

```
In [1]: from AtmoBuilder import AtmoBuilder

import numpy as np
import matplotlib.pyplot as plt
import copy

%matplotlib inline

/Users/joachim/anaconda/lib/python2.7/site-packages/IPython/kernel/__init__.py:13: ShimWarning: The
`IPython.kernel` package has been deprecated. You should import from ipykernel or jupyter_client instead.
"You should import from ipykernel or jupyter_client instead.", ShimWarning)

In [2]: ab = AtmoBuilder()

Found 16 MODTRAN files:
Pachon_MODTRAN.10.7sc
Pachon_MODTRAN.11.7sc
Pachon_MODTRAN.12.7sc
Pachon_MODTRAN.13.7sc
Pachon_MODTRAN.14.7sc
Pachon_MODTRAN.15.7sc
Pachon_MODTRAN.16.7sc
Pachon_MODTRAN.17.7sc
Pachon_MODTRAN.18.7sc
Pachon_MODTRAN.19.7sc
Pachon_MODTRAN.20.7sc
Pachon_MODTRAN.21.7sc
Pachon_MODTRAN.22.7sc
Pachon_MODTRAN.23.7sc
Pachon_MODTRAN.24.7sc
Pachon_MODTRAN.25.7sc
MODTRAN files have been read.

Read filter data from LSST software stack.
Filters: ['u', 'g', 'r', 'i', 'z', 'y4']
Read hardware data from LSST software stack.

In [3]: ab.readAll()

# Read 4855 MS stars from /Users/joachim/anaconda/opt/lsst/sims_sed_library/starSED/kurucz/
# Read 849 white dwarfs from /Users/joachim/anaconda/opt/lsst/sims_sed_library/starSED/wDs/
# Read 74 mlt stars from /Users/joachim/anaconda/opt/lsst/sims_sed_library/starSED/mlt/
# Generated 2520 galaxies at redshifts between 0.000000 and 3.000000
# Generated 76 quasars at redshifts between 0.000000 and 7.500000
# Generated 39 sn's at redshifts between 0.000000 and 1.200000 on days ['0', '20', '40']

In [4]: maxp = 1.2
minp = 0.8
airmass = 2.0
deltaGrey_obs = 12.0

def deltaGreyLimitPlot(comp, maxp=maxp, minp=minp, deltaGrey=deltaGrey_obs, deltaGreyRange=[-20.0, 2
0.0], err=5.0, componentBins=50, deltaGreyBins=51, regressionSed='stars'):

    prange, pnum = ab._componentCheck(comp, 20)

    atmo_std = ab.buildAtmo(ab.parameters, airmass)

    name_max = 'max_dGTest_allMS_OR' + str(int(maxp*100.0))
    name_min = 'min_dGTest_allMS_OR' + str(int(minp*100.0))

    ab.computeDeltaGreyFit(comp, deltaGrey, atmo_std, deltaGreyRange=deltaGreyRange, componentBins=co
mponentBins,
                           deltaGreyBins=deltaGreyBins, regressionSed=regressionSed, pickleString=name_
max, plotDmags=False, override=True, overrideValue=maxp)
    ab.computeDeltaGreyFit(comp, deltaGrey, atmo_std, deltaGreyRange=deltaGreyRange, componentBins=co
mponentBins,
                           deltaGreyBins=deltaGreyBins, regressionSed=regressionSed, pickleString=name_
min, plotDmags=False, override=True, overrideValue=minp)
    return
```

## **Components:**

- $H_2O$
- $O_2$
- $O_3$
- Rayleigh
- Aerosol
- Alpha

$H_2O$

```
In [5]: deltaGreyLimitPlot('H2O')
```

```
Computing nonlinear regression for H2O.  
Observed atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]  
Observed atmosphere airmass: 2.0  
Standard atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]  
Standard atmosphere airmass: 1.2  
Observed atmosphere parameter for H2O: 1.0  
  
Fitting for H2O between 0.20 and 5.00 in 50 bins.  
Fitting for deltaGrey between -20.00 and 20.00 mmags in 51 bins.  
  
Regression SEDs: 5778 Stars (MS,WD,MLT) SEDs.  
  
Regressing 2550 parameter combinations per filter...  
Magnitude Error: 5.0 mmags  
  
Override triggered...  
Override value detected, proceeding with deltaGrey best-fit minimization at new component best-fit value...  
  
Calculating best fit parameters for u filter...  
@pickle_results: using precomputed results from 'pickles/X20_P101010101017_H2O_dG_XSTD12_DG120_DGR-2_020_E5_stars_u_51dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for u filter.  
Saved Chi-Squared at best fit deltaGrey for u filter.  
Completed u filter.  
  
Calculating best fit parameters for g filter...  
@pickle_results: using precomputed results from 'pickles/X20_P101010101017_H2O_dG_XSTD12_DG120_DGR-2_020_E5_stars_g_51dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for g filter.  
Saved Chi-Squared at best fit deltaGrey for g filter.  
Completed g filter.  
  
Calculating best fit parameters for r filter...  
@pickle_results: using precomputed results from 'pickles/X20_P101010101017_H2O_dG_XSTD12_DG120_DGR-2_020_E5_stars_r_51dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for r filter.  
Saved Chi-Squared at best fit deltaGrey for r filter.  
Completed r filter.  
  
Calculating best fit parameters for i filter...  
@pickle_results: using precomputed results from 'pickles/X20_P101010101017_H2O_dG_XSTD12_DG120_DGR-2_020_E5_stars_i_51dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for i filter.  
Saved Chi-Squared at best fit deltaGrey for i filter.  
Completed i filter.  
  
Calculating best fit parameters for z filter...  
@pickle_results: using precomputed results from 'pickles/X20_P101010101017_H2O_dG_XSTD12_DG120_DGR-2_020_E5_stars_z_51dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for z filter.  
Saved Chi-Squared at best fit deltaGrey for z filter.  
  
AtmoBuilder.py:892: FutureWarning: comparison to `None` will result in an elementwise object comparison in the future.  
if sedkeylist == None:  
/Users/joachim/anaconda/lib/python2.7/site-packages/matplotlib/text.py:52: UnicodeWarning: Unicode equal comparison failed to convert both arguments to Unicode - interpreting them as being unequal  
if rotation in ('horizontal', None):
```

Completed z filter.

Calculating best fit parameters for y4 filter...  
@pickle\_results: using precomputed results from 'pickles/X20\_P101010101017\_H2O\_dG\_XSTD12\_DG120\_DGR-2\_020\_E5\_stars\_y4\_51dgb\_50b\_max\_dGTest\_allMS\_OR120.pkl'  
Saved LogL at best fit deltaGrey for y4 filter.  
Saved Chi-Squared at best fit deltaGrey for y4 filter.  
Completed y4 filter.

Best fit parameters (Filter, H2O, dG, logL, Chi-Squared):  
u 0.98 12.00 9.09845498312e-06 1.81969099662e-05  
g 0.98 12.00 2.13963373218e-05 4.27926746436e-05  
r 0.98 12.00 0.0002567958587 0.0005135917174  
i 0.98 12.00 0.000183642274655 0.000367284549309  
z 0.98 12.00 0.0445723179232 0.0891446358463  
y4 0.98 12.00 0.190847051957 0.381694103914

Override best fit parameters (Filter, H2O, dG):  
u 1.20 12.00  
g 1.20 12.00  
r 1.20 12.00  
i 1.20 12.00  
z 1.20 12.00  
y4 1.20 12.00

Computing nonlinear regression for H2O.  
Observed atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]  
Observed atmosphere airmass: 2.0  
Standard atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]  
Standard atmosphere airmass: 1.2  
Observed atmosphere parameter for H2O: 1.0

Fitting for H2O between 0.20 and 5.00 in 50 bins.  
Fitting for deltaGrey between -20.00 and 20.00 mmags in 51 bins.

Regression SEDs: 5778 Stars (MS,WD,MLT) SEDs.

Regressing 2550 parameter combinations per filter...  
Magnitude Error: 5.0 mmags

Override triggered...  
Override value detected, proceeding with deltaGrey best-fit minimization at new component best-fit value...

Calculating best fit parameters for u filter...  
@pickle\_results: using precomputed results from 'pickles/X20\_P101010101017\_H2O\_dG\_XSTD12\_DG120\_DGR-2\_020\_E5\_stars\_u\_51dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for u filter.  
Saved Chi-Squared at best fit deltaGrey for u filter.  
Completed u filter.

Calculating best fit parameters for g filter...  
@pickle\_results: using precomputed results from 'pickles/X20\_P101010101017\_H2O\_dG\_XSTD12\_DG120\_DGR-2\_020\_E5\_stars\_g\_51dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for g filter.  
Saved Chi-Squared at best fit deltaGrey for g filter.  
Completed g filter.

Calculating best fit parameters for r filter...  
@pickle\_results: using precomputed results from 'pickles/X20\_P101010101017\_H2O\_dG\_XSTD12\_DG120\_DGR-2\_020\_E5\_stars\_r\_51dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for r filter.  
Saved Chi-Squared at best fit deltaGrey for r filter.  
Completed r filter.

Calculating best fit parameters for i filter...  
@pickle\_results: using precomputed results from 'pickles/X20\_P101010101017\_H2O\_dG\_XSTD12\_DG120\_DGR-2\_020\_E5\_stars\_i\_51dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for i filter.  
Saved Chi-Squared at best fit deltaGrey for i filter.  
Completed i filter.

Calculating best fit parameters for z filter...  
@pickle\_results: using precomputed results from 'pickles/X20\_P101010101017\_H2O\_dG\_XSTD12\_DG120\_DGR-2\_020\_E5\_stars\_z\_51dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for z filter.  
Saved Chi-Squared at best fit deltaGrey for z filter.  
Completed z filter.

Calculating best fit parameters for y4 filter...  
@pickle\_results: using precomputed results from 'pickles/X20\_P101010101017\_H2O\_dG\_XSTD12\_DG120\_DGR-2\_020\_E5\_stars\_y4\_51dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'

```

Saved LogL at best fit deltaGrey for y4 filter.
Saved Chi-Squared at best fit deltaGrey for y4 filter.
Completed y4 filter.

```

Best fit parameters (Filter, H2O, dG, logL, Chi-Squared):

```

u 0.98 12.00 9.09845498312e-06 1.81969099662e-05
g 0.98 12.00 2.13963373218e-05 4.27926746436e-05
r 0.98 12.00 0.0002567958587 0.0005135917174
i 0.98 12.00 0.000183642274655 0.000367284549309
z 0.98 12.00 0.0445723179232 0.0891446358463
y4 0.98 12.00 0.190847051957 0.381694103914

```

Override best fit parameters (Filter, H2O, dG):

```

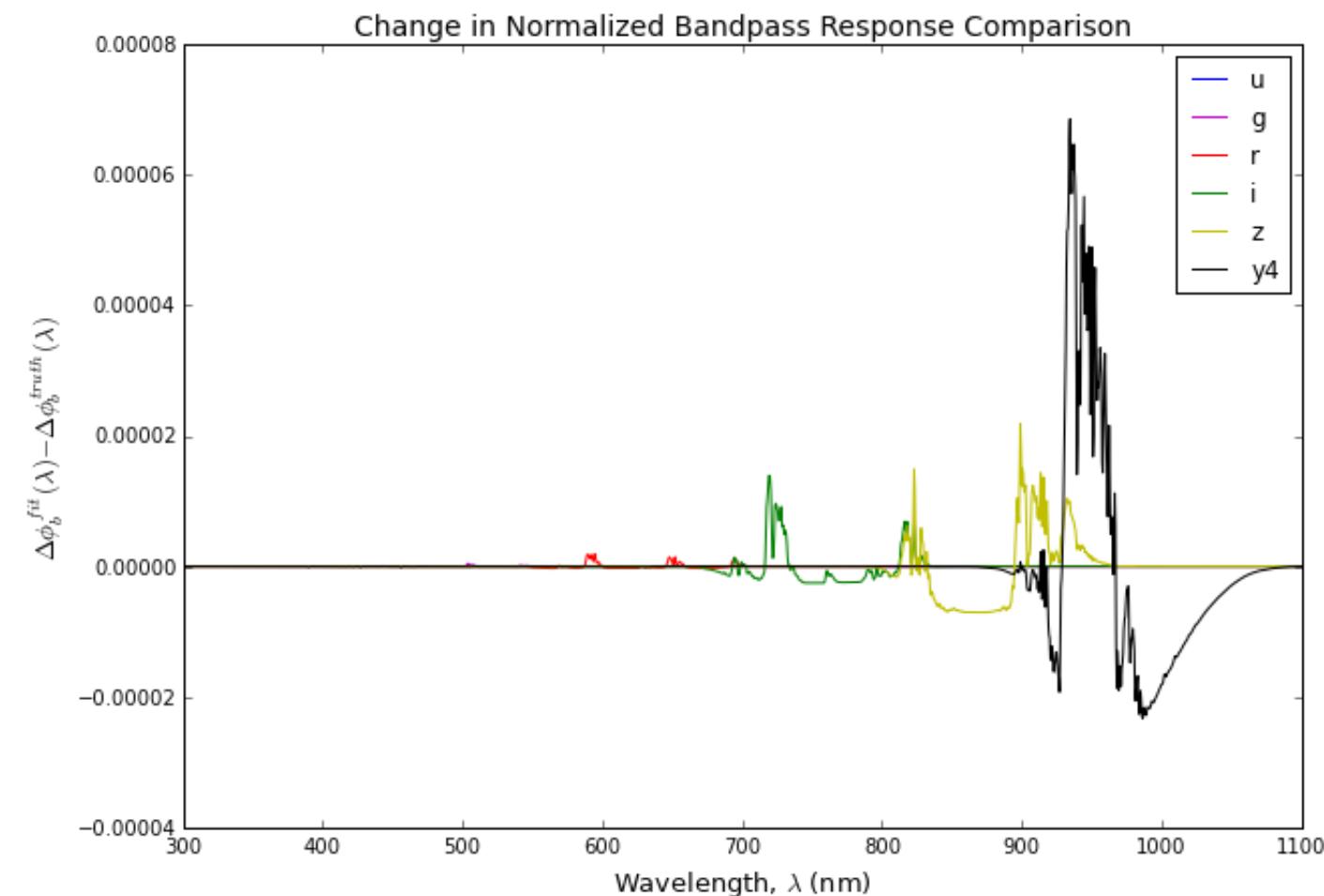
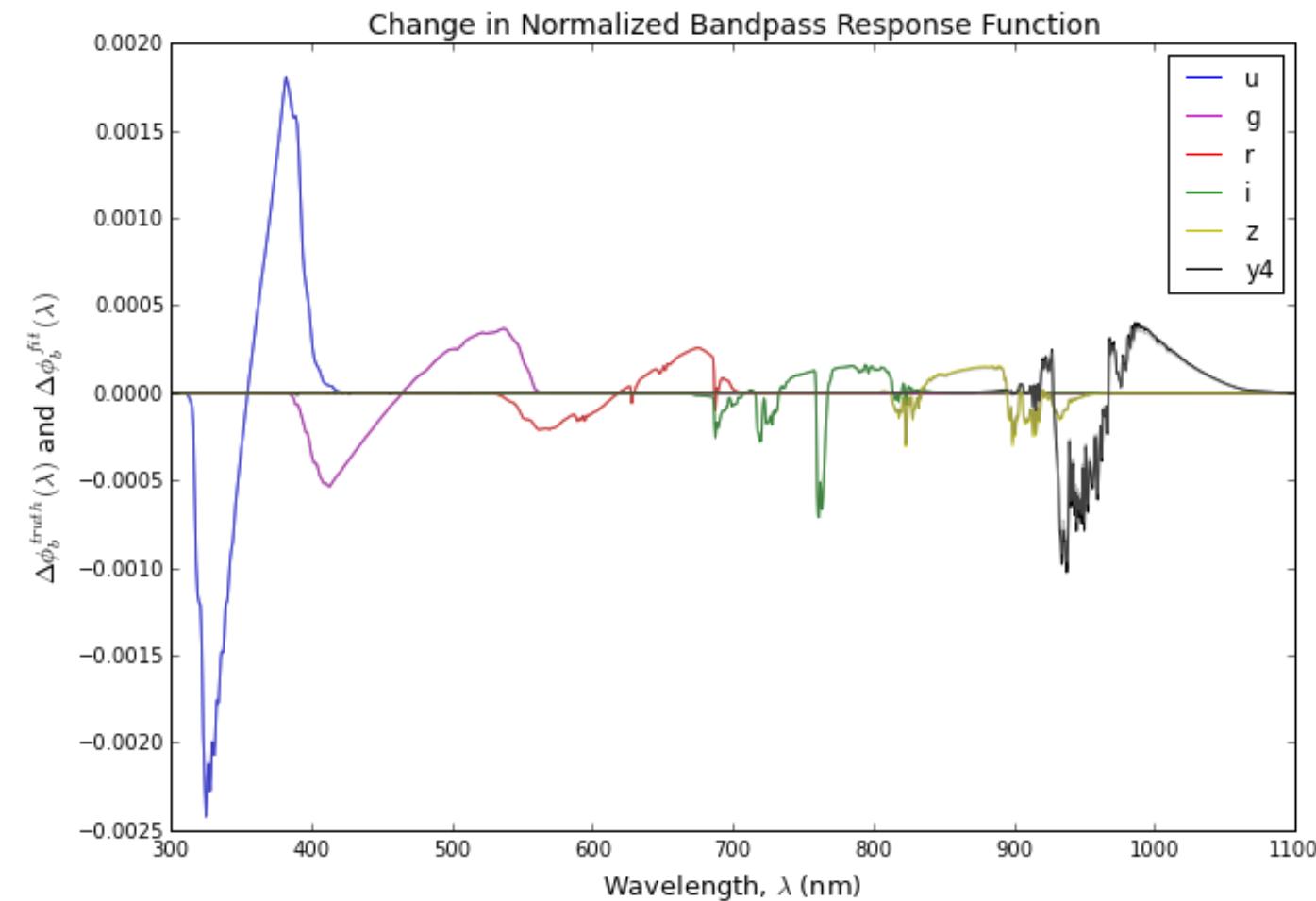
u 0.80 12.00
g 0.80 12.00
r 0.80 12.00
i 0.80 12.00
z 0.80 12.00
y4 0.80 12.00

```

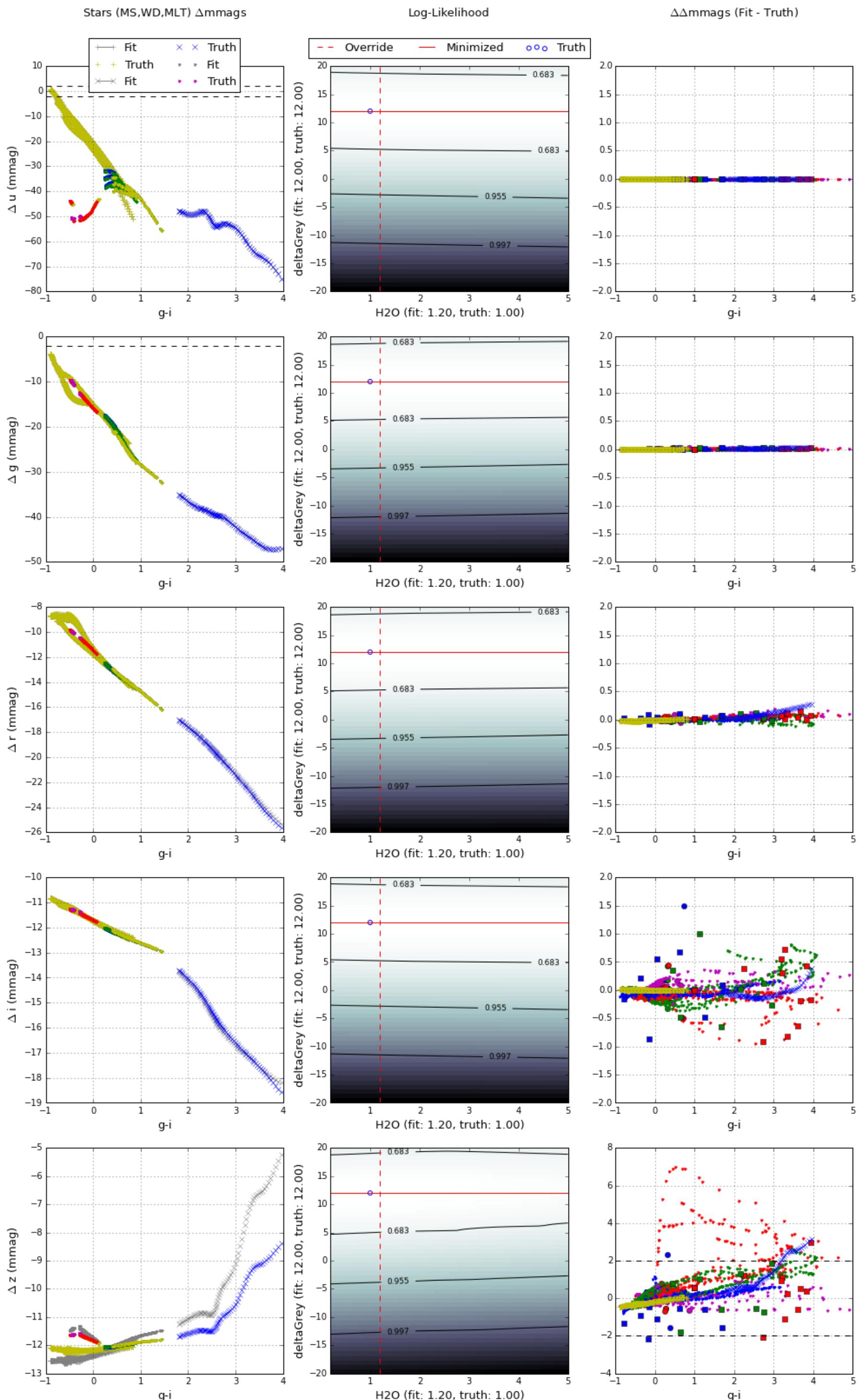
```

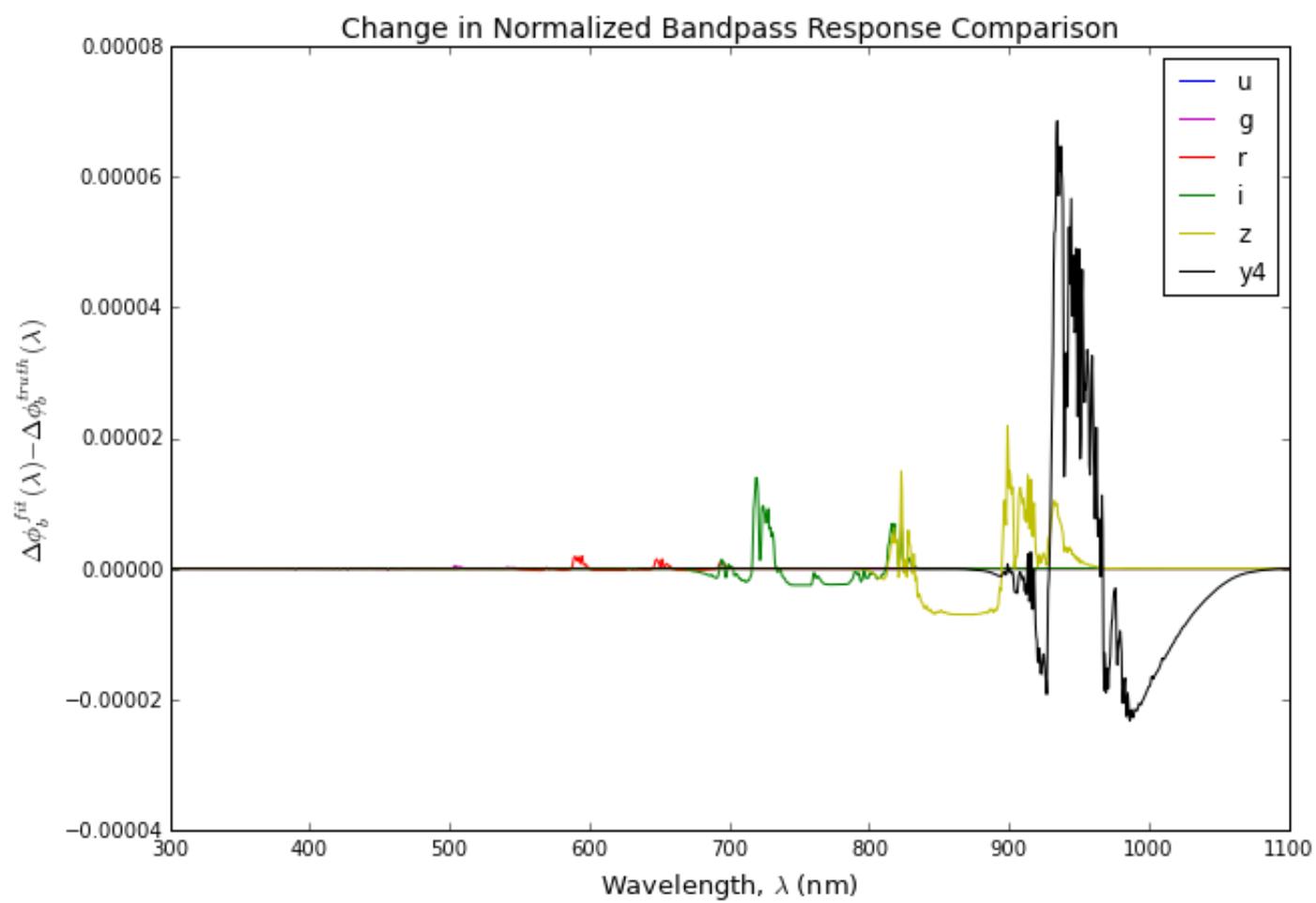
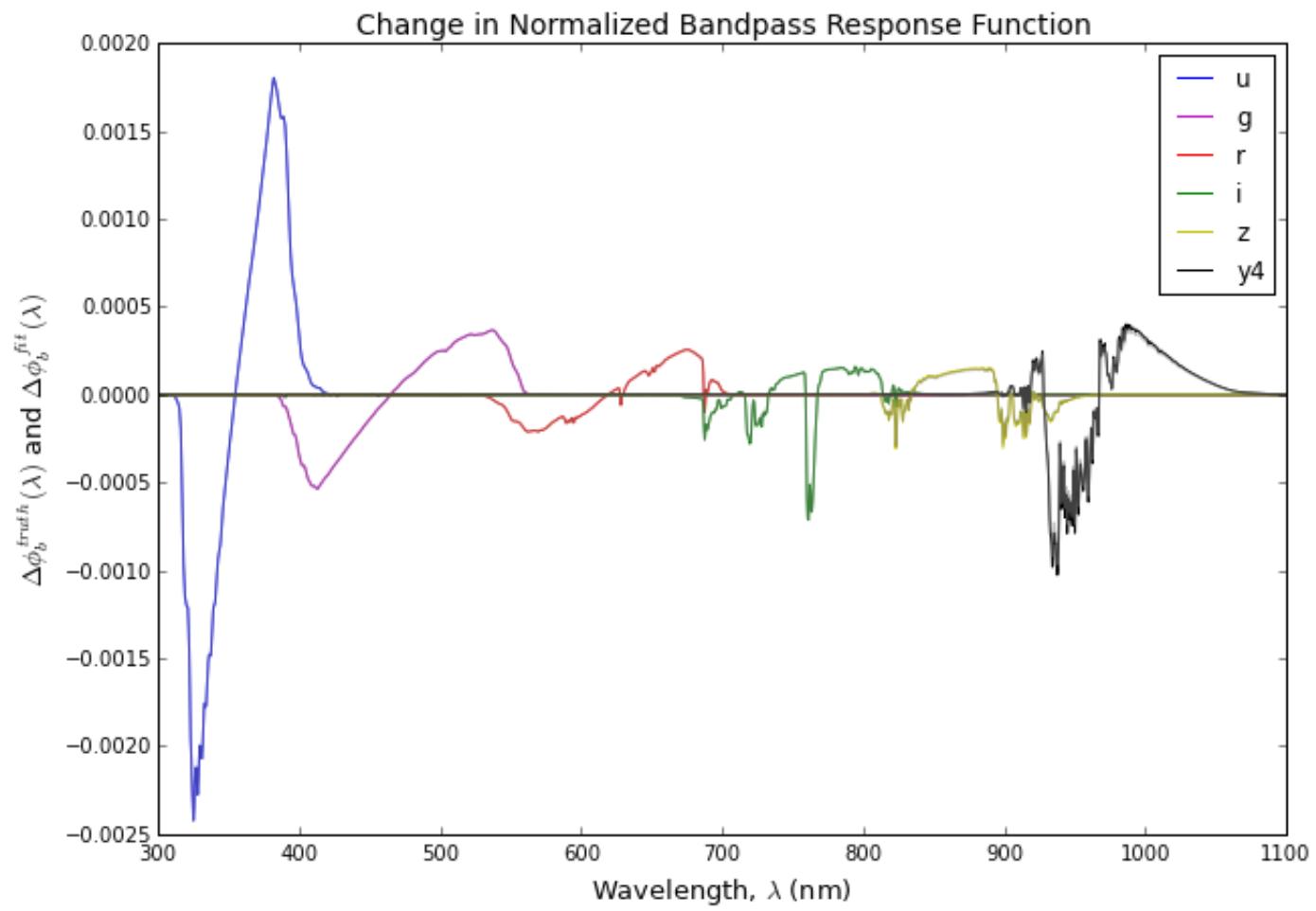
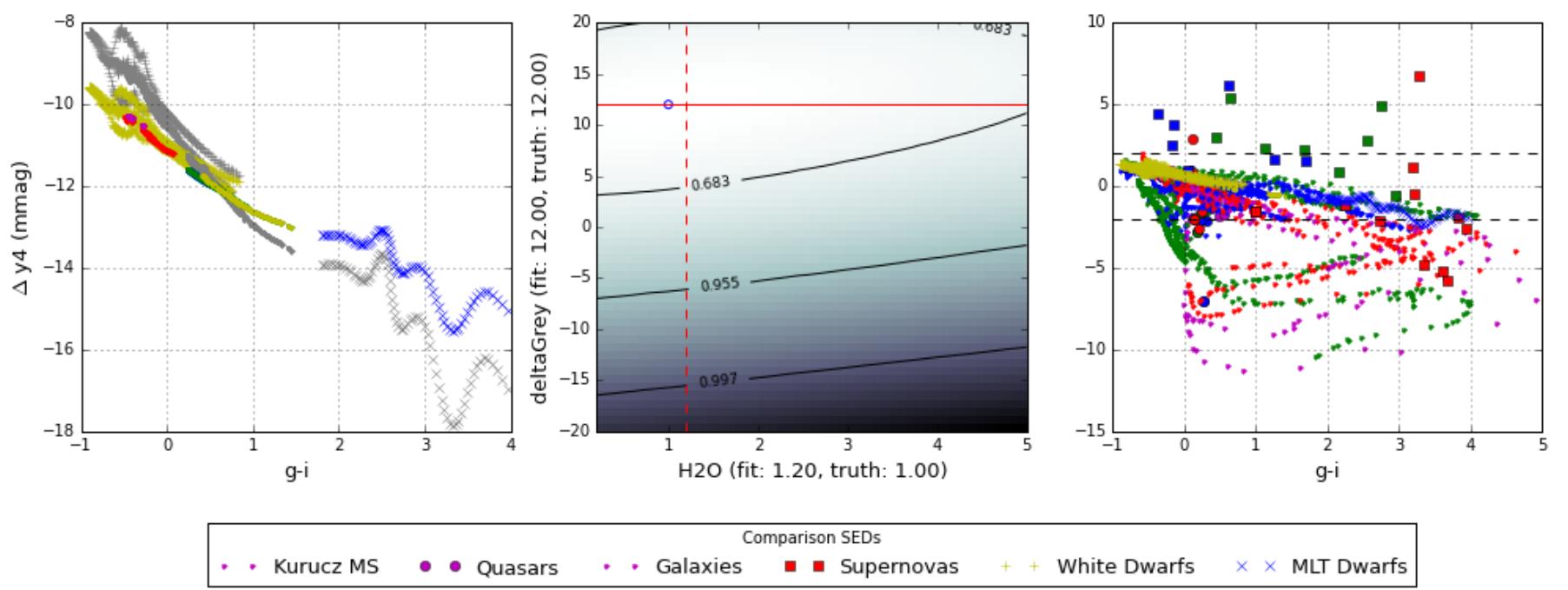
/Users/joachim/anaconda/lib/python2.7/site-packages/matplotlib/text.py:54: UnicodeWarning: Unicode equal comparison failed to convert both arguments to Unicode - interpreting them as being unequal
    elif rotation == 'vertical':

```

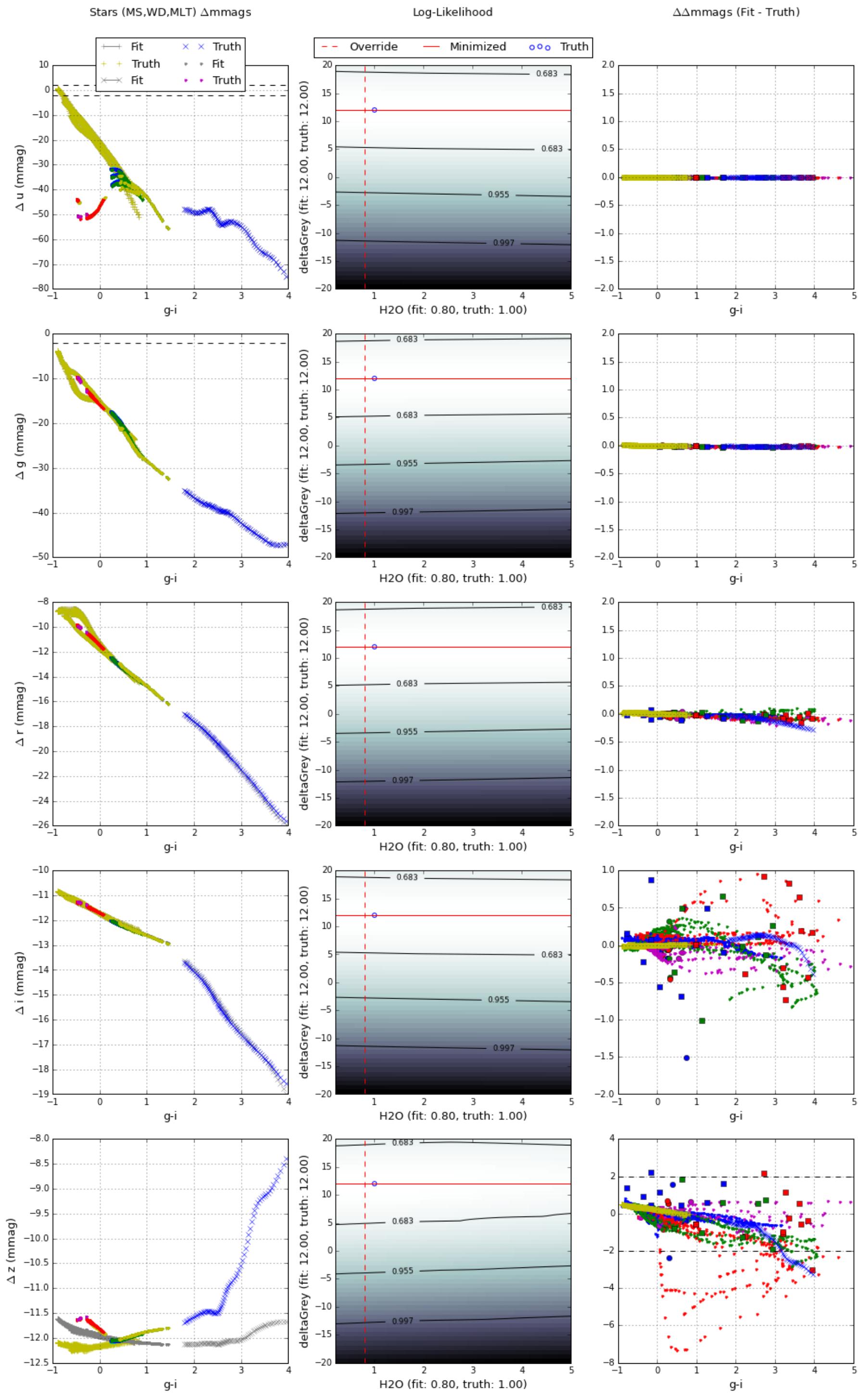


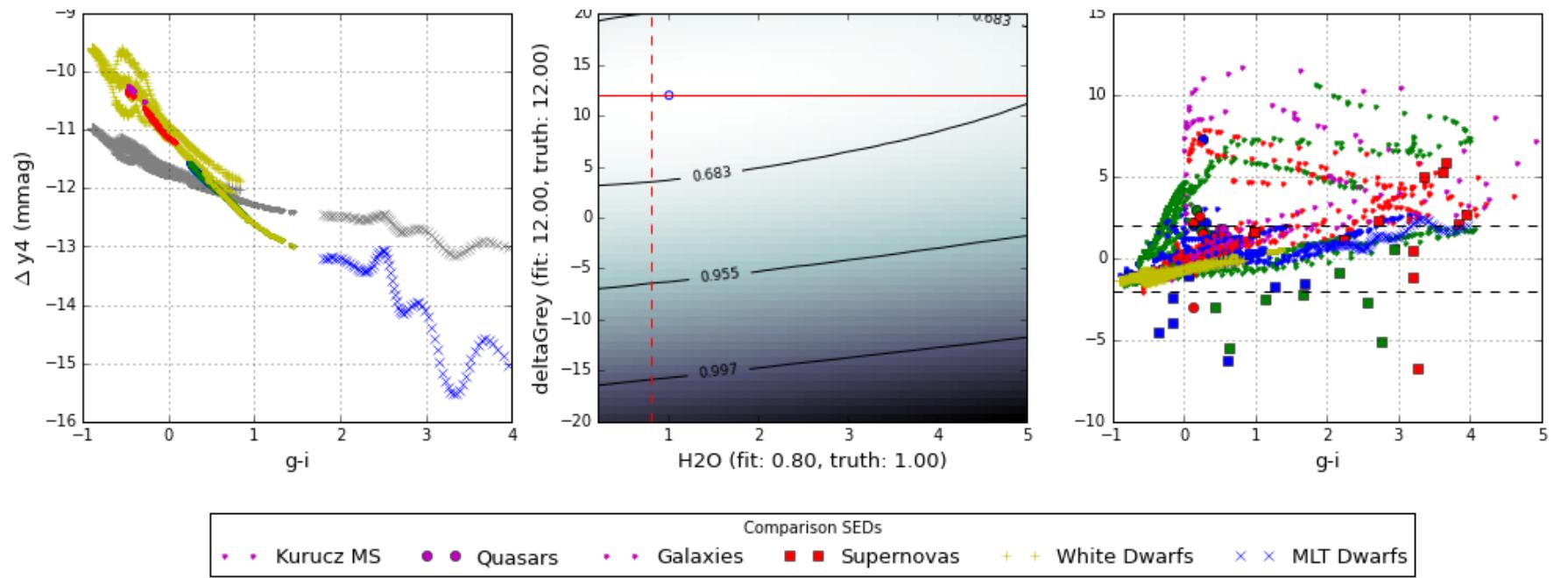
$\Delta\text{mmags}$ , Regression Contours,  $\Delta\Delta\text{mmags}$  for each LSST filter ( $\delta\text{Grey}: 12.0$ )





$\Delta\text{mmags}$ , Regression Contours,  $\Delta\Delta\text{mmags}$  for each LSST filter ( $\delta\text{Grey} = 12.0$ )





```
In [6]: deltaGreyLimitPlot('H2O',deltaGreyBins=50)
```

```
Computing nonlinear regression for H2O.  
Observed atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]  
Observed atmosphere airmass: 2.0  
Standard atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]  
Standard atmosphere airmass: 1.2  
Observed atmosphere parameter for H2O: 1.0  
  
Fitting for H2O between 0.20 and 5.00 in 50 bins.  
Fitting for deltaGrey between -20.00 and 20.00 mmags in 50 bins.  
  
Regression SEDs: 5778 Stars (MS,WD,MLT) SEDs.  
  
Regressing 2500 parameter combinations per filter...  
Magnitude Error: 5.0 mmags  
  
Override triggered...  
Override value detected, proceeding with deltaGrey best-fit minimization at new component best-fit value...  
  
Calculating best fit parameters for u filter...  
@pickle_results: using precomputed results from 'pickles/X20_P101010101017_H2O_dG_XSTD12_DG120_DGR-2_020_E5_stars_u_50dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for u filter.  
Saved Chi-Squared at best fit deltaGrey for u filter.  
Completed u filter.  
  
Calculating best fit parameters for g filter...  
@pickle_results: using precomputed results from 'pickles/X20_P101010101017_H2O_dG_XSTD12_DG120_DGR-2_020_E5_stars_g_50dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for g filter.  
Saved Chi-Squared at best fit deltaGrey for g filter.  
Completed g filter.  
  
Calculating best fit parameters for r filter...  
@pickle_results: using precomputed results from 'pickles/X20_P101010101017_H2O_dG_XSTD12_DG120_DGR-2_020_E5_stars_r_50dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for r filter.  
Saved Chi-Squared at best fit deltaGrey for r filter.  
Completed r filter.  
  
Calculating best fit parameters for i filter...  
@pickle_results: using precomputed results from 'pickles/X20_P101010101017_H2O_dG_XSTD12_DG120_DGR-2_020_E5_stars_i_50dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for i filter.  
Saved Chi-Squared at best fit deltaGrey for i filter.  
Completed i filter.  
  
Calculating best fit parameters for z filter...  
@pickle_results: using precomputed results from 'pickles/X20_P101010101017_H2O_dG_XSTD12_DG120_DGR-2_020_E5_stars_z_50dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for z filter.  
Saved Chi-Squared at best fit deltaGrey for z filter.  
Completed z filter.  
  
Calculating best fit parameters for y4 filter...  
@pickle_results: using precomputed results from 'pickles/X20_P101010101017_H2O_dG_XSTD12_DG120_DGR-2_020_E5_stars_y4_50dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for y4 filter.  
Saved Chi-Squared at best fit deltaGrey for y4 filter.  
Completed y4 filter.  
  
Best fit parameters (Filter, H2O, dG, logL, Chi-Squared):  
u 5.00 11.84 1.59448440853 3.18896881706  
g 0.20 11.84 2.71172714173 5.42345428346  
r 0.59 11.84 2.95060870608 5.90121741215  
i 1.67 11.84 2.80020463042 5.60040926083  
z 0.98 11.84 2.96483612316 5.92967224632  
y4 0.98 11.84 2.68977264504 5.37954529008  
  
Override best fit parameters (Filter, H2O, dG):  
u 1.20 11.84  
g 1.20 11.84  
r 1.20 11.84  
i 1.20 11.84  
z 1.20 11.84  
y4 1.20 11.84  
  
Computing nonlinear regression for H2O.  
Observed atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]  
Observed atmosphere airmass: 2.0  
Standard atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]  
Standard atmosphere airmass: 1.2
```

```
Observed atmosphere parameter for H2O: 1.0

Fitting for H2O between 0.20 and 5.00 in 50 bins.
Fitting for deltaGrey between -20.00 and 20.00 mmags in 50 bins.

Regression SEDs: 5778 Stars (MS,WD,MLT) SEDs.

Regressing 2500 parameter combinations per filter...
Magnitude Error: 5.0 mmags

Override triggered...
Override value detected, proceeding with deltaGrey best-fit minimization at new component best-fit v
alue...

Calculating best fit parameters for u filter...
@pickle_results: using precomputed results from 'pickles/X20_P101010101017_H2O_dG_XSTD12_DG120_DGR-2
020_E5_stars_u_50dgb_50b_min_dGTest_allMS_OR80.pkl'
Saved LogL at best fit deltaGrey for u filter.
Saved Chi-Squared at best fit deltaGrey for u filter.
Completed u filter.

Calculating best fit parameters for g filter...
@pickle_results: using precomputed results from 'pickles/X20_P101010101017_H2O_dG_XSTD12_DG120_DGR-2
020_E5_stars_g_50dgb_50b_min_dGTest_allMS_OR80.pkl'
Saved LogL at best fit deltaGrey for g filter.
Saved Chi-Squared at best fit deltaGrey for g filter.
Completed g filter.

Calculating best fit parameters for r filter...
@pickle_results: using precomputed results from 'pickles/X20_P101010101017_H2O_dG_XSTD12_DG120_DGR-2
020_E5_stars_r_50dgb_50b_min_dGTest_allMS_OR80.pkl'
Saved LogL at best fit deltaGrey for r filter.
Saved Chi-Squared at best fit deltaGrey for r filter.
Completed r filter.

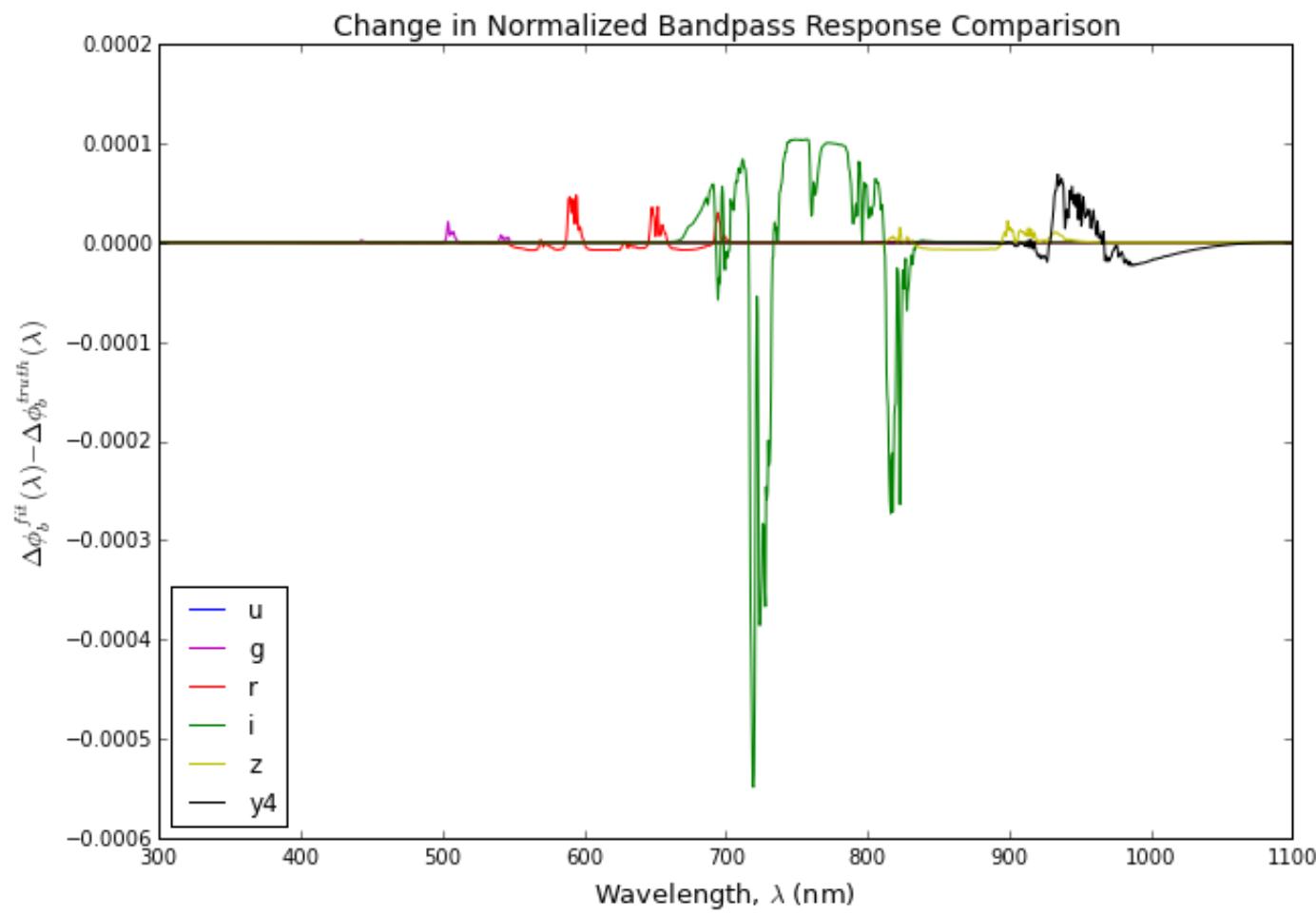
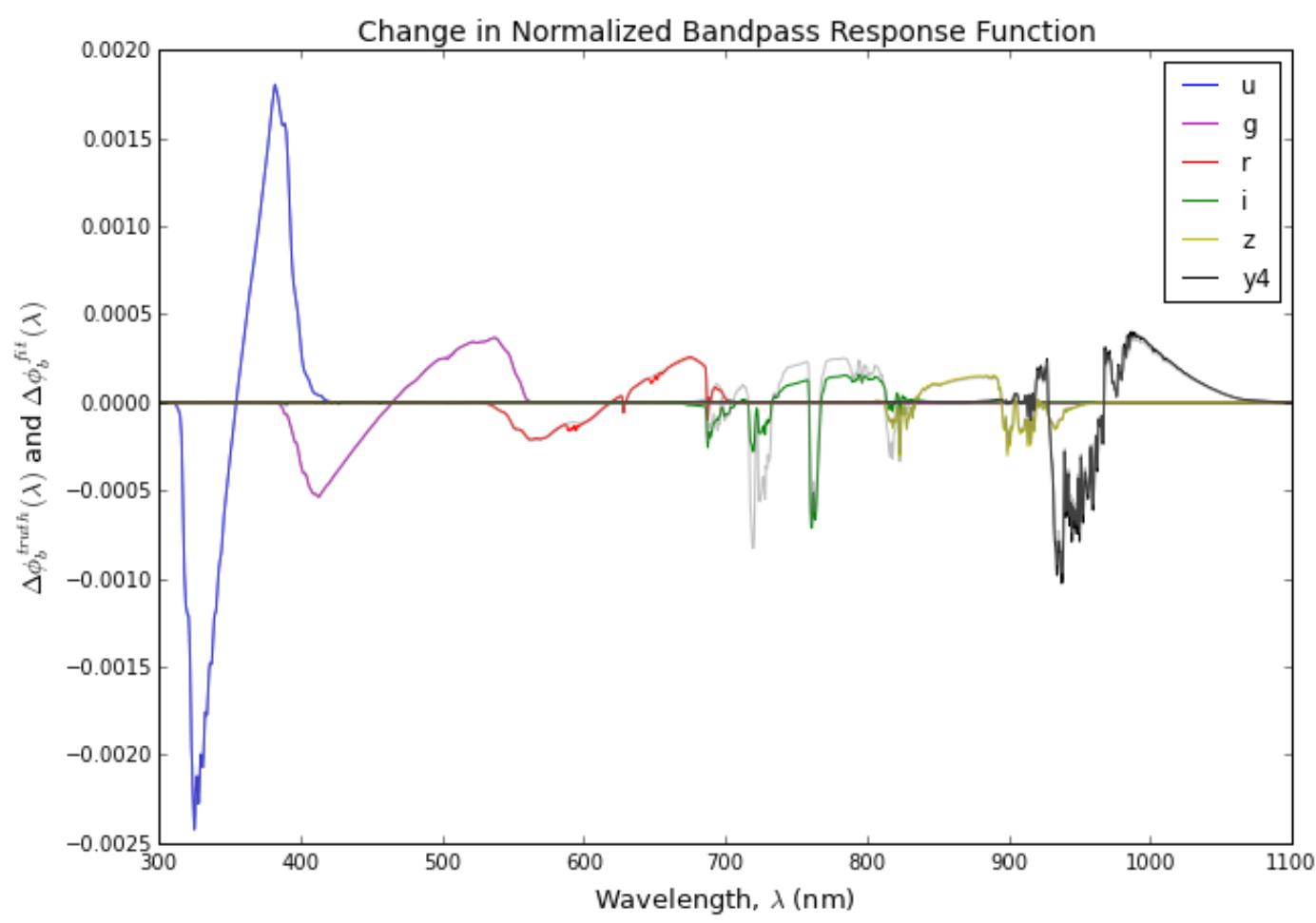
Calculating best fit parameters for i filter...
@pickle_results: using precomputed results from 'pickles/X20_P101010101017_H2O_dG_XSTD12_DG120_DGR-2
020_E5_stars_i_50dgb_50b_min_dGTest_allMS_OR80.pkl'
Saved LogL at best fit deltaGrey for i filter.
Saved Chi-Squared at best fit deltaGrey for i filter.
Completed i filter.

Calculating best fit parameters for z filter...
@pickle_results: using precomputed results from 'pickles/X20_P101010101017_H2O_dG_XSTD12_DG120_DGR-2
020_E5_stars_z_50dgb_50b_min_dGTest_allMS_OR80.pkl'
Saved LogL at best fit deltaGrey for z filter.
Saved Chi-Squared at best fit deltaGrey for z filter.
Completed z filter.

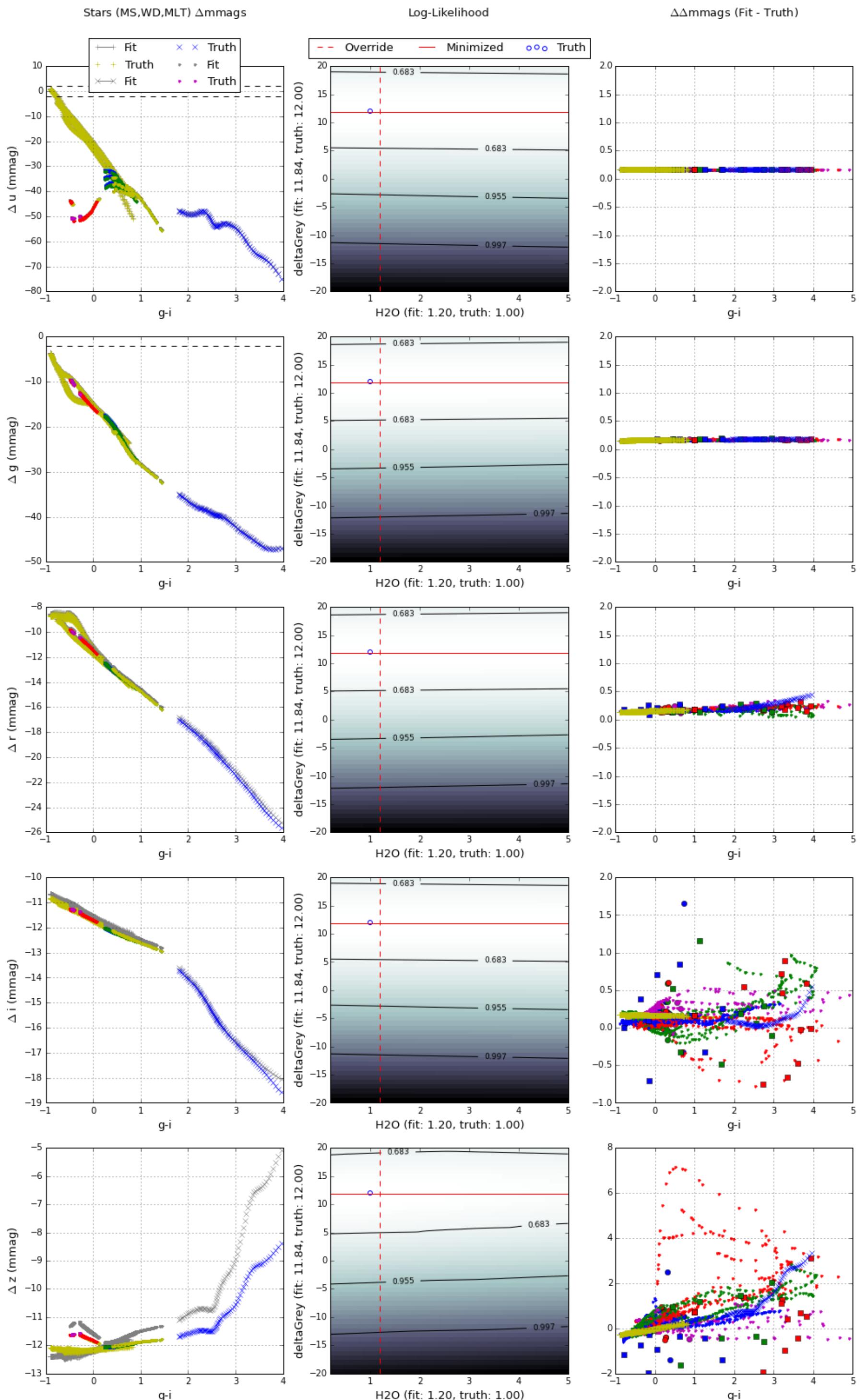
Calculating best fit parameters for y4 filter...
@pickle_results: using precomputed results from 'pickles/X20_P101010101017_H2O_dG_XSTD12_DG120_DGR-2
020_E5_stars_y4_50dgb_50b_min_dGTest_allMS_OR80.pkl'
Saved LogL at best fit deltaGrey for y4 filter.
Saved Chi-Squared at best fit deltaGrey for y4 filter.
Completed y4 filter.

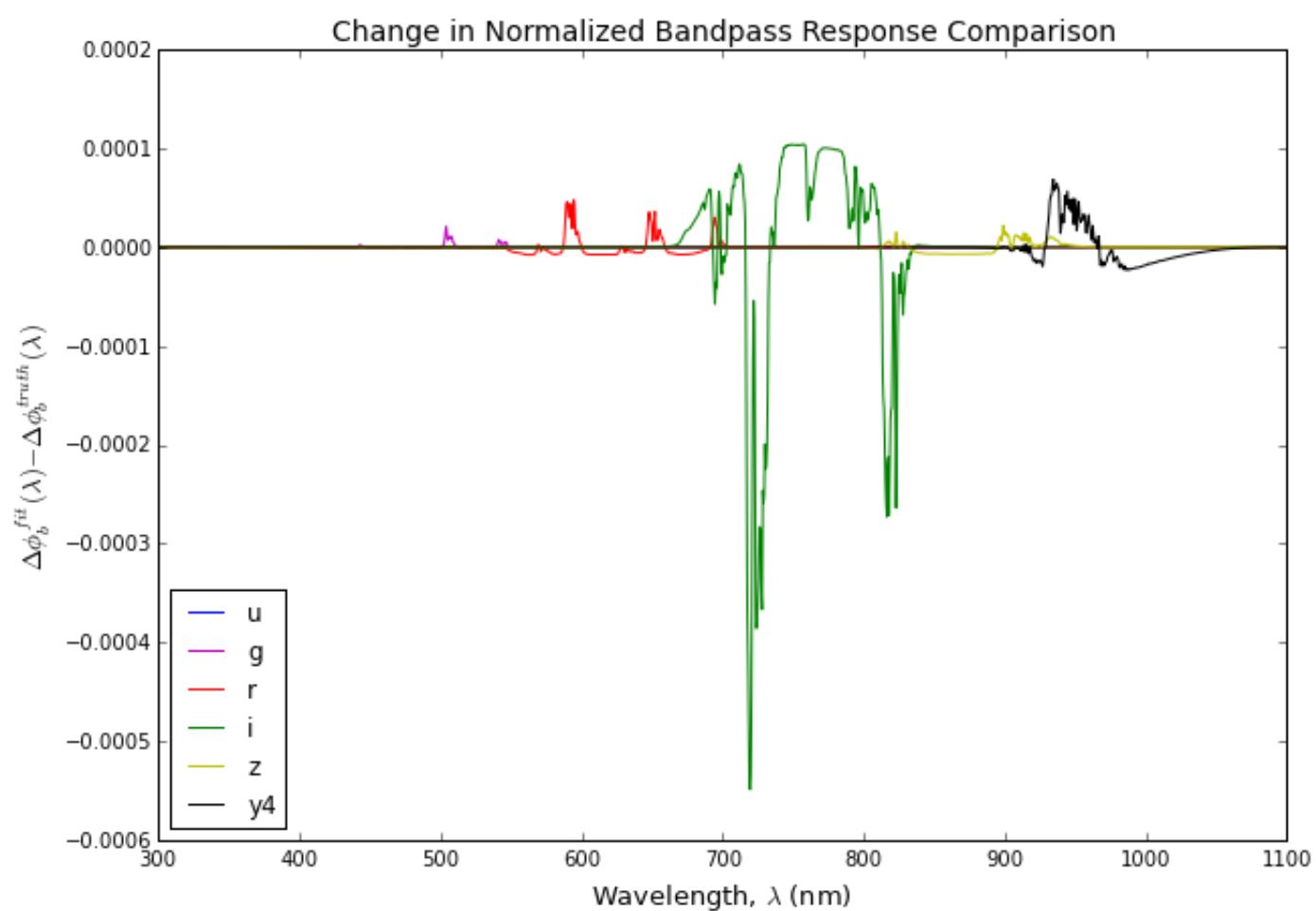
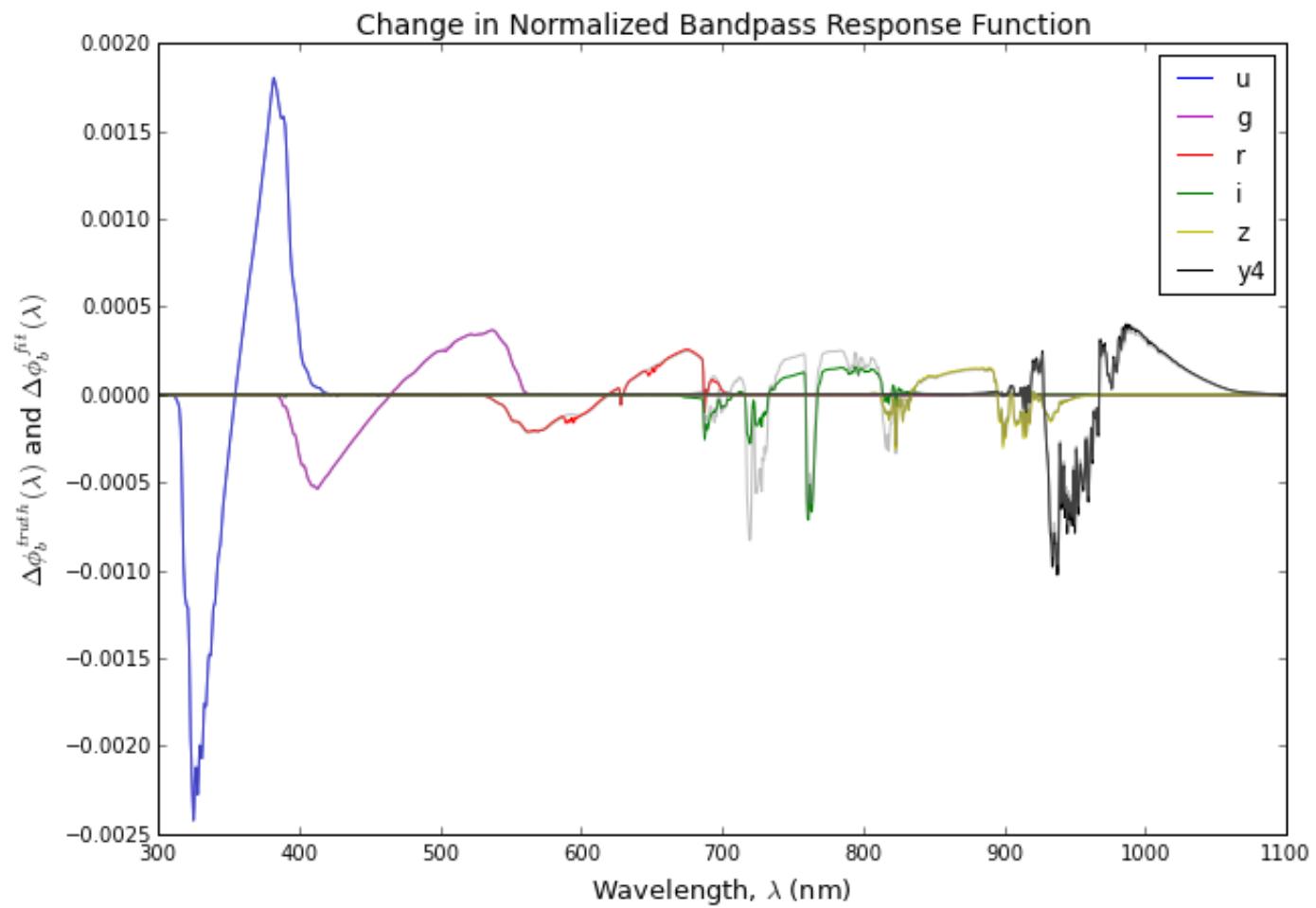
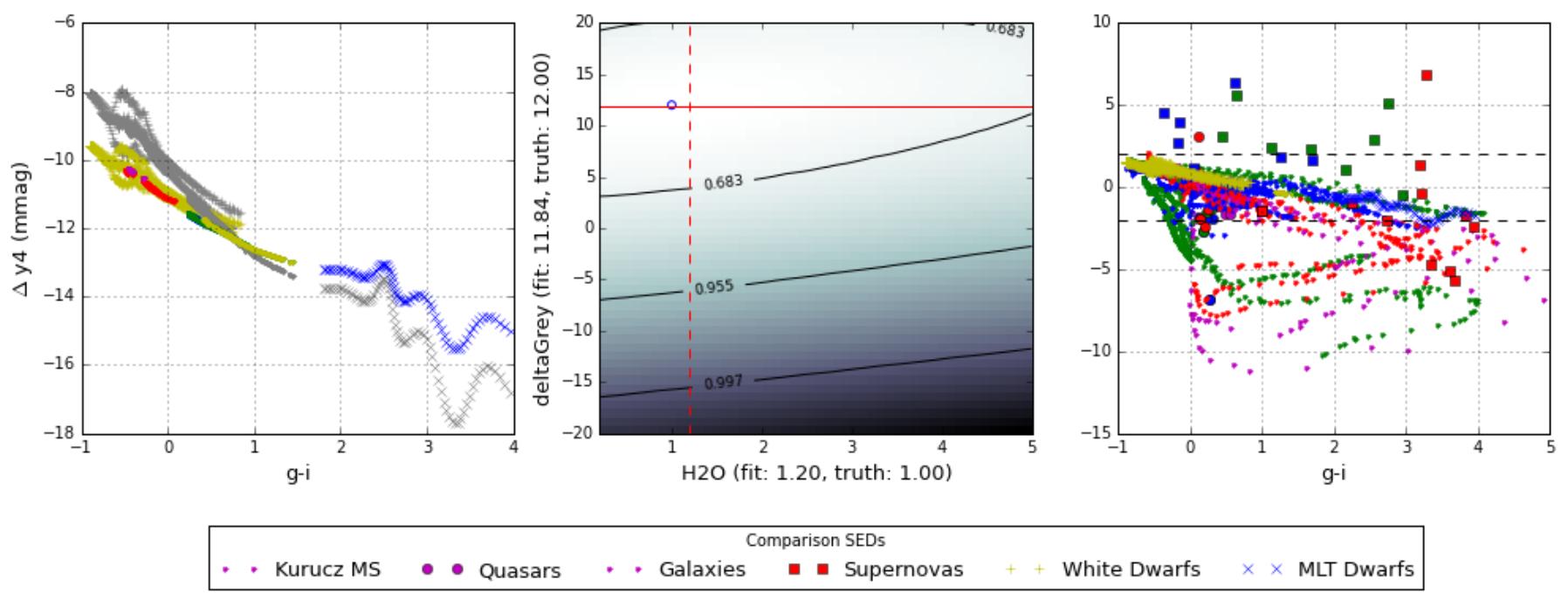
Best fit parameters (Filter, H2O, dG, logL, Chi-Squared):
u 5.00 11.84 1.59448440853 3.18896881706
g 0.20 11.84 2.71172714173 5.42345428346
r 0.59 11.84 2.95060870608 5.90121741215
i 1.67 11.84 2.80020463042 5.60040926083
z 0.98 11.84 2.96483612316 5.92967224632
y4 0.98 11.84 2.68977264504 5.37954529008

Override best fit parameters (Filter, H2O, dG):
u 0.80 11.84
g 0.80 11.84
r 0.80 11.84
i 0.80 11.84
z 0.80 11.84
y4 0.80 11.84
```

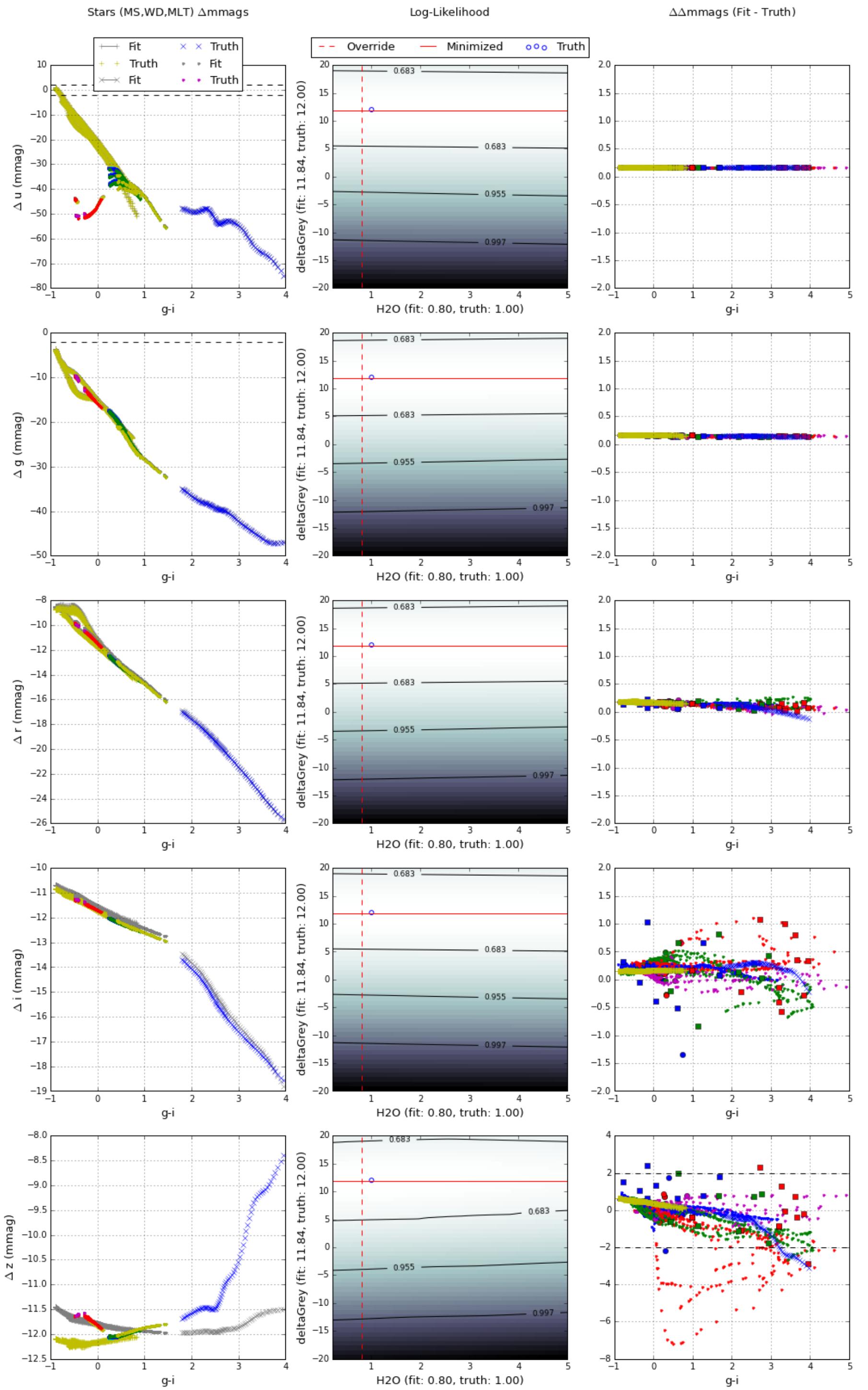


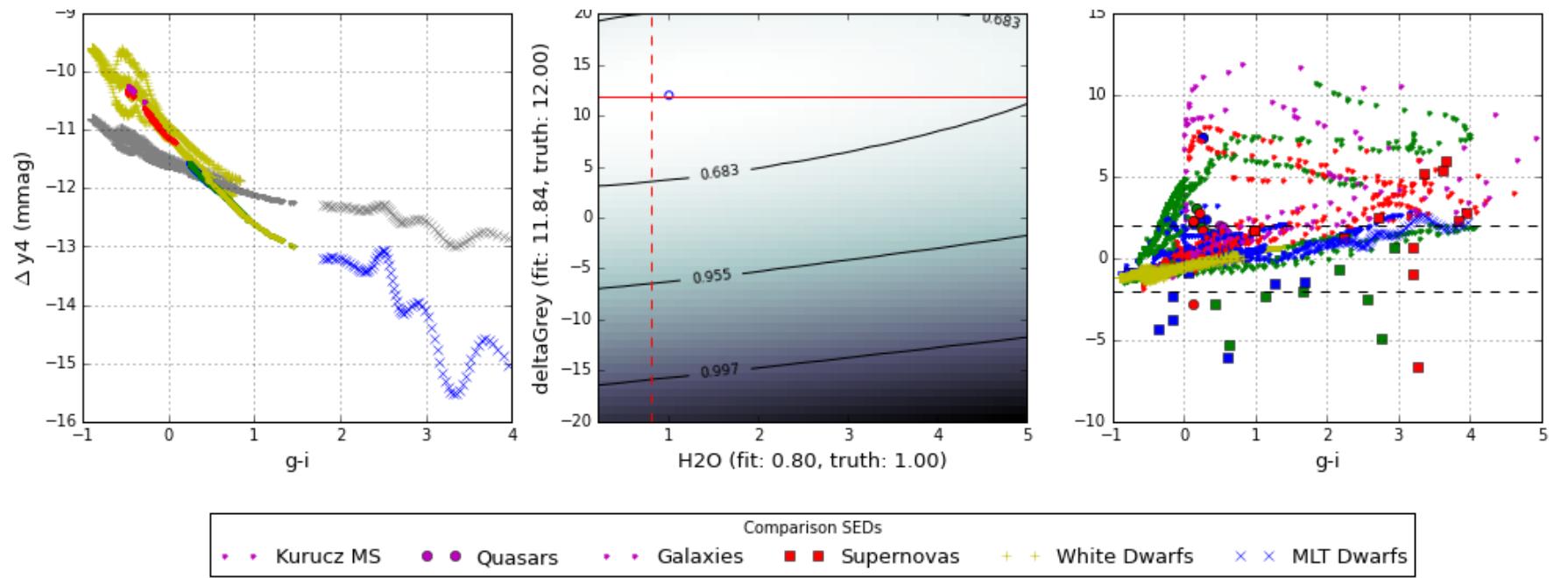
$\Delta\text{mmags}$ , Regression Contours,  $\Delta\Delta\text{mmags}$  for each LSST filter ( $\delta\text{Grey}: 12.0$ )





$\Delta\text{mmags}$ , Regression Contours,  $\Delta\Delta\text{mmags}$  for each LSST filter ( $\delta\text{Grey} = 12.0$ )





$O_2$

```
In [7]: deltaGreyLimitPlot('02')
```

```

Computing nonlinear regression for O2.
Observed atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]
Observed atmosphere airmass: 2.0
Standard atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]
Standard atmosphere airmass: 1.2
Observed atmosphere parameter for O2: 1.0

Fitting for O2 between 0.20 and 5.00 in 50 bins.
Fitting for deltaGrey between -20.00 and 20.00 mmags in 51 bins.

Regression SEDs: 5778 Stars (MS,WD,MLT) SEDs.

Regressing 2550 parameter combinations per filter...
Magnitude Error: 5.0 mmags

Override triggered...
Override value detected, proceeding with deltaGrey best-fit minimization at new component best-fit value...

Calculating best fit parameters for u filter...
@pickle_results: using precomputed results from 'pickles/X20_P101010101017_O2_dG_XSTD12_DG120_DGR-20
20_E5_stars_u_51dgb_50b_max_dGTest_allMS_OR120.pkl'
Saved LogL at best fit deltaGrey for u filter.
Saved Chi-Squared at best fit deltaGrey for u filter.
Completed u filter.

Calculating best fit parameters for g filter...
@pickle_results: using precomputed results from 'pickles/X20_P101010101017_O2_dG_XSTD12_DG120_DGR-20
20_E5_stars_g_51dgb_50b_max_dGTest_allMS_OR120.pkl'
Saved LogL at best fit deltaGrey for g filter.
Saved Chi-Squared at best fit deltaGrey for g filter.
Completed g filter.

Calculating best fit parameters for r filter...
@pickle_results: using precomputed results from 'pickles/X20_P101010101017_O2_dG_XSTD12_DG120_DGR-20
20_E5_stars_r_51dgb_50b_max_dGTest_allMS_OR120.pkl'
Saved LogL at best fit deltaGrey for r filter.
Saved Chi-Squared at best fit deltaGrey for r filter.
Completed r filter.

Calculating best fit parameters for i filter...
@pickle_results: using precomputed results from 'pickles/X20_P101010101017_O2_dG_XSTD12_DG120_DGR-20
20_E5_stars_i_51dgb_50b_max_dGTest_allMS_OR120.pkl'
Saved LogL at best fit deltaGrey for i filter.
Saved Chi-Squared at best fit deltaGrey for i filter.
Completed i filter.

Calculating best fit parameters for z filter...
@pickle_results: using precomputed results from 'pickles/X20_P101010101017_O2_dG_XSTD12_DG120_DGR-20
20_E5_stars_z_51dgb_50b_max_dGTest_allMS_OR120.pkl'
Saved LogL at best fit deltaGrey for z filter.
Saved Chi-Squared at best fit deltaGrey for z filter.
Completed z filter.

Calculating best fit parameters for y4 filter...
@pickle_results: using precomputed results from 'pickles/X20_P101010101017_O2_dG_XSTD12_DG120_DGR-20
20_E5_stars_y4_51dgb_50b_max_dGTest_allMS_OR120.pkl'
Saved LogL at best fit deltaGrey for y4 filter.
Saved Chi-Squared at best fit deltaGrey for y4 filter.
Completed y4 filter.

Best fit parameters (Filter, O2, dG, logL, Chi-Squared):
u 0.98 12.00 5.07514265068e-07 1.01502853014e-06
g 0.98 12.00 4.27610563505e-08 8.5522112701e-08
r 0.98 12.00 0.00682624928111 0.0136524985622
i 0.98 12.00 0.00121031508919 0.00242063017839
z 0.98 12.00 3.38668100927e-08 6.77336201855e-08
y4 0.98 12.00 4.65075558501e-06 9.30151117003e-06

Override best fit parameters (Filter, O2, dG):
u 1.20 12.00
g 1.20 12.00
r 1.20 12.00
i 1.20 12.00
z 1.20 12.00
y4 1.20 12.00

Computing nonlinear regression for O2.
Observed atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]
Observed atmosphere airmass: 2.0
Standard atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]
Standard atmosphere airmass: 1.2

```

Observed atmosphere parameter for O2: 1.0

Fitting for O2 between 0.20 and 5.00 in 50 bins.  
Fitting for deltaGrey between -20.00 and 20.00 mmags in 51 bins.

Regression SEDs: 5778 Stars (MS,WD,MLT) SEDs.

Regressing 2550 parameter combinations per filter...  
Magnitude Error: 5.0 mmags

Override triggered...  
Override value detected, proceeding with deltaGrey best-fit minimization at new component best-fit value...

Calculating best fit parameters for u filter...  
@pickle\_results: using precomputed results from 'pickles/X20\_P101010101017\_O2\_dG\_XSTD12\_DG120\_DGR-20\_20\_E5\_stars\_u\_51dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for u filter.  
Saved Chi-Squared at best fit deltaGrey for u filter.  
Completed u filter.

Calculating best fit parameters for g filter...  
@pickle\_results: using precomputed results from 'pickles/X20\_P101010101017\_O2\_dG\_XSTD12\_DG120\_DGR-20\_20\_E5\_stars\_g\_51dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for g filter.  
Saved Chi-Squared at best fit deltaGrey for g filter.  
Completed g filter.

Calculating best fit parameters for r filter...  
@pickle\_results: using precomputed results from 'pickles/X20\_P101010101017\_O2\_dG\_XSTD12\_DG120\_DGR-20\_20\_E5\_stars\_r\_51dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for r filter.  
Saved Chi-Squared at best fit deltaGrey for r filter.  
Completed r filter.

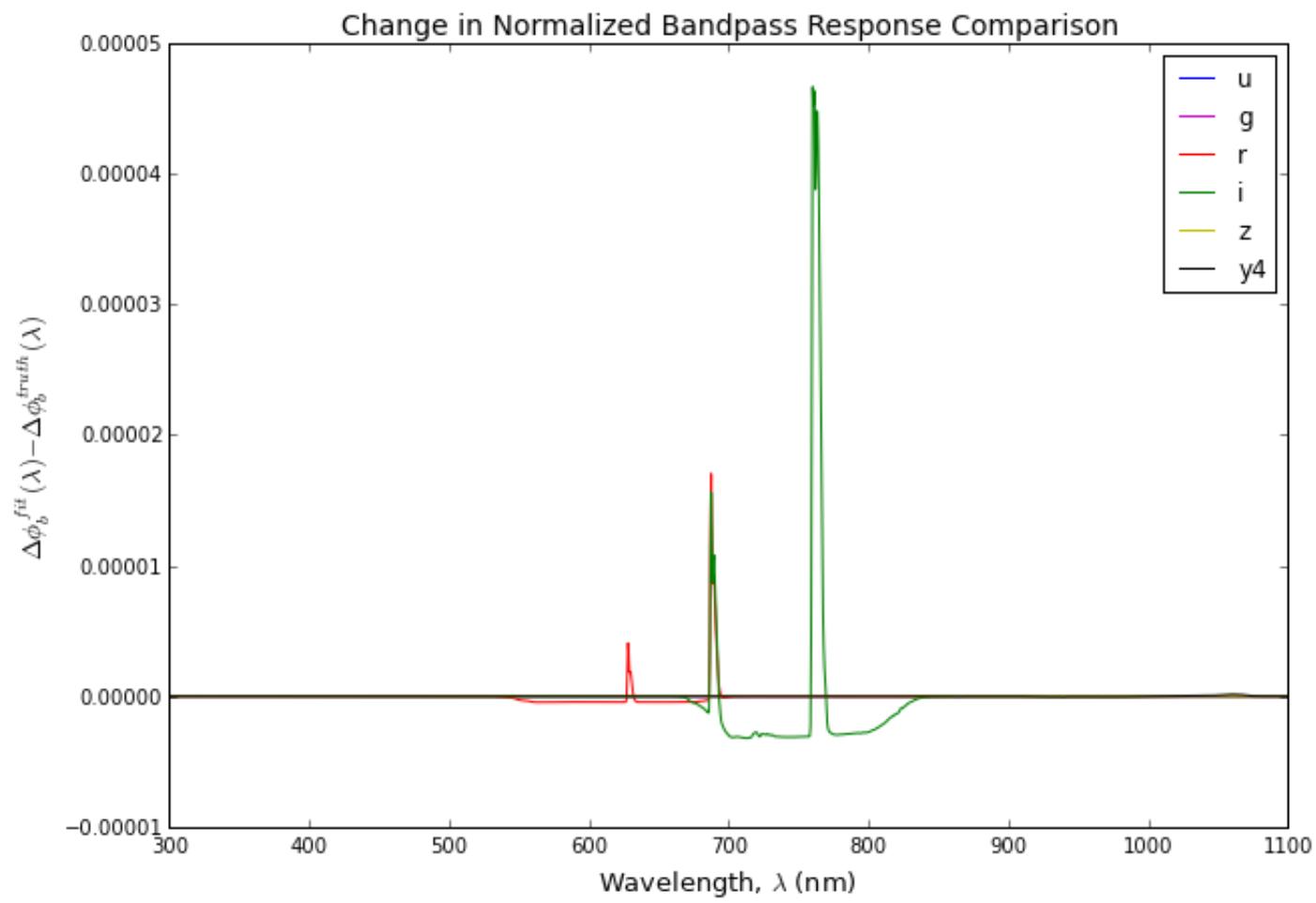
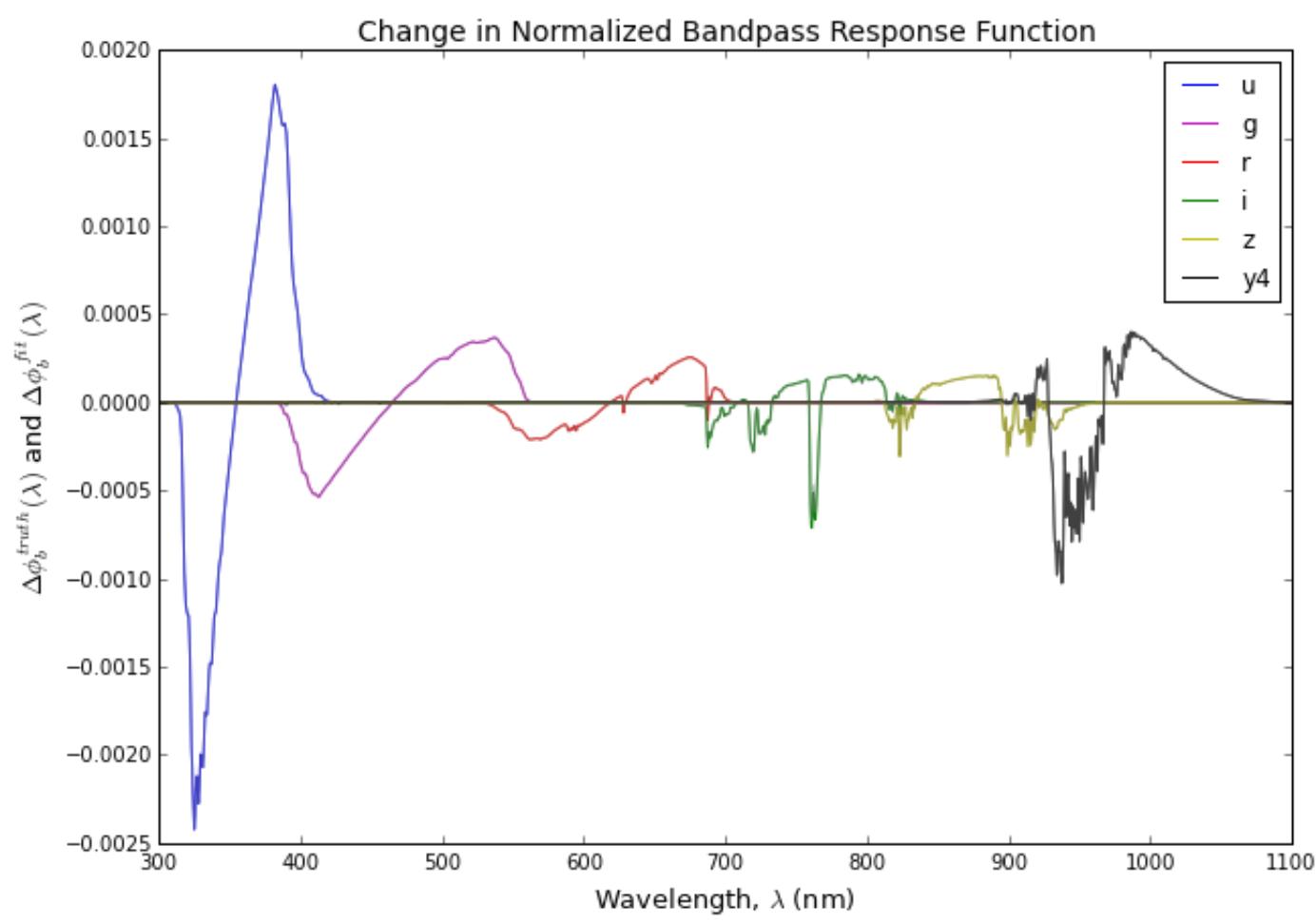
Calculating best fit parameters for i filter...  
@pickle\_results: using precomputed results from 'pickles/X20\_P101010101017\_O2\_dG\_XSTD12\_DG120\_DGR-20\_20\_E5\_stars\_i\_51dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for i filter.  
Saved Chi-Squared at best fit deltaGrey for i filter.  
Completed i filter.

Calculating best fit parameters for z filter...  
@pickle\_results: using precomputed results from 'pickles/X20\_P101010101017\_O2\_dG\_XSTD12\_DG120\_DGR-20\_20\_E5\_stars\_z\_51dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for z filter.  
Saved Chi-Squared at best fit deltaGrey for z filter.  
Completed z filter.

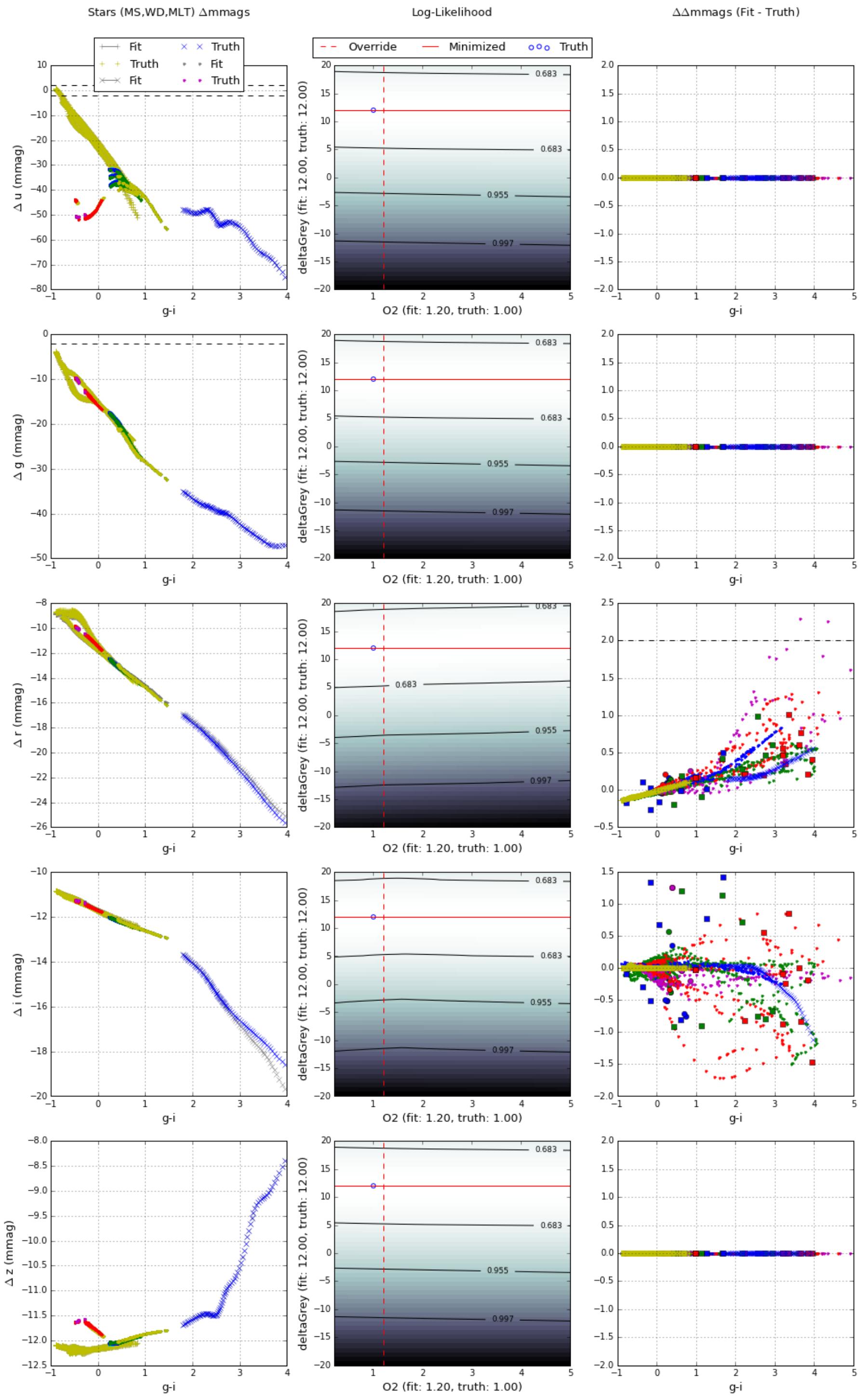
Calculating best fit parameters for y4 filter...  
@pickle\_results: using precomputed results from 'pickles/X20\_P101010101017\_O2\_dG\_XSTD12\_DG120\_DGR-20\_20\_E5\_stars\_y4\_51dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for y4 filter.  
Saved Chi-Squared at best fit deltaGrey for y4 filter.  
Completed y4 filter.

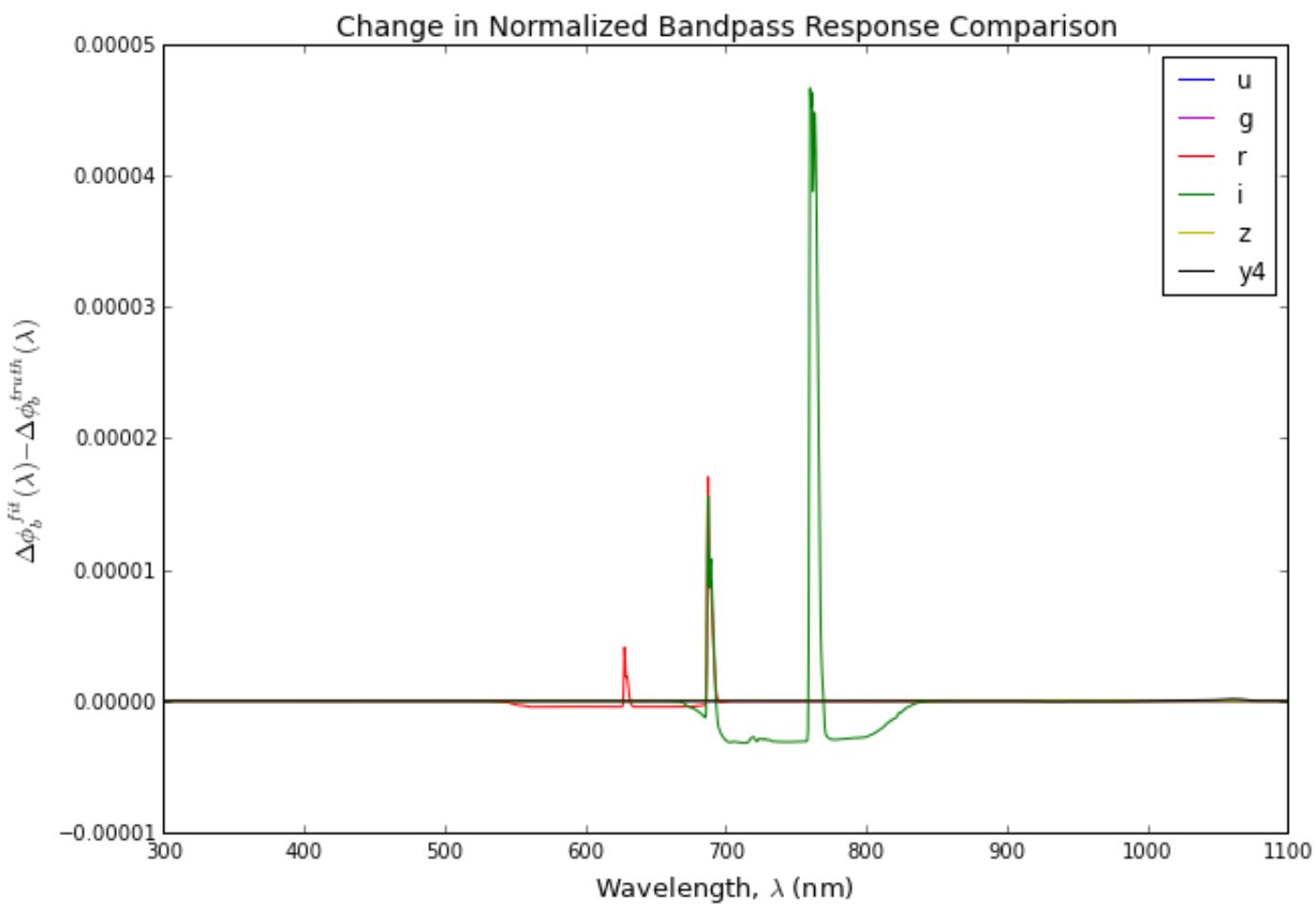
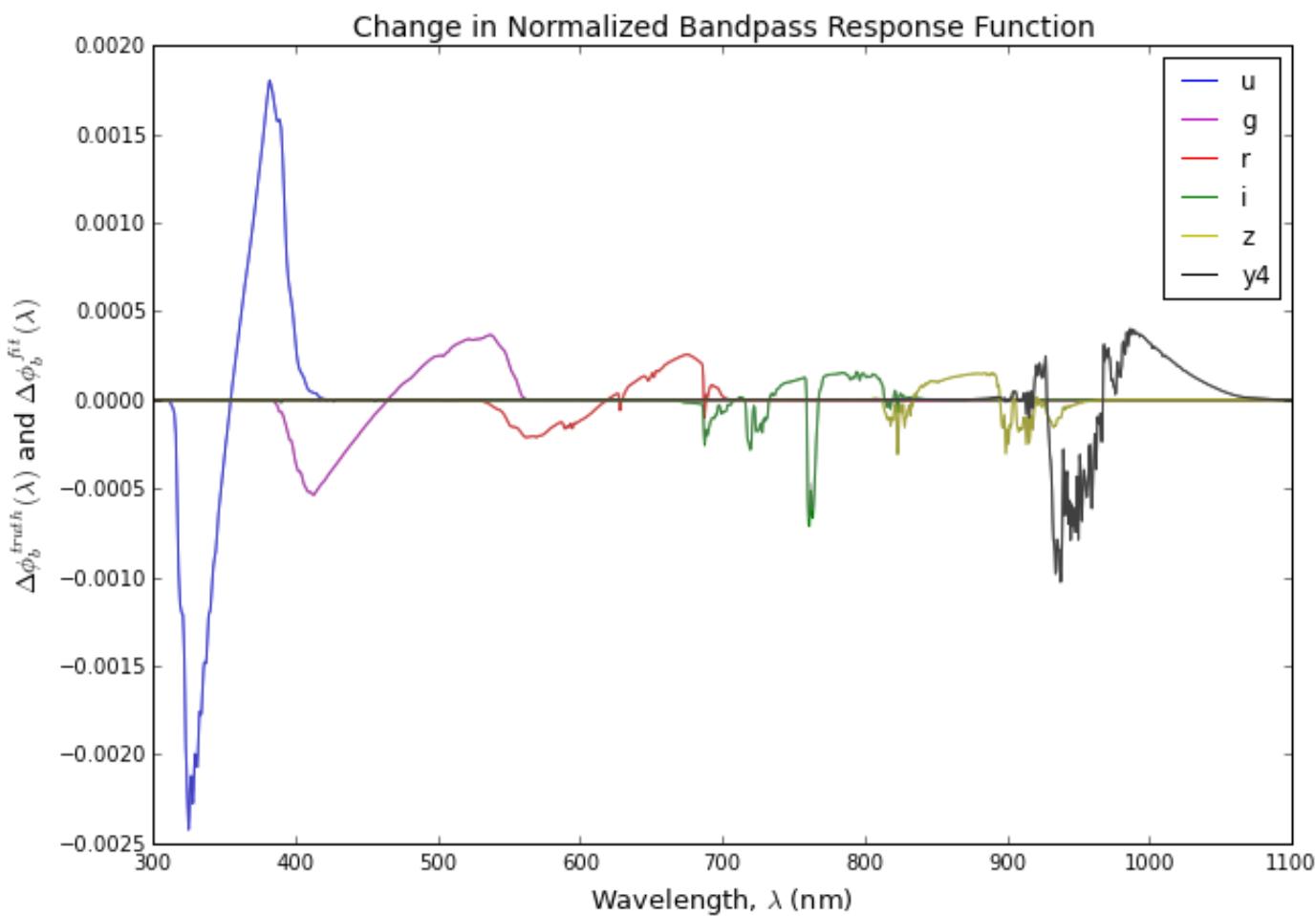
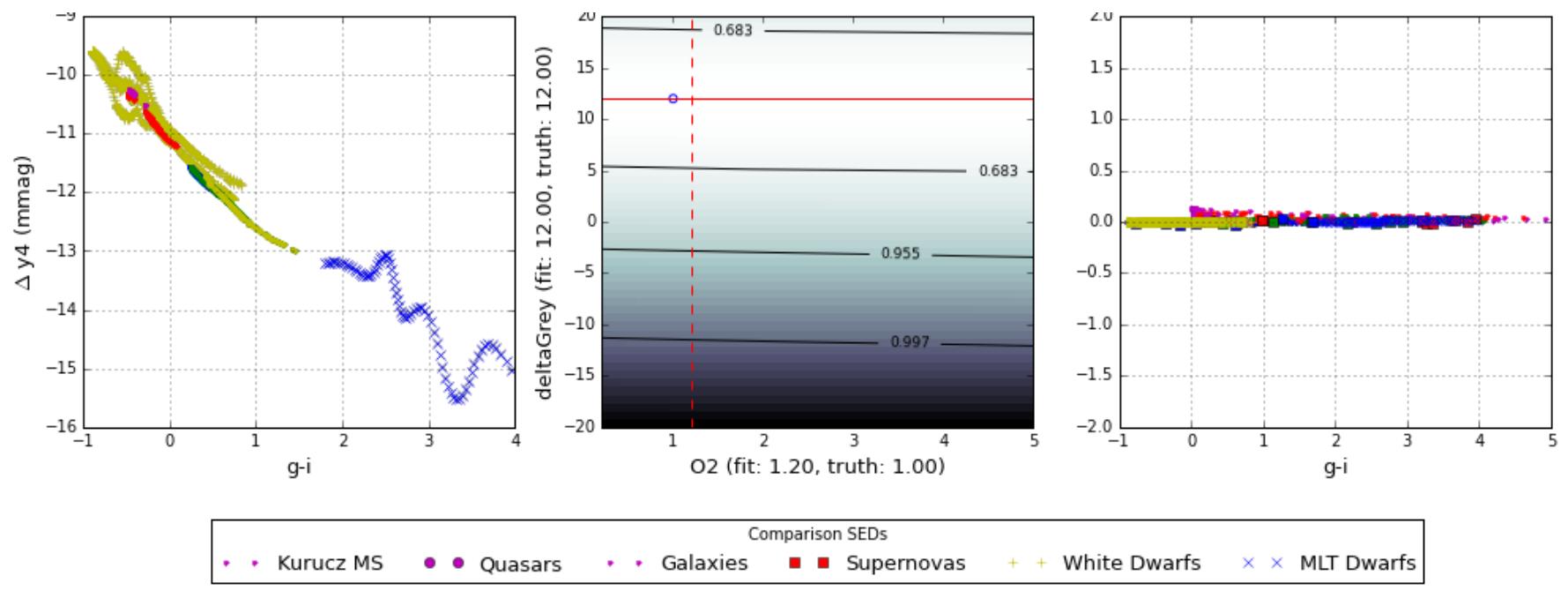
Best fit parameters (Filter, O2, dG, logL, Chi-Squared):  
u 0.98 12.00 5.07514265068e-07 1.01502853014e-06  
g 0.98 12.00 4.27610563505e-08 8.5522112701e-08  
r 0.98 12.00 0.00682624928111 0.0136524985622  
i 0.98 12.00 0.00121031508919 0.00242063017839  
z 0.98 12.00 3.38668100927e-08 6.77336201855e-08  
y4 0.98 12.00 4.65075558501e-06 9.30151117003e-06

Override best fit parameters (Filter, O2, dG):  
u 0.80 12.00  
g 0.80 12.00  
r 0.80 12.00  
i 0.80 12.00  
z 0.80 12.00  
y4 0.80 12.00

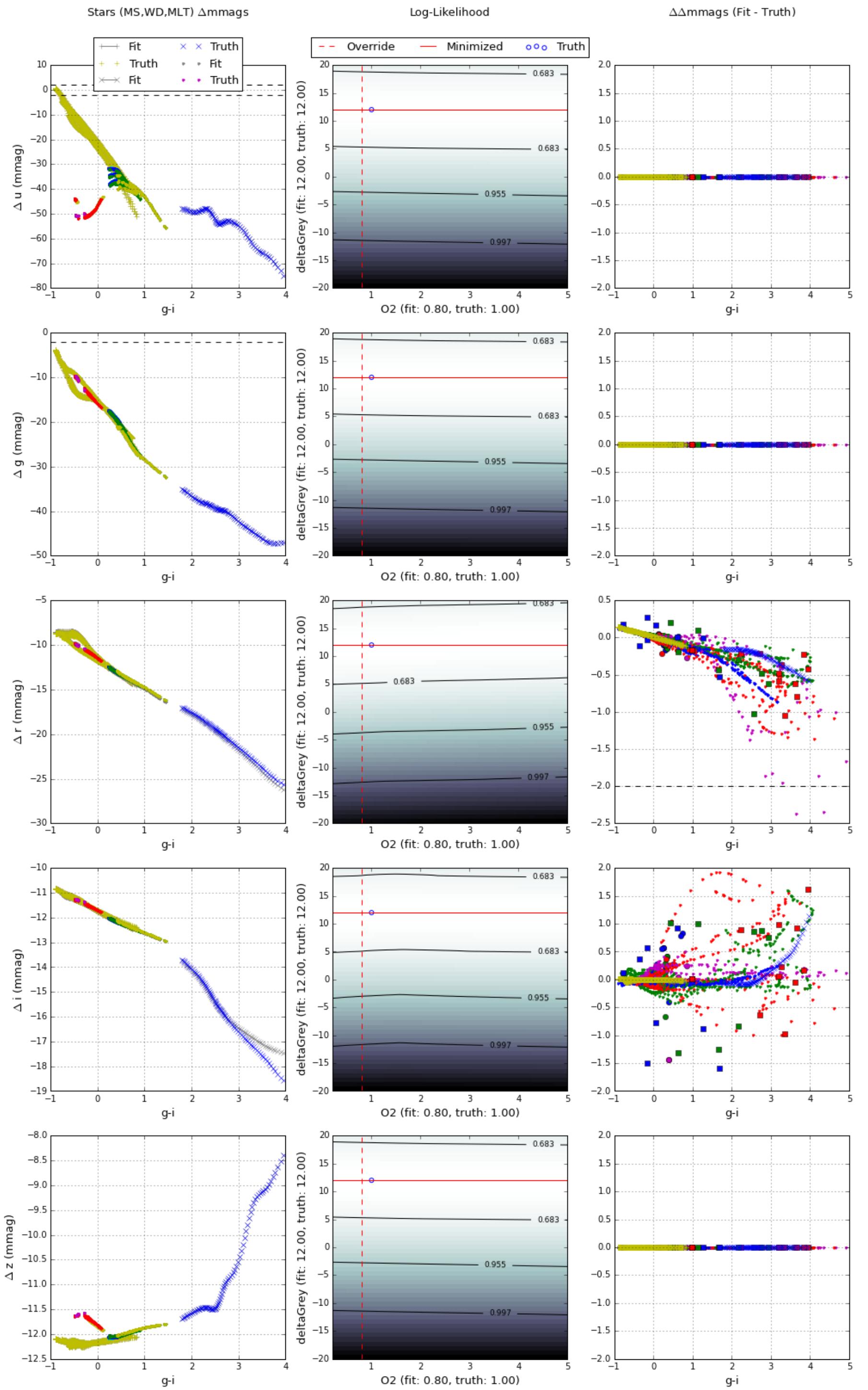


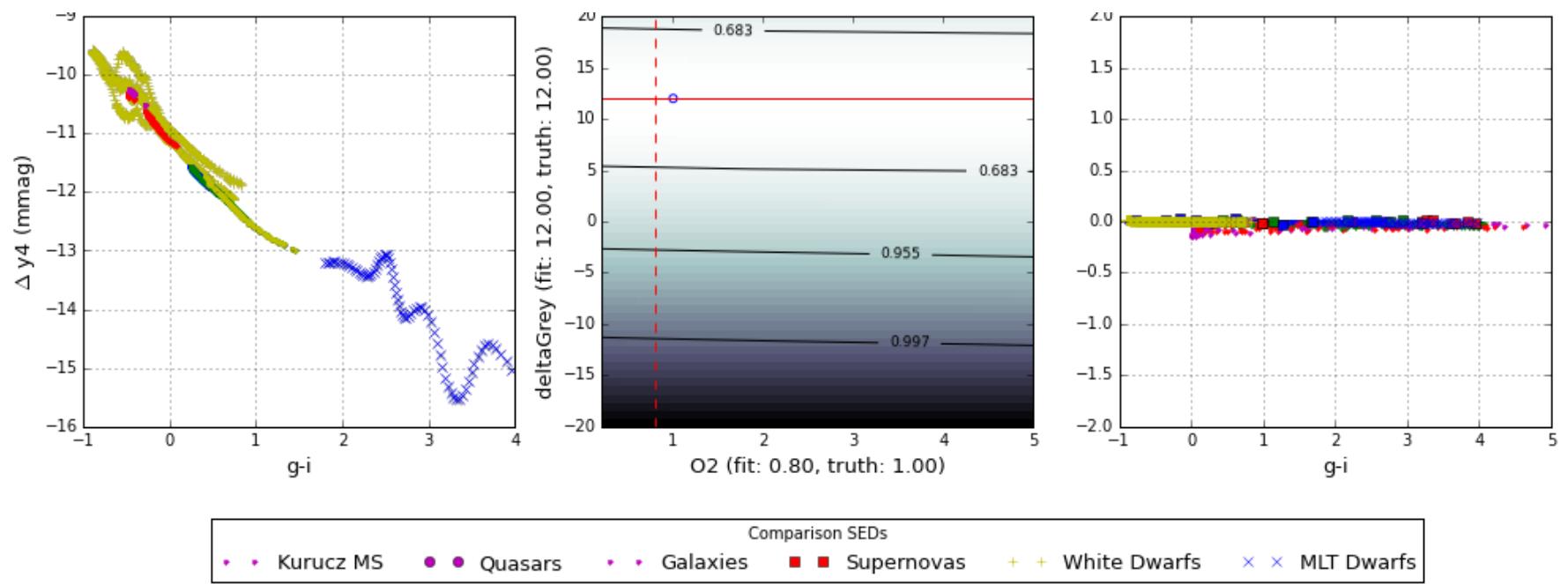
$\Delta\text{mmags}$ , Regression Contours,  $\Delta\Delta\text{mmags}$  for each LSST filter ( $\delta\text{Grey} = 12.0$ )





$\Delta\text{mmags}$ , Regression Contours,  $\Delta\Delta\text{mmags}$  for each LSST filter ( $\delta\text{Grey} = 12.0$ )





```
In [8]: deltaGreyLimitPlot('02',deltaGreyBins=50)
```

```
Computing nonlinear regression for O2.  
Observed atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]  
Observed atmosphere airmass: 2.0  
Standard atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]  
Standard atmosphere airmass: 1.2  
Observed atmosphere parameter for O2: 1.0  
  
Fitting for O2 between 0.20 and 5.00 in 50 bins.  
Fitting for deltaGrey between -20.00 and 20.00 mmags in 50 bins.  
  
Regression SEDs: 5778 Stars (MS,WD,MLT) SEDs.  
  
Regressing 2500 parameter combinations per filter...  
Magnitude Error: 5.0 mmags  
  
Override triggered...  
Override value detected, proceeding with deltaGrey best-fit minimization at new component best-fit value...  
  
Calculating best fit parameters for u filter...  
@pickle_results: using precomputed results from 'pickles/X20_P101010101017_O2_dG_XSTD12_DG120_DGR-20  
20_E5_stars_u_50dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for u filter.  
Saved Chi-Squared at best fit deltaGrey for u filter.  
Completed u filter.  
  
Calculating best fit parameters for g filter...  
@pickle_results: using precomputed results from 'pickles/X20_P101010101017_O2_dG_XSTD12_DG120_DGR-20  
20_E5_stars_g_50dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for g filter.  
Saved Chi-Squared at best fit deltaGrey for g filter.  
Completed g filter.  
  
Calculating best fit parameters for r filter...  
@pickle_results: using precomputed results from 'pickles/X20_P101010101017_O2_dG_XSTD12_DG120_DGR-20  
20_E5_stars_r_50dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for r filter.  
Saved Chi-Squared at best fit deltaGrey for r filter.  
Completed r filter.  
  
Calculating best fit parameters for i filter...  
@pickle_results: using precomputed results from 'pickles/X20_P101010101017_O2_dG_XSTD12_DG120_DGR-20  
20_E5_stars_i_50dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for i filter.  
Saved Chi-Squared at best fit deltaGrey for i filter.  
Completed i filter.  
  
Calculating best fit parameters for z filter...  
@pickle_results: using precomputed results from 'pickles/X20_P101010101017_O2_dG_XSTD12_DG120_DGR-20  
20_E5_stars_z_50dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for z filter.  
Saved Chi-Squared at best fit deltaGrey for z filter.  
Completed z filter.  
  
Calculating best fit parameters for y4 filter...  
@pickle_results: using precomputed results from 'pickles/X20_P101010101017_O2_dG_XSTD12_DG120_DGR-20  
20_E5_stars_y4_50dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for y4 filter.  
Saved Chi-Squared at best fit deltaGrey for y4 filter.  
Completed y4 filter.  
  
Best fit parameters (Filter, O2, dG, logL, Chi-Squared):  
u 5.00 11.84 2.69362495535 5.3872499107  
g 5.00 11.84 2.97985885976 5.95971771952  
r 0.79 11.84 1.97862054296 3.95724108591  
i 0.79 11.84 2.95291827768 5.90583655535  
z 5.00 11.84 3.06479951721 6.12959903443  
y4 5.00 11.84 2.75646034194 5.51292068388  
  
Override best fit parameters (Filter, O2, dG):  
u 1.20 11.84  
g 1.20 11.84  
r 1.20 11.84  
i 1.20 11.84  
z 1.20 11.84  
y4 1.20 11.84  
  
Computing nonlinear regression for O2.  
Observed atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]  
Observed atmosphere airmass: 2.0  
Standard atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]  
Standard atmosphere airmass: 1.2
```

```
Observed atmosphere parameter for O2: 1.0

Fitting for O2 between 0.20 and 5.00 in 50 bins.
Fitting for deltaGrey between -20.00 and 20.00 mmags in 50 bins.

Regression SEDs: 5778 Stars (MS,WD,MLT) SEDs.

Regressing 2500 parameter combinations per filter...
Magnitude Error: 5.0 mmags

Override triggered...
Override value detected, proceeding with deltaGrey best-fit minimization at new component best-fit value...

Calculating best fit parameters for u filter...
@pickle_results: using precomputed results from 'pickles/X20_P101010101017_O2_dG_XSTD12_DG120_DGR-20
20_E5_stars_u_50dgb_50b_min_dGTest_allMS_OR80.pkl'
Saved LogL at best fit deltaGrey for u filter.
Saved Chi-Squared at best fit deltaGrey for u filter.
Completed u filter.

Calculating best fit parameters for g filter...
@pickle_results: using precomputed results from 'pickles/X20_P101010101017_O2_dG_XSTD12_DG120_DGR-20
20_E5_stars_g_50dgb_50b_min_dGTest_allMS_OR80.pkl'
Saved LogL at best fit deltaGrey for g filter.
Saved Chi-Squared at best fit deltaGrey for g filter.
Completed g filter.

Calculating best fit parameters for r filter...
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_O2_dG_XSTD12_DG120_DGR-2
020_E5_stars_r_50dgb_50b_min_dGTest_allMS_OR80.pkl'
Saved LogL at best fit deltaGrey for r filter.
Saved Chi-Squared at best fit deltaGrey for r filter.
Completed r filter.

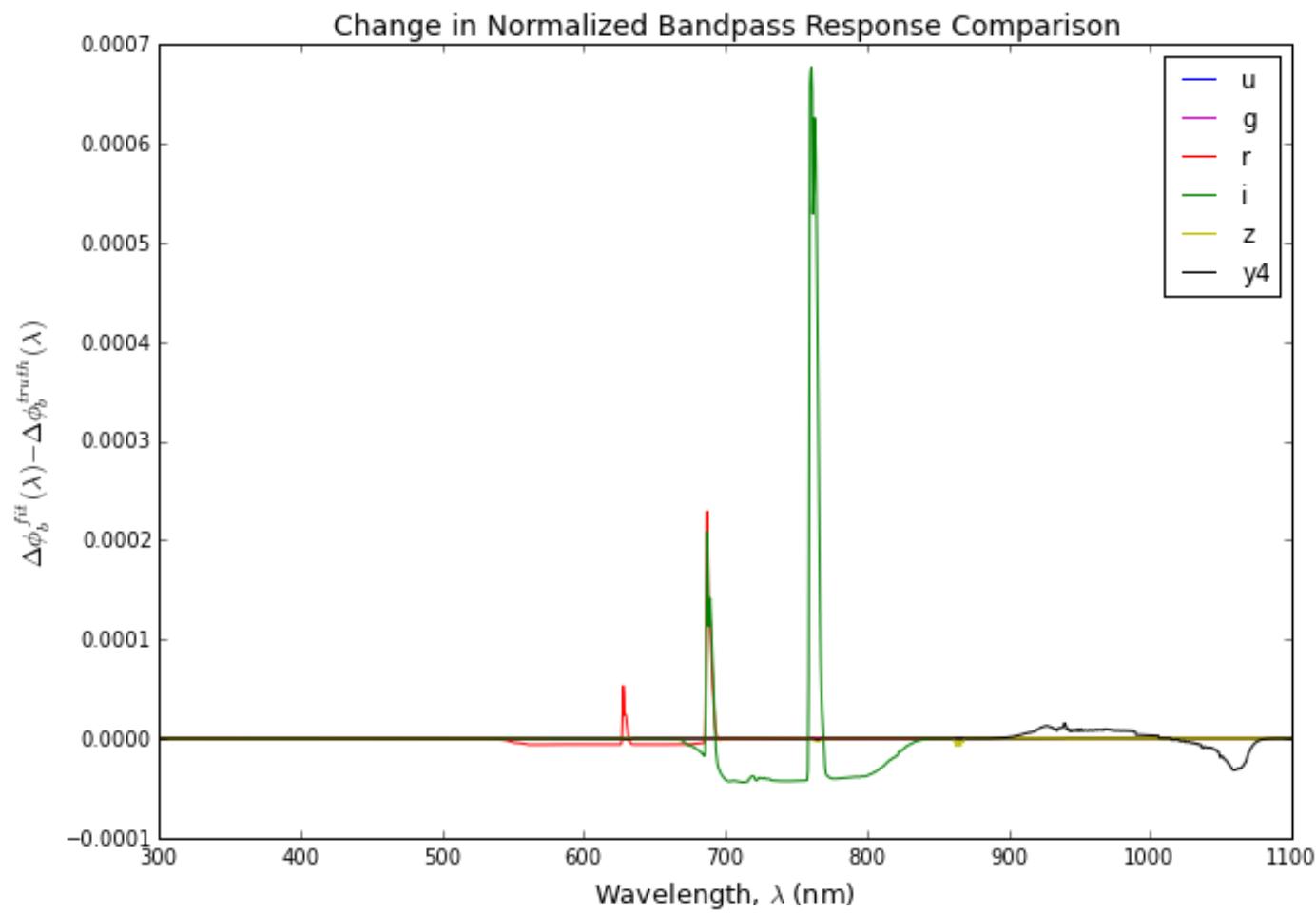
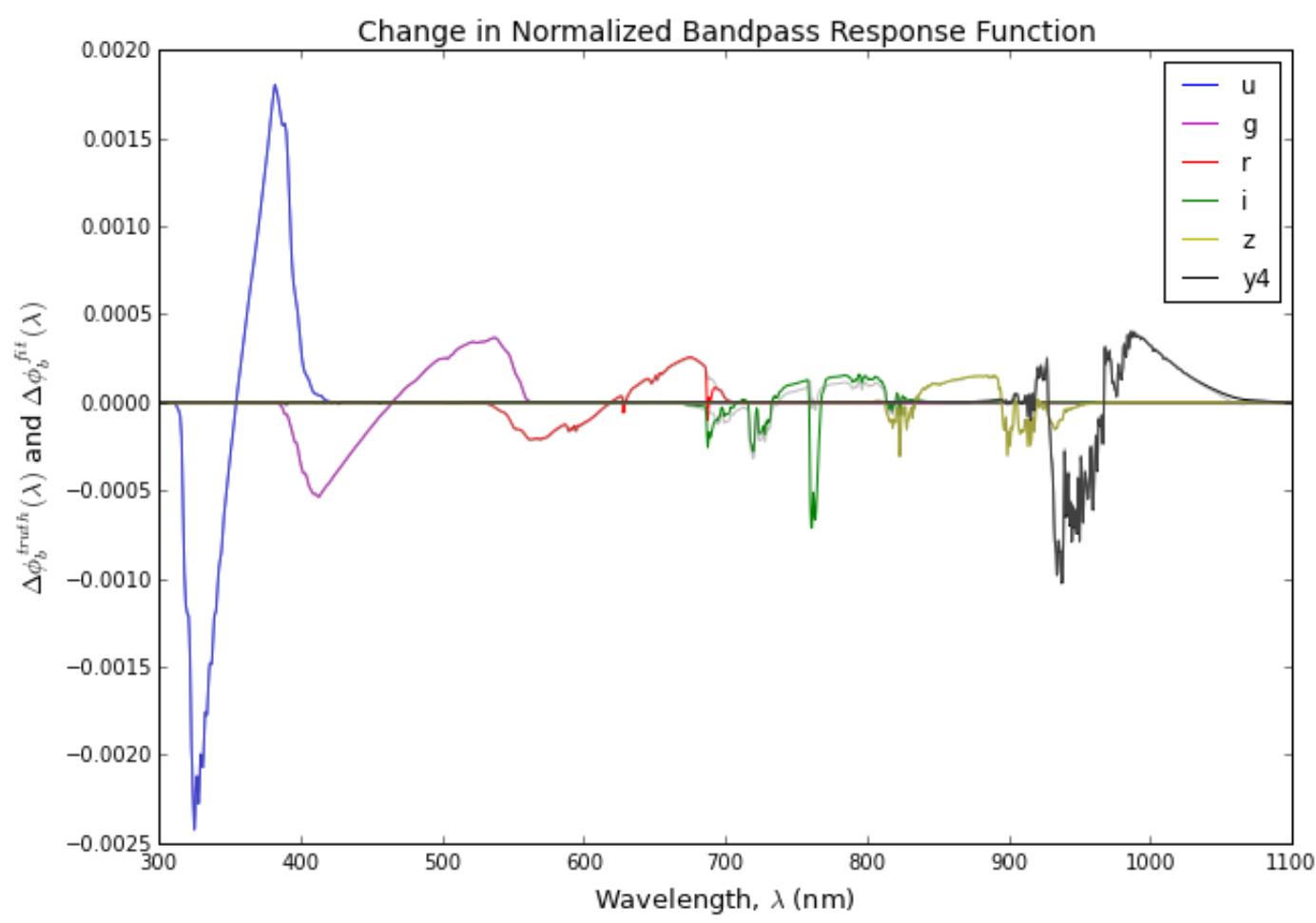
Calculating best fit parameters for i filter...
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_O2_dG_XSTD12_DG120_DGR-2
020_E5_stars_i_50dgb_50b_min_dGTest_allMS_OR80.pkl'
Saved LogL at best fit deltaGrey for i filter.
Saved Chi-Squared at best fit deltaGrey for i filter.
Completed i filter.

Calculating best fit parameters for z filter...
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_O2_dG_XSTD12_DG120_DGR-2
020_E5_stars_z_50dgb_50b_min_dGTest_allMS_OR80.pkl'
Saved LogL at best fit deltaGrey for z filter.
Saved Chi-Squared at best fit deltaGrey for z filter.
Completed z filter.

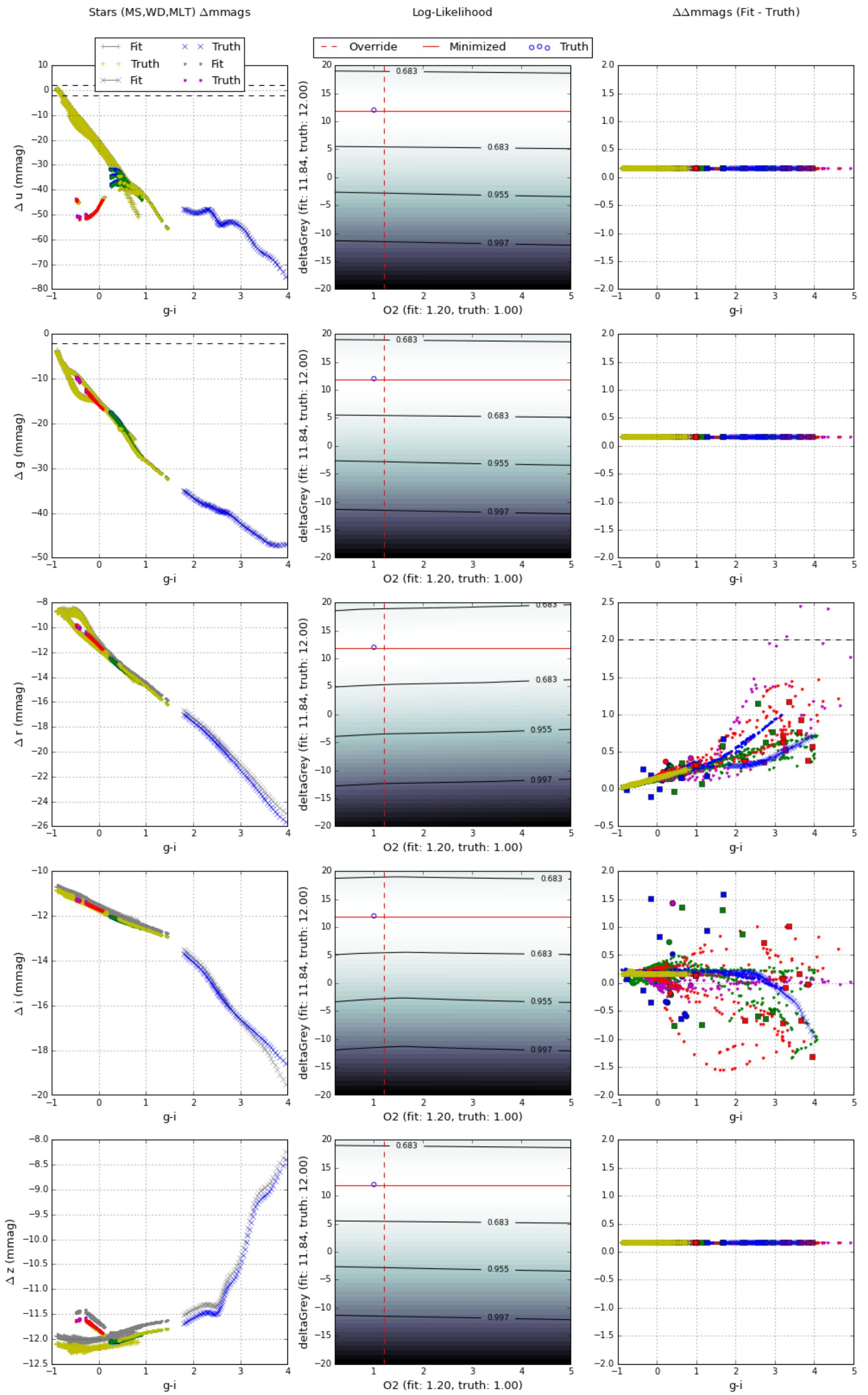
Calculating best fit parameters for y4 filter...
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_O2_dG_XSTD12_DG120_DGR-2
020_E5_stars_y4_50dgb_50b_min_dGTest_allMS_OR80.pkl'
Saved LogL at best fit deltaGrey for y4 filter.
Saved Chi-Squared at best fit deltaGrey for y4 filter.
Completed y4 filter.

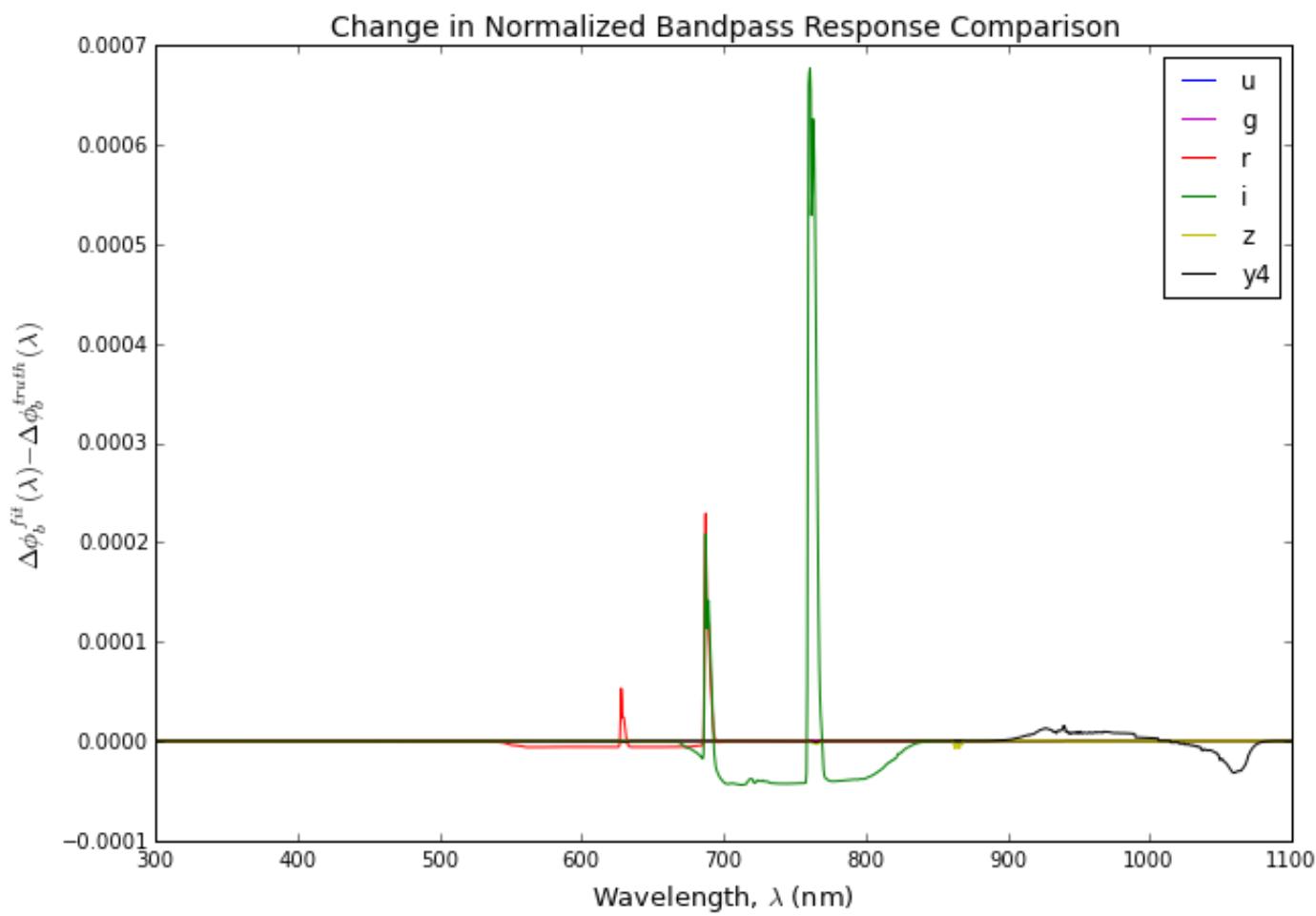
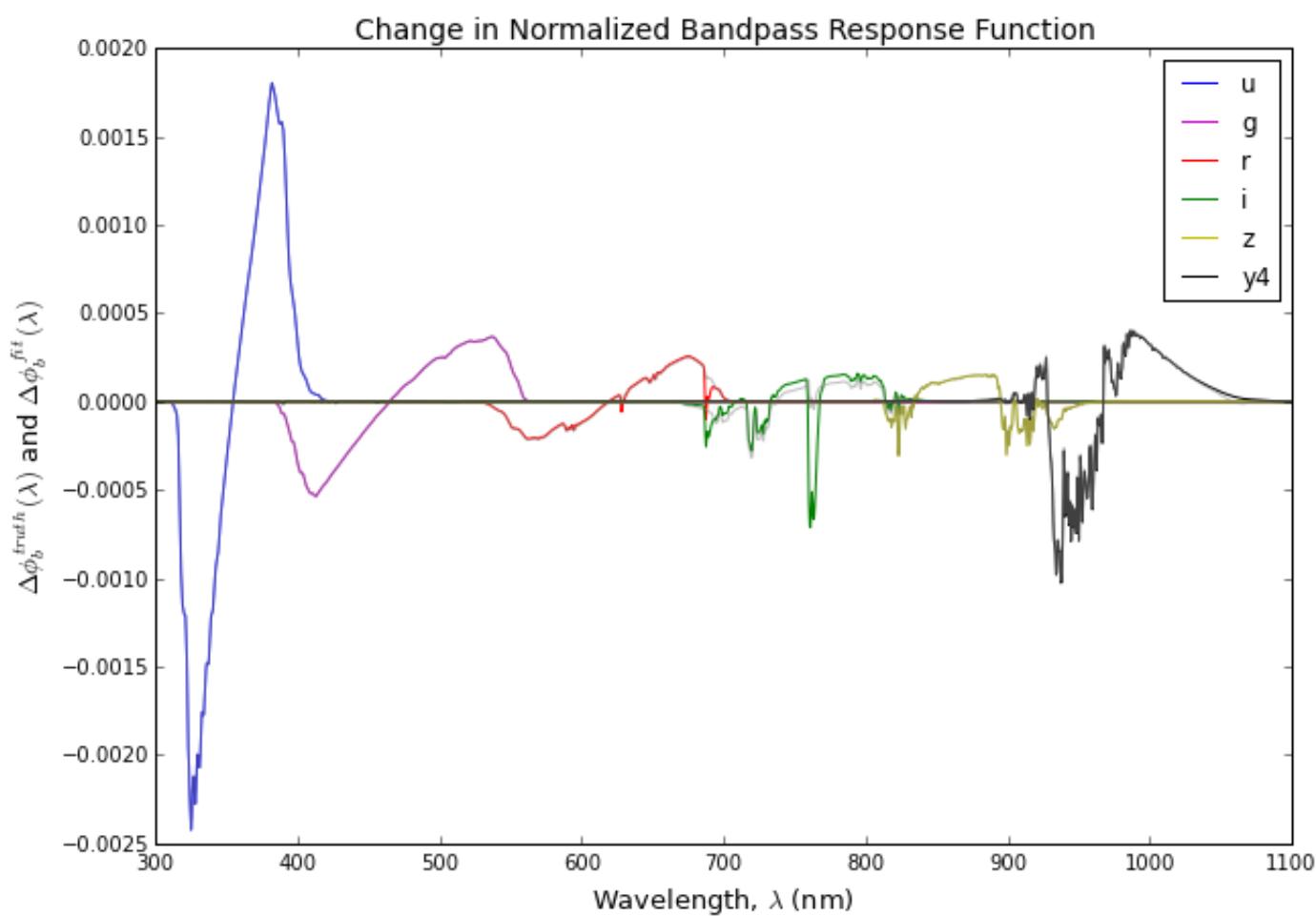
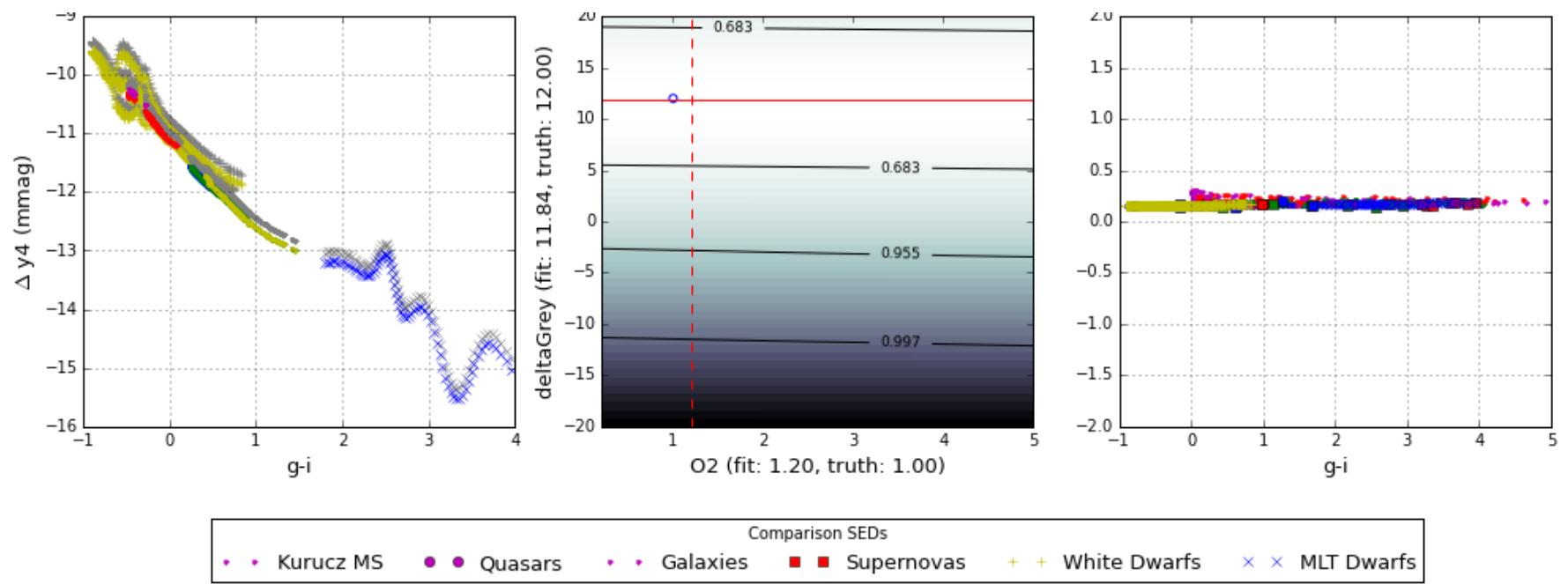
Best fit parameters (Filter, O2, dG, logL, Chi-Squared):
u 5.00 11.84 2.69362495535 5.3872499107
g 5.00 11.84 2.97985885976 5.95971771952
r 0.79 11.84 1.97862054296 3.95724108591
i 0.79 11.84 2.95291827768 5.90583655535
z 5.00 11.84 3.06479951721 6.12959903443
y4 5.00 11.84 2.75646034194 5.51292068388

Override best fit parameters (Filter, O2, dG):
u 0.80 11.84
g 0.80 11.84
r 0.80 11.84
i 0.80 11.84
z 0.80 11.84
y4 0.80 11.84
```

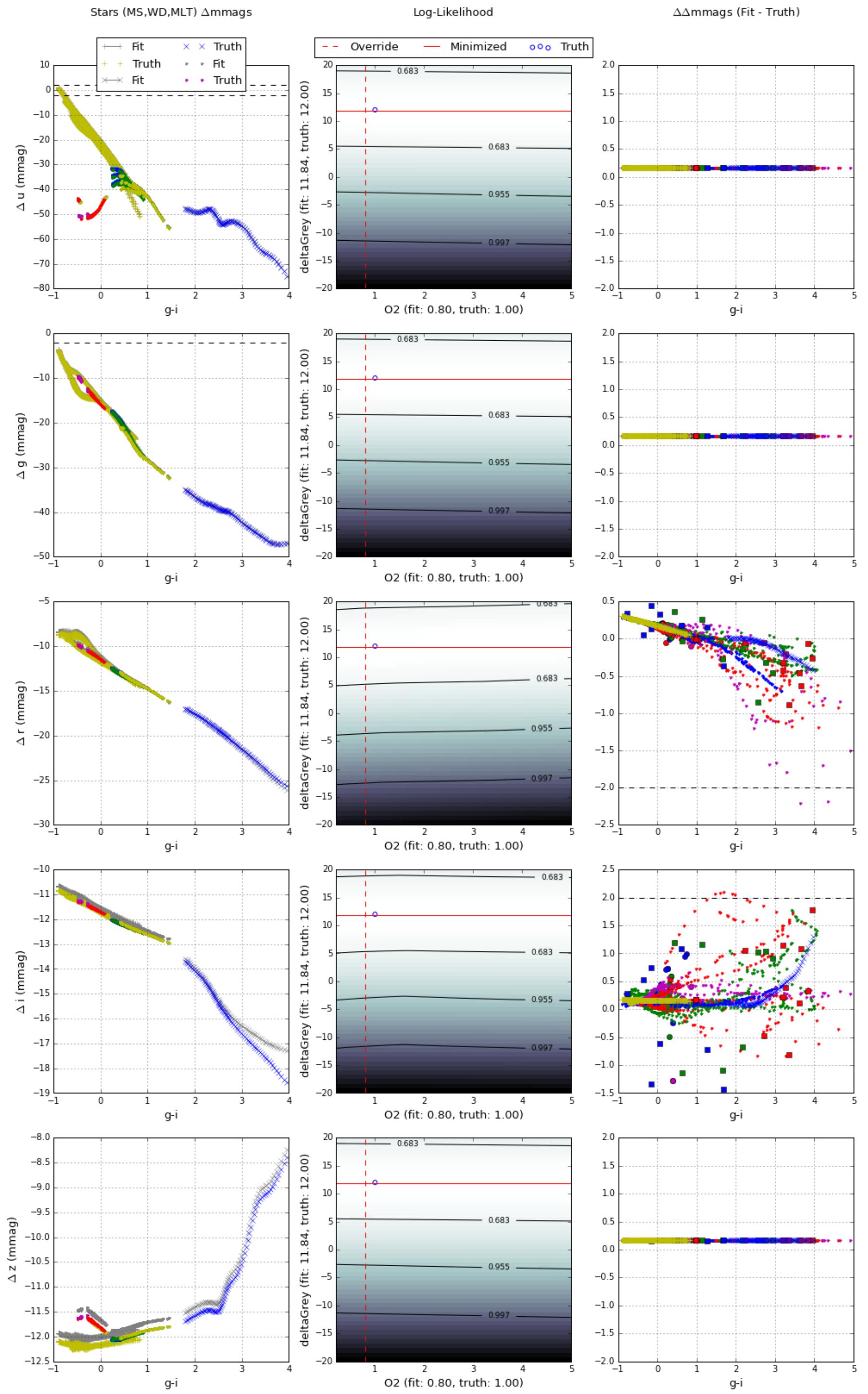


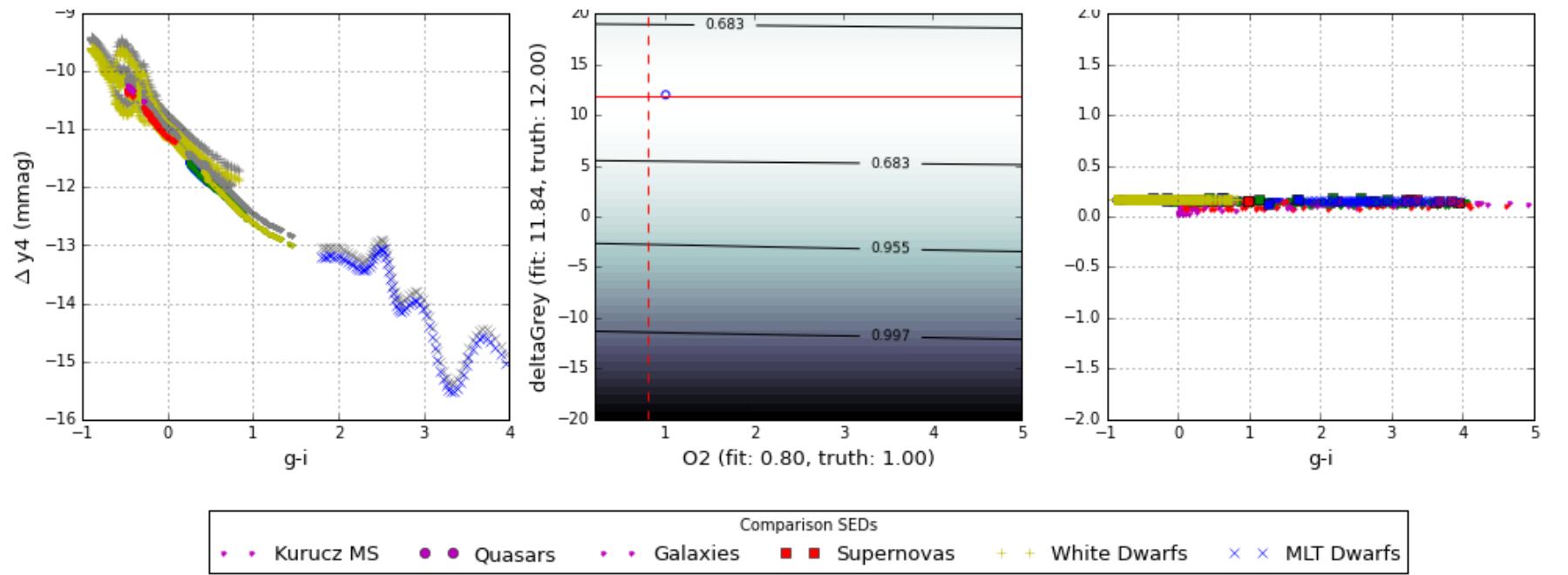
$\Delta\text{mmags}$ , Regression Contours,  $\Delta\Delta\text{mmags}$  for each LSST filter ( $\delta\text{Grey} = 12.0$ )





$\Delta\text{mmags}$ , Regression Contours,  $\Delta\Delta\text{mmags}$  for each LSST filter ( $\delta\text{Grey} = 12.0$ )





$O_3$

```
In [9]: deltaGreyLimitPlot('03')
```

```
Computing nonlinear regression for O3.  
Observed atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]  
Observed atmosphere airmass: 2.0  
Standard atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]  
Standard atmosphere airmass: 1.2  
Observed atmosphere parameter for O3: 1.0  
  
Fitting for O3 between 0.20 and 5.00 in 50 bins.  
Fitting for deltaGrey between -20.00 and 20.00 mmags in 51 bins.  
  
Regression SEDs: 5778 Stars (MS,WD,MLT) SEDs.  
  
Regressing 2550 parameter combinations per filter...  
Magnitude Error: 5.0 mmags  
  
Override triggered...  
Override value detected, proceeding with deltaGrey best-fit minimization at new component best-fit value...  
  
Calculating best fit parameters for u filter...  
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_O3_dG_XSTD12_DG120_DGR-2_020_E5_stars_u_51dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for u filter.  
Saved Chi-Squared at best fit deltaGrey for u filter.  
Completed u filter.  
  
Calculating best fit parameters for g filter...  
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_O3_dG_XSTD12_DG120_DGR-2_020_E5_stars_g_51dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for g filter.  
Saved Chi-Squared at best fit deltaGrey for g filter.  
Completed g filter.  
  
Calculating best fit parameters for r filter...  
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_O3_dG_XSTD12_DG120_DGR-2_020_E5_stars_r_51dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for r filter.  
Saved Chi-Squared at best fit deltaGrey for r filter.  
Completed r filter.  
  
Calculating best fit parameters for i filter...  
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_O3_dG_XSTD12_DG120_DGR-2_020_E5_stars_i_51dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for i filter.  
Saved Chi-Squared at best fit deltaGrey for i filter.  
Completed i filter.  
  
Calculating best fit parameters for z filter...  
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_O3_dG_XSTD12_DG120_DGR-2_020_E5_stars_z_51dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for z filter.  
Saved Chi-Squared at best fit deltaGrey for z filter.  
Completed z filter.  
  
Calculating best fit parameters for y4 filter...  
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_O3_dG_XSTD12_DG120_DGR-2_020_E5_stars_y4_51dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for y4 filter.  
Saved Chi-Squared at best fit deltaGrey for y4 filter.  
Completed y4 filter.  
  
Best fit parameters (Filter, O3, dG, logL, Chi-Squared):  
u 0.98 12.00 2.95404962788 5.90809925577  
g 0.98 12.00 0.408411736509 0.816823473018  
r 0.98 12.00 0.088350845443 0.176701690886  
i 0.98 12.00 0.00261716224758 0.00523432449517  
z 0.98 12.00 2.74481350512e-05 5.48962701023e-05  
y4 0.98 12.00 8.05928697349e-06 1.6118573947e-05  
  
Override best fit parameters (Filter, O3, dG):  
u 1.20 10.40  
g 1.20 12.80  
r 1.20 12.00  
i 1.20 12.00  
z 1.20 12.00  
y4 1.20 12.00  
  
Computing nonlinear regression for O3.  
Observed atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]  
Observed atmosphere airmass: 2.0  
Standard atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]  
Standard atmosphere airmass: 1.2
```

Observed atmosphere parameter for O3: 1.0

Fitting for O3 between 0.20 and 5.00 in 50 bins.  
Fitting for deltaGrey between -20.00 and 20.00 mmags in 51 bins.

Regression SEDs: 5778 Stars (MS,WD,MLT) SEDs.

Regressing 2550 parameter combinations per filter...  
Magnitude Error: 5.0 mmags

Override triggered...  
Override value detected, proceeding with deltaGrey best-fit minimization at new component best-fit value...

Calculating best fit parameters for u filter...  
@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_O3\_dG\_XSTD12\_DG120\_DGR-2\_020\_E5\_stars\_u\_51dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for u filter.  
Saved Chi-Squared at best fit deltaGrey for u filter.  
Completed u filter.

Calculating best fit parameters for g filter...  
@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_O3\_dG\_XSTD12\_DG120\_DGR-2\_020\_E5\_stars\_g\_51dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for g filter.  
Saved Chi-Squared at best fit deltaGrey for g filter.  
Completed g filter.

Calculating best fit parameters for r filter...  
@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_O3\_dG\_XSTD12\_DG120\_DGR-2\_020\_E5\_stars\_r\_51dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for r filter.  
Saved Chi-Squared at best fit deltaGrey for r filter.  
Completed r filter.

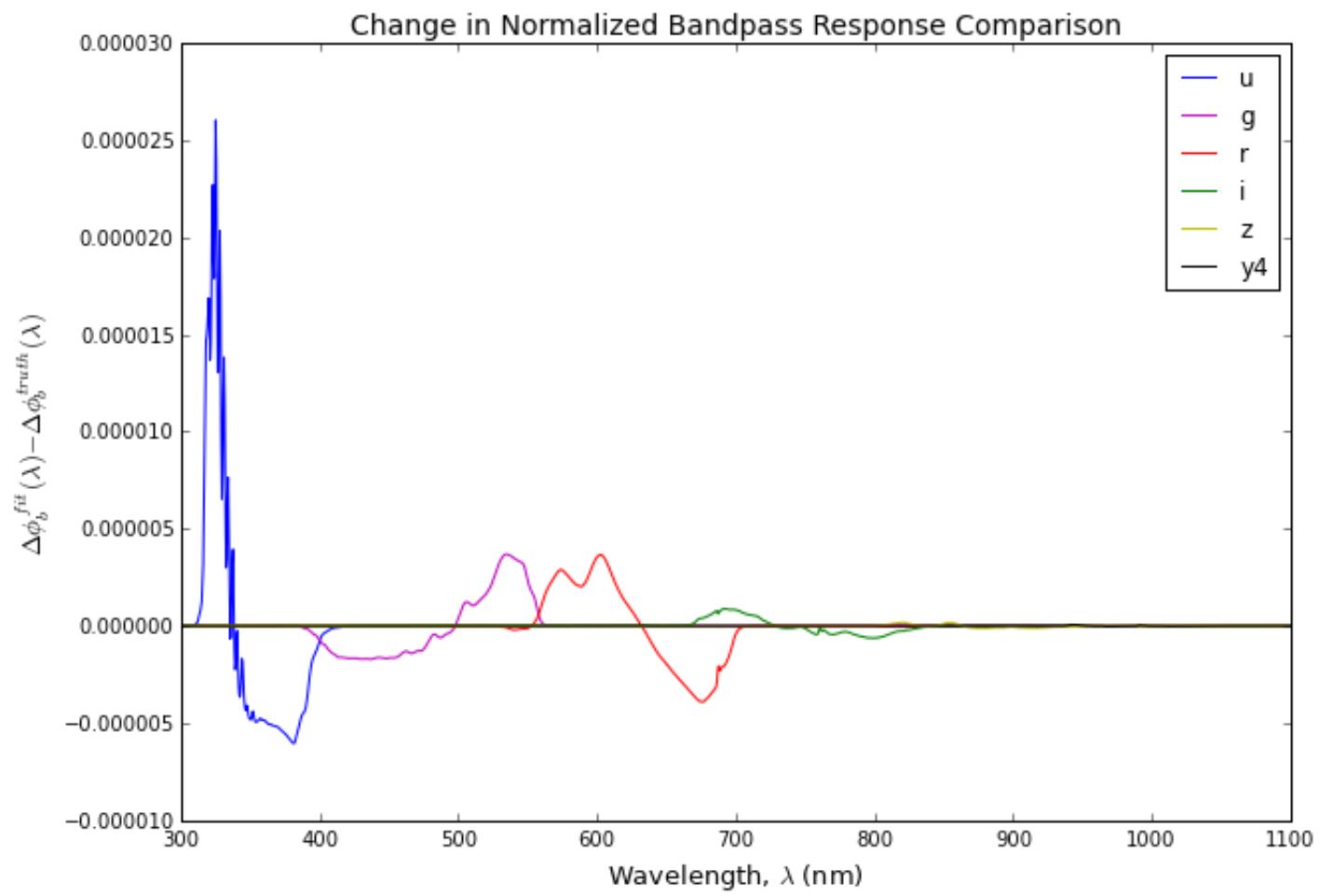
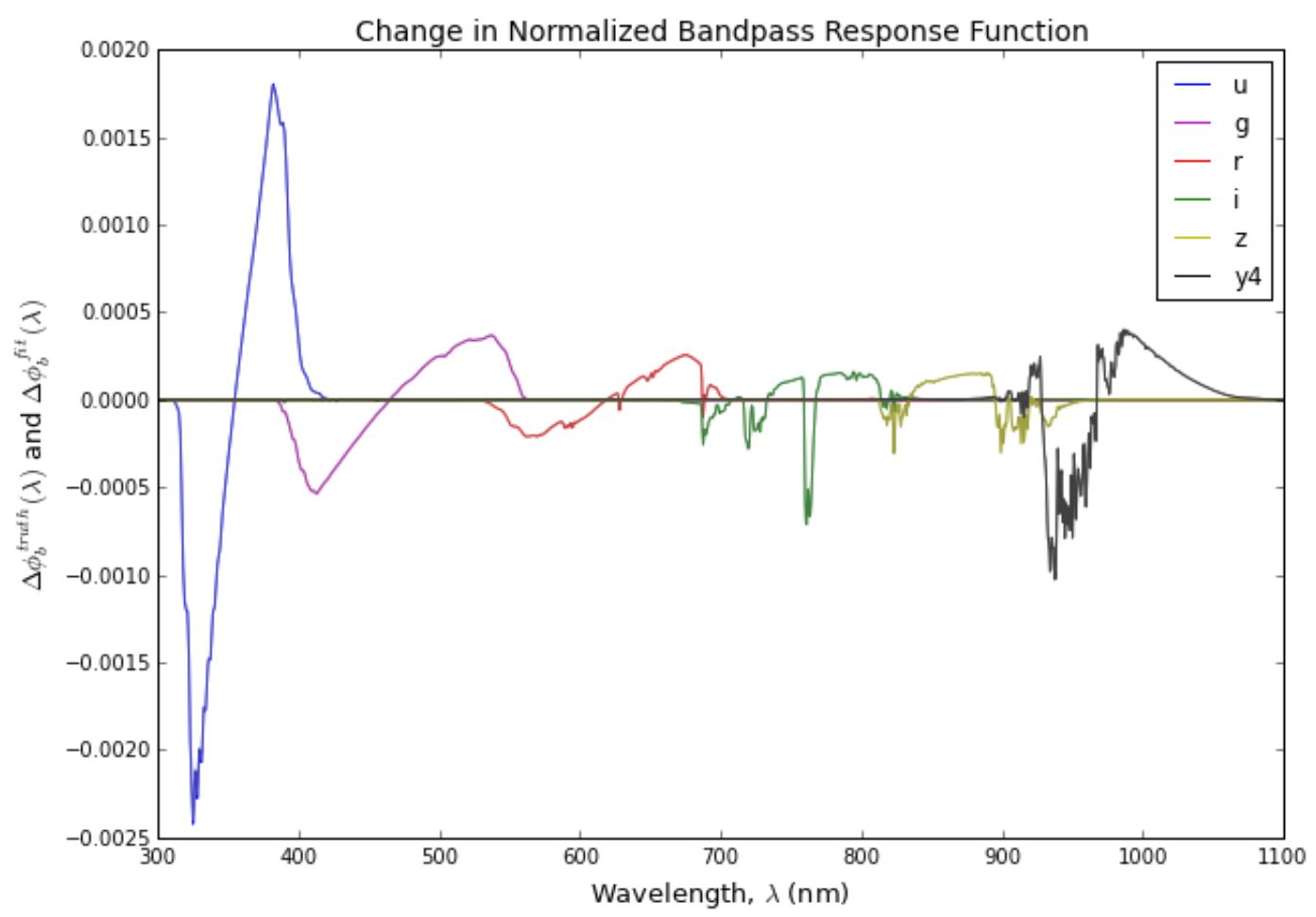
Calculating best fit parameters for i filter...  
@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_O3\_dG\_XSTD12\_DG120\_DGR-2\_020\_E5\_stars\_i\_51dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for i filter.  
Saved Chi-Squared at best fit deltaGrey for i filter.  
Completed i filter.

Calculating best fit parameters for z filter...  
@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_O3\_dG\_XSTD12\_DG120\_DGR-2\_020\_E5\_stars\_z\_51dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for z filter.  
Saved Chi-Squared at best fit deltaGrey for z filter.  
Completed z filter.

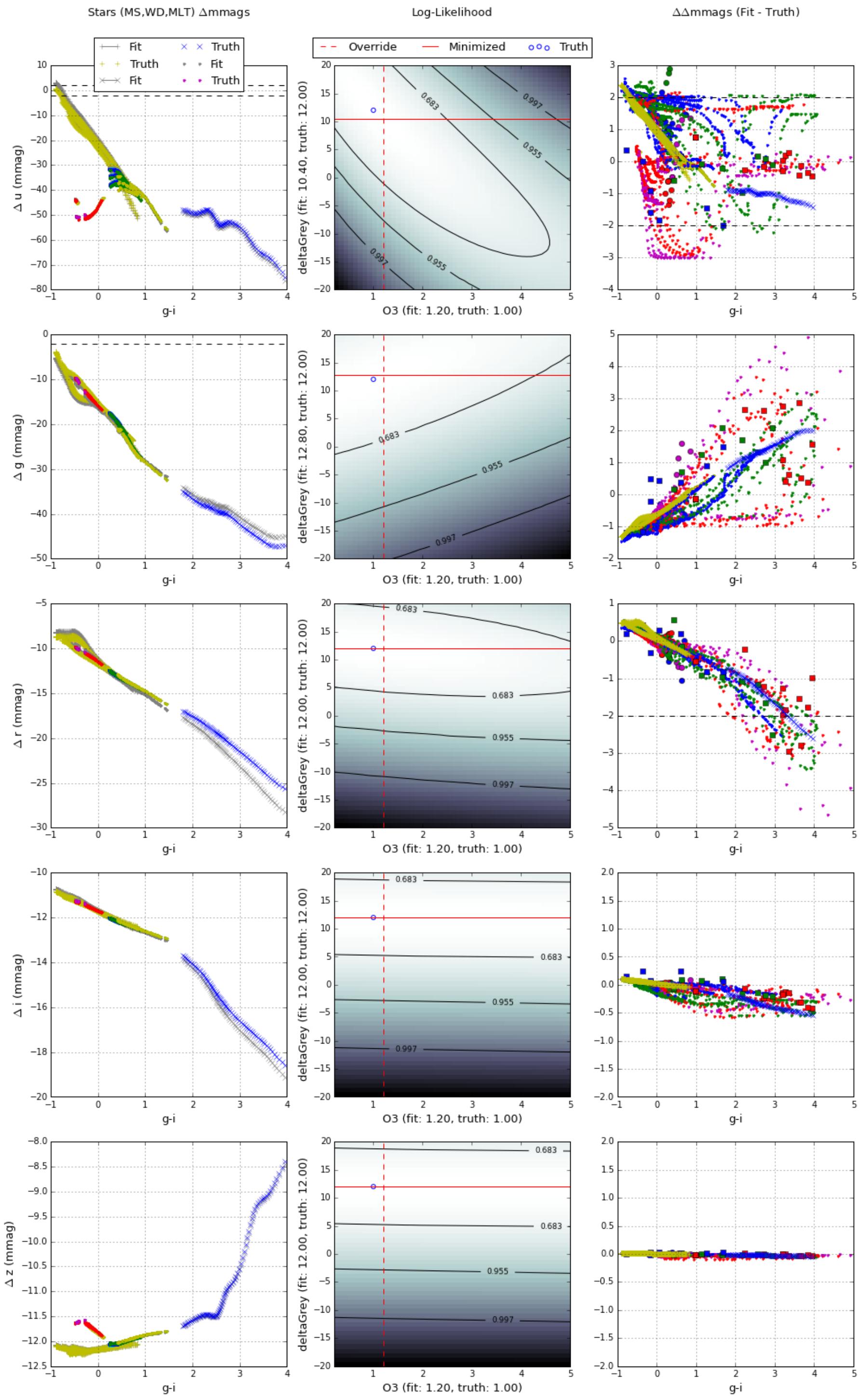
Calculating best fit parameters for y4 filter...  
@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_O3\_dG\_XSTD12\_DG120\_DGR-2\_020\_E5\_stars\_y4\_51dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for y4 filter.  
Saved Chi-Squared at best fit deltaGrey for y4 filter.  
Completed y4 filter.

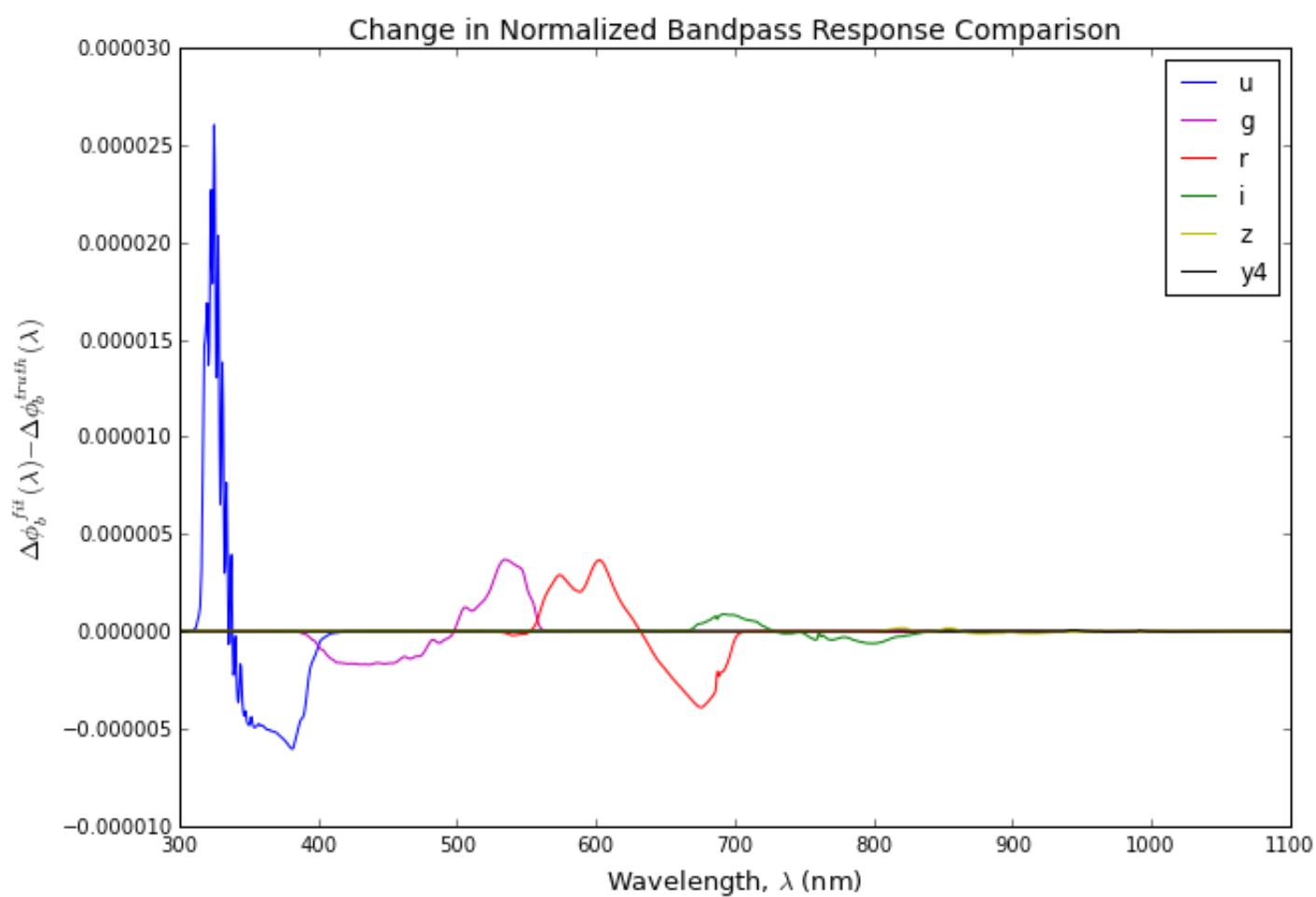
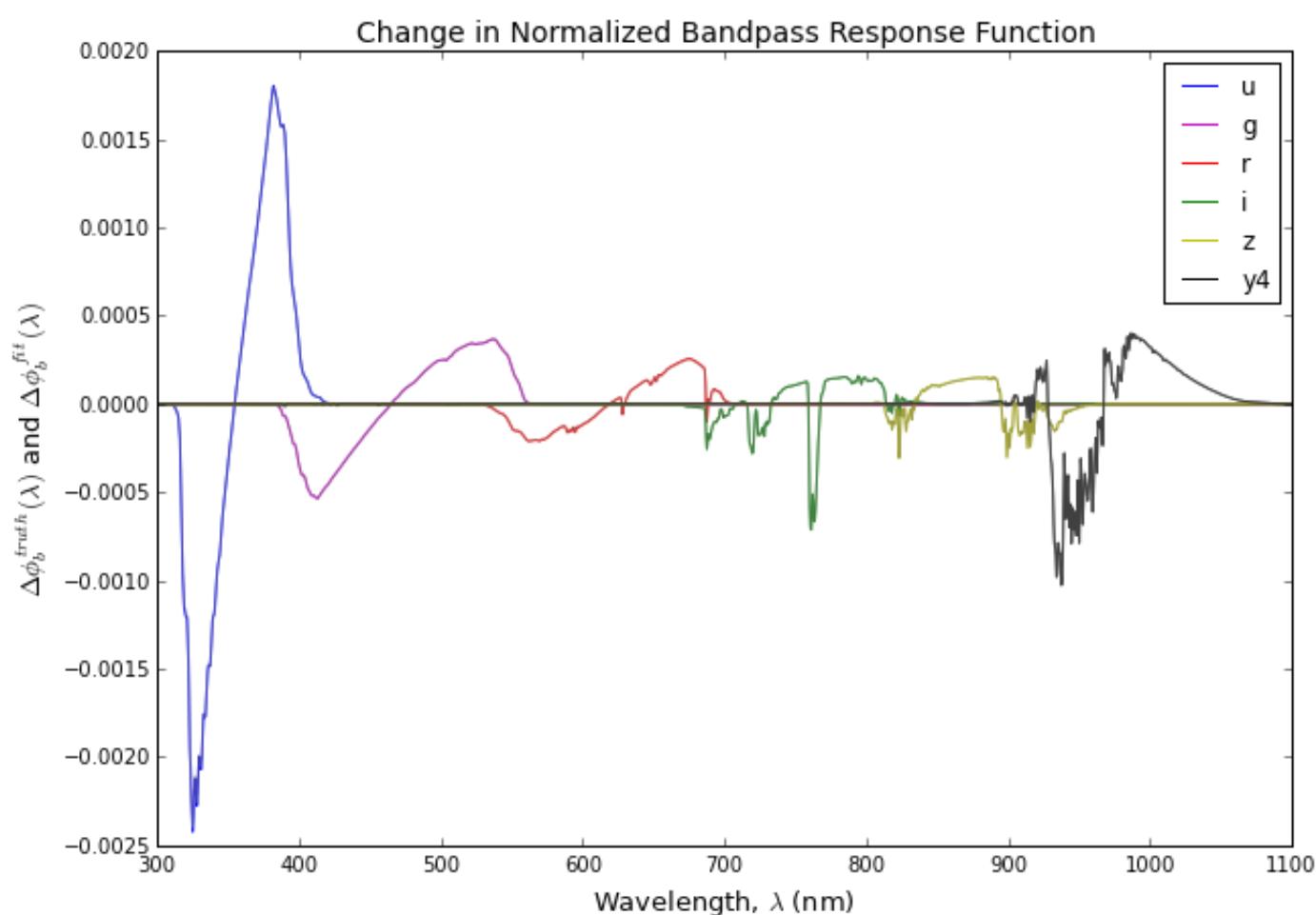
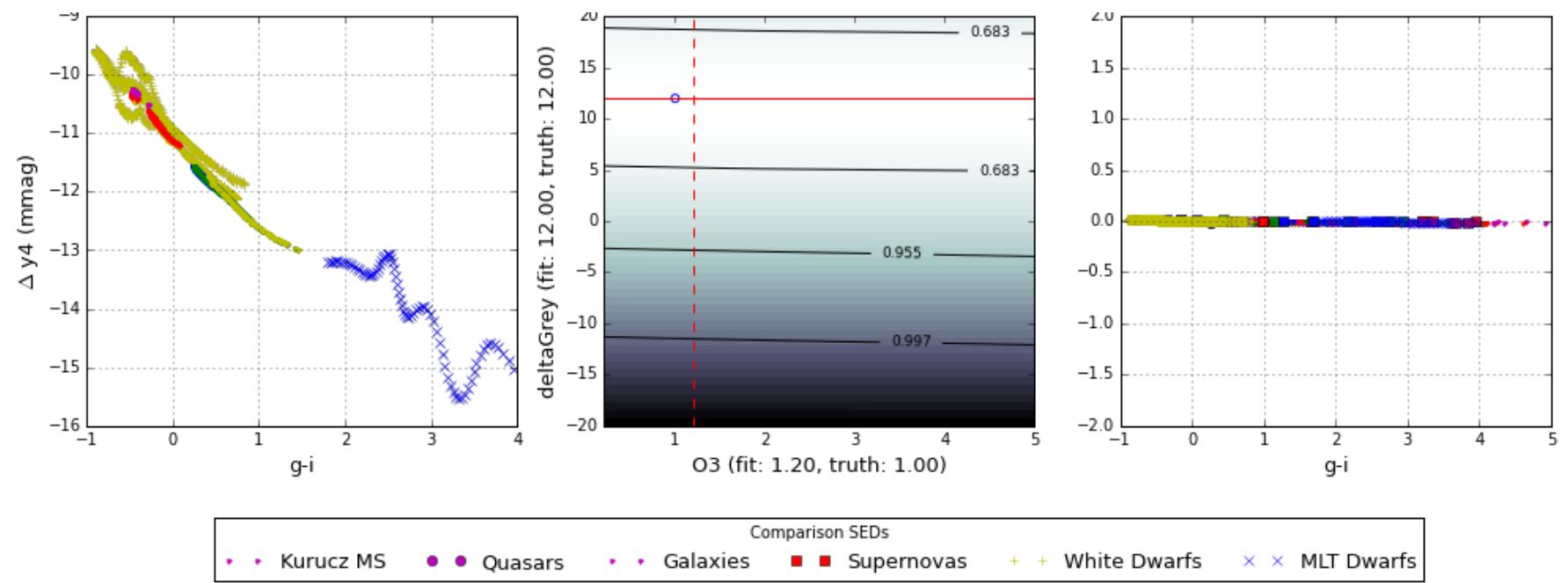
Best fit parameters (Filter, O3, dG, logL, Chi-Squared):  
u 0.98 12.00 2.95404962788 5.90809925577  
g 0.98 12.00 0.408411736509 0.816823473018  
r 0.98 12.00 0.088350845443 0.176701690886  
i 0.98 12.00 0.00261716224758 0.00523432449517  
z 0.98 12.00 2.74481350512e-05 5.48962701023e-05  
y4 0.98 12.00 8.05928697349e-06 1.6118573947e-05

Override best fit parameters (Filter, O3, dG):  
u 0.80 13.60  
g 0.80 11.20  
r 0.80 12.00  
i 0.80 12.00  
z 0.80 12.00  
y4 0.80 12.00

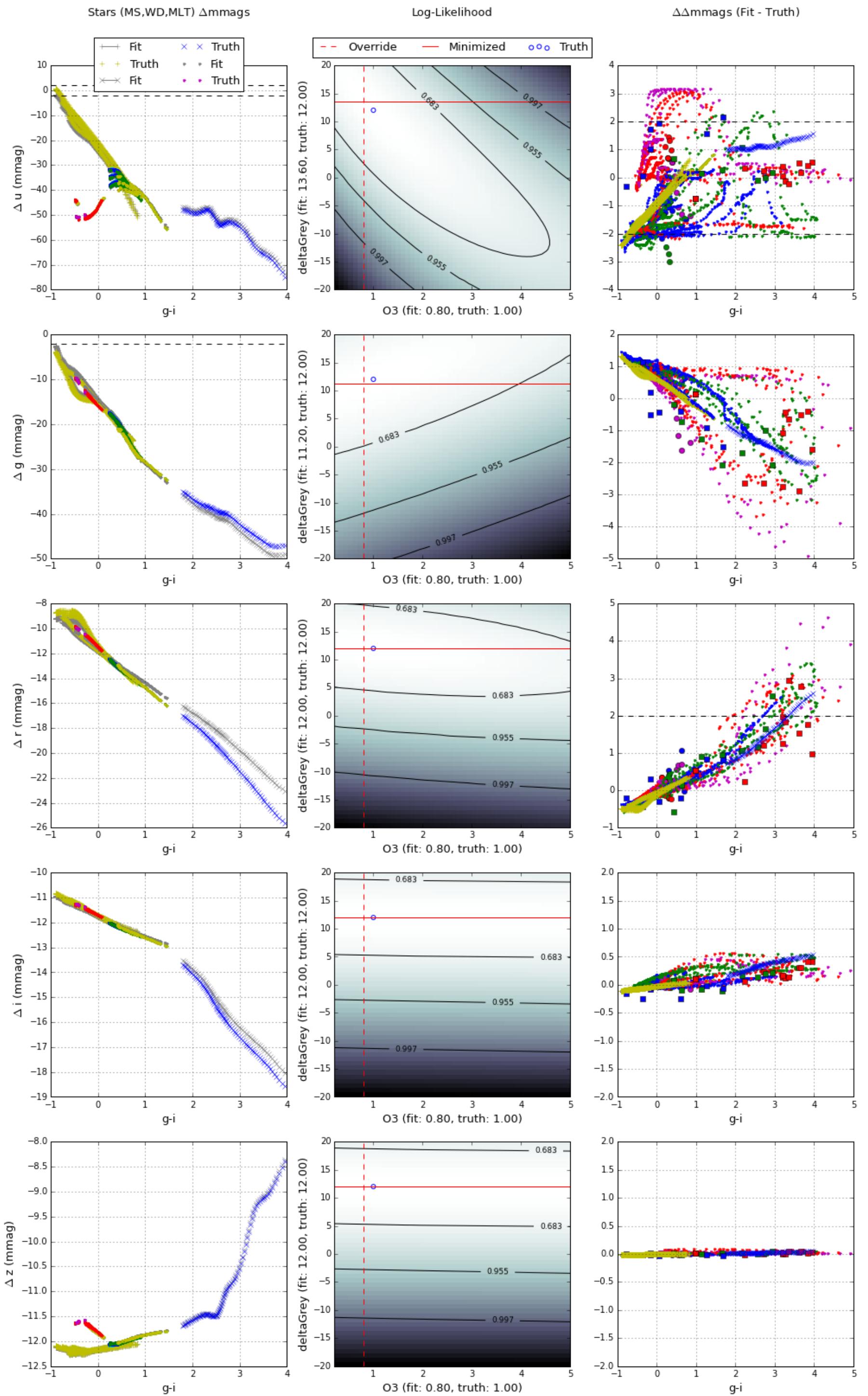


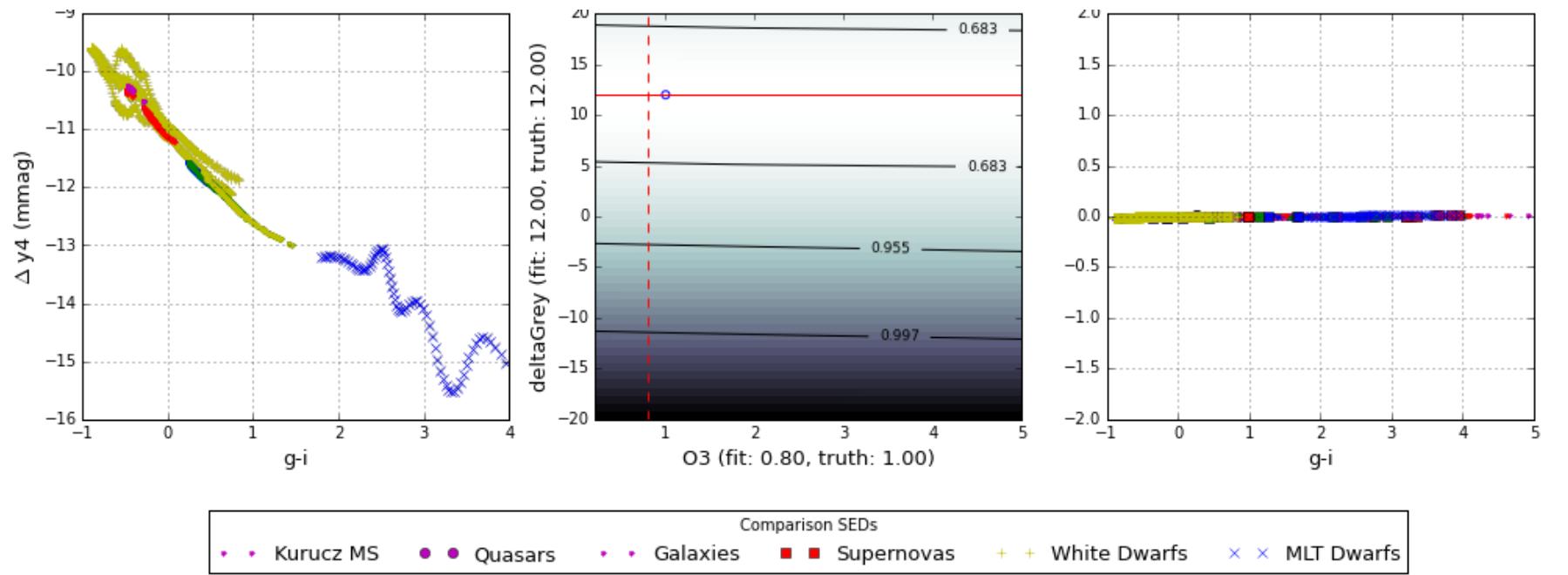
$\Delta\text{mmags}$ , Regression Contours,  $\Delta\Delta\text{mmags}$  for each LSST filter ( $\delta\text{Grey} = 12.0$ )





$\Delta\text{mmags}$ , Regression Contours,  $\Delta\Delta\text{mmags}$  for each LSST filter ( $\delta\text{Grey} = 12.0$ )





```
In [10]: deltaGreyLimitPlot('03',deltaGreyBins=50)
```

```
Computing nonlinear regression for O3.  
Observed atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]  
Observed atmosphere airmass: 2.0  
Standard atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]  
Standard atmosphere airmass: 1.2  
Observed atmosphere parameter for O3: 1.0  
  
Fitting for O3 between 0.20 and 5.00 in 50 bins.  
Fitting for deltaGrey between -20.00 and 20.00 mmags in 50 bins.  
  
Regression SEDs: 5778 Stars (MS,WD,MLT) SEDs.  
  
Regressing 2500 parameter combinations per filter...  
Magnitude Error: 5.0 mmags  
  
Override triggered...  
Override value detected, proceeding with deltaGrey best-fit minimization at new component best-fit value...  
  
Calculating best fit parameters for u filter...  
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_O3_dG_XSTD12_DG120_DGR-2_020_E5_stars_u_50dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for u filter.  
Saved Chi-Squared at best fit deltaGrey for u filter.  
Completed u filter.  
  
Calculating best fit parameters for g filter...  
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_O3_dG_XSTD12_DG120_DGR-2_020_E5_stars_g_50dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for g filter.  
Saved Chi-Squared at best fit deltaGrey for g filter.  
Completed g filter.  
  
Calculating best fit parameters for r filter...  
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_O3_dG_XSTD12_DG120_DGR-2_020_E5_stars_r_50dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for r filter.  
Saved Chi-Squared at best fit deltaGrey for r filter.  
Completed r filter.  
  
Calculating best fit parameters for i filter...  
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_O3_dG_XSTD12_DG120_DGR-2_020_E5_stars_i_50dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for i filter.  
Saved Chi-Squared at best fit deltaGrey for i filter.  
Completed i filter.  
  
Calculating best fit parameters for z filter...  
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_O3_dG_XSTD12_DG120_DGR-2_020_E5_stars_z_50dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for z filter.  
Saved Chi-Squared at best fit deltaGrey for z filter.  
Completed z filter.  
  
Calculating best fit parameters for y4 filter...  
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_O3_dG_XSTD12_DG120_DGR-2_020_E5_stars_y4_50dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for y4 filter.  
Saved Chi-Squared at best fit deltaGrey for y4 filter.  
Completed y4 filter.  
  
Best fit parameters (Filter, O3, dG, logL, Chi-Squared):  
u 0.98 11.84 11.4727178242 22.9454356485  
g 0.98 11.84 1.75084163226 3.50168326452  
r 1.08 11.84 2.89997325125 5.79994650249  
i 1.18 11.84 2.87315146174 5.74630292348  
z 2.16 11.84 2.93624557648 5.87249115296  
y4 1.57 11.84 3.06880707064 6.13761414128  
  
Override best fit parameters (Filter, O3, dG):  
u 1.20 10.20  
g 1.20 12.65  
r 1.20 11.84  
i 1.20 11.84  
z 1.20 11.84  
y4 1.20 11.84  
  
Computing nonlinear regression for O3.  
Observed atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]  
Observed atmosphere airmass: 2.0  
Standard atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]  
Standard atmosphere airmass: 1.2
```

Observed atmosphere parameter for O3: 1.0

Fitting for O3 between 0.20 and 5.00 in 50 bins.  
Fitting for deltaGrey between -20.00 and 20.00 mmags in 50 bins.

Regression SEDs: 5778 Stars (MS,WD,MLT) SEDs.

Regressing 2500 parameter combinations per filter...  
Magnitude Error: 5.0 mmags

Override triggered...  
Override value detected, proceeding with deltaGrey best-fit minimization at new component best-fit value...

Calculating best fit parameters for u filter...  
@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_O3\_dG\_XSTD12\_DG120\_DGR-2\_020\_E5\_stars\_u\_50dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for u filter.  
Saved Chi-Squared at best fit deltaGrey for u filter.  
Completed u filter.

Calculating best fit parameters for g filter...  
@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_O3\_dG\_XSTD12\_DG120\_DGR-2\_020\_E5\_stars\_g\_50dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for g filter.  
Saved Chi-Squared at best fit deltaGrey for g filter.  
Completed g filter.

Calculating best fit parameters for r filter...  
@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_O3\_dG\_XSTD12\_DG120\_DGR-2\_020\_E5\_stars\_r\_50dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for r filter.  
Saved Chi-Squared at best fit deltaGrey for r filter.  
Completed r filter.

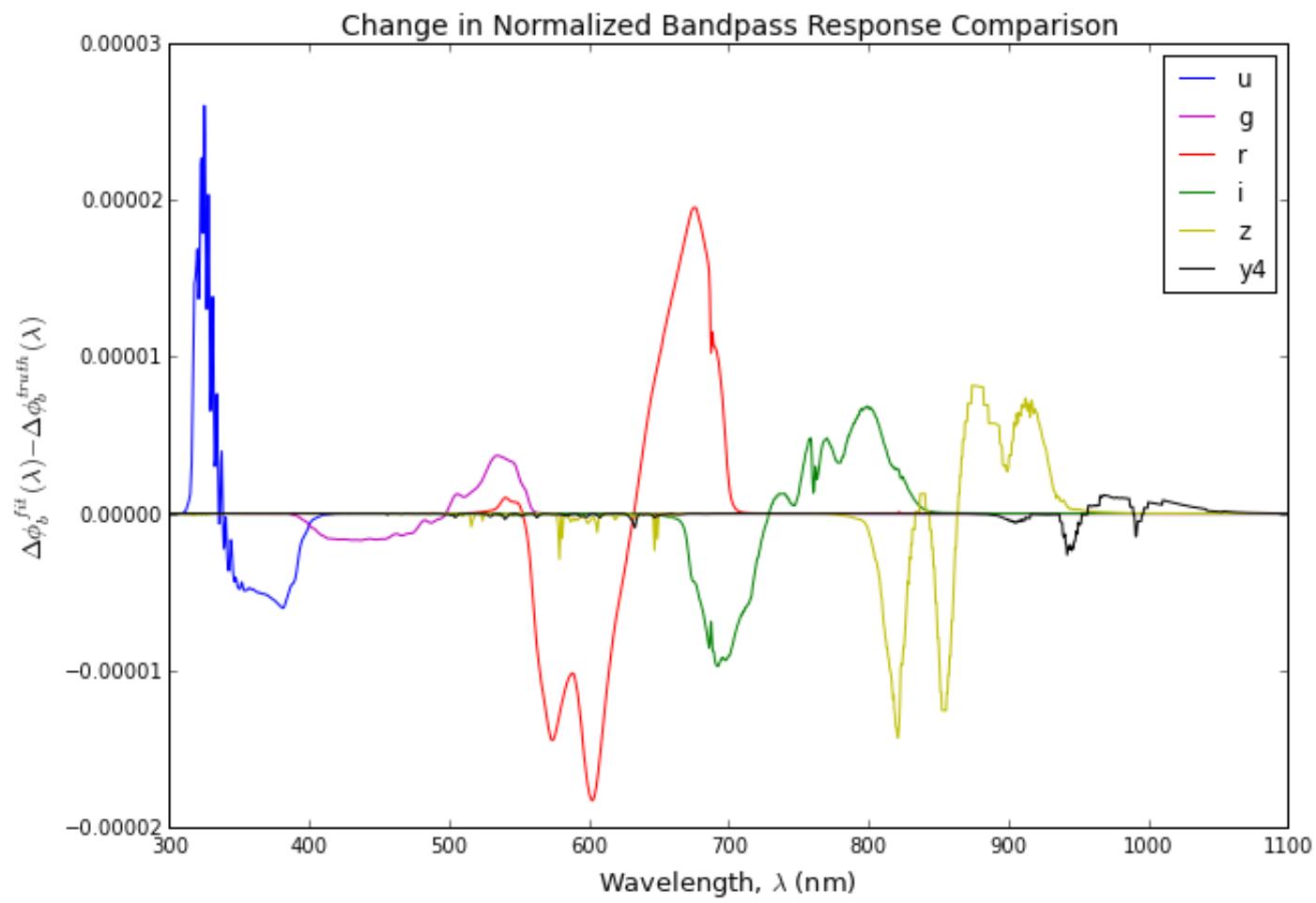
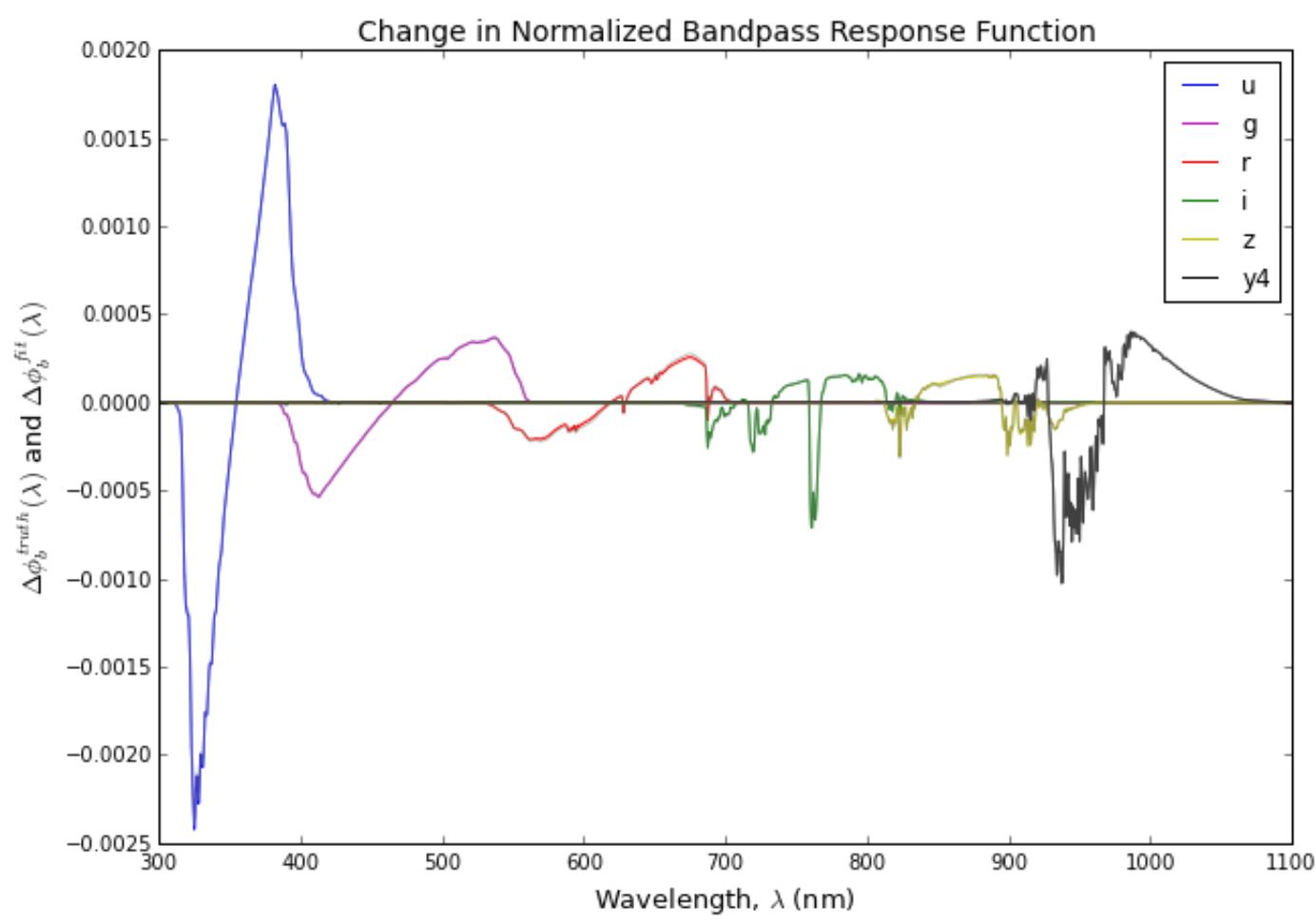
Calculating best fit parameters for i filter...  
@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_O3\_dG\_XSTD12\_DG120\_DGR-2\_020\_E5\_stars\_i\_50dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for i filter.  
Saved Chi-Squared at best fit deltaGrey for i filter.  
Completed i filter.

Calculating best fit parameters for z filter...  
@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_O3\_dG\_XSTD12\_DG120\_DGR-2\_020\_E5\_stars\_z\_50dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for z filter.  
Saved Chi-Squared at best fit deltaGrey for z filter.  
Completed z filter.

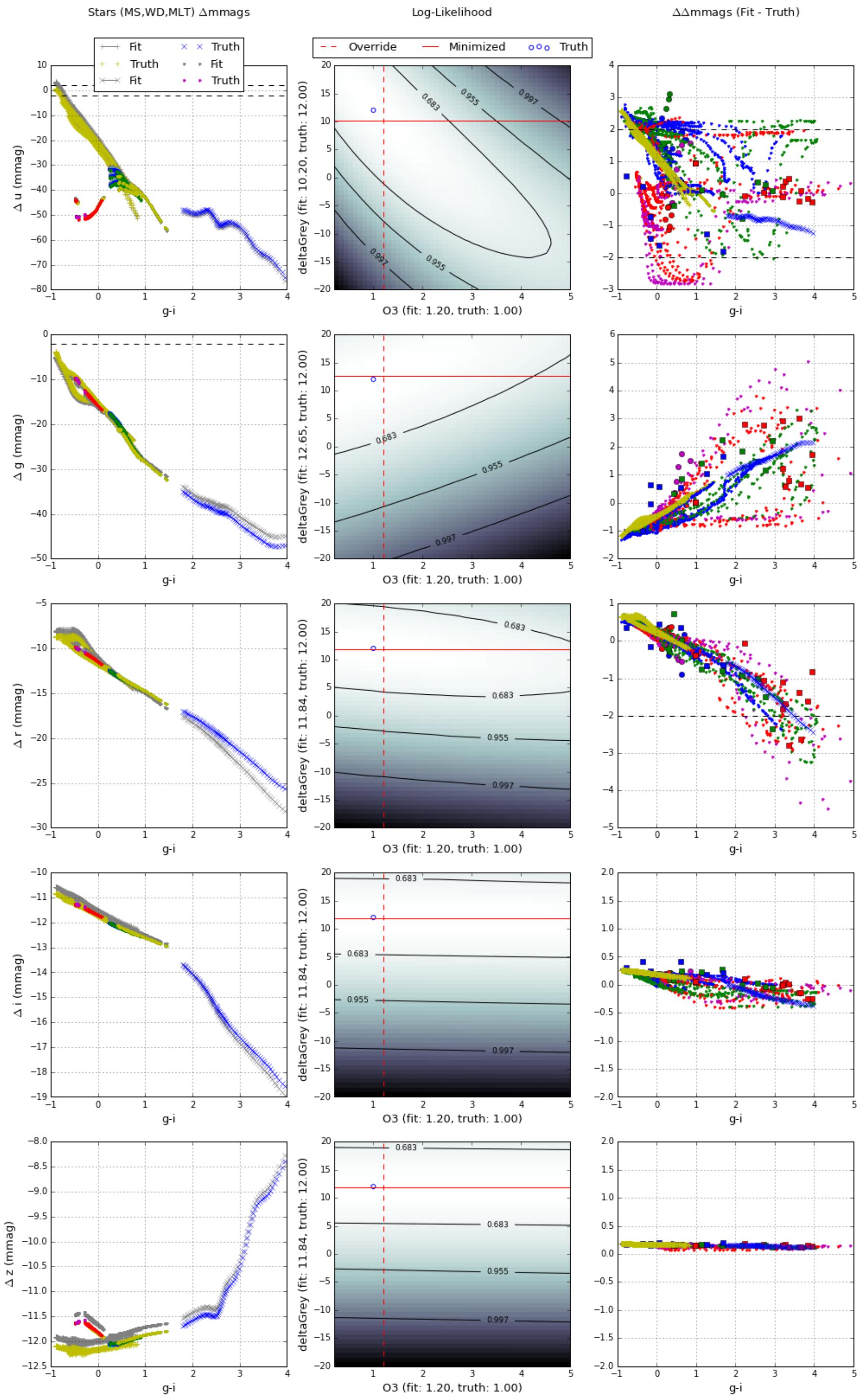
Calculating best fit parameters for y4 filter...  
@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_O3\_dG\_XSTD12\_DG120\_DGR-2\_020\_E5\_stars\_y4\_50dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for y4 filter.  
Saved Chi-Squared at best fit deltaGrey for y4 filter.  
Completed y4 filter.

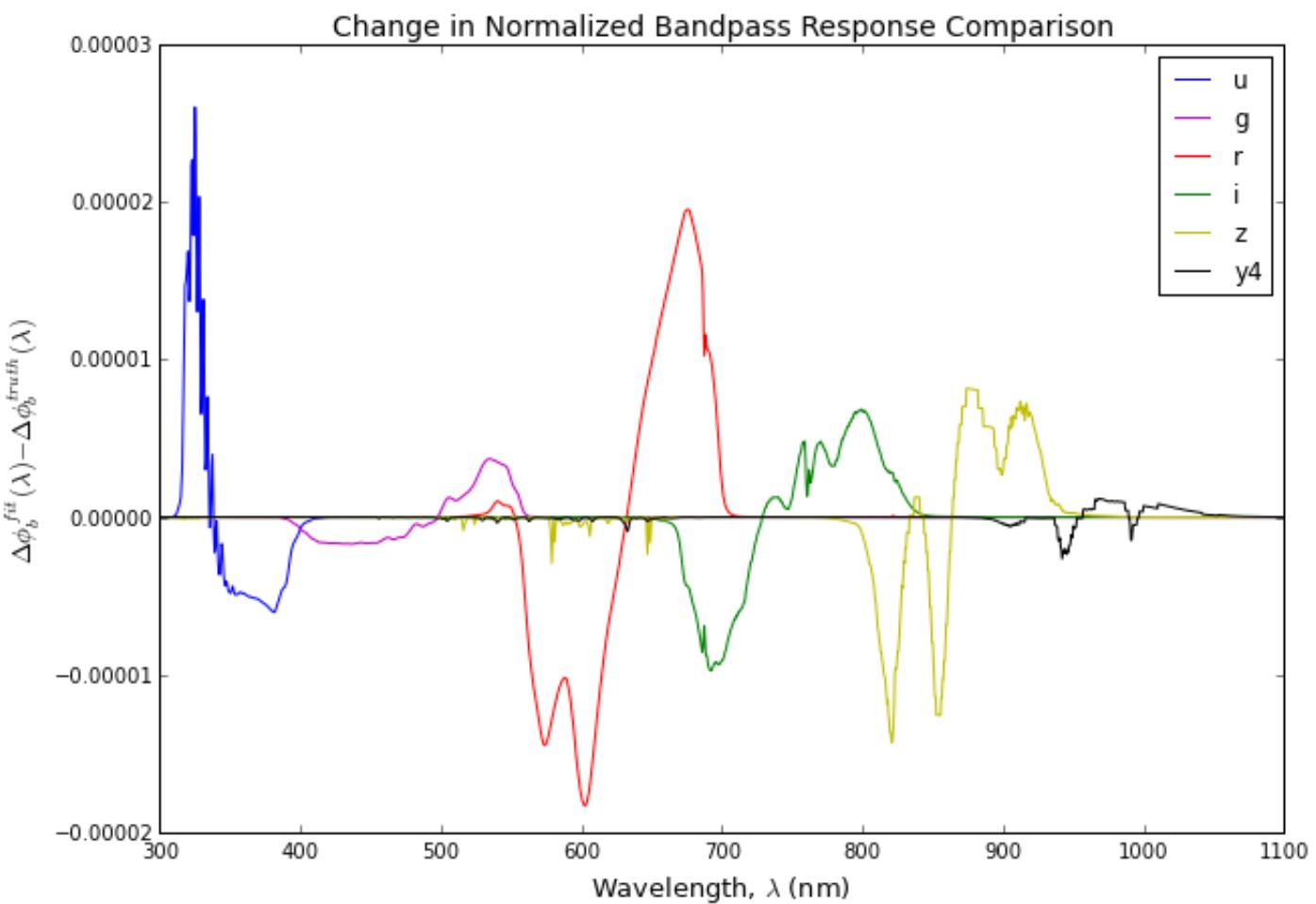
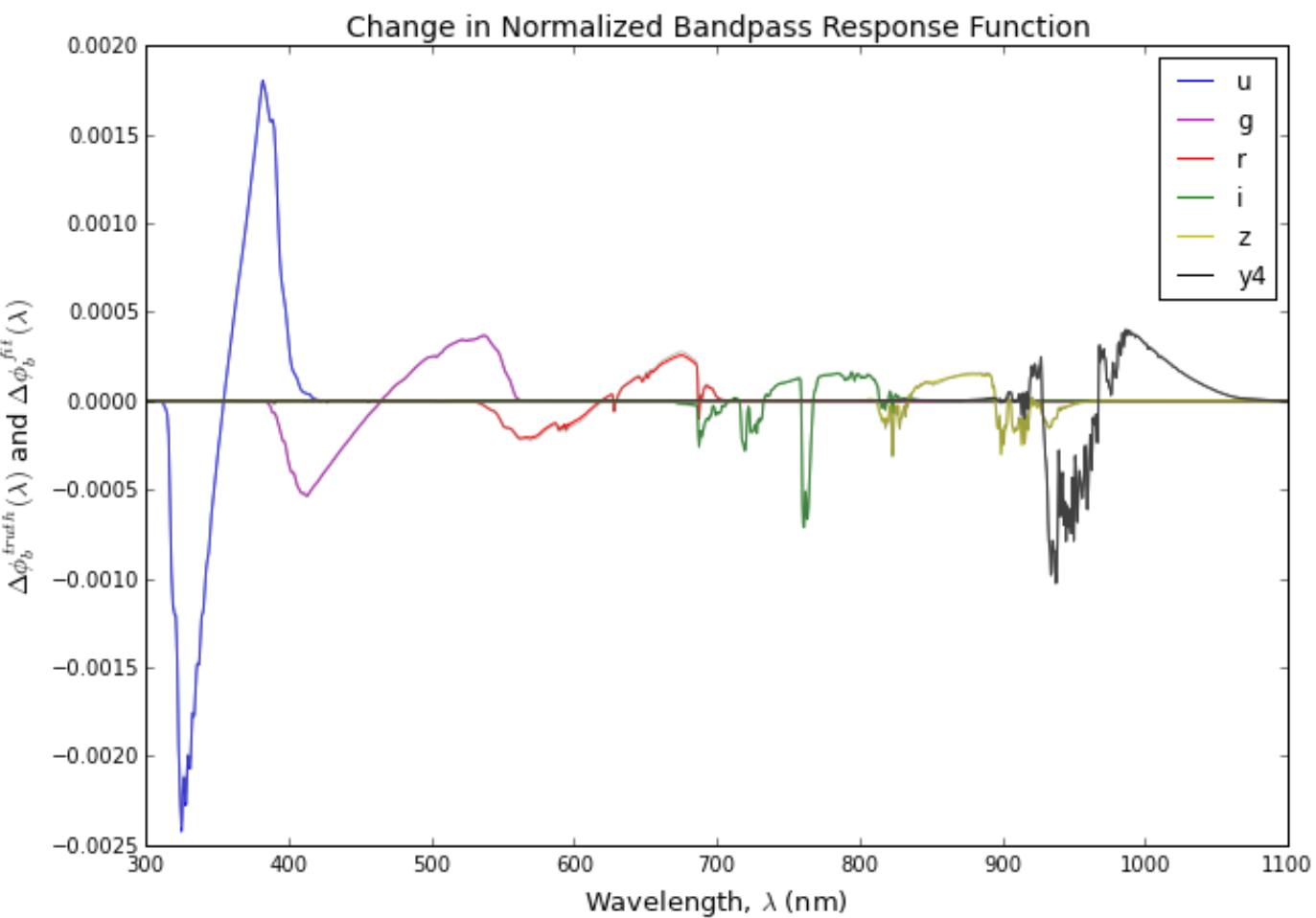
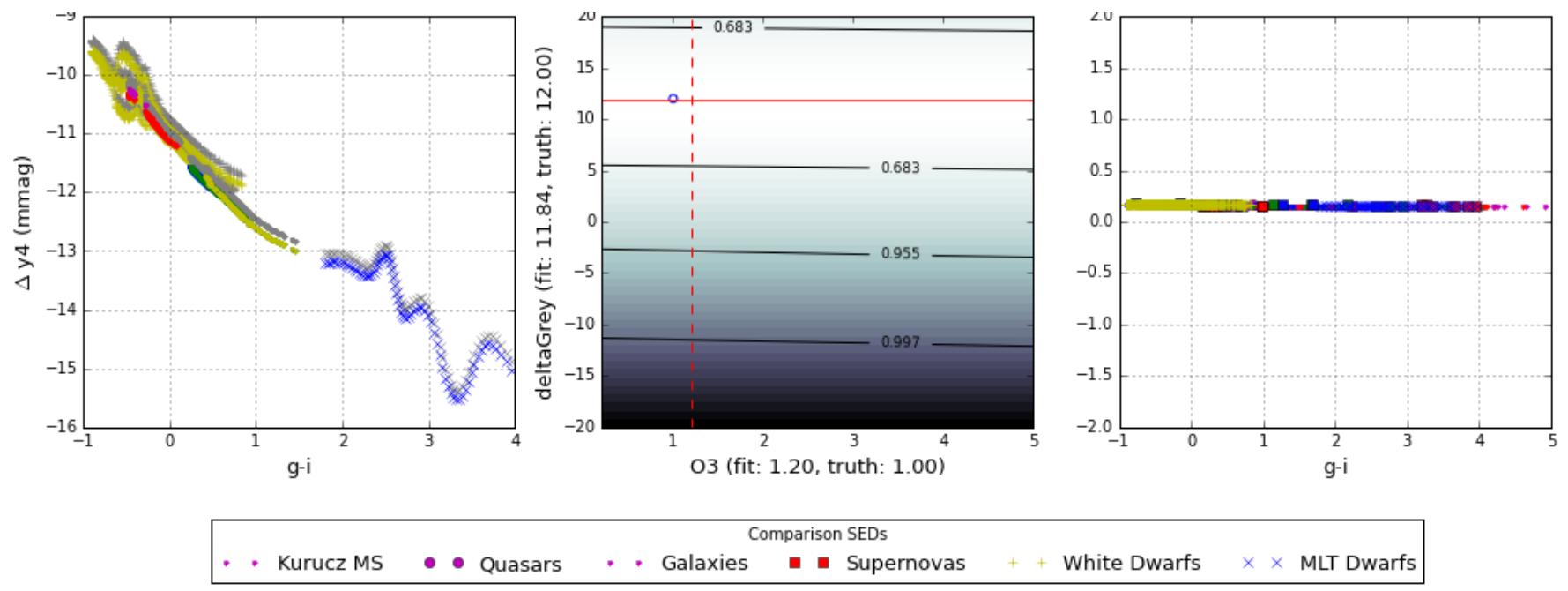
Best fit parameters (Filter, O3, dG, logL, Chi-Squared):  
u 0.98 11.84 11.4727178242 22.9454356485  
g 0.98 11.84 1.75084163226 3.50168326452  
r 1.08 11.84 2.89997325125 5.79994650249  
i 1.18 11.84 2.87315146174 5.74630292348  
z 2.16 11.84 2.93624557648 5.87249115296  
y4 1.57 11.84 3.06880707064 6.13761414128

Override best fit parameters (Filter, O3, dG):  
u 0.80 13.47  
g 0.80 11.84  
r 0.80 11.84  
i 0.80 11.84  
z 0.80 11.84  
y4 0.80 11.84

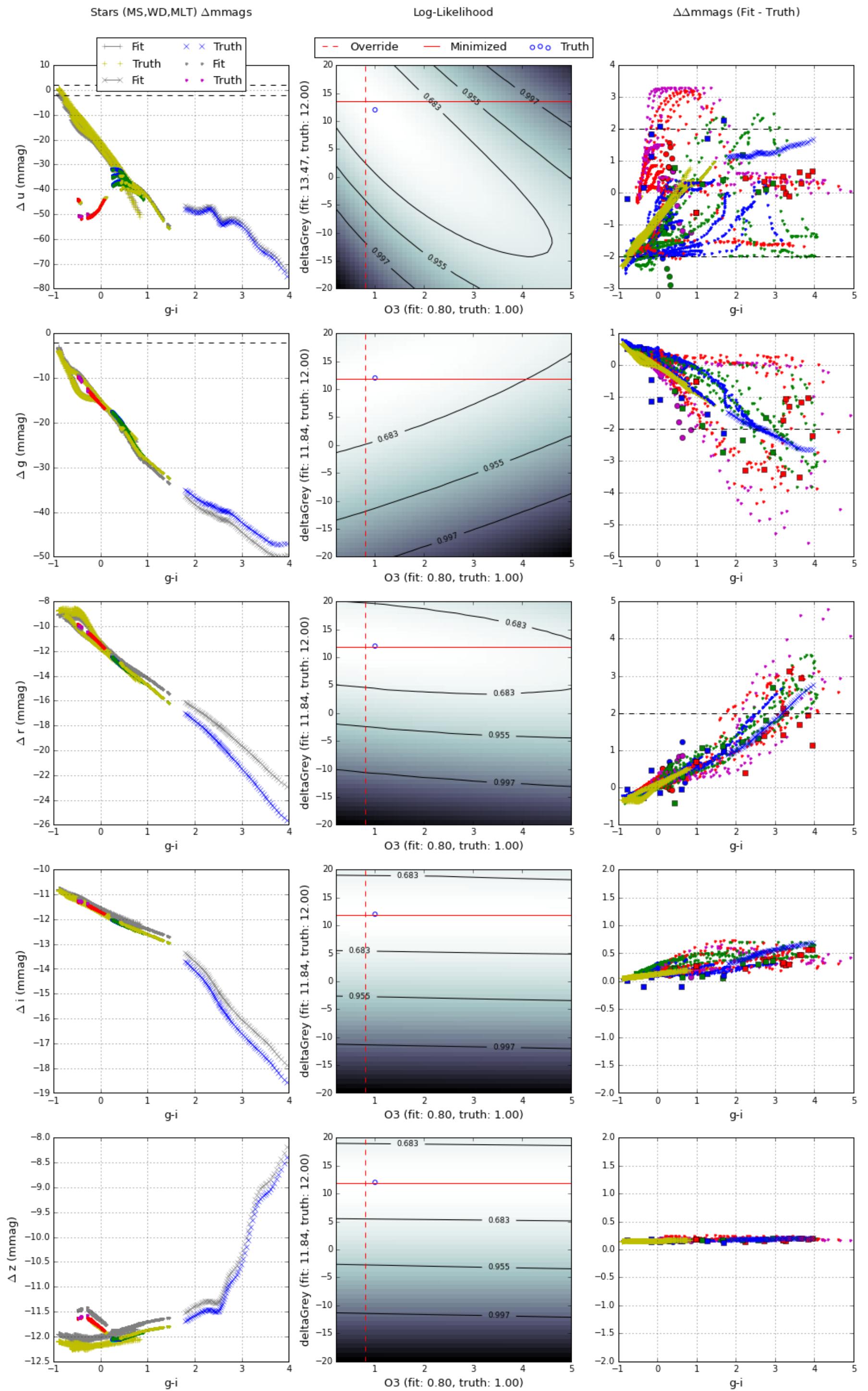


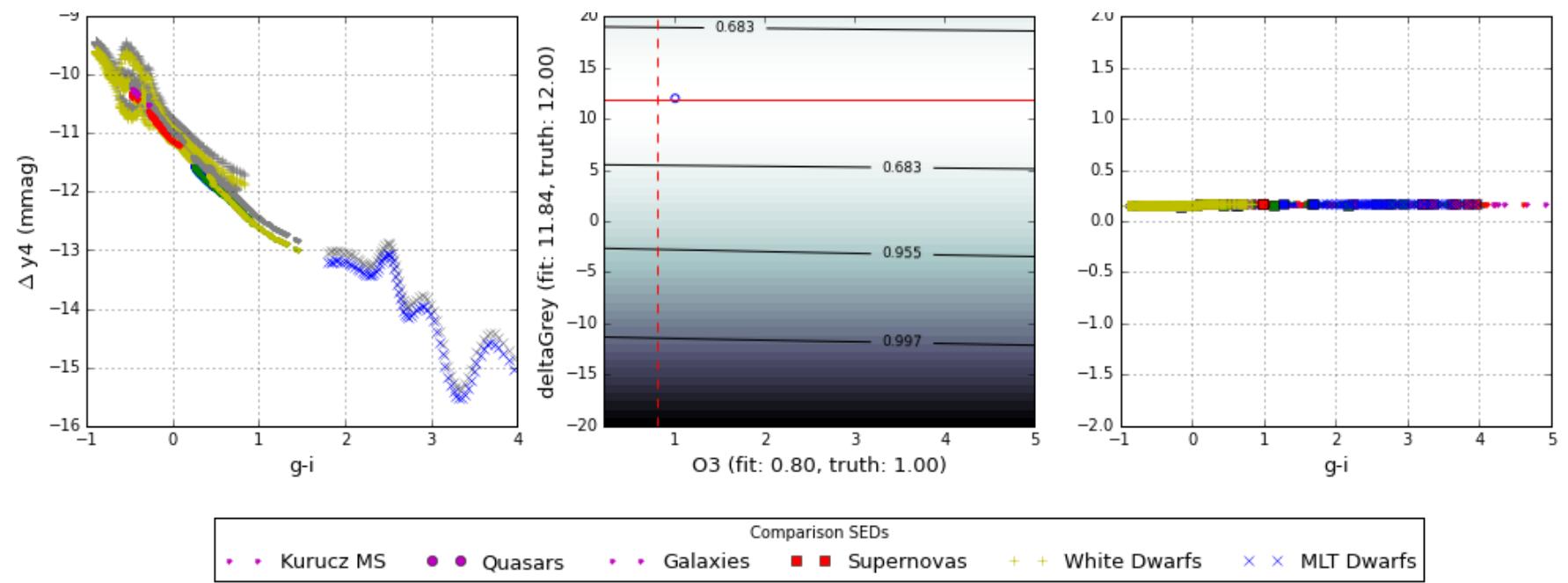
$\Delta\text{mmags}$ , Regression Contours,  $\Delta\Delta\text{mmags}$  for each LSST filter ( $\delta\text{Grey} = 12.0$ )





$\Delta\text{mmags}$ , Regression Contours,  $\Delta\Delta\text{mmags}$  for each LSST filter ( $\delta\text{Grey} = 12.0$ )





**Rayleigh**

```
In [11]: deltaGreyLimitPlot('Rayleigh')
```

```
Computing nonlinear regression for Rayleigh.  
Observed atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]  
Observed atmosphere airmass: 2.0  
Standard atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]  
Standard atmosphere airmass: 1.2  
Observed atmosphere parameter for Rayleigh: 1.0  
  
Fitting for Rayleigh between 0.20 and 5.00 in 50 bins.  
Fitting for deltaGrey between -20.00 and 20.00 mmags in 51 bins.  
  
Regression SEDs: 5778 Stars (MS,WD,MLT) SEDs.  
  
Regressing 2550 parameter combinations per filter...  
Magnitude Error: 5.0 mmags  
  
Override triggered...  
Override value detected, proceeding with deltaGrey best-fit minimization at new component best-fit value...  
  
Calculating best fit parameters for u filter...  
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Rayleigh_dG_XSTD12_DG12_0_DGR-2020_E5_stars_u_51dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for u filter.  
Saved Chi-Squared at best fit deltaGrey for u filter.  
Completed u filter.  
  
Calculating best fit parameters for g filter...  
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Rayleigh_dG_XSTD12_DG12_0_DGR-2020_E5_stars_g_51dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for g filter.  
Saved Chi-Squared at best fit deltaGrey for g filter.  
Completed g filter.  
  
Calculating best fit parameters for r filter...  
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Rayleigh_dG_XSTD12_DG12_0_DGR-2020_E5_stars_r_51dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for r filter.  
Saved Chi-Squared at best fit deltaGrey for r filter.  
Completed r filter.  
  
Calculating best fit parameters for i filter...  
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Rayleigh_dG_XSTD12_DG12_0_DGR-2020_E5_stars_i_51dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for i filter.  
Saved Chi-Squared at best fit deltaGrey for i filter.  
Completed i filter.  
  
Calculating best fit parameters for z filter...  
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Rayleigh_dG_XSTD12_DG12_0_DGR-2020_E5_stars_z_51dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for z filter.  
Saved Chi-Squared at best fit deltaGrey for z filter.  
Completed z filter.  
  
Calculating best fit parameters for y4 filter...  
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Rayleigh_dG_XSTD12_DG12_0_DGR-2020_E5_stars_y4_51dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for y4 filter.  
Saved Chi-Squared at best fit deltaGrey for y4 filter.  
Completed y4 filter.  
  
Best fit parameters (Filter, Rayleigh, dG, logL, Chi-Squared):  
u 0.98 12.80 34.39990227 68.79980454  
g 0.98 12.00 14.3477559347 28.6955118695  
r 0.98 12.00 0.168952693907 0.337905387814  
i 0.98 12.00 0.00951764612298 0.019035292246  
z 0.98 12.00 0.000877145028542 0.00175429005708  
y4 0.98 12.00 0.000811253551235 0.00162250710247  
  
Override best fit parameters (Filter, Rayleigh, dG):  
u 1.20 0.00  
g 1.20 8.80  
r 1.20 12.00  
i 1.20 12.00  
z 1.20 12.00  
y4 1.20 12.00  
  
Computing nonlinear regression for Rayleigh.  
Observed atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]  
Observed atmosphere airmass: 2.0  
Standard atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]  
Standard atmosphere airmass: 1.2
```

Observed atmosphere parameter for Rayleigh: 1.0

Fitting for Rayleigh between 0.20 and 5.00 in 50 bins.  
Fitting for deltaGrey between -20.00 and 20.00 mmags in 51 bins.

Regression SEDs: 5778 Stars (MS,WD,MLT) SEDs.

Regressing 2550 parameter combinations per filter...  
Magnitude Error: 5.0 mmags

Override triggered...  
Override value detected, proceeding with deltaGrey best-fit minimization at new component best-fit value...

Calculating best fit parameters for u filter...  
@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_Rayleigh\_dG\_XSTD12\_DG12\_0\_DGR-2020\_E5\_stars\_u\_51dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for u filter.  
Saved Chi-Squared at best fit deltaGrey for u filter.  
Completed u filter.

Calculating best fit parameters for g filter...  
@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_Rayleigh\_dG\_XSTD12\_DG12\_0\_DGR-2020\_E5\_stars\_g\_51dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for g filter.  
Saved Chi-Squared at best fit deltaGrey for g filter.  
Completed g filter.

Calculating best fit parameters for r filter...  
@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_Rayleigh\_dG\_XSTD12\_DG12\_0\_DGR-2020\_E5\_stars\_r\_51dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for r filter.  
Saved Chi-Squared at best fit deltaGrey for r filter.  
Completed r filter.

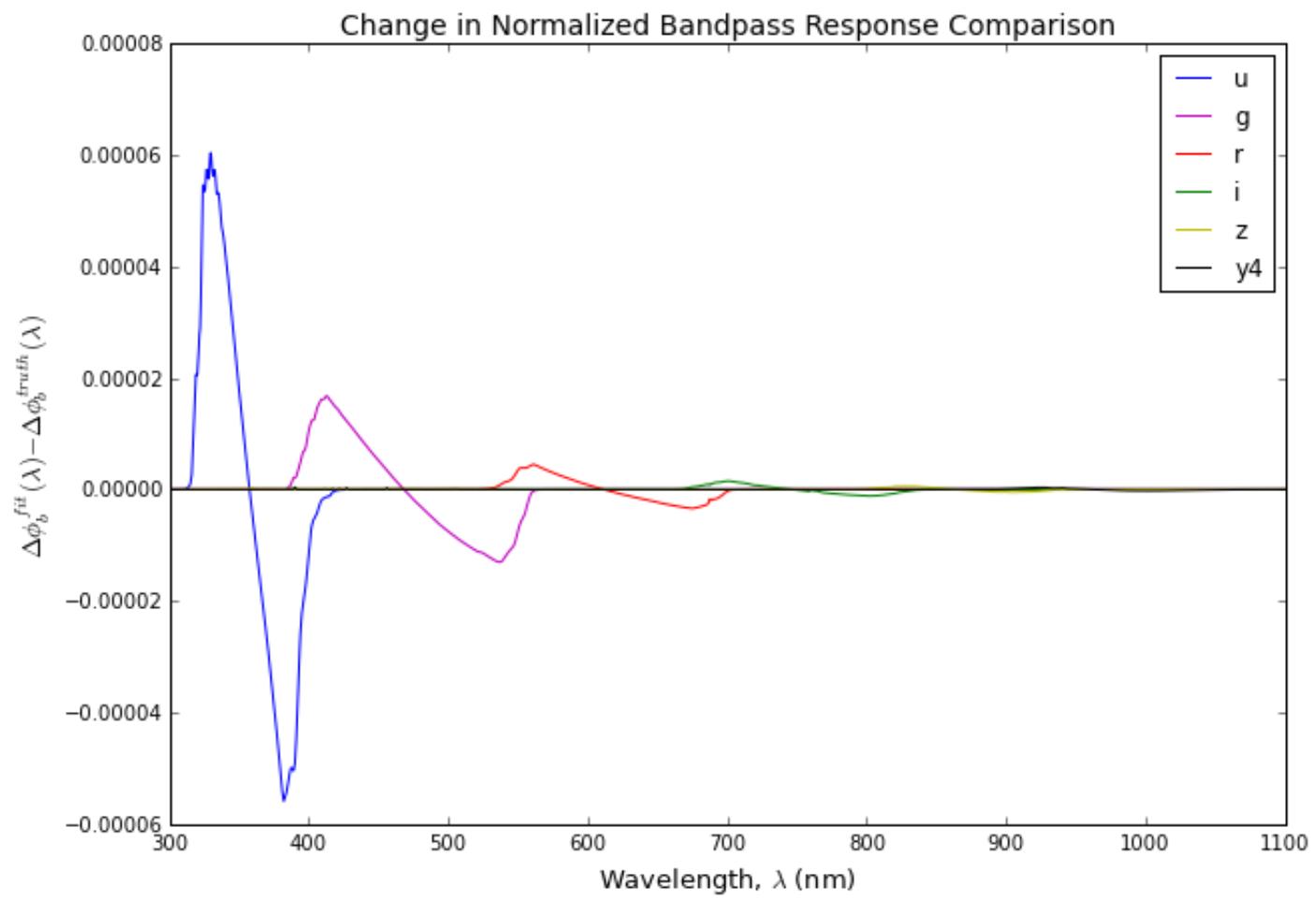
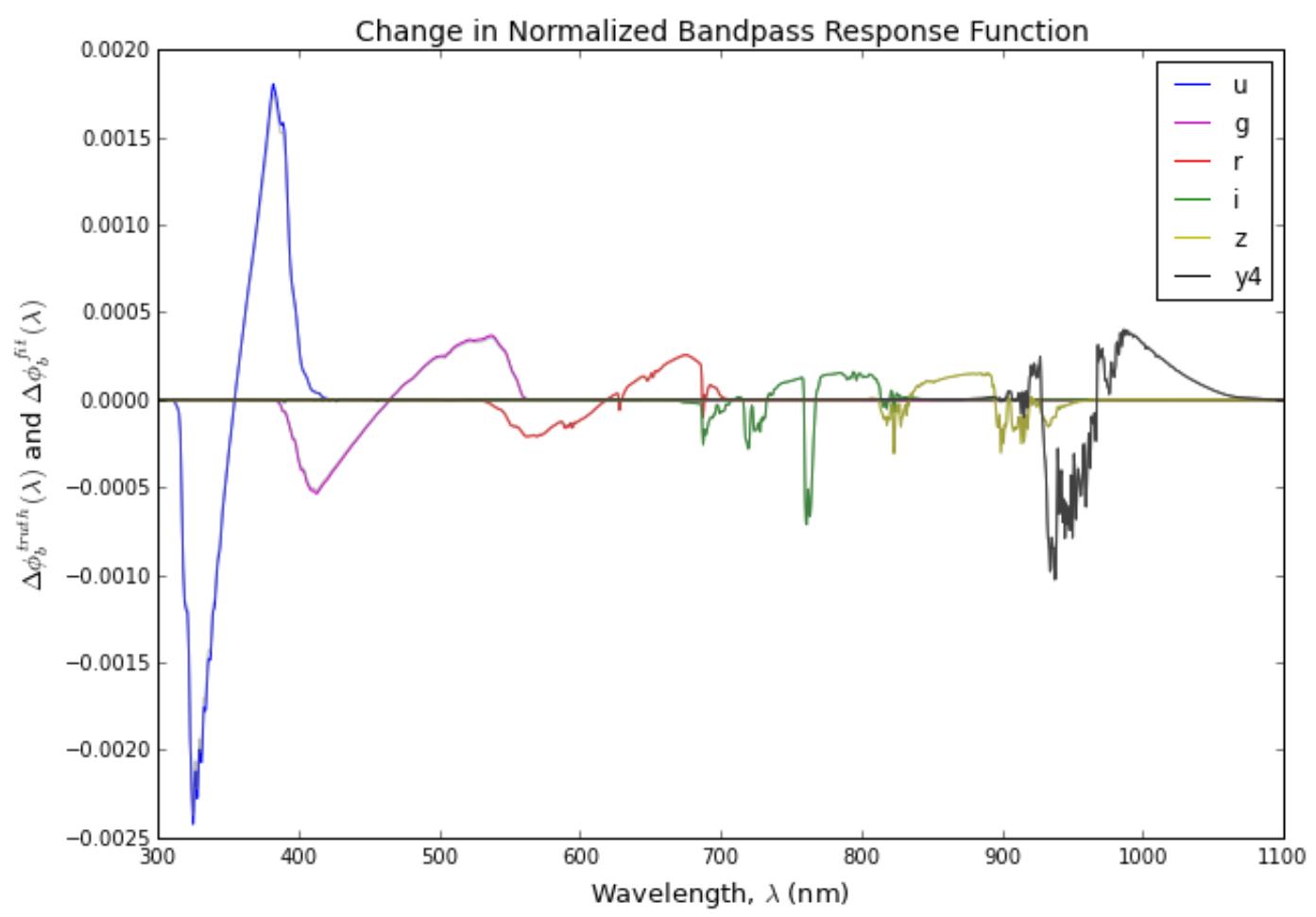
Calculating best fit parameters for i filter...  
@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_Rayleigh\_dG\_XSTD12\_DG12\_0\_DGR-2020\_E5\_stars\_i\_51dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for i filter.  
Saved Chi-Squared at best fit deltaGrey for i filter.  
Completed i filter.

Calculating best fit parameters for z filter...  
@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_Rayleigh\_dG\_XSTD12\_DG12\_0\_DGR-2020\_E5\_stars\_z\_51dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for z filter.  
Saved Chi-Squared at best fit deltaGrey for z filter.  
Completed z filter.

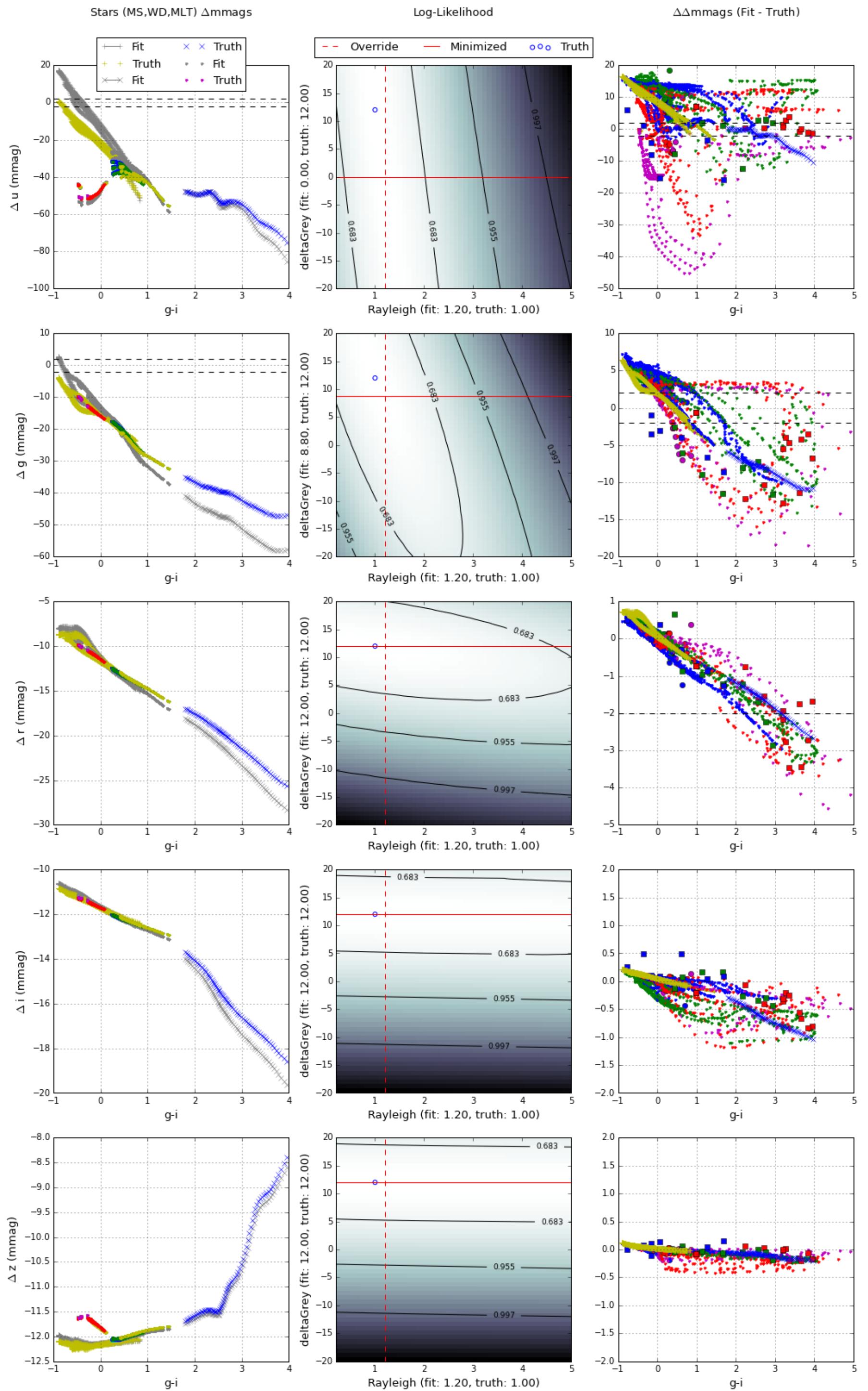
Calculating best fit parameters for y4 filter...  
@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_Rayleigh\_dG\_XSTD12\_DG12\_0\_DGR-2020\_E5\_stars\_y4\_51dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for y4 filter.  
Saved Chi-Squared at best fit deltaGrey for y4 filter.  
Completed y4 filter.

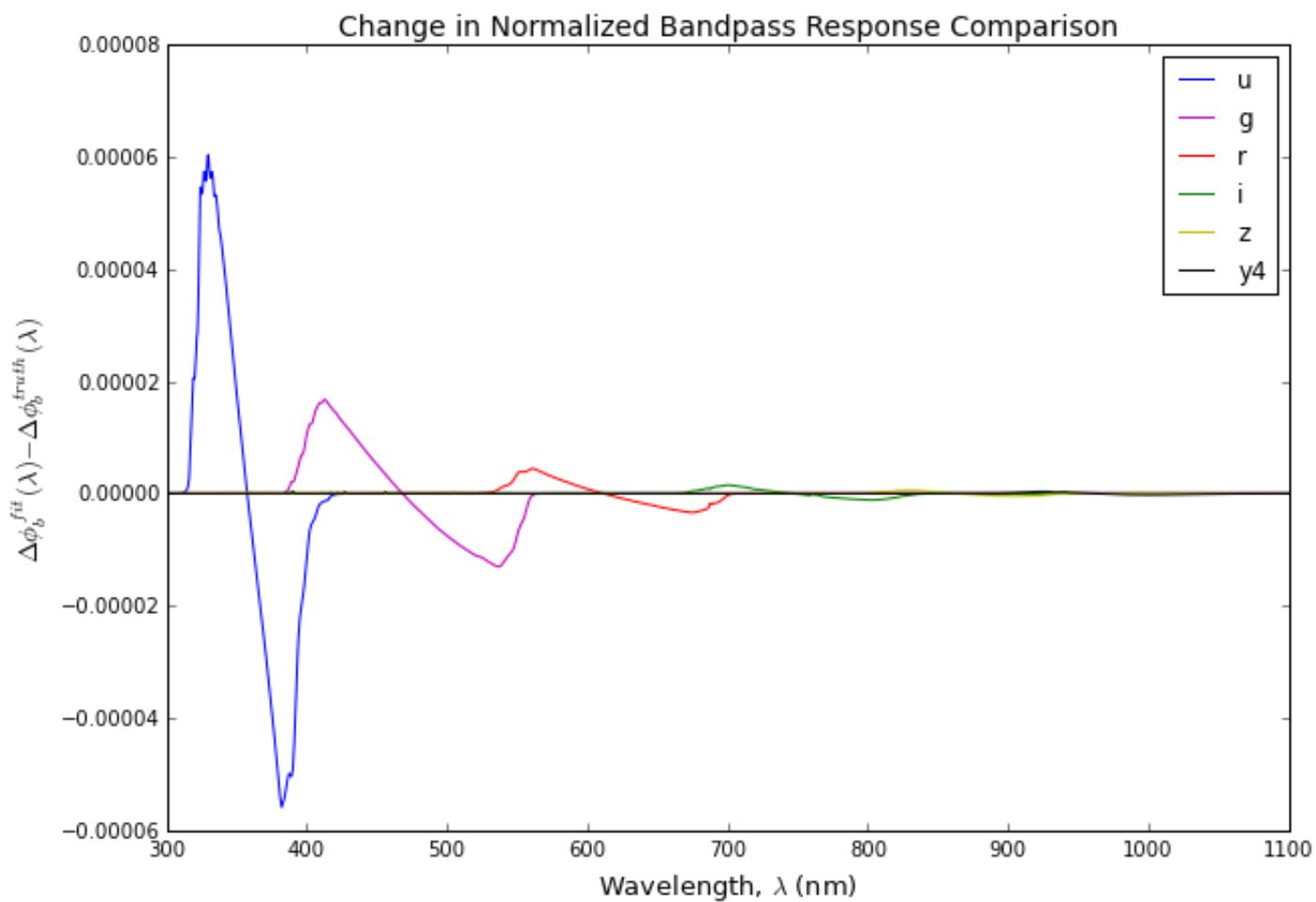
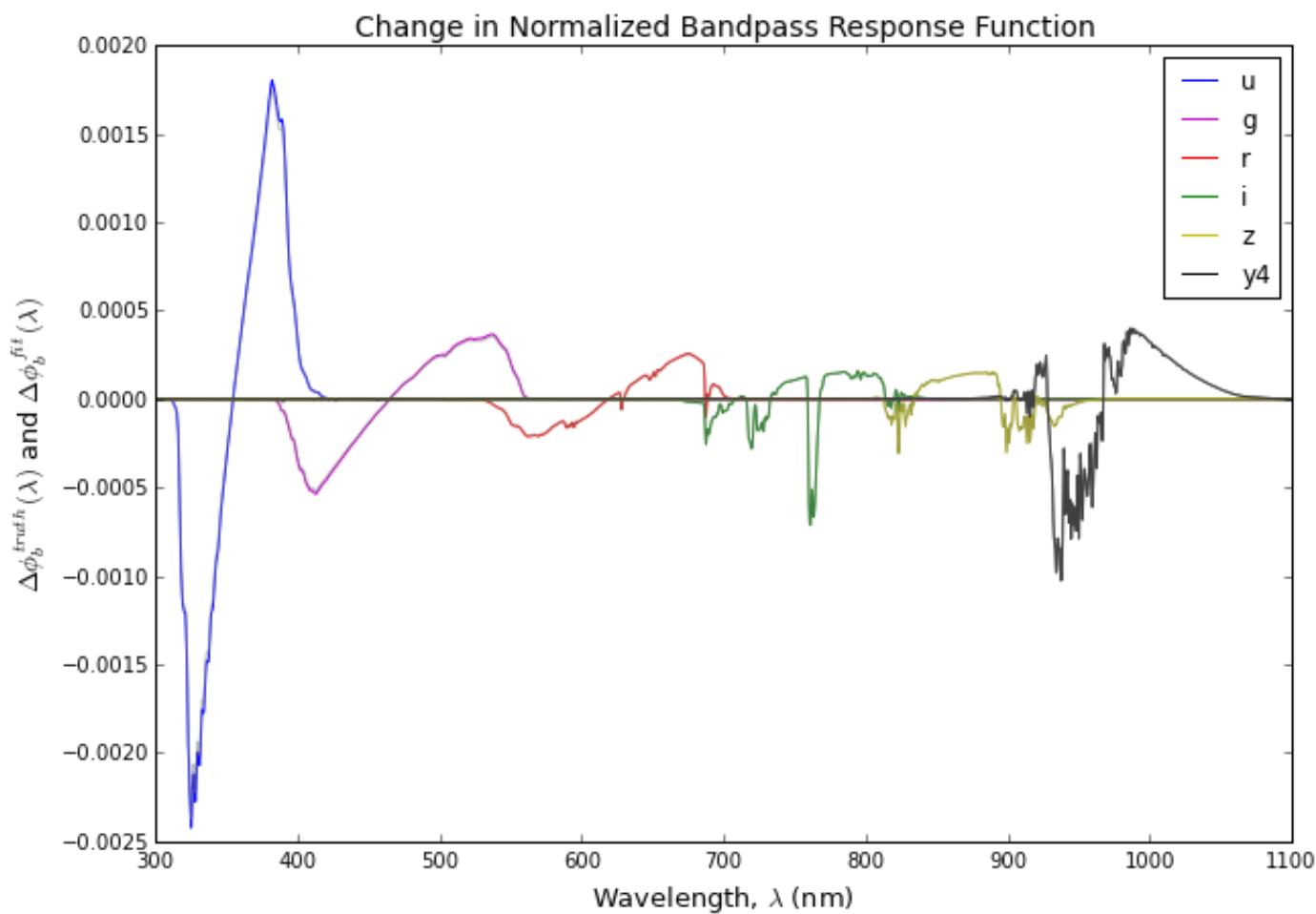
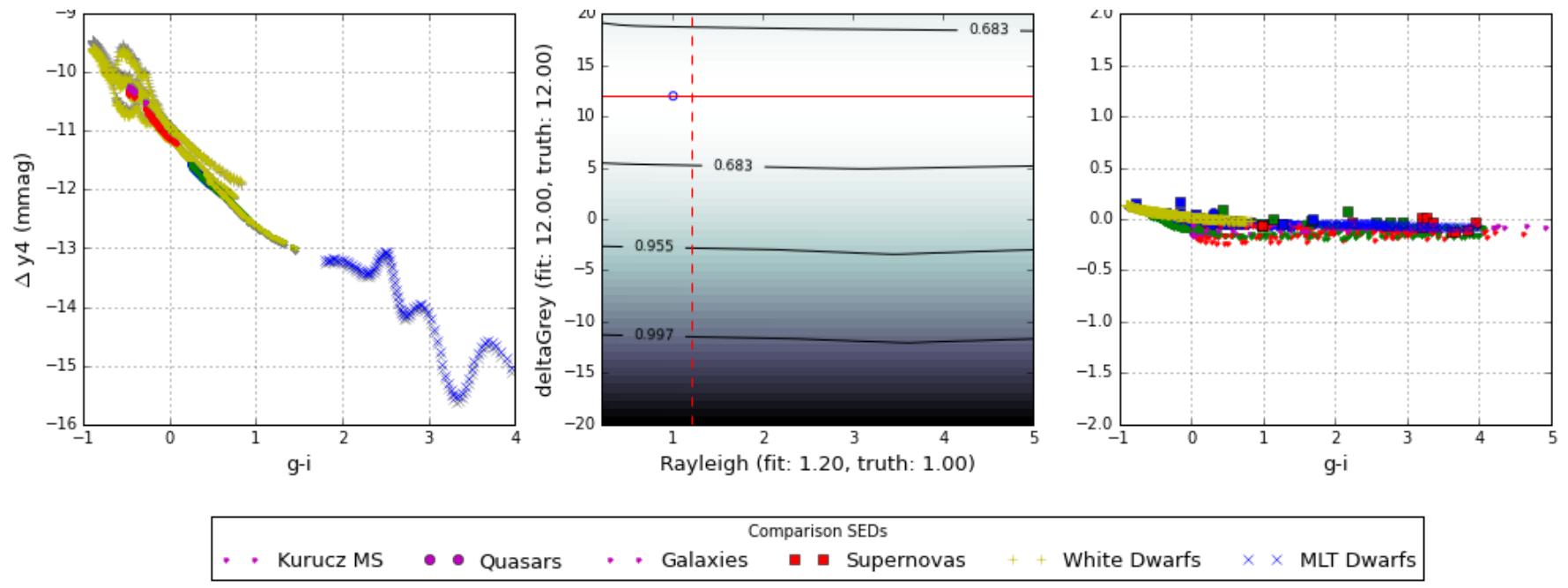
Best fit parameters (Filter, Rayleigh, dG, logL, Chi-Squared):  
u 0.98 12.80 34.39990227 68.79980454  
g 0.98 12.00 14.3477559347 28.6955118695  
r 0.98 12.00 0.168952693907 0.337905387814  
i 0.98 12.00 0.00951764612298 0.019035292246  
z 0.98 12.00 0.000877145028542 0.00175429005708  
y4 0.98 12.00 0.000811253551235 0.00162250710247

Override best fit parameters (Filter, Rayleigh, dG):  
u 0.80 20.00  
g 0.80 15.20  
r 0.80 12.00  
i 0.80 12.00  
z 0.80 12.00  
y4 0.80 12.00

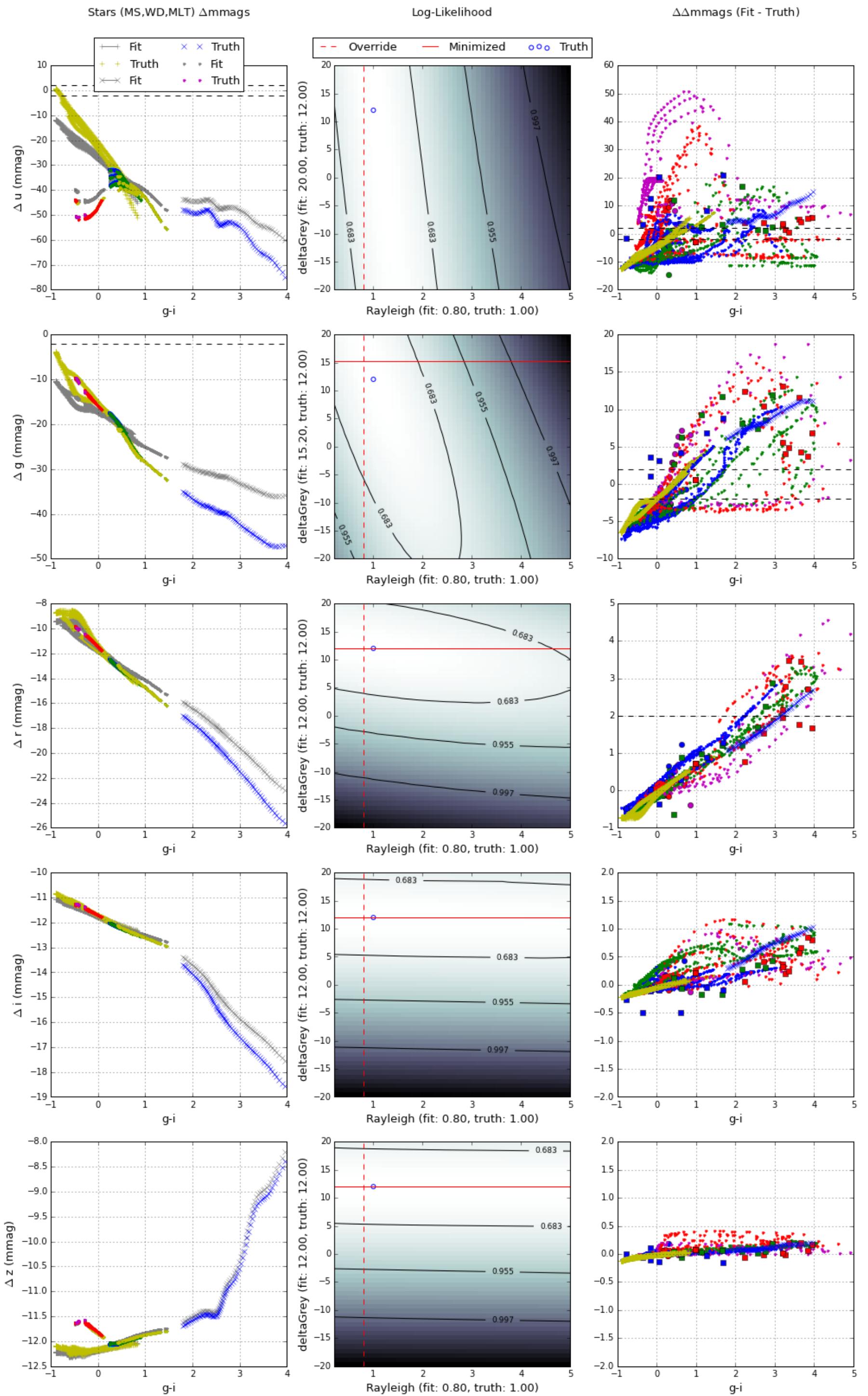


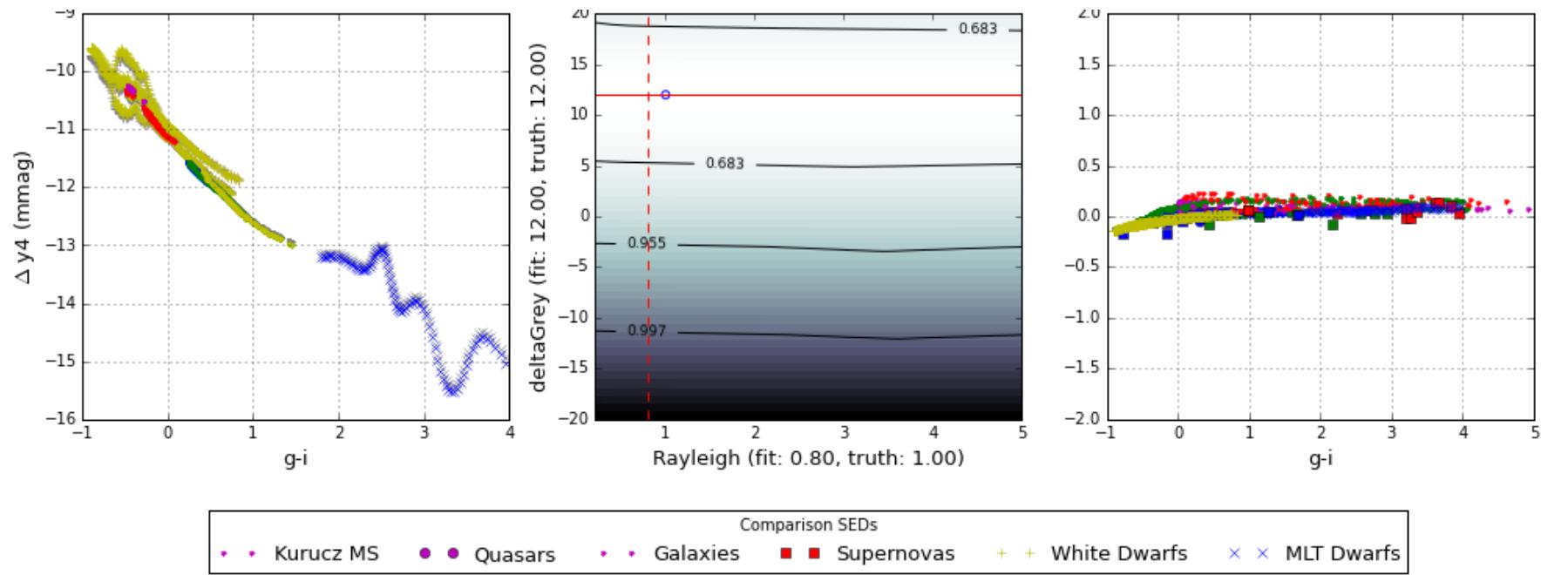
$\Delta\text{mmags}$ , Regression Contours,  $\Delta\Delta\text{mmags}$  for each LSST filter ( $\delta\text{Grey} = 12.0$ )





$\Delta\text{mmags}$ , Regression Contours,  $\Delta\Delta\text{mmags}$  for each LSST filter ( $\delta\text{Grey} = 12.0$ )





```
In [12]: deltaGreyLimitPlot('Rayleigh',deltaGreyBins=50)
```

```
Computing nonlinear regression for Rayleigh.  
Observed atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]  
Observed atmosphere airmass: 2.0  
Standard atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]  
Standard atmosphere airmass: 1.2  
Observed atmosphere parameter for Rayleigh: 1.0  
  
Fitting for Rayleigh between 0.20 and 5.00 in 50 bins.  
Fitting for deltaGrey between -20.00 and 20.00 mmags in 50 bins.  
  
Regression SEDs: 5778 Stars (MS,WD,MLT) SEDs.  
  
Regressing 2500 parameter combinations per filter...  
Magnitude Error: 5.0 mmags  
  
Override triggered...  
Override value detected, proceeding with deltaGrey best-fit minimization at new component best-fit value...  
  
Calculating best fit parameters for u filter...  
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Rayleigh_dG_XSTD12_DG12_0_DGR-2020_E5_stars_u_50dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for u filter.  
Saved Chi-Squared at best fit deltaGrey for u filter.  
Completed u filter.  
  
Calculating best fit parameters for g filter...  
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Rayleigh_dG_XSTD12_DG12_0_DGR-2020_E5_stars_g_50dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for g filter.  
Saved Chi-Squared at best fit deltaGrey for g filter.  
Completed g filter.  
  
Calculating best fit parameters for r filter...  
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Rayleigh_dG_XSTD12_DG12_0_DGR-2020_E5_stars_r_50dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for r filter.  
Saved Chi-Squared at best fit deltaGrey for r filter.  
Completed r filter.  
  
Calculating best fit parameters for i filter...  
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Rayleigh_dG_XSTD12_DG12_0_DGR-2020_E5_stars_i_50dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for i filter.  
Saved Chi-Squared at best fit deltaGrey for i filter.  
Completed i filter.  
  
Calculating best fit parameters for z filter...  
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Rayleigh_dG_XSTD12_DG12_0_DGR-2020_E5_stars_z_50dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for z filter.  
Saved Chi-Squared at best fit deltaGrey for z filter.  
Completed z filter.  
  
Calculating best fit parameters for y4 filter...  
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Rayleigh_dG_XSTD12_DG12_0_DGR-2020_E5_stars_y4_50dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for y4 filter.  
Saved Chi-Squared at best fit deltaGrey for y4 filter.  
Completed y4 filter.  
  
Best fit parameters (Filter, Rayleigh, dG, logL, Chi-Squared):  
u 0.98 12.65 44.0081331073 88.0162662147  
g 0.98 12.65 21.0287926653 42.0575853307  
r 1.08 11.84 3.5655518504 7.13110370081  
i 1.08 11.84 2.81711946704 5.63423893408  
z 1.38 11.84 2.68781377285 5.3756275457  
y4 1.18 11.84 3.00639497985 6.01278995969  
  
Override best fit parameters (Filter, Rayleigh, dG):  
u 1.20 -0.41  
g 1.20 8.57  
r 1.20 11.84  
i 1.20 11.84  
z 1.20 11.84  
y4 1.20 11.84  
  
Computing nonlinear regression for Rayleigh.  
Observed atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]  
Observed atmosphere airmass: 2.0  
Standard atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]  
Standard atmosphere airmass: 1.2
```

```
Observed atmosphere parameter for Rayleigh: 1.0

Fitting for Rayleigh between 0.20 and 5.00 in 50 bins.
Fitting for deltaGrey between -20.00 and 20.00 mmags in 50 bins.

Regression SEDs: 5778 Stars (MS,WD,MLT) SEDs.

Regressing 2500 parameter combinations per filter...
Magnitude Error: 5.0 mmags

Override triggered...
Override value detected, proceeding with deltaGrey best-fit minimization at new component best-fit v
alue...

Calculating best fit parameters for u filter...
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Rayleigh_dG_XSTD12_DG12
0_DGR-2020_E5_stars_u_50dgb_50b_min_dGTest_allMS_OR80.pkl'
Saved LogL at best fit deltaGrey for u filter.
Saved Chi-Squared at best fit deltaGrey for u filter.
Completed u filter.

Calculating best fit parameters for g filter...
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Rayleigh_dG_XSTD12_DG12
0_DGR-2020_E5_stars_g_50dgb_50b_min_dGTest_allMS_OR80.pkl'
Saved LogL at best fit deltaGrey for g filter.
Saved Chi-Squared at best fit deltaGrey for g filter.
Completed g filter.

Calculating best fit parameters for r filter...
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Rayleigh_dG_XSTD12_DG12
0_DGR-2020_E5_stars_r_50dgb_50b_min_dGTest_allMS_OR80.pkl'
Saved LogL at best fit deltaGrey for r filter.
Saved Chi-Squared at best fit deltaGrey for r filter.
Completed r filter.

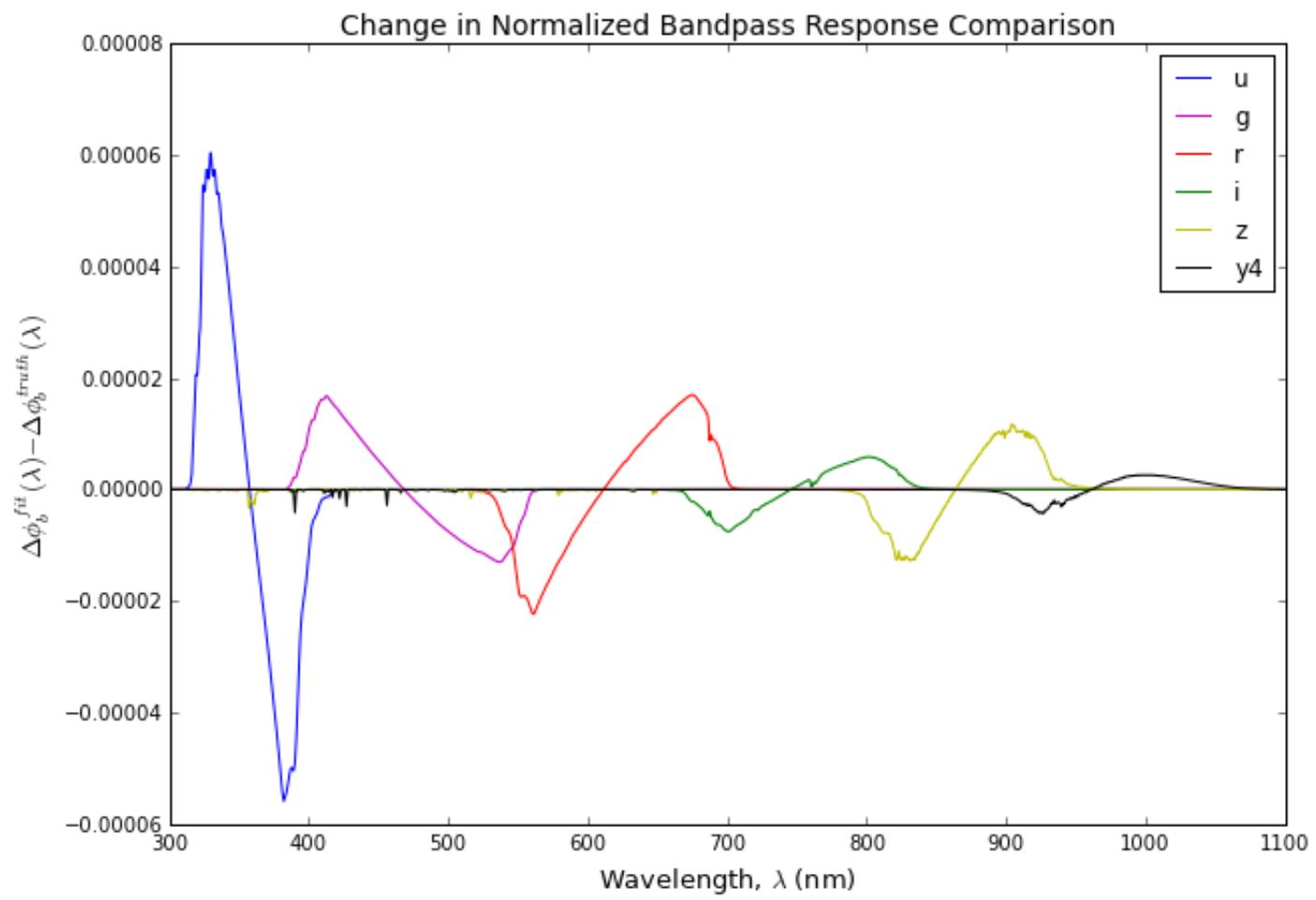
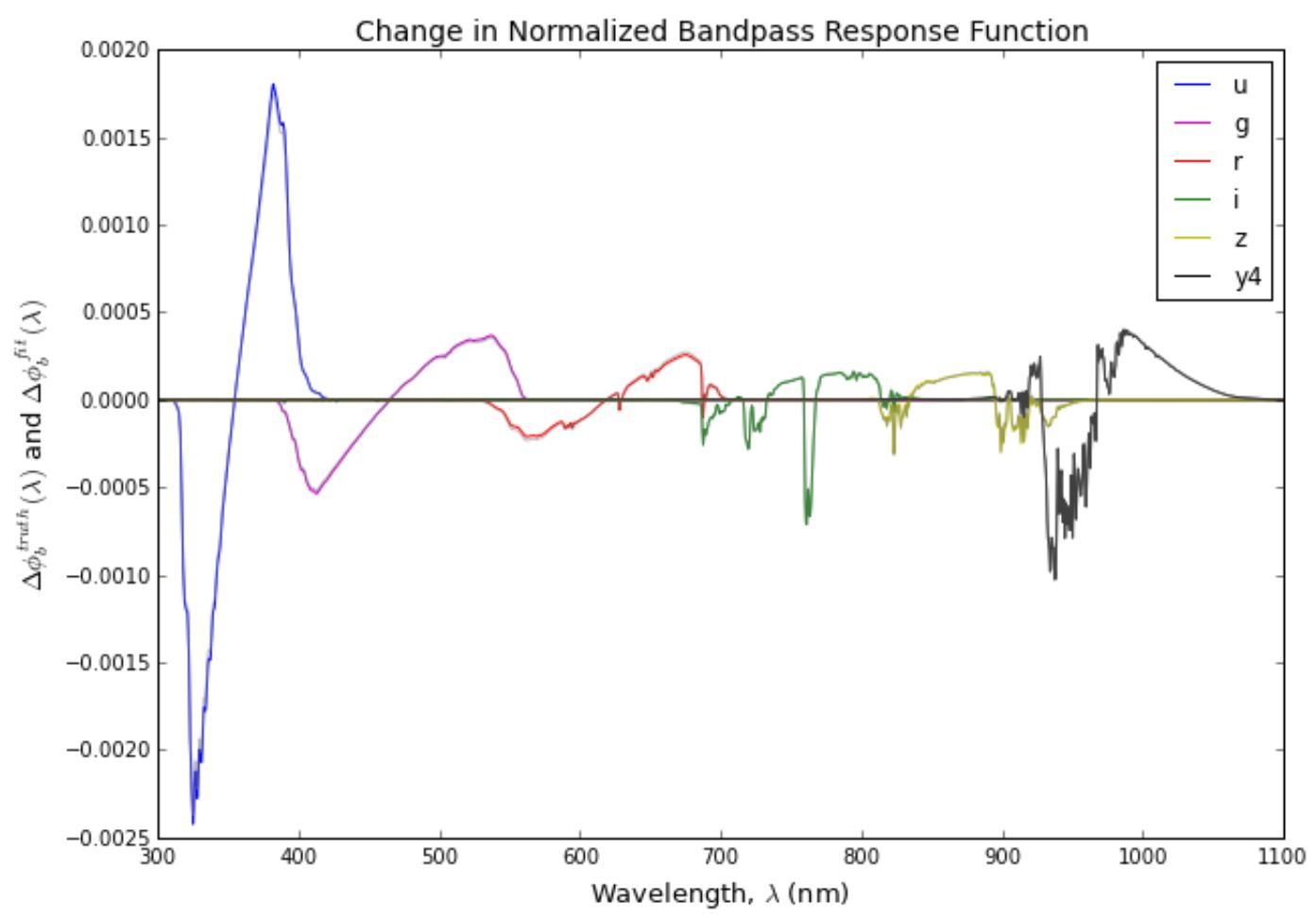
Calculating best fit parameters for i filter...
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Rayleigh_dG_XSTD12_DG12
0_DGR-2020_E5_stars_i_50dgb_50b_min_dGTest_allMS_OR80.pkl'
Saved LogL at best fit deltaGrey for i filter.
Saved Chi-Squared at best fit deltaGrey for i filter.
Completed i filter.

Calculating best fit parameters for z filter...
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Rayleigh_dG_XSTD12_DG12
0_DGR-2020_E5_stars_z_50dgb_50b_min_dGTest_allMS_OR80.pkl'
Saved LogL at best fit deltaGrey for z filter.
Saved Chi-Squared at best fit deltaGrey for z filter.
Completed z filter.

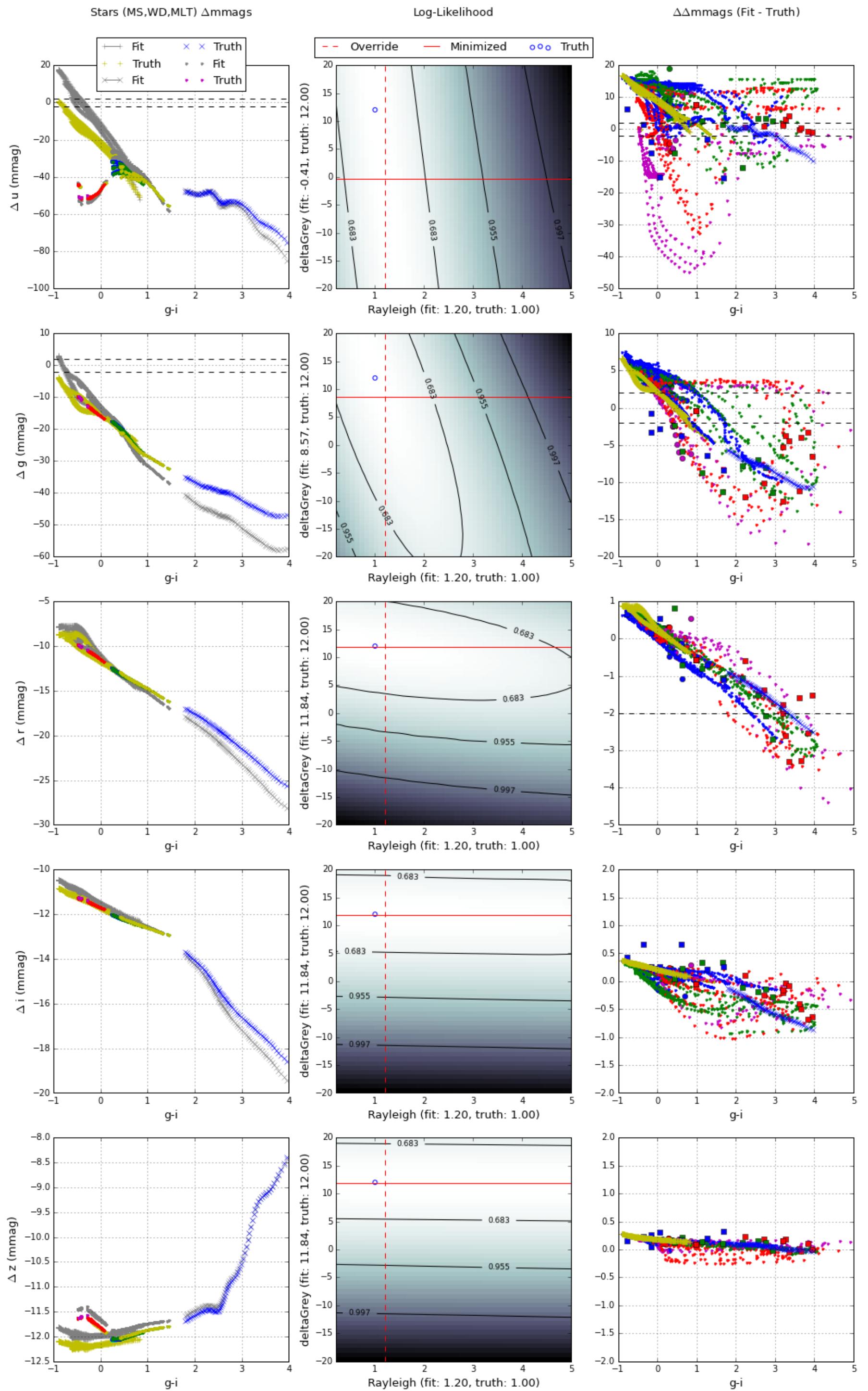
Calculating best fit parameters for y4 filter...
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Rayleigh_dG_XSTD12_DG12
0_DGR-2020_E5_stars_y4_50dgb_50b_min_dGTest_allMS_OR80.pkl'
Saved LogL at best fit deltaGrey for y4 filter.
Saved Chi-Squared at best fit deltaGrey for y4 filter.
Completed y4 filter.

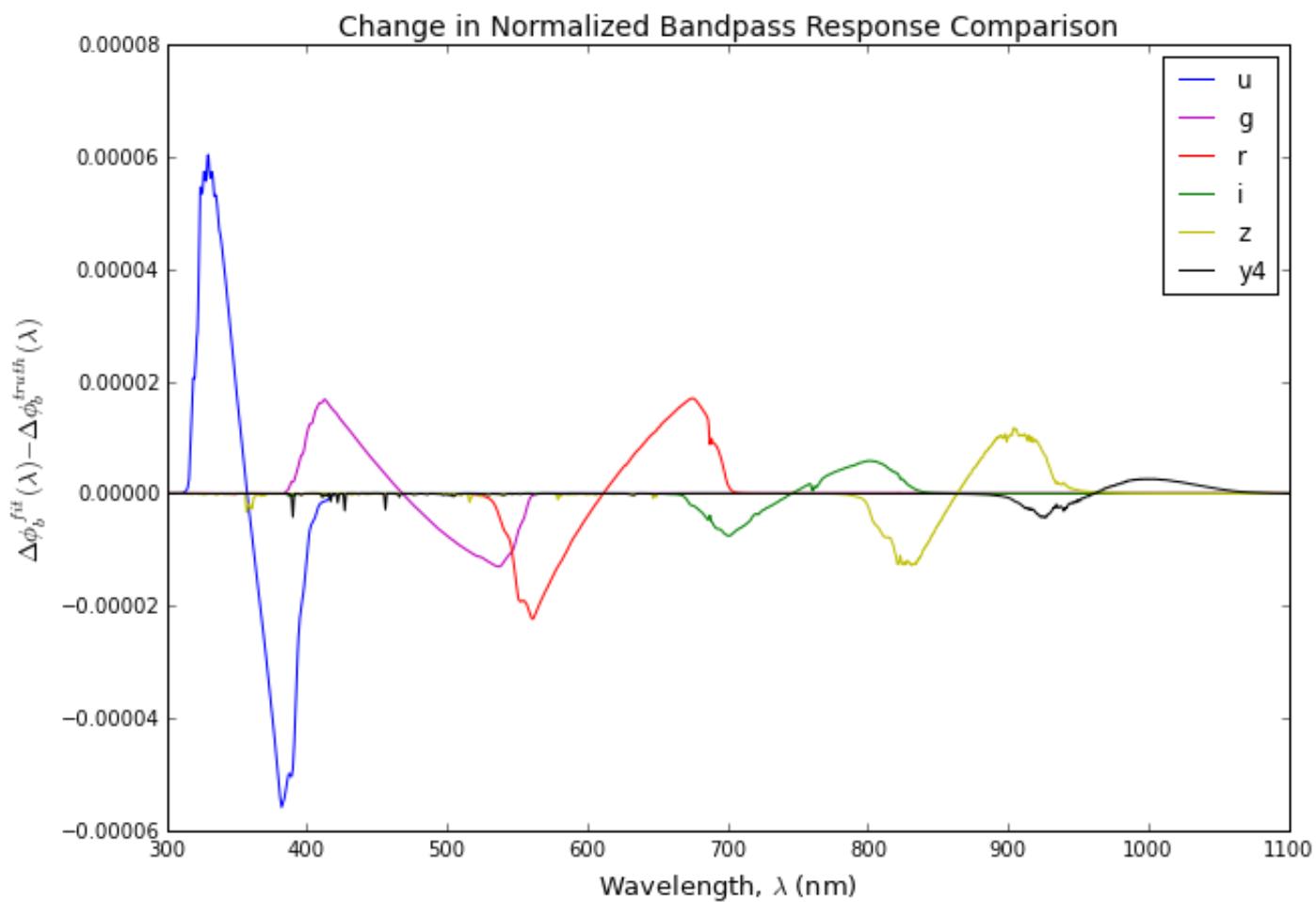
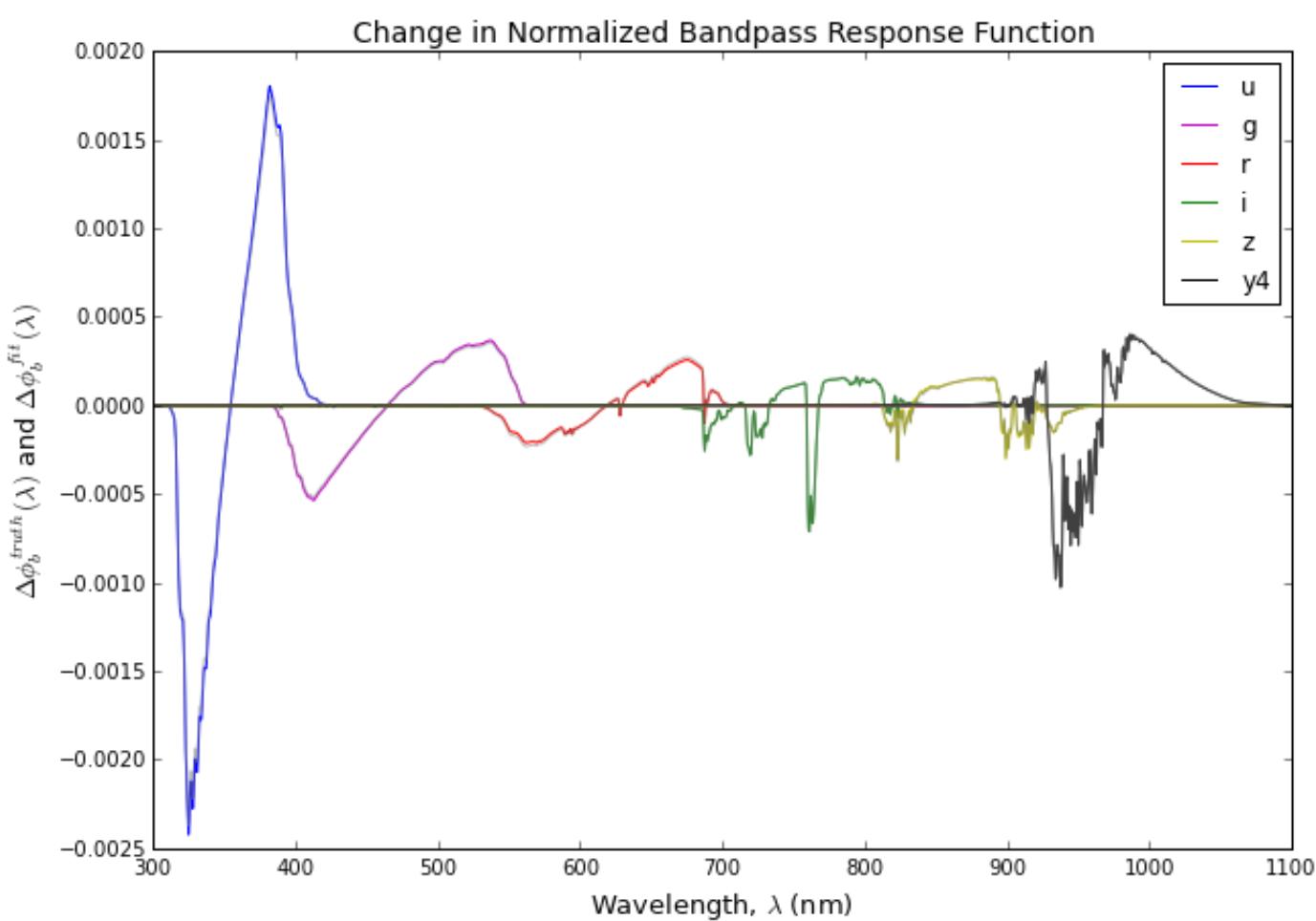
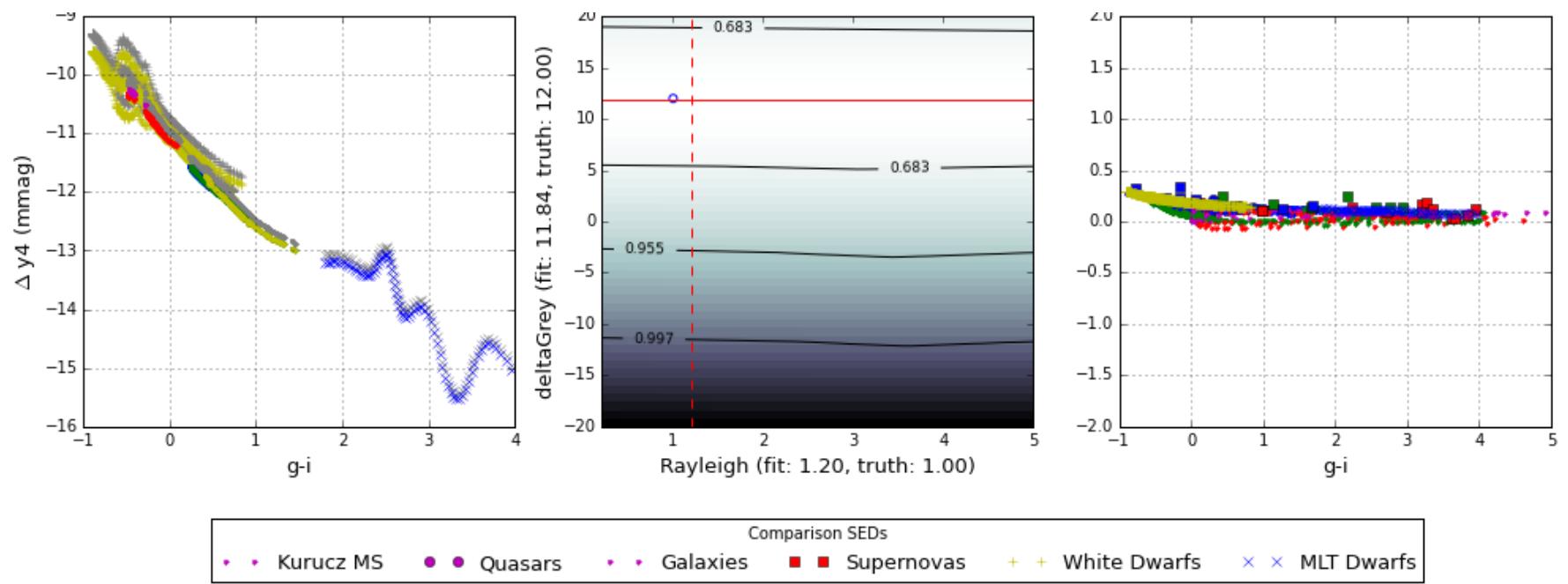
Best fit parameters (Filter, Rayleigh, dG, logL, Chi-Squared):
u 0.98 12.65 44.0081331073 88.0162662147
g 0.98 12.65 21.0287926653 42.0575853307
r 1.08 11.84 3.5655518504 7.13110370081
i 1.08 11.84 2.81711946704 5.63423893408
z 1.38 11.84 2.68781377285 5.3756275457
y4 1.18 11.84 3.00639497985 6.01278995969

Override best fit parameters (Filter, Rayleigh, dG):
u 0.80 20.00
g 0.80 15.10
r 0.80 11.84
i 0.80 11.84
z 0.80 11.84
y4 0.80 11.84
```

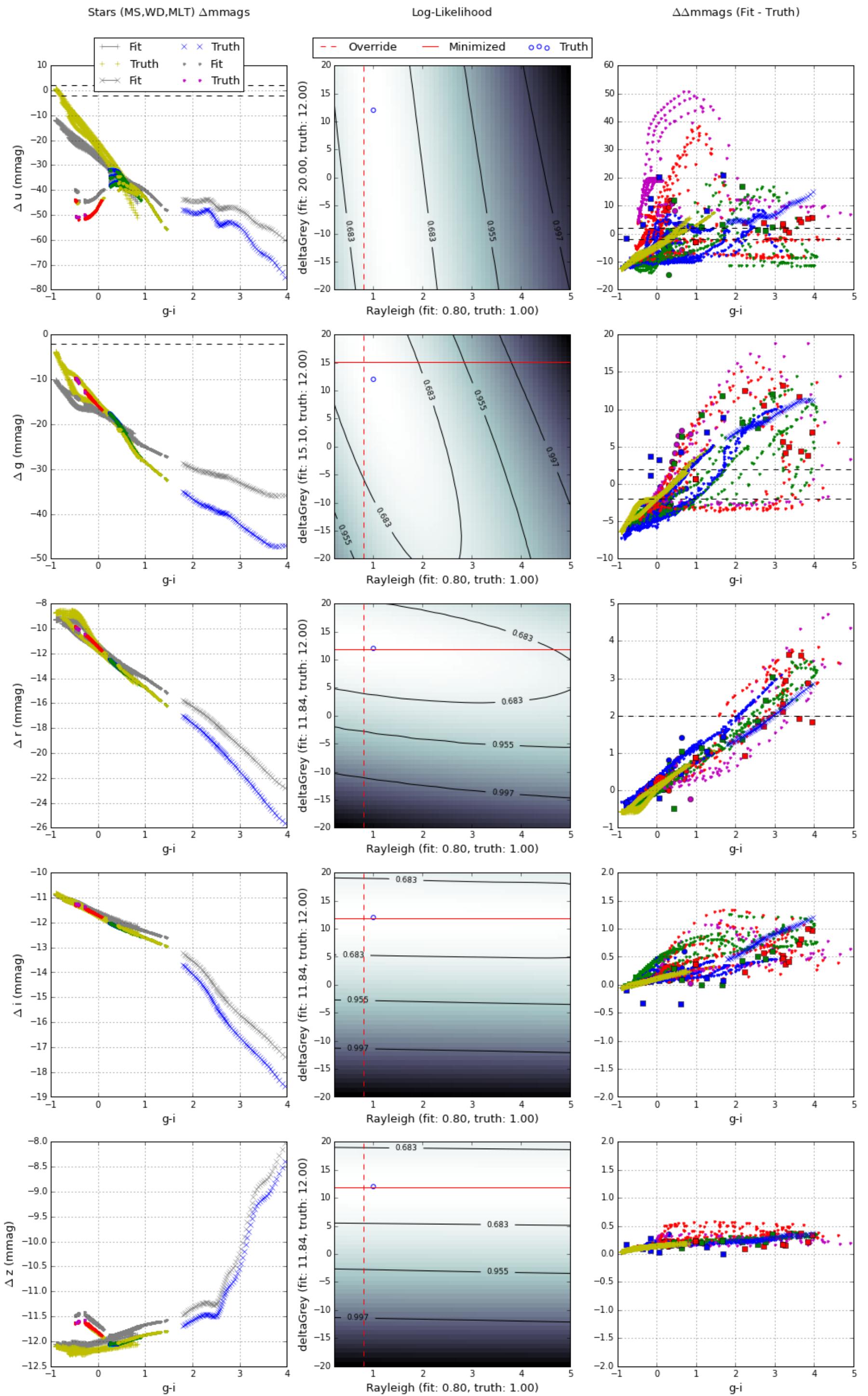


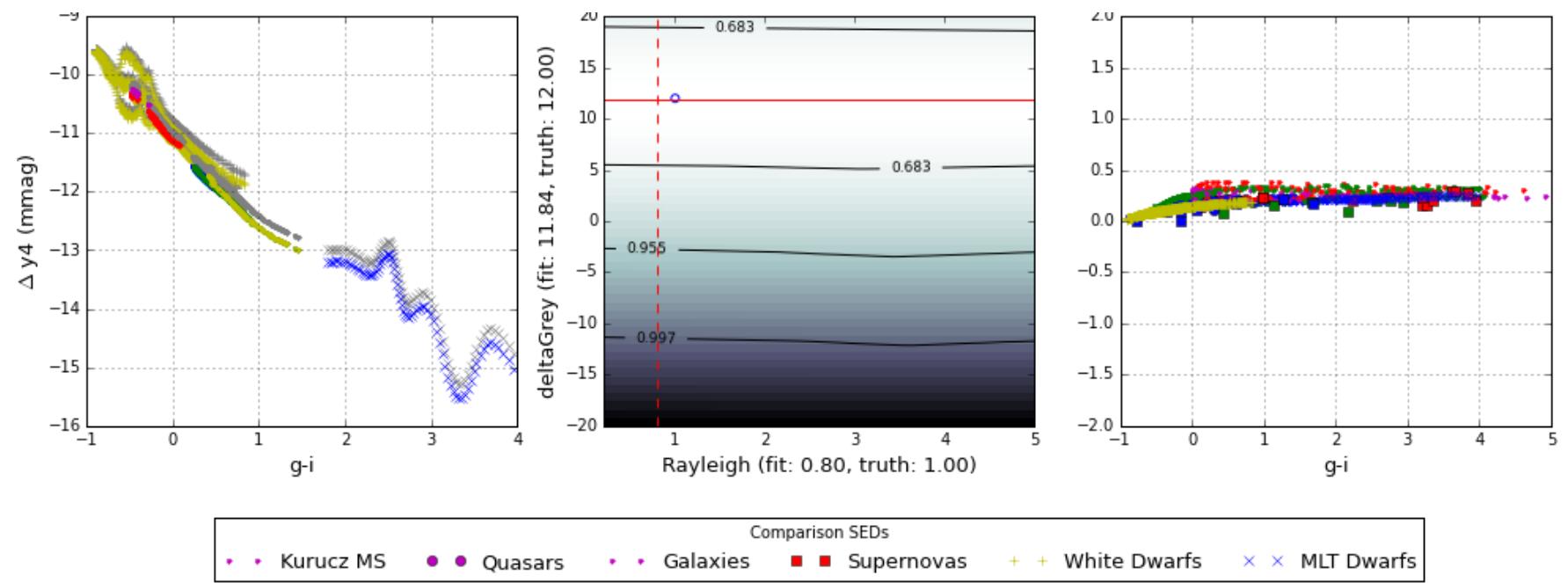
$\Delta\text{mmags}$ , Regression Contours,  $\Delta\Delta\text{mmags}$  for each LSST filter ( $\delta\text{Grey} = 12.0$ )





$\Delta\text{mmags}$ , Regression Contours,  $\Delta\Delta\text{mmags}$  for each LSST filter ( $\delta\text{Grey} = 12.0$ )





## Aerosol

```
In [13]: deltaGreyLimitPlot('Aerosol')
```

```
Computing nonlinear regression for Aerosol.  
Observed atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]  
Observed atmosphere airmass: 2.0  
Standard atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]  
Standard atmosphere airmass: 1.2  
Observed atmosphere parameter for Aerosol: 1.0  
  
Fitting for Aerosol between 0.20 and 5.00 in 50 bins.  
Fitting for deltaGrey between -20.00 and 20.00 mmags in 51 bins.  
  
Regression SEDs: 5778 Stars (MS,WD,MLT) SEDs.  
  
Regressing 2550 parameter combinations per filter...  
Magnitude Error: 5.0 mmags  
  
Override triggered...  
Override value detected, proceeding with deltaGrey best-fit minimization at new component best-fit value...  
  
Calculating best fit parameters for u filter...  
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Aerosol_dG_XSTD12_DG12_0_DGR-2020_E5_stars_u_51dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for u filter.  
Saved Chi-Squared at best fit deltaGrey for u filter.  
Completed u filter.  
  
Calculating best fit parameters for g filter...  
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Aerosol_dG_XSTD12_DG12_0_DGR-2020_E5_stars_g_51dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for g filter.  
Saved Chi-Squared at best fit deltaGrey for g filter.  
Completed g filter.  
  
Calculating best fit parameters for r filter...  
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Aerosol_dG_XSTD12_DG12_0_DGR-2020_E5_stars_r_51dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for r filter.  
Saved Chi-Squared at best fit deltaGrey for r filter.  
Completed r filter.  
  
Calculating best fit parameters for i filter...  
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Aerosol_dG_XSTD12_DG12_0_DGR-2020_E5_stars_i_51dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for i filter.  
Saved Chi-Squared at best fit deltaGrey for i filter.  
Completed i filter.  
  
Calculating best fit parameters for z filter...  
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Aerosol_dG_XSTD12_DG12_0_DGR-2020_E5_stars_z_51dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for z filter.  
Saved Chi-Squared at best fit deltaGrey for z filter.  
Completed z filter.  
  
Calculating best fit parameters for y4 filter...  
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Aerosol_dG_XSTD12_DG12_0_DGR-2020_E5_stars_y4_51dgb_50b_max_dGTest_allMS_OR120.pkl'  
Saved LogL at best fit deltaGrey for y4 filter.  
Saved Chi-Squared at best fit deltaGrey for y4 filter.  
Completed y4 filter.  
  
Best fit parameters (Filter, Aerosol, dG, logL, Chi-Squared):  
u 0.98 12.00 6.09713044409 12.1942608882  
g 0.98 12.00 2.2453549606 4.49070992119  
r 0.98 12.00 0.0993165179319 0.198633035864  
i 0.98 12.00 0.0136797572857 0.0273595145714  
z 0.98 12.00 0.00130294586621 0.00260589173243  
y4 0.98 12.00 0.00107054188388 0.00214108376776  
  
Override best fit parameters (Filter, Aerosol, dG):  
u 1.20 9.60  
g 1.20 10.40  
r 1.20 12.00  
i 1.20 12.00  
z 1.20 12.00  
y4 1.20 12.00  
  
Computing nonlinear regression for Aerosol.  
Observed atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]  
Observed atmosphere airmass: 2.0  
Standard atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]  
Standard atmosphere airmass: 1.2
```

Observed atmosphere parameter for Aerosol: 1.0

Fitting for Aerosol between 0.20 and 5.00 in 50 bins.  
Fitting for deltaGrey between -20.00 and 20.00 mmags in 51 bins.

Regression SEDs: 5778 Stars (MS,WD,MLT) SEDs.

Regressing 2550 parameter combinations per filter...  
Magnitude Error: 5.0 mmags

Override triggered...  
Override value detected, proceeding with deltaGrey best-fit minimization at new component best-fit value...

Calculating best fit parameters for u filter...  
@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_Aerosol\_dG\_XSTD12\_DG12\_0\_DGR-2020\_E5\_stars\_u\_51dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for u filter.  
Saved Chi-Squared at best fit deltaGrey for u filter.  
Completed u filter.

Calculating best fit parameters for g filter...  
@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_Aerosol\_dG\_XSTD12\_DG12\_0\_DGR-2020\_E5\_stars\_g\_51dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for g filter.  
Saved Chi-Squared at best fit deltaGrey for g filter.  
Completed g filter.

Calculating best fit parameters for r filter...  
@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_Aerosol\_dG\_XSTD12\_DG12\_0\_DGR-2020\_E5\_stars\_r\_51dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for r filter.  
Saved Chi-Squared at best fit deltaGrey for r filter.  
Completed r filter.

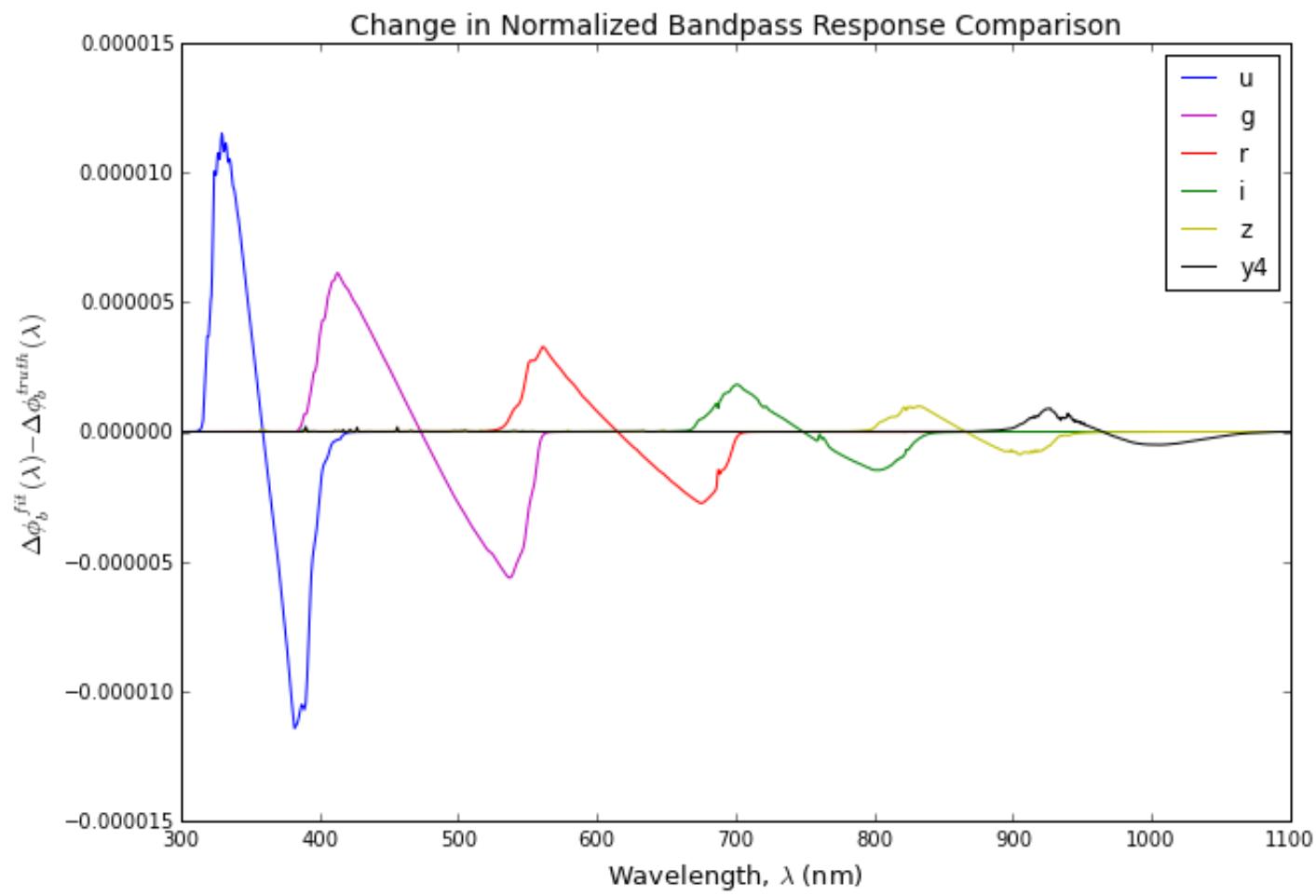
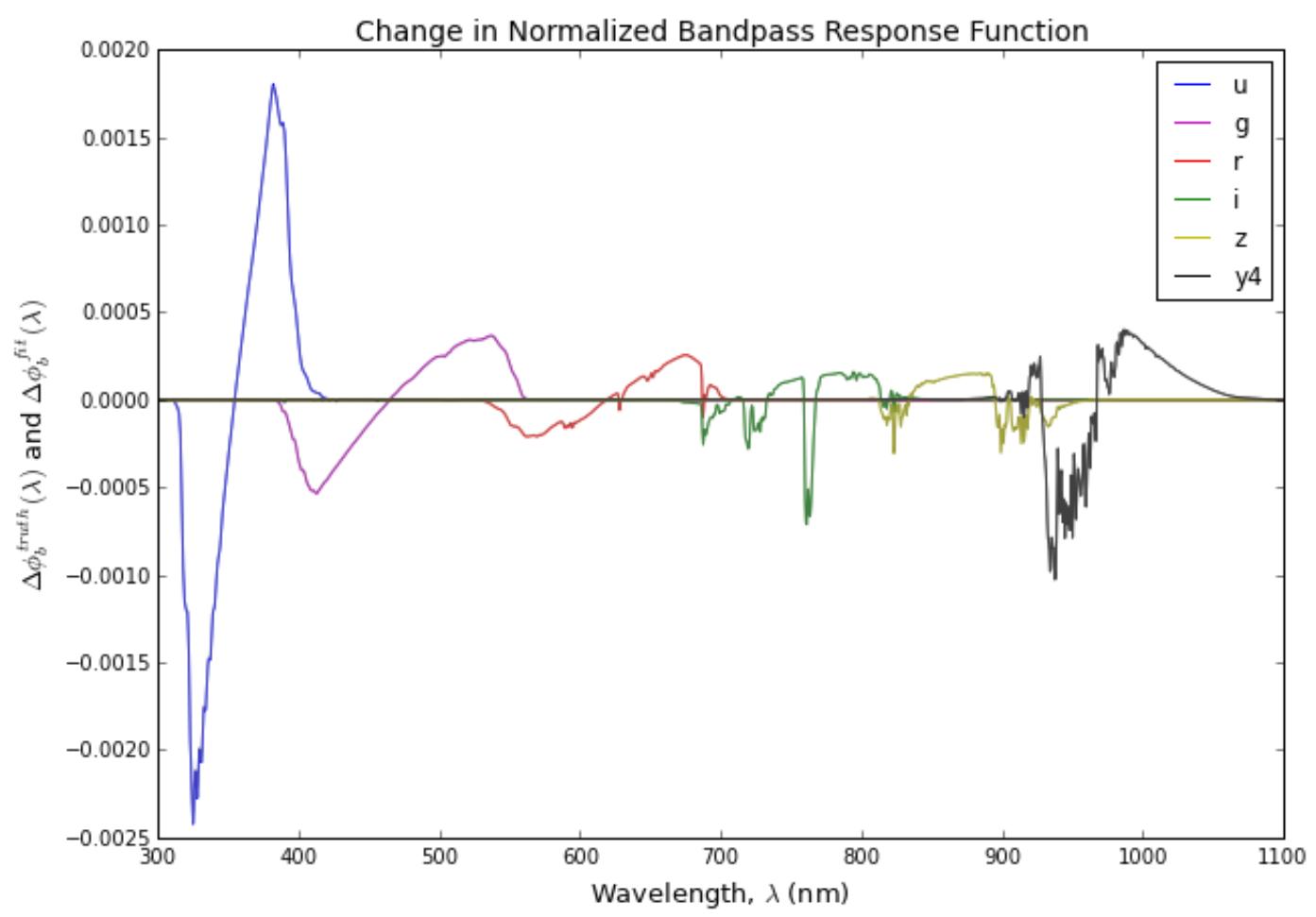
Calculating best fit parameters for i filter...  
@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_Aerosol\_dG\_XSTD12\_DG12\_0\_DGR-2020\_E5\_stars\_i\_51dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for i filter.  
Saved Chi-Squared at best fit deltaGrey for i filter.  
Completed i filter.

Calculating best fit parameters for z filter...  
@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_Aerosol\_dG\_XSTD12\_DG12\_0\_DGR-2020\_E5\_stars\_z\_51dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for z filter.  
Saved Chi-Squared at best fit deltaGrey for z filter.  
Completed z filter.

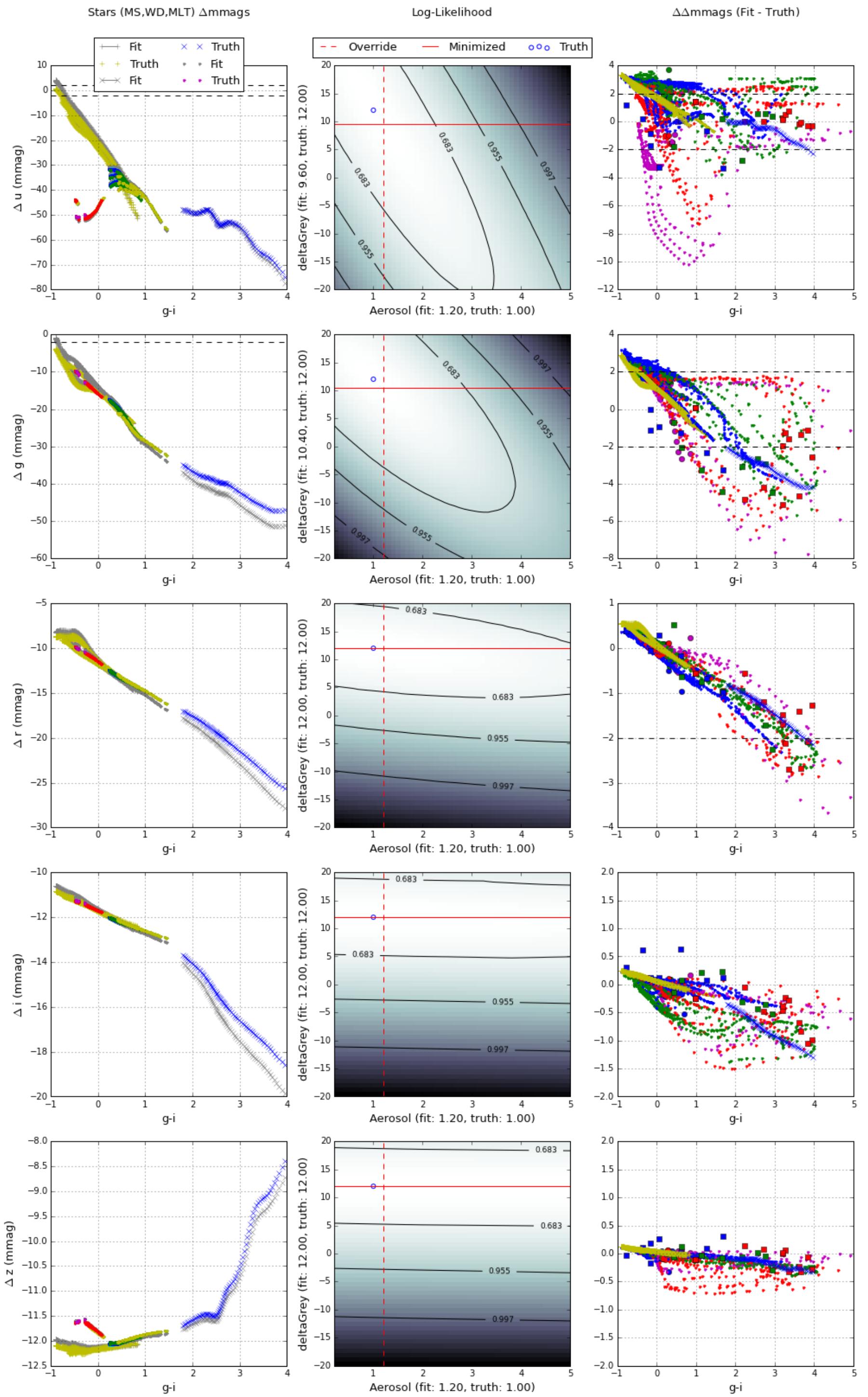
Calculating best fit parameters for y4 filter...  
@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_Aerosol\_dG\_XSTD12\_DG12\_0\_DGR-2020\_E5\_stars\_y4\_51dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for y4 filter.  
Saved Chi-Squared at best fit deltaGrey for y4 filter.  
Completed y4 filter.

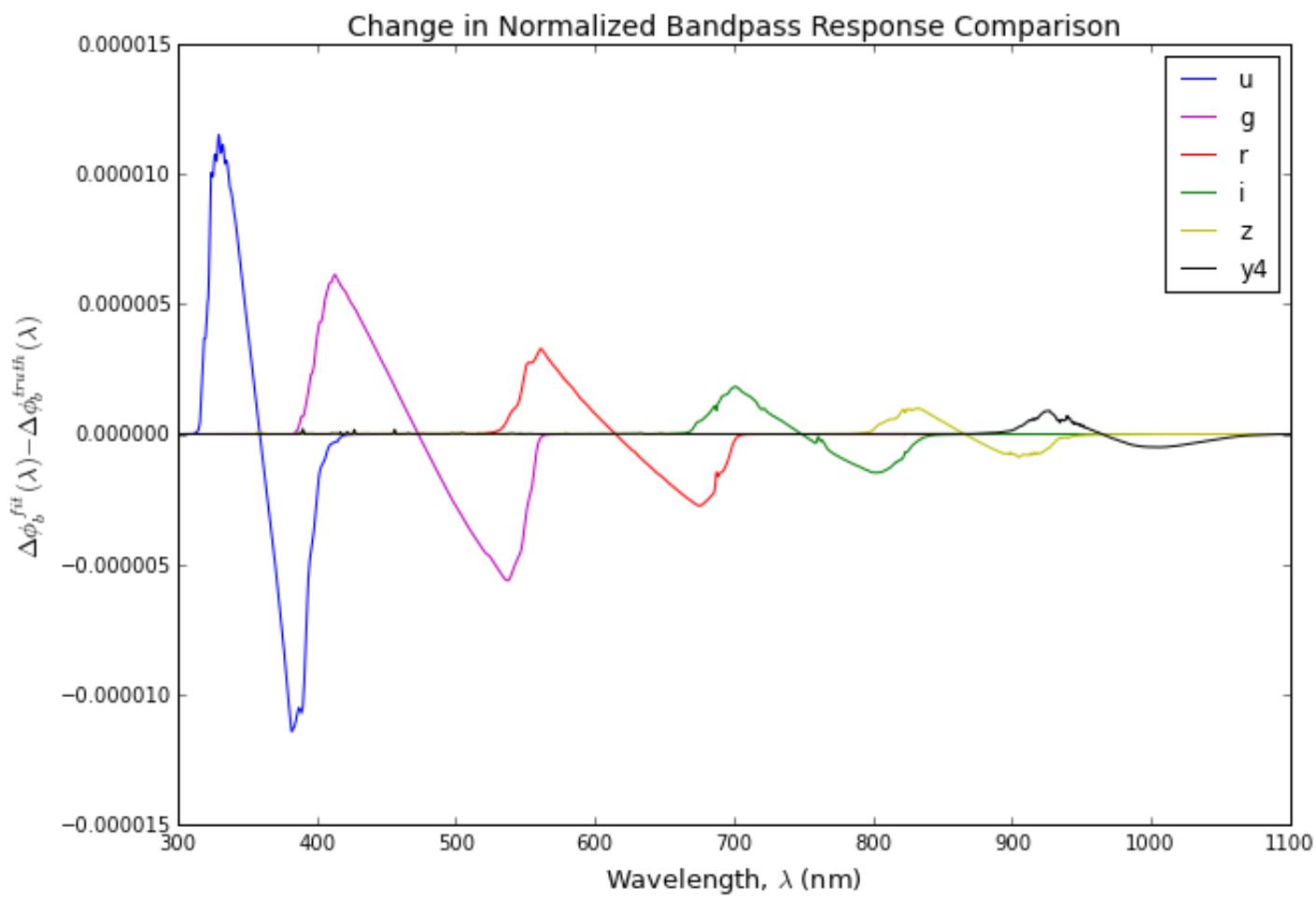
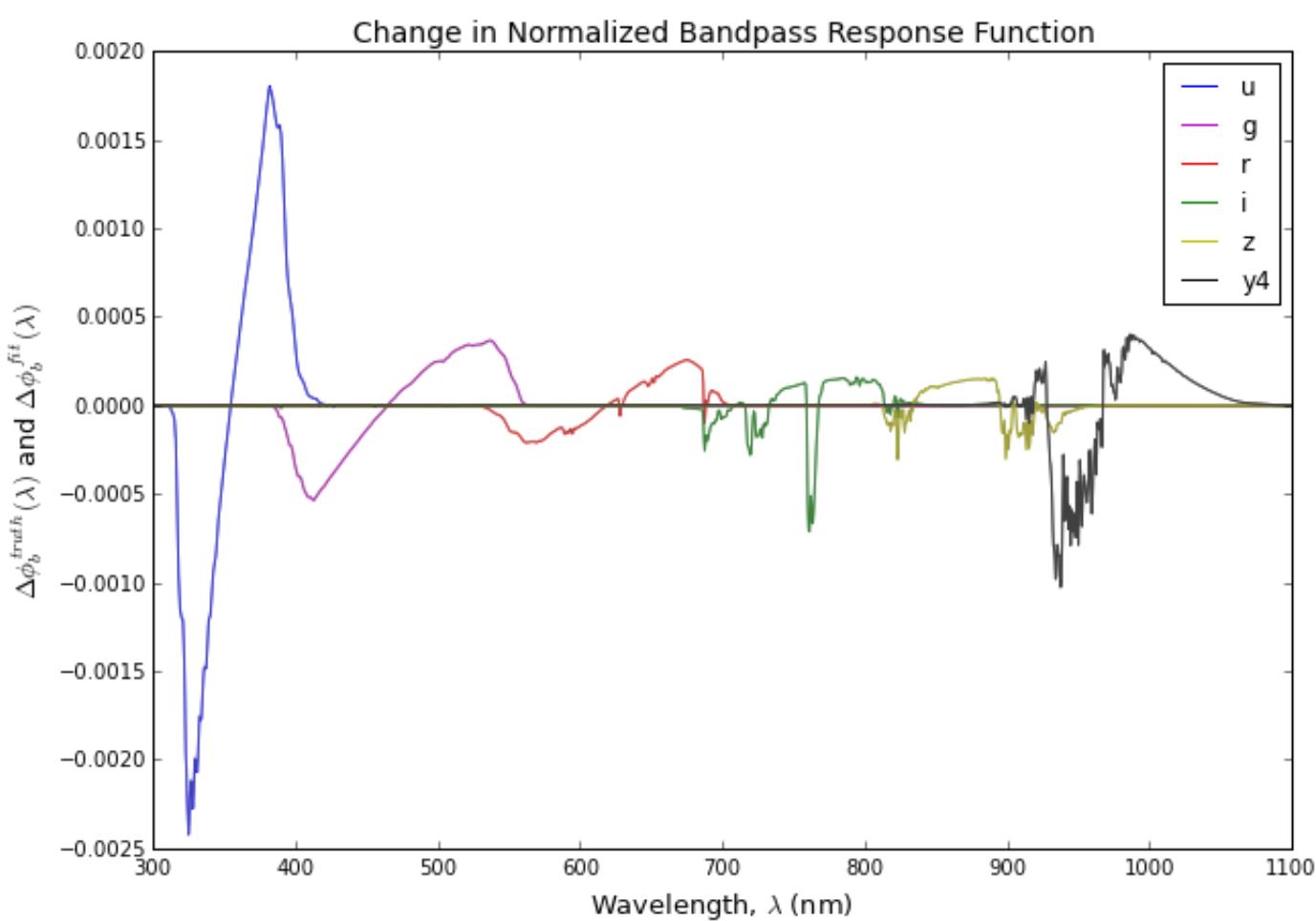
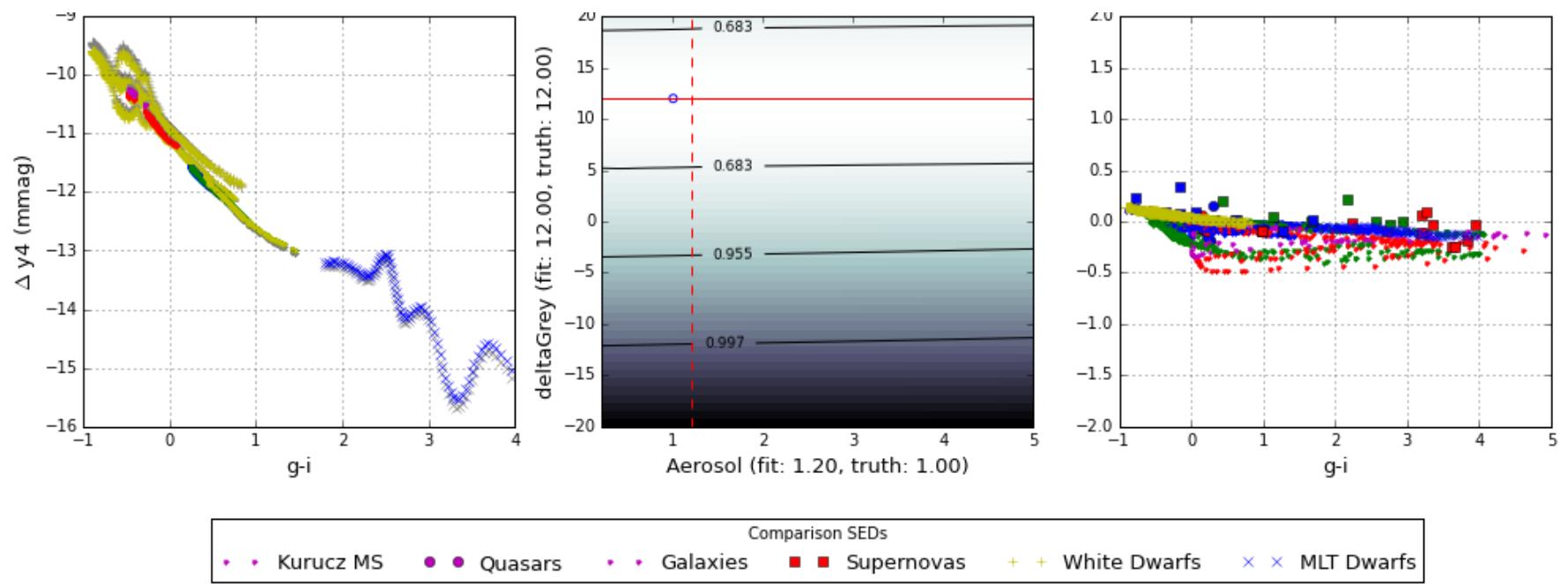
Best fit parameters (Filter, Aerosol, dG, logL, Chi-Squared):  
u 0.98 12.00 6.09713044409 12.1942608882  
g 0.98 12.00 2.2453549606 4.49070992119  
r 0.98 12.00 0.0993165179319 0.198633035864  
i 0.98 12.00 0.0136797572857 0.0273595145714  
z 0.98 12.00 0.00130294586621 0.00260589173243  
y4 0.98 12.00 0.00107054188388 0.00214108376776

Override best fit parameters (Filter, Aerosol, dG):  
u 0.80 14.40  
g 0.80 13.60  
r 0.80 12.00  
i 0.80 12.00  
z 0.80 12.00  
y4 0.80 12.00

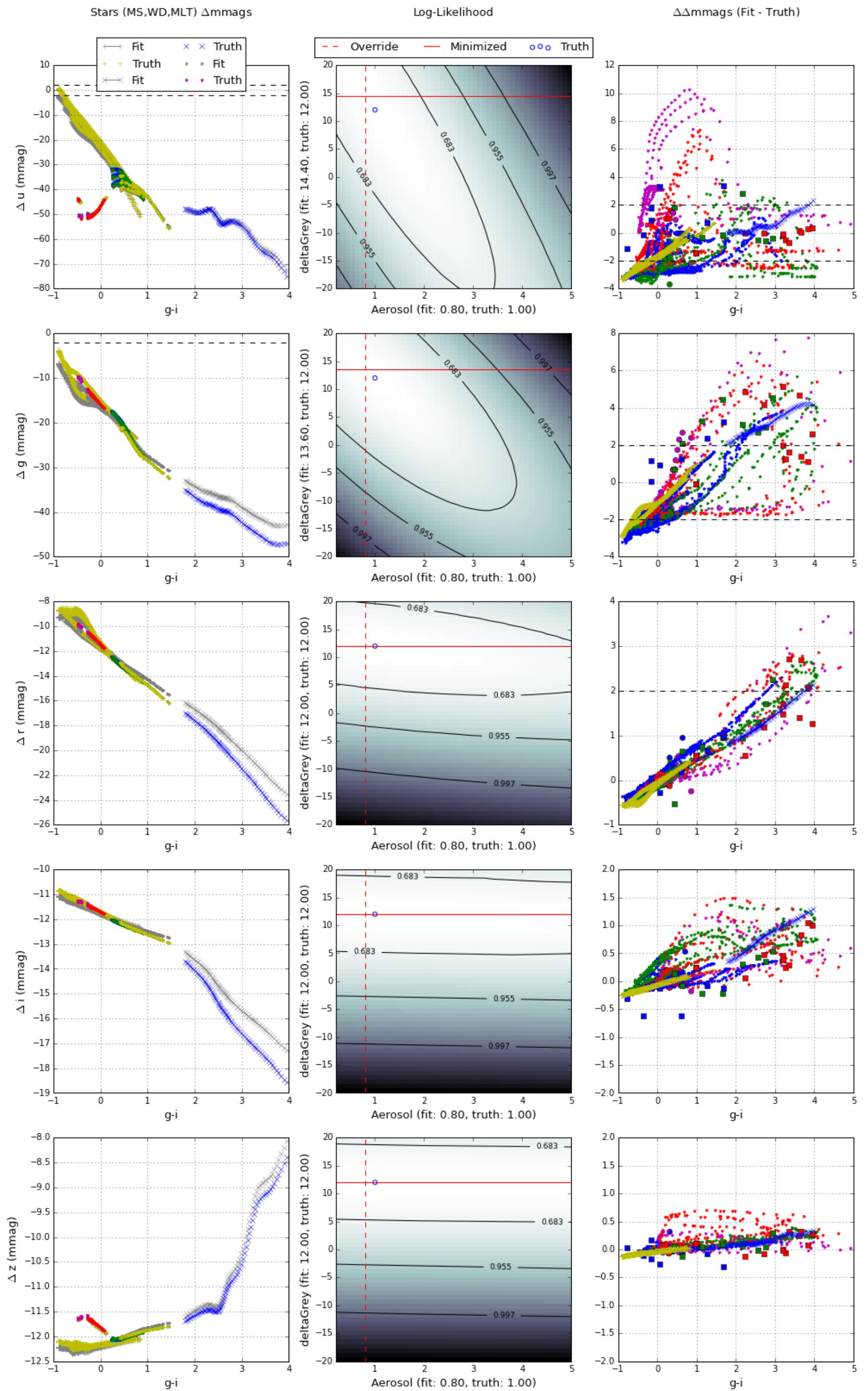


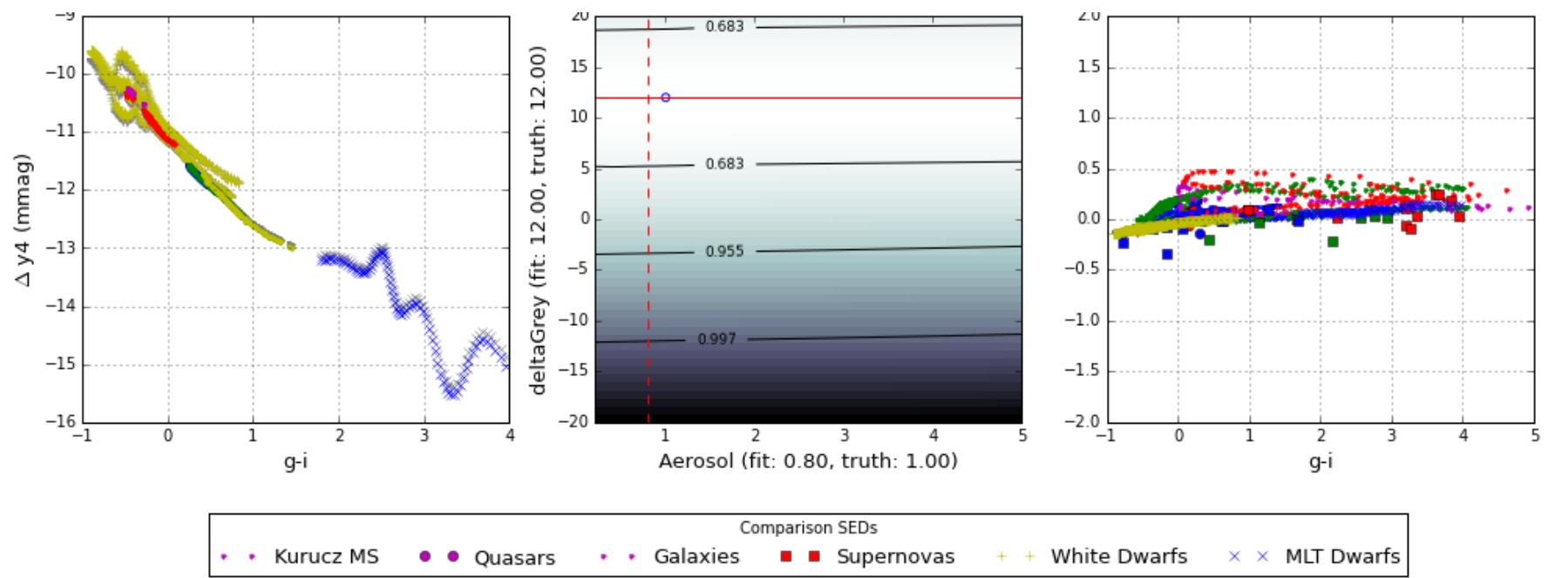
$\Delta\text{mmags}$ , Regression Contours,  $\Delta\Delta\text{mmags}$  for each LSST filter ( $\delta\text{Grey} = 12.0$ )





$\Delta\text{mmags}$ , Regression Contours,  $\Delta\Delta\text{mmags}$  for each LSST filter ( $\delta\text{Grey} = 12.0$ )





```
In [14]: deltaGreyLimitPlot('Aerosol',deltaGreyBins=50)
```

```
Computing nonlinear regression for Aerosol.
Observed atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]
Observed atmosphere airmass: 2.0
Standard atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]
Standard atmosphere airmass: 1.2
Observed atmosphere parameter for Aerosol: 1.0

Fitting for Aerosol between 0.20 and 5.00 in 50 bins.
Fitting for deltaGrey between -20.00 and 20.00 mmags in 50 bins.

Regression SEDs: 5778 Stars (MS,WD,MLT) SEDs.

Regressing 2500 parameter combinations per filter...
Magnitude Error: 5.0 mmags

Override triggered...
Override value detected, proceeding with deltaGrey best-fit minimization at new component best-fit value...

Calculating best fit parameters for u filter...
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Aerosol_dG_XSTD12_DG12_0_DGR-2020_E5_stars_u_50dgb_50b_max_dGTest_allMS_OR120.pkl'
Saved LogL at best fit deltaGrey for u filter.
Saved Chi-Squared at best fit deltaGrey for u filter.
Completed u filter.

Calculating best fit parameters for g filter...
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Aerosol_dG_XSTD12_DG12_0_DGR-2020_E5_stars_g_50dgb_50b_max_dGTest_allMS_OR120.pkl'
Saved LogL at best fit deltaGrey for g filter.
Saved Chi-Squared at best fit deltaGrey for g filter.
Completed g filter.

Calculating best fit parameters for r filter...
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Aerosol_dG_XSTD12_DG12_0_DGR-2020_E5_stars_r_50dgb_50b_max_dGTest_allMS_OR120.pkl'
Saved LogL at best fit deltaGrey for r filter.
Saved Chi-Squared at best fit deltaGrey for r filter.
Completed r filter.

Calculating best fit parameters for i filter...
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Aerosol_dG_XSTD12_DG12_0_DGR-2020_E5_stars_i_50dgb_50b_max_dGTest_allMS_OR120.pkl'
Saved LogL at best fit deltaGrey for i filter.
Saved Chi-Squared at best fit deltaGrey for i filter.
Completed i filter.

Calculating best fit parameters for z filter...
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Aerosol_dG_XSTD12_DG12_0_DGR-2020_E5_stars_z_50dgb_50b_max_dGTest_allMS_OR120.pkl'
Saved LogL at best fit deltaGrey for z filter.
Saved Chi-Squared at best fit deltaGrey for z filter.
Completed z filter.

Calculating best fit parameters for y4 filter...
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Aerosol_dG_XSTD12_DG12_0_DGR-2020_E5_stars_y4_50dgb_50b_max_dGTest_allMS_OR120.pkl'
Saved LogL at best fit deltaGrey for y4 filter.
Saved Chi-Squared at best fit deltaGrey for y4 filter.
Completed y4 filter.

Best fit parameters (Filter, Aerosol, dG, logL, Chi-Squared):
u 0.98 11.84 16.9182605147 33.8365210294
g 0.98 11.84 9.51142246391 19.0228449278
r 1.08 11.84 2.72749746293 5.45499492586
i 1.08 11.84 2.87834938651 5.75669877302
z 1.18 11.84 2.92320055565 5.8464011113
y4 0.98 11.84 3.07726342399 6.15452684799

Override best fit parameters (Filter, Aerosol, dG):
u 1.20 9.39
g 1.20 11.02
r 1.20 11.84
i 1.20 11.84
z 1.20 11.84
y4 1.20 11.84

Computing nonlinear regression for Aerosol.
Observed atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]
Observed atmosphere airmass: 2.0
Standard atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]
Standard atmosphere airmass: 1.2
```

Observed atmosphere parameter for Aerosol: 1.0

Fitting for Aerosol between 0.20 and 5.00 in 50 bins.

Fitting for deltaGrey between -20.00 and 20.00 mmags in 50 bins.

Regression SEDs: 5778 Stars (MS,WD,MLT) SEDs.

Regressing 2500 parameter combinations per filter...

Magnitude Error: 5.0 mmags

Override triggered...

Override value detected, proceeding with deltaGrey best-fit minimization at new component best-fit value...

Calculating best fit parameters for u filter...

@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_Aerosol\_dG\_XSTD12\_DG12\_0\_DGR-2020\_E5\_stars\_u\_50dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'

Saved LogL at best fit deltaGrey for u filter.

Saved Chi-Squared at best fit deltaGrey for u filter.

Completed u filter.

Calculating best fit parameters for g filter...

@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_Aerosol\_dG\_XSTD12\_DG12\_0\_DGR-2020\_E5\_stars\_g\_50dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'

Saved LogL at best fit deltaGrey for g filter.

Saved Chi-Squared at best fit deltaGrey for g filter.

Completed g filter.

Calculating best fit parameters for r filter...

@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_Aerosol\_dG\_XSTD12\_DG12\_0\_DGR-2020\_E5\_stars\_r\_50dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'

Saved LogL at best fit deltaGrey for r filter.

Saved Chi-Squared at best fit deltaGrey for r filter.

Completed r filter.

Calculating best fit parameters for i filter...

@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_Aerosol\_dG\_XSTD12\_DG12\_0\_DGR-2020\_E5\_stars\_i\_50dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'

Saved LogL at best fit deltaGrey for i filter.

Saved Chi-Squared at best fit deltaGrey for i filter.

Completed i filter.

Calculating best fit parameters for z filter...

@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_Aerosol\_dG\_XSTD12\_DG12\_0\_DGR-2020\_E5\_stars\_z\_50dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'

Saved LogL at best fit deltaGrey for z filter.

Saved Chi-Squared at best fit deltaGrey for z filter.

Completed z filter.

Calculating best fit parameters for y4 filter...

@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_Aerosol\_dG\_XSTD12\_DG12\_0\_DGR-2020\_E5\_stars\_y4\_50dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'

Saved LogL at best fit deltaGrey for y4 filter.

Saved Chi-Squared at best fit deltaGrey for y4 filter.

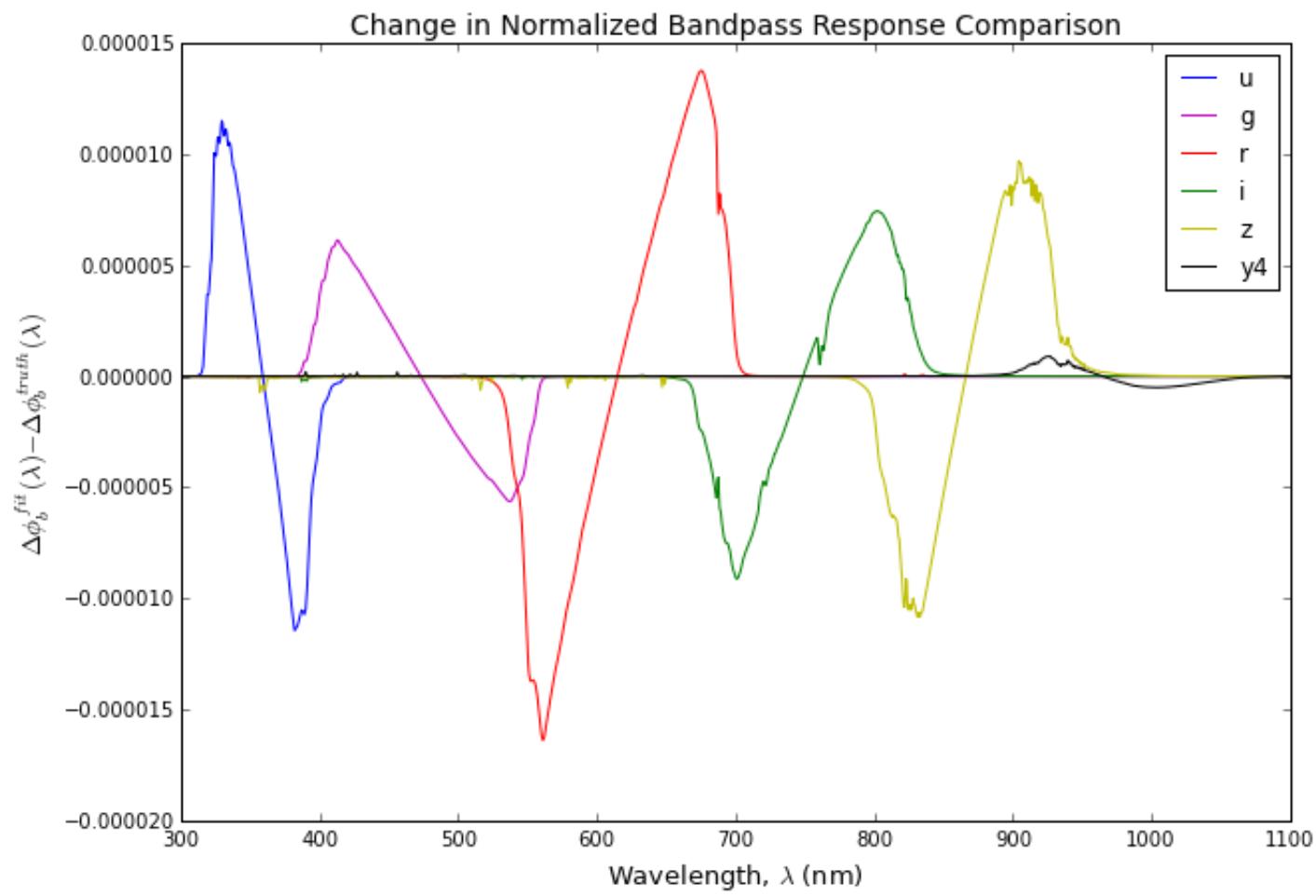
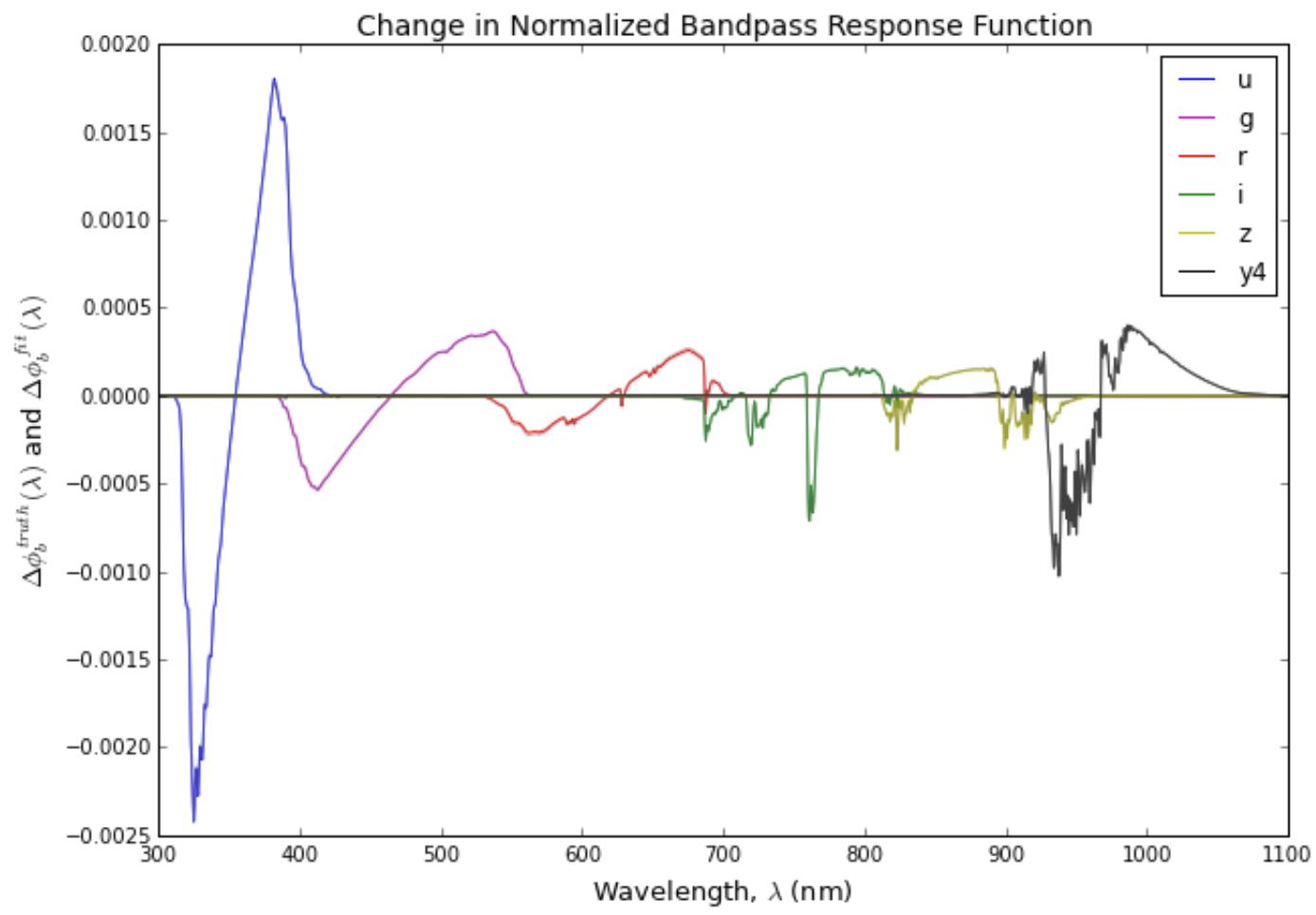
Completed y4 filter.

Best fit parameters (Filter, Aerosol, dG, logL, Chi-Squared):

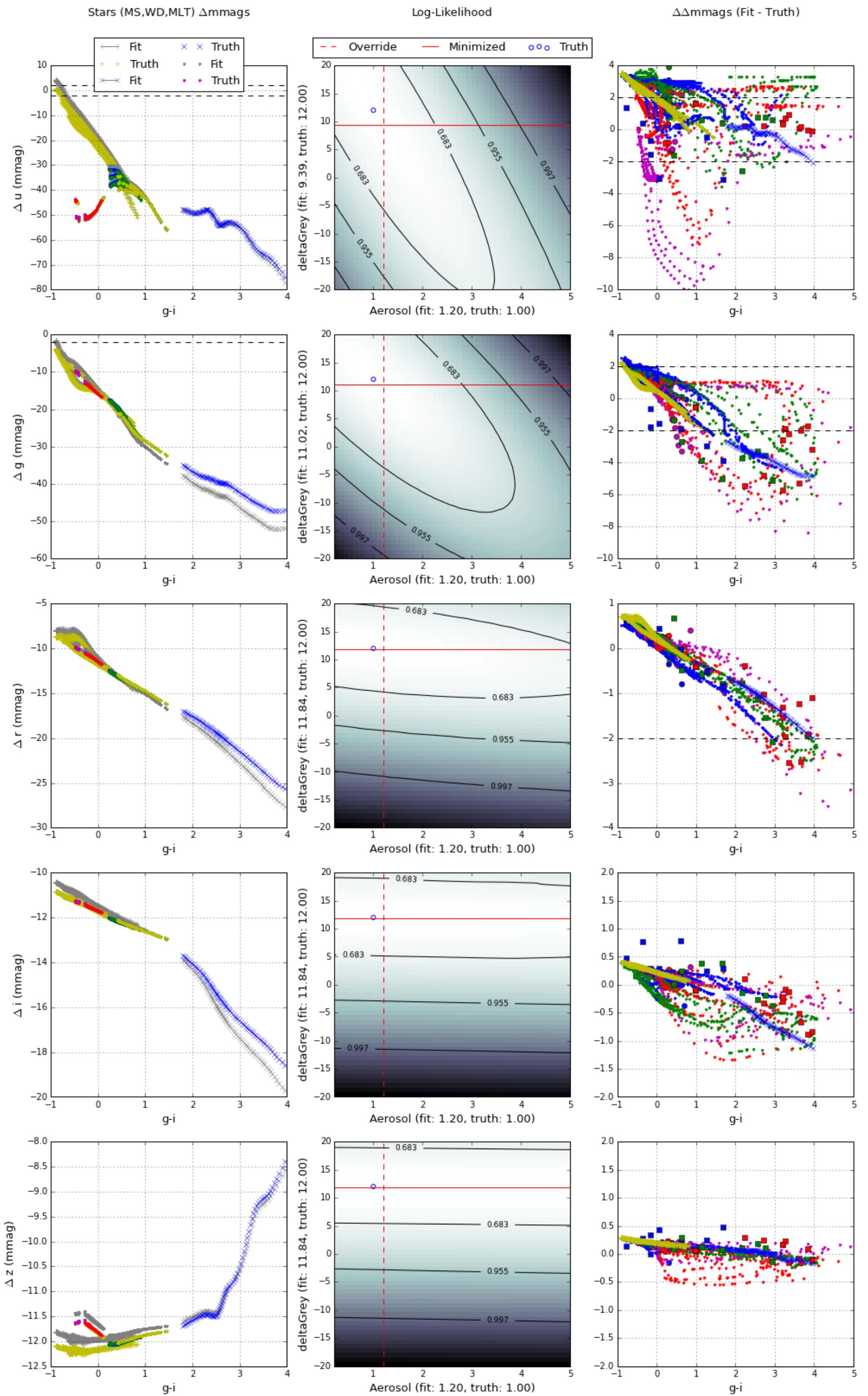
Filter	Aerosol	dG	logL	Chi-Squared
u	0.98	11.84	16.9182605147	33.8365210294
g	0.98	11.84	9.51142246391	19.0228449278
r	1.08	11.84	2.72749746293	5.45499492586
i	1.08	11.84	2.87834938651	5.75669877302
z	1.18	11.84	2.92320055565	5.8464011113
y4	0.98	11.84	3.07726342399	6.15452684799

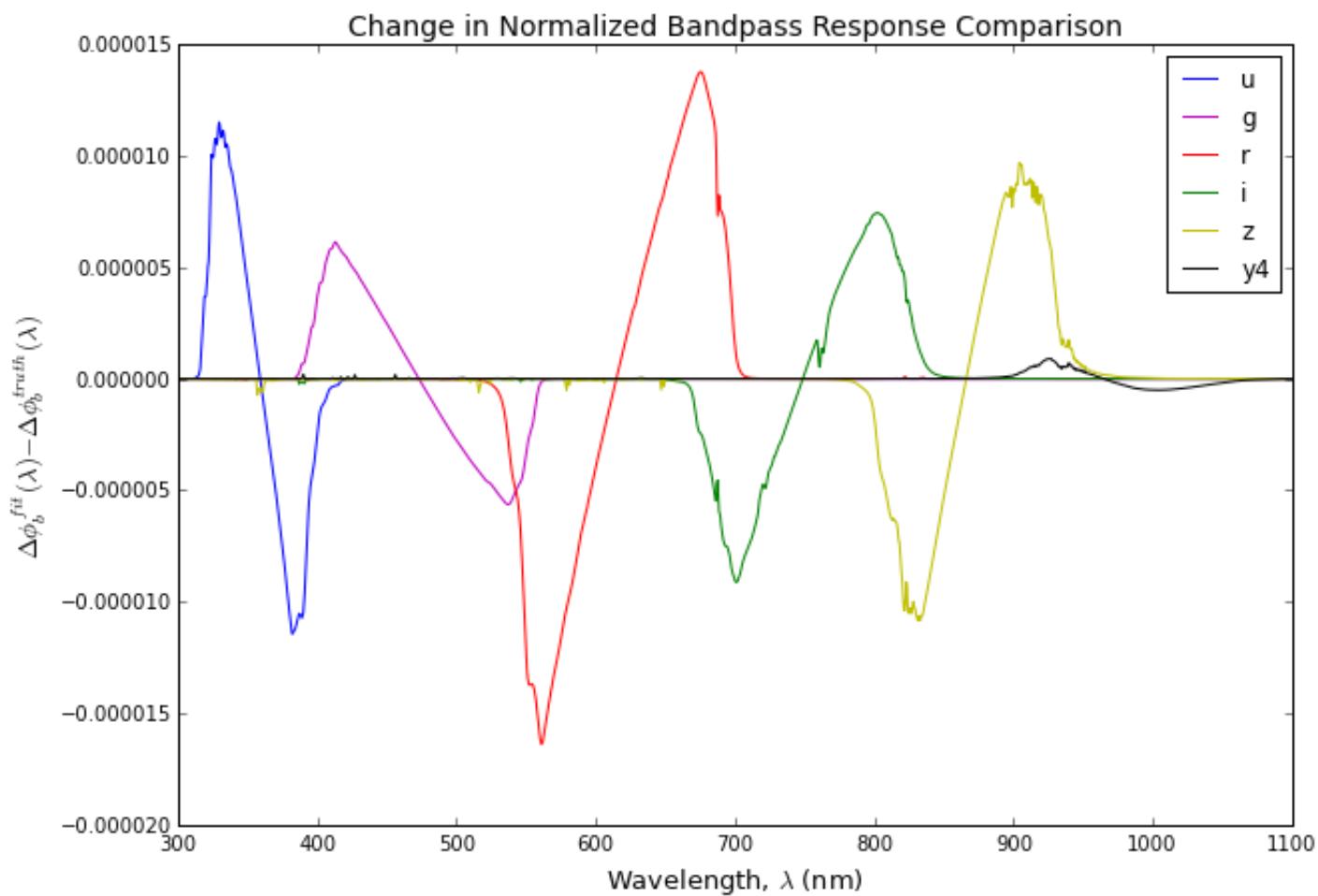
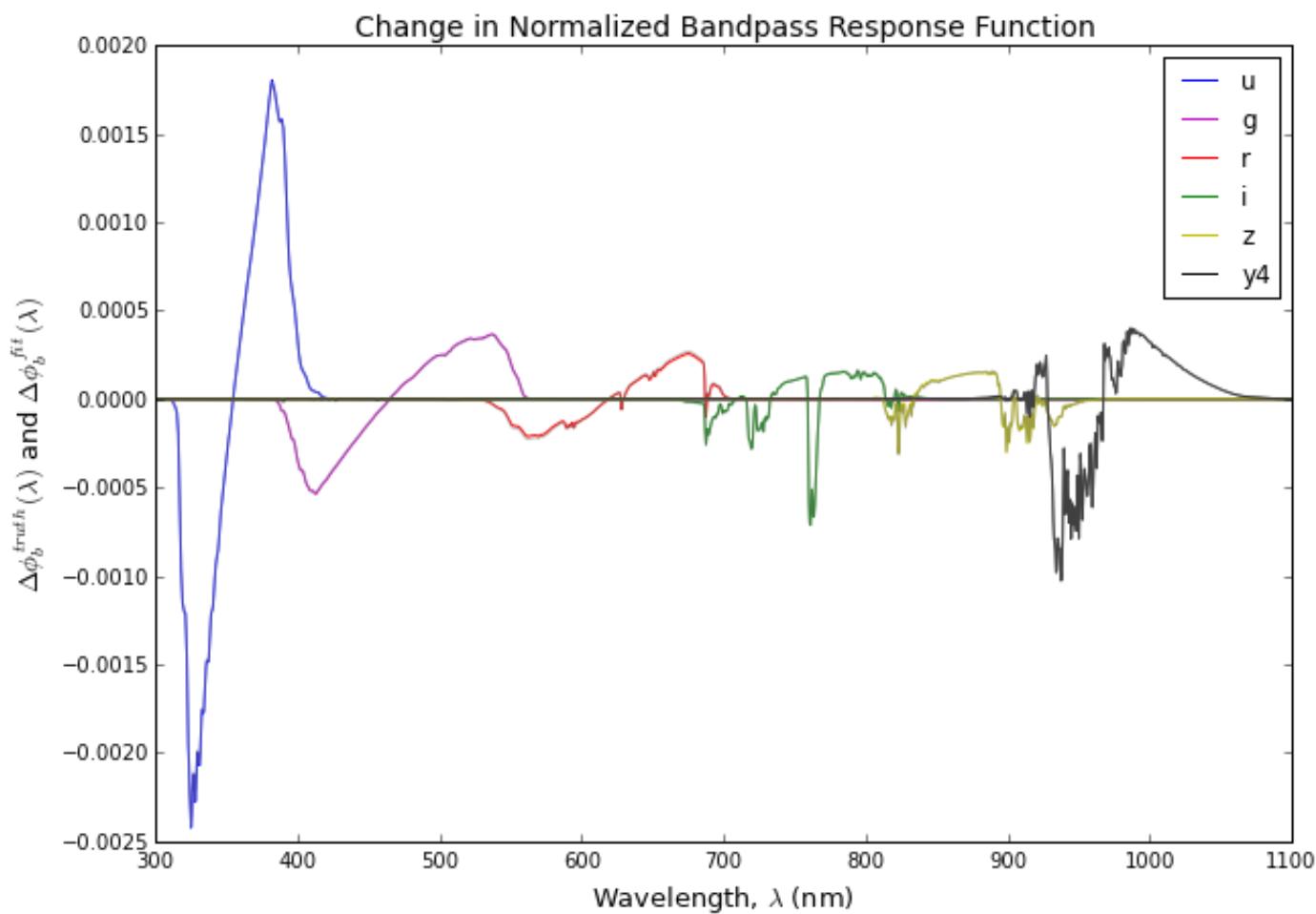
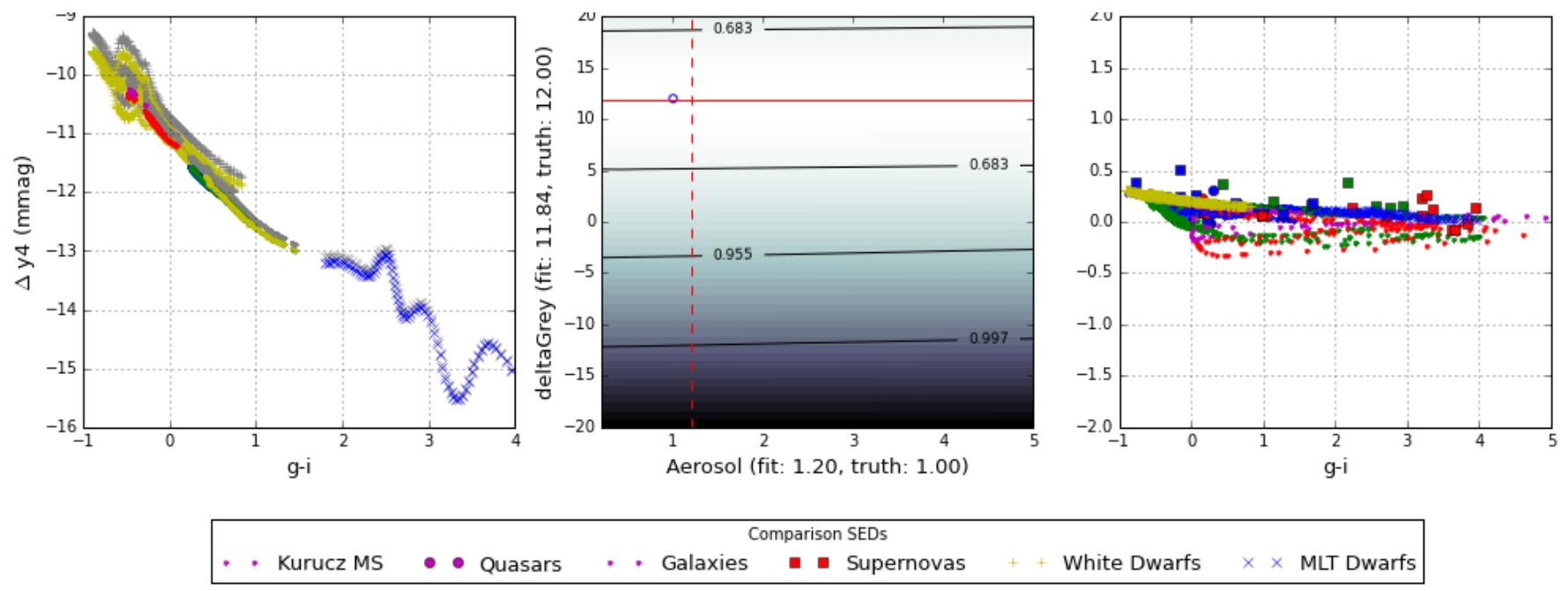
Override best fit parameters (Filter, Aerosol, dG):

Filter	Aerosol	dG
u	0.80	14.29
g	0.80	13.47
r	0.80	11.84
i	0.80	11.84
z	0.80	11.84
y4	0.80	11.84

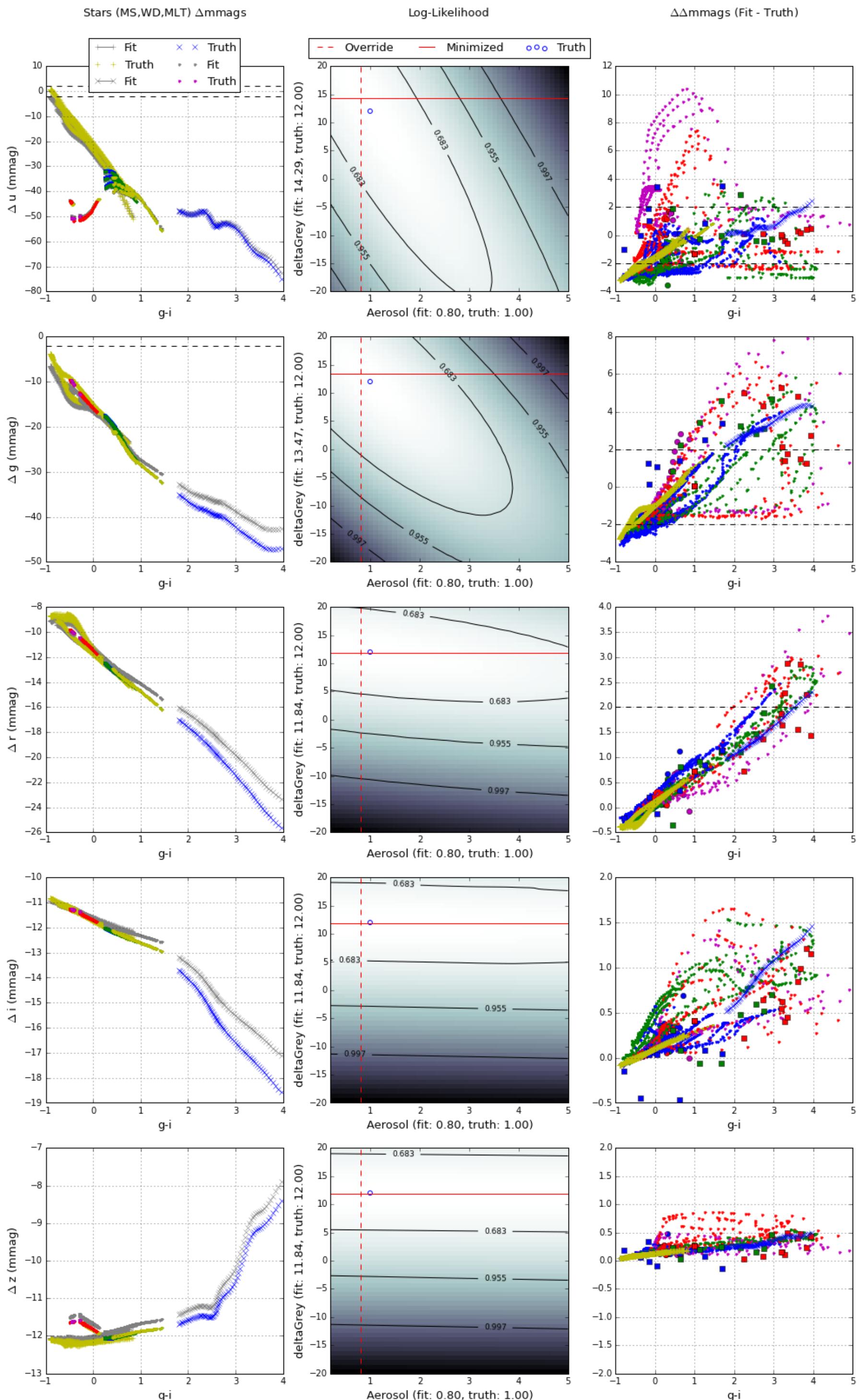


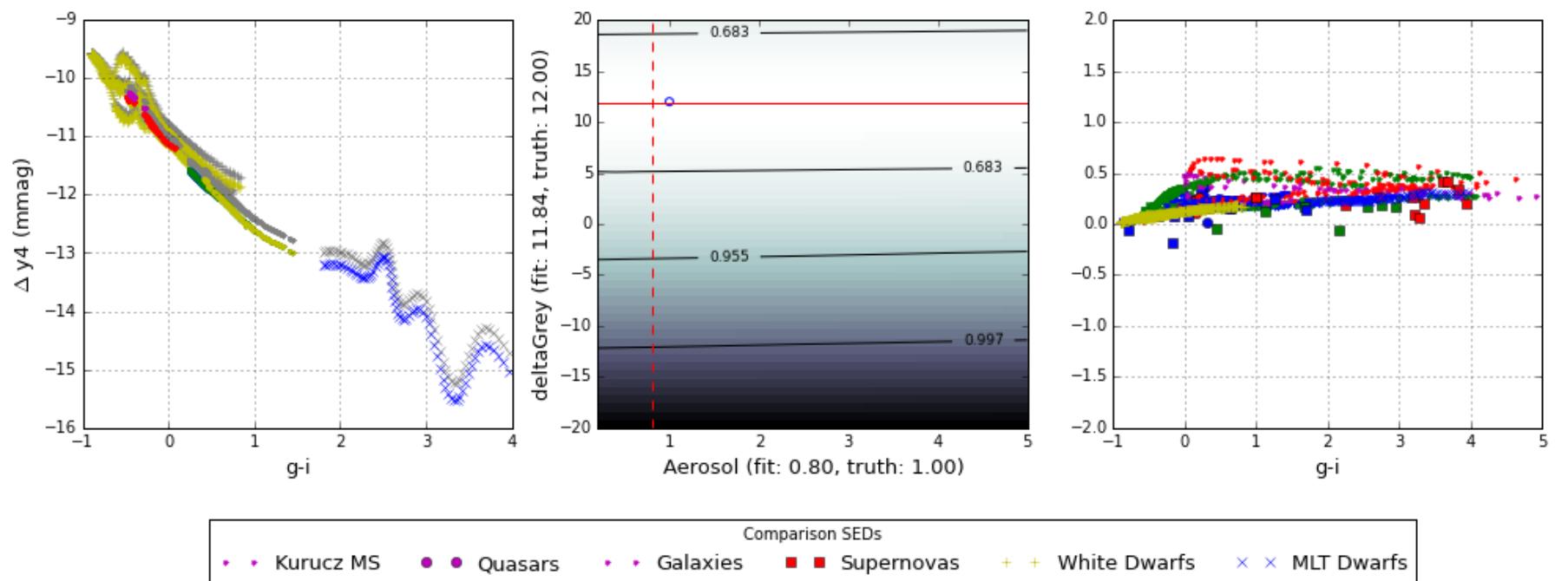
$\Delta\text{mmags}$ , Regression Contours,  $\Delta\Delta\text{mmags}$  for each LSST filter ( $\delta\text{Grey} = 12.0$ )





$\Delta\text{mmags}$ , Regression Contours,  $\Delta\Delta\text{mmags}$  for each LSST filter ( $\delta\text{Grey}: 12.0$ )





**Alpha**

```
In [15]: deltaGreyLimitPlot('Alpha')
```

```

Computing nonlinear regression for Alpha.
Observed atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]
Observed atmosphere airmass: 2.0
Standard atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]
Standard atmosphere airmass: 1.2
Observed atmosphere parameter for Alpha: 1.7

Fitting for Alpha between 0.20 and 5.00 in 50 bins.
Fitting for deltaGrey between -20.00 and 20.00 mmags in 51 bins.

Regression SEDs: 5778 Stars (MS,WD,MLT) SEDs.

Regressing 2550 parameter combinations per filter...
Magnitude Error: 5.0 mmags

Override triggered...
Override value detected, proceeding with deltaGrey best-fit minimization at new component best-fit value...

Calculating best fit parameters for u filter...
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Alpha_dG_XSTD12_DG120_DG_R-2020_E5_stars_u_51dgb_50b_max_dGTest_allMS_OR120.pkl'
Saved LogL at best fit deltaGrey for u filter.
Saved Chi-Squared at best fit deltaGrey for u filter.
Completed u filter.

Calculating best fit parameters for g filter...
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Alpha_dG_XSTD12_DG120_DG_R-2020_E5_stars_g_51dgb_50b_max_dGTest_allMS_OR120.pkl'
Saved LogL at best fit deltaGrey for g filter.
Saved Chi-Squared at best fit deltaGrey for g filter.
Completed g filter.

Calculating best fit parameters for r filter...
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Alpha_dG_XSTD12_DG120_DG_R-2020_E5_stars_r_51dgb_50b_max_dGTest_allMS_OR120.pkl'
Saved LogL at best fit deltaGrey for r filter.
Saved Chi-Squared at best fit deltaGrey for r filter.
Completed r filter.

Calculating best fit parameters for i filter...
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Alpha_dG_XSTD12_DG120_DG_R-2020_E5_stars_i_51dgb_50b_max_dGTest_allMS_OR120.pkl'
Saved LogL at best fit deltaGrey for i filter.
Saved Chi-Squared at best fit deltaGrey for i filter.
Completed i filter.

Calculating best fit parameters for z filter...
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Alpha_dG_XSTD12_DG120_DG_R-2020_E5_stars_z_51dgb_50b_max_dGTest_allMS_OR120.pkl'
Saved LogL at best fit deltaGrey for z filter.
Saved Chi-Squared at best fit deltaGrey for z filter.
Completed z filter.

Calculating best fit parameters for y4 filter...
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Alpha_dG_XSTD12_DG120_DG_R-2020_E5_stars_y4_51dgb_50b_max_dGTest_allMS_OR120.pkl'
Saved LogL at best fit deltaGrey for y4 filter.
Saved Chi-Squared at best fit deltaGrey for y4 filter.
Completed y4 filter.

Best fit parameters (Filter, Alpha, dG, logL, Chi-Squared):
u 1.67 12.00 21.6817972742 43.3635945485
g 1.67 12.00 4.40048485 8.80096970001
r 1.67 12.00 0.0812655412846 0.162531082569
i 1.67 12.00 0.00410954851359 0.00821909702718
z 1.67 12.00 0.000219774310557 0.000439548621114
y4 1.67 12.00 0.000188679909952 0.000377359819905

Override best fit parameters (Filter, Alpha, dG):
u 1.20 17.60
g 1.20 14.40
r 1.20 12.00
i 1.20 12.00
z 1.20 12.00
y4 1.20 12.00

Computing nonlinear regression for Alpha.
Observed atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]
Observed atmosphere airmass: 2.0
Standard atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]
Standard atmosphere airmass: 1.2

```

Observed atmosphere parameter for Alpha: 1.7

Fitting for Alpha between 0.20 and 5.00 in 50 bins.  
Fitting for deltaGrey between -20.00 and 20.00 mmags in 51 bins.

Regression SEDs: 5778 Stars (MS,WD,MLT) SEDs.

Regressing 2550 parameter combinations per filter...  
Magnitude Error: 5.0 mmags

Override triggered...  
Override value detected, proceeding with deltaGrey best-fit minimization at new component best-fit value...

Calculating best fit parameters for u filter...  
@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_Alpha\_dG\_XSTD12\_DG120\_DG\_R-2020\_E5\_stars\_u\_51dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for u filter.  
Saved Chi-Squared at best fit deltaGrey for u filter.  
Completed u filter.

Calculating best fit parameters for g filter...  
@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_Alpha\_dG\_XSTD12\_DG120\_DG\_R-2020\_E5\_stars\_g\_51dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for g filter.  
Saved Chi-Squared at best fit deltaGrey for g filter.  
Completed g filter.

Calculating best fit parameters for r filter...  
@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_Alpha\_dG\_XSTD12\_DG120\_DG\_R-2020\_E5\_stars\_r\_51dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for r filter.  
Saved Chi-Squared at best fit deltaGrey for r filter.  
Completed r filter.

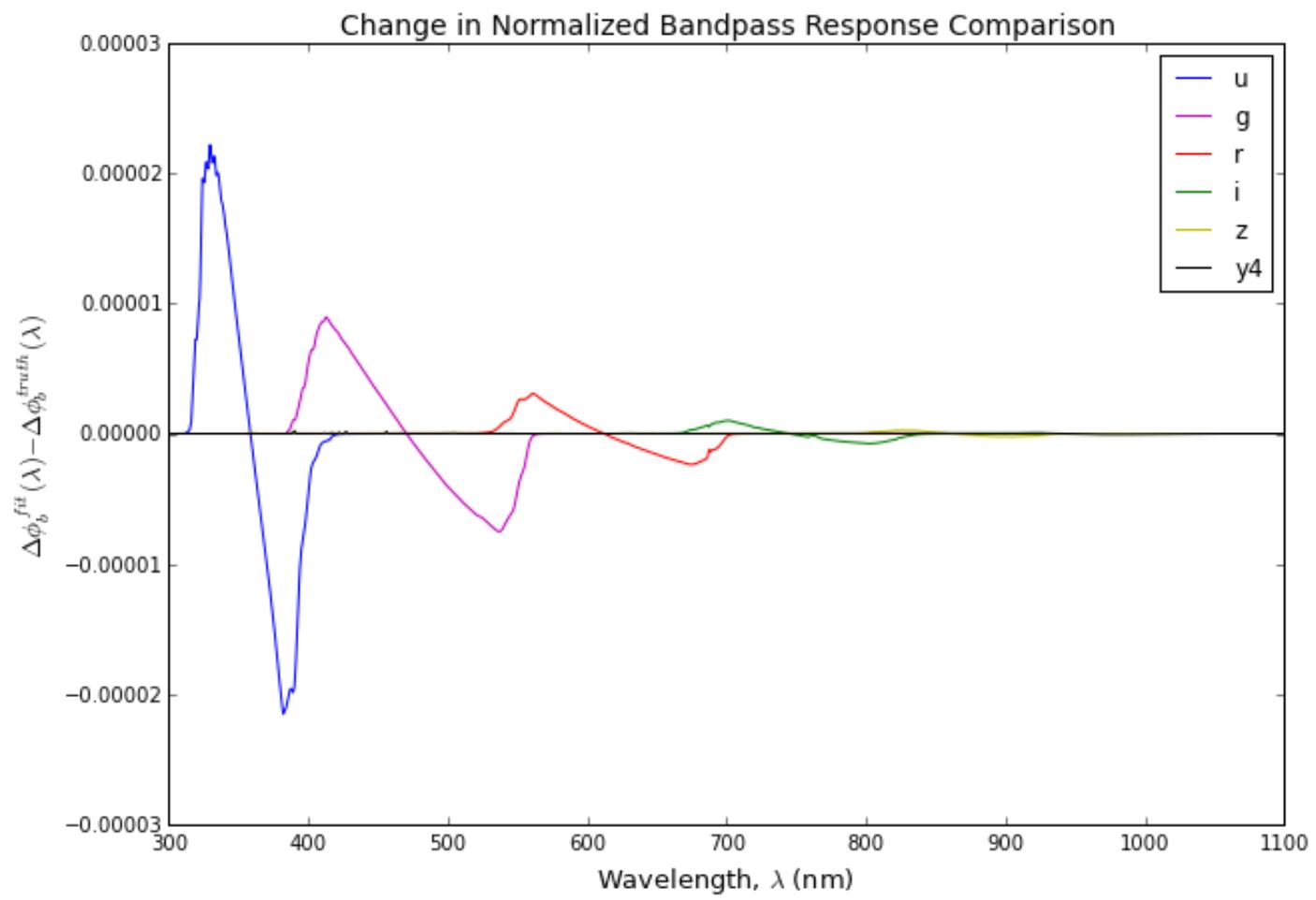
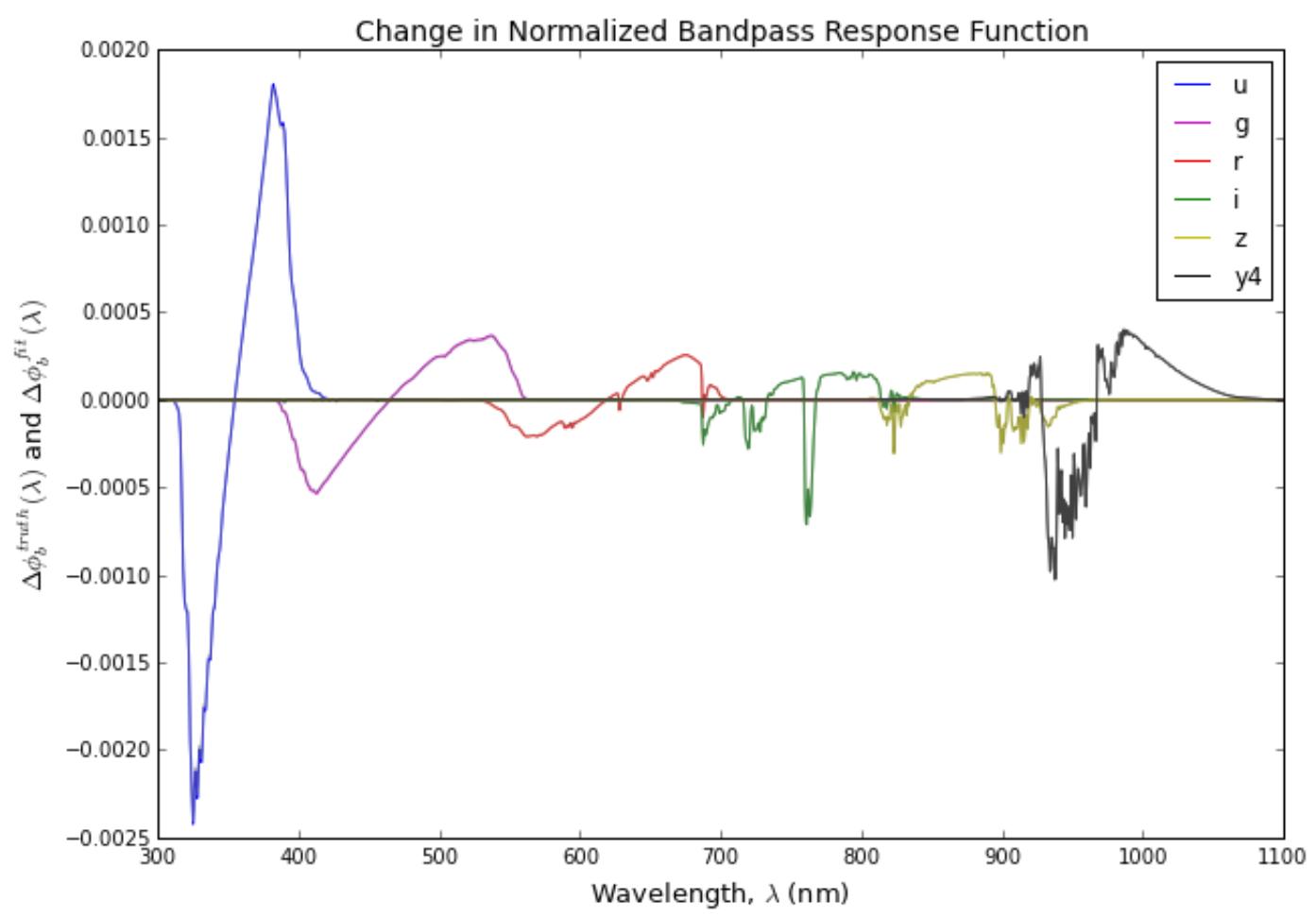
Calculating best fit parameters for i filter...  
@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_Alpha\_dG\_XSTD12\_DG120\_DG\_R-2020\_E5\_stars\_i\_51dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for i filter.  
Saved Chi-Squared at best fit deltaGrey for i filter.  
Completed i filter.

Calculating best fit parameters for z filter...  
@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_Alpha\_dG\_XSTD12\_DG120\_DG\_R-2020\_E5\_stars\_z\_51dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for z filter.  
Saved Chi-Squared at best fit deltaGrey for z filter.  
Completed z filter.

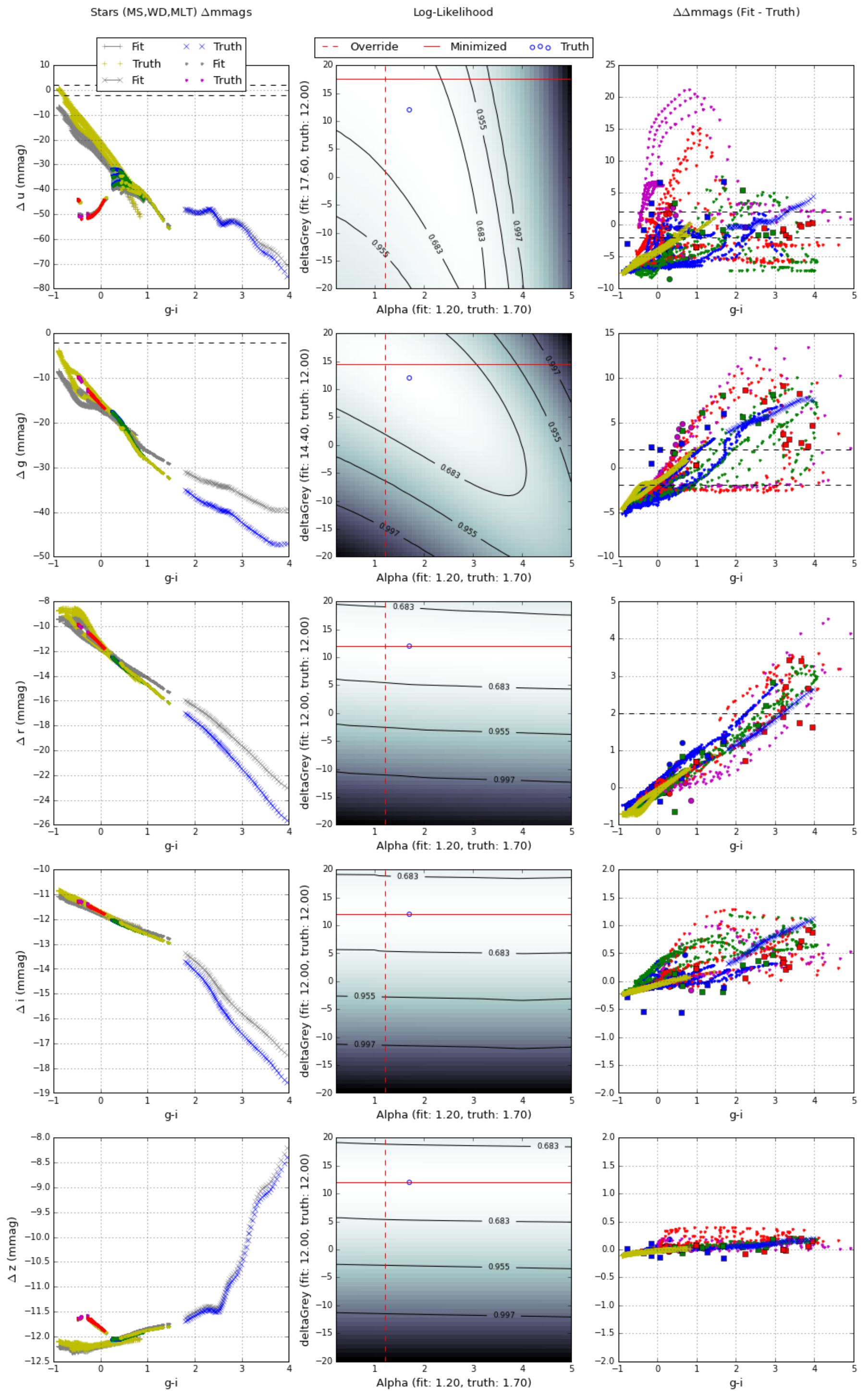
Calculating best fit parameters for y4 filter...  
@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_Alpha\_dG\_XSTD12\_DG120\_DG\_R-2020\_E5\_stars\_y4\_51dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for y4 filter.  
Saved Chi-Squared at best fit deltaGrey for y4 filter.  
Completed y4 filter.

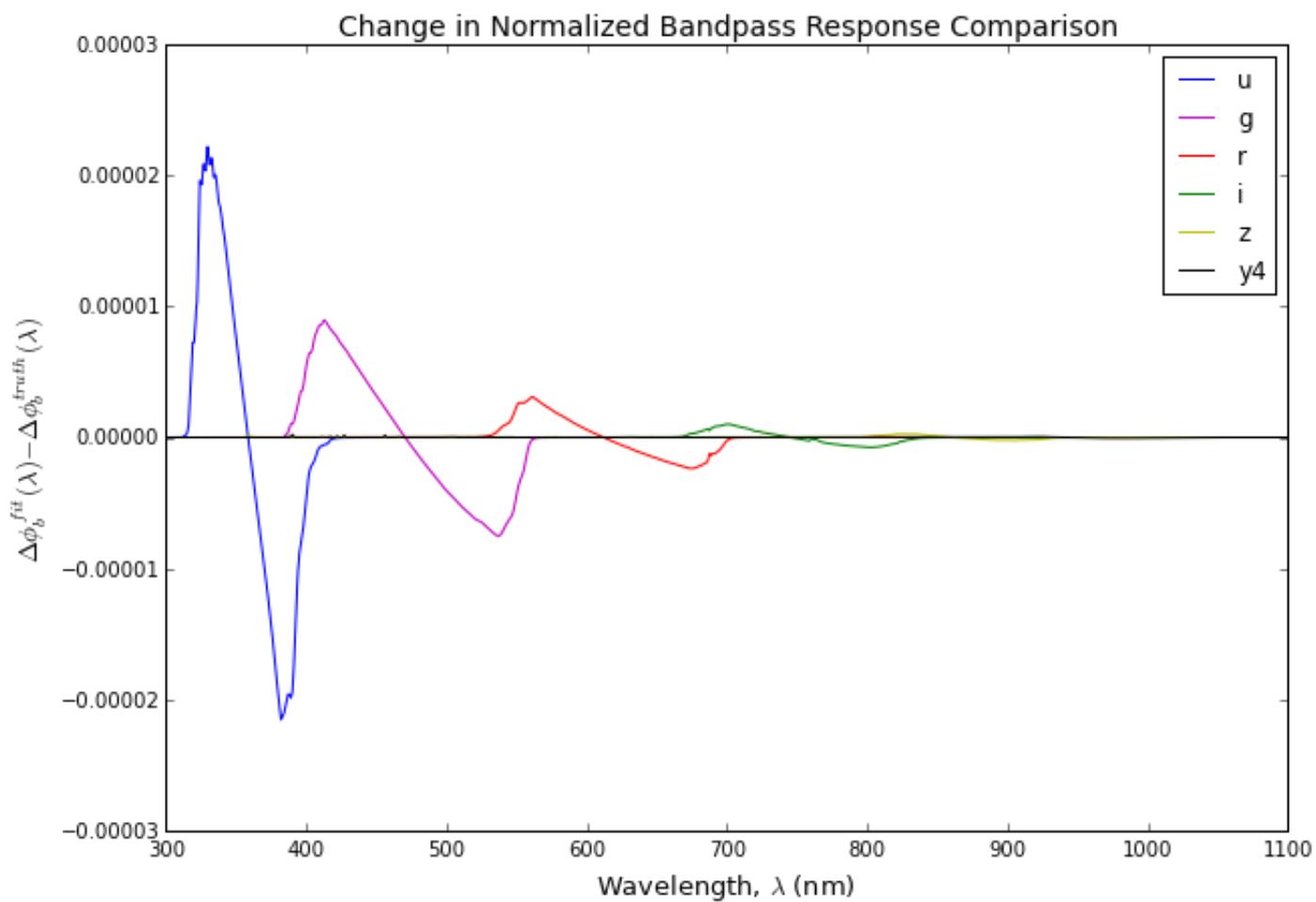
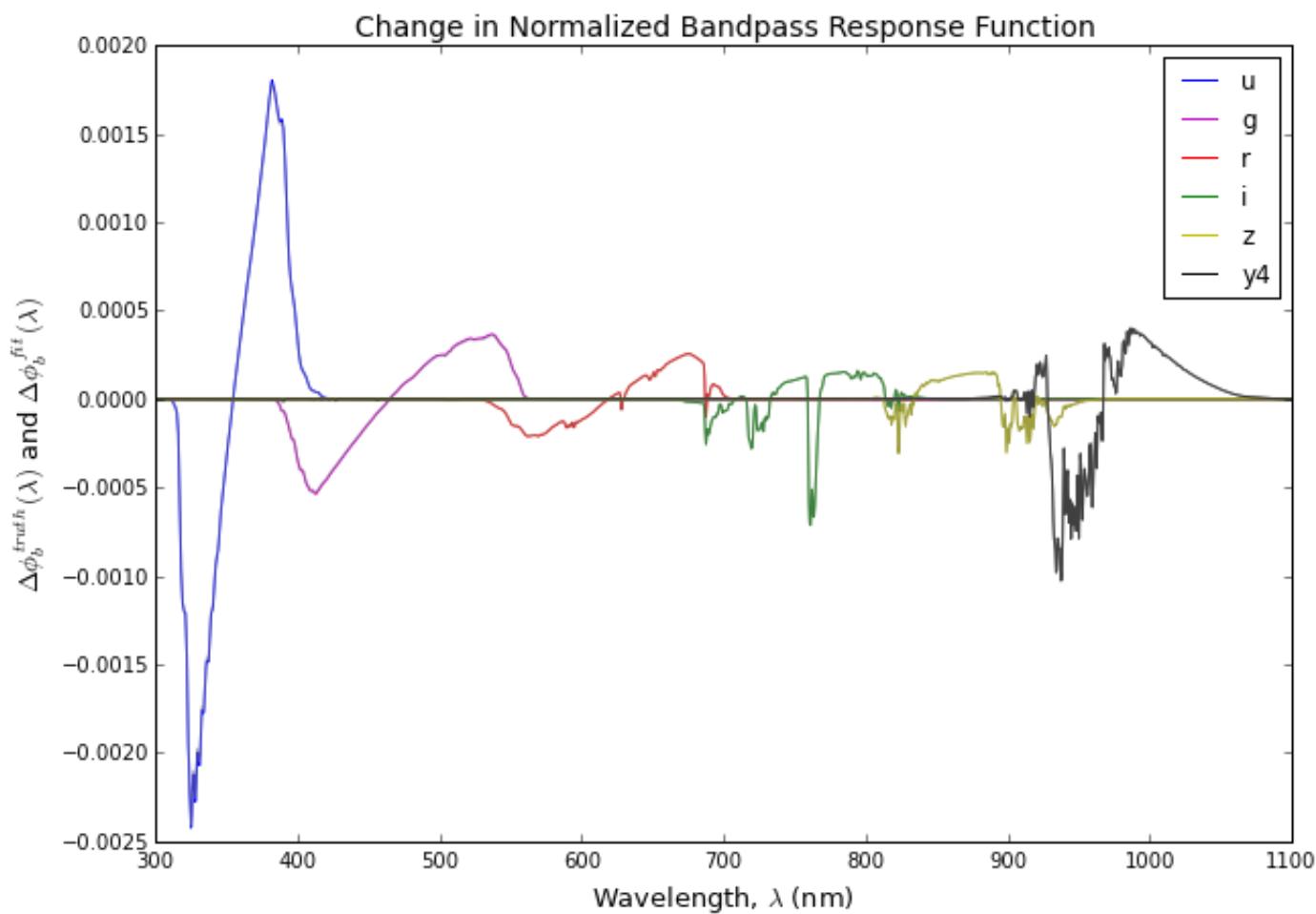
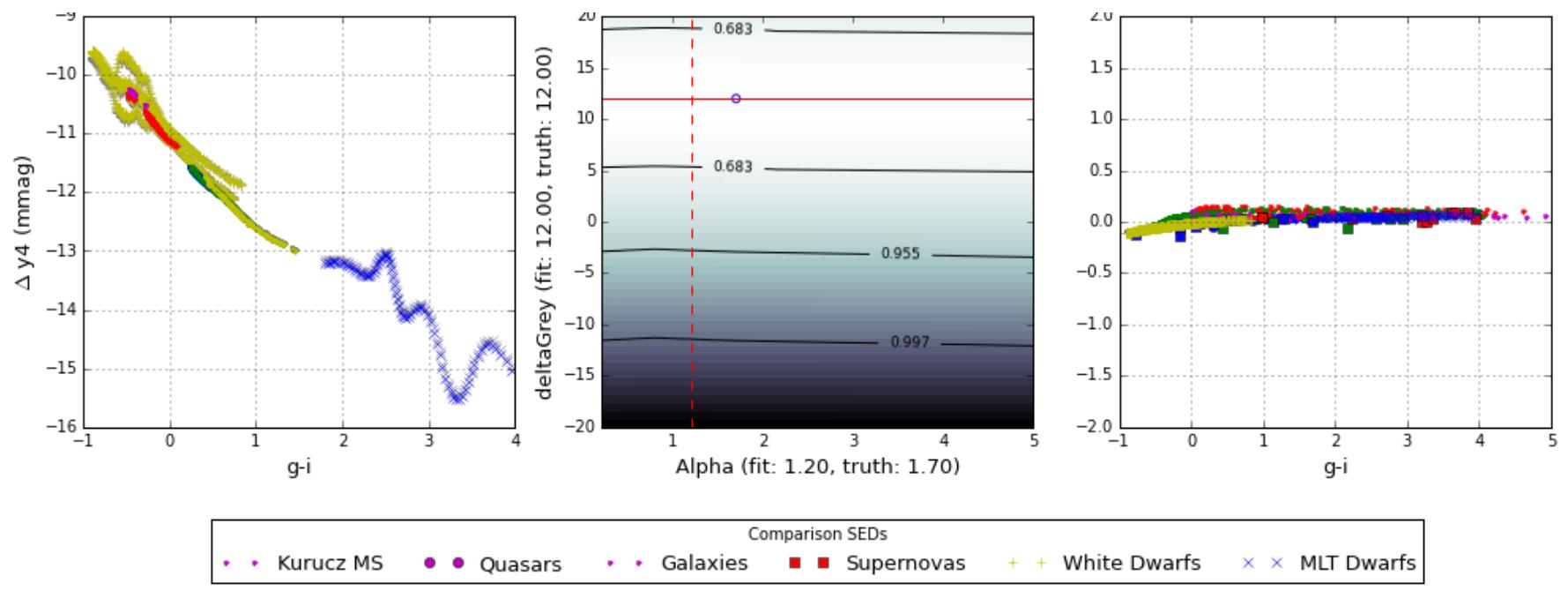
Best fit parameters (Filter, Alpha, dG, logL, Chi-Squared):  
u 1.67 12.00 21.6817972742 43.3635945485  
g 1.67 12.00 4.40048485 8.80096970001  
r 1.67 12.00 0.0812655412846 0.162531082569  
i 1.67 12.00 0.00410954851359 0.00821909702718  
z 1.67 12.00 0.000219774310557 0.000439548621114  
y4 1.67 12.00 0.000188679909952 0.000377359819905

Override best fit parameters (Filter, Alpha, dG):  
u 0.80 20.00  
g 0.80 16.00  
r 0.80 12.80  
i 0.80 12.00  
z 0.80 12.00  
y4 0.80 12.00

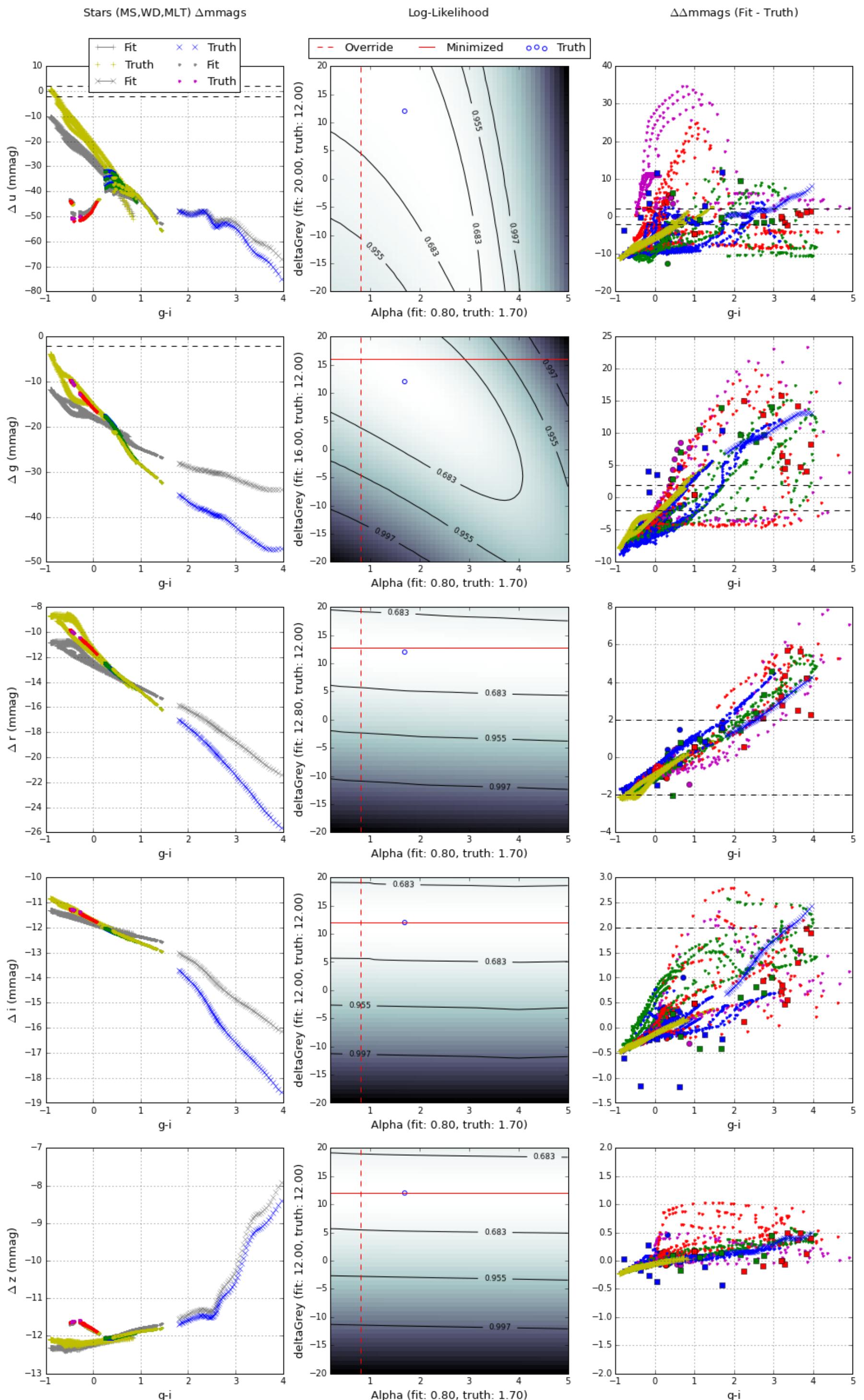


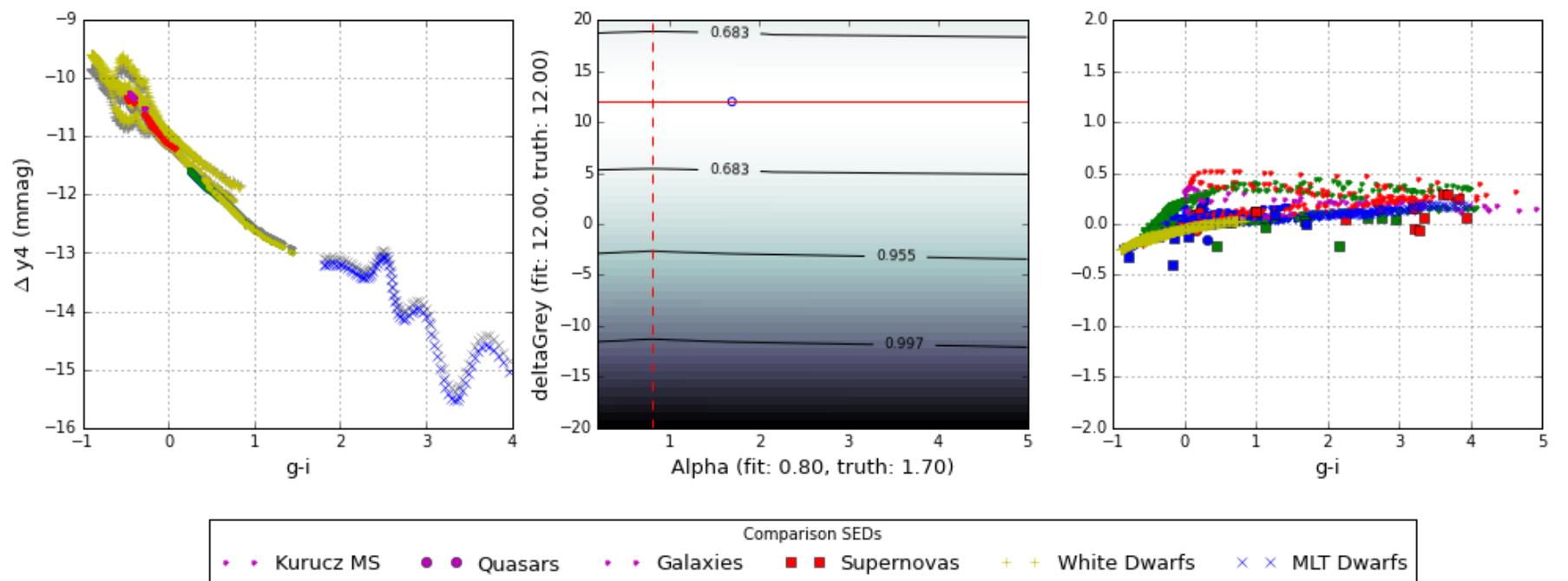
$\Delta\text{mmags}$ , Regression Contours,  $\Delta\Delta\text{mmags}$  for each LSST filter ( $\delta\text{Grey} = 12.0$ )





$\Delta\text{mmags}$ , Regression Contours,  $\Delta\Delta\text{mmags}$  for each LSST filter ( $\delta\text{Grey} = 12.0$ )





```
In [16]: deltaGreyLimitPlot('Alpha',deltaGreyBins=50)
```

```
Computing nonlinear regression for Alpha.
Observed atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]
Observed atmosphere airmass: 2.0
Standard atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]
Standard atmosphere airmass: 1.2
Observed atmosphere parameter for Alpha: 1.7

Fitting for Alpha between 0.20 and 5.00 in 50 bins.
Fitting for deltaGrey between -20.00 and 20.00 mmags in 50 bins.

Regression SEDs: 5778 Stars (MS,WD,MLT) SEDs.

Regressing 2500 parameter combinations per filter...
Magnitude Error: 5.0 mmags

Override triggered...
Override value detected, proceeding with deltaGrey best-fit minimization at new component best-fit value...

Calculating best fit parameters for u filter...
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Alpha_dG_XSTD12_DG120_DG_R-2020_E5_stars_u_50dgb_50b_max_dGTest_allMS_OR120.pkl'
Saved LogL at best fit deltaGrey for u filter.
Saved Chi-Squared at best fit deltaGrey for u filter.
Completed u filter.

Calculating best fit parameters for g filter...
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Alpha_dG_XSTD12_DG120_DG_R-2020_E5_stars_g_50dgb_50b_max_dGTest_allMS_OR120.pkl'
Saved LogL at best fit deltaGrey for g filter.
Saved Chi-Squared at best fit deltaGrey for g filter.
Completed g filter.

Calculating best fit parameters for r filter...
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Alpha_dG_XSTD12_DG120_DG_R-2020_E5_stars_r_50dgb_50b_max_dGTest_allMS_OR120.pkl'
Saved LogL at best fit deltaGrey for r filter.
Saved Chi-Squared at best fit deltaGrey for r filter.
Completed r filter.

Calculating best fit parameters for i filter...
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Alpha_dG_XSTD12_DG120_DG_R-2020_E5_stars_i_50dgb_50b_max_dGTest_allMS_OR120.pkl'
Saved LogL at best fit deltaGrey for i filter.
Saved Chi-Squared at best fit deltaGrey for i filter.
Completed i filter.

Calculating best fit parameters for z filter...
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Alpha_dG_XSTD12_DG120_DG_R-2020_E5_stars_z_50dgb_50b_max_dGTest_allMS_OR120.pkl'
Saved LogL at best fit deltaGrey for z filter.
Saved Chi-Squared at best fit deltaGrey for z filter.
Completed z filter.

Calculating best fit parameters for y4 filter...
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Alpha_dG_XSTD12_DG120_DG_R-2020_E5_stars_y4_50dgb_50b_max_dGTest_allMS_OR120.pkl'
Saved LogL at best fit deltaGrey for y4 filter.
Saved Chi-Squared at best fit deltaGrey for y4 filter.
Completed y4 filter.

Best fit parameters (Filter, Alpha, dG, logL, Chi-Squared):
u 1.67 12.65 12.5169696055 25.0339392111
g 1.77 11.84 11.8420556486 23.6841112971
r 1.77 11.84 2.34059828463 4.68119656925
i 5.00 11.84 2.24003953108 4.48007906217
z 5.00 11.84 2.04033773232 4.08067546464
y4 5.00 11.84 1.70095030726 3.40190061453

Override best fit parameters (Filter, Alpha, dG):
u 1.20 17.55
g 1.20 14.29
r 1.20 11.84
i 1.20 11.84
z 1.20 11.84
y4 1.20 11.84

Computing nonlinear regression for Alpha.
Observed atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]
Observed atmosphere airmass: 2.0
Standard atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]
Standard atmosphere airmass: 1.2
```

Observed atmosphere parameter for Alpha: 1.7

Fitting for Alpha between 0.20 and 5.00 in 50 bins.  
Fitting for deltaGrey between -20.00 and 20.00 mmags in 50 bins.

Regression SEDs: 5778 Stars (MS,WD,MLT) SEDs.

Regressing 2500 parameter combinations per filter...  
Magnitude Error: 5.0 mmags

Override triggered...  
Override value detected, proceeding with deltaGrey best-fit minimization at new component best-fit value...

Calculating best fit parameters for u filter...  
@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_Alpha\_dG\_XSTD12\_DG120\_DG\_R-2020\_E5\_stars\_u\_50dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for u filter.  
Saved Chi-Squared at best fit deltaGrey for u filter.  
Completed u filter.

Calculating best fit parameters for g filter...  
@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_Alpha\_dG\_XSTD12\_DG120\_DG\_R-2020\_E5\_stars\_g\_50dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for g filter.  
Saved Chi-Squared at best fit deltaGrey for g filter.  
Completed g filter.

Calculating best fit parameters for r filter...  
@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_Alpha\_dG\_XSTD12\_DG120\_DG\_R-2020\_E5\_stars\_r\_50dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for r filter.  
Saved Chi-Squared at best fit deltaGrey for r filter.  
Completed r filter.

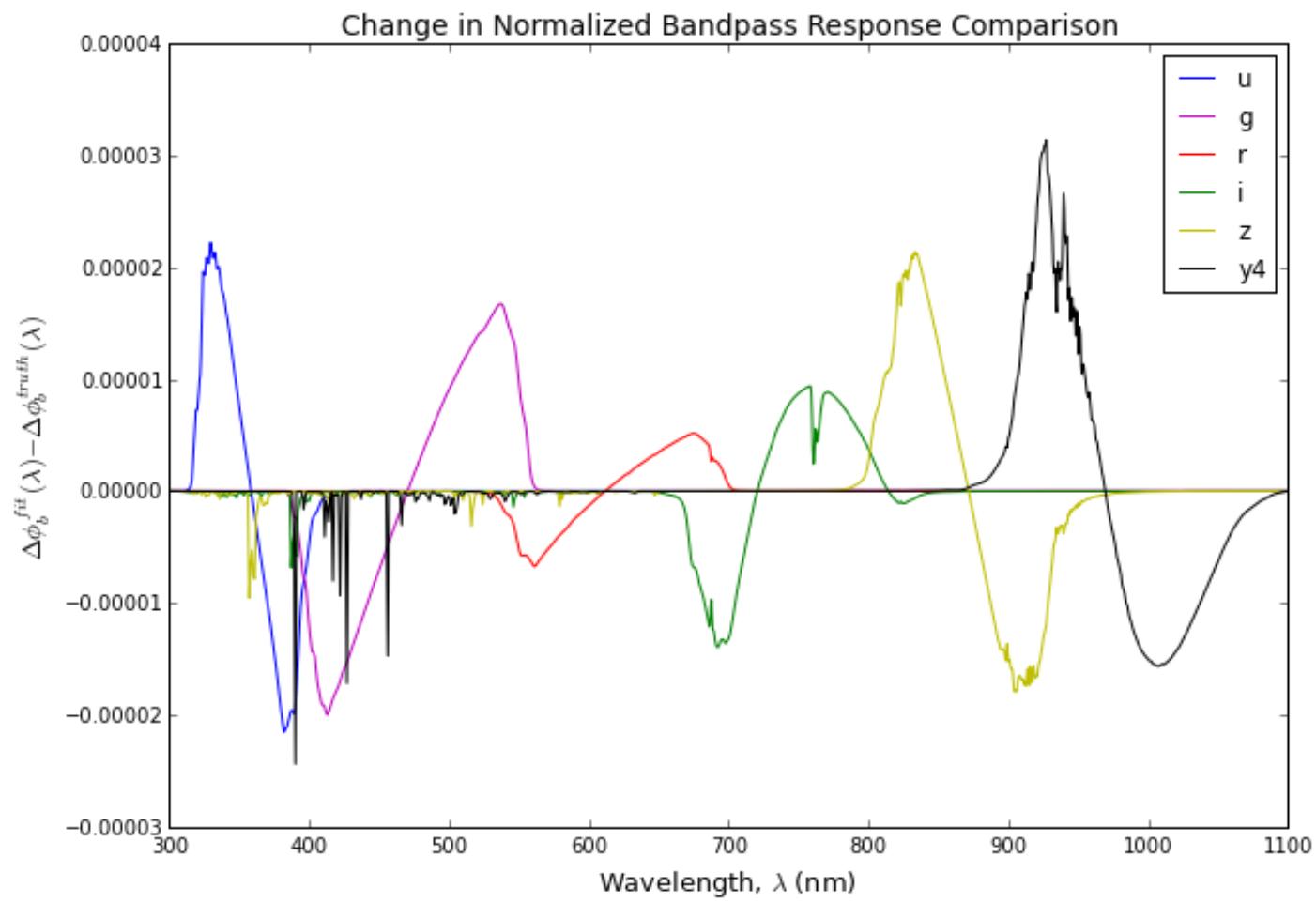
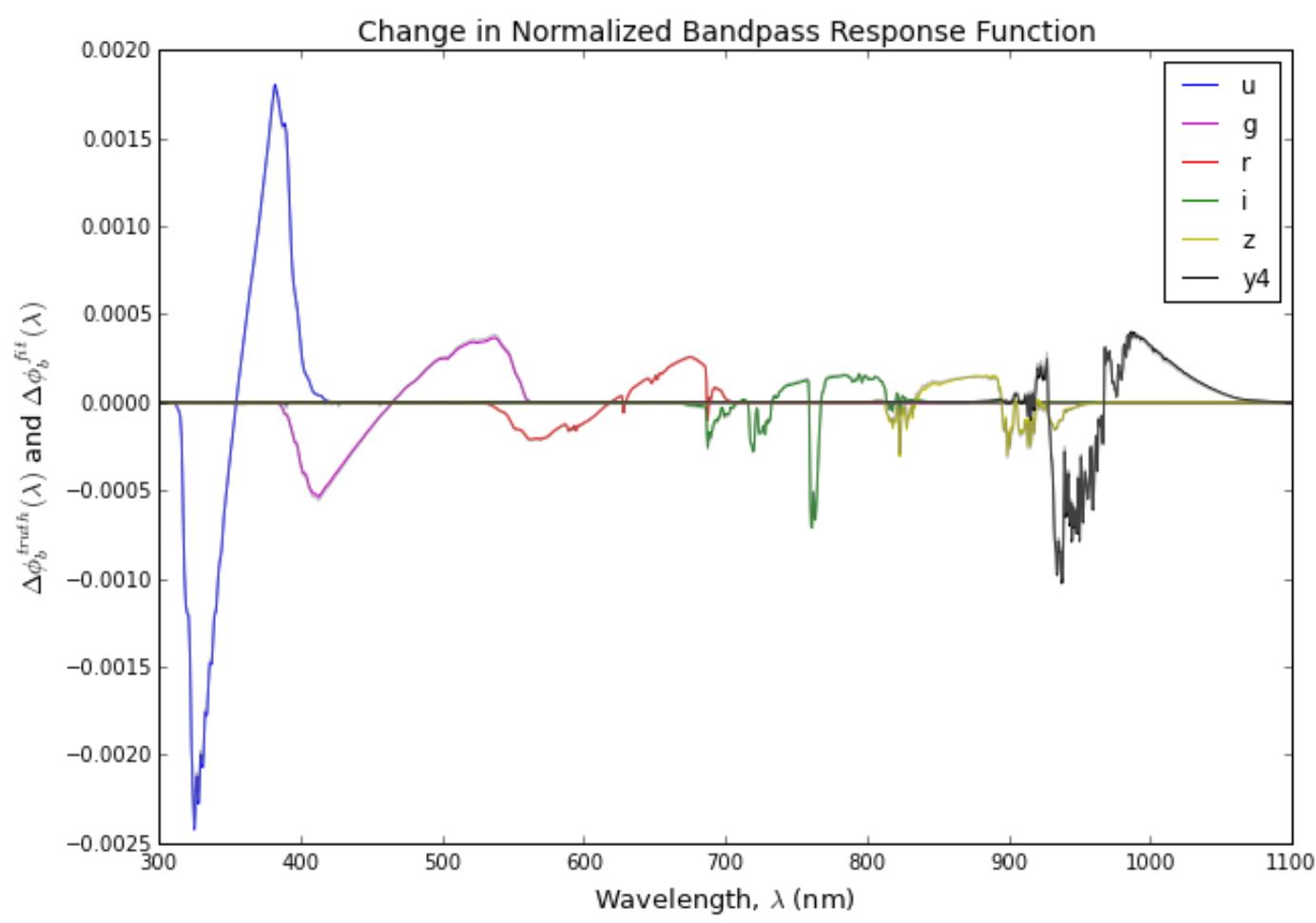
Calculating best fit parameters for i filter...  
@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_Alpha\_dG\_XSTD12\_DG120\_DG\_R-2020\_E5\_stars\_i\_50dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for i filter.  
Saved Chi-Squared at best fit deltaGrey for i filter.  
Completed i filter.

Calculating best fit parameters for z filter...  
@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_Alpha\_dG\_XSTD12\_DG120\_DG\_R-2020\_E5\_stars\_z\_50dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for z filter.  
Saved Chi-Squared at best fit deltaGrey for z filter.  
Completed z filter.

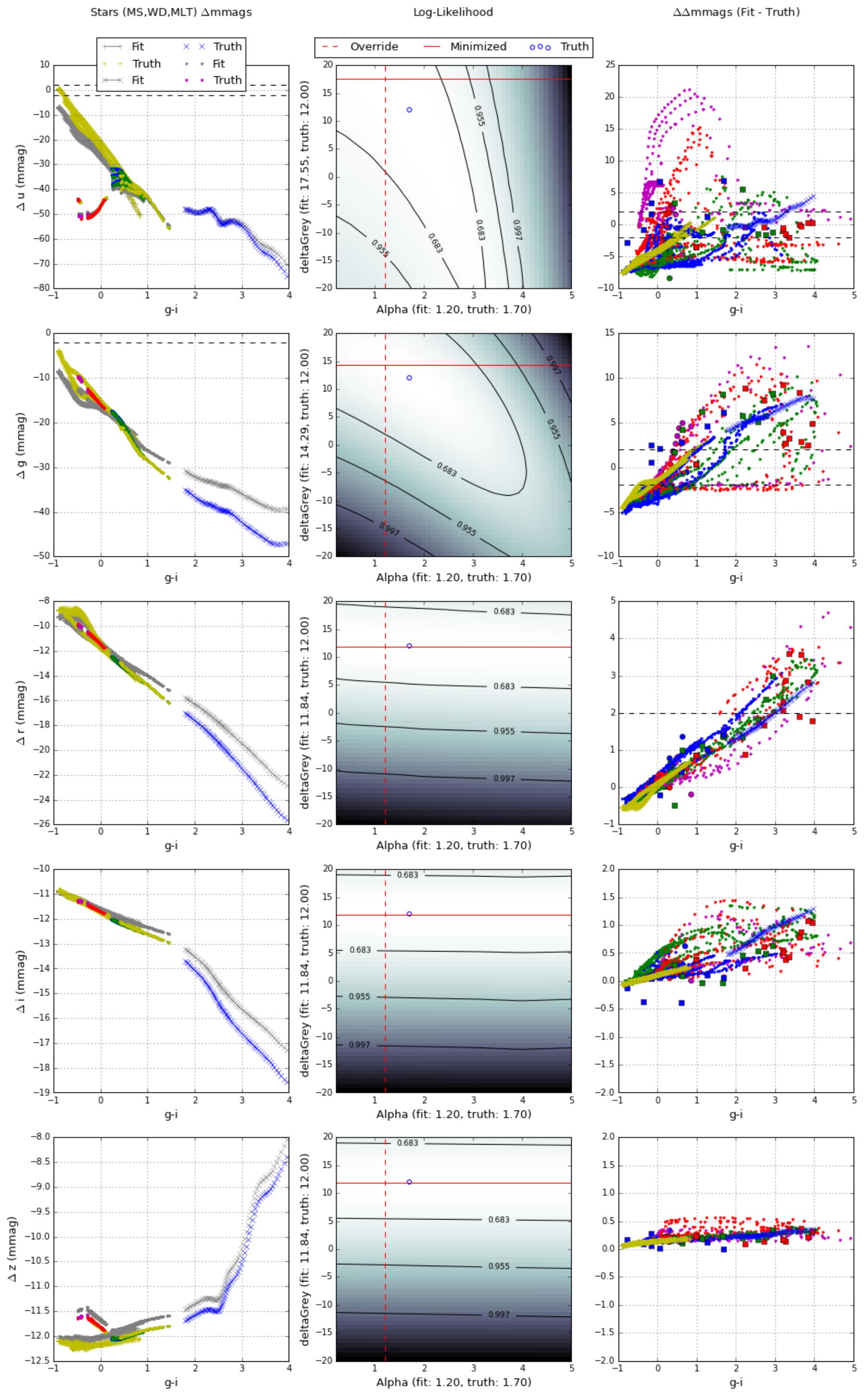
Calculating best fit parameters for y4 filter...  
@pickle\_results: computing results and saving to 'pickles/X20\_P101010101017\_Alpha\_dG\_XSTD12\_DG120\_DG\_R-2020\_E5\_stars\_y4\_50dgb\_50b\_min\_dGTest\_allMS\_OR80.pkl'  
Saved LogL at best fit deltaGrey for y4 filter.  
Saved Chi-Squared at best fit deltaGrey for y4 filter.  
Completed y4 filter.

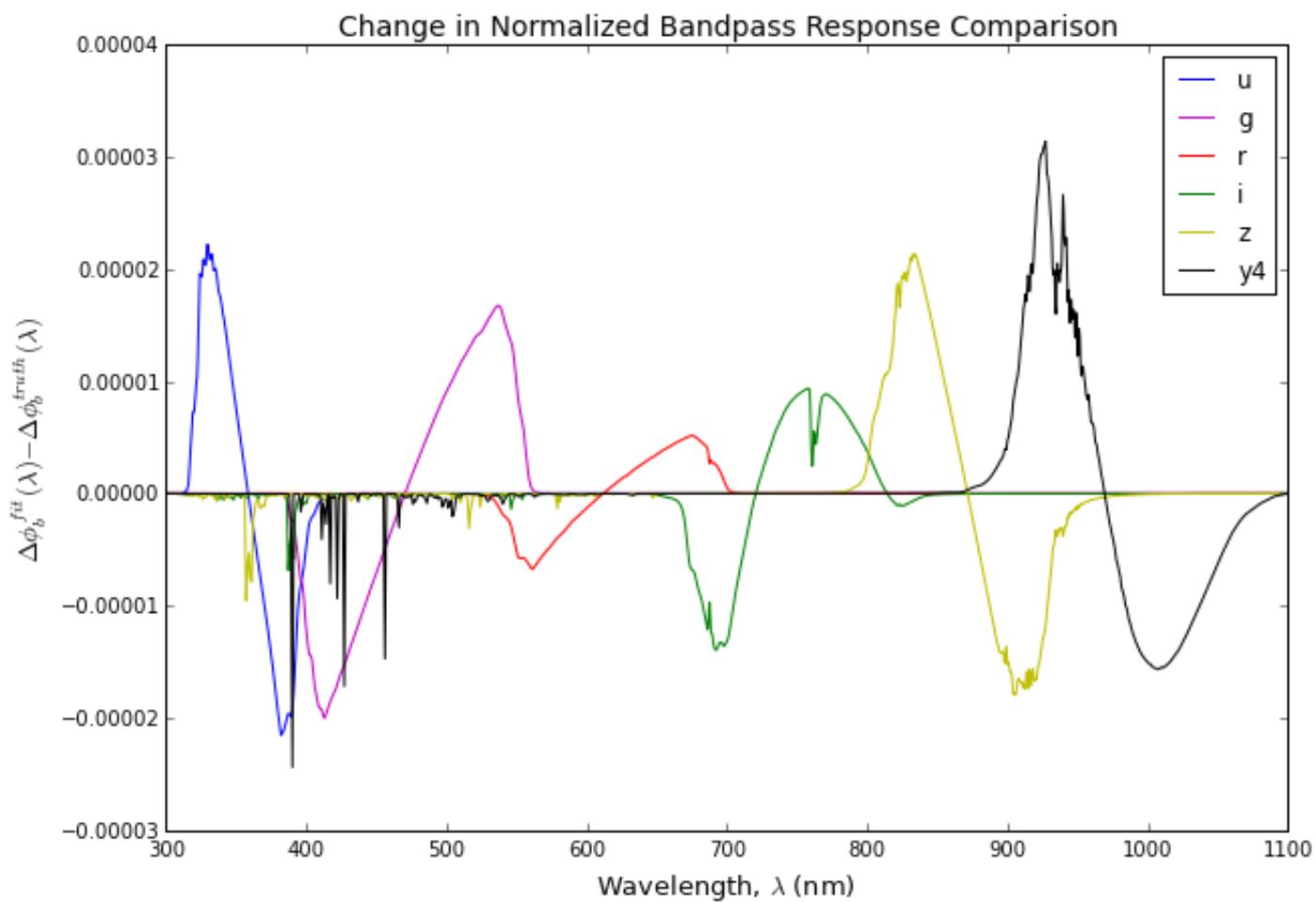
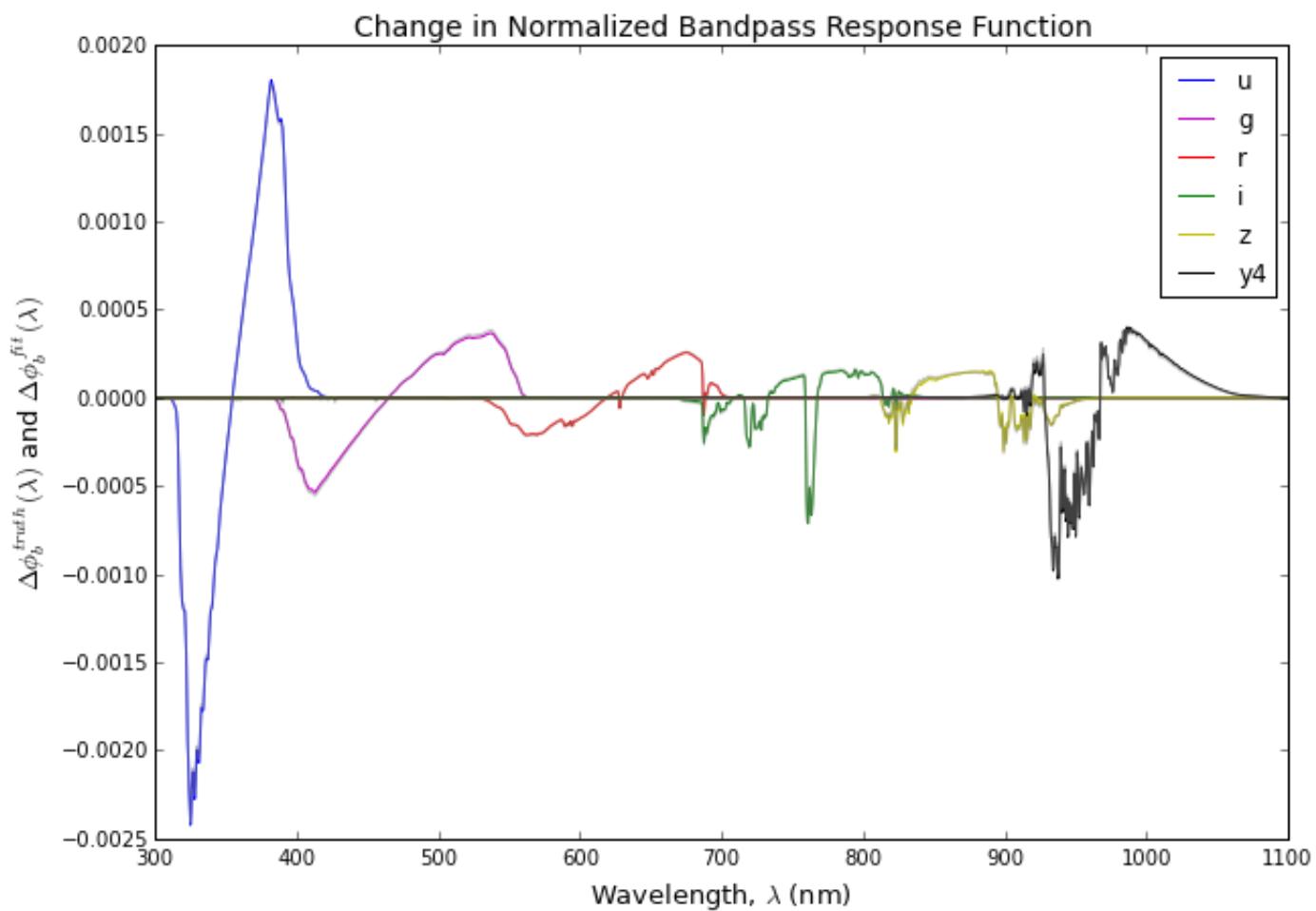
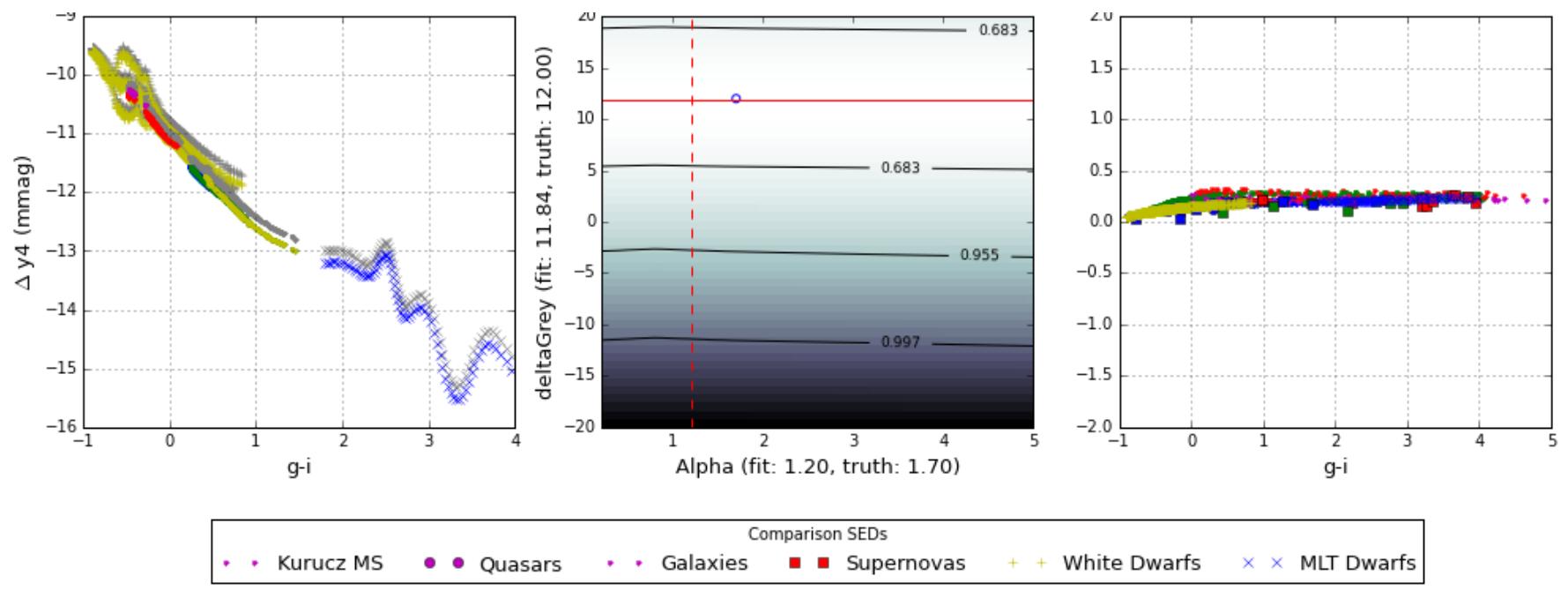
Best fit parameters (Filter, Alpha, dG, logL, Chi-Squared):  
u 1.67 12.65 12.5169696055 25.0339392111  
g 1.77 11.84 11.8420556486 23.6841112971  
r 1.77 11.84 2.34059828463 4.68119656925  
i 5.00 11.84 2.24003953108 4.48007906217  
z 5.00 11.84 2.04033773232 4.08067546464  
y4 5.00 11.84 1.70095030726 3.40190061453

Override best fit parameters (Filter, Alpha, dG):  
u 0.80 20.00  
g 0.80 15.92  
r 0.80 12.65  
i 0.80 11.84  
z 0.80 11.84  
y4 0.80 11.84

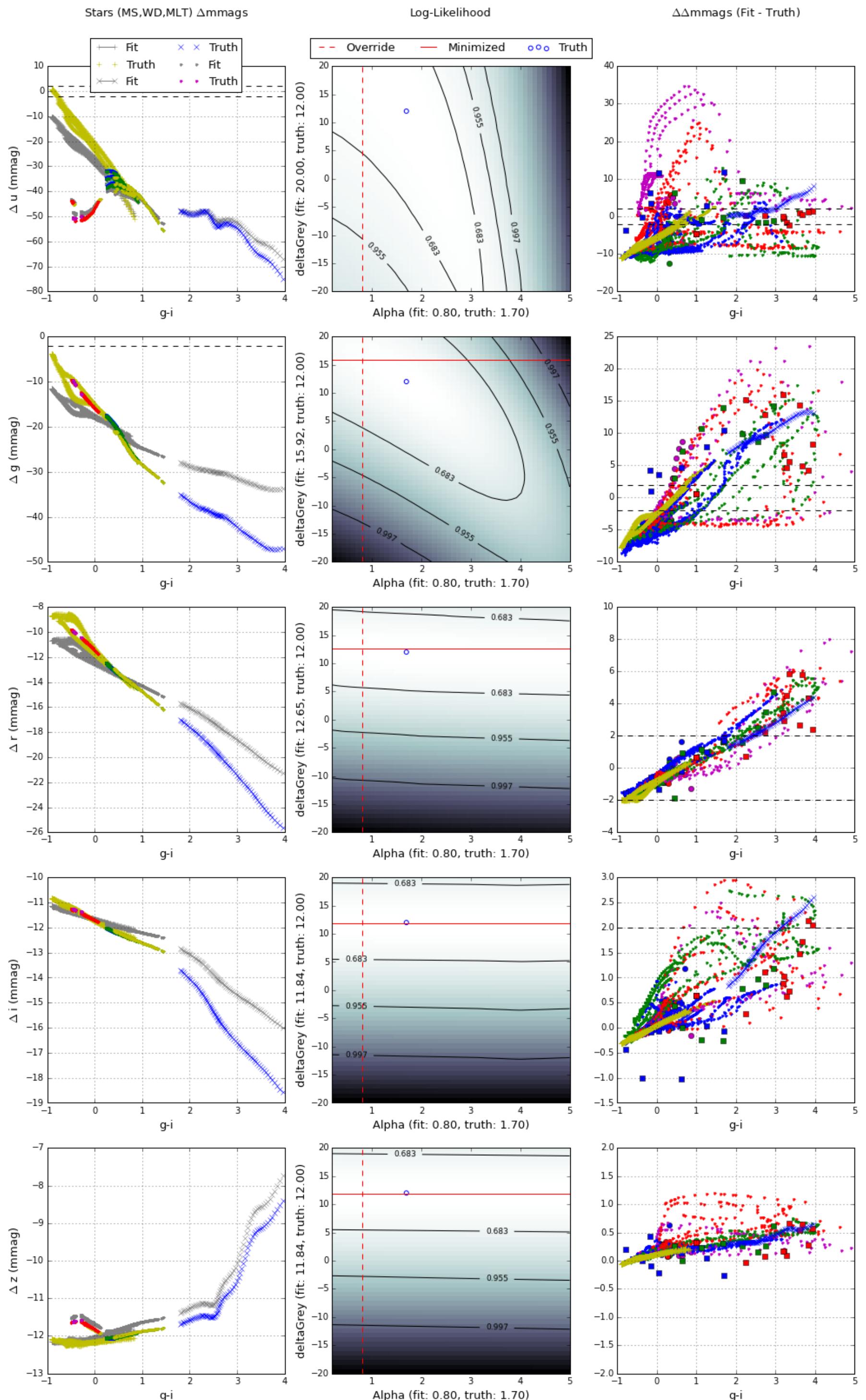


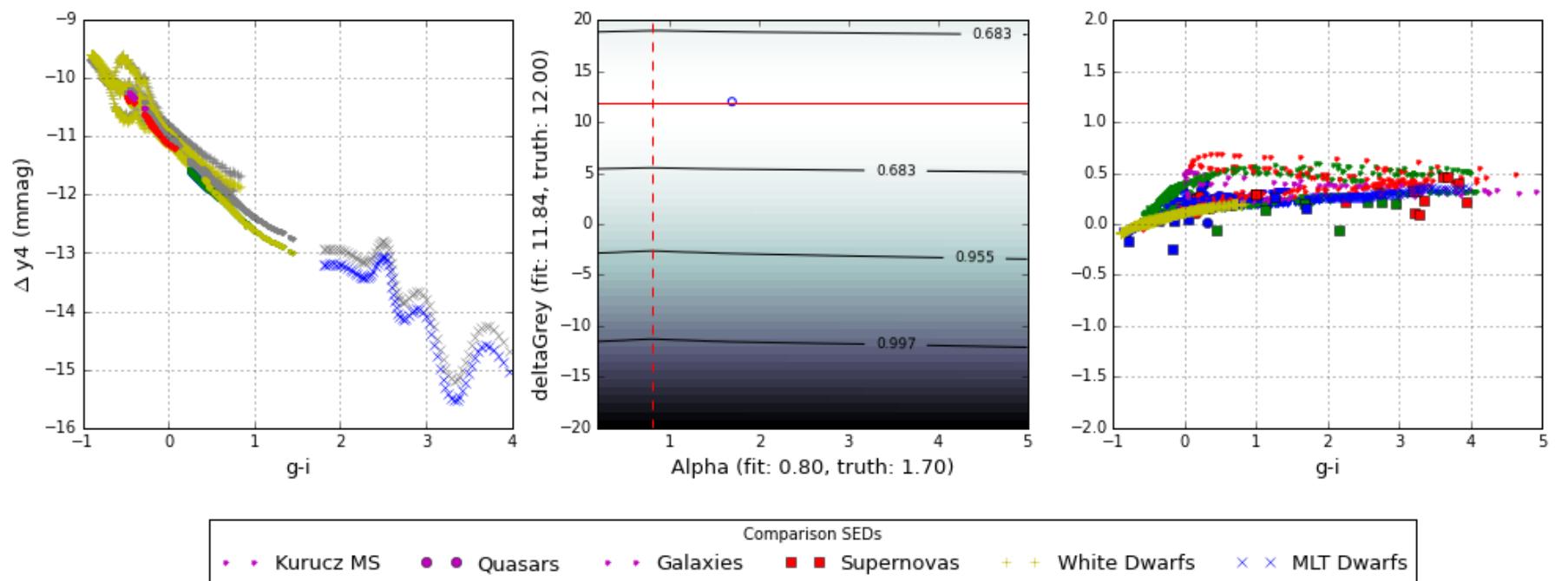
$\Delta\text{mmags}$ , Regression Contours,  $\Delta\Delta\text{mmags}$  for each LSST filter ( $\delta\text{Grey} = 12.0$ )





$\Delta$ mags, Regression Contours,  $\Delta\Delta$ mags for each LSST filter ( $\delta$ Grey: 12.0)





In [ ]: