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The MeteoMet2 project—highlights and results

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*Original*

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24 February 2024





# 1 INTRODUCTION

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## 1.1 BACKGROUND

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E \ FOLPDWH YDULDELOLW \ DQG FkdQJH ' >

## 1.2 METEOMET

*MeteoMet* ± ±  
*Association of National Institutes of Metrology*

*European*

*Meteomet*

*MeteoMet*

*MeteoMet 1 and 2*

KDQG EHFDXVH PDQ \ RI WKH μODQG ¶ (&9V

*MeteoMet*

## 2 TOPICS IN METEOMET2

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### 2.1 AIR: HUMIDITY AND TEMPERATURE MEASUREMENTS ABOVE GROUND LEVEL

RI ZDWHU LQ WKH (DUWK ¶ V DWPRVSKHUH <HW PHDVXUH

2.1.1 Calibration of radiosondes under atmospheric conditions.

2.1.2 Measurement of the enhancement factor under atmospheric conditions.

2.1.3 Spectroscopic thing

2.1.4 On-site calibration of airborne instruments.

2.1.5 Measurement of fast transients of temperature and humidity.

2.1.6 Microwave Hygrometry

2.2 SEA: TEMPERATURE AND SALINITY MEASUREMENTS IN OCEANS

2.2.1 Pressure dependence of deep-sea thermometers .

2.2.2 Thermodynamic calibration of deepa thermometers.

2.2.3 Ocean temperature sensors based on optical fibre Bragg gratings.

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7 KLV SURMHFW LV GHVFULEHG IXUWKHU LQ WKH  $\mu$ +LJKOLJK

2.2.4 Test and calibration facility for refractive index salinometers.

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7 KLV SURMHFW LV GHVFULEHG IXUWKHU LQ WKH  $\mu$ +LJKOLJK

2.3 LAND: TEMPERATURE AND HUMIDITY MEASUREMENTS IN GROUND LEVEL MEASUREMENTS

*Meteomet*

LQ WKH  $\mu$ +LJKOLJK



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2.3.1 Thermometer Screens

2.3.2 Effect of obstacles on meteorological sites

2.3.3 Effect of rain on temperature measurements

2.3.4 Albedo of Thermometer Screens

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### 2.3.5 Inter laboratory comparison

### 2.3.6 In situ calibration

*Earth Dynamics Investigation Experiment*

± ±

*in situ*

### 2.3.7 Historical records

### 2.3.8 Agro-meteorology

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### 2.3.9 Mars Simulator

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R S H U D W L Q J L Q <sup>3</sup>( D U W K F R Q G L W L R Q V ' I R U W H

### 2.3.10 Dynamic calibrations of hygrometers.

2.3.11 Precipitation and soil moisture.

2.3.12 Soil Moisture Measurements

2.3.13 Soil Moisture questionnaire

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2.4 CRYOSPHERE

### 3 SELECTED HIGHLIGHTS

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#### 3.1 SITRACEABLE HUMIDITY CALIBRATIONS FOR RADIOSONDES

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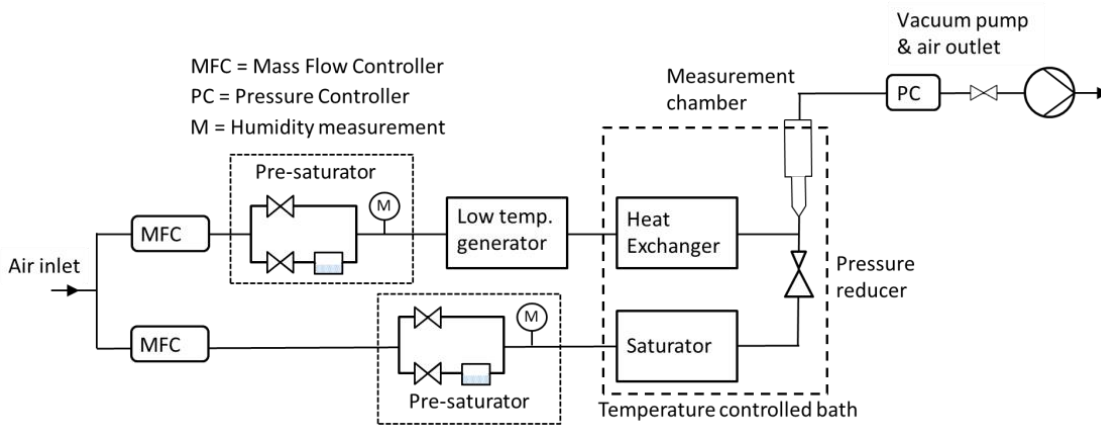


Figure 1.

### 3.2 A CORRECTION FOR THE TEMPERATURE HISTORICAL SERIES

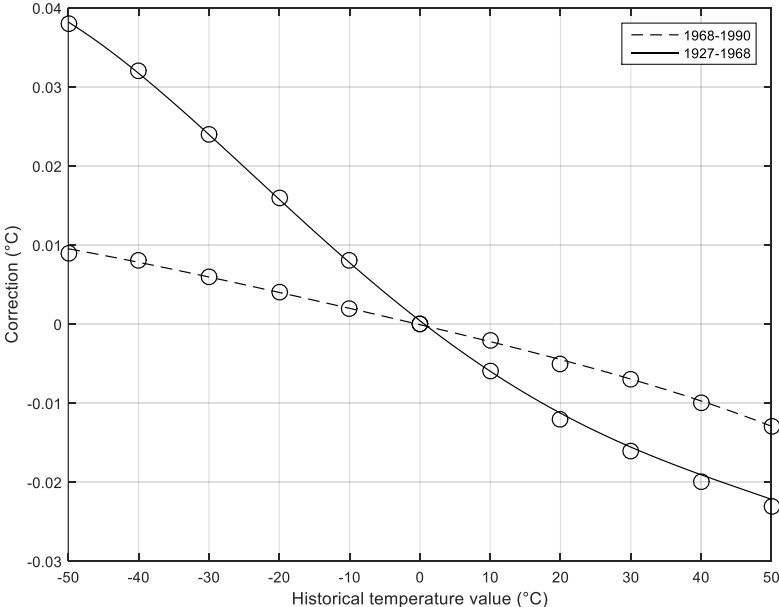


Figure 2

### 3.3 EXPERIMENTAL SEA TEMPERATURE MEASUREMENTS BY DISTRIBUTED TEMPERATURE SENSORS

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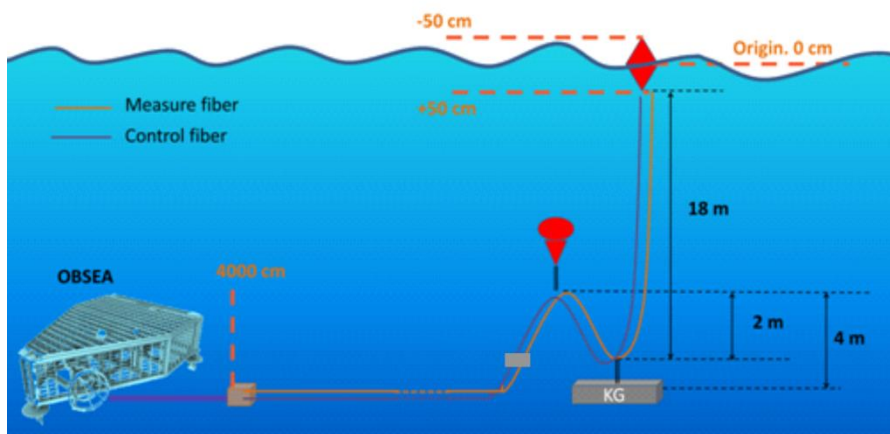


Figure 3.

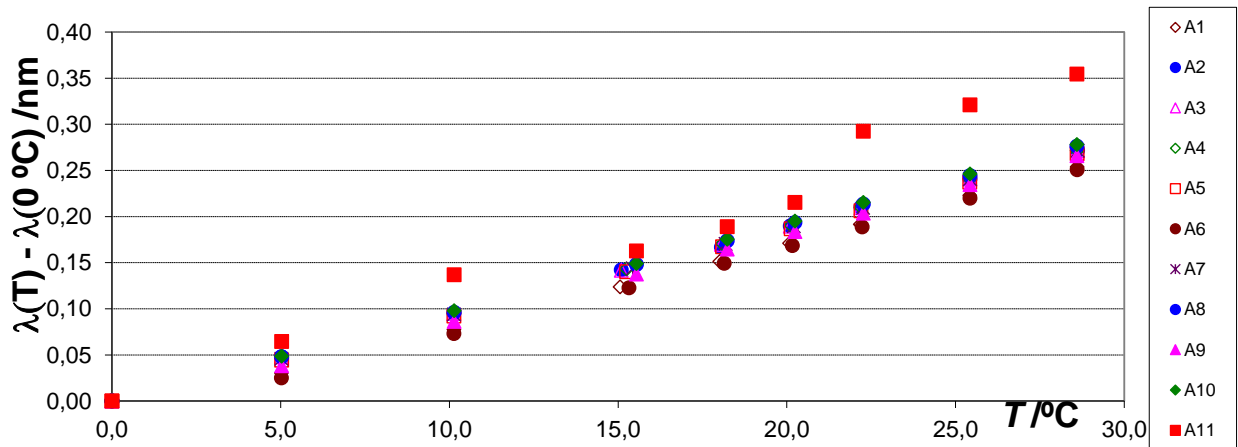


Figure 4.

### 3.4 CALIBRATION OF CONDUCTIVITY, TEMPERATURE AND DEPTH SENSORS

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Table.1. & 7 ' ¶ V

Uncertainty component description	Quantity	Unit	Uncertainty	Probability distribution	Divisor	Sensitivity coefficient	Standard deviation	
	$x_i$					$c_i$	$u(x_i)$ °C	
<b>Measuring system of the laboratory</b>								
Resistance bridge calibration	$L_p$	Ω	1.00E-06	Rectangular	√3	$R_s/sp$	1.48E-04	
Drift of the resistance bridge	$\cong L$	Ω	6.10E-06	Rectangular	√3	$R_s/sp$	9.03E-04	
Reference Resistor calibration	$R_s$	Ω	2.80E-04	Normal	2	$L_{ref}/sp$	7.18E-04	
Drift reference Resistor	$\cong R_{sd}$	Ω	1.00E-04	Rectangular	√3	$L_{ref}/sp$	2.96E-04	
Calibration of Reference thermometers	$\cong t_c$	°C	0.002 2	Normal	≡	1	1.00E-03	
Drift of Reference thermometers	$\cong t_d$	°C	0.002	Rectangular	√3	1	1.15E-03	
Temperature bath Stability	$\cong t_e$	°C	0.002	Rectangular	√3	1	1.15E-03	
Temperature bath Uniformity	$\cong t_u$	°C	0.001	Rectangular	√3	1	5.77E-04	
<b>Characteristics of the CTDs</b>								
Resolution of CTD	$t_i$	°C	0.005	Rectangular	√3	1	0.0029	
Combined uncertainty							°C	0.004
Expanded uncertainty							°C	$k = 2$ 0.008

### 3.5 SELF-HEATING EFFECT OF METEOROLOGICAL TEMPERATURE SENSORS

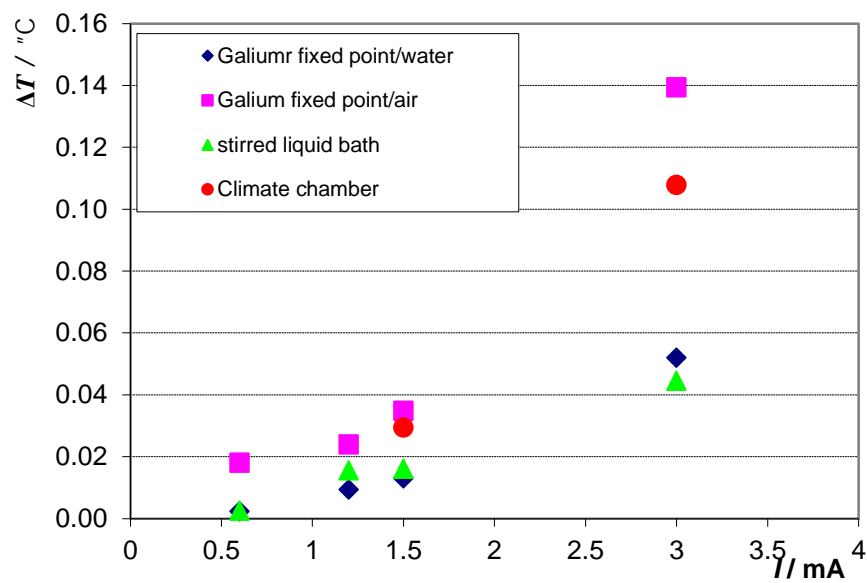


Figure 5.

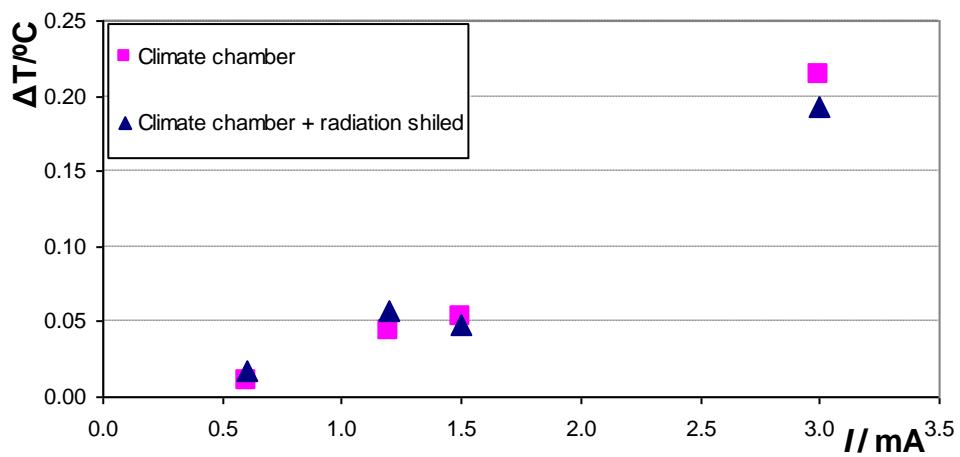


Figure 6.



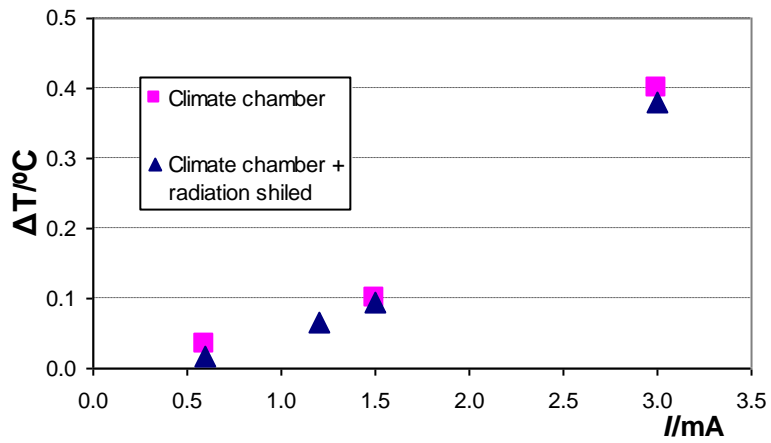


Figure 7.

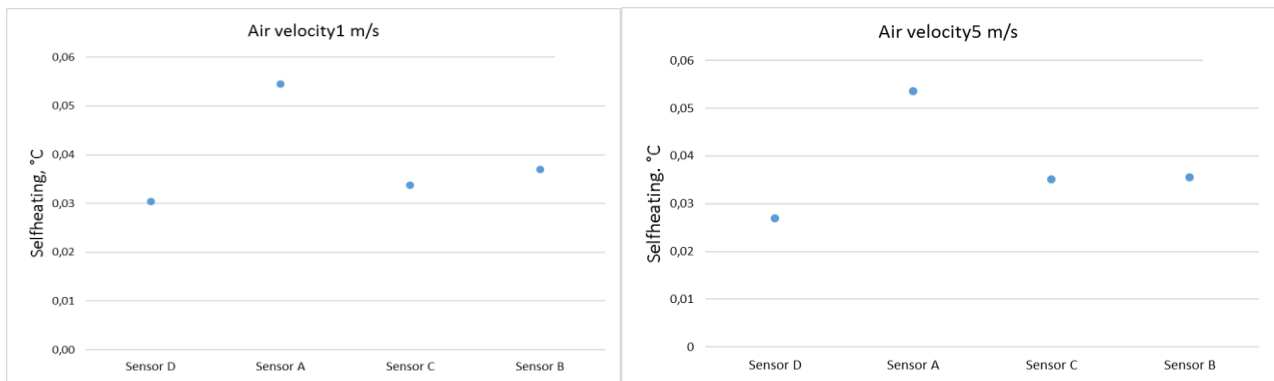


Figure 8

### 3.6 EVALUATION OF THE HYSTERESIS EFFECT OF SOME METEOROLOGICAL THERMOMETERS

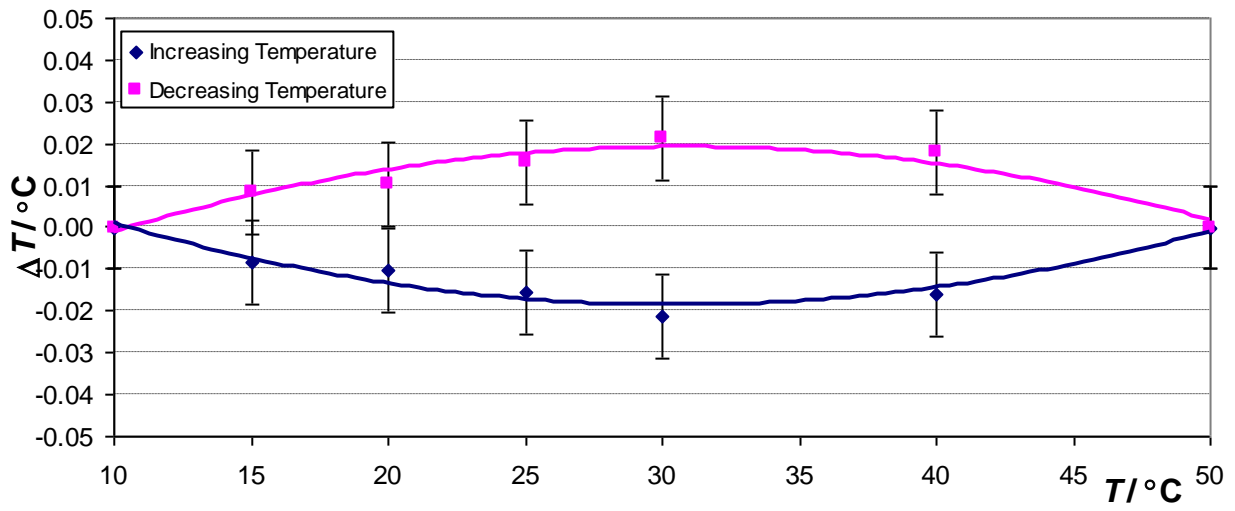


Figure 9.

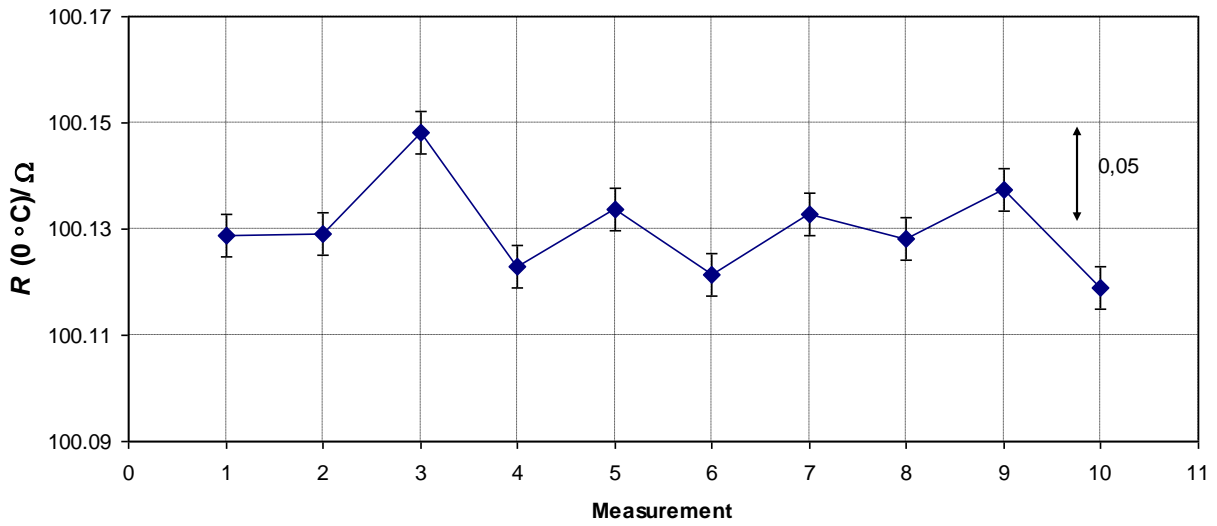


Figure 10

### 3.7 PERMAFROST SENSOR DYNAMIC

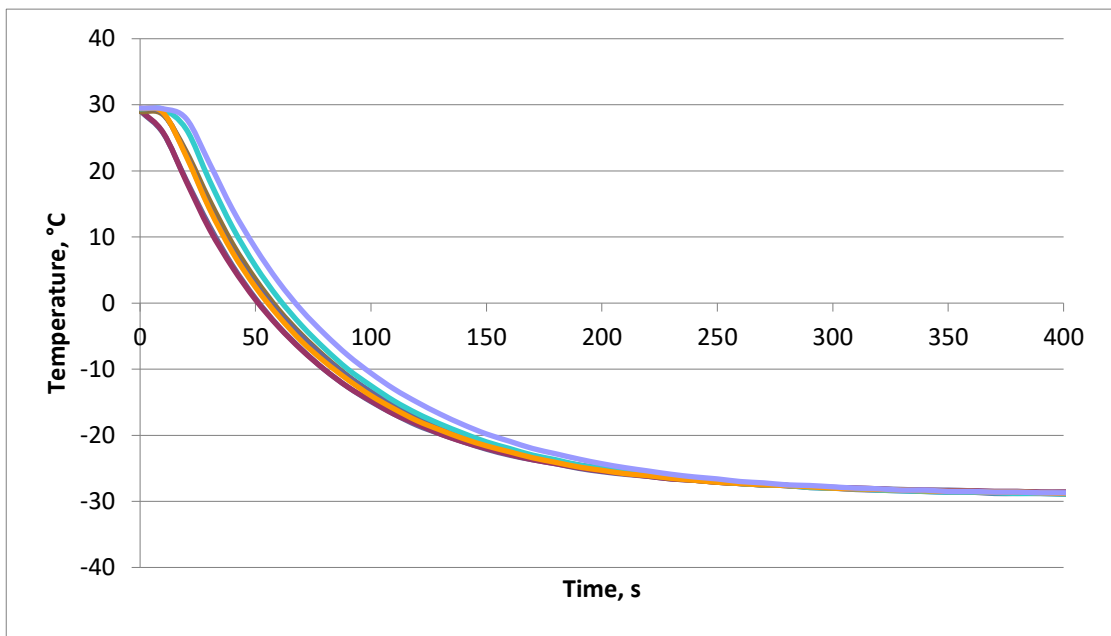


Figure 15.

## 4 CONCLUSIONS AND PROSPECTS

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### 4.1 CONCLUSIONS

### 4.2 FURTHER WORK

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### 4.3 IMPACT

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- ISO 17714:2007 and CCT Task Group for Guides on Thermometry (CCT-TG-GoTh) and Working Group for Humidity (WG-Hu);
- ISO/TS 17892-1:2004 and ISO 11271:2002 on Soil moisture;
- CIMO-XV/Doc. 4 and CIMO Expert team on standardisation documents on siting uncertainty;
- European Earth Observation Programme “Copernicus” ;
- PermaNET network .

### 4.4 ACKNOWLEDGMENTS

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*Comité Consultatif de Thermométrie*

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