The MeteoMet2 project—highlights and results

24 February 2024

1 INTRODUCTION

1.1 BACKGROUND

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± ±

$V VWDWHG E\ *&26 ³ORQJ

E\ FOLPDWH YDULDELOLW\ DQG FKDQJH´ >

1.2 METEOMET

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

Meteomet

MeteoMet

<u>*MeteoMet 1 and 2*</u>

KDQG EHFDXVH PDQ\ RI WKH µODQG¶ (&9V

MeteoMet

2 TOPICS IN METEOMET2

2.1 AIR: HUMIDITY AND TEMPERATURE MEASUREMENTS ABOVE GROUND LEVEL

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

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 deep-sea thermometers.

2.2.3 Ocean temperature sensors based on optical fibre Bragg gratings.

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7KLV SURMHFW LV GHVFULEHG IXUWKHU LQ WKH µ+LJKOLJK

2.2.4 Test and calibration facility for refractive-index salinometers.

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7KLV SURMHFW LV GHVFULEHG IXUWKHU LQ WKH µ+LJKOLJK

2.3 LAND: TEMPERATURE AND HUMIDITY MEASUREMENTS IN GROUND LEVEL MEASUREMENTS

Meteomet

LQ WKH µ+LJKOL

5 H J D U G L Q J (& 9 ¶ V

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

LVVXHV ZHUH VROYHG DQG WHVWV ZHUH SHUIRUPHG WR HY

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

¶V XQFHUWDLQW\

2.3.9 Mars Simulator

$ VSHFLDO IDFLOLW\ FDOOHG ³0DUV VLPXODWRU´ DW $D
RSHUDWLQJ LQ ³(DUWK FRQGLWLRQV´ IRU WH

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

WKH 8QLWHG .LQJGRP¶V QDWLRQDO ZHDWKHU VHUY

2.4 CRYOSPHERE

3 SELECTED HIGHLIGHTS

3.1 SI TRACEABLE HUMIDITY CALIBRATIONS FOR RADIOSONDES

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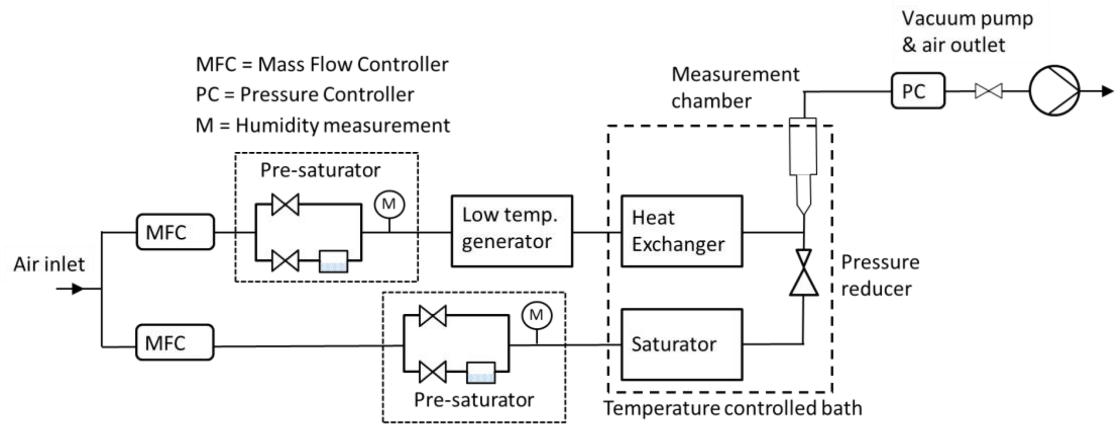

Figure 1.

3.2 A CORRECTION FOR THE TEMPERATURE HISTORICAL SERIES

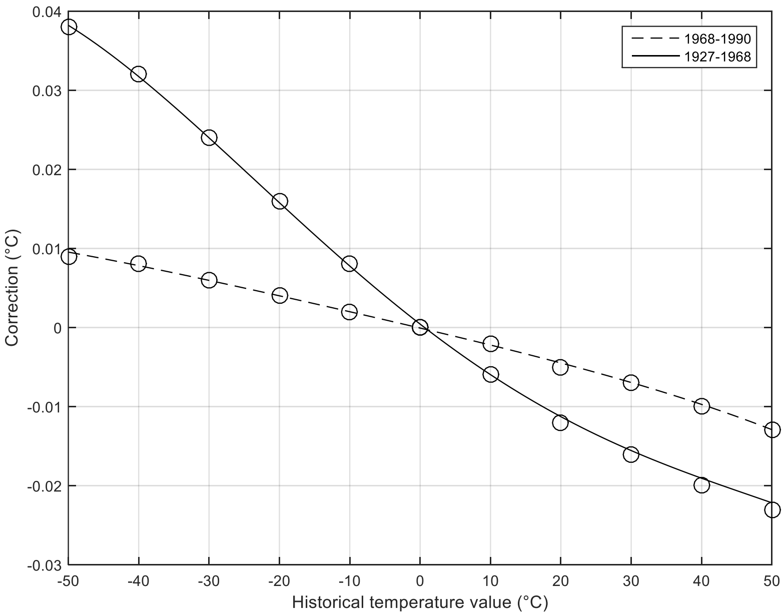

Figure 2

3.3 EXPERIMENTAL SEA TEMPERATURE MEASUREMENTS BY DISTRIBUTED TEMPERATURE SENSORS

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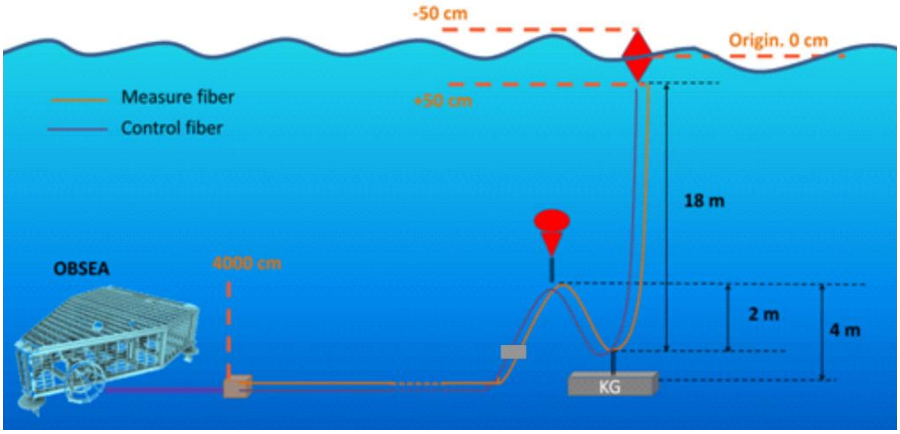


Figure 3.

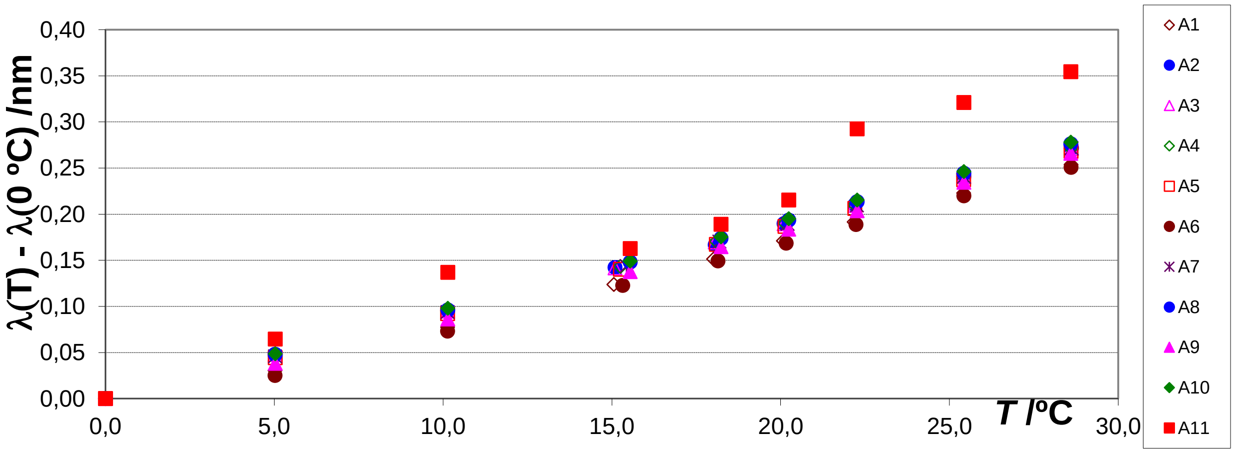


Figure 4.

3.4 CALIBRATION OF CONDUCTIVITY, TEMPERATURE AND DEPTH SENSORS

7KH EDWK VKRZV D VWDELOLW\ DQG XQLIRUPLW\ RI P. LQ

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
	Measuring system of the laboratory						
Resistance bridge calibration	L_p	≅ |	1.00E-06	Rectangular	√3	R_s/sp	1.48E-04
Drift of the resistance bridge	≅ L	≅ |	6.10E-06	Rectangular	√3	R_s/sp	9.03E-04
Reference Resistor calibration	R_s	≅	2.80E-04	Normal	2	L_{ref}/sp	7.18E-04
Drift reference Resistor	≅R_{sd}	≅	1.00E-04	Rectangular	√3	L_{ref}/sp	2.96E-04
Calibration of Reference thermometers	≅t_c	ºC	0,002 2	Normal	≅	1	1.00E-03
Drift of Reference thermometers	≅t_d	ºC	0.002	Rectangular	√3	1	1.15E-03
Temperature bath Stability	≅t_e	ºC	0.002	Rectangular	√3	1	1.15E-03
Temperature bath Uniformity	≅t_u	ºC	0.001	Rectangular	√3	1	5.77E-04
	Characteristics of the CTDs						
Resolution of CTD	t_i	ºC	0.005	Rectangular	√3	1	0.0029
			Combined uncertainty		ºC		0.004
			Expanded uncertainty		ºC	k = 2	0.008

3.5 SELF-HEATING EFFECT OF METEOROLOGICAL TEMPERATURE SENSORS

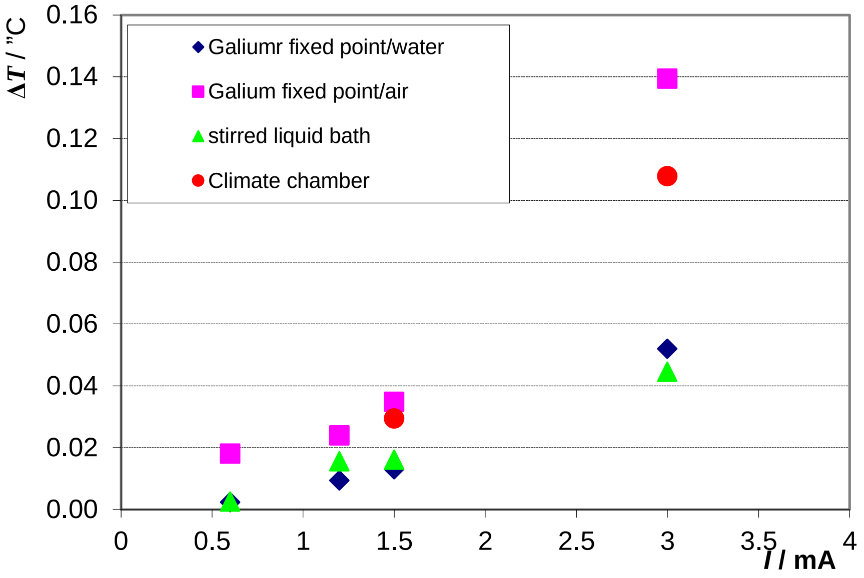


Figure 5.

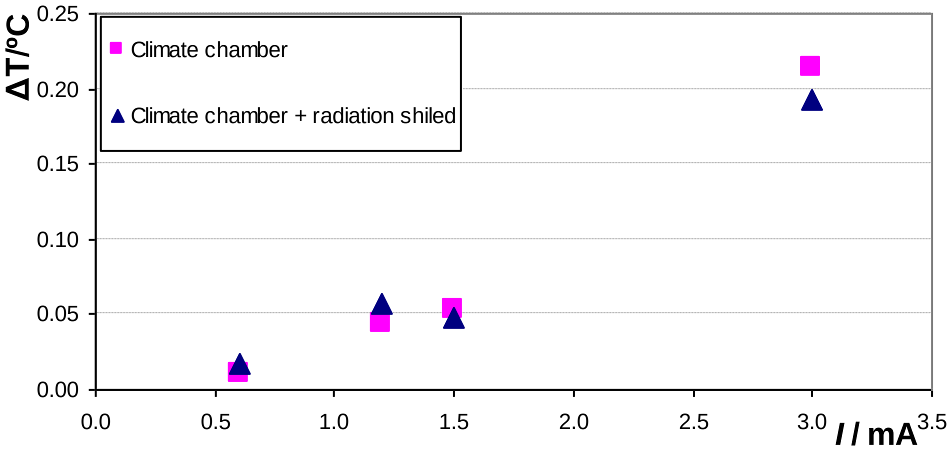


Figure 6.

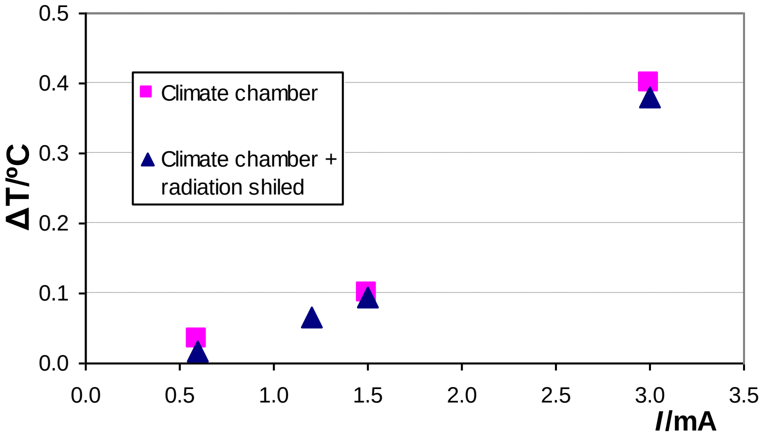


Figure 7.

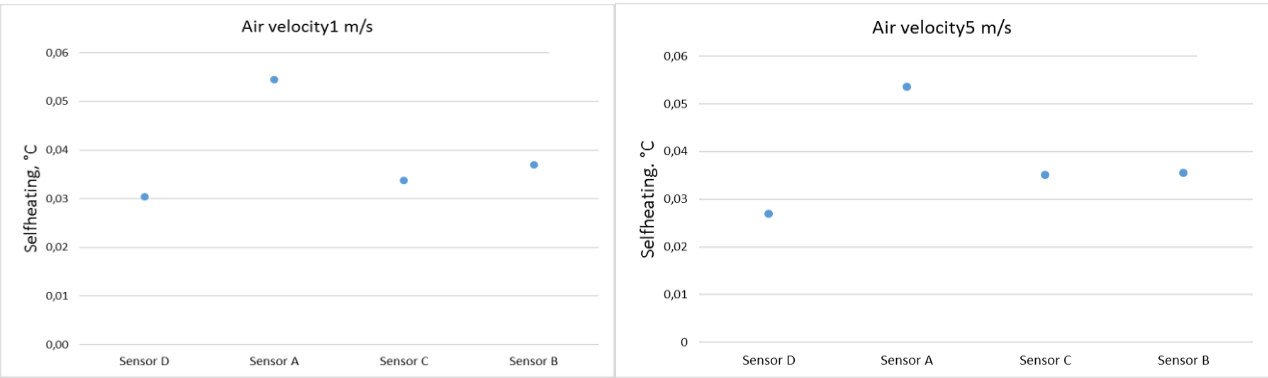


Figure 8.

3.6 EVALUATION OF THE HYSTERESIS EFFECT OF SOME METEOROLOGICAL THERMOMETERS

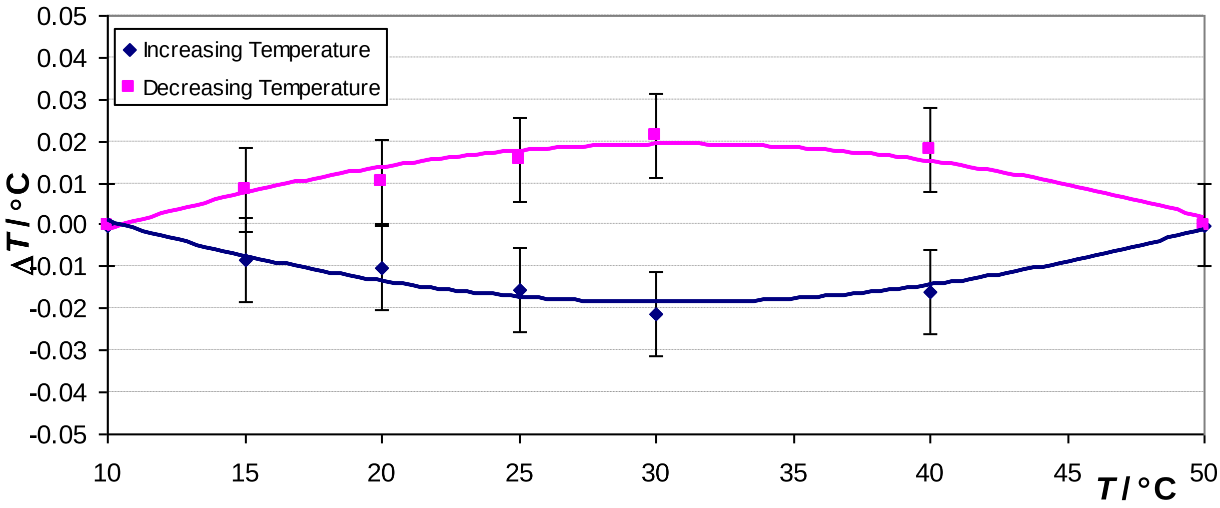


Figure 9.

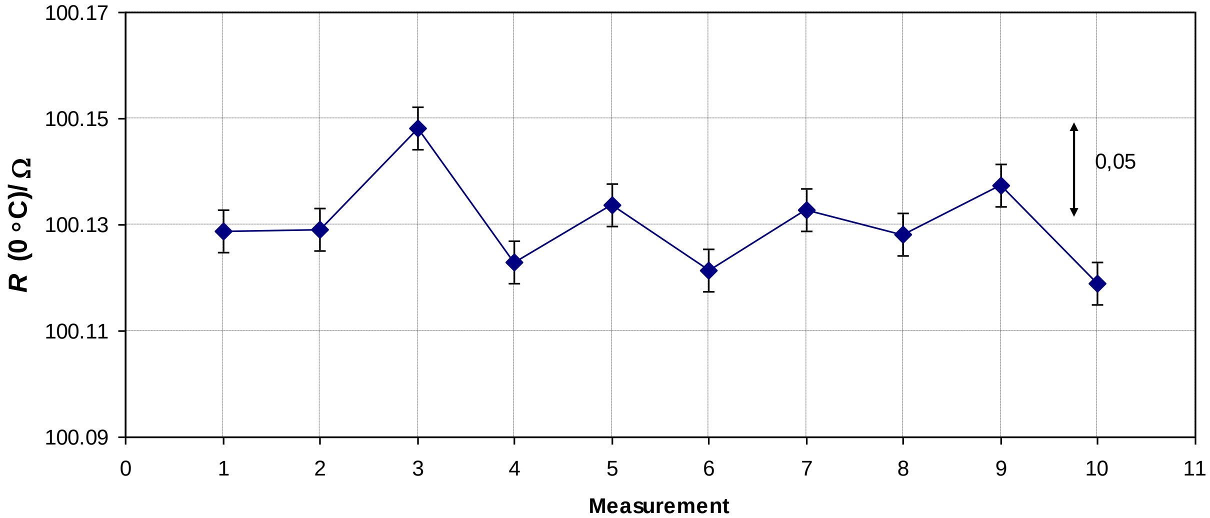
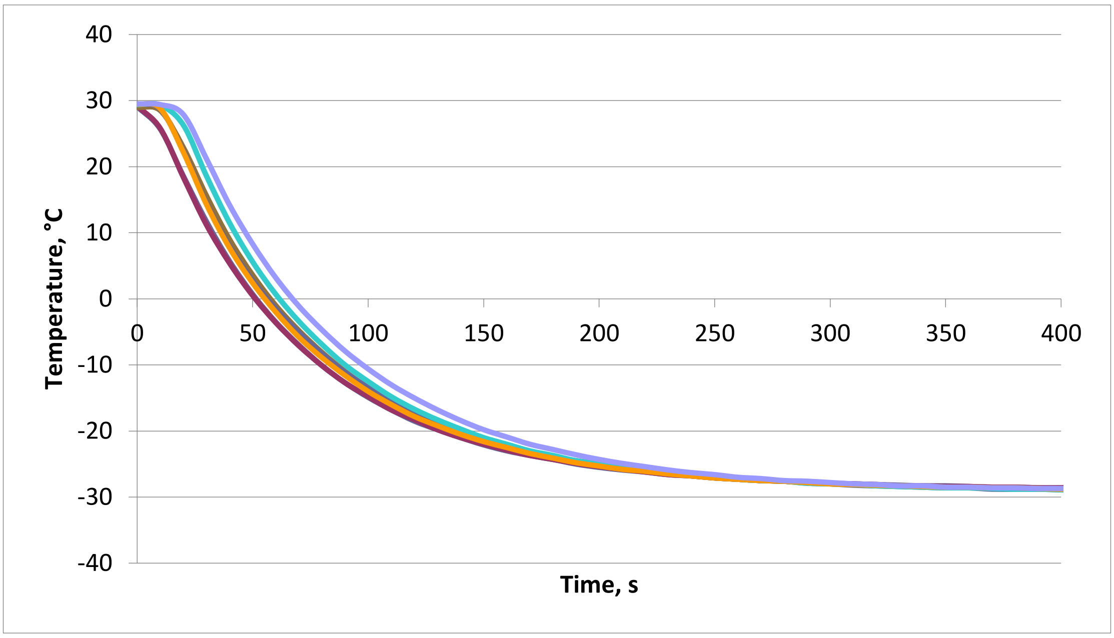


Figure 10.

3.7 Permafrost sensor dynamic



40
30
20
10
0
-10
-20
-30
-40
Temperature, °C
0
50
100
150
200
250
300
350
400
Time, s

Figure 15.

4 CONCLUSIONS AND PROSPECTS

4.1 CONCLUSIONS

4.2 FURTHER WORK

ZKLFK LQFOXGHG DQ ³$UFWLF 0HWURORJ\ &DPSDLJQ´

F VWXGLHV UHODWHG WR WKH XQGHU

RI (DUWK¶V HYROXWLRQ DQG PRVW LPSRUWDQWO\ I

4.3 IMPACT

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6ORYHQLD 53 3LHPRQWH 9DO G¶$RVWD

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QWHUQDWLRQDO &RQIHUHQFH RQ ³0HWURORJ\ IRU 0H

- 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

4.5 REFERENCES

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PHWHRURORJLFDO ODERUDWRULHV 9 %HJHã * HW DO

@ *URVHOM ' %RMNRYVNL - %HJHã *

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Annex 1.

Table 1.

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Table 2.

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	:URFáDZVNL	
	±	

¶ 9DOOH G¶$RV¶WD 1

± ,VWLWXWR GL 6FLHQ]H G±HOO¶$WPRVIHUD H GHO

± ±