Unweighted vs Weighted flat-fielding: impact on PSF-fit photometry

Frank Masci

October 1, 2020














HEISING-SIMONS FOUNDATION

Science Image Selection Criteria in *g* & *r* (*quadrant based*)

- 2020-06-14 <= night date <= 2020-07-08
- DIQ (median FWHM) <= 3.0 arcsec
- Airmass <= 1.2
- Moon altitude < 30°
- Photometric ZP > 26.1 mag.
- 2000 <= number PSF-fit catalog sources <= 30000
- Number of matching PS1 calibrator stars >= 200
- Exptime = 30 sec.
- Clean processing/achive quality status flags.

- Total number of quadrant images in *g*-filter = 71,368 (from 1402 exposures)
- Total number of quadrant images in *r*-filter = 94,226 (from 2102 exposures)

Procedure

- Processed each quadrant image using same-night *weighted filter-on* flats
- Weights applied to dome flat exposures according to the four LED wavelengths used:

  ***g*:** `0.342067 (452nm); 0.348724 (480nm); 0.079262 (500nm); 0.229947 (525nm)`

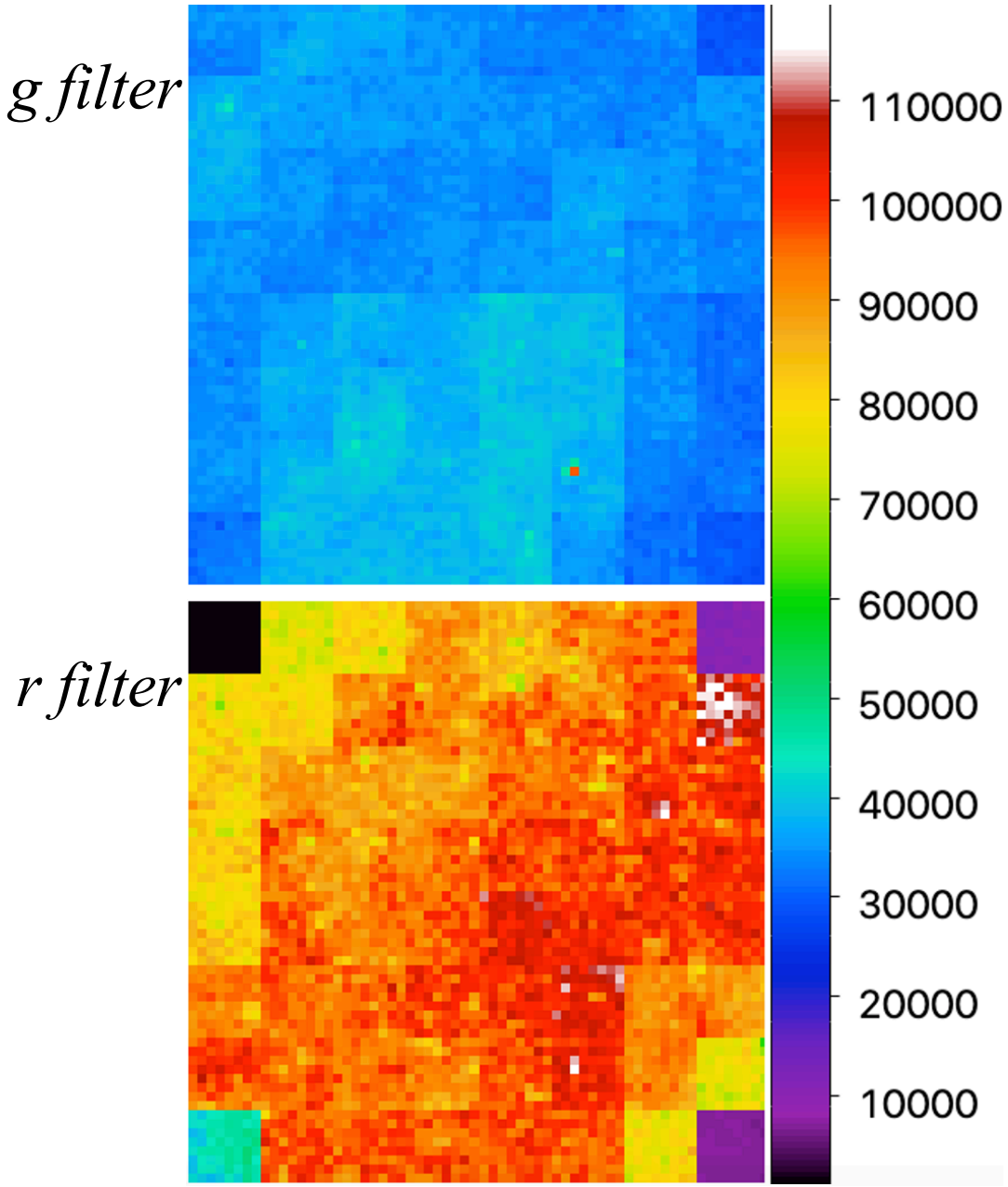
  ***r*:** `0.052513 (594nm); 0.217099 (621nm); 0.324989 (633nm); 0.405399 (653nm)`
- Benchmark:

  compare above to archived products that used *unweighted filter-on* flats

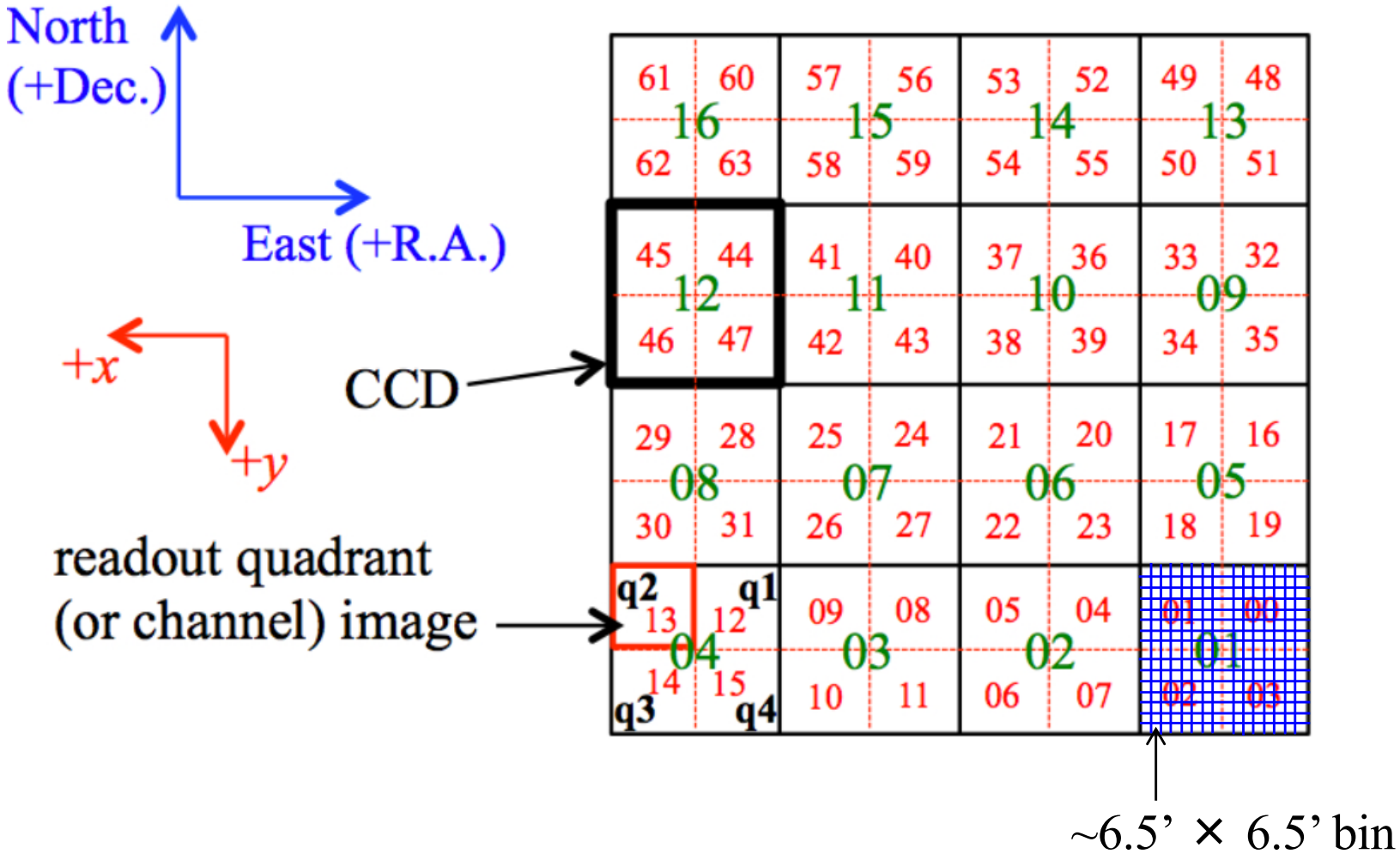
---

- Partitioned each quadrant image into 8 × 8 bins (~ 6.5 × 6.5 arcmin^2 bins)
- Used ZTF sources with mags: 13.5 <= mag <= 18.5
- Used *raw* archived catalogs with **no post corrections** applied to photometry
- Matched to *stellar* sources in PS1 catalog per quadrant partition over 8 × 8 grid
- Calibrated ZTF mags using quadrant-based ZP, color term, and PS1 $g - r$ colors
- Computed median *DeltaMag* = *PS1mag* – *ZTFmag* per bin
- Stitched all 8 × 8 quads × (8 × 8 partitions per quad) = 64 × 64 bins into mosaic
- Resulting number of ZTF-to-PS1 matches per bin: ~ 1,200 – 150,000 (see slide 4)

Number of ZTF-to-PS1 catalog matches per bin



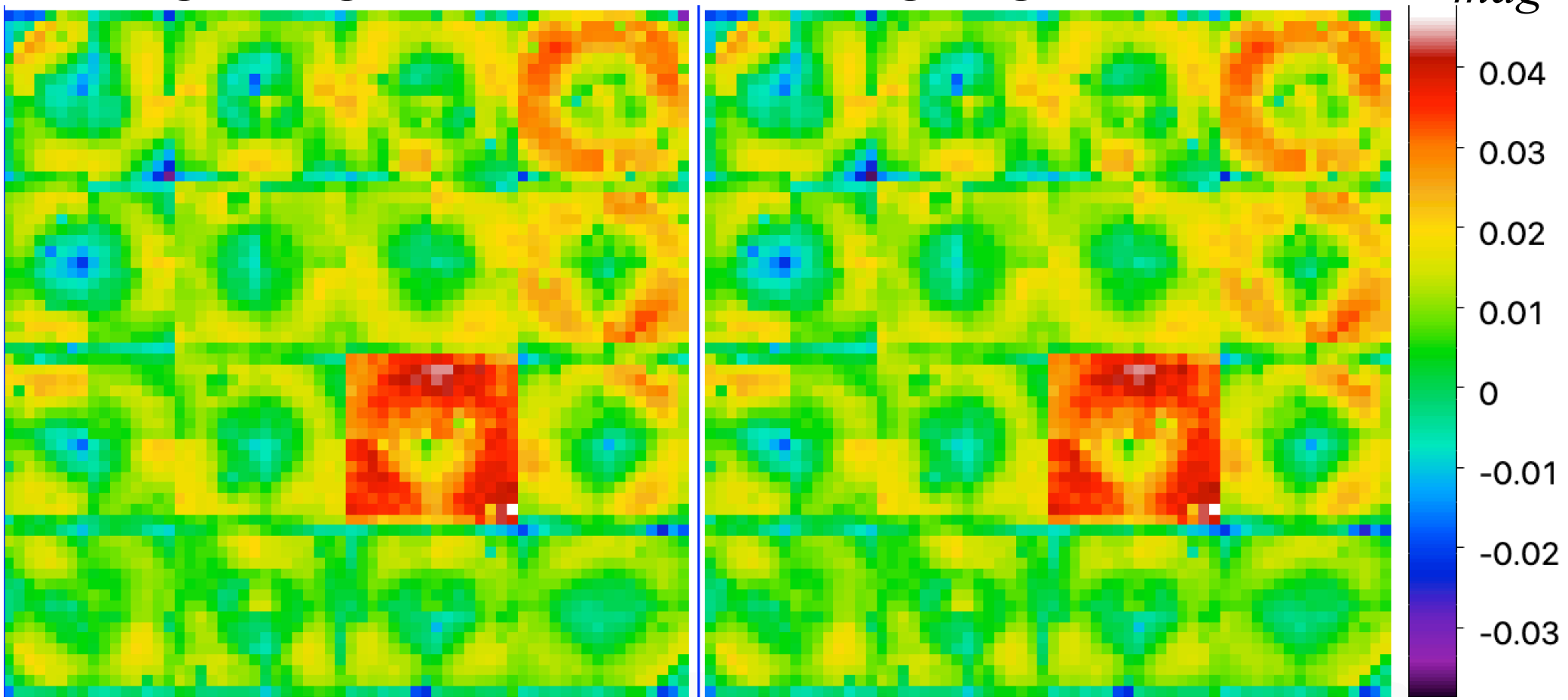
Assumed CCD / quadrant image layout



‘PS1 – PSF-fit’ photometry mag residuals (*g*)

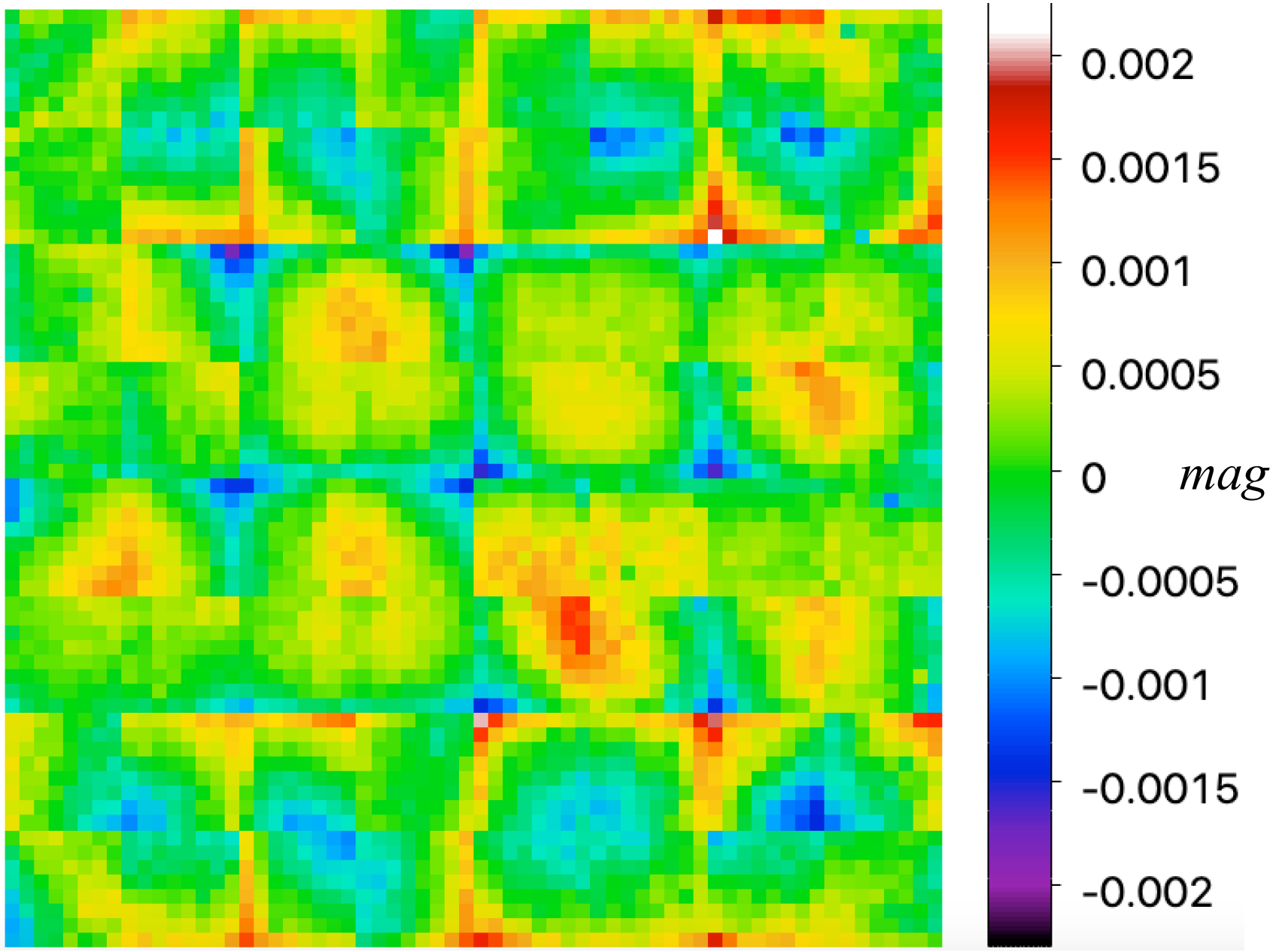
g unweighted flats

g weighted flats



‘PS1 – PSF-fit’ photometry mag residuals (*g*)

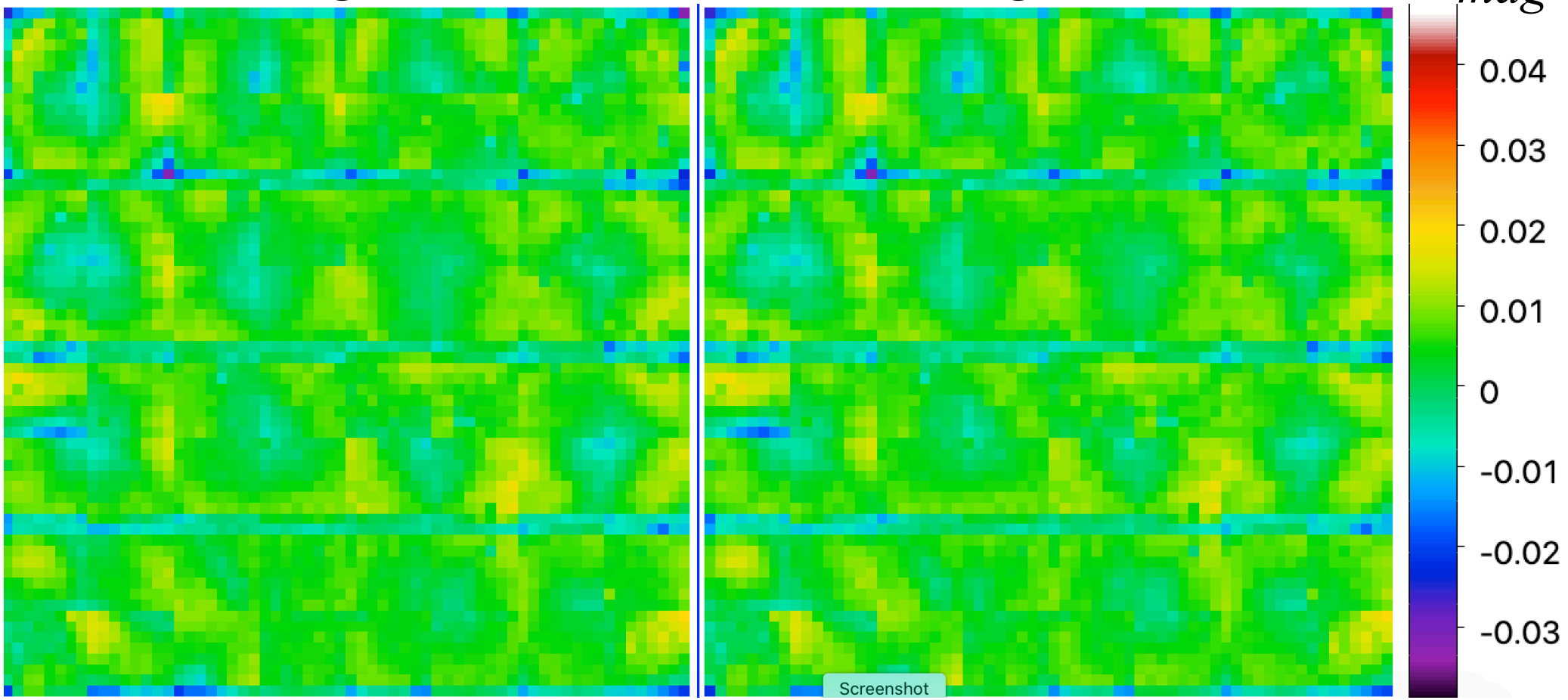
difference in g: unweighted – weighted



‘PS1 – PSF-fit’ photometry mag residuals (*r*)

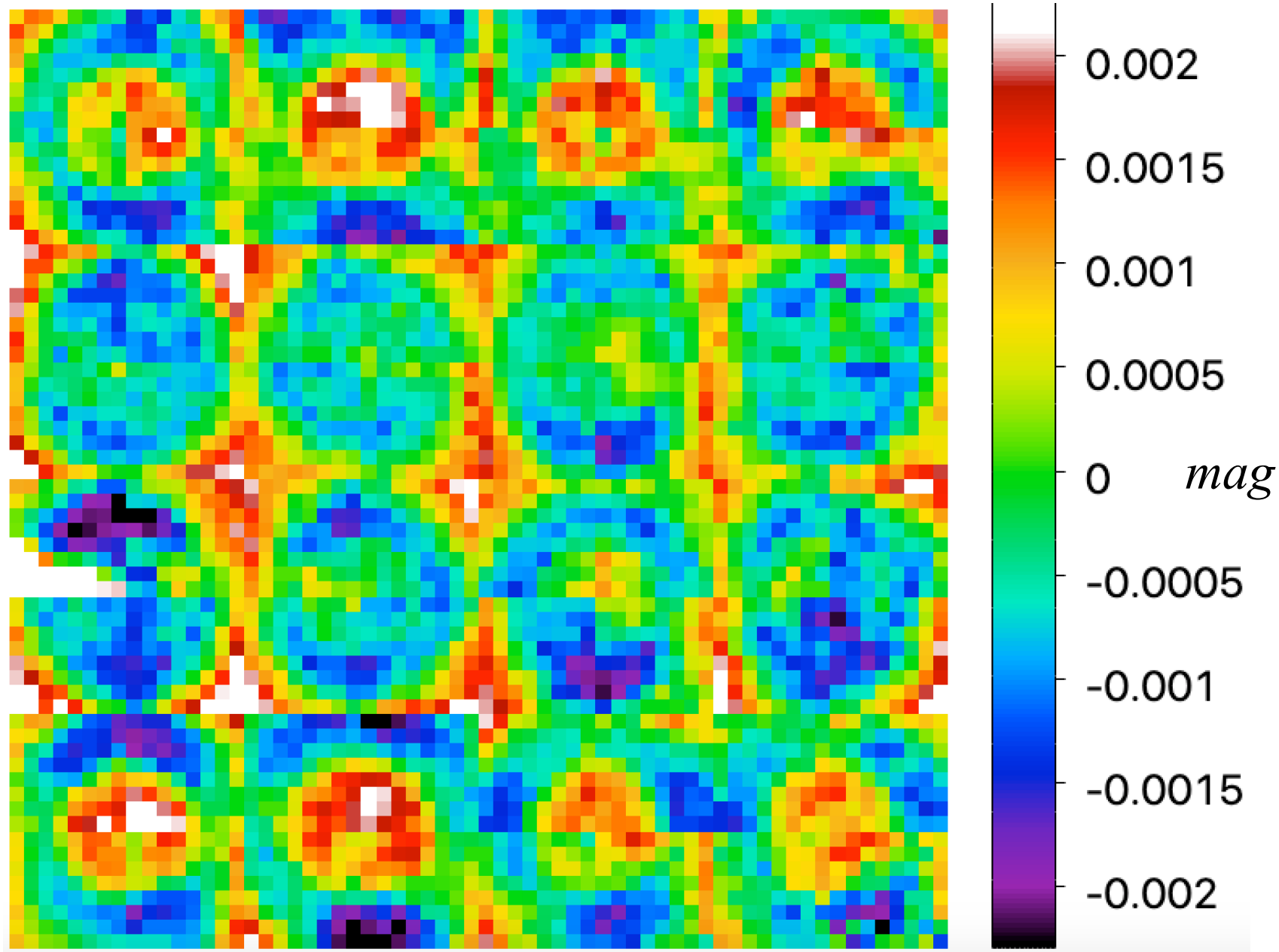
r unweighted flats

r weighted flats



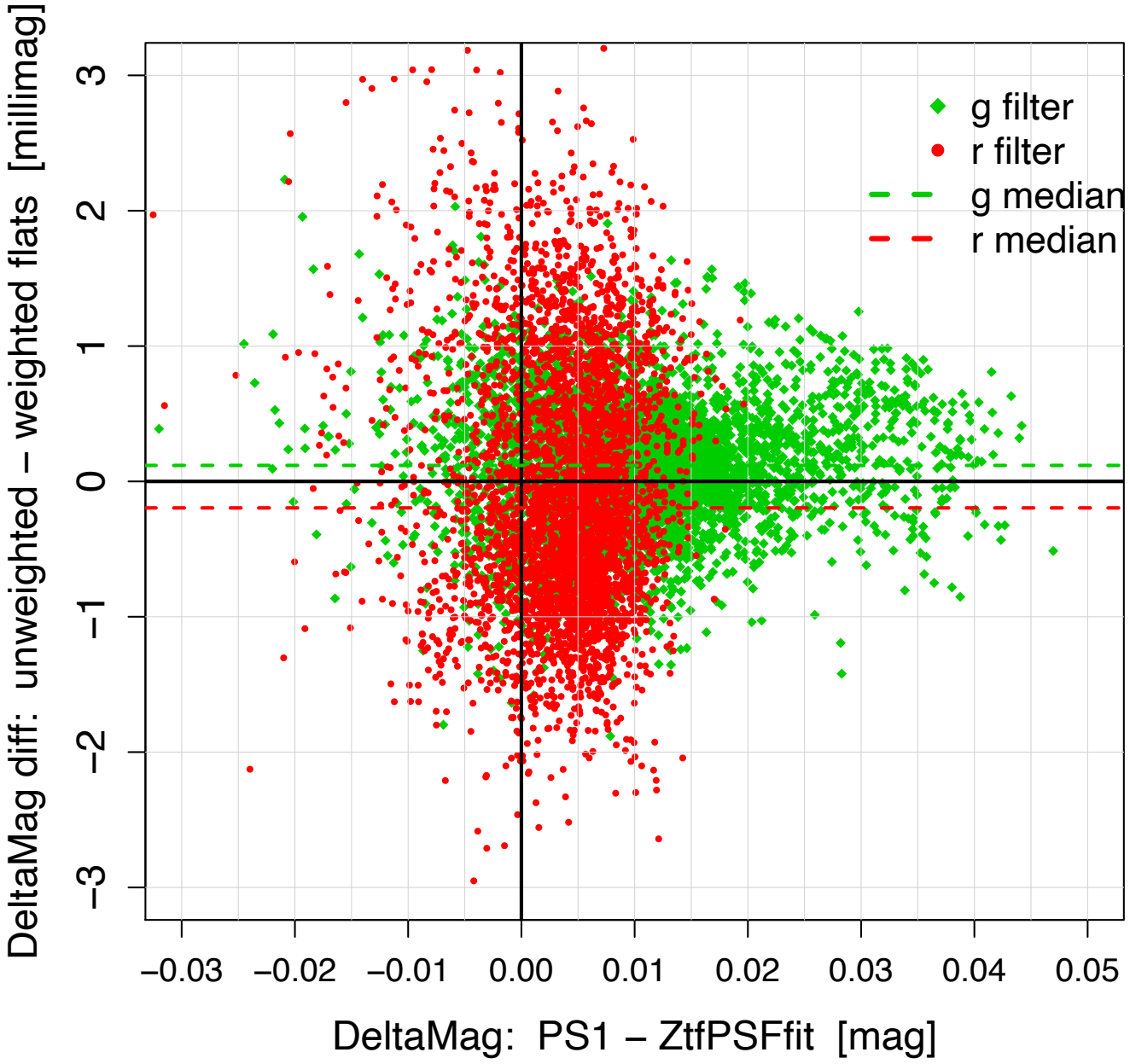
‘PS1 – PSF-fit’ photometry mag residuals (*r*)

difference in r: unweighted – weighted



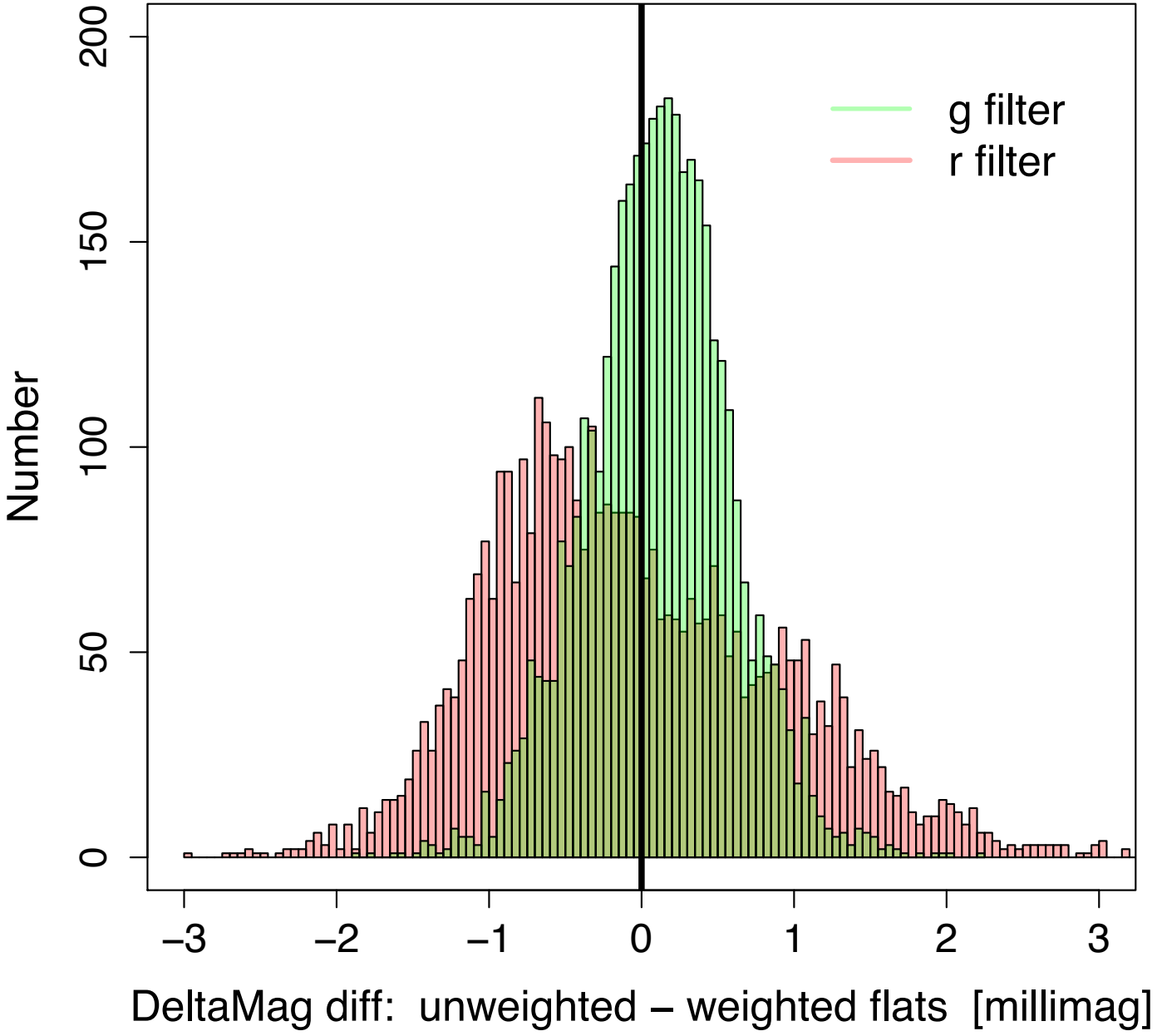
‘PS1 – PSF-fit’ photometry mag residuals

difference in residuals versus residuals per bin

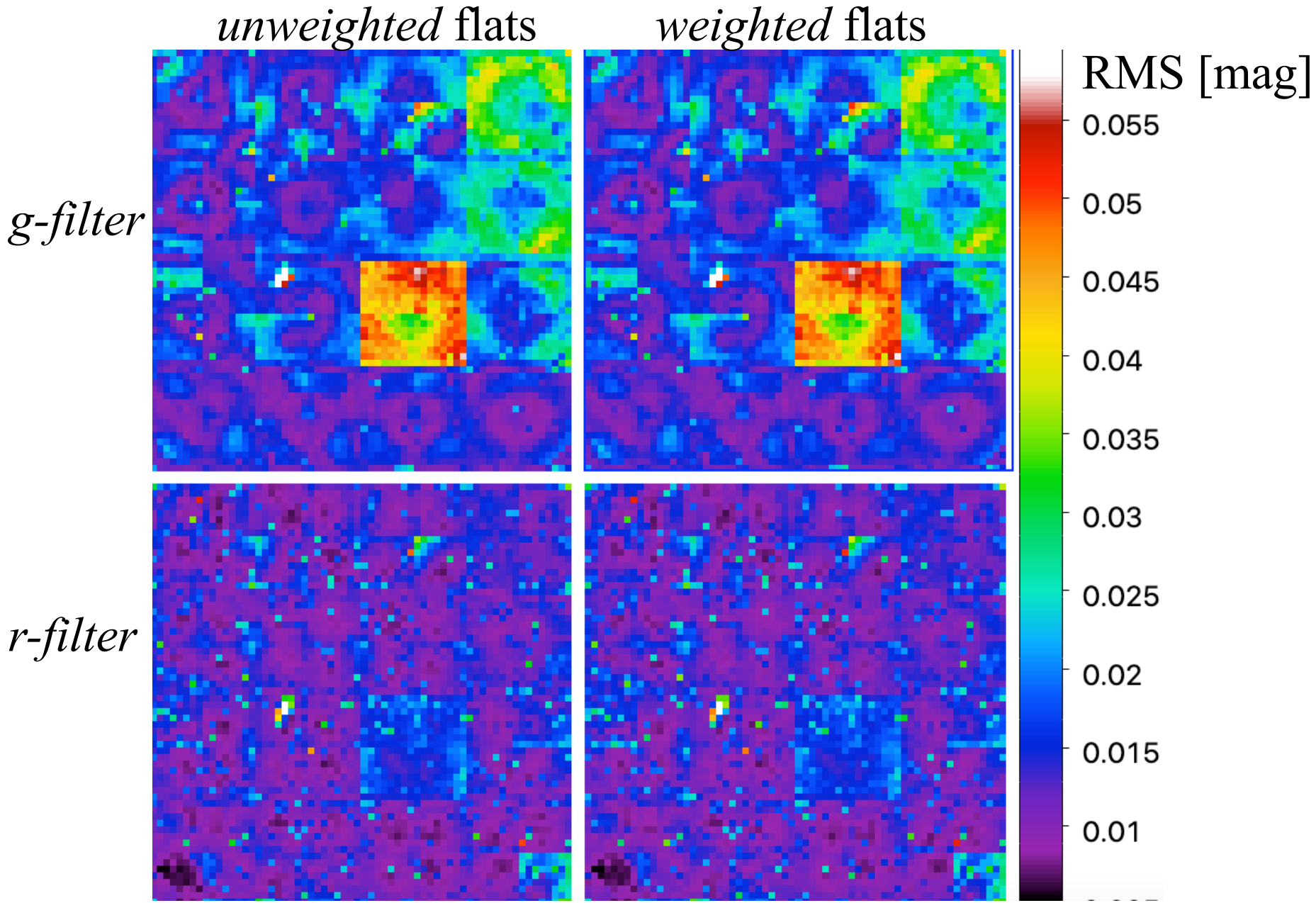


‘PS1 – PSF-fit’ photometry mag residuals

histograms of difference in residuals



RMS in ‘PS1 – PSF-fit’ photometry mag residuals

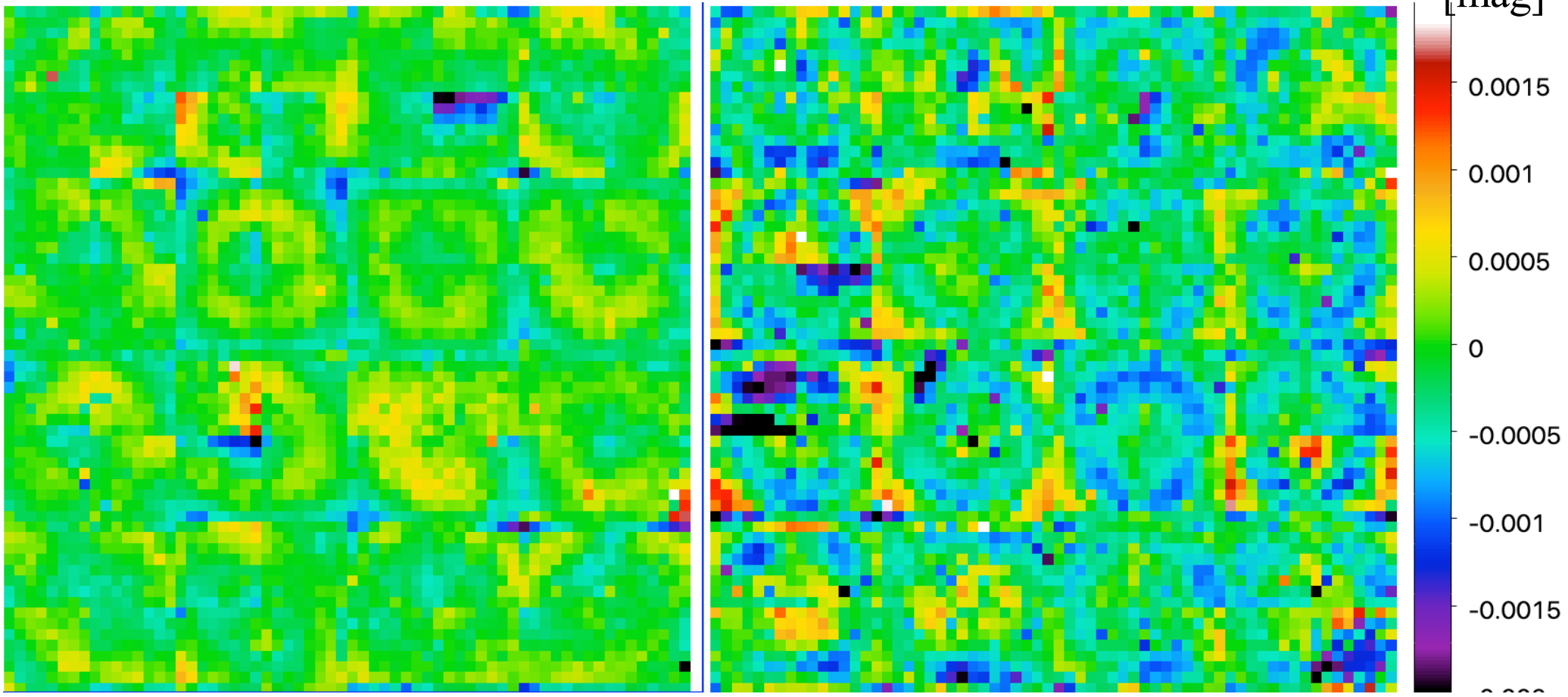


‘PS1 – PSF-fit’ photometry mag residuals

difference of RMS maps: *unweighted – weighted*

g-filter

r-filter

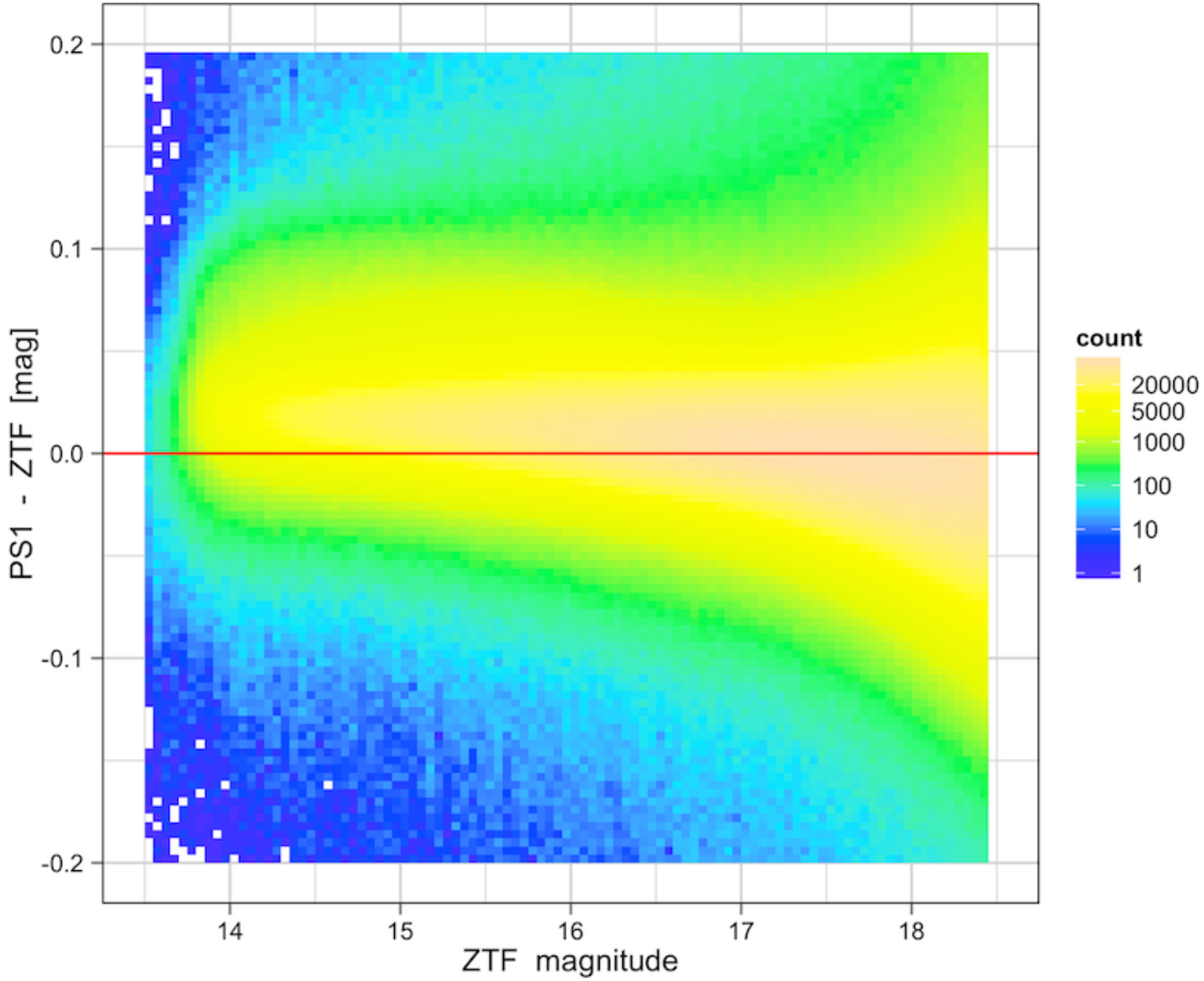


median = -0.052 millimag
%bins with ΔRMS <= 0 = 58.15%

median = -0.264 millimag
%bins with ΔRMS <= 0 = 72.38%

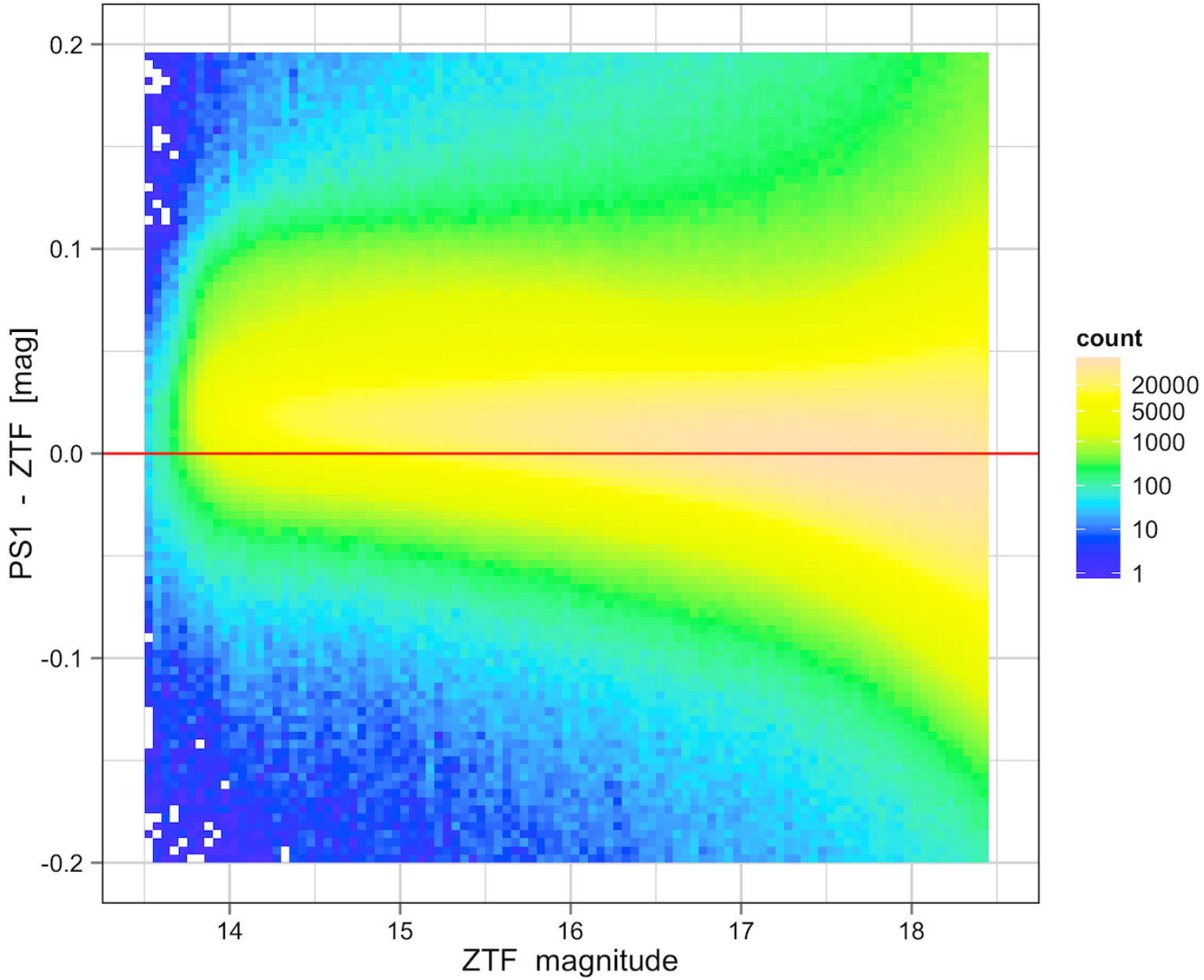
‘PS1 – PSF-fit’ photometry mag residuals

*using g-band **unweighted** flats*

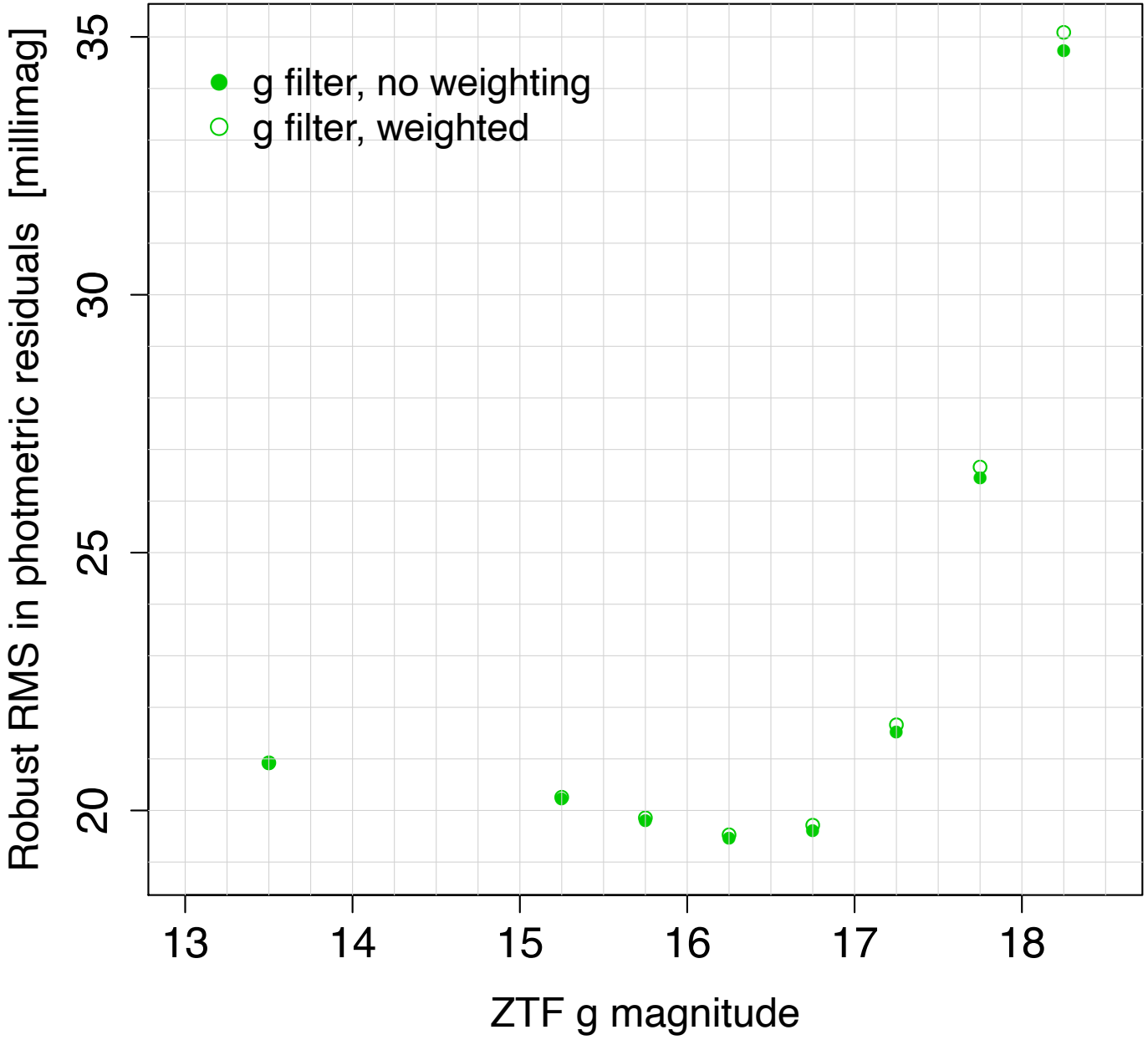


‘PS1 – PSF-fit’ photometry mag residuals

*using g-band **weighted** flats*

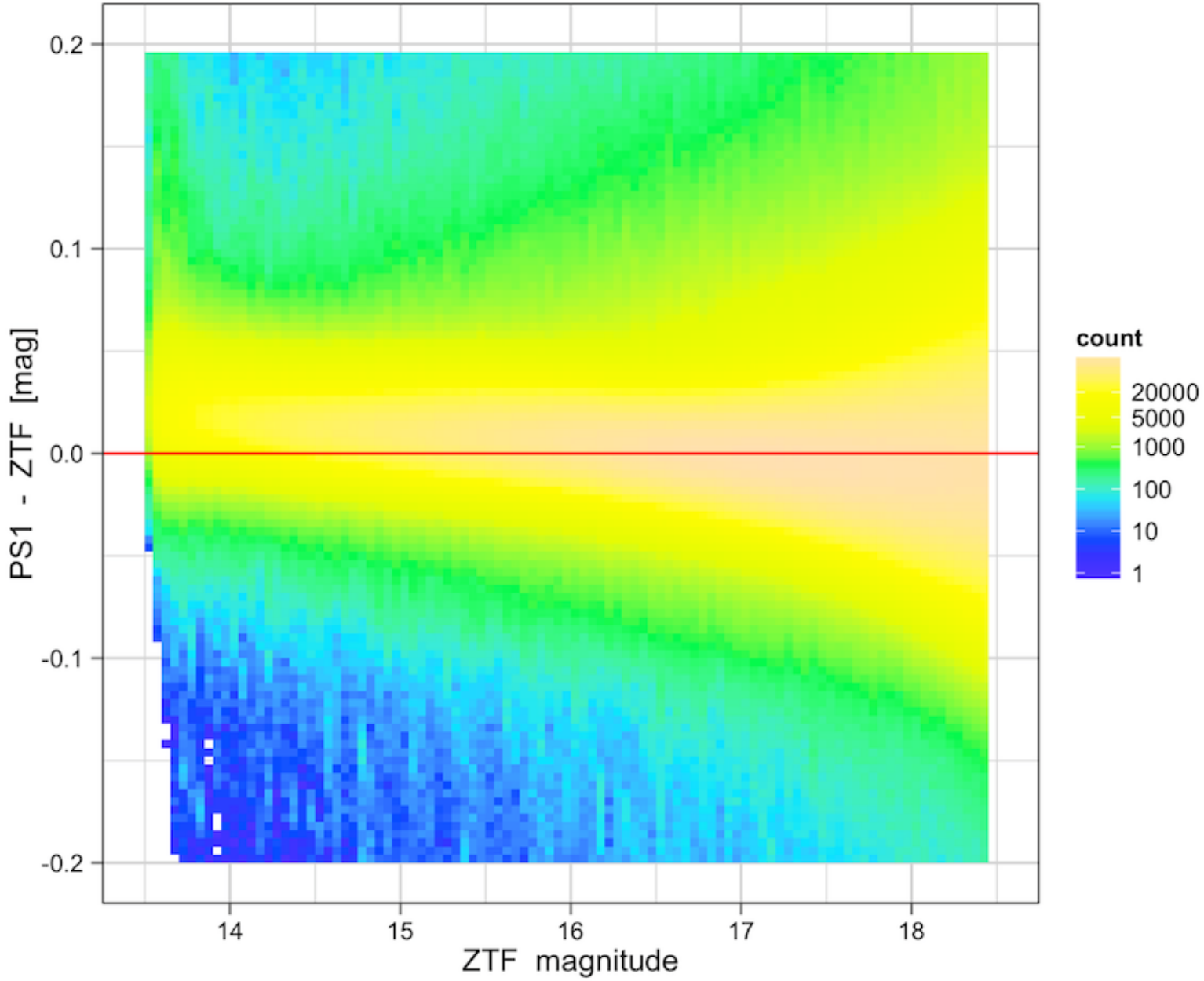


RMS in *g filter* 'PS1 – PSF-fit' photometry residuals



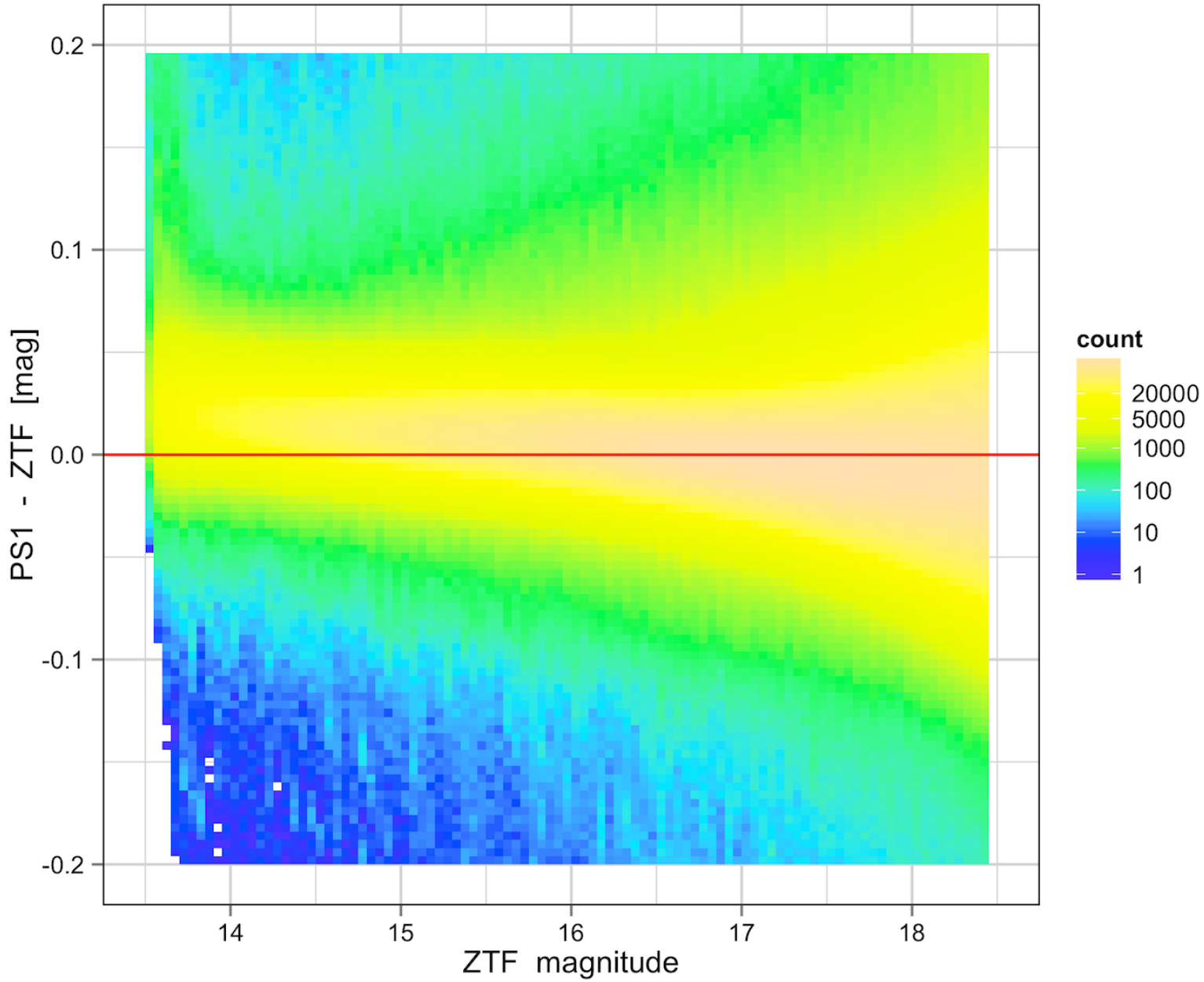
‘PS1 – PSF-fit’ photometry mag residuals

*using r-band **unweighted** flats*



‘PS1 – PSF-fit’ photometry mag residuals

*using r-band **weighted** flats*



RMS in *r filter* 'PS1 – PSF-fit' photometry residuals