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EVALUATION OF THE SURVEY ON LIGHTNING DETECTION SYSTEMS
REPORT ON CURRENT OPERATIONAL NETWORKS

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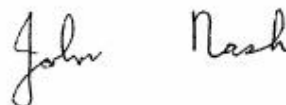
FOREWORD

This publication reports on the results of the CIMO survey on lightning detection systems. This survey was the first in its category. It was initiated by the CIMO in its 14th inter-session period as part of a review of the current operational lightning detection systems networks used by Members, to assess the need and possibility to organize an intercomparison of such systems. In that context, CIMO charged the Expert Team on Remote Sensing Upper-Air Technology and Techniques to conduct this work.

This IOM Report, prepared by a member of the Expert Team, Mr Mohamed Dahoui provides the results of the analysis of the survey that was performed in 2009 to document and review the current operational lightning detection networks used by Members. It describes briefly the scope of the survey, the subsequent analysis approach and focuses on the detailed analysis. It provides a number of findings and recommendations from the author.

The survey was prepared so as to reflect the current status of the operational lightning detection networks, and report on their strengths and weaknesses, including coverage, accuracy, reliability and cost effectiveness. It comprises six sections covering the network and data management aspects.

I wish to express my sincere gratitude and that of CIMO to the author of this report, Mr Dahoui for elaborating this report. I am confident that a number of WMO Members will find this report very informative.

A handwritten signature in black ink, reading "John Nash". The signature is written in a cursive style with a large initial "J" and "N".

(Dr. J. Nash)

President Commission
for Instruments and Methods of Observation

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CIMO SURVEY ON LIGHTNING DETECTION SYSTEMS (2009)

1. SUMMARY

The Survey on lightning detection system has been conducted by WMO to evaluate the current status of operational lightning detection systems used by Members. It aims to report on strengths and weaknesses, including system coverage, accuracy, reliability and cost effectiveness.

This document provides the results of an analysis of the NMHSs responses to the 2009 CIMO survey on lightning detection systems.

An overview of the scope of the Survey and the subsequent analysis approach is provided in section 2 and 3. Section 4 focuses on the detailed analysis of the results. Within the Section 4 “Key Findings” and “Recommendations” extracted from the analysis are provided and shown against the question to which they refer. Individual responses to the survey section 6 are compiled in a table and presented at the end of section 4. NMHSs comments provide valuable information that needed to be preserved as it is. Appendix A contains a copy of the Survey questionnaire.

2. BACKGROUND

The current survey is the first in its category. It was initiated by the CIMO in its fourteenth session as part of a review of the current operational lightning detection systems networks used by Members. In that context, the CIMO charged the Expert Team on Remote Sensing Upper Air Technology and Techniques to conduct this work.

3. SURVEY PREPARATION

3.1. Contents of the Survey

The survey has been prepared in a way to reflect the current status of the operational lightning detection networks, and report on strengths and weaknesses, including coverage, accuracy, reliability and cost effectiveness. It comprises six sections covering the following subjects:

Section 1: Access and use of lightning data

Section 2: Configuration of the network

Section 3: Network performance

Section 4: Applications of lightning data

Section 5: Data exchange

Section 6: Additional information

3.2. Targets and Distribution

The survey has been sent to all WMO Members' NMHSs. It was clearly stated in the survey that it's highly recommended to include also lightning detection networks owned by national external entities even if the NMHS has his own network.

The survey was conducted in English only as a MS word document.

A total of 68 NMHSs have replied to the survey by e-mail and by FAX. We were not able to process three replies due to corrupted received files and therefore the results from 65 NMHSs have been used to compile this report.

3.3. Survey Analysis Procedure

As replies were received by e-mail and by FAX, it was difficult to implement an automatic collation and processing of the results. Therefore the analysis has been undertaken manually. A few replies were not internally consistent with each other but the results have been presented as reported. The survey results are presented in the form of statistics related to each question. Key

findings and recommendations are presented whenever it's possible after each question or at the end of each section.

4. SURVEY RESULTS

4.1. SECTION 1: ACCESS AND USE OF LIGHTNING DATA

Survey question 1: Does your organization have access to automatically measured lightning data?

All NMHSs have replied to this question (65 replies). 62 % (see Figure 1) confirmed that they have access to automatically measured lightning data. Only few NMHSs are planning to have access to such data in the future.

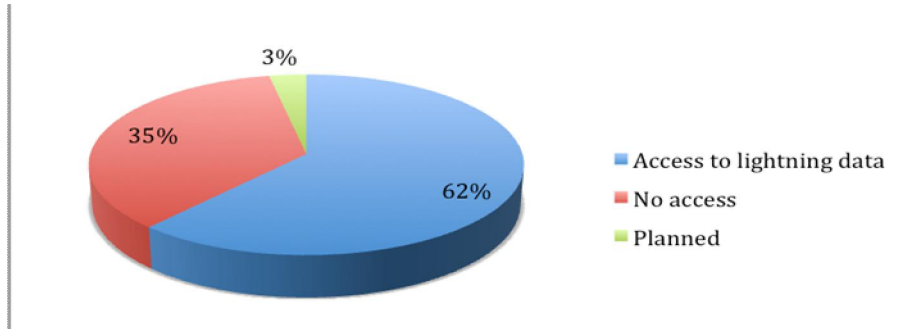


Fig 1: Access to automatic measured lightning data

Key finding: A large number of NMHSs (38 %) don't have access to automatically measured lightning data. This situation is not expected to significantly change in the near future as only few countries are planning to obtain access to this type of data.

Survey question 2: Does your organization own the lightning detection network?

This question has been included in the survey mainly to appreciate to what extent lightning data are considered to be part of the core observing system of NMHSs. Usually, strategic observing systems are owned by NMHS. Only NMHSs having access to automatically measured lightning data are considered in statistics presented in Figure 2.

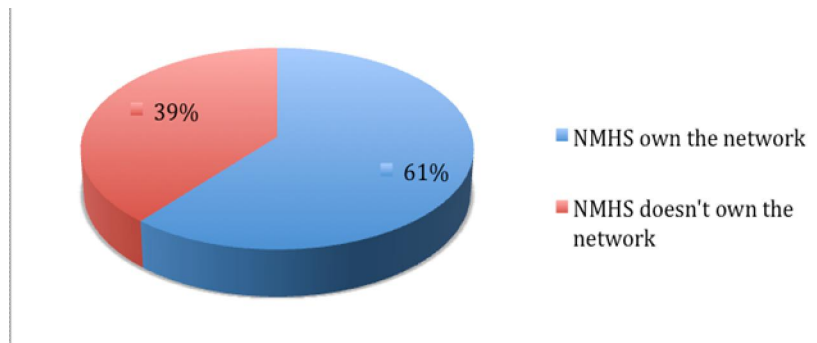


Fig 2: NMHSs lightning detection networks ownership status

Key finding: The majority of NMHSs own their lightning detection networks. This result highlights the importance of lightning detection networks for NMHSs.

Survey question 3: Is data provided by: national public organization, foreign public organization, national private company or foreign private companies?

This question applies only to NMHSs that do not own the lightning detection network but receive data from another organisation.

We obtained 17 replies for this question. The majority of NMHSs (see Figure 3) are receiving data from foreign public and private organizations.

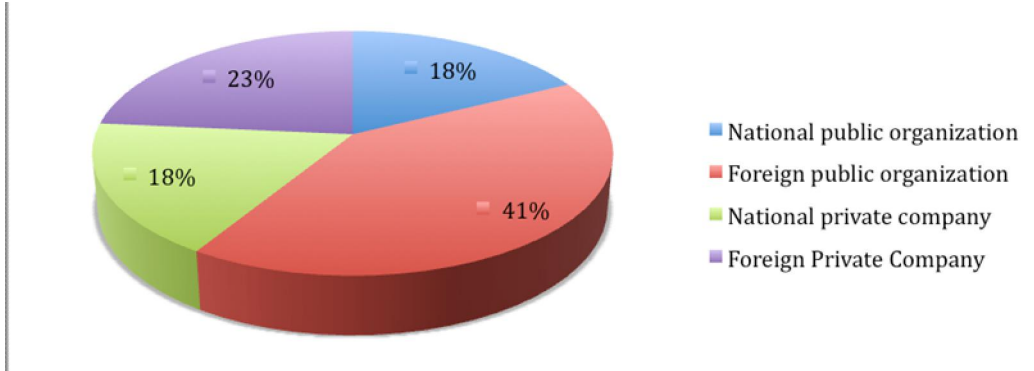


Fig 3: Category of NMHSs lightning data providers

Survey question 4: Is data provided via: Cooperation agreement or Commercialization process?

16 NMHSs replied to this question. The majority of them indicated that lightning data is being provided through a cooperation agreement. However, a significant part (41%) of the data provision is made through a commercialization processes.

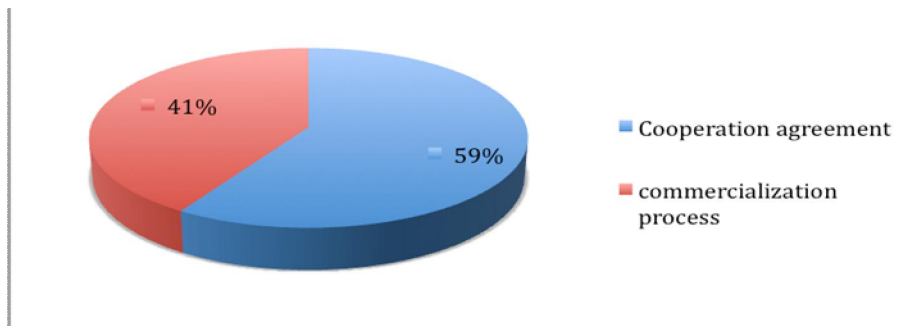


Fig 4: Lightning data distribution protocols

Survey question 5: What is the main motivation for the installation of the network: Now-casting forecasts, Research studies or Commercialization?

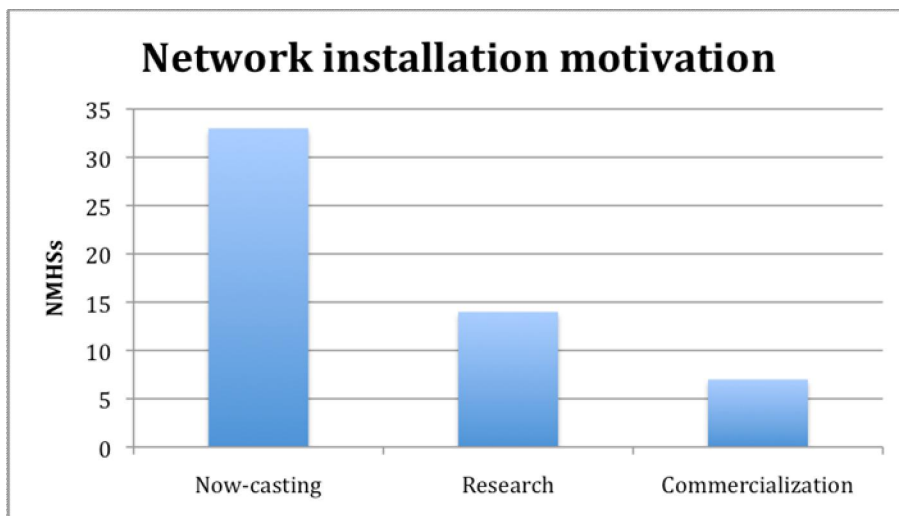


Fig 5: Lightning detection networks installation motivation

From a total of 36 replies, 32 Members indicated that the main reason for installing a lightning detection network is mainly to satisfy weather now-casting needs. Research activities are the second reason for implementing a network.. Three Network owners indicated that the only reason for installing a network is to sell the data.

Survey question 6: What is the reason for non-use of lightning data?

This question was addressed to NMHSs not having access to automatically measured lightning data.

A total of 25 responses have been collected for this question. The majority of NMHSs indicated that the main reason of not having access to lightning data is a lack of funding. For few NMHSs, the benefit of having lightning data doesn't justify such a large investment. Surprisingly, a significant number of NMHSs confirmed that the reason of not seeking access to lightning data is the absence of a requirement or a lack of knowledge about the data.

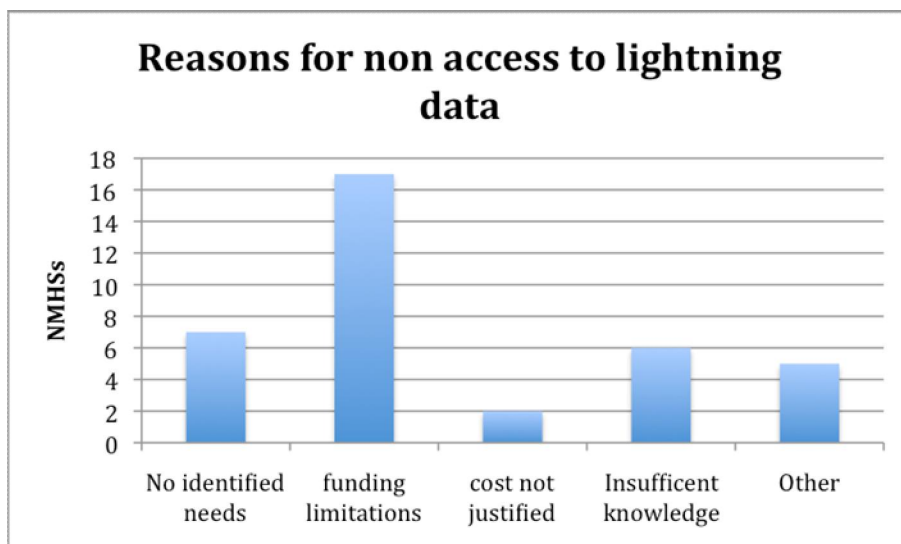


Fig 6 : Reasons for non access to lightning data

Key finding: A significant number of NMHSs are not aware of lightning data and their potential usefulness.

Recommendation 01: WMO is invited to improve the dissemination of information about lightning data and areas of potential application to its Members.

4.2. SECTION 2: CONFIGURATION OF THE NETWORK

Survey question 7: Equipment in use (manufacturer, type, technology, localization method, number of sensors and telecommunication supports)

This question was addressed to NMHSs having lightning detection networks installed in their country (operated by themselves or by other organizations). There were 38 responses to this question.

Manufacturer	Number of networks
VAISALA	25
TOA systems, Inc	2
UK Met Office, ATDNET	1 (used by 3 NMHSs)
BOLTEK	3
Nowcast GmbH	3
Resolution displays VLF-2	1
China National Huayun Technology Development Corp	3

Table 1: Lightning detection networks manufacturers

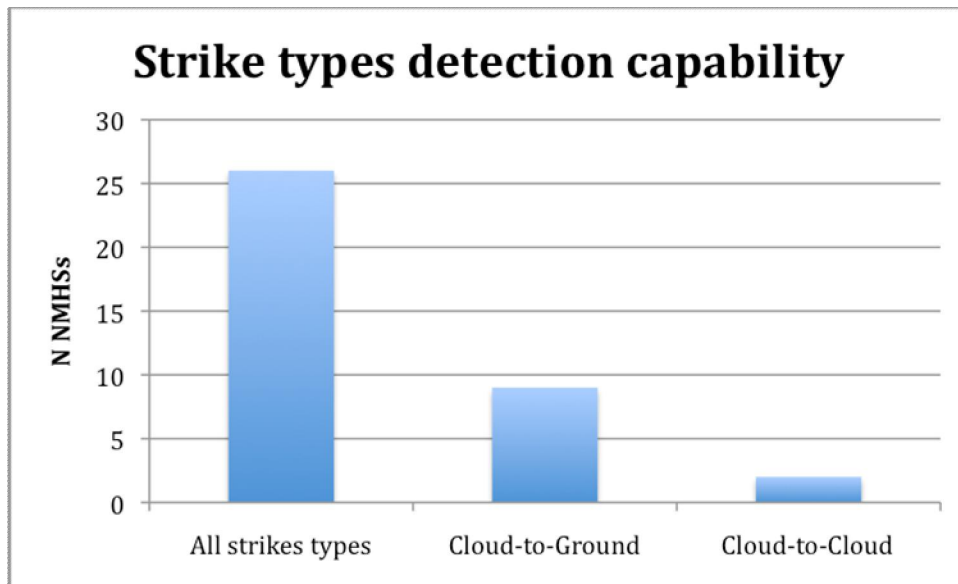


Fig 7 : Strikes types detection capability

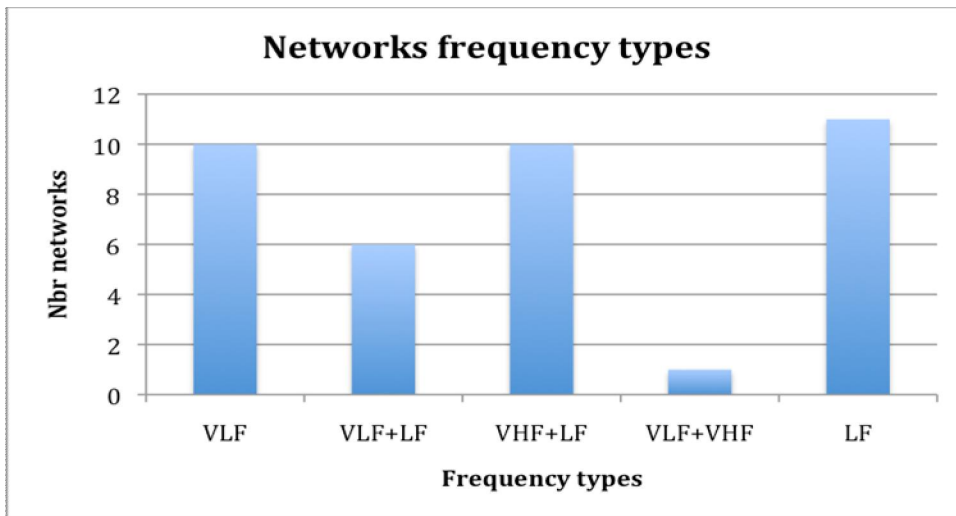


Fig 8: Networks classified by frequency types

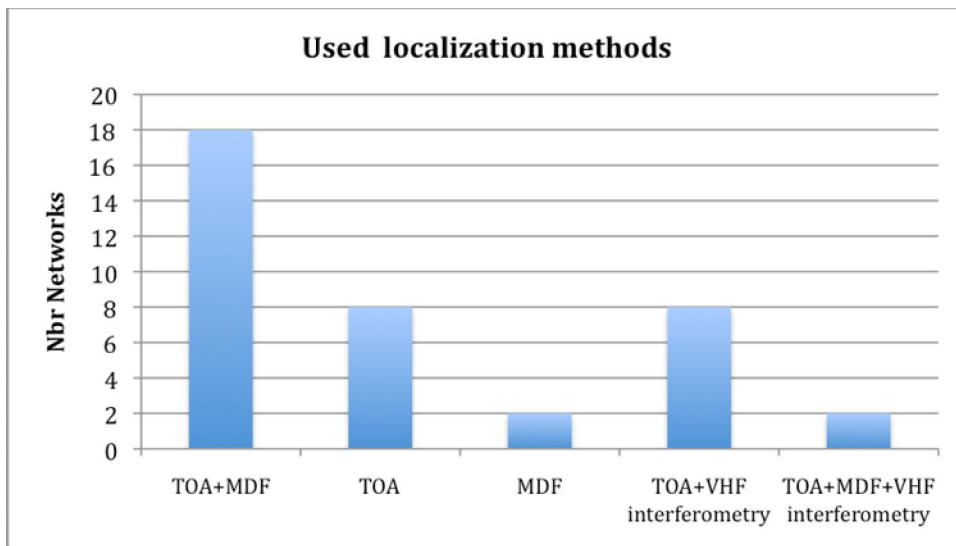


Fig 9: Used lightning localization methods

Key finding 1: Replies to question 7 showed some inconsistencies. Several networks use the same sensors but the reported stroke detection capability is inconsistent. Sensors based on VLF cannot, in principal, detect cloud-to-cloud strokes. Ignoring these inconsistencies, results presented in this document reflect NMHSs replies.

Key finding 2: Several NMHSs have networks using a combination of different sensor types. A small number of NMHSs have two different networks with different technologies and manufactures.

Key finding 3: VAISALA have a significantly dominant position in the provision of lightning detection systems.

Survey questions 8 & 9: Is there any component of the processing/archiving software, which is not provided by the manufacturer?

This question has been included in the survey to investigate whether or not industrial systems are comprehensively designed to fulfill almost user's requirements without major adaptations/additions.

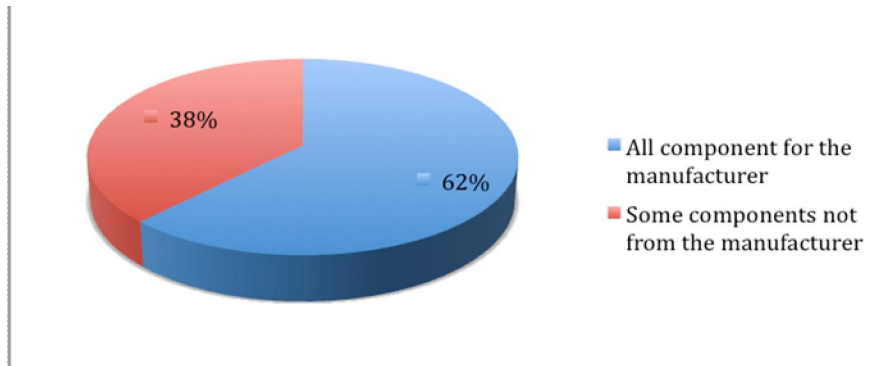


Fig 10: Third party lightning detection systems components

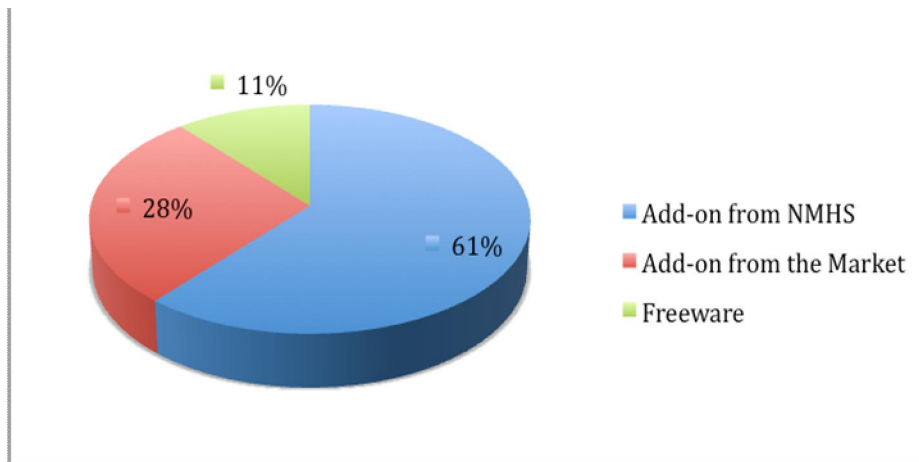


Fig 11: Origin of third party components

Key finding: The analysis of replies indicate that a number of NMHSs need add-on components for their lightning detection systems. A significant proportion of these add-ons are developed by the NMHSs themselves indicating a need for tailored components. Almost all add-ons are for the visualisation, archive and impacts localization of the data.

Recommendation 02: Lightning detection system manufacturers are invited to take note of the nature of NMHS developed add-ons and where possible include them as part of the basic system functionality..

Survey question 10: Does the network cover the whole country?

This question intended to appreciate to how extent the lightning detection coverage is ensured for countries having access to automatically measured lightning data.

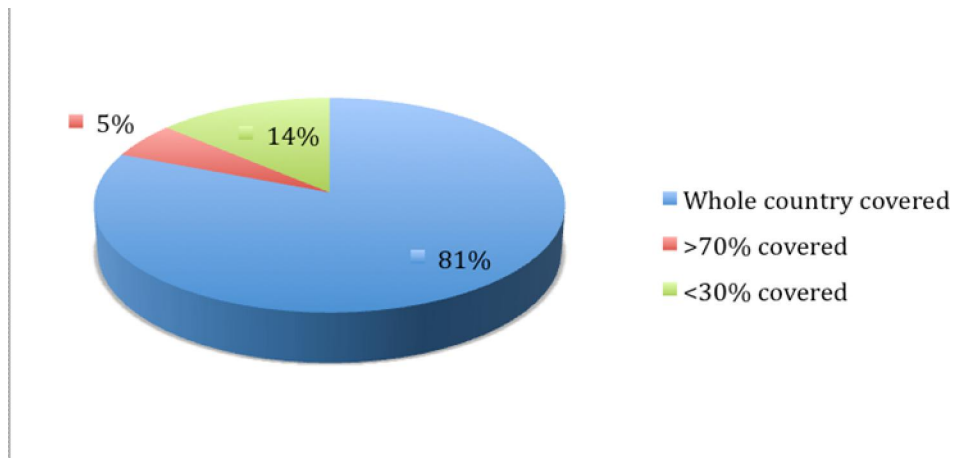


Fig 12: Lightning detection networks coverage

Key finding: Almost all NMHSs having access to automatically measured lightning data are covered completely by the detection network. Only few NMHSs are covered poorly.

Survey questions 11 & 12: Who maintains the network? What’s the maintenance cost?

These two questions were included in the survey mainly to give complementary answers regarding the network availability when it is below a certain percentage.

A total of 32 NMHSs replied to this question. 56% of Members are maintaining the networks themselves. The rest (44%) are delegating this task to private companies through maintenance contracts. NMHSs which have not replied to this question are those not owning the network and therefore are not responsible for its maintenance.

4.3. SECTION 3: NETWORK PERFORMANCE

Survey question 13: Do you have an estimation of the network performances?

This question is the first in a series of questions aiming to evaluate the lightning detection networks performance.

For this first question, 74% of NMHSs are aware of the performance of their networks. Surprisingly, 26% ignore the performance of the network producing the data. It should be noted that almost all the NMHSs that are not aware of networks performance do not own the network generating the lightning data.

Recommendation 03: WMO is invited to improve NMHS awareness of the usefulness of objective systems evaluation. In this context, advertising networks evaluation studies can provide NMHSs with practical and objective methods to follow.

Survey question 14: How the network performances are estimated?

This question is very important to evaluate the verification method of lightning data. It’s well known that the appropriate method is the use of independent good quality data and a suitable scoring method.

Verification method	Number of NMHSs (total of 28)
Manufacturer estimation	16
Theoretical estimation based on the lightning data themselves	15
Feedback from forecasters and the network operators	14
Statistics based on independent verification data	12
Other methods	5

Table 2: Lightning detection systems evaluation method

The methods classified as “other” are simply comparison with data from independent lightning detection networks.

It should be noted that a significant number of NMHSs have reported that network performance are estimates are made using a combination of methods (among the proposed list).

Key finding: A significant number of NMHSs still base their estimation of networks performances on non-objective methods.

Survey question 15: What is the estimation of the network availability?

Among 28 responses received for this question, all confirm a high availability of lightning detection networks. Indeed, 25 NMHSs indicated an availability of greater than 95%. The availability for the other Members is greater than 90%. This result gives a first indication about the high availability of individual components (individual sensors, telecommunication support, ...).

Survey question 16: What is the estimation of individual sensors availability?

This question is complementary to the previous one. It helps in the understanding of the sources of networks unavailability. If the unavailability of individual networks is not so high, the increase of the number of sensors (backup) can increase the availability of the whole network.

Overall 23 responses were received; all have a high availability of individual sensors confirming the high availability of the whole network.

Survey question 17: What is the estimation of the availability of the telecommunications support?

Similarly to the previous question, this one helps in the understanding of the sources of networks unavailability.

Again, 23 responses were received, telecommunications systems are judged to be highly available. For nearly all of them, the availability is greater than 95%. It should be noted that almost all networks are using leased lines as the telecommunication method. Several networks use satellite and Internet based Telecommunication systems. A backup telecommunication system solution is available for few lightning detection networks.

Key finding: Almost all networks are highly available. This is an indication of well designed and implemented networks.

Survey questions 18 and 19: What is the estimation of the network detection efficiency and accuracy?

These two questions are the most important and difficult to answer. The detection efficiency and accuracy are generally area and network dependent. Results are also highly dependent on the verification method. A few NMHSs, provided detailed results while the majority gave average values as was requested minimally by the survey. Networks owners were asked to provide their estimation of the availability and the quality in normal¹ and degraded² mode.

NMHSs were requested, if possible, to provide WMO with lightning detection network evaluation studies. The analysis of responses revealed that the question was not well formulated and consequently not well understood. The target was to collect such studies (or references) as part of the survey response. Almost all NMHSs have replied to this question by “yes” only. Few of them have attached explanatory documents and references.

The analysis of responses revealed that we should have requested the efficiency according to strokes type for those having cloud-to-cloud and cloud-to-ground detection capability

Only 21 NMHSs have responded to this important question. Few of them provided us with the detection efficiency for cloud-to-cloud strikes and the detection efficiency in degraded mode.

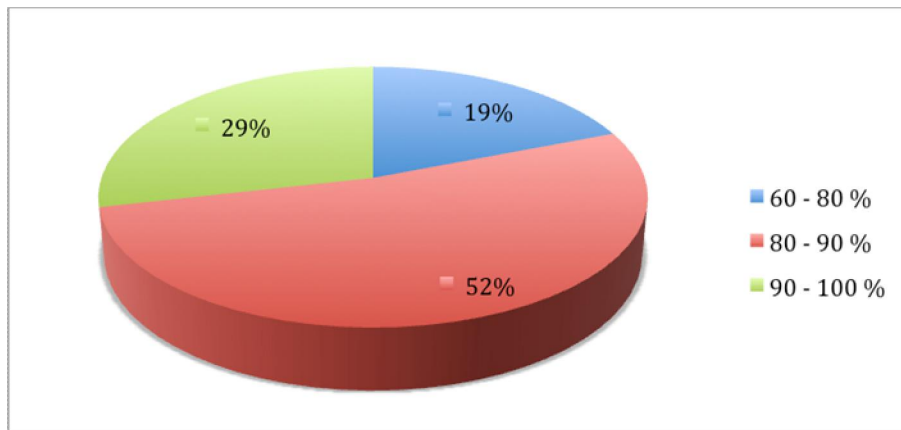


Fig 13: Lightning networks detection efficiency

Except for one case, the detection efficiency remains greater than 75 % even in degraded mode and for cloud-to-cloud strikes.

It should be noted that NMHSs having networks with combined technologies (e.g. Finland), observe area dependent detection efficiency especially for cloud-to-cloud strikes which are mainly detected by VHF based networks.

Concerning the detection accuracy, most NMHSs from which we got a reply provided us with pre-dominant estimations over their domain but stressed that the accuracy is highly area dependent especially towards network boundaries. Values presented in Figure 14 represent averages provided by NMHSs:

¹ Nominal use of all network capabilities

² Some network components are not available but the strikes detection and impact localization functions are still available

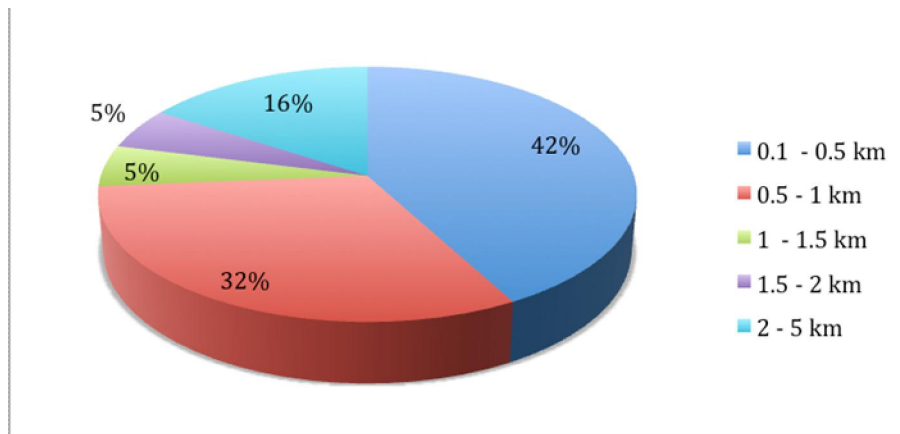


Fig 14: Lightning networks impacts localization accuracy

The UK Met Office provided kindly, a broad estimation of the detection accuracy of their wide area detection network (used by many NMHSs). It's around 1-1.5 km over the UK and surrounding areas, 2-20 km over Europe/east Atlantic and more than 15 km over the rest of the globe. These values are obviously related the current configuration of the network. More sensors in other places will necessarily enhance the accuracy.

Recommendation 04: NMHSs are invited to establish, when possible, a data exchange with neighbouring networks to improve the coverage, detection efficiency and strokes localization accuracy.

Survey question 21: What is the limitation for not doing performance studies?

It can be inferred from a number of NMHSs replies regarding networks performances, that a considerable number of Members don't have access to such important information. For a significant number of NMHSs the estimation of lightning detection network performance is highly influenced by the manufacturer estimation. This question aimed to investigate why such important information is still not well objectively accessible.

We got 27 responses. Several NMHSs gave a combination of factors limiting them from doing objective evaluation studies.

Limitations of doing performance studies	Number of NMHSs (from a total of 27)
Insufficient knowledge about verification methods	9
Insufficient resources	16
Insufficient verification data	11
Other reasons	2

Table 3: Factors limiting lightning networks evaluation

Key finding 1: A large number of NMHSs lack the resources to undertake objective evaluation studies.

Key finding 2: A significant number of NMHSs lack independent verification data sets.

Key finding 3: Several NMHSs lack of knowledge of objective verification methods.

4.4. SECTION 4: APPLICATIONS OF LIGHTNING DATA

Survey question 22: In your organization, what is lightning data used for?

The survey listed five main usage purposes: Weather now-casting, severe weather phenomena verification, climatological studies, meteorology for aviation and research studies. NMHSs were invited to specify, if any, the other non-listed topics.

A total of 37 responses have been collected for this question. The analysis of replies (see Figure 15) indicated that lightning data is used, quasi unanimously, for all topics listed in the survey.

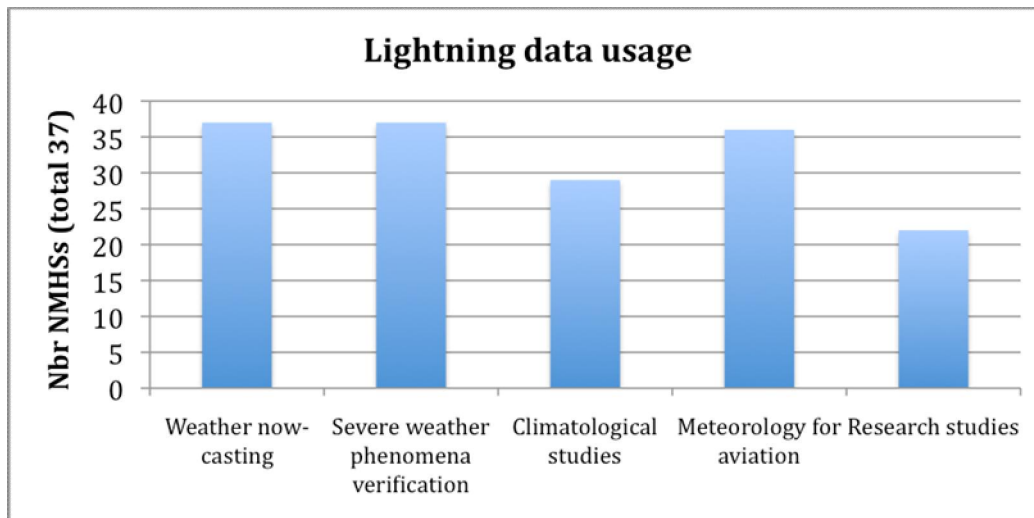


Fig 15: Lightning data usage

According to Italy's reply, lightning data have been used in the simulation of lightning observations from a space borne platform. In this context, it is worth to mention, the foreseen satellite lightning measurements that will be provided by EUMETSAT MTG program from around 2015 onwards.

Key finding: lightning data is being used by critical application areas that are considered as core activities in all NMHSs. Lightning data is contributing to the security and safety of life and property.

Survey question 23 & 24: Is lightning data supplied to other public or private entities? What is the main use of lightning data by other entities?

From a total of 39 responses, the majority of NMHSs (88%) are providing lightning data to third parties.

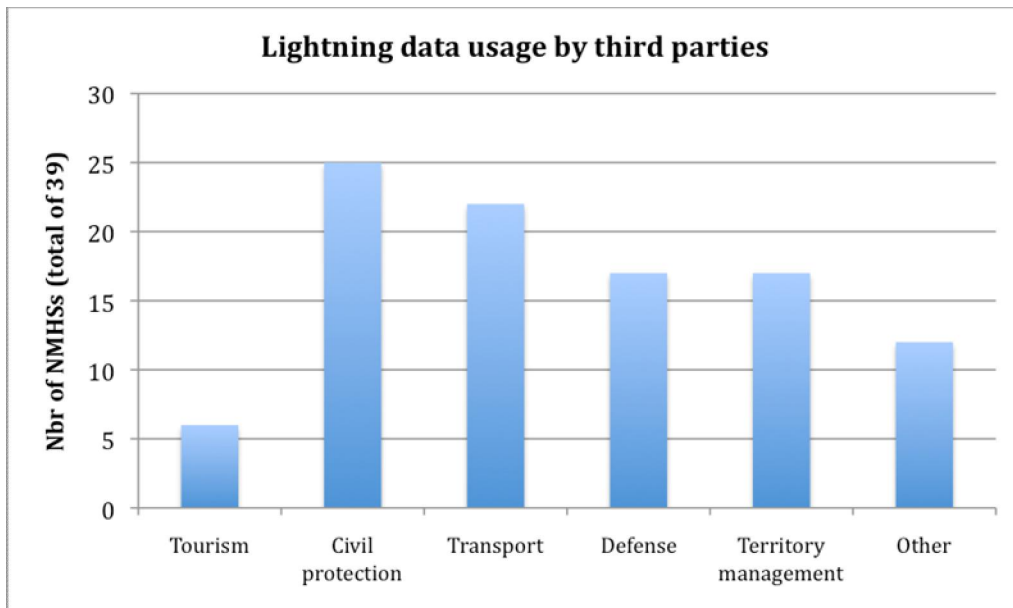


Fig 16: Lightning data usage by third parties

Here again, lightning data are used by critical public operators mainly to ensure the safety, security and regularity of public services. In the category of “other” many NMHSs mentioned the usefulness of lightning data for insurance and energy.

4.5. SECTION 5: DATA EXCHANGE

This section of the survey is of great interest. It allows the quantification of the cooperation within the meteorological community regarding use and exchange of lightning data. It allows also the evaluation of how the data exchange is being done and what is the benefit for parties involved. As already reflected by the analysis of the previous responses, a direct benefit is the enhancement of detection efficiency and accuracy in networks borders where the performances are reduced.

Survey question 25: Is the network inter-connected to other networks?

35 NMHSs have responded to this question. Lightning data is being exchanged between 18 NMHSs.

Key finding: A great potential is available for the enhancement of lightning detection availability, efficiency and accuracy.

Survey question 26: What is the form of lightning data exchange?

The benefit of lightning data exchange depends significantly on how the data is being exchanged. It is obvious that a simple visualization of lightning data detected and processed by an independent network has less value than the exchange of raw data. The simple visualization can help in the monitoring of lightning mainly in border area and therefore contributes to the detection efficiency. Raw data, can be processed by the lightning network processors and leads to a significant improvement of the coverage, detection efficiency and localization accuracy.

16 NMHSs have responded to this question. 13 NMHSs (among 18 exchanging the data) are exchanging raw data, which is the most beneficial way. 5 NMHSs are exchanging impact localizations. Among 16 NMHSs, 2 are exchanging both raw data and processed data.

Survey Question 27: What is the networks inter-connection value added?

As mentioned above, data exchange has theoretically a clear benefit. However, this benefit can be reduced for different reasons. This question aimed to get the point of view of NMHSs regarding the added value of such exchange.

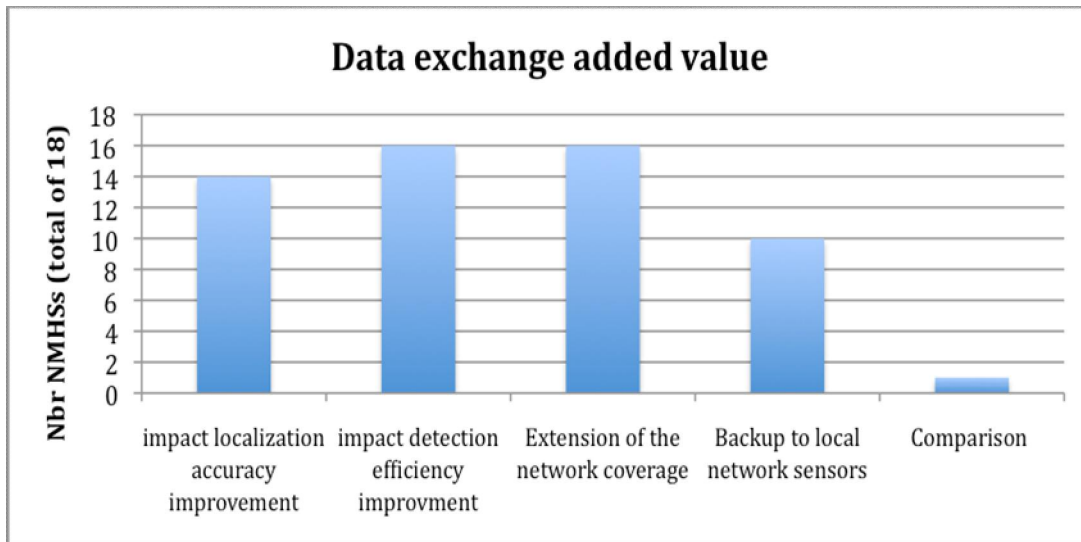


Fig 17: Data exchange added value

Key finding: Lightning data exchange has a great value for NMHSs involved. The direct benefit is the enhancement of the detection efficiency, localisation accuracy and improvement of networks availability.

4.6. SECTION 6: ADDITIONAL INFORMATION

The objective of this section was the collection of any additional information not covered by the survey. The main comments are presented in table 4.

NMHSs	Comment
Italy	<p>Ufficio Generale Spazio Aereo e Meteorologia carried on several attempts, since 2004 with formal letters of invitation to Mediterranean and surrounding Countries, to establish exchange of raw information from the sensors or localizations from the central suite. Feedback was very poor, almost negative, major problems raised from the commercial data policy of the domestic networks even with Countries which expressed favourably . Anyway some technical problems have still to be solved.</p> <p>USAM, anyway, is still interested for a cooperative programme in lightning detection in the Mediterranean</p> <p>Ref:http://www.eumetsat.int/groups/pps/documents/document/pdf_mtg_mmt5_10</p>
Argentina	<p>At present an experimental detection system from private industry (INVAP) were located by agreement in Pilar Observatory -Cordoba Argentina- The results will be comment at soon as possible when will be available</p>
British Caribbean	<p>It is intended that a lightning detection system will be used for all areas of Q22 and the information will be also supplied to private entities (Q23) such as Utilities (power generation) and energy exploitation (oil and gas) sector.</p>

Canada	Some provinces run lightning networks for their own purposes - forestry, energy. This information is not shared.
Salvador	We have currently no lightning network. We are using NOAA estimates lightning detection.
Fiji	<p>The Fiji Meteorological Service (FMS) archives only human observed occurrences of lightning in Fiji. The checked questions are thereby specifically related to actual lightning occurrence only.</p> <p>FMS views gathering of lightning data and setting up of a monitoring/detection network as very important to all sectors of our community. Because of this need FMS applied some years back for capital funding from Government, but without success.</p>
Finland	<p>The FMI lightning detection network operates as a part of the NORDLIS lightning detection network, which covers Norway, Sweden, Finland and Estonia. Therefore the combined sensor number is at present 32 sensors and the reasonable coverage extends about 500 km outward from the sensor network. We all have our own central processors and can use the data covering the whole area.</p> <p>All these sensors are also a part of the Pan-European EUCLID-network, but operationally we use only the data processed by ourselves. EUCLID is providing commercial services to other users.</p> <p>The network performance verification is almost impossible in a strictly quantitative way, because accurate reference material does not exist. The generally accepted method to measure direct hits on instrumented mast is not really useful in Finland, because our ground flash density is below 1/km²/year. Therefore the best way to analyse the data quality is qualitative realtime comparison between radar images and occasional comparison with known CG-strike points. Also a technical analysis of the sensor data itself is very efficient way for a Vaisala LF-system, because on average we have about 5 sensors participating on each position fix: The data from those 5 sensors does not correlate well together by accident.</p>
France	<p>We aren't owner of the network, we made a tender to buy data and services last spring. It's why I can't answer on maintenance questions. We buy data at a private company.</p> <p>We also receive data from ATDnet network, it's why I check also foreign public office in Q3. However, for others question, my answers are only on the Vaisala type network.</p> <p>Atdnet are used by forecasters mainly, and the main interest is the coverage. Data quality is sufficient for forecaster usage. We don't use them for now casting (on France, we have the others data, with the good right of usage)</p>
Germany	<p>The answers to Q7 and Q13-Q19 are from nowcast GmbH. DWD had a contract with nowcast for delivering the data 2006 until 2009. Nowcast is going to continue delivering the data for the next three years as a result of the tendering in the first half 2009.</p> <p>Comments by nowcast GmbH:</p> <p>Q18 - Detection efficiency:</p> <p>Quite often efficiencies are quoted without precisely detailing the situation. For example, the claim that a network has 80% efficiency is useful only when the minimum threshold is also given, for which the network detects and reports (for example: strokes with currents >10 kA). This clarification is necessary for a second reason: the precise 100% value is not known to anybody. This situation also holds for CC strokes.</p> <p>When VLF/LF and VHF networks are compared with respect to CC, it must be</p>

	<p>realized that VHF systems detect different discharge steps as compared to VLF/LF systems. Thus, only CC flashes can be counted reliably, because VHF does not detect strokes. As regards CG: these are always detected by VLF/LF, even when CC comes from VHF.</p> <p>Q19 - Location accuracy:</p> <p>An important quality feature is - in addition to the statistical mean location error - the distribution of errors around the mean value. Many networks have small average errors of, say 500 m, but a large fraction of locations have errors of 10 km or even more. The consequences are: storm cells appear diffuse and not as sharp as they really are, areas actually free of lightning show many (false) stroke positions, and specific strokes can not be trusted with respect to their precise location.</p> <p>It is obvious that the distribution of location errors should receive attention in the evaluation of a network.</p>
HongKong	http://www.weather.gov.hk/wservice/tsheet/lis.htm
Iceland	We also own older location systems, 4 LLP stations and 4 ALDF stations as well as one EFMS vertical E_field wave recording station. Furthermore, we operate about 100 manned weather stations recording lightning occurrences.
Ireland	<p>Met Éireann, (The Irish Meteorological Service) has a lightning detector from the British Met Office's ATDNET network located in Valentia Observatory on the South West coast of Ireland.</p> <p>The British Met Office will have more up to date and accurate details of the technical specifications of the ATDNET network, hence sections 2,3 & 5 have been left blank.</p>
Madagascar	Our NMHS is very interested in using these data and wish to have access to the world lightning data base.
Malawi	CURRENTLY MALAWI DOES NOT HAVE LIGHTNING DETECTION SYSTEM BUT CONSIDERING THE IMPORTANCE OF LIGHTNING DATA IN WEATHER FORECASTING, VERIFICATION OF SEVERE WEATHER PHENOMENONE, AVIATION WEATHER SERVICES, ETC IT IS OUR WISH TO HAVE SUCH SYSTEMS IN PLACE. HOWEVER, LIMITED FUNDING IS HUMPERING SUCH AMBITIONS
New Zealand	The network is owned by Transpower, a State Owned Enterprise, that owns and maintains the national electricity grid for New Zealand. MetService operates the network on their behalf.
Russia	It is quite good that WMO pays now attention to lightning detection systems
Aarabia Saudia	Questions under sections 2, 3, 4 and 5 are not applicable. Lightning detection systems were not within our priorities in the current PME long term plan. Reconsideration of such systems in future plans depends on the improvement of their performance in advancing the operational met. activities, especially in the fields of now-casting and aviation services.
Sri Lanka	Department of Meteorology has identified the importance of Lightning Detection Systems. However we are in the process acquiring doplar radar and Department of Meteorology would be considering procuring the Lightning Detection System later.
Switzerland	For further information about the network contact our provider: météoorage http://www.meteorage.com/
USA	This questionnaire has been filled out from the perspective of the National Lightning Detection network in USA. Vaisala can offer Global coverage with its GLD360

	data product which will cover 100% of the World with a 70% detection efficiency and 5-10km location accuracy.
Poland	Weaknesses of lightning detection network is insufficient feedback with manufacturer and access to knowledge of network's construction, no information on algorithms and technology basics (parameters or solution used by manufacturer)

Table 4: NMHSs comments

5. APPENDICES

5.1. APPENDIX 1. Survey Specimen

CIMO Survey on the use of lightning detection systems and products in National Meteorological and Hydrological Services (NMHSs)

INTRODUCTORY NOTE

In its fourteenth session, the Commission for Instruments and Methods of Observations (CIMO) has requested to the Expert Team on Remote Sensing Upper-air Technology and Techniques to document and review the current operational lightning detection networks, and report on strengths and weaknesses, including coverage, accuracy, reliability and cost effectiveness. Such work requires the collection of official information from NMHSs. This survey will be sent to all WMO members. Results will be carefully analyzed by the CIMO expert team on Remote Sensing Upper-air Technology and Techniques.

The survey has six sections covering the following subjects:

Section 1: Access and use of lightning data

Section 2: Configuration of the network

Section 3: Network performance

Section 4: Applications of lightning data

Section 5: Data exchange

Section 6: Additional information

All questions should be answered if applicable. If you select the option “**Other**”, please add a short explanation.

Please enter your organization details below:

- WMO member:
- Does this response represent an entity related to the NMHS or an external entity?

NMHS external entity³

- Name of this entity:
- Contact person in your organization:

Mr/Ms/Mrs/Dr:

Address:

Tel.:

Fax:

E-mail:

³ It is highly recommended to include, if possible, information about the lightning networks owned by national external entities even if the NMHS has his own network.

SECTION 1: ACCESS AND USE OF LIGHTNING DATA

Q1) Does your organization have access to automatically measured lightning data?

Yes no planned

If the answer is “**No**” please jump directly to **Q6**.

Q2) Does your organization own the lightning detection network?

Yes no

If the answer is “**Yes**” please jump directly to **Q5**.

Q3) Is data provided by?

National public organization Foreign public organization

National private company Foreign Private Company

Q4) Is data provided via?

Cooperation agreement Commercialization process

Q5) What is the main motivation for the installation of the network?

Now-casting forecasts Research studies

Commercialization

Q6) What the reason for non use of lightning data?

- No identified needs
- Funding limitations
- The ratio cost/benefit don't justify such investment
- Insufficient knowledge about these data
- Other reasons:

SECTION 2: CONFIGURATION OF THE NETWORK

Q7) Equipment in use:

- Manufacturer:
- Type:

- Technology:

- Detection capabilities:
 - cloud to cloud strikes cloud to ground strikes

- Impact localization technique:

- Number of sensors:

- Telecommunications support:

- Installation date:

Q8) Is there any component of the processing/archiving software which is not provided by the manufacturer?

Yes No

If the answer is “**No**”, please jump to **Q10**.

If the answer is “**Yes**”, what is the main function of this component?

Q9) Is this software component developed by

NMHS itself private company

Free licensed software

Other:

Q10) Does the network cover the whole country?

Yes No

If the answer is “**No**”, what is the percentage of the area covered?

Q11) Who maintains the network?

NMHS itself maintenance contract

Q12) Do you have an estimation of the annual maintenance cost⁴:

⁴ If this information is confidential, the ratio (**annual maintenance cost/initial investment**) is sufficient.

SECTION 3: NETWORK PERFORMANCE

Q13) Do you have an estimation of the network performances⁵?

Yes No

If the answer is “**No**” please jump directly to **Q21**.

Q14) The network performances are estimated based on:

- Theoretical estimation based on the lightning data themselves
- Statistics based on independent verification data
- Feedback from Forecasters and the network operators
- Manufacturer estimation
- Other:

Q15) What is the estimation of the network availability?

Q16) What is the estimation of individual sensors availability?

Q17) What is the estimation of the availability of the telecommunications support?

Q18) What is the estimation of the network detection efficiency?

In normal⁶ mode:

In degraded⁷ mode:

If the efficiency is highly area dependent please give more details (if possible efficiency charts).

Q19) What is the estimation of the network detection accuracy?

In normal mode:

In degraded mode:

If the accuracy is highly area dependent please give more details (if possible accuracy charts).

⁵ “**Performance**” includes efficiency, accuracy, availability and reliability.

⁶ Nominal use of all network capabilities,

⁷ Some network components are not available but the strikes detection and impact localization functions are still available

Q20) Do you agree to provide WMO with any results (or references) of studies related to lightning detection networks performances?

Yes No

Q21) What is the limitation for not doing performance studies?

- Insufficient knowledge about verification methods
- Insufficient resources
- Insufficient verification data
- Other:

SECTION 4: APPLICATIONS OF LIGHTNING DATA

Q22) In your organization, What is lightning data used for?

Weather now-casting Severe weather phenomena verification

Climatological studies Meteorology for aviation

Research studies

Other:

Q23) Is lightning data supplied to other public or private entities?

Yes No

Q24) What is the main use of lightning data by other entities?

Tourism Civil protection Transport

Defense Territory management

Other:

SECTION 5: DATA EXCHANGE

Q25) Is the network inter-connected to other networks?

Yes No

If the answer is “**No**” please jump directly to **SECTION 6**.

Q26) Data from other networks is received as

Raw sensors data Localized impact information (for visualization)

Other

Q27) What is the networks inter-connection value added?

- Enhance the impact localization accuracy
- Enhance the impact detection efficiency
- Extension of the network coverage
- Backup to local network sensors
- Other:

SECTION 6: ADDITIONAL INFORMATION

Please use this section to add any information, which can be useful but not included in the questionnaire. This section can be used to comment the questionnaire itself.