News from the metrology community

Andrea Merlone — BIPM – CCT TG Environment chair
EURAMET TG Environment chair
MeteoMet coordinator

&

Walter Bich — JCGM WG1 chair person

Overview

- MeteoMet news
- Euramet news
- BIPM news
- New GUM

METEOMET

Metrology for Meteorology

Meteomet is a EURAMET joint research project

10 M€ Budget

300 Deliverables

960 Man months

(80 years!)

MeteoMet is the

larger EURAMET consortium

21 National Institutes of Metrology

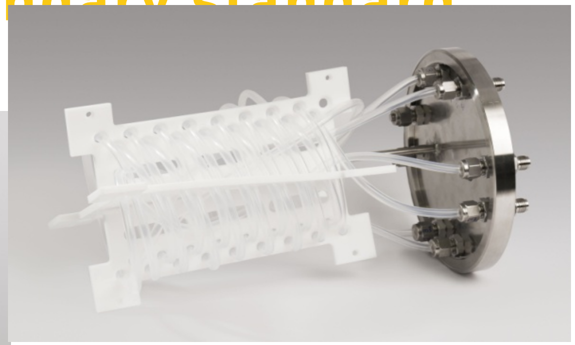
12 Universities

13 Research centers

9 Instrument Companies

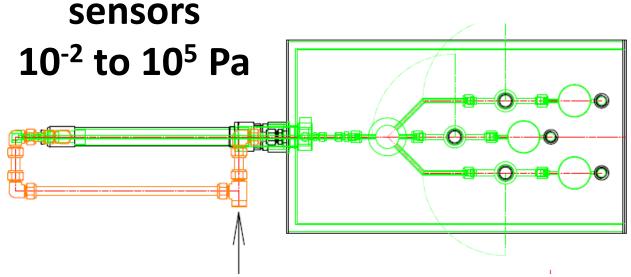
10 Meteo agencies

The realization of a traceable portable calibration facility for hygrometers using permeation tubes for the in-field use as secondary standard



Pressure measurement system

3 pressure sensors
10^{-2} to 10^{5} Pa



- Posters no. 52 and 54

- **The AquaVIT 2 intercomparison campaign** with a highly stable humidity source and a traceable calibrated dew point hygrometer.

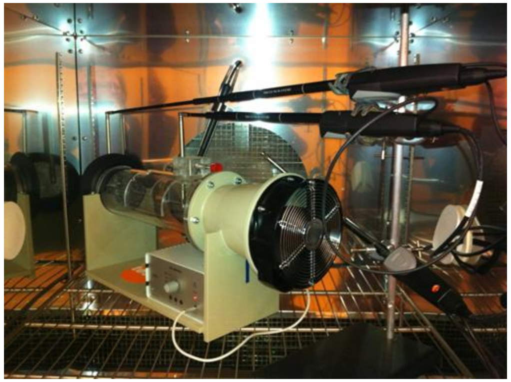
NMI

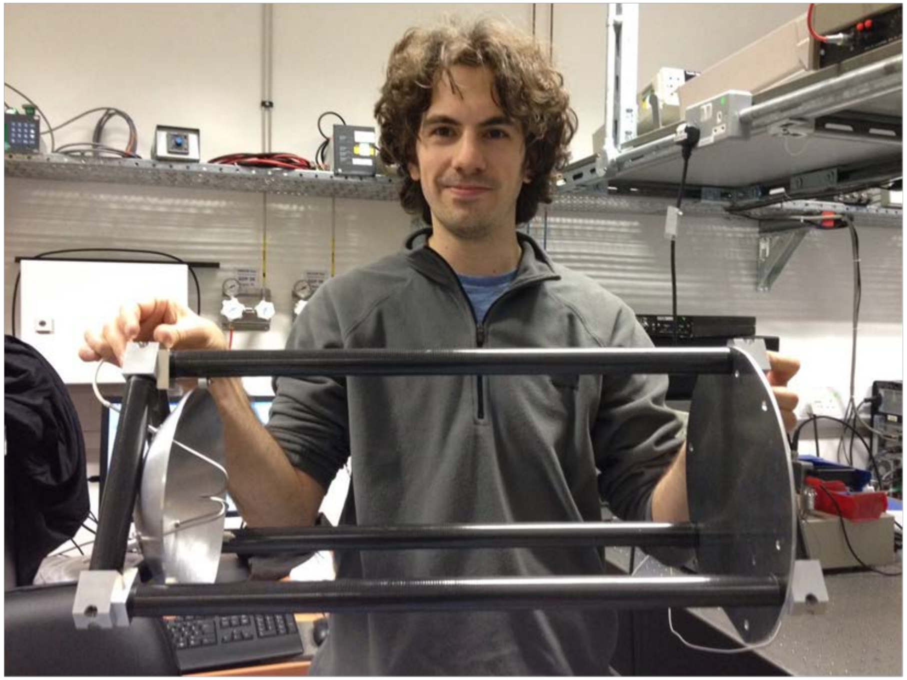
+

Field measurements

**Manufacturter
Instr. Provider
Accredited Lab.**

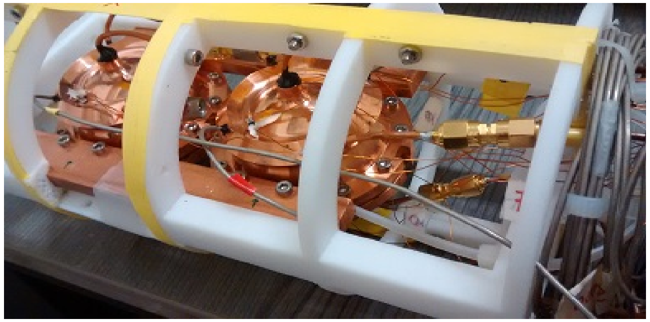
NPL **acoustic free-space thermometer between -40 ° C and +40 ° C with TDLAS hygrometer**





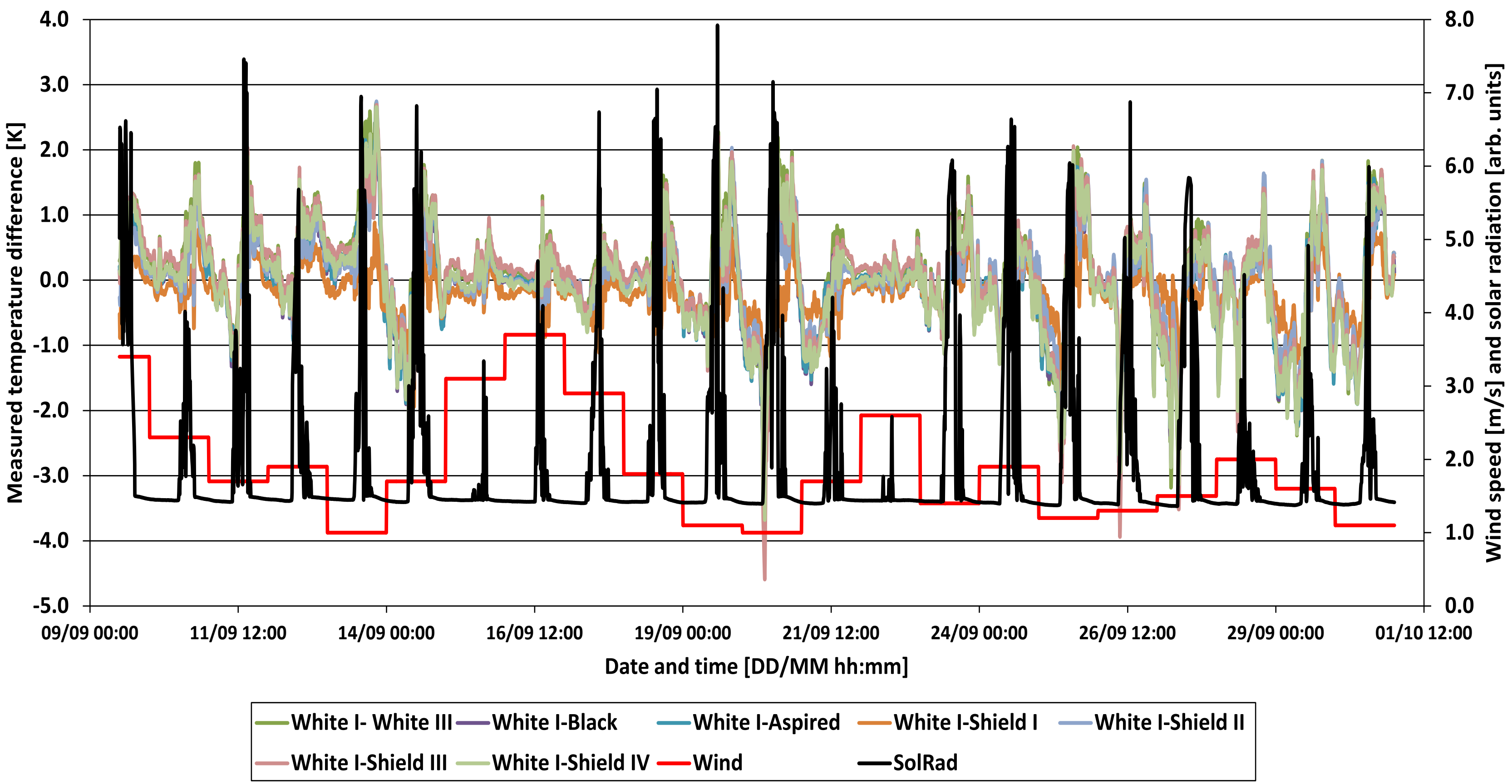
CNAM **Novel hygrometers based on microwave resonant cavities: 10 to 10^5 ppmv water vapour**

Test mounting



Resonator

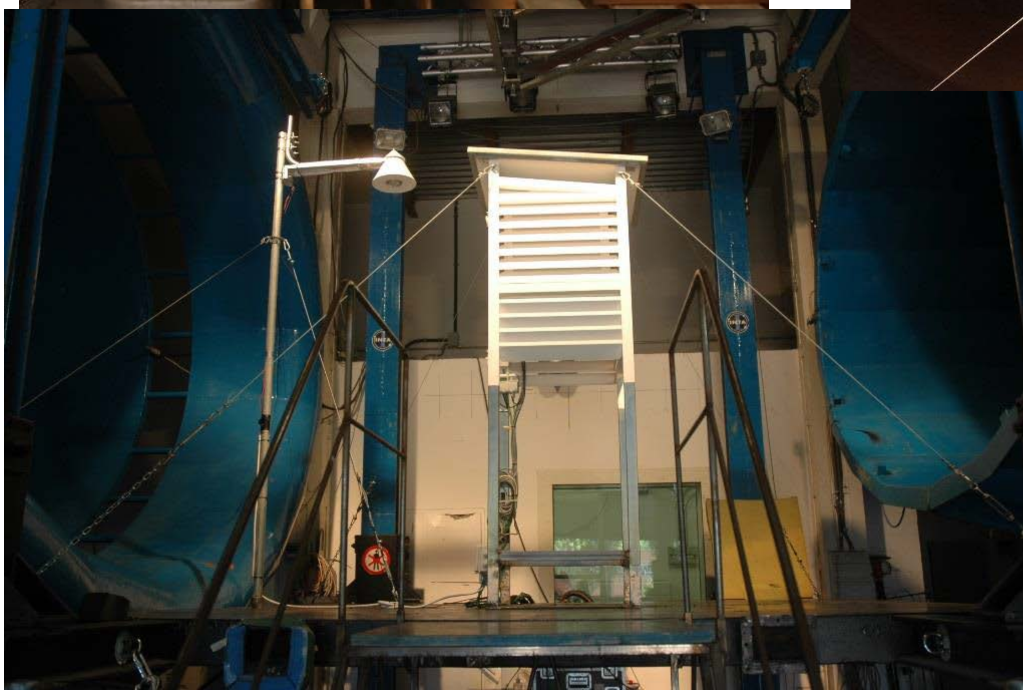
3.2.2 Long term investigations on various solar radiation shields in different parts of Europe



Meas
Aeroe

Forskningsinstitut (SP) in northern
Europe.



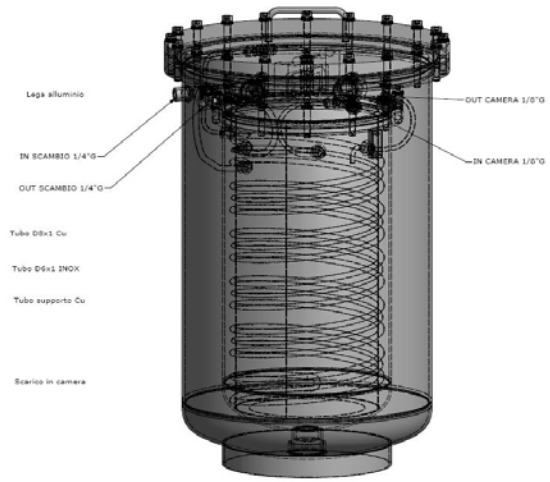


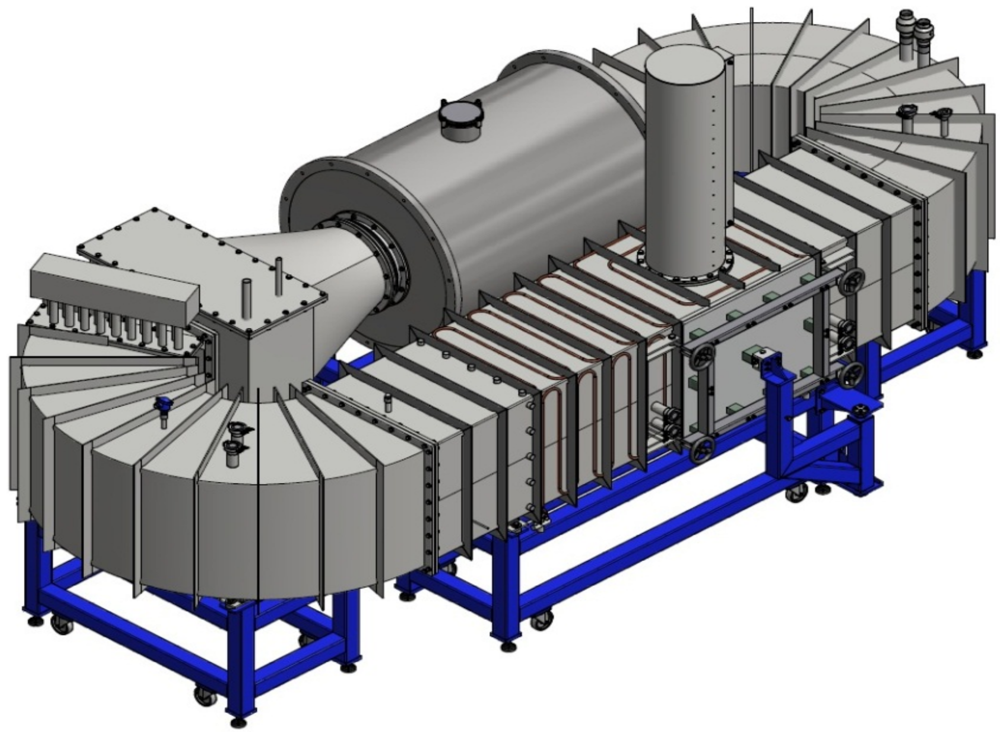

GRUAN

Arctic metrology 2014

EDIE & EDDIE

Earh Dynamics Investigation Experiment



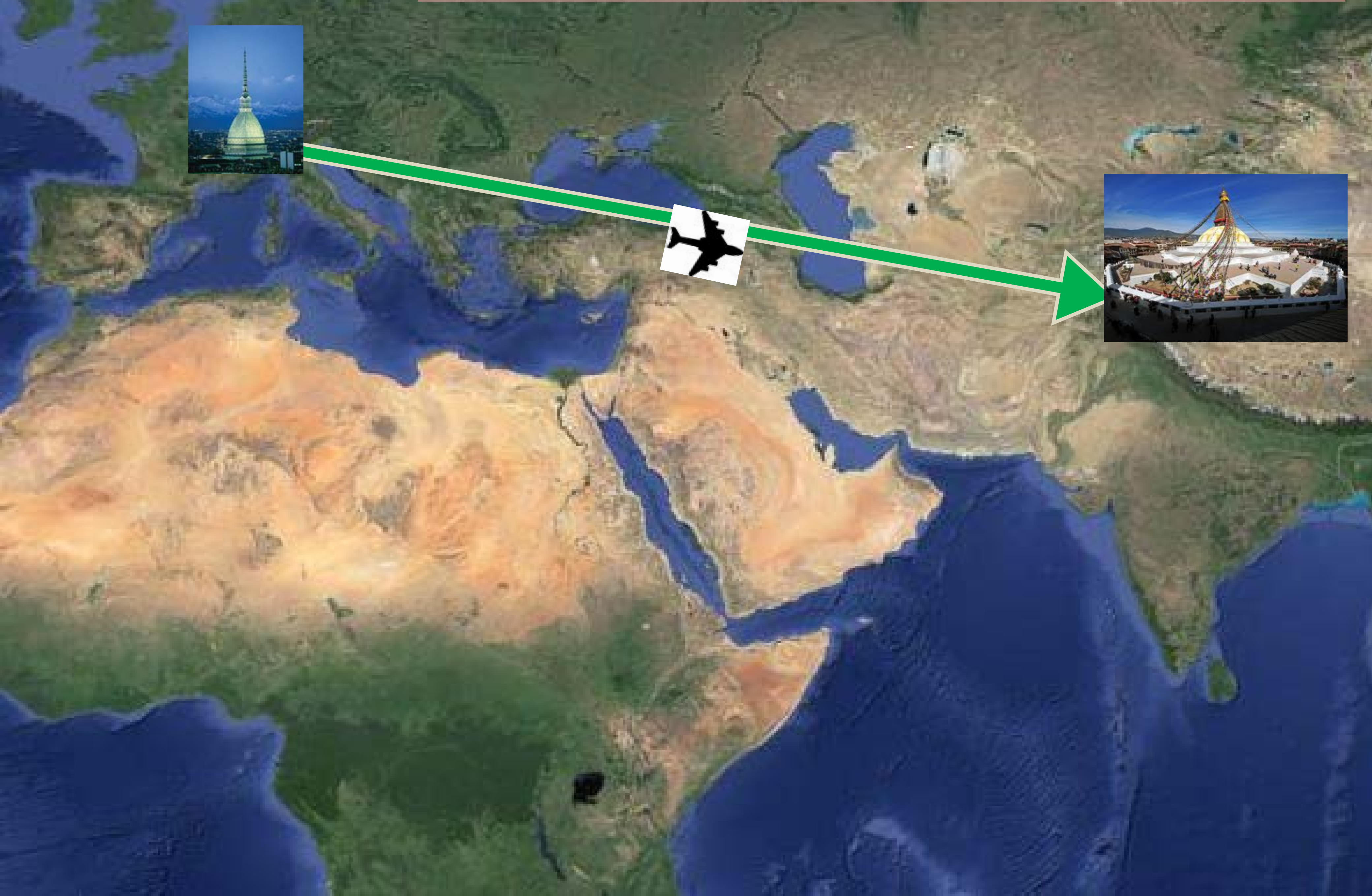


Earth Dynamics Direct Investigation Experiment

EDIE-2

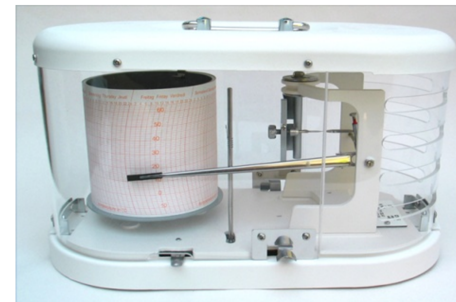
6 June 2013

❖ August 2013 the EDIE2 goes to Kathmandu first…




METEOMET
Metrology for Meteorology

Task 4.2: Development of the calculation model for uncertainty evaluation of the historical data with respect to ITS-90 introducing the data fusion method to support temperature uncertainty estimation

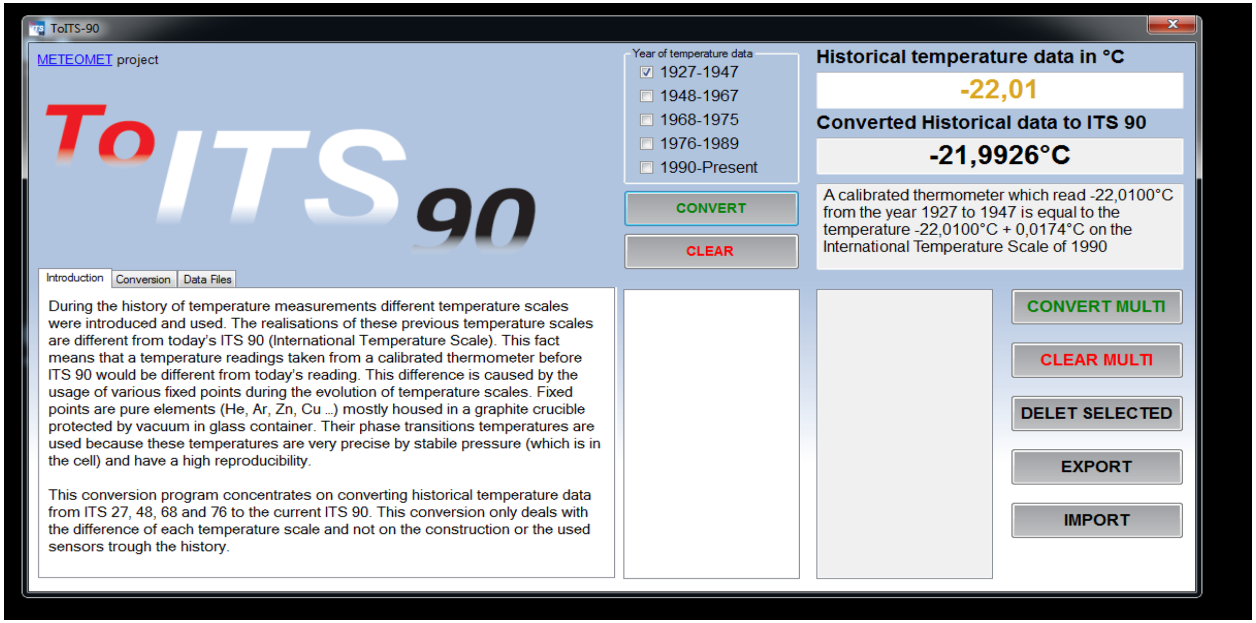


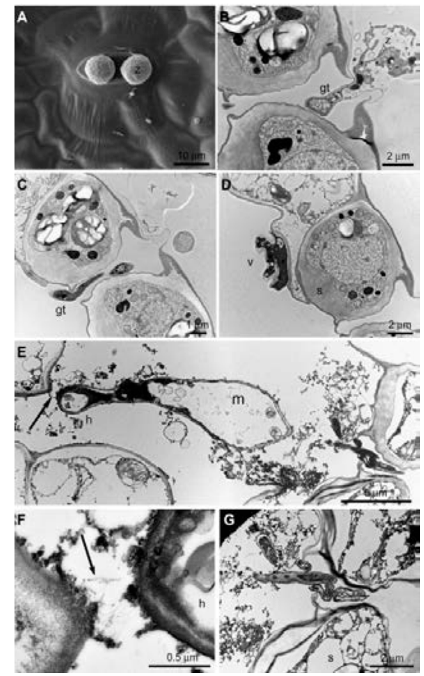
99 historical temperature series collected and analysed

Norway (2), Spain (22), Italy (2), Germany (72), Czech Republic (1)

Then sent to ISTI

The software tool to convert historical temperature data into ITS-90 values





A metrological approach applied to sustainable agricultural meteorology

Collaborators and stakholders

Universities
Research centers
Private companies
Public offices/Institutions (Meteo services)
International Organizations

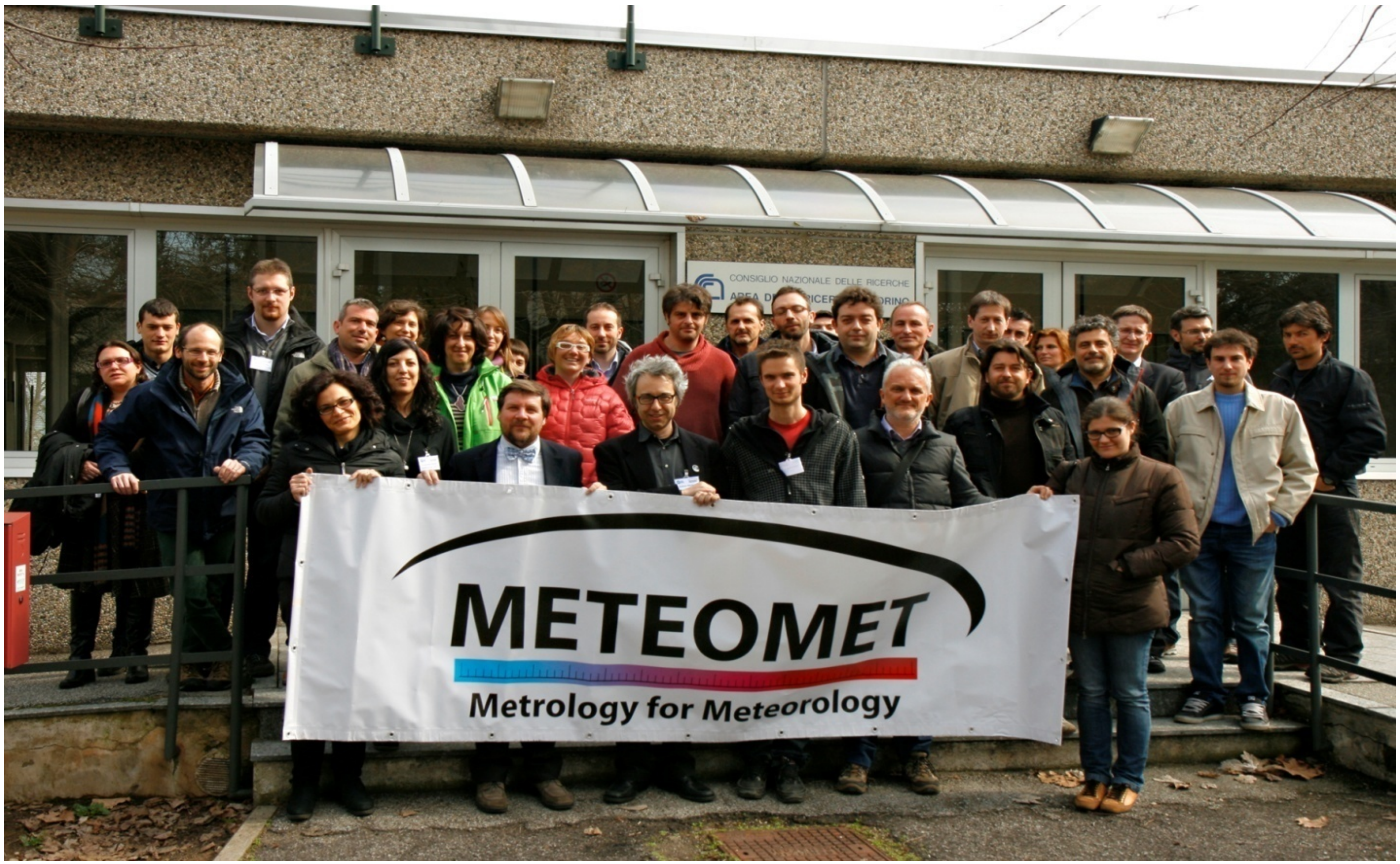
Royal Meteorological Institute of Belgium	Belgium
Bulgarian National Insitute of Meteorology	Bulgaria
Czech Hydrometeorological Institute	Czech Republic
Danish Meteorological Institute	Denmark
Vaisala Oyj	Finland
Finnish Meteorological Institute	Finland
MétéoFrance	France
METEOMODEM	France
Istituto di Scienze dell'Atmosfera e del Clima	Italy
ARPA Lombardia	Italy
Lobard & Marozzini	Italy
Società Meteorologica Italiana	Italy
CAE	Italy
Università degli studi di Cassino	Italy
Galileo ambiente	Italy
Meteo Duomo	Italy
Climate Consulting	Italy
CERIS - CNR	Italy
Università di Torino dip. Fisica	Italy
Università di Torino dip. Scienze della Terra	Italy
Michell Italia S.r.l.	Italy
Extreme Energy Events Project (Uni. Torino)	Italy
Environmental Agency of the republic of Slovenia	Slovenia
C3-Universidad Rovira i Virgili, Tarragona	Spain
Agencia Estatal de Meteorologia	Spain
Swedish Meteorological and Hydrological Institute	Sweden
Department of Meteorology, University of Reading	UK
University of Edinburgh	UK
National Centre for Atmospheric Science (NCAS) Univ. Leeds	UK
Rotronic - Vaisala	UK
Turkish State Meteorological Service	Turkey
EarthTemp Network	UK / INT
International Surface Temperatures Initiative	INT
GCOS-GRUAN	INT


LA NOTTE DEI RICERCATORI
venerdí 28 settembre
7a EDIZIONE 2012


METEOMET
Metrology for Meteorology

1st training course on metrology for meteorology

2013 – March – 20 Torino



8 TV Broadcast
18 Internet articles
15 Newspaper articles

ISTI & GRUAN
Teleconfs

25 Journal articles published
95 conference papers presented
15 university lectures and seminars

International Events

- *WMO CIMO Training Workshop on Metrology November 21-25, 2011*
- *4th GRUAN Implementation Meeting (ICM-4), March 5– 9, 2012 - Tokyo*
- *Meteo services workshop Satellite Euramet TC-T. Istanbul 22 April 2012*
- *WMO-CIMO-TECO Conference Brussels 16-18 October 2012*
- *5th GRUAN (ICM-5), 25 Feb – 2 Mar, 2012, De Bilt*
- *12th EuroMeteo Society (EMS) & 9th Euro-Conf on App. Climatology (ECAC)*
- *1st annual EarthTemp Network meeting, June 2012*
- *Joint "Ocean" and "MeteoMet" meeting, Braunshweig, January 23 2013*
- *Round table on AWS comparison, March 21 2013*
- *MeteoMet presented at EURAMET TC-T meeting, Praha, April 2013*
- *European Geosciences Union, General Assembly 2013, Vienna 07 – 12 April 2013*
- *MeteoMet presented at EURAMET General Assembly, Iceland, 27 May 2013*
- *MeteoMet at ICAM 2013 - International Conference on Alpine Meteorology, June 7, 2013, Kranjska Gora, Slovenia*
- *Tempmeko 2013, Madeira – October 13-19 2013*
- *MMC2014 Metrology for Metoeorology and Climate – Sept. 2014 – Brdo - Slovenia*

EURAMET Impact Prize 2013

"… the MeteoMet project has achieved significant impact with the science undertaken within it, but also in bringing two scientific communities together to collaborate on problems that have far reaching implications for us all…"

EURAMET NEWSLETTER | JULY 2013 | Issue 8

EURAMET

European Association of National Metrology Institutes

COMMUNITY NEWS

Andrea Merlone wins EURAMET Impact Prize 2013

Andrea Merlone, JRP-Coordinator of EMRP Joint Research Project "Metrology for pressure, temperature, humidity and airspeed in the atmosphere" (MeteoMet) and senior researcher at INRIM (Instituto Nazionale di Ricerca Metrologica, Italy) is the winner of the EURAMET Impact Prize 2013.

Metrology and meteorology are two words that are easily confused. One concerns the science of measurement and the other the study of the atmosphere. The MeteoMet project is now bringing these two disciplines together in order to provide better measurements of temperature, pressure, humidity and airspeed, which are vital for our understanding of the Earth's

Andrea values the significance the award has for him and the whole project: "This prize has a deep meaning that even surpasses the great happiness of receiving it. It is the sign of having made it in a new attractive field of metrology. Years ago, as thermal metrologists, we started to think on how our role and experience could be devoted to climate science, with temperature being a key quantity involved in the global warming. We started to establish new collaborations between metrology and meteorology,

The EURAMET Impact Prize has been awarded only twice, to the individual who has demonstrated the best impact from a Joint Research Project among the 130 funded during the five years of the EMRP programme. Nomination and selection is carried out by the EMRP Committee and the Research Council.

MMC Slovenija 2014

METROLOGY FOR METEOROLOGY AND CLIMATE

- Traceability and uncertainty.

- Ground based systems. Temperature, humidity and pressure sensors. Wind speed and direction, solar radiation. Quantities of influence and mutual influences. Sensors dynamics.

- Upper air measurements. Aircraft-based measurements.

- Ocean research: metrological traceability to the SI system for the measurement of the key variables salinity, pH, composition and dissolved oxygen content of sea water.

- Water: water vapour, liquid water, ice, hygrometry, soil moisture. Rain and snow gauges. Permafrost temperature measurements: instruments, procedures and calibrations.

- Assessment of the historical temperature measurement data with respect to uncertainties on instruments used.

- Thermal and chemical metrology for environment.

- Instruments and measurements capabilities, calibration procedures, best practice and regulations.

International Surface Temperature Initiative World Meteorological Organization IAPWS GCOS GRUAN IMEKO TC12 TC-T Thermometry EURAMET Technical Committee APMP

METEOMET 2

Metrology for Meteorology

Metrology for Essential Climate Variables

Start: 2014 October 1

Domain	GCOS Essential Climate Variables
Atmospheric (over land, sea and ice)	**Surface** Air temperature, Wind speed and direction, Water vapour, Pressure, Precipitation, Surface radiation budget. **Upper-air:** Temperature, Wind speed and direction, Water vapour, Cloud properties, Earth radiation budget (including solar irradiance). **Composition:** Carbon dioxide, Methane, and other long-lived greenhouse gases[3], Ozone and Aerosol, supported by their precursors[4].
Oceanic	**Surface** Sea-surface temperature, Sea-surface salinity, Sea level, Sea state, Sea ice, Surface current, Ocean colour, Carbon dioxide partial pressure, Ocean acidity, Phytoplankton. **Sub-surface:** Temperature Salinity, Current, Nutrients, Carbon dioxide partial pressure, Ocean acidity, Oxygen, Tracers.
Terrestrial	River discharge, Water use, Groundwater, Lakes, Snow cover, Glaciers and ice caps, Ice sheets, Permafrost, Albedo, Land cover (including vegetation type), Fraction of absorbed photosynthetically active radiation (FAPAR), Leaf area index (LAI), Above-ground biomass, Soil carbon, Fire disturbance, Soil moisture.

MeteoMet2 is based on three technical WPs

AIR

WATER

LAND

Task 1.1: Improving the representativeness of radiosonde calibrations to actual measurement conditions (MIKES, INRiM)

The aim of this task is to develop facilities to calibrate radiosondes under atmospheric conditions including reduced pressure and low temperature. A numerical simulation based analysis tool developed by MIKES in the MeteoMet project will be exploited in designing measurement chambers applicable in operation under reduced pressure and low temperature. A thermodynamic-based humidity generator able to work at sub-atmospheric pressures will be developed. The generated water vapour mole fraction will cover the range from approx. 0.03 mol/mol to 1.5 10-6 mol/mol.

The calculated water vapour mixing ratio will cover the range from 1 g/kg to 0.001 g/kg. Both the frost-point temperature and the pressure will be independently controlled. This calibration facility will operate at constant pressure, from 200 hPa up to 1000 hPa (corresponding to altitude from about 13 km to ground, respectively). Upper air reference instruments can then be calibrated with respect to the frost point temperature at several sub-atmospheric pressures. The system will be designed to operate at constant frost-point temperature and linearly-variable total pressure (e.g., with a sawtooth pressure signal) and, consequently, variable mixing ratio to simulate the pressure profile expected during a humidity sensor ascent or descent. The facilities will be validated by means of thorough uncertainty analysis and an interlaboratory comparison.

Description of activities:

•MIKES will develop further the radiosonde calibration facility developed in ENV07 MeteoMet project to cover the actual pressure range of radiosondes during the ascent flight (i.e. down to 10 hPa abs.) in the temperature range down to -80 ° C and dew/frost point temperature range down to -90 ° C. (MIKES) (D1.1.1, D1.1.2)

•INRiM will develop a complementary calibration facility for airborne upper air reference instruments to cover the pressure range from 1000 hPa to 200 hPa and the dew/frost point temperature range from -20 ° C to -95 ° C, respectively. (INRiM) (D1.1.3, D1.1.4)

•The development includes collaboration between MIKES and INRiM in designing the chamber system for the calibration facility and in evaluating the facilities with agreed test procedures (MIKES, INRiM) (D1.1.5)

•MIKES and INRiM will compare the facilities over the whole pressure and dew/frost point temperature ranges with suitable transfer standard instruments (e.g., spectrometer-based trace moisture analyser or low-pressure chilled mirror dew-point hygrometer). (INRiM, MIKES) (D1.1.6)

•MIKES and INRiM will apply the developed calibration procedures to radiosondes provided by Vaisala and to compare the ensuing calibration results obtained with both facilities. (MIKES, INRiM) (D1.1.7)

Major facilities to be used: MIKES radiosonde calibration facility, trace-moisture analyzers and dew-point hygrometers of MIKES and INRiM

Task 1.4: Metrology for fast changing quantities in upper air (NPL, CETIAT, CNAM)

The aim of this task is to provide metrological support for measurements of fast-changing ECVs (temperature, water vapour), where the response time of conventional sensors may be too slow to correctly follow rapid transients being measured. The work aims to extending the characterization of sensors beyond the basic information known when sensors are calibrated in constant conditions. This respond to the needs expressed by WMO to identify for radiosondes what is the sensor time constant and what is the lower bound of the sensors sensitivity. Temperature time lag of the sensor relative to the temperature is considered a possible significant source of systematic error.

Background for microwave hygrometers
Microwave technology is able to provide very high sensitivity to the water concentration in a gas, especially when the water fraction is at the level of some parts per million, but also at higher water vapour concentrations (around 105 ppmv). According to the recent tests carried out in the ENV07 MeteoMet project, still in progress, microwave hygrometers are expected to deliver measurement accuracies better than 1 ppmv and very long-term traceability to the SI.
Size has been considerably reduced in MeteoMet, from a system of three 500 cm3 quasi-spherical resonators, to a system of three 65 cm3 quasi-spheres, but further reductions are possible, in order to make microwave hygrometers very suitable instruments for balloon-borne measurements.
Description of activities:
•NPL will develop a reference instrument for measurement of rapid transients of temperature and humidity in free space, building on earlier work (ENV07 MeteoMet project) on free-space combined measurement of temperature and humidity. Based on its existing range (approximately -40 ° C to +40 ° C, 10 ppm to 1% water vapour, at a range or pressures) the instrument will be adapted for best speed of response, for use as a reference measurement, and demonstration measurements will be made in its established temperature range. A report will be provided. INRiM will further develop the facility of Task 1.1 to independently control the frost-point temperature (-20 ° C to -95 ° C) and system pressure (from 1000 hPa to 200 hPa) with a dedicated PID pressure control to simulate true atmospheric profiles and radiosonde ascent/descent rates of several metres per second or, equivalently, tens of Pa/s. (NPL, INRiM) (D1.4.1)
•CNAM will pursue the development of the new generation of hygrometers based on microwave resonators, in order to improve the design of the first prototypes developed in the ENV07 MeteoMet project and to overcome the shortcomings of the present design, currently appearing in the ongoing characterization. The objective is to deliver an instrument appropriate for atmospheric humidity measurements and metrological well-characterized. Activities will focus on the following items:
•Response time reduction: thermalization of inlet air at resonator temperature induces response times of few minutes. Thermal analysis and modelling aiming at reducing response time below one minute will be undertaken.(D1.4.2)
•Turbulent flow analysis: turbulent flow inside the resonator may appear at low air pressure. Effects of turbulent air flow on humidity measurements will be analysed, and possible removal solutions will be studied and implemented, if necessary. (D1.4.3)
•Size reduction, realization and characterization: prototypes developed in ENV07 MeteoMet project consist of three quasi-spherical resonators, each with 65 cm3 of inner volume. New resonators will be realized in this JRP, with further reduced inner volume of around 30 cm3. They will implement the solutions found to reduce response time and to remove turbulent flow at low pressure. (CNAM, CETIAT), (D1.4.4)
•CNAM and CETIAT will carry out response-time measurements of microwave hygrometers developed by CNAM, using the facility for fast humidity transient analysis realized by CETIAT in Task 3.4 and working in the extended range (typically from -50 ° C up to +10 ° C in frost point temperature and from -20 ° C up to +20 ° C in dry temperature) [47], [48], [49]. (CNAM, CETIAT), (D1.4.5, D1.4.6)

Euramet NEWS

Maximum impact can be achieved if the research agendas are used to target long-term objectives.

…to enable and stimulate related investments in facilities and equipment…

…and pooling of metrological resources across national boundaries to tackle key societal challenges.

2014
EURAMET starts the new Task Group on Environment

Kick off meeting in Brdo!

TG-ENV Members

Andrea Merlone (convenor) - INRiM (Italy)	**Thermodynamics**
Annarita Baldan - VSL (The Netherlands)	**Chemistry**
Ryszard Broda Polatom (Poland)	**Ionizing radiation**
Richard Brown NPL (United Kingdom)	**Chemistry**
Ragne Emardson SP (Sweden)	**Remote sensing**
Carmen Garcia Izquierdo CEM (Spain)	**Thermometry**
Eric Georgin LNE (France)	**Humidity**
Julian Groebner PMOD/WRC (Switzerland)	**Radiometry**
Volker Ebert (replaces **Bernd Güttler**) PTB (Germany)	**Spectroscopy**
Roger Atkinson (replaces **Bertrand Calpini - President**)	**CIMO/WMO**
Maria Luisa Rastello (EURAMET BoD)	INRiM (Italy)
Invited:	
Janko Drnovsek (EURAMET vice person)	UL-LMK (Slovenia)
Martin Rides	NPL (United Kingdom)

TG-ENV 2014 and 2015 Activities

January – July. Meetings with TCs → **NMIs nominate their representatives in TG-ENV. A selection made based on expertise**

15 – 17 September 2014. MMC Workshop → **TG-ENV kickoff meeting**

MMC Slovenija 2014
METROLOGY FOR METEOROLOGY AND CLIMATE

*** Revised ToR**
*** Start preparation of the EURAMET Scientific Research Agenda on** Environmental Grand Challenge

21 January 2015. TG ENV meeting at WMO in Geneve → **SRA finalised and sent to EURAMET**

Euramet Strategic Research Agenda: Environment Grand Challenge

- **Approved by BoD on Feb 2015**
- **External consultation of the SRA within the next few months**

Greater consideration to Interdisciplinary and Multidisciplinary joint projects.

2.2.2 Environmental Grand Challenge

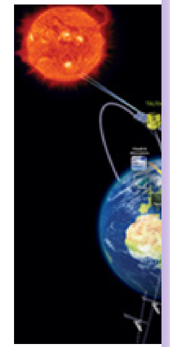
KEY CHALLENGES

The European Union (EU) have stated that *"Environmental quality is considered central to health and well-being."*, and have introduced laws *"… to ensure the careful use of natural resources, to minimise adverse environmental impact of production and consumption …" Furthermore,* the EU strives for "… tighter *environmental standards and for effective action against climate change"*[1].

The key environmental challenges facing Europe have very significant costs associated with them. To address these challenges, *"the EU has agreed that at least 20% of its €960bn budget for the 2014-2020 period should be spent on climate change-related action."* Furthermore, there will be significant costs for adaptation actions to alleviate the effects of climate change[2]. As highlighted by an EC impact assessment[3] *"The minimum cost of not adapting to climate change is estimated to range from €100bn a year in 2020 to €250bn in 2050 for the EU as a whole*[4]*."* The EU's General Union Environment Action Programme to 2020 *'Living well, within the limits of our planet'* states: *"In 2011, disasters partly due to climate change resulted in global economic losses of over €300bn.*

Many of the challenges that Europe faces in order to promote innovation and ensure sustainable growth in the future are dependent on addressing environmental grand challenges, specifically in the areas of **climate change** [e.g. Directive 2003/87/EC[5]], and **environmental sustainability and pollution** [e.g. Directives 2004/107/EC[6], 2008/50/EC[7], 2000/60/EC[8], 2010/75/EU[9] and 2002/49/EC[10]]. Furthermore, there are international protocols and treaties to which the Member States in Europe are party, e.g. Geneva Convention on Long-range Transboundary Air Pollution[11], Kyoto Protocol[12], 'Rio +20'[13], and Minamata Convention on Mercury[14] that demand and drive international collaboration on environmental metrology.

> *"To prevent the most severe impacts of climate change, the international community has agreed that global warming should be kept below 2 °C compared to the temperature in pre-industrial times."*[15]



> *"Preventing dangerous climate change is a strategic priority for the European Union."*
>
> *"Reining in climate change carries a cost, but doing nothing would be far more expensive in the long run."*[15]

It is essential that European (and global) policies on reducing anthropogenic effects on climate and implementing appropriate adaptation measures to climate change need to be based upon sound science and valid climate change predictions. A holistic view, based on comparable data, encompassing the atmosphere, oceans and land as well as solar and terrestrial radiation is essential for reliable climate change modelling.

> *" 'Uncertainties about the extent of future climate change' and 'unclear responsibilities' were both seen as barriers by a large number of countries* [to taking action to adapt to climate change]*."*[16]

Understanding and predicting climate change necessitates climate monitoring. Reliable climate predictions require quality models, traceable data and uncertainty budgets. Clearly, metrology has a critical role to play in monitoring, understanding and predicting climate change.

> *"This means not only to understand climate change but also to establish on the best possible scientific foundation the climate information services expected by decision makers."* [17]

EU policy on environmental pollution and environmental sustainability, as illustrated by the General Union Environment Action Programme to 2020 *'Living well, within the limits of our planet'*[18] has targets on various aspects of pollution; for example:

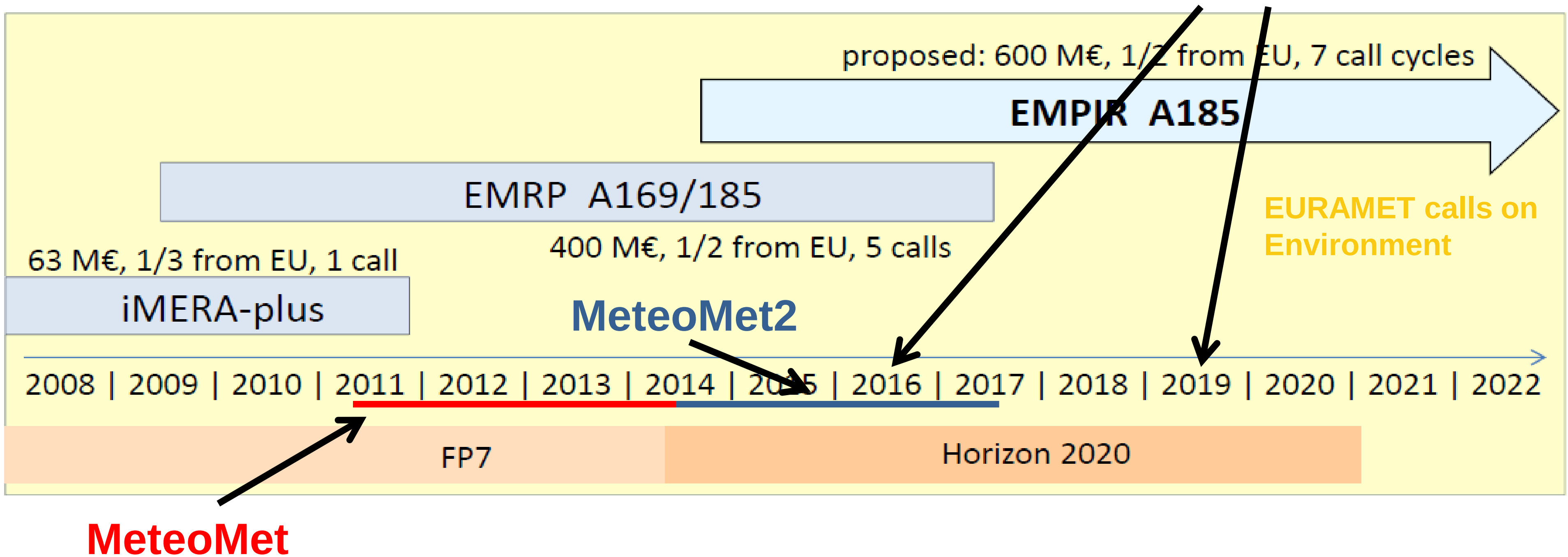
- achieving good environmental status (GES) of EU marine waters by 2020 [19, 20, 21],

Joint programming of metrology research

EURAMET
European Association of National Metrology Institutes

- coordination of national metrology research programmes (EMRP with those of 22 member states)
- jointly agreed strategic research agenda
- implemented by EURAMET e.V.
- highly integrated

New Environment calls planned for 2016 and 2019



Arctic Metrology Workshop

2015 April 22, INRiM, Torino, Italy

- to address metrology experience and activities in support of the arctic research
- to present the expertise of metrology Institutes and universities, for the science in the arctic
- to plan a joint effort towards the creation of a permanent metrology structure for arctic research

EURAMET

METEOMET Metrology for Meteorology

INRiM ISTITUTO NAZIONALE DI RICERCA METROLOGICA

MMC Spain 2016

METROLOGY FOR METEOROLOGY AND CLIMATE

&

World Meteorological Organization

CIMO-TECO

an occasion to reciprocally increase knowledge and understanding

Among the suggested topics:

- Ocean research. Metrological traceability to the SI system for the measurement of the key variables: salinity, pH, composition and dissolved oxygen content of sea water.

- Chemical metrology for environment and climate.

- Instruments and measurements capabilities, calibration procedures, best practice and regulations.

A selection of papers will be submitted to a special issue of *Meteorological Application*

BIPM NEWS

Metrology

BIPM

Bureau International
des Poids et Mesures

Sevres - France

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 thermal metrology community;
- research and coordinated analysis is required to build up a worldwide network supplying traceable baseline data sets, needed to develop more accurate models for climate change;

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;
- 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;
- to consider the most effective means by which CCs involved in climate and environmental activities should cooperate in order to establish a common response to the stated needs of the meteorological community; and
- to encourage CCs to alert their relevant working groups to the measurement, calibration and quality assurance needs of the climate change and monitoring communities.

BIPM
METPΩ XPΩ

May 2014
CCT XXVII Meeting

New Task Group on Metrology for Environment

WMO-OMM
Dr W. Zhang
Director, Observing and Information Systems Department
7 bis, avenue de la Paix
Case Postale 2300
CH- 1211 Genève 2
Suisse

Sèvres, 14 November 2014

Dear Dr Zhang,

I have the pleasure to accept your kind invitation, for representatives of the Consultative Committee for Thermometry (CCT) of the CIPM, to participate in a number of WMO CIMO Expert Teams where collaboration would be pertinent, perfectly in line with the signature made by the WMO of the CIPM MRA in 2010. For this purpose, I have identified five expert teams where CCT participation could be of mutual benefit. These are listed in the enclosed annex, as well as the contact details of the persons that I have nominated, respectively.

The CCT, under the auspices of the CIPM, has recently formed a Task Group on Environment – particularly dedicated to issues related to thermometry and humidity – to notably identify where our particular expertise in metrology and associated technologies may best contribute to progress within climatology and environmental issues. The group has also the task to promote a coherent and comprehensive approach on thermal metrology for environment. It would be of great value if one representative of the WMO CIMO may participate in this group. For this reason I kindly invite you to nominate a member to take part.

I am looking forward to a constructive collaboration.

With my best regards,

Yuning Duan

Dr Yuning Duan
President of the Consultative Committee for Thermometry
Member of the International Committee for Weights and Measures (CIPM)

BIPM → WMO

BIPM		WMO
Andrea Merlone	(INRiM)	on A1 Expert Team on Operational In Situ Technologies
Michaeld de Podesta	(NPL)	on A.2 Expert Team on Developments in Situ Technologies
Carmen Garcia Izquierdo	(CEM)	on A.3 Expert Team on Instrument Intercomparisons
Michael de Podesta	(NPL)	on C.1 Expert Team on Operational Metrology
Christian Monte	(PTB)	on A.5 Task Team on Radiation References

WMO

Drago Grosely
ARSO WMO RIC6

BIPM
CCT TG ENV

GRUAN

Peter Thorne

Towards a Joint group from BIPM CCT – ISTI - GRUAN – WMO CIMO & CCl for temperature uncertainty evaluation

Components derived from the control thermometer	Components derived from the measurement system	Components derived from the calibrated thermometer
• deviation of t_w results $u(\delta t_{w\_dev})$ • scattering of t_w value $u(\delta t_{scat})$ • uncertainty of reference PRT according to its *Calibration certificate* $u(\delta t_{w\_std})$ • drift of reference PRT $u(\delta t_{drift})$ • uncertainty of reference resistance bridge according to its *Calibration certificate* $u(\delta t_{b.std})$ • drift of reference resistance bridge $u(\delta t_{b.drift})$	• temperature stability $u(\delta t_{stab})$ • temperature distribution in the horizontal plane of the air/climatic chamber $u(\delta t_{gradH})$ • temperature distribution in the vertical plane of the air/climatic chamber $u(\delta t_{gradV})$ • radiation effect (only in the climatic chamber) $u(\delta t_{rad})$	• deviation of t_x • results $u(\delta t_{x\_dev})$ • **resolution** $u(\delta t_{xresol})$ • **repeatability** $u(\delta t_{xrep})$ • **hysteresis** $u(\delta t_{xhist})$

Towards a Joint group from BIPM CCT – ISTI - GRUAN – WMO CIMO & CCl for temperature uncertainty evaluation

- Introduction

Why we need to define the "reference grade" surface ground based temperature record
Target uncertainty for temperature values needed for climatology

- State of the art. Data from meteorology.

Old data, modern data.
Instrument used

- How to measure temperature

Thermometers, shields, speed of fan
Quantities of influence: instruments, amount of influence -> requested uncertainty

- Solar radiation
- Humidity
- Wind speed
- Albedo and Thermal inversion
- Rain – Snow

Calibration methods and calibration uncertainty achievable with SoA modern procedures.
Air temperature calibration: an open issue

- Towards a reference grade ground based stations network

Data comparability. Siting problems. Representativeness
Instruments characteristics requirements to last in the years.
Conclusions and plans

GUM News

Revision of the JCGM Guide to the expression of uncertainty in measurement

Walter Bich
INRIM – Istituto nazionale di ricerca metrologica
Torino (Italia)
JCGM-WG1

- **1977-79 BIPM questionnaire on uncertainties**

- **1981 Establishment of WG3 on uncertainties under ISO TAG4: BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, OIML**

- First publication in 1993

- **Reprint in 1995 with some corrections**

- **JCGM 100:2008 (free of charge) GUM 1995 with minor modifications**
- **Until now, a large number of documents based on the GUM has been written. The GUM has been translated into many languages**

- **In addition, the GUM has been adopted as a standard, in some cases as a law, in many countries**

The GUM is ambiguous

The definition of uncertainty in the GUM is

parameter, associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand

This is an intrinsically Bayesian view of uncertainty – uncertainty concerns the measurand

The definition contrasts with the way in which uncertainty is obtained, essentially frequentist – uncertainty concerns the measurand estimate, and is itself uncertain

- Not a few quantities of practical importance are such that the current practice $U = ku$ (with typically $k = 2$) is inappropriate

A paradox: **estimate** components to **evaluate** the total.

- **The GUM and its Supplements are now inconsistent**

How to revise the GUM?

- Main purpose: to make it consistent with its Supplements

- **Secondary purposes:**
  - **to make it consistent as much as possible with VIM3**
  - **to broaden its applicability to “new” needs**
  - **to minimize notational and terminological ambiguities**

Changes

- In the revised GUM there will be mostly generic guidance on the construction of coverage intervals
- Distribution-free coverage intervals, based on Chebyshev or Gauss inequalities, will be given
- Expanded uncertainty de-emphasized
- Greater consideration to non-symmetric coverage intervals
- Greater consideration to multi-variable problems
- Classification into Type A and Type B evaluations loses its scientific basis, but will be kept (de-emphasized) due to non scientific considerations

- MeteoMet news
- Euramet news
- BIPM news
- New GUM

Keep on working together!

If your experiment needs statistics,

you ought to perform a better experiment.

(Lord Rutherford)