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BEPI-COLOMBO filters (responses without zeros)

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Abstract

Key words: spectral libraries — flux calibration — filters

1 Determination of AB magnitudes

AB magnitudes were obtained by integrating over the spectra convolved with the filter response. Two codes were used for obtaining and testing the magnitudes: the pyphot code by Dr. Feausneau and Maria's IDL code.

By definition

$$mag_{AB} = -2.5 log_{10}(\bar{f_\nu}) - 48.60 \quad (1)$$

1.1 Calculation in IDL

AB magnitudes were obtained by integrating over the spectra convolved with the filter response.

By definition

$$mag_{AB} = -2.5 log_{10}(\bar{f_\nu}) - 48.60 \quad (2)$$

In the IDL code the formulation by Bessell & Murphy (2012) was implemented.

$$mag_{AB} = -2.5 log_{10} \frac{\int f_\lambda(\lambda) S(\lambda) \lambda \delta\lambda}{\int S(\lambda) c \delta\lambda/\lambda} - 48.60 \quad (3)$$

$f_\lambda(\lambda)$ is in erg cm^{-2} s^{-1} Å^{-1}, λ is in Å, and the light speed c is in Å s^{-1}

The integration is performed with the trapezoidal method in IDL.

1.2 pyphot code

The AB magnitudes are obtained using the formulation by Koornneef et al. (pythot link).

$$mag_{AB} = -2.5 log_{10}(\bar{f_\lambda}) - 2.5 log_{10}(\lambda_p^2/c) - 48.60 \quad (4)$$

$$\bar{f_\lambda} = \frac{\int f_\lambda(\lambda) S(\lambda) \lambda \delta\lambda}{\int S(\lambda) \lambda \delta\lambda} \quad (5)$$

$$\lambda_p^2 = \frac{\int S(\lambda) \lambda \delta\lambda}{\int S(\lambda) \delta\lambda/\lambda} \quad (6)$$

The speed of light c and λ_p must be expressed in matching units. The program pyphot is able to automatically transform the units, as long as they are indicated.

λ is the wavelength, $f_\lambda(\lambda)$ is the observed flux density, and $S(\lambda)$ is the photonic passband (response function).

The integration is performed with the numpy trapz (np.trapz) function.

2 Datasets

The synthetic magnitudes were measured on a subsample of 133 SPSSv3.4 stars, results are in Figs. 1 and 2.

The 61 PVL stars are shown in Figs. 3 and 4.

The CALSPEC stars are shown in Figs. 5 and 6.

2.1 Code differences

Using the 133 SPSSv3.4 stars and the results from python and IDL, the measured differences are listed in Table 1.

For the PVL, 62 stars are used and the differences are in Table 2.

For the CALSPEC, the differences are listed in Table 4. Now, the table looks nice; the problem was coming from some negative fluxes present in some spectra. A python script was made to counts exactly the number of negative numbers. The following spectra were removed 2MASSJ00361617+1821104,

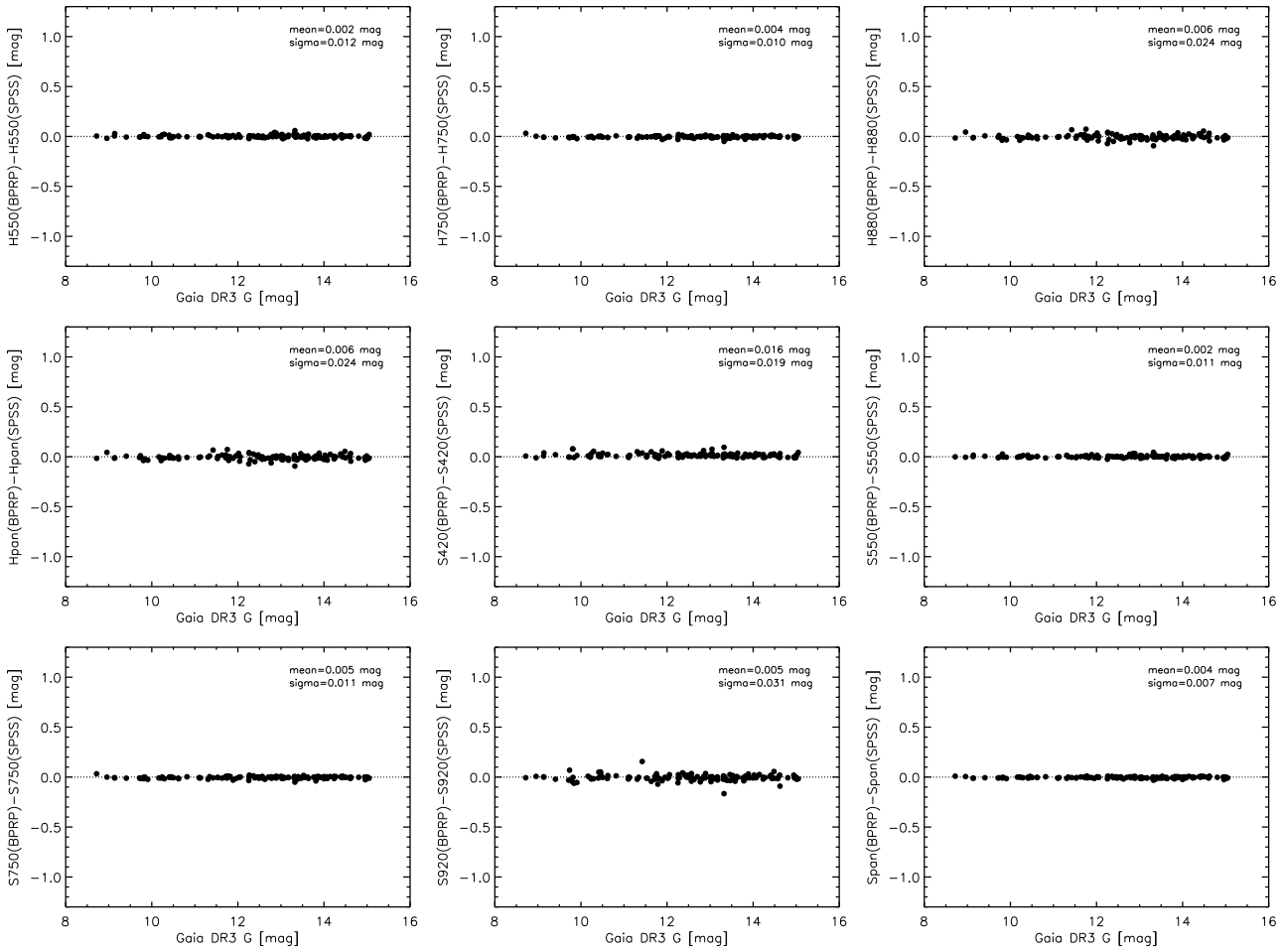

Fig. 1. Synth_mag(BPRP)-Synth_mag(SPSSv3.4) vs. G magnitudes.

;ok 31, ¿ 5000 2MASSJ05591914-1404488, ;ok 203 negative, ¿ 5000 hz43b8, and ;ok, ¿ 5000 VB8. ;ok 71 negative Three spectra starting at wave > 500 nm and one with 71 negative points in the blue side (VB8). ;BD-11_3759, ;ok 7 negative ;2MASSJ17583798+6646522, ; 4 negative, but not in range ;SF1615+001A, ; 9 negative, but not in range ;WD1057+719, ; fits ok, weird rebin figure ;LDS749B. ; fits ok, weird rebin figure Now, only 103 CALSPEC spectra are used, and 98 of them have BP/RP spectra.

Two changes were implemented:

- Using the files from Paolo (no zeros).
- The codes was modified to consider flux > 0 (rather than flux ! = 0).
- Four CALSPEC spectra were removed.

3 Comments

The Pythot code interpolates the transmission on the spectrum wavelength. The interpolator adds zero outside of the filter range. An index is then created where the transmission is not null. The integral is performed using the index.

The IDL code uses the linterp function to interpolate the transmission that adds zero outside the transmission limits. For the integral, no limits are considered because outside of the limits the transmission is null, and the integral is done over the entire spectrum.

The two codes perform identically (10^{-5}) when there are zeros in the files of the responses. The two codes perform well (10^{-3}) when there aren't zeros in the files of the responses.

section**References**

Bessell, M. & Murphy, S. 2012, PASP, 124, 140

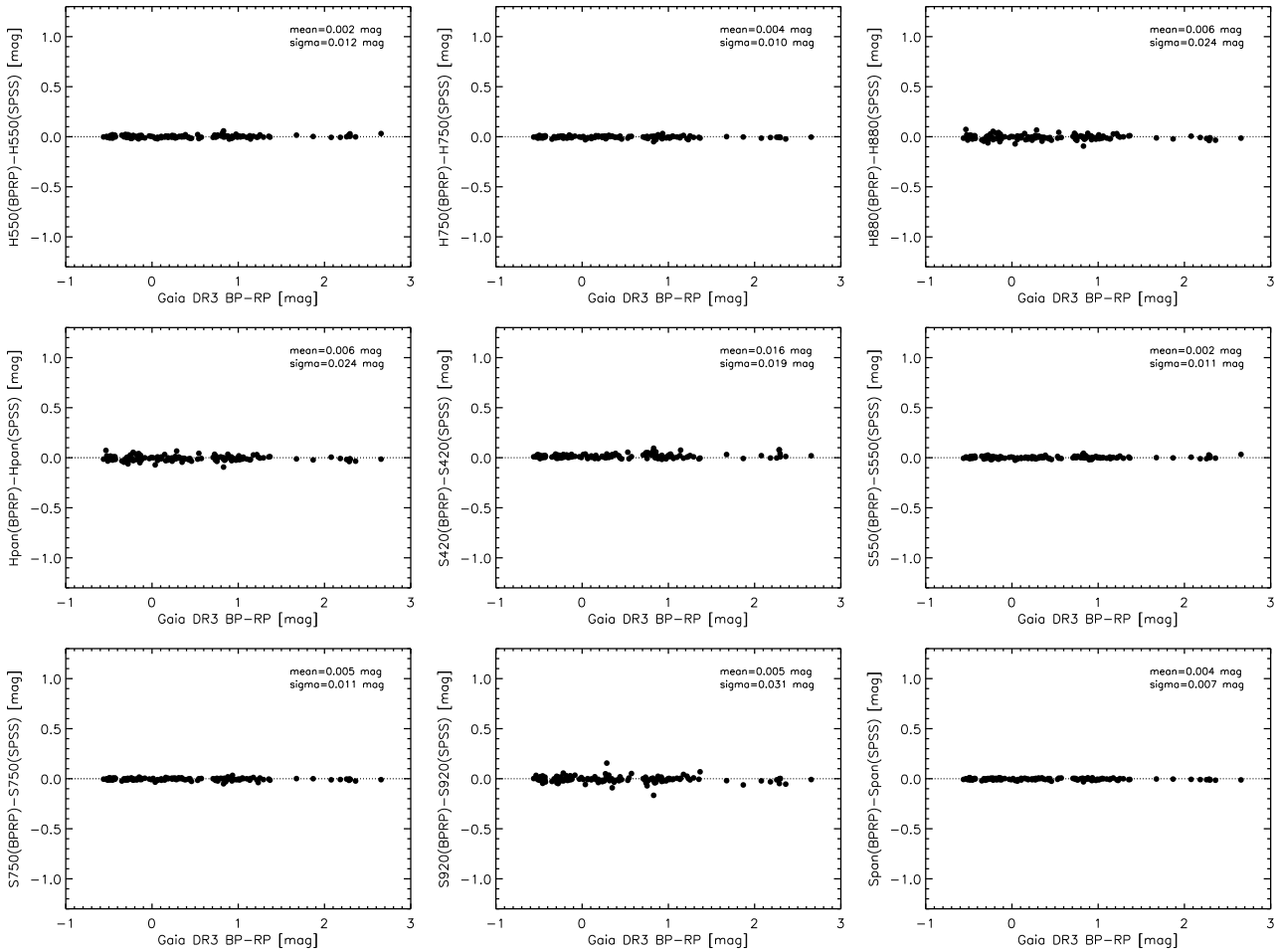

Fig. 2. Synth_mag(BPRP)-Synth_mag(SPSSv3.4) vs. BP-RP colors.

Table 1. SPSSv3.4: Differences between the magnitudes from the IDL code and those from the python code.

Δ	mean	sigma
H550mag_idl-H550mag_py	0.00011041111	0.0010037520
H750mag_idl-H750mag_py	-0.00012555517	0.00082735132
H880mag_idl-H880mag_py	-0.00011760310	0.00064737431
Hpanmag_idl-Hpanmag_py	8.9107599e-05	0.0011681707
S420mag_idl-S420mag_py	1.8184346e-05	4.2855609e-05
S550mag_idl-S550mag_py	2.4881578e-06	3.0302522e-05
S750mag_idl-S750mag_py	1.7854504e-06	2.8205282e-05
S920mag_idl-S920mag_py	1.4591934e-06	2.7370176e-05
Spanmag_idl-Spanmag_py	2.5742036e-06	2.9527988e-05

Table 2. PVL: Differences between the magnitudes from the IDL code and those from the python code.

Δ	mean	sigma
H550mag_idl-H550mag_py	0.00012950428	0.0017346454
H750mag_idl-H750mag_py	-7.3636164e-06	0.0013119964
H880mag_idl-H880mag_py	0.00029278583	0.00085835834
Hpanmag_idl-Hpanmag_py	0.00021285698	0.0010363222
S420mag_idl-S420mag_py	1.5563652e-05	9.4234845e-05
S550mag_idl-S550mag_py	-2.9001080e-06	2.6665004e-05
S750mag_idl-S750mag_py	-1.2819884e-06	2.8187697e-05
S920mag_idl-S920mag_py	4.4009725e-06	2.9079300e-05
Spanmag_idl-Spanmag_py	1.0037031e-05	2.8202332e-05

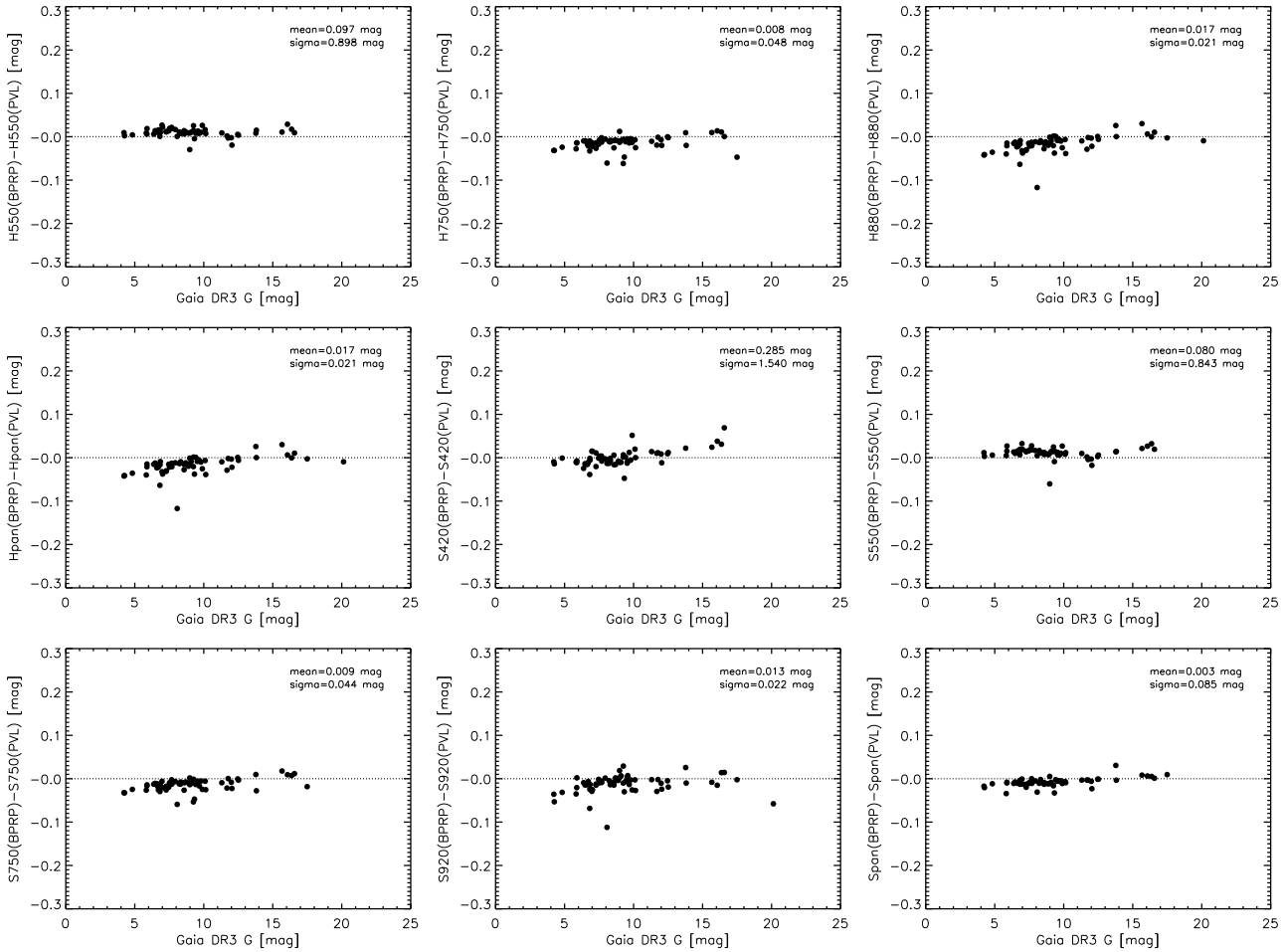

Fig. 3. Synth_mag(BPRP)-Synth_mag(PVL) vs. G magnitudes.

Table 3. CALSPEC: Differences between the magnitudes from the IDL code and those from the python code.

Δ	mean	sigma
H550mag_idl-H550mag_py	-0.00028580485	0.00074879270
H750mag_idl-H750mag_py	-0.00028999338	0.00065301077
H880mag_idl-H880mag_py	2.4948305e-05	0.00080978499
Hpanmag_idl-Hpanmag_py	-0.00017792160	0.0011456548
S420mag_idl-S420mag_py	2.5022377e-06	4.5991525e-05
S550mag_idl-S550mag_py	5.0611866e-06	2.9997020e-05
S750mag_idl-S750mag_py	1.0416346e-06	2.9407390e-05
S920mag_idl-S920mag_py	6.6664612e-07	2.9400612e-05
Spanmag_idl-Spanmag_py	3.4721152e-07	2.8782715e-05

Table 4. CALSPEC (using responses with zeros on the sides): Differences between the magnitudes from the IDL code and those from the python code.

Δ	mean	sigma
H550mag_idl-H550mag_py	1.1121185e-05	2.9679948e-05
H750mag_idl-H750mag_py	1.2823679e-06	2.7006031e-05
H880mag_idl-H880mag_py	-2.5994569e-06	4.1560965e-05
Hpanmag_idl-Hpanmag_py	-6.4581343e-06	7.9265793e-05
S420mag_idl-S420mag_py	4.6966145e-06	2.7334101e-05
S550mag_idl-S550mag_py	5.7579244e-06	2.9689256e-05
S740mag_idl-S740mag_py	2.1990063e-06	2.9840780e-05
S920mag_idl-S920mag_py	8.0159567e-06	3.1629783e-05
Spanmag_idl-Spanmag_py	9.4673009e-07	2.8698807e-05

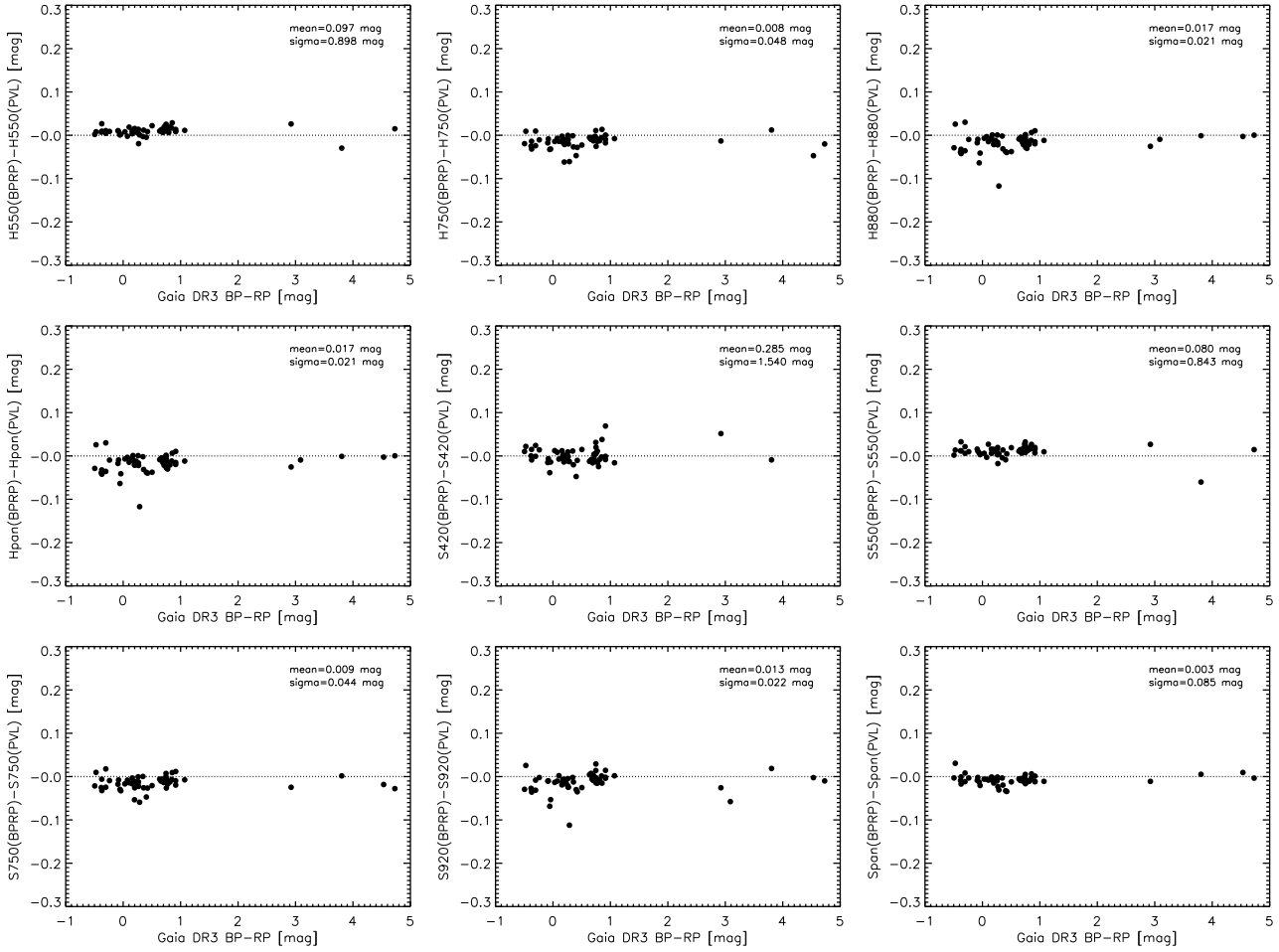

Fig. 4. Synth_mag(BPRP)-Synth_mag(PVL) vs. BP-RP colors.

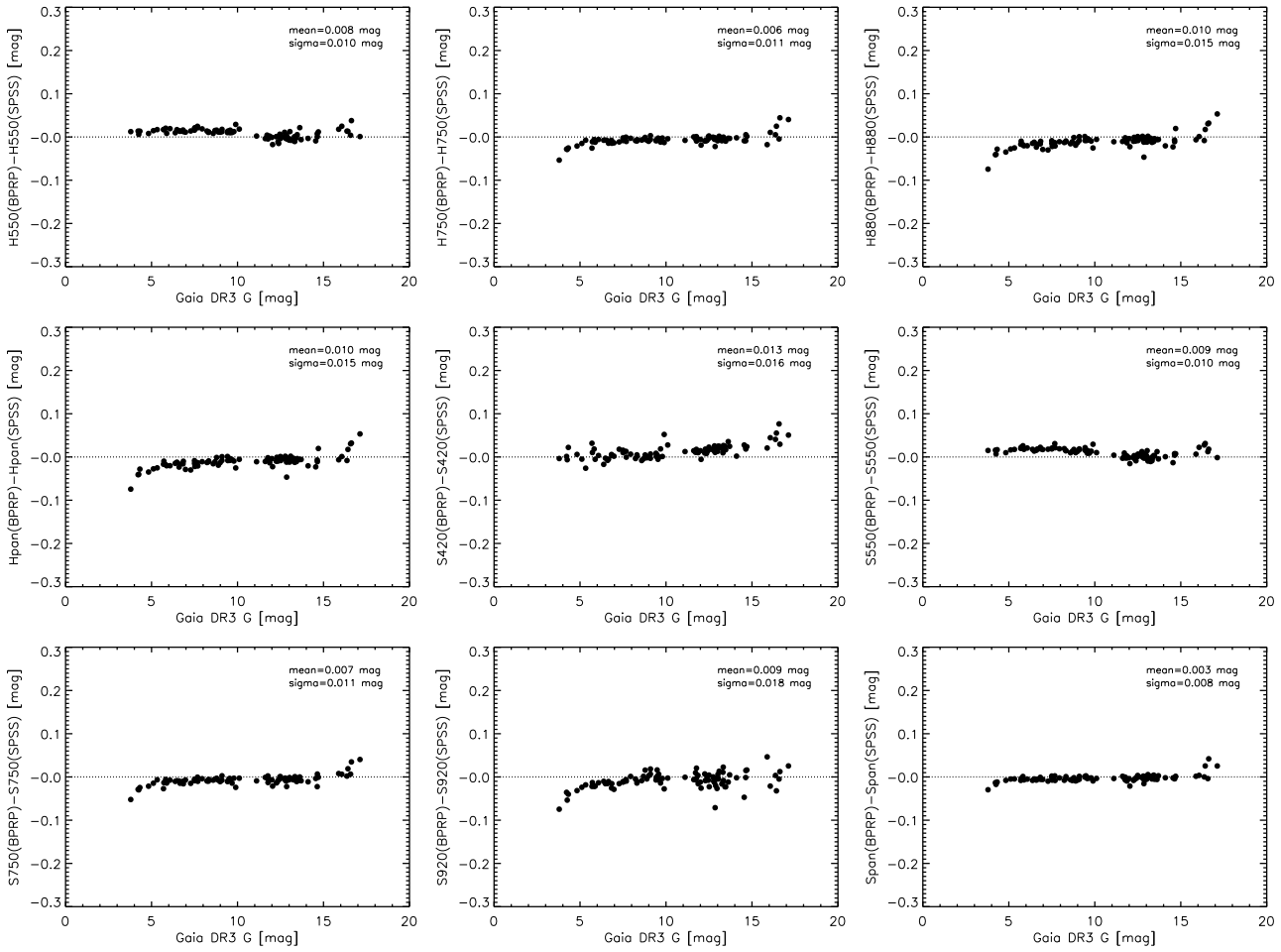

Fig. 5. Synth_mag(BPRP)-Synth_mag(CALSPEC) vs. G magnitudes.

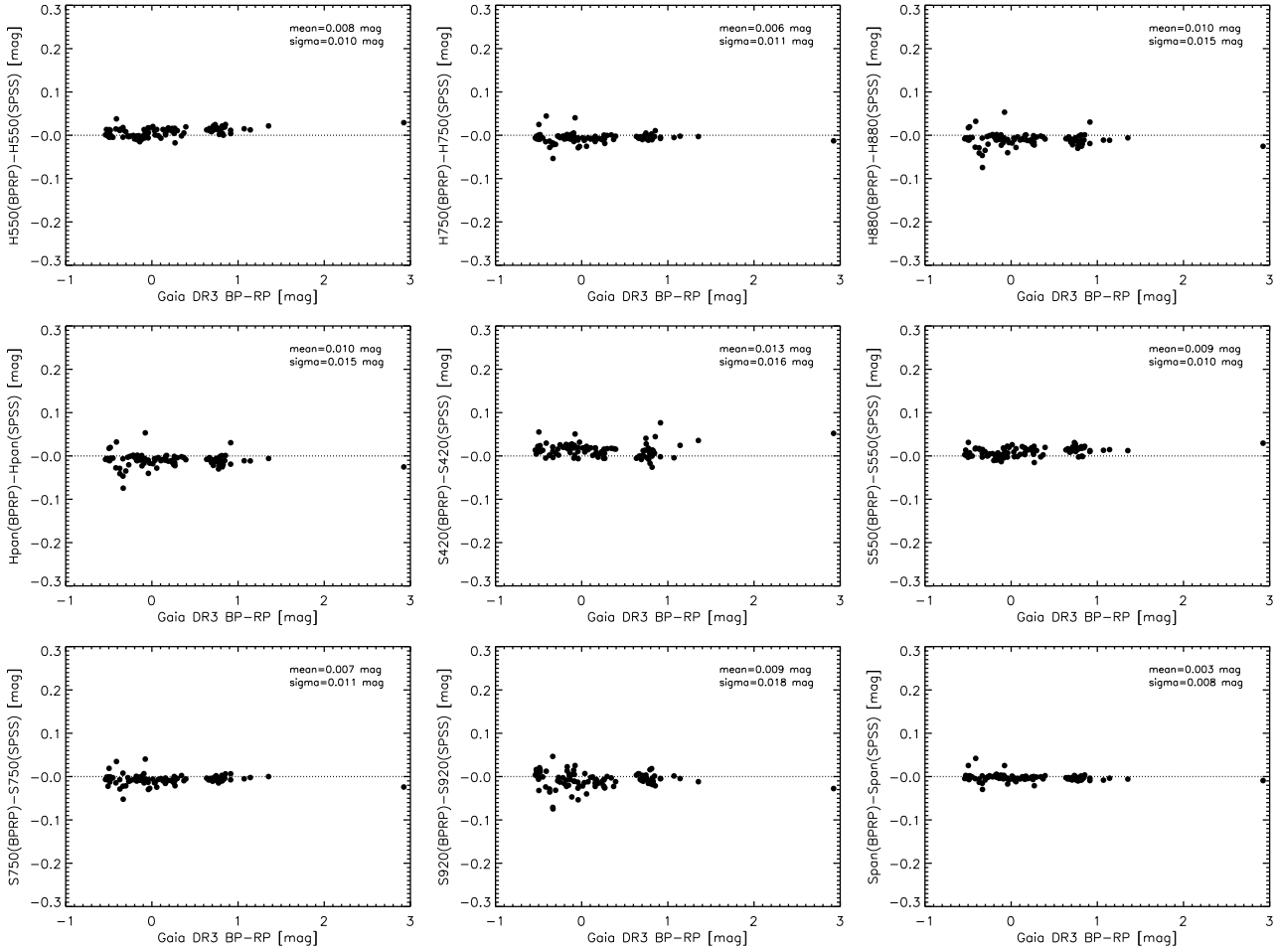

Fig. 6. Synth_mag(BPRP)-Synth_mag(CALSPEC) vs. BP-RP colors.