CIPM

Consultative Committee for Thermometry

Working Group Environment
and
Task Group Air Temperature

Report 2024-2026

Andrea Merlone
Åge Andreas Falnes Olsen

Andrea Merlone

Åge Andreas Falnes Olsen

CCT WG ENV + TG AirT

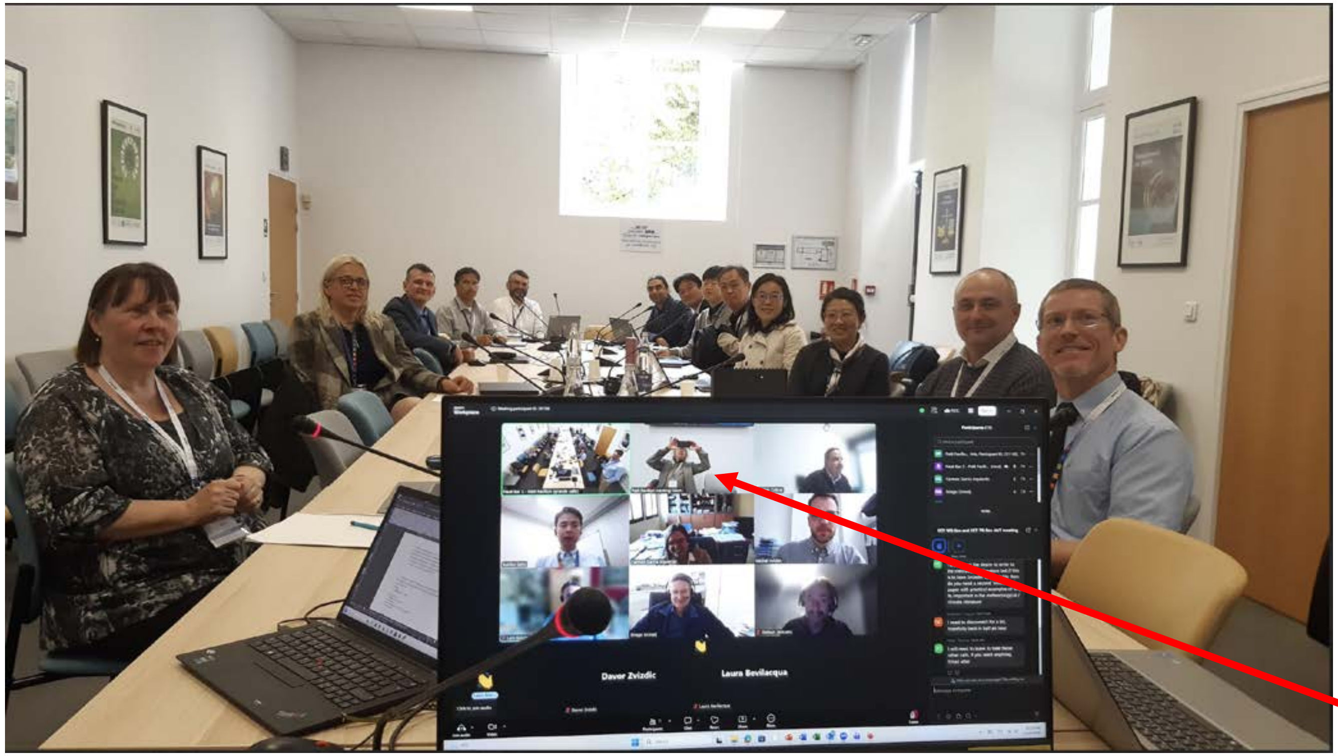
Joint meeting

19 May 2026

15 participants in person
10 participants online

28 members
8 Experts invited

3 WMO representatives



Åge here!

Andrea there!

Andrea Merlone

Åge Andreas Falnes Olsen

Two main topics

Interaction with the WMO

World Meteorological Organization

Air temperature

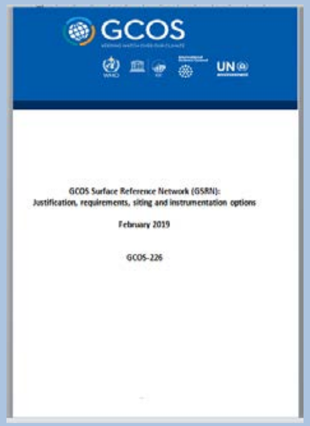
ATM

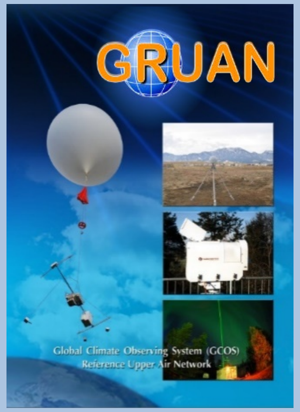
Air Temperature Metrology

Andrea Merlone Åge Andreas Falnes Olsen

CCT main subjects of interaction with the WMO

- Air Temperature (ground stations – upper air)
- Sea water temperature
- Permafrost temperature profile
- Cryosphere – Arctic Science
- Heat fluxes - Precipitation
- Reference stations for climate
- Uncertainties and best practices
- ILC and Istrument comparisons
- Contribution to guidelines
- Training





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Growing involvement and personal participation

Gaber Beges + *Jovan* (LMK)
Member ET QTC
WMO ILC Coordinator

Stephanie Bell (NPL)
Member ET QTC

Carmen G. Izquierdo (CEM)
Member ET QTC
Member ET Surface & Sub Surface
Member GCOS AOPC - GSRN TT

Andrea Merlone + *Graziano Coppa* (INRiM)
Chair ET MU
Chair GSRN SG5
Co-chair Permafrost best practice
National delegate at the WMO Commission and Congress
Member Standing Committee SC-MINT
Member ET QTC
Member GSRN SG3 “Uncertainties”

Javier Garcia Skabar
Member ET QTC

DTI, JV, BEV, SMU, CNAM, LNE, INTiBS, CMI, SMD, VNIIM, NMIJ, NMIA …

Contribution to guidelines:

* Permafrost best practice
(WMO Guide on Cryosphere variables GIMO Ch. 4)

* Guide on evaluation of extremes

* Climate Reference Stations:
definition and requirements

* Guide on field verification/validation

* GCOS-GSRN station requirements

* Contributions to GIMO No.8 (humidity, Annex 1A)

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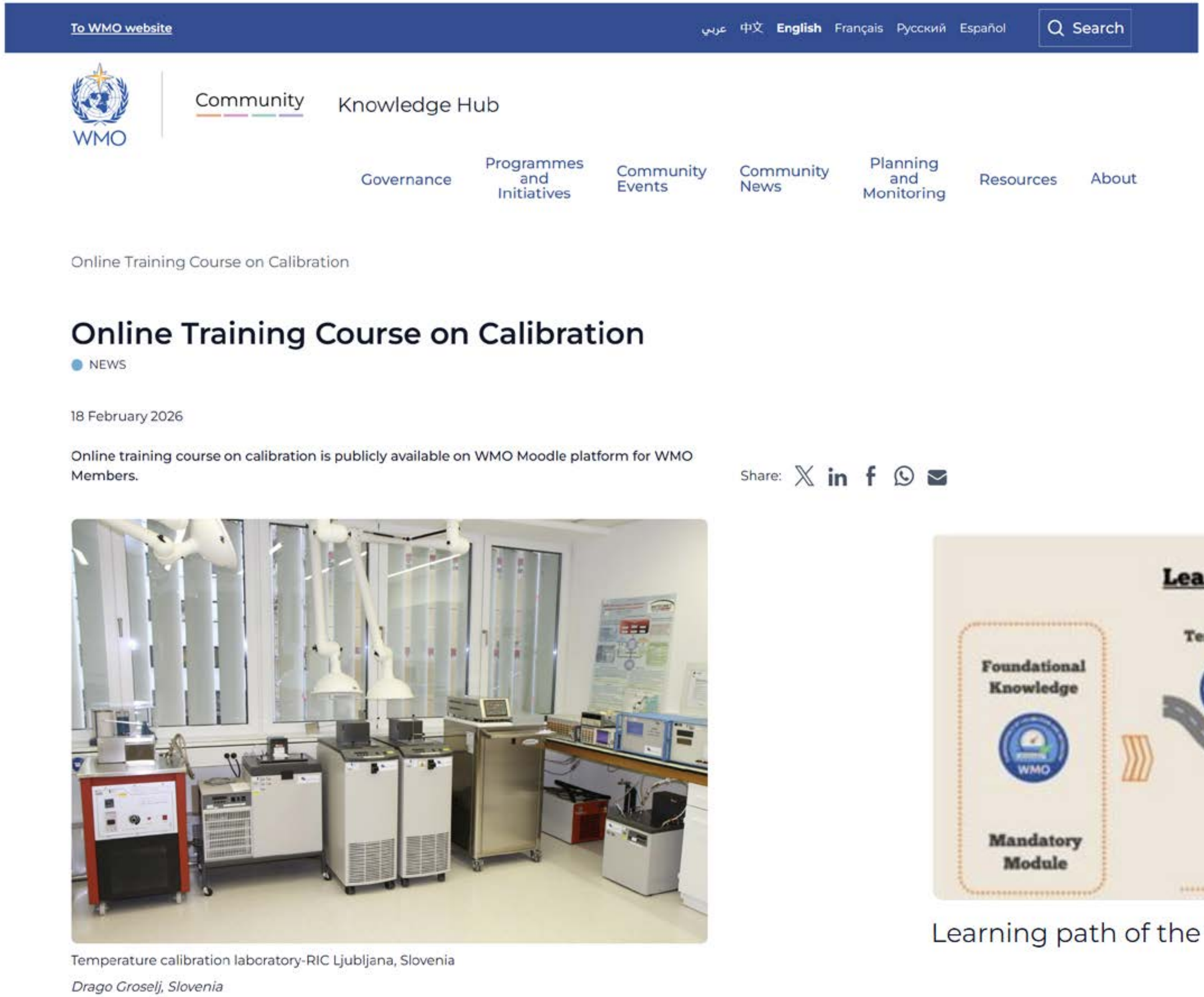

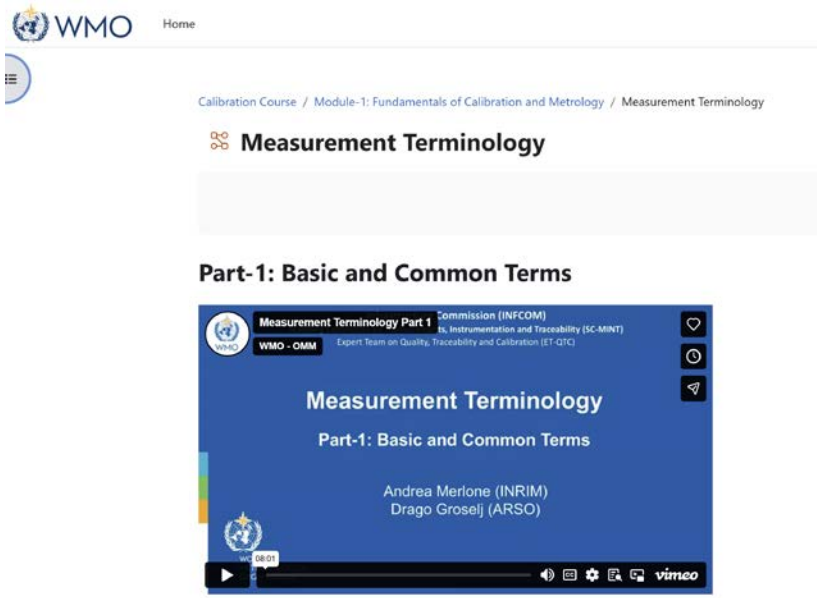

Learning path of the training course on calibration

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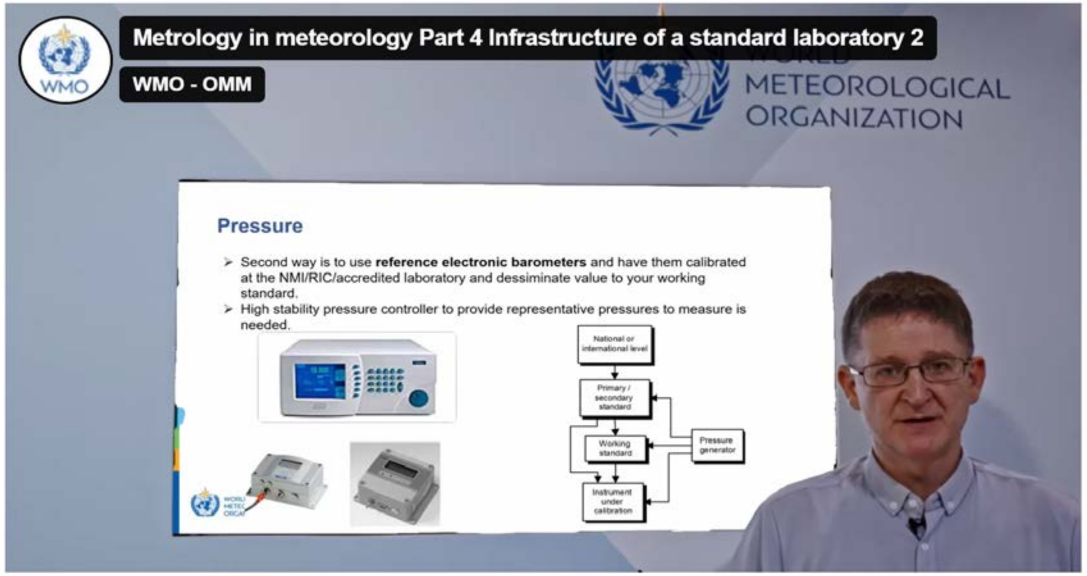
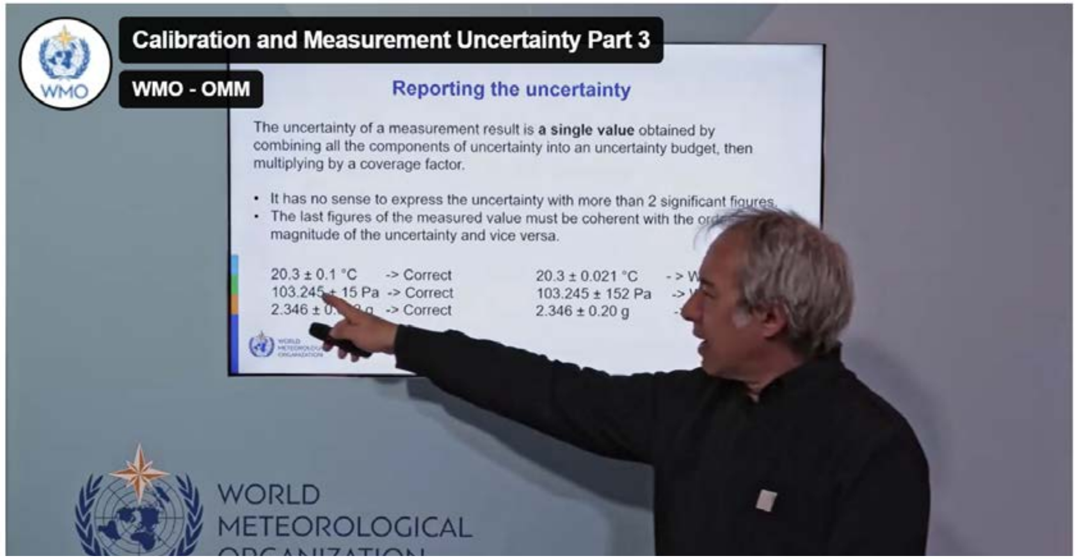
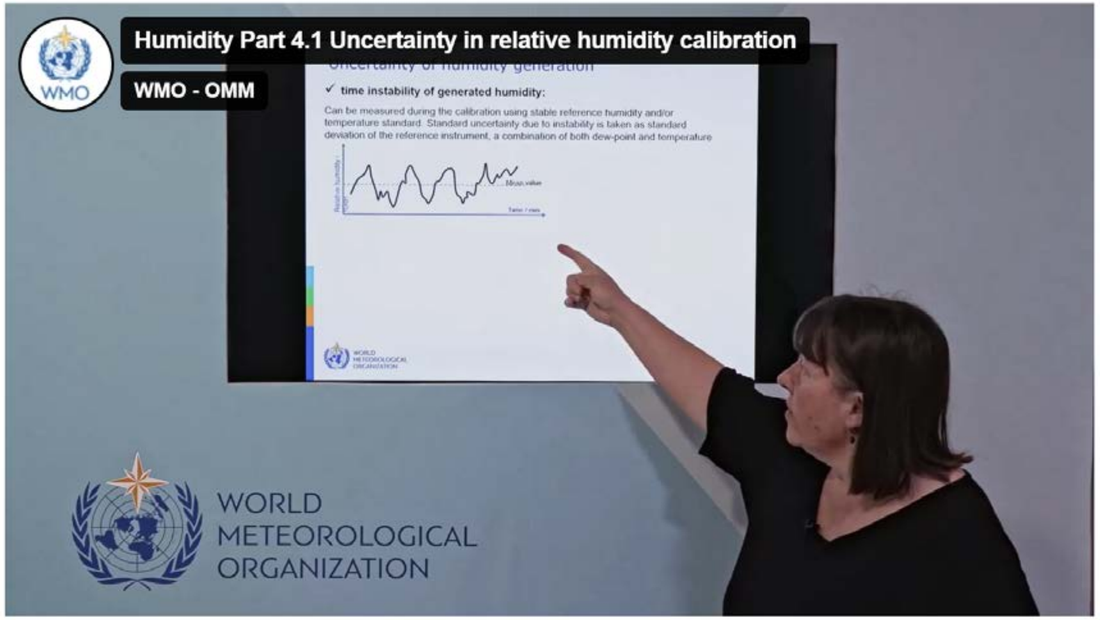
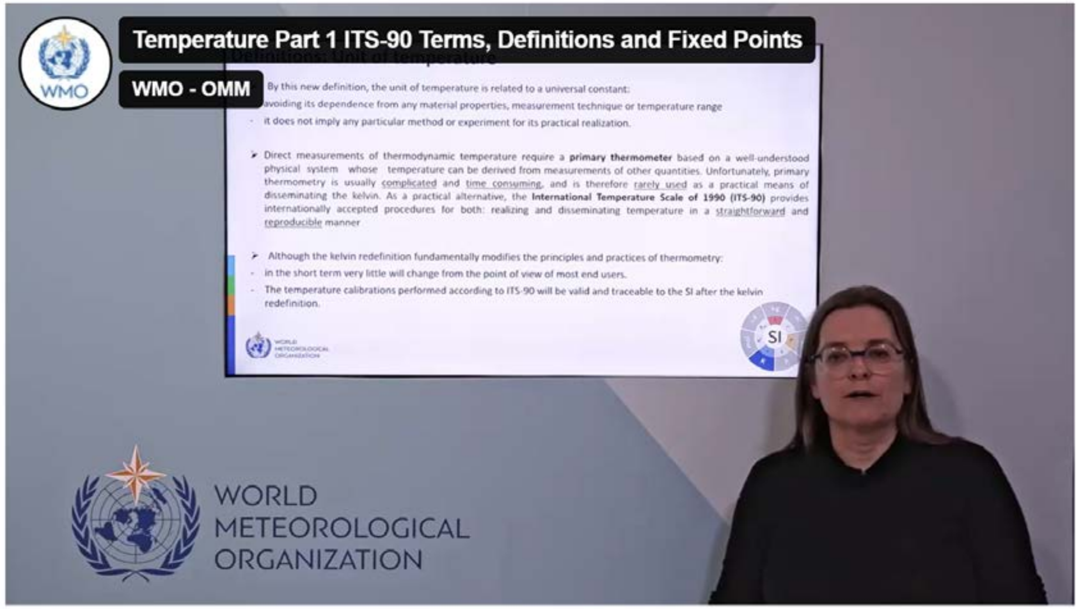
Part-3: Reporting the Uncertainty









Download presentation as PDF

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Reports from NMIs

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INRiM

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WMO Measurement Lead Center
Traceability and Field Metrology

METEOMET
Metrology for Meteorology

World Meteorological Organization

INRiM
ISTITUTO NAZIONALE
DI RICERCA METROLOGICA

The research infrastructure
In Metrology for Meteorolgy

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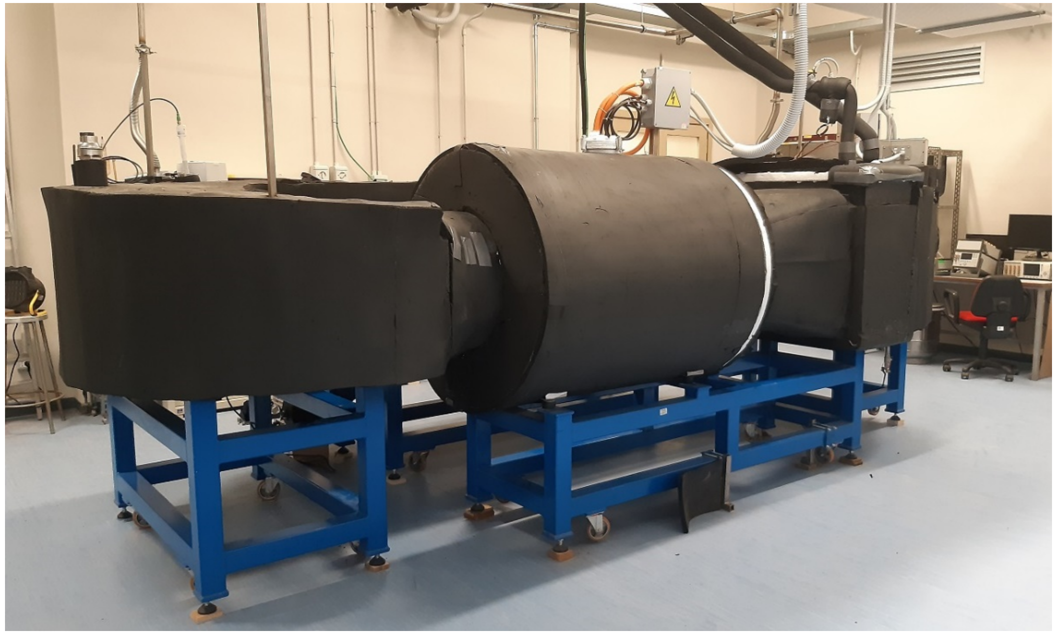
WMO Measurement Lead Center “Traceability and Field Metrology”

(INRiM – Torino – Italy Est. June 2024)

Laboratories



The EDDIE Climatic chamber – wind tunnel

Climatic chambers – liquid baths –
primary standards – travelling standards

Direct traceability to the SI

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WMO Measurement Lead Center "Traceability and Field Metrology"

(INRiM – Torino – Italy Est. June 2024)

Field research sites

Research Area and Campus Torino

Alpine sites (Permafrost, Albedo)

Climate Reference Station Stupinigi

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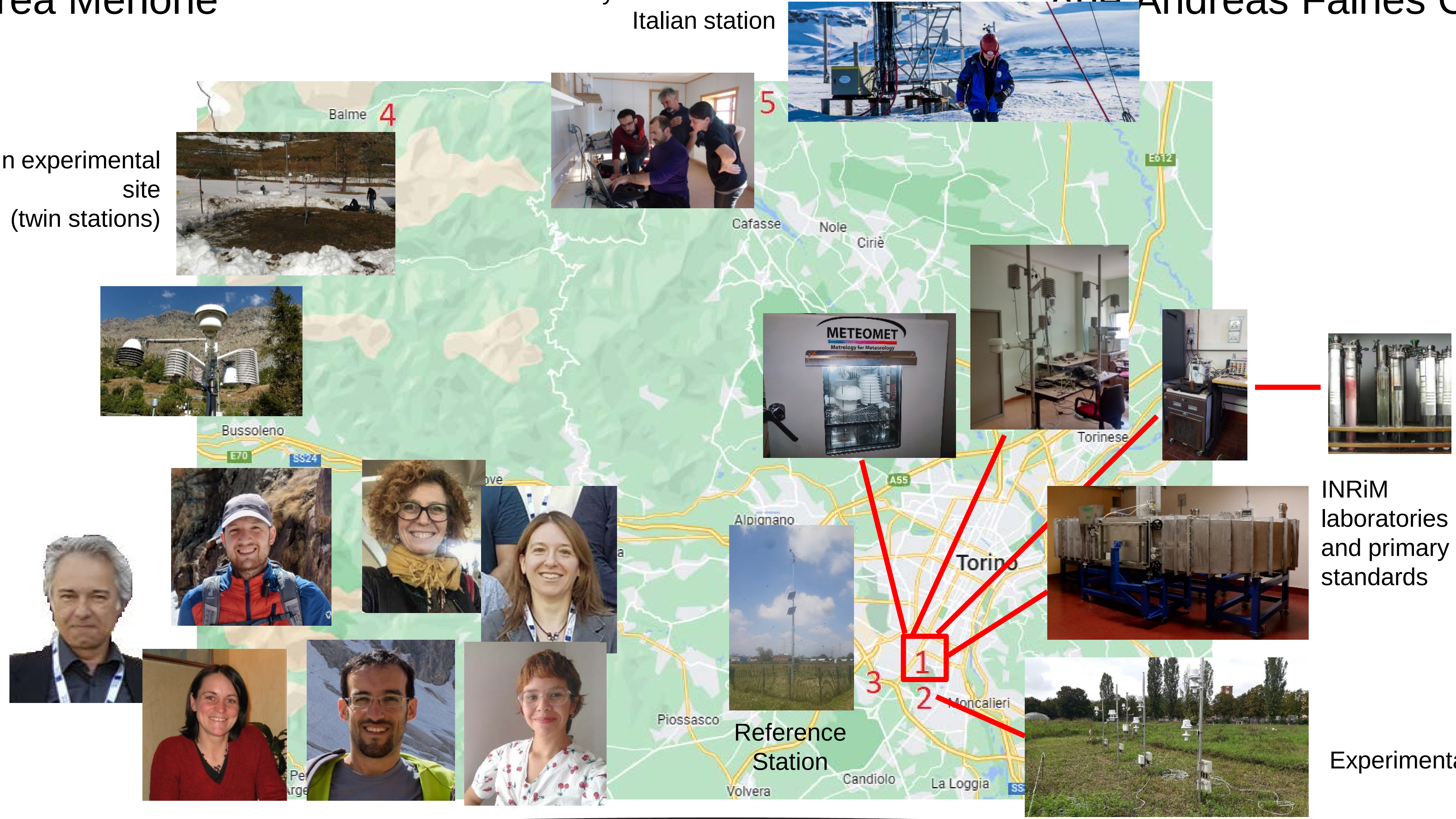
Ny-Ålesund arctic
Italian station

Mountain experimental
site
(twin stations)



INRiM
laboratories
and primary
standards

Experimental field

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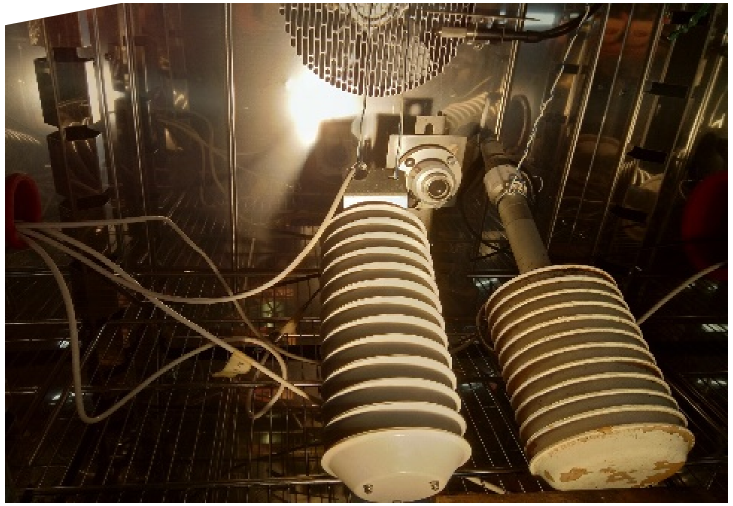
GCOS Field comparison

GSRN
GCOS SURFACE REFERENCE NETWORK

- Instruments: Thermometers + shields + loggers
- Participants GSRN Stations (EU at first) + LC
- Location: INRiM WMO Lead Center resear
- Duration: 3 month labor

Meeting on 11 June



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Åge Andreas Falnes Olsen

MMC 2027 Patras – Greece

28 – 30 September 2027

Andrea Merlone

Åge Andreas Falnes Olsen

2025 - 2029

CRIM

CLIMATE REFERENCE INSTRUMENTS AND MEASUREMENTS

WG3

Copernicus Europe's eyes on Earth

Climate Change Service

IMPLEMENTED BY ECMWF

IGS -> EGVAP - Climate Data Store

IGS INTERNATIONAL GNSS SERVICE

WG1

GCOS

GRUAN

GCOS Upper Air Reference Network

Ruud Dirksen – GRUAN LC-Chair – CRIM MC member
Fabio Madonna - GRUAN Co-Chair – CRIM MC member

WG2

GCOS

GSRN GCOS SURFACE REFERENCE NETWORK

GCOS Surface Reference Network

Tilman Holfelder – GSRN TT Co-Chair – CRIM MC member
Andrea Merlone – GSRN SG5 Chair - CRIM MC member

Andrea Merlone

Åge Andreas Falnes Olsen

METEOMET
Metrology for Meteorology

Since 2011

CoAT

2020-2023

ATM
Air Temperature Metrology

2017-2024
A2TM 2025-2028

SoMMet

2022 - 2025

CRIM
CLIMATE REFERENCE INSTRUMENTS AND MEASUREMENTS

2025-2028 cost EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

SimpleMet EU
2019-2022

CRS
Climate Reference Station
a MeteoMet initiative

2019-2022

PRIN RockFall
2022 - 2025

INCIPIT
Metrology for non-catching rain instruments

2018-2022

Scientific production 2024-2026 (of interest for the WG ENV)

1. **Coppa**, G., & **Massano**, L. T. (2026). Perspective on measurements and modeling of Earth's climate. *Measurement Science and Technology*, *37*(16), 161001. https://doi.org/10.1088/1361-6501/ae5c28
2. Cresi, L., Cimenti, A., Pisani, O., Acquaotta, F., Senese, A., **Coppa**, G., Piano, E., Piquet, A., Tolve, M., Nicolosi, G., Mammola, S., & Isaia, M. (2026). Temperature Series for 19 Caves Across the Western Italian Alps. *Geoscience Data Journal*, *13*(2), e70073. https://doi.org/10.1002/gdj3.70073
3. Nielsen, J., **Bottacin**, A., Østergaard, P., Nielsen, T., Rasmussen, M. K., **Musacchio**, C., **Coppa**, G., & **Merlone**, A. (2025). Evaluation of the influence of rain on air surface temperature measurements. *Measurement Science and Technology*, *36*(2), 025801. https://doi.org/10.1088/1361-6501/ada1ea
4. **Coppa**, G., Sanna, F., Paro, L., **Musacchio**, C., & **Merlone**, A. (2025). Metrological approach for permafrost temperature measurements. *Cold Regions Science and Technology*, *229*, 104364. https://doi.org/10.1016/j.coldregions.2024.104364
5. Irrgang, A., Isaksen, K., Noetzli, J., Schoeneich, P., Shiklomanov, N., Cable, W., Pellet, C., **Coppa**, G., **Merlone**, A., Luo, D., Portnov, A., & Zhao, L. (2025). *Guide to Instruments and Methods of Observation (WMO-No. 8), Volume II – Measurement of Cryospheric Variables* (pp. 99–149). WMO. https://doi.org/10.59327/WMO/CIMO/2
6. Le Menn, M., O'Carroll, A., Woolliams, E., Lucas, M., Izquierdo, C. G., & **Merlone**, A. (2025). The Measurement Model of Copernicus TRUSTED Fiducial Reference Measurement Drifting Buoys for Sea Surface Temperature. *Journal of Atmospheric and Oceanic Technology*, *42*(10), 1349–1362. https://doi.org/10.1175/JTECH-D-24-0117.1

Scientific production 2024-2026 (of interest for the WG ENV)

7. Tabandeh, S., Vedurmudi, A. P., Söderblom, H., Pourjamal, S., Harris, P., Luo, Y., Gruber, M., Vaa, Michael., Johansen, M., Koval, M., Østergaard, P. F., Milicevic, K., Zaidan, M. A., Hussein, T., Petäjä, T., Iturrate-Garcia, M., Davidović, M., van Dijk, M., Kok, G., Xhonneux, A., **Merlone**, A., Sousa, J.A., Pearce, J. (2025). Sensor network metrology: Current state and future directions. *Measurement: Sensors*, *38*, 101798. https://doi.org/10.1016/j.measen.2024.101798

8. **Coppa**, G., **Musacchio**, C., Becherini, F., Mazzola, M., Viola, A., & **Merlone**, A. (2024). On-site calibration of instruments in the Arctic: Assessment of temperature records at Climate Change Tower in Ny-Ålesund, Svalbard. *Arctic Science*, *10*(4), 643–652. https://doi.org/10.1139/as-2024-0008

9. **Coppa**, G., **Musacchio**, C., & **Merlone**, A. (2024). The metrology-meteorology cooperation on thermodynamic environmental issues. *Il Nuovo Cimento - C*, *47*, 309. https://doi.org/10.1393/ncc/i2024-24309-3

10. Garcia Izquierdo, C., **Coppa**, G., Hernández, S., & **Merlone**, A. (2024). Metrological Evaluation of the Building Influence on Air Temperature Measurements. *Atmosphere*, *15*(2), 209. https://doi.org/10.3390/atmos15020209

11. **Merlone**, A., Pasotti, L., **Musacchio**, C., Bessemoulin, P., Brunet, M., El Faldi, K., Jones, P., van der Schrier, G., Raspanti, A., Trewin, B., Krahenbuhl, D., & Cerveny, R. (2024). Evaluation of the highest temperature WMO region VI Europe (continental): 48.8°C, Siracusa Sicilia, Italy on August 11, 2021. *International Journal of Climatology*, *44*(3), 721–728. https://doi.org/10.1002/joc.8361

Scientific production 2024-2026 (of interest for the WG ENV)

12. Abdunabiev, S., **Musacchio**, C., **Merlone**, A., Paredes, M., Pasero, E., & Tordella, D. (2024). Validation and traceability of miniaturized multi-parameter cluster radiosondes used for atmospheric observations. *Measurement: Journal of the International Measurement Confederation*, *224*, 113879. https://doi.org/10.1016/j.measurement.2023.113879

13. García Izquierdo, C., Hernandez, S., Parrondo, M., Casas, A., Viola, A., Mazzola, M., **Merlone**, A., & Roulet, Y.-A. (2024). COAT Project: Intercomparison of Thermometer Radiation Shields in the Arctic. *Atmosphere*, *15*(7), 841. https://doi.org/10.3390/atmos15070841

14. **Merlone**, A., **Coppa**, G., & **Musacchio**, C. (2024). The air temperature conundrum. *Nature Physics*, *20*(3), 520–520. https://doi.org/10.1038/s41567-024-02428-w

15. Pearce, J. V., Rusby, R. L., Veltcheva, R. I., del Campo, D., Izquierdo, C. G., **Merlone**, A., **Coppa**, G., Kowal, A., Eusebio, L., Bojkovski, J., Žužek, V., Sparasci, F., Pavlasek, P., Kalemci, M., Uytun, A., & Peruzzi, A. (2024). Realizing the redefined Kelvin: Extending the life of ITS-90. *TEMPERATURE: ITS MEASUREMENT AND CONTROL IN SCIENCE AND INDUSTRY, VOLUME 9: Proceedings of the Tenth International Temperature Symposium*, 020002. https://doi.org/10.1063/5.0234458

16. **Aranda**, N. G., & **Merlone**, A. (2024). On-Site Calibration Procedure and Uncertainty Contributions on Air Temperature Sensors. *International Journal of Thermophysics*, *45*(1), 12. https://doi.org/10.1007/s10765-023-03296-x

17. **Merlone**, A., Beges, G., **Bottacin**, A., Brunet, M., Gilabert, A., Groselj, D., Harper, A., Hechler, P., Ivanov, M., **Musacchio**, C., Trewin, B., & Wrigh W. (2024). Climatological reference stations: Definitions and requirements. *International Journal of Climatology*, *44*(5), 1710–1724. https://doi.org/10.1002/joc.8406

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JV

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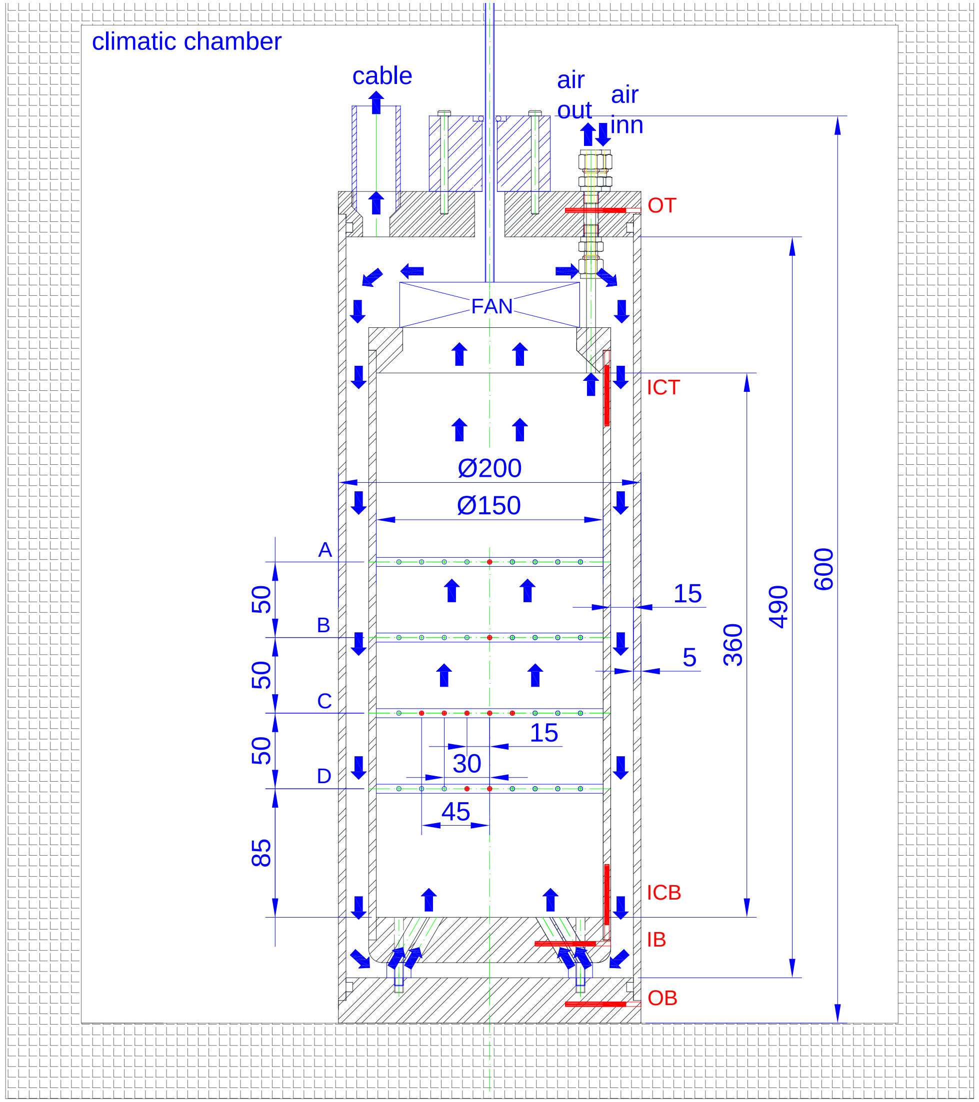
ATM

Air Temperature Metrology

A2TM



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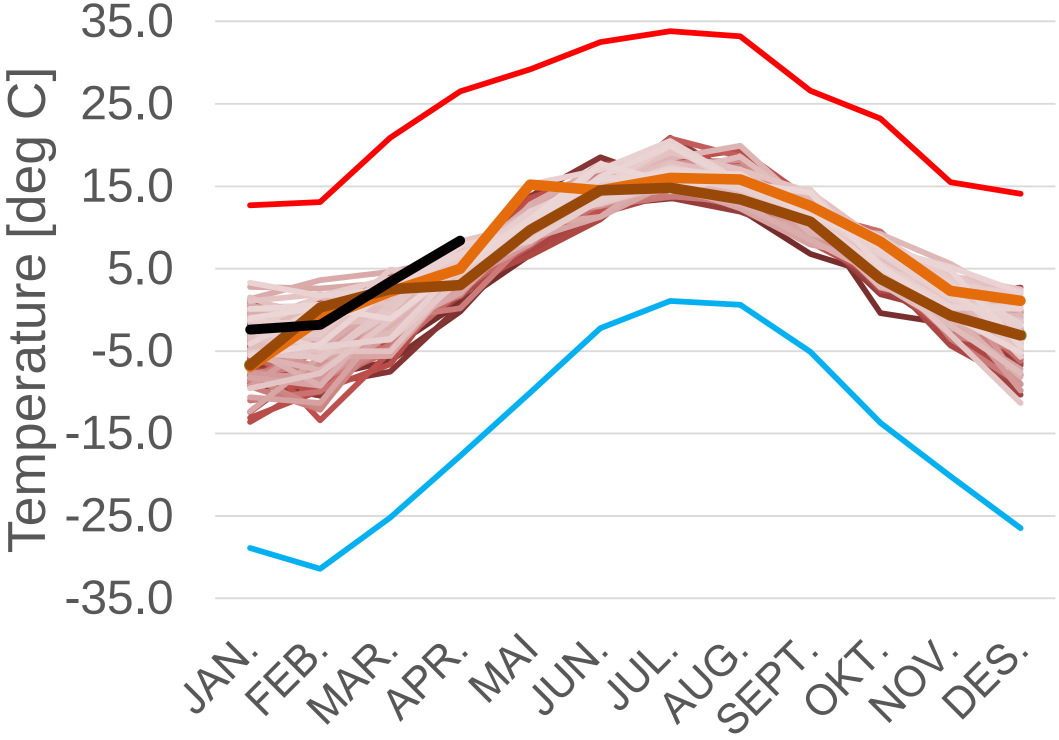
Background: the Ås station



Temperature range we consider: -40 °C to 40 °C

KRISS

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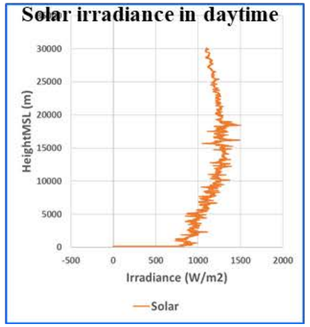
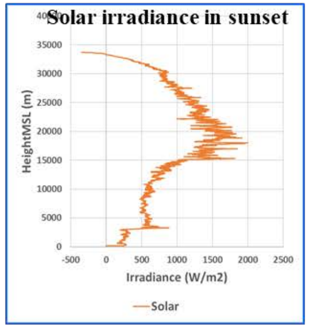
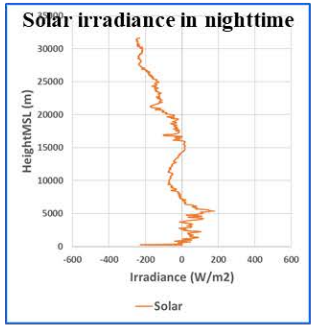
Activities in Air-T and O_3 measurement

Radiosonde sounding tests at Kota Kinabalu, Malaysia

- July 14 ~ 18, 2025
- Tests of the solar radiation effects on radiosonde using KRISS-DTR and Vaisala-RS41

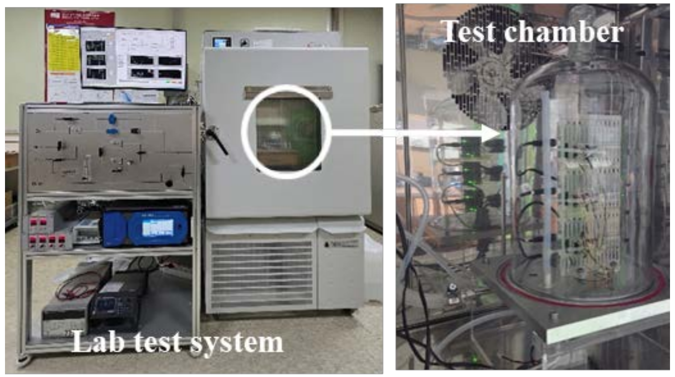




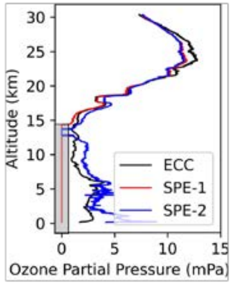


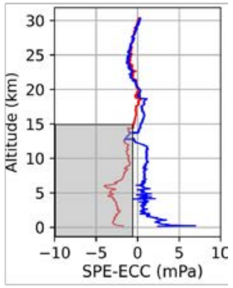
☐ Investigation of the Ozone profile using a solid polymer electrolyte (SPE) cell

- Replacement of the expensive and ineffective ECC (Electrochemical cell) system
- ECC vs SPE comparison using RS41-connected X-data SPE-sonde



- Field test at Yongin, Korea (August, 2025)





KRISS International activities

WMO expert activities

- Member of WMO SC-MINT/ET-UAM (Upper Air Measurement)
- Member of WMO SC-MINT/ET-MU (Measurement Uncertainty)

GRUAN activities

- Two presentations in GRUAN ICM-16 (2025) meeting

ISO activities

- Convenor (YG Kim) of TC 146/SC 5/WG 11 (Radiosonde)

WMO TECO conference (October, 2026)

- 6 presentations submitted

Publications

- ISO publications
  - ISO 8932-1: Laboratory Test method for calibration error of temperature sensor in radiosonde
  - ISO 8932-2: Laboratory test method for errors in radiosonde humidity sensor calibration
  - ISO 8932-3: Laboratory test method for solar radiation error of temperature sensor in radiosonde
- Papers
  - Evaluating Calibration Uncertainty and Response Time of RS41 Humidity Sensors Under a Ventilation Speed of 5 m/s, Meteorol Appl. 2025
  - Laboratory characterization of cryogenic frost-point hygrometers using an upper air simulator, Meteolo. Appl. 2026
  - Effects of a Cylindrical Subchamber on the Calibration Uncertainty of the Thermometer in the Climate Chamber, International Journal of Thermophysics (2026) 47:73
- International comparisons
  - Draft B of APMP.T-S17 (Comparison of air thermometer, Coordinated by KRISS) under CCT review

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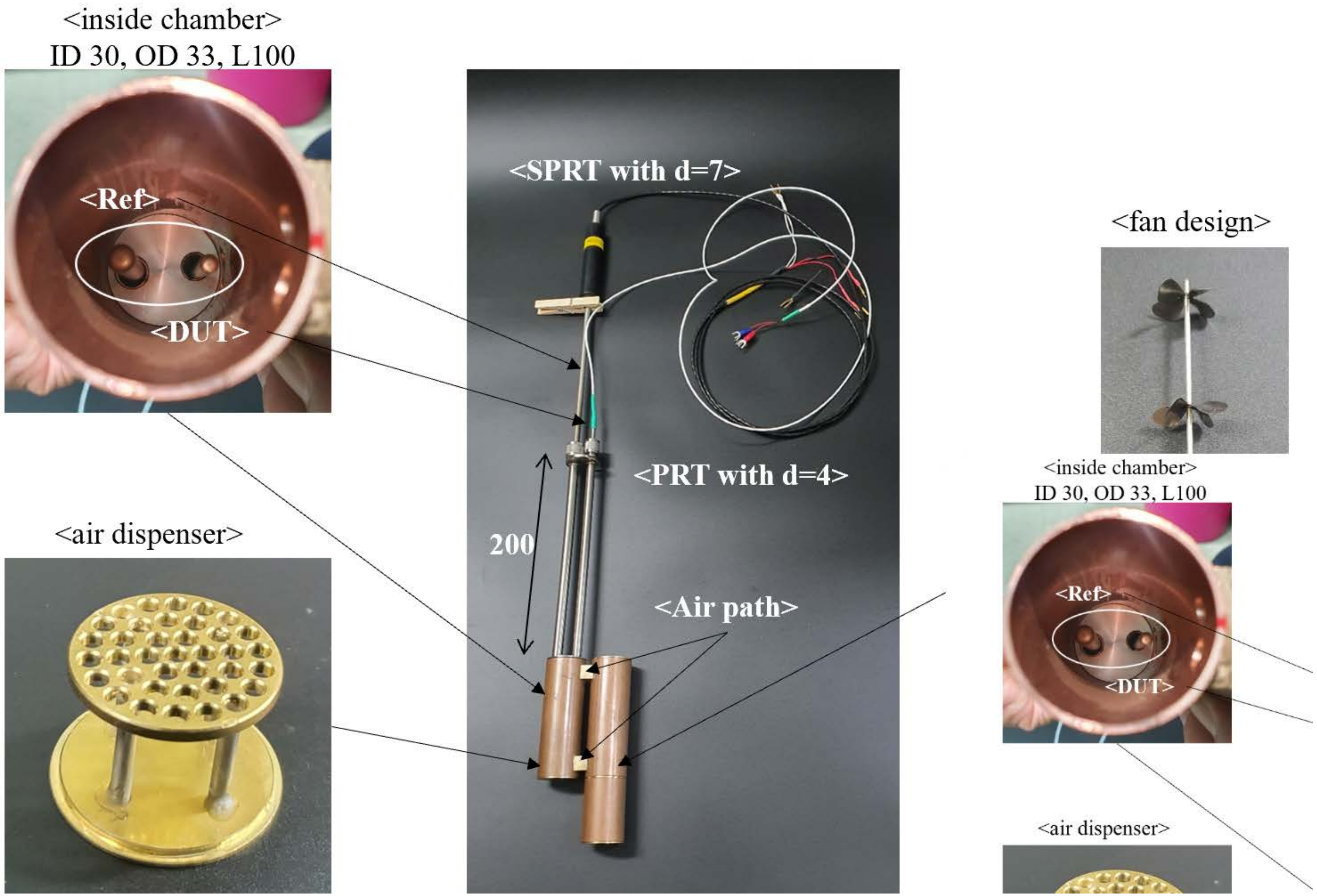

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INTiBS

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Cooperation

University of Wroclaw, Institute of Geography & Regional Development

- Department of Climatology & Atmosphere Protection

Institute of Meteorology and Water Management – National Research Institute

- Central Control Instruments Laboratory

Wroclaw University of Environmental and Life Science

University of Gdansk, Faculty of Oceanography and Geography

Institute of Oceanology Polish Academy of Sciences

Institute of Geophysics, Department of Polar and Marine Research PAS

- The Institute has a polar station on Hornsund

- Training in measurement, traceability and uncertainty estimation
- Performing measurements, checks and / or calibrations
- In-situ measurements
- New cooperation in the field of polar research
- A new national project in 2023 and new application for 2024-2026

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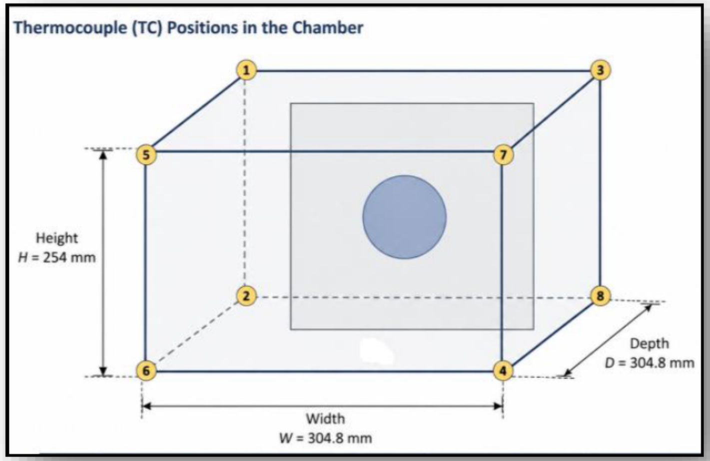
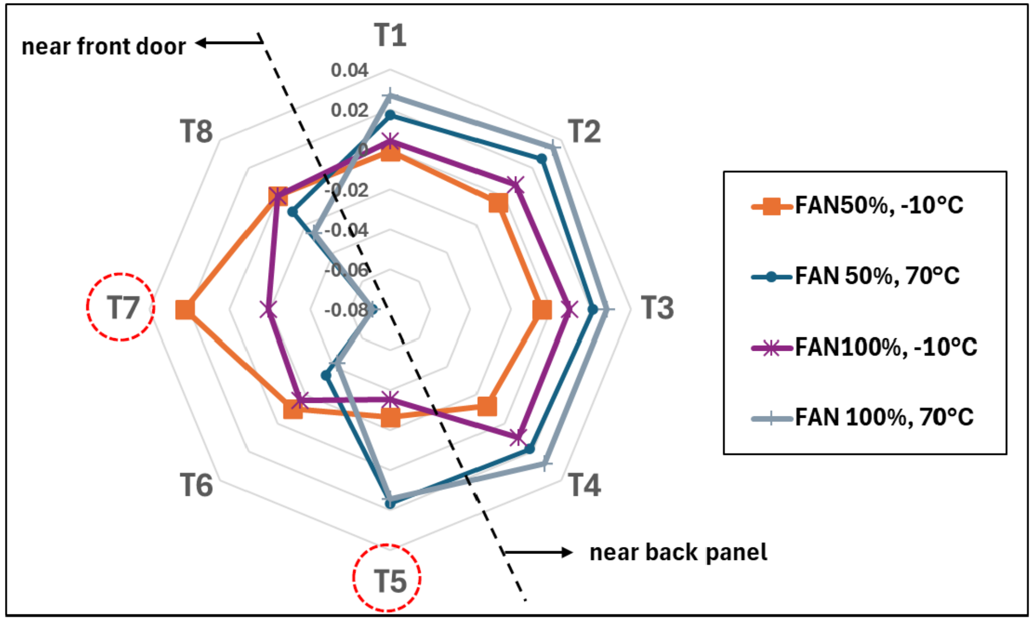
NMIA

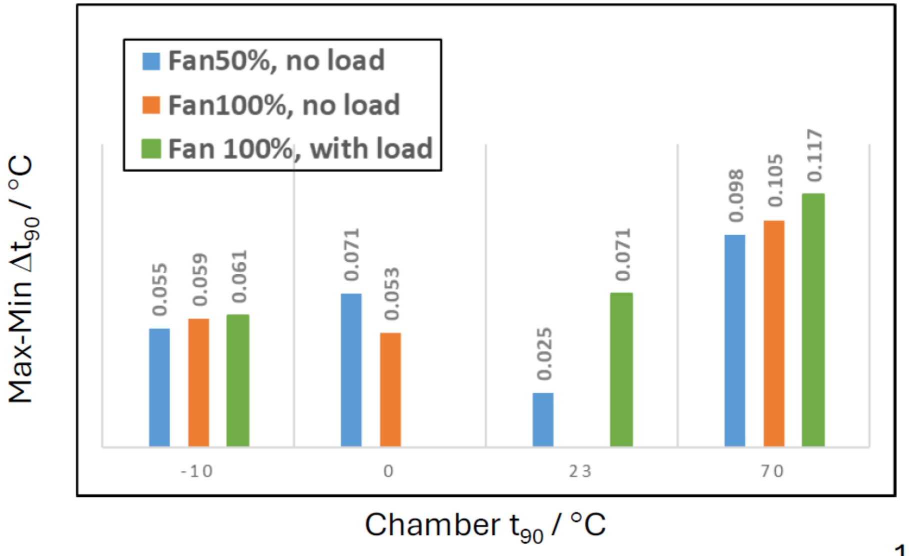
Update on chamber characterisation and PRT-based air temperature measurements

Preliminary investigation of spatial temperature behaviour



- A consistent spatial temperature pattern was observed across different operating conditions.
- Positions near chamber door generally appear to be the main regions of heat exchange.
- Increasing fan speed helped reduce equilibrium time, but did not significantly improve temperature uniformity.
- The observed spatial pattern may indicate a preferred thermal fluid circulation path within the chamber structure.
- Additional internal heat load (a light and a camera) showed limited impact on the overall temperature distribution.





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CEM

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Membership:

1. WMO/SC-MINT
    1.1. Expert team Quality, Traceability and Calibration
    1.2. Expert team on Classification
2. GCOS-AOPC.
    2.1. GCOS-Task Team on Rationalization: Establishing rationalization and governance processes of ECVs
    2.2. GSRN-Task Team

3 European Metrology Network on Climate and Ocean Observation

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NMIJ

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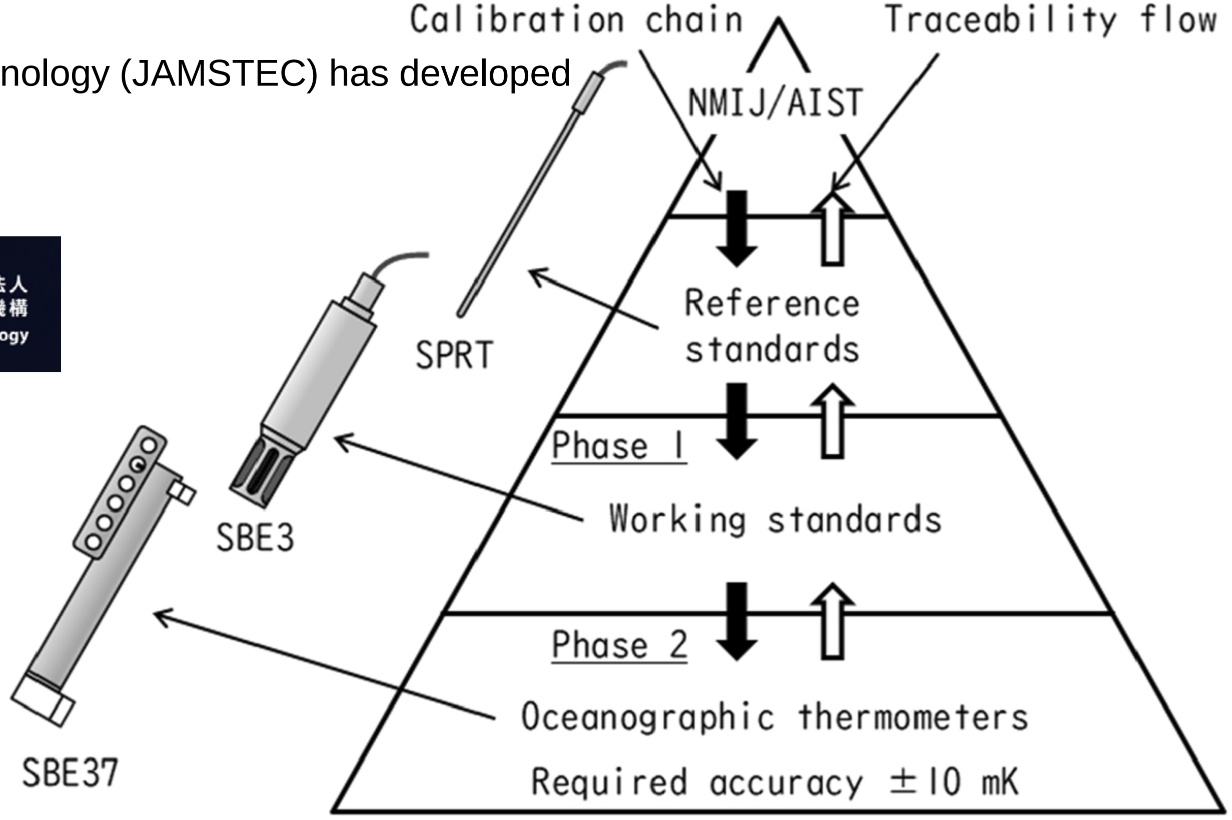
NMIJ/AIST and Japan Agency for Marine-Earth Science and Technology (JAMSTEC) has developed a calibration system for oceanographic thermometers.

Fig. 1

From: A Calibration Scheme for ITS-90-traceable Oceanographic Thermometers



A calibration systems were established in Phases 1 and 2, respectively.

Expanded uncertainty for both calibration phases are in 1.5 mK and 3.5 mK for the first and the second phases, respectively, which **satisfy the requirements of the oceanographic community** for the accurate monitoring of ocean temperature.

S. Baba, I. Saito, K. Yamazawa and T. Nakano, Int. J. Thermophys. 44, 154 (2023) https://link.springer.com/article/10.1007/s10765-023-03257-4

NPL

Membership of WMO ET QTC

Contribution to WMO GIMO (WMO No. 8) on humidity measurements

Air temperatutre measurand definition

Radiation effect on meteorological thermometers

NPL
National Physical Laboratory
npl.co.uk

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CMI

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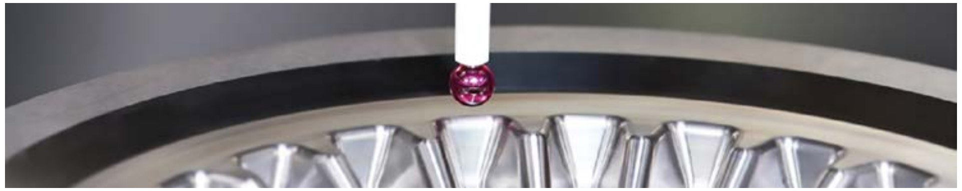

21GRD02

DURATION
2022-2025

Short Name: BIOSPHERE,

Metrology for Earth Biosphere: Cosmic rays, ultraviolet radiation and fragility of ozone shield

21GRD08

DURATION
2022-2025

Short Name: SoMMet

Metrology for multi-scale monitoring of soil moisture

CZECH METROLOGY INSTITUTE

A²TM

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SMU

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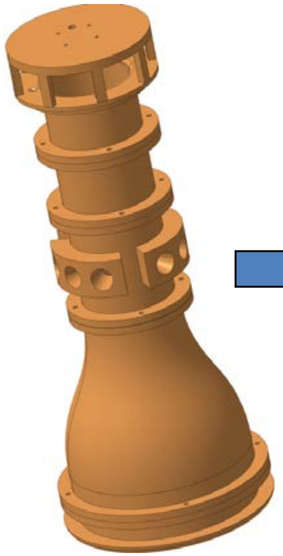
Mobile sub-chamber system

Mobile sub-chamber system development

- Choosing most suitable geometry (shape and size)
- Sensor selections (reference and influential quantities)
- Determination of best material and surface finishes



3D model

1st prototype

2nd prototype

3rd prototype

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VNIIM

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VNIIM

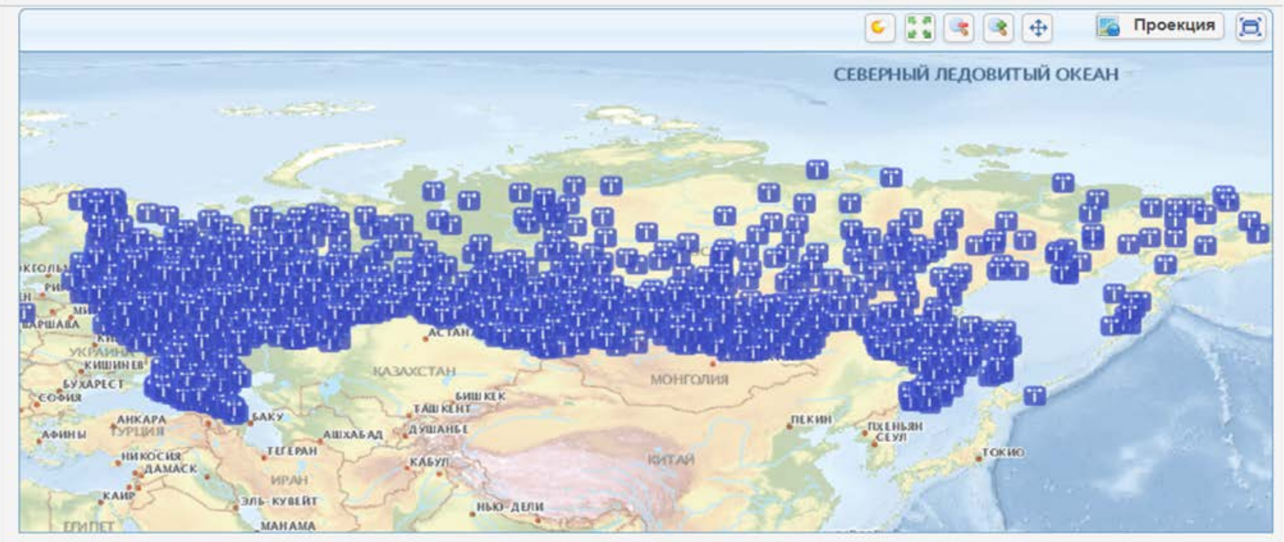
ВНИИМ

ФГУП "Всероссийский научно-исследовательский институт метрологии им. Д.И.Менделеева"

Traceability of meteorological observations

Providing state system of calibration laboratories for meteorology

There are 21 accredited laboratories - Departments of Hydrometeorology and Environmental Monitoring, which provides 1230 active meteorological stations



Online map of meteorological stations in Russia

Desing new portable and laboratory standards for calibration of meteorological thermometers and hygrometers

Humidity (portable)

Temperature (portable)

Temperature (lab)

Nominal values: 11 % (LiCl), 33 % ($MgCl_2$) 75 % (NaCl) 97 % (K_2SO_4) Uncertainty (k=2) (with hygrometer): 1 %	Range: from -60 °C to 60 °C Uncertainty of calibration (k=2): 0,01 °C For sensor up to 16 mm diameter	Range: from -60 °C to 60 °C Uncertainty of calibration (k=2): 0,02 °C – in liquid, 0,2 °C – in air. Any shape of sensors

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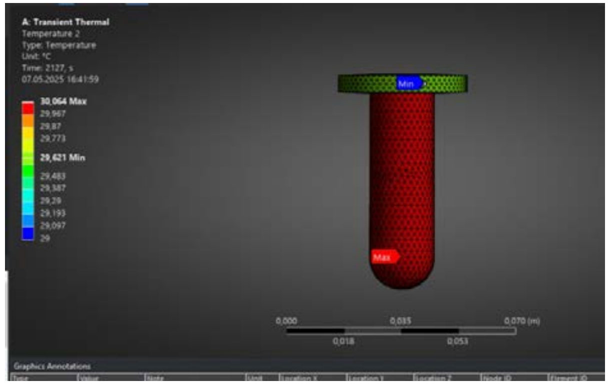
Minicells for in-field air thermometers validation

First stage

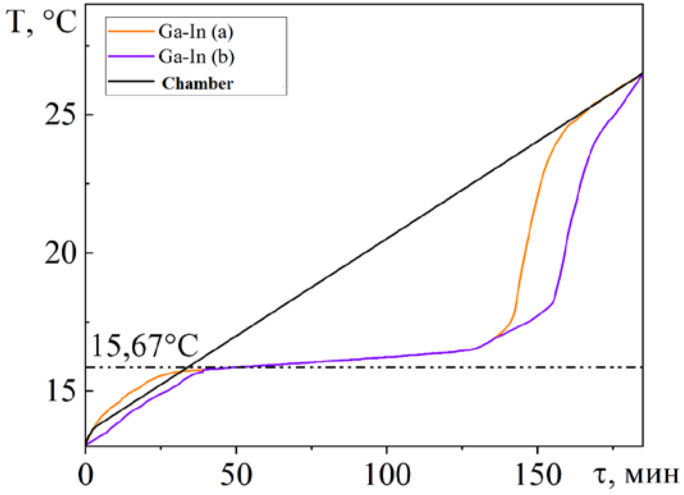
<u>Phase transition temperature:</u>

Ga-In alloy	15.646 °C
Ga-Sn alloy	20.482 °C
Ga-Zn alloy	25.210 °C

Reproducibility – less then 0.01 °C



Modelling – Filling - Testing



Ga (68)-In(22)-Sn(10) alloy	-19.0 °C
Ga-Sn-Zn alloy	-6.65 °C
Ga-In-Sn alloy	4.85 °C
Ga-In alloy	15.65 °C
Ga-Sn alloy	20.48 °C
Ga-Zn alloy	25.21 °C
Ga-Al alloy	26.60 °C

…

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LMK with ARSO and WMO ET QTC

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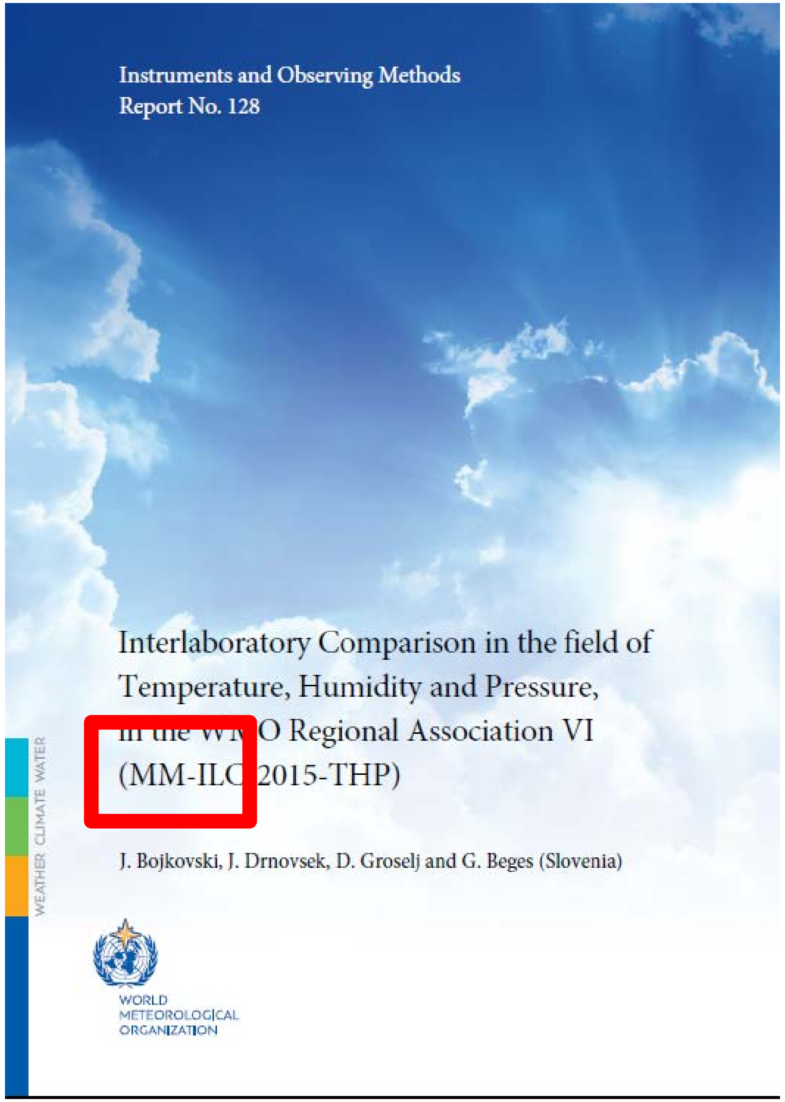
METEOMET

Metrology for Meteorology

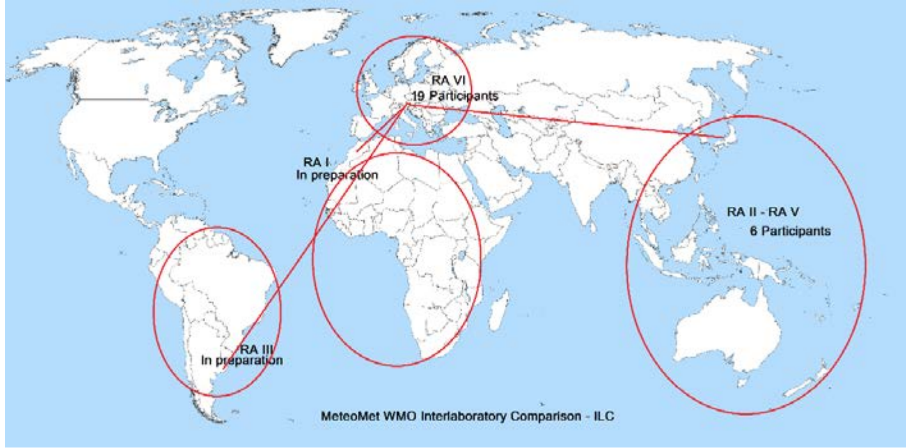

Instruments and Observing Methods
Report No. 128

Interlaboratory Comparison in the field of Temperature, Humidity and Pressure, in the WMO Regional Association VI (MM-ILC 2015-THP)

J. Bojkovski, J. Drnovsek, D. Groselj and G. Beges (Slovenia)

WEATHER CLIMATE WATER

WORLD METEOROLOGICAL ORGANIZATION



WMO-MM-ILC-2015-THP in WMO region VI published as IOM Report No. 128

University of Ljubljana Faculty of electrical engineering

WMO-MM-ILC-2018-THP-2 in WMO region II and V is in a final draft stage

気象庁 Japan Meteorological Agency

To spread the same idea is planned WMO-MM-ILC-2020-THP in WMO region I, III and IV

INTI Instituto Nacional de Tecnología Industrial

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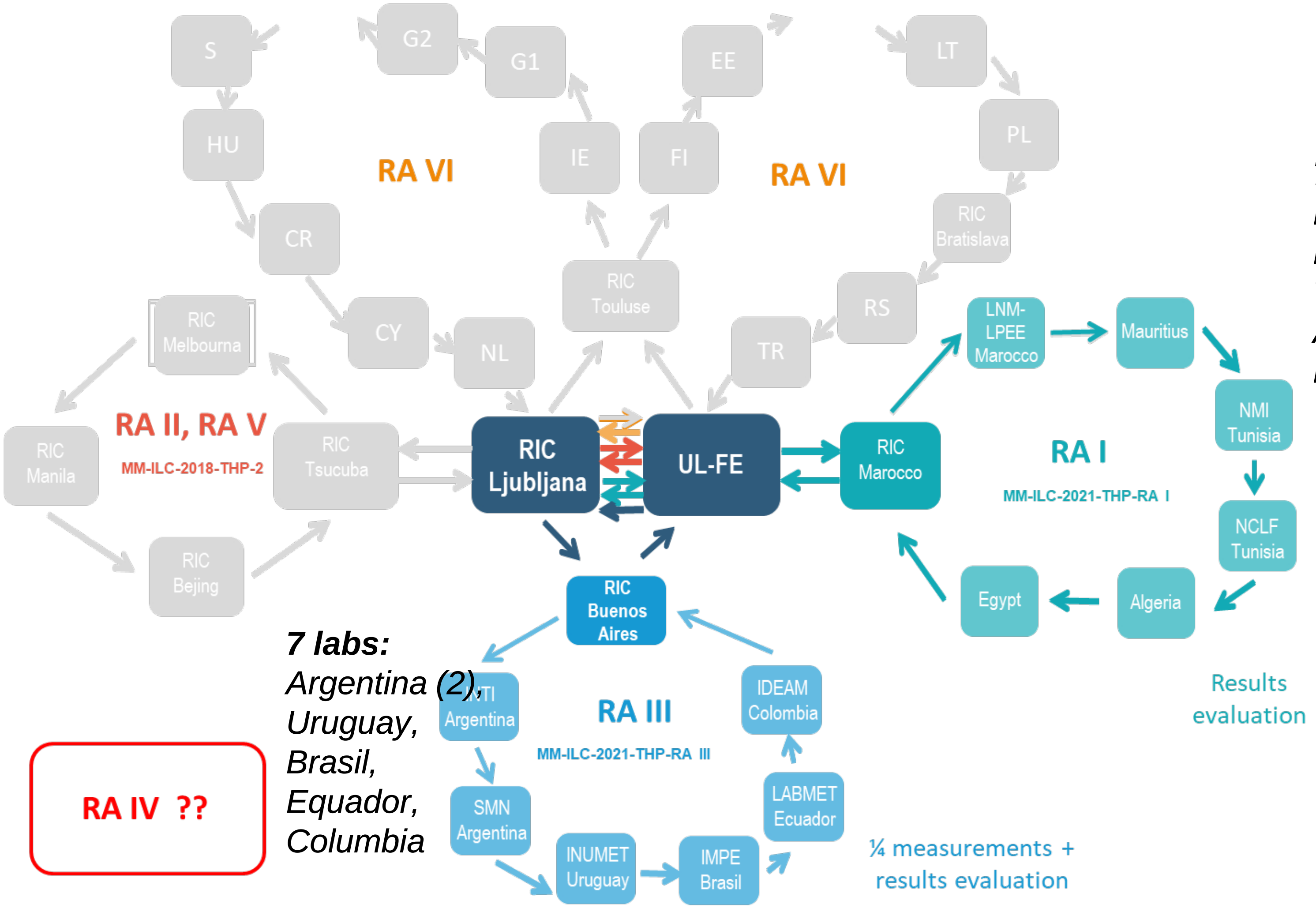
TWO ILCs ARE ON-GOING:

ILC in RA I (Africa) ***and*** **ILC in Region III (South America)**

- Same transfer standards
- Similar ILC protocol
- Same data evaluation
- Same linkage laboratories



7 labs:
Morocco (2),
Mauritious,
Tunisia (2),
Algeria,
Egypt

7 labs:
Argentina (2),
Uruguay,
Brasil,
Equador,
Columbia

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CCT Task Group on Air temperature «TG Air»

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CCT Task Group on Air temperature «TG Air»

Åge Andreas Falnes Olsen – Chairperson

Andrea Merlone – Vice-Chair

Terms of Reference

* To work towards and propose a practical definition of air temperature — SG1 – Stephanie Bell
* To work towards and propose how to evaluate the uncertainty contributions in air temperature measurements — SG2 – Davor Zvizdic
* To develop guidelines for the calibration of thermometers in air — SG3 – Peter Pavlasek replacing Yong-Gyoo Kim

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CCT TG Air T – SG1
Definition

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The air temperature measurand

What is air?

- Gas of atmospheric composition (N_2, O_2, Ar, H_2O, CO_2, other traces)
- At what pressure/density?
- Steady air or at what wind speed?
- Zero radiation or at what radiation (spectrum, intensity…)?
- Water vapour the most variable constituent (from trace level to several percent causing condensation, evaporation potential effects)

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A thermometer measures the temperature of the air. ?

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A thermometer measures the temperature ? of the air ?.

A (contact) thermometer gives an indication of its heat equilibrium at that time in that place under those conditions.

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This equilibrium is influenced by:

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- **Convection heat exchange**
  - Gas (wind) speed
  - Turbulent, laminar or mixed flow
  - Heat transfer coefficient
  - Convection surface area
  - Temperature gradients
- **Conduction heat exchange**
  - Coefficient of conductivity
  - Thickness of the conduction/insulation layers
  - Temperature gradients
- **Radiation heat exchange**
  - Emissivity coefficients
  - Reflectivity coefficients
  - Diathermy
  - Sub-surface conductivity (surface temperature)
  - Temperature difference
- **Phase change and heat sources**
  - Condensation/evaporation
  - Sublimation/melting
  - Heat sources in the thermometer body
- **Transient heat transfer**
  - Specific heat capacity of the thermometer
  - Mass of the thermometer
  - Initial temperature of the thermometer
  - Gas temperature dynamics (lag)

- **Probe is not adiabatic**
  - **Radiation exchange with surrounding**
  - **Convection between the probe and air**
  - **Conduction along probe stem**
- **Probe has imperfect geometry:**
  - **Partial stagnation**
  - **Stagnation different in laminar, turbulent or developing flow**
- **Flow is compressible at stagnation locations even at mainstream velocities less then 1/3 Mach**
- **Probe has finite mass – therefore time lag**
- **Probe has relatively large heat capacity vs. air**
- **Probe faces enclosures/surroundings with temperature:**
  - **different from gas**
  - **different from probe**
- **Probe indicates mean temperature (gas, probe body), not gas temperature.**
- **Difference of self-heating in air to that at calibration should be considered**
- **Real gas does not have one single total temperature**

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SG1: paper on proposed definition of air temperature.

Work in progress….

1. INTRODUCTION
    1.1 Background
    1.2 Measurement methods
    1.3 Calibration
    1.4 Uncertainty of measurement
    1.5 The measurand
2. KEY DEFINITIONS
    2.1 Definition of temperature
    2.2 Definition of air
3. WHY DOES THE AIR TEMPERATURE MEASURAND NEED A SPECIAL DEFINITION?
    […]
4. APPROACHES TO A DEFINITION OF THE MEASURAND
    4.1 Single generalised form of definition
    4.2 Definition for a given application
    4.n more sections
5. SPECIALISED CONTEXTS, AND IMPACTS ON THE DEFINITION
    5.1 Calibration
        5.1.1 Calibration in liquid
        5.1.2 Calibration in air
    5.2 Meteorology and climate
    5.3 Fast-moving air (high relative velocity)
    5.4 High temperatures where radiative transfer dominates
6. CALIBRATION AND TRACEABILITY FOR AIR TEMPERATURE
7. DISCUSSION - CONCLUSIONS

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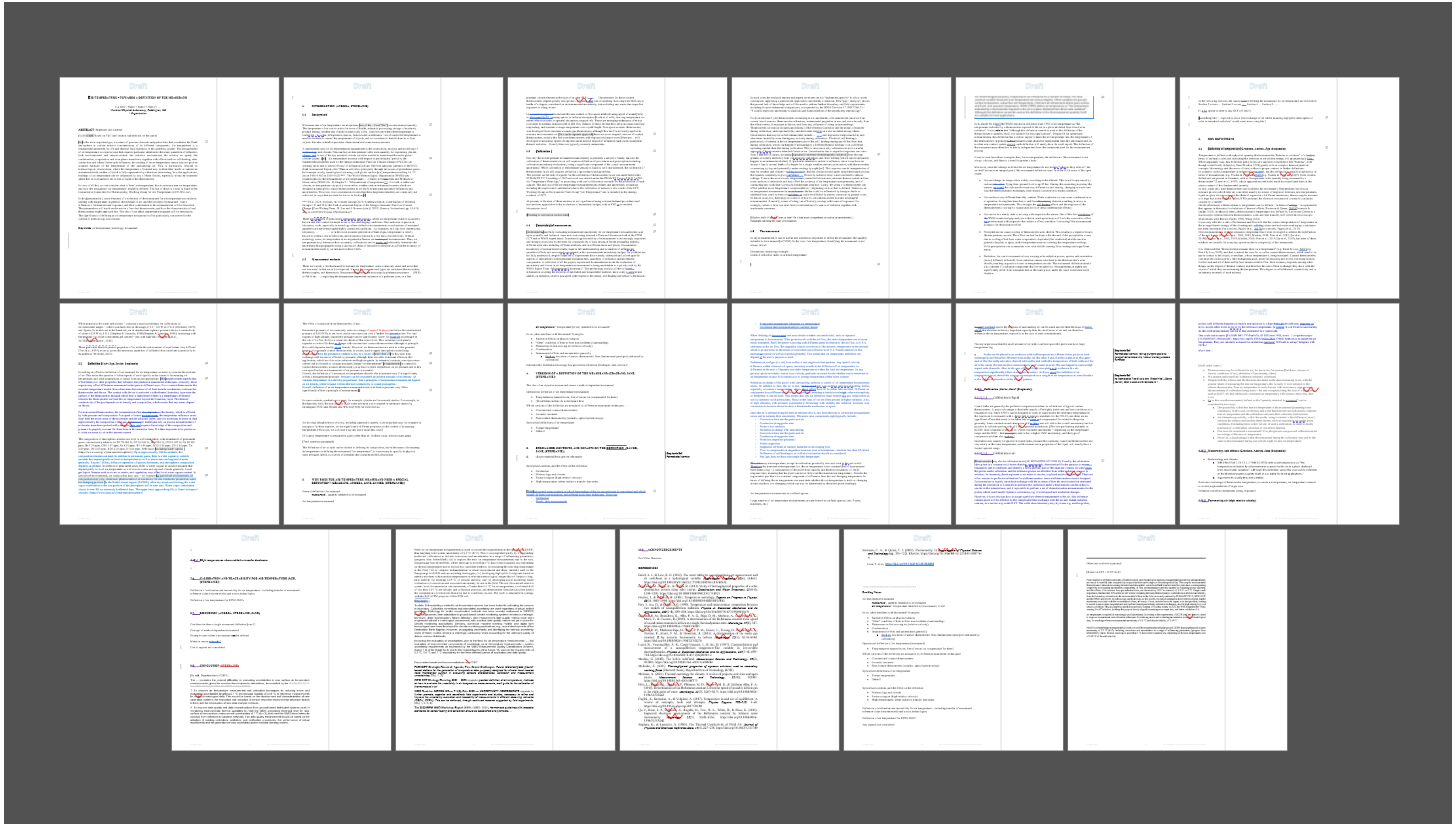
SG1: paper on proposed definition of air temperature.

Work in progress….



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CCT TG Air T – SG2
Uncertainties

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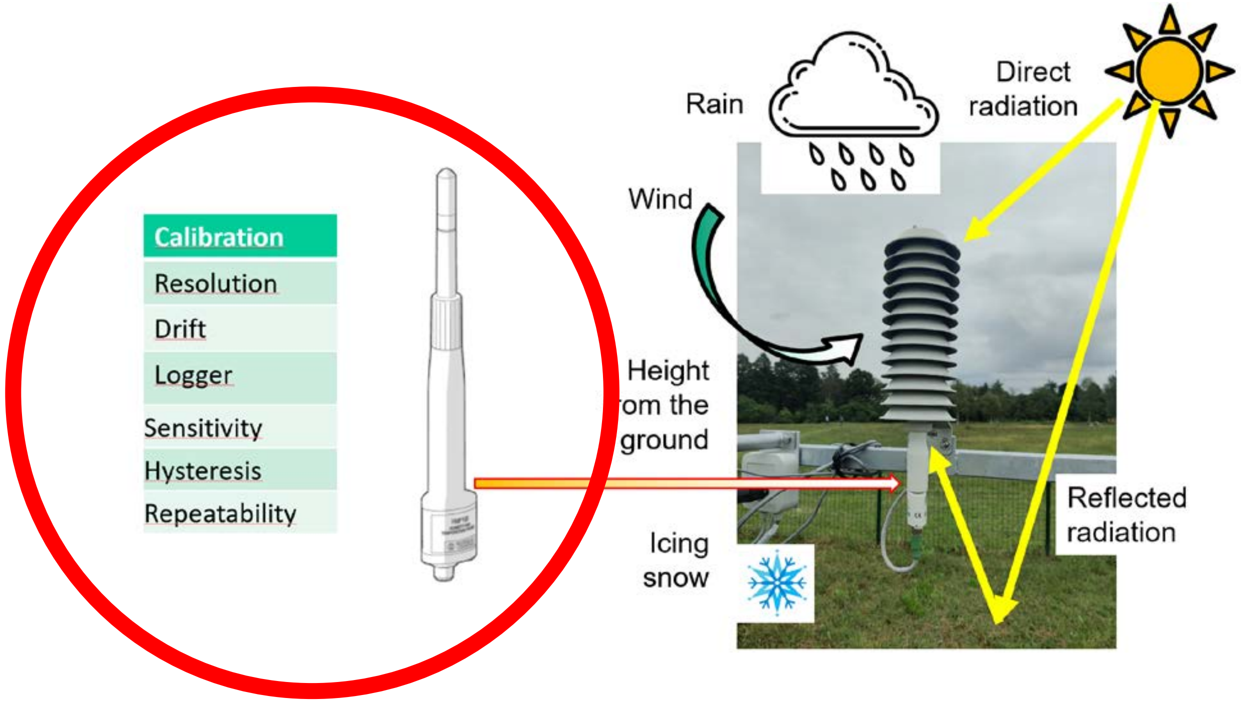
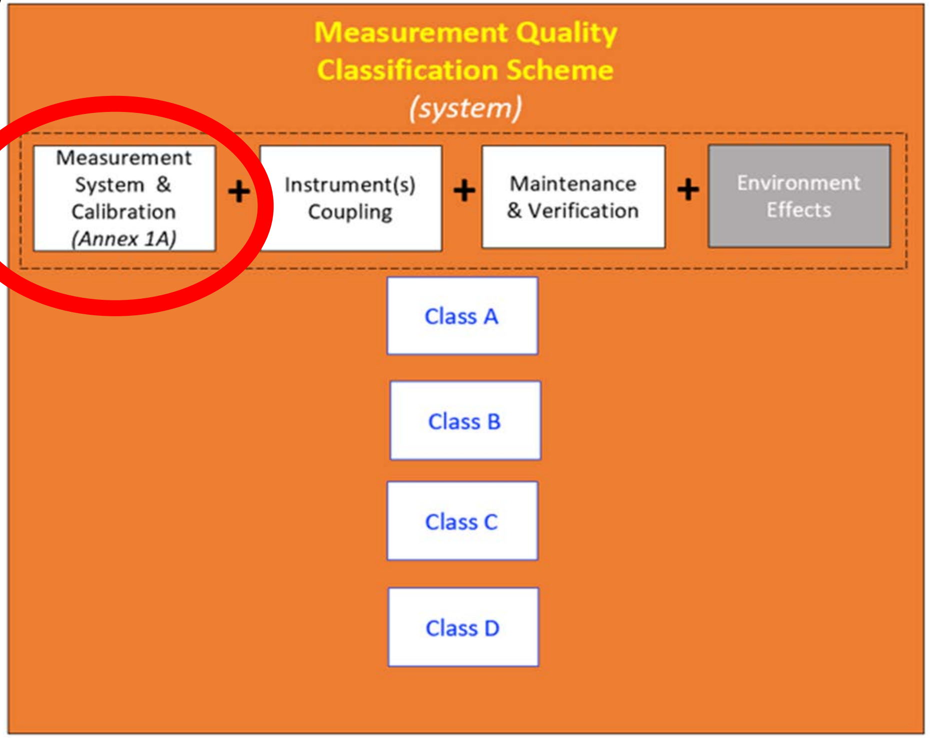
Clear distinction among measurements in
* laboratory-calibration (controlled)
* environment-field (dynamic)





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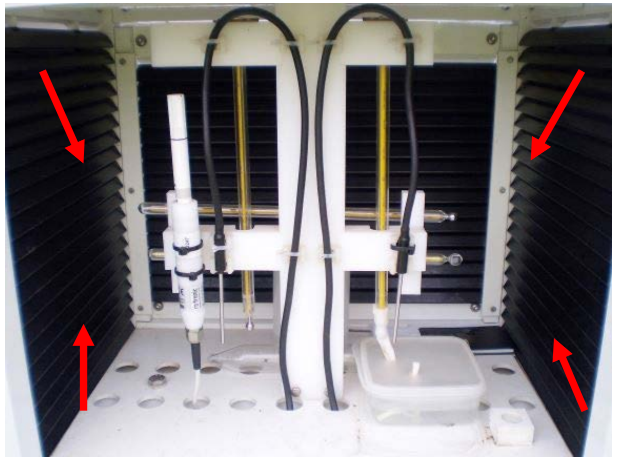
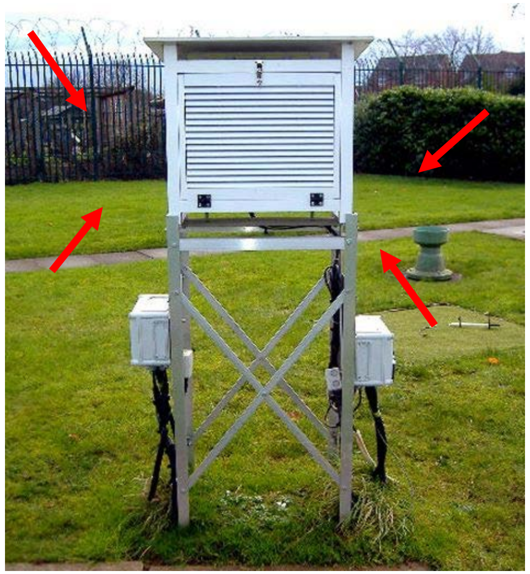
Uncertainty components for different measurands

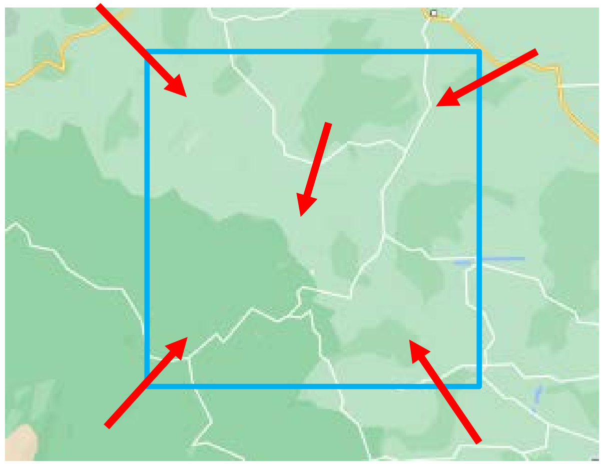
Temperature of thermometer?



Temperature of air inside a screen,



Temperature of air outside weather-station screen?



Temperature of air in wider local area?

Ongoing studies (A2TM TG AirT)

CCT – WMO Gap Analysis

Not of interest to CCT

Images: Met Office

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Next actions:

identification of known-calculable contributions (in laboratory)

gap analysis of missing knowledge including environmental effects
in cooperation with WMO ET-MU and GSRN

weighted list of contributions (corrections and/or uncertainties)

priority list and study – experiments planning
according to WMO Decision INFCOM2- 7.4(2) 2022

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- **Not complete knowledge for evaluating components of the air temperature measurement uncertainty budget, due to**

  Rain overcooling
  Radiation heating
  Wind speed *threshold* effects
  Condensation-icing
  Sensors and shields dimensions «best compromise»

- **Collect published material (papers, technical reports, testing reports) on uncertainties for air temperature**

WEATHER CLIMATE WATER

World Meteorological Organization — **INFCOM-2/Doc. 7.4(2)**

COMMISSION FOR OBSERVATION, INFRASTRUCTURE AND INFORMATION SYSTEMS

Submitted by: Chair

Second Session
24 to 28 October 2022, Geneva

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;

Contribution	
Description/Definition	Description of the quantity and (where available) a referenced definition or an accepted definition
Reason	Why this quantity must be included as a component of the measurement uncertainty (or correction + uncertainty where needed) and how it affects the measurement
Status	“State of knowledge” on the evaluation of this quantity as a component of uncertainty in NSAT
Documentation	References, studies, papers…
Actions required	If a study – experiment is needed to complete the missing knowledge for inclusion of this quantity as uncertainty component (ex. Comparisons, field measurements, specific instrument characterization by manufacturer/user
Distribution	The expected distribution as component of uncertainty
Notes	
Priority	Low to high or none.
More…	

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CCT TG Air T – SG3
ILC and guide

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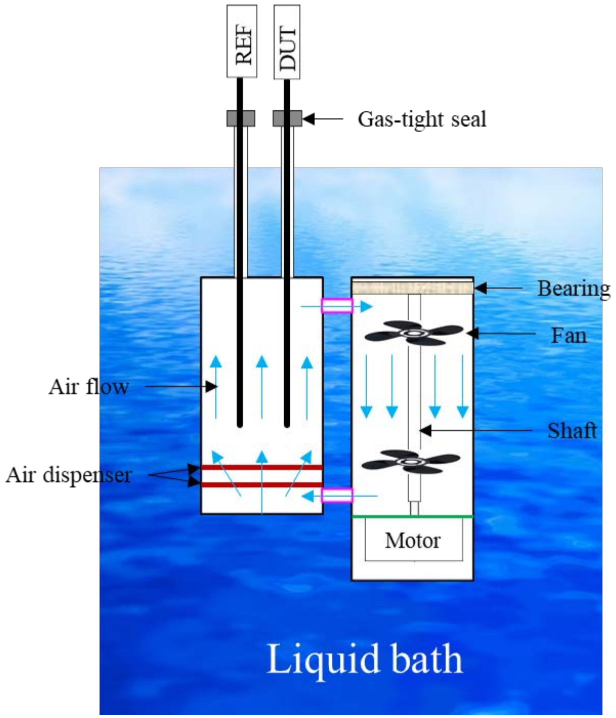
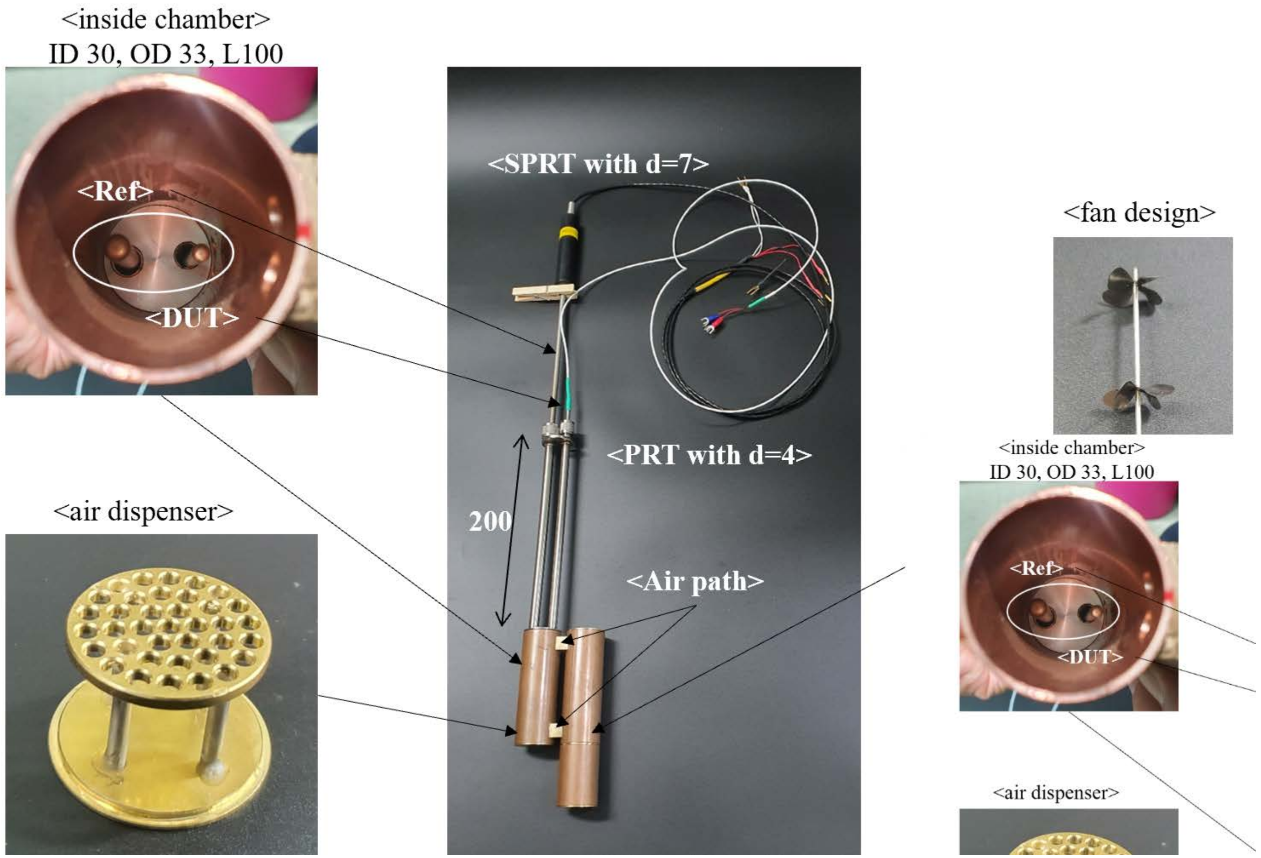
Sub-chamber in liquid bath





KRISS

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ATM

Air Temperature Metrology

A2TM

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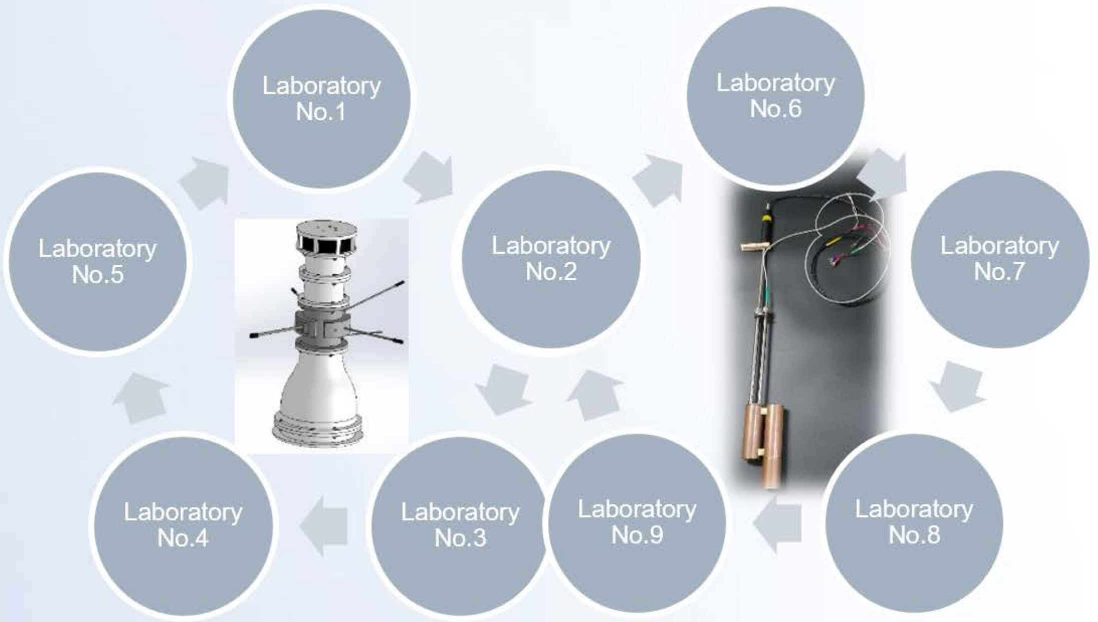
Design of the CCT-WMO ILC

- To **carry out an inter laboratory comparison** using the procedure developed
- Use the sub-chamber system and the transfer cell system (design KRISS)
- The desired range of temp. is proposed from -80 °C to 80 °C.



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Capacity building

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Actions and Decisions 4th CIPM-STG-CENV Core Group Meeting (Jan 22, 2026)

3.2 Progress on the new CCT Task Group on Capacity building and Coordination mechanisms with international partners and RMOs

AM informed the group that his Working Group will launch a capacity-building survey for NMIs, starting in May 2026. The objective is to have the survey results available by the end of 2027 or early 2028, in preparation for the next Stakeholders' Meeting.

Actions and Decisions

- **AM** and the CCT Working Group to keep the group informed of progress regarding the capacity-building survey for NMIs.

New CCT WG ENV Capacity Building Group

Created during WG ENV meeting on 19 May 2026

One representative for each RMO and the WMO:

Andrea Merlone SG Chair
Viktor Fuksov, VNIIM;
Eduardo Lopes, INMETRO;
Wenwen Lei, NMIA;
Carmen García Izquierdo, CEM.
Efrem Ejigu, NMISA
Drago Groselj, WMO

Questionnaire

Survey the status of connections among NMIs and NMHSs
Available services to establish traceability for ECVs at NMIs
Research initiatives in support t uncertainty analysis

Next action. Web meeting on structuring the quiestionnaire.

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Metrology for climate and environment

Growing interest
Increased participation and memberships
Improved cooperation with the WMO and the GCOS
Increased activities, no more limited to funded projects
More staff in metrology for meteorology and climate
Extended scientific production
Capacity building initiative

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Thank you