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Metrology for climate observation

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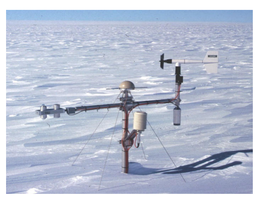
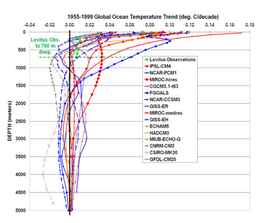
ABSTRACT

As stated by GCOS, "l*ong-term, high-quality and uninterrupted observations of the atmosphere, land and ocean are vital for all countries, as their economies and societies become increasingly affected by climate variability and change*". *High-quality* observation is possible only if based on a sustained traceability to SI and with documented uncertainties associated to the measured values. Following the signature of the MRA by the WMO in April 2010, the CCT of the CIPM, in its XXV meeting of May 2010, submitted a recommendation to CIPM. The document highlighted the need to "*encourage National Metrology Institutes (NMIs) [...] to face new perspectives, needs, projects and activities related to the traceability, quality assurance, calibration procedures and definitions for those quantities involved in climate studies and meteorological observations and to support a strong cooperation between NMIs and Meteorological Institutions at local, national and international levels".* In response to this call, several Joint Research Projects (JRPs) in metrology have been established. Their objective is to improve calibration procedures and measurement techniques for some Essential Climate Variables (ECVs), focussing especially on temperature, pressure and water vapour. Additional objectives have included investigations of sensor characteristics and the improvement of measurement devices and their use in the field. The impact effort is demonstrated also by the involvement of key international scientific Institutions such as GRUAN, ISTI, IAPWS, and prominent Manufacturers and Universities. The overall aim is to make a further step towards establishing full data comparability, consistency and long-term continuity, through a comprehensive evaluation of the measurement uncertainties for the quantities involved in the global climate observations. The improvement of quality of ECVs records, through the inclusion of measurement uncertainty budgets, will also highlight possible strategies for the reduction of the uncertainty. This contribution will report on JRPs advances, events and task group activities, with the vision to establish a permanent bridge between metrologists and climatologists, through which to strengthen and develop collaborations, joint activities/projects and results dissemination to the whole society.





The vision

To establish a permanent cooperation between metrology and meteorology communities, for the benefit of the future generations of climatologists.

Metrology for Meteorology. Why?

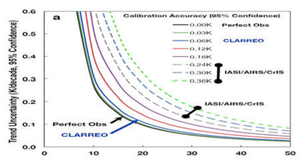
Contribution in evaluating measurement uncertainties (Full documented traceability)

Dedicated calibration procedures (Definition of reference grade data)

Calibrations and Uncertainties evaluations
to reach full comparability

- Comparability on climate-change scales
- Comparability to fundamental physical models
- Comparability across generations
- Comparability across borders & organizations
- Comparability across instrument/measurement types

Accurate Measurements
to Reduce the Time Necessary to Capture a Trend



Needs

Define measurements standard

Define Calibration procedures

New devices and instruments

METEOMET
Metrology for Meteorology

Data reliability

Uncertainty-evaluation methods

Traceability to national standards

Improve data quality, continuity and homogeneity

Interpretation historical data series

European common approach

Scientific and technical excellence

The project aims to develop metrological traceability for the Essential Climate Variables (ECVs) defined by Global Climate Observing System (GCOS): water vapor in upper-air and surface atmosphere, surface and deep sea temperature and salinity, air temperature, precipitation, albedo, permafrost temperature and soil moisture.

On the basis of results and experience achieved during the running **ENV07 MeteoMet Project**, this new proposal extends the activities to further objectives: from sensor calibration uncertainties to **measurement uncertainties**, **improvement of the developed devices** and their use **in field** oriented activities, new investigations on **sensors characteristics** for the generation of higher quality climate data, extension of the analyzed **ECVs**.

Relevance of Objectives

Integration and Efficiency:

A collaborative and multidisciplinary research for a common response of European NMIs to the needs of stakeholders.

Developing metrology capacity:

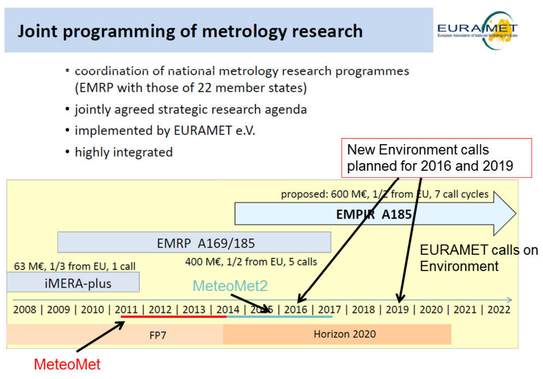
- To enlarge the NMIs expertise moving from the traditional laboratory calibration to measurement uncertainty evaluation in land, air and sea practical field conditions.
- Develop measurement devices and calibration procedure for fast changing quantities
- Traceability for ECVs observable in extreme environments (high mountains and deep ocean).

Stimulate innovation:

The involvement of metrologists in studying sensors for ECVs will increase the capacity of manufacturers in producing instruments with adequate metrological characteristics.

Involvement of outside researchers:

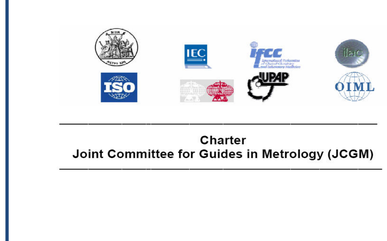
- Researchers from GRUAN, oceanographic laboratories, universities and manufacturers will be actively involved in the project progress and results evaluation.
- REG from Universitat Politècnica de Catalunya will bring external high level expertise in the field of sea-related ECVs measurements.

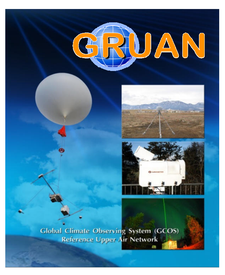


- This project has been written in close collaboration with key international stakeholders.
- **The GCOS-GRUAN** established a sub group to supervise and address part of this protocol.

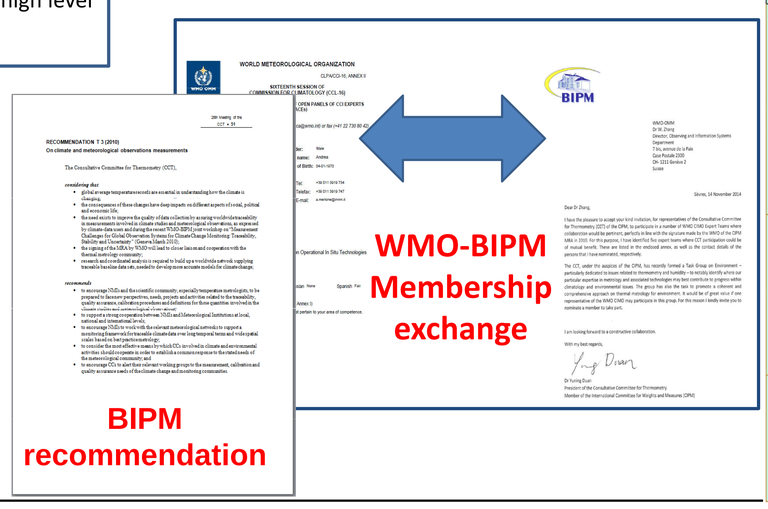
Impact

- **Provide links, input, and knowledge transfer to the "end users".**
- **Feed into the development of key standards, procedures and protocols through appropriate climate and meteorology bodies.**
- **Develop a coherent European approach to be proposed to other Regional Metrology Organizations.**
- **Continue and extend those dissemination activities that allowed MeteoMet to win the EURAMET Impact Prize 2013.**



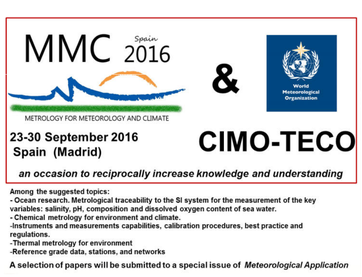


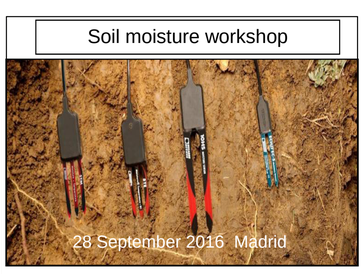
Revisions of the GRUAN manual and guide were delivered in 2012 to make them in line with the GUM



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, Ozone and Aerosol, supported by their precursors.
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.

Events





ISTI, GRUAN, WMO CCI CIMO ETs Teleconfs

National and local news coverage

GCOS science conference 2016, 2-4 March, Amsterdam (NL)