INTERCOMPARISON
BETWEEN METEO-FRANCE (RA VI RIC)
AND AUSTRALIAN BUREAU OF METEOROLOGY (RA II RIC)

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ABSTRACT

Australian Bureau of Meteorology has developed a transportable suite of reference meteorological instruments suitable for Regional Inter-comparisons of temperature, humidity and pressure. The instruments have uncertainties suitable for this application and can operate independently of local power supplies. They have also been selected for their ability to be used in a large range of situations such as; temperature baths, ambient air, environmental chambers etc and their stability during transport. This paper also outlines an inter-comparison between Australian Bureau of Meteorology and Météo-France using this suite. Results and uncertainties are presented.

RESUMÉ

Le bureau Australien de Météorologie a conçu et réalisé un ensemble transportable de références métrologiques convenant à la réalisation d'inter-comparaisons dans les domaines de la température, humidité et pression. Ces instruments présentent des incertitudes compatibles pour cette application et peuvent être utilisées indépendamment. Elles ont également été choisies pour leur capacité à être utilisées dans une variété de situations telles que les bains de température, les chambres climatiques et pour leur facilité de transport. Ce document présente également une intercomparaison entre le Bureau Australien de Métrologie et Météo-France en utilisant cet ensemble. Les résultats et les incertitudes sont présentées.

1. Introduction

Pressure, temperature and humidity are important state parameters of the atmosphere. Meteorological requirements for temperature measurements primarily relate to the surface, the upper air and the surface levels of the sea and lakes. These measurements are required for input to numerical weather forecast models, for agriculture, hydrology or climatology. According to the CIMO Guide [1], valid observational data can only be obtained when a comprehensive quality control programme is applied to the instruments and the network. Inherent elements of such quality programmes are the calibration and testing of instruments. On an international scale, the extension of Quality Control programmes to include inter-comparisons is important to the establishment of compatible datasets.
Regional Instrument Centres have been established for calibration and maintenance needs. According to the new Terms Of Reference [2], a RIC must participate in, or organize inter-laboratory comparisons of standard calibration instruments and methods.
The Australian Bureau of Meteorology has developed a suitable set of instruments to allow such inter-comparisons to take place. The French Metrology Laboratory of Météo-France subsequently organized an inter-comparison with the Australian Bureau and the RIC's of RA VI (Slovenia and Slovakia) to demonstrate the use of such a set [3].

2. Description

2.1. Introduction

Transfer standards were purchased or developed for the parameters of Pressure, Temperature and Humidity. The devices chosen were selected on the basis of their uncertainty, transportability, cost and the ability to be powered from a wide range of sources. The total cost of the kit including case is approximately Euro 4000. The complete kit weighs approximately 6 kg.

Figure 1. Assembled and packed inter-comparison kit

2.2. Pressure

The instrument presented is a digital barometer PTB 220A from Vaisala. This instrument is composed of three independent pressure sensing cells.

Figure 2. Vaisala PTB220A barometer

2.3. Humidity

The instrument chosen for the humidity transfer standard is the HM70, a hand-held Humidity and Temperature meter manufactured by Vaisala. The chosen probe is a HMP75. This probe is a general purpose probe for humidity measurements and well adapted to meteorology environment. Serial number are A2030005 and A2120024. This sensor is only used as an hygrometer. Temperature was measured by another instrument (see below).

Figure 3. Vaisala HM-70 humidity sensor

2.4. Temperature

The sensor used for temperature calibration is a thermometer from Instrulab 4312A-15-07 System composed of two PT100 Pt 100/ 15A-B5 probes and a display unit.

Figure 4. Instrulab 4312 PT100 temperature Indicator

3. Inter-comparison Results

3.1. Normalised Bias

Normalised Bias B_N is used to analyze the inter-comparison results. The calibrations are uncorrelated as the only common factor is the instrument.
If we considered each bias of each calibration, the Normalized Bias is defined as:

$$B_N = \frac{|B_A - B_F|}{\sqrt{U_A^2 + U_F^2}}$$

where B_A and B_F are respectively the bias (True value – Instrument value) for Australia and France, and U_A and U_F are the associated expanded uncertainties.
The normalized bias should be lower than 1 or less.

3.2. Pressure

The results of the Australian calibration are contained in the "DIGITAL BAROMOTER CALIBRATION CERTIFICATE" N° CALO 07/2570.
The results reported in the calibration certificate are the average of the 3 pressure sensor cells.
The expanded uncertainties are calculated as expressed in the ISO Guide of Uncertainty Measurement [4] with a 95% confidence interval and a coverage factor of 1.98. Uncertainty U_A was 0.06 hPa

Similarly, Meteo France results are based on the average of the 3 measurement cells as reported in the calibration certificate: "CERTIFICAT D'ETALONNAGE" LM P 08023827 et LM P 08033852.
The expanded uncertainties are calculated as expressed in the ISO Guide of Uncertainty Measurement [4] considering a 95% confidence interval and a coverage factor of 2.
Uncertainty U_A is U = 12,3 Pa + 3,4 10^{-5} * P, Pressure expressed in Pa.

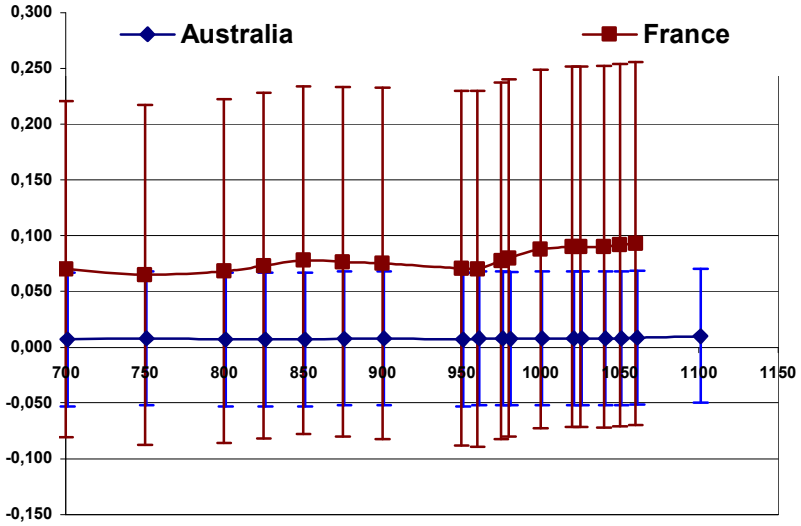

Figure 5: Compared bias from Australia and France

Differences are about 10 Pa with little divergence between the two curves (fig. 5). The associated uncertainties are respectively 16,2 and 6 Pa for the French and the Australian laboratories.

Pressure	Australian correction	Uncertainty	French corrections	Uncertainty	Normalized Bias
1050	0,008	0,060	0,092	0,163	0.482
1000	0,008	0,060	0,088	0,161	0.466
950	0,007	0,060	0,071	0,159	0.375
900	0,008	0,060	0,075	0,158	0.397
850	0,007	0,060	0,078	0,156	0.425
800	0,007	0,060	0,068	0,154	0.369

Table 1. Results of the Météo-France/Australia Pressure Inter-Comparison

As seen in the worksheet, the Normalised Bias were between 0.3 and 0.49. These results are good but should be better. This fact is due to the low drift between French and Australian calibrations. The French metrology laboratory performed a second calibration two months later and the results were similar. Slovakian and Slovenian calibrations with the same instrument set has given similar results [3]. Upon return to Australia, a second Australian calibration has been performed. The results are confirmed.

3.3. Humidity

The result of the French Metrology Laboratory are available through the "CERTIFICAT D'ETALONNAGE" n° LMHU0801003 2008/02/20 and "CONSTAT DE VERIFICATION" n° LMHO08020212 2008/03/14. Calibrations were performed using two different methods. The first used saturated salt solutions as the humidity generator and a Vaisala HMI 36 as the working reference standard. This method is accredited by the COFRAC (French accreditation body). The second calibration was performed using a two temperature bench.
The results of the Australian calibration are available through the "ELECTRONIC HUMIDITY PROBE VERIFICATION CERTIFICATE" CAL07/2517 of 2007/11/06. The Bureau use a Dew point Mirror model OPA10AG100 from General Eastern and calibrated by the Australian National Measurement Institute. The humidity generator was a Thunder Scientific two pressure humidity generator, model 1200 serial number 070 1032.

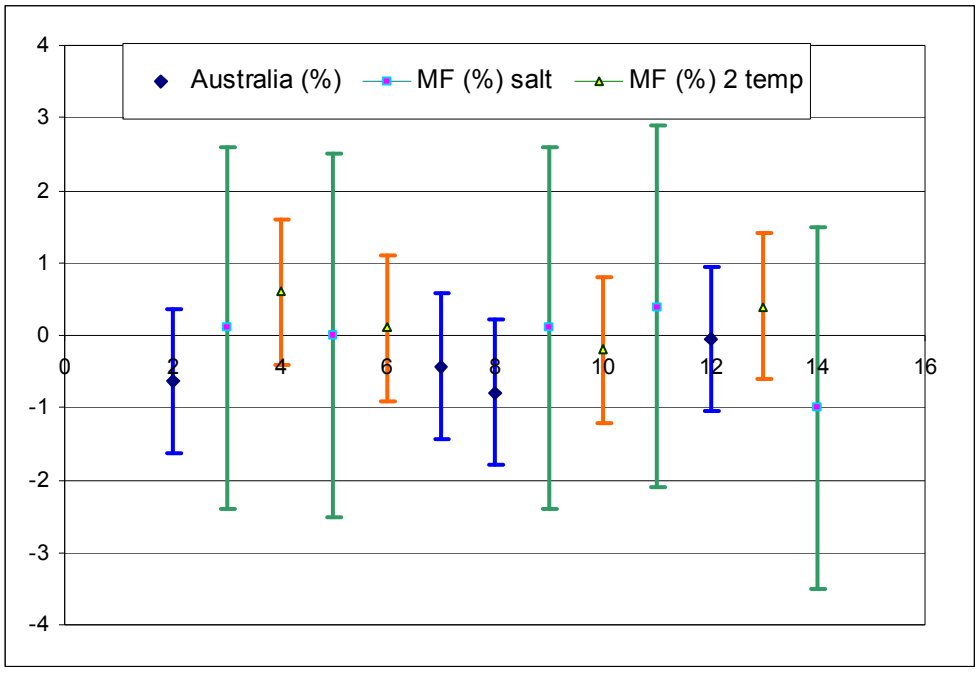

Figure 6: Humidity comparison (bias versus humidity %)

The results use for this comparisons are the five values from 10.7 to 95.8 % obtained with the accredited method. The Australian values are available from 10 to 80%, for more details see Table 2.
The uncertainties which are respectively equal to 2% for Meteo France and 1% for the Australian Bureau are also given.

Standard (%)	Correction Australia (%)	U -	Correction LM (%) Salt Solution	U ±(%)	Correction LM (%) 2 temp bench	U ±(%)	Normalised Bias
10	-0.64	1	0,1	2,5	0,6	1,6	0,27
35	-0.43	1	0	2,5	0,1	1,6	0,16
50	-0.79	1	0,1	2,5	-0,1	1,6	0,33
80	-0.05	1	0,4	2,5	0,4	1,6	0,17

Table 2. Results of the Météo-France/Australia Humidity Inter-Comparison

3.4. Temperature

The result of the French Metrology Laboratory are available through the "CERTIFICAT D'ETALONNAGE" N° LM T 08022548 of 18/02/2008.
The result of the Australian calibration are presented in "TEMPERATURE SENSOR CALIBRATION CERTIFICATE" CAL07/2564.

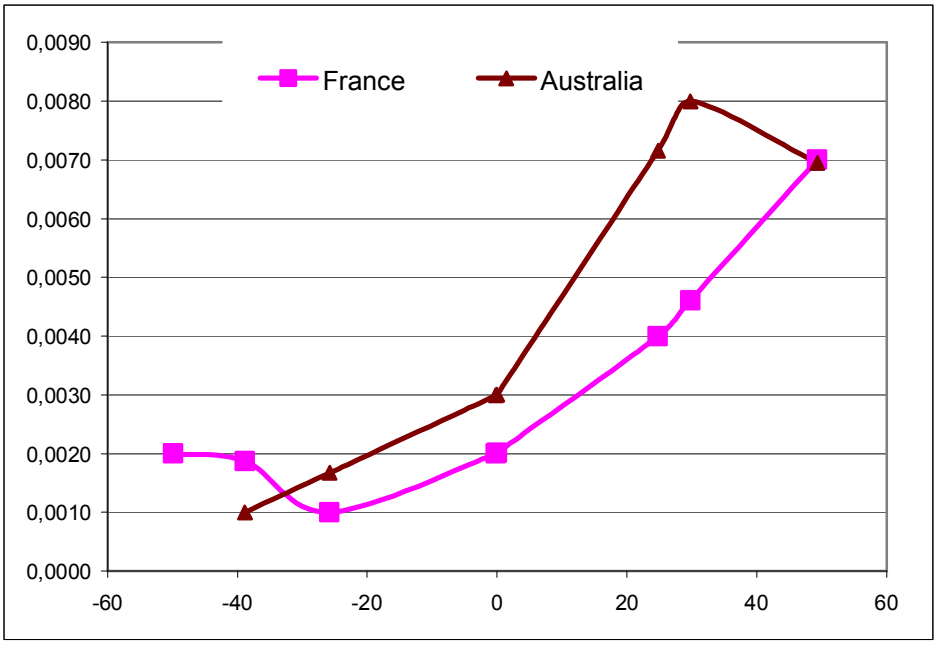

Figure 7: Temperature comparison (bias versus temperature °C)

Differences are approximately 0.01°C. This is insignificant compared to the uncertainties which are 0.035 for France and 0.018 for Australia respectively. The graphic (fig. 7) do not show the uncertainty because there are significantly larger than the differences between the two curves.

T °C	France		Australia		Bias	Normalized Bias
	Bias	U	Bias	U		
-40	0,0019	0,035	0,0010	0,0018	0,0009	0,02
-25	0,0010	0,035	0,0017	0,0018	0,0007	0,02
0	0,0020	0,035	0,0030	0,0018	0,0010	0,03
25	0,004	0,035	0,0072	0,0018	0,0032	0,08
30	0,0046	0,035	0,0080	0,0018	0,0034	0,09
50	0,007	0,035	0,0069	0,0018	0,0001	0,00

Table 3. Results of the Meteo-France/Australia Temperature Inter-Comparison

The normalized bias are lower than 0.09 (see table 3). Therefore, the calibrations are similar and within the stated uncertainties of the two laboratories.
Australia appears to have a problem around 30°C which is being investigated.

4. Conclusion

From these results it can be concluded that:

1. the RICs of Meteo France and Australia are operating within their stated uncertainties with respect to temperature, pressure and humidity;
2. the instruments chosen for the inter-comparison are stable for international transport by air and are therefore suitable for future inter-comparisons betweens RICs and NMHS;
3. the procedures adopted for this inter-comparison are suitable for international inter-comparisons;
4. Inter-comparisons are always very helpful for all participants and should be organized by RIC and promoted by WMO.

5. Bibliography

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