanzania	2		2	1
Zambia	1	1	1	2
Zimbabwe	3		4	5

RA II

Afghanistan, Islamic State of	1			
Bahrain	3		4	4
Bangladesh	1	1	2	2
Cambodia	2		1	
China	10	12	16	20
Democratic People's Republic of Korea	1	1		1
Hong Kong, China	2	1	7	3
India	8	2	25	1
Iran, Islamic Republic of	1	2	1	2
Iraq	1		2	
Japan	8	15	907	22
Kazakhstan	10	1	1	
Kuwait	1	1	1	3
Kyrgyz Republic	2		1	
Lao People's Democratic Republic	2		2	
Macao, China	1		2	
Maldives	1		2	
Mongolia	1	1	2	
Myanmar	1		2	
Nepal	1		2	
Oman	3	1		2
Pakistan	6	1	2	
Qatar	2		4	
Republic of Korea		9	40	5
Republic of Yemen	1		3	
Russian Federation	66	8	5	

WMO MEMBER	**# of APTs**	**# of HRPTs**	**# of WEFAXs**	**# of HRs**
Saudi Arabia	2	2	6	3
Socialist Republic of Viet Nam	1		5	
Sri Lanka	3		4	
Thailand	1	9	5	10
Turkmenistan	3		2	
United Arab Emirates	7	1	10	7
Uzbekistan	7	2	1	

RA III

Argentina	9	2	20	2

Bolivia	2		1	
Brazil	8	12	14	21
Chile	5	5	6	5
Colombia	2	1	3	1
Ecuador	1			1
France	2		4	1
Guyana	2		1	1
Paraguay	3	2	3	
Peru	1		1	
Suriname	1		1	
Uruguay	5	1	7	
Venezuela	3	1	3	

RA IV

Antigua and Barbuda			1	
Bahamas	2		2	
Barbados	3		2	2
Belize	1		2	1
British Caribbean Territories	2		2	
Canada	57	27	50	32
Costa Rica	2	1	2	1
Cuba	2	1	2	
Dominican Republic			1	
El Salvador	1		1	1
France	3		6	
Guatemala	2		3	
Haiti	1		2	
Honduras	2		2	
Jamaica	1		2	1
Mexico	1	3	2	2
Netherlands Antilles and Aruba			1	3
Nicaragua	3	1	2	
Panama	3	3	3	3
Trinidad and Tobago	6		8	
United States of America	936	160	385	157

WMO MEMBER	# of APTs	# of HRPTs	# of WEFAXs	# of HRs
RA V				
Australia	86	18	112	14
Brunei	2		6	1
Fiji		1	2	3
French Polynesia	1		1	
Indonesia	7	1	1	3
Malaysia		2	10	2
New Caledonia	2	1	3	
New Zealand	15	7	13	5
Papua New Guinea			1	
Philippines	1	1	14	2
Singapore		1	1	2
Solomon Islands			2	
United States of America	10	7	10	9
Vanuatu			2	
RA VI				
Albania	1		1	
Armenia	1		1	
Austria	6		46	6
Azerbaijan	2		1	
Belgium	19	3	55	5
Bulgaria	1		6	4
Croatia	4		6	5
Cyprus	2		2	
Czech Republic		3	16	4
Denmark	6	4	10	6
Estonia	1		1	
Finland	7	3	8	3
Former Yugoslav Republic of Macedonia			1	1
France	14	5	65	16
Georgia	3		1	
Germany	28	19	415	58
Greece	7	3	6	4
Hungary		2	4	3
Iceland	1			
Ireland	19		26	3
Israel	4	1	8	4
Italy	51	18	466	43
Jordan	1	2	3	2
Latvia	1	1	1	
Lebanon	2		2	
Lithuania	2		1	
Luxemburg	3		8	
Malta	4		4	1
Netherlands	51	15	172	21
Norway	6	2	5	4
Poland	5	3	21	6
Portugal	3	1	8	7
Republic of Belarus	1		1	

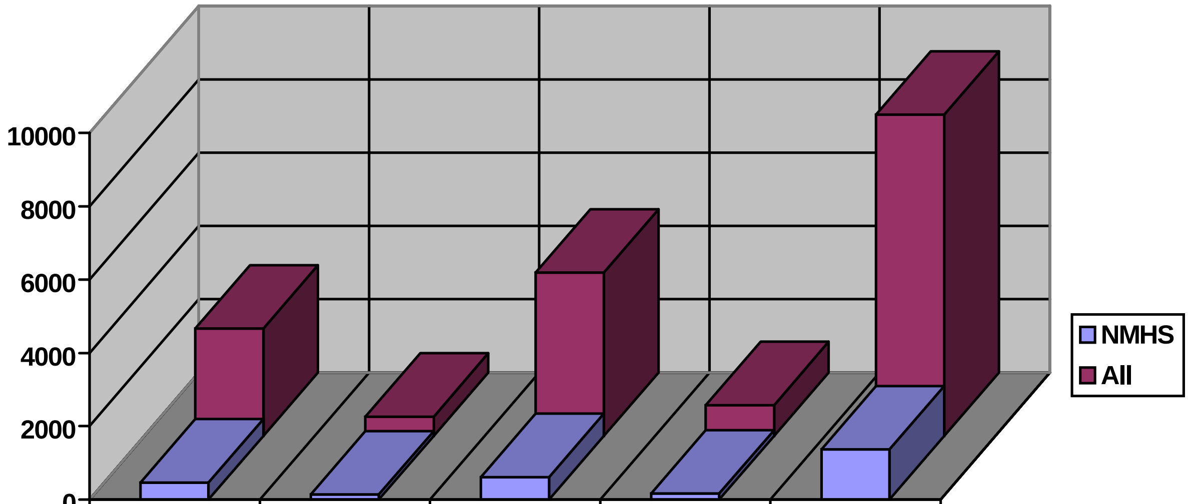
WMO MEMBER **# of APTs # of HRPTs # of WEFAXs # of HRs**

Republic of Moldova	2		1	
Romania	1		3	3
Russian Federation	40	6	8	1
Slovakia		1		1
Slovenia	1		3	3
Spain	72	7	134	20
Sweden	33	7	35	5
Switzerland	9	6	88	21
Syrian Arab Republic	1		1	
Turkey	1		2	2
Ukraine	5	1	3	1
United Kingdom of Great Britain and Northern Ireland	1037	60	877	155
Yugoslavia	1		2	
ANTARCTICA				
Argentina	1			
Australia	6	2	1	1
Chile	3	1	1	
Germany	3	1		
India	1			
Italy	1		1	
Japan	1		1	
Russian Federation	3			
United Kingdom of Great Britain and Northern Ireland	1	2		
United States of America	2	2		
Total :	**2929**	**529**	**4461**	**847**

Grand Total: 8,766

3.6 It is possible to view the total number of satellite receiving stations for each data type sorted by source listed. Since the geostationary satellite stations normally receive only data from one particular geostationary satellite, e.g. GOES, GMS, METEOSAT, etc., one can also view the total number of satellite receiving stations for each particular satellite operator sorted by source. Table 3.3 shows the total number of records for each satellite service while Table 3.4 shows the total number of records for each satellite.

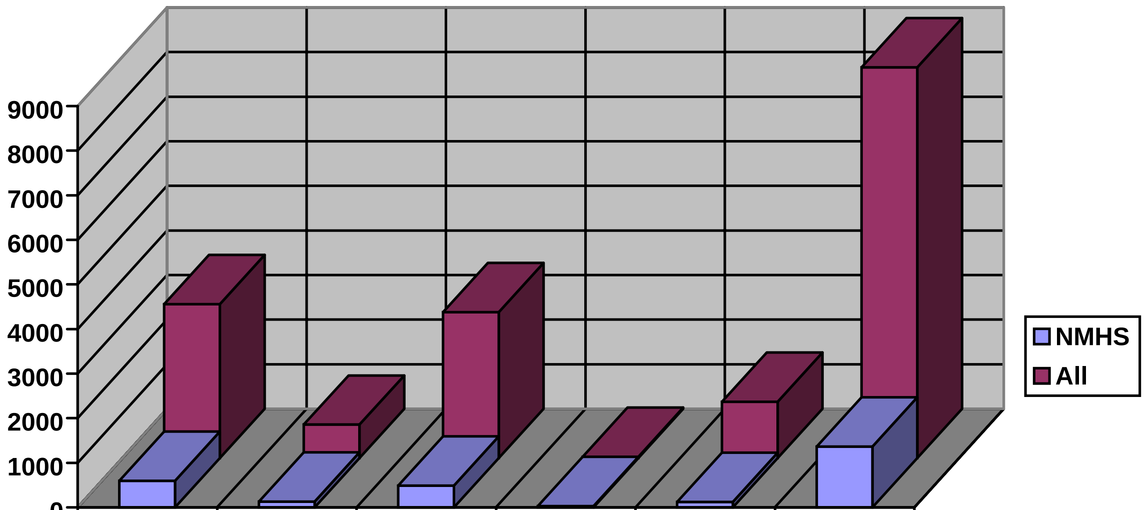
Table 3.3
Satellite receiving stations for each satellite service



	APT	HRPT	WEFAX	HR	Total
NMHS	460	135	607	161	1363
All	2929	529	4461	847	8766

Satellite service

Table 3.4
Satellite receiving stations for each satellite



	NOAA	GOES	Meteosat	INSAT	GMS	Total
NMHS	594	128	486	29	126	1363
All	3452	751	3270	29	1264	8766

Satellite series

3.7 In Chapters 5 and 6, geographical distribution for both the NMHS and All categories will be shown. Chapter 4 will be a more detailed analysis of the receiving equipment found in the NMHSs.

4. ANALYSIS PROCEDURES

4.1 The information listed in Chapter 3 was analyzed to determine various facts (including geographical distribution) concerning the status of implementation for satellite ground receiving equipment within NMHS(s) in WMO Regions as well as for the other sources of data in each Region.

4.2 NMHS(s) point and thematic maps for each type of receiving station were created. Each point map indicates the type of satellite receiving station, i.e. APT, HRPT, WEFAX or HR on a world plot where a dot indicates the location of a satellite receiving station. A thematic map was created by using the above point maps such that each grey shade indicates a range of the number of satellite receiving stations within each country. NMHS(s) shown in light grey on a map have one receiver while those in darker grey have two and those in black have three or more receivers. Those countries shown as not shaded have no receiver or have not provided any information. Please note that due to the scale of the charts, some smaller countries may not be indicated as having equipment. However, Table 3.1 should be used as the baseline for the actual number of stations in a country's NMHS(s). Figures 1 to 4 are the NMHS(s) point maps for each type of receiving station.

4.3 Table 5.1 shows the percentage of NMHS(s) equipped with the various types of receiving stations for each Region. Table 5.2 indicates the changes that have occurred in each Region since the 1992 survey. There is one column for each Region and three rows for each satellite data type. The first row indicates the number of receivers for 1999, the next row for 1992 and the following row indicates the changes during the seven year period. This is repeated for each satellite data type. More detailed descriptions of the facts that can be deduced from Tables 5.1 and 5.2 can be found in Chapter 5, Geographical Distribution of Equipment - NMHS.

4.4 Finally, it should be noted that the membership of WMO changed during the time period from 1992 to 1999. There were large changes in Eastern Europe with many new WMO Members joining Regional Associations II (Asia) and VI (Europe) as well as several new Members in the South-west Pacific. Since the change in membership also has a bearing on the percentage of implementation statistics, Table 5.3 shows the increase in each Regional Association from 1992 to 1999. It should be noted that RA I gained 1 Member, RA II gained 4, RA V gained 5 and RA VI incurred the largest gain - 12. The other two RAs (RA III and IV) remained as during the 1992 survey.

5. GEOGRAPHICAL DISTRIBUTION OF EQUIPMENT - NMHS

5.1 With the aid of the Figures 1 through 4 and Tables 5.4 through 5.9 at the end of this chapter, geographical distribution and characteristics of satellite receiving equipment in the NMHS(s) are described.

Region I (Africa)

5.2 RA I has 45 out of 56 Members equipped with low resolution polar-orbiting receivers (APT) but only 14 out of 56 Members equipped with high resolution polar-orbiting receivers (HRPT) (Table 5.4). From Table 5.1, 49 out of 56 Members are equipped with at least one polar-orbiting HRPT receiver, an increase of four from the previous report in 1995. The thematic map of polar-orbiting receivers (Figure 5) shows that large portions of Africa have no reception for polar-orbiting satellites. Since it is well recognized that high resolution polar-orbiting imagery is most useful for operational meteorological and hydrologic forecasting, increasing the number of high resolution polar-orbiting receivers should be high priority to enhance the implementation of the WWW. With regard to the geostationary satellite receivers, the situation has changed since 1995. In Table 5.5, 46 out of 56 Members have low resolution WEFAX receivers while 19 out of 56 Members have high resolution receivers. From Table 5.1, 49 out of 56 Members 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.

5.3 Paragraph 2.66 noted that goals for the percentage of implementation for WMO Members equipped with satellite receiving equipment are 100% for polar-orbiting satellite data receivers (either APT or HRPT) and 100% for geostationary satellite data receivers (either WEFAX or HR), i.e. each

Member should have at least one polar-orbiting and one geostationary receiver. Table 5.8 shows that 48 out of 56 Members have at least one polar-orbiting 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.

Region II (Asia)

5.4 RA II has 30 out of 34 Members equipped with low resolution polar-orbiting receivers (APT) but only 14 out of 34 Members equipped with high resolution polar-orbiting receivers (HRPT) (Table 5.4). Table 5.1 indicates that 32 out of 34 Members are equipped with at least one polar-orbiting receiver which is an increase of one from 1995. Figure 5 shows that large portions of Southern Asia have no reception for HRPT. An identical 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 (Table 5.5). In all, 32 out of 34 Members have at least one geostationary receiver (Table 5.1), the number has increased by six since the last survey. There were significant increases (192) in the numbers of receivers for both polar-orbiting and geostationary satellites (Table 5.2) 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 polar-orbiting receivers, an increase of 100 receivers.

5.5 When considering the WWW Implementation goals and the fact that 31 Members out of 34 have at least one polar-orbiting receiver as well as one geostationary receiver, it should be noted that another two RA II Members require polar-orbiting receivers and two require geostationary receivers to achieve the proposed goals.

Region III (South America)

5.6 RA III has 13 out of 13 Members equipped with low resolution polar-orbiting receivers (APT) but only 6 out of 13 Members equipped with high resolution polar-orbiting receivers (HRPT) (Table 5.4). Table 5.1 indicates that 13 out of 13 Members were equipped with at least one polar-orbiting receiver, an increase of one from the previous report. It can also be seen in the thematic map in Figure 5 that the western portions of RA III have no reception for HRPT. A near identical situation exists for the geostationary satellite receivers. Twelve out of 13 Members have low resolution WEFAX receivers while only 6 out of 13 Members have high resolution receivers (Table 5.5). Thirteen out of 13 Members have at least one geostationary receiver (Table 5.1), the number has increased by one since the last survey.

5.7 An improvement can be seen in this Region since the last survey because the percentage of Members equipped for both polar-orbiting and geostationary satellite receivers has increased. Noteworthy was the increase in the number of low-resolution receivers (24) for geostationary satellites (Table 5.2). In RA III, 13 out of 13 Members have at least one polar-orbiting receiver as well as at least one geostationary receiver. Therefore, 100% implementation has been achieved since 1995. RA III has achieved 100% of the WWW Implementation goal which is the highest percentage amongst all Regions.

Regional Association IV (North and Central America)

5.8 RA IV has 17 out of 25 Members equipped with low resolution polar-orbiting receivers (APT) but only 7 out of 25 Members equipped with high resolution polar-orbiting receivers (HRPT) (Table 5.4). The number of Members equipped with APT and HRPT receivers increased by one and three, respectively since 1995. This Region has 18 out of 25 Members equipped with at least one polar-orbiting receiver (Table 5.1) which is an increase of ten receivers as well as an increase of 4 percent points for equipped Members. For the geostationary satellite receivers, 20 out of 25 Members have low resolution WEFAX receivers and 5 out of 25 Members have high resolution receivers (Table 5.5). In Table 5.1, 21 out of 25 Members have at least one geostationary receiver, a small change since the 1995 survey. Eighteen out of 25 Members have at least one polar-orbiting receiver as well as one geostationary receiver. Seven Members need to be equipped which is an decrease of two from the previous report. RA IV showed a modest increase in the percentage (8%) of WWW Implementation. In applying the WWW Implementation goals, seven RA IV Members require polar-orbiting receivers and four RA IV Members require geostationary receivers.

Regional Association V (South-west Pacific)

5.9 Most of the statistics for RA V have been influenced by the addition of five new Members since the last survey. RA V has 5 out of 21 Members equipped with low resolution polar-orbiting receivers (APT) and 7 out of 21 Members equipped with high resolution polar-orbiting receivers (HRPT) (Table 5.4). Since 1995, there has been a increase of two low resolution and an increase of one high resolution polar-orbiting satellite receiver. From Table 5.1, RA V has 10 out of 21 Members equipped with at least one polar-orbiting receiver which is one more than in 1995. Although it might be inferred that this Region has adequate coverage from viewing the thematic map (Figure 5), there are a number of countries (7) yet to be equipped with polar-orbiting receivers (Table 5.1). For the geostationary satellite receivers, 13 out of 21 Members have low resolution WEFAX receivers and 7 out of 21 Members have high resolution receivers (Table 5.5). Thirteen out of 21 Members have at least one geostationary receiver which is no change since the last survey. Ten out of 21 Members have at least one polar-orbiting receiver as well as one geostationary receiver leaving eleven Members to be equipped. Since the percentage of Members equipped with polar-orbiting receivers is lowest amongst all the Regions, the percentage of Members equipped with both receiver types is also the lowest (Table 5.9). The WWW Implementation goals imply that another 11 RA V Members require polar-orbiting receivers and 8 RA V Members require geostationary receivers.

Regional Association VI (Europe)

5.10 RA VI has 36 out of 49 Members equipped with low resolution polar-orbiting receivers (APT) and 21 out of 49 Members equipped with high resolution polar-orbiting receivers (HRPT) (Table 5.4). The Region has 44 out of 49 Members equipped with at least one polar-orbiting receiver which is an increase of five from the previous report. It can be seen in Figure 5 that most of RA VI is adequately covered for reception of HRPT except Eastern Europe. The situation is the same for the geostationary satellite receivers. Out of 49 Members, 40 have low resolution WEFAX receivers and 27 have high resolution receivers (Table 5.5). Forty-four out of 47 Members have at least one geostationary receiver which is an increase of five since the last survey. One should note the large number (286) of low resolution WEFAX geostationary receivers reported by RA VI (Table 5.1). This number is more than two times more than any other Region. Figure 4 shows, similar to Figure 3, that most of RA VI is adequately covered for reception of high resolution satellite data except in the eastern most portion of Europe. Forty-three out of 49 Members have at least one polar-orbiting receiver as well as one geostationary receiver leaving 6 Members to be equipped (Table 5.8). Using the WWW Implementation goals, implies that another 5 RA VI Members require polar-orbiting receivers and 5 Members require geostationary receivers.

Conclusions

5.11 In summary, there have been large - almost doubling (698 to 1,363 since 1992) - and steady (277 since 1995) increases in the total number of satellite receiving stations with a concurrent increase in the WWW implementation, i.e. from 70% to 82% since 1992. The increase in percent implementation would have been even greater save the increase in new WMO Members who have not yet had an opportunity to report their number of receiving stations.

5.12 The expected change in the first decade of the new millenium to digital low resolution imagery coupled with improved capability to utilize satellite data within all WMO Members indicates that a strategy towards implementation of high resolution receivers should be pursued by WMO Members as well as through assistance programmes.

Table 5.1
Percentage of NMHS(s) with satellite receiving stations

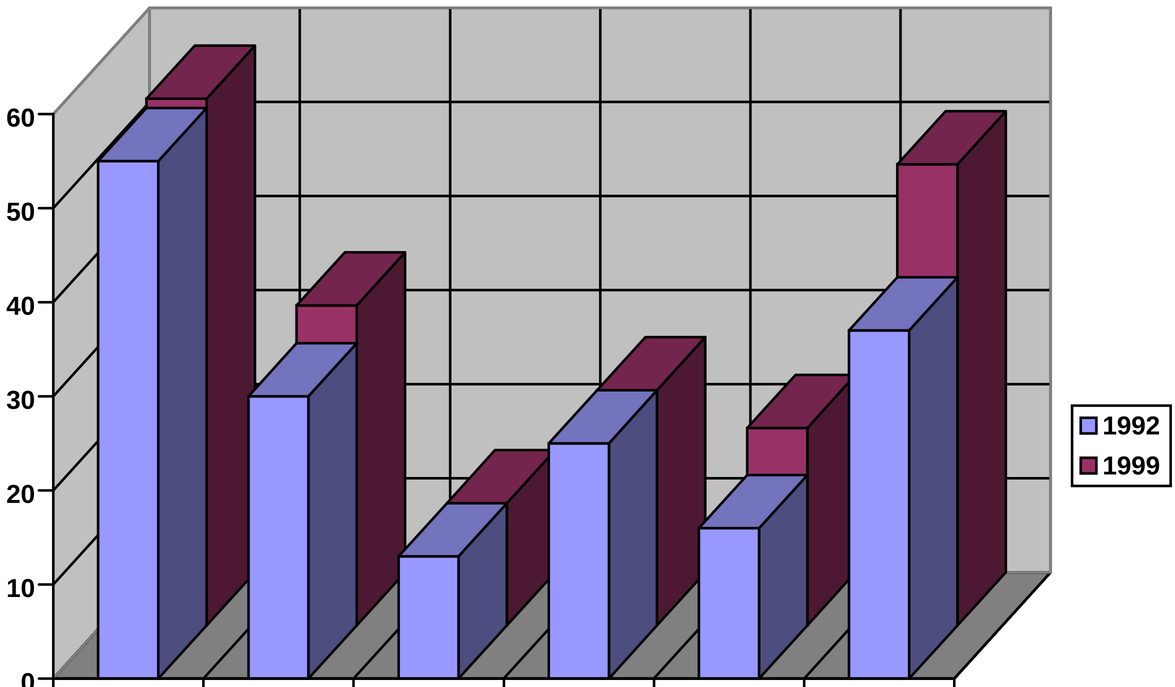
WMO Region						
	I	II	III	IV	V	VI
Total Number of Members	56	34	13	25	21	49
APT						
Receivers	67	137	34	34	14	161
Members equipped	45	30	13	17	5	36
% Members equipped	80	88	100	68	24	73
HRPT						
Receivers	14	40	11	22	9	37
Members equipped	14	14	6	7	7	21
% Members equipped	25	41	46	28	33	43
POLAR-ORBITING RECEIVERS (APT and HRPT)						
Receivers	81	177	45	56	23	198
Members equipped	49	32	13	18	10	44
% Members equipped	88	94	100	72	48	90
WEFAX						
Receivers	76	124	45	42	32	286
Members equipped	46	30	12	20	13	40
% Members equipped	82	88	92	80	62	82
HR						
Receivers	24	25	12	36	9	55
Members equipped	19	12	6	5	7	27
% Members equipped	34	35	46	20	33	55
GEOSTATIONARY RECEIVERS (WEFAX and HR)						
Receivers	100	149	57	78	41	341
Members equipped	49	32	13	21	13	44
% Members equipped	88	94	100	84	62	90

Table 5.2
Change in number of receivers in the NMHS(s) since 1992

	WMO Regional Association						
	I	II	III	IV	V	VI	TOTAL
APT							
Receivers (99)	67	137	34	34	14	161	447
Receivers (92)	47	37	21	29	14	76	224
Change (99 - 92)	20	100	13	5	0	85	223
HRPT							
Receivers (99)	14	40	11	22	9	37	133
Receivers (92)	7	16	5	17	8	19	72
Change (99 - 92)	7	24	6	5	1	18	61
WEFAX							
Receivers (99)	76	124	45	42	32	286	605
Receivers (92)	39	61	21	28	19	159	327
Change (99 - 92)	37	63	24	14	13	127	278
HR							
Receivers (99)	24	25	12	36	9	55	161
Receivers (92)	10	20	6	13	8	18	75
Change (99 - 92)	14	5	6	23	1	37	86
TOTAL 1999	181	326	102	134	64	539	1,346
TOTAL 1992	103	134	53	87	49	272	698
CHANGE (99 - 92)	78	192	49	47	15	267	648

N.B. There are 17 more stations Antarctica.

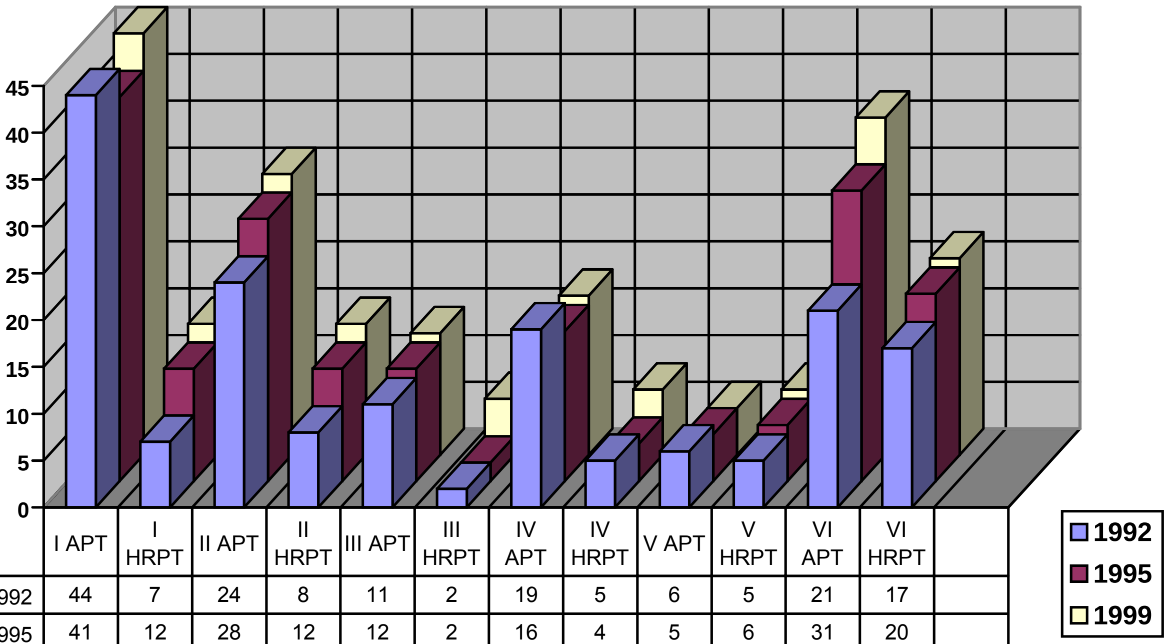
Table 5.3
Total number of WMO Members
in 1992 and 1999



	I	II	III	IV	V	VI
1992	55	30	13	25	16	37
1999	56	34	13	25	21	49

Region

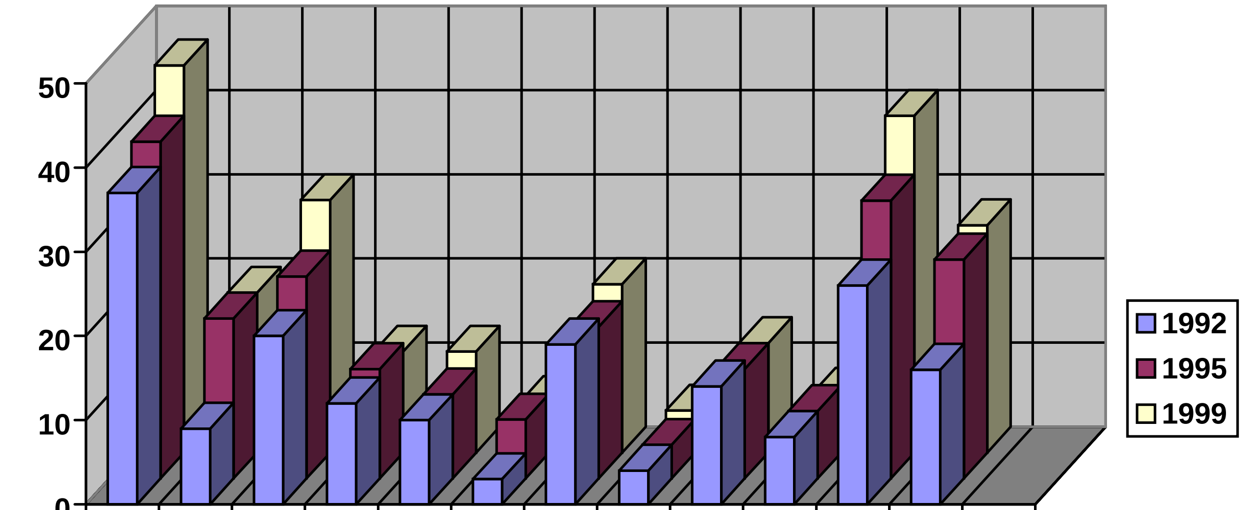
Table 5.4
Polar orbiting receivers
Number of WMO Members with APT or HRPT receivers



	I APT	I HRPT	II APT	II HRPT	III APT	III HRPT	IV APT	IV HRPT	V APT	V HRPT	VI APT	VI HRPT	
1992	44	7	24	8	11	2	19	5	6	5	21	17	
1995	41	12	28	12	12	2	16	4	5	6	31	20	
1999	45	14	30	14	13	6	17	7	5	7	36	21	

Region and receiver

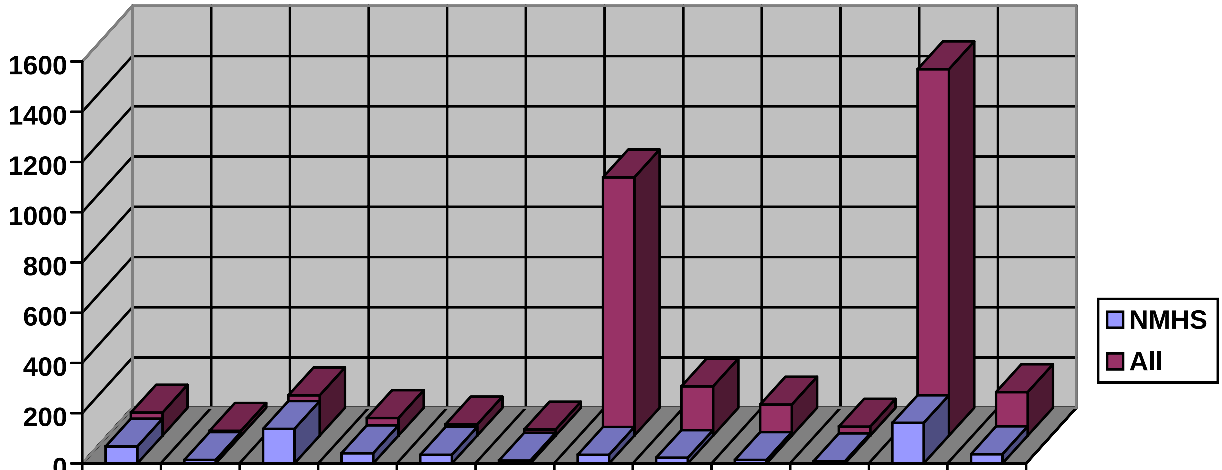
Table 5.5
Geostationary receivers
Number of WMO Members with WEFAX or High Resolution receivers



	I W	I HR	II W	II HR	III W	III HR	IV W	IV HR	V W	V HR	VI W	VI HR
1992	37	9	20	12	10	3	19	4	14	8	26	16
1995	40	19	24	13	10	7	18	4	13	8	33	26
1999	46	19	30	12	12	6	20	5	13	7	40	27

Region and receiver

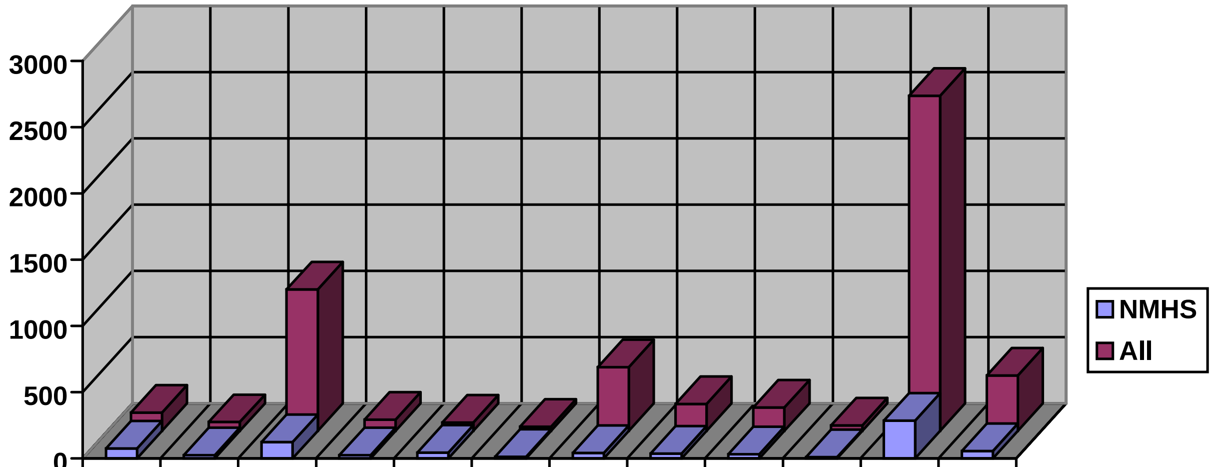
Table 5.6
Polar-orbiting receivers
Number of receivers in each WMO Region



	I APT	I HRPT	II APT	II HRPT	III APT	III HRPT	IV APT	IV HRPT	V APT	V HRPT	VI APT	VI HRPT
NMHS	67	14	137	40	34	11	34	22	14	9	161	37
All	92	19	160	70	44	24	1028	196	124	36	1459	173

Region and receiver

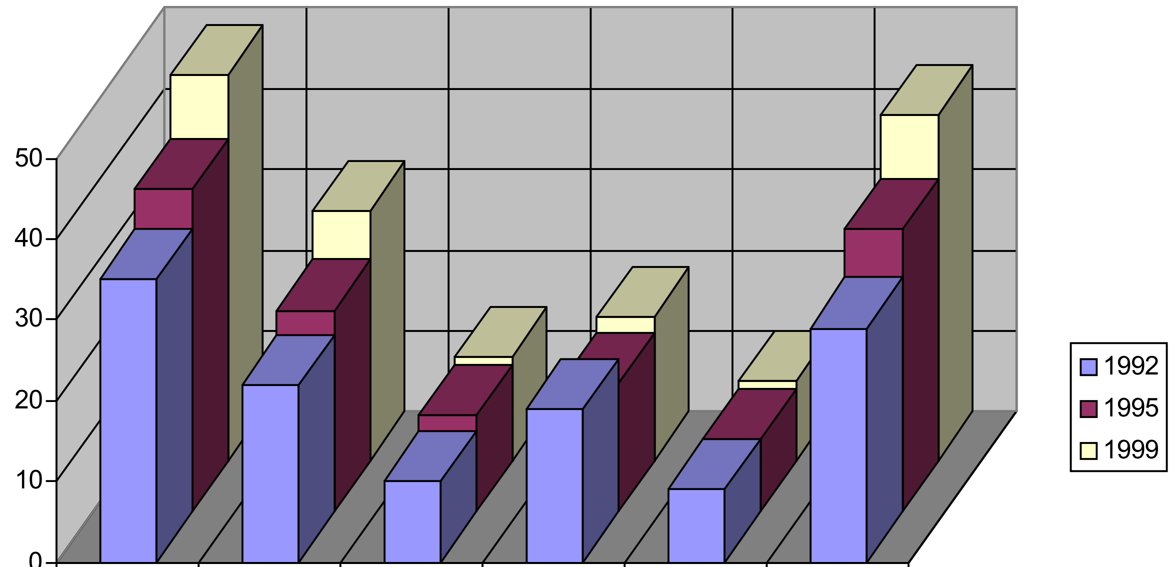
Table 5.7
Geostationary receivers
Number of receivers in each WMO Region



	I W	I HR	II W	II HR	III W	III HR	IV W	IV HR	V W	V HR	VI W	VI HR
NMHS	76	24	124	25	45	12	42	36	32	9	286	55
All	139	67	1067	85	64	32	481	203	178	41	2528	418

Region and receiver

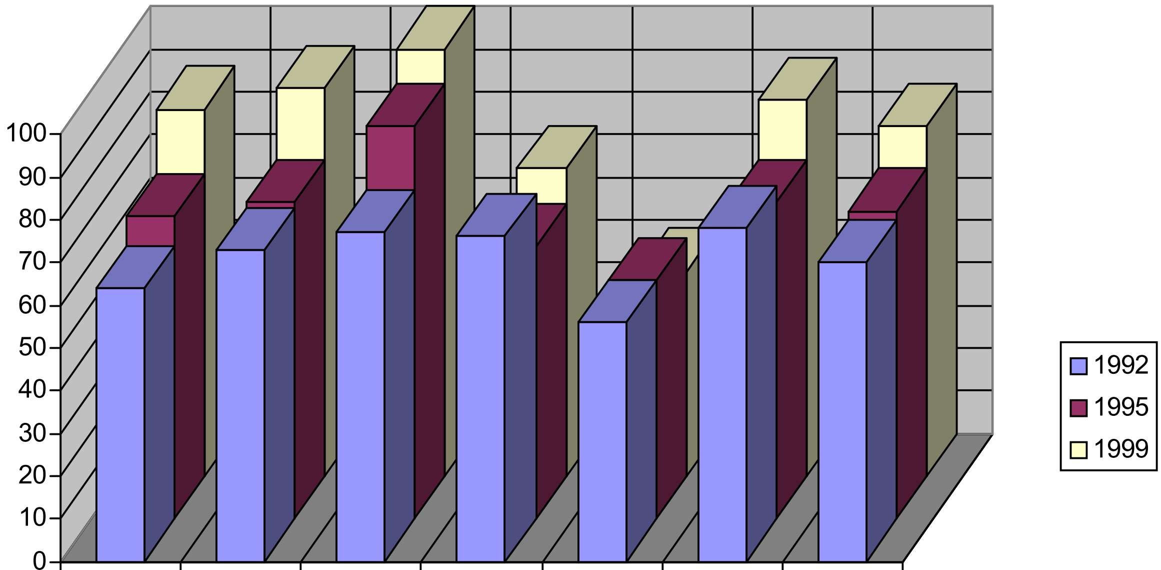
Tables 5.8
WWW Implementation Goals
Number of Members with at least one polar-orbiting and one geostationary receiver



	I	II	III	IV	V	VI
1992	35	22	10	19	9	29
1995	40	25	12	16	9	35
1999	48	31	13	18	10	43

Region

Table 5.9
WWW Implementation Goals
Percentage of Members with at least one polar-orbiting and one geostationary receiver



	I	II	III	IV	V	VI	All
1992	64	73	77	76	56	78	70
1995	71	74	92	64	56	74	72
1999	86	91	100	72	48	88	82

Region

6. GEOGRAPHICAL DISTRIBUTION OF EQUIPMENT - ALL

6.1 Chapter 5 dealt with the geographical distribution of satellite receiving stations within the NMHSs. This Chapter deals with receiving stations of all categories, including the stations of the NMHSs.

6.2 Figures 6 to 9 are combined point maps of the two types of polar-orbiting receivers and two types of geostationary receivers, respectively. The figures were produced using the database that combined all the various sources. It should be noted that the database contains the station name and geographic location for all the stations (8,766). The geographic location uses latitude/longitude coordinates. The database is exported to MapInfo where each station is geo-located and assigned a point symbol. In Figure 6 for polar-orbiting satellite receiving stations, APT stations are identified with a diamond while in Figure 7 HRPT stations are assigned a downward pointing triangle. In Figure 8 for geostationary satellite receiving stations, WEFAX stations are identified with squares and in Figure 9 HR stations are assigned an upward pointing triangle.

6.3 It should be noted for both APT and WEFAX that some receiving stations are shown in oceanic areas. In some of the sources, particularly from the manufacturers, the receiving station was indicated to be mobile since it was installed onboard a ship or sailing vessel. Therefore, a latitude/longitude at sea was assigned. It can also be seen that there are several satellite receiving stations around the periphery of the Antarctic Continent.

6.4 The database contains, in general, the same distribution as found in the NMHSs. There are more low-resolution (both APT and WEFAX) receivers than high-resolution. However, in Table 3.3 and within the NMHSs, the ratio is approximately 3 or 4 to 1 while in the full database the ratio is 5 to 1 for APT and WEFAX. In the 'Total' column of the Table 3.3, the ratio of the number of records of All and NMHSs is approximately 7 to 1, that is there are seven receivers outside the NMHSs for every one in a NMHS. This demonstrates that the primary user community for the direct broadcast satellite service is not the NMHSs but rather educational, commercial and amateurs. This is not surprising since the National Meteorological and Hydrological Services constitute a small number of personnel but service a very large community, their nation.

6.5 It can also be seen from Figures 6 to 9 that there is a very high density of satellite receivers in Europe, North America and Japan. This can be accounted for, in part, by the requirement of national telecommunication administration that all types of receivers be registered. The six countries with the most receivers in the database are the United Kingdom, United States of America, Japan, Italy, Germany and Netherlands in decreasing order. It is felt that the other developed countries without a mandatory registration requirement also have correspondingly large number of receivers. It has been estimated that there are at least 15,000 satellite receivers world-wide.

Figure 1

Map of Polar-orbiting Receivers --- NMHS

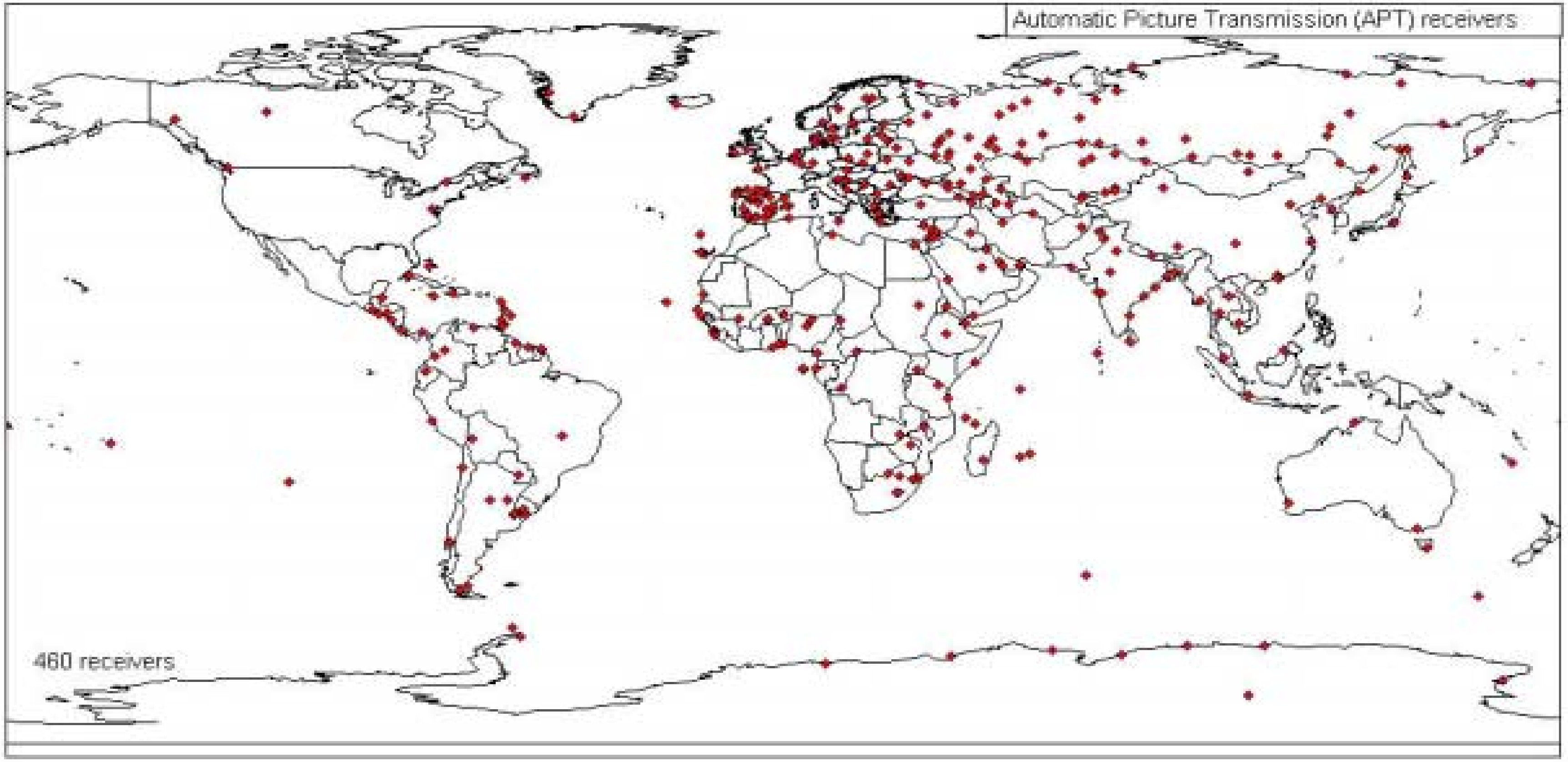


Figure 2

Map of Polar-orbiting Receivers --- NMHS

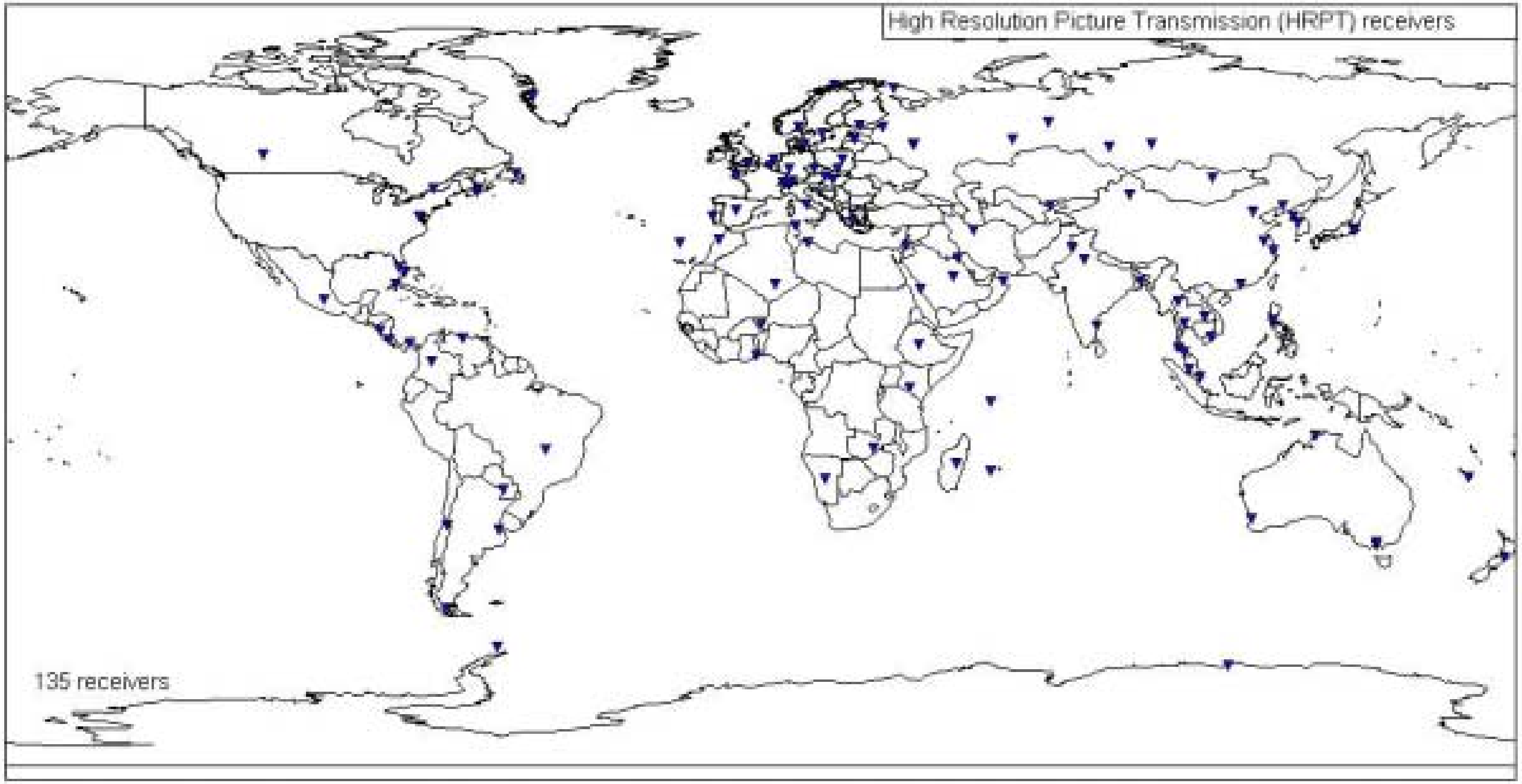


Figure 3

Map of Geostationary Receivers --- NMHS

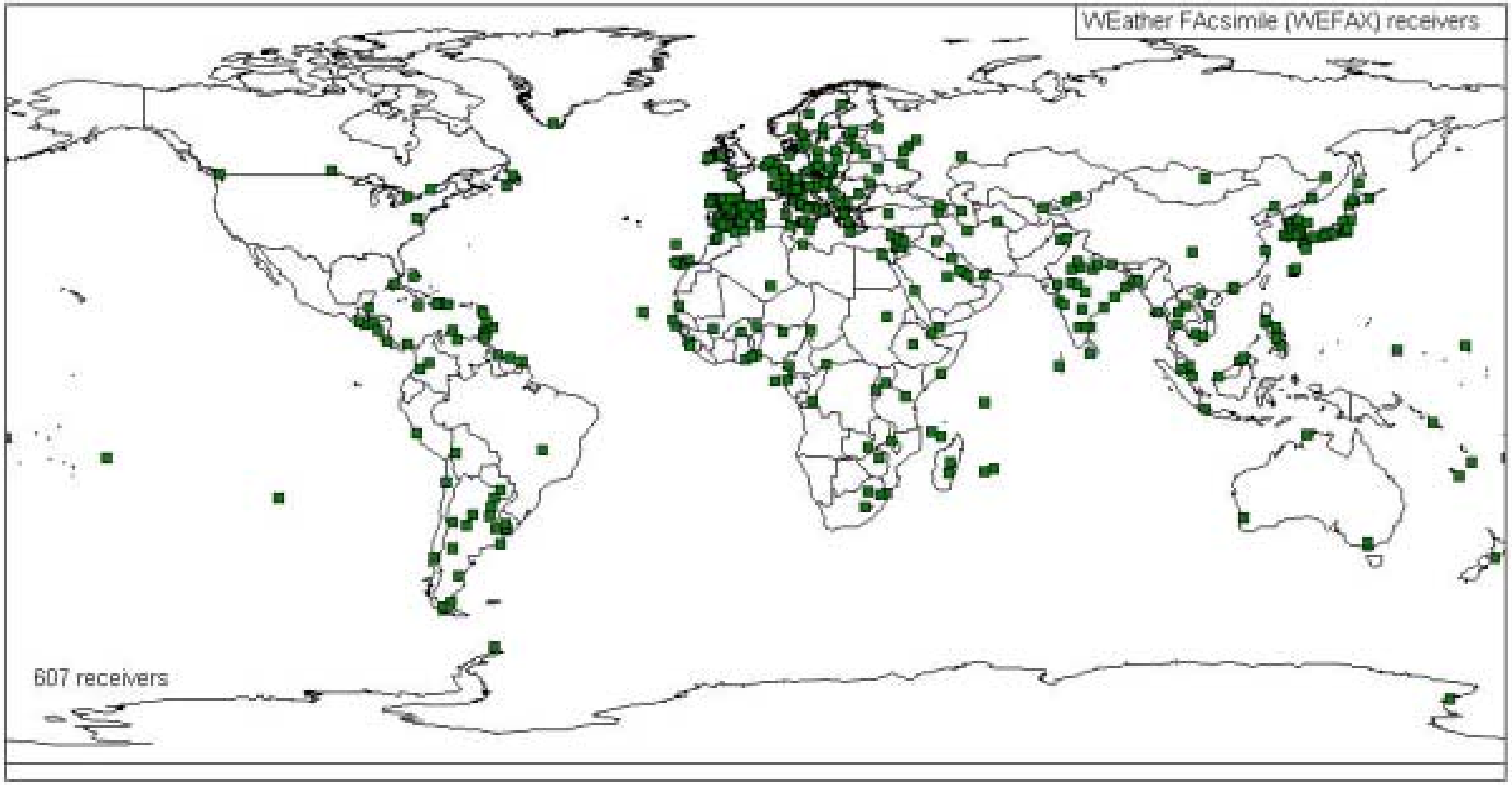


Figure 4

Map of Geostationary Receivers --- NMHS

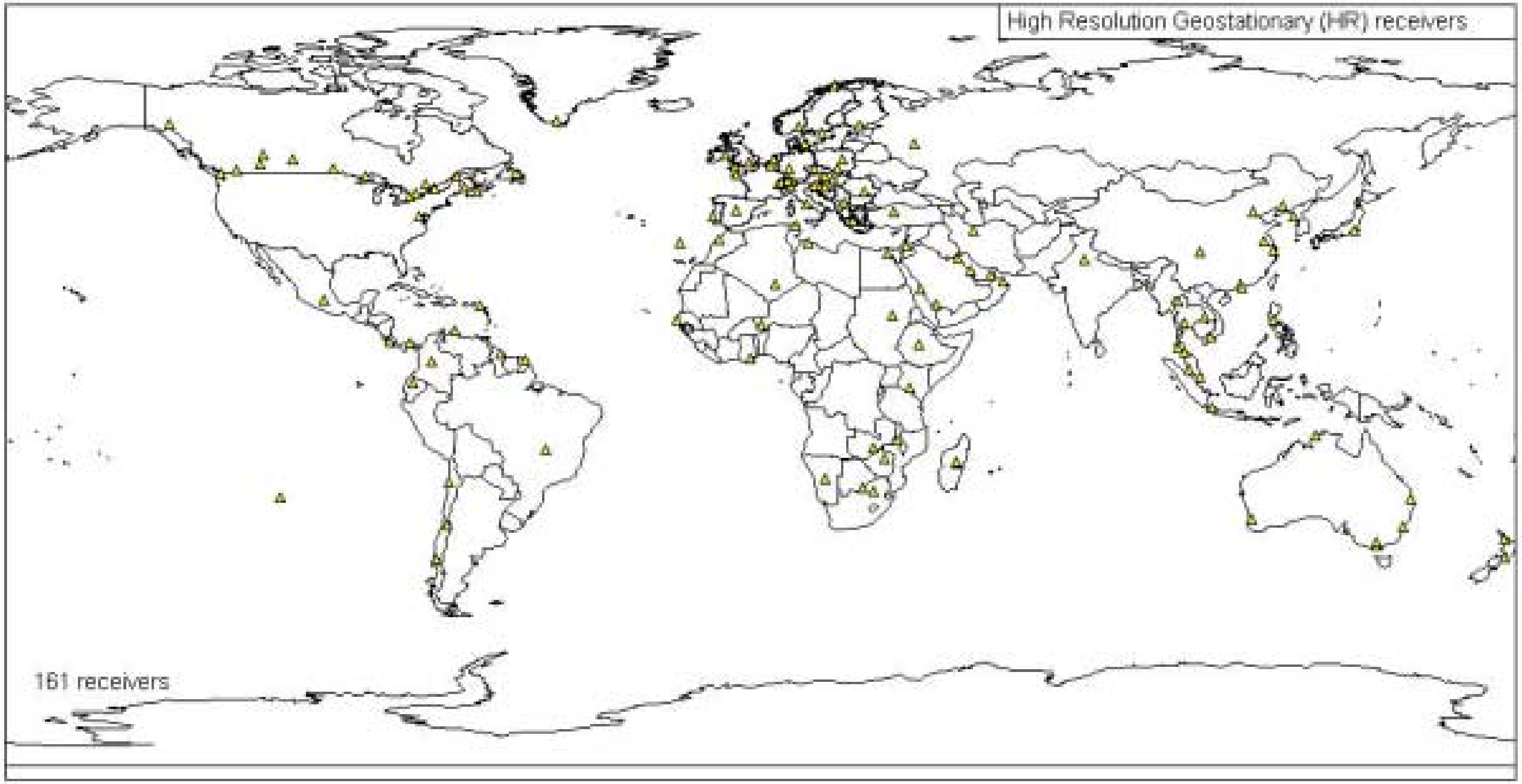


Figure 5

Thematic Map of receivers — (based on VCP priorities)

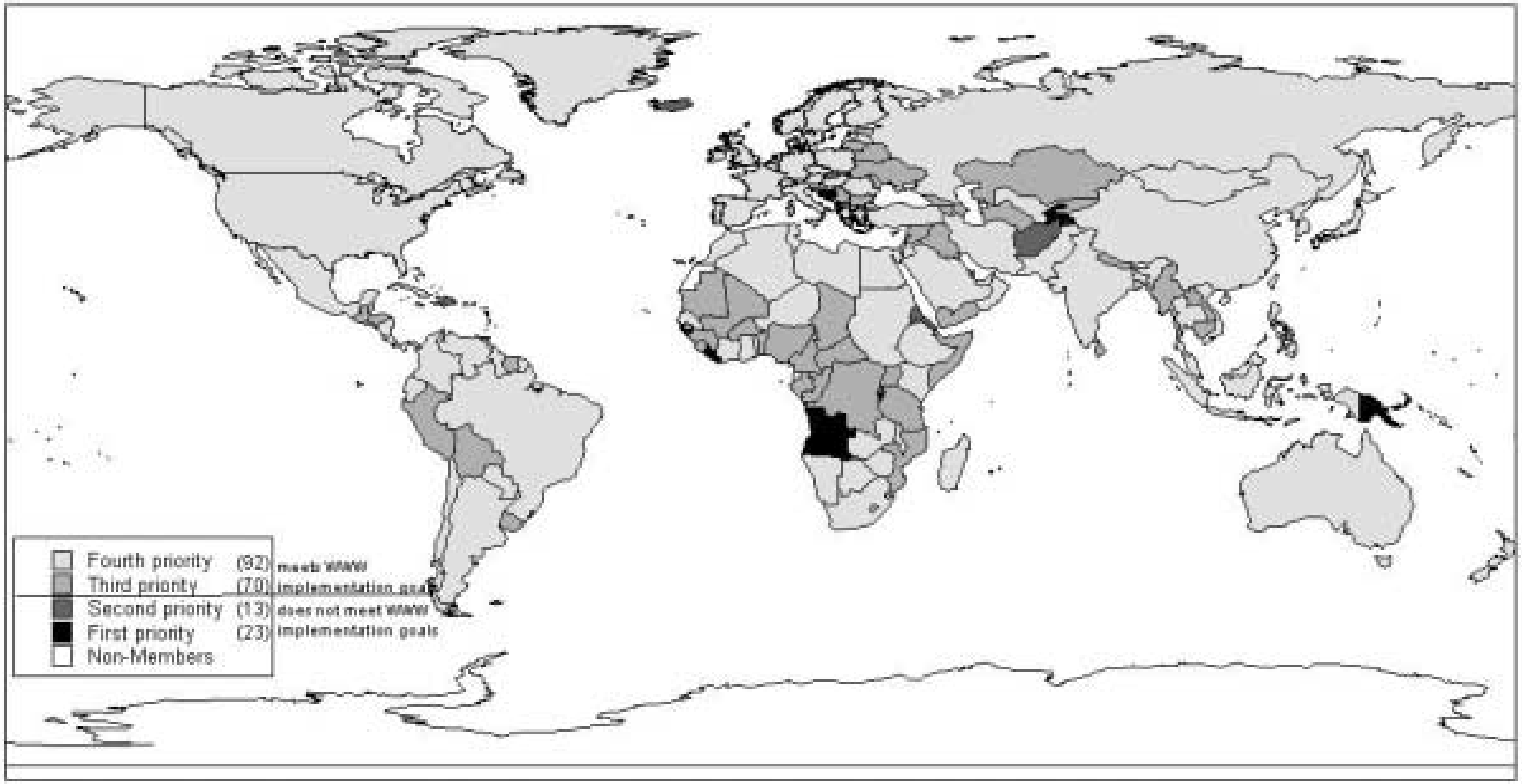


Figure 6

Map of Polar-orbiting Receivers — All

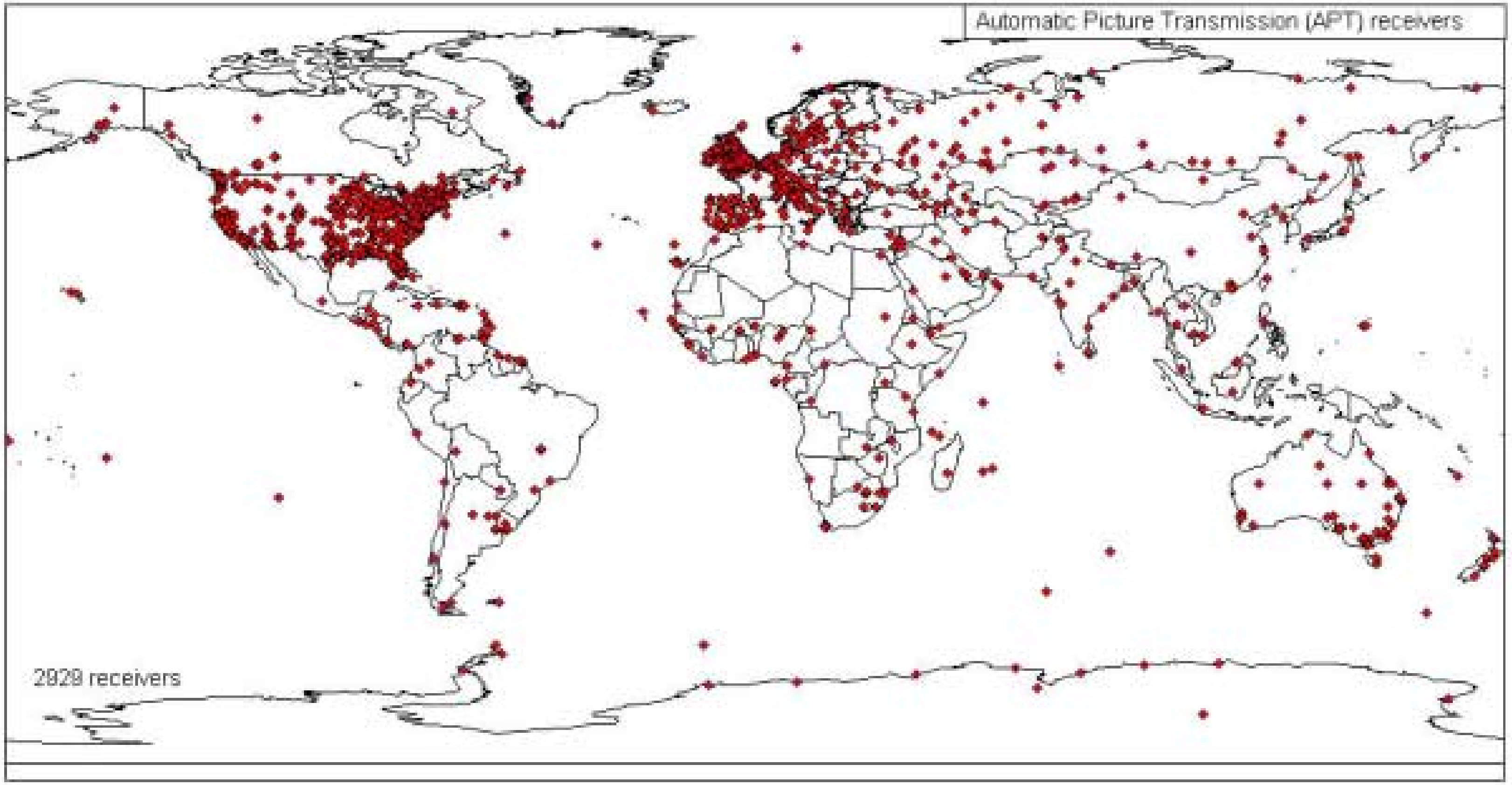


Figure 7

Map of Polar-orbiting Receivers --- All

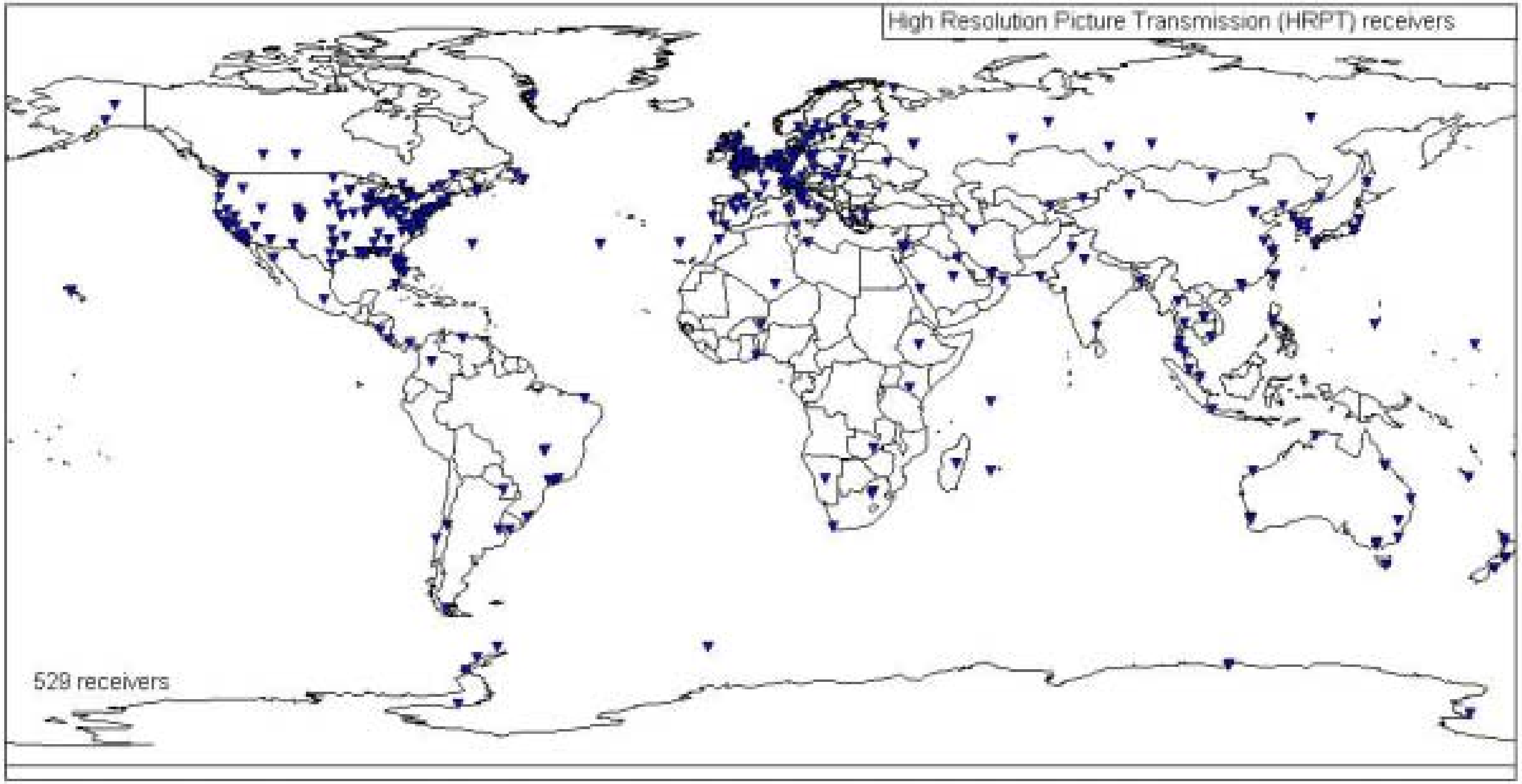


Figure 8

Map of Geostationary Receivers — All

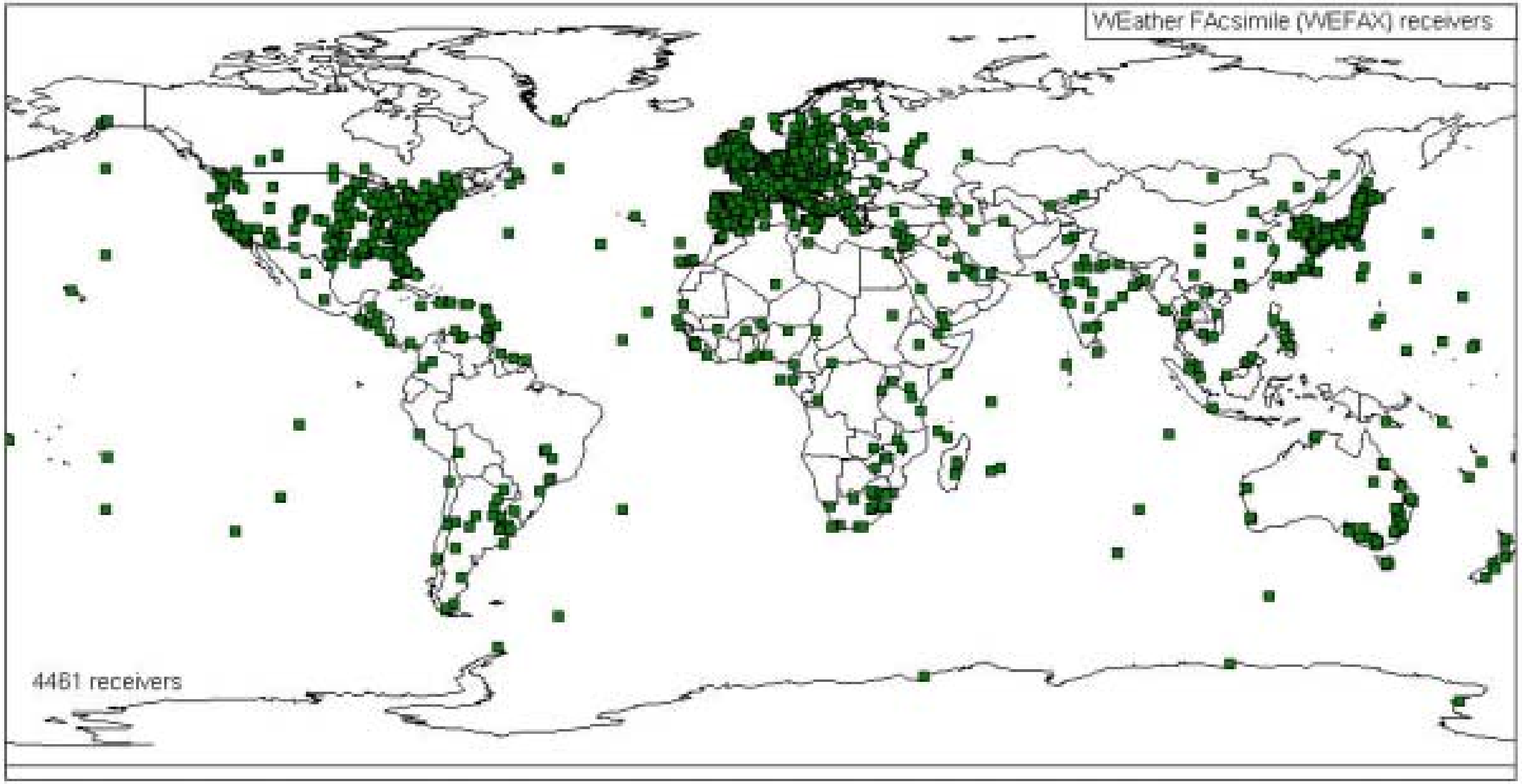


Figure 9

Map of Geostationary Receivers --- All