WMO Space Programme
SP-6

Status of the availability and use of satellite data and products by WMO Members

For the period 2006–2007

World Meteorological Organization
Weather • Climate • Water

WMO-TD No. 1483

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APPENDICES

EXECUTIVE SUMMARY

The Commission for Basic Systems (CBS) Open Programme Area Group on Integrated Observing Systems (OPAG-IOS) has the strategic goal to improve systematically the utilization of the capabilities of the space-based component of the Global Observing System (GOS) with an emphasis on improving the utilization of satellite data and services in developing countries. Progress towards this goal is monitored and stimulated by means of information obtained from a biennial questionnaire.

This document provides the results of an analysis of the responses to an edition of the biennial questionnaire that was distributed to WMO Members in early 2008 in order to assess the status of the availability and use of satellite data and products during the period 2006-2007.

An overview of the approach adopted to analyze the responses is contained in Section 2. Section 3 provides information related to the participation of WMO Members in the questionnaires. Sections 4, 5, 6 and 7 contain in-depth analyses of the responses to the various sections of the questionnaire from the different WMO Regions. Key findings from the analyses are extracted and, where appropriate, recommendations are shown. These are listed again in Appendices D and E respectively.

1. INTRODUCTION

The WMO Commission for Basic Systems (CBS) Open Programme Area Group on Integrated Observing Systems (OPAG-IOS) has the strategic goal to improve systematically the utilization of the space-based component of the Global Observing System's capabilities with emphasis on improving utilization of satellite data and services in developing countries.

One of the means to achieve this is through active monitoring and review of the availability and use of satellite data. The review and monitoring process is performed by means of a series of dedicated questionnaires; the latest of which was issued in early 2008 and is the subject of this report. While each edition has been somewhat different, they have become more concise.

A preliminary evaluation of the latest edition was performed by the OPAG-IOS Expert Team on Satellite Utilization and Products (ET–SUP) and the results and conclusions from that evaluation form the basis for this report.

In order to compare this analysis with that of previous editions it is important to clarify the association between the year a questionnaire was issued and the validity period of the responses. It should be noted that the year attributed to the questionnaire edition is the year the questionnaire was distributed. However, the period covered by the responses is somewhat notional. Only in the last two editions have WMO Members been explicitly asked to formulate their responses to be valid for a two-year period. This fact somewhat limits the usefulness of drawing conclusions that refer to all editions. The editions issued so far are shown in Table 1.

Year attributed to questionnaire edition in this document	Period covered by the responses
1996	1995 to 1996
1999	1997 to 1998
2001	1999 to 2000
2003	2001 to 2002
2006	2004 to 2005
2008	2006 to 2007

Table 1 - Questionnaire editions

2. OVERVIEW

As stated above, the current (2008) edition of the questionnaire covered the two-year period 2006-2007. This period included several changes to the space-based component of the Global Observing System (GOS) and was also a period in which significant changes to the available means of data access were introduced. These latter changes are summarized in the following section.

2.1 Changes to the means of access to satellite data

Major changes introduced during the period covered by the questionnaire included:

- Introduction of dissemination methods based on communication satellites:
  - Considerably increased dissemination content of EUMETCast,
  - Beginning of FengYunCast operations,
  - First disseminations via GEONETCast-Americas;
- Introduction of new and enhanced 'fast data delivery' schemes:
  - Establishment of the Asia-Pacific and South American Regional ATOVS Retransmission Services (RARS),
  - Extension of EUMETSAT Advanced Retransmission Service (EARS) to include data types other than ATOVS (specifically ASCAT and AVHRR);

- Implementation of “African Monitoring of the Environment for Sustainable Development” (AMESD) initiative to exploit the heritage of the “Preparing for Use of MSG in Africa” (PUMA) project (WMO RA I);
- Improved performance of Internet based distribution systems;
- Additional data sources became available:
  - MSG-2 operational,
  - Metop-A operational,
  - NOAA-18 operational,
  - MTSAT1-R fully operational,
  - FY-2D operational,
  - MODIS (more products becoming available),
  - AIRS (more data becoming available),
  - TRMM (easier data access),
  - ENVISAT (easier data access),
  - New R&D satellites including ALOS, CALIPSO, CloudSat, COSMIC;
- Further expanded activities of key programmes and groups:
  - Joint Center for Satellite Data Assimilation (JCSDA),
  - Short term Programme for operational Research and Transition (SPORT),
  - EUMETSAT Satellite Application Facilities (SAF) Continuous Development and Operations (CDOP) phase,
  - WMO Virtual Laboratory (VL) including the High Profile Training Event (HPTE) in 2006.

2.2 Identifying trends

A vital aspect of the analysis of responses is the identification of trends. Such trends provide evidence of the extent to which efforts to improve access and increase the utilization of satellite data and products are successful, or otherwise. However, trends can only be meaningfully described if questions remain consistent from one edition of the questionnaire to the next, which is sometimes not the case given that the structure of successive editions is modified as necessary to remain relevant to the changing world of satellite meteorology. Consequently, since the 2006 edition, specific questions have been included in the questionnaire to ask Members to identify whether changes have occurred during the two-year period of the questionnaire. Responses to these questions provide extremely valuable sources of information and should be prominent in the analysis.

(R1) Recommendation: Responses to trend questions (asking for changes observed during the period of the questionnaire) provide clear indications and should remain mandatory in future editions of the questionnaire.

The quantifying of trends across editions through the analysis of responses should be treated with caution due to the inhomogeneity of the data sets combined with the small sample size. The multi-edition comparisons thus only described what was reported in each edition and may to some extent provide a subjective feeling of the trends rather than mathematically precise statistics.

2.3 Approach to the analysis

At their 2008 meeting, ET-SUP reaffirmed that the questionnaire continued to be a suitable tool to assess the status and requirements for satellite data access and use as well as education and training in a comprehensive and systematic way. Its potential is, however, only fully realized if the participation by Members is sufficiently high so that the analysis of responses and conclusions drawn from them are based on a representative sample of opinion. A high level of participation in the survey is therefore the key for deriving a true picture of the situation and constructive conclusions from the answers. The questionnaire should play a key role in a structure of information gathering that addresses the satellite system operators and the system users along with the WMO Programmes that support them. This structure has depended upon the questionnaire series to pinpoint the successes, gaps and needs within the community of users within each WMO Member. Because the participation in all editions to date has been generally rather low and variable from one edition to the next (although participation is

relatively high in comparison to some other WMO questionnaires), the survey series has not always been as useful at identifying trends as it could be.

ET-SUP formed a working group that undertook a detailed analysis of the questionnaire and its responses with a view to assess the status, conclude on trends and elaborate recommendations. It was felt important by ET-SUP that recommendations should include follow-up correspondence with specific WMO Members to address deficiencies identified through their responses. Such follow-up actions would normally be undertaken by the WMO Space Programme but it is recognized that these recommendations will be critically dependent on the availability of adequate resources.

In addition to considering the questionnaire responses, the analysis also made reference to a number of hypotheses about expected trends. Where possible, these hypotheses were tested by using the responses from the questionnaire and, where appropriate, in combination with other information. The hypotheses were based on the awareness of the experts of major changes in satellite systems, instruments, processing, training or other related input. In the 2008 edition nearly the same hypotheses were used as for the 2006 edition (see Appendix B). The responses to the 2008 questionnaire did not always provide enough information to test all of the hypotheses. Other additional information has therefore to be taken into account in order to get a full picture of the status of availability and use of satellite data and products. Appendix C lists such other potential sources of complementary information.

The series of biennial questionnaires remains however a unique basis for Members to report not only on progress and achievements, but also, where relevant, on problems or deficiencies. It is then the responsibility of satellite operators, processing centres and training facilities to take the reported deficiencies and unfulfilled requirements into account and to look, as far as possible, for mitigation actions. This is the major benefit of the questionnaire, and therefore the major incentive for Members to complete and return it. WMO and the other members of the Coordination Group for Meteorological Satellites (CGMS) take the findings of the questionnaire into account when planning future activities.

(R2) Recommendation: Periodic analysis of the status of availability and use of satellite data and products should continue to be accomplished through a combination of an objective analysis of a periodic questionnaire completed by the Members complemented by an analysis based on information gathered from other sources related to satellite data accessing, processing and training.

(R3) Recommendation: For future analysis of the status of availability and use of satellite data and products, actions should be taken to seek to engage nearly *every* WMO Member. In addition, the engagement of relevant WMO Programmes through their lead Technical Commission and their infrastructure organizations of OPAGs and Expert Teams is considered extremely valuable, as is the involvement of Executive Council Panels, where appropriate (for example for Education and Training and Disaster Risk Reduction), and of the Regional Association Rapporteurs for the WMO Space Programme.

(R4) Recommendation: In general, mechanisms should be established to address questions and concerns raised by Members in their responses to the questionnaire and to provide relevant feedback to them. Particular recommendations are included in this report for those areas that are considered to require specific follow-up actions.

2.4 Regional Aspects

The analysis of questionnaire responses is usually broken down into WMO Regions. This adds value to the conclusions by highlighting issues that are particularly relevant to certain regions and provides a basis for targeted follow-up actions where these are practical and appropriate.

The locations of the six WMO Regional Associations are shown in the Figure 1.

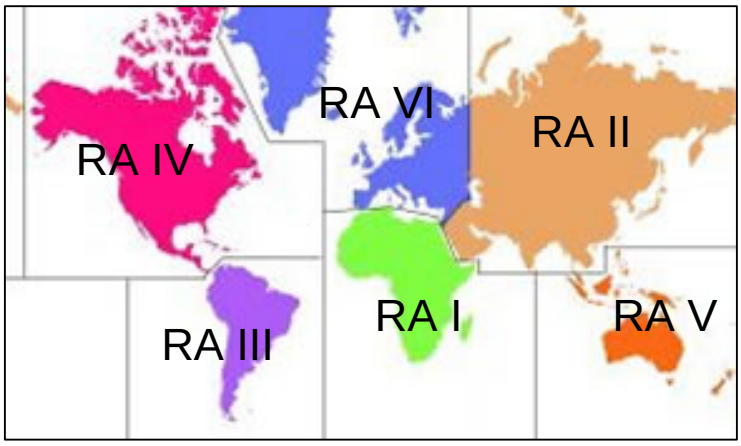

Figure 1 - WMO Regional Associations

3. PARTICIPATION IN THE SURVEY

3.1 General Comments on Total Participation

The number of actual responses received exceeded the number of WMO Members who responded. This is due to the fact that Members were encouraged to circulate the questionnaire to all relevant institutions within their country and subsequently some Members returned all responses directly to WMO without consolidating them at the national level. For the calculation of percentages only one answer from each Member is considered in case of multiple responses. The participation level for the 2008 edition was 83 Members out of a possible 188 (44%) which, while still relatively low, was higher than any previous edition except the very first in 1996 (45%).

In considering responses for all six editions of the questionnaire, a response for at least one edition has been received from 145 out of the total 188 WMO Members. Only seven members have answered all editions; however, out of the present 83 responses, 71 Members have answered at least one previous edition. This fact contributes to the significance of trends identified across editions.

[K1] **Key finding**: Forty-three (43) Members have never submitted a response, and only seven (7) Members have answered every edition.

[K2] **Key finding**: Total participation increased in comparison with previous editions following the adoption of some of the recommendations made to improve the response rate.

(R5) **Recommendation:** The possibility of issuing a second iteration of the questionnaire in the year x+1 (where x is the year of regular questionnaire) only for those countries that did not answer to the normal issue could be considered as a mechanism to increase overall participation and therefore increase the statistical validity of the analysis.

(R6) **Recommendation**: A specific targeted effort should be made to get questionnaire returns from those Members who have never responded in the past.

3.2 Participation Trends by Region

Tables 2a and 2b describe participation in percentage of total possible returns for all editions of the questionnaire broken down by WMO Region. (The number of Members per Region is referring to the status of WMO Membership after the ifteenth WMO Congress. The overall number of WMO Members (188) is not the sum of Members of all Regions (201) since some Members are present in several Regions).

WMO Region	Members in Region	2008	2006	2003	2001	1999	1996
RA I	56	18 (32%)	18 (32%)	8 (14%)	9 (16%)	15 (27%)	14 (25%)
RA II	35	16 (46%)	14 (40%)	13 (37%)	14 (40%)	14 (40%)	19 (54%)
RA III	13	6 (46%)	8 (61%)	5 (38%)	6 (46%)	6 (46%)	7 (54%)
RA IV	26	11 (42%)	9 (35%)	8 (31%)	6 (23%)	2 (8%)	6 (23%)
RA V	21	7 (33%)	6 (29%)	6 (29%)	7 (33%)	2 (10%)	8 (38%)
RA VI	50	33 (66%)	21 (42%)	25 (50%)	27 (54%)	22 (44%)	31 (62%)
ALL	**188**	**83 (44%)**	**76 (40%)**	**65 (35%)**	**69 (37%)**	**61 (32%)**	**85 (45%)**

Table 2a - Participation trends across questionnaire editions in each Region

WMO Region	Members in Region	At least one	At least two	At least three	At least four	At least five	All six
RA I	56	34 (61%)	21 (38%)	14 (25%)	8 (14%)	3 (5%)	1 (2%)
RA II	35	26 (74%)	22 (63%)	17 (49%)	12 (34%)	7 (20%)	4 (11%)
RA III	13	12 (92%)	11 (85%)	7 (54%)	4 (31%)	2 (15%)	2 (15%)
RA IV	26	15 (58%)	11 (42%)	7 (27%)	5 (19%)	2 (8%)	0 (0%)
RA V	21	14 (67%)	10 (48%)	5 (24%)	4 (19%)	2 (10%)	0 (0%)
RA VI	50	44 (88%)	38 (76%)	34 (68%)	22 (44%)	13 (26%)	7 (14%)
ALL	**188**	**145 (77%)**	**113 (60%)**	**84 (45%)**	**55 (29%)**	**29 (15%)**	**17 (9%)**

Table 2b - Participation trends across questionnaire editions in each Region

NOTE: Some WMO Members are present in more than one WMO Region (Colombia, France, Kazakhstan, Portugal, Russian Federation, Spain, United Kingdom, USA, Venezuela). Since most of these multi-regional Members did not break down their response per region, the following approach was adopted in this inquiry for evaluating the response rate per region: If such a Member indicated that its response was representing “the whole of a NMHS”, the response was counted in each of the Regions the Member is belonging to. However, for the following sections of the questionnaire that are pertaining to more technical aspects, if a single response was received it was assigned only to the Region where the Member has its capital city, unless mentioned otherwise by the Member in its reply.

(R7) Recommendation: For future editions more precise guidance should be given to those Members present in more than one WMO Region to allow a more accurate regional analysis.

An analysis of participation for each Region reveals the following facts:

RA I – The level of participation (32%) was the lowest of any Region. Only one Member has answered all six editions and 34 Members have answered at least one. Twenty-two Members have never responded. The relatively low return rate from RA I may be thought somewhat disappointing taking into account that all NMHSs of this Region have been equipped with a satellite data receiving facility in the context of the PUMA and AMESD projects.

RA II – The level of participation (46%) was the second highest, with all editions showing a similar level. Half of the Members have answered at least three editions and four Members have answered all six editions. Eight Members have never responded.

RA III – The level of participation (46%) was significantly lower than the previous edition, contrary to the overall trend. However, the significance of this change is low given the small numbers on Members in that Region. Nearly all Members have answered at least one edition and 85% have answered at least two, but only two have answered all six editions.
RA IV – The level of participation (42%) was the same as for the previous edition. However no Member has answered all editions and 11 Members have never responded.
RA V – The level of participation (33%) was the second lowest of any Region. No Member has answered all editions and seven Members have never responded.
RA VI – The level of Participation (66%) was the highest of all Regions. The level of participation of this Region has always been high and only six Members have never responded, while 68% have answered at least three editions.

[K3] **Key finding**: The level of response from RA VI was far higher than any other Region.

4. ACCESS TO SATELLITE DATA (Questionnaire Section 1)

Out of all the responses received just four Members indicated that they do not obtain satellite data from any source. Three of them have plans to obtain data in the next two years.

(R8) **Recommendation**: Members that do not have access to satellite data should be contacted and advice offered as to how to address this situation if appropriate.

4.1 Data Access Trends (Question 4)

Table 3 shows the extent to which access to satellite data and/or products changed in the WMO Regions over the period of the questionnaire. The percentage figures refer to the number of received responses to this question.

WMO Region	No significant change in data access	Slight increase in data access	Significant increase in data access	Slight decrease in data access	Significant decrease in data access
RA I	4	5	6	0	0
RA II	3	4	7	0	0
RA III	1	4	5	0	1
RA IV	3	1	6	0	0
RA V	1	4	2	1	0
RA VI	7	13	12	0	0
TOTAL (2008)	**19 (21%)**	**31 (34%)**	**38 (42%)**	**1 (1%)**	**1 (1%)**
TOTAL (2006)	11 (17%)	12 (19%)	38 (60%)	0 (0%)	2 (3%)

Table 3 - Data access trends in each Region

[K4] **Key finding**: 76% of the responding Members indicated an increase in satellite data access while only 2% reported a decrease. This is a very positive reflection of the efforts made over the past few years by several agencies to improve data access. In particular the significant increase reported from Members in RA VI proves the effectiveness of the EUMETCast-Europe service.

(R9) **Recommendation**: Those Members reporting a slight or significant decrease in data access should be contacted, the responses clarified if necessary and advice offered as to how to address this situation if appropriate.

4.2 Data Reception Mechanisms (Question 5)

Information about the data reception mechanisms was analyzed in isolation from the associated satellite type/name in recognition of the importance of this aspect. Comparisons with previous editions

of the questionnaire showing trends in this aspect are of particular interest and responses are summarized in Table 4 for each Region.

Data reception mechanism	WMO Region	2008	2006	2003	2001	1999	1996
Digital data disseminated via the satellite itself	**RA I**	**4**	12	5	6	9	9
	RA II	**9**	11	8	8	10	12
	RA III	**4**	6	3	4	5	3
	RA IV	**4**	2	3	2	1	2
	RA V	**5**	6	4	5	2	6
	RA VI	**17**	15	19	22	18	22
	All regions	**43**	52	42	47	45	54
Digital data disseminated via another satellite	**RA I**	**8**	16	3	1	0	0
	RA II	**4**	2	4	3	0	0
	RA III	**1**	2	0	1	0	0
	RA IV	**1**	2	1	0	0	0
	RA V	**1**	0	0	0	0	0
	RA VI	**23**	18	9	2	0	0
	All regions	**38**	40	17	7	0	0
Digital data received from a third party	**RA I**	**2**	3	0	0	0	0
	RA II	**1**	2	0	0	0	0
	RA III	**1**	1	0	0	0	0
	RA IV	**1**	4	0	0	0	0
	RA V	**3**	2	0	0	0	0
	RA VI	**6**	7	0	0	0	0
	All regions	**14**	19	0	0	0	0
Digital data obtained from the Internet	**RA I**	**1**	3	0	0	0	0
	RA II	**3**	4	0	0	0	0
	RA III	**1**	1	0	0	0	0
	RA IV	**5**	8	0	0	0	0
	RA V	**1**	3	0	0	0	0
	RA VI	**4**	5	0	0	0	0
	All regions	**15**	24	0	0	0	0
Analogue data disseminated via the satellite itself	**RA I**	**0**	3	2	5	13	11
	RA II	**1**	4	5	9	11	18
	RA III	**0**	0	1	4	5	6
	RA IV	**0**	0	4	4	1	3
	RA V	**0**	0	2	4	1	8
	RA VI	**1**	2	12	12	17	27
	All regions	**2**	9	26	38	48	73
Analogue data disseminated via another satellite	**All regions**	**0**	0	0	0	0	0
Analogue data received from a third party	**All regions**	**2**	1	0	0	0	0
Analogue data obtained from the Internet	**RA I**	**2**	2	0	0	0	0
	RA II	**3**	6	0	0	0	0
	RA III	**1**	1	0	0	0	0
	RA IV	**2**	1	0	0	0	0
	RA V	**1**	0	0	0	0	0
	RA VI	**3**	4	0	0	0	0
	All regions	**10**	14	0	0	0	0
Data received via the GTS	**RA I**	**1**	2	0	0	0	0
	RA II	**2**	2	1	1	0	0
	RA III	**0**	1	0	0	0	0
	RA IV	**1**	2	0	0	0	0
	RA V	**1**	1	2	0	0	0
	RA VI	**2**	3	3	4	0	0
	All regions	**7**	11	6	5	0	0

Table 4 - Data reception mechanism trends across questionnaire editions for each Region

An in-depth analysis of the data reception mechanisms in the different WMO regions and across successive editions of the questionnaire shows the following assessment and trends.

4.2.1 Digital data disseminated via the satellite itself (e.g. HRI, HRPT)

The total number of responses in this category shows a decline from the 2006 edition. The decline is present in most Regions but is especially noticeable in RA I which dropped from 12 responses in 2006 to just four in this edition. This is almost certainly due to the replacement of the Meteosat HRIT and LRIT services via direct broadcast with dissemination via EUMETCast along with the suspension of the HRPT and LRPT services from Metop-A.

4.2.2 Digital data disseminated via another satellite (e.g. EUMETCast)

The slight reduction in total responses in this category from 40 in the 2006 edition to 38 in the current edition is somewhat mysterious, especially given the tentative explanation to the decline in direct data reception from the satellite itself. The most significant reduction is in RA I whereas in RA VI there is a significant increase. It could be speculated that continued serviceability of the reception stations in RA I Member NMHS supplied under the PUMA / AMESD initiative may be in question.

[K5] Key finding: The use of DVB-S systems (e.g. EUMETCast) is the most widely used means to access satellite data in RA I and RA VI.

(R10) Recommendation: In future editions of the questionnaire the serviceability of existing reception systems could be explicitly queried as a possible cause for reduction in data reception capability.

4.2.3 Digital data received from a third party

There was a slight reduction in responses in this category in the current edition compared with the 2006 edition. This reduction occurred across almost all regions but there are no obvious contributory factors and it is in all probability too small to be significant.

4.2.4 Digital data obtained from the Internet

Once again there was a reduction in responses in this category in almost all Regions whereas other evidence might suggest an increase would be more likely.

4.2.5 Analogue data disseminated via the satellite itself (e.g. WEFAX)

The expected sharp reduction in the use of this reception mechanism observed over all editions is also evident here with only 2 responses. It may be expected that this mechanism plays no part in the future plans of NMHS and indeed it is absent from new generation satellites.

4.2.6 Analogue data disseminated via another satellite

Unsurprisingly there were no reports of the mechanism being used although, as described below, there may be some ambiguity about what Members perceive as “analogue data”.

4.2.7 Analogue data received from a third party

There were just two reports of this mechanism being used but it is not clear what precise form this data flow takes. It might also be the subject of a possible ambiguity in the understanding of “analogue data”.

4.2.8 Analogue data obtained from the Internet

There were 10 responses indicating the use of this mechanism, spread across all Regions. This is a similar number to the previous edition. However, it is not clear precisely what Members include in this

category. Taken literally, “Analogue data obtained from the Internet” is difficult to interpret. It is likely that it refers to graphical products rather than digital ones.

(R11) Recommendation: In future editions of the questionnaire the possible ambiguity regarding what constitutes “analogue” data should be removed by explanatory text and examples.

4.2.9 Data received via the GTS

There was a somewhat surprising reduction in this mechanism especially given that it has been increasing across previous editions, knowing also that Atmospheric Wind Vectors (SATOB) and Temperature and Humidity Soundings (SATEM) remain key products, that new instrument data and products are regularly added to the GTS and that the BUFR Code Tables are regularly updated to accommodate these new products. A reason for this apparent contradiction might be that the questionnaire only asks for one access means per satellite, and the respondent thus focuses on the main access means. Only a few respondents provided multiple replies to this question, and these replies generally included the GTS.

4.3 Data access by satellite name (Question 5)

Since the responses to this question involve combinations of satellite names and data access mechanisms, it is not straightforward to represent a breakdown by Region and a comparison with previous editions for each satellite in concise summary tables. In Table 5 totals are shown across all regions with percentage figures based on all responses (83).

Satellite type (1)	Satellite name	Digital data disseminated via the satellite itself	Digital data disseminated via another satellite	Digital data received from a third party	Digital data obtained from the Internet	Analogue data disseminated via the satellite itself	Analogue data disseminated via another satellite	Analogue data received from a third party	Analogue data obtained from the Internet	Data received via the GTS	TOTAL
I	**METEOSAT (0°)**	7	41	5	3	1	0	2	3	5	**67 (81%)**
I	**METEOSAT (57.5°E)**	5	28	1	1	0	0	0	3	4	**42 (51%)**
I	**GOES-E (75°W)**	10	26	5	5	0	0	0	4	2	**52 (63%)**
I	**GOES-W (135°W)**	7	25	4	3	0	0	0	2	2	**43 (52%)**
I	**MTSAT-1R (140°E)**	9	17	3	3	0	0	0	1	2	**35 (42%)**
I	**FY-2C (105°E)**	8	2	0	0	0	0	0	0	1	**11 (13%)**
I	**FY-2D (86.5°E)**	2	1	0	0	0	1	0	0	0	**4 (5%)**
I	**INSAT-3 (93.5°E)**	0	1	0	0	0	0	0	1	0	**2 (2%)**
I	**KALPANA-1 (74°E)**	0	0	0	1	0	0	0	3	0	**4 (5%)**
II	**NOAA series**	37	12	3	5	0	1	1	2	4	**65 (78%)**
II	**METOP series**	6	15	7	2	0	0	0	1	3	**34 (41%)**
II	**FY-1 series**	11	0	0	0	0	0	0	0	0	**11 (13%)**
III	**ERS series**	0	0	5	4	0	0	0	0	1	**10 (12%)**
III	**DMSP series**	0	0	4	6	0	0	0	0	3	**13 (16%)**
III	**SPOT series**	0	1	2	1	0	0	0	0	0	**4 (5%)**
III	**ENVISAT**	2	0	8	7	0	0	0	0	0	**17 (20%)**
III	**Quikscat**	0	0	8	7	0	0	0	2	2	**19 (23%)**
III	**Terra / Aqua**	8	1	7	8	0	0	0	3	2	**29 (35%)**
III	**TRMM**	0	0	1	3	0	0	0	4	0	**8 (10%)**
III	**JASON-1**	0	1	4	2	0	0	0	0	2	**9 (11%)**
III	**ALOS**	0	0	4	1	0	0	0	0	0	**5 (6%)**
III	**CBERS series**	0	0	1	1	0	0	0	0	0	**2 (2%)**

Table 5 - Satellites received with associated reception mechanisms

(1) Satellite types: I=operational geostationary satellite, II= operational low earth orbit satellite, III=R&D and other environmental (low earth orbit) satellites

An analysis of the different satellite types and the reception mechanisms reported shows the following assessment and trends.

4.3.1 Operational geostationary satellites (GEO)

Members confirmed that, for almost all GEO satellite systems, the most accessed data type is digital, and by far the most frequently used access mechanisms is digital data dissemination via another satellite, with this means becoming the most popular access means for all satellites except the FY-2 series for which the digital dissemination via the satellite itself is still the main way to access the data. These results, however, should be interpreted in the light of the high number of Members in RA I and RA VI that take advantage of the EUMETCast system (access to Meteosat data having the highest score) and that also includes the retransmission of data from satellites out of the Meteosat field of view (FOV). Access to analogue data disseminated via the satellite itself (e.g. WEFAX) has nearly disappeared, while some users still receive analogue (as well as digital data) via the Internet. Data received via a third party dissemination and via the GTS still accounts for very little of the accesses.

4.3.2 Operational low Earth orbit satellites (LEO)

A large majority of Members reported access to data from the NOAA series, while for the first time Metop data were included as a key element of the LEO constellation. The greatest reported accesses were by far those using digital data mechanisms such as HRPT disseminated via the satellite (for NOAA series and for FY-1). Digital dissemination from another satellite (EUMETCast) is the main way to access Metop data. Access to digital data via the Internet, the GTS and via third party accounts for some accesses, while just four Members still reported the use of analogue data compared with seven in the previous edition.

4.3.3 Research and Development (R&D) and other environmental satellites

The most often reported data type was digital data; but data received from a third party became the most frequent access mechanism cited by most Members, with the access to digital data via the Internet as a strong second. The R&D and environmental satellite category showed the highest number of responses for analogue data obtained from the Internet, data received via the GTS and data received from a third party. Data from Terra and Aqua was reported as the most widely received, followed by Quikscat, ENVISAT and DMSP data. The reduction in the access to TRMM data (just eight Members) was noteworthy.

4.4 Satellites which Members do not access but would like to receive (Question 5)

The indications of satellites which Members did not access, but would like to receive, were nearly equally shared between operational (106 responses) and R&D and other environmental satellites (111 responses). Adding the number of responses per satellite gave a ranking order for the top 10 most commonly mentioned satellites, taken across all Regions, as shown in Table 6.

A number of Members in most Regions would like to have access to data from geostationary satellites that provide coverage outside the Member's Region; in particular access to data from Meteosat at 57.5°E was widely mentioned by Members in RA II. Among other requests for operational satellite data, it was noted that access to data from Metop was highly prevalent in RA VI.

For R&D and other environmental satellites data from TERRA/AQUA and TRMM received the highest numbers of responses. The growing requests for SPOT data are noteworthy, especially from RA III.

Ranking (2008)	Ranking (2006)	Satellite(s)	Total Responses
1	--	METOP series	27
2=	4	Terra / Aqua	18
2=	1	TRMM	18
4	2	NOAA series	16
5	--	SPOT series	15
6	5	ENVISAT	12
7=	3	ERS series	11
7=	9=	FY-1 series	11
9=	--	Meteosat (57.5°E)	10
9=	--	Quikscat	10
		Others	<10

Table 6 - Satellites that Members do not receive but would like to receive

[K6] Key finding: Responses to which satellites Members did not access but would like to have are equally shared between operational and R&D and other environmental satellites.

[K7] Key finding: Request from SPOT data from RA III show a significant increase from previous editions.

[K8] Key finding: Access to Metop data is by far the most requested improvement for data availability.

5. USE OF SATELLITE DATA AND PRODUCTS (Questionnaire Section 2)

5.1 Data processing and usage (Question 6)

Table 7 shows numbers of responses on data processing and usage taken across all Regions.

	Data / product used	Produced in your country		Produced elsewhere		Used in NWP model	
		(2008)	(2006)	**(2008)**	(2006)	**(2008)**	(2006)
Level 1 data	**Image data rendered graphically**	**46**	48	**27**	24	**0**	1
	Imager data used quantitatively	**49**	45	**34**	27	**9**	7
	Sounder data	**24**	20	**25**	18	**18**	12
	Other level 1 data	**5**	1	**5**	0	**2**	2
Level 2 / Level 3 products	**Atmospheric Motion Vectors**	**18**	18	**43**	30	**12**	12
	Temperature / humidity profiles	**27**	28	**30**	24	**9**	8
	Cloud products	**43**	36	**36**	32	**7**	6
	Sea surface products	**28**	27	**41**	23	**9**	10
	Land surface products	**27**	27	**26**	19	**7**	12
	Precipitation products	**28**	26	**38**	29	**7**	7
	Other level 2 / level 3 products	**11**	14	**10**	6	**5**	3

Table 7 - Data processing and usage

[K9] Key finding: Reported data processing and usage increased in most categories when compared to the 2006 edition. The most significant changes are the increased use of Level 2 products

produced outside the respondent's country, especially Atmospheric Motion Vectors, Sea surface products, Precipitation products and Land Surface Products.

5.2 Distribution to Other Users (Question 7)

There were more respondents who indicated that they distribute satellite data to other users (54) than those who noted they are not doing so (32). Only for RA I was the number of "No" responses the same as the "Yes" responses. This indicates that the NMHSs are not only using satellite data and/or products for their own purposes but they commonly make them available also to other users.

5.3 Limiting Factors in the Use of Satellite Data and Products (Question 8)

Table 8 describes the occurrences of various factors limiting the use of satellite data and products. Percentages are based on the total number of answers to this question in order to compare with the previous edition.

WMO Region	No significant limiting factors	Insufficient knowledge	Technical difficulties	Financial difficulties	Other reasons
RA I	3	6	9	9	2
RA II	3	6	7	8	1
RA III	4	4	6	6	0
RA IV	1	4	4	7	1
RA V	1	5	4	4	2
RA VI	9	10	12	15	6
TOTAL (2008)	**21 (13%)**	**35 (22%)**	**42 (26%)**	**49 (31%)**	**12 (8%)**
TOTAL (2006)	11 (8%)	34 (24%)	51 (36%)	44 (31%)	N/A

Table 8 - Limiting factors in data usage for each Region

[K10] Key finding: The most frequently reported limiting factor in the use of satellite data and products was financial difficulties, reported by about 30% of responses, followed by technical difficulties, reported by 26%. This is a change in comparison to the 2006 edition of the questionnaire where technical difficulties were reported most frequently as the primary limiting factor.

[K11] Key finding: In comparison to the 2006 edition of the questionnaire, a positive trend can be seen in the number of responses indicating no significant limiting factors in the use of satellite data and products with an increase from 8% in 2006 to 13% in 2008.

Three responses, all from RA VI, indicated the following "Other Reasons" as limiting factors in data usage: insufficient number of staff; economy and the resulting [limited] number of employees working in the fields [of satellite data usage]; lack of resources. These three reports are considered as variants of the category "financial difficulties" which is anyhow the most frequently reported limiting factor influencing the use of satellite data and products.

[K12] Key finding: Despite the positive trend, the number of reported limitations in the use of satellite data and products in 2008 is still high with 87% reporting some limiting factors.

(R12) Recommendation: Improving satellite data usage among Members should be addressed by focussing on reducing the most commonly stated limiting factors. Measures could include:

- For financial limitations and technical difficulties:
  - Distribute information to Members (via a newsletter for example) to describe the potential benefits associated with satellite data usage and how these benefits can be realized via a targeted commitment of resources;

  - Encourage the (further) development and implementation of schemes for cooperation and networking in order to share the workload of processing of satellite data; establish shared services to the benefit of all Members of such a cooperation network.
- For insufficient knowledge:
  - Encourage and foster the development and delivery of effective education and training in satellite data usage focussing on realizing the benefits that are available;
  - Ensure Members are aware of Internet-based training opportunities and encourage their participation recognizing that this itself requires a commitment of certain resources and is therefore linked to the question of financial limitations.

5.4 Change in usage by Region (Question 9)

Table 9 shows the extent to which usage of satellite data and/or products changed in Regions over the period of the questionnaire. The percentage figures refer to the number of received responses to this question.

WMO Region	No significant change in data usage	Slight increase in data usage	Significant increase in data usage	Slight decrease in data usage	Significant decrease in data usage
RA I	3	4	9	0	0
RA II	3	5	6	0	1
RA III	2	3	6	0	0
RA IV	3	2	5	0	0
RA V	1	3	3	1	0
RA VI	5	11	15	0	0
TOTAL (2008)	**17 (19%)**	**28 (31%)**	**44 (48%)**	**1 (1%)**	**1 (1%)**
TOTAL (2006)	15 (19%)	22 (27%)	42 (53%)	0 (0%)	1 (1%)

Table 9 - Change in data usage over the period of the questionnaire for each Region

[K13] Key finding: The number of responses indicating a decrease in the use of satellite data and products is now very low. The level responses indicating no significant change (19%) is almost unchanged in comparison to the 2006 edition as is the level of responses reporting an increase in data usage (79%). This indicates that there is a rather consistent continuous overall increase in satellite data and product usage.

(R13) Recommendation: Those Members reporting a slight or significant decrease in data usage should be contacted, the responses clarified if necessary and advice offered as to how to address this situation if appropriate.

6. APPLICATIONS OF SATELLITE DATA AND PRODUCTS (Questionnaire Section 3)

6.1 Most important of the available parameters (Question 10)

6.1.1 General Tendencies

In the interpretation of the trends related to the satellite-derived parameters for the different meteorological applications it should be noted that only 49 Members out of the 83 returning the questionnaire, answered in the previous edition, while only 45 of the Members who responded to the 2006 edition also responded to the 2003 edition. Moreover, since the last edition of the questionnaire; the formulation of the questions has been slightly modified and some new parameters added. However, it is felt that the statistics related to the applications result in a relatively clear picture of the general trends in the use of geophysical parameter for the different applications.

As a general tendency the cloud related parameters are still considered as the most used and critical for meteorological applications. Five cloud parameters are listed in the first seven places of the parameter list, with precipitation rate and SST at the fifth and sixth place respectively, accounting for more than 50% of the total indications. This is in line with the result of the previous edition, showing that the cloud imagery and the other cloud related parameters are still the most used for most applications.

Regarding other parameters, an increase in those related to land and sea monitoring (such as fires, snow cover, sea ice cover, significant wave height) was evident as well as atmospheric chemistry and radiative transfer (such as aerosol and imager and sounder radiances). Trace gases, sea ice cover and sounder radiances are new entries in the top 30 parameters, while less nominations were given for those parameters that are still not available or not available with the requested accuracy and/or resolution, such as rain profile, atmospheric instability index, soil moisture, ocean currents and lightning detection. Not unsurprisingly, most of these parameters are also in the top area of the list of most required parameters (see Section 6.2).

6.1.2 Most important parameters in each application area

Table 10 describes the distribution of the most important parameters for each application area. To restrict the table size, parameters with less than 14 reports are excluded although these may nevertheless be significant in application areas with naturally low numbers of responses or where reports were widely but thinly spread. However it should be noted that the parameters considered in the table (30 out of 55 listed parameters) accounted for more than 90% of the total number of the responses.

Ranking (2008)	Ranking (2006)	Parameter	Nowcasting & VSRF	Synoptic meteorology	Global and Regional NWP	Aeronautical Meteorology	Marine Meteorology	Agricultural Meteorology	Hydrology	Atmospheric Chemistry	Climatology & climate change	Environmental Applications	Disaster monitoring and security	Research applications	Public Weather Service (PWS)	TOTAL
1	1	**Cloud imagery**	**38**	**49**	2	**28**	9	7	11	1	5	2	14	**13**	**40**	**219**
2	2	**Cloud cover**	28	18	3	13	1	2	6	0	9	3	3	7	18	**111**
3	5	**Cloud top temperature**	28	29	5	16	2	2	5	0	2	1	4	5	9	**108**
4	3	**Cloud type**	19	23	1	22	2	3	2	0	2	0	4	2	11	**91**
5	4	**Precipitation rate**	9	4	2	2	1	11	**21**	0	3	1	15	4	9	**82**
6	6	**Sea surface temperature**	1	7	5	1	**25**	0	2	1	**17**	8	0	6	4	**77**
7	8	**Cloud top height**	6	14	2	20	0	0	0	0	4	0	2	2	3	**53**
8	16	**Wind vector over sea surface**	5	6	5	2	21	0	0	0	0	0	6	3	3	**51**
9	7	**Wind profile**	5	9	5	12	2	1	2	1	2	0	4	6	1	**50**
10	11	**Fires**	0	0	0	0	0	5	0	1	1	**10**	**19**	1	4	**41**
11	9	**Temperature profile**	3	3	8	8	1	1	1	1	8	3	0	3	0	**40**
12	17=	**Snow cover**	0	1	2	0	0	4	12	0	5	4	0	3	2	**33**
13	12	**Norm. Diff. Veg. Index (NDVI)**	0	0	0	0	0	**21**	0	0	0	6	1	3	0	**31**
14	19=	**Aerosol total column**	1	1	2	2	1	1	1	7	2	7	1	2	2	**30**
15=	10	**Atmospheric Instability Index**	12	7	0	1	1	0	0	0	1	0	1	1	3	**27**
15=	23	**Land surface temperature**	2	4	1	0	0	8	0	0	4	2	0	1	5	**27**
17	13	**Precipitation index**	1	1	1	0	1	4	6	0	4	1	2	2	2	**25**
18	19=	**Volcanic ash**	0	0	1	10	0	0	0	3	0	4	6	0	0	**24**
19	19=	**Ozone Profile**	0	0	1	0	0	0	0	10	3	6	0	2	1	**23**
20	15	**Wind speed over sea surface**	1	1	0	1	13	0	0	0	1	0	1	2	1	**21**
21=	25=	**Significant wave height**	0	0	0	0	17	0	0	0	1	1	1	0	0	**20**
21=	25=	**Imager radiances**	0	1	7	0	1	1	0	1	1	3	0	4	1	**20**
23	**--**	**Trace gases**	0	0	0	0	0	0	0	**10**	0	5	2	1	0	**18**
24	17=	**Cloud base height**	3	4	0	8	0	0	0	0	1	0	0	0	1	**17**
25=	19=	**Land cover**	0	0	0	0	0	6	3	0	1	2	2	2	0	**16**
25=	14	**Rain Profile**	1	0	3	0	0	1	3	0	1	1	2	2	2	**16**
27	25=	**Soil moisture**	0	0	2	0	0	5	6	0	0	1	0	1	0	**15**
28=	24	**Ozone total column**	0	0	1	0	0	0	0	7	1	4	0	0	1	**14**
28=	--	**Sea ice cover**	0	0	0	0	9	0	1	0	3	1	0	0	0	**14**
28=	**--**	**Sounder radiances**	0	0	**11**	0	0	0	0	0	0	0	0	3	0	**14**
		Others														**<14**

Table 10 – Most important parameters for each application area (top 30 parameters) The ranking is based on the column "TOTAL " where all applications are considered together. In the previous 13 columns, the best ranked parameter for each application is indicated in bold.

The analysis shows the top four parameters considered most important for most application areas are cloud field parameters with precipitation rate and sea surface temperature being the next most important. In particular, cloud imagery ranks first in five out of 13 application areas. The responses indicate a wide set of Mandatory parameters for some application areas. For other areas namely Nowcasting, Synoptic meteorology, Aeronautical meteorology, Disaster monitoring and Public Weather

Service some parameters are considered mandatory by more than 50% of the respondents. These parameters are among the first ten of the list in Table 10.

[K14] Key finding: Three parameters related to clouds were clearly rated as of highest importance overall, in the following ranking order: cloud imagery, cloud cover, and cloud type. Cloud imagery ranked first in five application areas. Precipitation rate was the highest parameter outside the area of cloud detection/analysis.

6.2 Required but not available parameters (Question 10)

In nearly all of the application areas, some of the parameters selected as "required but not available" are also listed in the top of the most important parameter lists. Where the same parameter was reported by the same Member as being most important and also required but not available, this is taken to imply that the non-availability is due to insufficient accuracy, timeliness or resolution. But, if the responses were from different Members, there is no clear implication to be drawn. In any case the inclusion of a specific parameter in both lists is a clear indication that that parameter is considered of outmost importance for the different applications.

(R14) Recommendation: In future editions of the questionnaire the question concerning application should be restructured to enable the distinction between parameters which are required and available, those which are required but not *adequate* in terms of accuracy, timeliness or resolution, and those which are not available at all.

Taken across all application areas and all Regions, adding the occurrences of parameters reported as "required but not available" gives the ranking order shown in Table 11, where the top 24 nominated parameters are shown (accounting for 75% of the total number of answers).

Ranking (2008)	Ranking (2006)	**Parameter**	**Responses**
1	1	Precipitation rate	114
2	18=	Wind speed over sea surface	76
3	14=	Trace gases	71
4	2	Lightning Detection	69
5=	4	Atmospheric Instability Index	52
5=	6=	Precipitation index	52
7	11=	Specific humidity profile	51
8=	9	Cloud base height	44
8=	6=	Rain Profile	44
10	10	Aerosol total column	37
11	11=	Ozone Profile	35
12	--	Specific humidity total column	34
13	20=	Wave period/direction	32
14	--	Snow melting conditions	28
15	22=	Cloud water profile	25
16=	--	Cloud type	24
16=	--	Tropopause temperature	24
18	14=	Ocean currents	23
19=	13	Fires	22
19=	18=	Land surface temperature	22
21	--	Volcanic ash	21
22=	14=	Sea surface temperature	20
22=	3	Wind profile	20
22=	--	Norm. Diff. Veg. Index (NDVI)	20
		Others	<20

Table 11 - Most required but not available parameters (top 24 parameters)

[K15] Key finding: Precipitation rate, lightning detection and atmospheric instability index are included in the top five parameters in both the current and the last edition.

[K16] Key finding: Precipitation rate, ranked fifth of the most important parameters, is also confirmed with a large number of responses as the overall most required but not available parameter. With precipitation index ranked fifth of the required parameters, this indicates that the knowledge of the precipitation field is still the most critical area of present usage where future improvements should be particularly sought.

[K17] Key finding: Wind speed over sea surface, which is ranked second as most required but unavailable parameter, was only ranked eighteenth in this category in the 2006 edition. In the same time, wind profile dropped down from position 3 to position 22, which is a surprise, bearing in mind that wind profiles would be a very important parameter for NWP models, the reasons for that drop are not clear.

[K18] Key finding: Trace gases, ranked third in the list of most required but unavailable parameters, are considerably more in demand than in the previous edition (ranked fourteenth in 2006), indicating a growing interest in the application linked to atmospheric chemistry, air quality and environment.

(R15) Recommendation: Careful note should be taken of the parameters most commonly indicated as required but not available and the pertinent information regarding unfulfilled requirements should be brought to the attention of satellite operators.

(R16) Recommendation: Considering the implications of low- and mid-level dust, smoke and aerosols in weather services that address such issues as human health, environmental and air traffic hazards, its potential inclusion as a separate parameter should be investigated for future editions.

7. TRAINING IN SATELLITE METEOROLOGY (Questionnaire Section 4)

7.1 Training in each Region (Question 11)

The analysis of responses has been limited to tabulating the number of reported staff trained per institution per Region and the number of staff trained per skill per Region, as shown in Tables 12 and 13 respectively. The percentage figures refer to the number of received responses to this question.

7.1.1 Number of staff trained by institution

WMO Region	RTC	WMO (other than RTC)	University / Industry	Internal	Bilateral Agreement other NMHS	Other
RA I	71	1	17	49	4	41
RA II	19	1	12	631	6	6
RA III	8	21	10	36	18	9
RA IV	0	8	2	70	15	25
RA V	59	27	28	204	0	0
RA VI	4	89	145	1030	216	278
TOTAL (2008)	**161 (5%)**	**147 (5%)**	**214 (7%)**	**2020 (64%)**	**259 (8%)**	**359 (11%)**
TOTAL (2006)	324 (5%)	145 (2%)	195 (3%)	6103 (86%)	173 (2%)	176 (2%)

Table 12 - Number of staff trained by institution for each Region

7.1.2 Number of staff trained by skill

WMO Region	Equipment, operation, maintenance	Software development	Physical basis for remote sensing	Satellite image interpretation	Other
RA I	22	12	26	120	13
RA II	179	38	121	333	4
RA III	10	7	27	53	5
RA IV	3	4	87	25	1
RA V	26	16	102	174	0
RA VI	203	16	387	1121	35
TOTAL (2008)	**443 (14%)**	**93 (3%)**	**750 (24%)**	**1826 (58%)**	**58 (2%)**
TOTAL (2006)	758 (11%)	153 (2%)	1807 (25%)	2962 (42%)	1436 (20%)

Table 13 - Number of staff trained by skill for each Region

[K19] Key finding: Direct comparisons of total numbers of staff trained with those from the 2006 edition are not very meaningful since the latter were significantly inflated by a few extremely high figures and were probably not truly representative.

As regards “Other training institutions” (see Table 12) the following was reported several times: “training on the job / on-site training”, “EUMETSAT VisitView distance learning lectures” and “training courses by EUMETSAT”.

[K20] Key finding: As in previous years, the largest numbers of staff who underwent training were trained by internal training mechanisms; this is valid for all WMO Regions. The next most reported training method is training in cooperation with other NMHS or RTC. Training at RTC is of specific relevance for RA I, II and V.

The most important training area is satellite image interpretation, followed in most of the Regions by physical bases for remote sensing and training on the use and maintenance of technical equipment.

7.2 Training Methods (Question 11)

The analysis of responses has been limited to tabulating the number of responses per skill per training method, as shown in Table 14. The percentage figures refer to the number of received responses to this question.

Skill	Classroom based presentations	Computer Assisted Learning (CAL)	Distance learning	Other
Equipment operation and maintenance	25	8	1	4
Software development	15	5	2	3
Physical basis of remote sensing	34	14	7	1
Satellite image interpretation	66	36	20	5
Other	5	0	2	1
TOTAL (2008)	**145 (57%)**	**63 (25%)**	**32 (13%)**	**14 (5%)**
TOTAL (2006)	119 (56%)	66 (31%)	17 (8%)	11 (5%)

Table 14 - Training methods employed

57% of the responses indicated use of classroom based training, an almost identical percentage to the 2006 edition. The figure indicating Computer Assisted Learning decreased from 31% in the 2006

edition to 25% reported in this edition. This is however compensated by an increase of Distance Learning from 8% in 2006 to 13% reported in 2008.

[K21] Key finding: Classroom training remains the most frequently reported training method with distance learning increasing significantly since the previous edition. This could be interpreted as a positive effect from the WMO/CGMS High Profile Training Event (HPTE) of 2006.

7.3 Virtual Laboratory Usage Reported from each Region (Questions 12 and 13)

Table 15 shows the awareness and usage of the Virtual Laboratory (VL) reported from each Region. The "Aware" and "Not Aware" percentages are based on total answers to this question (62+32=94) whilst the percentages for the use of the VL are based on number reported aware (62). This is consistent with previous edition and enables a meaningful comparison.

WMO Region	Aware of the VL	Not aware of the VL	Regularly use the VL	Occasionally use the VL	Never use the VL
RA I	9	8	N/A	N/A	N/A
RA II	9	6	N/A	N/A	N/A
RA III	7	4	N/A	N/A	N/A
RA IV	6	4	N/A	N/A	N/A
RA V	6	2	N/A	N/A	N/A
RA VI	25	8	N/A	N/A	N/A
TOTAL (2008)	**62 (66%)**	**32 (34%)**	**8 (13%)**	**35 (56%)**	**19 (31%)**
TOTAL (2006)	58 (70%)	25 (30%)	14 (24%)	26 (45%)	18 (31%)

Table 15 - Awareness and usage of the VL for each Region

Note. A breakdown of VL usage by Region was not feasible.

[K22] Key finding: Very surprisingly the awareness of the VL and regular use of the facility have both slightly decreased (in percentage terms) since the previous edition, although occasional use has increased. It is not straightforward to explain this phenomenon except to speculate that some of the previous momentum of the VL implementation may have been lost although in principle it might have been expected that the WMO/CGMS High Profile Training Event (HPTE) would have brought such momentum.

7.4 Limiting Factors in Education and Training in each Region (Question 14)

Table 16 shows the limiting factors in Education and Training in satellite meteorology for each Region. The percentage figures refer to the number of received responses to this question.

WMO Region	No significant limiting factors	Insufficient access to opportunities	Technical difficulties	Financial difficulties	Other reasons
RA I	1	7	4	11	3
RA II	4	5	3	9	1
RA III	4	5	4	7	0
RA IV	2	5	2	6	0
RA V	2	3	1	3	3
RA VI	9	8	6	16	8
TOTAL (2008)	**22 (15%)**	**33 (23%)**	**20 (14%)**	**52 (37%)**	**15 (11%)**
TOTAL (2006)	13 (9%)	33 (23%)	27 (19%)	56 (39%)	14 (10%)

Table 16 - Limiting factors in education and training for each Region

[K23] Key finding: The most commonly reported limiting factor in the education and training in satellite meteorology was financial difficulties, reported by 37% of responses.

(R17) Recommendation: NMHSs should be made more aware of the existence and benefits of web-based training material for self-learning purposes and of web-based distant learning possibilities (e.g. EUMeTRAIN) since such training methods do not require specific financial resources.

7.5 Changes in Education and Training in each Region (Question 15)

Table 17 shows the extent to which Education and Training in satellite meteorology changed in Regions over the period of the questionnaire. The percentage figures refer to the number of received responses to this question.

WMO Region	No significant change in staff training	Slight increase in staff training	Significant increase in staff training	Slight decrease in staff training	Significant decrease in staff training
RA I	6	10	0	1	0
RA II	6	4	2	0	3
RA III	2	6	3	0	0
RA IV	6	3	1	0	0
RA V	7	0	1	0	0
RA VI	9	14	8	1	0
TOTAL (2008)	**36 (39%)**	**37 (40%)**	**15 (16%)**	**2 (2%)**	**3 (3%)**
TOTAL (2006)	30 (37%)	30 (37%)	15 (19%)	4 (5%)	2 (2%)

Table 17 - Change in level of training over the period of the questionnaire for each Region

[K24] Key finding: 56% of respondents reported increased training while only 5% reported less. These percentages are nearly identical with those reported two years before, thus the increase in training is consolidated and efforts expended in focussing on this very important area continue to be effective.

(R18) Recommendation: Those Members reporting a slight or significant decrease in staff training should be contacted, the responses clarified if necessary and advice offered as to how to address this situation if appropriate.

8. GENERAL COMMENTS (Questionnaire Section 5)

8.1 Additional comments on the various topics

The 2008 edition of the questionnaire included the possibility for Members to provide additional information and comments. Where relevant, comments have been taken into account in the previous sections of this document. The free text information should be considered carefully as this may contain important messages from the individual institutions. Some of the free text responses provide details to given answers, others explain the plans for the future, but most important are reported problems. The following points were been mentioned explicitly:

- Regarding utilization of satellite data and products:
  - Insufficient number of staff;
  - Lack of resources.

- Regarding training:
  - Still more training needed;
  - There have never been training and education in satellite equipment due to lack of funding;

  - Technicians were trained by the equipment supplier for only a couple of days; no skilled staff;
  - Lack of resources for further training;
  - We need software to process NOAA and EUMETCast data and training in use;
  - We have improvement of satellite systems but have restrictions on equipment and training;
  - Limiting factor influencing E&T: no foreign languages for staff.

- Regarding applications:
  - Limiting factor for more work, education, applications, etc. is financial and the resulting [limited] number of employees working in these fields.

- Regarding working conditions:
  - Experts in satellite meteorology are overloaded;
  - Training opportunities are often limited by operational constraints.

8.2 Comments on the questionnaire itself

This section also invited suggestions for improving the questionnaire. There was only one specific proposal as follows:

- Language of the questionnaire should be in the official language of the WMO Member State.

The sentiment of this suggestion was reflected in other ways, for example, some of the respondents provided clear text information in another language (French, Spanish) rather than in English which was the language use in the questionnaire.

[K25] Key finding: As only one comment was submitted concerning the questionnaire itself, it may be concluded that the current form, content and means for access and return are acceptable.

(R19) Recommendation: It should once again be considered whether future editions of the questionnaire could be provided in all official WMO languages as a potential means for increasing the return rate. It is recognized, however, that this is a very time consuming process which would have to be started in good time so as not to delay the publication of the next edition.

APPENDIX A

W O R L D M E T E O R O L O G I C A L O R G A N I Z A T I O N

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2008 QUESTIONNAIRE ON THE AVAILABILITY AND USE OF SATELLITE DATA AND PRODUCTS

INTRODUCTORY NOTE

This questionnaire is distributed to all WMO Members every two years. Its purpose is to monitor the availability and use of existing satellite data and products and to identify any associated difficulties or limiting factors. In addition it invites WMO Members to identify needs for new or improved satellite data and products. This edition of the questionnaire covers the two-year period 2006-2007. The responses to the questionnaire are analyzed by the WMO Space Programme Office and the results are used to influence the evolution of the space-based component of the Global Observing System (GOS).

The analysis of previous editions of the questionnaire can be accessed at http://www.wmo.int/pages/prog/sat/Questionnaire/Questionnaire.html

The questionnaire has four sections covering the following subjects:

Section 1 The way in which satellite data and products are accessed by your Organization;

Section 2 The way in which satellite data and products are used in your Organization;

Section 3 Geophysical parameters retrieved from satellite data that are important or potentially important in various application areas in your Organization;

Section 4 The involvement of your Organization in education and training in satellite meteorology.

All questions should be answered if applicable but it is particularly important that you provide a response to the questions on trends and limitations (i.e. Questions 3 & 4 (if applicable), Questions 8 & 9 and Questions 14 & 15).

If you select the option “Other(s)” for any question please use the free text Section 5 to indicate what is meant in those cases.

Please enter your details below.

Name of Country:

Does this response represent the whole National Meteorological and Hydrological Service (NMHS) or just part of it (when several responses are prepared within a NMHS) or an external entity? (1)
[Please check only one box]

The response represents the whole NMHS ☐ or an organizational part of the NMHS ☐ or an external entity ☐

What is the name of your Organization? [(1)]

[(1)] *If the response is the unique return from a WMO Member, then the answers in the following pages shall refer to the whole NMHS, whereas if a WMO Member organizes the response to be provided from different organizational units (e.g. regional services), then the answers should only refer to each individual organizational unit responding. Consolidation will be made by WMO if necessary. The word "Organization" is used in the questionnaire to mean either the whole NMHS, or one of its organizational parts, or an individual external entity, as appropriate.*

SECTION 1 – ACCESS TO SATELLITE DATA AND PRODUCTS

Question 1 **Does your Organization routinely obtain satellite data and products from any source?**
Select one from these drop-down selections ⟶ **CLICK FOR OPTIONS ...**

If you answered **"Yes"** to Question 1 please jump directly to Question 4.
If you answered **"No"** to Question 1 please proceed with Question 2.

Question 2 **Do you have plans to routinely obtain satellite data and/or products for use in your Organization in the next two years?**
Select one from these drop-down selections ⟶ **CLICK FOR OPTIONS ...**

If you answered **"Yes"** to Question 2 please now proceed directly to SECTION 2 - USE OF SATELLITE DATA AND PRODUCTS below and your responses to that section should reflect your planned data reception.

However, if you answered **"No"** to Question 1 and Question 2, please answer Question 3 below and then jump to SECTION 4 - EDUCATION AND TRAINING.

Question 3 **Please complete Table 1 below to indicate what is/are the primary reason(s) that your Organization does not access satellite data and/or products.**
[Check one or more boxes]

Table 1

Reason	
We have no identified need for satellite data and products	☐
We have insufficient knowledge of what satellite data and products are available	☐
We have no satellite data reception capability	☐
We have technical difficulties preventing access to satellite data and products	☐
We have financial difficulties preventing access to satellite data and products	☐
Other reasons (describe in Section 5)	☐

Question 4 **Please indicate the extent to which access to satellite data and/or products has changed in your Organization over the past 2 years (2006-2007).**

Select one from these drop-down selections → **CLICK FOR OPTIONS ...**

Question 5 **Please indicate in Table 2 below which satellites you RECEIVE data from and which satellites you do NOT receive data from but WOULD LIKE to. For the data you do receive please indicate the corresponding reception mechanism by using the codes shown in the table on the right.**

[Check one or more boxes]

Table 2

Sat. type	Satellite name	Indicate below if data are RECEIVED	Reception mechanism (enter code values from table on the right)	Indicate below if data are NOT received but you WOULD LIKE to receive
Operational geostationary satellites	METEOSAT (0°)	☐		☐
	METEOSAT (57.5°E)	☐		☐
	GOES-E (75°W)	☐		☐
	GOES-W (135°W)	☐		☐
	MTSAT-1R (140°E)	☐		☐
	FY-2C (105°E)	☐		☐
	FY-2D (86.5°E)	☐		☐
	INSAT-3 (93.5°E)	☐		☐

Use the code values below to indicate the reception mechanism

Code	Reception mechanism
1	Digital data disseminated via the satellite itself (e.g. HRI, HRPT)
2	Digital data disseminated via another satellite (e.g. EUMETCast)
3	Digital data received from a third party
4	Digital data obtained from the Internet
5	Analogue data disseminated via the satellite itself (e.g. WEFAX)
6	Analogue data disseminated via another satellite
7	Analogue data received from a third party
8	Analogue data obtained from the Internet

	KALPANA-1 (74°E)	☐		☐
	Others (describe in Section 5)	☐		☐
Operational low earth orbiting satellites	NOAA series	☐		☐
	METOP series	☐		☐
	FY-1 series	☐		☐
	Others (describe in Section 5)	☐		☐
R/D & other environmental satellites	ERS series	☐		☐
	DMSP series	☐		☐
	SPOT series	☐		☐
	ENVISAT	☐		☐
	Quikscat	☐		☐
	Terra / Aqua	☐		☐
	TRMM	☐		☐
	JASON-1	☐		☐
	ALOS	☐		☐
	CBERS series	☐		☐
	Others (describe in Section 5)	☐		☐

9	Data received via the GTS
10	Other (describe in Section 5)

Note: Summary status information on satellite programmes can be found via the WMO Space Programme web pages at … http://www.wmo.int/pages/prog/sat/Satellites.html … where, in tables of current Geostationary, Low-Earth orbit and R&D satellites, there are also links to web sites describing satellite missions in more detail.

SECTION 2 – USE OF SATELLITE DATA AND PRODUCTS

Question 6 **Please indicate in Table 3 below how satellite data and products are used in your Organization.**
[Check one or more boxes]

Table 3

	Data / products used	Produced in your country	Produced elsewhere	Specify if used by assimilation in NWP model
Level 1 data (2)	Image data rendered graphically	☐	☐	N/A
	Imager data (VIS, IR, Microwave) used quantitatively	☐	☐	☐
	Sounder data	☐	☐	☐
	Other level 1 data (describe in Section 5)	☐	☐	☐
Level 2 / level 3 products (2)	Atmospheric Motion Vectors	☐	☐	☐
	Temperature / humidity profiles	☐	☐	☐
	Cloud products	☐	☐	☐
	Sea surface products	☐	☐	☐
	Land surface products	☐	☐	☐
	Precipitation products	☐	☐	☐
	Other level 2 / level 3 products (describe in Section 5)	☐	☐	☐

(2) *Level 1 data are basic instrument data, possibly having undergone calibration, earth location and/or quality control correction, usually expressed in radiance or brightness temperature units. Level 2 products are earth located, derived geophysical parameters based on the processing of level 1 data (and possibly also using ancillary data) and Level 3 products are gridded point geophysical products, possibly on a multi-pass or multi-sensor basis.*

Question 7 **Do you distribute satellite data and/or products to others?**

Select one from these drop-down selections ⟶ **CLICK FOR OPTIONS ...**

Question 8 **Please indicate in Table 4 below what is/are the primary limiting factor(s) in your Organization influencing your usage of satellite data and products.**

[Check one or more boxes]

Table 4

Reason	
We can identify no significant limiting factors	☐
We have insufficient knowledge of how to use some data and/or products	☐
We have technical difficulties limiting the use of satellite data and products	☐
We have financial difficulties limiting the use of satellite data and products	☐
Other reasons (describe in Section 5)	☐

Question 9 **Please indicate the extent to which use of satellite data and products has changed in your Organization over the past 2 years (2006-2007).**

Select one from these drop-down selections ⟶ **CLICK FOR OPTIONS ...**

SECTION 3 – APPLICATIONS OF SATELLITE DATA AND PRODUCTS

Question 10 **For each application area in Table 5 below, please indicate, using the codes from the table on the right, the most important geophysical parameters (up to three) relevant to the activities of your Organization and those parameters (up to three) that you would like to use but are not available [(3)].**

Table 5

Application area	Most important of the available parameters	Most required but not available [3] parameters
Nowcasting & VSRF		
Synoptic meteorology		
Global and regional NWP data assimilation		
Aeronautical meteorology		
Marine meteorology		
Agricultural meteorology		
Hydrology		
Atmospheric chemistry		
Climatology and climate change		
Environmental applications		
Disaster monitoring and Security		
Research applications		
Public Weather Services (PWS)		

Use the code values below to indicate the geophysical parameters

Code	Parameter	Code	Parameter
1	Aerosol total column	34	Sea surface temperature
2	Apparent Thermal Inertia	35	Short-wave outgoing rad. TOA
3	Atmospheric Instability Index	36	Short-wave irradiance at surface
4	Cloud base height	37	Significant wave height
5	Cloud cover	38	Snow cover
6	Cloud ice total column	39	Snow melting conditions
7	Cloud imagery	40	Soil moisture
8	Cloud top height	41	Specific humidity profile
9	Cloud Top Temperature	42	Specific humidity total column
10	Cloud type	43	Temperature Profile
11	Cloud water profile	44	Trace gases
12	Cloud water total column	45	Tropopause temperature
13	Fires	46	Vegetation Type
14	Height of tropopause	47	Wave period/direction
15	Icebergs	48	Wind profile
16	Land cover	49	Wind speed over sea surface
17	Land surface features	50	Wind vector over sea surface
18	Land surface temperature	51	Volcanic ash
19	Leaf Area Index (LAI)	52	LW incoming surface radiation
20	Long-wave surf. emissivity	53	Lightning detection
21	Long-wave outgoing rad. TOA	54	Sea-ice type
22	Norm. Diff. Veg. Index (NDVI)	55	*Intentionally blank*
23	Ocean currents	56	*Intentionally blank*
24	Ozone profile	57	*Intentionally blank*
25	Ozone total column	58	*Intentionally blank*
26	Precipitation index	59	Sounder radiances
27	Precipitation rate	60	Imager radiances
28	Rain profile	--	Other geophysical parameter
29	Salinity		(please specify)
30	*Intentionally blank*	61	
31	Sea-ice cover	62	
32	Sea-ice surface temperature	63	
33	Sea Level	64	

[3] *In this context "not available" means either completely unavailable or not available with sufficient accuracy, timeliness or resolution to meet your requirements.*

SECTION 4 – EDUCATION AND TRAINING

Question 11 **For each satellite meteorology skill given in Table 6 below, please indicate how many staff members have received training in that skill during the past two years (2006-2007). Please also indicate the type of institution that provided the training and what training methods were used.**

Table 6

Skills	8.2.1.1.1 Number of staff trained by institution (enter approximate number of staff)						8.2.1.1.2 Training method(s) used [Check one or more boxes]			
	RMTC	WMO (other than RMTC)	University / Industry	Internal	Through bilateral agreement with other WMO Member	Other (describe in Section 5)	Classroom based presentations	Computer Assisted Learning (CAL)	Distance learning	Other (describe in Section 5)
Equipment operation & maintenance							☐	☐	☐	☐
Software development							☐	☐	☐	☐
Physical basis for remote sensing							☐	☐	☐	☐
Satellite image interpretation							☐	☐	☐	☐
Others (describe in Section 5)							☐	☐	☐	☐

Question 12 **Are you aware of the Virtual Laboratory (VL) for Training in Satellite Meteorology?**

Select one from these drop-down selections → **CLICK FOR OPTIONS ...**

Question 13 **Do you use the VL to support training activities?**

Select one from these drop-down selections → **CLICK FOR OPTIONS ...**

Question 14 **Please indicate in Table 7 below what is/are the primary limiting factor(s) in your Organization influencing education & training in satellite meteorology.**

[Check one or more boxes]

Table 7

Reason	
We can identify no significant limiting factors	☐
We have insufficient access to education & training opportunities	☐
We have technical difficulties limiting education & training opportunities	☐
We have financial difficulties limiting education & training opportunities	☐
Other reasons (describe in Section 5)	☐

Question 15 **Please indicate the extent to which staff training in satellite meteorology has changed in your Organization over the past 2 years (2006-2007).**

Select one from these drop-down selections → **CLICK FOR OPTIONS ...**

SECTION 5 – ADDITIONAL INFORMATION

Please use this section to describe any references to “Others” in the questions above and also to comment on the questionnaire itself and provide any suggestions on how it could be improved.

========== END OF QUESTIONNAIRE

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APPENDIX B

ANALYSES OF HYPOTHESES

The hypotheses developed by ET-SUP related to the changes that had occurred during the period of the current Questionnaire and are listed below. The analyses of the hypotheses, where this has been possible from information available, are shown ***italicized thus***.

1. It was hypothesized that for data access (2006-2007):

   - The number of NMHSs obtaining or planning to obtain satellite data and products will increase; ***Hypothesis unproved – Evidence not available.***
   - The number of NMHSs reporting problems of knowledge how to access satellite data and products will decrease; ***Hypothesis unproved – Evidence not available.***
   - The number of NMHSs reporting significant decrease in access to satellite data and products will decrease; ***Hypothesis proved – see Section 4.1.***
   - The number of NMHSs reporting increase in access to satellite data and products will increase; ***Hypothesis proved – in particular valid for RAs I, II and VI, (due to EUMETCast), see Section 4.1.***
   - The number of NMHSs reporting reception of analogue data will decrease considerably; ***Hypothesis proved – see section 4.2***.
   - The number of NMHSs reporting reception via ADMs will increase; ***Hypothesis proved – with some differences for the different Regions; see section 4.2***.
   - The number of NMHSs reporting access to R&D satellite data and products will increase. ***Hypothesis proved – see Section 4.3.***

2. It was further hypothesized for data use (2006-2007) that:

   - Qualitative estimation by respondents of the extent of use of satellite data/products would increase across questionnaire editions; ***Hypothesis proved – 72% of the respondents indicate in 2008 a slight or significant increase in data usage over the passed two years. (The corresponding figure in the 2006 edition of the questionnaire was however slightly higher, 77% of the respondents reported a slight or significant increase)***.
   - The number of satellite sensors assimilated into NWP models would increase across questionnaire editions; ***There is insufficient evidence to test this hypothesis from the Questionnaire alone, the questionnaire would need to be more specific in this regard – additional information from NWP Centres would also be needed***.
   - The number of satellite observations (soundings, AMVs, radiances, surface winds) assimilated into NWP models would increase across questionnaire editions; ***Hypothesis proved partially – see Section 5.1; an increased usage of Level-1 sounder data in NWP is reported in 2008; for other data types the situation is not so clear from the responses to the questionnaire but reports from international satellite conferences give full evidence that more and more satellite data are used, with positive impact, in NWP***.
   - The number of satellite products used would increase across the questionnaire editions as a result of increased numbers of satellite sensors; ***Hypothesis proved – see Section 5.1; in total 621 data and products were reported to be used in 2008; the corresponding sum in 2006 was 522; the number of respondents 96 in 2008 and 83 in 2006; this results in an average of 6.5 products used per response in 2008 and an average of 6.3 in 2006; from that a slight increase in the number of used products can be concluded from the responses to the questionnaire. Reports from international satellite conferences confirm this trend. (But to be noted: it is very difficult to assess the trend in detail: less than 50% of the WMO Member States return questionnaires – what is the situation at the other ~50%? And as concerns international satellite conferences typically only those people attend which have a specific interest in that area – this means, their contributions to the conferences are not /fully) representative for the full community of WMO Member States).***
   - The number of products produced in the latest questionnaire edition not previously produced would increase (e.g., image products, temp/profiles, products, AMVs, cloud products, sea surface products, land, precipitation); ***Hypothesis proved – respondents provided as free text specifications of***

"Other" in questionnaire Table 3; these are products which are used but were not listed in the questionnaire, about 15 additional products were reported.

- The number of products available from R&D satellites would increase across editions; ***Hypothesis unproved – Evidence not available***
- The number of satellite products on the GTS would increase over time (can test outside of questionnaire); ***Hypothesis unproved – Evidence not available***
- The number of hits on satellite web pages (e.g. number of users downloading an image) would increase across questionnaire editions (test using data from NMHSs and WMO SP); ***There is insufficient evidence to test this hypothesis from the questionnaire alone – it requires complementary information and evidence from future editions.***
- The implementation of PUMA (Preparing Users for MSG in Africa) would result in an increase in satellite data/product usage in RA I (Africa). ***Hypothesis proved – see section 5.4***.

3. Given that telebriefing/teletraining is part of distance learning category, it was hypothesized that:

- There is more distance training going on than indicated by responses to the current version of the questionnaire. ***The number of reports for Distance Learning as employed training method increased from 11 in 2006 up to 32 in 2008, see Section 7.2. This could be an indication that there was more Distance Learning in 2006 than reported and from that the hypotheses may appear to be proved, but there is insufficient (or ambiguous) evidence to test this hypothesis from the questionnaire alone – it requires complementary information***.

APPENDIX C

SOURCES OF COMPLEMENTARY DATA AND INFORMATION

Examples of complementary data sources to improve status reporting by the WMO Space Programme identified by ET-SUP are tabulated below. Other sources of data include the International Precipitation Working Group (IPWG), the International ITOVS Study Conference (ITSC), the International Winds Workshop (IWW) and reports and activities of their Working Groups. ET-SUP noted that collecting and analyzing these complementary data was considered to be an intersessional activity to be led by the WMO Space Programme and acknowledged that associated responsibilities and resources needed to be investigated.

Area of interest (satellite data usage)	Information source	Comments
NWP usage of satellite data types, sensors	NWP Centres	Agreed already by WMO Space Programme.
Data reception and access	ADM operators; Satellite operators that maintain registration DB; Equipment manufacturers; WMO database	Potential commercial sensitivities on Location and number of sales of reception/processing equipment; Licensing for example with EUMETCast includes information on products used; WMO receiving station database is online but needs to be updated.
Training data	Regular RTC reports	Presumably in WMO ETR Programme – extract satellite specific training that is relevant to the Questionnaire.
Satellite relevant data	WMO Programmes	WMO Space Programme is well placed to identify those Programmes and their reports or databases
Web access information	NMHSs and WMO	Need to have statistics that are extremely specific to satellite data and Products, e.g. number of image downloads or number of users accessing one image.
GTS satellite products	NMHSs and WMO	RTHs could establish monitoring system.
Numbers of channels used and which channels	Questionnaire update	

APPENDIX D

KEY FINDINGS

[K1] Key finding: Forty-three (43) Members have never submitted a response, and only seven (7) Members have answered every edition.

[K2] Key finding: Total participation increased in comparison with previous editions following the adoption of some of the recommendations made to improve the response rate.

[K3] Key finding: The level of response from RA VI was far higher than any other Region.

[K4] Key finding: 76% of the responding Members indicated an increase in satellite data access while only 2% reported a decrease. This is a very positive reflection of the efforts made over the past few years by several agencies to improve data access. In particular the significant increase reported from Members in RA VI proves the effectiveness of the EUMETCast-Europe service.

[K5] Key finding: The use of DVB-S systems (e.g. EUMETCast) is the most widely used means to access satellite data in RA I and RA VI.

[K6] Key finding: Responses to which satellites Members did not access but would like to have are equally shared between operational and R&D and other environmental satellites.

[K7] Key finding: Request from SPOT data from RA III show a significant increase from previous editions.

[K8] Key finding: Access to Metop data is by far the most requested improvement for data availability.

[K9] Key finding: Reported data processing and usage increased in most categories when compared to the 2006 edition. The most significant changes are the increased use of Level 2 products produced outside the respondent's country, especially Atmospheric Motion Vectors, Sea surface products and Precipitation products.

[K10] Key finding: The most frequently reported limiting factor in the use of satellite data and products was financial difficulties, reported by about 30% of responses, followed by technical difficulties, reported by 26%. This is a change in comparison to the 2006 edition of the questionnaire where technical difficulties were reported most frequently as the primary limiting factor.

[K11] Key finding: In comparison to the 2006 edition of the questionnaire, a positive trend can be seen in the number of responses indicating no significant limiting factors in the use of satellite data and products with an increase from 8% in 2006 to 13% in 2008.

[K12] Key finding: Despite the positive trend, the number of reported limitations in the use of satellite data and products in 2008 is still high with 87% reporting some limiting factors.

[K13] Key finding: The number of responses indicating a decrease in the use of satellite data and products is now very low. The level responses indicating no significant change (19%) is almost unchanged in comparison to the 2006 edition as is the level of responses reporting an increase in data usage (79%). This indicates that there is a rather consistent continuous overall increase in satellite data and product usage.

[K14] Key finding: Three parameters related to clouds were clearly rated as of highest importance overall, in the following ranking order: cloud imagery, cloud cover, and cloud type. Cloud imagery ranked first in five application areas. Precipitation rate was the highest parameter outside the area of cloud detection/analysis.

[K15] Key finding: Precipitation rate, lightning detection and atmospheric instability index are included in the top five parameters in both the current and the last edition.

[K16] Key finding: Precipitation rate, ranked fifth of the most important parameters, is also confirmed with a large number of responses as the overall most required but not available parameter. With precipitation index ranked fifth of the required parameters, this indicates that the knowledge of the precipitation field is still the most critical area of present usage where future improvements should be particularly sought.

[K17] Key finding: Wind speed over sea surface, which is ranked second as most required but unavailable parameter,was only ranked eighteenth in this category in the 2006 edition. In the same time, wind profile dropped down from position 3 to position 22, which is a surprise, bearing in mind that wind profiles would be a very important parameter for NWP models. The reasons for that drop are not clear.

[K18] Key finding: Trace gases, ranked third in the list of most required but unavailable parameters, are considerably more in demand than in the previous edition (ranked fourteenth in 2006), indicating a growing interest in the application linked to atmospheric chemistry, air quality and environment.

[K19] Key finding: Direct comparisons of total numbers of staff trained with those from the 2006 edition are not very meaningful since the latter were significantly inflated by a few extremely high figures and were probably not truly representative.

[K20] Key finding: As in previous years, the largest numbers of staff who underwent training were trained by internal training mechanisms; this is valid for all WMO Regions. The next most reported training method is training in cooperation with other NMHS or RTC. Training at RTC is of specific relevance for RA I, II and V.

[K21] Key finding: Classroom training remains the most frequently reported training method with distance learning increasing significantly since the previous edition. This could be interpreted as a positive effect from the WMO/CGMS High Profile Training Event (HPTE) of 2006.

[K22] Key finding: Very surprisingly the awareness of the VL and regular use of the facility have both slightly decreased (in percentage terms) since the previous edition, although occasional use has increased. It is not straightforward to explain this phenomenon except to speculate that some of the previous momentum of the VL implementation may have been lost although in principle it might have been expected that the WMO/CGMS High Profile Training Event (HPTE) would have brought such momentum.

[K23] Key finding: The most commonly reported limiting factor in the education and training in satellite meteorology was financial difficulties, reported by 37% of responses.

[K24] Key finding: 56% of respondents reported increased training while only 5% reported less. These percentages are nearly identical with those reported two years before, thus the increase in training is consolidated and efforts expended in focussing on this very important area continue to be effective.

[K25] Key finding: As only one comment was submitted concerning the questionnaire itself, it may be concluded that the current form, content and means for access and return are acceptable.

APPENDIX E

RECOMMENDATIONS

(R1) Recommendation: Responses to trend questions (asking for changes observed during the period of the questionnaire) provide clear indications and should remain mandatory in future editions of the questionnaire.

(R2) Recommendation: Periodic analysis of the status of availability and use of satellite data and products should continue to be accomplished through a combination of an objective analysis of a periodic questionnaire completed by the Members complemented by an analysis based on information gathered from other sources related to satellite data accessing, processing and training.

(R3) Recommendation: For future analysis of the status of availability and use of satellite data and products, actions should be taken to seek to engage nearly *every* WMO Member. In addition, the engagement of relevant WMO Programmes through their lead Technical Commission and their infrastructure organizations of OPAGs and Expert Teams is considered extremely valuable, as is the involvement of Executive Council Panels, where appropriate (for example for Education and Training and Disaster Risk Reduction), and of the Regional Association Rapporteurs for the WMO Space Programme.

(R4) Recommendation: In general, mechanisms should be established to address questions and concerns raised by Members in their responses to the questionnaire and to provide relevant feedback to them. Particular recommendations are included in this report for those areas that are considered to require specific follow-up actions.

(R5) Recommendation: The possibility of issuing a second iteration of the questionnaire in the year x+1 (where x is the year of regular questionnaire) only for those countries that did not answer to the normal issue could be considered as a mechanism to increase overall participation and therefore increase the statistical validity of the analysis.

(R6) Recommendation: A specific targeted effort should be made to get questionnaire returns from those Members who have never responded in the past.

(R7) Recommendation: For future editions more precise guidance should be given to those Members present in more than one WMO Region to allow a more accurate regional analysis.

(R8) Recommendation: Members that do not have access to satellite data should be contacted and advice offered as to how to address this situation if appropriate.

(R9) Recommendation: Those Members reporting a slight or significant decrease in data access should be contacted, the responses clarified if necessary and advice offered as to how to address this situation if appropriate.

(R10) Recommendation: In future editions of the questionnaire the serviceability of existing reception systems could be explicitly queried as a possible cause for reduction in data reception capability.

(R11) Recommendation: In future editions of the questionnaire the possible ambiguity regarding what constitutes “analogue” data should be removed by explanatory text and examples.

(R12) Recommendation: Improving satellite data usage among Members should be addressed by focussing on reducing the most commonly stated limiting factors. Measures could include:

- For financial limitations and technical difficulties:

  - Distribute information to Members (via a newsletter for example) to describe the potential benefits associated with satellite data usage and how these benefits can be realized via a targeted commitment of resources;
  - Encourage the (further) development and implementation of schemes for cooperation and networking in order to share the workload of processing of satellite data; establish shared services to the benefit of all Members of such a cooperation network.
- For insufficient knowledge:
  - Encourage and foster the development and delivery of effective education and training in satellite data usage focussing on realizing the benefits that are available;
  - Ensure Members are aware of Internet-based training opportunities and encourage their participation recognizing that this itself requires a commitment of certain resources and is therefore linked to the question of financial limitations.

(R13) Recommendation: Those Members reporting a slight or significant decrease in data usage should be contacted, the responses clarified if necessary and advice offered as to how to address this situation if appropriate.

(R14) Recommendation: In future editions of the questionnaire the question concerning application should be restructured to enable the distinction between parameters which are required and available, those which are required but not *adequate* in terms of accuracy, timeliness or resolution, and those which are not available at all.

(R15) Recommendation: Careful note should be taken of the parameters most commonly indicated as required but not available and the pertinent information regarding unfulfilled requirements should be brought to the attention of satellite operators.

(R16) Recommendation: Considering the implications of low- and mid-level dust, smoke and aerosols in weather services that address such issues as human health, environmental and air traffic hazards, its potential inclusion as a separate parameter should be investigated for future editions.

(R17) Recommendation: NMHSs should be made more aware of the existence and benefits of web-based training material for self-learning purposes and of web-based distant learning possibilities (e.g. EUMeTRAIN) since such training methods do not require specific financial resources.

(R18) Recommendation: Those Members reporting a slight or significant decrease in staff training should be contacted, the responses clarified if necessary and advice offered as to how to address this situation if appropriate.

(R19) Recommendation: It should once again be considered whether future editions of the questionnaire could be provided in all official WMO languages as a potential means for increasing the return rate. It is recognized, however, that this is a very time consuming process which would have to be started in good time so as not to delay the publication of the next edition.