Traceability, uncertainty and reference measurements for in situ climate observations

Andrea Merlone

CCT WG Environment chair
WMO ET Measurement Uncertainty chair
WMO GCW Permafrost best practice Co-Chair
GCOS GSRN SG5 “Climate Reference Stations” Chair

The background

The issue

The actions

The background

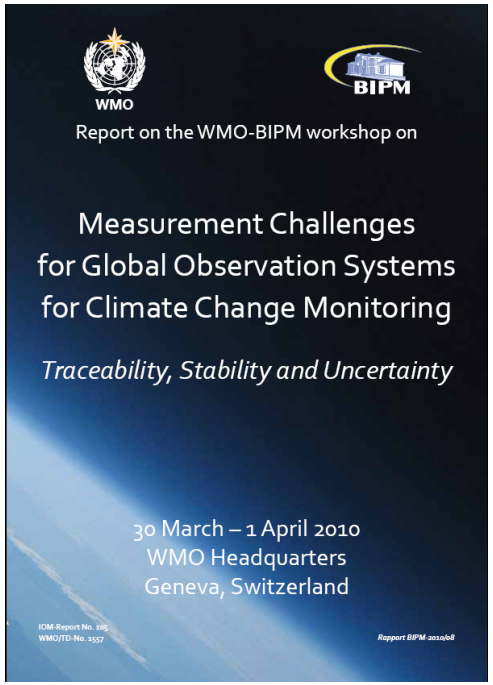
World Meteorological Organization
Working together in weather, climate and water

MRA

BIPM

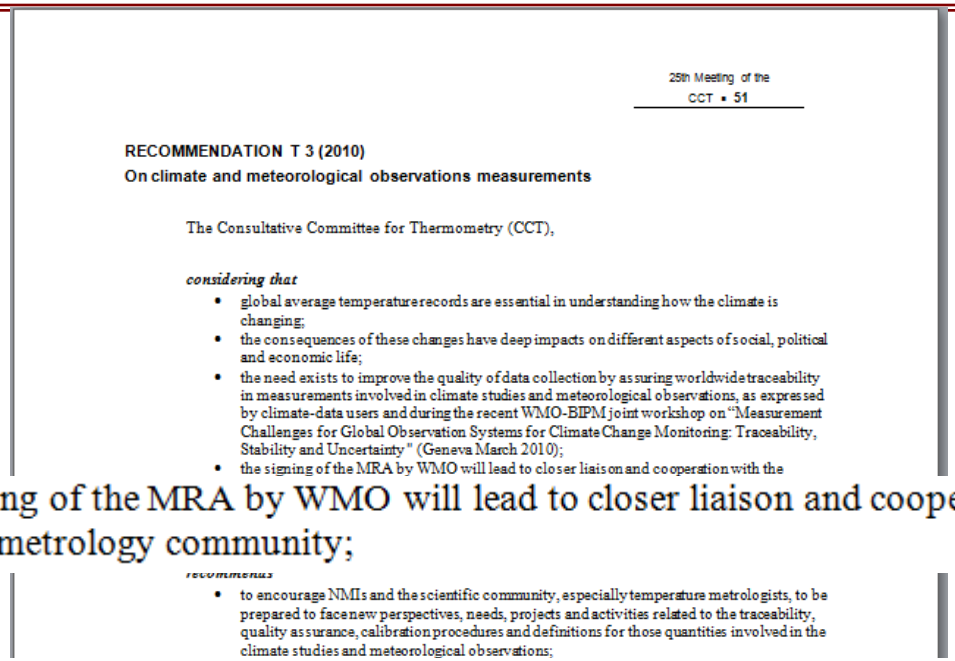
Michel Jarraud, Secretary General of the WMO, signed the Arrangement on behalf of the WMO. The signing ceremony took place on *1 April 2010*

Left to right: Len Barrie (WMO), Andrew Wallard (Director BIPM), Michel Jarraud (Secretary General WMO), Ernst Göbel (President CIPM), Wenjie Zhang (WMO)



May 2010

CCT Recommendation to CIPM



25th Meeting of the CCT • 51

RECOMMENDATION T 3 (2010)
On climate and meteorological observations measurements

The Consultative Committee for Thermometry (CCT),

considering that

- global average temperature records are essential in understanding how the climate is changing;
- the consequences of these changes have deep impacts on different aspects of social, political and economic life;
- the need exists to improve the quality of data collection by assuring worldwide traceability in measurements involved in climate studies and meteorological observations, as expressed by climate-data users and during the recent WMO-BIPM joint workshop on "Measurement Challenges for Global Observation Systems for Climate Change Monitoring: Traceability, Stability and Uncertainty" (Geneva March 2010);
- the signing of the MRA by WMO will lead to closer liaison and cooperation with the

recommends

- to encourage NMIs and the scientific community, especially temperature metrologists, to be prepared to face new perspectives, needs, projects and activities related to the traceability, quality assurance, calibration procedures and definitions for those quantities involved in the climate studies and meteorological observations;

- the signing of the MRA by WMO will lead to closer liaison and cooperation with the thermal metrology community;
- to encourage NMIs and the scientific community, especially temperature metrologists, to be prepared to face new perspectives, needs, projects and activities related to the traceability, quality assurance, calibration procedures and definitions for those quantities involved in the climate studies and meteorological observations;
- to support a strong cooperation between NMIs and Meteorological Institutions at local, national and international levels;
- to encourage NMIs to work with the relevant meteorological networks to support a monitoring framework for traceable climate data over long temporal terms and wide spatial scales based on best practice metrology;

2014 XXVII CCT launches the Task Group «Environment»
(A. Merlone Chair)

2017, the TG ENV becomes the permanent **Working Group Environment**

2021, a new **TG «Air T»** is created within the WG ENV

Andrea Merlone

Strategy Document for Rolling Programme Development for 2021 to 2030

The Consultative Committee for Thermometry

Objectives, activities and project supporting

WMO (INFCOM and SERCOM),
GCOS (GRUAN and GSRN),
Cryosphere science (GCW),
Oceanography
Arctic Environment (SIOS)
Air temperature metrology (ATM)

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.

Achievements 2017-2020	Future Scan 2021-2025	Future Scan 2025-2030+
The "Metrology for Meteorology and Climate" – MMC **Conference series** and associated workshops and satellite events • were fully participated in and endorsed by CCT WG ENV members • represent world top level events for increasing the collaboration between thermal metrologists and the stakeholder communities. Joint Research projects such as MeteoMet, INCIPIT, CRS, COAT progressed the scientific studies and technical research on improving calibration and measurement procedures and uncertainty evaluation. A metrology network on climate and ocean observation has been formed by EURAMET. The "ATM – Air Temperature Metrology" EURAMET project was launched in 2018, to execute an intercomparison of calibration procedures for thermometers in air and produce a guide. The project formed the basis to launch global initiatives on solving calibration and measurement issues for air temperature. APMP comparison on air temperature thermometers was also started in 2018. TG Air Temperature established.	Improved techniques, proposals of best practices (also for inclusion in the WMO guide no. 8) and on-site calibration devices will be addressed to cryosphere observations (high mountains and polar areas). Establishing reference test sites with the highest quality SI-traceable measurements of ECVs, including prototypes of climate reference stations and research infrastructures to support the implementation plan of the GSRN. Arctic Metrology: polar activities will continue with on site calibration campaigns, the implementation of the "Metrology Laboratory" at the arctic station in Ny-Ålesund, and a WMO intercomparison of thermometers and shields in polar environment. On-site thermometer shield with the minimum environmental effects will be designed and tested. Support in the validation of records associated to extreme events (such as temperature extremes and heat waves, precipitation events, pressure, wind speed etc.), through metrological analysis of the whole measuring process and instrumentation. Improved monitoring techniques for essential fresh water natural and artificial reservoirs and the creation of measurement recommendations.	The WG-ENV will continue to facilitate project proposals for funding and joint activities among the members on activities. WG-ENV members will continue studying and characterizing temperature, humidity and radiation sensors for ocean applications, ground based systems and radiosondes. Provide roadmap to address needs of data quality arising from possible new climate evolution scenarios. The CCT-WG-ENV will promote and contribute to interdisciplinary initiatives, worldwide and at regional level, to create forums and expert teams, to address the stakeholder's needs under coordinated efforts with other areas of metrology, also under future CIPM initiatives.

Achievements 2017-2020	Future Scan 2021-2025	Future Scan 2025-2030+
Collaboration and stakeholders WG-ENV members are formally members of expert teams in the WMO INFCOM and SERCOM, in the Global Cryosphere Watch, the GCOS (GRUAN and GSRN Task Teams) and the BSRN. WG-ENV members are involved and supporting official WMO worldwide laboratory intercomparisons in Europe, Asia, Latin America and Africa. Formal collaborations with national meteorological and hydrological services, universities, research centres and manufacturers have been established.	**Collaboration and stakeholders** The relationships with key world and international Institutions such as WMO, GCOS, and IAPWS will be sustained to provide channels for impact in the work of the WG-ENV. CCT-WG-ENV members will continue to contribute as experts in WMO, GCOS task teams. CCT-WG-ENV, together with operational meteorologists, climatologists and metrologists, to contribute with studies and activities to GCOS for the definition of the key aspects of GSRN in terms of station features, data characteristics and target uncertainties.	**Collaboration and stakeholders** Impact: CCT members continue to organize events, meetings, workshops, conferences and training to discuss and plan common activities with the climate and environmental communities. The GCOS Surface Reference Network (GSRN) of observing stations on land implementation plan was approved by WMO in 2021 and will require a continuous support from the thermal metrology community, being temperature and humidity of air and soil key observables.
Task Group for Air Temperature		
In 2020 a new Task Group on "Air temperature" was formed, tasked: • To work towards and propose a practical definition of air temperature • To work towards and propose how to evaluate the uncertainty contributions in air temperature measurements To develop guidelines for the calibration of thermometers in air.	Practical definition of air temperature proposed Method proposed on how to evaluate the uncertainty contributions in air temperature measurements Draft guide for the calibration of thermometers in air	Practical definition of air temperature agreed by CCT and promulgated to key stakeholders Method for evaluating the uncertainty contributions in air temperature measurement agreed by CCT Guide for the calibration of thermometers in air published on CCT website

WG ENV Members in WMO

Andrea Merlone

Andrea Merlone (INRiM)
Chair ET MU + GSRN SG5 + GCW Permafrost + Member ET QTC

Christian Monte (PTB)
Vice Chair ET – Radiation

Carmen G. Izquierdo (CEM) Member ET QTC + ET Surface & Sub Surface

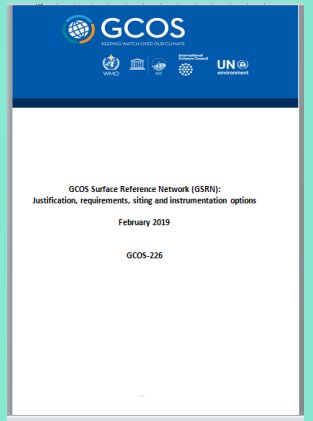
Gaber Beges (LMK)
Member ET QTC

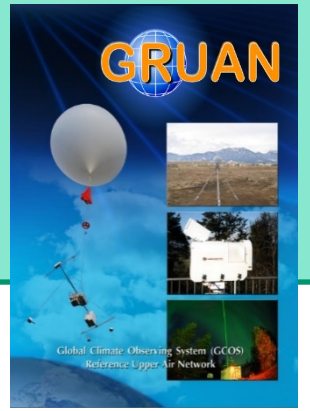
Stephanie Bell (NPL)
Member ET QTC

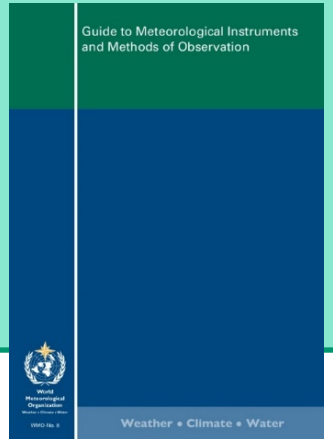
Yong-Gyoo Kim (KRISS)
Member ET MU – ET Upper Air

Contributions:

- Training on measurements, uncertainties and units to be published in WMO web pages
- Revision of the "WMO Guide on Instruments and Methods of Observations
- Interlaboratory comparisons
- Measurement Quality Classification
- Studies on Measurement Uncertainty evaluation
- Siting classification and experiments
- Terminology







CIMO and BIPM and Metrology

- CIMO represented in the EURAMET Research Council + on its Task Group Environment
- BIPM experts have been involved in several CIMO Expert Teams (e.g. meeting of the CIMO Task Team on Radiation References)
- List of key topics to work on were requested by BIPM experts to WMO/CIMO to refer to when developping reaserch proposal and projects (e.g. EMPIR)
- EURAMET MeteoMet project: closer ongoing ties between european metrology and meteorology experts
- Inter-laboratory comparison: participation of all RA VI RICs and many NMHS calibration laboratories

WMO OMM

The background

The issue

The actions

The issue

Andrea
Merlone

ipcc

SPM

Summary for Policymakers

Andrea Merlone

ipcc

SPM

Summary for Policymakers

A. Understanding Global Warming of 1.5 °C

A1. Global warming is likely to reach 1.5 °C between 2030 and 2052 if it continues to increase at the current rate. (high confidence)

A3. Climate-related risks for natural and human systems are higher for global warming of 1.5 °C than at present, but lower than at 2 °C (high confidence). These risks depend on the magnitude and rate of warming, […]

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SPM

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Capturing rates and evaluating magnitudes requires accurate and comparable measurements

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accurate ⟺ uncertainty

comparable ⟺ traceability

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accurate ⟺ uncertainty

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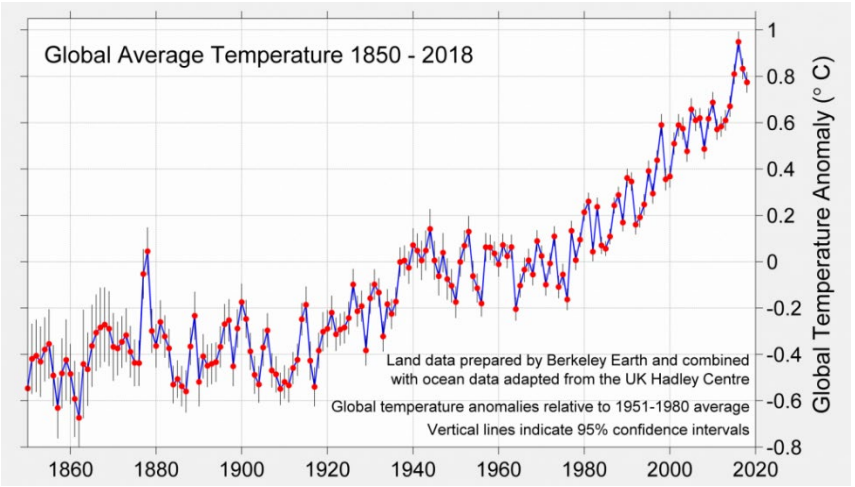
measurements are so far the best way we found to understand nature

We need to measure air temperature (near surface) to

a) make modern records comparable with historical series

b) make traceable, comparable and higher quality climate data available for the future generations of climatologists.



A thermometer measures the temperature of the air.

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?

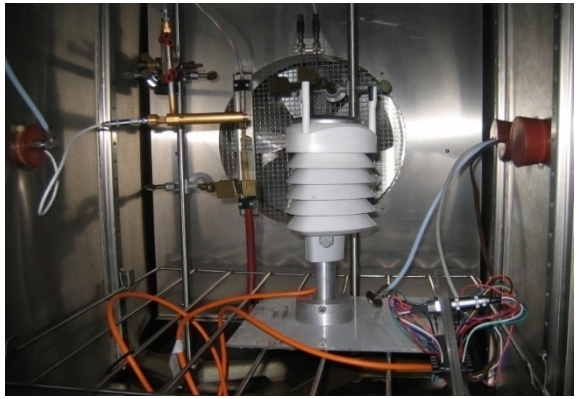
A thermometer measures the temperature of the air. ? ?

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

Different sensors, different solar shields, different technical solutions, different effects of environmental factors…

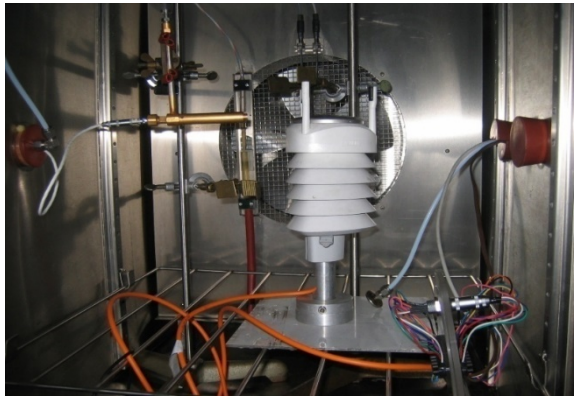
All of them introduce errors and uncertainties, resulting in biases in records and data series

A (contact) thermometer is calibrated in (as close as possible) adiabatic conditions.



A (contact) thermometer is calibrated in (as close as possible) adiabatic conditions.

But then a thermometer for atmospheric air temperature measurement is used in non-adiabatic conditions



Traceability ?

And we even still do not have a practical definition of air temperature…

The background

The issue

The actions

The actions

Interlaboratory comparisons

Innovative instrumentation (non contact)

Instruments intercomparisons

Experiments to improve the siting classification

Understanding and evaluating uncertainties

Normatives

In-field calibrations

Climate Reference Data and Reference Stations

Quantities of influence in field

Validation of extremes

Metrology for high mountains and polar environment

Andrea Merlone

Interlaboratory comparisons

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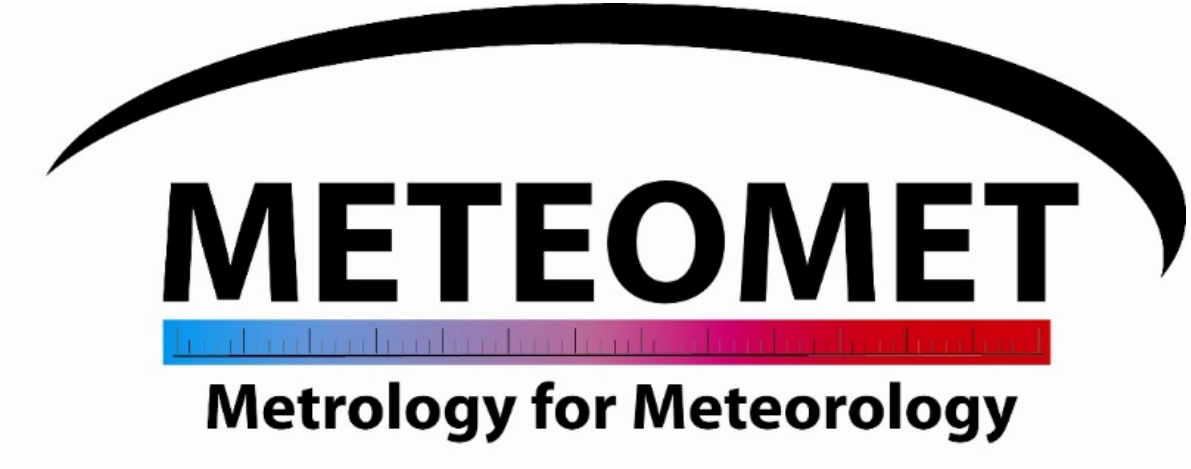

Understanding and evaluating uncertainties

In-field calibrations

Normatives

Climate Reference Data and Reference Stations

Quantities of influence in field

Validation of extremes

Metrology for high mountains and polar environment

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METEOMET

Metrology for Meteorology

2011 - 2017

COAT

*Increasing the **co**mparability of extreme **a**ir **t**emperature measurements for meteorology and climate studies*

2020-2023

ATM

Air Temperature Metrology

2017-2024

CRS

Climate Reference Station

a MeteoMet initiative

2019-2022

INCIPIT

Metrology for non-catching rain instruments

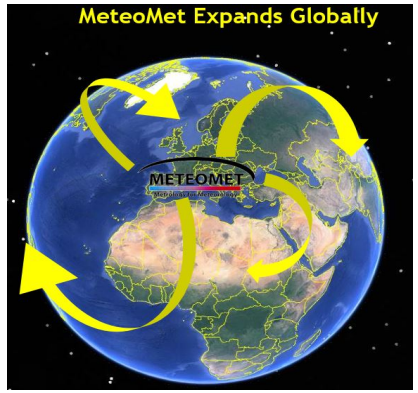
2018-2022

METEOMET
Metrology for Meteorology

a worldwide consortium born

as a EURAMET project

24 National Institutes of Metrology
12 Universities
13 Research centers
11 Instrument Companies
19 Meteorologycal services



ATM
Air Temperature Metrology

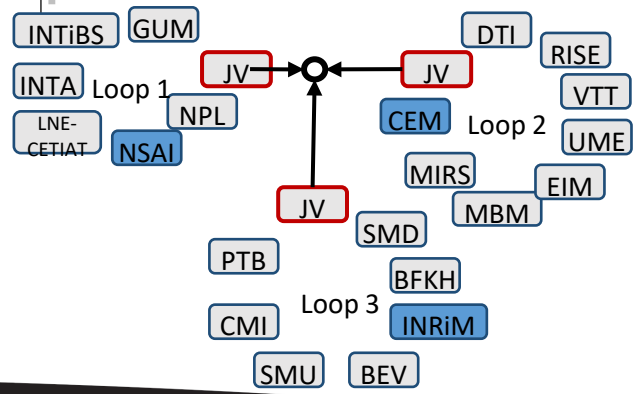
1. A pilot study in the form of interlaboratory comparisons
2. World guide on calibration of thermometers in air
3. Propose a reference definition (practical) of air temperature
4. Provide a complete uncertainty budget for field measurements




EURAMET Project Form

EURAMET

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: Name: Phone: E-mail:	INRiM - Italy Andrea Merlone +39011 3919 734 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)		



BIPM CCT Task Group Air Temperature kick off meeting 8 November 2021

METEOMET
Metrology for Meteorology

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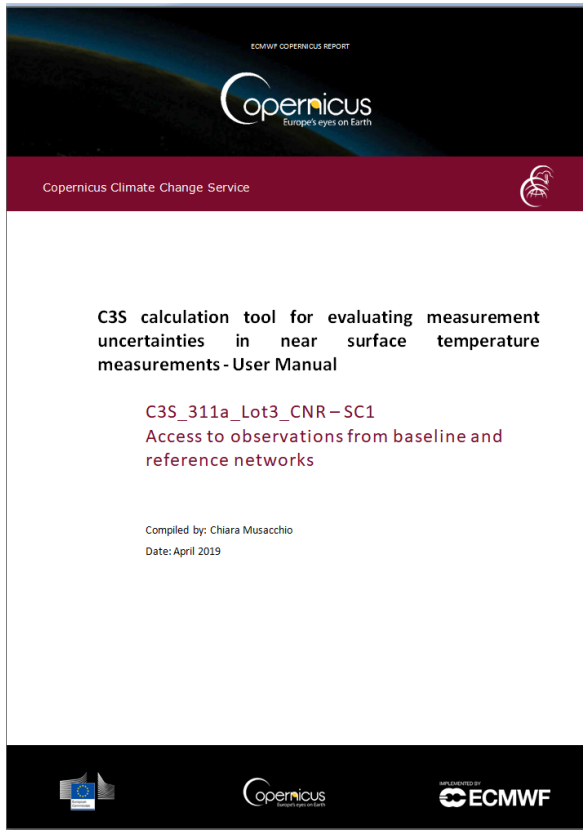
Understanding and evaluating uncertainties



Near Surface Temperature (NST) measurement uncertainty calculation tool

NPL and INRiM with Copernicus

METEOMET
Metrology for Meteorology

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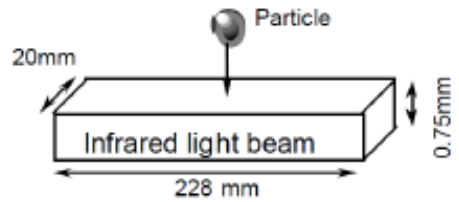
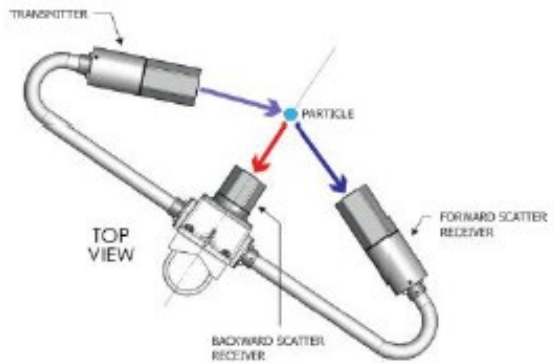
Innovative instrumentation (non contact)

INCIPIT

Metrology for non-catching rain instruments

Normatives





Traceable calibration methods for non-catching precipitation gauges to 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

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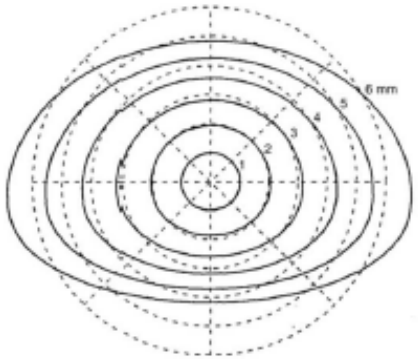
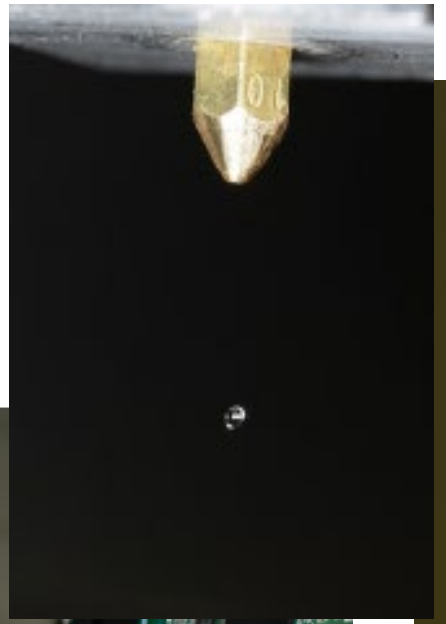
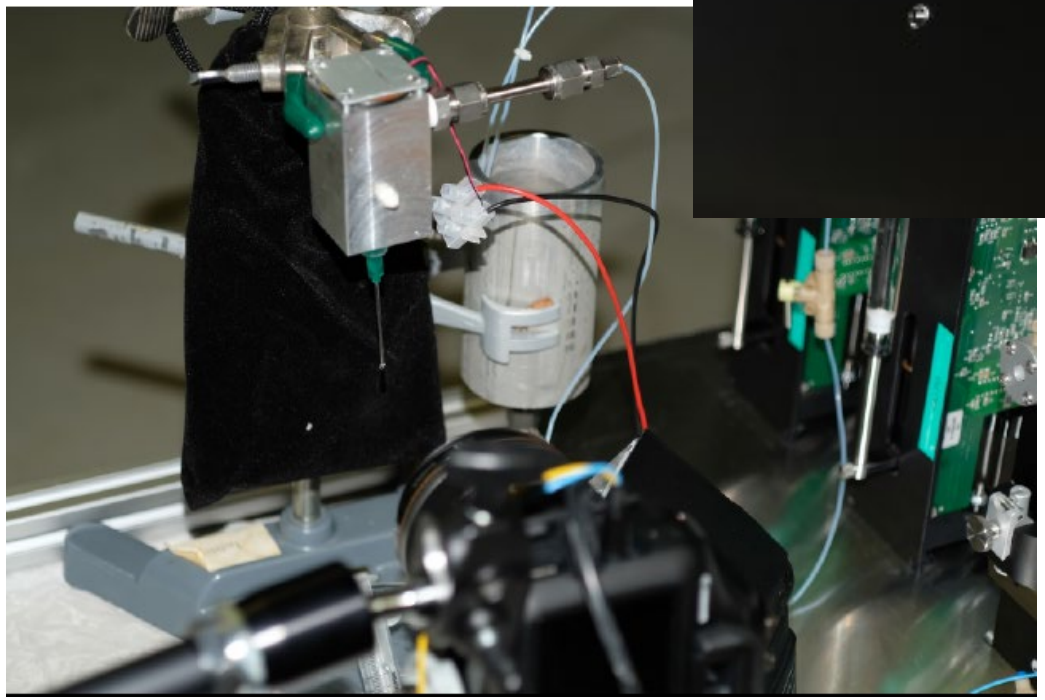
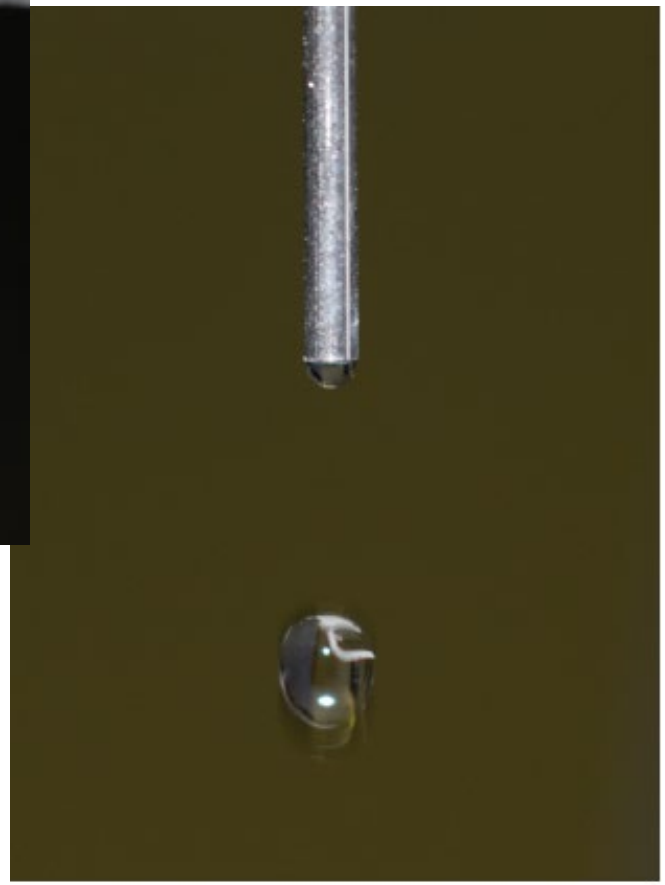








INCIPIT
Metrology for non-catching rain instruments

Calibration and accuracy of non-catching instruments to measure liquid/solid atmospheric precipitation

Overview of existing models and working principles of non-catching precipitation gauges together with test/calibration schemes for different types of non-catching precipitation gauges

Document Information

EMPIR Grant Agreement n°	18NRM03	
Project Title	Calibration and accuracy of non-catching instruments to measure liquid/solid atmospheric precipitation	
Project short name	INCIPIT	
Project Coordinator	Andrea Merlone - INRIM	
Document Lead Partner	UNIGE	luca.lanza@unige.it
Deliverable reference number:	D1	
Deliverable title	Overview of existing models and working principles of non-catching precipitation gauges together with test/calibration schemes for different types of non-catching precipitation gauges	
Dissemination Level	PP	
Due Date of Delivery	January 2020	
Actual submission date	March 2020	

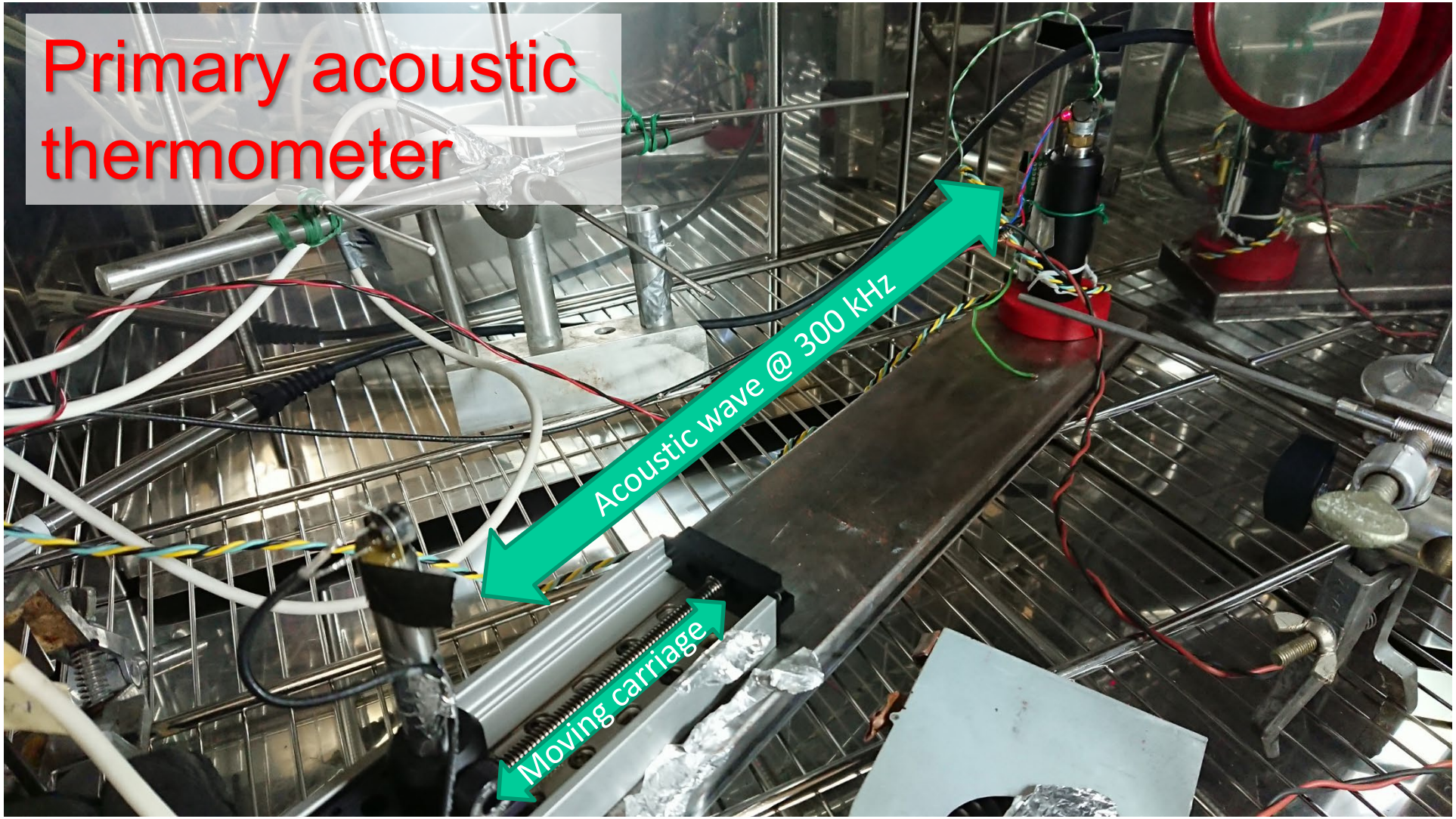
Dissemination level

PU	Unrestricted PUBLIC Access – EURAMET project	x
PP	Project Private, restricted to other programme participants (including EURAMET Services)	
RE	RESTRICTED, Restricted to a group specified by the consortium (including EURAMET Services)	
CO	CONFIDENTIAL, only for members of the consortium (including EURAMET Services)	

Innovative instrumentation (non contact)

2021 new experiment at INRiM

(opto-acoustic thermometer)



Climate Reference Data and Reference Stations

CRS
Climate Reference Station

EMPIR 19SIP03 –
«Climate Reference Station»

Coordinator: A. Merlone

Primary supporter: WMO

November 2020 – October 2023

Table 1: Instruments characteristics prescriptions for a GSRN station

Measurand	Instruments specifications	Maximum allowed documented uncertainty contributions (K=1)	Notes	Required auxiliary measurements
Air temperature	**Target Combined Expanded Uncertainty**	**0.2 °C**		
	Sensor: Platinum Resistance Thermometer (PRT) Type PT100 IEC-751, Class A Temperature coefficient (alpha): 0.00385 Measuring range: -40 °C + 50 °C (or lower limit for specific locations) Uncertainty: 0.05 °C over the whole range	Sensor: Max drift: 0.02 K/year Calibration: 0.02 K Sensitivity: 0.005 K Resolution: 0.005 K Logger: 0.05 K Solar Shield (incl ageing): 0.1 K	Note 1. Documented time constant of sensor and sensor + shield (in terms of response rate as a function of time with known temperature variation, for ISO 17741: time to reach 63% of a 10 °C sudden change). Laboratory calibration certificate according to ISO 17025 (full documented traceability to NMI primary standards).	· Relative humidity · Solar radiation · Wind speed at same height of thermometer · Precipitation · Soil temperature · Snow

WORLD METEOROLOGICAL ORGANIZATION

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION

GCOS Surface Reference Network (GSRN):
Justification, requirements, siting and instrumentation options

February 2019

GCOS-226

UNITED NATIONS ENVIRONMENT PROGRAMME

INTERNATIONAL SCIENCE COUNCIL

CRS

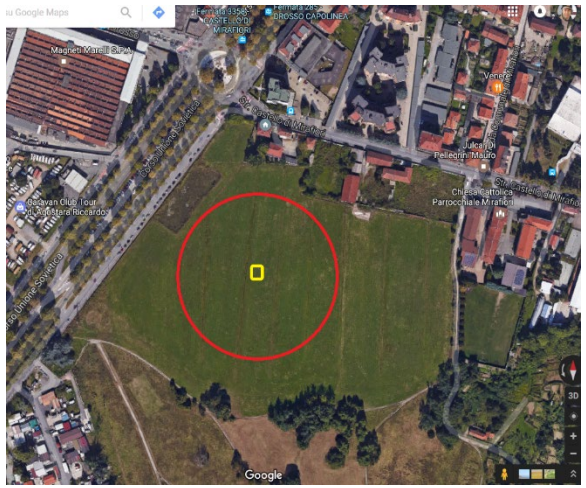
Climate Reference Station

a MeteoMet initiative

Andrea Merlone

Study and characterisation in laboratory and field
for instruments to estabblish a research site associated to the GCOS GSRN

Site selection



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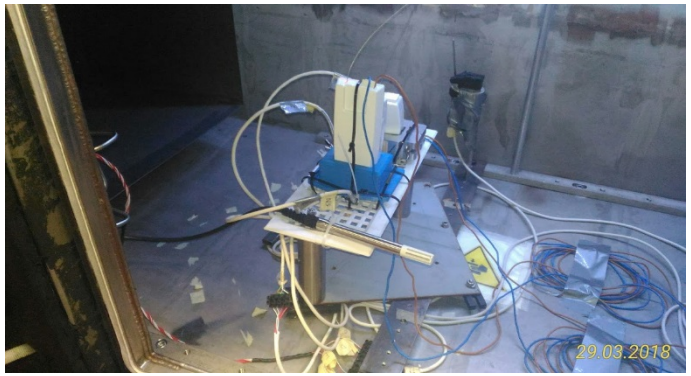
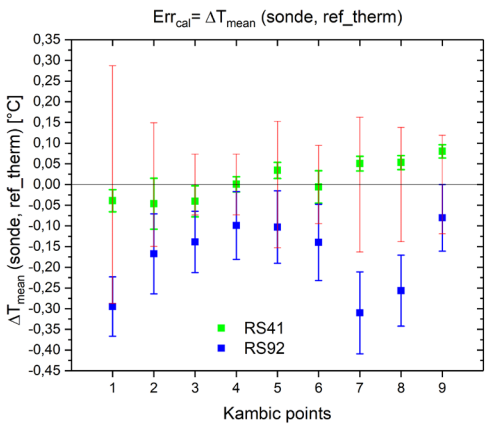
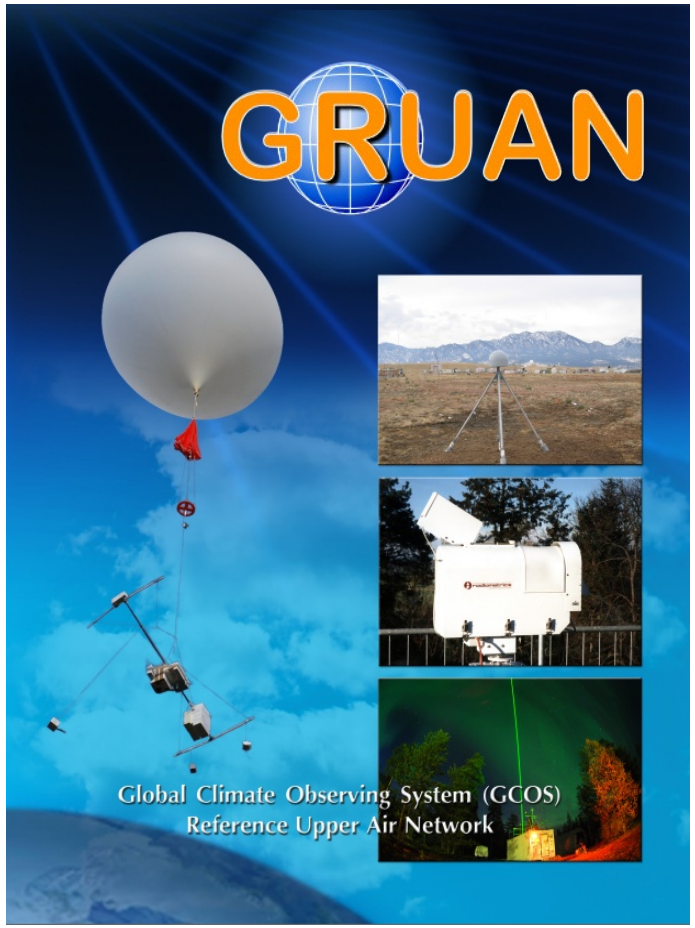
Climate Reference Data

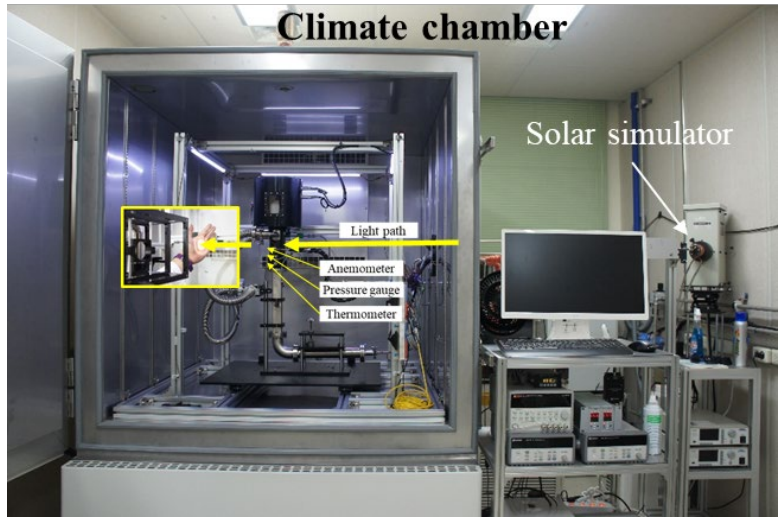
Comparison between Vaisala RS41 and RS92 radiosondes at INRiM and CNR







Studies on the solar radiation correction of radiosonde at KRISS



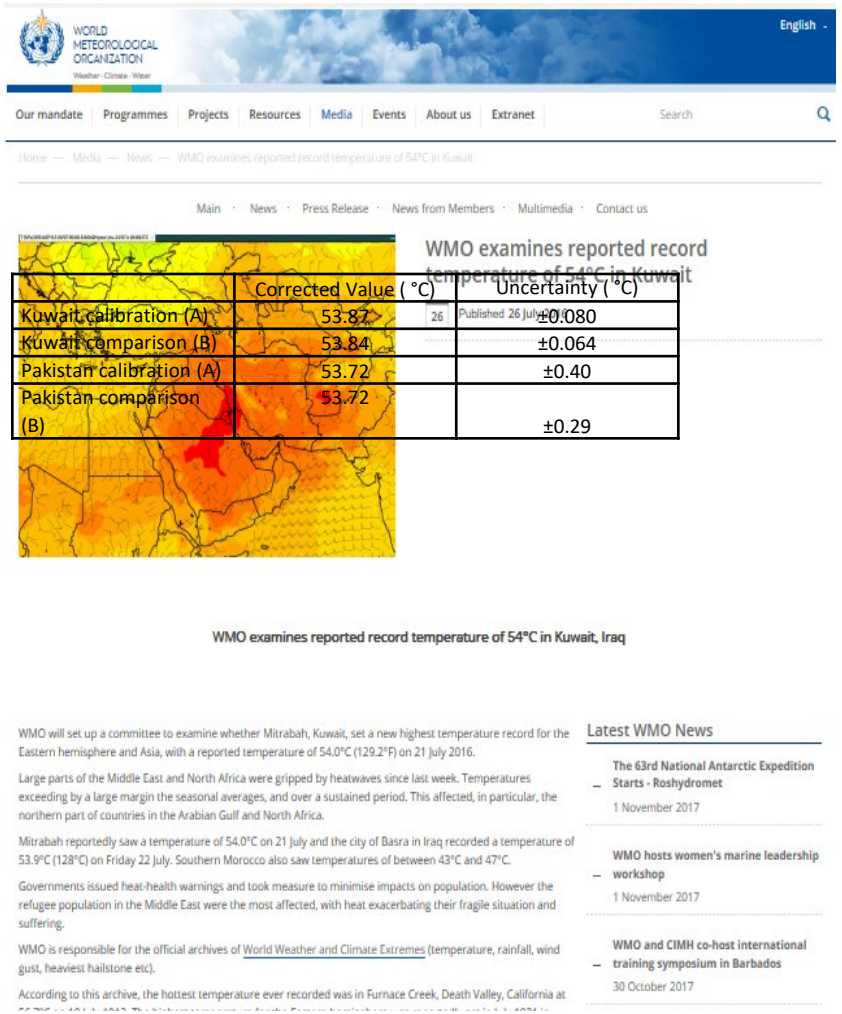
Low-Temperature and Low-Pressure Humidity Chamber

- Temperature: (-70 – 30) °C
- Pressure: (50 – 1000) hPa
- Dew/frost point temperature: (-90 – 20) °Cdp/fp
- Relative humidity: (2 – 100) %rh
- U = 1.96 %rh (*k* = 2)

Validation of extremes

2016 Mitribah - Kuwait 54 °C

2017 Turbat - Pakistan 54 °C



WORLD METEOROLOGICAL ORGANIZATION

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WMO examines reported record temperature of 54°C in Kuwait

	Corrected Value (°C)	Uncertainty (°C)
Kuwait calibration (A)	53.87	±0.080
Kuwait comparison (B)	53.84	±0.064
Pakistan calibration (A)	53.72	±0.40
Pakistan comparison (B)	53.72	±0.29

WMO examines reported record temperature of 54°C in Kuwait, Iraq

WMO will set up a committee to examine whether Mitrabah, Kuwait, set a new highest temperature record for the Eastern hemisphere and Asia, with a reported temperature of 54.0°C (129.2°F) on 21 July 2016.

Large parts of the Middle East and North Africa were gripped by heatwaves since last week. Temperatures exceeding by a large margin the seasonal averages, and over a sustained period. This affected, in particular, the northern part of countries in the Arabian Gulf and North Africa.

Mitrabah reportedly saw a temperature of 54.0°C on 21 July and the city of Basra in Iraq recorded a temperature of 53.9°C (128°C) on Friday 22 July. Southern Morocco also saw temperatures of between 43°C and 47°C.

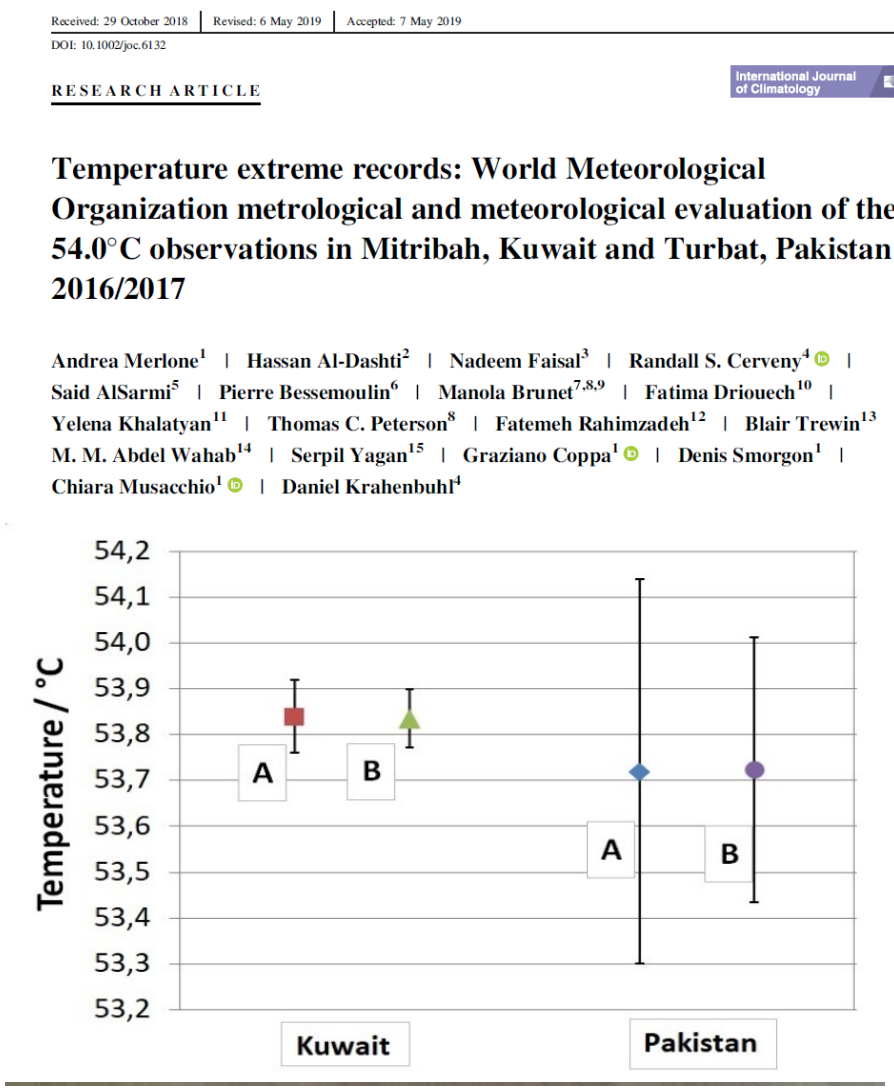
Governments issued heat-health warnings and took measure to minimise impacts on population. However the refugee population in the Middle East were the most affected, with heat exacerbating their fragile situation and suffering.

WMO is responsible for the official archives of World Weather and Climate Extremes (temperature, rainfall, wind gust, heaviest hailstone etc).

According to this archive, the hottest temperature ever recorded was in Furnace Creek, Death Valley, California at

Latest WMO News

- The 63rd National Antarctic Expedition Starts - Roshydromet
  1 November 2017
- WMO hosts women's marine leadership workshop
  1 November 2017
- WMO and CIMH co-host international training symposium in Barbados
  30 October 2017



Received: 29 October 2018 | Revised: 6 May 2019 | Accepted: 7 May 2019
DOI: 10.1002/joc.6132

RESEARCH ARTICLE

International Journal of Climatology | RMetS

Temperature extreme records: World Meteorological Organization metrological and meteorological evaluation of the 54.0°C observations in Mitribah, Kuwait and Turbat, Pakistan in 2016/2017

Andrea Merlone[1] | Hassan Al-Dashti[2] | Nadeem Faisal[3] | Randall S. Cerveny[4] | Said AlSarmi[5] | Pierre Bessemoulin[6] | Manola Brunet[7,8,9] | Fatima Driouech[10] | Yelena Khalatyan[11] | Thomas C. Peterson[8] | Fatemeh Rahimzadeh[12] | Blair Trewin[13] | M. M. Abdel Wahab[14] | Serpil Yagan[15] | Graziano Coppa[1] | Denis Smorgon[1] | Chiara Musacchio[1] | Daniel Krahenbuhl[4]

METEOMET

Metrology for Meteorology

Andrea Merlone

Interlaboratory comparisons

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

in cooperation with

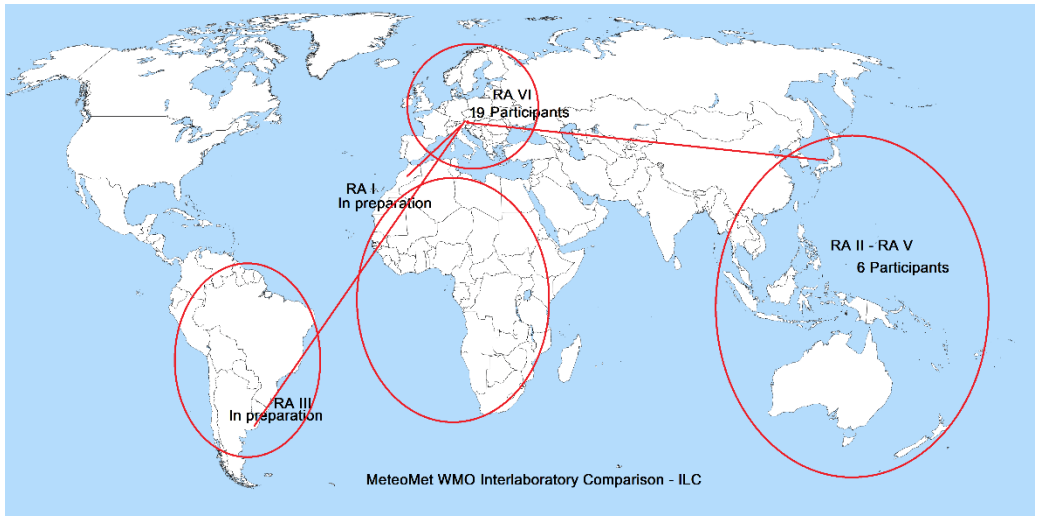
Final ILC protocol

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



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

Instituto Nacional de Tecnología Industrial
INTI

Andrea Merlone

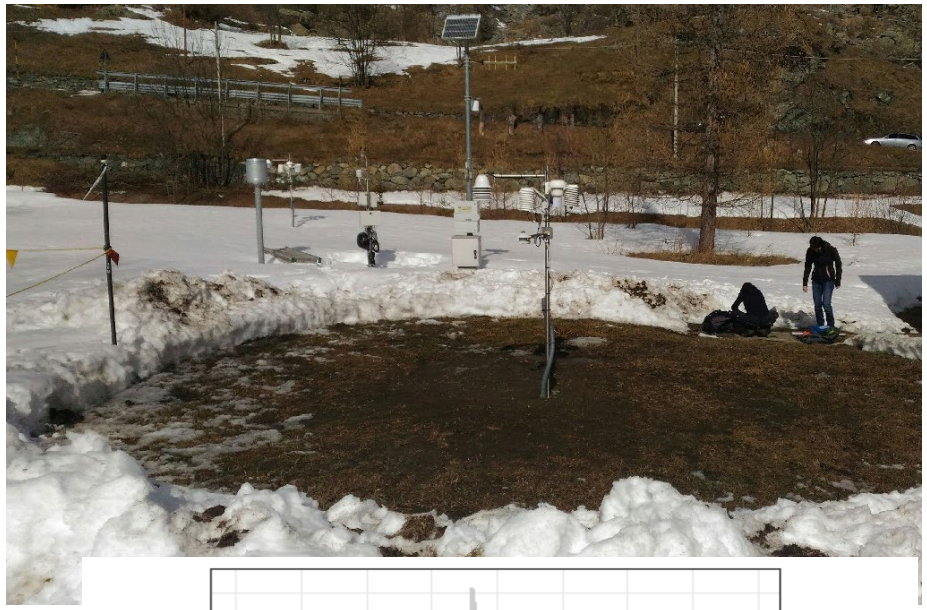
Quantities of influence in field

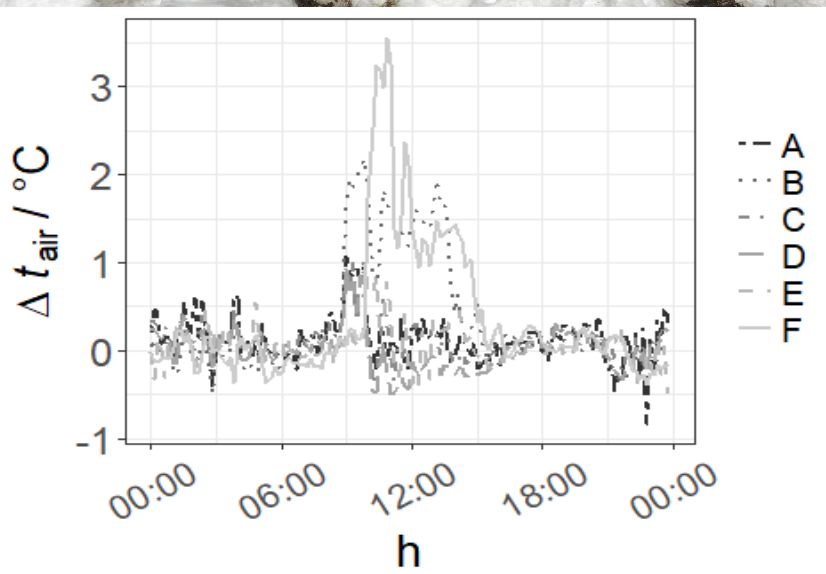
Albedo

Air temperature instruments are effected by radiative extra heating when exposed to snow covered surface .

Temperature records can be different from air temperature value

Different instrument show different magnitude of this effect.



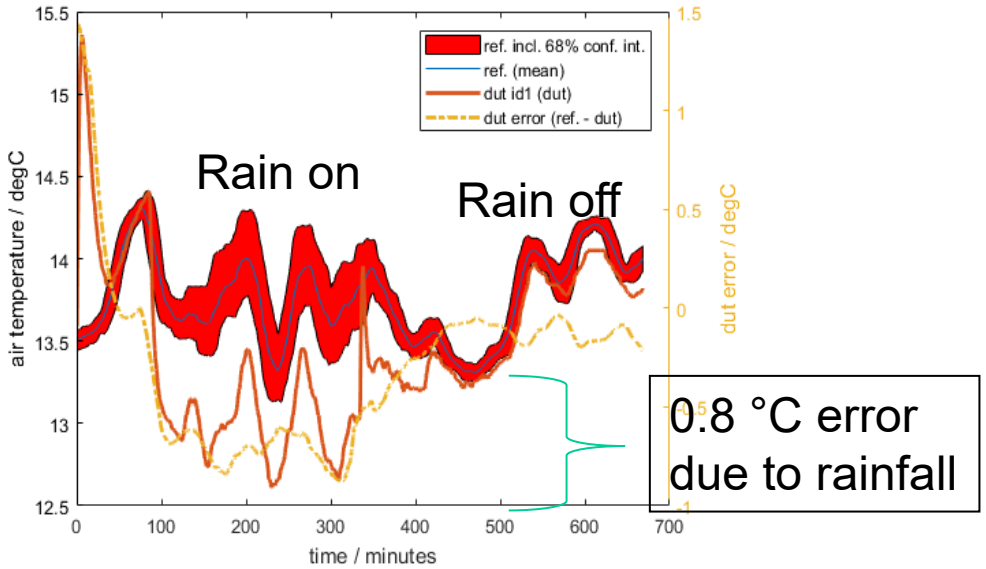


Results showed effects up to 3 °C (and never 0 °C !!)

Quantities of influence in field

Precipitation

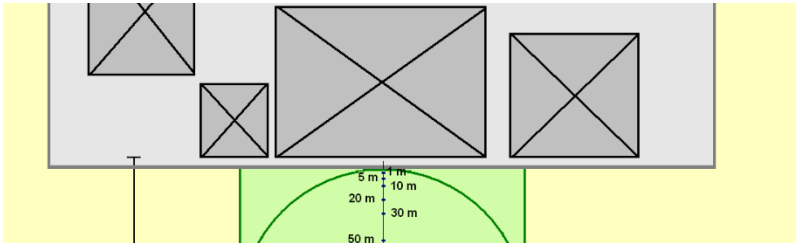
- Drops of rain are colder than the air.
- When rain starts, air temperature decreases.
- Convection causes overcooling (errors) in temperature measurements.



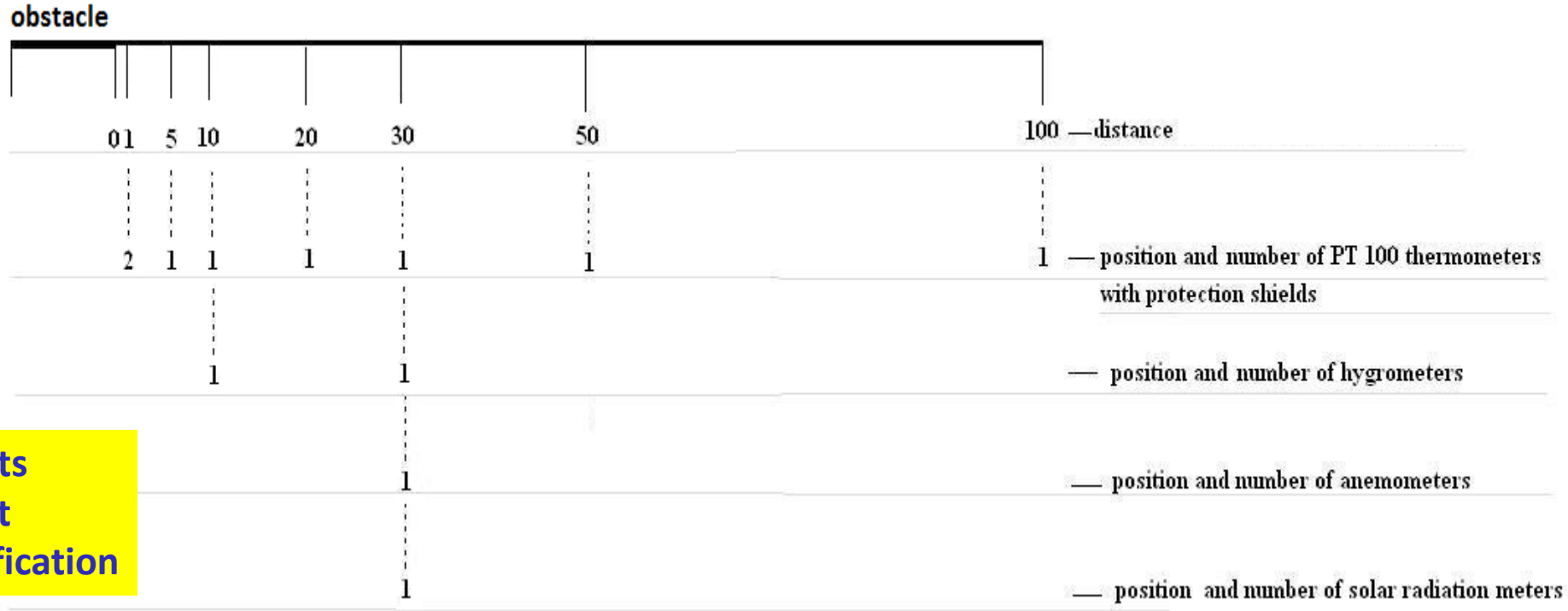
- Cooling effect is highly dependent on temperature difference between air and water
- Takes hours for the cooling effect to wear off, after the end of the rainfall
- Latency in the sensors can be significant

MeteoMet siting experiments

Andrea Merlone



- Three identical experiments in three nations (Italy, Spain, Czech R.)
- Only variable is the nature of the obstacle



Experiments to support the siting classification

Road (INRiM – IMBiH)

Trees (CMI)

Buildings (CEM)

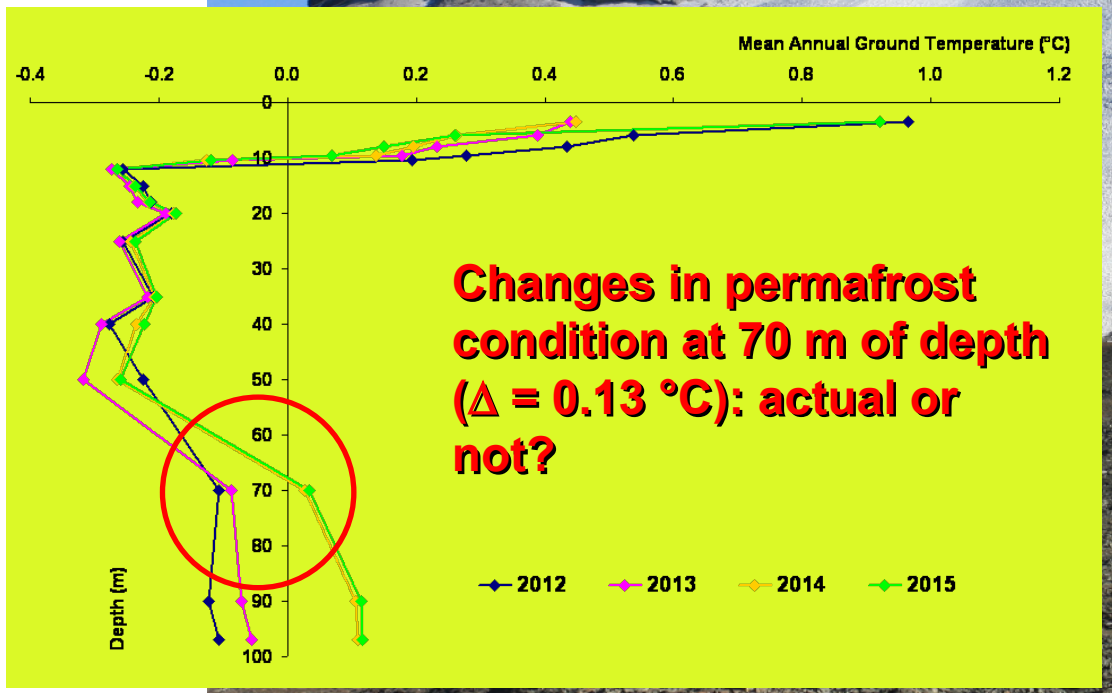
Preliminary result (2020)

The WMO siting classification over-estimates the uncertainties

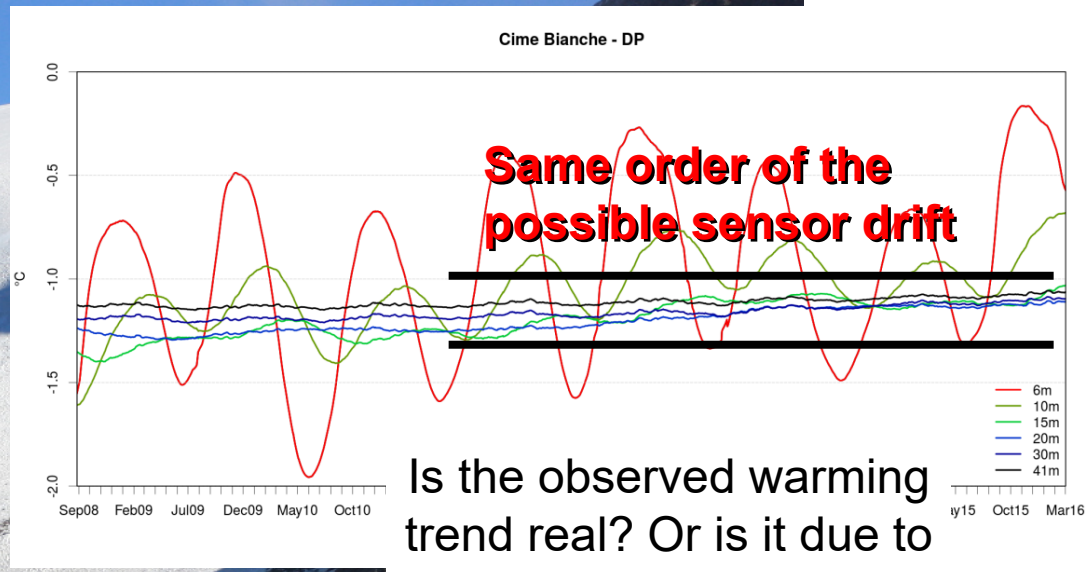
METEOMET
Metrology for Meteorology

Andrea Merlone

Metrology for high mountains and polar environment



Changes in permafrost condition at 70 m of depth (Δ = 0.13 °C): actual or not?



Same order of the possible sensor drift

Is the observed warming trend real? Or is it due to an instrumental drift?!

NEEDS OF PERIODIC CALIBRATION

Permafrost monitoring in high-mountains

100 m deep vertical borehole with thermistor chain

ARPA Valle d'Aosta

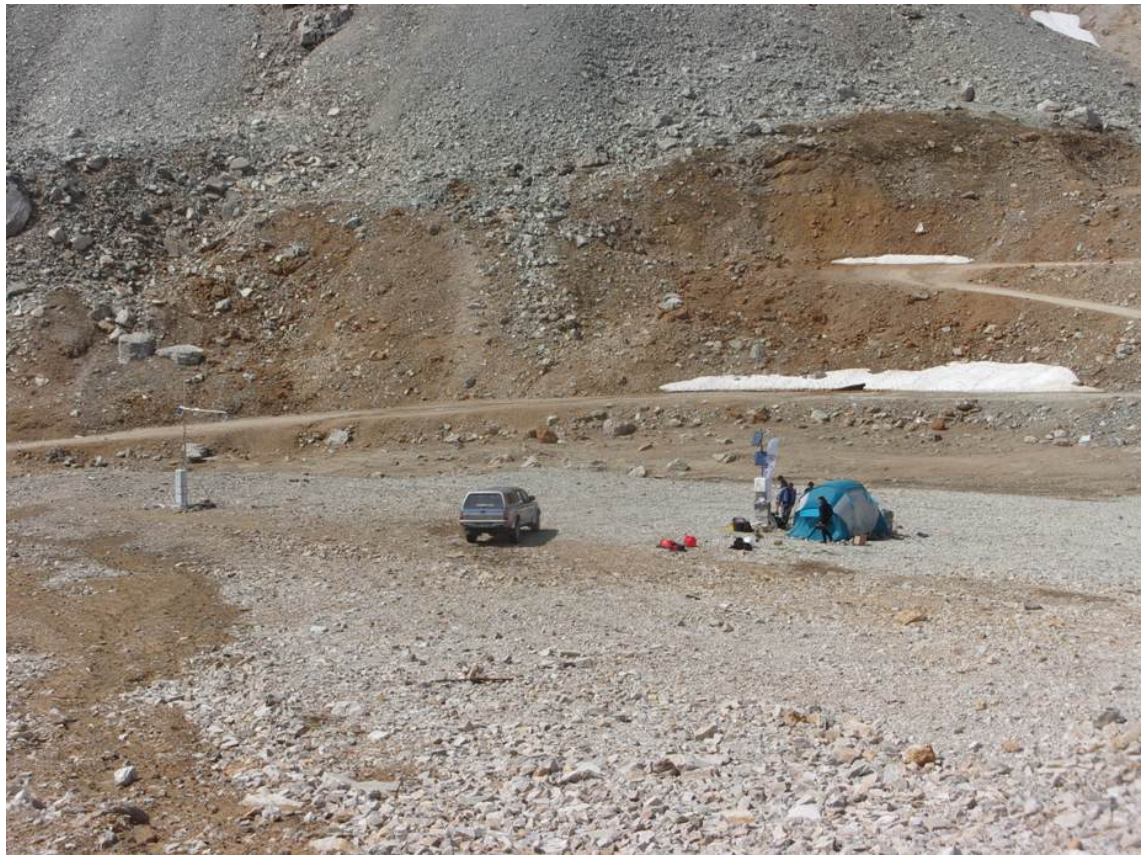
METEOMET
Metrology for Meteorology

Andrea Merlone

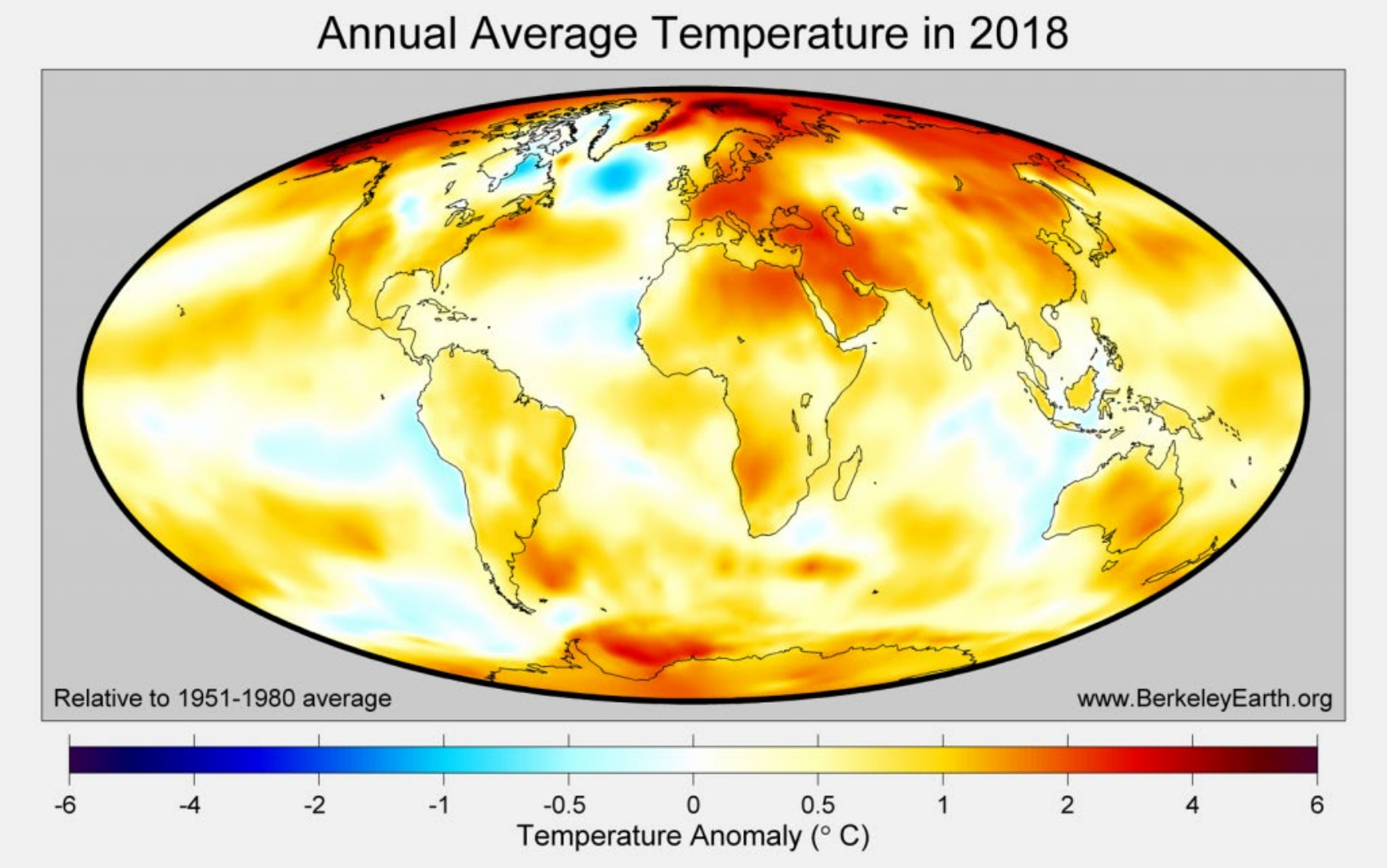
Metrology for high mountains and polar environment

July 2017, August 2018, August 2019. A metrology lab at 3000 m

In-field calibrations



In-field calibrations

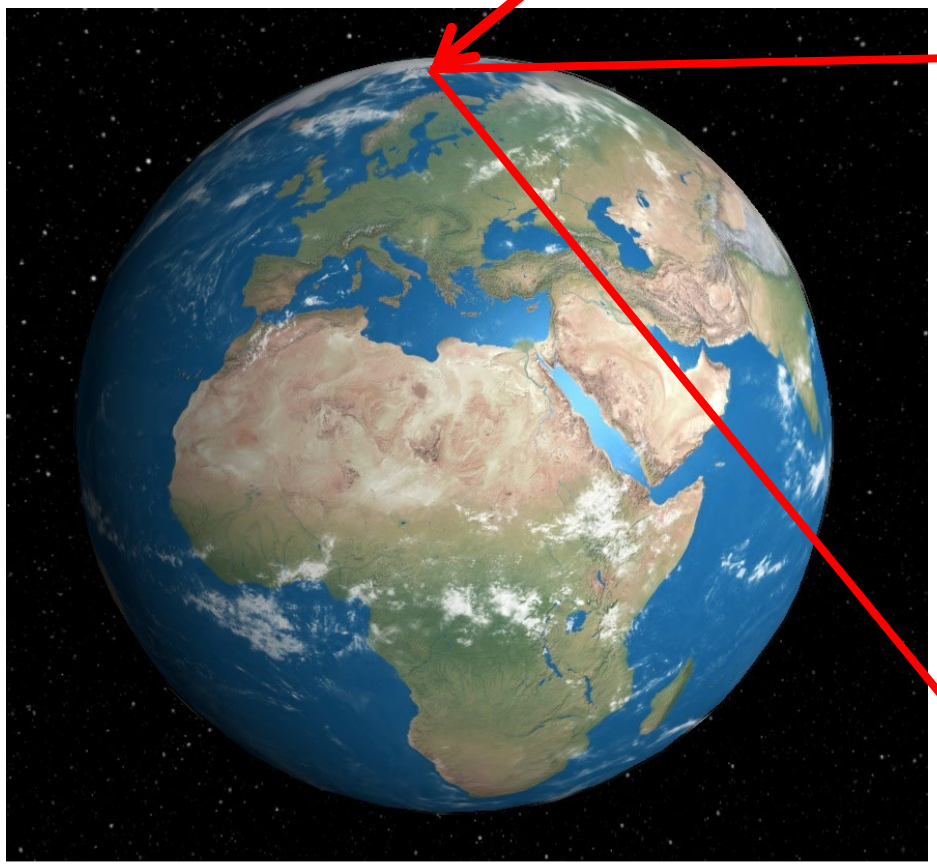


"Climate change comes first and faster in the Arctic"

Andrea Merlone

Svalbard Archipelago

78.9°N, 11.9°E



Ny-Ålesund 10 May 2017

New Metrology lab opened and presented at the station leaders in Ny-Ålesund

Andrea Merlone

Corrections on temperature profiles

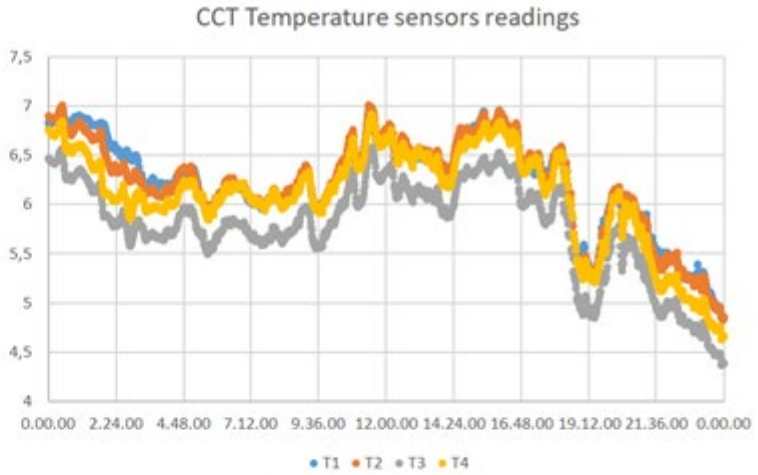
13/07/2017

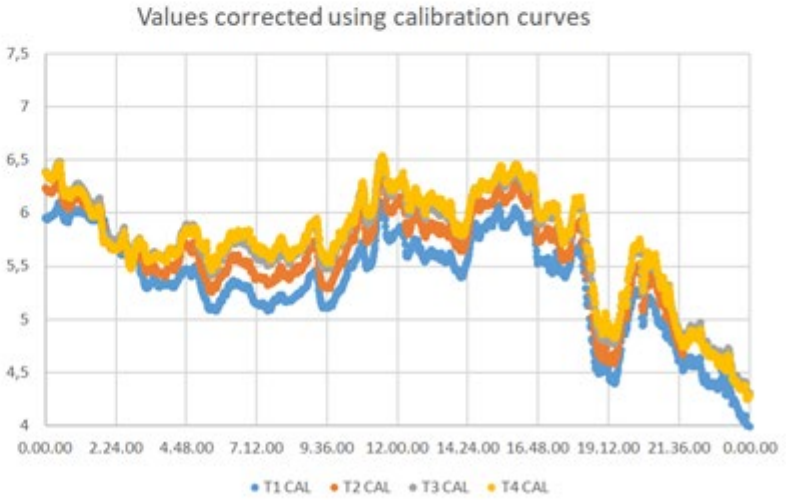
T1 34 m

T2 10 m

T3 5 m

T4 2 m





2017-2021 Calibration campaigns at the arctic station in Ny-Ålesund

METEOMET
Metrology for Meteorology

Andrea Merlone

Metrology for high mountains and polar environment

Intercomparison of thermometers and shields in polar environment

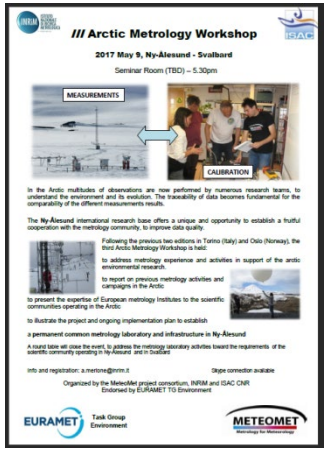
CoAT

Instruments intercomparisons

Field intercomparison area setup in August 2021

Arctic Metrology Workshops

Andrea Merlone


/// 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

1st Torino, April 2015
2nd Oslo, May 2016
3rd Ny-Ålesund, May 2017
4th Oslo, November 2019

Svalbard Integrated Arctic Earth Observing System - SIOS

•Break out session @ Arctic Circle 2015

Andrea Merlone

REYKJAVÍK • ICELAND
ARCTIC CIRCLE 2015
OCTOBER 16 - 18

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REGISTER FOR THE 2015 ASSEMBLY 16 -18 OCTOBER

2015 PROGRAM

ABOUT BOARD PARTNERS SECRETARIAT PRESS & MEDIA 2014 IMAGES VIDEO

HÁSKÓLINN Í REYKJAVÍK
REYKJAVIK UNIVERSITY

THE FUTURE OF ENERGY SECURITY IN THE ARCTIC

The Iceland School of Energy will organize a session on Thursday, October 15th, about the future of Arctic energy, with considerations of environmental and human security. The session will be organized in cooperation with the Harvard Kennedy School of Government and the Fletcher School of Law and Diplomacy at Tufts University.

THE FOREIGN MINISTER OF CHINA

The Opening Session of the 2015 Arctic Circle Assembly will include an address by the Foreign Minister of the People's Republic China, Wang Yi.

EURAMET

METROLOGY FOR ENVIRONMENT IN THE ARCTIC

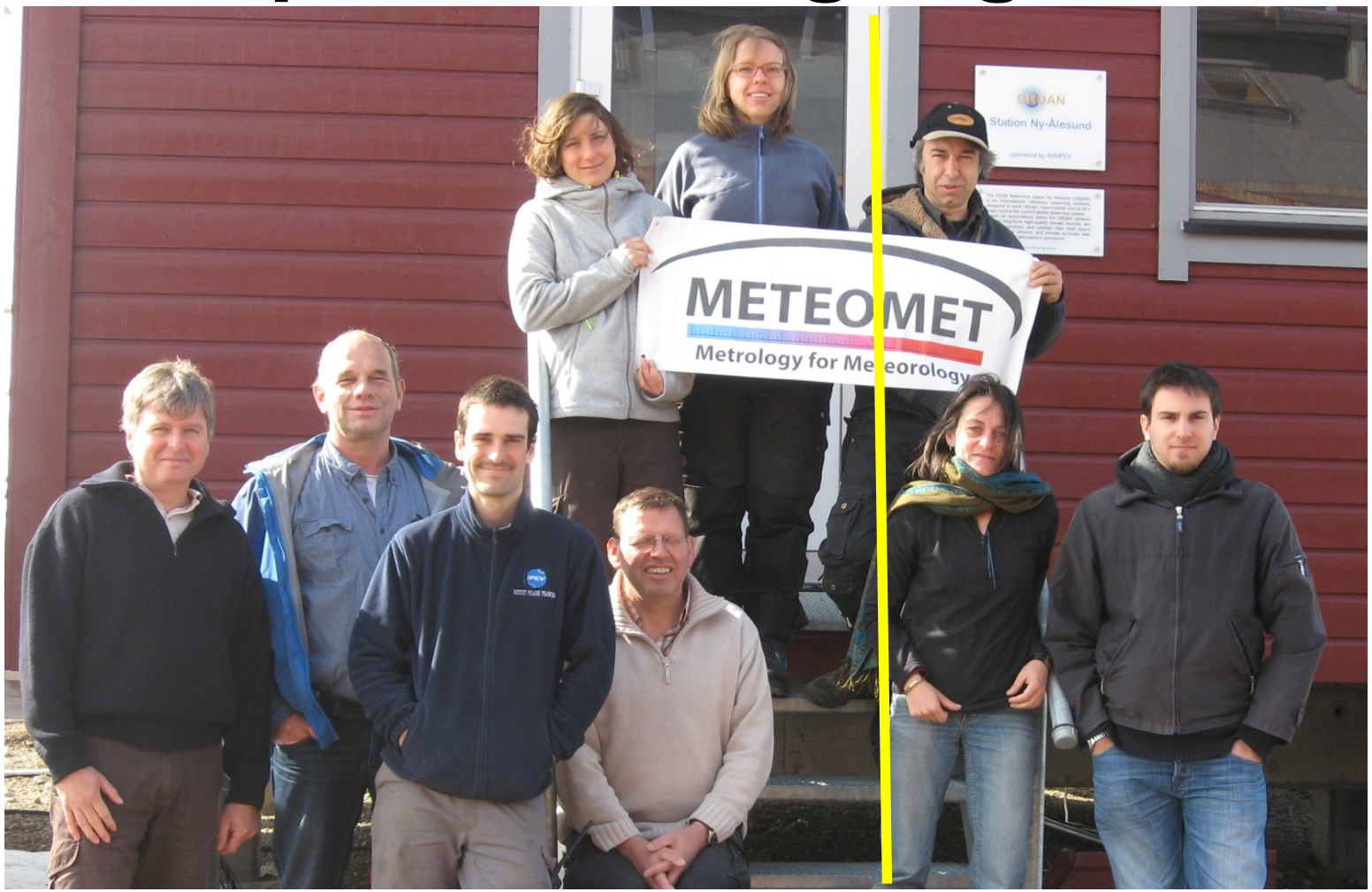
High-accuracy measurements are needed to understand the evolution of the Arctic environment in its many extremes. EURAMET, the European Association of National Metrology Institutes, is hosting a breakout session promoting common activities between metrology and Arctic scientific research to improve data quality.

Huh!? 0.1 °C resolution??
Where are the other 7 digits???

Metrologist point of view

Andrea Merlone

Keep on working together!



Thank you

a.merlone@inrim.it