GOBIERNO DE ESPAÑA

MINISTERIO DE INDUSTRIA, COMERCIO Y TURISMO

Climate change and Environment: needs and challenges to be addressed by the CCM

Carmen García Izquierdo
mcgarciaiz@cem.es

25th May 2023

CENTRO ESPAÑOL DE METROLOGÍA

Links between the BIPM and the WMO

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MINISTERIO DE INDUSTRIA, COMERCIO Y TURISMO

World Meteorological Organization

Working together in weather, climate and water

BIPM

Agreement between the World Meteorological Organization and the International Committee for Weights and Measures

Text approved by the CIPM on 10 October 2001

Article I

1. The World Meteorological Organization (WMO), referred hereinafter as "the Organization", and the International Committee for Weights and Measures, referred hereinafter as "the Committee", agree that with a view to facilitating the implementation of their objectives, set respectively in the Convention of WMO, and in the Metre Convention, they will act in close cooperation with each other and consult each other regularly in regard to matters of common interest.
2. The Committee recognizes the responsibilities of the Organization in the field of meteorology, hydrology and other related geophysical sciences as set forth in the Convention of the Organization and recognized in the Agreement between the United Nations and the Organization and in particular that the Organization has a mandate to ensure that data obtained in the course of its work is standardized, accurate and reliable.
3. The Organization recognizes the responsibilities of the Committee as set forth in the Metre Convention and in particular the recommendation of the Member States set out in Resolution 4 of the 21st General Conference of Weights and Measures (1999) related to the need to use SI[1] units in studies of Earth resources, the environment, human well being and related issues.
4. Accordingly, the Organization and the Committee will consult together to ensure that data, related in particular to measurements of state and composition of atmosphere and water resources, coming from the programmes organized under the auspices of the Organization are properly based on units traceable to the SI through the procedures of the Mutual Recognition Arrangement for National Measurement Standards drawn up by the Committee and those of the Technical Regulations of the Organization.

Article II

Reciprocal representation

1. Representatives of the Committee shall be invited to attend sessions of bodies of the Organization and to participate without vote in the deliberations of these bodies and, where appropriate of its committees or commissions with respect to items on the agenda in which the Committee has an interest.
2. Representatives of the Organization shall be invited to attend the General Conference of Weights and Measures and to participate without vote in the deliberations of that body with respect to items on the agenda in which the Organization has an interest.
3. Appropriate arrangements shall be made by agreement from time to time for reciprocal representation of the Organization and the Committee at other meetings convened under their respective auspices which consider matters in which the other organization has an interest.

Article III

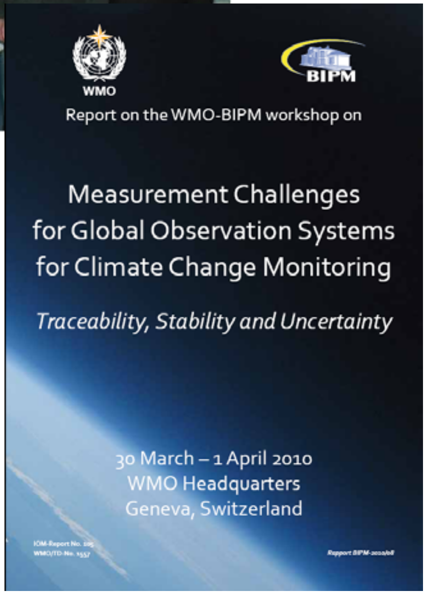
Traceability to SI

Michel Jarraud, WMO General Secretary, signed the MRA, 1st April 2010

Traceability to SI

+

Measurement uncertainty



CENTRO ESPAÑOL DE METROLOGÍA

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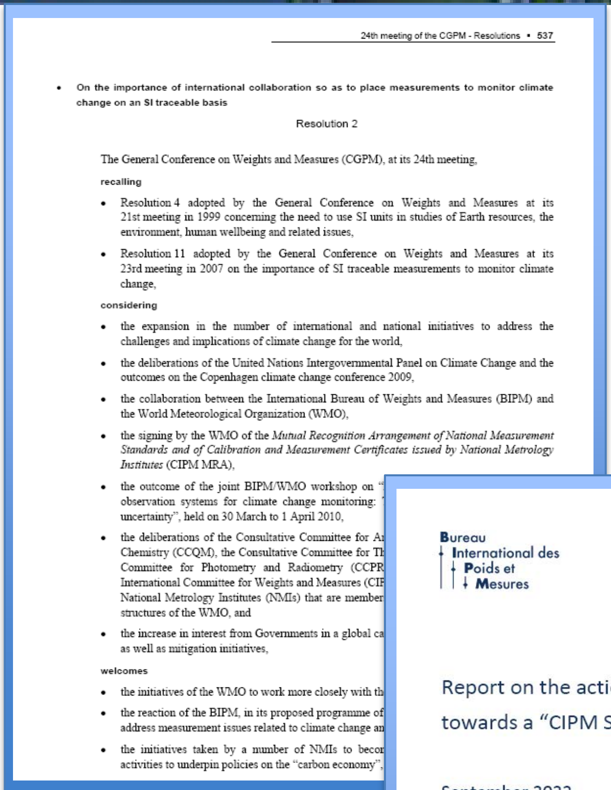


- On the importance of international collaboration so as to place measurements to monitor climate change on an SI traceable basis

Resolution 2

The General Conference on Weights and Measures (CGPM), at its 24th meeting,

recalling

- Resolution 4 adopted by the General Conference on Weights and Measures at its 21st meeting in 1999 concerning the need to use SI units in studies of Earth resources, the environment, human wellbeing and related issues,
- Resolution 11 adopted by the General Conference on Weights and Measures at its 23rd meeting in 2007 on the importance of SI traceable measurements to monitor climate change,

considering

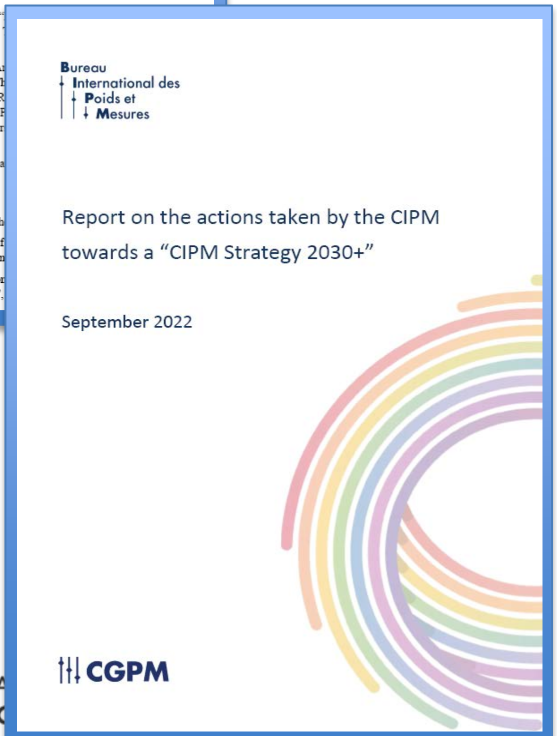
- the expansion in the number of international and national initiatives to address the challenges and implications of climate change for the world,
- the deliberations of the United Nations Intergovernmental Panel on Climate Change and the outcomes on the Copenhagen climate change conference 2009,
- the collaboration between the International Bureau of Weights and Measures (BIPM) and the World Meteorological Organization (WMO),
- the signing by the WMO of the *Mutual Recognition Arrangement of National Measurement Standards and of Calibration and Measurement Certificates issued by National Metrology Institutes* (CIPM MRA),
- the outcome of the joint BIPM/WMO workshop on "... observation systems for climate change monitoring: ... uncertainty", held on 30 March to 1 April 2010,
- the deliberations of the Consultative Committee for A... Chemistry (CCQM), the Consultative Committee for T... Committee for Photometry and Radiometry (CCPR... International Committee for Weights and Measures (CI... National Metrology Institutes (NMIs) that are member... structures of the WMO, and
- the increase in interest from Governments in a global ca... as well as mitigation initiatives,

welcomes

- the initiatives of the WMO to work more closely with th...
- the reaction of the BIPM, in its proposed programme of... address measurement issues related to climate change an...
- the initiatives taken by a number of NMIs to becom... activities to underpin policies on the "carbon economy",...

24th CGPM Resolutions, 2011

On the importance of **international collaboration** so as to place measurements to monitor climate change on an SI traceable basis.


Bureau International des Poids et Mesures

Report on the actions taken by the CIPM towards a "CIPM Strategy 2030+"

September 2022

CGPM

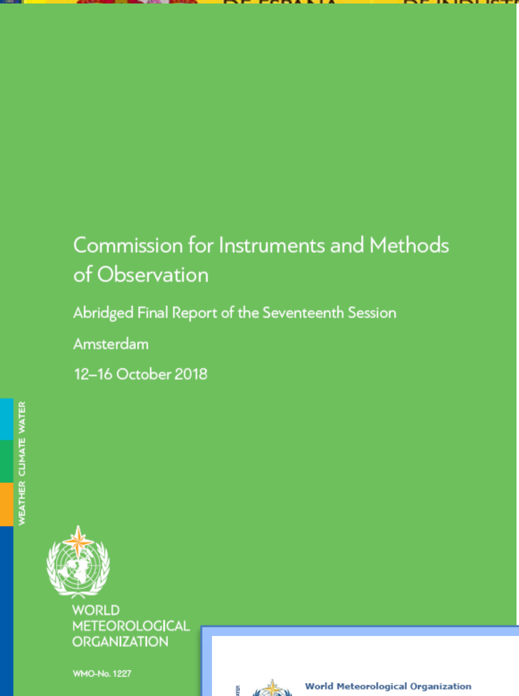
CIPM Strategy 2030+

CIPM identified the Climate change and Environment as one of the five "Metrology Grand Challenges"

CIPM recognized Metrology is critical to ensuring the monitoring of the global climate and broader environment,

The mitigation policies and their implementation are based on firm evidence.

CEM CENTRO ESPA... DE METROLO...



Recommendation 6 (WMO-CIMO-17), 2018

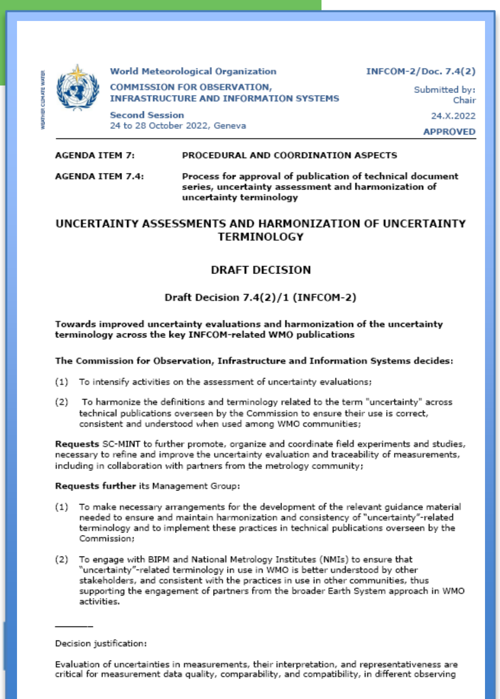
Improvement of traceability in measurement and calibration results in NMHS

the traceability of measurement and calibration results is key to ensuring confidence in:

- measurement data,
- their quality and
- their suitability for use in specific application areas: the assessment of climate variability and change

Recommendation 11 (WMO-CIMO-17), 2018

CIMO encouraged the cooperation between WMO and BIPM



World Meteorological Organization
COMMISSION FOR OBSERVATION, INFRASTRUCTURE AND INFORMATION SYSTEMS
Second Session
24 to 28 October 2022, Geneva

INFCOM-2/Doc. 7.4(2)
Submitted by: Chair
24.X.2022
APPROVED

AGENDA ITEM 7: **PROCEDURAL AND COORDINATION ASPECTS**

AGENDA ITEM 7.4: **Process for approval of publication of technical document series, uncertainty assessment and harmonization of uncertainty terminology**

UNCERTAINTY ASSESSMENTS AND HARMONIZATION OF UNCERTAINTY TERMINOLOGY

DRAFT DECISION

Draft Decision 7.4(2)/1 (INFCOM-2)

Towards improved uncertainty evaluations and harmonization of the uncertainty terminology across the key INFCOM-related WMO publications

The Commission for Observation, Infrastructure and Information Systems decides:

(1) To intensify activities on the assessment of uncertainty evaluations;

(2) To harmonize the definitions and terminology related to the term "uncertainty" across technical publications overseen by the Commission to ensure their use is correct, consistent and understood when used among WMO communities;

Requests SC-MINT to further promote, organize and coordinate field experiments and studies, necessary to refine and improve the uncertainty evaluation and traceability of measurements, including in collaboration with partners from the metrology community;

Requests further its Management Group:

(1) To make necessary arrangements for the development of the relevant guidance material needed to ensure and maintain harmonization and consistency of "uncertainty"-related terminology and to implement these practices in technical publications overseen by the Commission;

(2) To engage with BIPM and National Metrology Institutes (NMIs) to ensure that "uncertainty"-related terminology in use in WMO is better understood by other stakeholders, and consistent with the practices in use in other communities, thus supporting the engagement of partners from the broader Earth System approach in WMO activities.

———

Decision justification:

Evaluation of uncertainties in measurements, their interpretation, and representativeness are critical for measurement data quality, comparability, and compatibility, in different observing

WMO-INFCOM-2-decision 7, 2022

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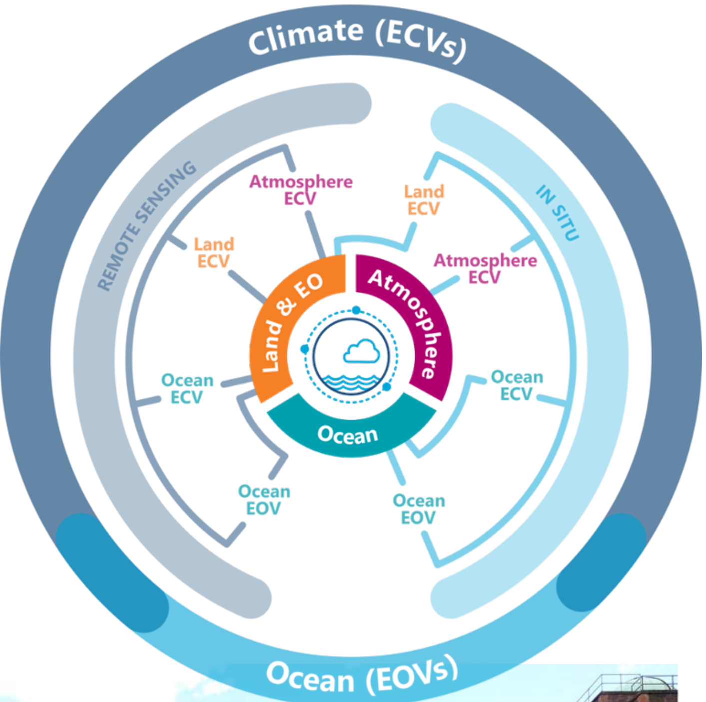
EURAMET

CLIMATE AND OCEAN OBSERVATION

European Metrology Network on Climate and Ocean Observations

Launched in 2019



Aim: Building partnerships between metrology and the climate & ocean observation communities to enhance metrological best practice across Europe and beyond.

Members: NMIs, Dis and Affiliated partners

Stakeholders needs report

Strategy Research Agenda

-In situ sensors
-Networks
-Satellite Sensors

In three domains: Atmosphere, Ocean, Land

ECVs
EOVs

https://www.euramet.org/climate-and-ocean-observation

GCOS
GLOBAL CLIMATE OBSERVING SYSTEM
RIA, COMERCIO

GCOS expert panels maintain definitions of **Essential Climate Variables (ECVs)** which are required to systematically observe Earth`s changing climate. GCOS currently specifies 55 ECVs

Essential Climate Variables

For graphical version click here
What are Essential Climate Variables (ECVs)?

Atmosphere

Surface
- Precipitation
- Pressure
- Radiation budget
- Temperature
- Water vapour
- Wind speed and direction

Upper-air
- Earth radiation budget
- Lightning
- Temperature
- Water vapor
- Wind speed and direction
- Clouds

Atmospheric Composition
- Aerosols
- Carbon dioxide, methane and other greenhouse gases
- Ozone
- Precursors for aerosols and ozone

Land

Hydrosphere
- Groundwater
- Lakes
- River discharge
- Terrestrial water storage

Cryosphere
- Glaciers
- Ice sheets and ice shelves
- Permafrost
- Snow

Biosphere
- Above-ground biomass
- Albedo
- Evaporation from land
- Fire
- Fraction of absorbed photosynthetically active radiation (FAPAR)
- Land cover
- Land surface temperature
- Leaf area index
- Soil carbon
- Soil moisture

Anthroposphere
- Anthropogenic Greenhouse gas fluxes
- Anthropogenic water use

Ocean

Physical
- Ocean surface heat flux
- Sea ice
- Sea level
- Sea state
- Sea surface currents
- Sea surface salinity
- Sea surface stress
- Sea surface temperature
- Subsurface currents
- Subsurface salinity
- Subsurface temperature

Biogeochemical
- Inorganic carbon
- Nitrous oxide
- Nutrients
- Ocean colour
- Oxygen
- Transient tracers

Biological/ecosystems
- Marine habitats
- Plankton

Physics	Biochemistry	Biology and Ecosystems
Sea state	Oxygen	Phytoplankton biomass and diversity
Ocean surface stress	Nutrients	Zooplankton biomass and diversity
Sea ice	Inorganic carbon	Fish abundance and distribution
Sea surface height	Transient tracers	Marine turtles, birds, mammals abundance and distribution
Sea surface temperature	Particulate matter	Hard coral cover and composition
Subsurface temperature	Nitrous oxide	Seagrass cover and composition
Surface currents	Stable carbon isotopes	Macroalgal canopy cover and composition
Subsurface currents	Dissolved organic carbon	Mangrove cover and composition
Sea surface salinity		Microbe biomass and diversity (*emerging)
Subsurface salinity		Invertebrate abundance and distribution (*emerging)
Ocean surface heat flux		
Ocean bottom pressure		
Cross-disciplinary (including human impact)		
	Ocean colour	Ocean sound
	Marine debris (*emerging)	

GOOS
The Global Ocean Observing System

Essential Ocean Variables
To be able to deliver ocean forecasts and early warnings, climate projections and assessments and protect ocean health and its benefits, it is vital to measure Essential Ocean Variables (EOVs). 33 EOVs

Surface pressure:

-**Actual pressure** + **Pressure trend** (pressure change + pressure characteristic).

The <u>pressure change</u> is the net difference between pressure readings for a specified interval of time.

The <u>pressure characteristic</u> is an indication of how the pressure has changed during that period of time, for example, decreasing then increasing, or increasing and then increasing more rapidly.

Pressure fields are a pillar for the predictions of the state of the atmosphere.

- barometer itself,
- The exposure also requires special attention.: wind, radiation, temperature, pressure shocks and vibrations
- WIND: A draught-free environment is needed. **Static Pressure Heads for minimizing wind influence. It** 'filters out' the effect of dynamic pressure,
- Differences in the way in which the barometer is operated during calibration compared with its operational use.
- Field inspections should be performed in low gradient weather conditions with stable atmospheric pressure and low wind speeds.

Upper-Air pressure:

Radiosonde –

Very large dynamic range (3, 1 000) hPa, with a resolution of 0.1 hPa over most of the range and a resolution of 0.01 hPa for pressures less than 100 hPa.

These instruments work under extremely wide range of meteorological conditions:

– (-95, 50) ºC
– (1%, 100%) for relative humidity
– heavy rain, in the vicinity of thunderstorms, and in severe icing conditions.

Today, many modern radiosonde systems use GPS navigation signals to locate the position of the radiosonde and have excluded the use of a pressure sensor . But still direct measurements of pressure in the troposphere present advantage for some proposes.

Wind speed and direction: Surface

-weather monitoring and forecasting,

-for wind-load climatology,

-for probability of wind damage

-estimation of wind energy, -

-as part of the estimation of surface fluxes: evaporation for air pollution dispersion and agricultural applications.

Usual wind instruments: **wind vane and cup or propeller anemometer**

New ones. **Sonic anemometers**: Work to be done on Calibration and uncertainty measurements

The most difficult aspect of wind measurement is the exposure of the anemometer (10 m above the ground and without obstacles around.

WMO/CIMO Siting classification (distance to obstacles). Uncertainties associated to influence of the obstacles

-**Urban Climate ??? Uncertainties in urban wind???**

In Upper-Air:

Wind is fundamental for understanding and predicting the behaviour of the atmosphere

-vertical wind

-horizontal wind

-Instruments working under extreme meteorological conditions

Precipitation :

Precipitation : is linear depth. Determined by volumetric (volume/area) or by weight measurements (mass/area)

Rainfall intensity is linear depth per hour, usually in millimetres per hour (mm h^{-1}).

Catching Instruments

The weight of the catch is measured, in particular for solid precipitation

Reference instruments

-rain

-snow

Non-Catching Instruments

Based on detection of the drops

-drop size distribution

-velocity of the drops

European Incipit Project

Traceability chain?

Standard?

Calibration uncertainties?

WMO Spice Project: Solid precipitation

In addition to traceability in the laboratory, the understanding of each **measurement uncertainty components** is needed

- **Catching uncertainty**: the ability of the instrument to collect the exact amount of water according to the definition of precipitation at the ground: wetting, evaporation, splashing, freezing and **wind**

- **Quantification uncertainty** are related to the ability of the instrument to sense correctly the amount of water collected by the instrument.

-**Other uncertainties** : for example sensitivity to exposure: WMO **Siting classification** + **Urban climate**.

Laboratory and field intercomparisons on rainfall intensity gauges is a powerful tool

Ocean

-Ocean Surface Stress: (N/m^2)

-Ocean Surface and Subsurface Salinity

-Ocean Surface and Subsurface Currents

-Sea State

-Sea Surface Height

-Ocean bottom pressure (OBP)

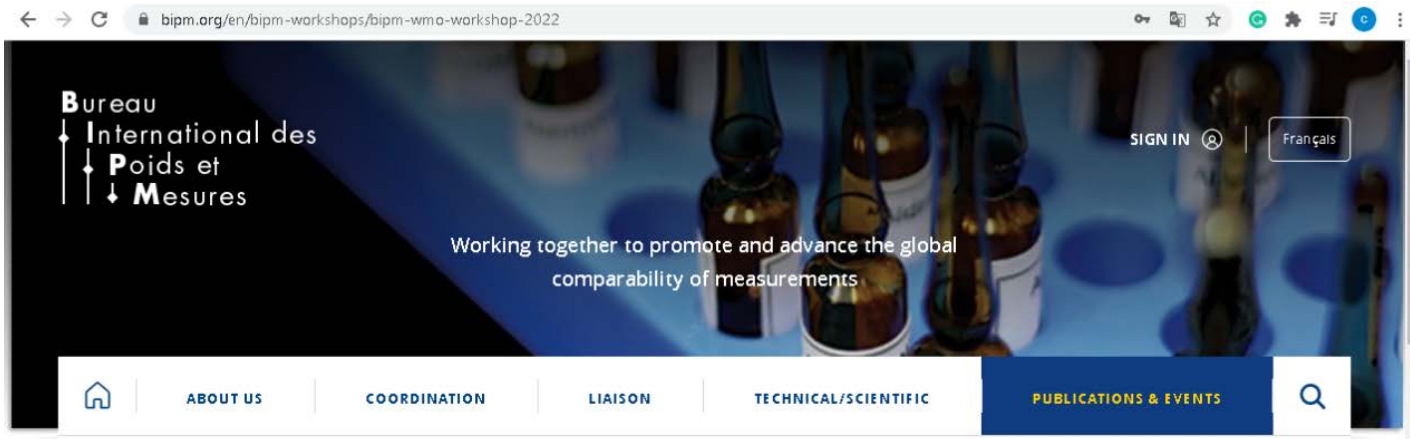
The Global Ocean Observing System
GOOS

Cryosphere

-Ice Sheets and Ice Shelves
-Snow
-Glaciers
-Permafrost

-All these four domains include different variables that characterize them

-Limits between ice and snow??



Metrology for Climate Action Workshop 2022

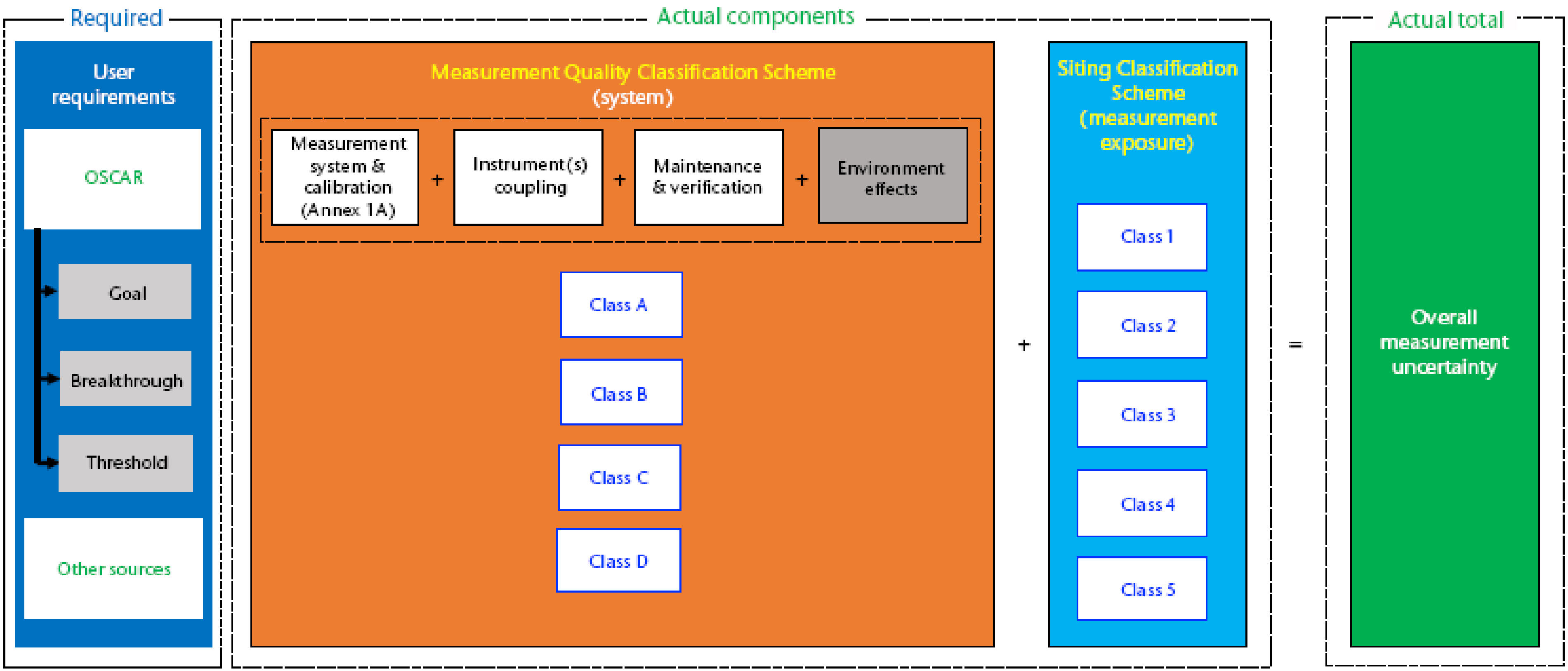
Hosted by the BIPM and WMO

26-30 September 2022

Participation

The workshop is open to experts and stakeholders active in the fields of climate science, observations, modelling, GHG mitigation and measurement and measurement science willing to contribute to the development of recommendations on key technical challenge areas for metrology in these fields.

Interest in participation can be registered below, including topics that the participant wishes to contribute to, as well as suggestions of


Required
User requirements
OSCAR
Goal
Breakthrough
Threshold
Other sources
Actual components
Measurement Quality Classification Scheme (system)
Measurement system & calibration (Annex 1A)
+
Instrument(s) coupling
+
Maintenance & verification
+
Environment effects
Class A
Class B
Class C
Class D
+
Siting Classification Scheme (measurement exposure)
Class 1
Class 2
Class 3
Class 4
Class 5
=
Actual total
Overall measurement uncertainty

Why is Metrology important?:

It provides:

- Robust comparability of the measurements taken in different places and at different times
- Detection of Climate tends in reduced time
- Understanding atmospheric/oceanic/cryosphere processes

Final goal: Establishment of powerful and fit for purpose policies for the mitigation and adaptation to climate change

How is Metrology useful?

- Contribution to the homogeneous definition of some Climate Variables
- Defining traceability chains
- Establishment of fit for purpose procedures for:
- 1. Calibration
- 2. Maintenance
- 2. Measurement
- 3. Evaluation of influence parameters
- 4. Uncertainty budgets
- 5. Laboratory instruments comparisons
- 6. Field instruments comparisons under real conditions of use
- 7. Defining the needed metadata associated to each measurement

Interdisciplinary teams

Thank you

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25th May 2023