

CAeM Global Survey of Aeronautical Meteorological Service Provision by WMO Members



WMO OMM

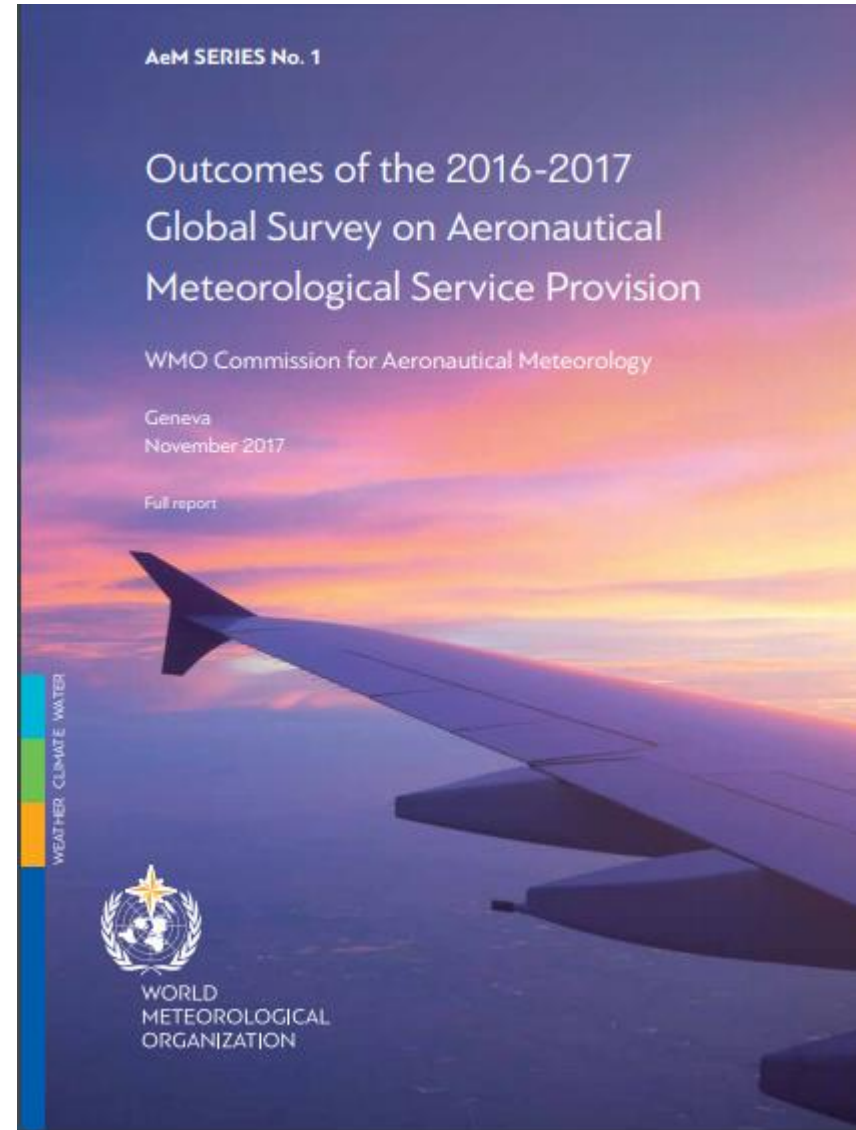
World Meteorological Organization
Organisation météorologique mondiale

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Dimitar Ivanov, Chief
Greg Brock, Scientific Officer
Yi Wang, Intern at AEM
Jan Sondij, CAeM ET-GOV
Aeronautical Meteorology Division

Content

- Methodology of survey
- Survey structure and response rate
- Response to each question
- Summary of findings per item



Methodology

- Method used was on-line web survey (SurveyMonkey)
 - Invitation send out by letter and email
 - Targeting Members
 - Permanent Representatives (PR)
 - Civil Aviation Authorities (CAA/regulator)
 - Aeronautical Meteorological Service Providers of ICAO/WMO functions of MWO, AMO, AMS (primarily MWO Service Providers)
 - Approximately 50 questions
- Survey base consists of 190 WMO Members
 - 185 Member States (Monaco excluded)
 - 6 Member Territories
- 192 persons from 172 States or Territories responded
 - Multiple entries merged to create a single response per Member
 - Processing of the survey included quality control of responses
 - All graphics and tables are based on the total population of 190 Members, unless stated otherwise



Methodology

- The global framework of meteorological service for international air navigation consists of various functions as laid out in ICAO Annex 3 and WMO Technical Regulations, Volume II (WMO-No. 49). These include:
 - World Area Forecast Centres (WAFC)
 - Tropical Cyclone Advisory Centres (TCAC)
 - Volcanic Ash Advisory Centres (VAAC)
 - Meteorological Watch Offices (MWO)
 - Aerodrome Meteorological Offices (AMO)
 - Aeronautical Meteorological Stations (AMS)
- Survey focused on regulatory, institutional, organizational and technical landscape for MWO, AMO and AMS functions.
- Survey represents the period November 2016 – January 2017
- Full report available online: [AeM Series No. 1](#)

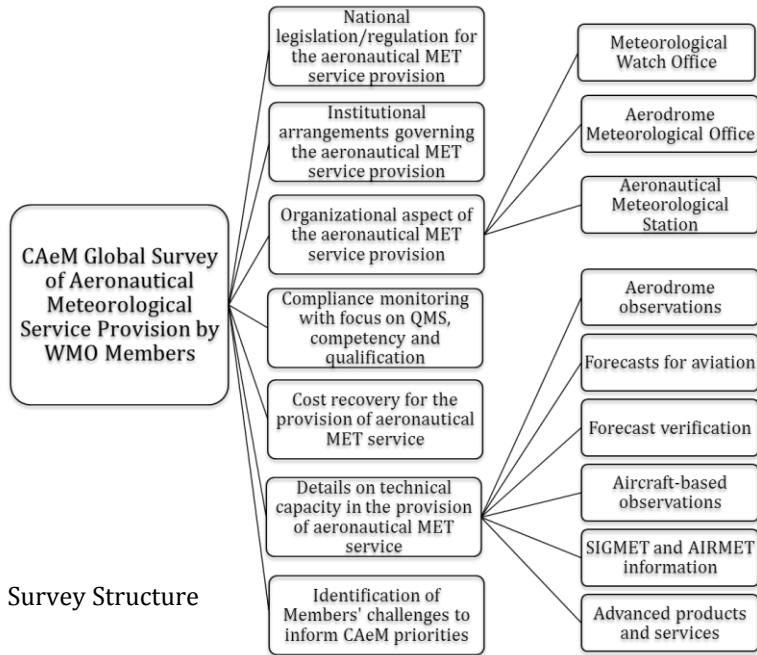


Seven major sections in the survey

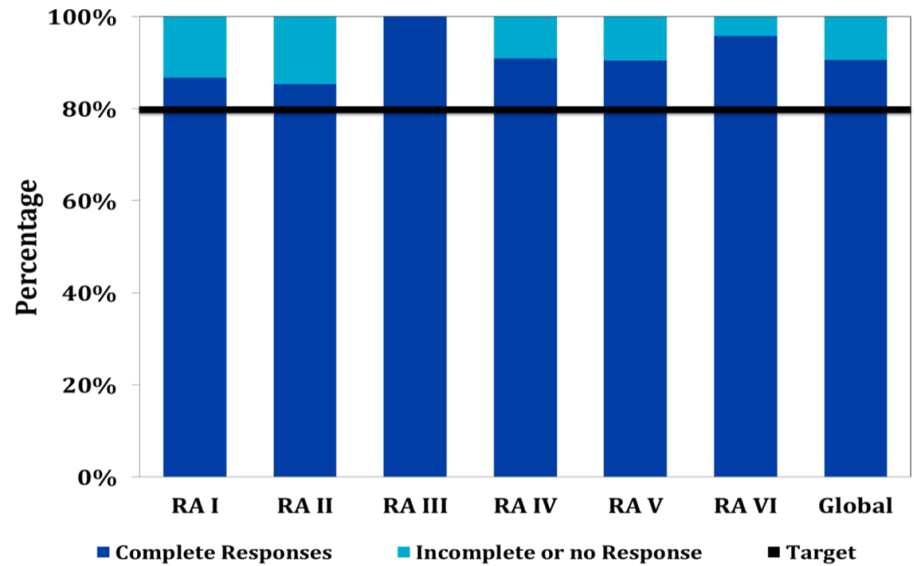
And they are addressing the following topics:

1. Survey responding rate and general picture
2. National legislation/regulation for the aeronautical MET service provision
3. Institutional arrangements governing the aeronautical MET service provision
4. Organizational aspect of the aeronautical MET service provision
5. Compliance monitoring with focus on QMS, competency and qualification
6. Cost recovery for the provision of aeronautical MET service
7. Details on technical capacity in the provision of aeronautical MET service
8. Identification of Members' challenges to inform CAeM priorities

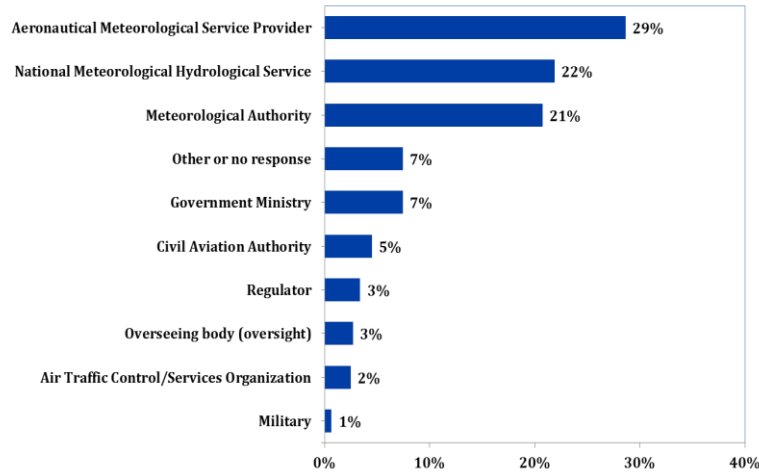
1. Survey responding rate and general picture



Survey Structure



Responding rate by Regional Association



Type of the organization/Entity participating the CAeM survey



NOTE:
All content included on this map is for informative purposes only.
For detail, please read WMO Disclaimer at public.wmo.int/en/disclaimer.



Response rate per WMO Member State and Member Territory

Summary of findings – response rate

Overall response rate very high

- 172 responses out of 190 Members, average of 91% (target set at 80%)
- Possible explanations:
 - Targeted both PRs (letter) and MWO AMSPs and regulators/CAA (email)
 - CAeM able to do so via vast network of contact persons
 - Importance put on aviation by AMSPs including NMHS

- RA I – Lowest response rate, still 87%
- RA II – Second lowest response rate, still 85%
- RA III – Highest score, 100%!
- RA IV – Response rate equals global average, 91%
- RA V – Response rate just under global average, 90%
- RA VI – Second highest response rate, 96%

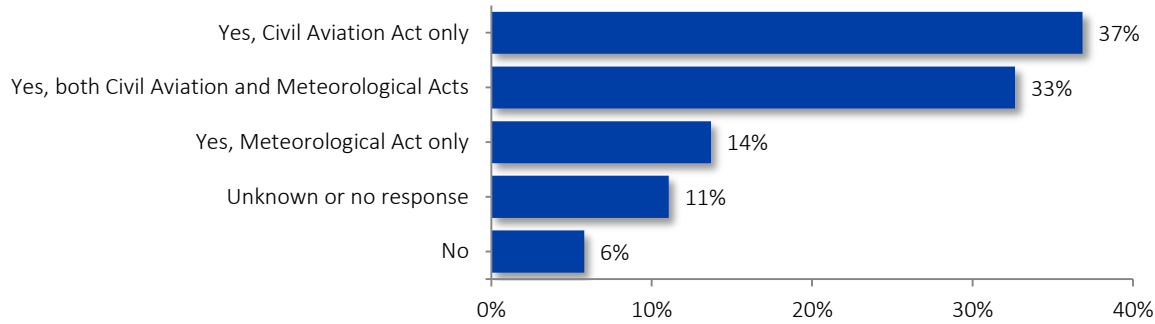
185 Member States and 6 Member Territories	
RA I	53
RA II	34
RA III	12
RA IV	22
RA V	21
RA VI	48 (excl. Monaco)
Total Population	190

	RA	Complete Response	Incomplete or no Response	Perc.
RA I	53	46	7	87%
RA II	34	29	5	85%
RA III	12	12	0	100%
RA IV	22	20	2	91%
RA V	21	19	2	90%
RA VI	48	46	2	96%
Global	190	172	18	91%

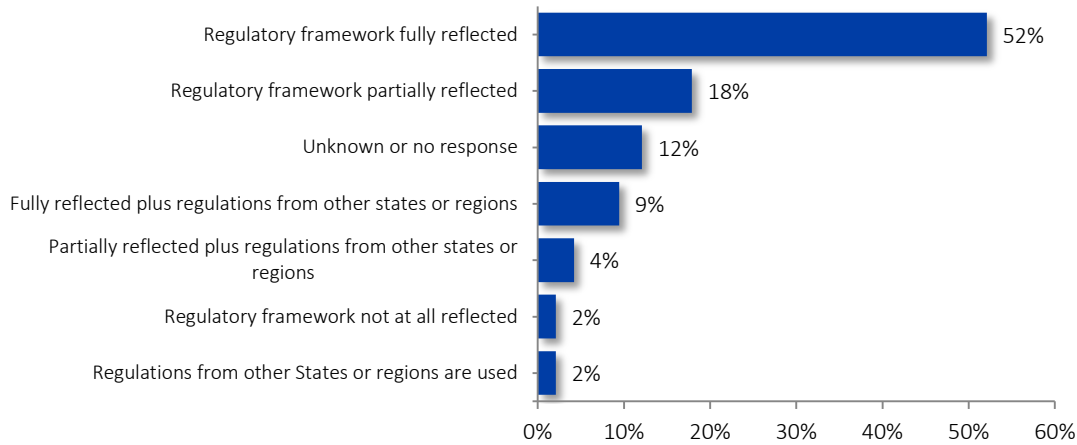
General findings of survey

- For the first time a consolidated picture of the global aeronautical meteorological service providers regulatory, institutional, organizational and technical landscape for MWO, AMO and AMS functions is available.
- There is a large variety of arrangements and conditions within and between States and Territories, as well as across regions, for the provision of aeronautical meteorological service.
- The maturity of aeronautical meteorological service providers varies significantly across the WMO Members.
- There is still a need to support and assist Members and it is recommended that WMO continues to support capacity development, provide technical assistance, and stimulates regional coordination and initiatives to further improve aeronautical meteorological service provision.

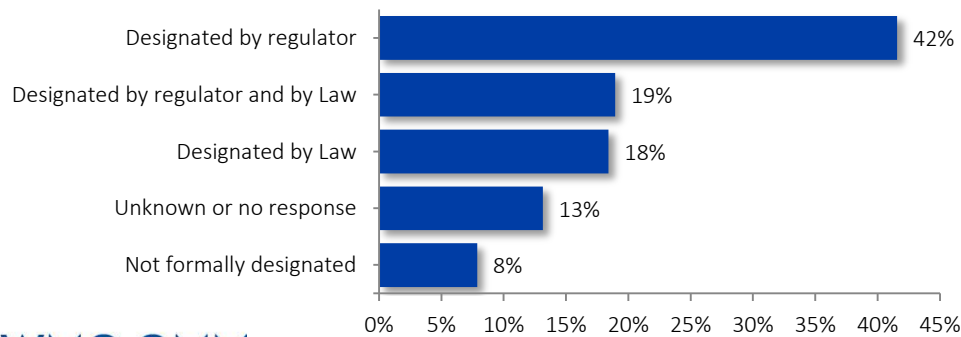
2. National legislation/regulation for the aeronautical MET service provision



2.1 Is there a national legal and regulatory framework in your State/Territory with regard to aeronautical meteorological service provision?



2.2 To what extent is the international regulatory framework for aeronautical MET service provision reflected in the national legal and regulatory framework of your State/Territory.

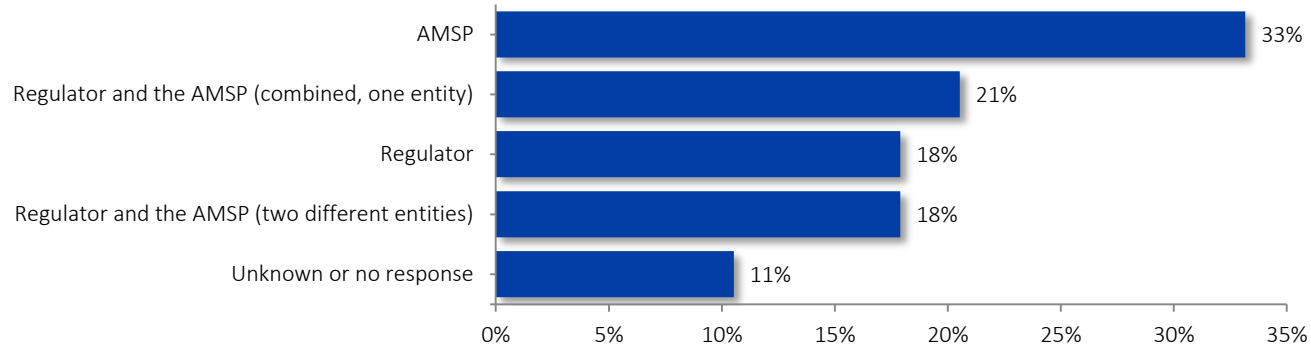


2.3 In what manner are the ICAO functions (AMS, AMO, MWO) of your State/Territory designated to the entity or entities providing aeronautical meteorological service?

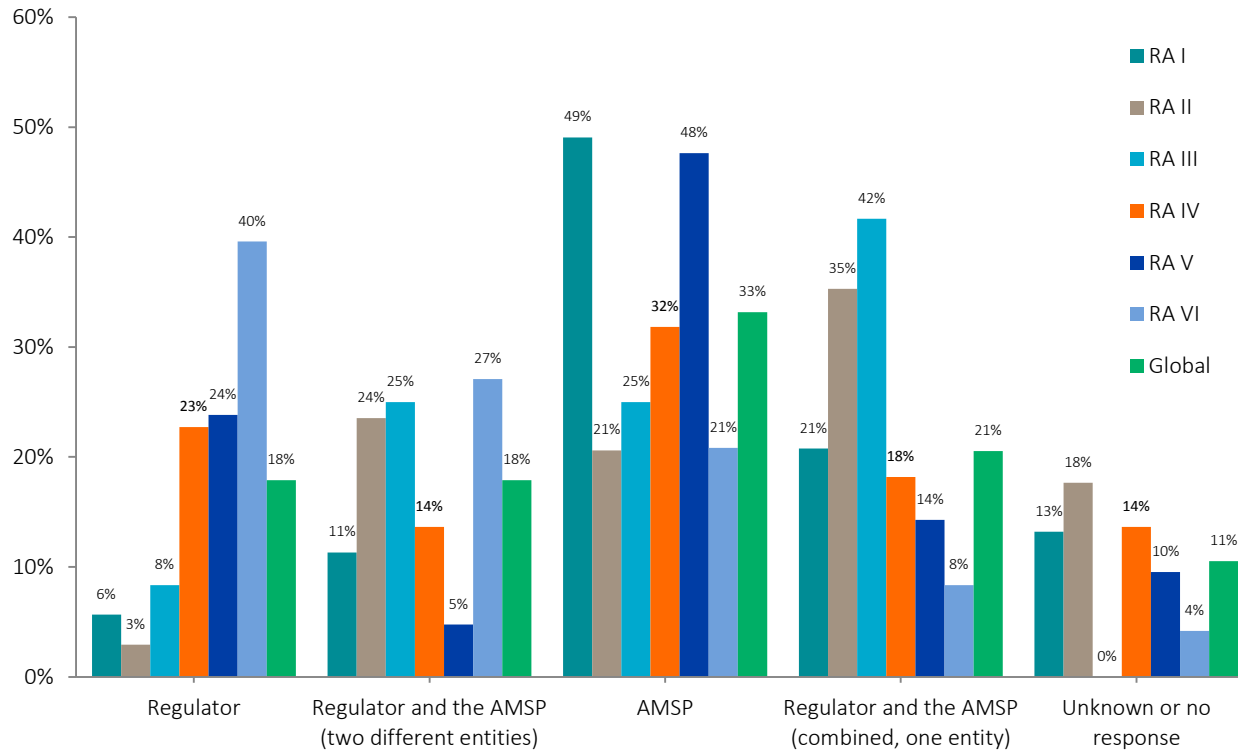
Summary of findings – regulatory framework

- Though variations of national practices exist, the provision of meteorological services for international air navigation is formally regulated in the majority of WMO Members. In more than 80% of the cases some form of legal and regulatory framework for aeronautical meteorological service provision is in place.
- The ICAO and WMO regulatory provisions are strongly reflected in the national legal/regulatory frameworks in 80% (in full 60%, partially 20%) of States and Territories.
- In almost 80% of States and Territories the ICAO/WMO service provision functions (MWO, AMO and AMS) are assigned through a formal designation to service providers; this is done through a relevant law and/or through designation by a national regulator.
- All in all this is a positive trend and WMO could consider to assist the remaining 15% of Members where there is inadequate national regulatory frameworks in order to improve the situation.

3. Institutional arrangements governing the aeronautical MET service provision



3.1 How is the notion of Meteorological Authority applied in your State/Territory?



Summary of findings – meteorological authority

- The notion of ‘Meteorological Authority’ is not applied uniformly by all responding States and Territories.
 - There seems to be a noticeable trend that the AMSP no longer performs the role of regulator, which was a common case in the past for many NMHS acting as AMSP. This reflects the, in many States required, functional separation at national level between regulator, service provider and oversight which is already the case for more than 70% of Members.

- Related, the notion of ‘Meteorological Authority’ is not applied uniformly, and it is recommended that WMO, in cooperation with ICAO, provides guidance on governance at a national level and the roles and responsibilities of regulator, service provider and oversight.

- RA I – The interpretation of “Meteorological Authority” as AMSP is most common in RA I and RA V.

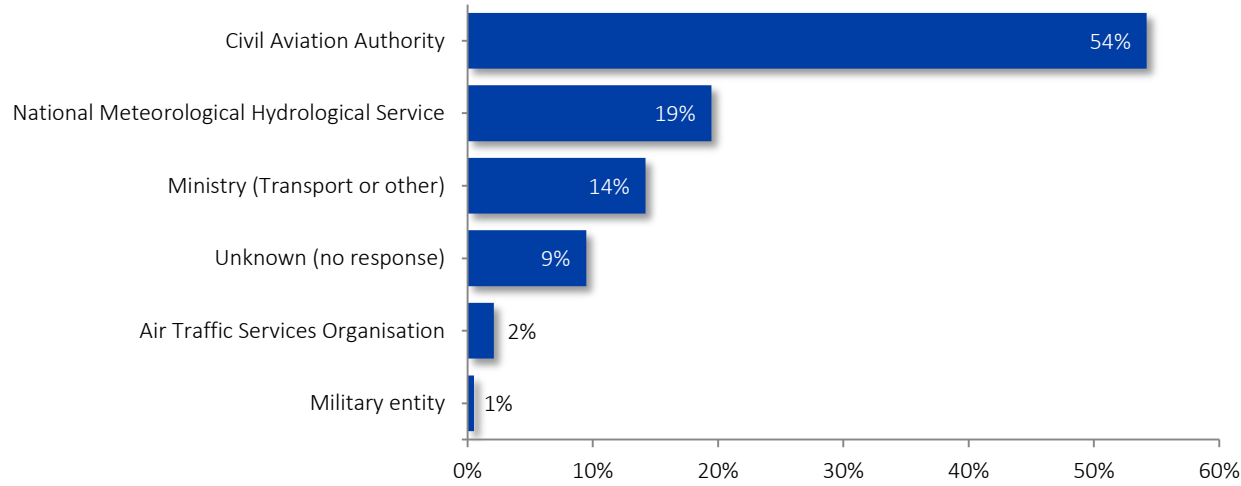
- RA II – Together with RA III the highest percentage of the interpretation of “Meteorological Authority” as one entity being both regulator and provider.

- RA III – Together with RA II the highest percentage of the interpretation of “Meteorological Authority” as one entity being both regulator and provider.

- RA IV – Interpretation of different options is distributed rather evenly.

- RA V – The interpretation of “Meteorological Authority” as AMSP is most common in RA I and RA V.

- RA VI – The use of “Meteorological Authority” for the regulator only is most common in RA VI. If combined with the option “regulator/AMSP – two different entities” then this presents almost 70% for RA VI.



3.2 What type of entity is the regulator of aeronautical meteorological services in your State/Territory?

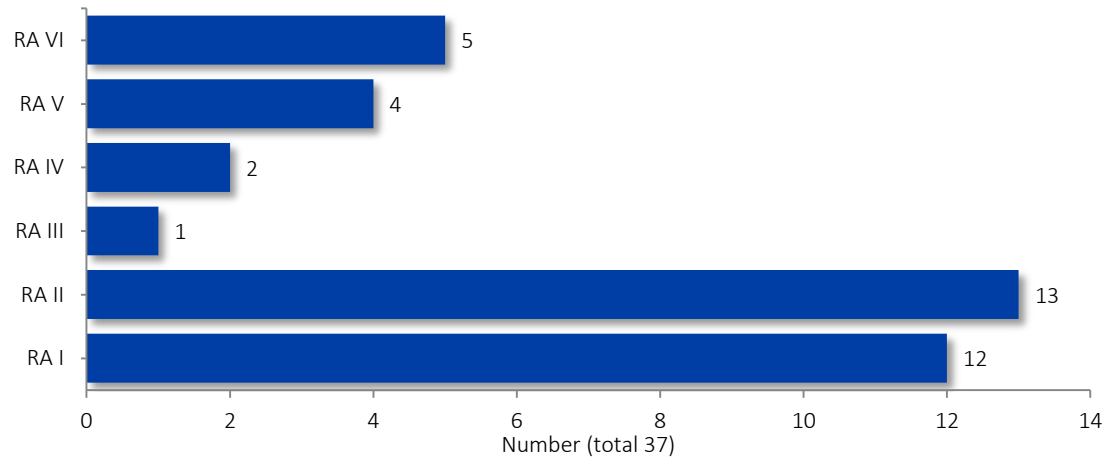
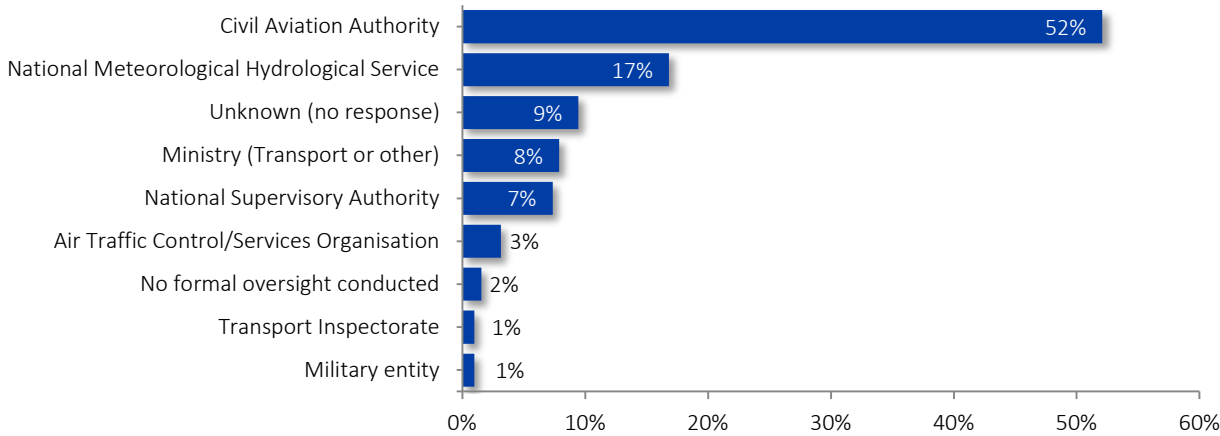


Figure 9. Regional distribution of NMHS acting as the regulator

Summary of findings - regulator

- In almost 70% of States and Territories the regulator is the civil aviation authority (CAA) or the ministry. The NMHS is considered the regulator in 19% of the States and Territories.
- RA I - Together with RA II the highest number of NMHS that acts as regulator.
- RA II - Together with RA I the highest number of NMHS that acts as regulator.
- RA III - NMHS acting as regulator almost non-existent (1 Member)
- RA IV - NMHS acting as regulator almost non-existent (2 Members)
- RA V - 4 Members have NMHS that acts as regulator.
- RA VI - 5 members have NMHS that act as regulator.



3.4 What type of entity performs the oversight on aeronautical meteorological service provision in your State/Territory?

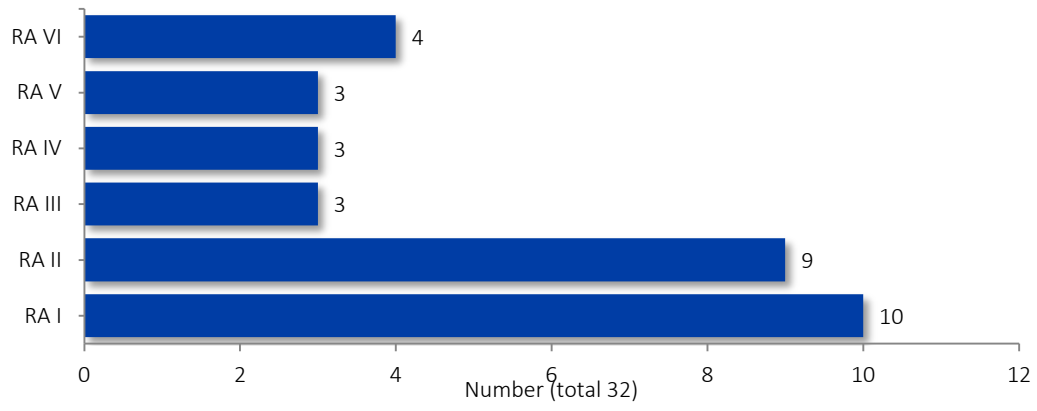
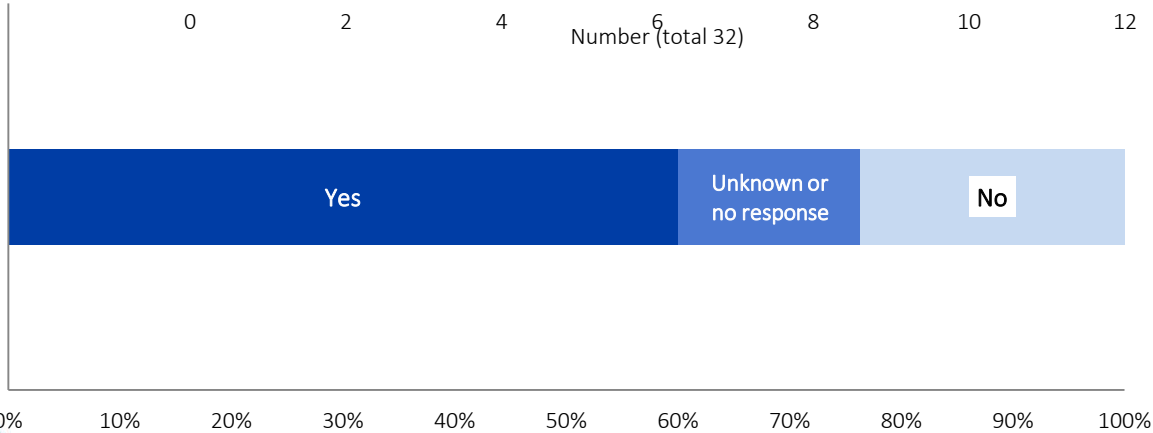


Figure 11. Regional distribution of NMHS performing oversight



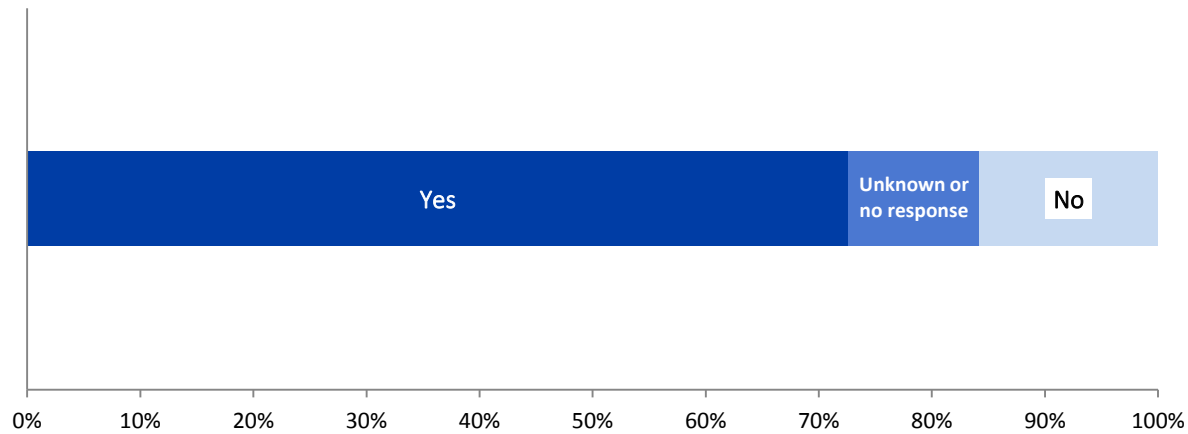
3.5. In your view, does the entity providing oversight of aeronautical meteorological service provision possess adequate expertise in aeronautical meteorology?

Summary of findings - oversight

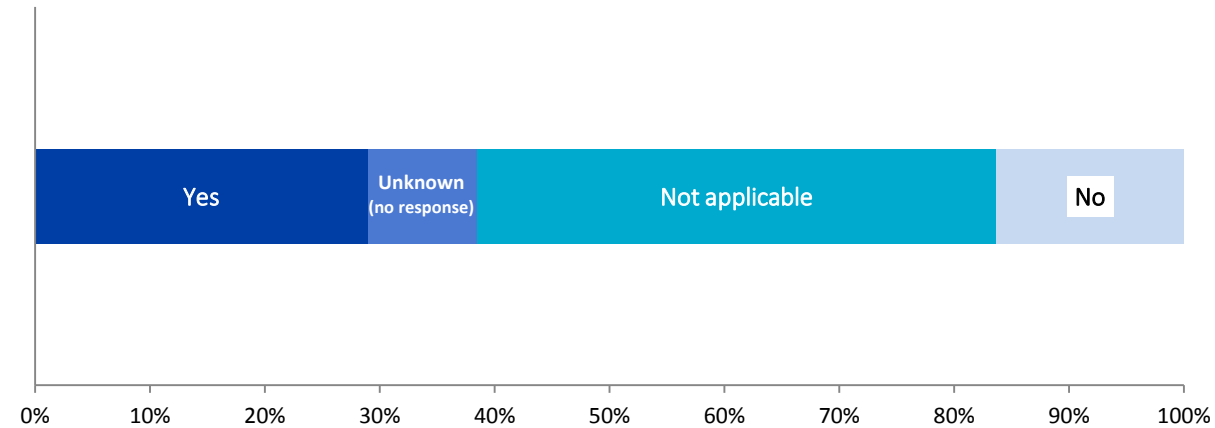
- In more than 50% of the cases the civil aviation authority performs the oversight. In Europe oversight (7%) is performed by the national supervisory authority (NSA) under Single European Sky regulations. Combined with the ministry (8%) and the transport inspectorate (1%) almost 70% of oversight is performed by external bodies.
- In almost 20% of States and Territories, and most common in RA I (Africa) and RA II (Asia), the NMHS acts as regulator and performs oversight on the aeronautical meteorological service provision.
- Furthermore, 25% of Members are of the opinion that the entity providing oversight does not possess adequate expertise in aeronautical meteorology.
- Several Members provided additional information on oversight issues. This ranged from no oversight at all, lack of competent oversight staff, the need for guidance and assistance, to receiving support from other countries and hiring competent staff from other organizations to perform oversight.
- It is recommended that WMO provides guidance material to assist States and Territories in ensuring that the personnel performing oversight functions are adequately competent.
- RA I - Most common, together with RA II, that the NMHS is responsible for oversight, 10 NMHS which is 19% .
- RA II - Most common , together with RA I, that the NMHS is responsible for oversight. 9 NMHS which is 26%
- RA III - 3 NMHS are responsible for oversight, which is 25%
- RA IV - 3 NMHS are responsible for oversight, which is 14%
- RA V - 3 NMHS are responsible for oversight, which is 14%
- RA VI - 4 NMHS are responsible for oversight, which is 8%



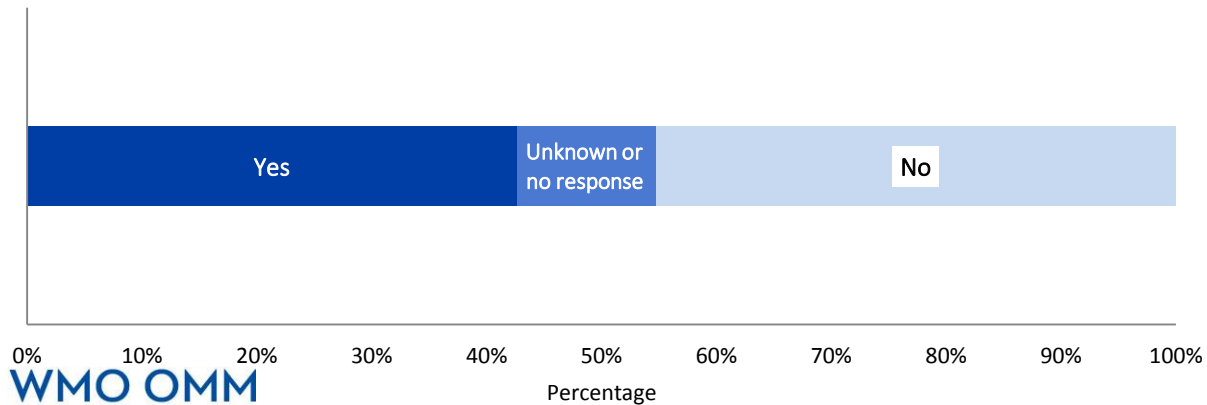
Functional Separation of Regulator, Service Provider and Oversight.



3.6. Is there functional separation between aeronautical meteorological service provision, regulation and oversight in your State/Territory?



3.7 If the AMSP in your State/Territory is not the NMHS, are there any formal cooperative arrangements (or similar) between the AMSP and the NMHS for data sharing, cost sharing, education and training or other such activities?



3.8. Do other formal service provision arrangements exist in your State/Territory between the AMSP and other entities for the provision of aeronautical meteorological service?



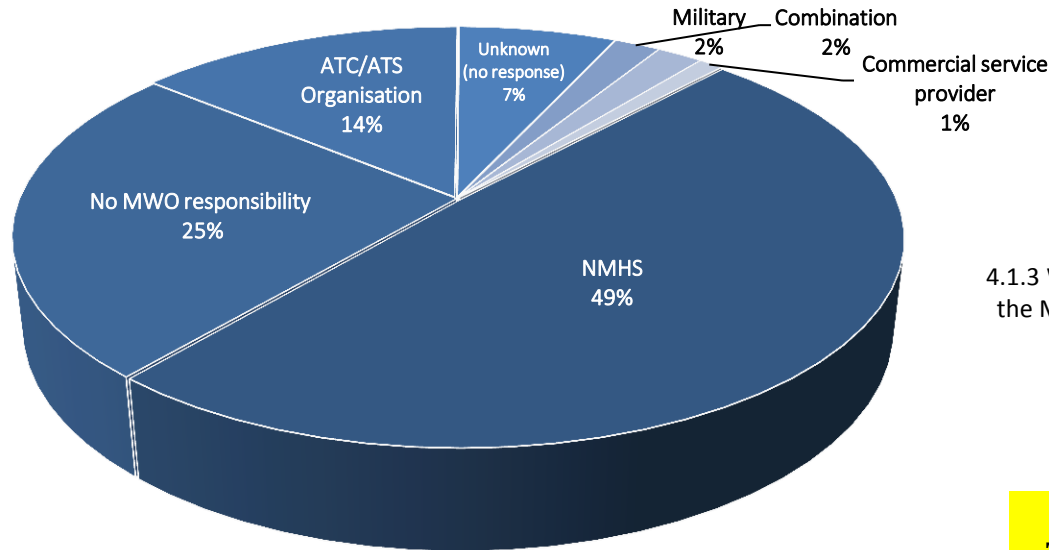
Summary of findings – functional separation of regulator, service provider and oversight

- There is a notable trend to organize **functional separation** at a national level between regulator, service provider and oversight, which is already the case for more than 70% of Members. In general the CAA or the ministry acts as the regulator, but in almost 20% of States and Territories the NMHS acts as regulator and provides oversight.
- Related, the notion of ‘Meteorological Authority’ is not applied uniformly, and it is recommended that WMO, in cooperation with ICAO, provides guidance on governance at a national level and the roles and responsibilities of regulator, service provider and oversight.
- Where the AMSP is not the NMHS, there is no formal cooperation arrangement for data sharing, cost sharing, education and training and so on in 16% of the States and Territories.
- Other formal service provision arrangements between the AMSP and other entities for the provision of aeronautical meteorological service exist only in 43% of States and Territories. The entities involved were the civil aviation authorities, the Ministry of Transport, the NMHS, the air traffic services organization, military, aerodromes and airlines. In most cases it involved combinations of these stakeholders.

4. Organizational aspect of the aeronautical MET service provision

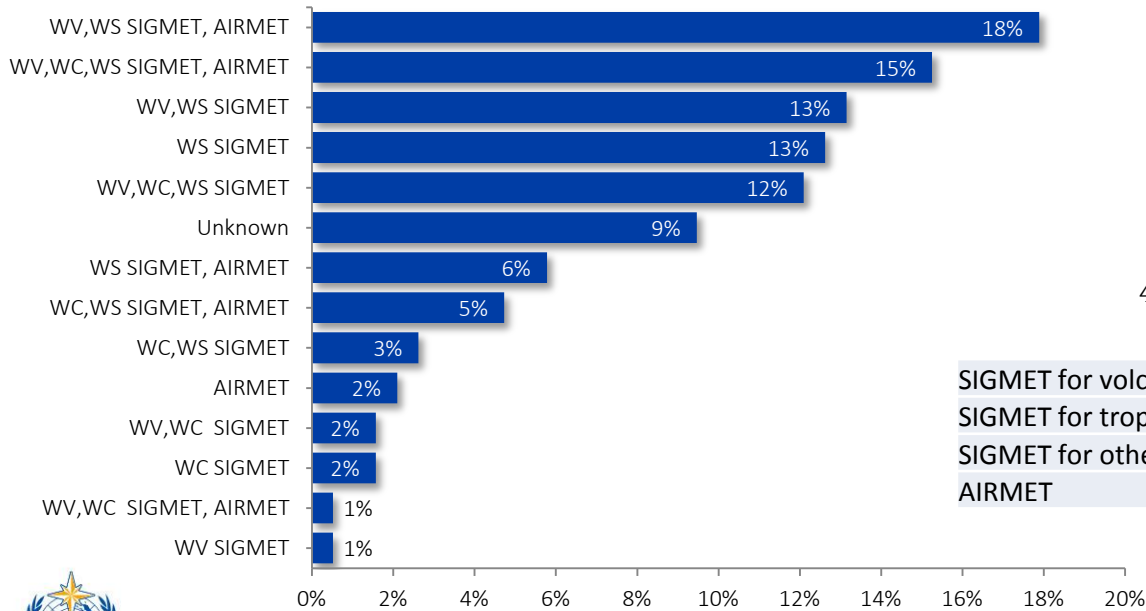
ICAO / WMO functions of MWO, AMO and AMS

- **Meteorological Watch Office (MWO)**
 - maintains continuous watch of meteorological conditions within its area of responsibility and provides products like SIGMET and AIRMET
- **Aerodrome Meteorological Office (AMO)**
 - provides products like TAF, TREND and aerodrome warnings
- **Aeronautical Meteorological Station (AMS)**
 - provides products like METAR and SPECI (including AUTOs thereof), local routine reports and local special reports and may provide automated sensor information to air traffic services authorities



4.1.3 What type of Organization/Entity is responsible for the Meteorological Watch Office(s) (MWO) function in your State/Territory?

The total number of MWOs provided by Members in this survey, including the MWOs of the 18 Members that did not respond, is 228.



4.1.5. Products provided by your MWO(s)?

SIGMET for volcanic ash (WV SIGMET)	WV SIGMET
SIGMET for tropical cyclones (WC SIGMET)	WC SIGMET
SIGMET for other hazardous phenomena (WS SIGMET)	WS SIGMET
AIRMET	AIRMET

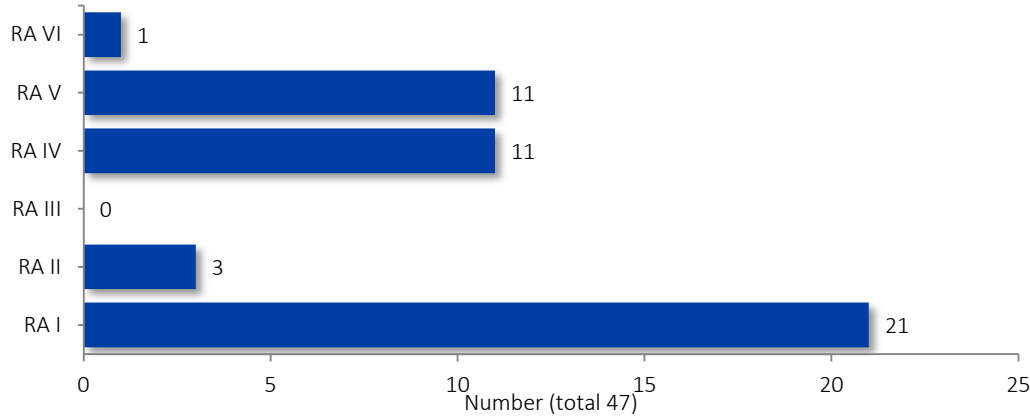


Figure 17. Regional distribution of Members with no MWO responsibility

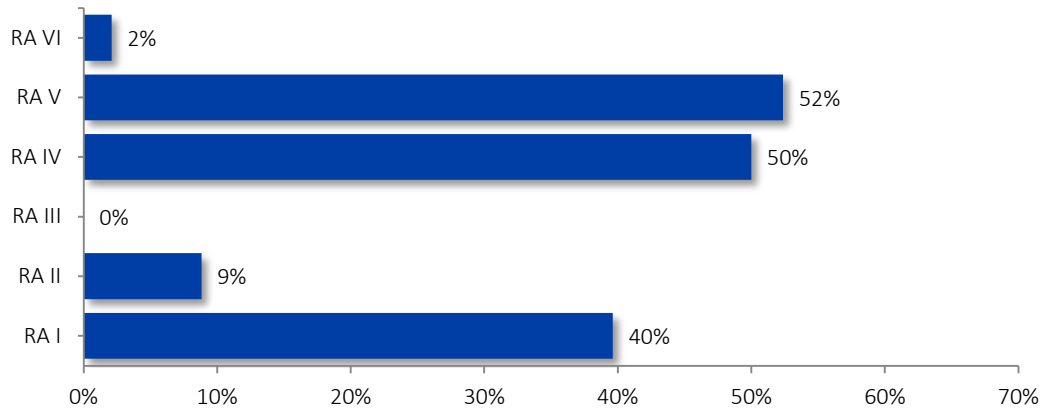


Figure 18. Regional distribution of Members with no MWO responsibility

In RA I (Africa) almost 40%, and in RA IV (North America, Central America and the Caribbean) and RA V (South-West Pacific) almost 50% of Members have no MWO responsibility, versus for example RA III (South America) and RA VI (Europe) where this is almost nonexistent.

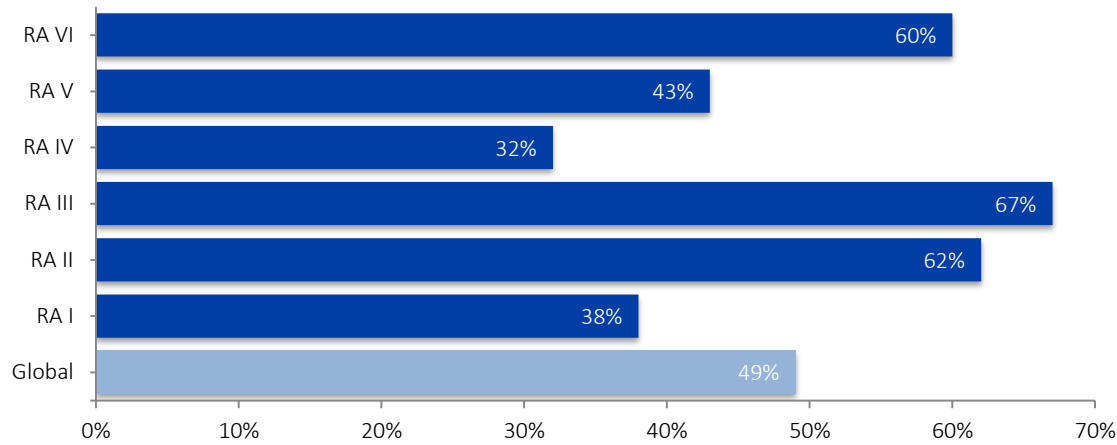


Figure 19. Regional distribution of NMHS serving as MWO provider

The percentage of NMHS and ATS with MWO responsibility is in reality higher as presented when taking the Members with no MWO responsibility into account.

It is concluded that approximately 66% of MWO AMSPs are part of an NMHS organization, and 25% are part of an ATS organization.

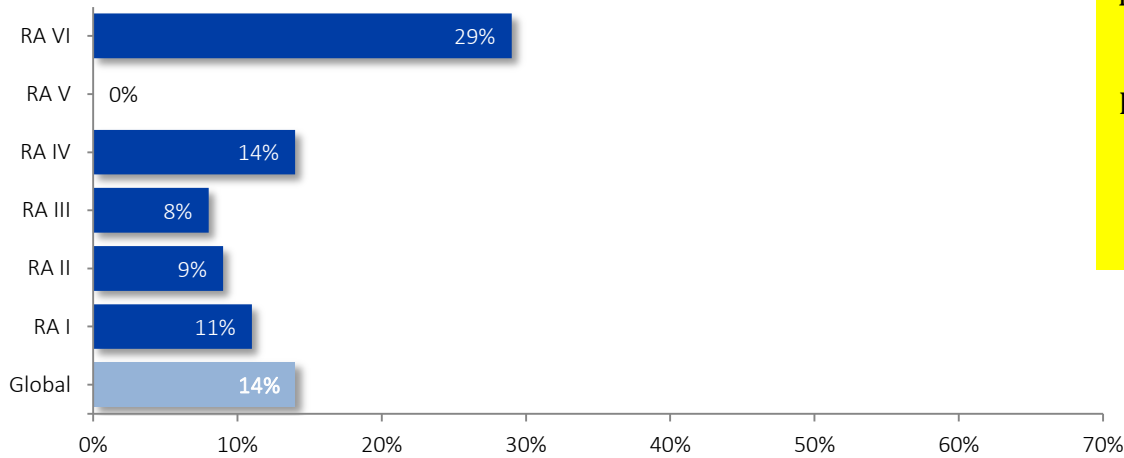
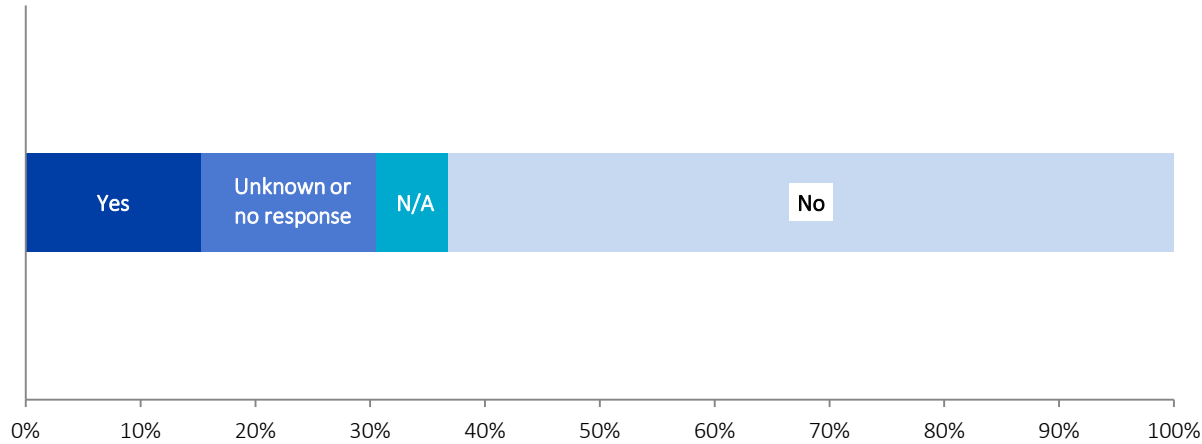
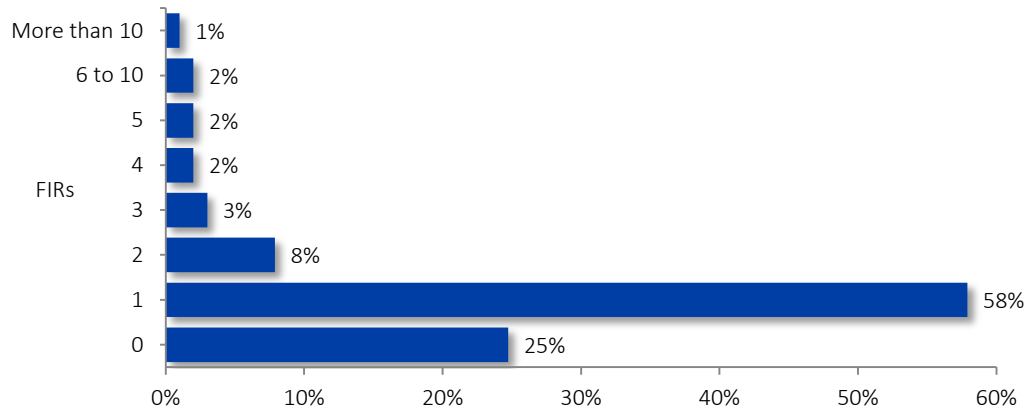


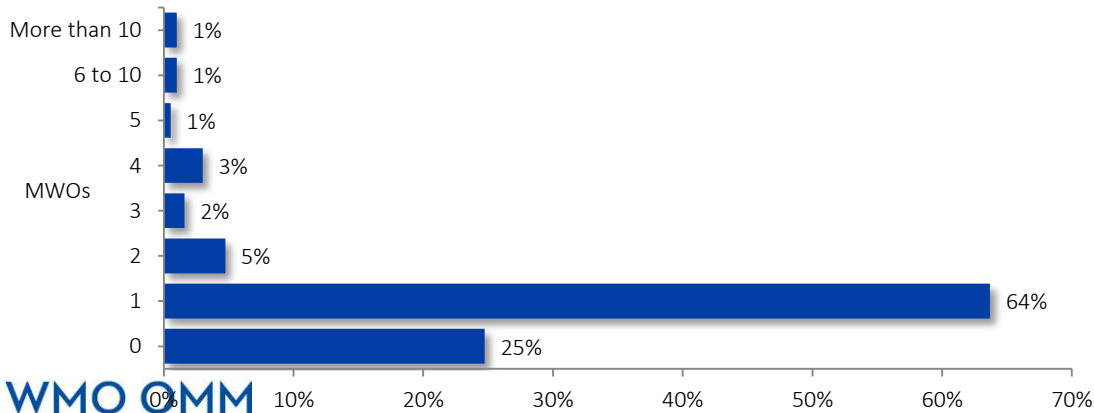
Figure 20. Regional distribution of ATS organizations serving as MWO provider



4.1.4. Are there any bi-lateral arrangements in place in your State/Territory for the delegation of the meteorological watch responsibilities to another State/Territory? (Select only one)



4.1.1. How many Flight Information Regions (FIR) does your State/Territory have responsibility for?



4.1.2. How many MWOs have been established to serve all the FIR(s) and/or Control Areas (CTA) indicated in the preceding question?

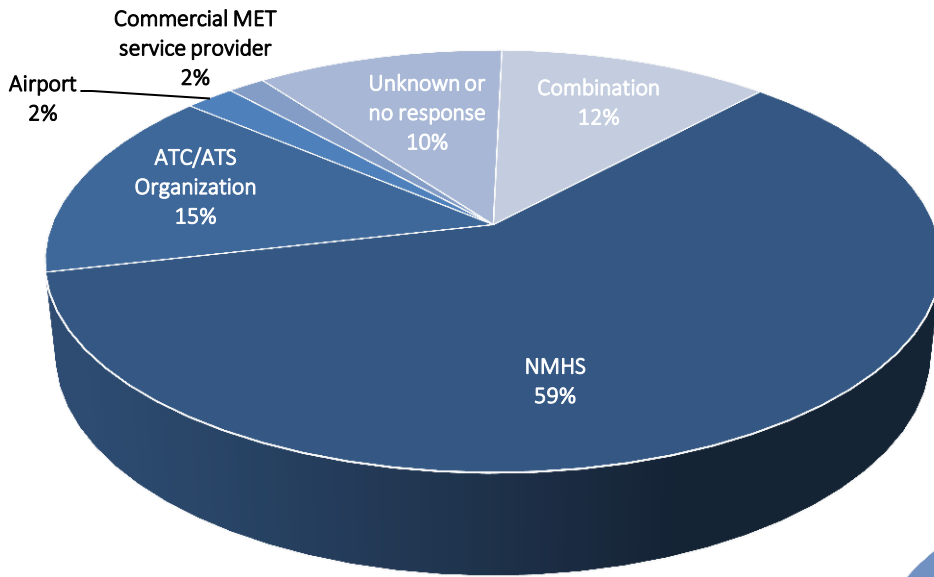


Summary of findings – MWO (1)

- The total number of MWOs provided by Members in this survey, including the MWOs of the 18 Members that did not respond, is 228. The total number of flight information regions (FIR) in this survey is 274, including the FIRs of the 18 Members that did not respond. This is a bit lower than the total number of FIRs in relevant ICAO sources, which is approximately 300 (2017) and not including Upper Information Regions .
- Twenty-five percent of Members indicated that they have no MWO responsibility. This is primarily the case in RA I (Africa) (almost 40%), and in RA IV (North America, Central America and the Caribbean) and RA V (South-West Pacific) (almost 50%).
- The NMHS is the MWO AMSP in 50% of States and Territories. In 14% of the States, this is the air traffic services organization. Military and commercial service providers are the MWO AMSP in 3% of the cases, and this is unknown in 7% of the States and Territories.
- In reality, the percentage of NMHS and ATS that perform the MWO function is higher when taking the Members with no MWO responsibility into account. In that case the percentage of NMHS that serve as MWO AMSP increases from 49% to 64%, and for air traffic services organizations the percentage increases from 14% to 25%.
- Fifteen percent of Members have bi-lateral arrangements in place in their State or Territory for the delegation of the meteorological watch responsibilities to another State or Territory. For 70% of Members arrangements are not in place or not applicable, and this is unknown for 15% of States and Territories.

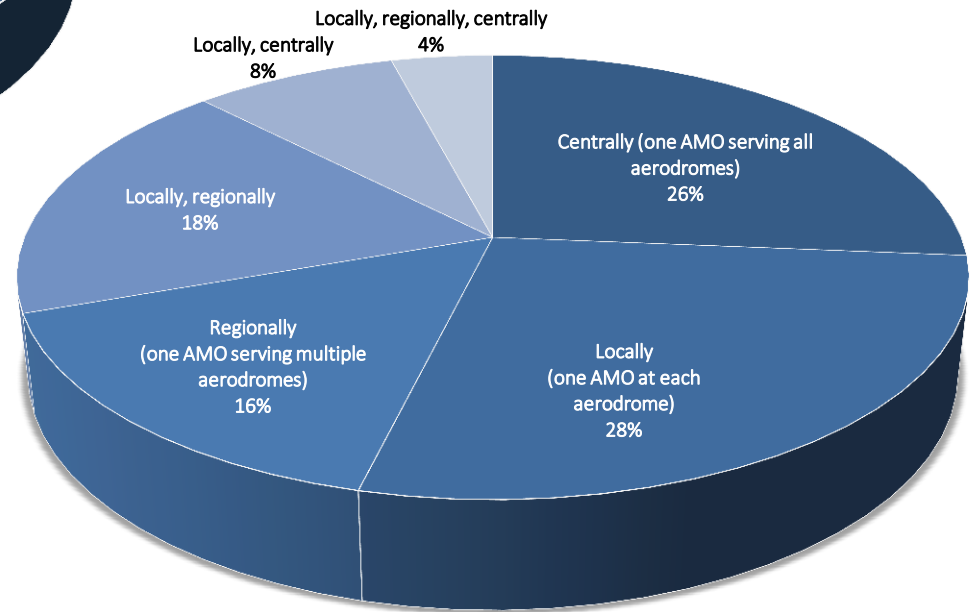
Summary of findings – MWO (2)

- More than 80% of Members provide SIGMET for hazardous phenomena (WS SIGMETs), in combination with or without other SIGMET types or AIRMET. Regional differences exist as for example some regions do not provide AIRMET, and in other regions Tropical Cyclones do not occur and such WC SIGMETs are not provided.
- Twenty-five percent of Members have no responsibility for an FIR, and in almost 60% of cases the Member is responsible for 1 FIR only. In 8% of cases (15 Members) there are 2 FIRs, and 3 until 9 FIRs combined, total another 8 %. There are two Members who have the responsibility for more than 25 FIRs.
- Twenty-five of Members (47 in total) have no MWO responsibility and as such have no MWOs. Sixty-four percent of Members have the responsibility for 1 MWO, and 5% of Members for 2 MWOs. Six percent of Members (13) have the responsibility for more than 2 WMOs, and this ranges from 2 till 9, with the one exception being 28 MWOs.
- In general the number of MWOs is smaller than, or equals the number of FIRs for which a State or Territory is responsible.

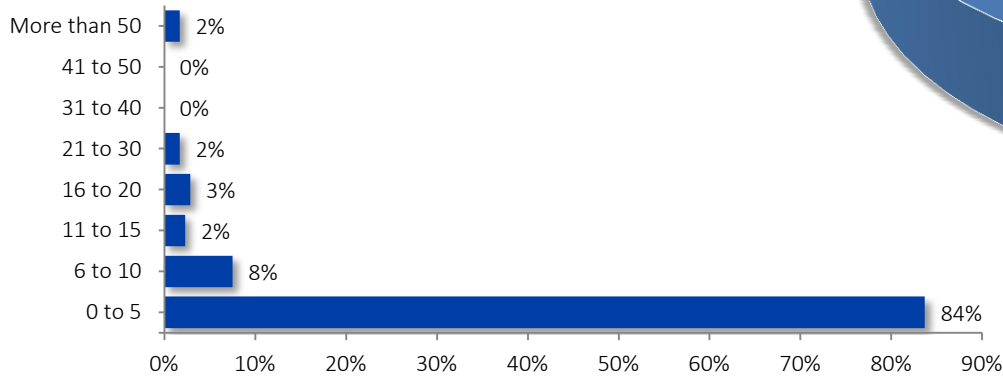


4.2.2. What type of entity provides the AMO functions in your State/Territory?

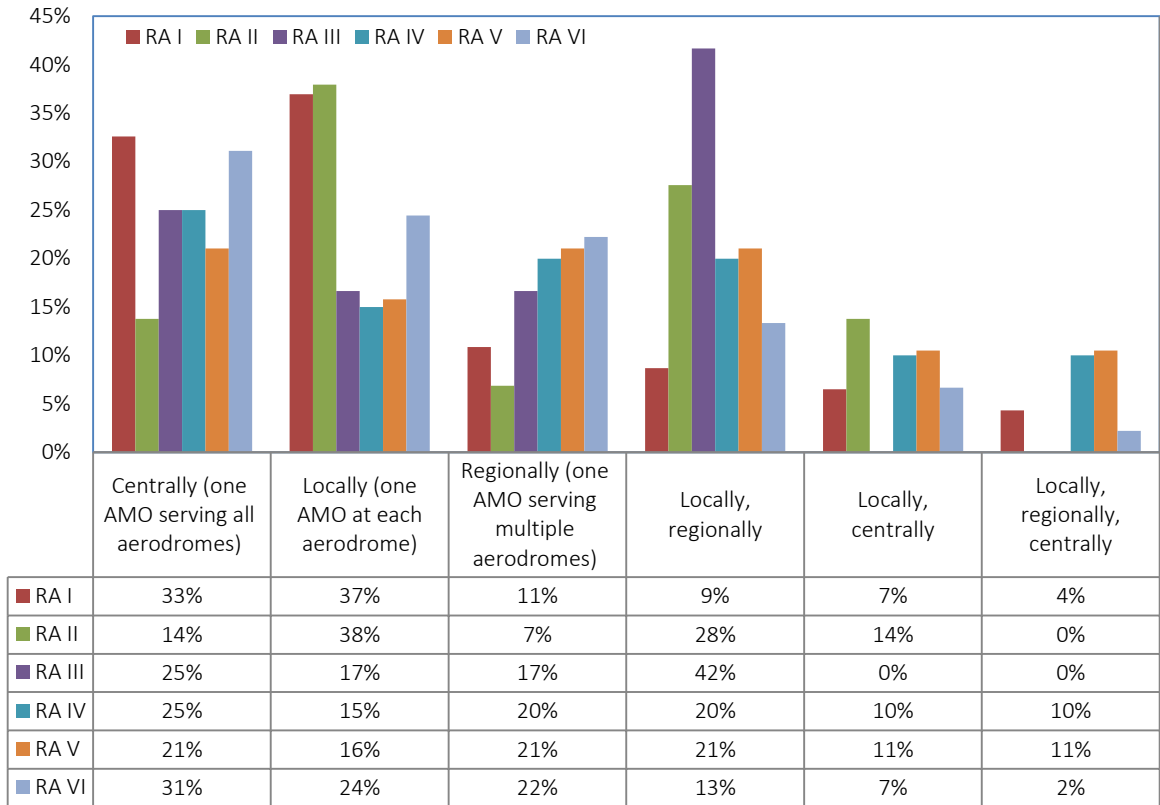
In total there are approximately 600 AMOs globally. This does not include the numbers for AMO of the 18 Members that did not respond.



4.2.3. In what manner are the AMOs in your State/Territory providing forecasting service to aerodromes?



4.2.1. How many Aerodrome Meteorological Offices (AMO) are there in your State?



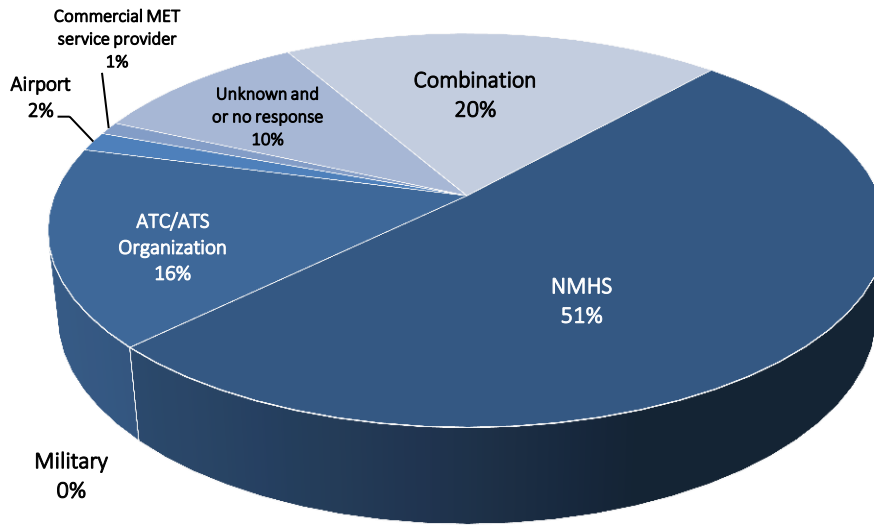
Some variation exists between the regional associations. An AMO locally at the aerodrome is more existent in RA I (Africa) and RA II (Asia), and to some extent in RA VI (Europe). The combination of locally at the aerodrome and regionally scores higher in RA III (South America).

4.2.3. In what manner are the AMOs in your State/Territory providing forecasting service to aerodromes?

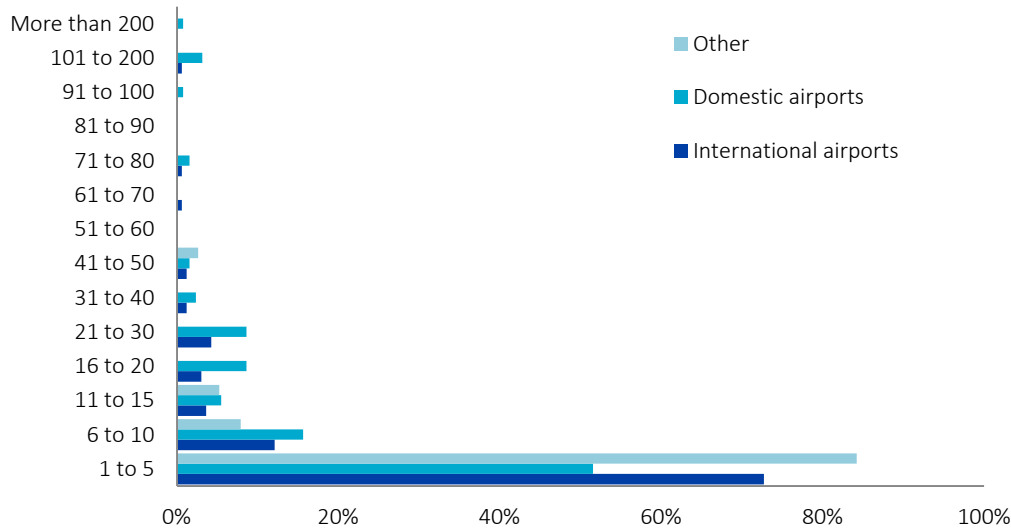
Summary of findings - AMO

- In total there are approximately 600 AMOs globally. This does not include the numbers for AMO of the 18 Members that did not respond.
- The information provided on aerodrome meteorological offices has to be interpreted carefully, as the interpretation of the ICAO/WMO service provision function for AMO can vary from State to State
- In 60% of the States and Territories the AMO AMSP is performed by NMHS organizations only. In 15% the AMO AMSP functions are solely provided by air traffic services organizations. Airports and commercial meteorological service providers each account for 2% of the cases, and for 10% this is unknown. Another 12% is made up of combinations from NMHS, ATS organizations, military, airport and commercial meteorological service providers.
- Almost 40% of Members have 1 AMO, and 25% of Members have 2 AMOs. In total over 80% of States and Territories have less than 5 AMOs. The range from 6 till 10 AMOs amounts for 8% of Members and 13 Members have a number of AMOs in the range from 11 till 30, and there are 3 States with more than 50 AMOs.
- Twenty-eight percent of AMOs are located locally at the aerodrome. Twenty-six percent of Members have one central AMO serving all aerodromes, and 16% have more than one regional AMO serving multiple but not all aerodromes. The other 30% consists of combinations of an AMO locally at the airport combined with a central or regional AMO.
- While precise data on number of AMOs existing in the past is not readily available, it is considered that the numbers of AMOs existing today has reduced over the years as more and more AMO functions performed from a regional or centralized location. In other words, AMO are no longer always physically located at an aerodrome.



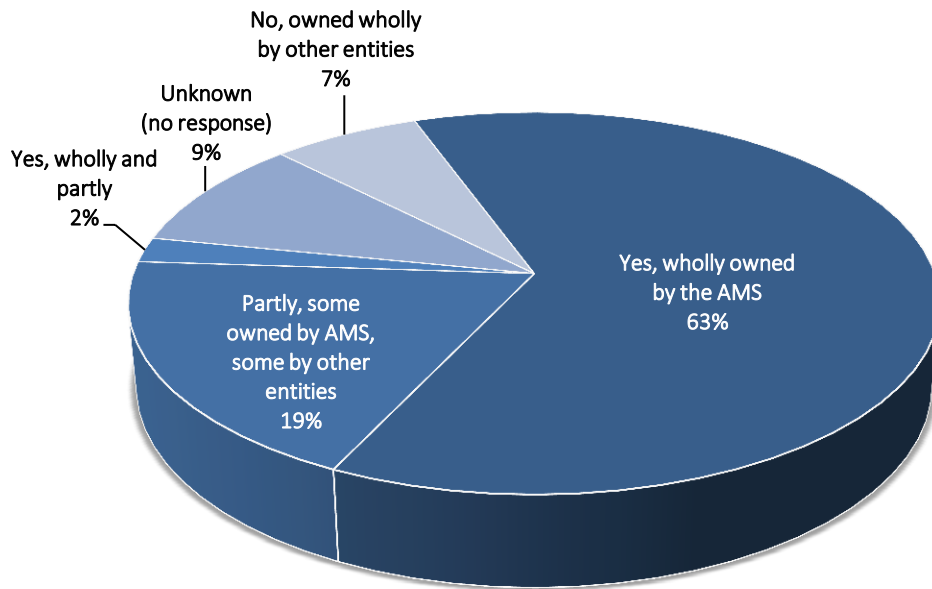


4.3.2. What type of entity provides the AMS functions in your State/Territory?

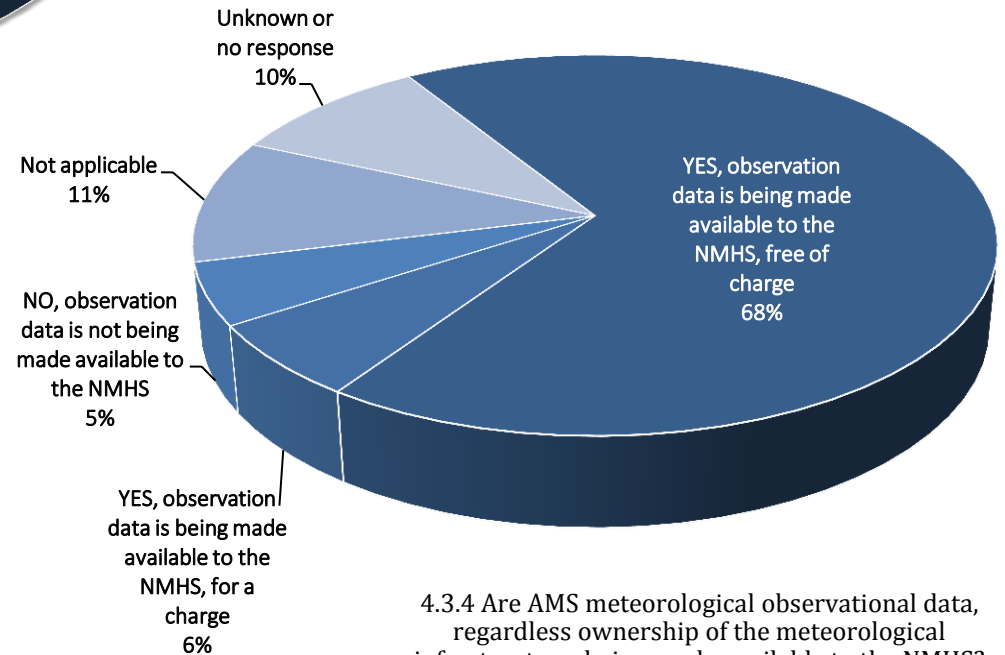


4.3.1. How many Aeronautical Meteorological Stations (AMS) are there in your State/Territory?

In total there are approximately 1,250 AMSs serving international air navigation globally. This does not include the numbers for AMS of the 18 Members that did not respond. The total number of domestic airports for which services are being provided is 2,500.



4.3.3. Is the ownership of the meteorological observation infrastructure at the aerodromes under the responsibility of the AMS?



4.3.4 Are AMS meteorological observational data, regardless ownership of the meteorological infrastructure, being made available to the NMHS?

Seventeen Members indicated that there are issues regarding the sharing and provision of the meteorological observation data in their State of Territory.

4.3.5 Are there any particular concerns with regard to the sharing and provision of the meteorological observation data between service providers in your country?

Summary of findings – AMS (1)

- In total there are approximately 1,250 AMSs serving international air navigation globally. This does not include the numbers for AMS of the 18 Members that did not respond. The total number of domestic airports for which services are being provided is 2,500.
- In more than 50% of the States and Territories the AMS AMSP is performed by NMHS organizations only. In 16% the AMS AMSP functions are solely provided by air traffic services organizations. Airports and commercial meteorological service providers account for respectively 2% and 1%, and for 10% this is unknown. In 20% of States and Territories the AMS AMSPs are made up of a combination of all mentioned entities.
- In 29 States or Territories the NMHS is involved in one of the combinations. This means that for in total 66% of States and Territories the NMHS is involved in providing AMS functions. Similarly this is 28% for air traffic service organizations, 13% for airports, 7% for military and 4% for commercial meteorological service providers.
- Based on the responses of 165 Members (86% of total) 75% percent of Members have 1 to 5 AMSs, and 12% have 6 to 10 AMSs in their State or Territory. The remainder 13% varies between 21 and 50 AMSs, and three Members (France, Russian Federation and United States of America) have respectively 67, 71 and 153 AMSs.

Summary of findings – AMS (2)

- In more than 60% of States and Territories the AMS infrastructure is wholly owned by the AMS AMSP. A situation where some infrastructure is owned by the AMS, and some by other entities exists in 19% of States and Territories.
- In a minority (7%) of the States and Territories the meteorological infrastructure at aerodromes is owned fully by other entities not being the AMS AMSP. Specifically the latter situation could result in challenges regarding the AMS service provision, for example regarding operational, technical, legal or financial issues.
- In a majority (70%) of States and Territories the meteorological observational data of the AMS AMSPs is made available, free of charge, to the NMHS. In 6% of cases a charge is involved for the NMHS and in 5% of States and Territories the observation data is not being made available to the NMHS. 17 Members (9%) indicated that there are issues regarding the sharing and provision of the meteorological observation data in their State of Territory.

Overall findings on MWO, AMO and AMS

- Globally, there are approximately 230 MWOs and at least 600 AMOs and 1,250 AMSs serving international civil aviation . In addition aeronautical meteorological services are being provided to approximately 2,500 domestic airports worldwide.
- There is a notable trend towards centralization of MWO and AMO functions, as well as automation for the AMS function. It is recommended that WMO keeps monitoring these developments in the future.
- In a majority (approximately 60%) of States and Territories, the MWO, AMO and AMS functions are provided by the NMHS. Twenty-five percent of Members have no responsibility to maintain a continuous meteorological watch over a flight information region and, therefore, do not have an MWO.
- Air traffic services organizations are the second largest provider (between 15 and 25%) with 25% performing the MWO function, while military entities, airport authorities and commercial meteorological service providers complete the portfolio of AMSPs.
- The largest variety of entities providing ICAO/WMO functions is noticed for AMS service provision. In 20% of States and Territories, the AMS service provision is made up of a combination of NMHS, air traffic services organizations, military entities, airport authorities and commercial meteorological service providers.

Overall findings on MWO, AMO and AMS

Entities providing the ICAO/WMO services have been identified as:

- NMHS;
- Air Traffic Services organization (ATS);
- Military;
- Airport authorities; and,
- Commercial meteorological service providers, although not as common.

Overview of MWO, AMO and AMS function by type of service provider	Number	Percentage	
MWO, AMO and AMS function provided by NMHS	60	32%	
MWO, AMO and AMS function provided by ATS	20	11%	
MWO, AMO and AMS function provided by military	0	0%	
MWO, AMO and AMS function provided by airport	0	0%	
MWO, AMO and AMS function provided by commercial service provider	1	1%	
Members without MWO responsibility	47	25%	see breakdown
MWO, AMO and AMS function are provided by a mix of service providers	49	26%	see breakdown
Unknown and/or no response to survey	13	7%	
	190	100%	

Table 1 – Entities providing ICAO/WMO functions of MWO, AMO and AMS.

Examples of identified organizational scenario's for MWO, AMO and AMS Service Provision within Members

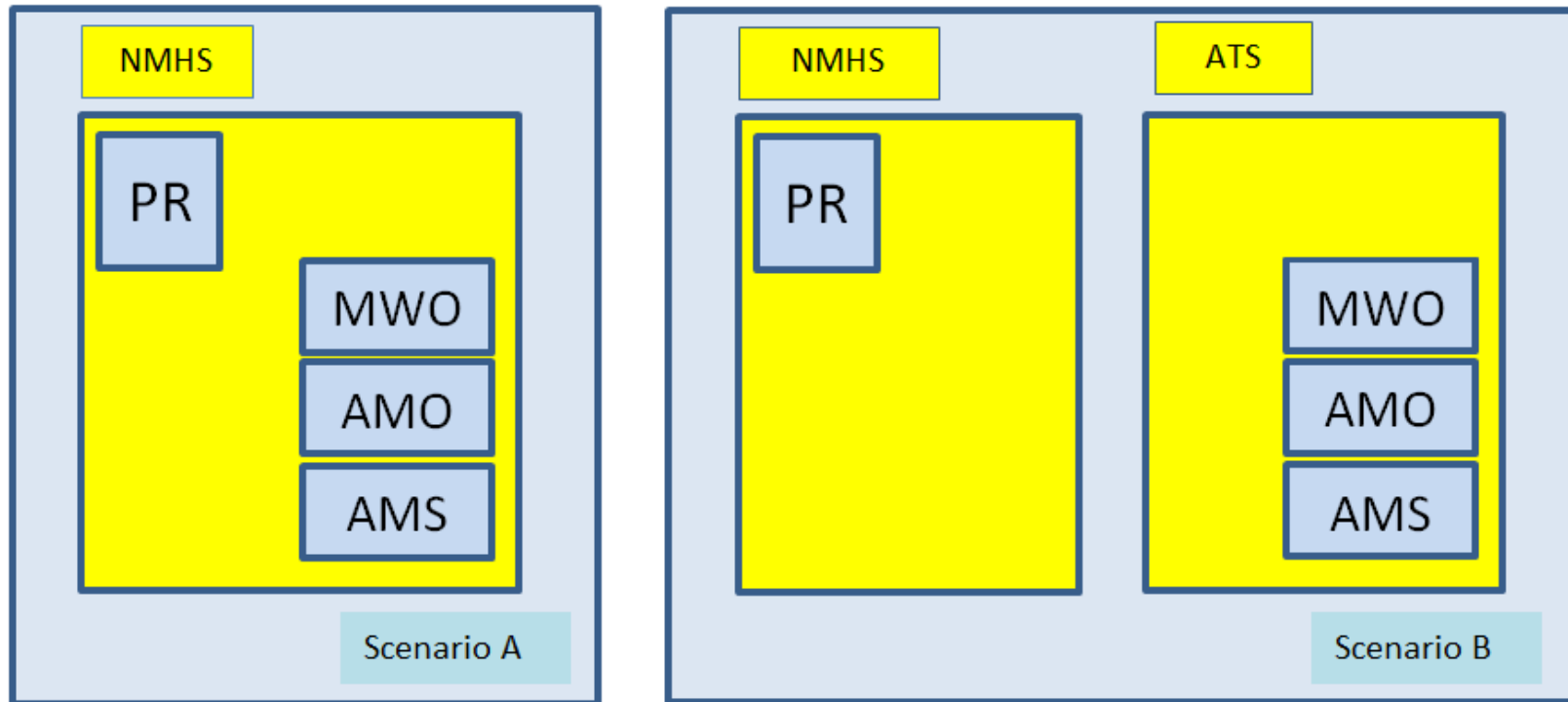


Figure A: Schematic representation of the two situations where one organization, either the NMHS (32%) or the ATS (11%), provides all the ICAO/WMO functions on MWO, AMO and AMS within a State or Territory.

The survey showed that 25% of WMO Members do not have the responsibility for an MWO. In that case the MWO responsibility is mandated to for example a neighbouring country. Both scenario's do not include these 25% of Members, and explains why the percentage of ATS or NMHS providing the MWO functions is higher in the survey.

Examples of identified organizational scenario's for MWO, AMO and AMS Service Provision within Members

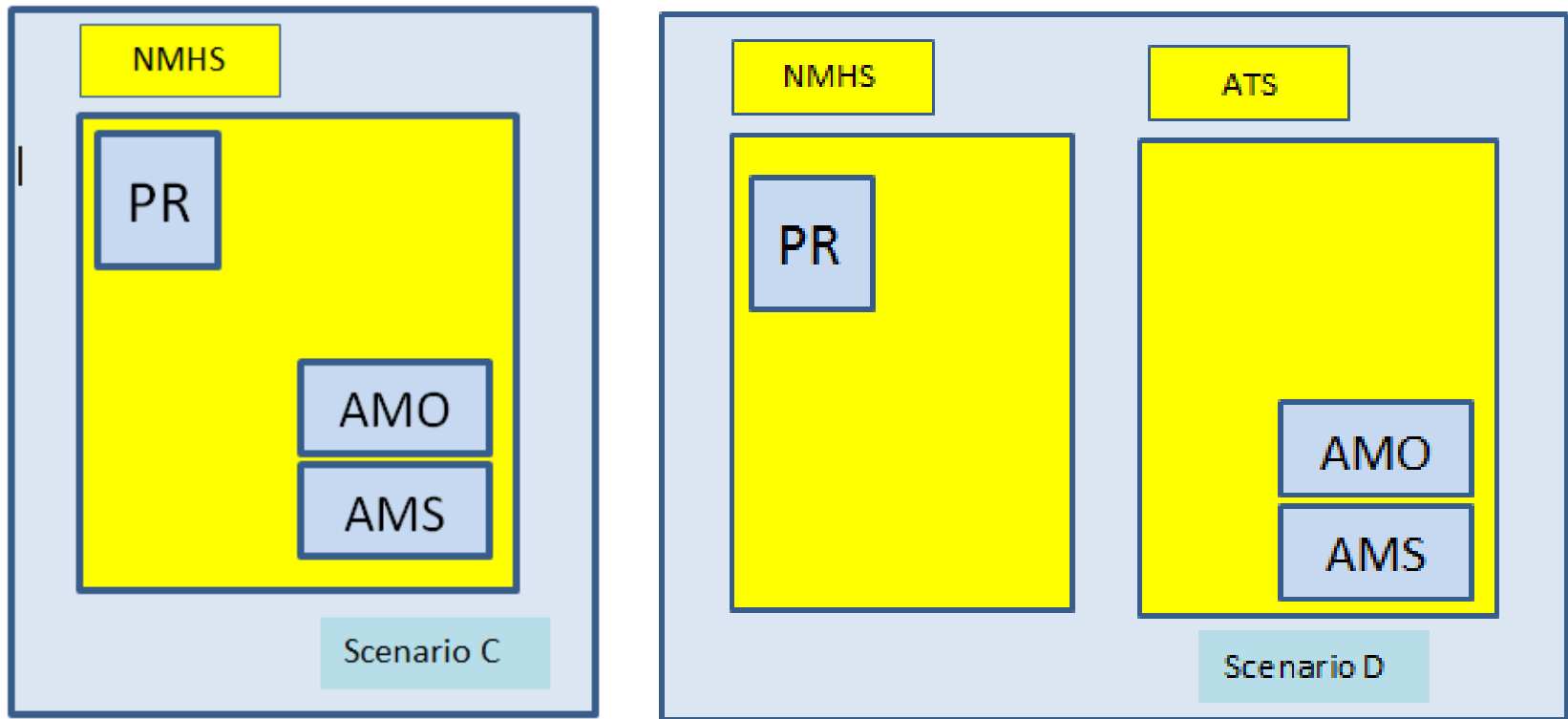


Figure B: Schematic representation of the situation where a Member has no responsibility for an MWO, which is the case for 25% (47 out of 190) of members. Scenario C depicts the situation where the NMHS (14% of the cases, 27 out of 190) provides all the ICAO/WMO functions on AMO and AMS within a State or Territory. In scenario D it is the ATS (2%, 4 out of 190) that provides the AMO and AMS functions.



Examples of identified organizational scenario's for MWO, AMO and AMS Service Provision within Members

Continuation of the 25% of Members that have no MWO responsibility. In most cases the MWO responsibility is mandated to a neighbouring country.

The remaining ICAO/WMO functions to be provided are AMO and AMS, see previous slide. For 3% the situation is unknown (6 out of 190), and the remaining 5% (10 out of 190) consists of a mix of NMHS, ATS and airport providing the AMO and AMS functions, see table 2.

Breakdown of AMO and AMS function for Members without MWO responsibility (47 Members which is 25% of total Members)	Number	Percentage	Percentage of total
AMO and AMS function provided by NMHS	27	57%	14%
AMO and AMS function provided by ATS	4	9%	2%
AMO and AMS function provided by military	0	0%	0%
AMO and AMS function provided by airport	0	0%	0%
AMO and AMS function are provided by a mix of service providers	10	21%	5%
Unknown and/or no response to survey	6	13%	3%
	47	100%	25%

Table 2 – Breakdown of entities providing ICAO/WMO functions of MWO, AMO and AMS for Members that do not have the responsibility for an MWO.

Examples of identified organizational scenario's for MWO, AMO and AMS Service Provision within Members

For 26% of Members the MWO, AMO and AMS functions are being provided by a mix of service providers of NMHS, ATS, military, airport and commercial service providers. In the majority of cases (18% of the total of 26%) the NMHS is involved in the MWO service provision, see table 3 on the next slide.

In 11% (of the total of 26%) of cases the NMHS is involved in both the MWO and AMO service provision, see table 4 on the next slide. For ATS these numbers are 4% and 1% respectively.

Examples of identified organizational scenario's for MWO, AMO and AMS Service Provision within Members

Breakdown of MWO, AMO and AMS function that are provided by a mix of service providers (49 Members which is 26% of total Members). This breakdown focuses primarily on the service provision of the MWO function.	Number	Percentage	Percentage of total
MWO function provided by NMHS , and AMO and AMS function is provided by a mix of NMHS, ATS, military, airport and commercial service providers	34	69,4%	18%
MWO function provided by ATS , and AMO and AMS function is provided by a mix of NMHS, ATS, military, airport and commercial service providers	7	14,3%	4%
MWO function provided by military , and AMO and AMS function is provided by a mix of NMHS, ATS, military and airport	2	4,1%	1%
MWO function provided by commercial service provider , and AMO and AMS function is unknown	1	2,0%	1%
MWO function provided by NMHS AND commercial service provider , and AMO and AMS function is provided by a mix of NMHS, ATS, military and airport	3	6,1%	2%
MWO function provided by NMHS AND military , and AMO and AMS function is provided by a mix of NMHS, ATS, military, airport and commercial service providers	1	2,0%	1%
MWO function provided by NMHS AND ATS AND commercial service provider , and AMO and AMS function is provided by a mix of NMHS, ATS, military and airport	1	2,0%	1%
	49	100%	26%

Table 3 – Breakdown of entities providing ICAO/WMO functions of MWO, AMO and AMS for Members where a mix of service providers exist.

Examples of identified organizational scenario's for MWO, AMO and AMS Service Provision within Members

Breakdown of MWO, AMO and AMS function that are provided by a mix of service providers (49 Members which is 26% of total Members). This breakdown focuses on the combined service provision of the MWO and AMO function. It shows that the largest variety of service providers is found for the AMS service provision.	Number	Percentage	Percentage of total
MWO and AMO function provided by NMHS , and AMS function is provided by a mix of NMHS, ATS, military, airport and commercial service providers	21	43%	11%
MWO and AMO function provided by ATS , and AMS function is provided by a mix of NMHS and ATS	1	2%	1%
MWO, AMO and AMS function provided by a mix of NMHS, ATS, military, airport and commercial service providers.	27	55%	14%
	49	100%	26%

Table 4 – Breakdown of entities providing ICAO/WMO functions of MWO, AMO and AMS for Members where a mix of service providers exist. The breakdown focuses on the combined service provision of the MWO and AMO function.

Examples of identified organizational scenario's for MWO, AMO and AMS Service Provision within Members

The largest variation of service providers is found for the service provision of the ICAO/WMO function of AMS. This is the case for 31% of Members (26% + 5% of the Members with no MWO responsibility). The amount of variation is large, and such it is not possible to depict all these situations in a schema. A generic overview is shown in the Figure below.

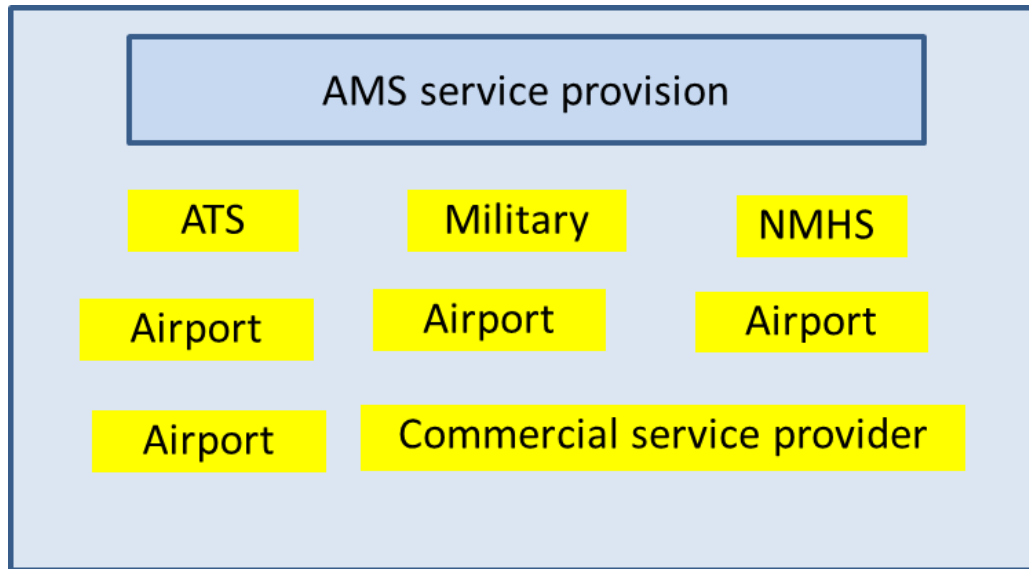
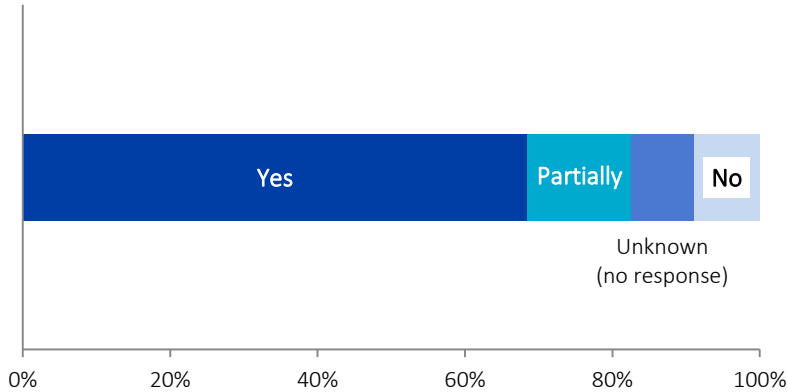
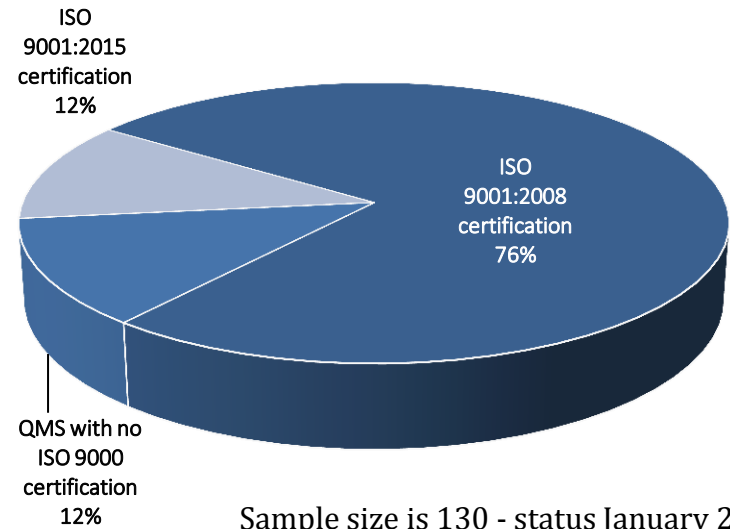


Figure C: Schematic representation of the service provision for the ICAO/WMO function of AMS where the MWO, AMO and AMS functions are being provided by a mix of different service providers.

5. Compliance monitoring with focus on QMS, competency and qualification



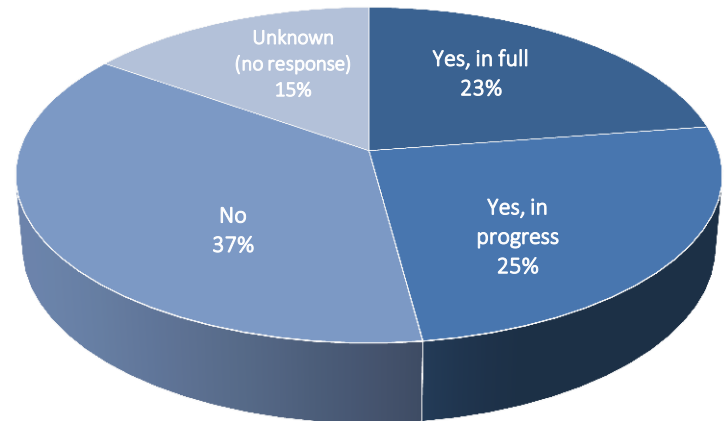
5.1. Have the Aeronautical Meteorology Service Providers (AMSPs) in your State/Territory established a properly organized Quality Management System (QMS) for the provision of aeronautical meteorological service to international air navigation?



Sample size is 130 - status January 2017

5.1. If your answer to the preceding question was "YES" please provide an indication of the type of QMS implemented

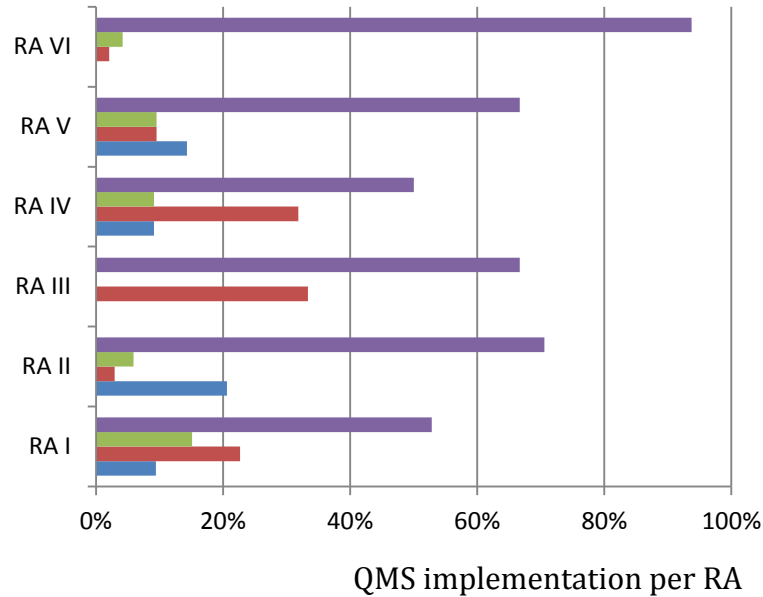
Reasons provided for partial or zero implementation of QMS are lack of funding and/or human resources, and/or low priority of the government



5.2. Has a Safety Management System (SMS) been established for the provision of the aeronautical meteorological service in your State/Territory?

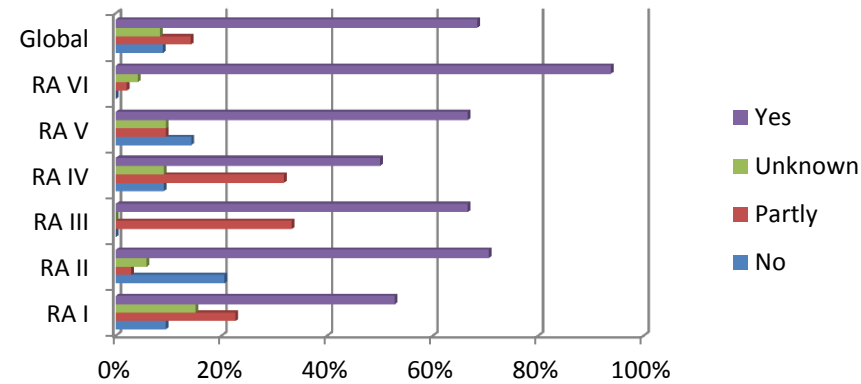
5.1. If your answer to the preceding question was "NO" please provide a brief explanation of the reason for lack of an established QMS

Regional characteristics - QMS



QMS	RA I	RA II	RA III	RA IV	RA V	RA VI	Global
No	9%	21%	0%	9%	14%	0%	9%
Partly	23%	3%	33%	32%	10%	2%	14%
Unknown	15%	6%	0%	9%	10%	4%	8%
Yes	53%	71%	67%	50%	67%	94%	68%
	100%	100%	100%	100%	100%	100%	100%

■ Yes
■ Unknown
■ Partly
■ No

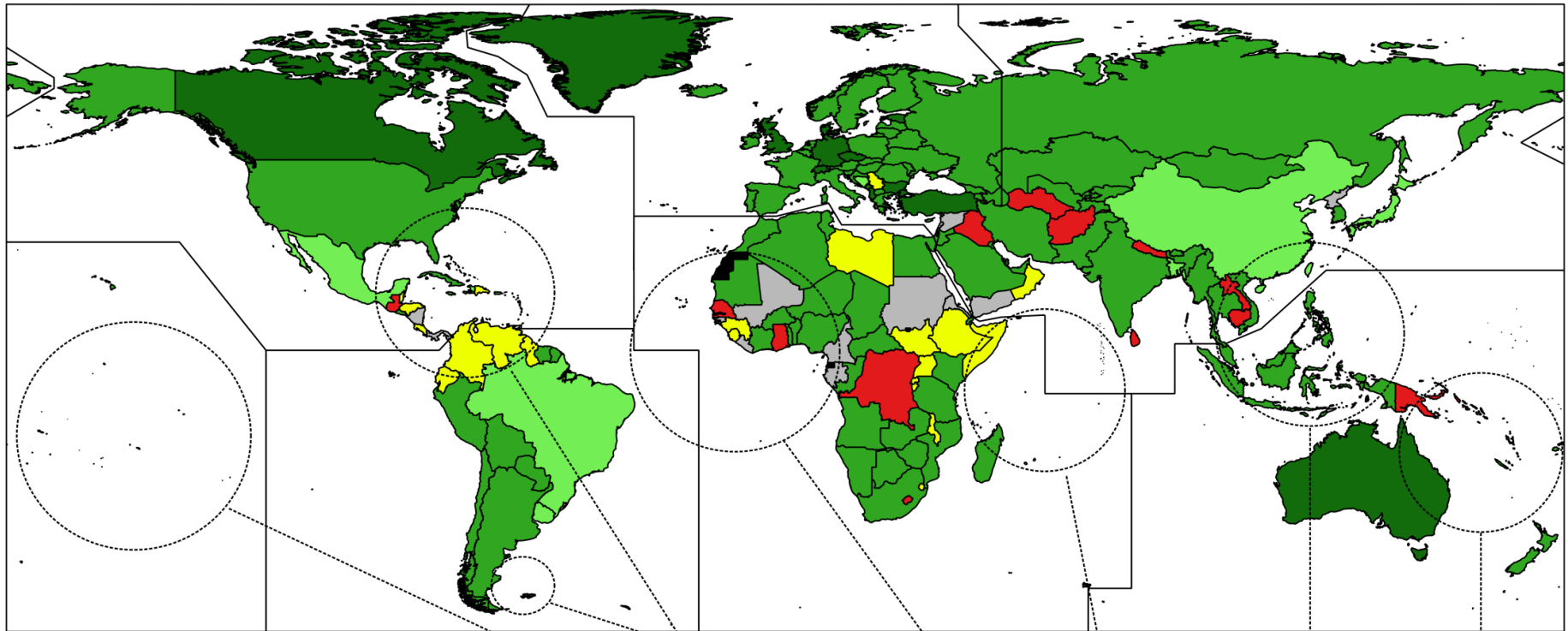


QMS implementation per RA and global average

- RA I – Second lowest full QMS implementation, 53%
- RA II – Second highest full QMS implementation, 71%
- RA III – High partial QMS implementation, together with RA I and RA IV
- RA IV – Lowest full QMS implementation, still 50%
- RA V – Full QMS implementation 67%
- RA VI – Highest full QMS implementation, 94%



Overview of global implementation and type of Quality Management System for aeronautical meteorological service provision (Status January 2017)



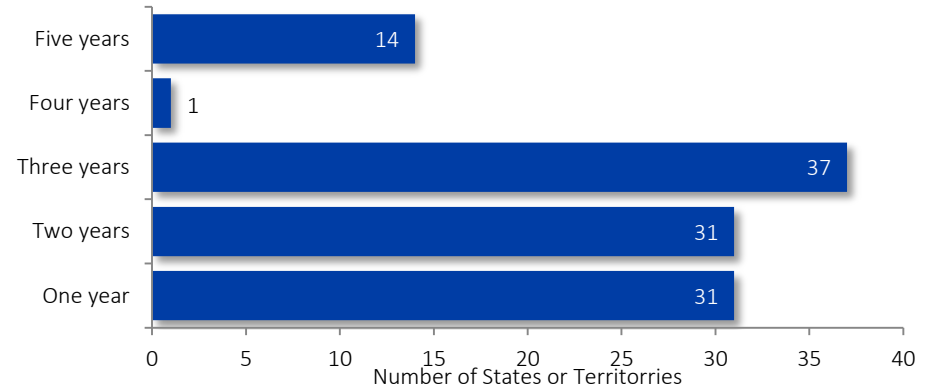
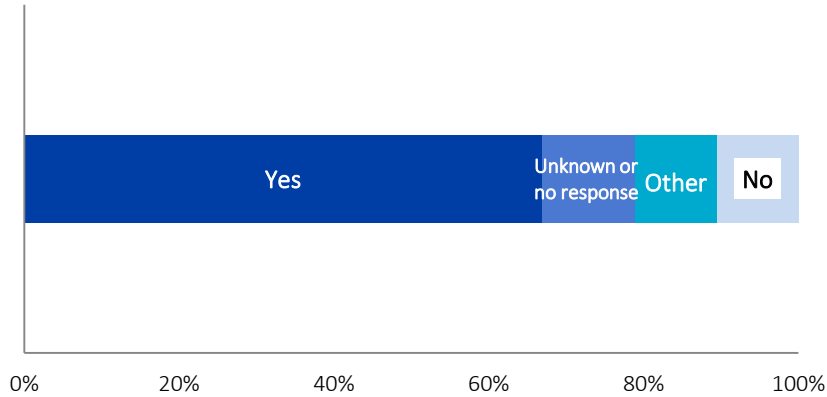
Legend (n=190)

- Yes - ISO 9001:2015 (7%)
- Yes - ISO 9001:2008 (51%)
- Yes - ISO 9000 but without certification (8%)
- Partially (17%)
- No (9%)
- Unknown (8%)
- Disputed

French Polynesia	Falklands/Malvinas	Republic of Cabo Verde	Comoros	Maldives	Brunei Darussalam	Singapore	Fiji	New Caledonia
Cook Islands	Jamaica	Sao Tome and Principe	Seychelles	Mauritius	Hong Kong, China	Macao, China	Micronesia, Federated States of	Solomon Islands
Samoa	Curacao and Sint Maarten				Timor-Leste		Vanuatu	Tuvalu
Tonga	Antigua and Barbuda							
	Bahamas							
	British Caribbean Territories							
	Haiti							
	Trinidad and Tobago							
	Barbados							
	Dominica							
	Dominica Republic							
	Saint Lucia							
	Niue							

Summary of findings - QMS

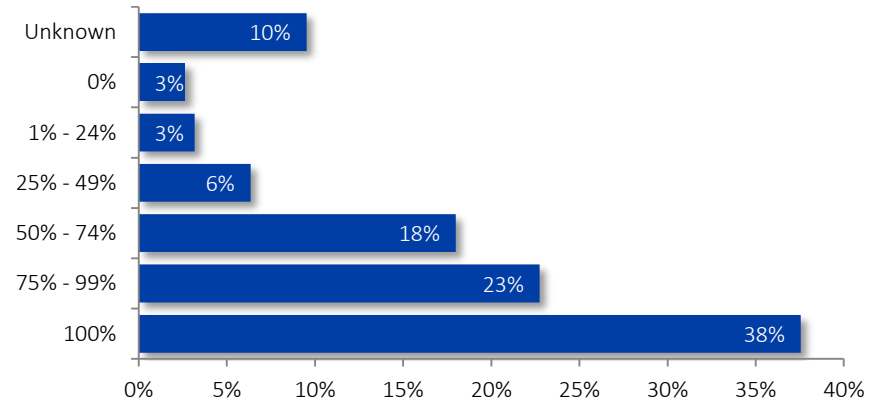
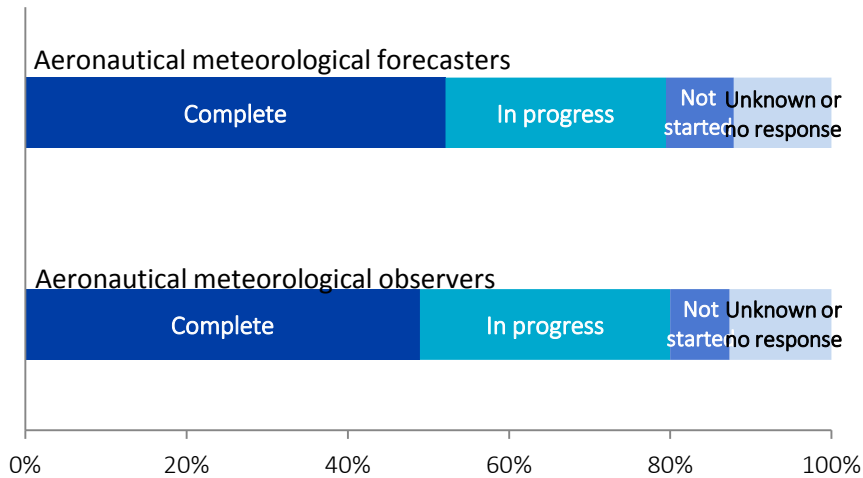
- In a majority of States and Territories (over 80%) the AMSPs have a fully (68%) or partially (14%) implemented QMS. **This is a significant improvement compared to previous years.** At the same time more than 30% of Members face a regulatory risk because of lack or only partially implemented QMS. The main reasons for such non-compliance have been stated as lack of funding and/or human resources, or low priority given by the government.
- The status of QMS implementation is given on a State or Territory level. Multiple entities can provide the MWO, AMO and AMS functions in a State or Territory and it is likely that one or more of these AMSPs is not compliant. It is difficult to reflect this situation on a State Level, and it is the understanding of CAeM that in many cases the QMS implementation status of the main AMSP is used. So in reality the number of States and Territories where AMSPs have fully implemented QMS may be lower as AMO and AMS AMSPs may not have been taken into account. A possible way to overcome this is to start reporting the QMS implementation for MWO, AMO and AMS AMSPs in a State or Territory.
- Of the AMSPs that are fully compliant 12% have an ISO 9001:2015 certification. Given the required update towards ISO 9001:2015 before October 2018, it is concluded that a considerable effort is still required from Members to either comply with the upgrade of the ISO standard or to become fully QMS compliant.
- At present there is no ICAO or WMO requirement for AMSPs to have a safety management system (SMS) in place. In 23% of States and Territories an SMS is fully implemented, and 25% are in progress of implementing. In many of the States where an SMS is implemented the AMSP entity is the air traffic services organization, for which SMS requirements do exist.



Sample size is 114 - status January 2017

5.3 Has a national competency assessment programme for aeronautical meteorological personnel been established in your State/Territory to ensure compliance with the WMO competency requirements?

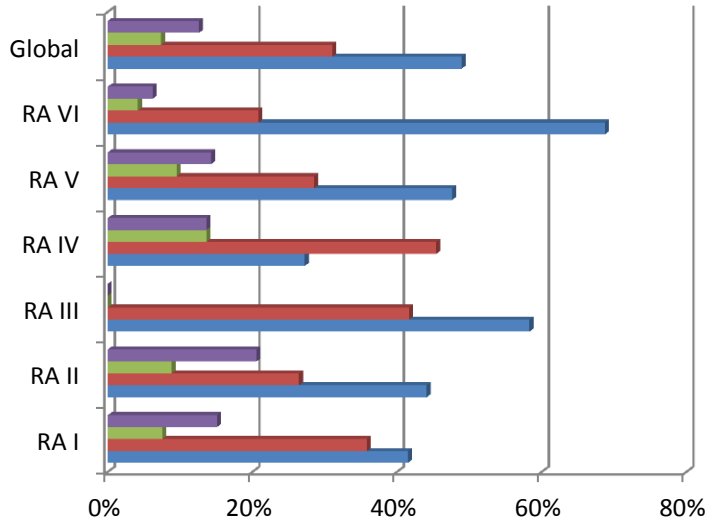
5.3. If your answer to the preceding question was "YES", what is the frequency of the competency assessment (in years)?



5.5. What is the readiness in your State/Territory to comply with the WMO qualification standard for aeronautical meteorological forecasters to become applicable on 1 December 2016?

5.4. What is the status of the competency assessment of aeronautical meteorological personnel (observers and forecasters) in your State/Territory in accordance with the competency standards of WMO (applicable since 1 December 2013)?

Regional characteristics - AMF



AMF	RA I	RA II	RA III	RA IV	RA V	RA VI	Global
Complete	42%	44%	58%	27%	48%	69%	49%
In progress	36%	26%	42%	45%	29%	21%	31%
Not started	8%	9%	0%	14%	10%	4%	7%
Unknown	15%	21%	0%	14%	14%	6%	13%
	100%	100%	100%	100%	100%	100%	100%

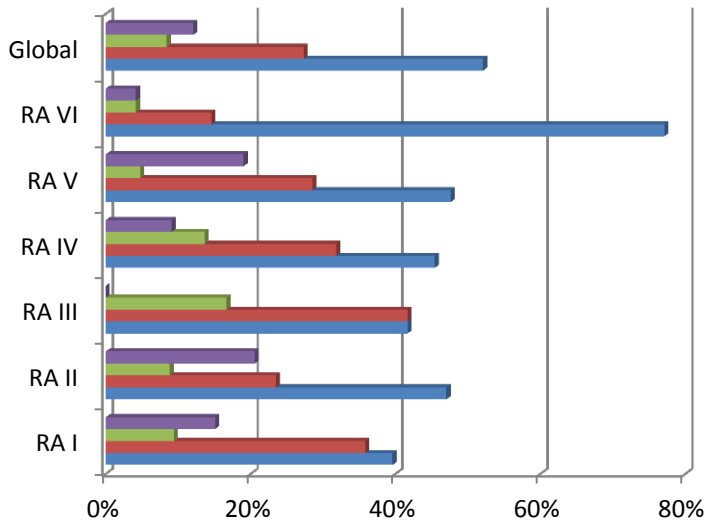
- Unknown
- Not started
- In progress
- Complete

AMF – status of competency assessment per RA and global average

- RA I – Thirty-six percent in progress, 8% not started and 15% unknown
- RA II – Nine percent not started, and 21% unknown
- RA III – Second highest complete (58%) and all remaining are in progress (42%)
- RA IV – Lowest percentage not complete (27%) and highest percentage not started (14%)
- RA V – Twenty-nine percent in progress, 10% not started and 14% unknown
- RA VI – Highest percentage complete (69%)

Regional characteristics - AMO

Competency Assessment



AMO	RA I	RA II	RA III	RA IV	RA V	RA VI	Global
Complete	40%	47%	42%	45%	48%	77%	52%
In progress	36%	24%	42%	32%	29%	15%	27%
Not started	9%	9%	17%	14%	5%	4%	8%
Unknown	15%	21%	0%	9%	19%	4%	12%
	100%	100%	100%	100%	100%	100%	100%

- Unknown
- Not started
- In progress
- Complete

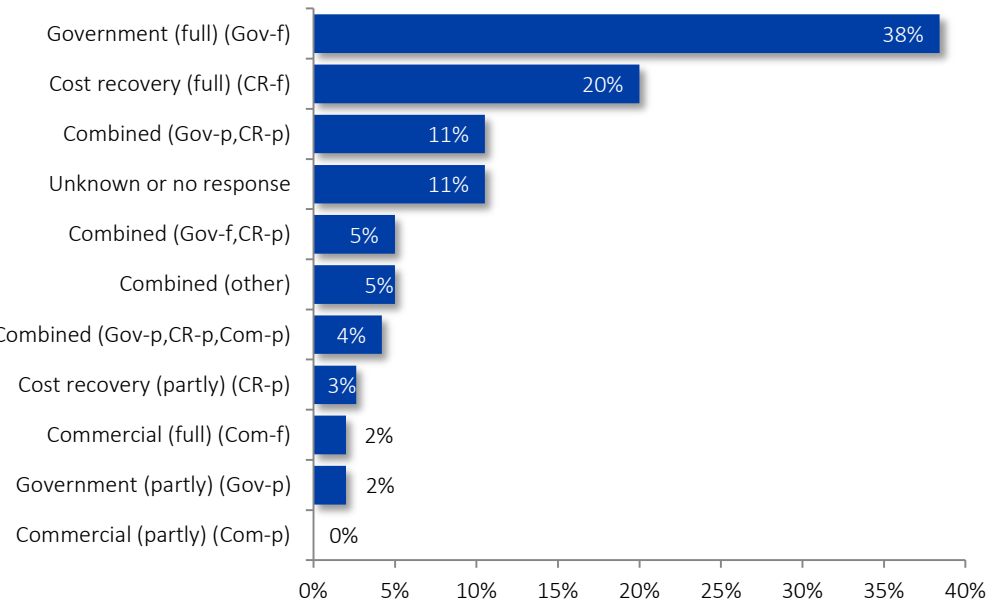
AMO – status of competency assessment per RA and global average

- RA I – RA I till RA V show similar numbers, circa 45% complete
- RA II – RA I till RA V show similar numbers, circa 45% complete
- RA III – RA I till RA V show similar numbers, circa 45% complete
- RA IV – RA I till RA V show similar numbers, circa 45% complete
- RA V – RA I till RA V show similar numbers, circa 45% complete
- RA VI – Highest percentage complete (77%)

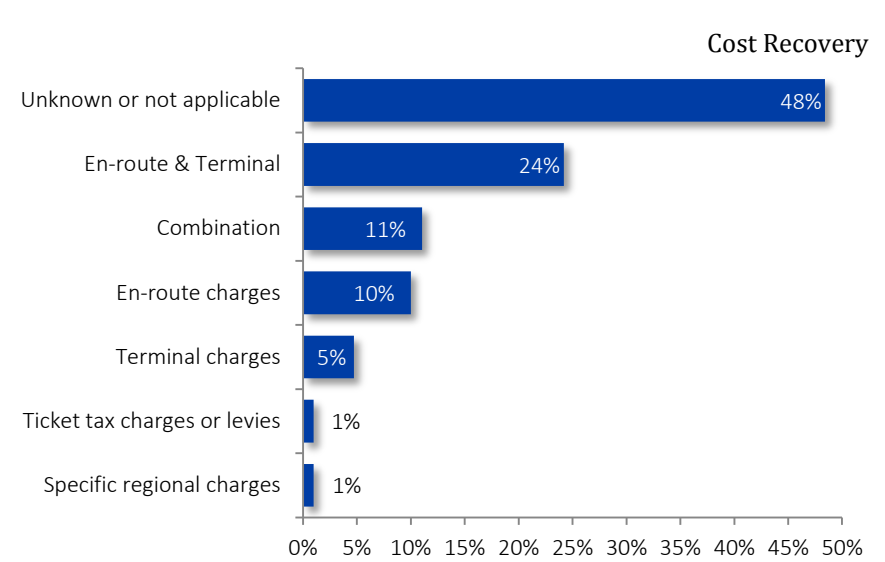
Summary of findings – competency assessment

- Almost 70% of States and Territories have established a national competency programme for aeronautical meteorological personnel. The frequency of the competency assessment varies and ranges between 1 and 5 years.
- By the time of the survey approximately 50% of Members have completed their competency assessment for aeronautical meteorological observers and forecasters in accordance with the competency standards of WMO which are applicable since the 1st of December 2013. Circa 30% of Members are in progress to comply with the competency assessment standards. Eight percent of Members have not started yet, and for 12% the status is unknown.
- Close to 40% of Members indicate that their AMSPs are fully compliant with the WMO qualification standard for aeronautical meteorological forecasters (AMF) which is applicable since the 1st of December 2016. Forty percent of Members indicated that 50% till 99% of their AMFs are compliant, for 12% of Members less than half of their AMFs comply, and the status is unknown for 10% of Members.
- In a majority of States and Territories the AMSPs comply with competency assessment for aeronautical meteorological observers and forecasters, and qualification standards for aeronautical meteorological forecasters. At the same time many Members face a regulatory risk because of non-compliance with competency assessment and qualification standards. Main reasons for such non-compliance have not been stated and several Members provided information on the status of their national plans to comply with WMO standards.

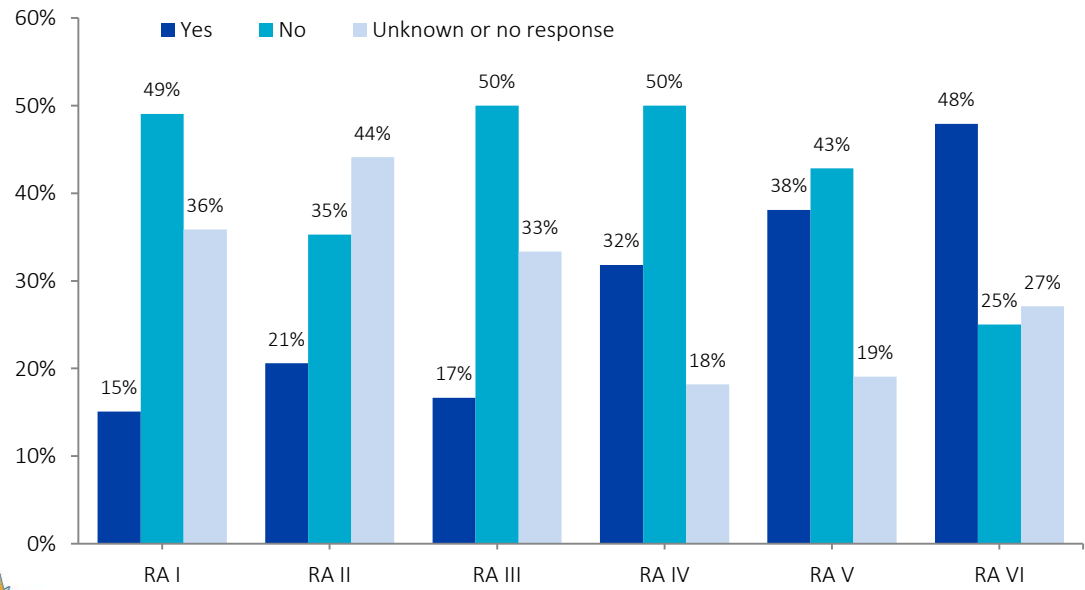
6. Cost recovery for the provision of aeronautical MET service



6.1. What is the funding mechanism for aeronautical meteorological service provision in your State/Territory?



6.2. If cost recovery exists in your State/Territory, what type of charges are represented in the mechanism used to recover costs for the provision of aeronautical meteorological service?



6.3. Does your State/Territory include a portion of the cost for core meteorological facilities or services (core cost) in the cost recovery arrangements for aeronautical meteorological service provision?

See full survey report for response to 6.3 and 6.4

6.3. If your answer to the preceding question was "YES", please specify the portion (as percentage) of the "core cost"

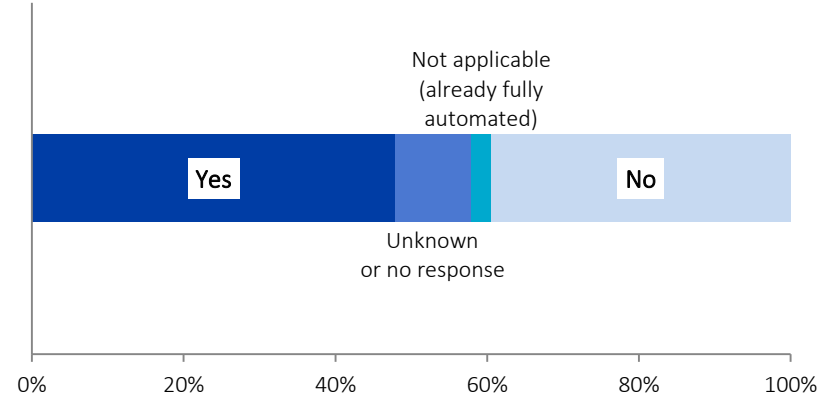
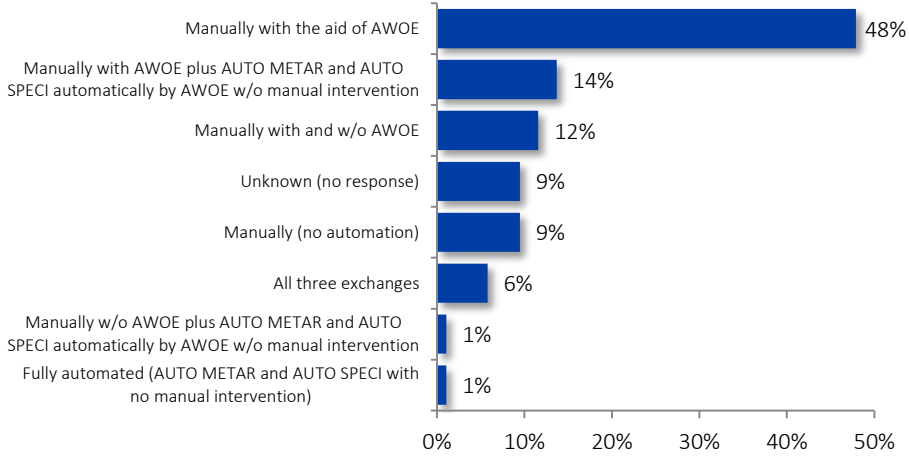
6.4. Please feel free to provide any other remark that you feel may be of use for this survey concerning cost recovery



Summary of findings – cost recovery

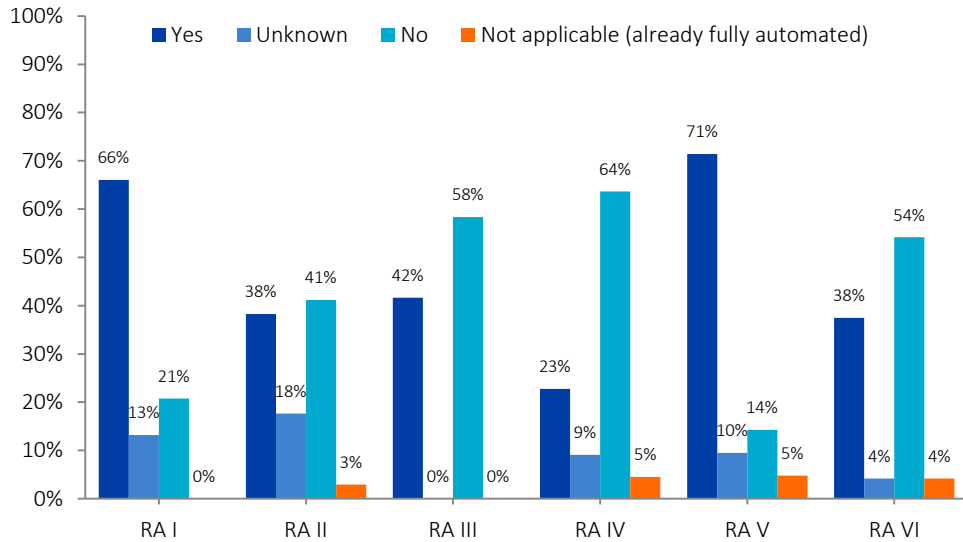
- Various arrangements for cost recovery exist, with certain types of cost recovery for aeronautical meteorological service provision applied in half of the States and Territories.
- In approximately 40% of Members the aeronautical meteorological service provision is fully funded by the government budget, and in 20% the service provision is fully funded via cost recovery mechanisms. For 30% of States and Territories the funding mechanism is made up of combinations of government funding, cost recovery and commercial revenues.
 - Some caution about these figures since financial arrangements may exist at State level unknown to the respondent.
- Significant variations exist between Members concerning the proportion of core costs being allocated to aeronautical meteorological service provision.
- Cost allocation and cost recovery for the provision of aeronautical meteorological service is an issue for a number of Members. WMO should consider to assist these Members by providing further guidance and support in order to help sustainable service provision.

7. Details on technical capacity in the provision of aeronautical MET service



7.1.1. Please indicate the nature of aerodrome observations produced in your State/Territory for international exchange.

7.1.2. Are there plans in your State/Territory for migrating to fully automated aerodrome observations?



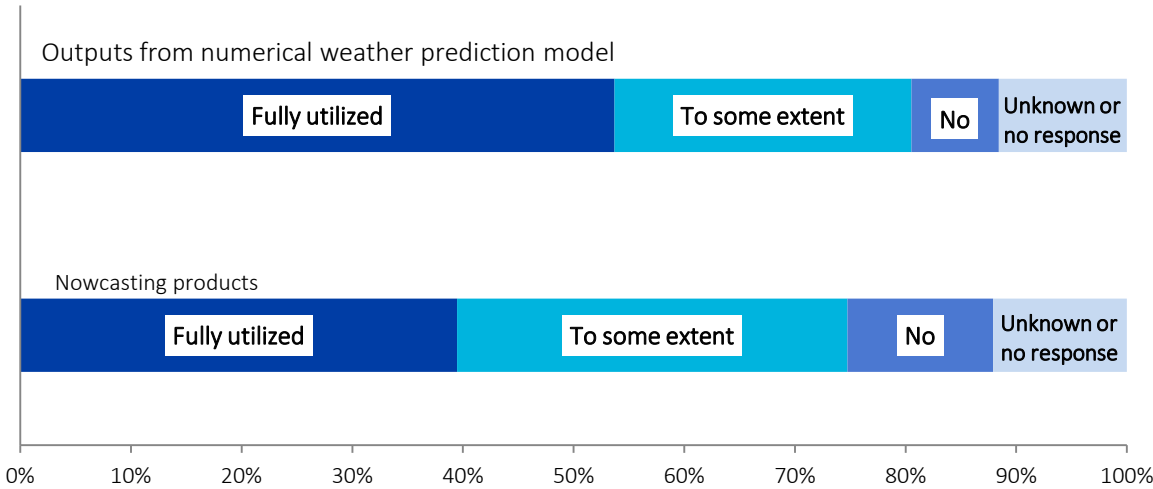
The reasons for not migrating fully to automated aerodrome observations vary significantly between States and Territories and across regions and includes quality issues, lack of funding or negative business cases as well as States and Territories that opt for a hybrid approach. Such hybrid approaches include fully automated observations only outside opening hours or non-operational hours of the aerodrome, semi-automated observations only with manual supervision over the system, and scenarios consisting of a mix of fully automated observations and manual observations, supported by automated weather observing equipment, for larger and or congested airports.

7.1.2. Are there plans in your State/Territory for migrating to fully automated aerodrome observations?



Summary of findings – aerodrome observations

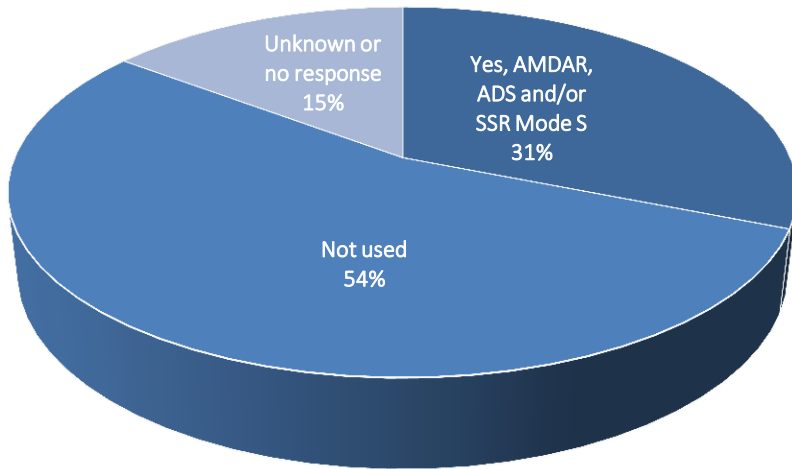
- In almost half (48%) of the States and Territories the AMS AMSPs produce METAR and SPECI manually with the aid of automated weather observing equipment. In 9% of States and Territories the METAR and SPECI are produced without the aid of automated weather observing equipment. The production of AUTO METAR and AUTO SPECI (with no manual intervention) only is the case in less than 1% of the States and Territories. In 32% of States and Territories the aerodrome observations are made up of a combination of these three methods of producing METAR and SPECI.
- Almost 50% of members indicated that there are plans to migrate to fully automated aerodrome observations, which is already the case for 3% of Members. Almost 40% of Members indicated that there are NO plans to migrate to fully automated aerodrome observations. The differences in this regard between regional associations are significant, for example in RA I (Africa) and RA V (South-West Pacific) approximately 70% of Members plan for full automation, where this is 40% in other regions, and 23% in RA IV (North America, Central America and the Caribbean).
- The reasons for not migrating fully to automated aerodrome observations vary significantly between States and Territories and across regions and includes quality issues, lack of funding or negative business cases as well as States and Territories that opt for a hybrid approach. Such hybrid approaches include fully automated observations only outside opening hours or non-operational hours of the aerodrome, semi-automated observations only with manual supervision over the system, and scenarios consisting of a mix of fully automated observations and manual observations, supported by automated weather observing equipment, for larger and or congested airports.



In total 117 Members provided information on the products and outputs used for nowcasting and forecasting in support of international air navigation. In general these are numerical weather prediction models and their outputs, weather radar, satellite imageries, WAFS data and lightning detection information. Mentioned in RA VI (Europe) are also Model Output Statistics and Ensemble forecast products. Little information was provided regarding the use of the data in the forecast production process.

7.2.1. Please indicate the extent to which your AMO(s) utilize nowcasting products and numerical weather prediction model output in the production of aeronautical meteorological forecasts and aerodrome warnings.

7.2.2. If your answer to the preceding question was "To some extent" or "Fully utilized", please indicate the types of the products/outputs used and their application in the forecast production process.



The responses are categorized in two parts:

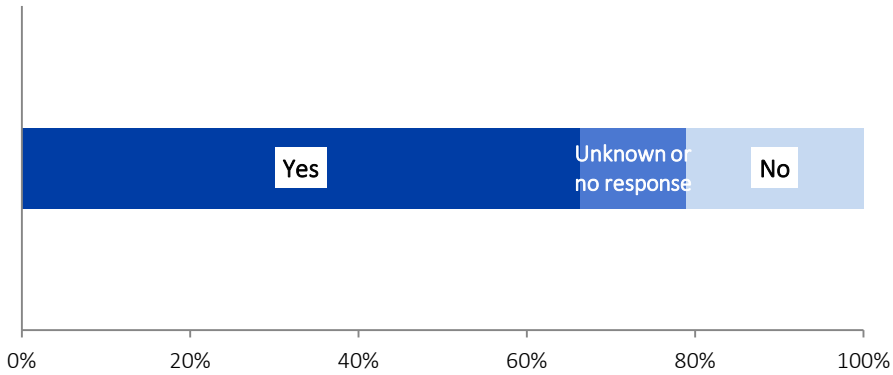
1. The aircraft-based observations (mainly wind and temperature) are used to produce initial fields for global and limited-area numerical weather prediction models, to provide weather model nowcasts and forecasts, and to verify numerical weather prediction models.
2. The aircraft based observations (mainly wind and temperature) are used by forecasters of MWO, AMO and AMS for the production of meteorological products and services.

7.4.1. Please indicate whether aircraft-based observations are used in the meteorological forecast production process

If your answer to the preceding question was "YES", please provide details of how such observations are used

Summary of findings – NWP and ABO

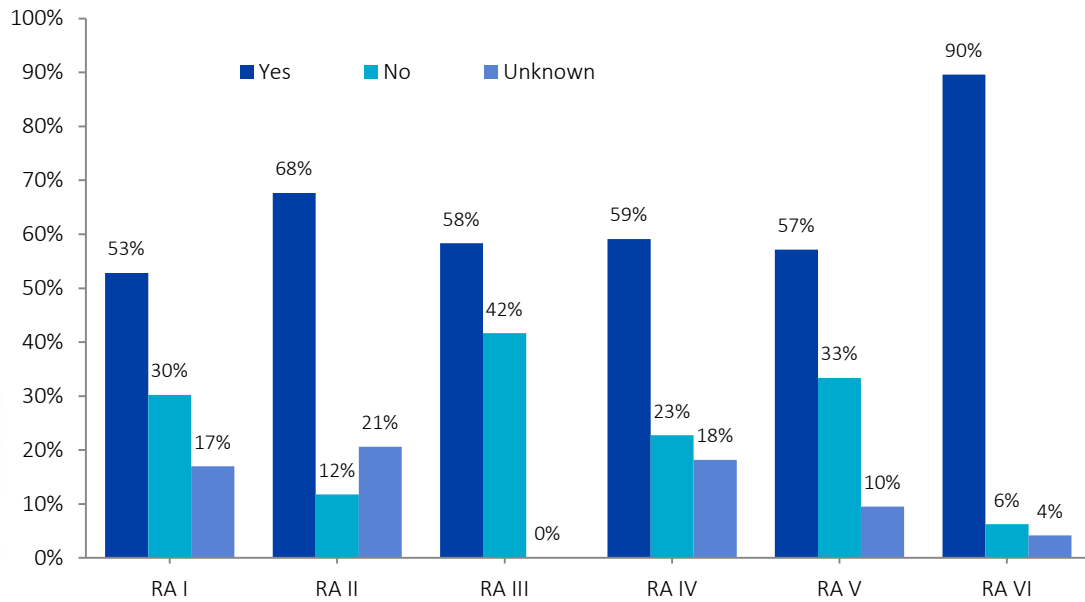
- Almost 80% of AMO AMSPs do utilize NWP output and nowcasting products (fully or to some extent) in the forecasting process, including warnings, while a minority of approximately 10% of AMSPs do not.
- Products and outputs used for nowcasting and forecasting in support of international air navigation are in general numerical weather prediction models and their outputs, weather radar, satellite imageries, WAFS data and lightning detection information.
- The specific models, satellites and systems that are used vary significantly between the regional associations.
- At the time of survey 30% of Members use aircraft based observations from AMDAR, ADS and or SSR Mode S in the aeronautical meteorological forecast production process.
- The use of the observations, mainly wind and temperature, is twofold. As input for NWP to provide weather model nowcasts and forecasts, as well as for NWP verification. And as information to be used by forecasters of MWO, AMO and AMS AMSPs for the production of meteorological products and the provision of services.



Of the 66% of Members that do conduct forecast verification almost half (44%) verifies TAF only. The other half is made up of combinations of TAF, SIGMET/AIRMET, and aerodrome warnings.

7.3.1. Please indicate whether your AMSP(s) conduct forecast verification.

If “YES”, please provide an indication of the types of forecast products for which verification is conducted.



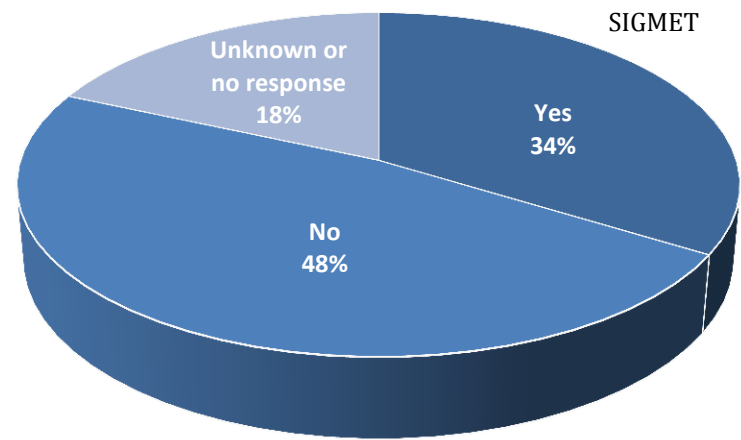
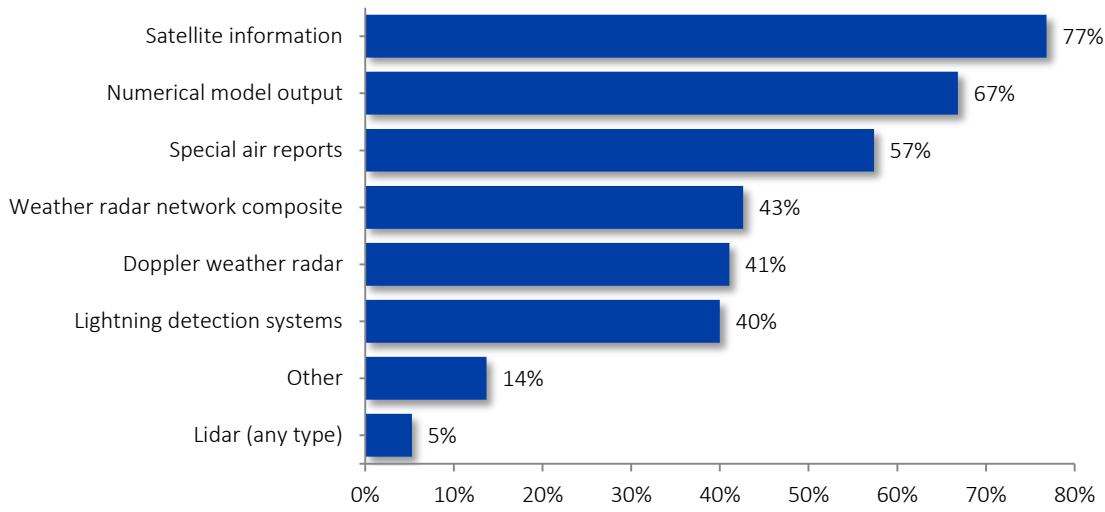
Based on the responses it can be concluded that the percentage of Members that will have verification in place for one or more meteorological forecast products for aviation as of 2019 will be around 80%.

7.3.1. Please indicate whether your AMSP(s) conduct forecast verification.

If “NO”, please provide an indication of whether forecast verification activities are planned and, if so, by when.

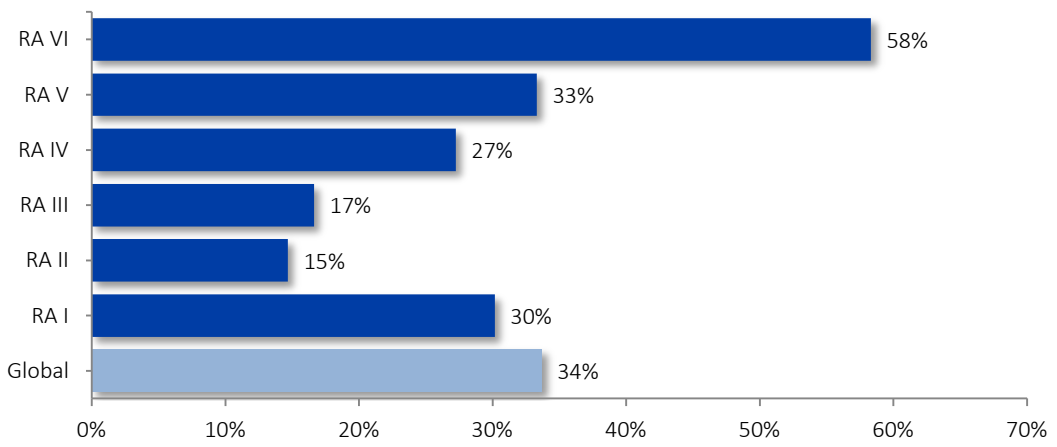
Summary of findings – forecast verification

- Almost 70% of States and Territories conduct forecast verification for either TAF, AIRMET/SIGMET or aerodrome warnings, and this percentage will go up to 80% by 2019.
 - Note: forecast verification should be an element of the QMS
- In every regional association at least 50% of States and Territories conduct forecast verification, but the highest level of forecast verification implementation is by far in RA VI (Europe) with 90%.



7.5.1. Please indicate which of the following information sources are used in the production of SIGMET and AIRMET information?

7.5.2. Do the MWO(s) in your State/Territory conduct cross-border coordination for SIGMET production with MWO(s) in neighboring FIR(s)?



In total 63 Members provided details on cross-border coordination for SIGMET production with MWOs in neighboring FIRs. In general the States or Territories where MWO AMSPs conducted SIGMET coordination were mentioned. For overview see the full Survey report.

7.5.2. Do the MWO(s) in your State/Territory conduct cross-border coordination for SIGMET production with MWO(s) in neighboring FIR(s)?

If your answer to the preceding question was "YES", please provide details

Summary of findings - SIGMET

- A multitude of information sources is used for the production of AIRMET or SIGMET by MWO AMSPs. Most used are satellite information (almost 80%) and Numerical weather model data output (almost 70%) as well as Special Air Reports (60%). Followed by lightning detection systems, weather radar network composite and Doppler weather radar (all 40%), and Lidar is used in 5% of the States and Territories.
- In 35% of States and Territories the MWO AMSPs conduct cross-border coordination for SIGMET production with MWOs in neighboring FIRs.

Summary of findings – advanced products and services

7.6.1. Please provide information on advanced products and services to air traffic management (ATM) beyond those currently defined in ICAO Annex 3/WMO Technical Regulations No. 49, Volume II. Explain briefly the types of advanced products and services and the methods used to make them available or to disseminate them.

- Forty Members provided information on advanced products and services to air traffic management beyond these currently defined in ICAO Annex 3 and WMO Technical Regulations No. 49, Volume II.
- This included weather radar data, space weather information, as well as services for airports and airlines. The majority of responses identified services for air traffic services organizations in much detail. These are for example special nowcasts and forecasts as input for airport collaborative decision making and decision support systems, LVP and probabilistic forecasts, turbulence and lightning products, wind aloft and integrated terminal weather systems.

Of the 99 Members that responded 59 Members provided a response that included current ICAO Annex 3 products and services.

Forty Members provided information on advanced products and services to air traffic management beyond these currently defined in ICAO Annex 3 and WMO Technical Regulations No. 49, Volume II. This included weather radar data and space weather information.

Several services for airports and airlines were mentioned. The majority of responses identified services for air traffic services organizations in much detail. These are for example special nowcasts and forecasts as input for airport collaborative decision making and decision support systems, LVP and probabilistic forecasts, turbulence and lightning products, wind aloft and integrated terminal weather systems.

A full overview of the responses provided is available in Appendix 5 of the Survey report.

8. Identification of Members' challenges to inform CAeM priorities

Top 10 priorities as indicated by members

1. Migration to XML
2. Qualification of AMF (including lack of qualified personnel)
3. QMS implementation/maintenance
4. Maintenance and calibration of observing equipment
5. Automation of aerodrome observation
6. Meeting demands for advanced products and services
7. Cost-recovery implementation
8. Competency assessment
9. SIGMET quality
10. Advanced MET information and services for terminal area

8.1. From your perspective, please choose up to 5 challenges faced by the AMSP(s) in your State/Territory at present and in the near future.

Summary of findings – Members priorities

- For the top 10 priorities see previous slide.
- Several Members identified other challenges for example competition from other providers (private sector, commercial providers or regionalization) on aeronautical meteorological service provision. Especially in Europe there is the challenge to comply with the cost reduction targets of Single European Sky, and at the same time comply with regulations and to contribute to increased safety and capacity by improving meteorological services for air traffic management.
- The identified challenges have an operational focus. An explanation for this could be that the pre-defined challenges by CAeM have an operational focus itself. Another explanation could be the operational nature of the respondents that have been contacted to conduct the CAeM survey.
- This shows that there is still a need to support and assist Members and it is recommended that WMO continues to support capacity development, provide technical assistance, and stimulates regional coordination and initiatives to further improve aeronautical meteorological service provision.

8. Final comments / requests for support

Overview of requests for support by responders, and non-responders by RA

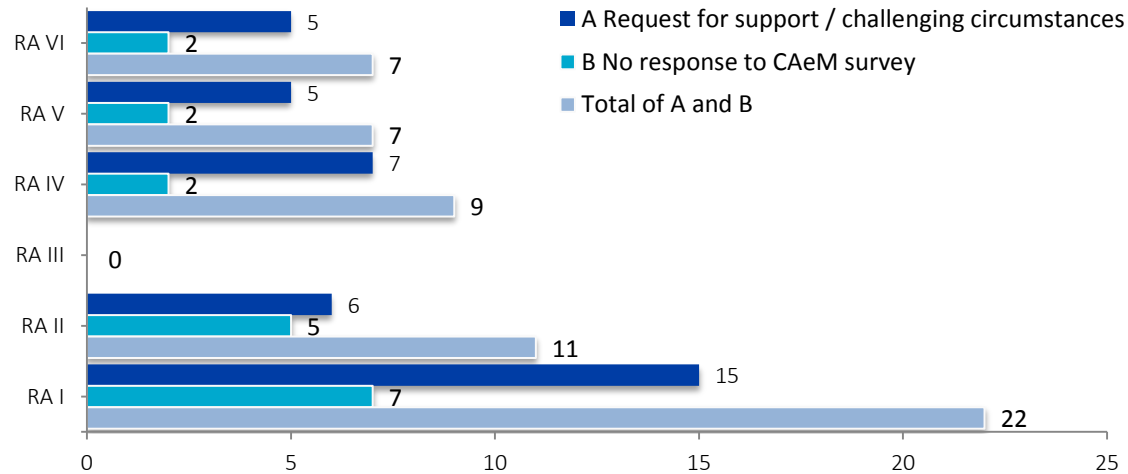


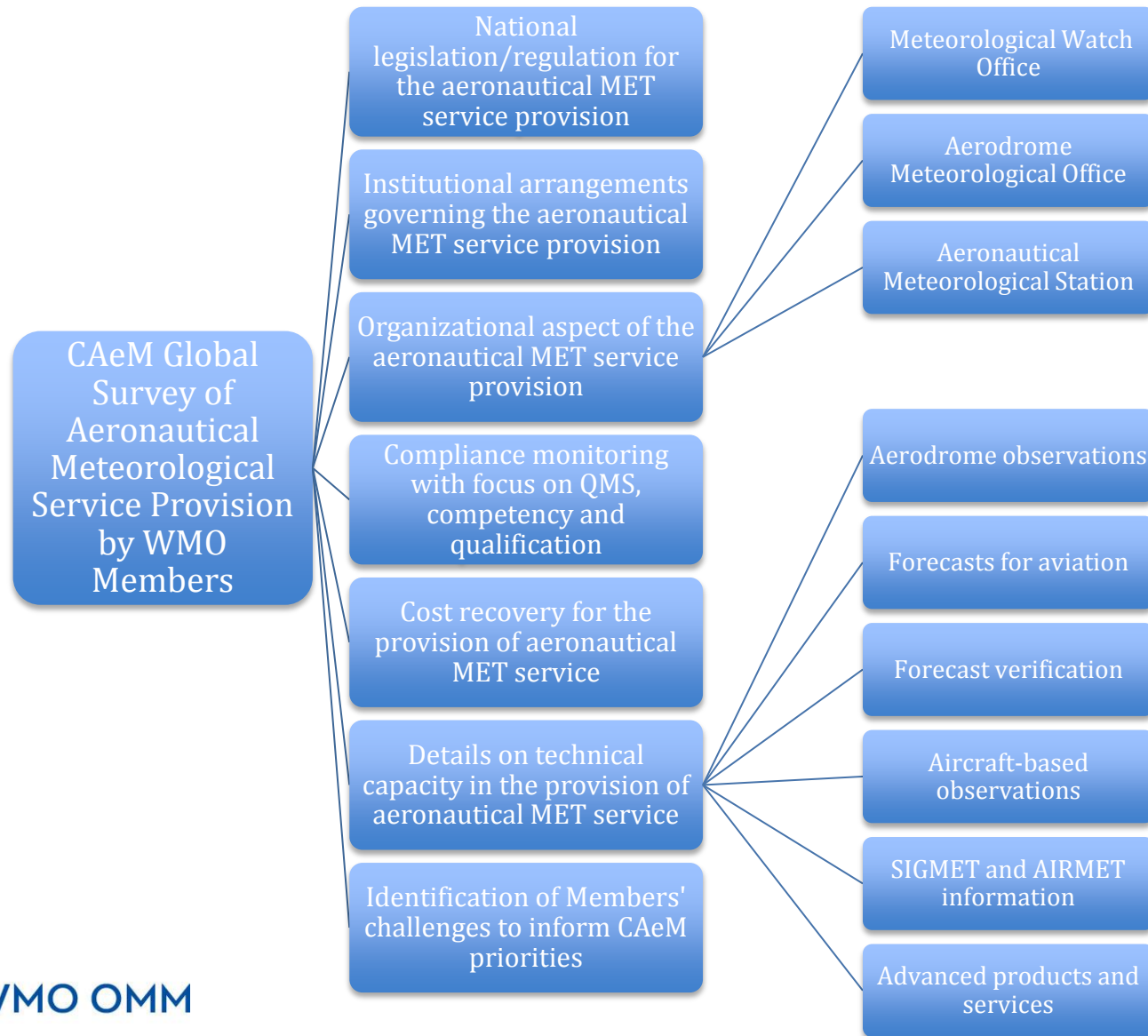
Figure 57. Regional distribution of requests for support and non-responders to survey

In total 38 Members provided responses to the survey indicating challenging circumstances, or directly or indirectly requesting WMO and/or ICAO for support. A regional distribution of these 38 Members is shown in Figure 57. Members from all regions responded, except for RA III (South America).

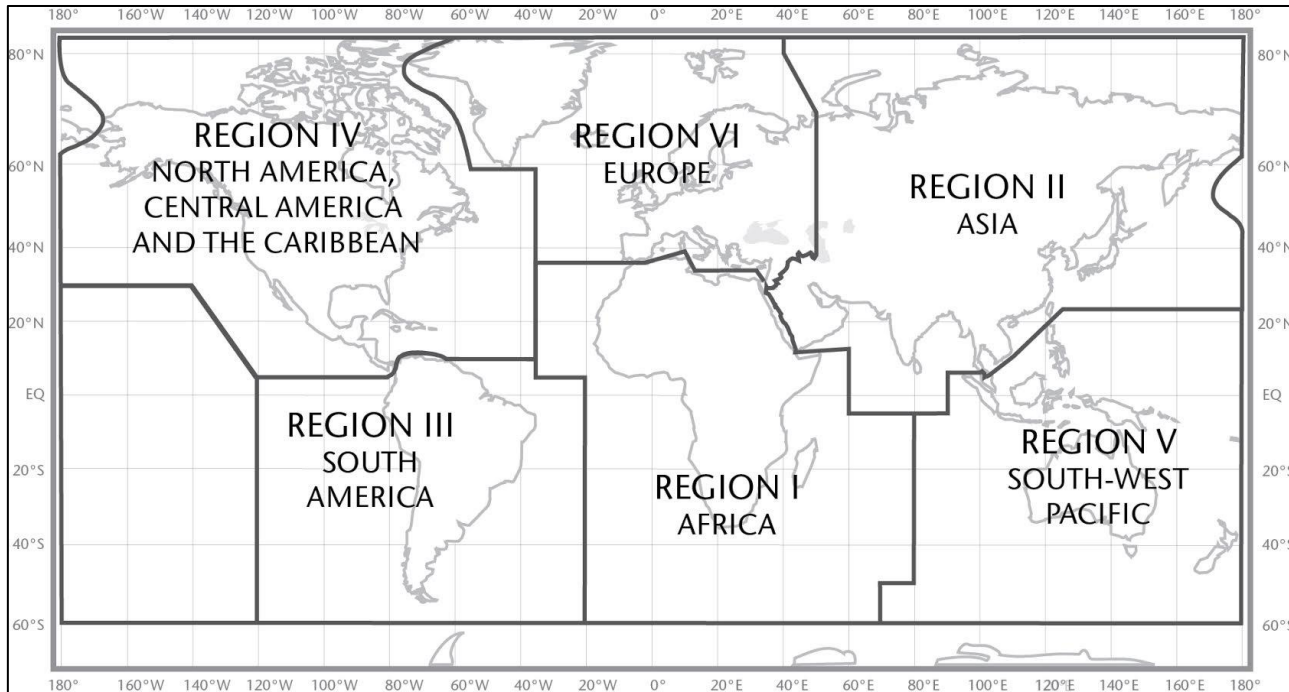
Also, 18 Members did not respond to the CAeM survey and have been included in this figure to show where additional regional action by CAeM may be required.

Survey Structure - Chart

Seven major sections in the survey

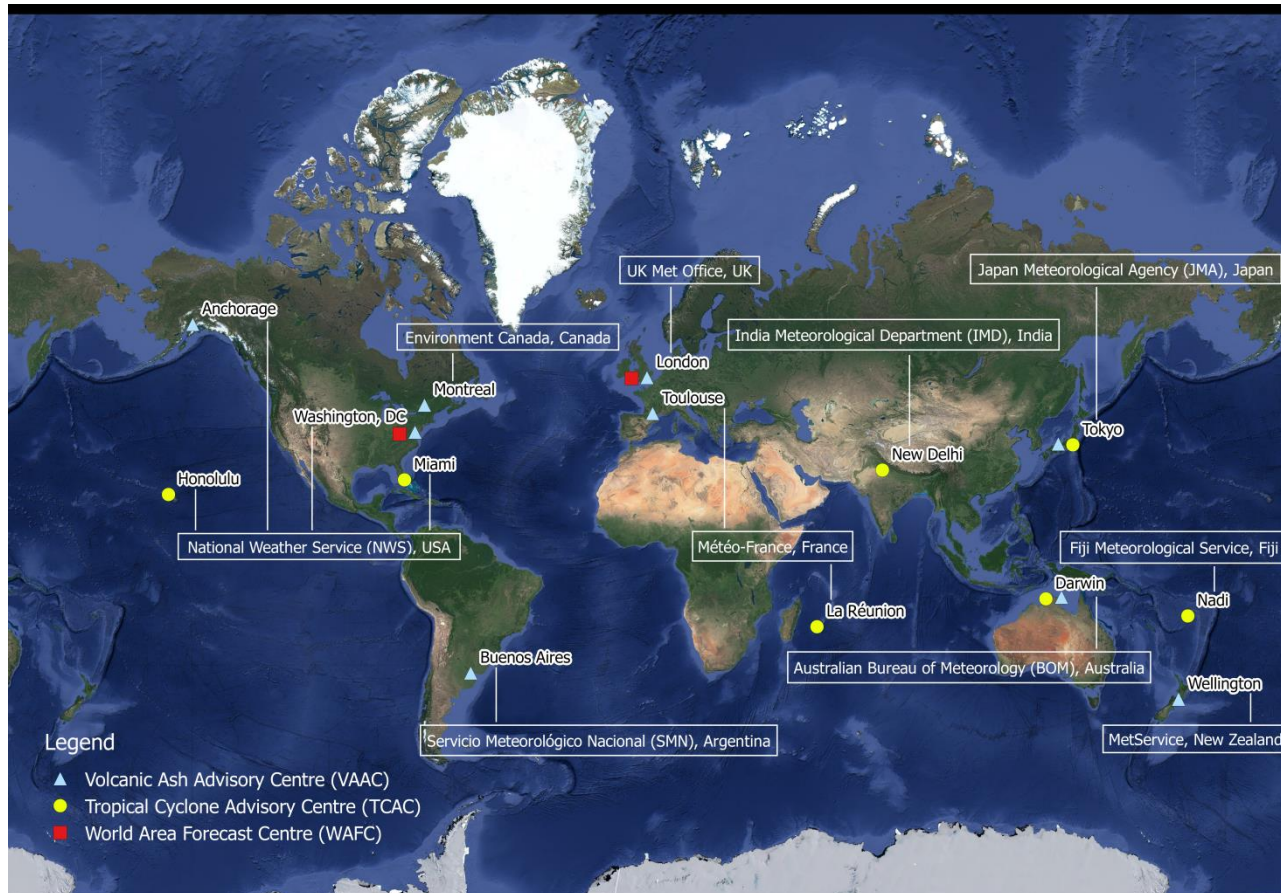


WMO regional associations and overview of Members



WMO has 185 Member States and 6 Member Territories divided in six regional associations, named RA I to RA VI, see <http://public.wmo.int/en/about-us/members>.

Global and regional centres jointly established by WMO and ICAO to serve International Air Navigation



The global system comprises of:
2 World Area Forecast Centres,
7 Tropical Cyclone Advisory Centres, and,
9 Volcanic Ash Advisory Centres.

Thank you



WMO OMM

World Meteorological Organization
Organisation météorologique mondiale