XMM-Newton CCF Release Note

XMM-CCF-REL-346

OM Photometry. New Time Dependent Sensitivity Degradation correction based on stars from OM Catalogue SUSS-2.1

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1 CCF components

Name of CCF	VALDATE	List of Blocks changed	CAL VERSION	XSCS flag
OM_PHOTTONAT_0006	2000-01-01T00:00:00	DEGRADATION		No

2 Changes

The table extension "DEGRADATION" was introduced in 2005 to contain the coefficients of the time dependent sensitivity degradation correction. This correction is defined as

$$Correction\_factor = A + B \times MJD \tag{1}$$

$$Corrected\_rate = Measured\_rate \times Correction\_factor \tag{2}$$

Where MJD is the Modified Julian Date of observation and A and B depend of the filter. Their current values are given in Table 1.

Since time dependent sensitivity variation is due in part to sensitivity degradation of the photocathode, it is wavelength dependent and therefore it is different in each of the OM lenticular filters.

The correction is based in measurements of the count rates of three spectrophotometric standard stars, BPM 16274, HZ 2 and GD 153, which are observed regularly with OM in all filters. As more

Table 1: Old OM Time sensitivity degradation corrections

	OM_PHOTTONAT_0004		OM_PHOTTONAT_0005	
filter	A	B	A	B
UVW2	- 2.72723	7.14543e-05	-1.1448062	4.2029730e-05
UVM2	- 2.91093	7.49769e-05	-1.1701736	4.2607553e-05
UVW1	- 1.16448	4.14899e-05	-0.30229645	2.5461415e-05
U	- 0.313603	2.51781e-05	0.19793896	1.5670360e-05
B	- 0.484320	2.84507e-05	0.14699201	1.6715890e-05
V	- 1.25429	4.32118e-05	-0.64141692	3.1820188e-05

data became available, we checked that the degradation had not deviated from its original values more than 1-2 %.

Data obtained in 2011, showed deviations from the original trend reaching 5 % CCF for UVM2 filter, 4 % for UVW2, 3 % for UVW1 and 2 % for U, B and V.

Then we updated the correction coefficients into a new OM_PHOTTONAT_0005 version of the CCF. Table 1 gives both sets of coefficients.

As time elapses, the corrected count rates start to deviate from the defined trend. Now, starting 2017 we face a similar situation to that occurred in 2011. A new update is necessary.

However, we have used a different approach to obtain the time dependent sensitivity degradation correction. Instead of using our standard stars, we have selected a set of stars from the OM SUSS-2.1 catalogue and we have derived our coefficients from the variation observed in these stars. The process is described in detail in (Talavera [1])

The new correction is quadratic instead of linear. Therefore:

$$Correction\_factor = A + B \times MJD + C \times MJD^2 \quad (3)$$

The corresponding coefficients for OM_PHOTTONAT_0006 are given in Table 2

3 Scientific Impact of this Update

The time dependent sensitivity degradation trend changes with time. Therefore we need to update the coefficients to be able to obtain a proper correction.

In Figure 1 we can see the the variation with time of the count rates of a few hundreds stars selected from the OM catalogue. The current correction, based in data of the standard stars obtained

Table 2: New OM Time sensitivity degradation corrections

	OM_PHOTTONAT_0006		
filter	A	B	C
UVW2	-3.2343915	1.1995443e-04	-0.7277611e-09
UVM2	-8.2351192	3.0736395e-04	-2.4809715e-09
UVW1	-1.4112562	0.68321985e-04	-0.4144195e-09
U	-2.0050605	0.97382127e-04	-0.7578798e-09
B	-0.41305610	0.38843047e-04	-0.2183961e-09
V	-3.8775029	1.5212479e-04	-1.1183811e-09

till 2011, is represented by a blue dashed line. The red dashed line gives the new adopted degradation. We see the increasing deviation of the trend given by the current SAS correction and the observed one in many stars.

4 Estimated Scientific Quality

In order to assess the quality of the new correction we have applied it to our standard stars. We present in Figure 2 the corrected, normalized count rates of the standard stars observed till the end of 2016.

The standard deviation is less than 1% for all filters, except for UVW2 and V for which it is 2%.

The correction coefficients were thoroughly tested before releasing the new correction. The time dependent sensitivity degradation is monitored regularly to ensure the repeatability and stability of all corrections applied by SAS when new observations and new versions of SAS become available (see test procedures and their results in the corresponding sections below).

5 Expected Updates

As the degradation trend changes in the future, then a new version of the correction coefficients will become necessary.

We shall continue using stars from updated versions of the OM catalogue with larger time coverage. The derived corrections will be validated using the standard stars, whose observations are repeated periodically.

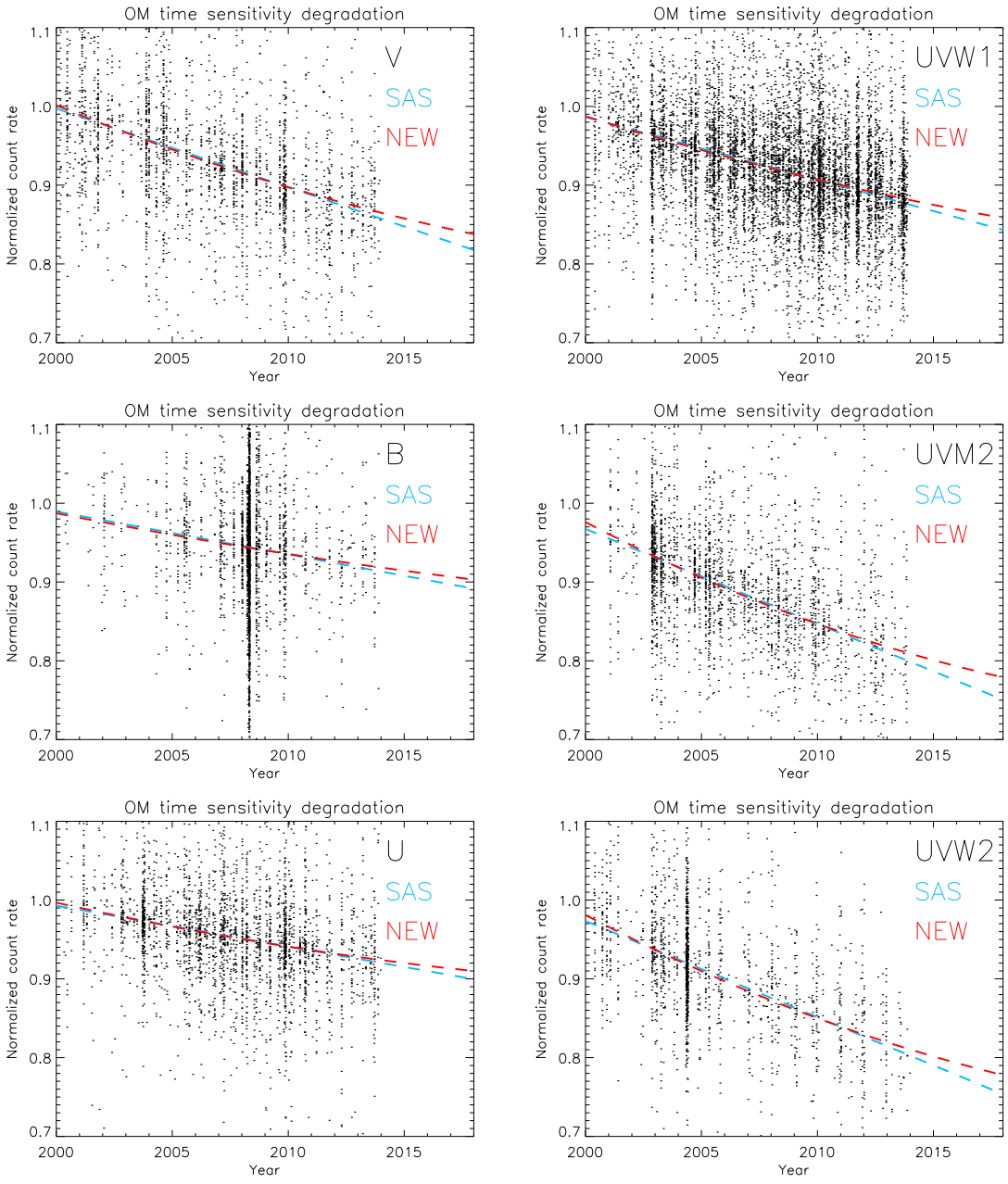

Figure 1: OM time dependent sensitivity degradation: uncorrected rates of many stars from the OM SUSS2.1 catalogue. Blue dashes show the current SAS degradation. Red dashes show a new quadratic fit.

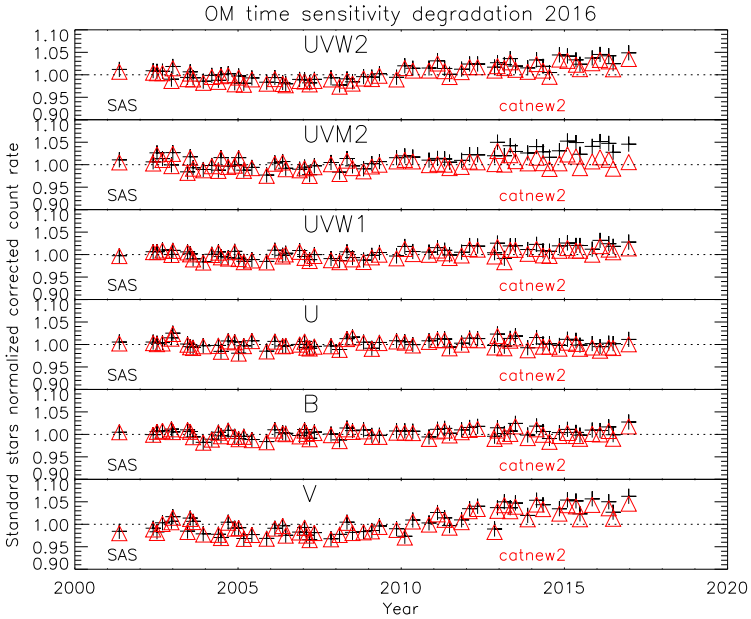

Figure 2: Corrected, normalized count rates of standard stars. Crosses: current SAS correction. Red triangles: new quadratic correction derived from catalogue stars.

6 Test procedures

The testing of the new correction has two parts. First, the correction is applied to the standard stars (see Fig. 2) to confirm its correctness.

Second, we perform a functional test of the CCF in SAS. All observations of the standard stars have been processed with SAS 16 and the new CCF with the updated time sensitivity degradation correction. In addition we have processed 50 ODFs selected randomly to verify the new correction.

Table 3 shows the results of processing the standard stars with the new and the old corrections. Table 4 shows

Table 3: Standard stars processed with SAS 16.0 and OM_PHOTTONAT_0006. Average count rates of several observations

star	N$_o$*bs*	UVW2	UVM2	UVW1	U	B	V
GD153	14	83.12	161.78	329.49	420.18	283.45	71.35
error (%)		1.4	1.5	0.8	1.4	1.0	2.1
HZ2	17	23.76	48.27	111.73	168.84	148.83	43.73
error (%)		2.0	1.3	1.3	0.9	0.8	2.9
BPM16274	32	14.73	30.34	72.92	112.68	107.77	32.95
error (%)		1.7	1.2	1.0	0.8	0.8	2.2

Table 4: Stars from 50 observations processed with OM_PHOTTONAT_0006 versus OM_PHOTTONAT_0005. Mean of rates ratios and standard deviation.

filter	UVW2	UVM2	UVW1	U	B	V
ratio	1.004	1.005	1.004	1.003	1.002	1.007
std.dev. (%)	5.5	6.7	4.8	1.2	2.0	10.6

7 Summary of the test results

We can see in Table 3 that in most cases of stars and filters the errors in the application of the new correction to the standard stars are very small (less than 2 %) and within the accuracy limits of OM photometry.

Table 4 gives the differences between the new proposed correction and the old one, currently implemented. It shows the deviations between the old and the new corrections as we see them in Figures 1 and 2.

References

[1] Talavera A., 2017, XMM-SOC-TN-0207, available at:

http://xmm2.esac.esa.int/~xmmdoc/CoCo/CCB/DOC/Attachments/XMM-SOC-CAL-TN-0207-1-0.pdf