CIPM

Consultative Committee for Thermometry

Working Group Environment
&
Task Group Air Temperature

Report 2022

Members:

- Stephanie Bell (NPL)
- Efrem Ejigu (NMISA)
- Carmen García Izquierdo (CEM)
- Drago Groselj (ARSO-WMO)
- Martti Heinonen (MIKES)
- Murat Kalemci (UME)
- Yong Gyoo Kim (KRISS)
- Christian Monte (PTB)
- Peter Pavlasek (SMU)
- Fernando Sparasci (LNE-Cnam)
- Howard Yoon (NIST)
- Naohiko Sasajima (NMIJ/AIST)
- Eric van der Ham (NMIA)
- Hao Xiaopeng (NIM)
- Victor Fuksov (VNIIM)
- Júlio D. Brionizio (INMETRO)

Chairperson: Andrea Merlone (INRIM)

- Co-opted members:
  Rainer Feistel (Leibniz Institute for Baltic Sea Research)
  Peter Thorne (Maynooth University)

- Invited to attend
  Åge Andreas Falnes Olsen (JV)
  Jahan Ferdouse (NMIA)
  Gaber Beges (UL-LMK)
  Javier García Skabar (INTI)
  Aleksandra Kowal (INTiBS)
  Krunoslav Premec (WMO)

CCT Working Group Environment

Chair: Åge Andreas Falnes Olsen – JV

Co-Chair: Andrea Merlone (INRIM)

Members:

Åge Andreas Falnes Olsen	JV
Andrea Merlone	INRiM
Carmen García izquierdo	CEM
Davor Zvizdić	FSB
Drago Groselj	ARSO-WMO
Efrem Ejigu	NMISA
Eric Gerogin	LNE-CETIAT
Fan yan	NMC A-Star
Ferdouse Jahan	NMIA
Graziano Coppa	INRiM
Julio Brionizio	INMETRO
Lars Bünger	PTB
Jeremy Lovell-Smith	MSL
Marco Pisani	INRiM
Matthijs Panman	VSL
Michal Voldan	CMI
Peter Pavlasek	SMU
Seda Aytekin	TUBITAK
Stephanie Bell	NPL
Stephen Burt	Uni Reading
Svitlana Fil	NSC
Tabandeh Shahin	VTT
Vitor Cabral	IPQ
Yong-Gyoo Kim	KRISS
Viktor Fuksov	VNIIM
Javier García Skabar	INTI

CCT Task Group Air Temperature

WG ENV Members in WMO

Andrea Merlone (INRiM)

Chair ET MU

Chair GCOS GSRN SG5

Co-Chair GCW Permafrost

Member ET QTC

Member SC-MINT

Member TT-GSRN

Christian Monte (PTB)

Vice Chair ET – Radiation

Carmen G. Izquierdo (CEM)

Member ET QTC

Member ET Surface & Sub Surface

Gaber Beges (LMK)

Member ET QTC – ILC coordinator

Stephanie Bell (NPL)

Member ET QTC

Yong-Gyoo Kim (KRISS)

Member ET MU – ET Upper Air

Javier García Skabar (INTI)

Member ET QTC – ILC pilot

Drago Groselj

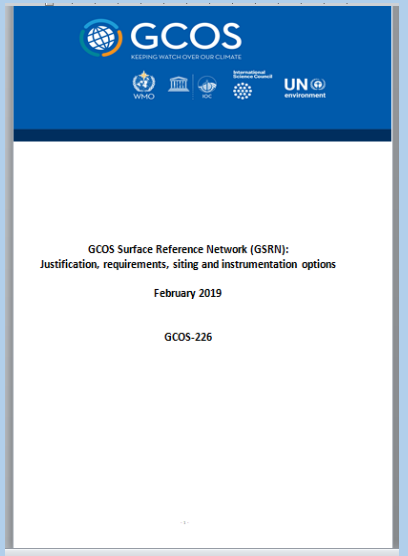
Chair ET QTC

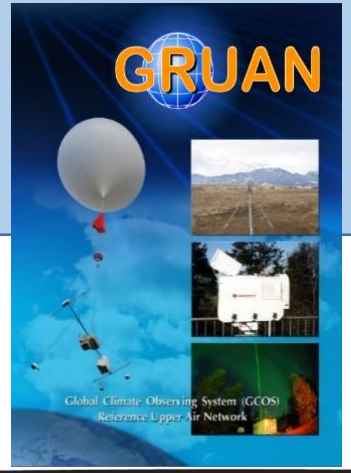
Member ET MU

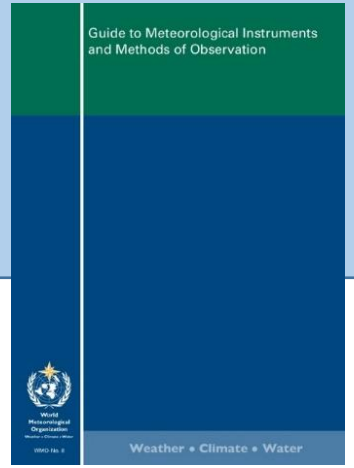
Contributions:

- Revision of the “WMO Guide on Instruments and Methods of Observations
- Interlaboratory comparisons
- Measurement Quality Classification
- Training on measurements, uncertainties and
- Studies on Measurement Uncertainty evaluation
- Siting classification and experiments
- Terminology

- Permafrost Best Practice
- Arctic Metrology
- Measurements for mountain climate (glaciers, periglacial processes)
- Marine sensors
- Upper air radiosondes and aircrafts







WG ENV and TG Air contribution to the CCT strategy "refresh"

- Prepared and submitted in May 2021
- CCT recommends NMIs to contribute in improving measurement quality and knowledge in monitoring of the environment and climate
- Air Temperature as a key scientific investigation topic

Achievements 2017-2020	Future Scan 2021-2025	Future Scan 2025-2030+
Working Group for Environment		
CIPM RECOMMENDATION T3 (2010) "On climate and meteorological observations measurements" and the ToR of the CCT WG Environment are the basis for establishing long term collaboration with the scientific community involved in research on climate and environmental monitoring and motivates specific projects and actions from the NMIs.	Data comparability: Include as reliable as possible uncertainty analysis in historical data; study and assess traceability. Water content measurements (air and soil): Develop suitable measurement techniques and guides. Evolving technologies, such as non-contact instruments, for meteorological and climatological measurements will be constantly followed, with dedicated activities and studies.	CCT recommends NMIs to include in their vision documents all possible actions within the expertise of the thermal metrology community contributing to improve measurement quality and knowledge on observation and monitoring of the environment and climate.

Consultative Committee for Thermometry
Task Group on Air temperature

Chair: Åge Andreas Falnes Olsen – JV

Vice-Chair: Andrea Merlone - INRiM

In 2021 three Sub Groups have been formed based on TG ToR

SG1 "**Definition**". Chair: Stephanie Bell - NPL

To work towards and propose a practical definition of air temperature

SG2 "**Uncertainty**". Chair: Davor Zvizdic - FSB

To work towards and propose how to evaluate the uncertainty contributions in air temperature measurements

SG3 "**Guidelines**". Chair: Yong Gyo Kim - KRISS

To develop guidelines for the calibration of thermometers in air

Consultative Committee for Thermometry

Task Group on Air temperature

Chairpersons meeting

2021 September 15

- Organize the work of Sub Groups
- Prepare the TG Air kick off meeting
- Contact TG Air members for Sub group/s selection

Kick off meeting.

2021 November 8

- Participats introduction
- Presentations from chair persons and Sub group Chairs
- Subgroups workplan planning
- Schedule for Sub Groups meetings and plenary TG Meetings

Task Group on Air temperature

Priorities

SG1 “Definition”	Work towards a clear definition with respect to measurement methods, including technical interaction between sensor and air, independent from the measuring technique, physical principles and methods, in order to fit also future improvement of new instruments, such as non-contact methods.
SG2 “Uncertainty”.	Identify and list uncertainty components Compile a “state of knowledge report” Evaluate contribution weight and evaluation capabilities
SG3 “Guidelines”.	Extend Euramet ILC to other RMO Prepare ILC protocol

Members activities

INRiM
ISTITUTO NAZIONALE
DI RICERCA METROLOGICA

Andrea Merlone
Chair: CCT WG Environment
Vice-chair: CCT TG Air Temperature

Chair ET Measurement Uncertainty
Chair GCOS GSRN SG5 “Climate References”
Chair GCW Permafrost
Member ET QTC
Member Standing Committee – MINT
Delegate at the WMO Congress
Co-Chair GCW Permafrost Best practice
Co-Chair International Surface Temperature Initiative

4 Permanent positions
2 Young Researchers
3 Laboratories
3 Field Research sites
1 Arctic metrology lab

Projects:

MeteoMet series

ATM	Air Temperature Metrology
INCIPIT	Rain gauges calibration
CRS	Climate Reference Stations
COAT	Intercomparison in the Arctic
MINKE	Marine EU infrastructure
MIDAS	Air and Pressure Sensors

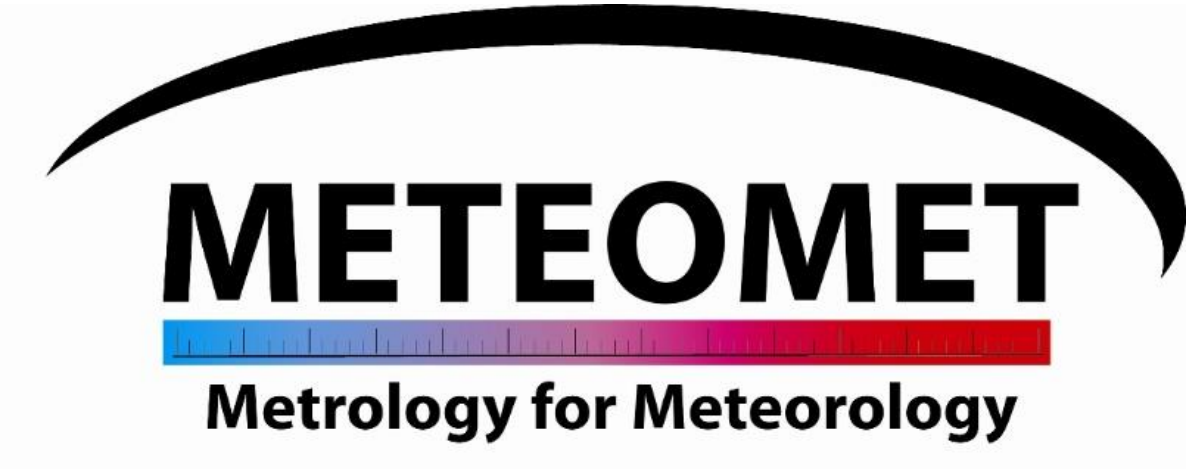
Influence quantities in field

Understanding and evaluating uncertainties

Training

In-field calibrations

Climate Reference Data and Reference Stations



Metrology for high mountains and polar environment

Validation of extremes

Innovative instrumentation (non contact)

Improve the siting classification

Normatives

Interlaboratory comparisons

Instruments testing and intercomparisons

CoAt

2020-2023

World Meteorological Organization

ATM

Air Temperature Metrology

2017-2024

World Meteorological Organization

METEOMET

Metrology for Meteorology

2011 - 2017

BIPM

ΜΕΤΡΩ ΧΡΩ

CRS

Climate Reference Station

a MeteoMet initiative

2019-2022

GCOS

cen

INCIPIT

Metrology for non-catching rain instruments

2018-2022

INRiM
ISTITUTO NAZIONALE
DI RICERCA METROLOGICA

INCIPIT

Metrology for non-catching rain instruments

Chief Stakeholder	World Meteorological Organisation (WMO)
Contact:	Bertrand Calpini - Permanent Representative on CIMO WMO
Address:	Ch. de l'Aérologie 1, CH-1530 Payerne
Phone:	+41 58 460 92 45
Email:	bertrand.calpini@meteoswiss.ch

This project will develop traceable calibration methods for non-catching precipitation gauges that are implemented in a form that can be incorporated into standards.

no.	Participant Type	Short Name	Organisation legal full name	Country
1	Internal Funded Partner	INRIM	Istituto Nazionale di Ricerca Metrologica	Italy
2	Internal Funded Partner	CEM	Centro Español de Metrología	Spain
3	Internal Funded Partner	DTI	Teknologisk Institut	Denmark
4	Internal Funded Partner	SMD	Federale Overheidsdienst Economie, KMO, Middenstand en Energie	Belgium
5	External Funded Partner	UNIGE	Università degli Studi di Genova	Italy
6	Unfunded Partner	EDI	Eidgenössische Departement des Innern	Switzerland

EMPIR 19SIP03 – CRS
Climate Reference Stations

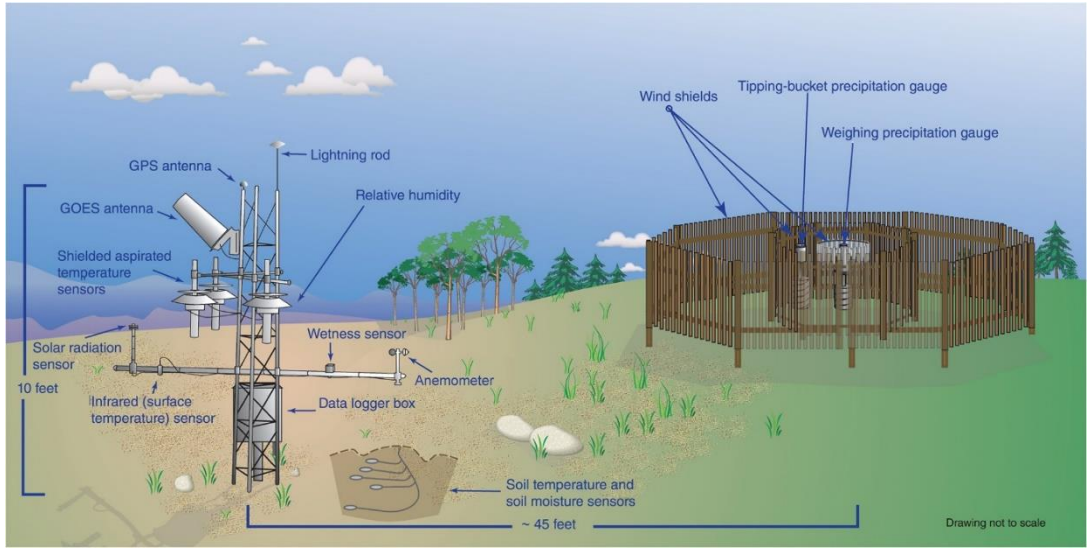
Climate Reference Station
a MeteoMet initiative

Primary Supporter:	**World Meteorological Organisation**
Contact:	Manola Brunet – WMO CCl President
Address:	Centre for Climate Change (C3) at University Rovira I Virgili - Carrer de l`Escorxador, s/n, 43003 Tarragona - Spain

Start date: Nov 2020

Coordinator: A. Merlone

Support the definition of the instrumental features required for reference climatological stations and their recommendation to the WMO Commission of Climatology and for the Global Climate Observing System Surface Reference Network (GSRN) for implementation.



ATM

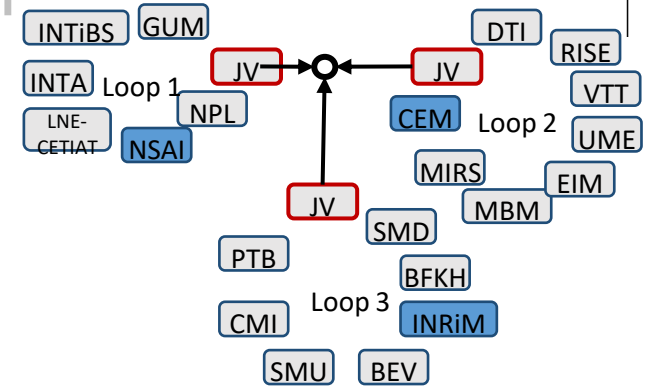
Air Temperature Metrology

EURAMET Project Form

EURAMET

Document: G-GPS-TMP-024 Version: 2.0
Approved: Head of Secretariat 2013-02-01

1	**Status**	X proposed ☐agreed	**Reference No:** *(if already existing)*
2	**Subject Field**	T - Temperature T - Temperature	
3	**Type of collaboration**	Cooperation in Research	
3A	**In the case of a comparison** Registered as Key comparison (KC) or Supplementary Comparison (SC) in the KCDB: X no ☐yes If yes: No. of KC/SC: In case of a KC: Protocol approved by the responsible CC WG? ☐no ☐yes		
4	**Coordinator** Institute/Country: INRiM - Italy Name: Andrea Merlone Phone: +39011 3919 734 E-mail: a.merlone@inrim.it		
5	**Participating Partners**		
5A	EURAMET members or associates (Institute's standard acronym with country code in brackets) as registered on EURAMET website. INRiM (IT) CEM (ES) CMI (CZ) DTI (DK) LNE (FR) INTiBs (PL) NPL (UK) NSAI NML (IE) MIRS/UL-FE/LMK (SI) SMD (BE) UME (TK)		



Two main tasks:

1. Perform a pilot study in the form of interlaboratory comparisons, to explore issues around calibration in air of temperature sensors ; **CONCLUDED!**

2. Feed into a guidance document the findings from the pilot study. (main objective)

CCT Task Group on Air temperature

Alpine Metrology

- **New on site calibration campaigns in 2020 for permafrost sensors**

- **Improved system:**
  - **Lower uncertainty (<10 mK)**
  - **Reduced times on site (1 day)**
  - **Less power required**

Alpine Metrology

- **New on site calibration campaigns in 2020 for permafrost sensors**

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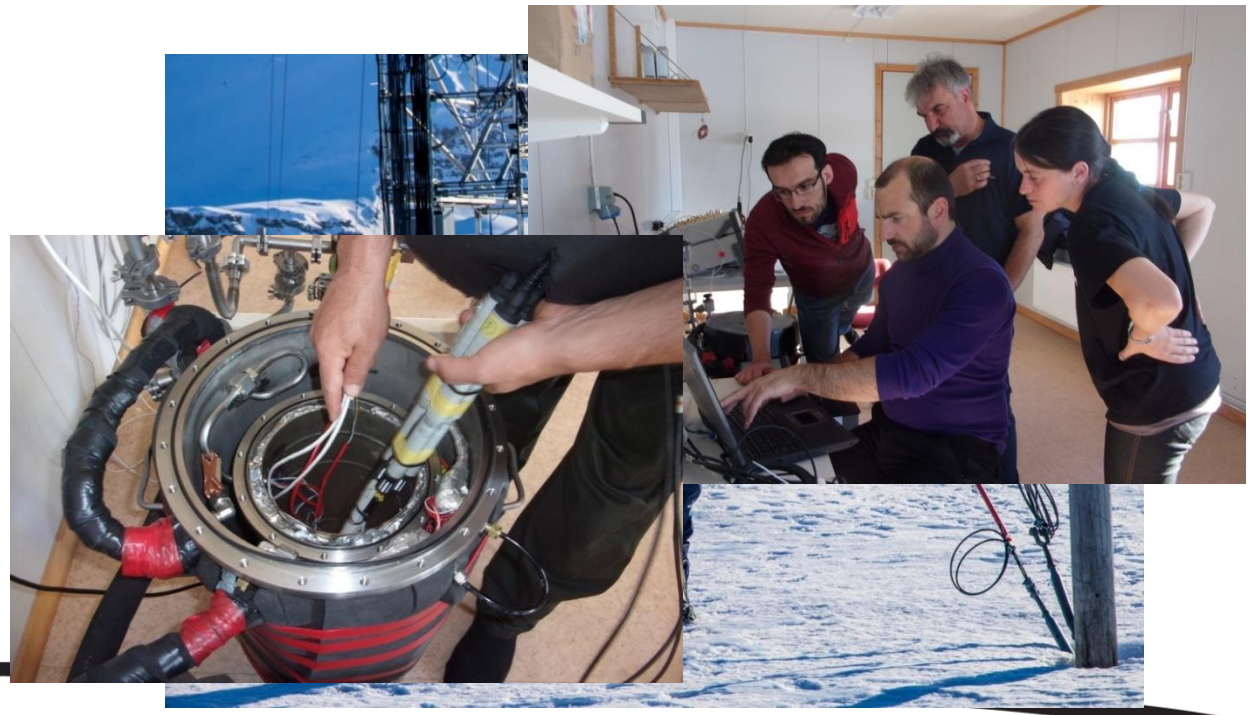
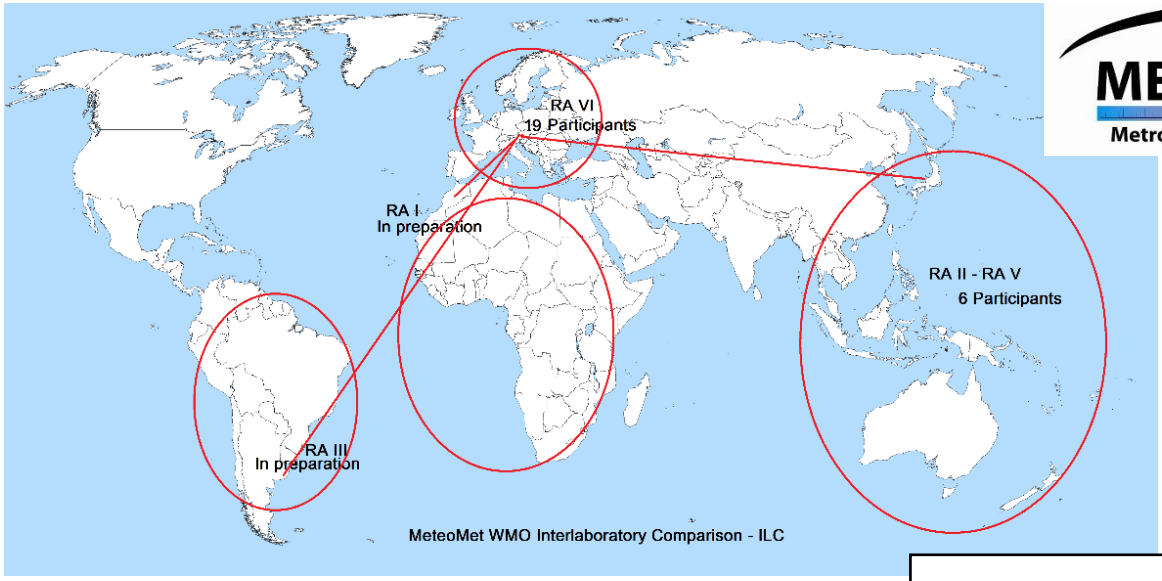
Arctic Metrology

- **From 201[illegible]e c[illegible] pr[illegible]mpaign 20[illegible]**
- **Metrology lab Ny-Ålesund operative in cooperation with Polar Institute**

+ New campaign 2021
+ Secondment in 2022



University of Ljubljana
Faculty of Electrical Engineering



METEOMET
Metrology for Meteorology

Interlaboratory comparison Temperature, Humidity, Pressure

A MeteoMet initiative for the
Meteorological ad Hydrological services of WMO

WMO-MM-ILC-2015-THP in WMO region VI
published as GAW Report No. 128 — Completed

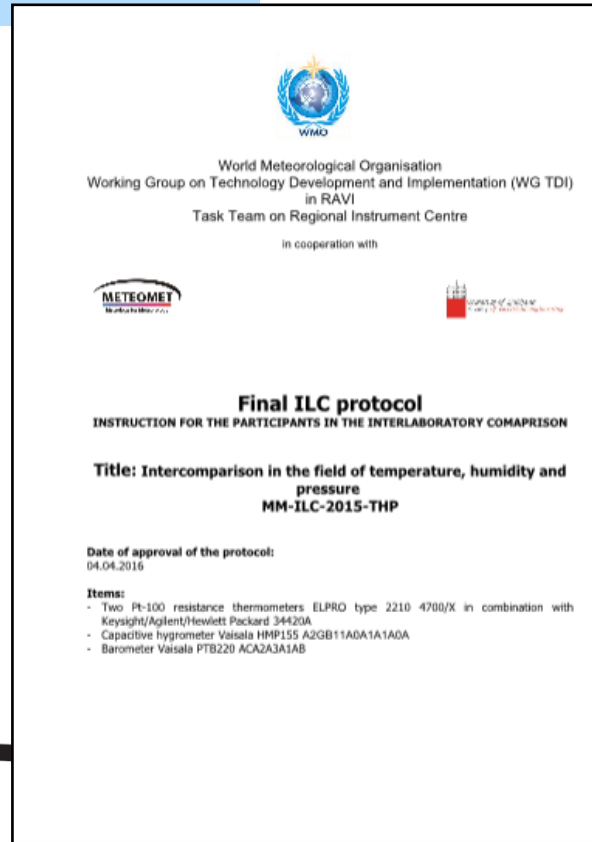
WMO-MM-ILC-2018-THP in WMO region II and V
is in a final draft stage — Completed

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

University of Ljubljana Faculty of electrical engineering

気象庁
Japan Meteorological Agency

Instituto Nacional de Tecnología Industrial
INTI



World Meteorological Organisation
Working Group on Technology Development and Implementation (WG TDI)
in RAVI
Task Team on Regional Instrument Centre

in cooperation with

Final ILC protocol
INSTRUCTION FOR THE PARTICIPANTS IN THE INTERLABORATORY COMAPRISON

Title: Intercomparison in the field of temperature, humidity and pressure
MM-ILC-2015-THP

Date of approval of the protocol:
04.04.2016

Items:
- Two Pt-100 resistance thermometers ELPRO type 2210 4700/X in combination with Keysight/Agilent/Hewlett Packard 34420A
- Capacitive hygrometer Vaisala HMP155 A2GB11A0A1A1A0A
- Barometer Vaisala PTB220 ACA2A3A1AB

KRISS
Korea Research Institute of Standards and Science

1. Advances in researches on Upper-Air Measurements

- Completion of evaluation tests of Upper-Air Simulator for the realization of temperature and humidity standards of radiosondes

- Presentation at the GRUAN ICM-13 meeting on Nov. 2021

2. Join the ISO/TC 146/SC5: Meteorology

- Cooperation works in Korean Upper-Air Network

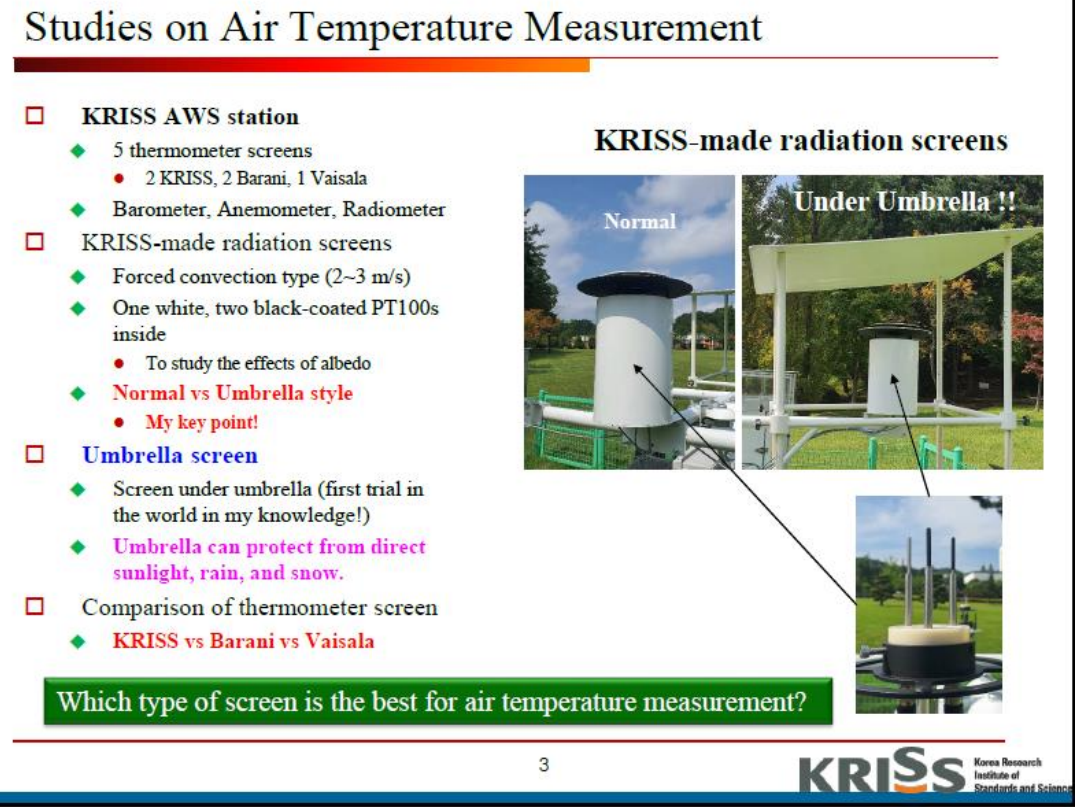
- ISO/NP 8931-1 (Temperature sensor of radiosonde)

- ISO/NP 8931-2 (Humidity sensor of radiosonde)

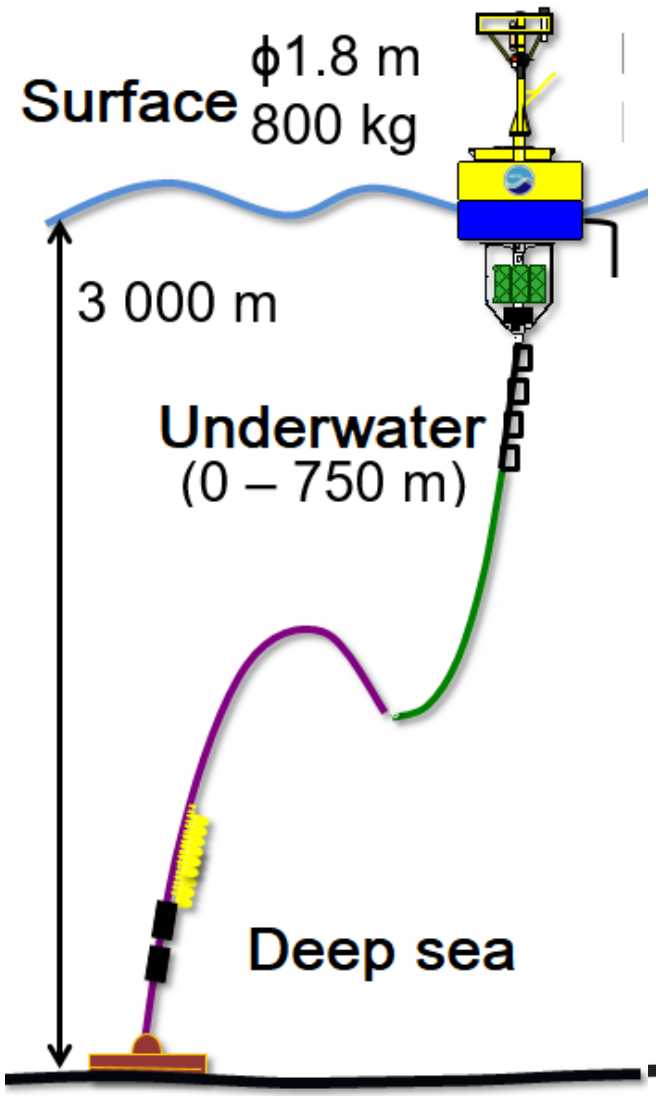
- ISO/NP 8931-3 (Radiation correction of radiosonde)

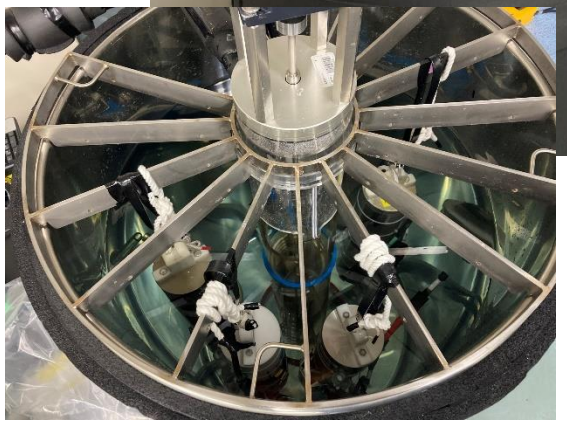
3. KRISS as chair of TG Air Subgroup-3

4. Joining the COAT intercomparison of thermometer shields



A calibration system for ocean thermometers U<10 mK

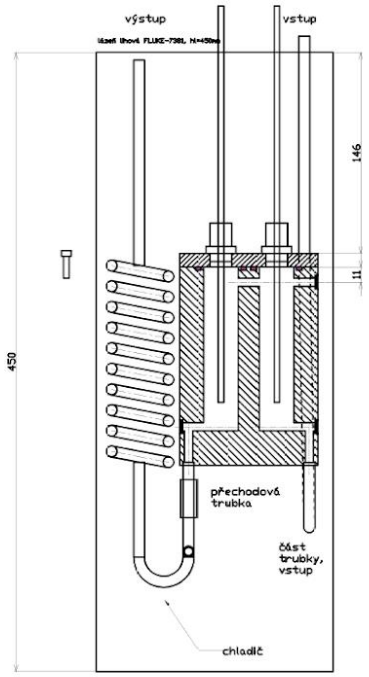


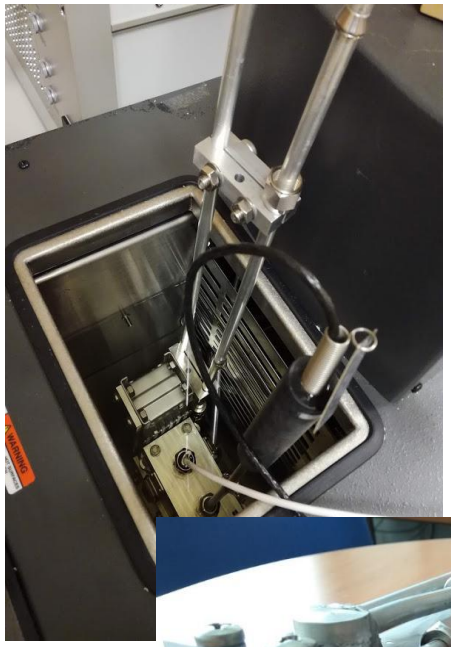


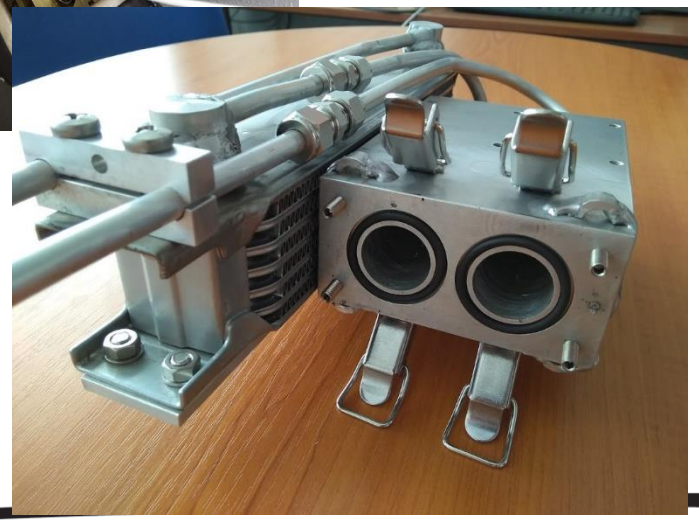
300 L bath for the calibration of oceanographic sensors including large size ones (SBE 3, 35, 19, 41)

Check the stability of the thermometer in long-term use

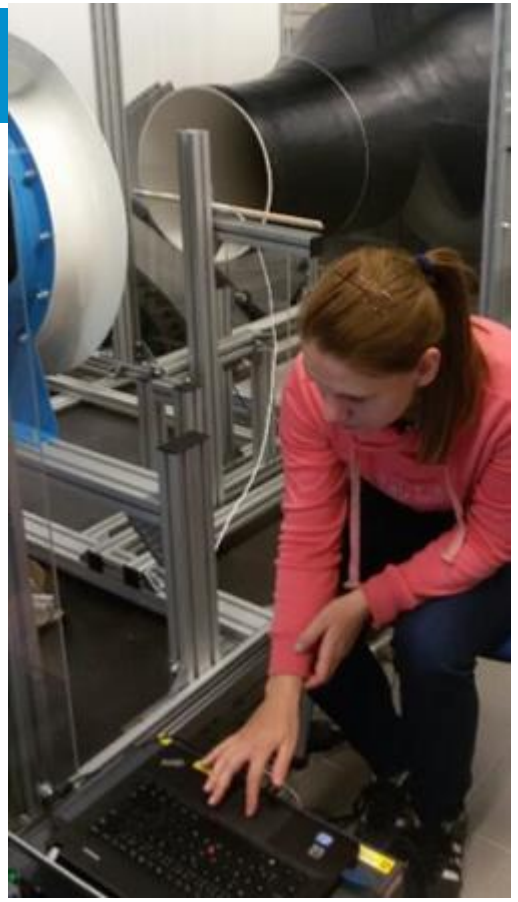
Calibration chamber evolved in ATM Air Temperature Metrology Euramet







Wind tunnel at CMI



Temperature range:
(-70 to 80) °C

Uncertainty of calibration of thermometers in flowing gas < 0.05 °C

Flowrate measured by LDA method

National Physical Laboratory

- Completion of 17SIP02 SimpleMeteoU on developing simplified expression of uncertainty for meteorological observations, with illustrations for air temperature
- A new research weather station on the NPL site as a test platform for further studies on air temperature for weather/climate.
- Direct interaction and cooperation with UK Met Office
- Chair of TG Air SG1 “Definition”
- Member of WMO ET QTC

CENTRO ESPAÑOL DE METROLOGÍA

WMO- INFCOM/SC-MINT ET-QTC

- Contribution to the document “Field verification of Metrological Instruments and sensors”
- Elaboration of the training modules about temperature: “ITS-90” “temperature calibration by comparison”.
- Elaboration of a training module ”calibration of thermometer for Marine Applications”.

WMO- INFCOM/SC-MINT ET-SSM

Task 4: “Measurement Quality Classification and Siting Classification for Surface Observing Stations on Land”

4.a Review of the website on Siting classification

4.b Review reports about Siting classification studies.

4.c working with WMO- INFCOM/SC-MINT ET-Uncertainties on siting classification

Task8: “Intercomparisons”

8.a . Supporting the organization of a comparison of thermometers and shields in the Arctic

Task9:

9.a. collaboration in the document “Guidelines for Conducting and Reporting on the Verification and Calibration of Performance of Discharge Measurement Instruments”

HMEI:

Presentation of the European COAT project to HMEI and other manufacturers of metrological instrumentation

METEOMET
Metrology for Meteorology

CoAt

Increasing the COmparability of extreme Air Temperature measurements for meteorological and climate studies

EMPIR 06 SIP 19 – (MeteoMet SIP) – Coordinator Carmen Garcia Izquierdo – CEM – Oct 2020 – Sept. 2023

WMO Intercomparison of thermometers and shields in polar environment

Primary Supporter:

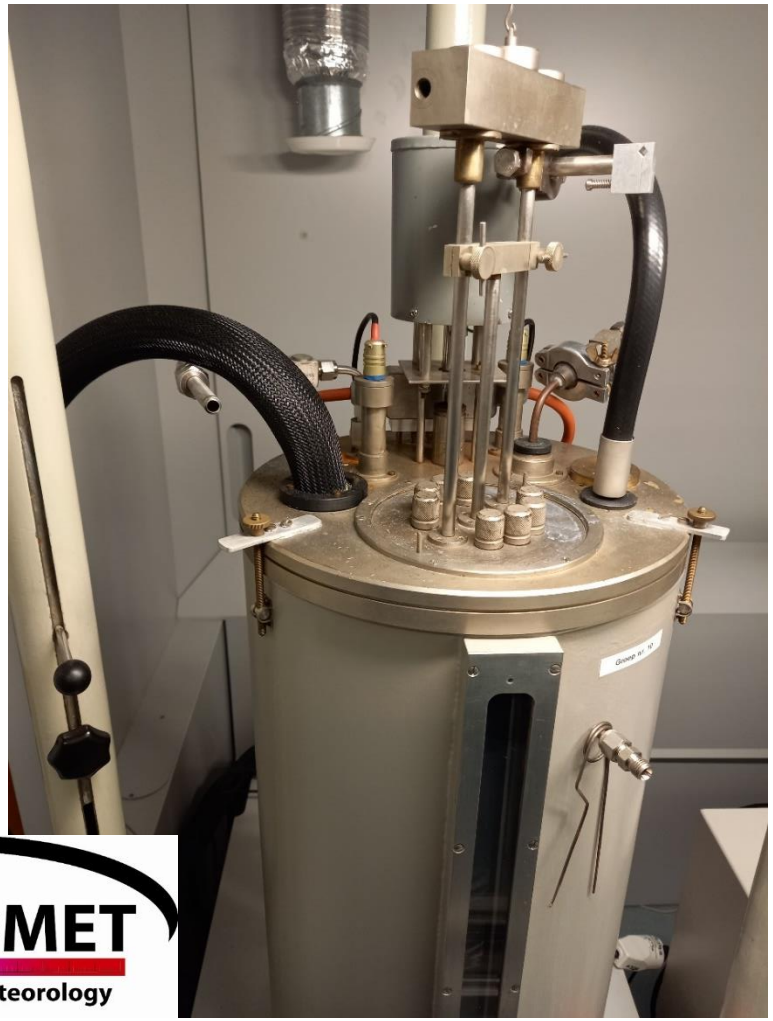
Primary Supporter:	World Meteorological Organization
Contact:	Bruce W. Forgan
Address:	WMO Secretariat – 7 bis, avenue de la Paix – Case postale 2300 – CH 1211 Genève 2 – Suisse

Participant details:

a. Partners (participants who will accede to the Grant Agreement)

no.	Participant Type	Short Name	Organisation legal full name	Country
1	Internal Funded Partner	CEM	Centro Español de Metrología	Spain
2	Internal Funded Partner	INRIM	Istituto Nazionale di Ricerca Metrologica	Italy
3	External Funded Partner	CNR	Consiglio Nazionale delle Ricerche	Italy
4	Unfunded Partner	EDI	Eidgenössische Departement des Innern	Switzerland

Sub-milikelvin thermal bath for the calibration of deep-sea thermometers in the temperature range 0 – 30 °C and **pressure range of 0.1 to 60 MPa**



- Uncertainty budget for the calibration setup of air temperature thermometers provided to TG Air and ATM

- Re-validation of the existing primary humidity standard to operate in the pressure range 0.1 to 1 MPa. The setup is adapted to work with hydrogen within the scope of the EMPIR project JRT-v09 “Metrology for the Hydrogen Supply Chain” which is part of the European Green Deal.

METEOMET
Metrology for Meteorology

Events

NPL Metrology for Climate Action workshop

(a COP26 associated event)

- 13 – 14 October 2021
- Joined by INRIM, NIM, and NIST
- Jointly promoted by BIPM
- Participated by WMO, ESA, Met Office.

NPL

Measurement for our planet

Providing confidence in climate action

Measurement for Climate Action

WORLD METEOROLOGICAL ORGANIZATION · esa · Met Office · Bureau International des Poids et Mesures · INRiM Istituto Nazionale di Ricerca Metrologica · 中国计量科学研究院 National Institute of Metrology, China · NIST National Institute of Standards and Technology U.S. Department of Commerce

~ 500 participants

Speakers and the panel

Chair

Richard Barker
Head of Energy & Environment, NPL

Speakers

Dr Bruce Forgan
Vice-president of the WMO Commission for Observation, Infrastructure and Information Systems (Infrastructure Commission), WMO

Dr Susanne Mecklenburg
Head of ESA Climate Office, ESA

Dr Robert Wielgosz
Steering Committee Member: BIPM-WMO Metrology for Climate Action Initiative, BIPM

Professor Nigel Fox
NPL Fellow in Earth Observation, Climate and Optical Radiometry
Chair of the CEOS WGCV IVOS Subgroup
UK science lead for the TRUTHS satellite mission, NPL

Dr Andrea Merlone
Senior Researcher, INRiM
CCT WG Environment Chairperson, BIPM
SC-MINT Expert Team "Measurement Uncertainty" Chairperson, WMO

Dr Hong Lin
Group Leader of Greenhouse Gas and Air Pollutant Inventory Research, NIM

Dr James R Whetstone
Special Assistant to the Director for Greenhouse Gas Measurement, NIST

Waiting for MMC

MMC Webinar 2021

METROLOGY FOR METEOROLOGY AND CLIMATE

Hybrid workshop 25-28 October 2021

Jezersko – Slovenia

~ 100 participants (85 remotely + 15 in person) from

Europe, Australia, Asia, North and South America

- WMO Expert Team meetings organized
- EMPIR Project meetings
- Copernicus Climate Change Service Sessions

Training Workshops

(June 2021)
Online Training Workshop on Quality, Traceability and Compliance – General Metrology and Temperature, for WMO RICs and RMICs

(December 2021)
6th Marine Instrumentation Workshop for Asia-Pacific Region

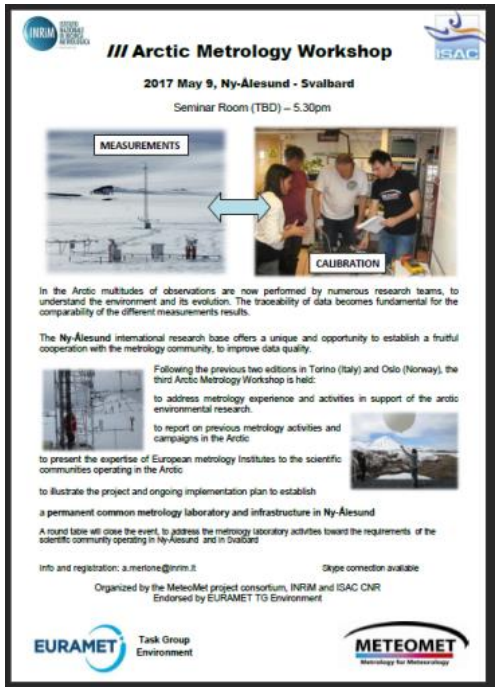
WG ENV Members contributed in the general organization and in Training modules on

General Metrology
Terminology
Uncertainty
Temperature sensors and measurements

V Arctic Metrology Workshop

Longyearbyen – Svalbard

Hosted by University of Svalbard and SIOS May 2022



/// Arctic Metrology Workshop

2017 May 9, Ny-Ålesund - Svalbard

Seminar Room (TBD) – 5.30pm

MEASUREMENTS

CALIBRATION

In the Arctic multitudes of observations are now performed by numerous research teams, to understand the environment and its evolution. The traceability of data becomes fundamental for the comparability of the different measurements results.

The Ny-Ålesund international research base offers a unique and opportunity to establish a fruitful cooperation with the metrology community, to improve data quality.

Following the previous two editions in Torino (Italy) and Oslo (Norway), the third Arctic Metrology Workshop is held:

to address metrology experience and activities in support of the arctic environmental research.

to report on previous metrology activities and campaigns in the Arctic

to present the expertise of European metrology Institutes to the scientific communities operating in the Arctic

to illustrate the project and ongoing implementation plan to establish

a permanent common metrology laboratory and infrastructure in Ny-Ålesund

A round table will close the event, to address the metrology laboratory activities toward the requirements of the scientific community operating in Ny-Ålesund and in Svalbard

Info and registration: a.merlone@inrim.it Skype connection available

Organized by the MeteoMet project consortium, INRIM and ISAC CNR
Endorsed by EURAMET TG Environment

EURAMET Task Group Environment

METEOMET

Thermal metrology for climate and environment

- Growing involvement of NMIs
- More national and international projects
- Extended areas of interest
- Enforced cooperation and mutual membership with the WMO
- New laboratories, new equipment, field sites and research installations
- Contribution to best practices and regulatory material
- More training and practical experience for NMI’s staff
- Increased scientific production and direct benefit to users

Thank you