XMM-Newton CCF Release Note

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OM Photometry. Update of the Time Dependent Sensitivity Degradation correction based on stars from OM Catalogue SUSS-3

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1 CCF components

Name of CCF	VALDATE	List of Blocks changed	CAL VERSION	XSCS flag
OM_PHOTTONAT_0007	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 was 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.

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 first implemented correction was based in measurements of the count rates of three spectrophotometric standard stars, BPM 16274, HZ 2 and GD 153, which are observed regularly with

Table 1: Current OM Time sensitivity degradation correction

	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

OM in all filters. As more 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 % for UVM2 filter, 4 % for UVW2, 3 % for UVW1 and 2 % for U, B and V. An update of the CCF was done.

As time elapsed, the corrected count rates start to deviate from the defined trend. At the beginning of 2017 we had a similar situation to that occurred in 2011. A new update was necessary.

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

The new implemented correction was quadratic instead of linear. Therefore:

$$Correction\_factor = A + B \times MJD + C \times MJD^2 \tag{3}$$

The corresponding coefficients for OM_PHOTTONAT_0006 are given in Table 1

Now, with the availability of SUSS-3, which gives us a longer time baseline we have decided to update the coefficients into OM_PHOTTONAT_0007. The procedure has been the same used before. The results are shown 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 variation with time of the count rates of a few hundreds stars selected

Table 2: New OM Time sensitivity degradation correction

	OM_PHOTTONAT_0007		
filter	A	B	C
UVW2	-5.4737201	2.0277698e-04	-1.4947433e-09
UVM2	-8.0156908	3.0052112e-04	-2.4309392e-09
UVW1	-2.9094205	1.2485785e-04	-9.4811403e-10
U	-2.5592432	1.1768159e-04	-9.4432318e-10
B	-5.1267290	2.1239059e-04	-1.8165414e-09
V	-4.7953377	1.8578538e-04	-1.4274067e-09

from the OM catalogue. The current correction, based in data from the OM Catalogue SUSS-2.1 containing observations till end 2013, is represented by a blue dashed line. The red dashed line gives the new adopted degradation, based now in data from SUSS-3 with observations till mid 2015. We see the increasing deviation of the trend in the UV filters which justifies updating the coefficients.

4 Estimated Scientific Quality

The correction coefficients have been 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.

Table 3 shows the results of processing the standard stars with the new corrections. We can see that the errors (standard deviation of the mean values) for each star and filter are less than 2 % in the majority of cases.

Table 3: Standard stars processed with SAS 17.0 and OM_PHOTTONAT_0007. Average count rates of several observations

star	N_obs	UVW2	UVM2	UVW1	U	B	V
GD153	15	83.29	161.89	330.03	420.25	283.69	71.57
error (%)		1.5	1.5	1.0	1.4	1.0	2.4
HZ2	18	23.81	48.27	111.78	168.71	148.83	43.84
error (%)		2.1	1.3	1.3	0.9	0.8	3.0
BPM16274	34	14.75	30.34	72.96	112.62	107.81	33.04
error (%)		1.8	1.2	1.0	0.8	0.9	2.4

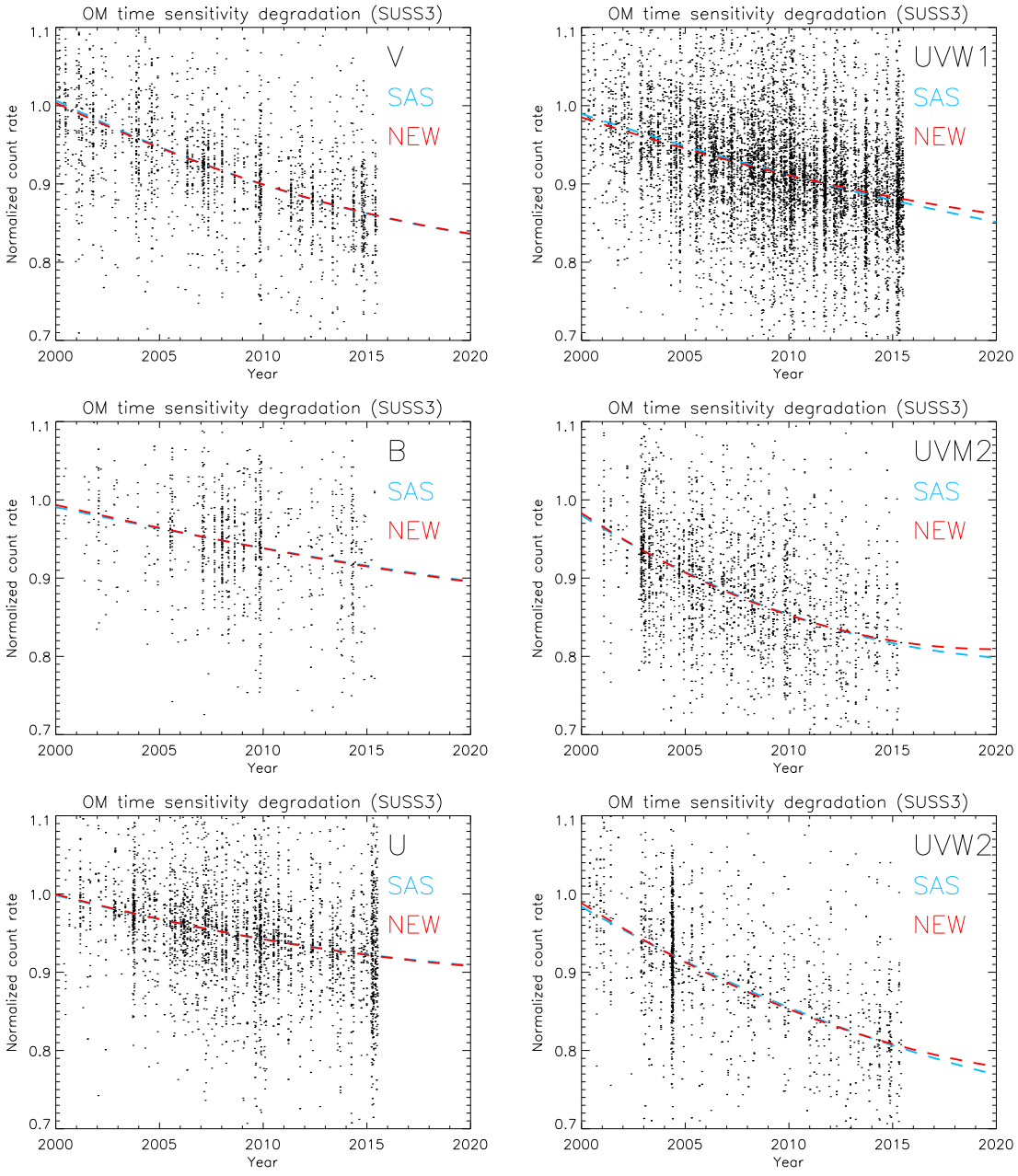

Figure 1: OM time dependent sensitivity degradation: uncorrected rates of many stars from the OM SUSS3 catalogue. Blue dashes show the current SAS degradation. Red dashes show a new quadratic fit.

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.

6 Test procedures

The testing of the new correction has two parts. First, the correction is applied directly to the uncorrected rates of the standard stars 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 17 and the new CCF with the updated time sensitivity degradation correction, OM_PHOTTONAT_0007.

Table 3 mentioned before shows the results of processing the standard stars with the new corrections.

7 Summary of the test results

As shown in Table 3 the errors in mean count rates obtained with the new correction are less than 2 % in the majority of cases, thus within the accuracy limits of OM photometry.

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