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Comparison of the Regional Association V and A Fuess (S/N F6754) Standard Barometer for the Philippines Atmospheric, Geophysical and Astronomical Services Administration

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1. INTRODUCTION

A comparison of the Philipines Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) Fuess (F6754) barometer with the Regional Association Five (RAV) Hass barometer (3063) was carried out over the period 6th February 1997 to 16th April 1997. The aim of this comparison was to establish the accuracy of the PAGASA standard barometer. The last comparison of this type with PAGASA occurred in 1991 [1].

2. EXPERIMENTAL

Three transfer barometers (digital aneroid barometers manufactured by Negretti and Zambra CBM 106, 115 and 120) and one Paroscientific electronic barometer were shipped to PAGASA in November 1996. They were returned to Bureau of Meteorology in September 1997. These barometers were compared against the RAV Hass for a period of two weeks both prior to shipping, and on return to the Bureau of Meteorology. The comparisons were carried according to Bureau of Meteorology Observations Instruction No. 88/6 [2].

Both the before and after tour index correction for the transfer standard digital aneroid barometers (DAs) were examined for outliers or unusual results. The conditions during testing, such as the wind speed or pressure trend, were not noted for a large number of the observations. If the observation condition failed particular criteria or there was any doubt about the observation they were removed. In total 2 observations were deleted from the index checks and two pairs from the comparison data.

3. RESULTS

The data was analysed according to the standard procedure for analysis of intercomparisons [3]. Three modifications to this procedure were made due to better understanding of the equipment and better process of testing. The uncertainty attributed to the variation from steady rates of change in index correction was revised down from 0.08 to 0.03hPa. This was based on analysis of the last two years regional comparison index corrections for these barometers. Similarly the impact of the air transport was revised down from 0.15 to 0.06hPa based on the same data. The third change was the introduction of an uncertainty for the variability between DAs, estimated at 0.025hPa. (See Table 1)

These changes to the uncertainty budget revise the contribution to the overall uncertainty from the test conditions and shipping down from 0.177 to 0.087hPa. This reduces the final estimate of uncertainty down from 0.096 to 0.057hPa for all four transfer barometers from 0.135 to 0.080hPa for CBM 115 and 120. (See Table 1)

Figures 1 to 4 in Appendix 1 and Table 2 show the before and after tour results for the transfer barometer used in this comparison. The bars are the individual observations, the solid line is the mean correction and the dotted lines are the 95% confidence intervals for the mean. It can be seen from these results that DA CBM 106 and the Paroscientific shifted their calibration significantly during the tour. This was also reflected in the comparison results for CBM106, which was 0.13hPa higher than the other barometers, 0.670 to 0.439hPa. Because of the unusually long time the barometers were away (10 months) it was decided that these two barometers should not be used in the determination of the correction of the Fuess to the RAV barometer. (See Table 1).

The results of the comparison of the Fuess to the transfer barometers are given in Figures 5 to 8 in Appendix 2 and Table 1. The DA CBM 106 is clearly in error compared to the other barometers. The results for the comparison using the Paroscientific barometer appear consistent, however as previously mentioned deviation in the before and after index corrections means that it has not been used to establish the correction for Fuess F6754.

Table 1 Calculation of correction and uncertainty for comparison of Fuess (S/N F6754) to RAV Hass Barometer (S/N 3063)

Difference to RAV	CBM106	CBM115	CBM120	Paros55745
Mean	0.6697	0.4165	0.4617	0.4514
Number of Samples	34	34	34	34
Mean All	0.500			
Mean (CBM 115, 120)	0.439			
Uncertainty	**CBM106**	**CBM115**	**CBM120**	**Paros55745**
In the index correction XI, Determined from the sample standard deviation before and after comparison	0.021	0.017	0.021	0.020
In the mean difference between the transfer DA barometers and the Fuess	0.041	0.045	0.033	0.034
Sub total for measurement process	*(0.046)*	*(0.048)*	*(0.040)*	*(0.039)*
Estimated systematic error in the observers reading of the RAV standard barometer.	0.02	0.02	0.02	0.02
Estimated systematic error in the observers reading of the Philippine's standard barometer.	0.05	0.05	0.05	0.05
Estimated systematic error in the observers reading of the transfer standard DA barometer.	0.02	0.02	0.02	0.02
Sub total for the observations	*(0.057)*	*(0.057)*	*(0.057)*	*(0.057)*
Estimated deviation due to the use of the DAs in conditions different from the calibration against the RAV standard.	0.05	0.05	0.05	0.05
Estimated systematic deviation from assumed steady state change in index correction.	0.03	0.03	0.03	0.03
Estimated effect of air transport	0.06	0.06	0.06	0.06
Estimated deviation between transfer DAs.	0.025	0.025	0.025	0.025
Sub total for transport and test conditions	*(0.087)*	*(0.087)*	*(0.087)*	*(0.087)*
U_{95}	0.114	0.115	0.112	0.112
U_{95} All	0.057			
U_{95} (CBM 115, 120)	0.080			

Table 2 Before and after tour results for comparison of the transfer standards against the RAV standard.

		DA (CBM106)	DA (CBM115)	DA (CBM120)	Paros (55745)
Before Tour	**Average**	-0.035	-0.034	-0.017	0.085
	U95	0.016	0.010	0.015	0.016
	Count	19	19	19	17
After Tour	**Average**	-0.005	-0.038	-0.015	0.134
	U95	0.011	0.008	0.010	0.013
	Count	19	17	18	19
All Data	**Average**	-0.020	-0.036	-0.016	0.111
	U95	0.011	0.008	0.010	0.013
	Count	38	36	37	36

The final correction for the Philippines Fuess F6754 barometer is estimated at 0.439 ± 0.08hPa. This means that the Philippines barometer reads 0.44 hPa lower than the RAV reference. This is a significant difference and a considerable shift in the calibration from the last comparison in 1991 [1]. The outcome of this comparison was a correction 0.22 ± 0.12 hPa.

The temperature correction tables used during the comparison were checked to ensure the bias was not a result of fault in these. The range of pressure covered in this comparison was slightly difference to the previous comparison; 1004 to 1012hPa compared to 1000 to 1008hPa during the 1991 comparison. However analysis of the results of both comparisons as a function of pressure showed no correlation. This indicates that the different ranges of pressure were not the source of the shift in calibration.

4. CONCLUSION

It is concluded from this comparison that the change in the calibration is a result of the deterioration of Fuess barometer. The most likely cause being contamination of the mercury.

There are two possible solutions to this problem:

1. that the above correction (0.439hPa) be used immediately with the Fuess and a further comparison occur later in 1998 to confirm the result and establish whether it an ongoing deterioration, or

2. immediately replace the barometer and have the new barometer compared to the RAV as soon as possible.

5. REFERENCES

[1] Bureau of Meteorology Instrument Test Report No. 617;
Comparison of the Regional Association V and a Philippines Standard Barometer. By M. Brunt 1991.

[2] Bureau of Meteorology Observational Instruction No. 88/6
Comparison of barometers with the RA V Standard using precision aneroid barometers as transfer standards by A. F. Young 1988.

[3] Bureau of Meteorology, Physics Laboratory Method AN01SAM01;
Processing of data obtained during international comparisons by A. F. Young.

APPENDIX 1 Index Corrections for DAs

Figure 1 Before and after tour results for digital aneroid transfer standard CBM 106.

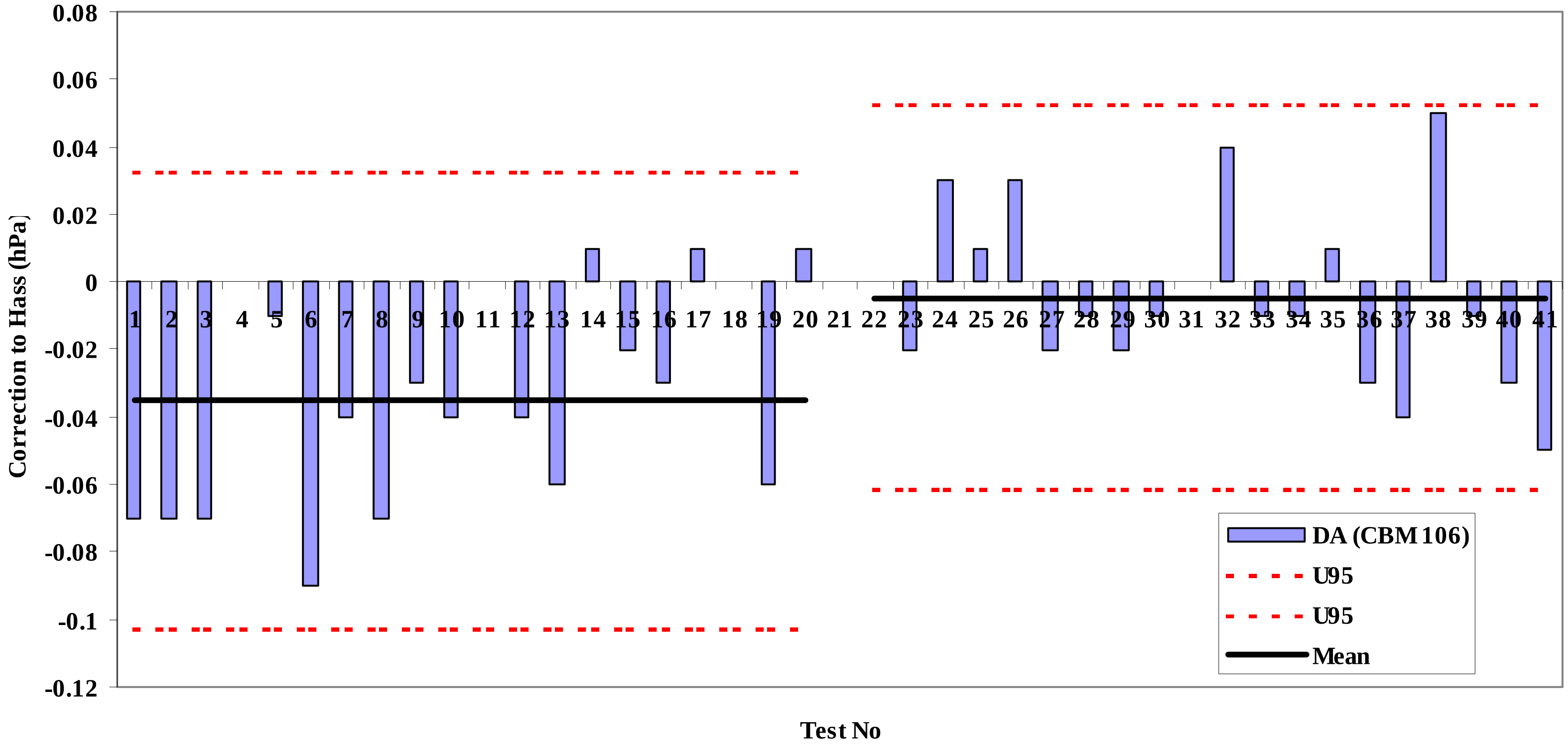


Figure 2 Before and after tour results for digital aneroid transfer standard CBM 115.

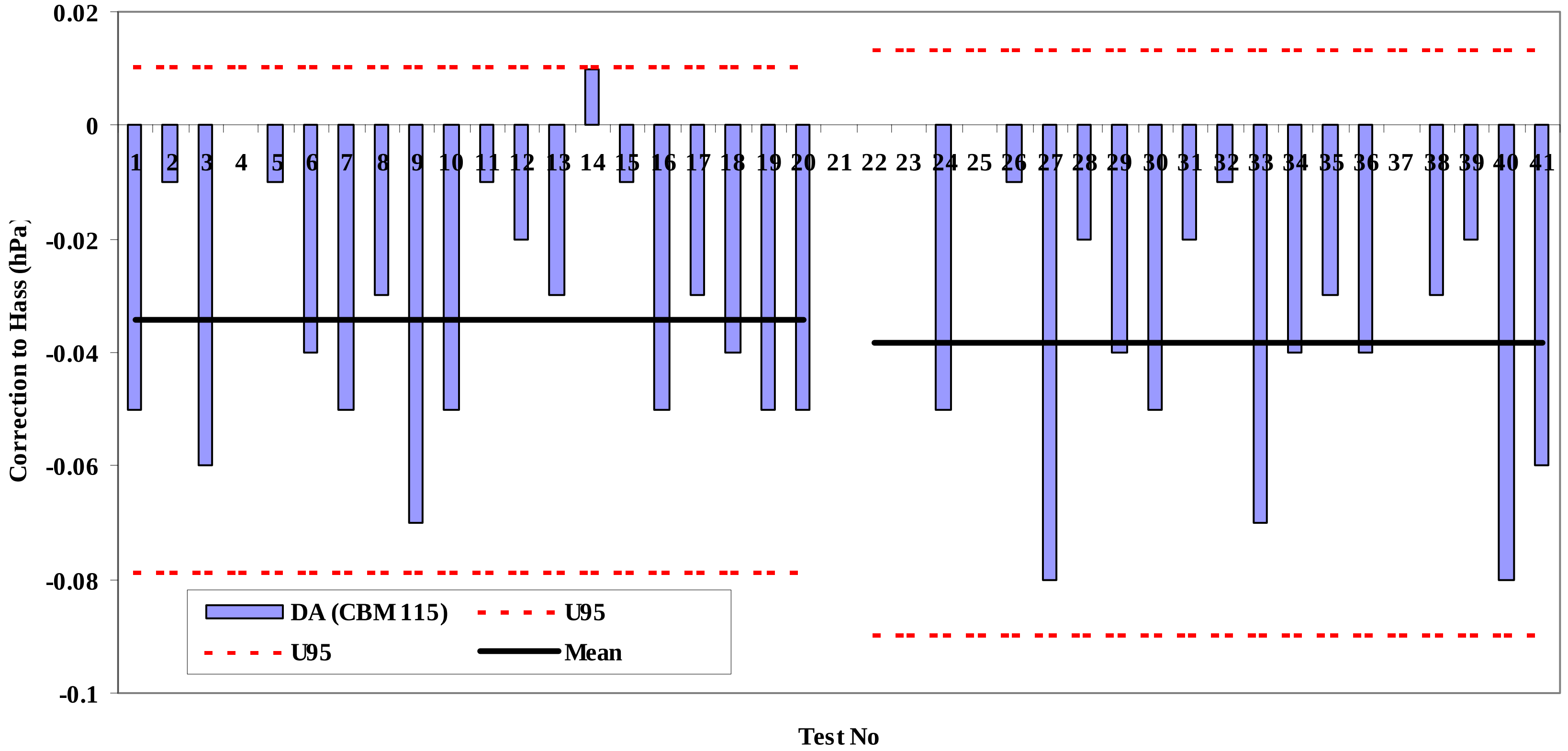


Figure 3 Before and after tour results for digital aneroid transfer standard CBM 120.

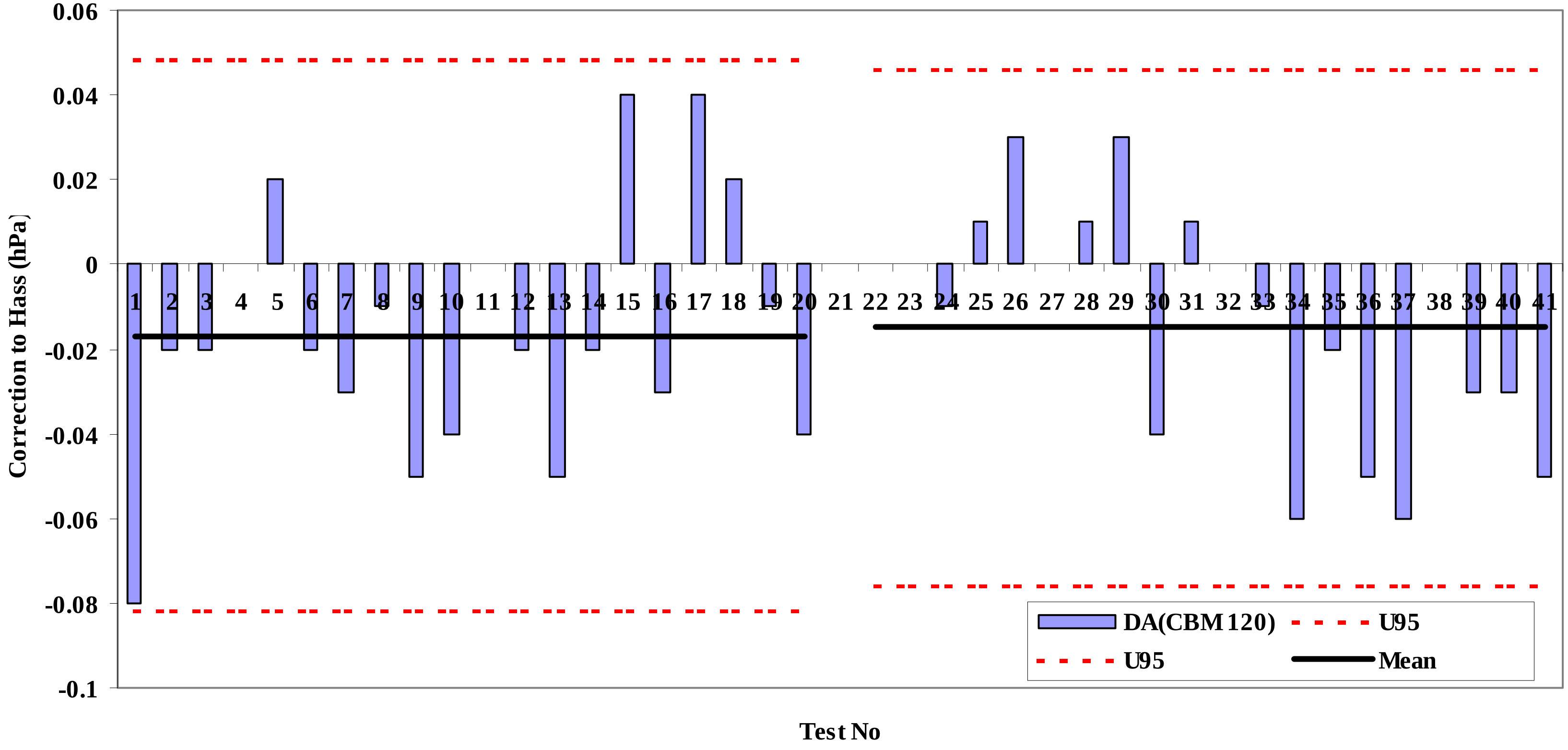
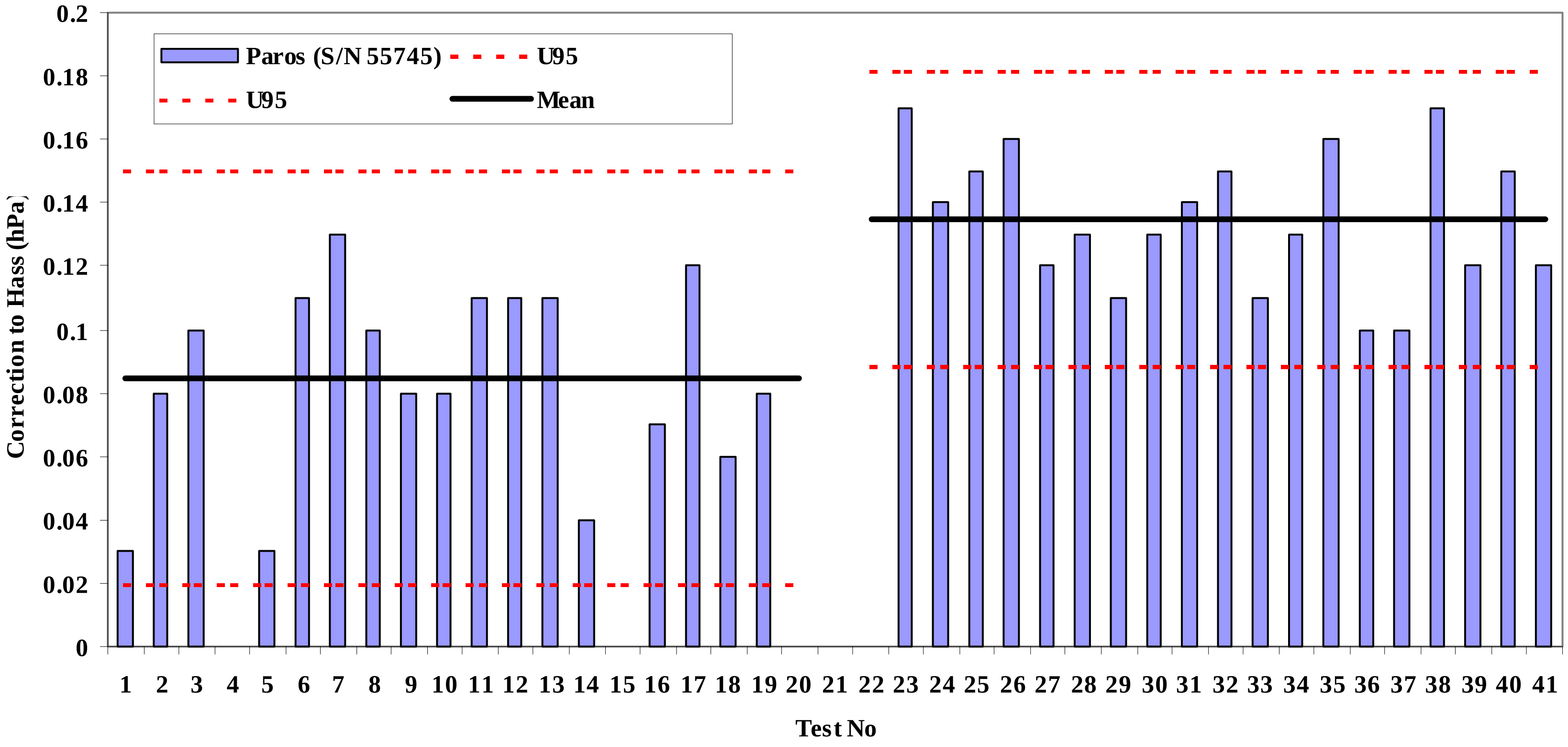


Figure 4 Before and after tour results for Paroscientific transfer standard S/N 55745



Appendix 2 Comparison data between Philippines Fuess F6754 Standard Barometer and Transfer Stnadrads

Figure 5 Plot of comparison data for the Fuess F6754 and DA CBM 106. The bars are the individual observations, solid line is the means of all values and the dotted line is 95% confidence interval for the mean

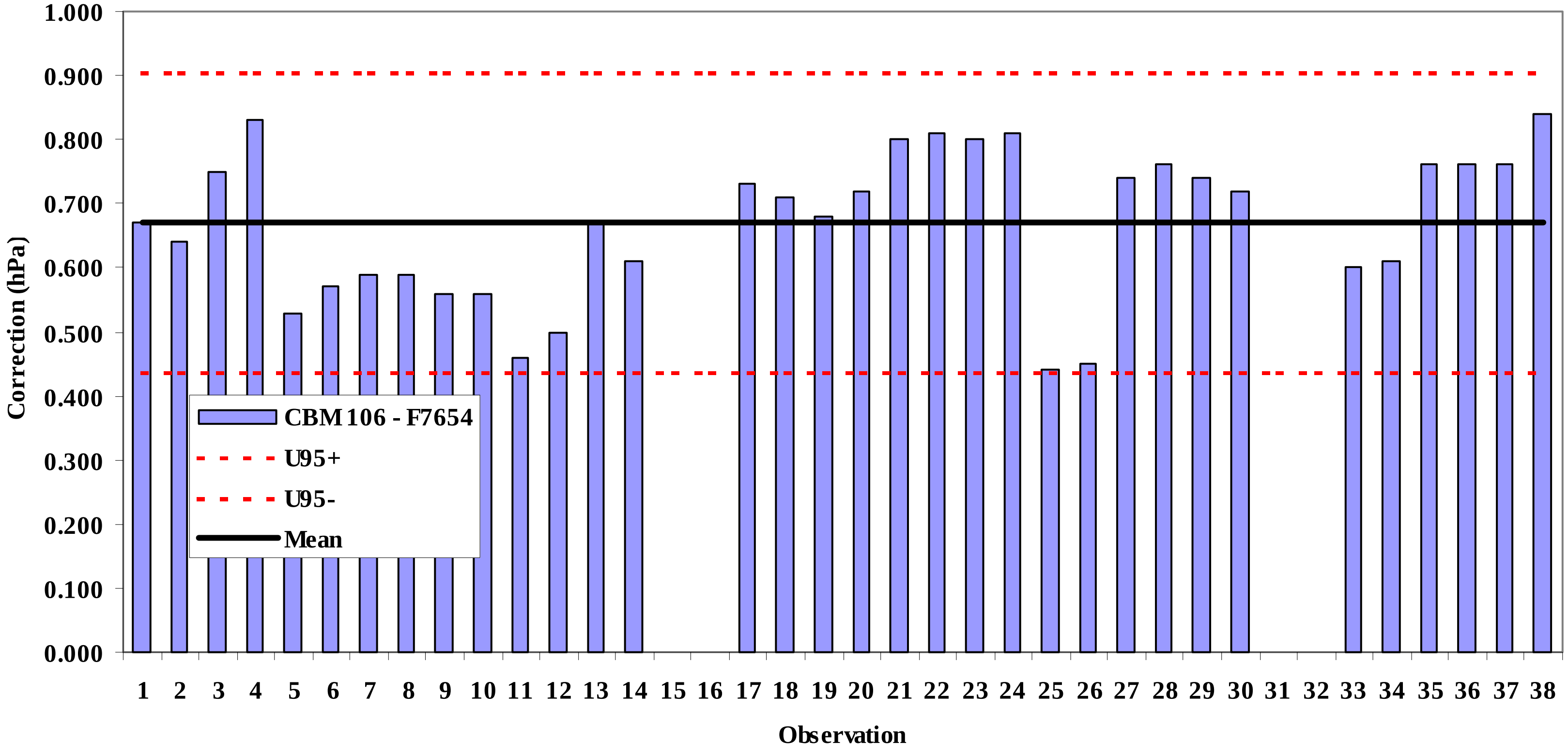


Figure 6 Plot of comparison data for the Fuess F6754 and DA CBM 115. The bars are the individual observations, solid line is the means of all values and the dotted line is 95% confidence interval for the mean

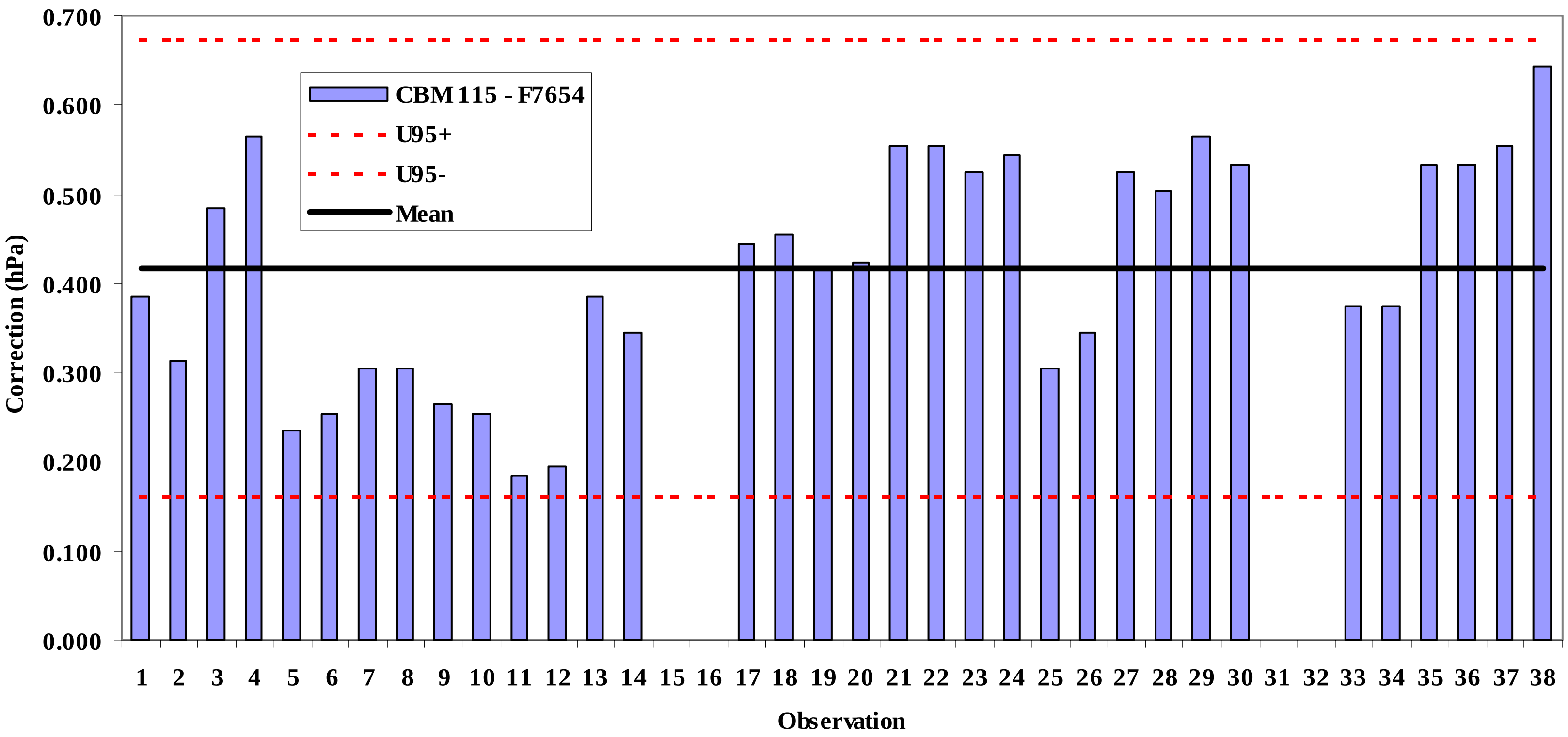


Figure 7 Plot of comparison data for the Fuess F6754 and DA CBM 120. The bars are the individual observations, solid line is the means of all values and the dotted line is 95% confidence interval for the mean

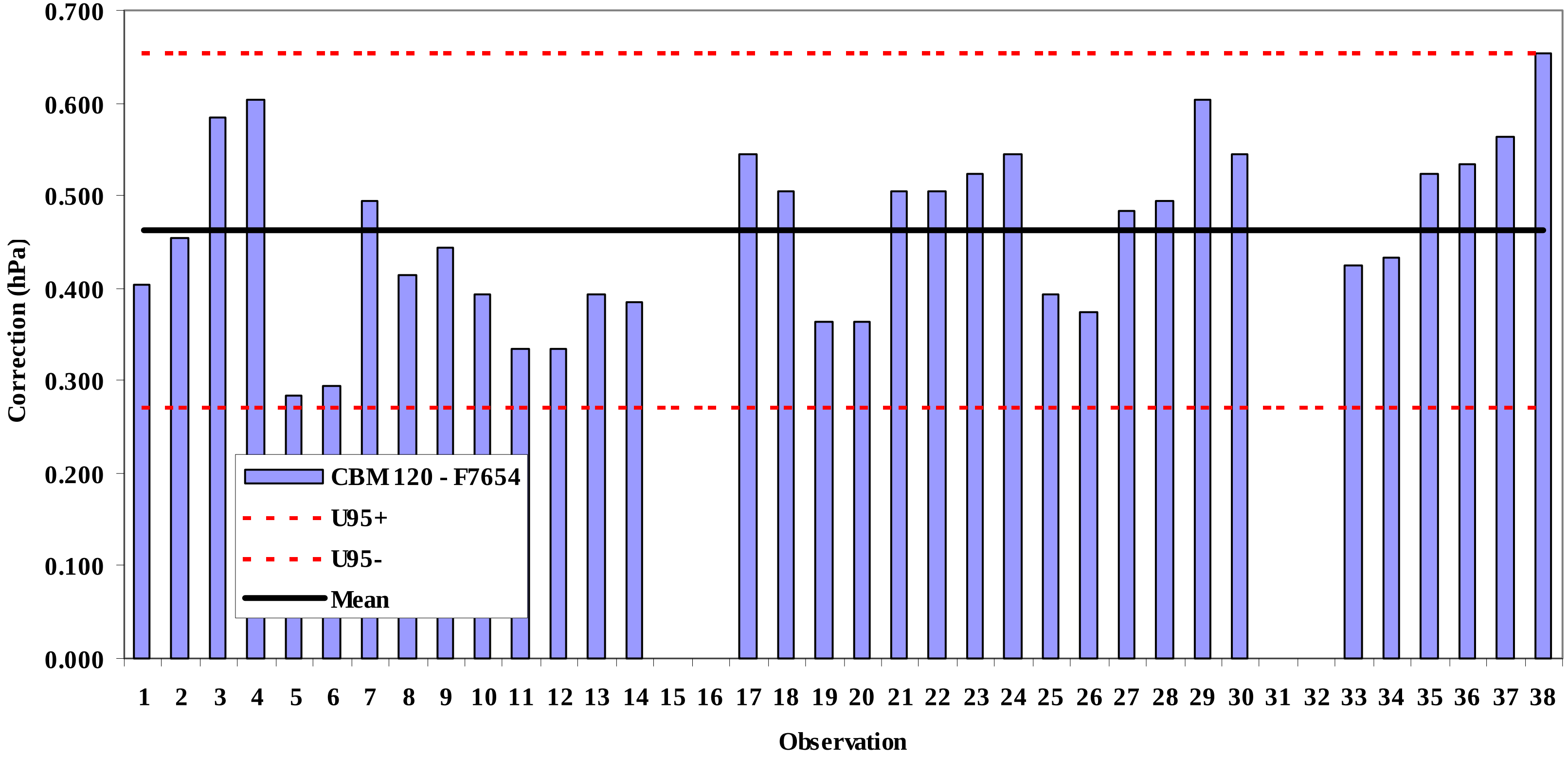


Figure 8 Plot of comparison data for the Fuess F6754 and Paroscientific 55745. The bars are the individual observations, solid line is the means of all values and the dotted line is 95% confidence interval for the mean