Calibration Report on Brewers #033, #157, #183, #185 at Izaña – Aug. 28-Sept. 6, 2009

I. Introduction and Instrument Status:

International Ozone Services Inc. (IOS) completed the ozone and UV calibration and service of the four AEMET Brewer Spectrophotometers. The IOS traveling standard instrument #017 along with local standards #185 and #157 were used as calibration references. #185 had to be shipped to the RBCC campaign (El Arenosillo) and so only had only 2.5 days together with #017 here.

All of these Brewers have operated quite well in the past year except #033 that failed in May 2009. Standard Lamp (SL) ratios R6/R5 from #157 and #185 had not changed in past 2 years. #033 ratios shifted after the rework and #083 has had slow increase in ratios in the past year.

Below is table of results and a graph of all the direct sun ozone/SO_2 results is on the next page. For some half-day periods the ozone is stable enough to obtain independent ETC constants, however the Aerosol Optical Depth (AOD) levels were higher than desired.

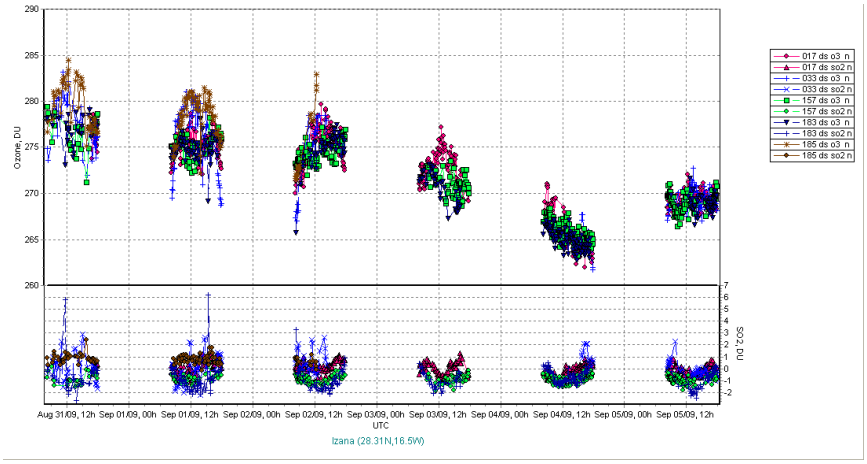
II. Summary of results and changes:

Instrument	#033	#157	#183	#185
SL ratios 2009	2250 / 4230 -> 2270/4275	338 / 580	485/845 -> 335/560	310 / 440
SL ratios change from 2007	+120 / 275	0 / 0	+85/140 -> -65/-145	-4 / -8
ETC constants 2009 (chg?)	3575 / 3910 (+135/290)	1605 / 243 (n/c)	1610 / 250 (-90/-180)	1574 / 80 (n/c)
ETC constants last cal 2007	3440 / 3620	1605 / 243	1700 / 430	1574 / 80
Cal step (old / new)	919 / 912 -> 916 (248)	1026 / 1026	1021 / 1021	284 / 284
Absorpt. Coeff. (no changes)	.3365 / 1.1362	.3397 / 1.15	.3415 / 1.146	.3422 / 1.1445
ICF file recommended	icf24709.033	icf28406.157	icf24709.183	icf24109.185
DCF file recommended	dcf27900.033	dcf25601.157	dcf20206.183	dcf28106.185
DT present/last/setting	38 / 39 / 40	25 / 28 / 32	23 / 24 / 26	30 / 30 / 33
GS const. (change?)	n / a	.998, -10 (n/c)	.992, 8 (small chg)	.995 / 2.5 (n/c)
CI scan on SL to 2007 scan	-35%	+2%	-30 -> -28%	+10 -> 8%
CZ on 2967 Hg line, FWHH	ok, .61nm	ok, .63nm	ok, .62nm	ok, .64nm
Rework done	align ZE + spectr., new SL	new SL	align shutter, new SL	align ZE, new SL

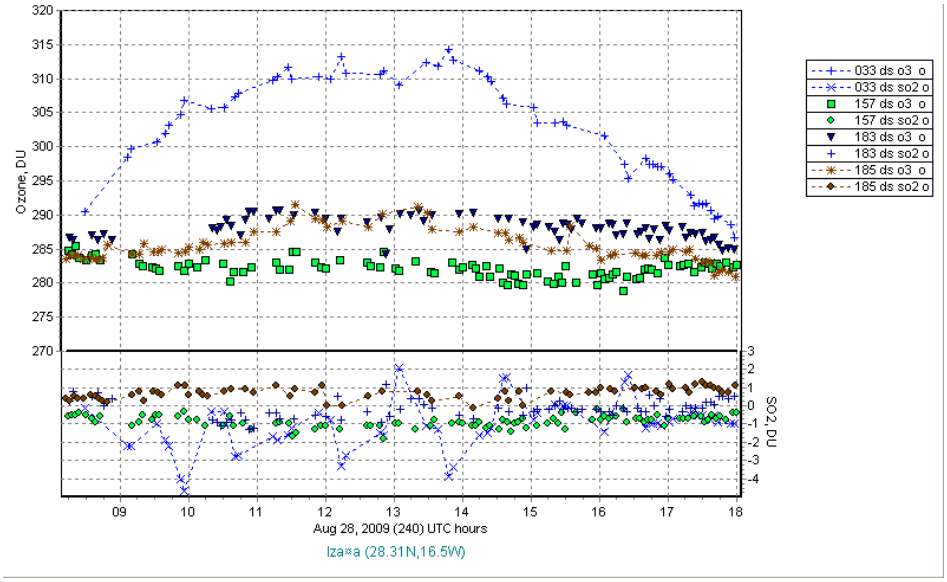
III. Final ETC constants and Ozone Test Results:

The weather co-operated quite well for the 6 days and so many direct sun observations and UV scans were collected. Dispersion tests (dsp) were completed on each instrument using the internal mercury and an external cadmium spectral lamps to check the wavelength accuracy for UV scanning, ozone operating wavelengths, absorption coefficients and slit functions.

Below are the final ozone results of the ozone comparison data collected, using the recommended constants listed above. For #183 the ETC constants were set to 1768/555 for the first 4 days.



Below is graph of the ozone/SO_2 results without any corrections from the 4 local instruments on the day before this visit. #033 showed the greatest differences and #185 had higher ozone results than normal when compared to the very stable #157 instrument.



IV. Servicing and Software changes:

The spectrometer and standard lamp alignment was improved on #033. The shutter assembly alignment to the slits was improved on #183, which resulted in shift in the SL ratios, and the ETC constants had to be adjusted.

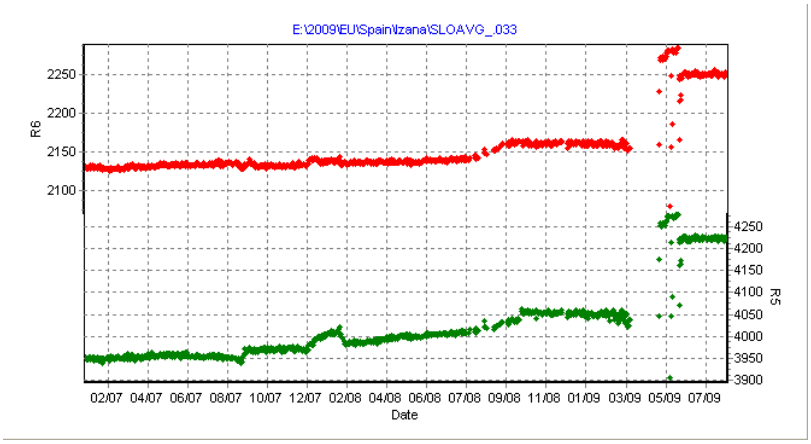
The two micrometer offset constants on #185 were corrected to values of 20, -55 from 0, 0. It was found that if the HP test had been done regularly before HG test that ozone and UV results would likely have been more stable. There were occasions when only HG test was done after a reset of all motors and so this test was being done at different wavelengths on second spectrometer. IOS believes that the shifts in zenith prism alignment on #185 have probably been triggered by the use of the ZE command before siting. During this visit this command was not used and no such problems were encountered. The RE command can be used when it is believed to be necessary to zero motors before siting. The user advised that #185 has had variability in UV results at various times in past 2 years. IOS believes that the change in zenith alignment and the micrometer constants shift are the likely reasons for this instability. The zenith motor has too much torque and periodically runs into end stop and shifts the prism's clamped position. This shift can be first detected by shifts of ~20 steps in zenith solar tracking (horizon correction changes). Some resistors (82 ohm) should be added in the motor wiring to reduce the motor torque.

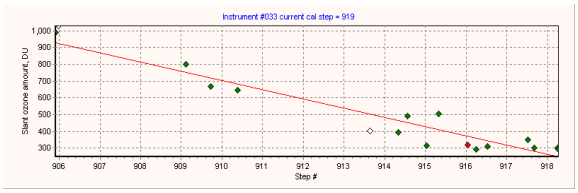
The standard lamp was replaced on #157 and as with the others, cleaning and lubrication as required was done to the micrometer drives and pushrod bearings.

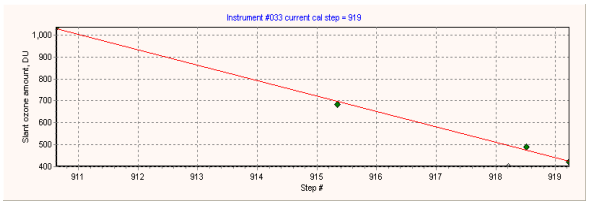
The most recent software (v376b) was installed on #183 and provided for the other systems. The automatic HP test before HG feature of this software has not being adopted by the user here. There have been still some software crashes with this software and a new version (v3.77) that is more stable is available now from IOS.

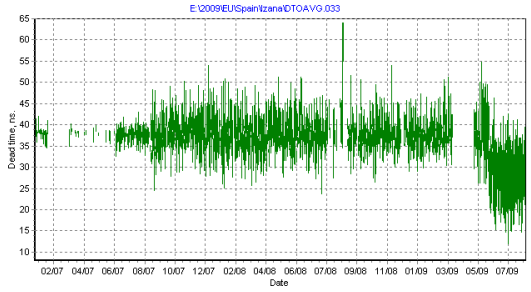
V. Note and graphs of SL, SC, DT, RS, CZ and CI results for the MKII Brewer #033:

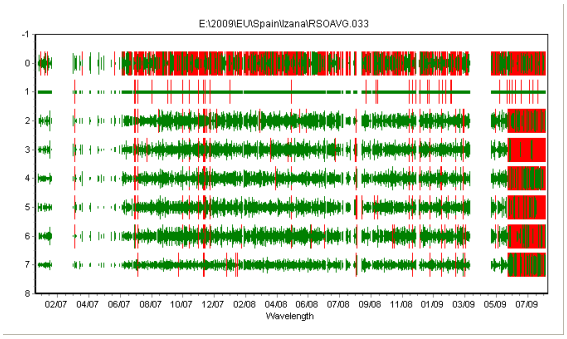
The instrument required servicing a few months ago and the heat sink assembly was replaced to fix high voltage problem. The larger mirror was adjusted since Hg test would not work which was wrong method to use. The spectrometer alignment was completed during this visit, which did not require any large adjustments. The standard lamp was replaced and the zenith drive aligned. The initial sun scan results in first graph below showed that the cal step setting of 919 should be adjusted to 912. After the re-alignments the final cal step setting was 916 as shown in second graph. The last graph shows final and previous SL CI scans, note the higher intensity level now.

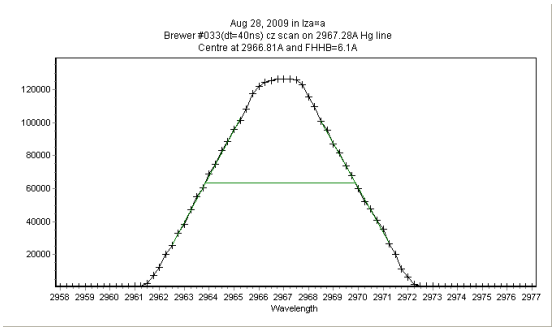


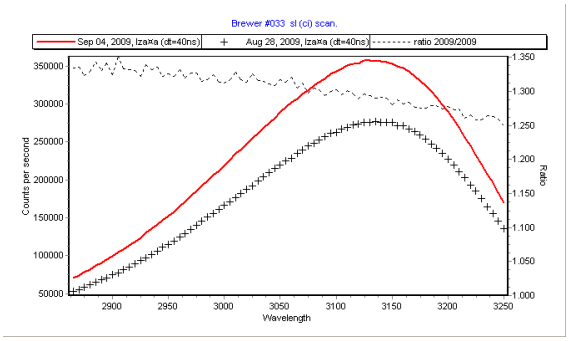






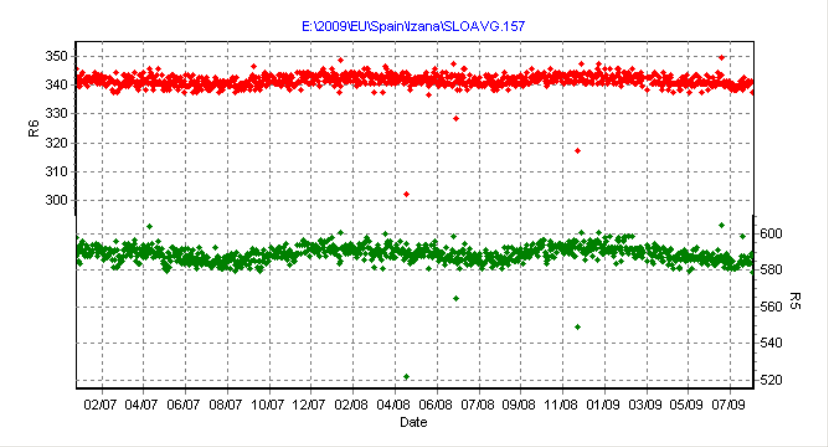


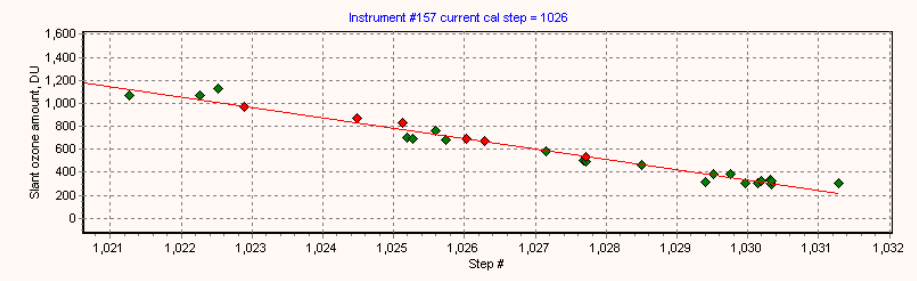


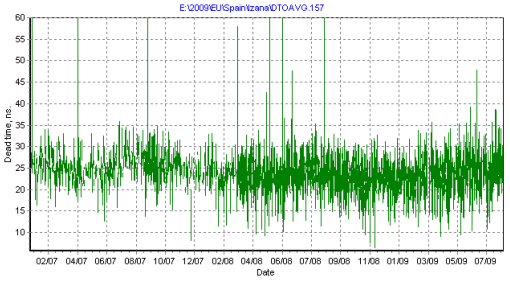


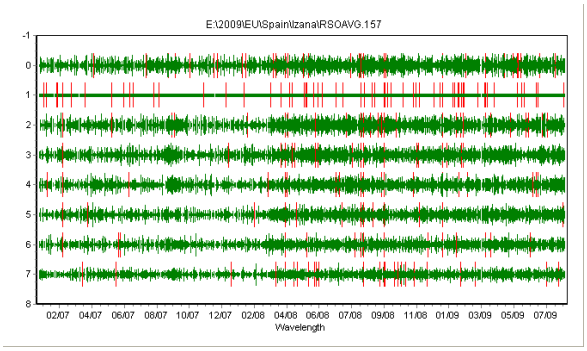
VI. Below are graphs of MKIII Brewer #157 of SL, SC, DT, RS, CZ and CI results:

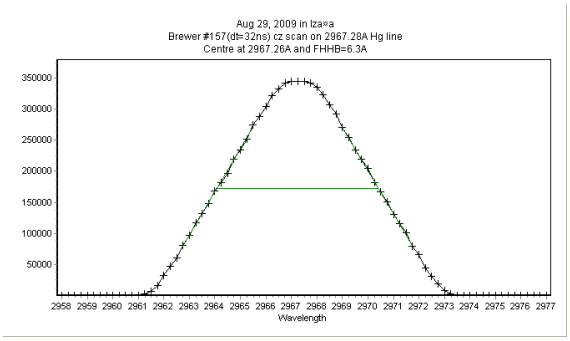
In the past 2 years the lamp test results from #157 have continued to be very stable. During this visit the standard lamp was replaced and power adjusted to increase intensity, reference the last graph. The sun scan results show cal step 1026 is still the proper position.

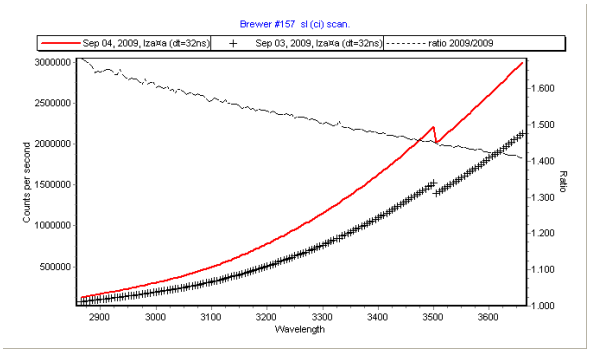






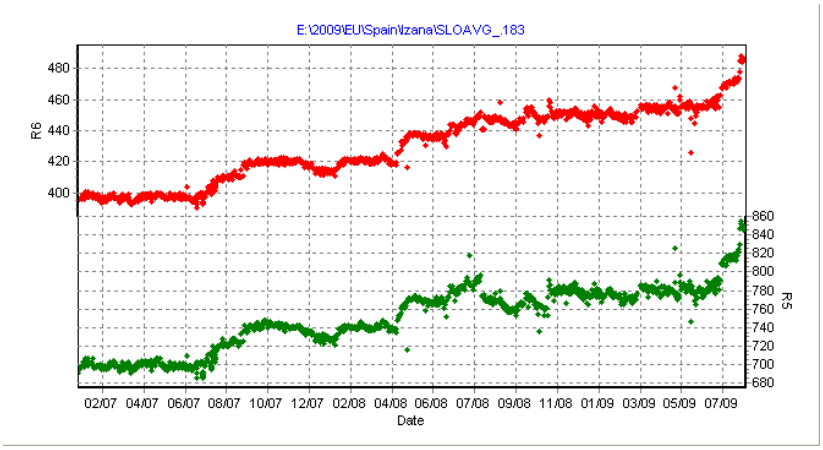


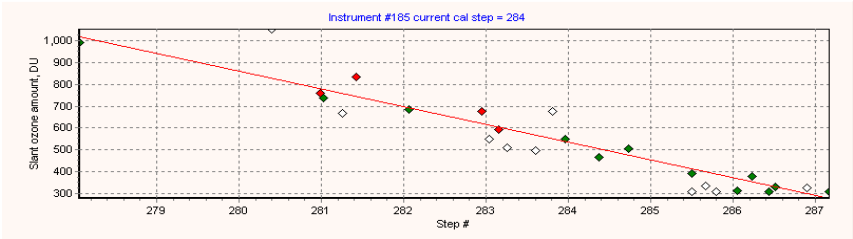


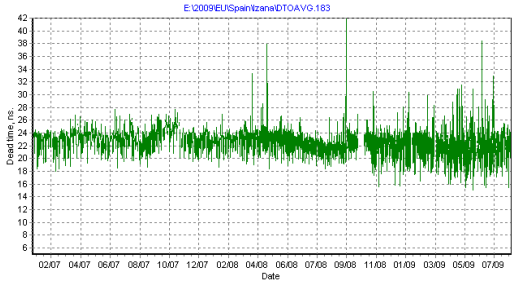


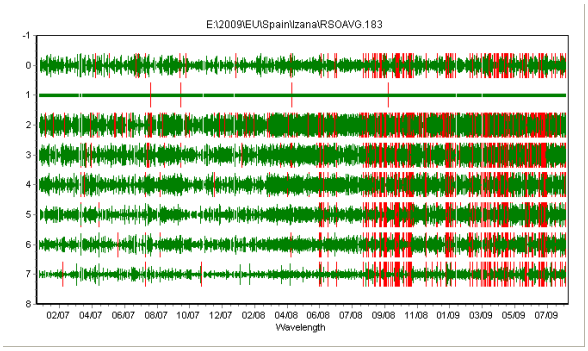
VII. Below are graphs of SL, SC, DT, RS, CZ and CI test results from the MKIII Brewer #183:

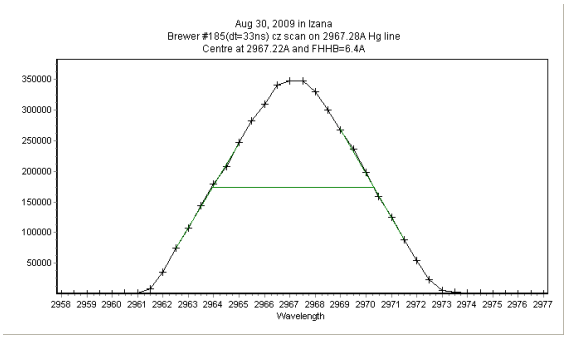
Note the increasing SL ratios, the noisier DT and RS results in past year. The shutter alignment on the slits was improved and the SL ratios decreased to 335/560 and the other test results improved. The sun scan results show cal step 1021 is still the proper setting for Hg calibration tests. The last graph shows the difference of CI scans before and after replacement of SL and shutter adjustment.

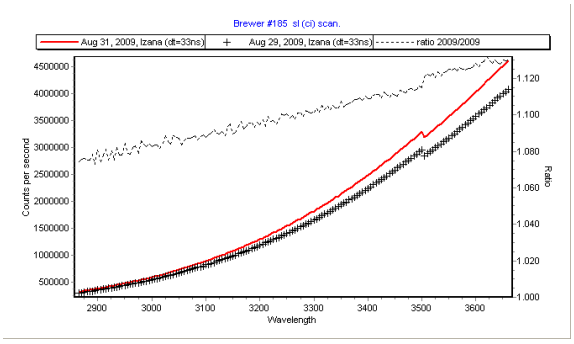












VIII. Below are graphs of SL, SC, DT, RS, CZ and CI test results from the MKIII Brewer #185:

All test results show quite good stability. The instrument had traveled to Finland and Switzerland in the past two years. The zenith prism alignment to SL had to be adjusted back to normal setting. The zenith motor has too much torque and periodically runs into end stop and shifts the prism's clamped position. This shift can be first detected by shifts of ~20 steps in zenith solar tracking (horizon correction changes). Some resistors (82 ohm) should be added in the motor wiring to reduce the motor torque. The UV calibration can be affected by this zenith prism alignment shift also. The sun scan results show cal step 284 is still the proper setting for Hg calibration tests. The last graph of SL CI scans, before and after zenith prism assembly alignment to SL.