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

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September 21, 2020

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 ($\sim 6.5 \times 6.5$ 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: $\sim 1{,}200 - 150{,}000$ (see slide 4)
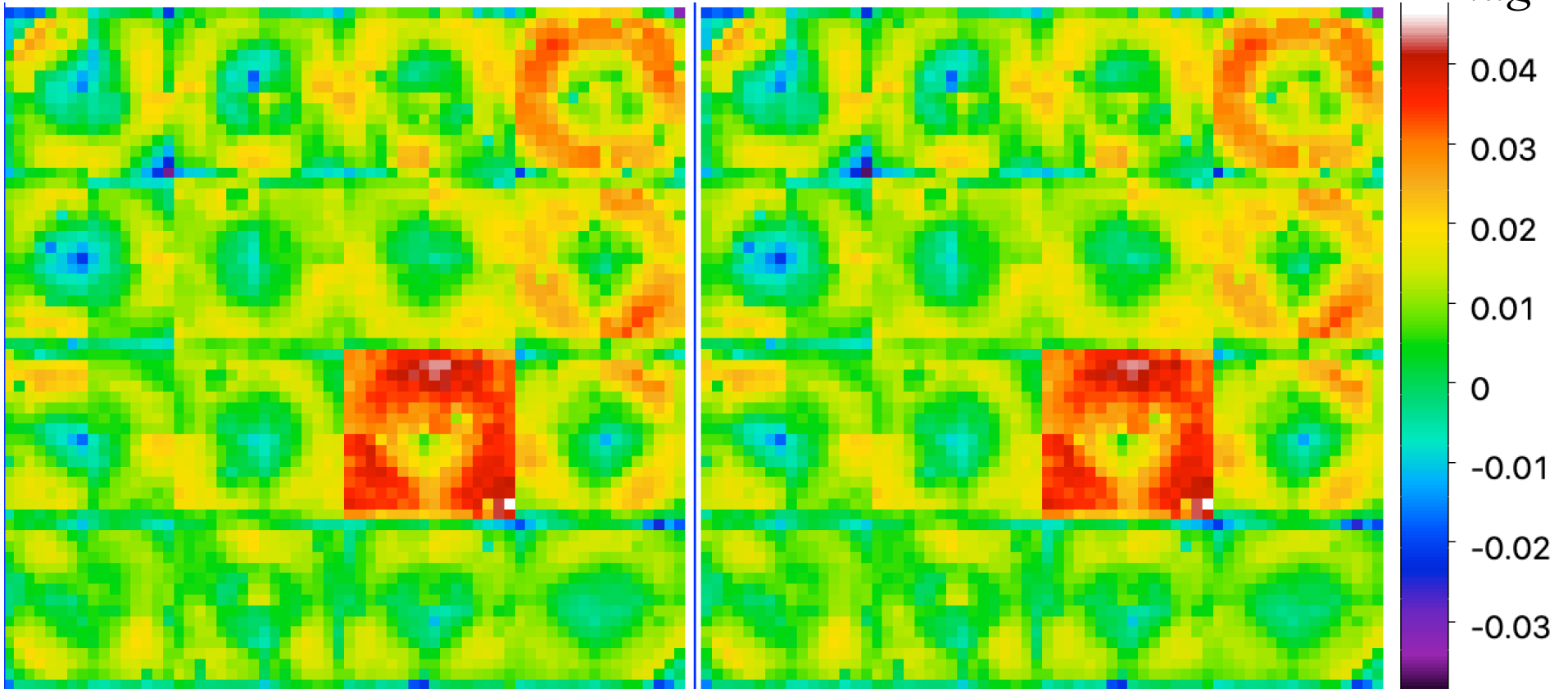
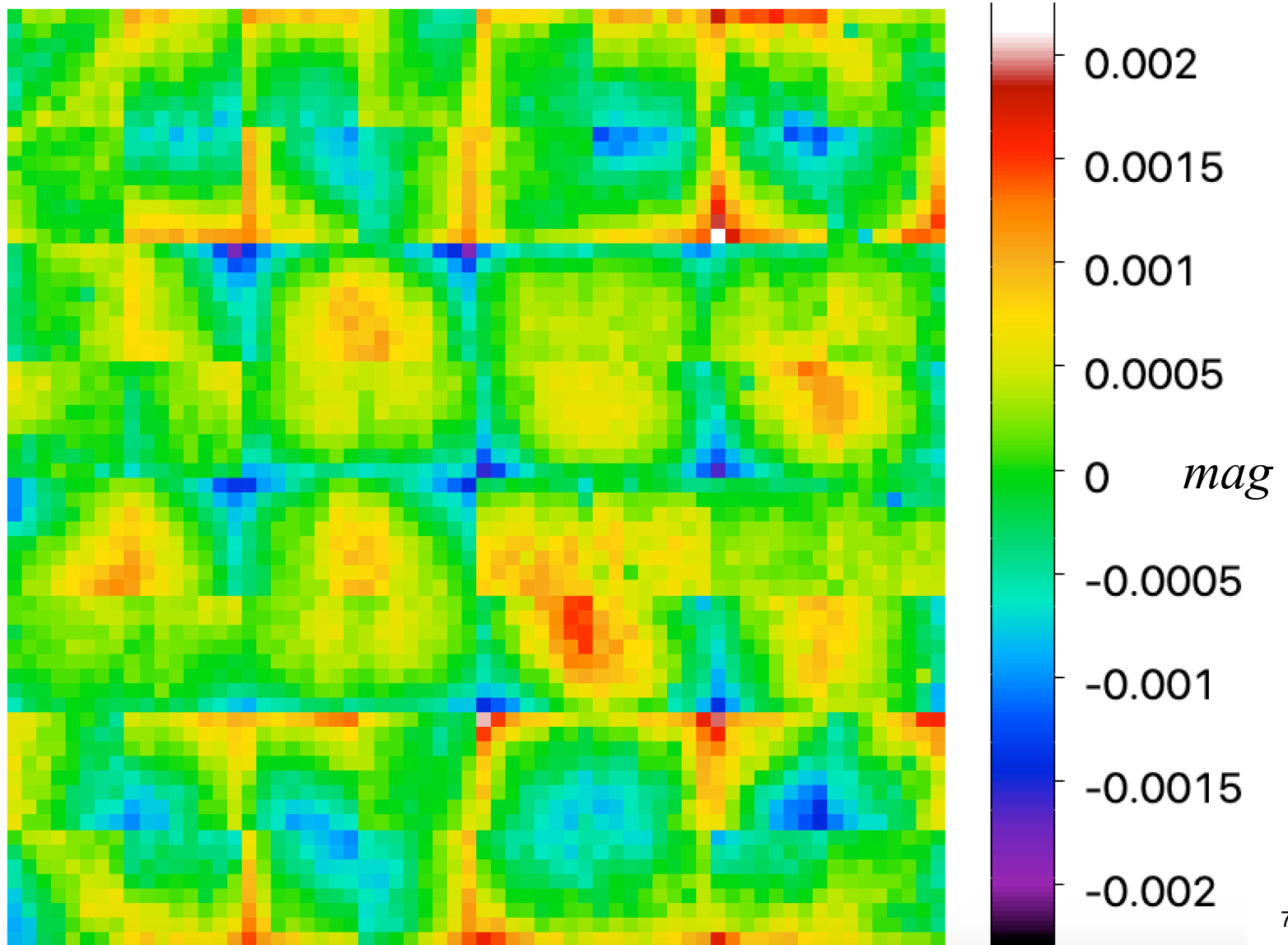# Number of ZTF-to-PS1 catalog matches per bin
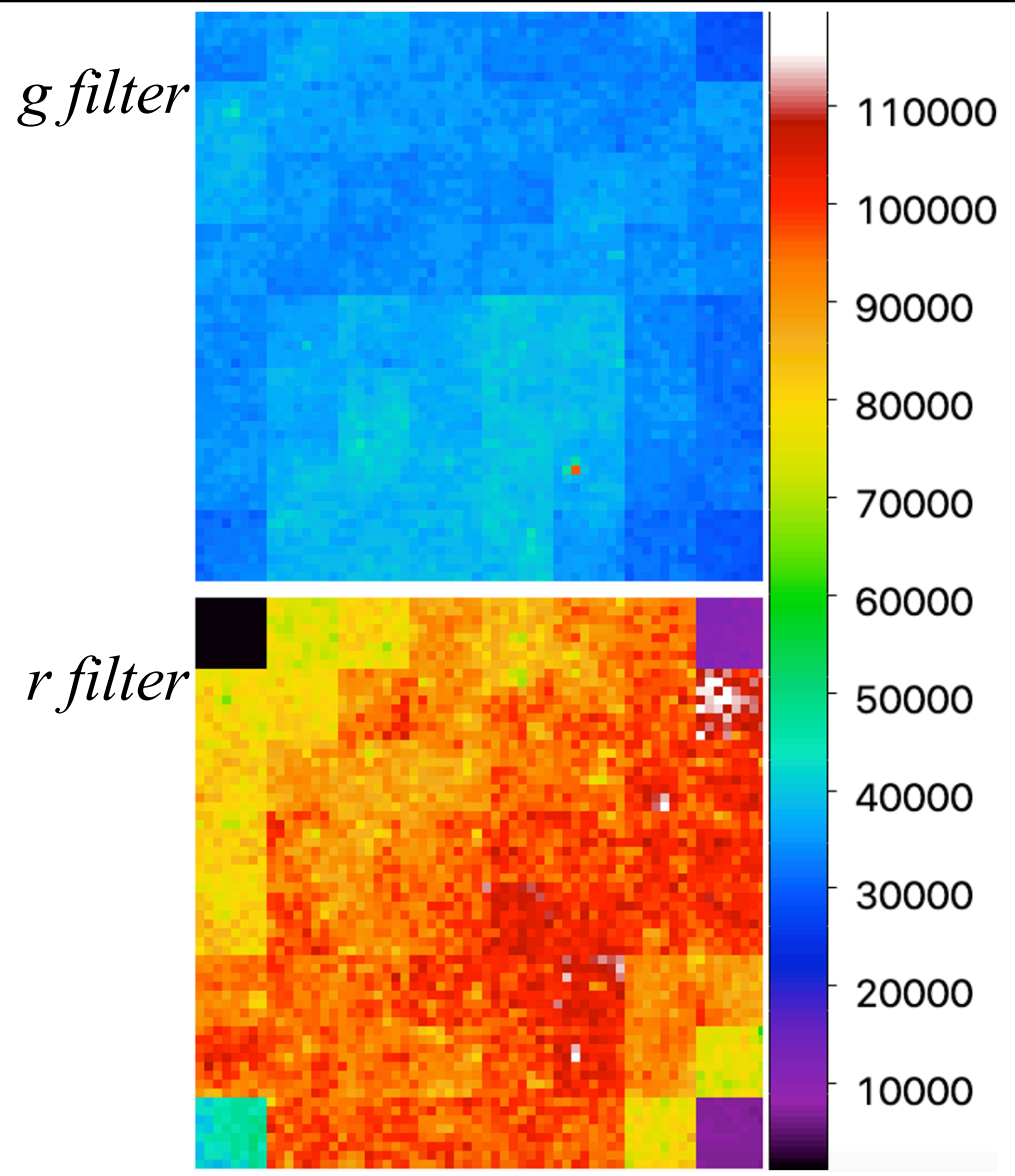
Assumed CCD / quadrant image layout

North (+Dec.)

East (+R.A.)

+x

+y

CCD

readout quadrant (or channel) image

~6.5' × 6.5' bin
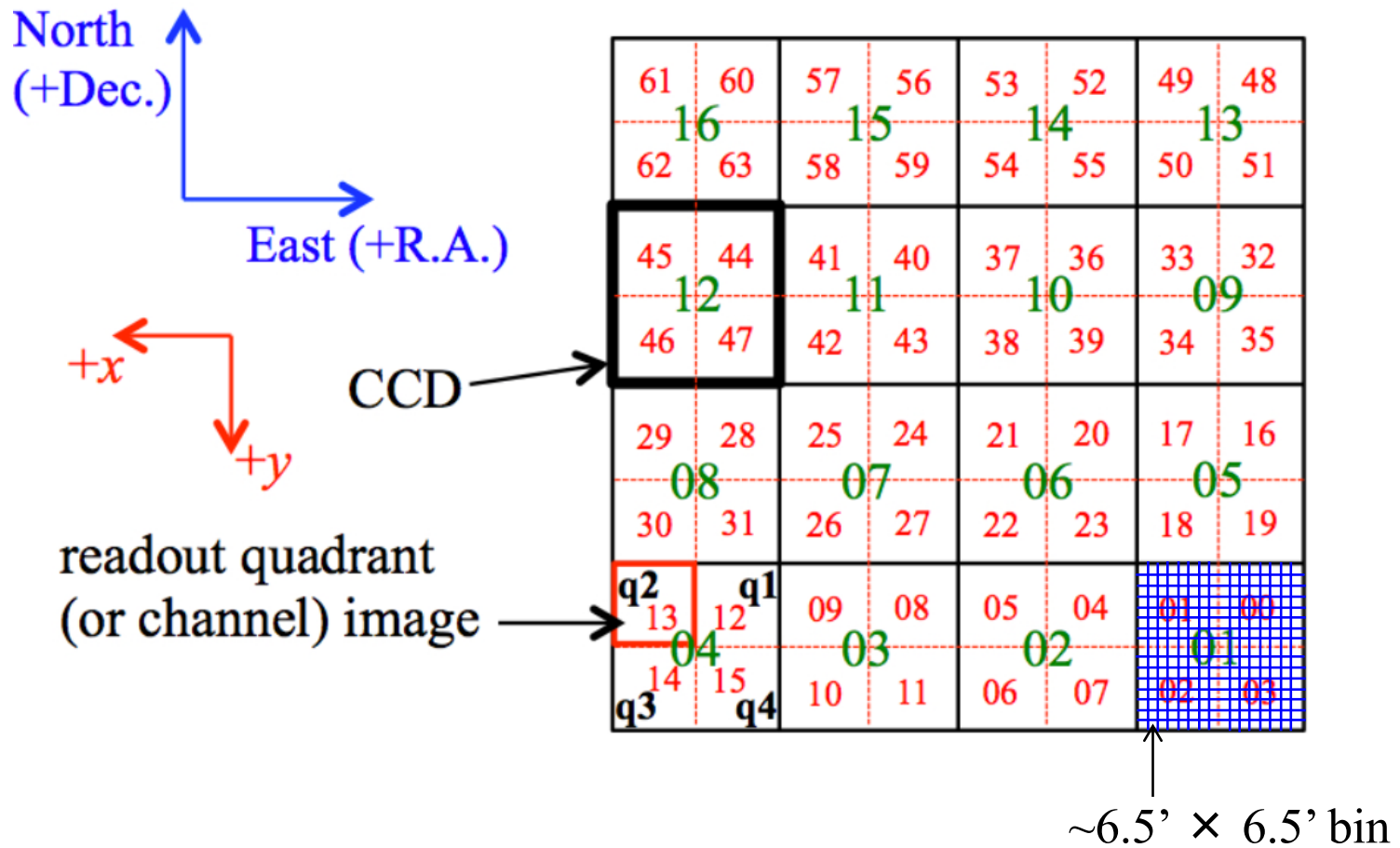
'PS1 – PSF-fit' photometry mag residuals (*g*)

g unweighted flats   *g weighted* flats
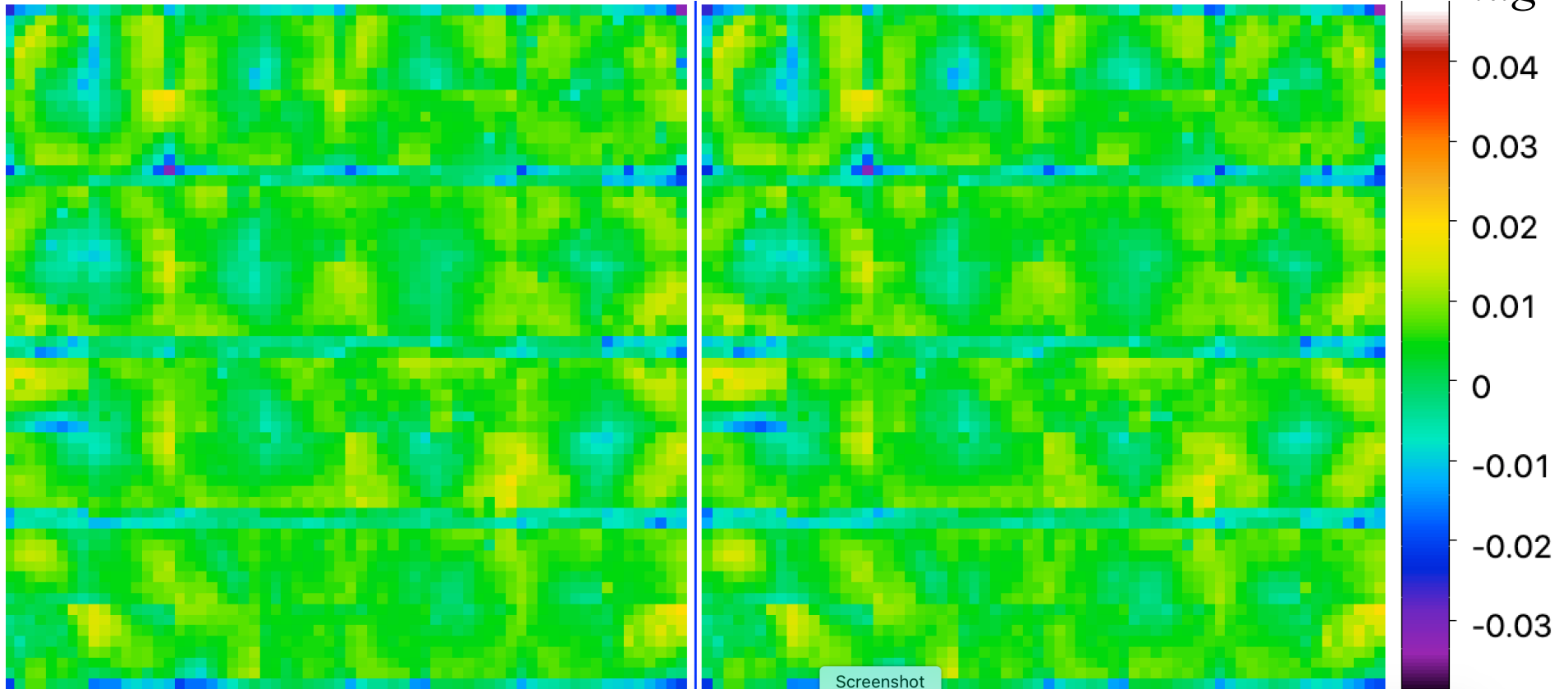
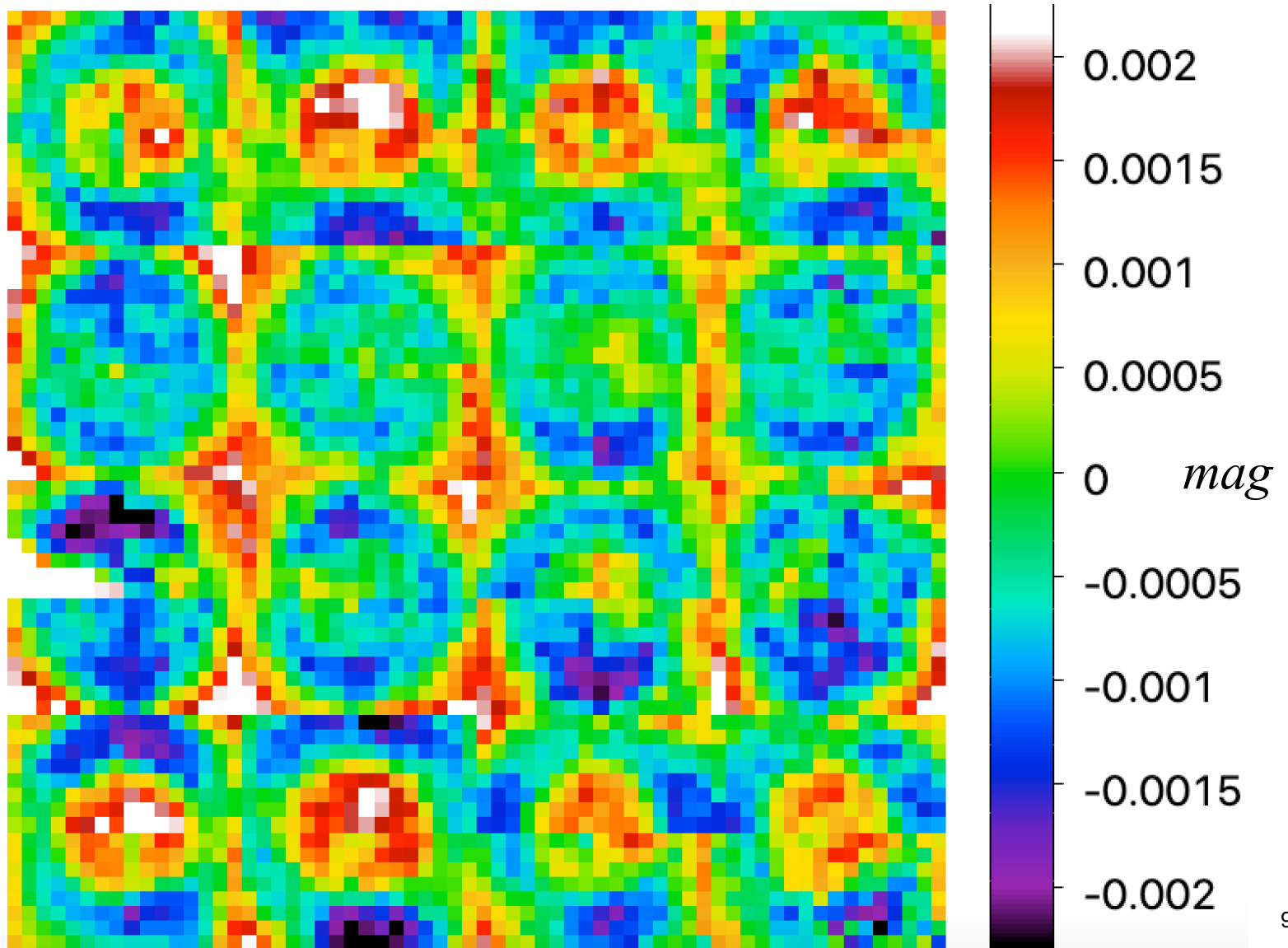# 'PS1 – PSF-fit' photometry mag residuals (*g*)
difference in g: unweighted – weighted

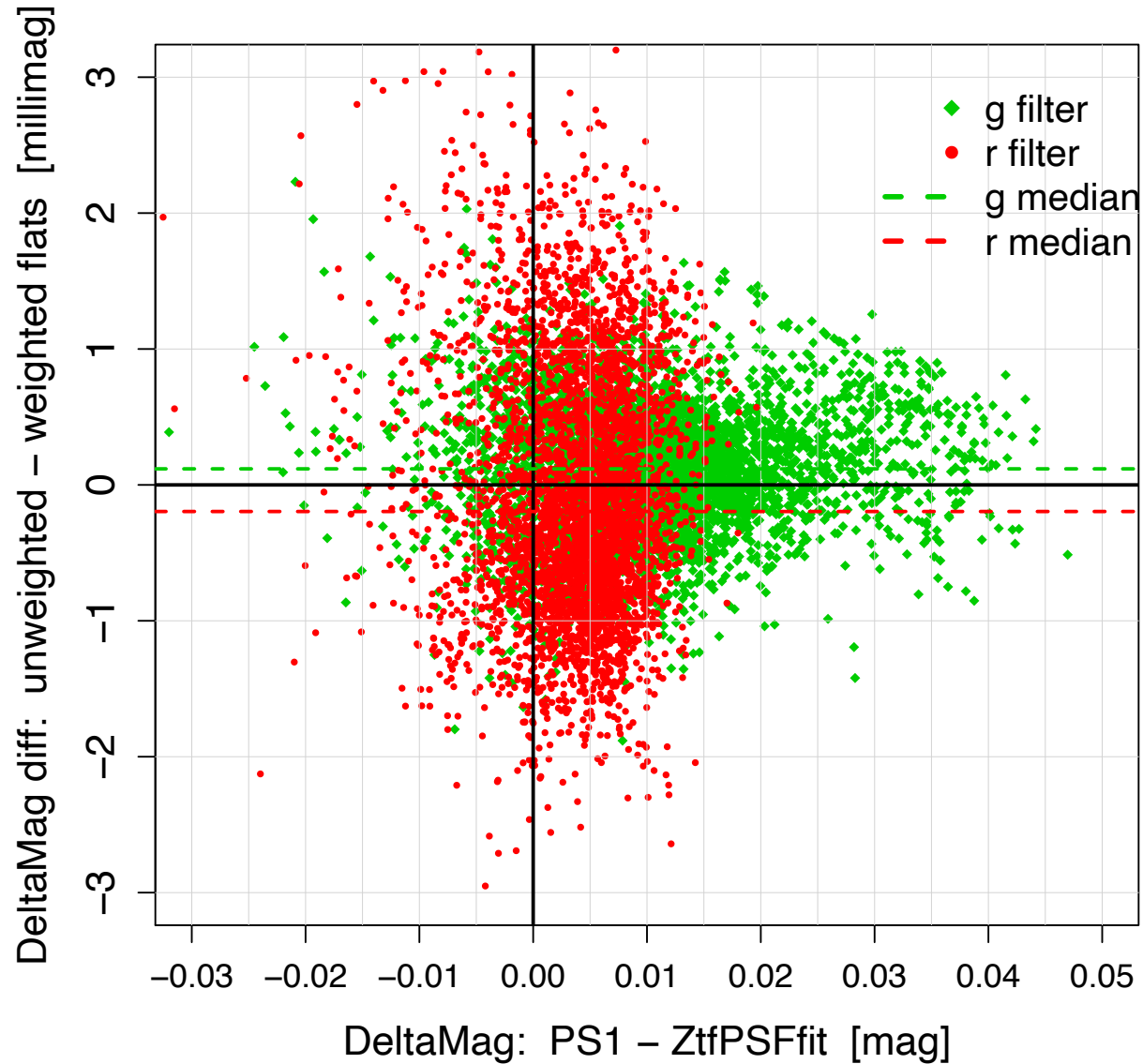# 'PS1 – PSF-fit' photometry mag residuals (r)

r unweighted flats   *r weighted* flats
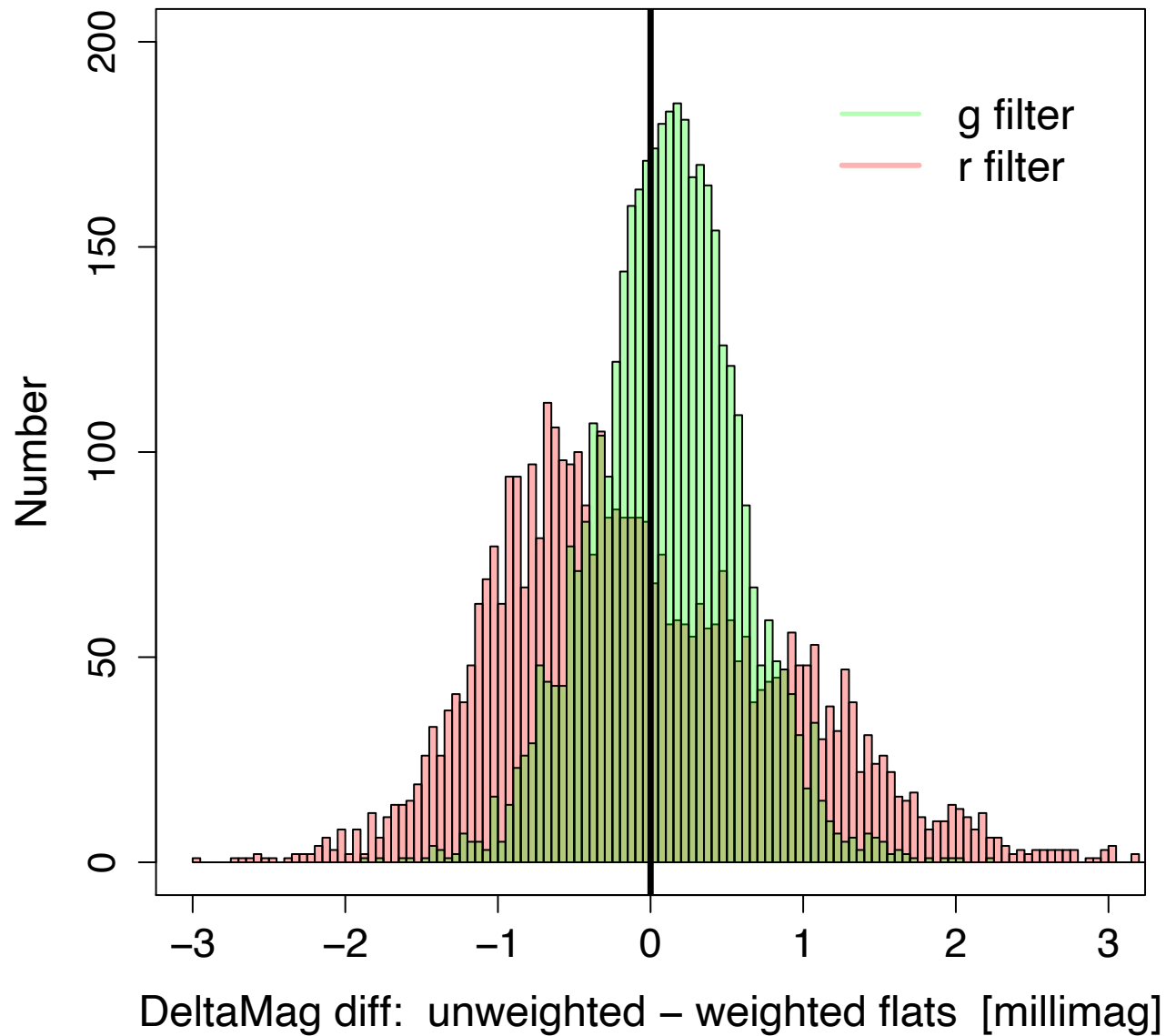
mag

0.04
0.03
0.02
0.01
0
-0.01
-0.02
-0.03

'PS1 – PSF-fit' photometry mag residuals (*r*)
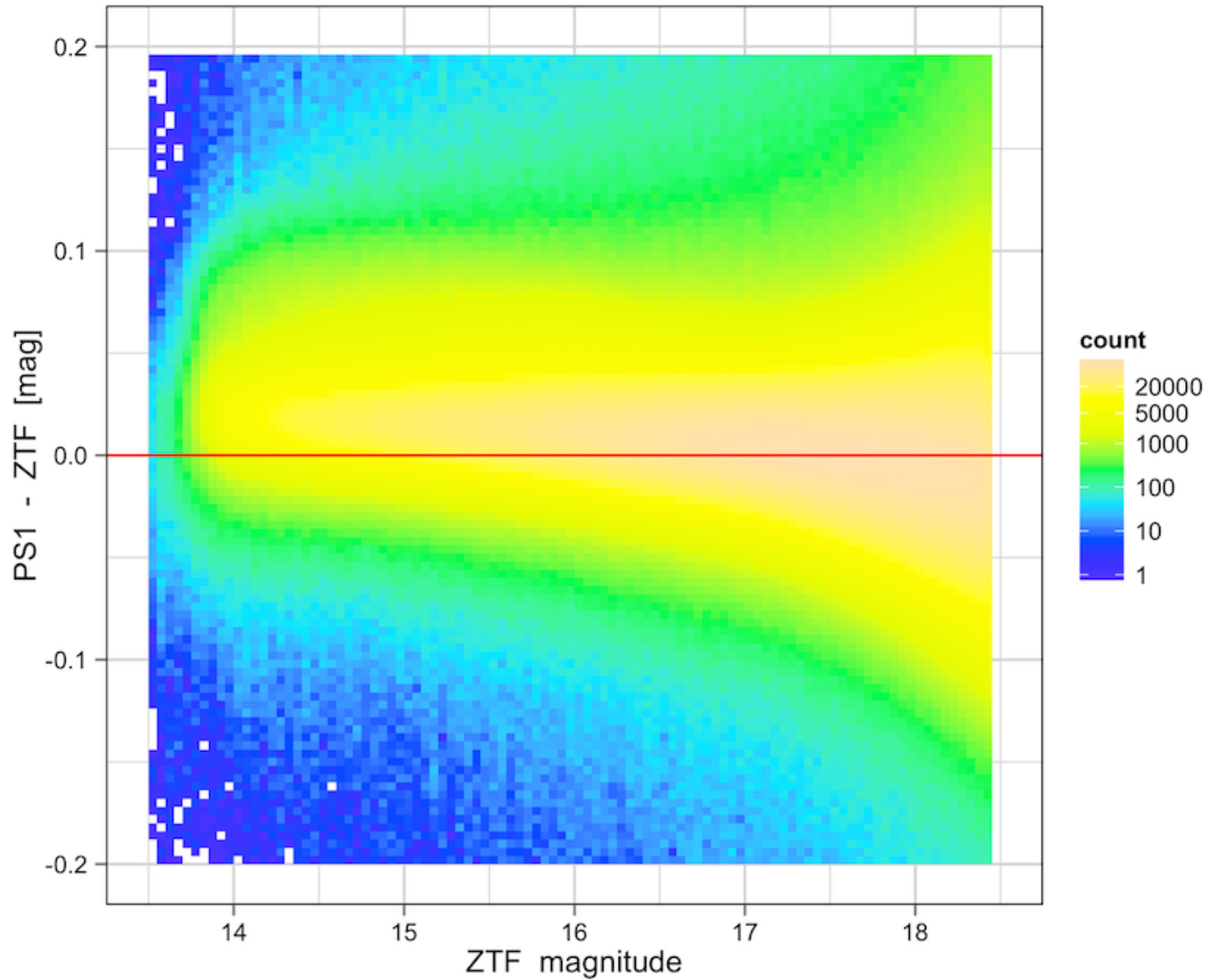## *difference in r: unweighted – weighted*

'PS1 – PSF-fit' photometry mag residuals
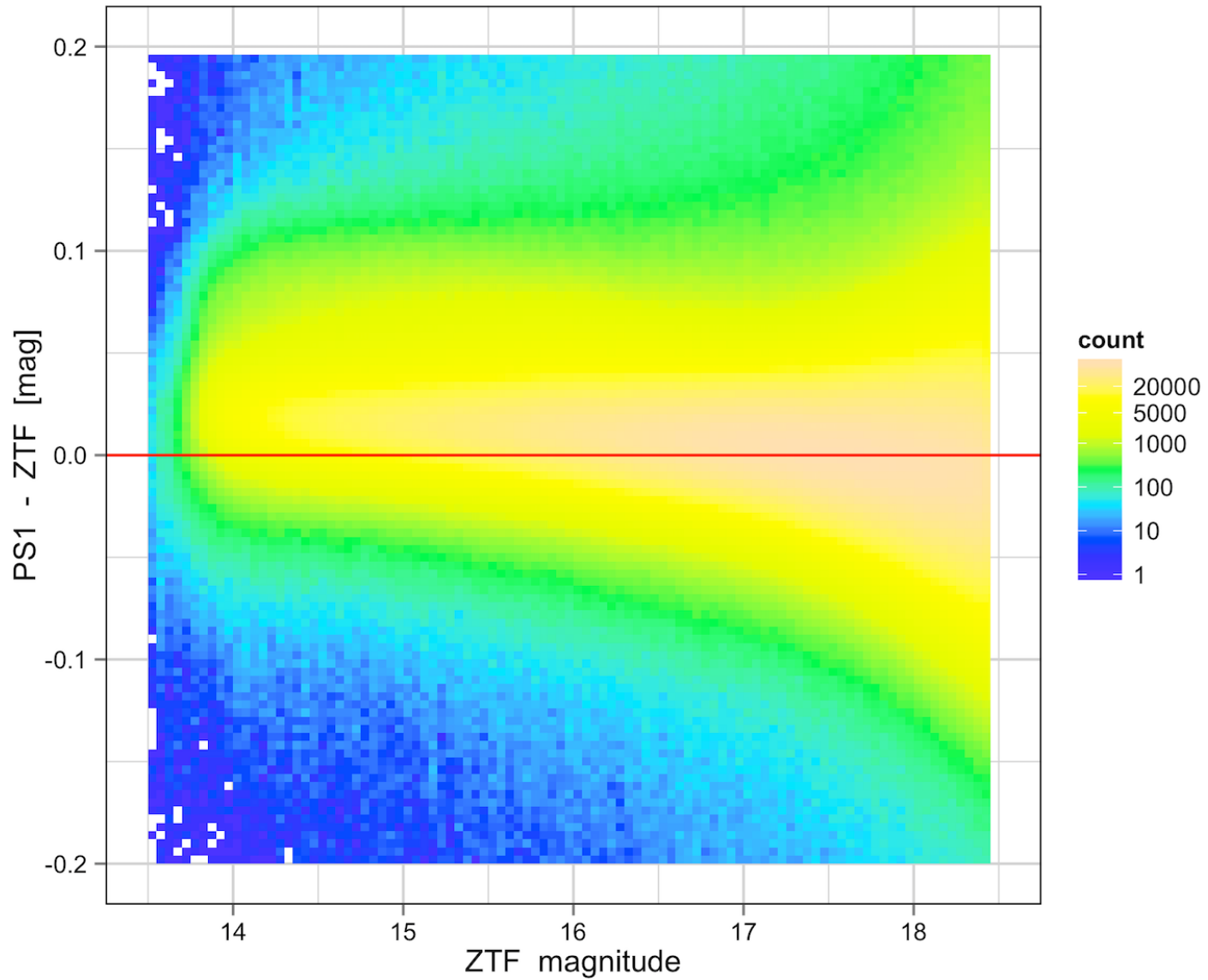## *difference in residuals versus residuals per bin*

'PS1 – PSF-fit' photometry mag residuals
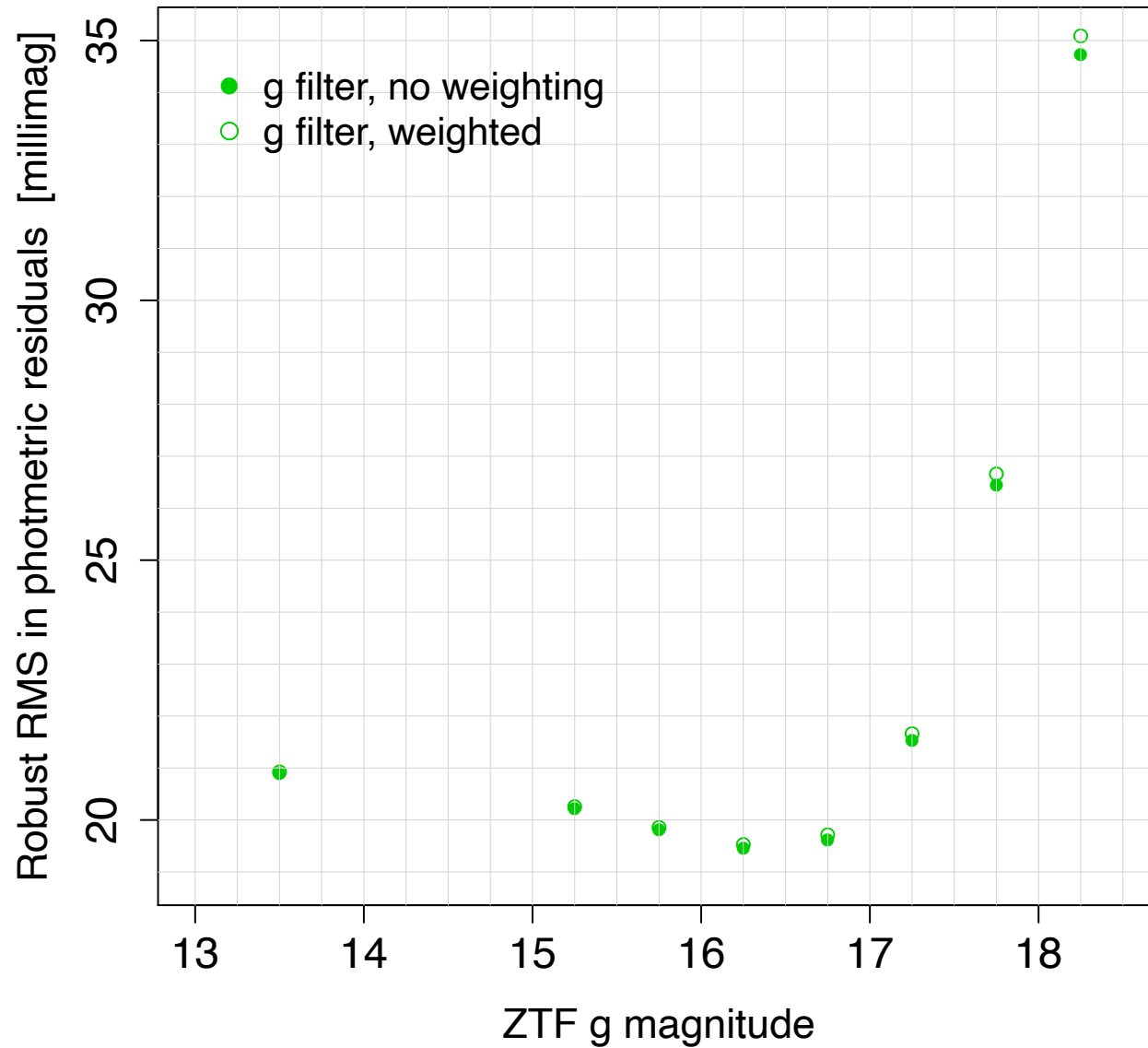## *histograms of difference in residuals*

DeltaMag diff: unweighted – weighted flats [millimag]

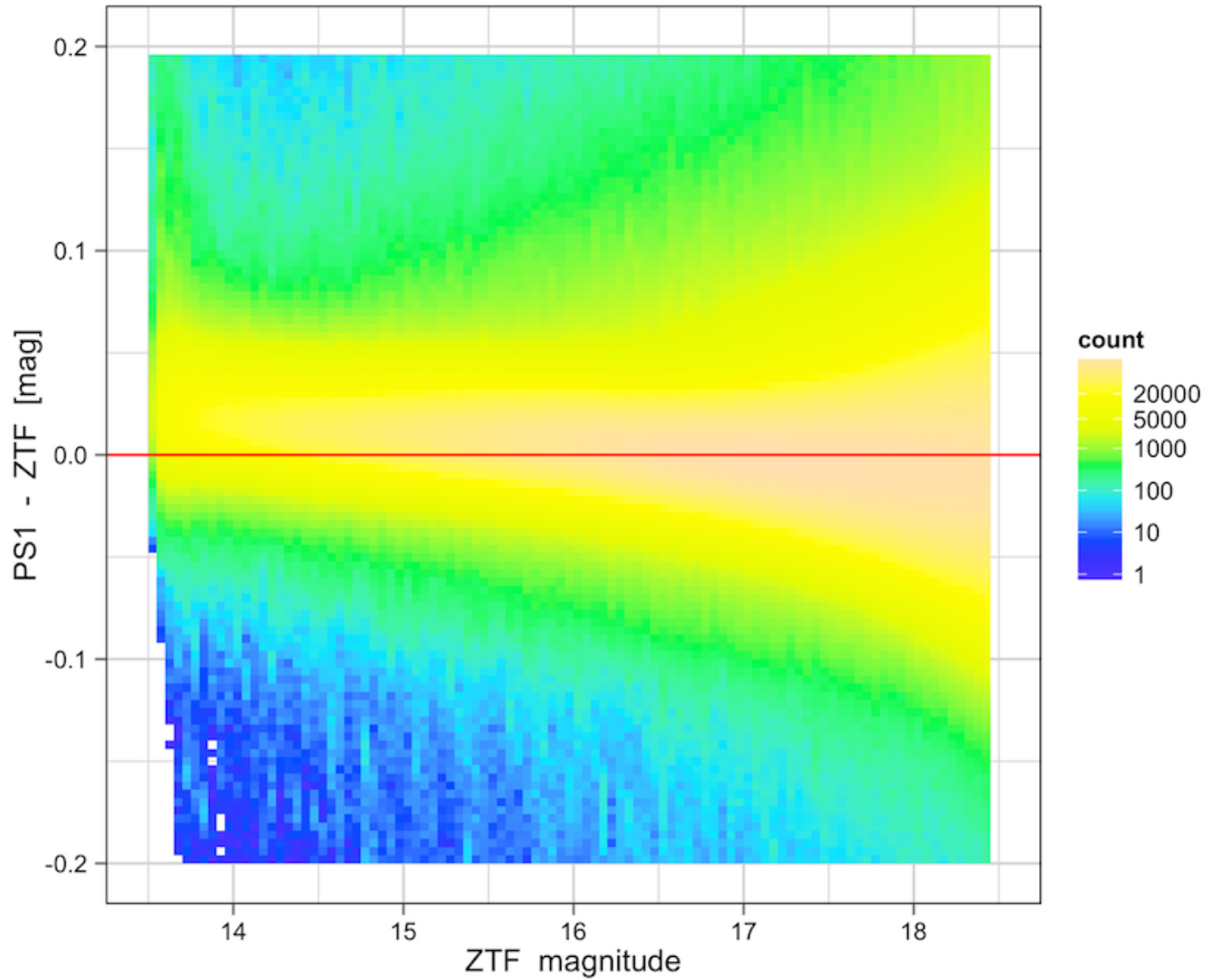# 'PS1 – PSF-fit' photometry mag residuals
*using g-band **unweighted** flats*

'PS1 – PSF-fit' photometry mag residuals
*using g-band **weighted** flats*

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

The figure shows a scatter plot with "ZTF g magnitude" on the x-axis (ranging from 13 to 18) and "Robust RMS in photmetric residuals [millimag]" on the y-axis (ranging from 20 to 35). Legend: filled green circle = "g filter, no weighting"; open green circle = "g filter, weighted".

'PS1 – PSF-fit' photometry mag residuals
*using r-band **unweighted** flats*

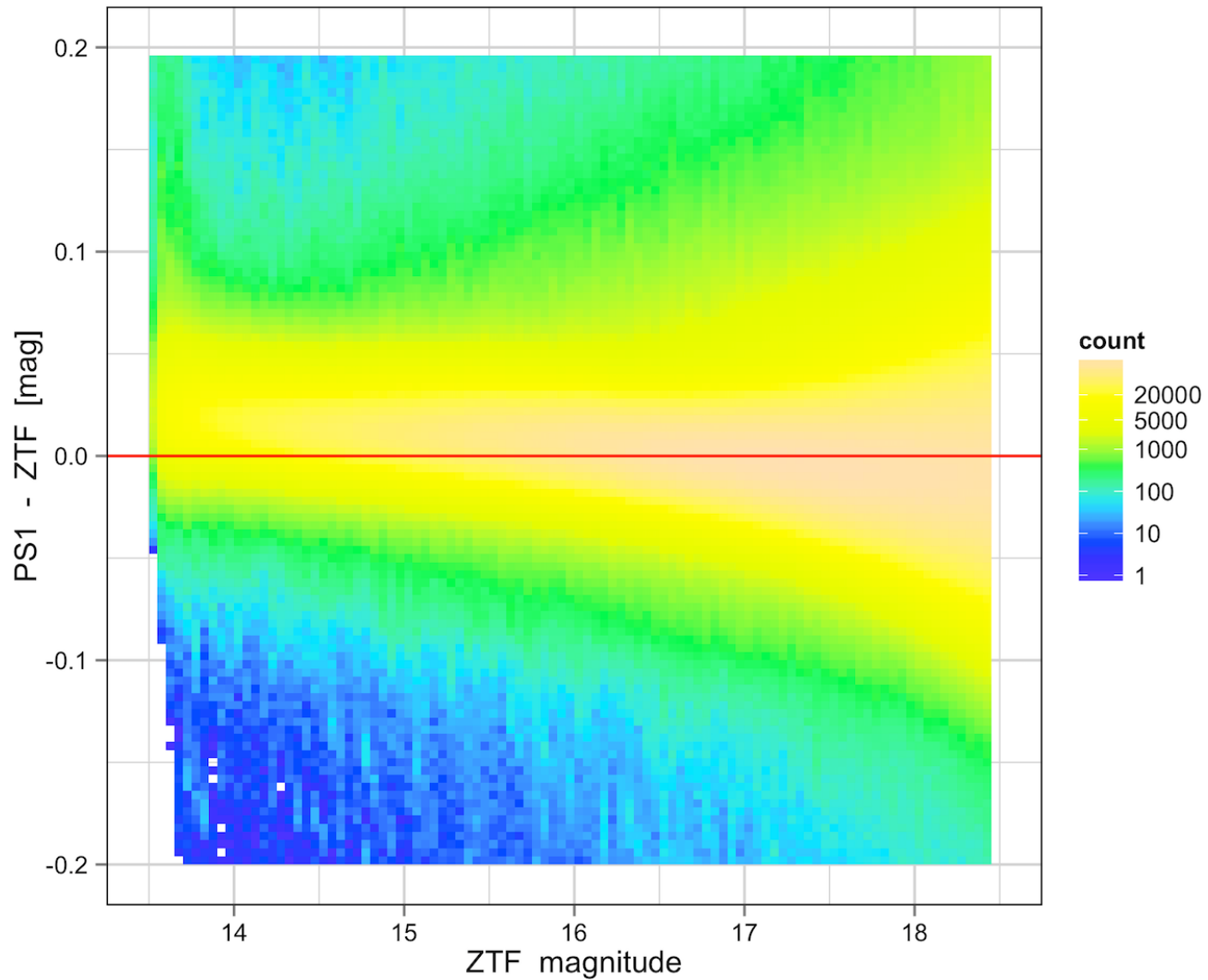# 'PS1 – PSF-fit' photometry mag residuals
*using r-band **weighted** flats*

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