World Meteorological Organization

Weather • Climate • Water

COMMISSION FOR INSTRUMENTS AND METHODS OF OBSERVATION

CIMO/WIGOS Explratory Workshop:
Improving Surface-Based Data Quality through improved Standardization of Procedures

Langen, Germany 3-5 December 2014

Setting the scene: Current situation and perspectives

Bertrand Calpini

Background

- Regional Instrument Centres, RICs as recommended by CIMO-IX in 1985, and updated by CIMO-XIV in 2006
- approved by the Regional Associations concerned for the RICs established within their field of responsibility.
  - RICs with full capability
  - RICs with reduced capability

Background

- RICs with full capability can assist Members of the Region in calibrating their national meteorological standards and related environmental monitoring instruments for the following variables: temperature, humidity, pressure and possibly others.
- RICs with basic capability propose this service for at least one of these variables.

Background

- CIMO Guide

“Considering the need for regular calibration and maintenance of meteorological instruments to meet the increasing needs for high quality meteorological and hydrological data, the requirements of Members for standardization of meteorological instruments, the need for international instrument comparisons and evaluations, and for training of instrument experts, it is recommended to establish Regional Instrument Centres”

Background

- CIMO Guide

"Regular evaluations of the RICs via an Evaluation Scheme for RIC to support them in carrying out their regular audits, and improving their capabilities to meet regions needs, where necessary.

This Evaluation Scheme is based on the Terms of Reference of RICs"

Background

RA I
Alger (Algeria)
Cairo (Egypt)
Casablanca (Morocco)
Nairobi (Kenya)
Gaborone (Botswana)

RA II
Beijing (China)
Tsukuba (Japan)

RA III
Buenos Aires (Argentina)

RA IV
Bridgetown (Barbados)
San José (Costa Rica)
Mount Washington (United States)

RA V
Manila (Philippines)
Melbourne (Australia)

RA VI
Toulouse (France)
Bratislava (Slovakia)
Ljubljana (Slovenia)

Background

RIC at Casablanca, Morocco (Region I)

(Information on this page is based on a report from the RIC received in July 2013. Please refer to the RIC's webpage for the latest information.)

General Information
Address: Direction de la Météorologie Nationale, Hay Hassani, Casablanca 20220, Marocco
Website: http://cri.marocmeteo.ma/
Contact person: AZIZ Mounir
Title: RIC Responsible Metrology and basic instrumentation service Natinal Meteorological Service of Morocco
Email: azizmounirgmail.com
Tel: +212 661 47 23 98
Fax: +212 (0) 522 90 85 93
Calibration capabilities: Temperature, Pressure, Humidity, Radiation, Precipitation

Background

World, Regional and National Radiation Centres

World, Regional and National Radiation Centres were established under the auspices of CIMO. The World Standard Reference for solar radiation measurements is maintained by the World Radiation Centre (Davos, Switzerland). The Regional Standard Instruments are made available at the 22 Regional Radiation Centres established within the WMO Regions. Please refer to the CIMO Guide: WMO-No. 8 (6th ed.), Chapter I,7 "Radiation Measurements".

Background

… at least three stable absolute pyrheliometers with a traceable 95% uncertainty of less than 1 Wm-2 to the World Radiometric Reference

in stable clear sun conditions with direct irradiances above 700 Wm-2, 95% of any single measurements of direct solar irradiance will be expected to be within 4 Wm-2 of the irradiance.

The World Radiation Centre Davos is requested to maintain the World Standard Group for the realization of the World Radiometric Reference

Standort: Adresse und Anfahrt

The issues are distributed among the National Meteorological Services which send their solar radiation data to the WRDC.

For more detailed information, please, contact:
Voeikov Main Geophysical Observatory,
World Radiation Data Centre,
7, Karbyshev Str.,
194021, St.Petersburg,
Russian Federation
tel.: 7 (812) 297-43-90
fax.: 7 (812) 297-86-61

Please direct any comments or suggestions regarding this site and about the WRDC data to
Dr. Anatoly V. Tsvetkov, Head of WRDC.
tel: 7 (812) 295-04-45
e-mail:
wrdc@main.mgo.rssi.ru
tsvetkov@main.mgo.rssi.ru

Thank you for your interest to the WRDC web-server data.

In accordance with the WMO Resolution 40(Cg-XII), these data are intended for research and educational communities of countries - WMO Members for their non-commercial activities.

To make the WRDC web-server more helpful for users, would you send your comments and, in particular, inform us in which project you are going to use the data presented, at the e-mail addresses.

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KENYA METEOROLOGICAL DEPARTMENT
Institute for Meteorological Training and Research (IMTR/WMO-RTC)
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Telephone: 254 (0) 20 3867895/83, **Cell:** +254-(0)724 255153-4 or +254-(0)736 655153-4
Fax: 254 (0) 20 3876955/3877373/3867888
E-mail: imtr@meteo.go.ke; Website: http://www.meteo.go.ke/imtr

Instruments Maintenance and Calibration Course IMCC

NAIROBI-WMO RTC, October 2014

Bertrand Calpini, CIMO president

CIMO mission

Promote:

- **high quality observational data**
- **world-wide compatibility**

by:

- **Defining technical standards,**
- **Testing and calibration**
- **Performing instrument intercomparisons,**
- **Implementing quality control procedures.**
- **Increasing expertise and Capacity-building**

OPAG – Capacity Building

A subset of the OPAG activities:

CIMO ET-RIC:

- RIC Website
- RIC Evaluations & RIC Intercomparisons
- Estimation of Calibration Uncertainty
- Strategy to Ensure Measurement Traceability to SI
- Replacement / Safer Use of Dangerous/Obsolete Instruments (e.g. Hg, H_2, autographs)
- Observer/Technician Competencies
- Regional Instrument Calibration and Maintenance Workshops

CIMO Guide Editorial Board:

- Coordinate updates of CIMO Guide
- Contribute to update of WMO Technical Regulations and Manual on WIGOS

Some useful resources:

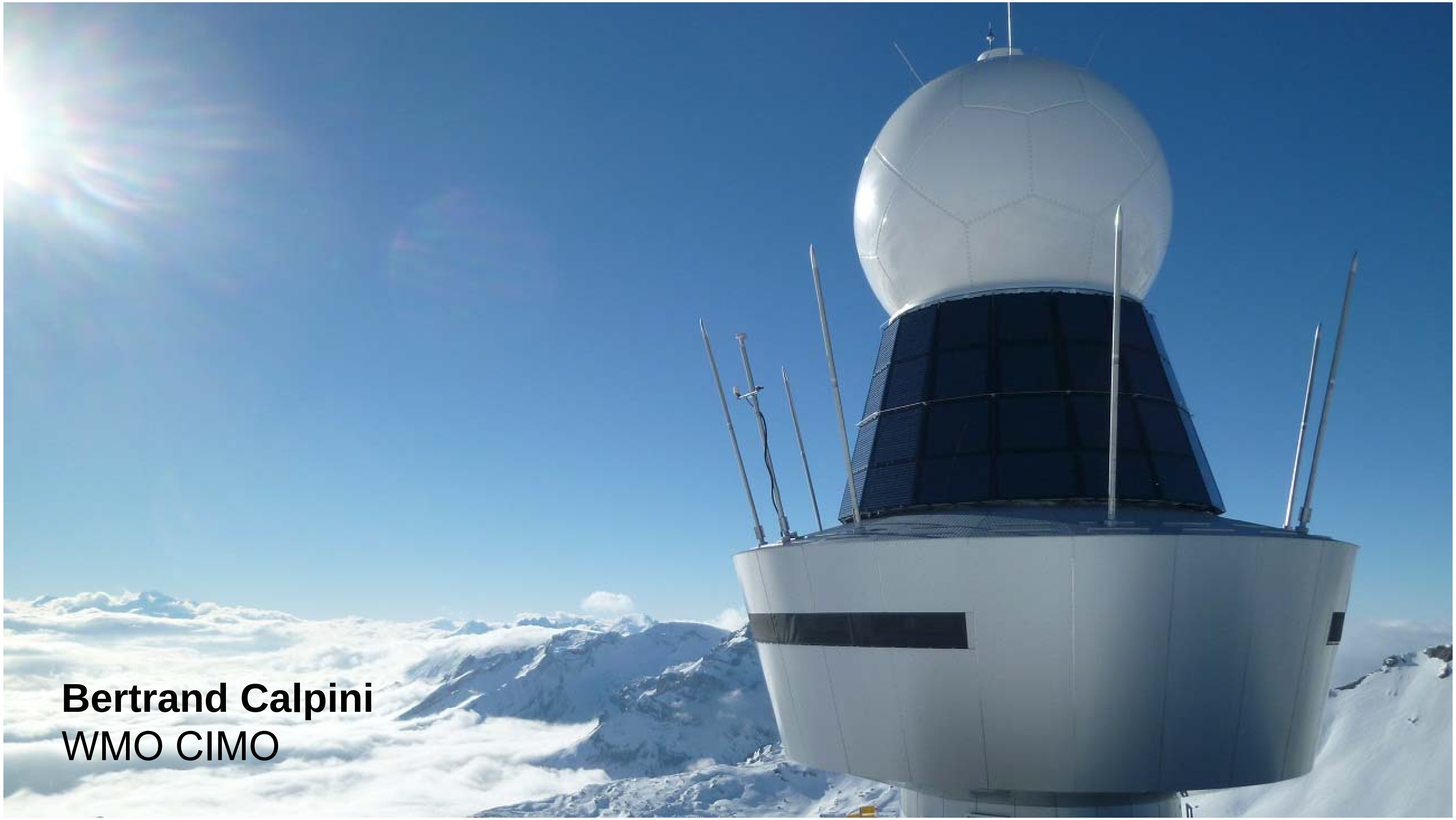
- **IMOP website** http://www.wmo.int/pages/prog/www/IMOP/IMOP-home.html: with links to:
  - CIMO Guide
  - IOM Reports
  - RICs
  - HMEI (Association of Hydro-Meteorological Equipment Industry) website: http://www.hydrometeoindustry.org/
  - More…

The Scene is set …

… and now onward :

The Scene is set …

…vs Weather Radar standards …



Weather radars – ISO standard versus WMO recommendations - the WMO-CIMO point of view

Urs Germann CH, Paul Joe Canada, Daniel Michelson Sweden

Starting thoughts

- Technology is relatively mature, but at the same time there is rapid evolution and variety in scope (usage) and technology (antenna, scanning strategy and capability, signal processing, etc)
- Data quality is a mix of hardware performance and signal statistics

- These days “anyone” can build a radar (by integrating components) and consumers need quality assurance, guidance and advice. This is the biggest need for users without extensive radar knowledge. What is good enough, for what application/use and at what price?
- Many kinds of radars of different type and quality: TV radars, boat radars, wind profiling radars, high-quality radars of national weather services, research radars: again, consumers need guidance

Main applications

Monitoring severe weather

- Identification and tracking of supercells, severe convection, thunderstorms, hail cells, tornadoes, flash floods, etc

Monitoring precipitation (qualitative and quantitative)

- Detailed real-time picture of precipitation in 4D
- Quantitative estimation of precipitation rates at the ground (just one application but the most demanding for radar and data quality)

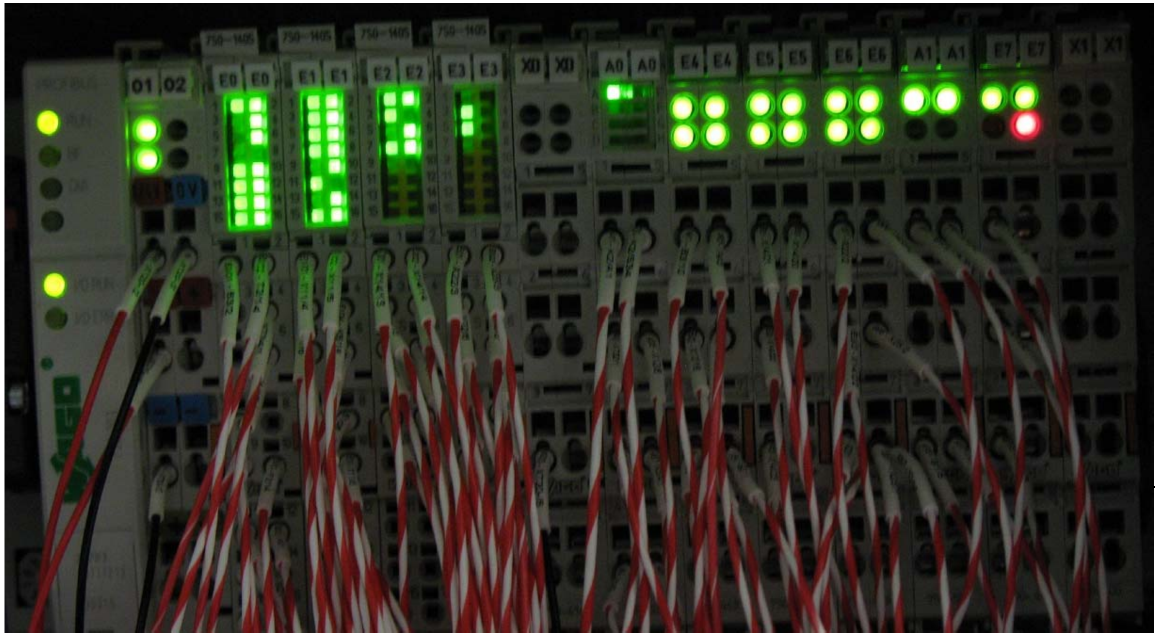
Meteorological and hydrological forecasting

- Clear air sensing for convective initiation
- Extrapolation of severe weather and precipitation fields (nowcasting)
- Alerts
- Assimilation in models for numerical weather prediction and runoff modelling

And more: Snowfall monitoring, wind measurements, hydrometeor classification, climatology, research in general, and several others …

Why we need a common reference

- Common level of quality (hardware, data, product)
- Fullfil user needs
- Definitions (what is a weather radar and what not)
- Benchmark
- Interoperability
- Guidelines and starting point for newcomers



*Specs and performance of radars on the market shall reflect the **needs** of radar operators and end users,*

***rather** than being driven by radar manufacturers.*

Challenges

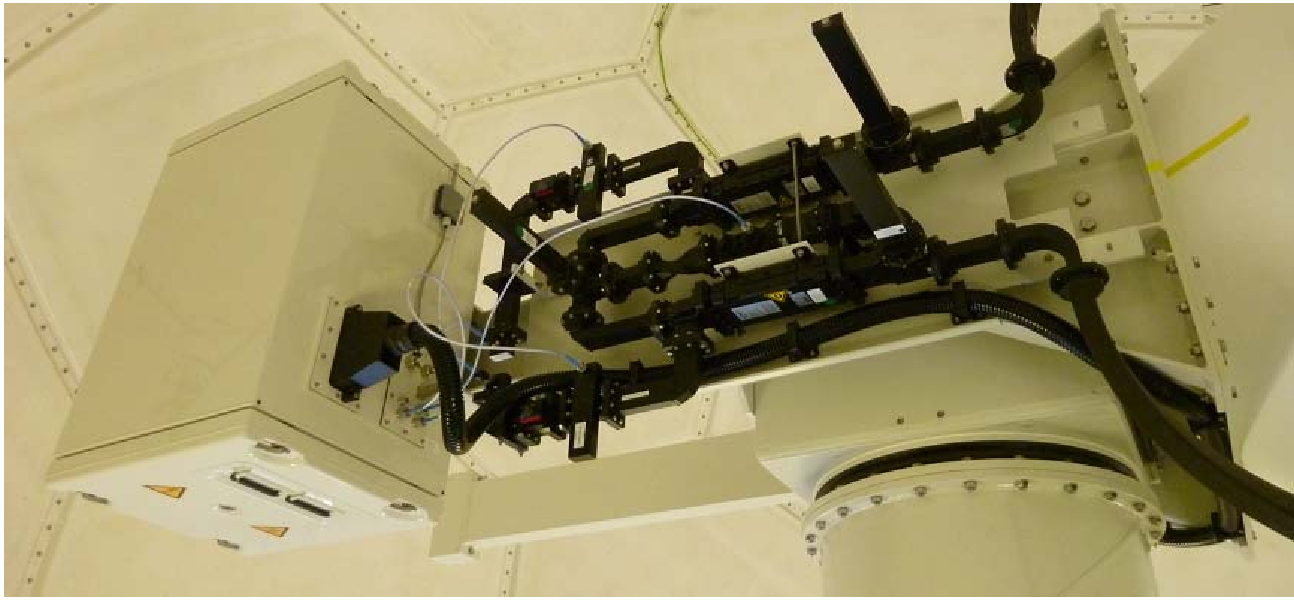
Allow new technologies to emerge. There is a risk a strict standard will slow down technological progress. We need to

- **guarantee a common minimum level of performance,**

and, at the same time,

- **foster innovation beyond that level.**

-> How to include this in a standard ?



Challenges

High performance in the lab is important. **But** real-world performance, stability, robustness, reliability, up-time and time-to-repair are important as well.

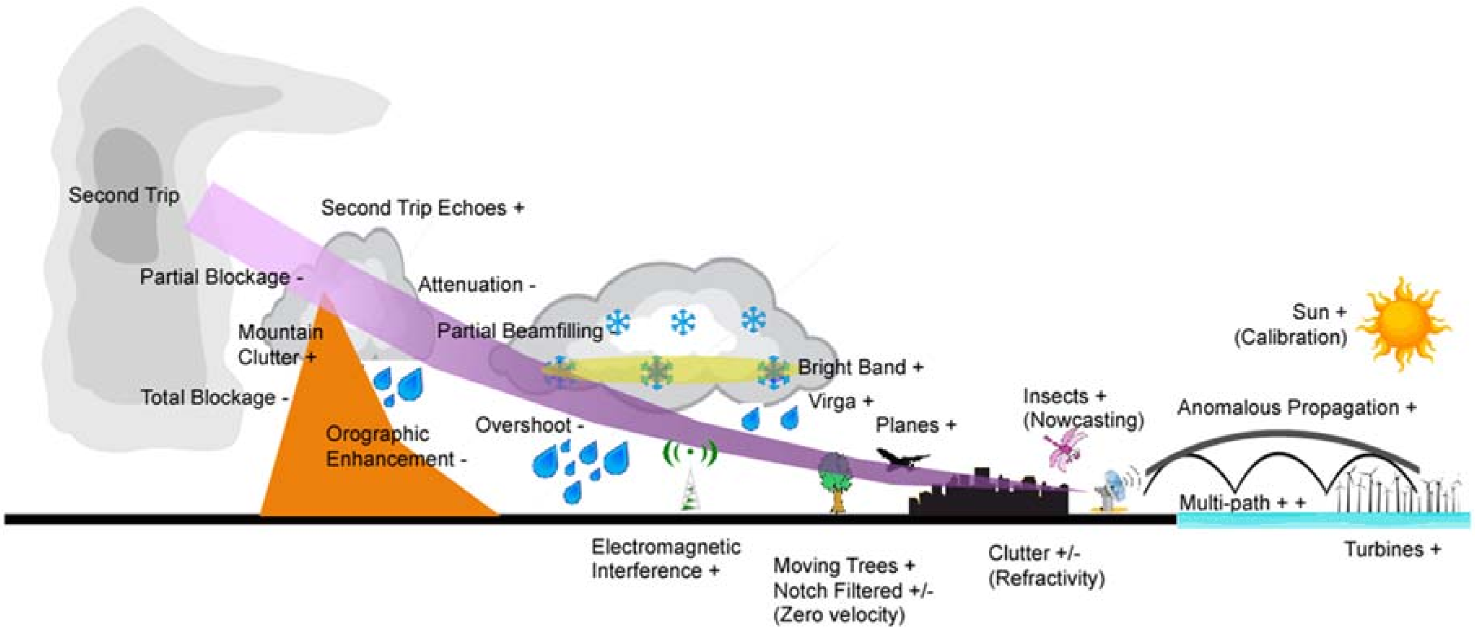
«Even the best performant radar doesn't help anything, if it is out of order.»

Operation practices: Rigorous acceptance testing, optimum configuration, meticulous calibration, automatic monitoring and calibration of the whole system, regular preventive maintenance, …

-> How to include robustness and reliability ?

Complexity

For instance: Sources of error and need for appropriate hardware and software design and sophisticated data processing.



-> How to define a standard that takes this into account?

Context

Optimum design heavily depends on needs and context
(monitoring snow in Finland vs flash floods in Spain vs orographic precipitation in Switzerland …).

-> How to define a standard that takes this into account?

VDI draft for ISO is narrow. Covers maybe 20% of the range of nowadays applications of weather radar technology.

Scope of the standard ?

Careful thinking required.
To give a few examples:

- Radio frequency (possibly S, C and X)
- Large number of low-cost radars vs few high-performance radars
- Include rain retrieval from microwave links?
- Antenna: mechanical vs electronical, beam shape, volume-scanning vs 2D and 1D
- Tx: Klystron, Magnetron, low-power solid-state with long pulses and pulse compression
- Rx: receiver over elevation vs receiver in the technical room
- Radar hardware only, or also data and product processing
- Include acceptance testing, operation and maintenance practices, or just procurement and installation
- Calibration, monitoring and adjustment: different strategies
- Applications: hydrology only vs including all sorts of applications
- Multi-purpose-radars (meteorology + civil aviation + military)
- And many more …

ISO standard is not the right solution
at the moment

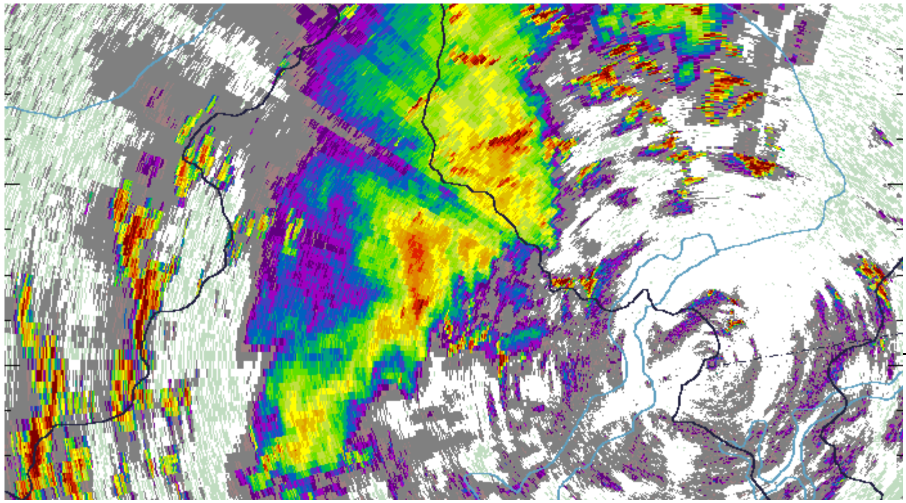
- Rapid evolution in technology
- Many different technological solutions
- Large variety in needs
- Needs are rapidly changing
- Poor metrics for definition of a strict standard
  (particularly for robustness and reliability except MTBF!)
- No common agreement on standard solution
  (neither for hardware nor for data processing)
- How to make sure the needs from operators and users are covered ?
- Any standard should be freely available, not proprietary.

Conclusions and way forward

WMO is the international reference for observing systems for weather, hydrology and climate. WMO is driven by the national services, not the manufacturers.

ISO community has expertise in the definition of standards

- Establish WMO Regulatory Material as international reference. Substantial work already done (CIMO Guide). Allow for variety and regular updates. WMO is driven by needs of operators and users by construction.



Go for ISO at a later time

(start with ISO Technical Report, then ISO Standard)

Conclusions and way forward

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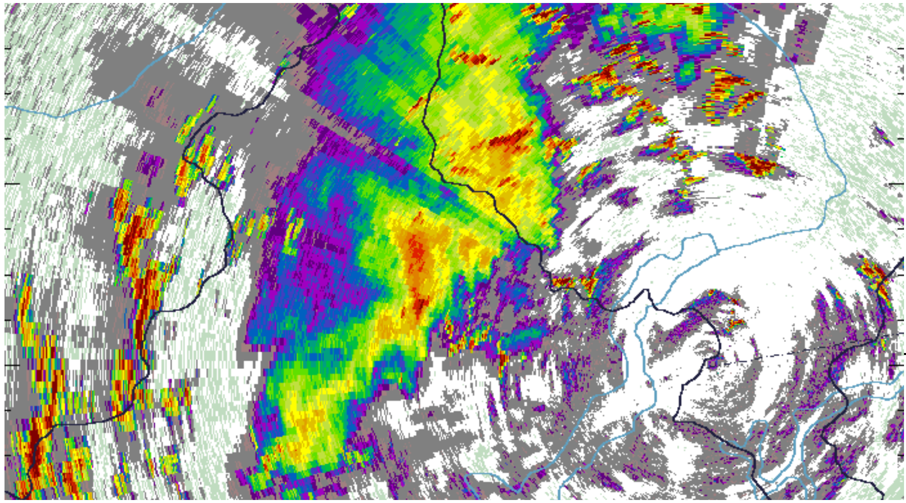


The WR ISO 1st step:

Maintenance, calibration, training and capacity building, QA QC

(but no tech spec vs WR system components, either HW or SW)

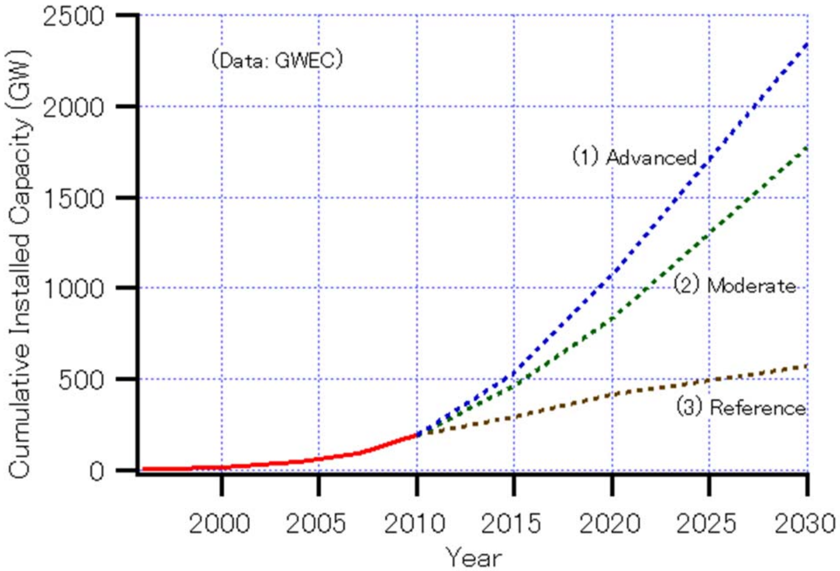
The Scene is set …

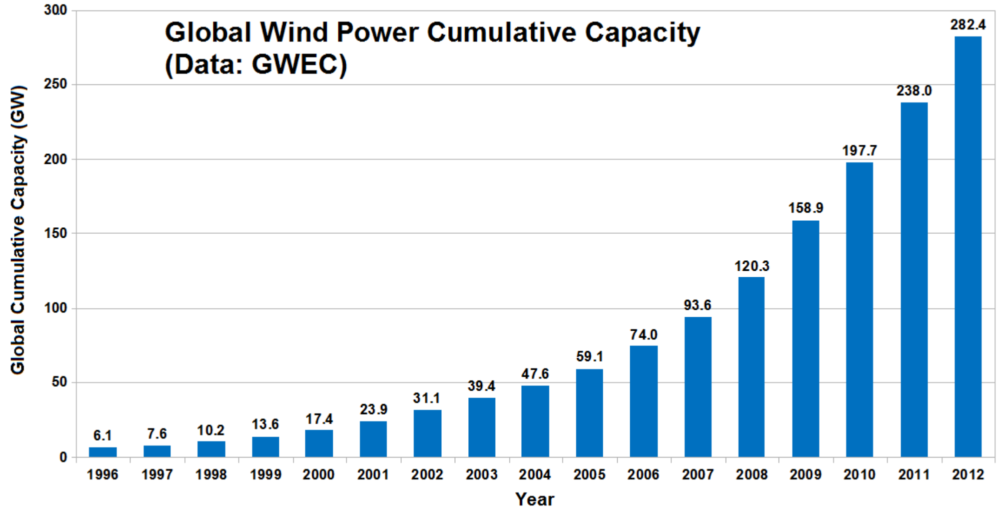
…vs Wind lidar standards …

Doppler wind LIDAR:
a technology making a standard

“Ground based remote sensing of wind by Doppler LIDAR”. Why do we need a standard?

- There is no standard defining the measurement of the wind vector by remote sensing technology.
- The branch of market related to remote sensing wind measurements is growing considerably every year for both monitoring and assessment purposes.
- Between 2005 and 2010 the average annual growth in new wind farm installations was 27.6%. Wind power market penetration is expected to reach 3.35% by 2013 and 8% by 2018.
- Stakeholders need to be «protected» by a recognized reference when using wind measurements for commercial activities.





"Ground based remote sensing of wind by Doppler LIDAR". Where is the expertise?

- End users and vendors of wind Doppler LIDAR have the same needs.
- End users are: Met services, research centres, stakeholders, banks...
- Both end users and vendors shall contribute to identify what is needed to define a standard.
- Under the mandate of CIMO an Editorial Board and a Review Board have been created to facilitate the creation of the International Standard for wind Doppler LIDAR.

Stages of the development of International Standards

1 Proposal Stage
2 Preparatory Stage ← Jan 2014
3 Committee Stage
4 Enquiry Stage
5 Approval Stage
6 Pubblication Stage ← Nov 2014

Need to create a list of clear actions to progress actively through the following steps.

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WMO OMM

Plan for 2014/2015

D1. Editorial Board (EB):
Laurent Sauvage (coordinator)/Jean-Pierre Cariou (Leosphere, FR)
Simon Jäckel (VDI, DE)
Volker Lehmann (DWD, DE)
Gianni Martucci (MCH, CH)
Holger Wille (Lufft, DE)
Alain Dabas (MeteoFrance, FR)
Guy Pearson (Halo Photonics, UK)

D2. Review Board (RB):
Marc de Huu (METAS, CH)
Gianni Martucci (MCH, CH)
Volker Lehmann (DWD, DE)
Sebastian kauczok (Selex, DE)
Holger Wille (Lufft, DE)
Christoph Münkel (Vaisala, DE)
Alexander Haefele (MCH, CH)
Bertrand Calpini (WMO CIMO)
Arnoud Apituley (WMO CIMO)

A1. First unofficial draft by the EB based on the proposed structure:
11 March, 2014 (EB to send to RB)

A2. Review phase by the RB:
11-18 March, 2014 (RB)

A3. Discussion of the reviewed unofficial draft:
TOPROF meeting 18-20 March, 2014 (RB/EB)

A4. Revision of the unofficial draft:
Finalized by mid-May, 2014 (EB)

A5. Approval of the unofficial draft:
June 2014 (RB/EB)

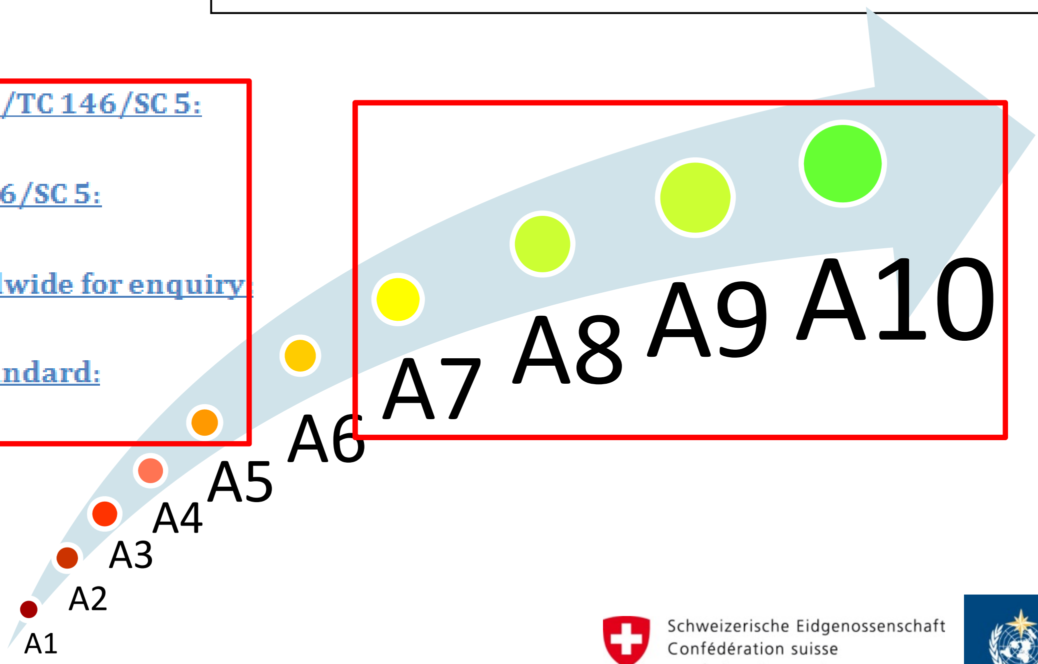
A6. Advanced draft reworked at TECO2014:
July 2014

A7. Draft ISO 28902-2 submitted for enquiry within ISO/TC 146/SC 5:
September-November 2014

A8. Output of the enquiry the enquiry within ISO/TC 146/SC 5:
November 2014

A9. The draft international standard is published worldwide for enquiry:
February 2015

A10. Output of the international enquiry of the draft standard:
May 2015



The Scene is set …

…vs Ceilometers standards …

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Ceilometer network:
users requirements and scope

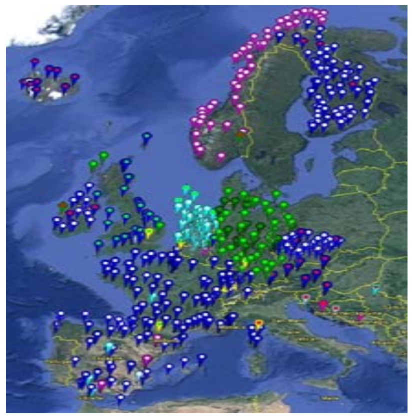
Automatic LIDAR and Ceilometer Network: E-PROFILE mission

Addition of Automatic Lidar and Ceilometer (ALC) observations

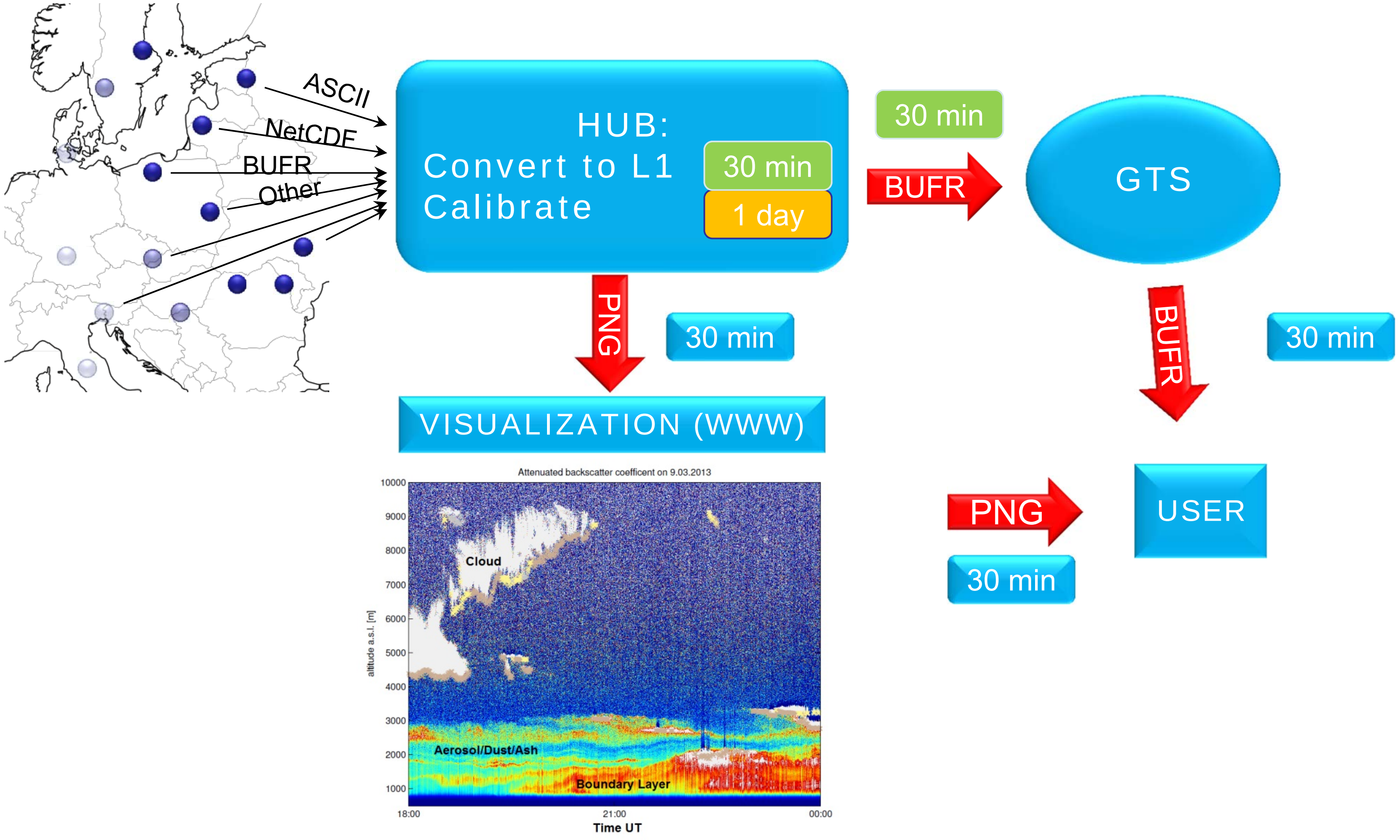
- Minimum operational requirement: vertical backscatter profiles from ALC
  - Analysis of the user requirements for ALC observations.
  - Production of business case.
  - Implementation and operational acceptance.
- Scientific perspective: to use ALCN as data source for higher-level products, e.g. extinction, mass concentration

18 country members (+2 in 2015)

~800 LIDAR



Data Flow


ASCII
NetCDF
BUFR
Other
HUB:
Convert to L1
Calibrate
30 min
1 day
30 min
BUFR
GTS
PNG
30 min
BUFR
30 min
VISUALIZATION (WWW)
Attenuated backscatter coefficent on 9.03.2013
altitude a.s.l. [m]
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
Cloud
Aerosol/Dust/Ash
Boundary Layer
18:00
21:00
00:00
Time UT
PNG
30 min
USER

Review of Requirements

Review is based on 3 pillars:

1)WMO RRR data base and OSCAR tool

2)Official documentation (ICAO, VAAC, ICOS, …)

3)User survey

1st Pillar: WMO Statement of Guidance

Aeronautical Meteorology

Global NWP

High-resolution NWP

- Vertically resolved information (Lidar)
- Operational network
- Combination of observations (dense ceilometer network with research HSR Lidar)
- QA managed on regional level (Europe)

1st Pillar: OSCAR observation requirements

Variable	Layer	App. Area	Uncertainty	Horiz. Res.	Vert. res.	Obs. cycle	Timeliness	Coverage
Cloud base height	n/a (2D)	Global NWP	0.2 km 0.5 km 1 km	5 km 15 km 50 km		60 min 3 h 12 h	6 min 30 min 6 h	global
Cloud base height	n/a (2D)	Aeronautical meteorology	nd	nd	nd	nd	nd	Point
Aer. Ext. Coeff	LT	climate	1e-05 m-1 1.5e-05 m-1 2e-05 m-1	10 km 20 km 100 km	0.5 km 0.65 km 1 km	24 h 2 d 7 d	7 d 14 d 60 d	global
Aer. Ext. Coeff	LT	Aeronautical meteorology	nd	nd	nd	nd	nd	global

Variable	Layer	App. Area	Uncertainty	Horiz. Res.	Vert. res.	Obs. cycle	Timeliness	Coverage
Aer. Mass Mix. Ratio	LT	Atm. Chem.	5% 8% 20%	50 km 100 km 500 km	1 km 1.7 km 5 km	6 h 10 h 24 h	12 h 29 h 7 d	global
Aer. Mass Mix. Ratio	LT	Clim. Model. Research	10% 15% 20%	50 km 100 km 500 km	nd	6 h 24 h 7 d	30 d 45 d 60 d	global
Aer. Mass Mix. Ratio	LT	Global NWP	10% 20% 50%	15 km 50 km 250 km	0.2 km 3 km 3 km	60 min 6 h 24 h	6 min 30 min 6 h	global

goal is marked blue, breakthrough green and threshold orange

2nd Pillar: ICAO, VAAC, ICOS

ICAO(International Civil Aviation Organization) and

VAAC (Volcanic Ash Advisory Center)

- Detection of volcanic ash (VA)
- VA forecast with models
- Advisories
- Real-time and 24h system

ICOS (Integrated Carbon Observation System)

- Centralized QC
- PBL estimation

3rd Pillar: User Survey

- Online questionnaire with 27 questions
- 80 responses from 24 countries devided into 7 domains

Coverage, sampling frequency, timeliness
- 50 ≤ Hres ≤ 100 km
- Δt = 10 minutes
- T = 10 minutes

Information to be provided
- Cloud base height.
- Backscatter/Extinction coefficient (profile measurement).
- Geographic location of the aerosol/VA layer.
- Lower and upper boundaries of the aerosol/VA layer.
- Mass concentration within the VA layer.

Data access
- Quicklooks accessible on internet.
- Numeric data accessible on internet.
- NetCDF/HDF format
- BUFR format

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Requirements

Indexed list of requirements based on the RoR.

	Requirements
1	ALC measurements should provide vertically-resolved information
2	Operational observational capability, i.e. in real time and 24/7
3	Dense network of ceilometers in each country and one or two advanced (multi-wavelength) Lidar stations per country/region for continuous calibration
4	ALC systems should be managed at the European/EU level and at the global scale to provide consistent data
5	Same QA/QC procedures and data processing
6	Values and the uncertainties of the ash cloud density and position at any given time in near real time
7	Monitor relevant data to detect volcanic ashes
8	Activate models to forecast movement of ash clouds
9	VAAC recommends to issue advisory information
10	Issue updated information, as necessary
11	Centralized, QA and harmonized network of ALC capable to provide near-real-time retrievals of the planetary boundary layer height
12	Centralized automatic ALC data quality monitoring interacting in near real time with the operators within the ALC network
13	Cloud base height
14	Attenuated Backscatter coefficient profile
15	Backscatter/Extinction coefficient profile
16	$50 \leq H_{res} \leq 100$ km, $1000 \leq N \leq 4000$
17	Temporal resolution $\Delta t = 10$ minutes
18	Timeliness T = 10 minutes
19	Geographic location of the plume
20	Lower and upper boundaries of the plume
21	Mass concentration within the plume
22	Quicklooks accessible on internet
23	Numeric data accessible on internet
24	NetCDF/HDF or BUFR format

E-PROFILE ALC Services

- Hub Services
  - Data collection, **calibration (attenuated backscatter)**, formatting, distribution, blocking, visualisation, access (GTS), archiving
- Quality control
  - Automatic & visual QC, daily message, monthly report, comparison with research lidar
- Technical support
  - Guidelines, best practices, peer-to-peer support, workshop, contact with manufacturer

Schweizerische Eidgenossenschaft

Service versus Requirements

- 17 of 24 requirements can be met.

Important limitations:

- No backscatter / extinction coefficient.
- No ash mass concentration
- Vertical range limited to 7 km for 75% of the network.

Future developments

- Advanced retrievals in combination with other data

	Requirements	E-PROFILE
1	ALC measurements should provide vertically-resolved information	
2	Operational observational capability, i.e. in real time and 24/7	
3	Dense network of ceilometers in each country and one or two advanced (multi-wavelength) Lidar stations per country/region for continuous calibration	Research lidar network will be only used for quality monitoring.
4	ALC systems should be managed at the European/EU level and at the global scale to provide consistent data	
5	Same QA/QC procedures and data processing	
6	Values and the uncertainties of the ash cloud density and position at any given time in near real time	
7	Monitor relevant data to detect volcanic ashes	Attenuated backscatter coefficient will be provided
8	Activate models to forecast movement of ash clouds	
9	VAAC recommends to issue advisory information	
10	Issue updated information, as necessary	
11	Centralized, QA and harmonized network of ALC capable to provide near-real-time retrievals of the planetary boundary layer height	Centralised calibration and QA, no PBL algorithm
12	Centralized automatic ALC data quality monitoring interacting in near real time with the operators within the ALC network	
13	Cloud base height	
14	Attenuated Backscatter coefficient profile	Vertical range depending on instrument and atmospheric conditions (see Section 3)
15	Backscatter/Extinction coefficient profile	
16	$50 \leq H_{res} \leq 100$ km, $1000 \leq N \leq 4000$	Depends on the strategies of the national NMS
17	Temporal resolution Δt = 10 minutes	
18	Timeliness T = 10 minutes	
19	Geographic location of the plume	By visual inspection
20	Lower and upper boundaries of the plume	By visual inspection, vertical range depending on instrument and atmospheric conditions (see Section 3)
21	Mass concentration within the plume	
22	Quicklooks accessible on internet	
23	Numeric data accessible on internet	
24	NetCDF/HDF or BUFR format	
		17
		71%

Benefits

- Operational performance
- Large scale
- Harmonization
- Quantitative vertical profiles
- Easy data access
- Measurement synergy
- Collaboration, exchange and capacity building
- Lower costs
- New opportunities

World Meteorological Organization

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Thank you for your attention